Fishery Data Series No. 14-02

Size Composition and Yield Potential of Lake Trout in Lake Louise, 2006

by

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and

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January 2014

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

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
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
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
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
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	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
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.
minute (angular)	'
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
variance	
population	Var
sample	var

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January 2014

Development and publication of this manuscript were partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-22 Job No. R-3-3(a)

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This document should be cited as:
Joy, P., B. Scanlon, and B. Taras. 2014. Size composition and yield potential of lake trout in Lake Louise, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 14-02, Anchorage.

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ABSTRACT

In 2006 weight and length data were collected from lake trout *Salvelinus namaycush* in Lake Louise in order to estimate the yield potential (YP) using a model based on lake surface area. Lake trout were captured on their spawning grounds in Lake Louise between September 12 and September 21, measured for both total length (TL) and fork length (FL), and a proportion of those sampled were weighed to the nearest gram. Based on an average weight of 3.48 kg for lake trout over 600 mm TL, and a YP estimate of 2,219 kg/yr, the estimated number of lake trout ≥600 mm TL that can be harvested annually (YP_{number}) is 638 lake trout/yr. This number was above the three-year average (2003–2005) of lake trout harvested (511 lake trout/yr), but when an assumed hooking mortality rate of 3.9% of the estimated three-year average catch rates (3,233 lake trout/yr) was added to the harvest, the overall fishing mortality was approximately equal to YP_{number}. The estimate of YP_{number} is thought to be conservative (smaller than the true yield potential) because (1) it was derived from weights of spawners whose condition at a given length is greater than at other times of the year, and (2) there is likely movement of lake trout to and from the nearby and connected Susitna and Tyone lakes. It is recommended that further research be conducted to determine the degree of exchange among the lakes, the relative abundances of lake trout in the lakes, and the yield potential of Susitna Lake. The implications of lake specific FL to TL ratios, and their impact on calculating yield potential, are also discussed.

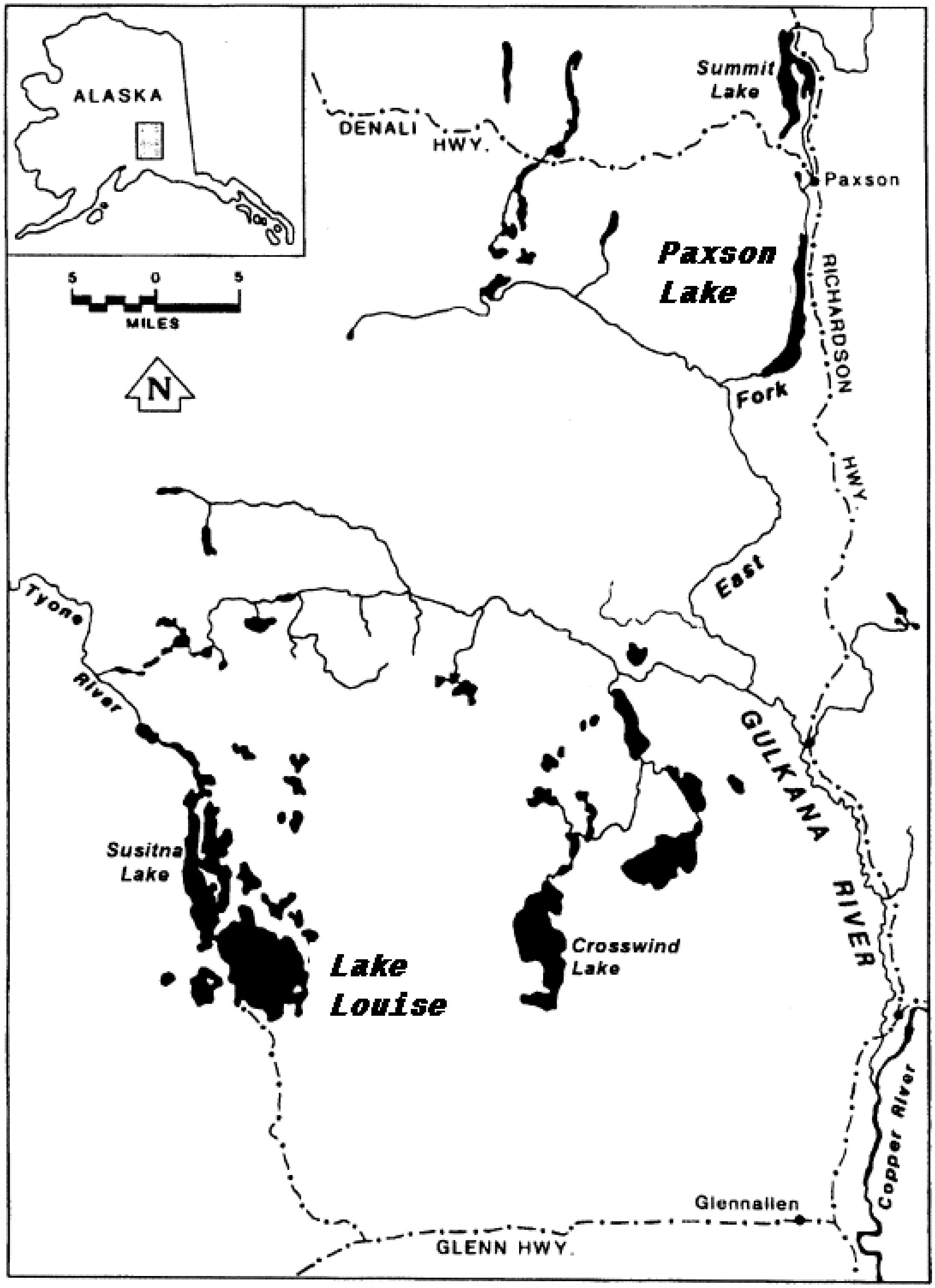
Key words: Lake trout, *Salvelinus namaycush*, length weight, fork length, total length, lake area model, Lake Louise, yield potential.

INTRODUCTION

Lake trout *Salvelinus namaycush* support important recreational fisheries in Alaska on both roadside and remote lake systems. Lake trout are characterized as having slow growth rates, low fecundity, and strict habitat requirements (cold, deep, oligotrophic lakes with a sufficient prey base and few competitors; Martin and Olver 1980) which make them susceptible to over-exploitation when not managed properly. Sport fishing for lake trout is popular throughout the year, with some of the best fishing occurring in winter. From 1990 to 2004, the average annual sport catch of lake trout in Alaska was 37,698 fish, and the average annual harvest was 9,226 (Mills 1991–1994; Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a-b, 2007; Walker et al. 2003; Table 1).

Lake Louise is a large, road accessible lake in the Copper Basin that is popular for its lake trout fishery (Figure 1). Since 1990, harvests of lake trout in Lake Louise have comprised 4%–13% of statewide annual lake trout harvests (averaging 8% annually), making it the largest single lake trout fishery in the state (Mills 1991–1994; Howe et al. 1995, 1996, 2001 a-d; Jennings et al. 2004, 2006a-b, 2007; Walker et al. 2003). After sport fish regulations restricted harvest by increasing the minimum size limit in 1994, annual harvests of lake trout in Lake Louise dropped off markedly (Table 1). In 2006, the daily bag and possession limit for lake trout in Lake Louise was one fish per day which must be greater than 24 inches, and one fish in possession.

Previous studies conducted on lake trout in Lake Louise have included estimating abundance of mature lake trout on known spawning grounds; estimating abundance of all mature fish using a creel survey as a second sampling event; and estimating yield potential using a surplus production model based upon available thermal habitat volume (Szarzi 1992, 1993; Szarzi and Bernard 1994). Estimates of abundance of males on known spawning grounds in Lake Louise from 1992–1994 ranged from 1,438 fish (SE = 77) in 1992 to 2,004 fish (SE = 94) in 1993.



Redrawn from Szarzi and Bernard (1997)

Figure 1.–Lake Louise study location.

Table 1.–Estimated number of lake trout harvested, lake trout caught, and lake trout harvested per catch in Alaska compared to harvest and catch of lake trout in Lake Louise, 1990–2006.

	Statewide			Lake Louise	
Year	Catch	Harvest	Harvest/Catch	Catch	Harvest
1990	42,443	12,602	0.30	2,971	1,036
1991	35,670	13,772	0.39	2,131	1,332
1992	43,295	12,525	0.29	3,108	1,033
1993	53,578	13,094	0.24	6,979	1,316
1994	45,107	11,374	0.25	5,087	1,463
1995	28,262	8,412	0.30	2,798	946
1996	33,242	9,086	0.28	3,021	662
1997	30,701	7,486	0.24	2,897	585
1998	22,807	5,985	0.26	2,516	625
1999	45,910	9,948	0.22	4,753	430
2000	32,176	6,292	0.20	3,103	563
2001	26,040	4,995	0.19	1,495	259
2002	43,218	7,109	0.16	2,985	458
2003	37,434	7,084	0.19	3,145	393
2004	44,051	7,934	0.18	3,985	770
2005	40,714	7,312	0.18	2,570	370
2006	19,239	3,103	0.16	1,468	200
Average 1990–1994	44,019	12,673	0.29	4,055	1,236
Average 1995–2004	34,384	7,502	0.22	3,070	569

Because lake trout inhabit deep water and typically occur in low densities, stock assessment research is difficult and costly, and may result in biased and relatively imprecise estimates, particularly in large or remote lakes. In lieu of stock assessments, researchers and managers increasingly rely on models to estimate yield potential (YP) of lake trout based upon environmental variables.

To maintain harvest below maximum sustainable yield (MSY), the Alaska Board of Fisheries (BOF) in 2006 adopted the *Wild Lake Trout Management Plan* for Upper Copper-Upper Susitna area lakes including Lake Louise (5AAC 52.060). In this plan, a lake area (LA) model (Evans et al. 1991) is used to determine YP for lakes containing lake trout, and regulatory steps to be taken when reported harvests near or exceed YP (Burr 2006).

The current LA model YP estimate for lake trout in Lake Louise is 2,219 kg/yr or 540 fish/yr (Burr 2006) and is based on weights collected from lake trout sampled from a creel survey conducted in the years 1991–1993. At that time the average weight of lake trout ≥ 24 in total length in Lake Louise was 4.1 kg (Burr 2006). Harvests have exceeded the YP estimate in 6 of the 10 years from 1995 to 2004, most recently in 2004 (Table 1). Because of the importance of this fishery and the lack of recent stock information, updated weight-length measurements were needed to reassess YP for Lake Louise.

This study was undertaken to estimate the mean weight for lake trout ≥600 mm TL (i.e., those vulnerable to harvest) in Lake Louise in order to update the YP estimate and compare this value with current harvest levels.

OBJECTIVES

The research objectives for this experiment were to:

1. Estimate the mean weight of lake trout ≥600 mm TL (i.e., those vulnerable to harvest) in Lake Louise such that the estimated threshold number of lake trout that could be harvested each year (i.e., YP_{number}) was within 15% of the true value 95% of the time; and,
2. Estimate the proportion of lake trout ≥600 mm TL on the known spawning grounds of Lake Louise such that the estimate was within five percentage points of the true proportion 95% of the time.

In addition, project tasks were to:

1. Weigh 10 fish of each sex in each of three 50 mm length categories from 450 to 600 mm;
2. Describe the length composition of the lake trout captured and the weight composition of those weighed; and,
3. Affix a uniquely-numbered Floy®[1] tag to all captured lake trout, and give all a left pectoral fin clip for future identification.

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[1] Product names are included in this report for scientific completeness, but do not constitute a product endorsement.

Task 1 was conducted primarily for data archival purposes. If in the future a proposal is submitted to the BOF to remove the regulation that establishes a minimum length limit in Lake Louise for lake trout, then the data collected from this task can be used to calculate a new YP_{number} without having to conduct additional sampling.

METHODS

DESCRIPTION OF STUDY AREA

Lake Louise (62˚19' N, 146˚32' W) is part of a complex of lakes including Louise, Susitna, and Tyone, which together form the headwaters for the Susitna River (Figure 1). Lake Louise is 6,519 ha with a maximum depth of 51 m and an elevation of 720 m (Szarzi 1992). The lake is accessible from the Glenn Highway via a 32 km gravel road. Numerous cabins, four lodges and a state-maintained boat launch are located on the lake. In addition to lake trout, other species found in Lake Louise include Arctic grayling *Thymallus arcticus*, humpback whitefish *Coregonus clupeaformis*, Alaska whitefish *Coregonus nelsonii*, longnose suckers *Catostomus catostomus*, and burbot *Lota lota*.

Sampling Design and Fish Capture

This experiment was designed to estimate the mean weight of lake trout ≥600 mm (24 inches) TL in order to determine the threshold number of lake trout that can be harvested in a year (YP_{number}). In previous studies, mean weights of lake trout were obtained by conducting creel surveys and by sampling the harvested lake trout (Szarzi and Bernard 1997). Because of the high cost of conducting a creel survey, this project used the weights of spawning lake trout ≥ 600 mm TL, which could be sampled at relatively low cost, as a surrogate for the weights of harvested fish.

Implicit in this design was the assumption that the lake trout sampled on the spawning grounds that were ≥ 600 mm TL were representative of the population of fish that were harvested by anglers; and the average weight of lake trout sampled on the spawning grounds was equal to that harvested by anglers. It was recognized that spawning fish (especially females) would likely weigh more than the same fish at other times of the year, thus leading to an estimate of YP_{number} which was conservative from a surplus production perspective (i.e., estimated YP_{number} < true YP_{number}).

In the fall, mature lake trout congregate on rocky shoals to spawn, generally over cobble that is 3-15 mm in diameter (Healy 1978; Martin and Olver 1980; Burr 1988). ADF&G researchers have previously identified fifteen spawning locations on Lake Louise (Figure 2), and have sampled adequate numbers of spawning fish to estimate abundance of lake trout on these spawning locations (Szarzi 1992, 1993; Szarzi and Bernard 1994, 1995). Lake trout could readily be captured using beach seines and gill nets during this time.

Spawning occurs in two general areas in the lake with one area comprised of seven spawning locations and the other area comprised of six locations (Clusters A and B), with two other smaller spawning sites found farther north (Figure 2). Lake trout in Lake Louise have demonstrated a high degree of fidelity to spawning sites. In 1991, 159 of 168 males (95%) and 18 of 19 females (95%) recaptured in 1992 were marked on the same spawning site in 1990 (Szarzi 1992).

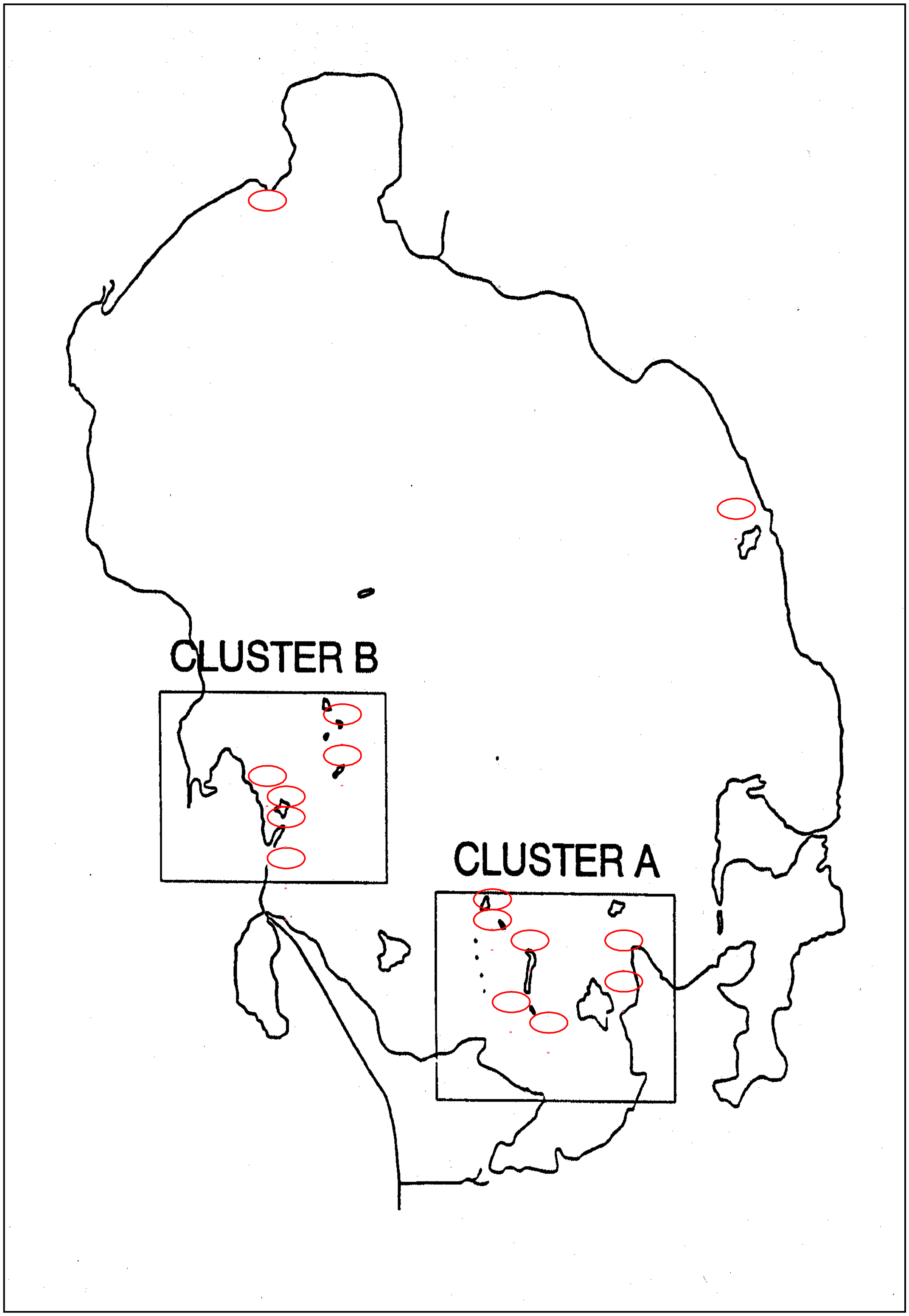

Figure 2.–Lake Louise lake trout spawning clusters and specific spawning areas within each cluster.

Effort was dispersed as evenly as possible among known spawning areas and by sampling as many spawning locations as conditions allowed. Crews spent at least three nights in both clusters and attempted to sample both of the spawning sites north of the clusters at least three times. Spawning grounds were sampled in a geographically ordered sequence during the spawning period between September 12 and September 21, 2006. The largest spawning areas were targeted first with sampling proceeding to smaller spawning areas when fish were present.

SAMPLE SIZES

Using the data from the creel survey and from sampling the spawning grounds from 1991–1995 (Szarzi 1992, 1993; Szarzi and Bernard 1994, 1995, and 1997), it was estimated that 29 females ≥600 mm TL would be necessary to meet the precision criteria for Objective 1. Limited weight data for lake trout ≥600 mm TL were available to estimate the mean weight (and its variance) of the population of lake trout susceptible to harvest. Specifically 17, 13, and 8 lake trout ≥600 mm TL were weighed during the 1991, 1992, and 1993 creel surveys, respectively. These data were pooled to estimate the sample size necessary to attain the objective criteria.

Using methods of Cochran (1977), it was estimated that 288 fish were required to estimate the binomial proportion specified in Objective 2 to the desired precision. This sample size was calculated assuming the true proportion of fish ≥600 mm TL on the known spawning grounds was less than 0.25 (average for 1991–1995 = 0.20).

SAMPLING METHODS

Sampling occurred at night when lake trout congregated on spawning grounds. Crew members scanned the shoals where lake trout spawn until they observed a large congregation of adult fish. A 400 ft by 8 ft beach seine was used to capture mature fish. The seine was deployed from a boat in a semi-circle with both ends eventually being drawn up on the shore, effectively keeping fish from swimming out into deeper water. Fish were dipnetted into tubs and sampled immediately.

Captured fish were measured for fork and total length to the nearest millimeter, weighed to the nearest gram, affixed with a uniquely numbered Floy® tag, given a left pectoral fin clip for future identification, and had sex determined by presence of sex products. Only healthy fish were tagged. The first eight males and the first two females caught in each length category beginning at 400 mm and extending to 600 mm in 50 mm increments were weighed as were all fish ≥600 mm TL.

DATA ANALYSIS

OBJECTIVE 1

Lake trout populations are usually characterized by having a 1:1 sex ratio for mature fish (Martin and Olver 1980) and the sex ratio of the sport harvest of lake trout normally reflects that of the underlying population. However, there is normally a preponderance of males captured when spawning grounds are sampled. Therefore, the mean and associated standard error of the weights for males and females were calculated separately and their means were combined to estimate the mean weight of lake trout vulnerable to harvest:

$$\hat{\mu}_{LT \geq 600mm} = \frac{\overline{X}_{maleLT \geq 600mm} + \overline{X}_{femaleLT \geq 600mm}}{2}, \quad (1)$$

where:

$\overline{X}_{maleLT \geq 600mm}$ and $\overline{X}_{femaleLT \geq 600mm}$ were the sample mean weights (kg/fish).

The variance associated with this estimate was estimated as follows:

$$\hat{V}[\hat{\mu}_{LT \geq 600mm}] = \frac{1}{4}\left(se^2_{\overline{X}_{maleLT \geq 600mm}} + se^2_{\overline{X}_{femaleLT \geq 600mm}}\right), \quad (2)$$

where:

$se_{\overline{X}_{maleLT \geq 600mm}}$ and $se_{\overline{X}_{femaleLT \geq 600mm}}$ were the standard errors of the sample means.

YP_{number} (fish/yr) was calculated by dividing YP by the mean weight of lake trout >600 mm and its variance was estimated using the Delta method (Seber 1982):

$$\hat{YP}_{number} = \frac{YP}{\hat{\mu}_{LT \geq 600mm}} \quad (3)$$

$$\hat{V}[\hat{YP}_{number}] \approx YP^2 \frac{\hat{V}[\hat{\mu}_{LT \geq 600mm}]}{\left[\hat{\mu}_{LT \geq 600mm}\right]^4} \quad (4)$$

The variance estimate for YP_{number} was a minimum estimate, as uncertainty contributed by the LA model (i.e., in YP) was not quantified in this study. YP_{number} was then compared to the estimate of the mean harvest (most recent 3 years with available data) at the 5% significance level.

OBJECTIVE 2

The proportion of lake trout on the known spawning grounds of Lake Louise of length ≥600 mm TL was estimated. The proportion and variance estimators were:

$$\hat{p} = \frac{x}{n}, \text{ and} \quad (5)$$

$$\hat{V}[\hat{p}] = \frac{\hat{p}(1 - \hat{p})}{n-1} \quad (6)$$

where:

$\hat{p}$ = the estimated proportion of lake trout on the spawning grounds that were of length ≥600 mm TL;

x = the number of lake trout captured on the spawning grounds that were of length ≥600 mm TL; and,

n = the total number of lake trout captured on the spawning grounds of known length.

RESULTS

CATCH SUMMARY

From 12 September through 21 September, 545 unique lake trout were captured (412 males, 132 females, 1 unknown) on the spawning grounds. Of these, 267 (167 males, 100 females) were weighed (Table 2). There was no observation of tag loss or mortality during the sampling, no spent fish were observed, and 38 lake trout with Floy® tags from prior sampling efforts were identified.

Of the 545 unique lake trout sampled, 207 came from cluster A, 299 came from cluster B and 39 came from other spawning areas outside of the two main clusters. Sampling occurred in cluster A on 6 nights, in cluster B on 5 nights and in the other spawning areas on 4 nights.

Table 2.–Length and weight statistics for lake trout in Lake Louise in September 2006.

Statistic	Males	Females	All
Total Number Sampled	412	132	545
Number sampled ≥ 600 mm TL	99	62	161
Mean length (mm)	592	626	602
SD (mm)	93	91	94
Range (mm)	430–973	515–908	430–973
p ≥ 600 mm TL	0.24	0.47	0.30
SE (p)	0.021	0.044	0.020
Total Number Weighed	167	100	267
Mean Weight (kg)	2.81	2.53	2.70
SD (kg)	1.97	1.57	1.83
Range (kg)	0.29–9.78	1.18–7.47	0.29–9.78
Number weighed ≥ 600 mm TL	55	29	84
Mean weight (kg)	5.07	4.57	4.82
SD (kg)	1.89	1.56	1.79
Range (kg)	2.23–9.78	2.26–7.47	2.23–9.78

LENGTH AND WEIGHT COMPOSITION

The mean length of all sampled male lake trout was 592 mm TL (SE = 4.7) and of all sampled females was 626 mm TL (SE = 7.9; Figure 3, Table 2). The length distribution of female lake trout was significantly larger than that of males (D = 0.293; P <0.01), although the difference was not significant for fish >600 mm TL (D = 0.17; P = 0.177). The proportion of all fish sampled on the spawning grounds that were ≥600 mm TL was 0.30 (SE = 0.02). For males, the proportion of sampled fish ≥600 mm TL was 0.24 (SE = 0.02) and for females was 0.47 (SE = 0.04). Male and female lake trout had similar length-weight relationships (Figure 4).

Fish sampled on spawning grounds outside of the clusters (males and females combined) were significantly longer than those sampled on cluster A (D = 0.240; P = 0.027) and cluster B (D = 0.472; P < 0.01) (Figure 5). For male lake trout, those sampled outside of the two clusters were also longer than those sampled on cluster A (D = 0.283; P = 0.014) and cluster B (D = 0.51; P < 0.01). However, females lake trout sampled outside of the two clusters were not significantly longer than those sampled in either cluster (vs. A: D = 0.213, P = 0.911; vs. B: D = 0.363, P = 0.435).

When comparing lengths of all fish sampled in cluster A and cluster B, those sampled in cluster A were significantly longer (D = 0.284, P < 0.01). This was also true for male lake trout (D = 0.299, P < 0 .01) and for female lake trout (D = 259, P = 0.021). When examining only male lake trout ≥600 mm TL, the difference was still significant (D = 0.392, P =0.006) but was not so for females ≥600 mm TL (D = 0.54, P = 0.60).

Weight distributions were also compared between clusters and results from these tests were consistent with those seen with length distributions. For all fish ≥600 mm TL, fish sampled outside of the clusters were significantly heavier than those on cluster A (D = 0.349, P = 0.021) which were significantly heavier than those sampled on cluster B (D = 0.348, P = 0.001). For male fish that were ≥ 600 mm TL fish sampled outside of the clusters were heavier than those sampled in cluster A (D = 0.400, P = 0.018), which were in turn heavier than those sampled on cluster B (0.375, P = 0.009). For female lake trout ≥600 mm TL fish sampled outside the clusters were not significantly heavier than those sampled on either cluster A (D = 0.290, P = 0.850) or cluster B (D = 0.556, P = 0.169), although it should be noted that there were only four females ≥600 mm TL that were sampled outside of the main spawning clusters. For females ≥600 mm TL, fish sampled on cluster A were significantly heavier than those sampled on cluster B (D = 0.455, P = 0.003).

YIELD POTENTIAL

The mean weight for male lake trout ≥600 mm TL was 3.77 kg (SD = 2.07) and for female lake trout ≥600 mm TL was 3.19 kg (SD = 1.72). For all fish ≥600 mm TL the mean weight was 3.48 kg (SD = 1.96). Applying the relationship of annual yield potential to surface area of Lake Louise (6,519 ha) and mean weight of harvestable fish in the sample resulted in a YP estimate of 2,219 kg/yr (Burr 2006), and an annual YP_{number} estimate of 638 lake trout/yr ≥ 600 mm TL (SE ≈163). The three year average (2002–2005) of annual harvest for Lake Louise was 511 lake trout and the three year average for lake trout catch was 3,233 fish. Applying a hooking mortality rate of 3.9% resulted in an average 3 year fishing mortality approximately equal to the estimated annual YP_{number} (Figure 6).

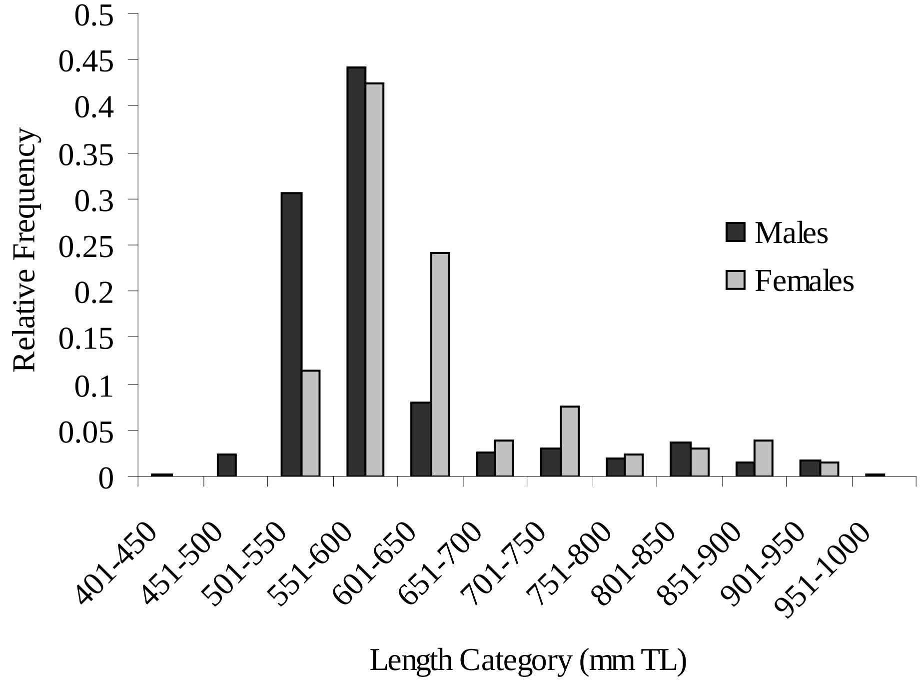

Figure 3.–Length distributions of male and female lake trout sampled in Lake Louise, September 2006.

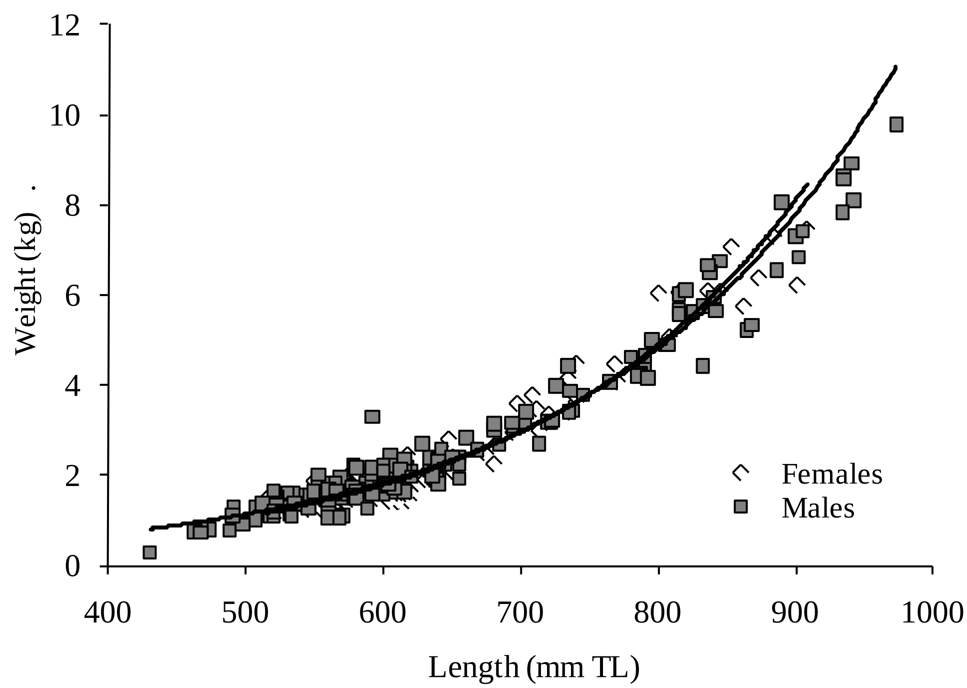

Figure 4.–Length-weight relationship for lake trout sampled on the spawning grounds in Lake Louise, September 2006. R^2 for males = 0.92 and for females = 0.93.

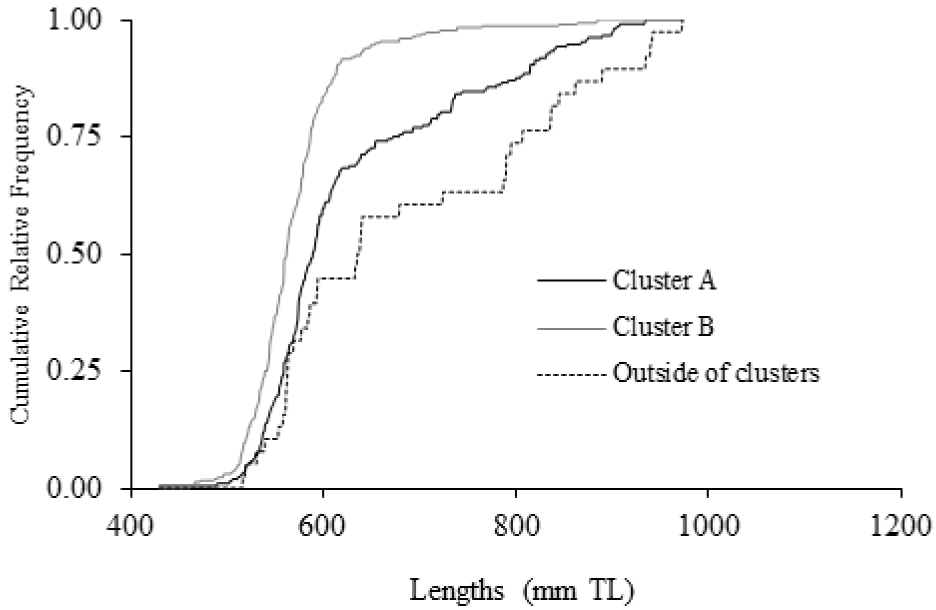

Figure 5.–Length distribution of lake trout sampled on two different spawning clusters and outside of those clusters on Lake Louise, September 2006.

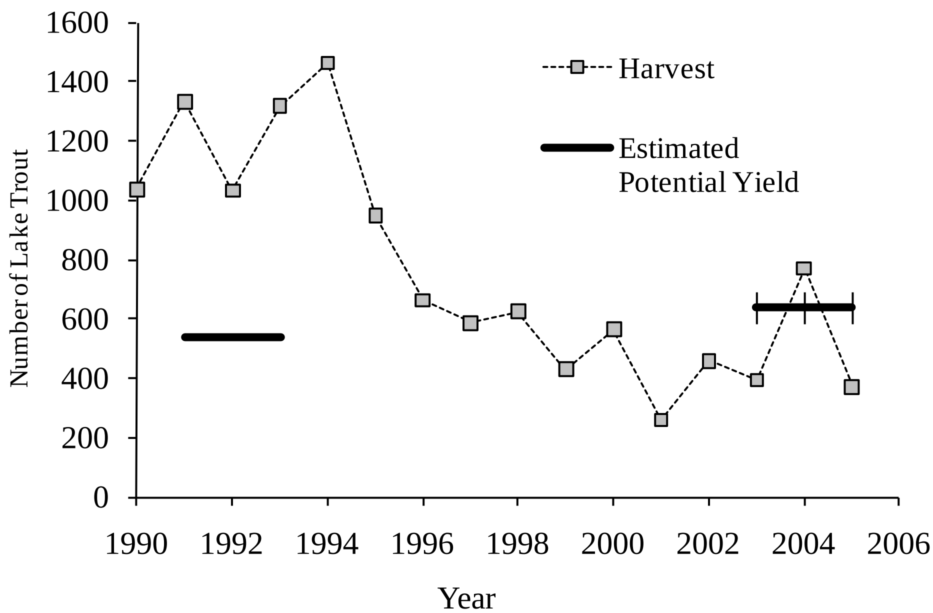

Figure 6.–Number of lake trout harvested from Lake Louise and estimated yield potential (YP_{number}).

HISTORICAL COMPARISONS

Lake trout sampled in 2006 were longer than those sampled in 1995. The average fork length (FL) of male lake trout in 2006 was 541 mm FL (SE = 4.32) and in 1995 was 525 (SE = 2.18). The average fork length for female lake trout sampled in 2006 was 573 (SE = 7.49) and in 1995 was 546 (SE = 5.54) (Szarzi and Bernard 1997). Additionally, a larger portion of the sampled lake trout were ≥600 mm TL; the average proportion from 1991 to 1995 was 0.20 and in 2006 was 0.30.

DISCUSSION

Estimates of yield potential were based on the assumption that a representative sample of lake trout ≥600 mm TL was collected and that anglers harvest lake trout in proportion to that sample. A non-representative sample would have been indicated by heterogeneity in size composition between spawning clusters and if sampling effort was not distributed proportional to spawning abundance. Evidence presented indicates that lake trout sampled outside of cluster A and B were larger than lake trout in cluster A and B and lake trout sampled in cluster A were consistently larger than those sampled in cluster B (Figure 5).

Data from recaptures indicates a high degree of fidelity to spawning clusters. Of the 68 lake trout recaptured from previous sampling events, only three (4%) were captured in different clusters. Moreover, of the 31 lake trout sampled in this experiment that were captured initially between 1991 and 1995 only two (6%) were captured on different spawning clusters from which they were originally sampled.

Evaluating whether or not sampling was distributed in proportion to spawning abundance is not possible; estimates of spawning abundance within clusters were not generated in this experiment. However, sampling effort was distributed across the various spawning areas over the course of sampling with 6 nights of sampling in cluster A, 5 nights spent in cluster B and 4 nights on spawning sites located outside of the two main clusters. Given that over 200 samples were obtained in each of the two main spawning clusters and 39 were taken on the spawning sites outside of the clusters and given that the spawning sites in Lake Louise are well documented (Szarzi and Bernard 1997) it is reasonable to treat these samples as representative of the lake population. Nevertheless, future research performed in Lake Louise should be designed to address the possibility of distinct spawning populations within the lake.

The yield potential calculated in this study was greater than the recent three year average (2002–2005) of harvest in Lake Louise (638 lake trout yield potential versus 511 three year average of harvest; Figure 6). Although hooking mortality is difficult to assess and is spread out across a larger length range than the harvest (some fish smaller than 600 mm TL are caught and released), and is assumed to be relatively low, the high catch rates in Lake Louise (3-year average of 3,233 fish) could push the overall fishing mortality of lake trout up to the YP estimate with a hooking mortality of 3.9%. While the yield potential calculated in this report is conservative based on the weighing of pre-spawning adults and some of the harvest effects are likely partially mitigated by movement of lake trout between Lake Susitna and Tyone Lake (Szarzi and Bernard 1994), the small disparity between harvests and yield potential may nevertheless require further research to assess the population status.

Interpretation of the updated YP relative to the management plan will be complicated by the mixing of lake trout between Lake Louise and Susitna Lake (and possibly Tyone Lake). Based upon tag recoveries it has been demonstrated that fish may travel between Lake Louise and Susitna Lake through a short (~200 m), shallow creek that flows throughout the open water season. Of the 17 tagged lake trout recovered in the 1993 creel survey on Lake Louise, five (29%) were originally tagged on the spawning grounds in Susitna Lake in 1992 (Szarzi and Bernard 1994). Significant movement of lake trout between lakes may necessitate managing the entire lake complex as a single fishery and further research will be required to determine the degree of exchange among the lakes, the relative abundances of lake trout in the lakes, and the yield potential of Susitna Lake.

FORK LENGTHS VERSUS TOTAL LENGTHS

There was a sizeable discrepancy in the average weight of lake trout ≥600 mm TL estimated in this report and the average weight reported in Burr (2006), which was calculated from creel survey data taken in the early 1990s. Burr (2006) reported the average weight of fish ≥600 mm TL to be 4.1 kg whereas this study estimated average weight to be 3.5 kg. In Burr's (2006) analysis of Lake Louise lake trout, the length data collected were *fork lengths* whereas state regulations for minimum length of harvest refer to *total lengths*. Burr (2006) converted fork lengths to total lengths using a conversion factor of 0.935 FL:TL ratio based on generalized lake trout data, thus resulting in a length limit of 561 mm FL. These lengths were then converted to weight data by regressing on the weight/length curve and an average of 4.1 kg was generated for fish over 600 mm TL.

When data from this report was analyzed using Burr's (2006) methods a similar average weight was generated. By averaging the length of fish greater than 561 mm FL (based on generalized lake trout data) and then using the length/weight regression to calculate an average weight, an estimate of 4.2 kg was generated. When the actual weight of all fish over 560 mm FL was averaged, the estimated mean weight was 4.0 kg.

Because data taken on the spawning grounds for this report included both fork length and total lengths it was possible to generate a FL:TL ratio of 0.915 that was specific to Lake Louise lake trout. Although this appears similar to the FL:TL ratio of 0.935 used in Burr 2006, this disparity results in significant differences in the calculated average weights used in the lake area models. Instead of a cutoff fork length of 561 generated by the generalized lake trout data used in Burr (2006) the cutoff length using the Lake Louise specific ratio of 0.915 generated a fork length cutoff of 550 mm FL. When this value was used the average weight generated by the length/weight regression was 3.84 and the average weight generated by the actual weights of fish larger than 550 mm FL was 3.48. Both of these values were statistically indistinguishable from the average weight generated in this study using the methods described. Similarly, when the cutoff fork length derived from the Lake Louise data (550 mm FL) was used on Burr's (2006) data an average weight was generated of 3.48 kg. By using the generalized FL:TL ratio of 0.935 a portion of the smaller fish actually susceptible to harvest were incorrectly excluded from the calculations and thus the average size of lake trout that are susceptible to harvest was overestimated. This resulted in an overly conservative estimate of YP_{number}.

This exercise illustrated important points with regards to the metrics used in estimating yield potential for lake trout in Alaska. It will be important for future research that measurements are directly comparable to those used in the state fishing regulations; in this case *total length*. It is important to also measure fork lengths on these projects in order to generate lake specific FL:TL ratios. As illustrated here, small differences in this ratio can have profound effects on the average weights generated from historical data. In lakes where annual harvests are near the estimated YP_{number}, this may have direct implications for management of the fishery. Where managers are forced to rely on historical fork length data to generate yield potentials it would be worthwhile to sample lake trout from the lake in question in order to generate a lake specific FL:TL ratio. This would not necessitate a large sampling crew or a lot of time and could be accomplished relatively inexpensively.

ACKNOWLEDGEMENTS

Brian Collyard, Austin Mahalkey, Ron Burr, Dan Becker and Mark Somerville were responsible for the execution and data collection for this project. Klaus Wuttig provided study design oversight. Rachael Kvapil edited and formatted this report for publication. The U.S. Fish and Wildlife Service provided partial funding for this study through the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-22, Job No. R-3-3(a).

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APPENDIX A

Appendix A1.–Capture history of lake trout from Lake Louise tagged in previous experiments that were also sampled in 2006.

Tag #	Date First Caught	Sex	Length (mm)	2006 Sample Date	New Length (mm)	Change in length (mm)	Years Since Last Capture	Average Annual Growth
240107	9/23/91	M	505	9/16/06	521	16	15	1.07
240187	9/19/91	M	482	9/18/06	520	38	15	2.53
240218	9/12/95	M	490	9/17/06	513	23	11	2.09
272062	9/8/95	M	505	9/13/06	552	47	11	4.27
272152	9/12/95	M	550	9/18/06	603	53	11	4.81
272155	9/13/95	M	510	9/17/06	640	130	11	11.81
272175	9/13/95	M	460	9/18/06	513	53	11	4.81
272222	9/14/95	M	455	9/19/06	484	29	11	2.63
272239	9/14/95	M	518	9/19/06	565	47	11	4.27
272253	9/15/95	M	510	9/16/06	545	35	11	3.18
272305	9/18/95	M	489	9/19/06	526	37	11	3.36
272323	9/18/95	M	463	9/14/06	524	61	11	5.55
272338	9/18/95	M	472	9/19/06	518	46	11	4.18
272361	9/19/95	M	495	9/16/06	540	45	11	4.09
272465	9/25/95	M	494	9/17/06	526	32	11	2.91
325034	9/9/94	F	512	9/17/06	585	73	12	6.07
325131	9/12/94	M	466	9/19/06	526	60	12	4.99
325496	9/20/94	M	735	9/16/06	798	63	12	5.25
365015	9/8/92	M	467	9/17/06	524	57	14	4.06
365160	9/16/92	F	499	9/14/06	558	59	14	4.22
365364	9/12/95	M	608	9/20/06	685	77	11	6.99
365553	9/8/95	M	504	9/16/06	524	20	11	1.81
365945	9/13/93	M	433	9/17/06	517	84	13	6.46
367124	9/8/95	M	673	9/13/06	756	83	11	7.54
367134	9/11/95	M	667	9/20/06	861	194	11	17.60
367139	9/14/93	M	543	9/16/06	570	27	13	2.08
367183	9/16/93	F	537	9/17/06	774	237	13	18.23
367272	9/12/94	M	491	9/19/06	538	47	12	3.91
367346	9/18/95	M	465	9/13/06	509	44	11	4.01

Appendix A2.–Summary of statistics from weighed subsample of lake trout (X females, X males) captured in Lake Louise in September 2006.

Length Category (mm TL)	Female Mean Weight (kg)	Number of females in Category	Male Mean Weight (kg)	Number of males in category
400-424	0	0	0	0
425-449	0	0	0.29	1
450-474	0	0	0.77	6
475-499	0	0	1.00	5
500-524	1.34	2	1.35	11
525-549	1.34	9	1.435	14
550-574	1.49	12	1.59	18
575-599	1.70	16	1.86	17
600-624	1.78	23	1.98	26
625-649	2.29	8	2.20	12
650-674	2.34	3	2.40	7
675-699	2.87	4	3.02	5
700-724	3.41	4	3.15	6
725-749	3.97	6	3.82	6
750-774	4.39	3	4.08	1
775-779	0	0	4.48	7
800-824	5.73	3	5.53	6
825-849	6.10	2	5.92	8
850-874	6.41	3	5.28	2
875-899	7.31	1	7.31	2
900-924	6.85	2	7.19	3
925-949	0	0	8.41	5
950-974	0	0	9.78	1