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Stock Assessment and Biological Characteristics of Burbot in Tolsona and Klutina Lakes, 2003

by

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and

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February 2005

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

FISHERY DATA REPORT NO. 05-03

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ABSTRACT

Stock assessments of burbot *Lota lota* were conducted in Tolsona and Klutina lakes using baited hoop traps systematically set along randomly selected transects during the spring of 2003. In Tolsona Lake, abundance, mean CPUE and length composition were estimated for the population of burbot, and in Klutina Lake, mean CPUE and length composition were estimated. In Tolsona Lake, the mean CPUE of fully recruited burbot (i.e., ≥ 450 mm TL) per 48-hour set was 4.02 (SE = 0.58), which was the second highest estimate of CPUE since 1989. Mean length of fully recruited burbot captured in Tolsona Lake was 544 mm (SE = 5.1). Abundance of fully recruited burbot in Tolsona Lake during May 2002 was estimated as 763 (SE = 224) using the Jolly-Seber mark-recapture method. Water quality measurements in Tolsona Lake were within preferred ranges of burbot for temperature, dissolved oxygen, and pH. Sampling in Klutina Lake indicated that burbot densities were relatively low. Mean CPUE of fully recruited burbot from Klutina Lake was 0.086 (SE = 0.029) and mean length of fully recruited burbot captured in Klutina Lake was 618 mm (SE = 26.6).

Key words: Burbot, *Lota lota,* Jolly-Seber, abundance, length composition, catch per unit effort, hoop traps, mean length, Tolsona Lake, Klutina Lake.

INTRODUCTION

Historically, the lakes of the Upper Copper/Upper Susitna Management Area (UCUSMA; Figure 1) supported the largest burbot fishery in the state. Annual harvests from the UCUSMA averaged over 8,000 burbot, or 57% of the statewide burbot harvest from 1977 – 1988 (Taube 2002). 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). Concerns of overexploitation resulted in the Alaska Department of Fish and Game (ADF&G) initiating a continuing research study in 1986 to assess stock status and to estimate the sustained yield of burbot in interior Alaska lakes. Many studies have been conducted on lake burbot throughout the UCUSMA since 1986 (Lafferty and Bernard 1993, Lafferty et al. 1990-1992; Parker et al. 1987-1989; Perry-Plake and Bernard *in prep*; Taube and Bernard 1995, 1999, 2001, 2004, Taube et al. 1994, 2000). In 1988, the Alaska Board of Fisheries adopted as regulation (5 AAC 52.045, 1988) a lake burbot management plan that directs the lake burbot fisheries in the UCUSMA be managed for maximum sustained yield.

The department has since managed harvest levels of burbot fisheries in the UCUSMA through reduced bag limits, gear restrictions, and lake closures. In 1988, the use of setlines was prohibited by emergency order in the Tyone River drainage, and in Tolsona and Moose lakes. In 1991 regulation passed prohibiting the use of setlines in the entire UCUSMA. Since the elimination of setlines in the UCUSMA, annual burbot harvests have remained relatively stable, ranging between 1,000 – 3,000 burbot. Various bag and possession limits have been enacted since 1991. Presently, the bag and possession limit for burbot on most lakes, including Klutina Lake, is five. Tolsona Lake is presently closed to the retention of burbot. One lake presently has a bag and possession limit of one burbot (Lake Louise), and several road accessible lakes have bag and possession limits of two burbot (Summit Lake located near Paxson, Hudson, Moose, Susitna, and Tyone lakes).

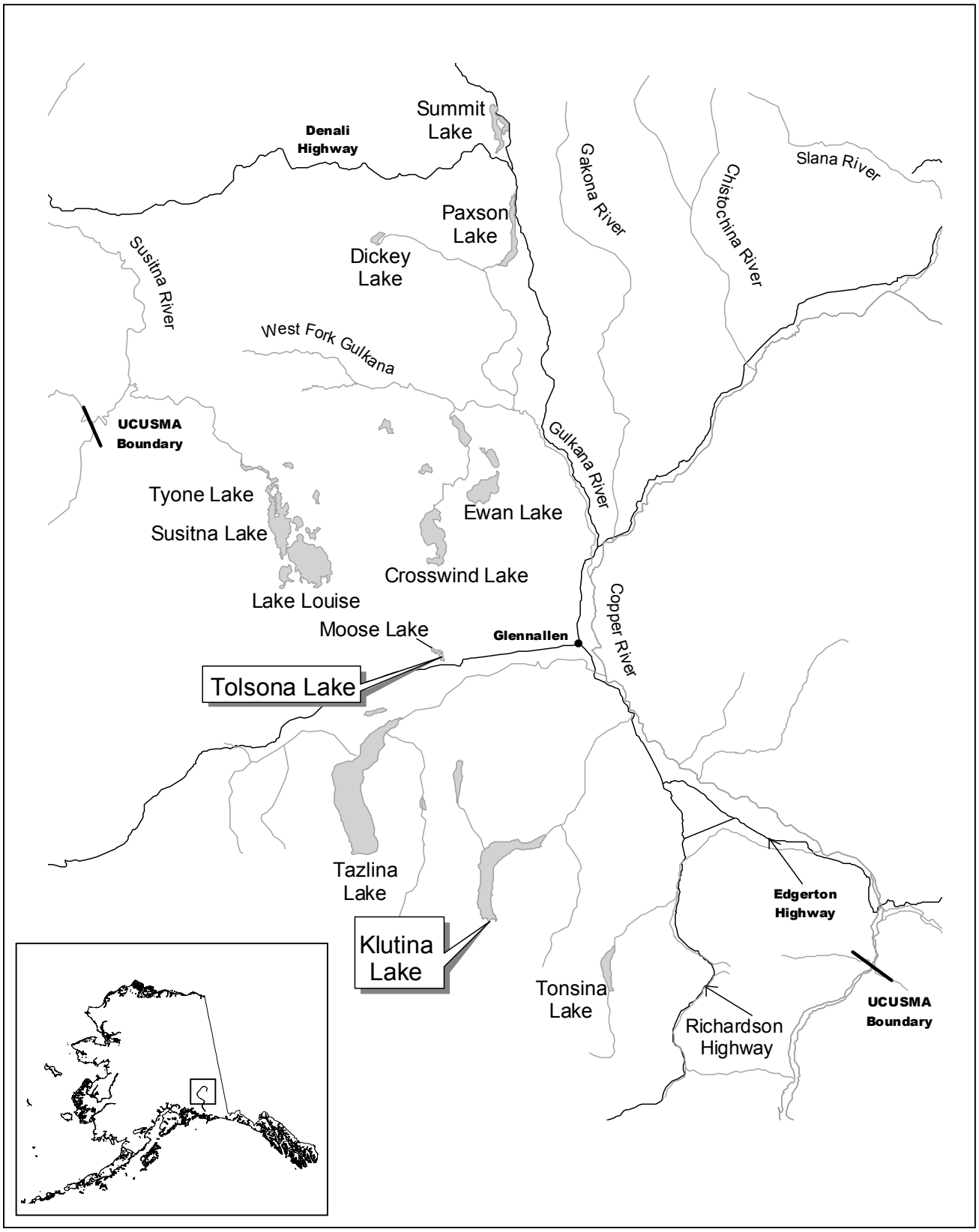

Figure 1.-Locations of Tonsina and Klutina lakes, and selected lakes of the UCUSMA.

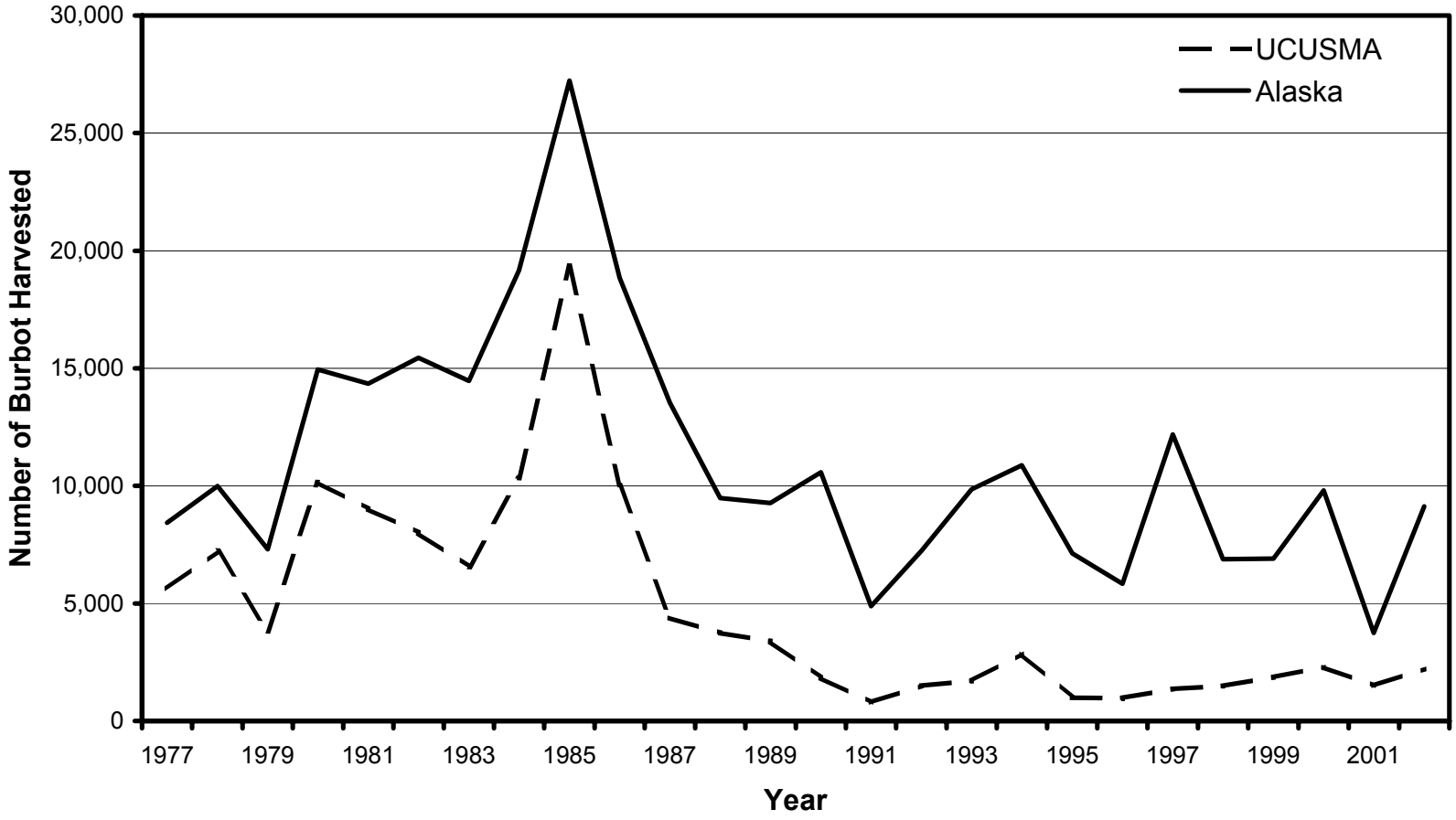

Figure 2.–Harvest of burbot in sport fisheries of the Glennallen area (UCUSMA) compared to total Alaskan sport harvest, 1977-2002.

Stock assessments of burbot at Tolsona Lake have been conducted annually since 1986 (Lafferty and Bernard 1993; Lafferty et al. 1990-1992; Parker et al. 1987-1989; Perry-Plake and Bernard *in prep*; Taube and Bernard 1995, 1999, 2001, 2004; Taube et al. 1994, 2000; Figure 1) to determine the population's status relative to prescribed management objectives. The continuous and long-term nature of this project has provided an improved understanding of population dynamics on a burbot stock that resides in a shallow, productive lake, atypical of burbot in Alaska. In 1998, Tolsona Lake was closed to burbot fishing due to a significant 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. Tolsona Lake will remain closed to the harvest of burbot until its population reaches 1,500 fully recruited burbot, a level deemed sufficient to sustain anticipated harvest with a two burbot bag limit and the use of setlines prohibited (Taube and Bernard 2001).

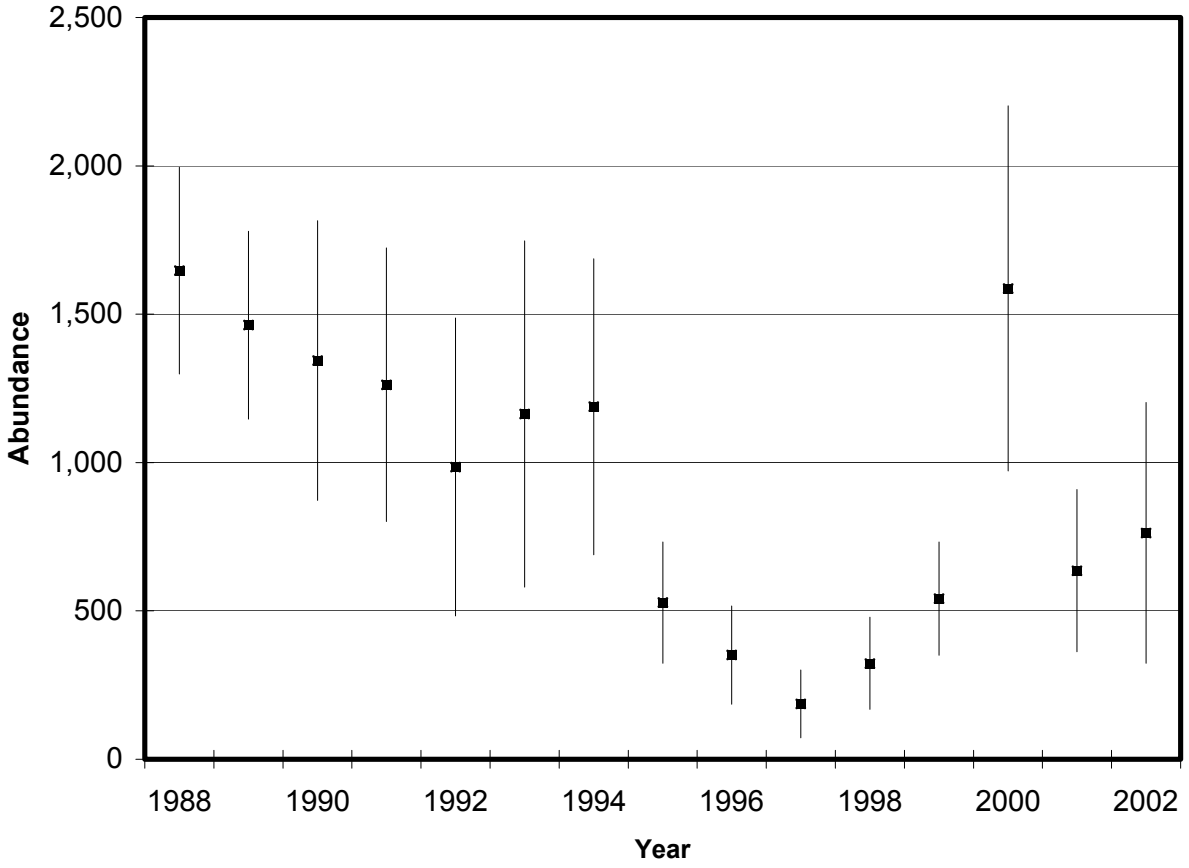

Figure 3.–Estimated abundance and 95% confidence intervals of fully recruited (≥ 450 mm) burbot in Tolsona Lake, 1987-2002.

Dissolved oxygen, temperature, pH, conductivity and water clarity have been measured in Tolsona Lake since 1998. This monitoring program was initiated after the observed decline in burbot abundance from 1995 – 1997, which was attributed more to lethal water quality conditions than to exploitation (Taube and Bernard 2001). Tolsona Lake is relatively small and shallow and has approached the critical temperature level (> 18º C) for burbot in the past, and may be prone to reach the critical value for dissolved oxygen (< 2.0 ppm) in late winter (Simpson 1997). Additionally, effluent runoff (e.g., septic, road) may occur at Tolsona Lake and the continuous sampling of water quality may detect any adverse effects this potential runoff may have on the lake and burbot production.

While stock assessment at Tolsona Lake has a long history, burbot of Klutina Lake (Figure 1; Appendix A) had never been studied prior to 2003. Although harvests of burbot have been historically low (last reported harvest was 19 fish in 1993), stock assessment at Klutina Lake was conducted because of an anticipated increase in fishing pressure as indicated from an increase in snow machine activity and public interest in the area. An estimate of mean CPUE for burbot would provide a gross measure of potential sustained yield, which in turn could be used to determine if a more rigorous stock assessment of the population was warranted if meaningful increases in harvests occurred. Length information gathered would also be valuable for providing insights into the degree to which the population was exploited. For example, the relatively high occurrence of larger-sized or older burbot in the sample could indicate a low level of exploitation.

The objectives for the project during 2003 were to:

1. estimate the length composition of fully recruited burbot (≥ 450 mm TL) for each sampling event in Klutina and Tolsona lakes such that the estimated proportions were within ± 10% of the actual values 95% of the time;
2. estimate mean catch per unit of effort (CPUE) of fully recruited burbot in Klutina Lake such that the estimated mean CPUE was within ± 15% of its asymptotic value 95% of the time; and,
3. estimate the abundance of fully recruited burbot in Tolsona Lake for May 2002 such that the estimated abundance was within ± 50% of the true abundance 90% of the time.

Project tasks for 2003 were to:

1. collect temperature data to provide a temperature profile of Tolsona Lake during the open-water period;
2. collect water quality information at one-month intervals in Tolsona Lake from May – September;
3. collect dissolved oxygen measurements from Tolsona and area lakes during April; and,
4. estimate mean CPUE of fully recruited burbot in Tolsona Lake.

METHODS

STUDY DESIGN

Burbot were captured in 3-m long baited hoop traps with 25-mm mesh netting 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. No traps were set deeper than 15 meters in Klutina Lake to avoid decompression induced mortality associated with burbot captured at greater depths (Bernard et al. 1993). Sampling at Tolsona and Klutina lakes commenced within a couple days after each lake became ice-free to maximize the catch per set (Bernard et al. 1993). A set was defined as a single hoop trap baited with Pacific herring *Clupea pallasi* soaked for 48 hours. In Tolsona Lake 60 sets were fished and 420 sets were fished in Klutina Lake (Table 1).

Table 1.–Number of sets and dates of sampling events for the stock assessment of burbot populations in Tolsona and Klutina lakes, 2003.

Lake	Area (ha)	Dates of Sampling Events	Number of Sets
Tolsona	130	5/19 – 5/21	60
Klutina	6,380	5/29 – 6/04	420

After lifting a hoop trap, the catch was emptied into a holding tank and all burbot were measured for total length (to the nearest 5 mm). Burbot sampled from Klutina Lake were released immediately after measuring. Burbot captured from Tolsona Lake were inspected for previous tags and secondary marks. If marked with a tag, the tag number was recorded. If no tag was present, the fish was marked with an individually numbered internal anchor tag (Floy™ FD-94) inserted in the musculature beneath the dorsal fin. All tags were checked to ensure that they were locked between the pterygiophores of the dorsal fin. A hole was cut with a paper punch in the left operculum of each burbot captured. Excision of the left ventral fin (2001), excision of the right ventral fin (2002), and a punched hole in an operculum (2003) have been used as secondary marks in a three-year rotation at Tolsona Lake since 1990, except for 1995-1997 when the dorsal fin clip was used. A recaptured burbot missing its tag was considered to have been last captured in the most recent year the secondary mark was used. Individual trap and associated catch information were recorded on standard hoop-net mark-sense forms (Heineman *unpublished*). Trap information included: hoop trap number, location of set, depth of set, hour set and 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.

Monthly measurements (.5 m depth increments) of water temperature, conductivity, dissolved oxygen, pH and clarity at Tolsona Lake were planned for 2003 beginning with first effort through the ice in April. A hole was drilled through the ice and measurements were recorded with a Minisonde 4 Hydrolab[1] on 10 April 2003. Subsequent measurements in the open-water

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

period were not taken. Staff turnover and the lack of access to sampling equipment prohibited the planned open water measurements. Measurements of water temperature, dissolved oxygen, and pH were compared to that of preferred ranges for burbot (Scott and Crossman 1973; Simpson 1997). Conductivity and pH measurements were also compared to those collected in 1993 during a University of Alaska-Fairbanks research project (Simpson 1997).

DATA ANALYSIS

Length-frequency distributions of captured burbot from Tolsona and Klutina lakes were summarized in 50-mm increments. Cumulative length-frequency distributions of captured burbot from Tolsona Lake were compared to previous years. Kolmogorov-Smirnov two-sample tests were used to determine if significant changes occurred in the population, which may, for example, reflect strong recruitment or low survival when considering changes in abundance indices (i.e., mean CPUE).

Mean CPUE was estimated for fully and partially recruited burbot in both Tolsona and Klutina lakes 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 was:

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

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 auto-correlated or follow a trend (Wolter 1984). Analysis of data from previous 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 2003 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 were:

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

Abundance, survival rate and recruitment statistics were generated for the burbot population in Tolsona Lake 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. Individual burbot captured more than once in 2003 were considered caught only once in this analysis to estimate abundance. Estimates of abundance are lagged one year and estimates of survival and recruitment are lagged two years from the most recent sampling event due to the nature of the model. Conditions for producing accurate statistics with the Jolly-Seber model were:

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.

Statistics were only generated for burbot ≥ 450 mm TL because Bernard et al. (1991) demonstrated that burbot < 450 mm TL are not fully recruited to the hoop traps used in this project (Bernard et al. 1991). 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), the proportion of fish over 900 mm is negligible. 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 fin clip) permitted correction of bias in estimates due to loss of tags. Previous studies indicated little evidence of capture-induced behavior (trap happiness or trap shyness) with a sampling hiatus of one year (Bernard et al. 1991). Although an intermittent stream connects Moose and Tolsona lakes, only one of over a thousand burbot recaptured from 1986 - 2003 had moved between lakes.

RESULTS

TOLSONA LAKE

Two hundred ninety-five burbot were captured from Tolsona Lake in 2003, and 241 of these were fully recruited to the gear (Appendix B). Of these 295 burbot, 52 had been previously captured. Ten of these (19.2%) experienced tag loss, evident from the presence of only secondary marks. Of these, four had left ventral fin clips indicating capture in 2001, one had a right ventral fin clip indicating capture in 2002, and five had dorsal fin clips indicating they were captured in 1995, 1996 or 1997. These latter five fish were not used in the mark-recapture analyses because the exact year of last capture could not be determined. In addition, seven previously tagged burbot were not counted as recaptured fish because they were not fully recruited to the gear at the time of first capture (Appendix B).

Length distribution was unimodal with the peak occurring at 475 mm (midpoint of 50 mm TL class; Figure 4). The mean length of fully recruited burbot was 544 mm (SE = 5.1) and the mean length of partially recruited burbot was 409 mm (SE = 3.7; Table 2).

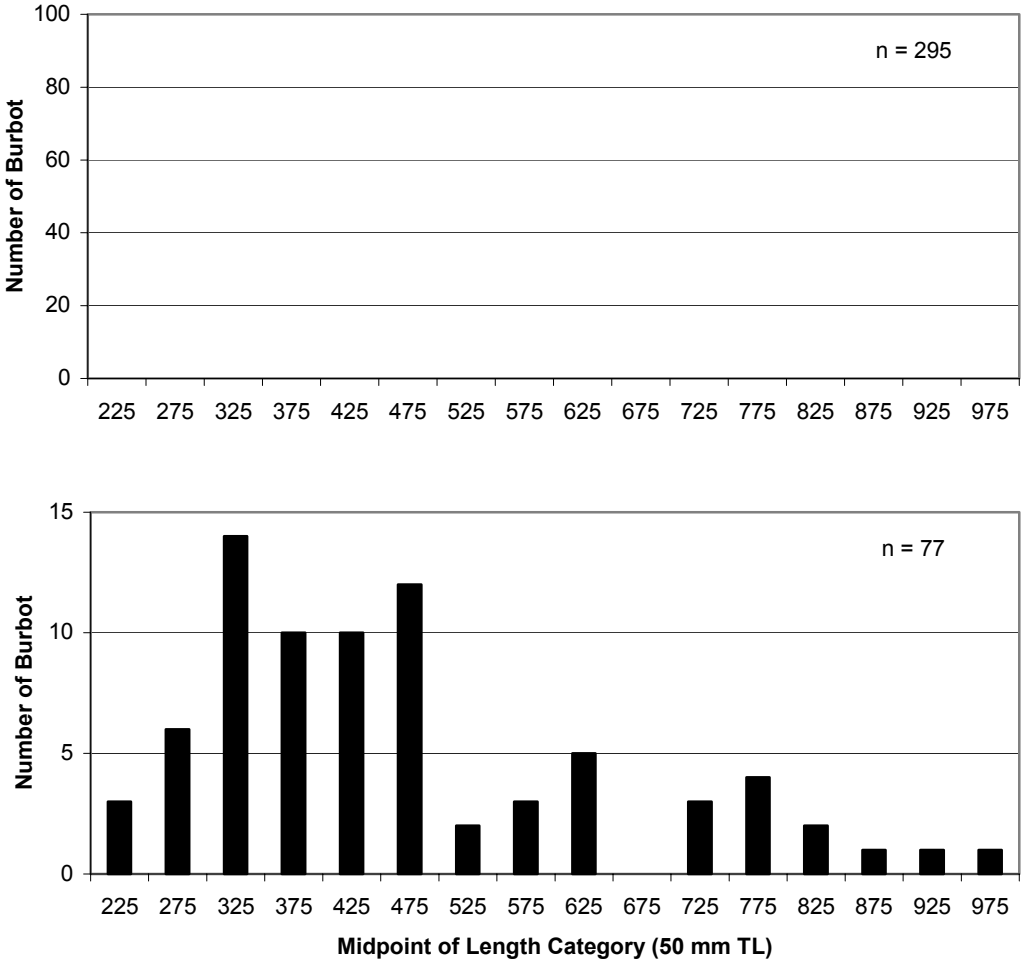

Figure 4.–Length-frequency of burbot captured in Tolsona (upper graph) and Klutina (lower graph) lakes, 2003.

Table 2.–Mean length (mm TL) of burbot measured during sampling events in Tolsona and Klutina lakes, 2003.

Lake	Statistic	Partially Recruited[a]	Fully Recruited	All
Tolsona Lake	Mean	409	544	518
	SE	3.7	5.1	5.2
	Sample size	54	241	295
Klutina Lake	Mean	347	618	474
	SE	8.8	26.6	20.4
	Sample size	41	36	77

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

Mean CPUE of fully recruited burbot in Tolsona Lake in 2003 was 4.02 (SE = 0.58; Table 3), and estimated abundance a year earlier was 763 (SE = 224; Table 4; Figure 3). Abundance in 2002 corresponds with an estimated density of 5.87 burbot/ha (SE = 1.72). Recruitment was estimated at 116 burbot (SE = 127) and survival rate was estimated to be 102% (SE = 30.3%) between spring sampling events in 2001 and 2002 (Table 5). Average catch per set was greater in shallow water sets (0-3 m) for partially recruited burbot and greater in deep water sets (4-6 m) for fully recruited burbot (Appendix C).

Table 3.–Estimated mean CPUE of fully recruited (≥ 450 mm TL) and partially recruited (< 450 mm TL) burbot in Tolsona and Klutina lakes, 2003.

Lakes and Dates	Strata	Sets	Transects	Mean CPUE			Bootstrapped	
				Bootstrapped	Arithmetic	%Δ	SE	CV
Tolsona Lake								
5/19 – 5/21	All depths	60	9					
		Fully Recruited:		3.99	4.02	0.2	0.58	14.5
		Partially Recruited:		0.89	0.90	1.1	0.24	27.0
Klutina Lake								
5/29 – 6/04	< 15 m	420	82					
		Fully Recruited:		0.085	0.086	1.1	0.029	34.3
		Partially Recruited:		0.096	0.098	2.2	0.026	26.7

Table 4.–Estimated abundance and density of fully recruited (≥ 450 mm TL) burbot in Tolsona Lake, 2002.

Lake	Date	Abundance	SE	Area of Lake (ha)	Density (burbot/ha)	SE
Tolsona	6/6/02 – 6/8/02	763	224	130	5.87	1.72

Table 5.–Estimates of population parameters of fully recruited (≥ 450 mm TL) burbot in Tolsona Lake, 1986-2002.

Date	Days Between Events	CPUE[a]	Abundance[a]			Survival Rate %[a]		Recruitment[a]	
			Estimate	SE	CV %	Estimate	SE	Estimate	SE
9/26/86		3.98	1,901	120	6.3				
	235					60.0	4.6	138	209
6/25/87		2.79	1,291	120	9.3				
	335					77.9	7.1	645	144
5/26/88		5.93	1,647	178	10.8				
	95					66.6	7.4	45	111
9/01/88		3.58	1,142	132	11.5				
	263					77.8	9.1	576	124
5/24/89		5.86	1,464	162	11.1				
	110					95.1	17.6	277	174
9/13/89		4.08	1,846	311	16.8				
	251					47.9	9.8	460	153
5/24/90		3.59	1,344	240	17.9				
	104					35.0	6.3	86	67
9/07/90		2.95	556	85	15.3				
	255					67.0	12.2	890	191
5/22/91		3.62	1,262	235	18.6				
	109					35.9	6.5	96	87
9/12/91		1.14	549	105	19.1				
	273					87.5	22.6	505	171
6/11/92		3.14	985	256	26.0				
	341					25.2	6.0	915	275
5/20/93		3.83	1,164	298	25.6				
	375					95.1	18.2	86	349
6/01/94		3.50	1,188	255	21.5				
	354					31.8	7.0	150	74
5/23/95		3.44	528	104	19.7				
	377					38.3	9.3	149	56
6/05/96		2.19	352	84	23.9				
	354					37.6	11.6	54	37
5/27/97		0.80	187	58	31.0				
	355					35.3	10.2	257	74
5/19/98		2.19	323	79	24.5				
	375					74.5	10.1	301	119
6/01/99		2.57	541	98	18.1				
	367					119.9	21.6	940	243
6/08/00		6.25	1,587	314	19.8				
	356					32.2	6.5	125	108
5/31/01		1.83	635	139	21.9				
	371					101.9	30.3	116	127
6/06/02		2.03	763	224	29.4				
	348								
5/21/03		4.02							

[a] Data from Lafferty et al. 1990-1992, Lafferty and Bernard 1993; Parker et al. 1987-1989; Perry-Plake and Bernard i*n prep*; Taube and Bernard 1995, 1999, 2004, Taube et al. 1994, 2000.

Measurements of water temperature, dissolved oxygen and pH were within preferred ranges for Tolsona Lake in April 2003, with the exception of dissolved oxygen near the bottom of the lake (Table 6). This is common near the bottom of interior lakes in late winter and typically does not affect survival. There were no reports of burbot carcasses on the shore in springtime, which would have indicated winter mortality.

Table 6.–Measurements of limnological parameters from Tolsona Lake, April 10, 2003.

Measurement	Preferred Range[a]	Depth						
		0.0 m	0.5 m	1.0 m	1.5 m	2.0 m	2.5 m	2.8 m
Temperature (C°)	< 18°C	0.45	0.14	1.09	2.51	3.48	3.92	3.84
Dissolved Oxygen[a]	>2.0 ppm	4.80	4.18	3.78	3.32	3.05	2.35	1.24
pH	6.5 – 9	7.45	7.43	7.43	7.44	7.45	7.41	7.40
Conductivity (µS/cm)	NA	534	528	516	505	501	503	504

[a] From Simpson (1997) and Scott and Crossman (1973).

KLUTINA LAKE

Seventy-seven burbot were captured from Klutina Lake in 420 sets, and 36 of the burbot were fully recruited to the gear (≥ 450 mm TL). The mean CPUE of burbot in Klutina Lake was extremely low at 0.086 (SE = 0.029) for fully recruited burbot and 0.096 (SE = 0.028) for partially recruited burbot (Table 3). Relative precision (with 95% confidence) for both of these estimates was poor: 67% for fully recruited burbot and 53% for partially recruited burbot. The length-frequency distribution of all sampled burbot was irregular (Figure 4) as would be expected for such small sample sizes. However, relatively large numbers of big fish (> 700 mm) were captured. The mean length of fully recruited burbot was 618 mm (SE = 26.6) and the mean length of partially recruited burbot was 347 mm (SE = 8.8; Table 2).

DISCUSSION

Estimated abundance of fully recruited burbot in Tolsona Lake has fluctuated the last several years, but has generally increased from the declines in 1995 – 1997 (Figure 3; Table 5). This increase in abundance was likely due to a combination of reduced harvest (fishery closure since March 1998) and favorable environmental conditions. The 2002 point estimate of 763 (95% CI = 326 – 1,200) was the second highest since 1997, below only the 2000 point estimate of 1,587 (95% CI = 971 – 2,203) burbot (Table 5). However, the 2000 and 2002 estimates were not significantly different from each other, nor was the 2002 estimate different from all other years since the fishery closure. With the exception of 2000, all estimates of abundance since 1998 were significantly less than 1,500 burbot, the level prescribed for reopening the fishery.

Because mean CPUE and abundance are significantly related ($R^2 = 0.65$, $P < 0.01$; Figure 5), the 2003 Jolly-Seber spring abundance estimate may increase from the 2002 spring estimate. The mean CPUE of 4.02 for fully recruited burbot was the second highest since 1990; however, it was substantially less than the high of 6.25 in 2000 (Table 5). While mean CPUE is highest in the spring, mean CPUE also declines at this time (Bernard et al. 1993), making such year-to-year comparisons problematical.

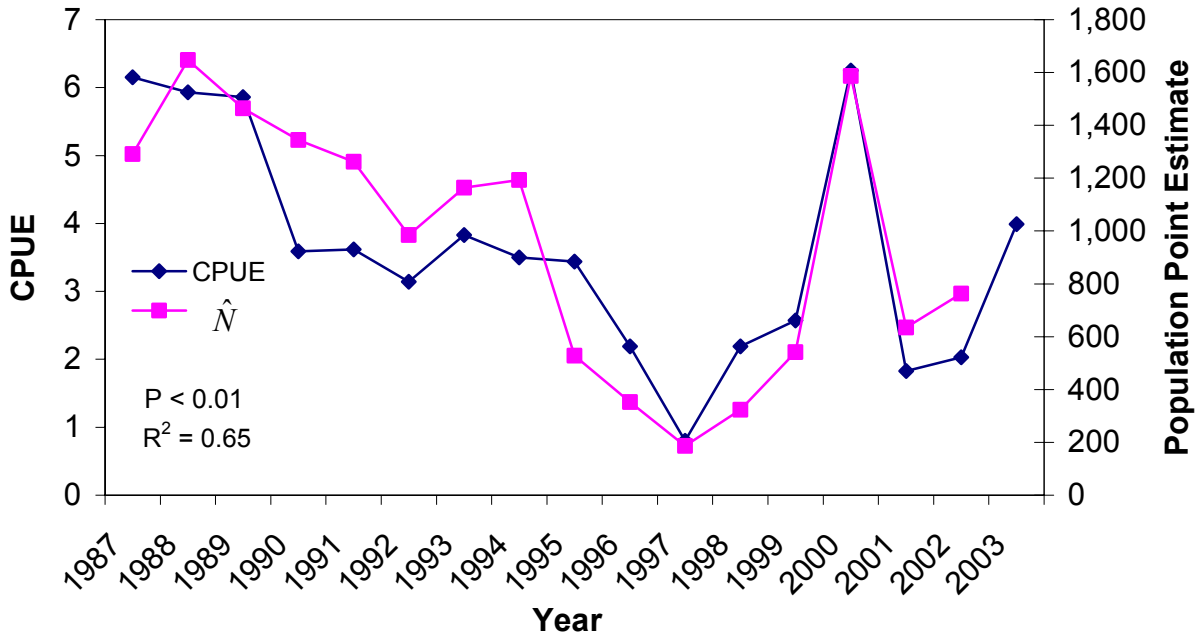

Figure 5.–Comparison of mean CPUE and abundance estimates ($\hat{N}$) of fully recruited burbot in Tolsona Lake, 1987-2002.

The five fully recruited burbot with tag loss as evident by a dorsal fin clip adds bias to the estimates. Assuming these fish were captured initially in 1995, 1996 or 1997, estimates of survival and abundance would be higher than what the model currently estimates for each year after these fish were initially captured. The abundance estimate for the year the fish were initially captured would decrease because the recapture rate of fish tagged in that year would be higher. The earlier the year of initial capture, the greater the bias would be.

The observed increase in the CPUE index of abundance and the differences in length composition suggest that strong recruitment occurred between 2002 and 2003, which should be corroborated by the Jolly-Seber model after sampling in 2004. There was a significant difference in the cumulative length distribution of all burbot sampled in 2002 and 2003 (DN = 0.21, P < 0.01), as well as a significant difference between fully recruited burbot cumulative length frequencies sampled in those two years (DN = 0.29, P < 0.01; Figure 6). Mean length of all sampled burbot in 2002 was 535 mm, compared to 519 mm for 2003 (Perry-Plake and Bernard *in prep*; Table 2). Additionally, mean length of fully recruited burbot was 575 mm in 2002, compared to 544 mm in 2003.

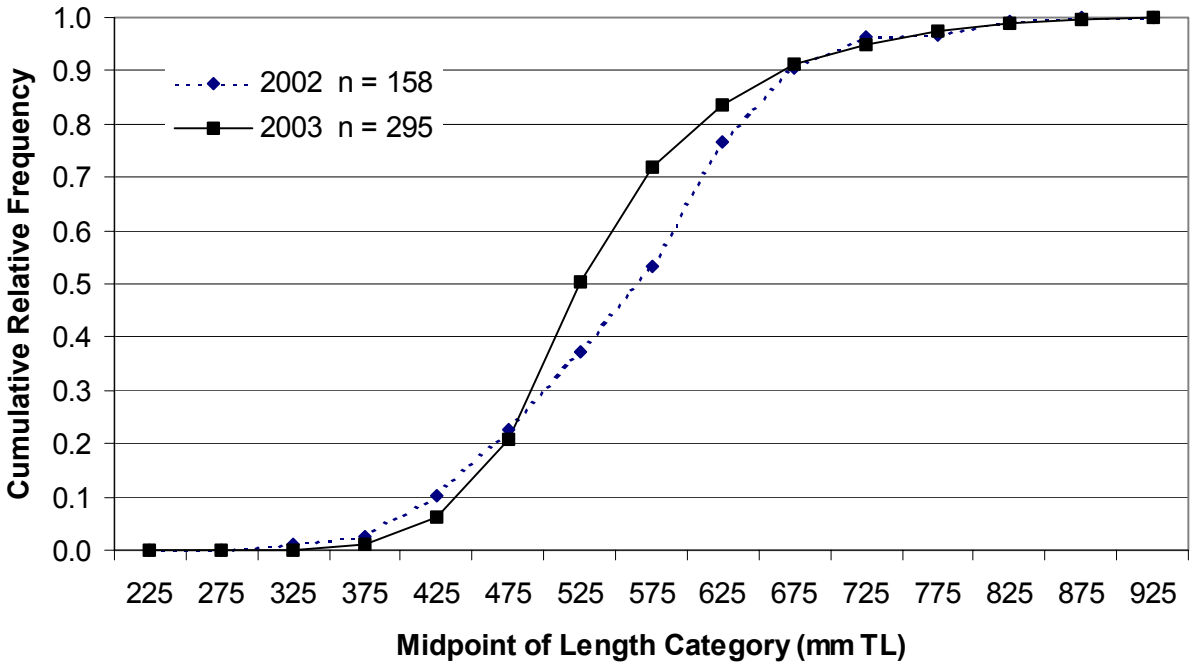

Figure 6.–Comparison of cumulative length frequency distributions of all burbot sampled from Tolsona Lake, 2002 and 2003.

Information from the population in Klutina Lake indicates little opportunity for an intensive fishery for burbot in the future. Mean CPUE of less than 0.1 burbot per set indicates a sparse population. For comparison, previous spring sampling in similarly sized Lake Louise yielded a mean CPUE estimate of 0.42 fully recruited burbot with a density of about two fully recruited burbot every 1.5 ha (Lafferty et al. 1992; Taube and Bernard 1995; Taube et al. 1994, 2000). However, even given the apparent low density, Klutina Lake is so large (6,380 ha) that it is likely the lake supports a large enough population to provide for a limited consumptive fishery. Klutina Lake is glacially occluded, and Lake Louise is not, but it is doubtful catchability of burbot in hoop traps in glacially occluded lakes is significantly different than those of non glacial lakes. The apparent low density in Klutina Lake is most likely because of natural conditions (i.e., low productivity) and not the result of overexploitation. No harvest of burbot has been reported in the statewide harvest survey since 1993, when 19 burbot were estimated as being harvested. The frequent occurrence of relatively large burbot among the 36 captured in 2003 is consistent with low exploitation.

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APPENDIX A

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 past years. Tolsona Lake has Arctic grayling *Thymallus arcticus*, longnose suckers *Catostomus catostomus* and stocked rainbow trout *Oncorhynchus mykiss*.

KLUTINA LAKE (61°42’ N, 145°45’ W) is accessible from a road originating at approximately mile 101 of the Richardson Highway. A designated boat launch area exists on the upper Klutina River approximately three km below the lake outlet. Klutina Lake is 6,380 hectare with a maximum depth of over 100 m and its elevation is 520 m. Several cabins exist at the outlet where the road ends. Much of the lake is undeveloped. Other species that reside in the lake are red salmon *Oncorhynchus nerka*, king salmon *Oncorhynchus tshawytscha*, Dolly Varden *Salvelinus malma*, Arctic grayling, whitefish *Coregoninae* and longnose suckers.

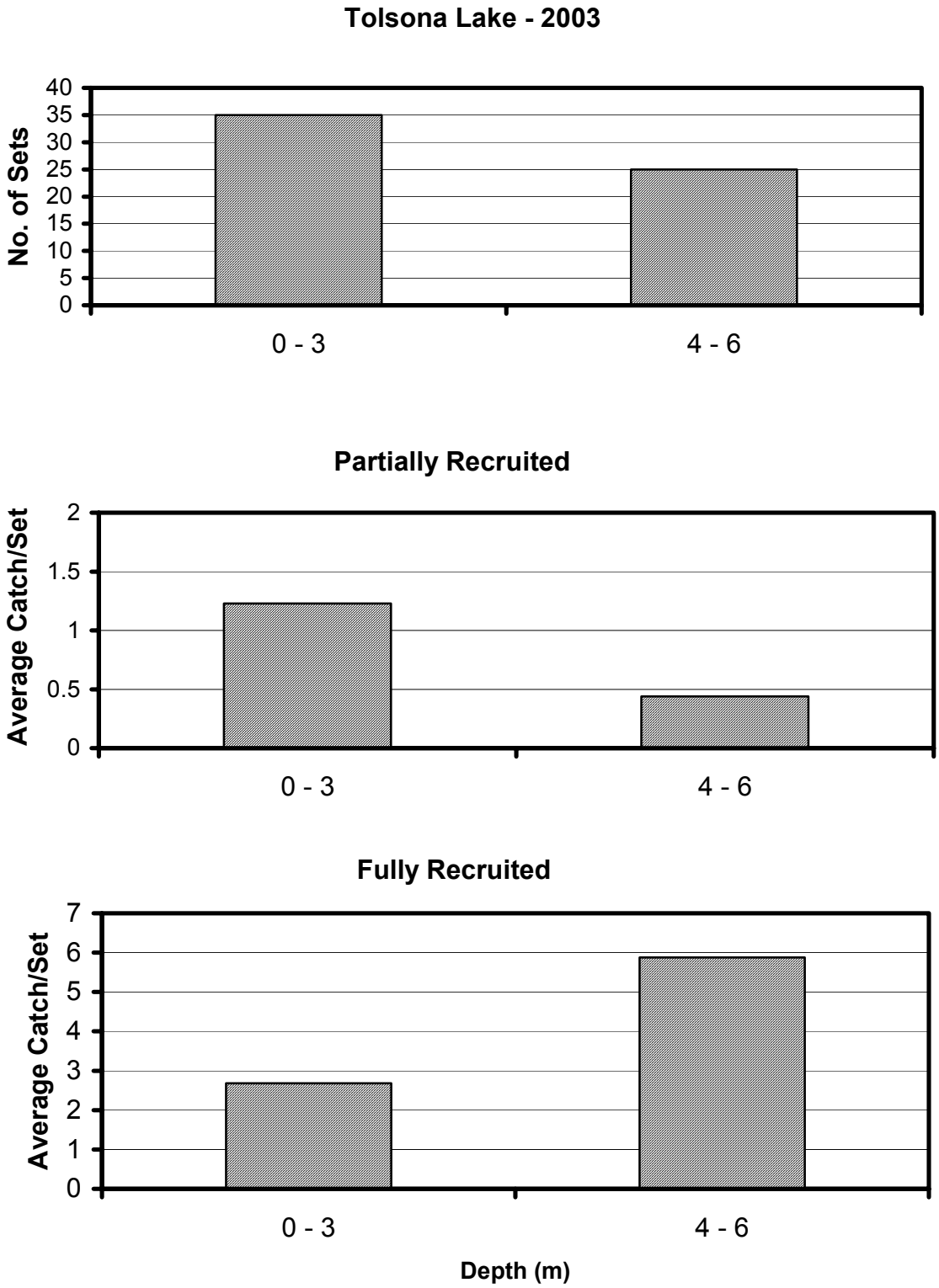
APPENDIX B

Appendix B1.–Mark-recapture histories of fully recruited (≥ 450 mm TL) burbot, Tolsona Lake, 1988-2003.

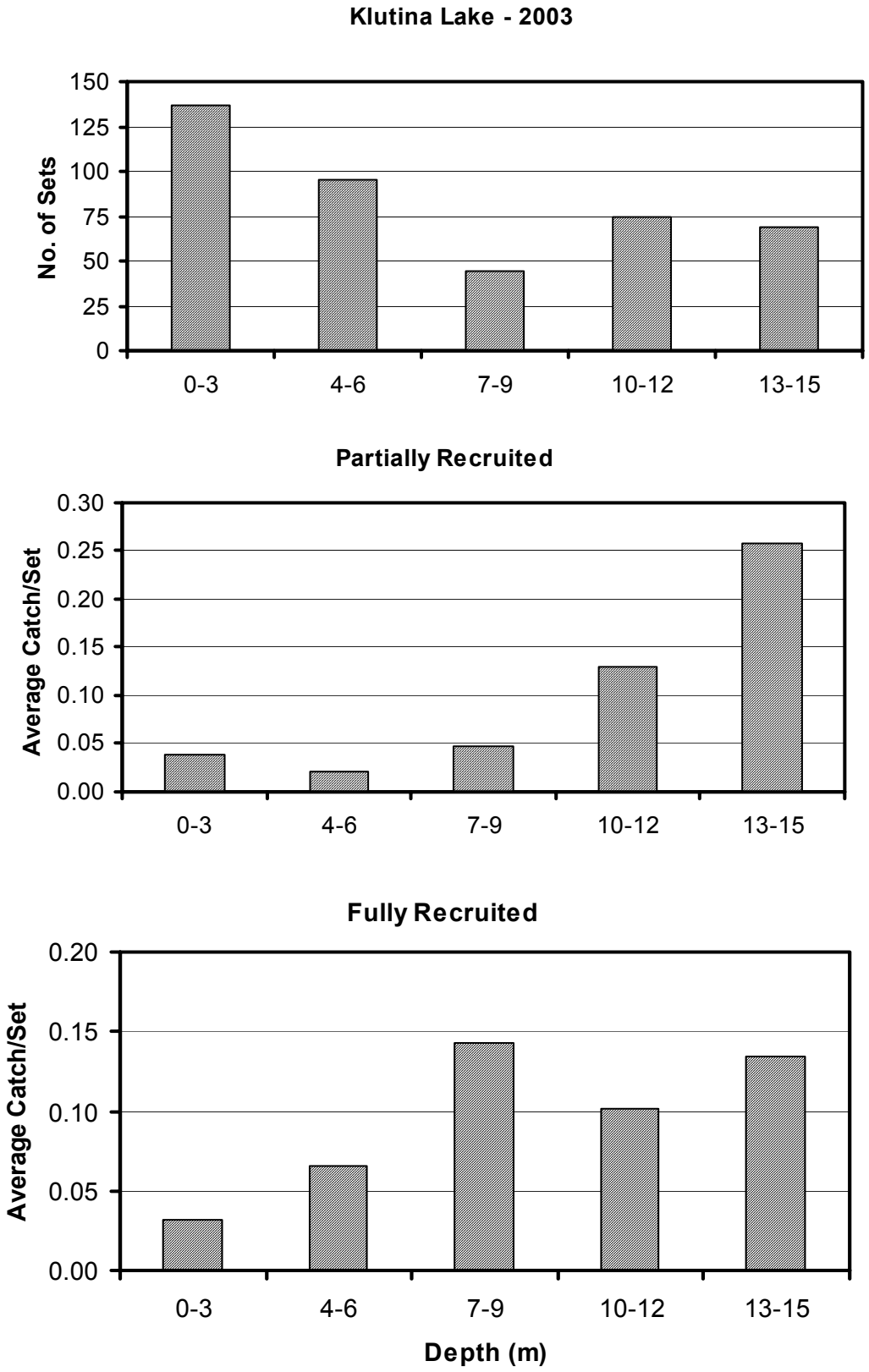
Event	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Date : Year	1988	1988	1989	1989	1990	1990	1991	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Beginning	5/25	8/30	5/22	9/11	5/22	9/05	5/20	9/09	6/11	5/20	6/01	5/23	6/05	5/27	5/19	6/01	6/06	5/29	6/04	5/19
Ending	5/27	9/01	5/24	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	6/08	6/31	6/06	5/21
Number of Fully Recruited Burbot:																				
Recaptured from Event 1	0	51	36	13	11	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 2		0	45	13	4	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 3			0	63	14	8	10	2	0	0	0	1	0	0	0	0	0	0	0	0
Recaptured from Event 4				0	22	9	5	2	0	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 5					0	21	15	2	2	0	0	1	0	0	0	0	0	0	0	0
Recaptured from Event 6						0	33	7	8	2	1	0	0	0	0	0	0	0	0	0
Recaptured from Event 7							0	35	14	8	1	0	1	0	0	0	0	0	0	0
Recaptured from Event 8								0	27	3	3	1	0	0	0	0	0	0	0	0
Recaptured from Event 9									0	6	7	6	0	1	1	0	0	0	0	0
Recaptured from Event 10										0	39	17	7	2	0	0	0	0	0	0
Recaptured from Event 11											0	27	3	2	0	0	0	0	0	0
Recaptured from Event 12												0	29	3	2	0	1	0	0	0
Recaptured from Event 13													0	11	6	3	1	0	0	0
Recaptured from Event 14														0	6	5	0	0	0	0
Recaptured from Event 15															0	24	23	4	5	0
Recaptured from Event 16																0	41	8	7	4
Recaptured from Event 17																	0	21	16	10
Recaptured from Event 18																		0	16	13
Recaptured from Event 19																			0	13
Recaptured from Event 20																				0
Captured with tags	0	51	81	89	51	51	66	48	51	19	51	53	40	19	15	32	66	33	44	40
Captured without tags	0	164	277	160	1164	129	297	89	145	210	159	142	89	29	118	120	308	79	78	201
Captured	350	215	358	249	215	180	363	137	196	229	210	195	129	48	133	152	374	112	122	241
Released with tags	350	215	358	249	215	180	362	136	196	225	209	195	129	48	133	151	372	112	121	240

APPENDIX C

Appendix C1.–Frequency of sets by depth and average catch of burbot by depth in Tolsona Lake, 2003.



Appendix C2.–Frequency of sets by depth and average catch of burbot by depth in Klutina Lake, 2003.



APPENDIX D

Appendix D1.–Summary of data archives.

Location	Project leader	Storage Software
Fairbanks	Lin Perry-Plake 822-3309	Delimited ASCII files, Microsoft EXCEL workbook

Lake	File Name	Data Format	Software
Tolsona	i-039800h012003.dta	Hoop net	RTS-ASCII
	2003 Tolsona BB tag history.xls	Tag history	Microsoft EXCEL
Klutina	i-019100h012001.dta	Hoop net	RTS-ASCII

Definition of data formats:

Hoop net: a mark-sense form developed by Alaska Department of Fish and Game, Division of Sport Fish Research and Technical Services (RTS) for the recording of trap, catch, and tagging information. Specific codes and organization of columns for data format is available on request.

Tag history: an EXCEL file that contains lake specific historical tagging information by individual tags and recaptures by sampling events.