Fishery Data Series Number 00-40

Stock Assessment and Biological Characteristics of Burbot in Tolsona Lake, 1999 and Lake Louise, 1995-1996, 1999

by

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and

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December 2000

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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by

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December 2000

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-10-14, Job R-3-4(c).

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This document should be cited as:
Taube, T. T, Perry-Plake, L. J. and D. R. Bernard. 2000. Stock Assessment and Biological Characteristics of Burbot in Tolsona Lake, 1999 and Lake Louise, 1995-1996, 1999. Alaska Department of Fish and Game, Fishery Data Series Number 00-40, Anchorage.

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ABSTRACT

Abundance, mean CPUE, and length composition were estimated for populations of burbot *Lota lota* in Lake Louise and Tolsona Lake in Southcentral Alaska. Sampling occurred in May and June of 1999. Bootstrapped mean catch per unit of effort of fully recruited burbot (450 mm total length and larger) per 48-hour set was 0.38 (SE = 0.05) in Lake Louise and 2.57 (SE = 0.58) in Tolsona Lake. Abundance during 1998 of fully recruited burbot estimated with mark-recapture experiments was 1,831 (SE = 748) in Tolsona Lake. Estimated annual survival rate for fully recruited burbot in Tolsona Lake was 48.1% (SE = 19.3%) between 1997-1998. Catch per unit effort of fully recruited burbot in Lake Louise in 1999 was similar to estimates from prior years. Estimated abundance in Lake Louise during 1999 based on expanded mean CPUE was 3,307 burbot (SE=248) and was similar to estimates calculated for 1995 and 1996. Estimated length composition indicated few large (>675 mm TL) burbot present in either lake, but good recruitment of small burbot (< 450 mm TL) in Tolsona Lake. Water quality measurements in Tolsona Lake were below critical indicator levels for Temperature, dissolved oxygen, pH, and water clarity.

Key words: Burbot, *Lota lota,* abundance, length composition, catch-per-unit effort, hoop traps, mean length, survival rate, recruitment.

INTRODUCTION

Historically, the lakes of the Upper Copper/Upper Susitna management area (UCUSMA; Figure 1) supported the largest burbot fishery in the state. Harvests from the UCUSMA averaged over 9,000 burbot or 60% of the statewide burbot harvest from 1977 – 1986 (Taube 2000). Harvest from the fishery peaked in 1985 when over 19,000 burbot were harvested from the UCUSMA, accounting for 71% of the statewide burbot harvest (Mills 1986; Figure 2). The Tyone River drainage (consisting of Lake Louise and Susitna and Tyone lakes) supported over half of the burbot harvest in the Glennallen area (UCUSMA) prior to 1987. Concerns about overexploitation resulted in the Alaska Department of Fish and Game (ADF&G) initiating a research study in 1986 to collect basic life history information necessary to assess stock status and to estimate the sustained yield of burbot in interior Alaskan lakes. In 1988, the Board of Fisheries adopted as regulation (5 AAC 52.045) a lake burbot management plan so that the burbot fishery in the UCUSMA could be managed for maximum sustained yield and opportunity to participate. This plan gives the department the authority to manage burbot stocks in the UCUSMA to permit maximum sustainable harvests on healthy stocks and rebuild depressed stocks.

ADF&G has managed the UCUSMA burbot fisheries through bag limit reduction, gear restriction, and lake closure. Since 1988, bag and possession limits have been reduced to 5 burbot per day on most lakes, and 2 burbot per day on some heavily fished road accessible lakes. The use of setlines has been prohibited, by emergency order in the Tyone River drainage and Tolsona and Moose lakes from 1989 - 1991, and by regulation since 1991 in the entire UCUSMA. The Lake Louise burbot sport fishery was closed in 1988 due to continued declines in burbot abundance. Lake Louise remains closed to burbot fishing, as stock assessment indicates that the population has stabilized but has not returned to historical levels. Since 1996, stock assessment on Lake Louise occurs once every three years.

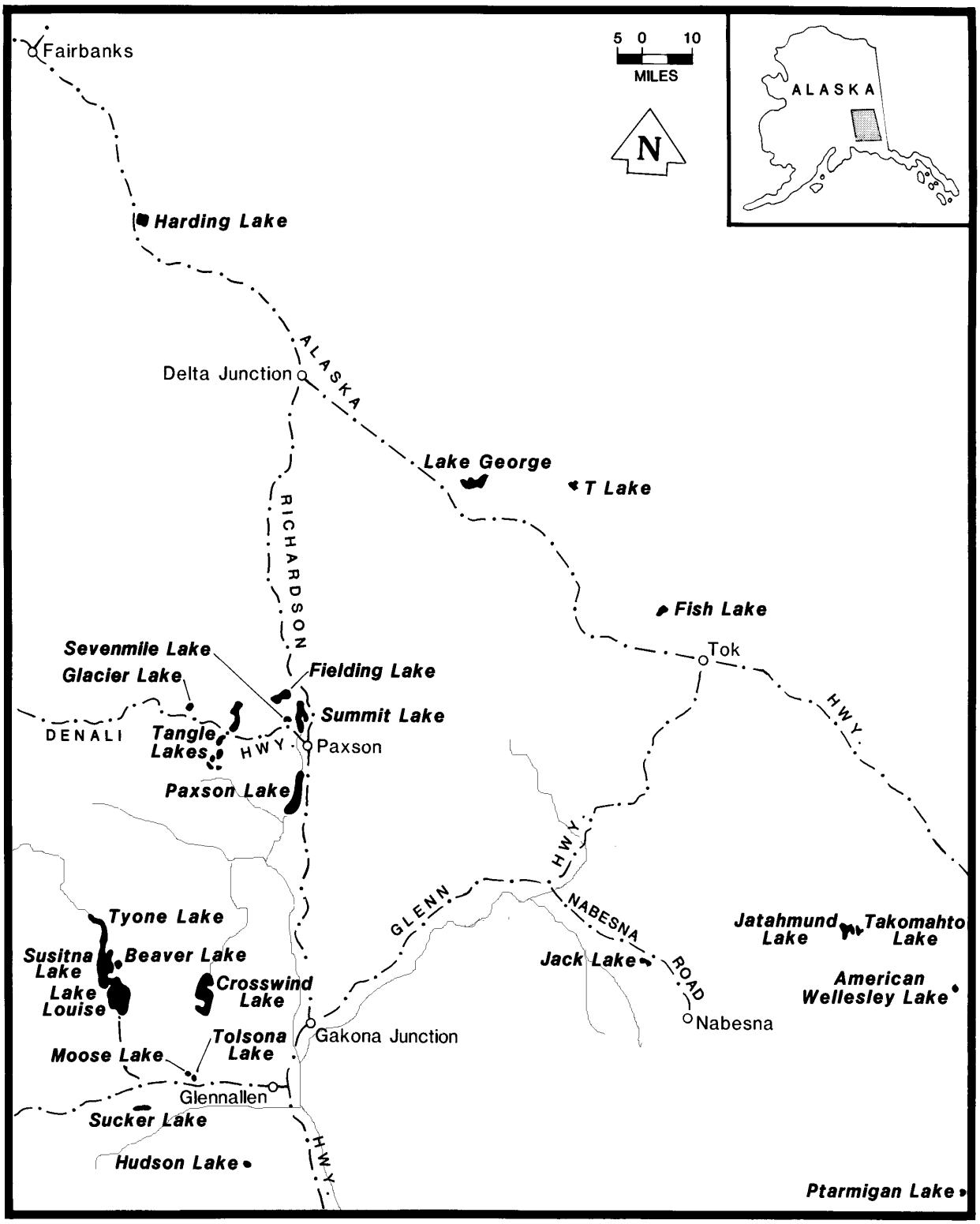

Figure 1.-Locations of lakes sampled in 1999.

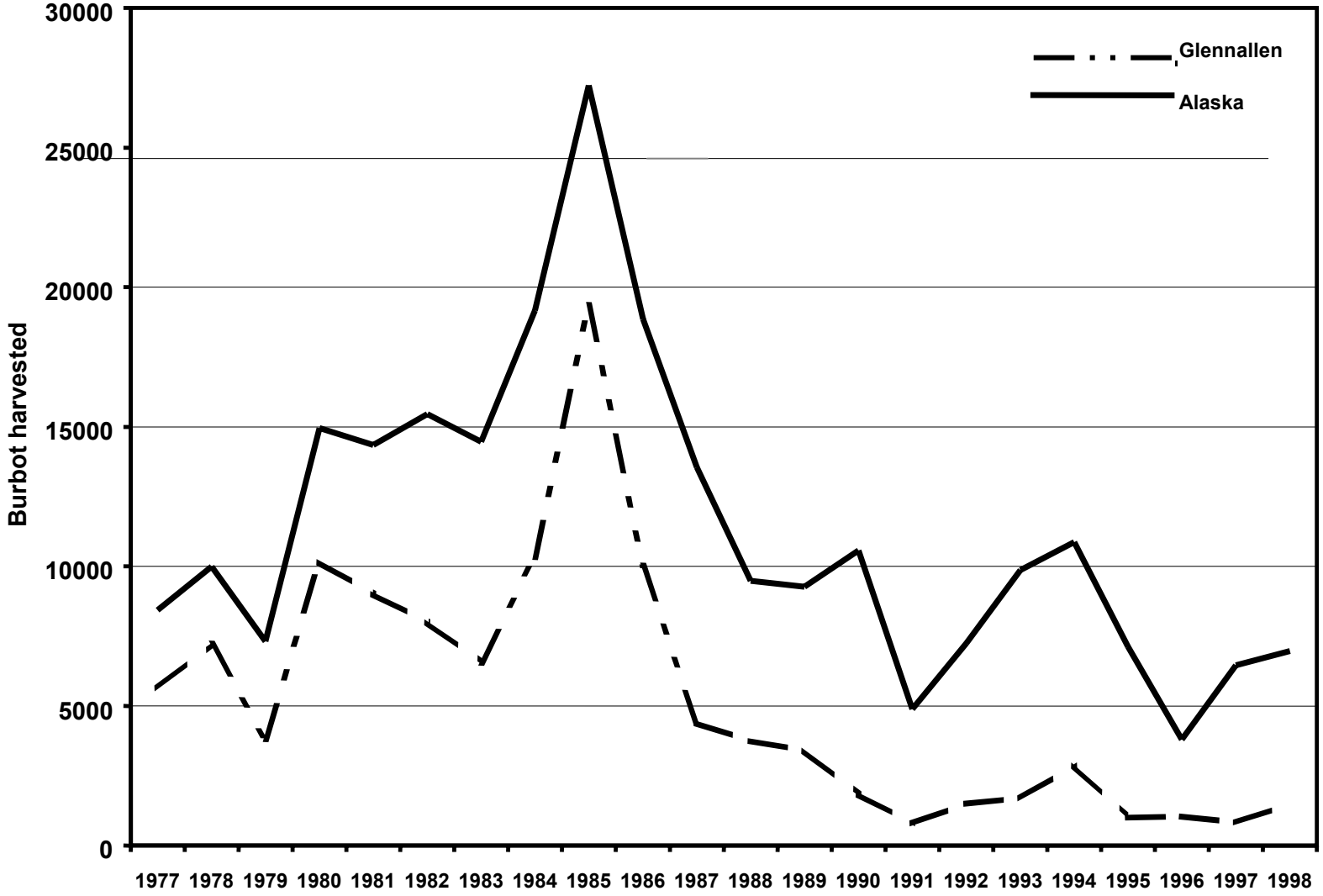

Figure 2.-Harvest of burbot in sport fisheries of the Glennallen area (UCUSMA) compared to total Alaskan sport harvest, 1977-1998

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Tolsona Lake is the only lake in the UCUSMA that has been assessed every year since 1986. This is due to accessibility, ease of sampling, and the opportunity for a long-term study on an exploited population. It has also provided information on an atypical burbot stock that resides in a shallow, productive lake. In 1998, Tolsona Lake was closed to burbot fishing due to a dramatic decline in burbot abundance and poor summer survival (Figure 3). This decline was likely due to a combination of factors, but high summer water temperatures may have contributed most to this decline. In 1999, Lake Louise and Tolsona Lake were assessed for abundance, length composition and CPUE of burbot. In addition, water temperature profile and water chemistry were collected in Tolsona Lake.

The objectives for the project during 1999 were to:

1. estimate the length composition of burbot (≥ 450 mm TL) for each sampling event in Lake Louise and Tolsona and Hudson lakes;
2. estimate the abundance of burbot (≥ 450 mm TL) in Lake Louise, Tolsona and Hudson lakes; and,
3. estimate mean catch-per-unit of effort (CPUE) of burbot (≥ 450 mm TL) in Lake Louise and Tolsona and Hudson lakes.

Project tasks for 1999 were to:

1. collect temperature data to provide a temperature profile of Tolsona and Moose lakes during the open-water period; and,
2. collect water quality data at one-month intervals in Tolsona and Moose lakes from May – September.

Past research on these and other lakes in interior and south-central Alaska can be found in previous technical reports (Potterville and Bernard 1987; Parker et al. 1988, 1989; Lafferty et al. 1990-1992; Lafferty and Bernard 1993; Taube et al. 1994; and Taube and Bernard 1995, 1999). Presentation of tables and figures are in similar format to past reports to provide easy summarization of time series information. Each of the populations studied in 1999 has (or had) a popular sport fishery for burbot. Descriptions of each study lake are presented in Appendix A.

METHODS

STUDY DESIGN

Burbot were captured in 3-m long, baited hoop traps with 25-mm mesh net set on the bottom as described in Bernard et al. (1991). Burbot ≥ 450 mm TL are fully recruited to this gear. Traps were positioned according to a systematic sampling design as described in Bernard et al. (1993) to minimize competition among the gear while still covering the bottom of each lake. Sampling at Tolsona Lake and Lake Louise commenced immediately after the lakes became ice-free to maximize the catch per set (Bernard et al. 1993). A set is defined as a single hoop trap soaked for 48 hours. Traps were systematically placed along randomly chosen transects across Tolsona Lake and Lake Louise, however in Lake Louise no traps were placed in waters > 15 m deep. Traps in Lake Louise were restricted to shallow waters to reduce mortalities of burbot from decompression. Past studies showed such restrictions had little effect on estimates of mean

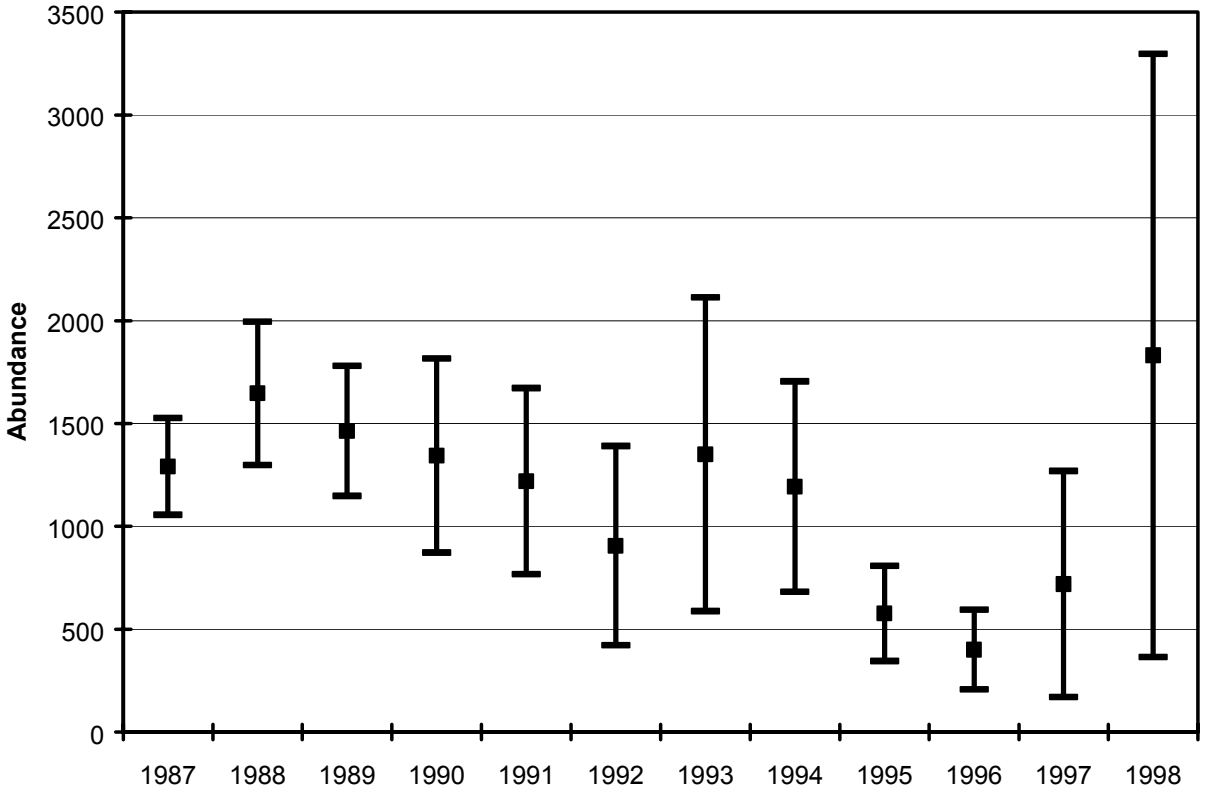

Figure 2.-Estimated abundance and 95% confidence intervals of fully recruited (≥ 450 mm) burbot in Tolsona Lake, 1987-98.

CPUE (Bernard et al. 1993). Dates of sampling and number of sets fished at Tolsona Lake and Lake Louise are listed in Table 1. The Jolly-Seber model (Seber 1982) was used to estimate abundance of burbot in Lake Louise for 1994 (not given in previous reports) and in Tolsona Lake for 1998. Estimates of mean CPUE were expanded to obtain estimates of abundance in both lakes for 1999.

Table 1.-Number of sets and dates of sampling events for the stock assessment of burbot populations in Lake Louise, 1995, 1996, and 1999 and Tolsona Lake, 1999.

Lake	Area (ha)	Dates of Sampling Events	Number of Sets
Louise	6,519	6/16 – 25/99	600
		6/11 – 17/96	300
		6/05 - 17/95	1,346
Tolsona	130	6/01 – 03/99	59

After lifting a hoop trap, the catch was emptied into a holding tank and burbot were inspected for previous marks, tagged (if necessary), measured for total length (to the nearest 5 mm), then returned to the lake. Each unmarked burbot was tagged with an individually numbered Floy tag inserted in the musculature beneath the dorsal fin. All tags were checked so that they were locked between the pterygiophores of the dorsal fin. Each burbot also received a second mark in the form of a right ventral finclip. This second mark was used to evaluate loss of Floy tags. The left opercular punch (1997), left ventral finclip (1998), and right ventral fin clip (1999) have been used as secondary marks in a three-year rotation in Tolsona Lake. A recaptured burbot missing its tag was considered to have been last captured in the previous year the secondary mark was used with one exception. Because the same clip was used from 1995-7 (a half-dorsal clip), specific year of previous capture could not be assigned to recaptured burbot with this mark and no tag. Individual trap and associated catch information were recorded on the standard hoopnet mark-sense form (Heineman *Unpublished*). Trap information included the following: hoop trap number, location of set, depth of set, hour set and hour pulled, and number of fish caught by species. Tag number and color, secondary mark, and total length were recorded on the mark-sense form for each burbot caught in each set. In the event of sampling-induced mortalities, otoliths were extracted, and age was determined at a later date. Processing and reading of otoliths followed the procedures described by Chilton and Beamish (1982). Ages were recorded into the appropriate databases.

Temperature and water quality data for Tolsona Lake were collected twice during the open water period in 1999. Water clarity (determined by use of a secchi disk), conductivity and pH were collected for comparison to data collected in 1993 during a University of Alaska-Fairbanks research project (Simpson 1997). These data would indicate whether water and environmental conditions at Tolsona Lake had changed over time that may have influenced burbot survival. Indicator levels are those collected in 1993, with the exception of temperature and dissolved

oxygen, which are defined thresholds for physiological stress for burbot survival (Scott and Crossman 1973).

DATA ANALYSIS

Abundance, survival rate, and recruitment statistics were generated for the burbot population in Tolsona Lake (through 1998) and Lake Louise (through 1994) with the Jolly-Seber model (Seber 1982) using the computer program JOLLY (Model A) developed by Brownie et al. (1986) (see Pollock et al. 1990 for a description of JOLLY). Model A is the most general form of the Jolly-Seber model and assumes capture probabilities and survival rates vary over time. Abundance of burbot in Lake Louise for 1999 was estimated by expansion of mean CPUE.

Individual burbot captured more than once in 1999 were considered caught only once in this analysis to estimate abundance. Conditions for producing accurate statistics with the Jolly-Seber model are:

1. all burbot have the same probability of capture during each sample event (probability of capture can vary among events) or marked burbot must completely mix with unmarked burbot between sample events;
2. no marks are lost between sample events;
3. marked burbot must behave (enter traps) as do unmarked burbot;
4. marked burbot must have the same mortality rate as unmarked burbot; and
5. immigration and emigration are permanent.

Because burbot < 450 mm TL are not fully recruited to the sampling gear used in this project (Bernard et al. 1991), statistics were only generated for burbot ≥ 450 mm TL. Although the probability of capturing extremely large burbot (> 900 mm TL) is less than the probability of capturing other burbot ≥ 450 mm TL in the hoop traps used in this project (Bernard et al. 1991), populations studied here have been heavily exploited and have few extremely large fish. Traps were distributed uniformly to promote mixing and to homogenize the probability of capture of burbot across Tolsona Lake. Over the span of a year, burbot should completely mix throughout Tolsona Lake. Double marking of burbot (tag and finclip) permitted correction of bias in estimates due to loss of tags. Previous studies indicate little change in behavior (trap happiness or trap shyness) of captured burbot (Bernard et al. 1991). Although an intermittent stream connects Moose and Tolsona lakes, only one of several thousand burbot recaptured from 1986 - 1999 had moved between lakes.

Mean CPUE was estimated for fully and partially recruited burbot in both Tolsona Lake and Lake Louise following a two-stage sampling design with transects as first-stage units and sets along transects as second-stage units (Sukhatme et al. 1984). Although all transects had an equal probability of being included in a sample event, they were of different lengths depending upon the shape of each lake. Under these conditions, an unbiased estimate of mean CPUE is:

$$\overline{CPUE} = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{m_i}\sum_{j=1}^{m_i}\omega_i c_{ij} \qquad (1)$$

where:

c_{ij} = catch of burbot from the jth set on the ith transect;

n = number of transects;

m_i = number of sets sampled on the ith transect;

$\omega_i = M_i / \overline{M}$

M_i = maximum possible sets on the ith transect; and

$\overline{M}$ = mean of possible sets across all transects.

Although the M_i and $\overline{M}$ are unknown, the m_i and m were used as substitutes because both M and m are directly related to the length of transects. Thus $\varpi_i = m_i/m$ was used to estimate ω_i. Because few burbot enter traps during daylight (Bernard et al. 1991), catches were not adjusted for the few hours deviation in soak times from the standard 48 h for most sets. A two-stage, resampling procedure (Efron 1982, Rao and Wu 1988) was used to generate an empirical distribution of mean CPUE for each sample event from which variance of mean CPUE and bias from using ω were estimated. In resampling procedures, sets were chosen randomly within each transect although the original selection of sets was systematic. Systematically drawn data can be treated as randomly drawn with little concern for bias in the resultant statistics only so long as these data are not autocorrelated or follow a trend (Wolter 1984). Analysis of data from surveys has revealed no meaningful trends or autocorrelations among catches along transects (Bernard et al. 1993). Estimates of mean CPUE for two groups of burbot (≥ 450 mm and < 450 mm TL) were calculated for each sample event using procedures described in Bernard et al. (1993). The computer program RAOWU.EXE was used to estimate mean CPUE, approximate its variance, and estimate inherent bias in the estimate according to a two-stage bootstrap procedure based on a model in Rao and Wu (1988). Individual burbot captured more than once in 1999 were considered different fish each time captured in calculation of mean CPUE. Conditions for the accurate calculation of mean CPUE as an index of abundance are:

1. gear do not compete for burbot;
2. burbot do not saturate the gear; and,
3. gear is not size-selective.

Bernard et al. (1993) showed that the spacing of sets used in this project is sufficient to avoid competition among gear for burbot and that saturation of gear by burbot is negligible. Because hoop traps as fished in this project are size-selective for burbot (Bernard et al. 1991, 1993), mean CPUE for only fully-recruited burbot will be considered as a valid index of abundance.

Mean CPUE was used to estimate abundance of fully recruited burbot in Lake Louise in 1999 using the relationship:

$$\hat{N} = A(\overline{CPUE})\hat{q}^{-1} \qquad (2a)$$

$$v(\hat{N}) \cong \hat{N}^2 \left[\frac{v(\overline{CPUE})}{\overline{CPUE}^2} + \frac{v(\hat{q})}{\hat{q}^2} \right] \qquad (2b)$$

where A is the surface area of the lake (ha) and q is the catchability coefficient (the fraction of the population removed instantaneously with one unit of sampling effort). Estimates of q were obtained from previous sampling at Lake Louise (Lafferty and Bernard 1993).

RESULTS

Due to limited staffing, water quality and temperature data for Moose Lake was not collected in 1999. Hudson Lake was not sampled in 1999, as the local landowners denied access to the lake.

TOLSONA LAKE

Estimated abundance of burbot for 1998 at Tolsona Lake (1,831, SE = 748) was the highest since fall 1989 (Table 2, Figure 3). Estimated recruitment (1,490, SE = 663) was the highest since the study began in 1986 and contributed to the increased abundance. However, numbers of large fish in Tolsona Lake remain low (Figure 4). Estimated density of fully recruited burbot in 1998 was 14.09 burbot/ha in Tolsona Lake, the highest density since 1989 (Table 3). Of the fully recruited burbot released in previous years and recaptured in 1999, 4% had lost their tags. Two of 48 fish recaptured from previous years were identified by secondary marks. All secondary marks were right ventral, which was the secondary mark used in 1998, evidence the tag loss occurred between 1998 and 1999.

Mean CPUE of fully recruited burbot in Tolsona Lake in 1999 was greater than the previous three years, but was still less than the previous estimates for Tolsona Lake of 3.63, 3.14, 3.83, 3.50, and 3.43 from 1991 – 1995, respectively. (Lafferty et al. 1992, Lafferty and Bernard 1993, Taube et al. 1994, Taube and Bernard 1995, 1999; Table 4).

Temperature and water quality data for Tolsona Lake in 1999 did not exceed the indicator levels (Table 5). Water level in Tolsona Lake increased in 1999, which was likely responsible for water temperature not exceeding critical levels for burbot and impacting future recruitment.

LAKE LOUISE

The estimate of abundance in 1994 calculated by the Jolly-Seber model (not previously cited) was 4,698 (SE=811) burbot (Table 3) and was to estimates in previous years (Parker et al. 1989, Lafferty et al. 1990- 1992, Lafferty and Bernard 1993, Taube et al. 1994, Taube and Bernard 1995; Table 6). Abundance estimates based on the expansion of CPUE for Lake Louise in 1995, 1996, and 1999 were not significantly different from estimates since 1989 (Figure 5; Table 4). Length composition of burbot sampled in 1995 and 1996 were similar, but there were more fish ≥ 675 mm captured in 1999 (Figure 6). Mean length of fully recruited burbot was 655 mm TL (SE=5) in 1999, 636 mm TL (SE=6) in 1996, and 616 mm TL (SE=3) in 1995 (Table 7), and were not significantly different ($F = 0.28$, $P = 0.77$). From Equation 2, estimated abundance of burbot ≥ 450 mm TL in Lake Louise is 3,142 (SE=413), 3,720 (SE=579), and 3,307 (SE=248) for 1995, 1996, and 1999, respectively ($\hat{q} = 0.79$, SE = 0.19).

Statistics for both Lake Louise and Tolsona Lake concerning mean CPUE for partially recruited burbot are listed in Table 8.

Table 2.-Estimates of abundance, survival rate, and recruitment for fully recruited (≥ 450 mm TL) burbot residing in Tolsona Lake.

Date	Days between events	Abundance			Survival Rate %		Recruitment	
		Estimate	SE	CV %	Estimate	SE	Estimate	SE
9/26/86		1,901[a]	120	21.6				
	235				60.0	4.6	138	209
6/25/87		1,291	120	9.3				
	335				77.9	7.1	645	144
5/26/88		1,647	178	10.8				
	95				66.6	7.4	45	111
9/01/88		1,142	132	11.5				
	263				77.8	9.1	576	124
5/24/89		1,464	162	11.0				
	110				100.0[b]	17.6	277	174
9/13/89		1,846	311	16.8				
	251				47.9	9.8	460	152
5/24/90		1,344	240	17.9				
	104				36.0	6.6	88	69
9/07/90		572	89	15.6				
	255				63.5	12.0	856	186
5/22/91		1,220	231	18.9				
	109				33.4	6.1	96	80
9/12/91		503	96	19.0				
	273				85.3	23.1	478	163
6/11/92		906	247	27.3				
	341				24.6	6.2	1,127	368
5/20/93		1,350	389	28.8				
	375				90.9	17.7	-30	435
6/01/94		1,193	261	21.9				
	354				33.3	7.5	180	84
5/23/95		576	118	20.5				
	377				36.4	9.1	192	67
6/05/96		401	99	26.8				
	354				62.0	22.7	484	218
5/27/97		719	280	50.1				
	355				48.1	19.3	1,490	663
5/19/98		1,831	748	50.1				

[a] Estimate obtained from Potterville and Bernard (1987).

[b] Actually computed at 107.2. Since this value is impossible, estimate was truncated to 100.

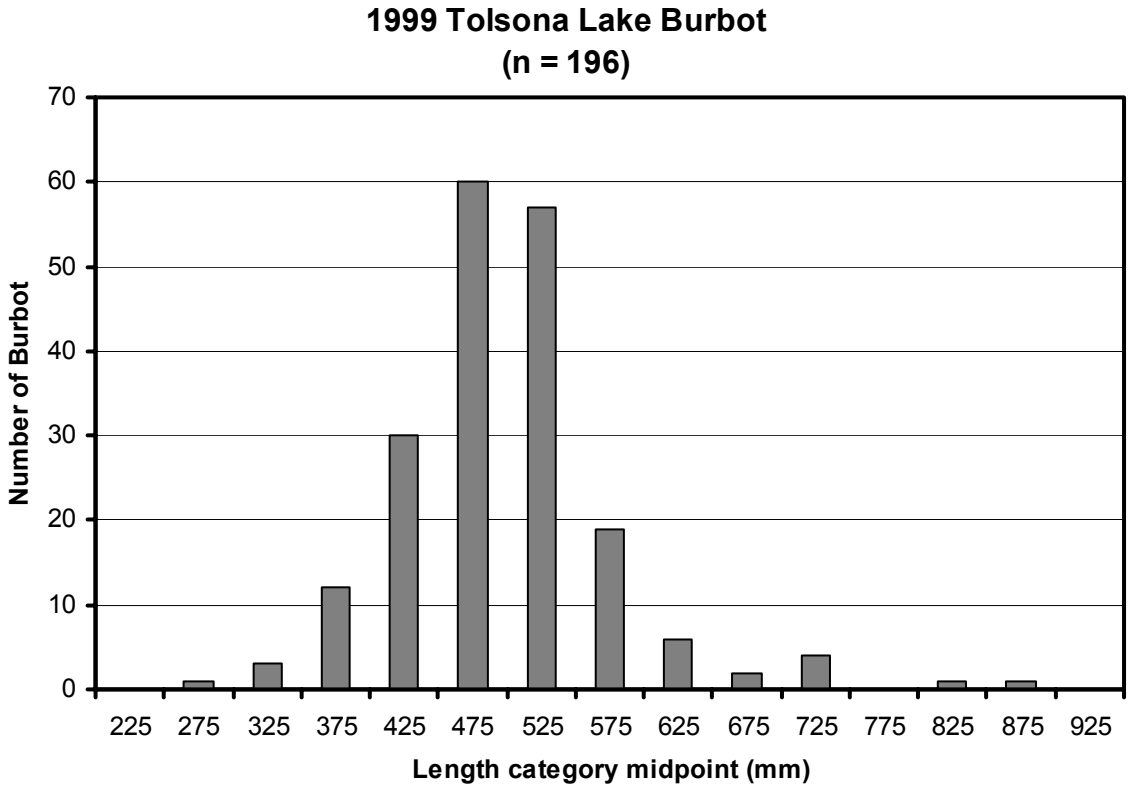

Figure 3.-Length frequency of burbot captured in Tolsona Lake, 1999.

Table 3.-Estimated abundance and density of fully recruited (≥ 450 mm TL) burbot in Tolsona Lake during 1998 and Lake Louise during 1994.

Lake	Date	Abundance	SE	Area of Lake (ha)	Density (burbot/ha)	SE
Tolsona						
1998	5/19-21	1,831	748	130	14.09	5.75
Louise						
1994	6/06-20	4,698	811	6,519	0.72	0.12

Table 4.-Estimated mean CPUE of fully recruited (≥ 450 mm TL) burbot in Tolsona Lake, 1999 and Lake Louise, 1995, 1996, and 1999.

Lakes and Dates	Strata	Sets	Transects	Mean CPUE			Bootstrapped	
				Bootstrapped	Arithmetic	%Δ	SE	CV
Tolsona								
6/1-3/99	All depths	59	7	2.57	2.58	-0.1%	0.58	22.5%
Louise								
6/16-25/99	< 15 meters	600	32	0.38	0.38	0.0%	0.05	14.2%
6/11-17/96	< 15 meters	300	21	0.45	0.46	-1.1%	0.07	14.5%
6/05-17/95	< 15 meters	1363	142	0.40	0.40	0.0%	0.03	7.6%

Table 5.-Water quality data collected at Tolsona Lake, 1999.

Measurement	Indicator Critical level	July				September			
Depth		1.5 m	2.2 m	2.6 m	3.2 m	2.1 m	2.4 m	3.3 m	3.8 m
Temperature (C°)	> 18°C	15.80	15.43	15.41	15.41	10.07	10.10	10.16	10.16
Dissolved Oxygen	< 2.0 ppm	10.18	7.84	4.53	4.01	8.31	9.60	9.50	9.90
PH	7-9	7.95	8.32	8.11	8.22	8.37	8.58	8.30	8.61
Water clarity	< 2.0 m	2.16				3.25			

Table 6.-Estimates of abundance, survival rate, and recruitment for fully recruited (≥ 450 mm TL) burbot residing in Lake Louise.

Date	Days between events	Abundance			Survival Rate %		Recruitment	
		Estimate	SE	CV %	Estimate	SE	Estimate	SE
6/25/86		6,990	2,131	30.5				
	358				30.9	5.8	1,864	2,032
7/06/87		3,788	1,028	27.1				
	330				89.2	14.2	2,718	1370
6/11/88		5,843	1,318	22.6				
	357				55.5	7.0	1,280	851
6/01/89		4,473	703	15.7				
	360				58.5	5.6	1,076	489
6/04/90		3,688	418	11.3				
	360				85.0	8.4	1,843	501
6/04/91		4,977	583	11.7				
	372				68.1	7.7	834	409
6/16/92		4,220	496	11.8				
	356				80.4	10.8	985	391
6/07/93		4,374	579	13.2				
	349				65.0	11.6	1,859	491
6/06/94		4,698	811	17.3				

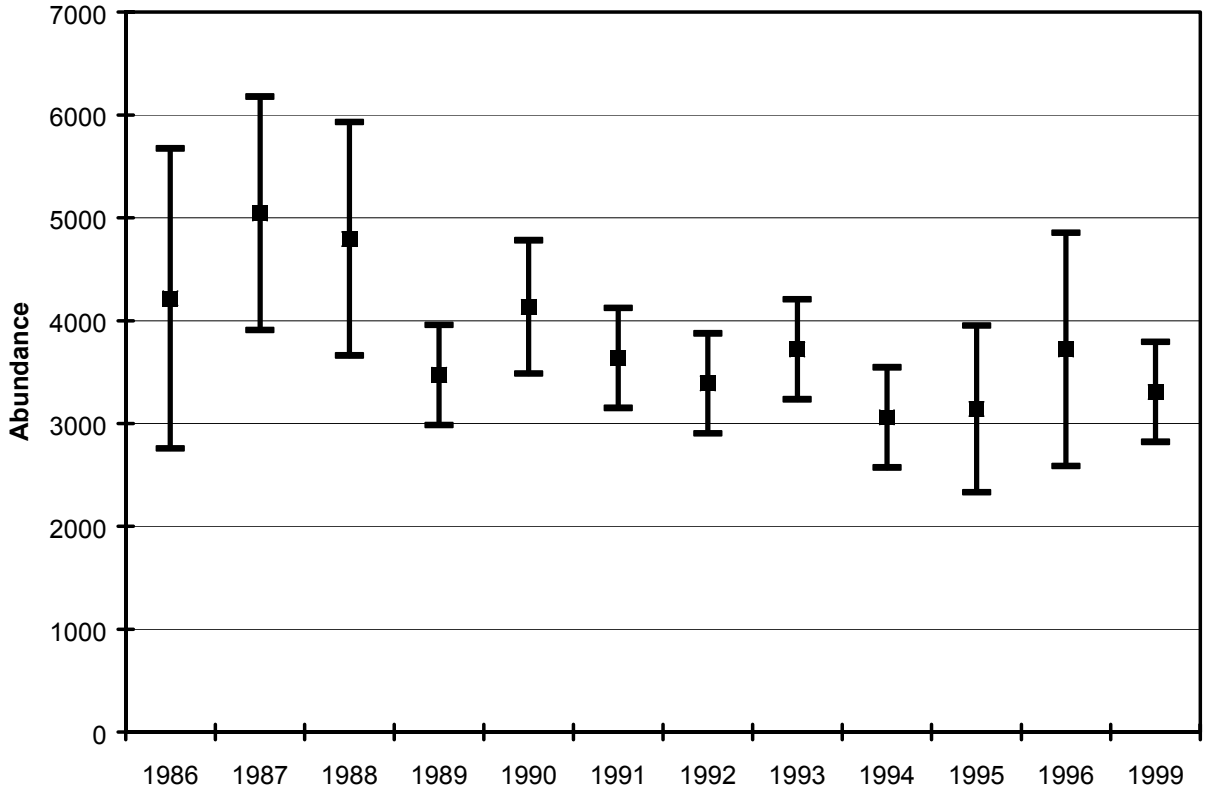

Figure 5.-Estimated abundance (expanded from CPUE) and 95% confidence intervals of fully recruited (≥ 450 mm) burbot in Lake Louise, 1986-99.

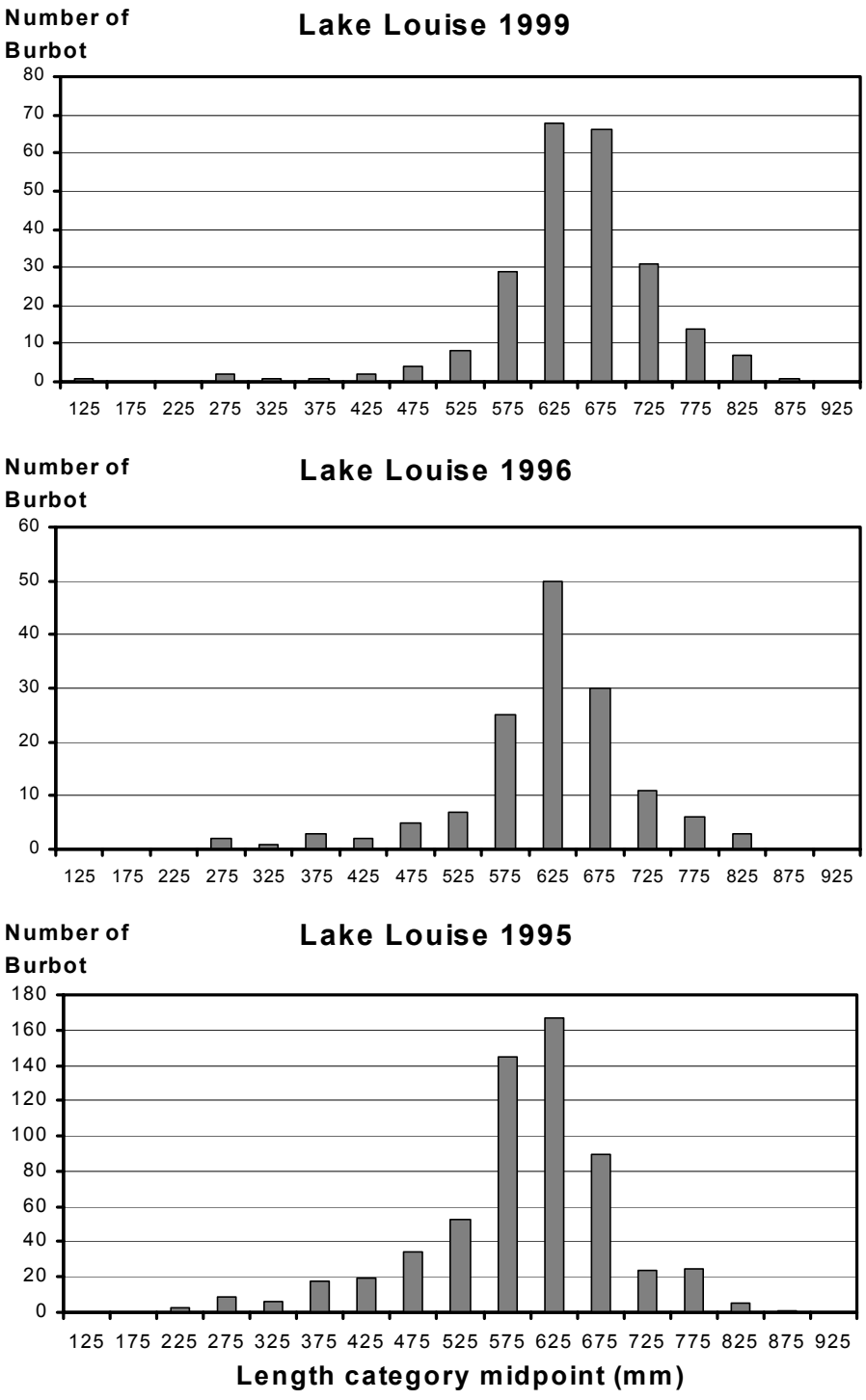

Figure 6.-Length frequencies of burbot captured in Lake Louise, 1995, 1996, and 1999.

Table 7.-Mean length (mm TL) of burbot measured during sampling events in Tolsona Lake, 1999 and Lake Louise, 1995, 1996, and 1999.

Lake	Statistic	Partially Recruited[a]	Fully Recruited	All
Tolsona	Mean	399	524	496
	SE	6	5	6
	Sample size	44	152	196
Louise				
1999	Mean	298	655	646
	SE	38	5	6
	Sample size	6	229	235
1996	Mean	349	636	620
	SE	19	6	8
	Sample size	8	137	145
1995	Mean	361	616	594
	SE	9	3	4
	Sample size	51	548	599

[a] Burbot partially recruited to the gear are < 450 mm TL and fully recruited burbot are ≥ 450 mm TL.

Table 8.-Estimated mean CPUE of partially recruited (<450 mm TL) burbot in Tolsona Lake, 1999 and Lake Louise, 1995, 1996, and 1999.

Lakes and Dates	Strata	Sets	Transects	Mean CPUE			Bootstrapped	
				Bootstrapped	Arithmetic	%Δ	SE	CV
Tolsona								
6/1-3/99	All depths	59	7	0.73	0.75	-2.0%	0.230	31.4%
Louise								
6/16-25/99	< 15 meters	600	32	0.01	0.01	-3.5%	0.005	66.3%
6/11-17/96	< 15 meters	300	21	0.03	0.03	-0.6%	0.015	55.1%
6/05-17/95	< 15 meters	1363	142	0.04	0.04	1.6%	0.009	23.0%

DISCUSSION

Abundance of burbot in Tolsona Lake in 1998 has apparently rebuilt to levels observed prior to the recent population decline. Currently, the estimate of abundance for 1998 is not statistically different than estimates for earlier years, due mainly to the uncertainty in the 1998 estimate. In the Jolly-Seber model, the most recent estimate of abundance has the greatest degree of uncertainty. Sampling again in 2000 should reduce the uncertainty of the estimate for 1998.

The sport fishery for burbot at Tolsona Lake was closed in 1998 to protect the then limited number of adults in the population. In anticipation of the Tolsona Lake burbot fishery reopening before the next Board of Fisheries meeting (which occurs in 2002), the Board of Fisheries in December 1999 reduced the daily bag limit from five to two burbot for Tolsona and Moose lakes. This reduction was requested by the department to reduce harvest at Tolsona Lake to a sustainable level, even if climatic and environmental conditions cause population declines, and would allow for an uninterrupted fishery. Though Moose Lake did not suffer a decline in burbot abundance, the proximity of the lake to Tolsona Lake could result in increased effort on Moose Lake. Identical bag limits at both lakes should not result in additional effort at either lake.

The increase in burbot abundance in Tolsona Lake is likely due to a combination of reduced harvest (fishery closure since March 1998) and favorable climate conditions. In 1992, the Copper River Basin experienced a late spring and early fall. As a result, water temperatures in Tolsona Lake during the open water period were favorable for survival of young burbot. This was reflected in the high recruitment between 1997-98. No burbot were reported harvested in 1997 and 1998 (Howe et al. 1998-1999). Average annual harvest declined from 84 burbot during 1989-1992 to 56 burbot during 1993-1996. The declining harvests from 1989-1996 may reflect the declining abundance during this period and may have resulted in little effort in 1997 and early winter 1998. The lack of harvest during 1997-98 no doubt contributed to the increased abundance in May 1998.

Recent estimates of abundance in Lake Louise indicate little increase in the population since the initiation of sampling in 1988. Lake Louise has essentially been closed to sport fishing through Emergency Order or by regulation since 1988 (Szarzi and Bernard 1995). There has been some concern regarding illegal setline activity on the lake, but it is unknown what level of harvest this represents. Winter fishery surveys conducted by UCUSMA staff in 1998 revealed little evidence of this activity. As a result, it is unclear why the Lake Louise burbot population has not increased. The length distribution has remained relatively similar since 1989, with a mode at the 625 mm category (Lafferty et al. 1990-1992; Lafferty and Bernard 1993; Taube et al. 1994; and Taube and Bernard 1995). Prior to 1989, the impact of the sport fishery is observed with few large fish in the sample (Potterville and Bernard 1987; Parker et al. 1988, 1989). One hypothesis is that the lake trout population increased and filled the niche occupied by the previously larger burbot population. Lake trout research began on Lake Louise in 1990 and concluded in 1995, providing estimates of lake trout abundance for 1991-94 (Szarzi 1992, 1993, Szarzi and Bernard 1994, 1995, 1997). Based upon this research there appears to be an increase in the Lake Louise lake trout population during this period. However, this information does not provide conclusive evidence that the lake trout population in Lake Louise has increased as a result of the fishery-induced decline in the burbot population.

Although the mean length and abundance of burbot in Lake Louise has remained stable from 1995 to 1999, there are more burbot > 675 mm indicating the total biomass of burbot in Lake Louise has increased. It appears that this is a result of larger than average recruitment in 1993 moving through the population (Table 2). Large recruitment also occurred in 1987 and 1990, which is likely the reason why the length composition in 1999, resembles the 1992 and 1995 length compositions more closely than those years in between (Lafferty and Bernard 1993).

ACKNOWLEDGMENTS

A note of appreciation to the field crew who conducted the sampling: Doug Edwards, James Savereide, Doug Vollman, and Nate Tobey. Thanks to Mike Wallendorf for biometric assistance and Dr. Margaret Merritt and Matt Evenson for editorial expertise on this manuscript and assistance in the coordination of the project.

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APPENDIX A

Appendix A1.-Description of lakes with burbot populations sampled in 1999.

LAKE LOUISE (62°20’ N, 146°30’ W) is the largest lake in a three-lake system that drain into the Susitna River, and is accessible by the Glenn Highway on a 25 km gravel road. Lake Louise is 6,519 hectare with a maximum depth of 51 m and an elevation of 720 m. A state campground with boat launch is available. Four lodges are found along the south end of the lake, and numerous cabins are located around the shore. Lake Louise has supported year-round fishing for Arctic grayling, lake trout, and round whitefish. Longnose suckers are also present.

TOLSONA LAKE (62°06’ N, 146°04’ W) is accessible from the Glenn Highway. Tolsona Lake is 130 hectare with a maximum depth of 4 m and an elevation of 625 m. Tolsona Lake has numerous cabins and one lodge. No public recreational facilities are available. This lake has had a popular burbot fishery in the winter in recent years. Tolsona Lake has Arctic grayling, longnose suckers, and stocked rainbow trout.

APPENDIX B

Appendix B1.-Mark-recapture histories of fully recruited (≥450 mm TL) burbot by year for the population in Tolsona Lake.

Tolsona Lake																		
Date : Year	1986	1987	1988	1988	1989	1989	1990	1990	1991	1991	1992	1993	1994	1995	1996	1997	1998	1999
Beginning	9/23	6/02	5/25	8/30	5/22	9/11	5/22	9/05	5/20	9/09	6/11	5/20	6/01	5/23	6/05	5/27	5/19	6/01
Ending	10/10	6/04	5/27	9/01	5/24	9/13	5/24	9/07	5/23	9/12	6/13	5/22	6/03	5/25	6/07	5/29	5/21	6/03
Number of Fully Recruited Burbot:																		
Recaptured from Event 1	0	123	35	14	5	3	5	9	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 2		0	79	32	33	18	11	5	1	1	0	0	0	0	0	0	0	0
Recaptured from Event 3			0	51	36	11	8	6	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 4				0	47	12	10	5	3	0	0	0	0	0	0	0	0	0
Recaptured from Event 5					0	62	16	11	10	2	0	0	0	1	0	0	0	0
Recaptured from Event 6						0	22	11	3	1	0	0	0	0	0	0	0	0
Recaptured from Event 7							0	21	12	2	2	0	0	1	0	0	0	0
Recaptured from Event 8								0	33	5	7	0	1	0	0	0	0	0
Recaptured from Event 9									0	35	12	6	1	0	1	0	0	0
Recaptured from Event 10										0	27	3	3	1	0	0	0	0
Recaptured from Event 11											0	6	6	5	0	1	1	0
Recaptured from Event 12												0	37	16	7	2	0	0
Recaptured from Event 13													0	27	3	2	0	0
Recaptured from Event 14														0	29	3	2	0
Recaptured from Event 15															0	11	6	3
Recaptured from Event 16																0	6	5
Recaptured from Event 17																	0	24
																		0
Captured with tags	0	123	114	97	121	106	72	68	62	46	48	15	48	51	40	19	15	32
Captured without tags	531	379	236	118	237	143	143	112	301	91	148	214	162	151	111	96	264	163
Captured	531	502	350	215	358	249	215	180	363	137	196	229	210	202	151	115	279	195
Released with tags	531	497	350	215	358	249	215	180	362	136	196	225	209	198	129	104	279	195

Appendix B2.-Mark-recapture histories of fully recruited (≥450 mm TL) burbot by year for the population in Lake Louise.

Lake Louise

Date : Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Beginning	6/25	7/06	6/11	6/01	6/04	6/04	6/16	6/07	6/06	6/05
Ending	9/02	8/19	6/24	6/17	6/19	6/14	6/30	6/21	6/20	6/17
Number of Fully Recruited Burbot:										
Recaptured from Event 1	0	19	9	12	2	2	1	2	1	1
Recaptured from Event 2		0	19	12	15	3	3	2	1	0
Recaptured from Event 3			0	32	21	12	6	3	4	4
Recaptured from Event 4				0	72	34	22	12	8	0
Recaptured from Event 5					0	73	43	48	15	8
Recaptured from Event 6						0	59	37	18	15
Recaptured from Event 7							0	58	31	22
Recaptured from Event 8								0	49	28
Recaptured from Event 9									0	47
Recaptured from Event 10										0
Captured with tags	0	19	28	56	110	124	134	162	127	125
Captured without tags	523	501	494	573	607	497	423	450	443	459
Captured	523	520	522	629	717	621	557	612	570	584
Released with tags	470	235	430	625	714	618	554	609	569	581

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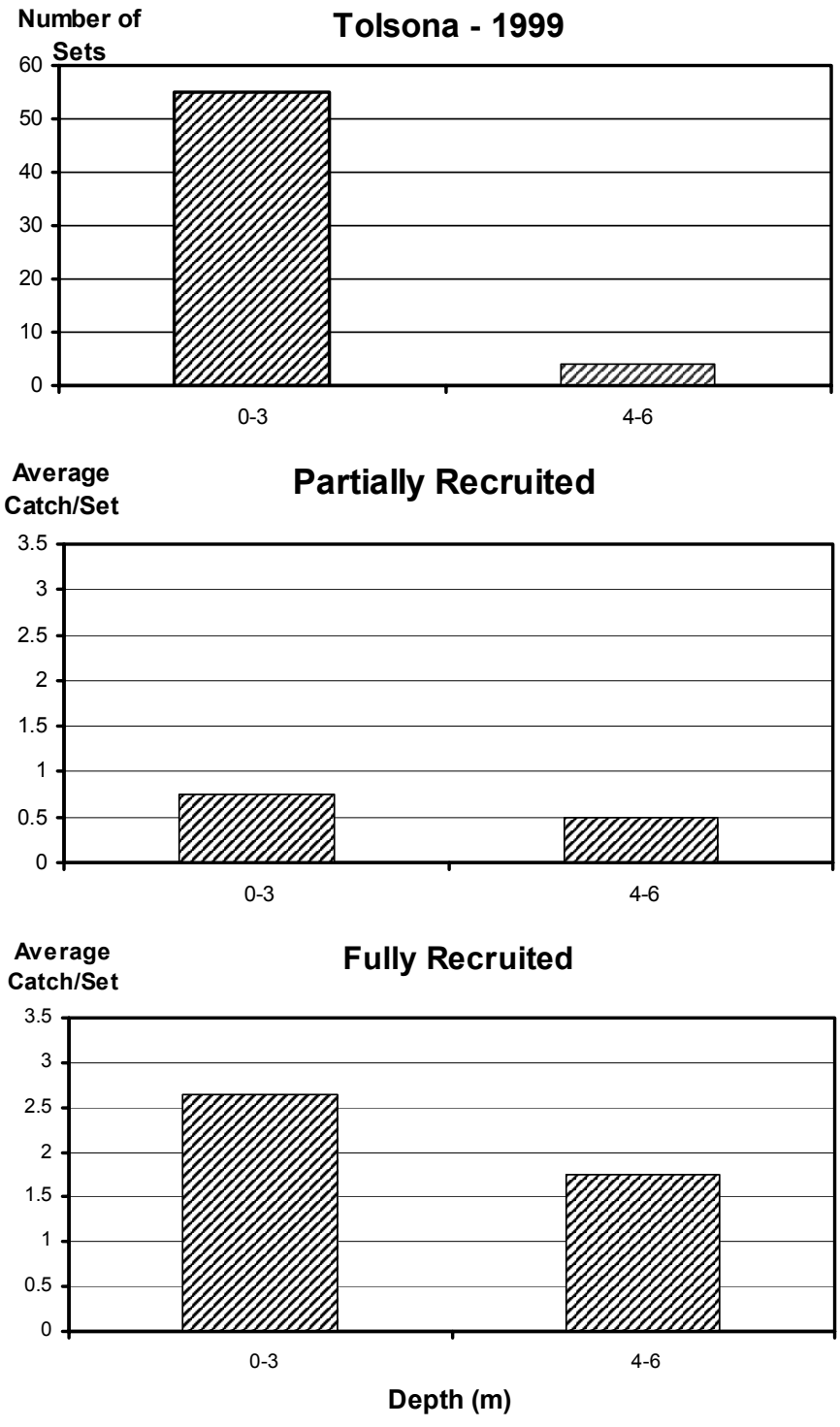
APPENDIX C

Appendix C1.-Frequency of sets by depth and average catch of burbot by depth in Tolsona Lake in 1999.



Appendix C2.-Frequency of sets by depth and average catch of burbot by depth in Lake Louise, 1995, 1996, and 1999.