Fishery Data Series No. 01-24

Salmon Studies in Interior Alaska, 2000

by
Lisa Stuby

December 2001

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition.

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

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
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	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

FISHERY DATA SERIES NO. 01-24

SALMON STUDIES IN INTERIOR ALASKA, 2000

by
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December 2001

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ABSTRACT

Attempts were made to acquire estimates of escapement for chinook salmon *Oncorhynchus tshawytscha* for the Chena and Chatanika rivers near Fairbanks, Alaska, using tower-count methodology. The counts were conducted from 29 June to 12 August for the Chena River and 4 July to 4 August for the Chatanika River. High water and subsequent poor visibility precluded acquisition of complete tower estimates for both rivers. The incomplete tower estimates for chinook salmon were 1,903 (SE = 165) for the Chena River and 398 (SE = 83) for the Chatanika River. A mark-recapture estimate was subsequently conducted on the Chena River in order to acquire a total estimate of abundance, which was 4,694 (SE = 1,184) chinook salmon. An aerial-survey count of chinook salmon during the period of maximum escapement was 934 for the Chena River, which was 0.21 of the mark-recapture estimate. For the Chena River, age, sex, and length compositions were examined by means of carcass and electroshock surveys, with the latter used to estimate compositions because it showed less bias with respect to gender. Males composed 0.66 (SE = 0.04) of the carcass samples and 0.80 (SE = 0.02) of the electroshocked samples. The majority of males examined were age 1.3 (0.36) and the rest comprised ages 1.1 (0.01), 1.2 (0.30), 1.4 (0.12), and 1.5 (0.01). The majority of females were age 1.4 (0.17) and the rest comprised 1.3 (0.03) and 1.5 (0.02). A carcass survey was conducted on the Chatanika River to estimate age, sex, and length compositions. The majority of males were age 1.3 (0.67) and the rest comprised 1.2 (0.25) and 1.4 (0.08). The majority of females were age 1.4 (0.64) and the rest 1.3 (0.36).

A portion of the escapement of chum salmon *Oncorhynchus keta* for the Chena and Chatanika rivers were also estimated during the tower-counts. The incomplete estimate of escapement for chum salmon was 3,515 (SE = 300) for the Chena River and 944 (SE = 138) for the Chatanika River.

The Bering Sea Fishermen's Association conducted tower counts of salmon on the Salcha River from 30 June to 12 August along with a carcass survey to estimate age, sex, and length compositions. High water also precluded acquisition of complete estimates of escapement for the Salcha River. The incomplete estimates of escapement were 3,140 (SE = 165) chinook salmon and 20,516 (SE = 403) chum salmon. A total estimate of 4,595 (SE = 802) chinook salmon was calculated by expanding missed counts based on historic run timing patterns. The majority of males were age 1.3 (0.57) and the rest comprised ages 1.2 (0.30) and 1.4 (0.13). The majority of females were age 1.3 (0.39) and 1.4 (0.39) and the rest comprised ages 1.2 (0.11) and 1.5 (0.11).

Escapement of coho salmon *Oncorhynchus kisutch* was enumerated for the Delta Clearwater River by means of a boat survey. A count of coho salmon in the mainstem river was 9,225 on 24 October. An expansion of 2,364, which was based on five years of aerial survey data of river tributaries that were not boat accessible, was added to the boat survey for a total escapement of 11,589 coho salmon. An aerial survey count of coho salmon on 26 October was 2,175 for the Richardson Clearwater River.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *Oncorhynchus keta*, coho salmon, *Oncorhynchus kisutch*, Salcha River, Chena River, Chatanika River, Delta Clearwater River, Richardson Clearwater River, mark-recapture, electroshock, age-sex-length composition, counting towers, carcass survey, aerial survey, boat survey, escapement.

CHINOOK AND CHUM SALMON STUDIES IN THE CHENA, CHATANIKA, AND GOODPASTER RIVERS

INTRODUCTION

The Chena River (Figure 1) has some of the largest chinook salmon *Oncorhynchus tshawytscha* escapements in the Yukon River drainage (Schultz et al. 1994). A popular sport fishery occurs in the lower 72 km of this river. Annual estimates of harvest since 1978 ranged from 0 to 1,270 chinook salmon (Mills 1979-1994; Howe et al. 1995-1996, 2001a-d; Table 1). The Chatanika River (Figure 2) supports a small run of chinook salmon. Recent estimates of sport harvests (0-348; Table 1), however, have indicated that relative exploitation may be large. The Goodpaster River originates in the uplands of the Tanana River and flows southwest for 224 km to its confluence with the Tanana River, 16 km north of Delta Junction (Figure 3). The entire

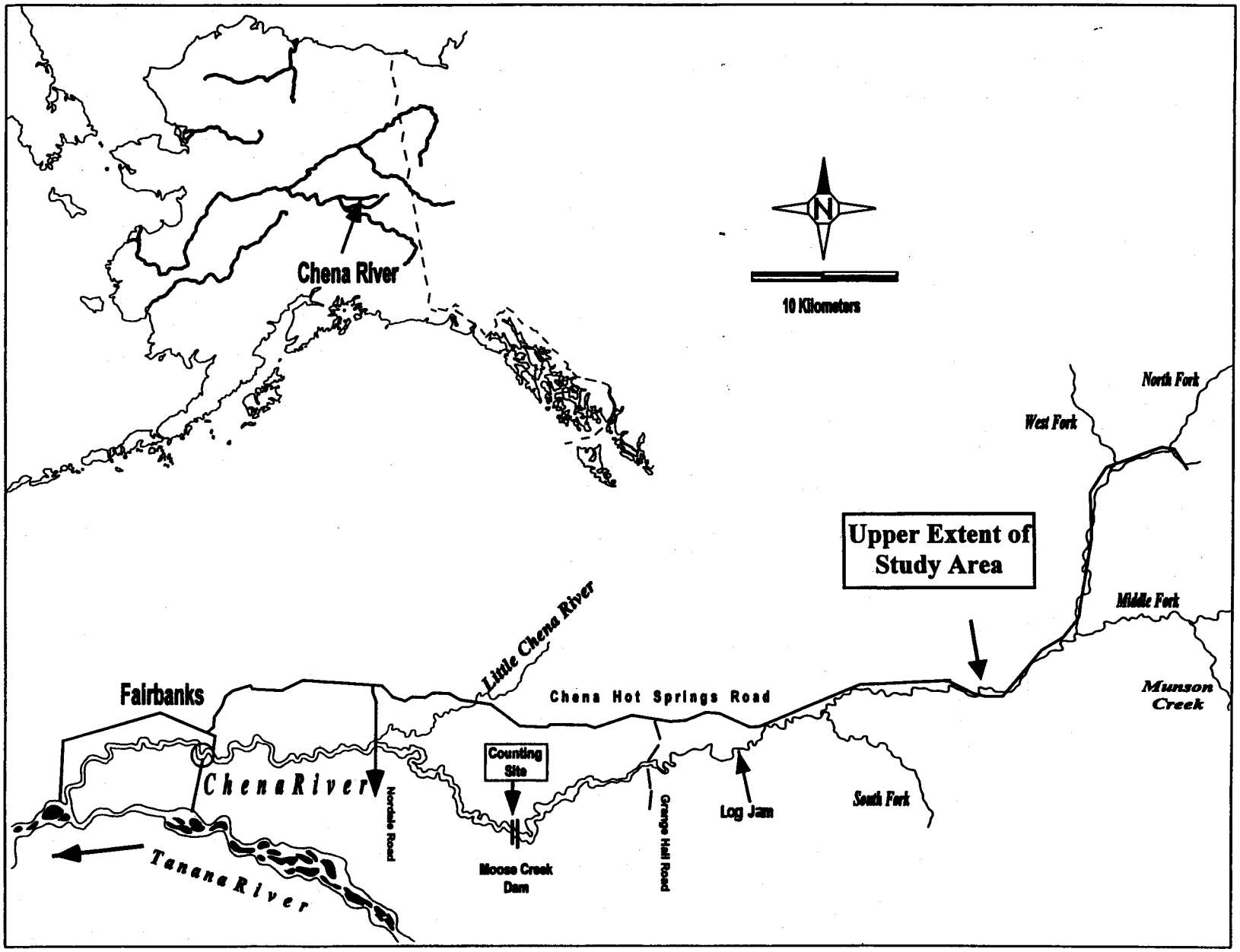


Figure 1.-Chena River study area.

Table 1.-Estimated sport, commercial, and subsistence harvests of anadromous chinook salmon in the Tanana River drainage, 1978 - 2000.

	Sport Harvest										
	Creel Survey[a]		Statewide Survey[b]						Commercial	Subsistence and Personal Use	Total Estimated
Year	Chena River	Salcha River	Chena River	Salcha River	Chatanika River	Nenana River	Other Streams	Tanana Drainage	Harvest[d]	Harvest[d,e]	Harvest
									Tanana Drainage		
1978	-	-	23	105	35	-	0	163	635	1,231	2,029
1979	-	-	10	476	29	-	0	515	772	1,333	2,620
1980	-	-	0	904	37	-	0	941	1,947	1,826	4,714
1981	-	-	39	719	5	-	0	763	987	2,085	3,835
1982	-	-	31	817	136	-	0	984	981	2,443	4,408
1983	-	-	31	808	147	-	10	1,048	911	2,706	4,665
1984	-	-	0	260	78	-	0	338	867	3,599	4,804
1985	-	-	37	871	373	-	75	1,356	1,142	7,375	9,873
1986	-	526	212	525	0	-	44	781	950	3,701	5,432
1987	-	111	195	244	21	7	7	474	3,338	4,096	7,908
1988	567	19	73	236	345	36	54	744	786	5,507	7,037
1989	685	123	375	231	231	39	87	963	2,181	2,999	6,143
1990	24	200	64	291	37	0	0	439	2,989	3,069	6,497
1991	-	362	110	373	82	11	54	630	1,163	2,515	4,308
1992	-	4	39	47	16	0	0	118	785	2,438	3,341
1993	-	54	733	601	192	0	19	1,573	1,445	2,098	5,116
1994	-	776	993	714	105	0	59	1,871	2,606	2,370	6,847
1995	-	811	662	1,448	58	0	320	2,488	2,747	2,178	7,413
1996	-	-	1,270[c]	1,136	348	53	118	2,925	447	1,392	4,764
1997	-	-	1,029[c]	719	155	10	0	1,913	2,728	3,025	7,666
1998	-	-	299	121	6	15	0	441	963	2,276	3,680
1999	-	-	442	445	36	11	0	934	690	1,955	3,579
2000	-	-	71	72	0	24	0	167	0	1,058[f]	1,225

a Creel census estimates from Clark and Ridder (1987), Baker (1988, 1989), Merritt et al. (1990), and Hallberg and Bingham (1991-1996).

b Sport fishery harvest estimates from Mills (1979-1994), Howe et al. (1995-1996, 2001a-d).

c Sport fishery harvest estimates from Doxey (2001).

d Commercial, subsistence, and personal use estimates (Schultz 1994; Bergstrom, et al. 2001; Borba and Hamner 2001, *in prep*).

e The personal use designation was implemented in 1988 to account for non-rural fishermen participating in this fishery.

f Preliminary data subject to change.

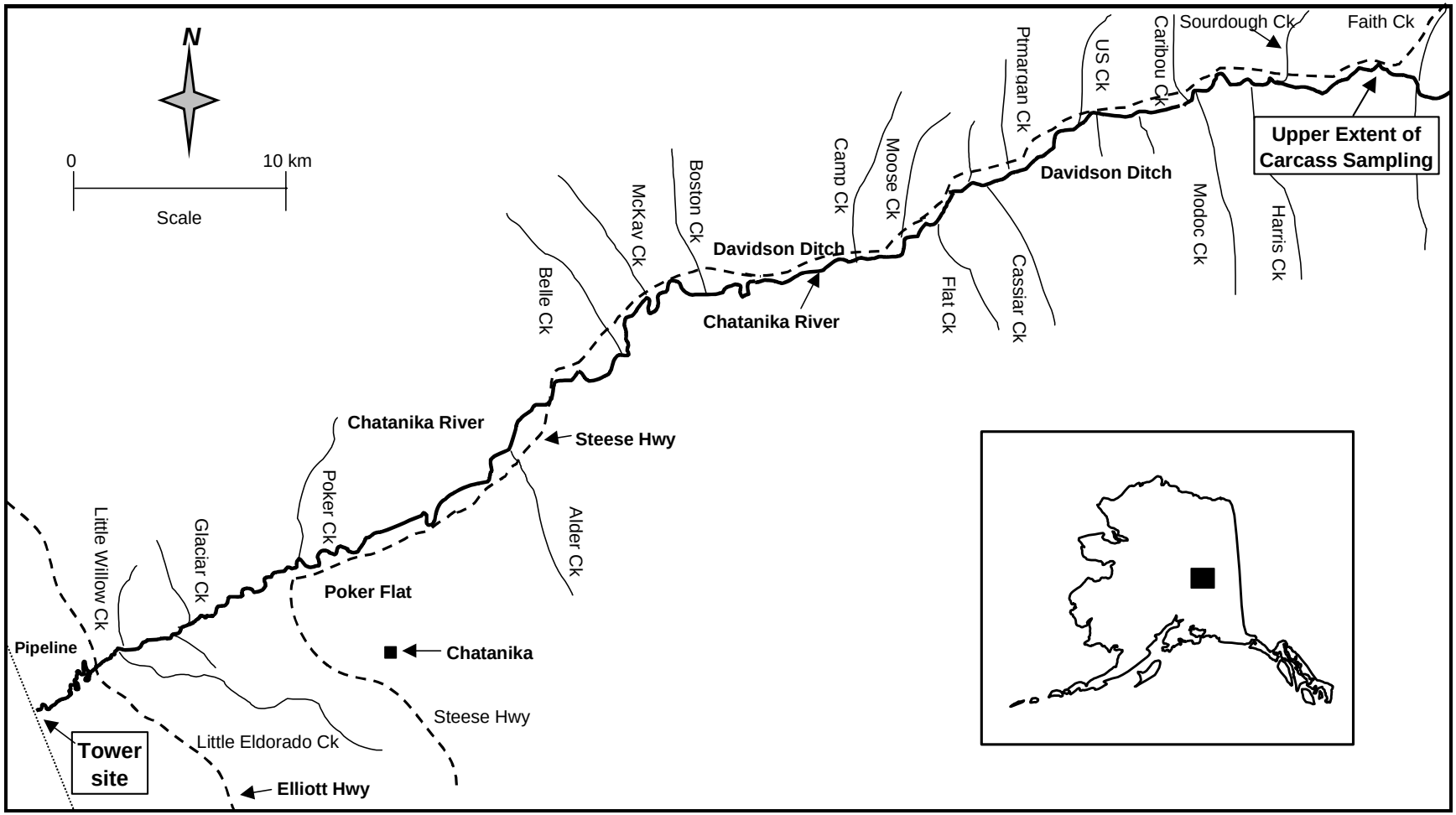


Figure 2.-Chatanika River study area.

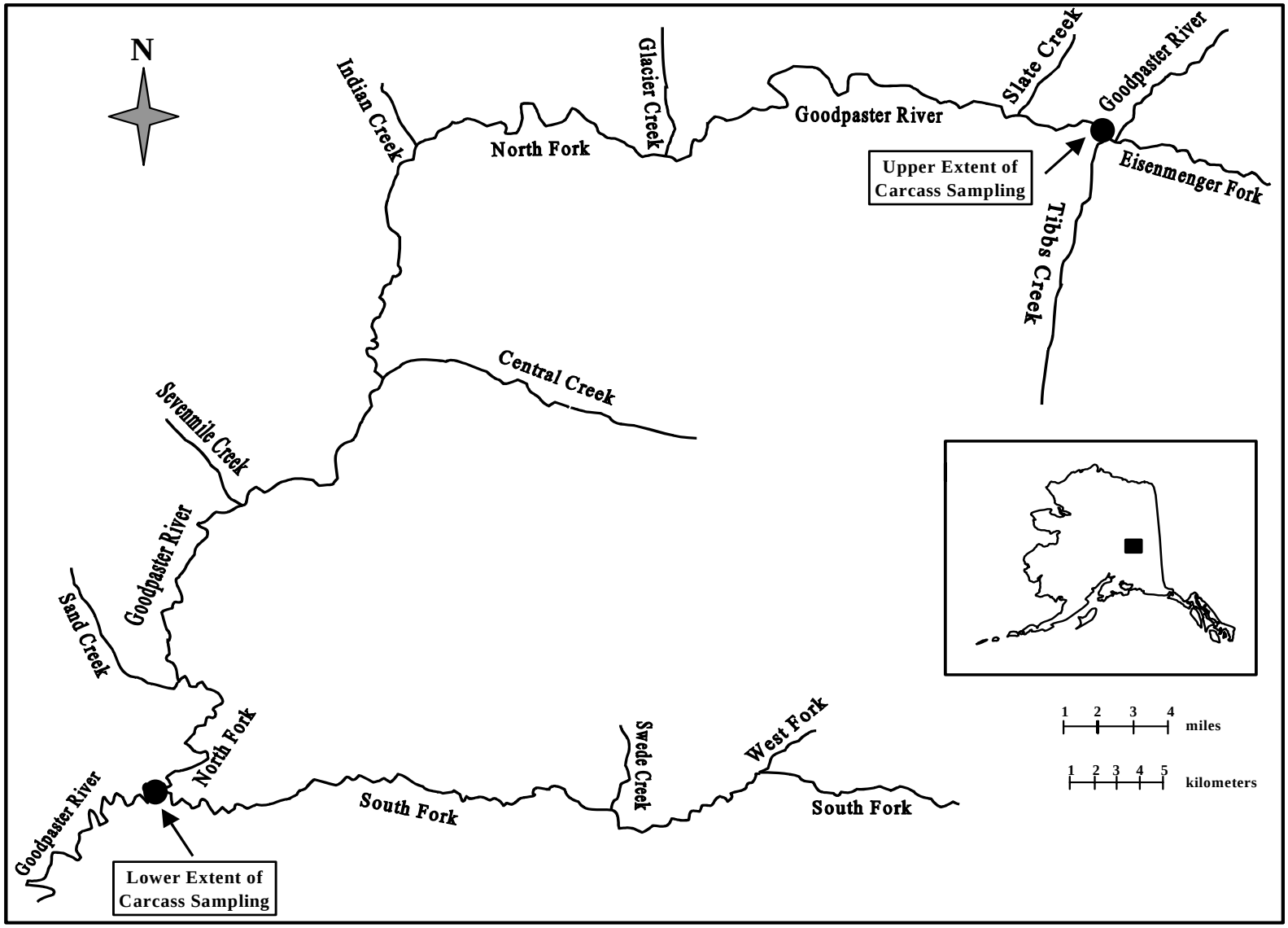


Figure 3.-Goodpaster River study area.

Goodpaster River drainage has been closed to all salmon fishing by regulation since 1975. Unlike the Chena and Chatanika rivers, the Goodpaster River is not road accessible. Before reaching spawning grounds in the middle to upper reaches of these rivers, chinook salmon travel about 1,500 km from the Bering Sea and pass through six different commercial fishing districts in the Yukon and Tanana rivers (Figure 4). Subsistence and personal use fishing also occur in each district.

From 1986 to 1993, escapements of chinook salmon in the Chena River were estimated using mark-recapture experiments and monitored with aerial surveys. This information has been used to evaluate management of the commercial, subsistence, personal use, and sport fisheries on these stocks. However, these methods provide only limited information that fishery managers can use during the fishing season. Mark-recapture experiments occur after the escapement has passed through the various fisheries, and aerial surveys do not provide consistent indices of escapement. Thus, tower-counting methodology was initiated on the Salcha and Chena rivers in 1993 to provide additional information on escapement inseason.

Escapements of chinook salmon in the Chatanika River prior to 1997 were assessed on a semi-annual basis with aerial surveys from fixed wing aircraft. This methodology was inadequate, as survey estimates from some years were less than harvest estimates for the same years. A mark-recapture experiment was conducted in 1997. The method was abandoned, however, due to difficulties in capturing adequate numbers of fish. As a result, tower-counting methods were initiated. Two thousand was the third season tower-counting methods were applied to the Chatanika River.

Escapements of chinook salmon in the Goodpaster River were assessed occasionally with aerial surveys from fixed-wing aircraft from 1954 to 1998. Helicopter surveys have been used to assess escapement since 1998.

In January 2001, the Board of Fisheries approved a proposal which will manage future sport harvests of chinook salmon in the Chena River using a Biological Escapement Goal (BEG) to evaluate escapements. The BEG was calculated using a spawner-recruit model which incorporated past mark-recapture/tower escapement values, harvest estimates, and composition data from escapements and harvest. The BEG for the Chena River is 2,800-5,700 chinook salmon. However, during 2000, the fishery was managed using a minimum escapement guideline of 6,300 fish, which was based on an expansion of historical aerial survey data. Also in January 2001, the Board of Fisheries did away with the guideline harvest levels of 300 to 600 chinook salmon. The guideline harvest levels were an interim management strategy, which were replaced by an escapement-based management strategy.

Chum salmon returning to the Chena River are also harvested in the sport fishery, but to a much smaller degree. The migration timing of chum salmon is later than that of chinook salmon, but does overlap. Because sport fisheries exploit these stocks, chum salmon escapements were also monitored throughout the duration of the chinook salmon counts. Counting chum salmon in addition to chinook salmon presented no significant extra work to the technicians. Additionally, the data acquired was used by the Alaska Department of Fish and Game, Commercial Fisheries Division (CFD) for inseason management of commercial and subsistence fisheries for the Tanana River. Currently there are no established escapement objectives or harvest guidelines for chum salmon in the Chena and Chatanika rivers.

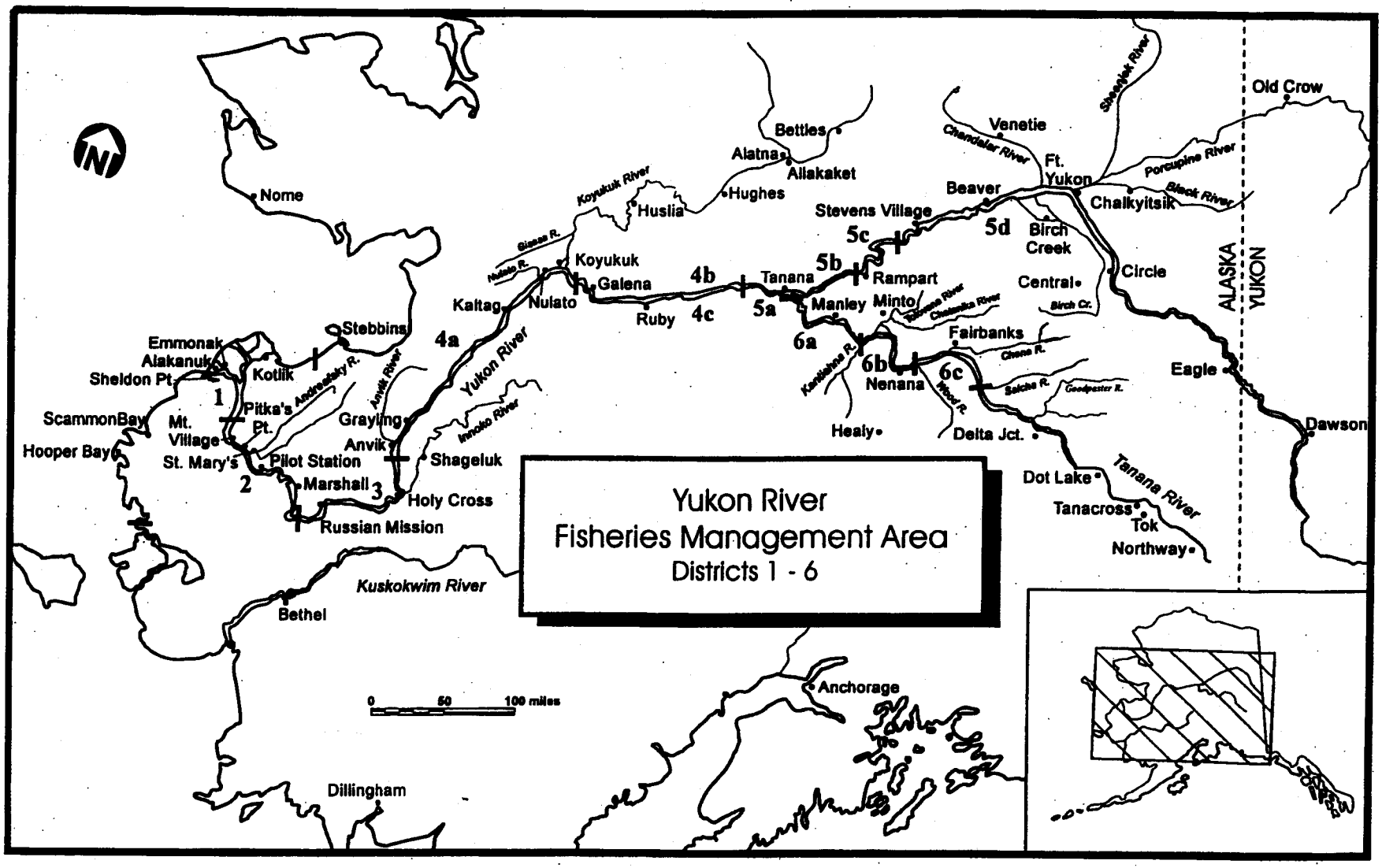


Figure 4.-Fishing districts in the Yukon River drainage.

The research objectives of the interior chinook salmon projects in 2000 were to:

1. estimate the total escapement of chinook salmon in the Chena and Chatanika rivers using tower counting techniques such that the estimates were within 15% of the actual value 95% of the time;
2. estimate age, sex, and length compositions of chinook salmon carcasses in the Chena River such that all estimated proportions were within 5 percentage points of the actual proportions 90% of the time;
3. estimate age, sex, and length compositions of chinook salmon carcasses in the Chatanika River such that the estimates were within 10 percentage points of the actual proportions 90% of the time;
4. estimate the total escapement of chinook salmon in the Chena River using mark-recapture techniques only if the tower counts become unreliable due to poor viewing conditions. The mark-recapture estimates should be within 25% of the actual value 95% of the time.

In addition, chum salmon in the Chena and Chatanika rivers were subsequently counted along with the chinook salmon for the duration of the chinook salmon run using tower-counting techniques. Chinook salmon carcasses in the Goodpaster River were collected and examined for CFD tags and age, sex, and lengths were recorded.

METHODS

Tower-counts

Daily escapements of chinook and chum salmon returning to the Chena and Chatanika rivers were estimated by counting fish at fixed intervals as they passed beneath elevated counting sites. The counts were conducted from 29 June to 12 August for the Chena River and 4 July to 4 August for the Chatanika River. The Moose Creek Dam was used as a counting structure for the Chena River (Figure 1). The counting site for the Chatanika River was located immediately downstream from the Alyeska pipeline (Figure 2). Little or no spawning occurs downstream from these sites. Sport fishing on the Chena River is restricted to areas downstream of the counting site. Therefore, for the Chena River, completed estimates from tower-counts represent total escapement. For the Chatanika River, most sport fishing occurs upstream from the counting site because there is no road access to areas below this site. Thus, complete tower-count estimates represent the total in-river return for the Chatanika River.

Light-colored fabric panels were placed on the bottom of the rivers just downstream from the counting structures in order to improve visibility of moving fish. Lights were suspended over the panels to provide illumination during periods of low light. Because salmon will often try to avoid areas with artificial substrate or illumination, the panels and overhanging lights were configured to form a continuous band across the rivers. Once the light strings were turned on, they were left on until ambient light was sufficient to observe salmon. This was done to ensure that salmon would pass over the panels at the same rate during counting periods as during non-counting periods.

Sampling Design

A stratified systematic sampling design was used to estimate daily passage of chinook and chum salmon. Personnel were assigned 8-h shifts and counted salmon 20 min of each hour. Counts were limited to 20 min to alleviate eyestrain and fatigue. The width of the Chena River made it

possible for fish to escape the counters' watch. Thus, river was divided in half by placing a red fabric strip across the panels near the center of the channel, and 10-min counts were conducted on each side. Seibel (1967) evaluated the use of hourly 10-min counts as the basis for estimating hourly migration, and thus total seasonal migration, and found relative errors to be less than 10%. Start times for the first count were chosen randomly within the first 10 min of the hour. Counts began on the left side of the river facing upstream. The second count immediately followed the first. In contrast, the Chatanika River channel was sufficiently narrow to permit a single 20 min count of the entire width. A week consisted of 21 possible 8-h shifts (three shifts per day). Shift I started at 24:00 hours and ended at 07:59 hours; shift II started at 08:00 hours and ended at 15:59 hours; shift III started at 16:00 hours and ended at 23:59 hours.

Three technicians were assigned to count on the Chena and Chatanika rivers. Out of 21 possible shifts, 15-20 were conducted each week for the Chena River, and 15-16 were conducted each week for the Chatanika River (Appendix A). High, murky water prevented a large number of the scheduled counts for both rivers.

The total number of fish passing over the panels during any one 10 or 20 min count was recorded as the number of fish moving upstream minus the number of fish moving downstream. Drifting carcasses or obviously spawned-out fish moving downstream were not counted. In some cases more fish were counted moving downstream than upstream. The resulting negative number was expanded and used as part of the daily estimate of passage.

Abundance Estimator

Estimates of abundance were stratified by day and by river half for the Chena River. The daily estimates of abundance were considered a two-stage direct expansion where the first stage consisted of 8-h shifts within a day and the second stage consisted of 10 min counting periods within a shift. The second stage was considered systematic sampling because the 10 min counting periods were not randomly chosen.

The expanded shift passage on day i and shift j was calculated by:

$$Y_{di} = \frac{M_{di}}{m_{di}} \sum_{j=1}^{m_{di}} y_{dij} \,. \tag{1}$$

The average shift passage for day d was:

$$\overline{Y}_d = \frac{\sum_{i=1}^{h_d} Y_{di}}{h_d} \,. \tag{2}$$

The expanded daily passage was:

$$\hat{N}_d = \overline{Y}_d H_d \,. \tag{3}$$

The period sampling was systematic, because a period was sampled every hour in a shift. The variance associated with periods was calculated as:

$$s_{2di}^2 = \frac{1}{2(m_{di}-1)} \sum_{j=2}^{m_{di}} \left(y_{dij} - y_{dij-1}\right)^2 . \tag{4}$$

Shift sampling was random. The between shift variance was calculated as:

$$s_{1d}^2 = \frac{1}{h_d - 1} \sum_{i=1}^{h_{sd}} \left(Y_{di} - \overline{Y}_d\right)^2 . \tag{5}$$

The variance for the expanded daily passage was estimated by:

$$\hat{V}\left(\hat{N}_d\right) = \left[(1 - f_{1d}) H_d^2 \frac{s_{1d}^2}{h_d} \right] + \left[\frac{1}{f_{1d}} \sum_{i=1}^{h_d} \left((1 - f_{2di}) M_{di}^2 \frac{s_{2di}^2}{m_{di}} \right) \right] \tag{6}$$

where:

$$f_{1d} = \frac{h_d}{H_d} \text{; and,} \tag{7}$$

$$f_{2di} = \frac{m_{di}}{M_{di}} . \tag{8}$$

d = day;
i = 8-h shift;
j = 10 min counting period;
y = observed period count;
Y = expanded shift passage;
m = number of 10 min counting periods sampled;
M = total number of possible 10 min counting periods;
h = number of 8-h shifts sampled;
H = total number of possible 8-h shifts;
D = total number of possible days;
f_1 = fraction of 8-h shifts sampled;

f_2 = fraction of 10 min counting periods sampled;

s_2^2 = estimated variance of total across counting periods; and,

s_1^2 = estimated variance of total across shifts.

Passage for the entire run was estimated by:

$$\hat{N} = \sum_{d=1}^{D} \hat{N}_d \text{ ; and,} \tag{9}$$

$$\hat{V}\left(\hat{N}\right) = \sum_{d=1}^{D} \hat{V}(\hat{N}_d) . \tag{10}$$

For the Chena River, the daily-expanded shift passage and the associated variance were calculated for each side and then added. Total abundance and the associated variance were calculated similarly by summing the estimates from each side. For the Chatanika River, the same estimator and variance equations were used except that j, m, M and f_2 represented 20-min counting periods and were adjusted accordingly.

The above equations worked well when two or three 8-h shifts were worked in a day. However, for a few days, due to high water, technicians could only conduct one 8-h count per day for the two rivers. The equation for total estimated variance across shifts (equation 5) assumed more than one 8-h shift was worked each day, or the denominator becomes zero. For days with only one shift, the SE was estimated from the total average daily coefficient of variation (CV) for each river and species for those days with greater than one counting period. The CV was used because it is independent of the magnitude of the estimate and is relatively constant throughout the run (Evenson 1995).

When up to four consecutive days were not sampled due to adverse viewing conditions, the moving average estimate for the missing day i was calculated as:

$$\hat{N}_i = \frac{\sum_{j=i-k}^{i+k} I(\text{day j was sampled})\hat{N}_j}{\sum_{j=i+k}^{i+k} I(\text{day j was sampled})} \tag{11}$$

where:

$$I(\cdot) = \begin{cases} 1 & \text{when the condition is true} \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

is an indicator function.

The estimate of the daily variation for missed days was the maximum variance of the number of (k) days before and the number of (k) days after the missed day (i).

Mark-Recapture Experiment

Heavy rain and subsequent high water precluded obtaining a complete tower estimate for the Chena River. Therefore, a two-sample mark-recapture experiment was conducted as a backup means of estimating total escapement of chinook salmon.

Marking Event

A riverboat equipped with electrofishing gear (Clark 1985) and long-handled dip nets were used to capture adult chinook salmon on the spawning grounds. Sex was determined for all captured fish by appearance and by partially extruding gametes. All fish were measured to the nearest 5 mm from mid-eye to fork of the tail (MEF) and tagged with an individually numbered jaw tag. In addition to the jaw tag, a secondary fin clip was made which varied according to the week and river section of tagging. Fish were marked during two complete passes through the study section. The first pass occurred from 24-27 July, and the second occurred from 31 July – 3 August. The study section was 90 km in length and corresponded to the same area that is assessed during aerial surveys. For analysis of mixing, the section was delineated into two approximately equal areas with the boundary being a substantial logjam located between Grange Hall Road and the South Fork of the Chena River (Figure 1). The marking event was timed to correspond with the short period after completion of immigration and spawning and before the fish began to die.

Recapture Event

The recapture event for the Chena River entailed examination of chinook carcasses on the spawning grounds. Carcasses were collected with long handled spears from a jet-powered riverboat. These samples were collected from the Moose Creek Dam to approximately 76 km upriver (Figure 1). Area of recapture was noted for later examination of movement from the tagging areas. One pass was made through the same sections where marking occurred from 7 - 9 August. After examination, all carcasses were sliced on their left sides in order to prevent resampling. Desired sample numbers for both the mark and recapture events were determined *a posteriori* at the desired precision and accuracy (95% ± 25%) according to Robson and Reiger (1964).

Assumptions

An unbiased estimate of abundance from this two-event mark-recapture experiment (Seber 1982) required that the following two assumptions were fulfilled:

1. catching and handling the fish did not affect the probability of recapture; and,
2. marked fish did not lose their mark.

It can be assumed that catching and handling the fish would not have significantly affected the probability of recapture because the experiment was designed to mark live fish and later recover carcasses. Because the salmon were predestined to die, capture effects such as handling mortality, trap shyness/happiness, and delayed effects would not have been factors. If jaw tags were lost, the secondary mark (fin clip) was easily identified.

Of the following assumptions, at least one must have been fulfilled:

1. every fish had an equal probability of being marked and released during the marking event;
2. every fish had an equal probability of being collected during the recapture event; or,

3. marked fish mixed completely with unmarked fish between mark and recapture events.

The procedures for testing these assumptions and the methods for alleviating bias due to gear selectivity are described in Appendix B.

Abundance Estimator

The Chapman estimator and associated sampling variance (Chapman 1951) were used to estimate abundance:

$$\hat{N}^* = \left[\frac{(n_1+1)(n_2+1)}{(m_2+1)} \right] - 1 \text{ ;and,} \tag{13}$$

$$V(\hat{N}^*) = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \tag{14}$$

where:

$\hat{N}^*$ = the estimated abundance of chinook salmon;

n_1 = the number of fish marked during the first event;

n_2 = the number of carcasses collected during the recapture event; and,

m_2 = the number of marked carcasses collected during the recapture event.

Age-Sex-Length Compositions

Age, sex, and length data were collected from both live chinook salmon and carcasses in the Chena River as part of the mark-recapture experiment. Given few recaptures, which resulted in low power detecting a true size bias between fish collected between both events, the electroshocked sample was used to estimate length, sex, and age composition. The justification of this was based on Bernard (Alaska Department of Fish and Game, personal communication, 2000). He showed through previous mark-recapture experiments on the Chena River that carcass samples are usually biased with respect to sex and length and that electroshocked salmon tend to be more representative of the underlying populations.

For the Chatanika River, carcasses were collected from the Alyeska Pipeline Crossing to approximately 85 km upriver using a canoe (Figure 2). Sampling took place on the Chatanika River on 1 - 2 August and 7 - 8 August.

Chinook salmon carcasses were collected on the Goodpaster River as part of a cooperative effort with CFD. Sport Fish Division conducted the survey and CFD provided the funding. This was the first season of a multi-year cooperative radiotelemetry program conducted by CFD and the National Marine Fisheries Service. Near Marshall and Russian Mission on the lower Yukon River, 766 chinook salmon were marked with spaghetti tags and 91 of these also had radio transmitters inserted into their stomachs. The 2000 carcass survey was funded with the hope of recovering tags in addition to acquiring age, sex and length data. In 1991 and 1992, carcass surveys were also conducted between Eisemerger Fork and the South Fork of the Goodpaster River (Figure 3) to acquire age, sex, and length data. These previously unreported data are presented for the first time in this report and compared to 2000 data. For 2000, chinook carcasses were collected from Tibbs Creek to just below the South Fork of the Goodpaster River

from 6 to 10 August (Figure 3). The carcasses were speared from a 13-foot rubber raft with a 40-hp jet motor. Below the South Fork of the Goodpaster River the river becomes dark-colored with tannins, making carcasses difficult to discern.

All length measurements on electrofished chinook salmon and carcasses were made from mid-eye to fork-of-tail. Three scales were removed from the left side of the fish approximately two rows above the lateral line along a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander 1940). Scale impressions were later made on acetate cards and viewed at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Ages were determined from scale patterns as described by Mosher (1969).

For the Chena, Chatanika, and Goodpaster rivers, proportions of chinook salmon by ocean-age and the associated variances for each river were calculated separately for each sex (s) using:

$$\hat{p}_{sj} = \frac{n_{sj}}{n_s} \text{; and,} \tag{15}$$

$$\hat{V}(\hat{p}_{sj}) = \frac{\hat{p}_{sj}\left(1-\hat{p}_{sj}\right)}{n_s - 1} \tag{16}$$

where:

$\hat{p}_{sj}$ = estimated proportion of chinook salmon of sex s in age group j; and,

n_s = number of chinook salmon of sex s.

Mean lengths and associated variances were calculated for each sex and associated age class using:

$$\bar{l}_j = \frac{\sum_{j=1}^{n} l_j}{n} \text{; and,} \tag{17}$$

$$V\left[\bar{l}_j\right] = \frac{\sum_{j=1}^{n}\left(l_j - \bar{l}_j\right)^2}{n\left(n-1\right)} \tag{18}$$

where:

l_j = length of salmon of a given sex in age group j; and,

n = number of samples of a given sex in age group.

The estimated abundance of chinook salmon by sex and age group was estimated:

$$\hat{N}^*_{sj} = \hat{p}_{sj}\hat{N}^* \tag{19}$$

with variance from Goodman's exact variance (Goodman 1960);

$$V(\hat{N}^*_{sj}) = V(\hat{p}_{sj})\hat{N}^{*2} + V(\hat{N}^*)\hat{p}_{sj}^{\ 2} - V(\hat{p}_{sj})V(\hat{N}^*)\,. \tag{20}$$

Aerial Counts

An aerial survey count was conducted by CFD at the time of peak escapement for the Chena River. The daily tower-counts of chinook salmon and weather conditions were considered to determine the optimum flying day. The survey was conducted on 29 July. The count was made from a low flying, fixed-wing aircraft. Barton (1987b) described the methods used for this survey. The proportion of salmon counted by the aerial survey to the total estimated escapement was calculated.

RESULTS

Data for these analyses are archived as described in Appendix C.

Chena River Chinook Salmon Studies

Tower Estimates

Heavy rain and subsequent high water and poor visibility prevented counting from 11 through 16 July. Because six consecutive days were missed during what may have been the peak of the run, there was too much uncertainty in using equations 11 and 12 to calculate abundance for those days. Consequently, a mark-recapture experiment was conducted in order to acquire an estimate of total abundance. The incomplete tower escapement was estimated at 1,903 (SE=165) chinook salmon. The largest expanded daily count of chinook salmon for the Chena River was 481 (SE = 116) on 17 July, the day after viewing conditions improved enough for counting (Table 2). By 1 August daily passage of chinook salmon was minimal. Between 1 and 12 August the majority of chinook salmon observed were spawned out and floating/swimming downstream and therefore not included in the estimation (Appendices D1-D2). The largest number of chinook salmon to pass during one 10-min count was 12 on 17 July at 1800 on the left side. Typically, counts were larger for the left side of the Chena River (Appendices D1-D2). On visual inspection, passage of chinook salmon for the Chena River showed no distinct diurnal variation (Figure 5).

The dates where 50% of the total count of chinook salmon traveling past the Moose Creek Dam during 1993-1999 have varied from 14 - 24 July (Figure 6). For 2000, the 50% point of the total count may have been around 18 July, although the point of 50% escapement was unknown. The run timing curve would probably be different if counts had been conducted from 11 - 16 July. The average expanded cumulative escapement estimated from tower-counts for 1993, 1994, 1997, and 1999 was 9,976. The tower counts were unreliable for estimating escapement in 1995, 1996 and 2000 due to high water events. Consequently mark-recapture experiments had to be performed to acquire estimates of escapement. Every year since the inception of the tower-counts, the escapement has exceeded the minimum of the BEG range (2,800; Figure 7).

Mark-Recapture Experiment

Three hundred fifty-eight chinook salmon were electroshocked, tagged, and released during the marking event. Before release, all fish were measured, sex was noted, and scales were sampled for later aging. During the recapture event, 169 fish were collected and age, sex, and length data was also gathered from each carcass. All carcasses were examined for tags and secondary marks

Table 2.-Number of counts, daily counts, and expanded number of chinook salmon passing by the counting site by date in the Chena River, 2000. Shaded cells indicate days with missing counts due to high water.

	Number of	Left Side			Right Side			Total		
	10 min		Expanded			Expanded			Expanded	
Date	Counts	Count	Count	SE	Count	Count	SE	Count	Count	SE
29-Jun-00	6	0	0	0	0	0	0	0	0	0
30-Jun-00	16	0	0	0	0	0	0	0	0	0
1-Jul-00	16	0	0	0	0	0	0	0	0	0
2-Jul-00	16	0	0	0	0	0	0	0	0	0
3-Jul-00	16	0	0	0	0	0	0	0	0	0
4-Jul-00	16	0	0	0	0	0	0	0	0	0
5-Jul-00	16	1	9	7	0	0	0	1	9	7
6-Jul-00	24	1	6	4	0	0	0	1	6	4
7-Jul-00	16	3	27	10	1	9	9	4	36	14
8-Jul-00	16	0	0	0	0	0	0	0	0	0
9-Jul-00	16	5	45	24	0	0	0	5	45	24
10-Jul-00	16	5	45	16	0	0	0	5	45	16
11-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
12-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
13-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
14-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
15-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
16-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
17-Jul-00	12	37	451	114	3	31	19	40	481	116
18-Jul-00	16	28	252	66	12	108	33	40	360	74
19-Jul-00	24	12	72	23	15	90	23	27	162	33
20-Jul-00	24	-2	-12	7	2	12	6	0	0	9
21-Jul-00	16	6	54	18	6	54	20	12	108	26
22-Jul-00	24	19	114	26	4	24	11	23	138	28
23-Jul-00	24	13	78	22	8	48	15	21	126	27
24-Jul-00	15	6	59	17	4	37	17	10	96	24
25-Jul-00	24	8	48	12	1	6	6	9	54	13
26-Jul-00	23	9	56	24	1	7	5	10	63	24
27-Jul-00	24	4	24	16	1	6	6	5	30	17
28-Jul-00	24	5	30	10	-1	-6	4	4	24	11
29-Jul-00	23	7	47	14	0	0	0	7	47	14
30-Jul-00	24	4	24	8	2	12	27	6	36	29
31-Jul-00	16	3	27	28	-1	-9	9	2	18	30
1-Aug-00	24	2	12	7	1	6	6	3	18	9
Total	527	176	1,468	152	59	435	64	235	1,903	165

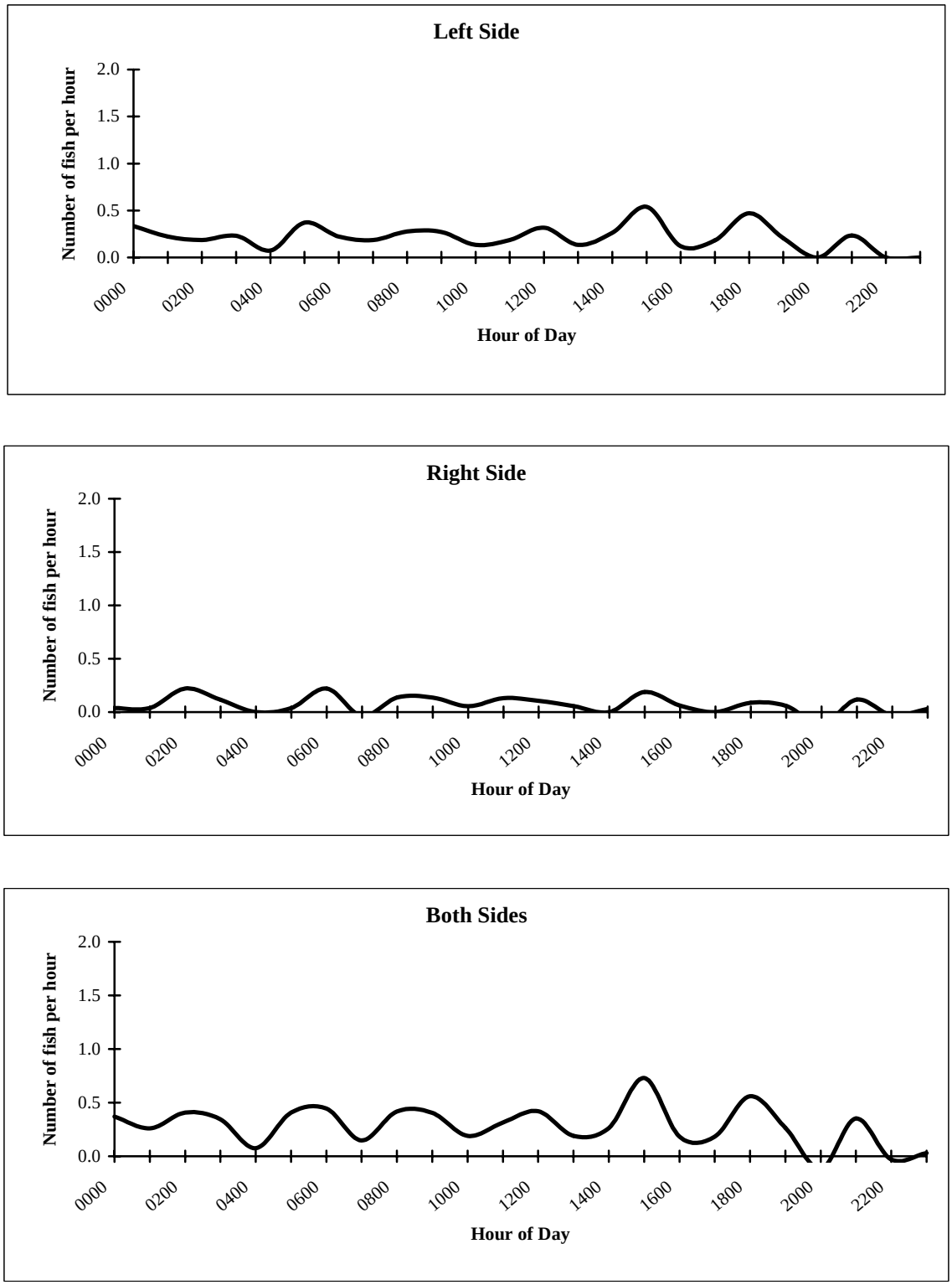


Figure 5.-Average hourly escapement of chinook salmon in the Chena River, 2000.

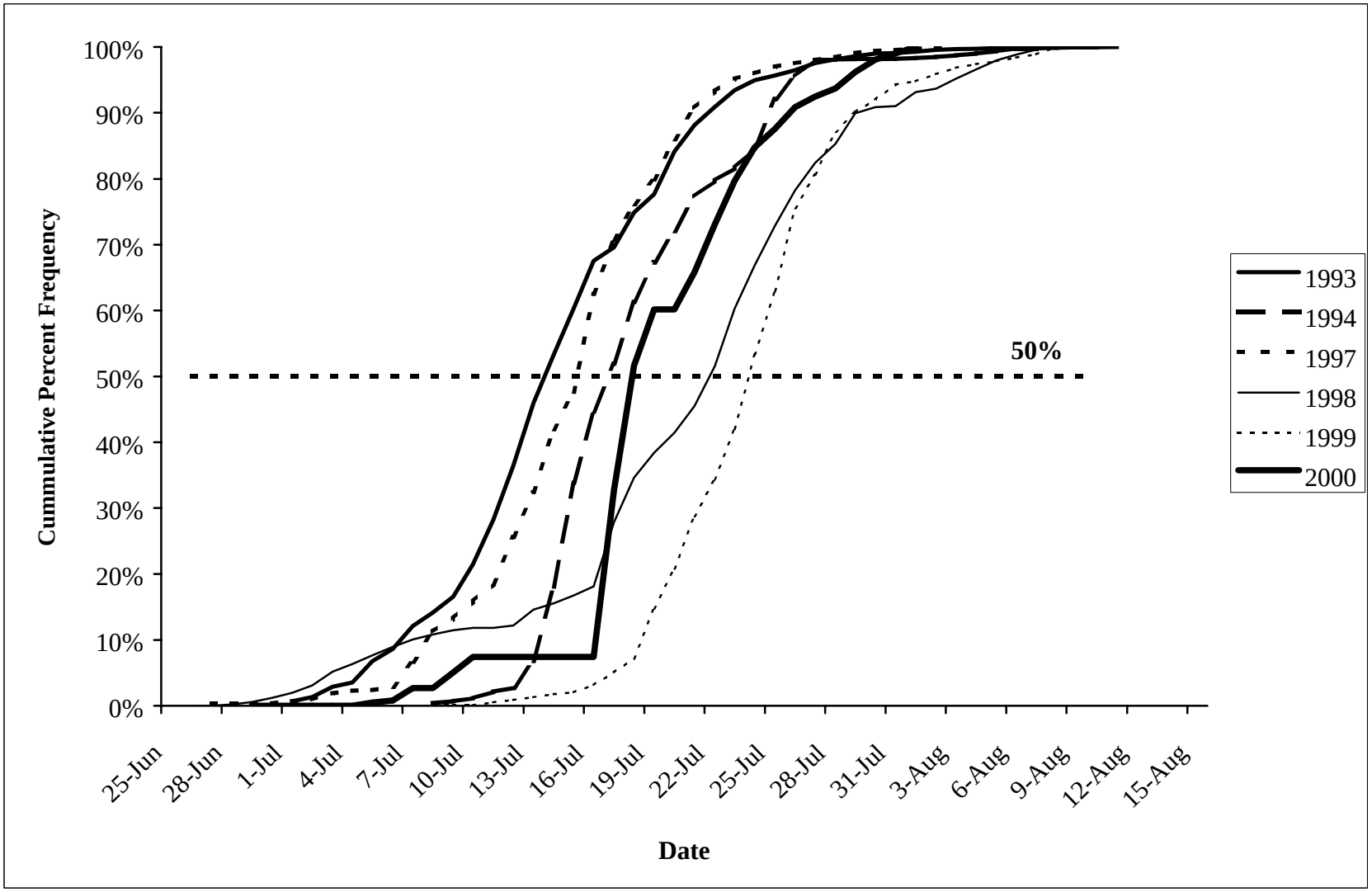


Figure 6.-Run timing of chinook salmon for 1993, 1994 and 1997 – 2000 for the Chena River. The 2000 data was incomplete.

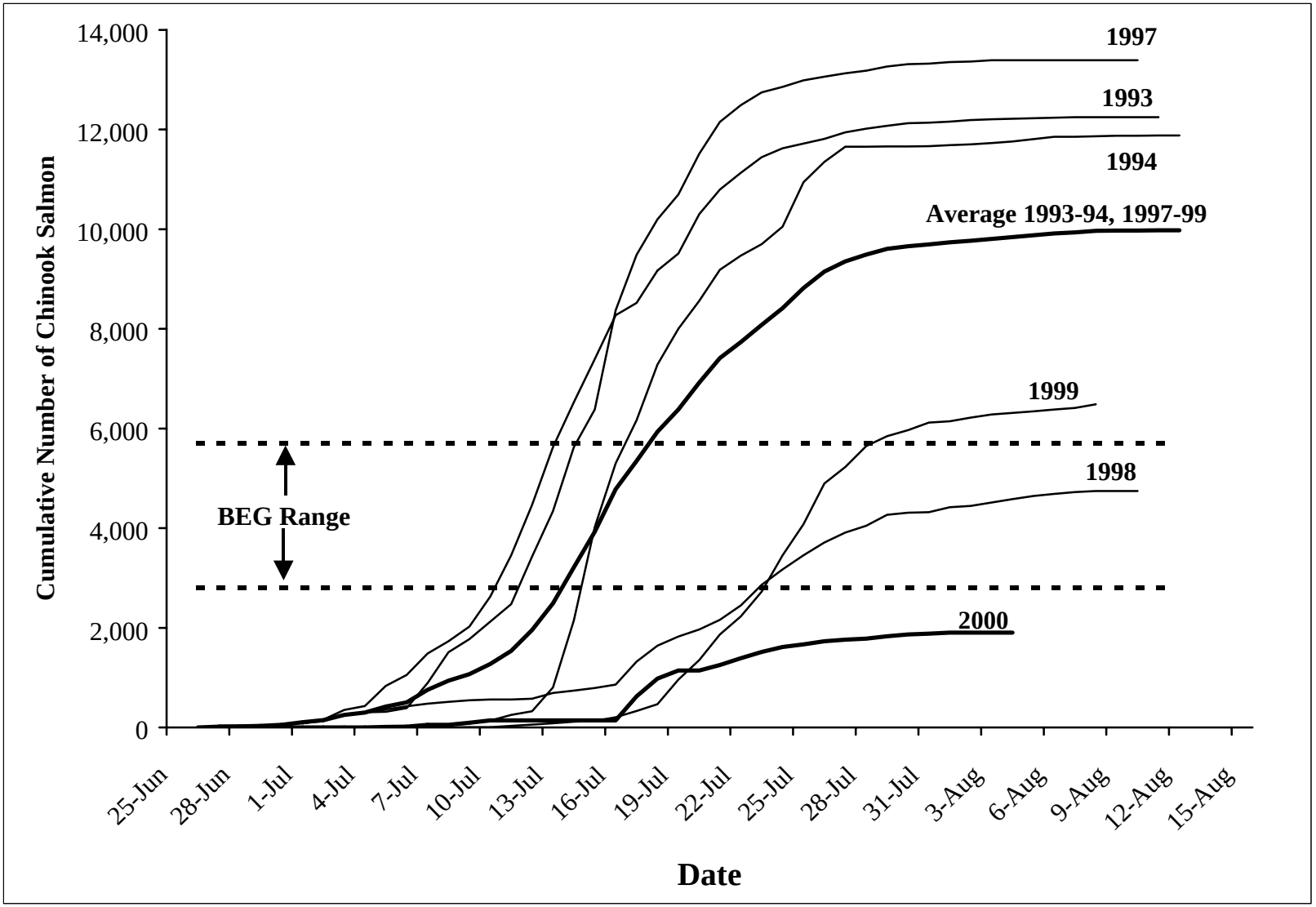


Figure 7.-Cumulative passage of chinook salmon for 1993, 1994 and 1997 – 2000 from tower-counts for the Chena River. The 2000 data was incomplete.

(Table 3). Of the 12 recaptures, one had lost a jaw tag, but was easily recognized by the secondary clip. The recapture rates for males (0.03) and females (0.06) were not significantly different (χ^2 = 1.35, df = 1, P = 0.25; Table 4). Therefore, males and females were combined for analysis. The capture rates for the marking event for males (0.07) and females (0.07) were almost identical (χ^2 < 0.01, df = 1, P = 0.99; Table 5).

Length distributions of all marked releases and all recaptures obtained during the carcass survey were not significantly different (D = 0.22, P = 0.62; Figure 8). The length distributions of all marked fish and all fish sampled during the carcass survey were also not significantly different (D = 0.12, P = 0.06). However, visual inspection of Figure 8 shows an apparent greater discrepancy between all marked salmon and all recaptured carcasses than between marked salmon and the total number of carcasses, despite the more conclusive P value of the former. The small recapture size resulted in low power in detecting differences in the two distributions. According to Sokal and Rohlf (1995), given an α = 0.05, D = 0.22, and n1 = 358, the second sample required in the K-S test should have been 43 in order to get a power of difference detection of 50%. Thus, with 12 recaptures, the probability of detecting a true difference was low.

The results of the chi-square tests of consistency indicated geographic stratification was not required. Movement probabilities were similar (χ^2 = 2.06, df = 1, P = 0.36) between the upper and lower portions of the Chena River as were the recaptured to not recaptured (χ^2 = 0.55, df = 1, P = 0.46) and marked to unmarked (χ^2 = 2.15, df = 1, P = 0.14) ratios (Table 6).

The assumption testing indicated that an unstratified Chapman estimator (Chapman 1951) should be used to estimate abundance (Appendix B). The estimate of total abundance was 4,694 (SE = 1,184).

Age, Sex and Length Compositions

According to the statistical tests in Appendix B, the K-S tests showed that there was no size selectivity during both the marking and recapture events and recommended pooling lengths. However, because of the low power of the K-S test in detecting differences in electroshocked salmon lengths and the history of biased carcass samples and gender-selective sampling; lengths, ages, and sexes from the first sampling event were used to estimate age composition proportions. The sex composition for the electroshocked salmon, including those not aged, was 0.80 (SE=0.02) males and 0.20 (SE=0.02) females. Ages were determined for 89% of the sample. The average male/female ratio of aged fish from 1989 to 2000 was 0.54 males and 0.46 females (Table 7). For the 169 chinook salmon sampled from the 2000 carcass survey, 0.67 (SE = 0.04) were males and 0.33 (SE = 0.04) were females (Table 8). The odds-ratio between sex and capture year was used to evaluate probability of capture for males and females with respect to the gear type. Accordingly, males were found to be twice as likely to be sampled with electroshocking gear than during a carcass survey ($\hat{\alpha} = 2.076$) for 2000.

The dominant age classes for males collected in 2000 were 1.3, with an abundance of 1,683 and 1.2 with an abundance of 1,417 (Table 9). Males were also represented by ages 1.1, 1.4 and 1.5 with relative abundances of 15, 546, and 15, respectively. The dominant age class for females was 1.4 with an abundance of 782. Females were also represented by ages 1.3 and 1.5 with abundances of 148 and 89, respectively. Lengths of males ranged from 370 to 965 mm and lengths of females ranged from 760 to 975 mm (Figure 9).

Table 3.-Summary of capture histories of chinook salmon caught during the mark-recapture experiment in the Chena River, 2000.

Section Tagged	Section Recaptured		Total Recaptured	Number not Recaptured	Total Marked	Unmarked Carcasses Examined	Total Carcasses Examined
	Upper	Lower					
				Total Fish			
Upper	7	2	9	263	272	131	139
Lower	1	2	3	83	86	26	30
Total	8	4	12	346	358	157	169
				Males			
Upper	6	2	8	223	231	90	96
Lower	0	0	0	55	55	15	17
Total	6	2	8	278	286	105	113
				Females			
Upper	1	0	1	40	41	41	43
Lower	1	2	3	28	31	11	13
Total	2	2	4	68	72	52	56

Table 4.-Capture history and contingency-table analysis of recapture rates of male and female chinook salmon caught during the mark-recapture experiment in the Chena River, 2000.

Capture History	Male	Female	Total
Recaptured	8	4	12
Not Recaptured	278	68	346
Total	286	72	358
Recapture Rate	0.03	0.06	0.03
	$\chi^2 = 1.35$, df = 1, $P = 0.25$		
	Pr(M)/Pr(F) = 0.50[a]		

[a] Corresponds to the ratio of the recapture rates for males and females.

Table 5.-Marking history of examined fish and contingency-table analysis of marked to unmarked ratios of male and female chinook salmon sampled during the mark-recapture experiment in the Chena River, 2000.

Marking History	Male	Female	Total
Marked	8	4	12
Unmarked	105	52	157
Total	113	56	169
Marked/Unmarked	0.07	0.07	0.07
	$\chi^2 \leq 0.01$, df = 1, $P = 0.99$		
	Pr(M)/Pr(F) = 0.99[a]		

[a] Corresponds to the ratio of capture rates for males and females.

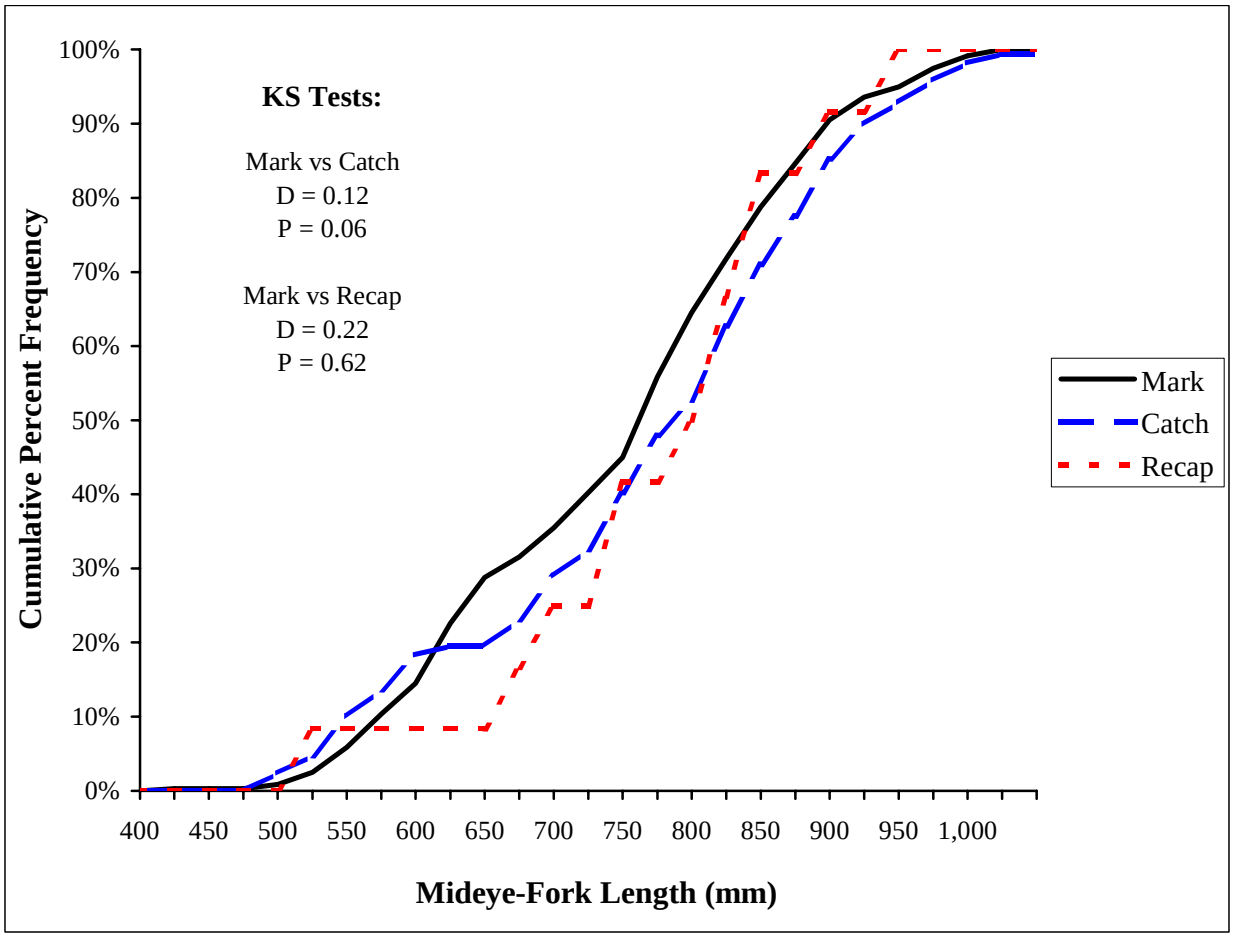


Figure 8.-Cumulative length frequency distributions comparing all chinook salmon caught during the first (Mark) and second (Catch) events, and all recaptured (Recap) fish caught during the second event from the mark-recapture experiment in the Chena River, 2000.

Table 6.-Chi-square tests of consistency[a] for the Petersen estimator of chinook salmon sampled in the Chena River, 2000. Analysis of marked\unmarked corresponded to the probability of capture during the first event and recaptured/not recaptured corresponded to the probability of capture during the second event.

River Section	Sampling Event	River Section Upper	River Section Lower	Not Recaptured	Test Results
			Test I[b]		
Upper		7	2	263	
Lower		1	2	83	$\chi^2 = 2.06$; df = 2, $P = 0.36$
			Test II[c]		
	Recaptured	8	4		
	Not Recaptured	263	83		$\chi^2 = 0.55$, df = 1, $P = 0.46$
			Test III[d]		
	Marked	8	4		
	Unmarked	131	26		$\chi^2 = 2.15$, df = 1, $P = 0.14$

a The tests for consistency were taken from Seber (1982). At least one hypothesis needs to be accepted in order for the Petersen to be valid.

b This tests the hypothesis that the probability of movement from one section to the other is the same for both sections: H1: $\theta ij = \theta j$. Theta applies to both marked and unmarked salmon.

c This tests the hypothesis of homogeneity on the columns of this 2-by-2 contingency table with respect to recapture probabilities between the two river areas: H2: $\Sigma j\theta ijpj = d$. Theta applies to both marked and unmarked salmon.

d This tests the homogeneity on the columns of the 2-by-2 contingency table with respect to the probability of movement of marked fish in stratum i to the unmarked fraction in j: H4: $\Sigma iai\theta ij = kUj$. Theta does not apply to both marked and unmarked salmon.

Table 7.-Percent male and female chinook salmon sampled from the Chena and Chatanika rivers from 1987-2000.

Year	Sample Size			% Males	% Females
	Males	Females	Total		
		Chena River			
1989[a]	119	218	337	0.35	0.65
1990[a]	430	382	812	0.53	0.47
1991[a]	267	120	387	0.69	0.31
1992[a]	369	212	581	0.64	0.36
1993[a]	205	38	243	0.84	0.16
1994[a]	326	275	601	0.54	0.46
1995[a]	312	586	898	0.65	0.66
1996[a]	268	346	614	0.44	0.56
1997[a]	524	354	878	0.60	0.40
1998[a]	160	107	267	0.60	0.40
1999[a]	74	134	208	0.36	0.64
2000[b]	286	72	358	0.80	0.20
Average	217	192	409	0.60	0.40
		Chatanika River			
1995[a]	21	49	70	0.30	0.70
1996[a]	60	48	108	0.56	0.44
1997[c]	231	71	302	0.76	0.24
1998[a]	40	20	60	0.67	0.33
1999[a]	7	19	26	0.27	0.73
2000[a]	26	11	37	0.70	0.30
Average	64	36	101	0.54	0.46

[a] Samples collected during carcass surveys.

[b] Samples collected during electroshock surveys.

[c] Combined samples collected during an electroshocking event and carcass survey.

Table 8.-Number sampled and estimated proportions by age and sex of chinook salmon sampled by means of electroshocking from a boat and a carcass survey for the Chena River, 2000.

	Sample Size		Proportion		SE	
Age[a]	Electroshock	Carcass	Electroshock	Carcass	Electroshock	Carcass
			Male			
1.1	1		0.00		0.00	
1.2	96	30	0.39	0.30	0.03	0.05
1.3	114	44	0.46	0.44	0.03	0.05
1.4	37	22	0.15	0.22	0.02	0.04
1.5	1	3	0.00	0.03	0.00	0.02
Total Aged	249	99	1.00			
Total Fish[b]	286	113	0.80	0.67	0.02	0.04
			Female			
1.3	10	9	0.14	0.18	0.04	0.06
1.4	53	31	0.77	0.62	0.05	0.07
1.5	6	10	0.09	0.20	0.03	0.06
Total Aged	69	50	1.00			
Total Fish[b]	72	56	0.20	0.33	0.02	0.04

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e. an age of 2.4 represents two annuli formed during river residence and four annuli formed during ocean residence).

[b] Totals include those chinook salmon which could not be aged.

Table 9.-Numbers sampled, estimated proportions, abundance, and mean length by sex and age class of chinook salmon in the Chena River, 2000.

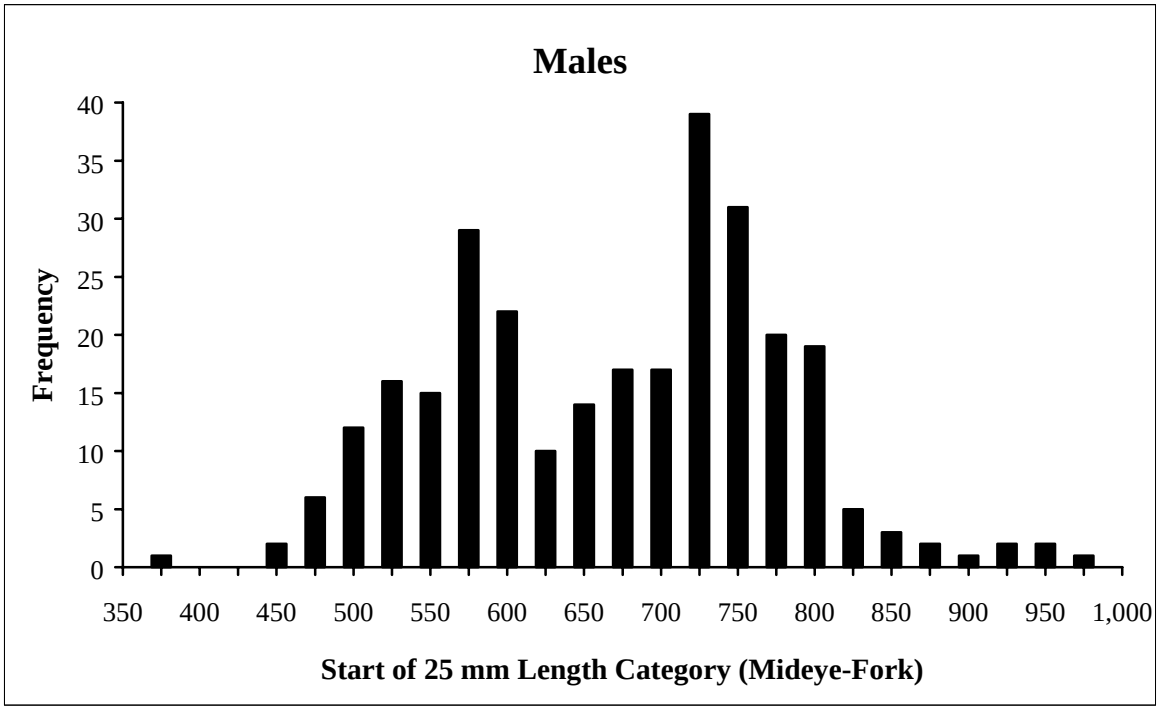
Age[a]	Sample Size	Proportion	SE	Abundance[d]	SE[d]	Length (mm) Mean	SE	Min	Max
				Male					
1.1	1	0.00	0.00	15	15	370	-	370	370
1.2	96	0.30	0.03	1,417	376	548	5	440	710
1.3	114	0.36	0.03	1,683	442	715	5	565	910
1.4	37	0.12	0.02	546	160	766	13	590	950
1.5	1	0.00	0.00	15	15	965	-	965	965
Total Aged	249	0.78							
Total Fish[b]	286	0.80[c]	0.02[c]	3,675		660	6	370	965
				Female					
1.3	10	0.03	0.01	148	58	824	16	775	945
1.4	53	0.17	0.02	782	219	838	6	760	940
1.5	6	0.02	0.01	89	41	933	9	910	960
Total Aged	69	0.22							
Total Fish[b]	72	0.20[c]	0.02[c]	1,019		846	6	760	975

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e. an age of 2.4 represents two annuli formed during river residence and four annuli formed during ocean residence).

[b] Totals include those chinook salmon for which sex could be determined, including those that could not be aged.

[c] Proportion and corresponding SE were based on total number (358) of electroshocked chinook salmon.

[d] Abundances and associated SE were derived from the Chapman estimate of 4,694 (SE = 1,184).



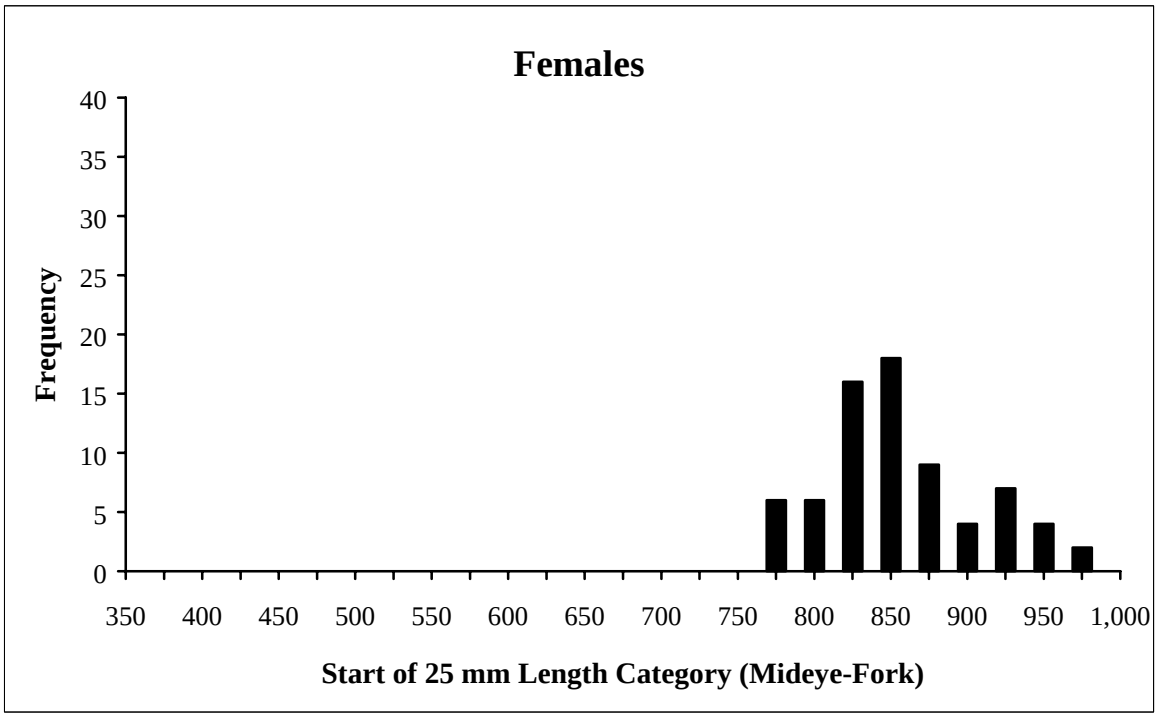


Figure 9.-Length frequency distributions of male and female chinook salmon, which were electrofished from the Chena River, 2000.

Aerial Survey Count for the Chena River

The peak count of chinook in the Chena River from aerial surveys occurred on 29 July (934 chinook salmon). Visibility for the Chena River was rated as poor on this day and the count was incomplete. This count represented 0.21 of the mark-recapture estimate of total abundance. Since 1986, the proportion of the population observed as the peak count from aerial surveys has ranged from 0.08 to 0.59 of tower/mark-recapture estimates and averaged 0.29 (Table 10).

Chena River Chum Salmon Studies

Chum salmon were first counted on 17 July. Because six previous days of counting were missed due to high water and poor visibility, it us unknown if chum salmon migrated past the tower during this period. The chum salmon migration was still underway when counting ended. The partial escapement through 12 August was 3,515 (SE=300; Table 11). The largest observed daily-expanded count was 438 on 29 July. The largest number of chum salmon passing during any one 10-min count was 14 for the left side of the Chena River at 1400 on 6 August. Overall, counts tended to be much higher for the left side of the Chena River (Appendices D3-D4). On visual inspection, passage of chum salmon for the Chena River showed no distinct diurnal variation (Figure 10).

Chatanika River Chinook/Chum Salmon Studies

High water and subsequent poor visibility precluded acquisition of a complete estimate of escapement for 2000 in contrast to the previous two years (Table 12). An incomplete escapement of 398 (SE = 83) chinook salmon was estimated (Table 13). The largest daily expanded count of chinook salmon for the Chatanika River was 81 (SE = 55) for 16 July. The largest number of chinook salmon to pass during one 20-min count was 4 at 1900 and 2200 hours on 17 July, 2200 hours on 20 July, and 0100 on 22 July (Appendix D5). Daily passage of chinook salmon was minimal when counts were terminated on 4 August.

For 2000 the run may have hit the 50% mark on 19 July, however, this date was influenced by the five days of missing data (Figure 11). For comparison, past dates when 50% of the total escapement of chinook salmon had traveled past the counting tower were 22 July for 1998 and 26 July for 1999. The average escapement for 1998 and 1999 was 740.

The 2000 data was incomplete. The main objective of the tower-count was to estimate chinook salmon escapement; counting chum salmon was ancillary. Similar to the Chena River, the salmon count was concluded while the chum salmon were still travelling to their spawning grounds. The incomplete estimate of chum salmon from 4 July through 4 August was 944 (SE=138). The largest daily-expanded count of chum salmon was 170 (SE=61) on 30 July (Table 13). The largest number of chum salmon to pass during one 20-minute count was 15 at 2300 hours on 28 July (Appendix D6). From visual inspection, chum and chinook salmon showed highest average rates of passage between 2100 and 0300 hours (Figure 12).

Age, Sex, and Length Compositions

Thirty-seven chinook salmon carcasses were collected to estimate age, sex, and length composition. Ages were determined for 95% of the sample and sex was determined for all fish (Table 14). Of the fish examined, 0.70 (SE=0.08) were male and 0.30 (SE=0.08) were female. The average male/female ratio from 1995-2000 of fish aged was 0.54 males and 0.46 females (Table 7). The majority of males examined were age 1.3 (0.67). Other age classes included 1.2

Table 10.-Estimated abundance, peak counts during aerial surveys, aerial survey conditions, proportion of the population observed during aerial surveys for chinook salmon escapement in the Chena River, sport harvest, and sport catch by year.

Year	Estimated Abundance[a]	SE	Aerial Survey Count	Aerial Survey Condition[b]	Proportion of Total Escapement	Sport Harvest[f]	Sport Catch[f]
1986	9,065[c]	1,080	2,031	Fair	0.22	212	NE[g]
1987	6,404[c]	557	1,312	Fair	0.20	195	NE[g]
1988	3,346[c,e]	556	1,966	Fair-Poor	0.59	73	NE[g]
1989	2,666[c]	249	1,180	Fair-Good	0.44	375	NE[g]
1990	5,603[c]	1,164	1,436	Fair-Poor	0.26	64	406
1991	3,025[c]	282	1,276	Poor	0.42	110	258
1992	5,230[c]	478	825	Fair-Poor	0.16	39	71
1993	12,241[d]	387	2,943	Fair	0.24	733	2,545
1994	11,877[d]	479	1,570	Fair-Poor	0.13	993	1,308
1995	9,680[c]	958	3,567	Fair	0.37	662	1,095
1996	7,153[c]	913	2,233	Poor-Good	0.31	1,270	3,663
1997	10,811[c]	1,160	3,495	Fair-Good	0.32	1,029	3,151
1997	13,390[d]	699	3,495	Fair-Good	0.26		
1998	4,745[d]	503	386	Incomplete	0.08	299	779
1999	6,485[d]	427	2,412	Fair	0.37	442	1,260[g]
2000	4,694[c]	1,184	934	Poor-Incomplete	0.21	71	958
Average					0.29		

[a] Estimates from Barton (1987a and 1988); Barton and Conrad (1989); Burkholder (1991); Evenson (1991-1993; 1995-1996); Evenson and Stuby (1997), Skaugstad (1988, 1989, 1990b, 1992, 1993, and 1994), Stuby and Evenson (1998), Stuby (1999, 2000).

[b] During these surveys, conditions were judged on a scale of "poor, fair, good, excellent" unless otherwise noted.

[c] Estimate was obtained from mark-recapture techniques.

[d] Estimate was obtained from tower-counts.

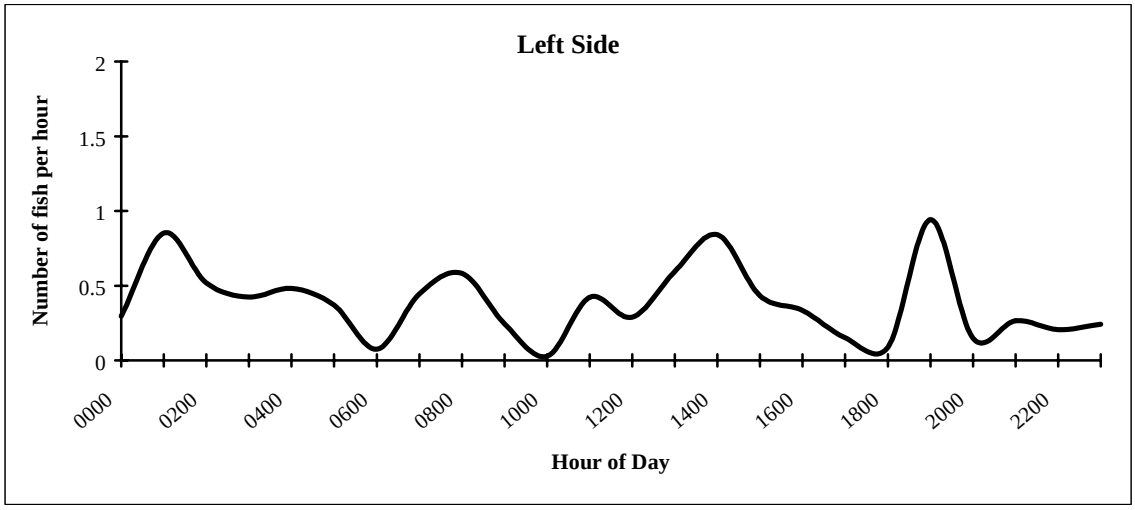
[e] Original estimate was 3,045 (SE=561) for a portion of the river. The estimate was expanded based on the distribution of spawners observed during an aerial survey.

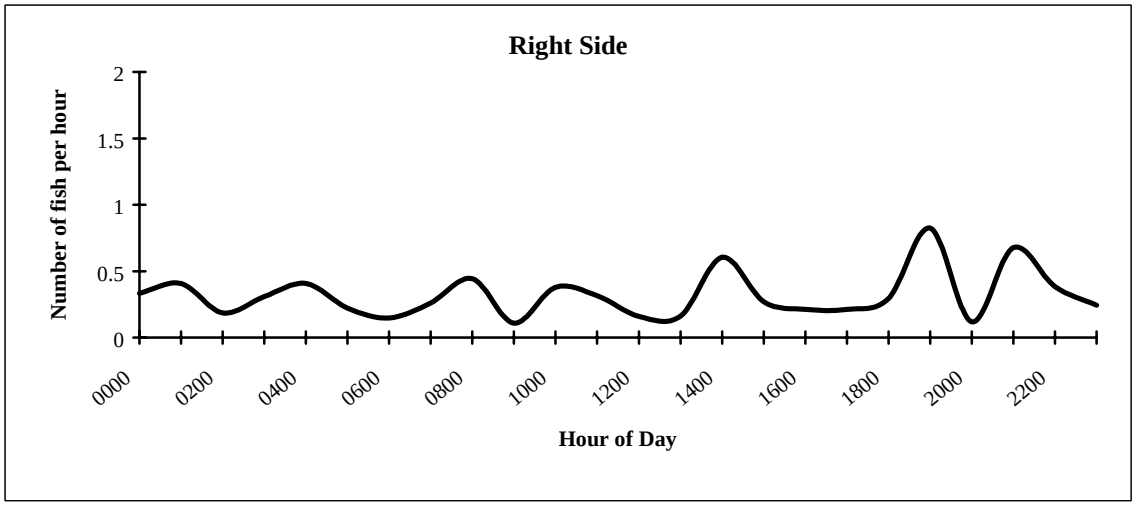
[f] Data from Mills (1981-1994) and Howe et al. (1995-1996, 2001).

[g] Data from Doxey (2002, *in prep*).

Table 11.-Number of counts, daily counts, and expanded number of chum salmon passing by the counting site by date in the Chena River, 2000. Shaded cells indicate days with missing counts due to high water.

Date	Number of 10 min Counts	Left Side			Right Side			Total		
		Count	Expanded Count	SE	Count	Expanded Count	SE	Count	Expanded Count	SE
29-Jun-00	6	0	0	0	0	0	0	0	0	0
30-Jun-00	16	0	0	0	0	0	0	0	0	0
1-Jul-00	16	0	0	0	0	0	0	0	0	0
2-Jul-00	16	0	0	0	0	0	0	0	0	0
3-Jul-00	16	0	0	0	0	0	0	0	0	0
4-Jul-00	16	0	0	0	0	0	0	0	0	0
5-Jul-00	16	0	0	0	0	0	0	0	0	0
6-Jul-00	24	0	0	0	0	0	0	0	0	0
7-Jul-00	16	0	0	0	0	0	0	0	0	0
8-Jul-00	16	0	0	0	0	0	0	0	0	0
9-Jul-00	16	0	0	0	0	0	0	0	0	0
10-Jul-00	16	0	0	0	0	0	0	0	0	0
11-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
12-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
13-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
14-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
15-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
16-Jul-00	0	0	0	N/A	0	0	N/A	0	0	N/A
17-Jul-00	12	0	0	0	1	14	15	1	14	15
18-Jul-00	16	2	18	13	1	9	9	3	27	15
19-Jul-00	24	0	0	0	3	18	10	3	18	10
20-Jul-00	24	5	30	10	7	42	17	12	72	20
21-Jul-00	16	3	27	18	1	9	9	4	36	20
22-Jul-00	24	4	24	14	5	30	15	9	54	20
23-Jul-00	24	3	18	12	5	30	13	8	48	18
24-Jul-00	15	4	36	27	5	45	31	9	81	41
25-Jul-00	24	2	12	8	7	42	17	9	54	19
26-Jul-00	23	1	7	14	3	18	10	4	25	17
27-Jul-00	24	30	180	83	21	126	58	51	306	101
28-Jul-00	24	20	120	37	13	78	24	33	198	44
29-Jul-00	23	39	246	73	30	192	60	69	438	94
30-Jul-00	24	29	174	67	15	90	47	44	264	82
31-Jul-00	16	15	135	75	2	18	19	17	153	77
1-Aug-00	24	16	96	53	21	126	40	37	222	66
2-Aug-00	24	14	84	33	7	42	21	21	126	39
3-Aug-00	24	10	60	34	4	24	11	14	84	36
4-Aug-00	24	8	48	23	15	90	41	23	138	48
5-Aug-00	24	23	138	52	29	174	66	52	312	84
6-Aug-00	16	15	135	127	2	18	10	17	153	128
7-Aug-00	24	2	12	25	3	18	27	5	30	36
8-Aug-00	24	14	84	62	8	48	19	22	132	65
9-Aug-00	24	7	42	22	13	78	84	20	120	87
10-Aug-	24	18	108	36	8	48	23	26	156	42
11-Aug-	23	13	87	51	16	101	35	29	188	62
12-Aug-	24	4	24	12	7	42	20	11	66	24
Total	782	301	1,944	243	252	1,571	177	553	3,515	300





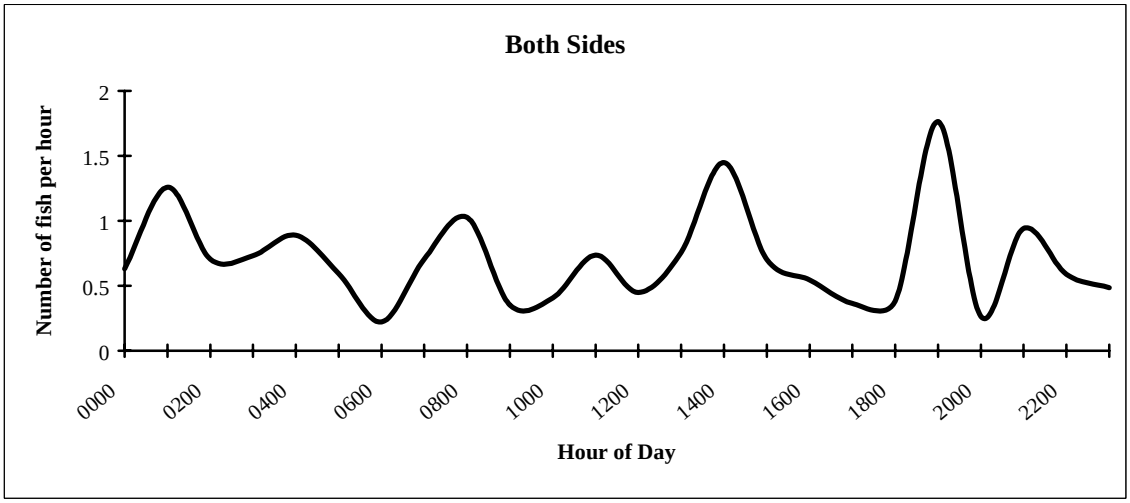


Figure 10.-Average hourly escapement of chum salmon in the Chena River, 2000.

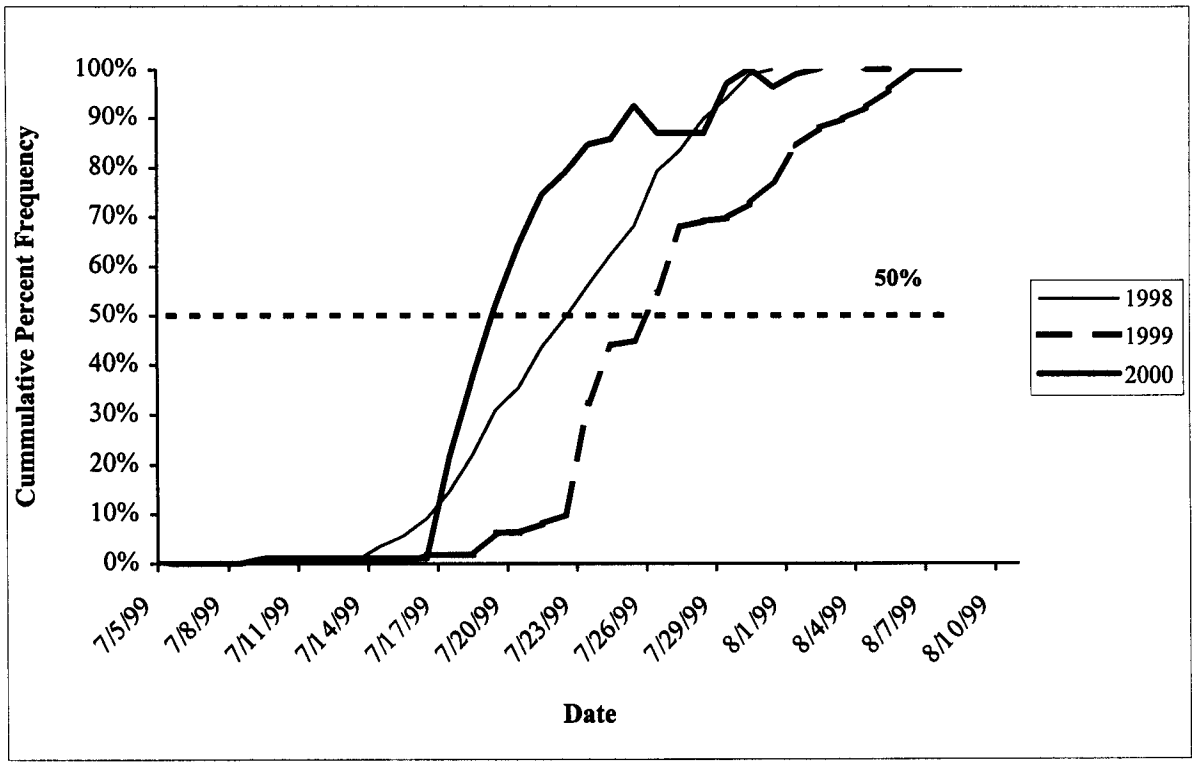
Table 12.-Method of count, counts by river section, survey conditions, sport harvest, and sport catch by year of chinook salmon in the Chatanika River, 1980-2000.

		River Section				Survey	Sport	Sport
Year	Method	Lower[a]	Middle[b]	Upper[c]	Total	Condition	Harvest[d]	Catch[d]
1980	Aerial	NA[e]	NA	NA	37	Fair	37	NE[f]
1981			No Survey				5	NE
1982	Aerial	NA	NA	NA	159	Fair-Good	136	NE
1983			No Survey				147	NE
1984	Aerial	NA	NA	NA	9	Poor	78	NE
1985			No Survey				373	NE
1986	Aerial	NA	NA	NA	79	Fair	0	NE
1987			No Survey				21	NE
1988			No Survey				345	NE
1989	Aerial	NA	NA	NA	75	Fair	231	NE
1990	Aerial	10	46	5	61	Fair-Poor	37	164
1991	Aerial	2	84	18	104	Fair	82	181
1992	Aerial	NC[g]	78	NC[g]	78[h]	Fair	16	31
1993	Aerial	6	46	23	75	Fair	192	625
1993	Boat	NC	253	NC[g]	253[h]	Good	192	625
1994	Aerial	49	NC	NC[g]	372	Fair	105	278
1995	Boat	NC	326	118	444[h]	Fair-Good	58	134
1996	Boat	NC	147	51	198[h]	Fair-Good	499	1,164
1997	M-R	NE	NE	NE	3,809	NA	225	425
1998	Tower	NE	NE	NE	864	NA	6	30
1999	Tower	NE	NE	NE	503	NA	36	63
2000	Tower	NE	NE	NE	398[i]	NA	0	0

[a] Lower section runs from the Trans Alaska Pipeline upstream to the Elliott Highway Bridge.
[b] Middle section runs form the Elliott Highway Bridge upstream to the Steese Highway Bridge.
[c] Upper section runs from the Steese Highway Bridge upstream to the confluence of Faith and McManus Creeks (Figure 4).
[d] Sport fishery harvest estimates from Mills (1981-1994) and Howe et al. (1995-1996, 2001).
[e] NA = section subtotals are not available.
[f] NE = no estimate is available.
[g] NC = no count was conducted during this survey.
[h] Incomplete survey.
[i] Incomplete tower estimate.

Table 13.-Number of counts, number counted, and expanded number of chinook and chum salmon passing by the counting site by date in the Chatanika River, 2000. Shaded cells indicate days with missing counts due to high water.

Date	Number of 20 min Counts	Chinook			Chum		
		Count	Expanded Count	SE	Count	Expanded Count	SE
4-Jul-00	16	0	0	0	0	0	0
5-Jul-00	16	0	0	0	0	0	0
6-Jul-00	16	0	0	0	0	0	0
7-Jul-00	14	0	0	0	0	0	0
8-Jul-00	16	1	5	3	0	0	0
9-Jul-00	16	0	0	0	0	0	0
10-Jul-00	20	0	0	0	0	0	0
11-Jul-00	0	0	0	N/A	0	0	N/A
12-Jul-00	0	0	0	N/A	0	0	N/A
13-Jul-00	0	0	0	N/A	0	0	N/A
14-Jul-00	0	0	0	N/A	0	0	N/A
15-Jul-00	0	0	0	N/A	0	0	N/A
16-Jul-00	8	9	81	55	3	27	15
17-Jul-00	16	14	63	21	3	14	5
18-Jul-00	16	13	59	14	1	5	4
19-Jul-00	16	11	50	13	14	63	44
20-Jul-00	16	9	41	15	4	18	8
21-Jul-00	16	4	18	15	1	5	4
22-Jul-00	16	5	23	24	3	14	6
23-Jul-00	16	1	5	11	0	0	0
24-Jul-00	16	6	27	24	4	18	14
25-Jul-00	16	-5	-23	8	10	45	28
26-Jul-00	24	0	0	9	29	87	23
27-Jul-00	16	0	0	14	2	9	5
28-Jul-00	16	9	41	15	27	122	72
29-Jul-00	14	3	12	16	17	98	49
30-Jul-00	14	-3	-15	14	35	170	61
31-Jul-00	14	2	11	4	9	47	20
1-Aug-00	16	1	5	11	16	72	37
2-Aug-00	15	2	10	4	17	78	40
3-Aug-00	7	-1	-10	-7	2	21	11
4-Aug-00	16	0	0	6	8	36	16
Total	418	81	398	83	205	944	138



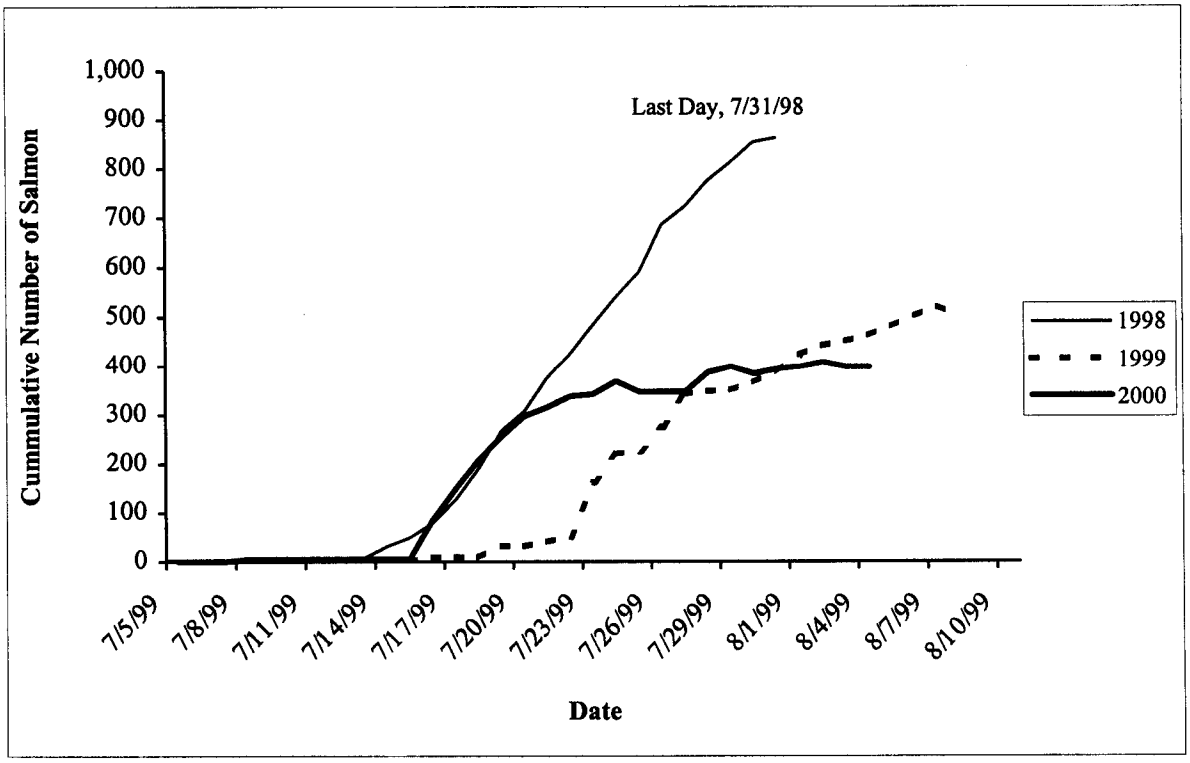
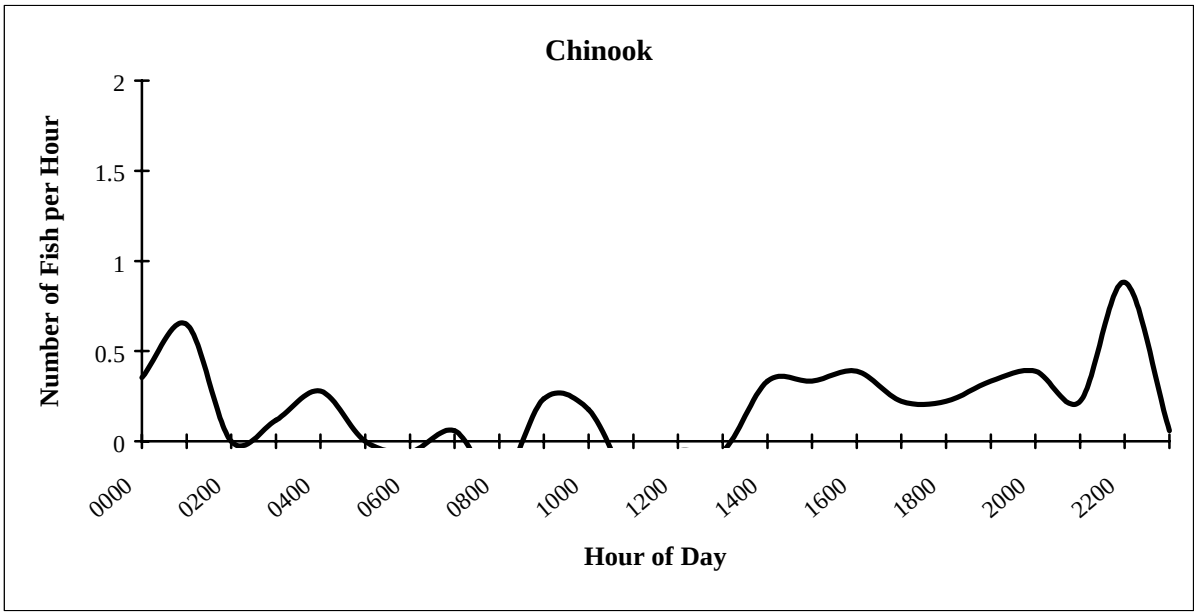


Figure 11.-Average expanded cumulative passage and run timing of chinook salmon for 1998-2000 tower counts for the Chatanika River.



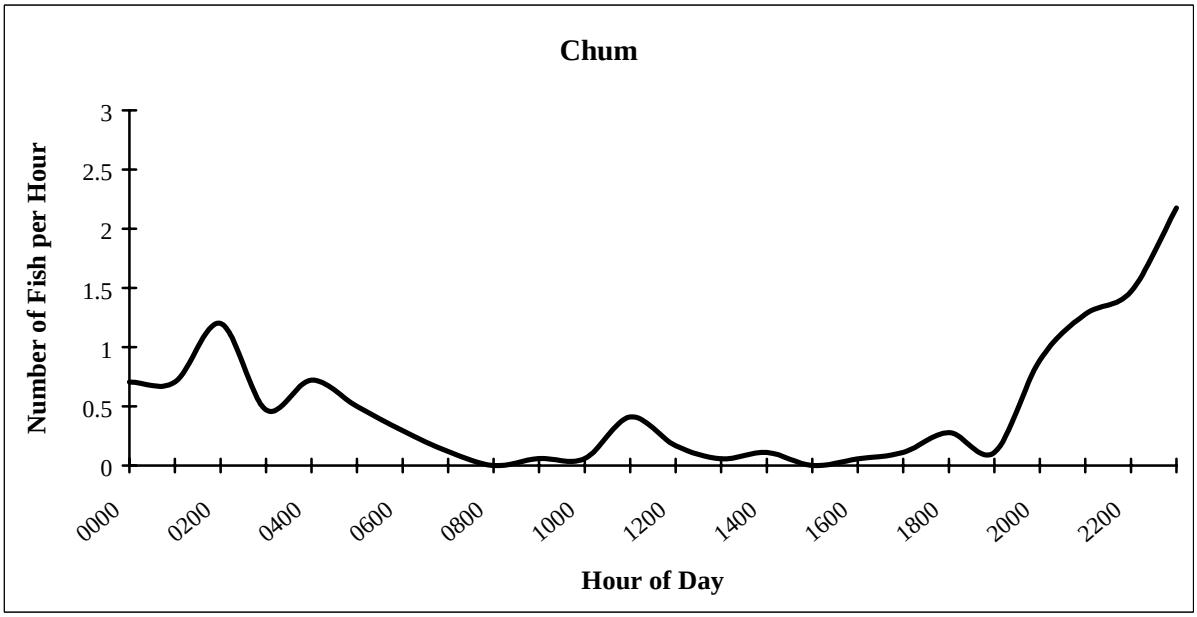


Figure 12.-Average hourly escapement of chinook and chum salmon in the Chatanika River, 2000.

Table 14.-Age, number sampled, estimated proportions, and mean length by sex and age class of chinook salmon in the Chatanika River, 2000.

Age[a]	Sample Size	Proportion	SE	Length Mean	Length SE	Length Min	Length Max
			Male				
1.2	6	0.25	0.09	569	22	495	660
1.3	16	0.67	0.10	718	16	565	790
1.4	2	0.08	0.06	720	5	715	725
Total Aged	24	1.00					
Total[b]	26	0.70	0.08	684	17	495	790
			Female				
1.3	4	0.36	0.15	721	12	700	755
1.4	7	0.64	0.15	847	13	785	890
Total Aged	11	1.00					
Total[b]	11	0.30	0.08	801	21	700	890

[a] Age represents the number of annuli formed during river residence and ocean residence (i.e. an age of 2.4 represents two annuli formed during river residence and four annuli formed during ocean residence).

[b] Totals include those chinook salmon which could not be aged.

(0.25) and 1.4 (0.08). The females were age 1.4 (0.64) and 1.3 (0.36). Male lengths varied from 495 to 790 mm, and female lengths varied from 700 to 890 mm (Figure 13).

Goodpaster River Chinook Salmon Studies

Aerial surveys from fixed-wing aircraft have been sporadically conducted since 1954. Survey areas in the 1960s and 1970s were generally between the South Fork of the Goodpaster River to either Indian or Slate creeks (Barton 1984). Later aerial surveys were extended to Slate Creek or further upstream (Figure 3). Aerial counts have shown this run to be relatively small (Table 15). However, for 1999 and 2000, helicopter counts conducted by Teck Resources, Inc. from the South Fork of the Goodpaster River to Eisenmenger Fork were 1,743 and 2,240 chinook salmon respectively. The 2000 survey was approximately 25% higher than that observed in 1999 using similar survey techniques.

Age, Sex, and Length Compositions

One hundred seventy eight chinook salmon carcasses were collected to estimate age, sex, and length compositions. Ages were determined for 87% of the sample. Of the fish examined, 0.49 (SE = 0.04) were male and 0.51 (SE = 0.04) were female (Table 16). In 1991, males were 0.64 (SE = 0.05) of the carcass sample and 0.71 (SE = 0.04) of the sample for 1992. The majority of males examined for 2000 were age 1.3 (0.68). Other age classes present for males were 1.2 (0.13) and 1.4 (0.19). The majority of females were age 1.4 (0.64). Other age classes for females were 1.3 (0.33) and 1.5 (0.04). Male lengths ranged from 470 to 880 mm. Female lengths ranged from 590 to 930 mm (Figure 14).

DISCUSSION

Tower-count methodology has been used for eight consecutive years as a means of estimating daily and seasonal abundance of chinook salmon for the Chena River. Tower-counts offer a few advantages for estimating abundance over mark-recapture techniques and aerial surveys. For one, tower-counts are an on-going process throughout the salmon run. Thus, they provide in-season information that can be used by fishery managers to help regulate harvest on the fisheries. Based on historical run-timing (Figure 6), managers can predict what percent of the escapement has passed the towers at a given date. With this prediction, a manager can take measures to increase or decrease harvest. For example, the sport fishing bag limit was increased by emergency-order regulation from one to two chinook salmon per day in 1993 and 1994 as a result of large, early escapements. In 1998, due to low escapement into the Salcha and Chena rivers by what should have been the 50% mark of the escapement, both chinook salmon fisheries were restricted to catch-and-release only on 14 July for the duration of the season. In 2000, high water and poor visibility prohibited an accurate assessment of the 50% mark. As a result the 2000 sport fishery was closed completely after the subsistence fishery in the Tanana River was restricted due to poor catches throughout the drainage.

The greatest limitation of tower-counting methodology is that it requires near normal to low water conditions (good visibility) for most of the run. High-water events that muddy the water for more than two days add a great deal of uncertainty to the estimate, especially if this occurs during peak portions of the runs. Of the eight attempts to estimate the escapement with tower-counts on the Chena River, five were successful. For years when a complete estimate of escapement cannot be generated from tower-counts, the daily estimates can still be used for in-season management purposes, especially during the early portion of the run. If an estimate of

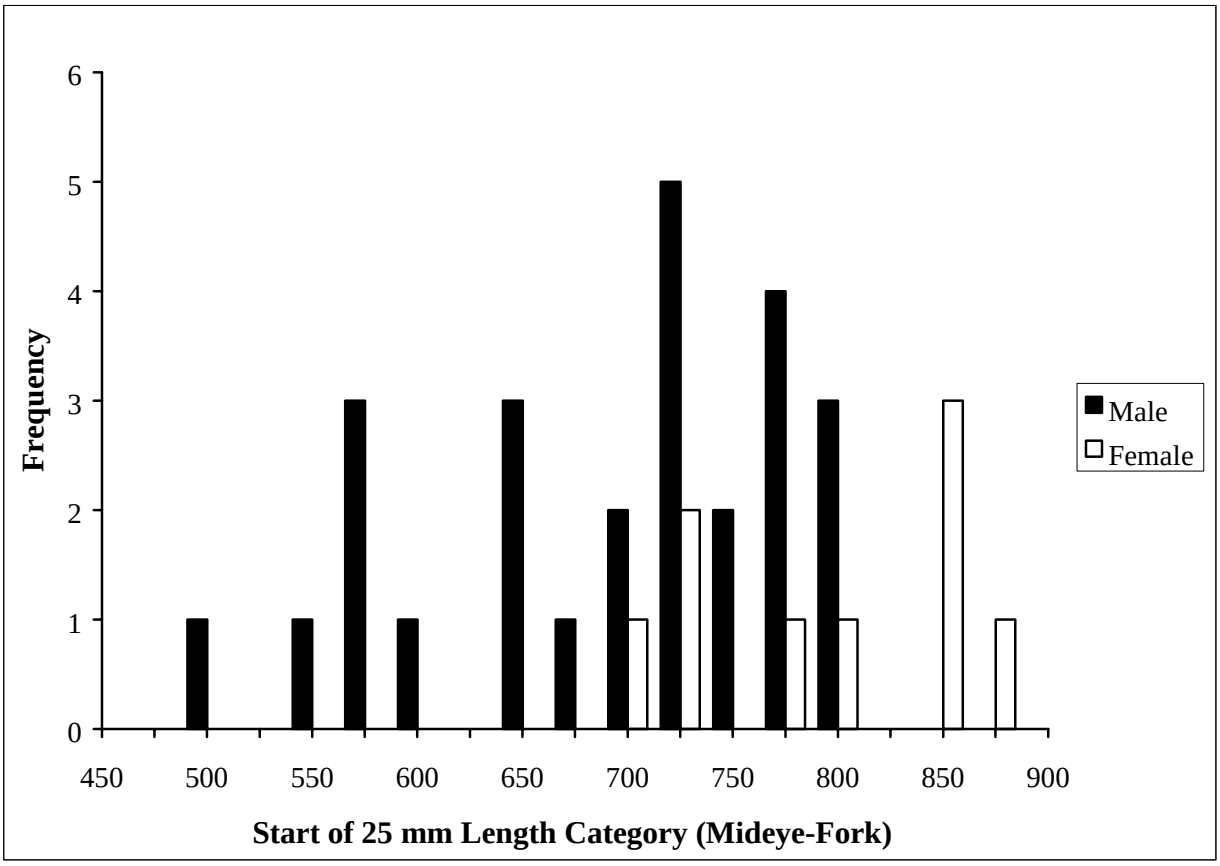


Figure 13.-Length frequency distributions of male and female chinook salmon carcasses sampled on the Chatanika River, 2000.

Table 15.-Chinook salmon spawning escapement counts for the Goodpaster River, 1972-2000.

Year	Date	Survey Rating	Total[b]
1972	8-Aug	NA[a]	29
1973	7-Aug	NA	13
1973	10-Aug	NA	18[c]
1974	29-July	NA	194
1974	27-July to 3-Aug	NA	248[d]
1975	1-Aug	NA	NA
1976	29-July	NA	130
1977	3-Aug	NA	29
1978	NA	NA	NA
1979	NA	NA	NA
1980	NA	NA	NA
1981	NA	NA	NA
1982	NA	NA	NA
1983	29-July	Good	150
1984	8-Aug	Good	165
1985	16-Aug	Fair-Poor	132
1986	NA	NA	NA
1987	NA	NA	NA
1988	NA	NA	NA
1989	NA	NA	NA
1990	27-July	Fair	510
1991	21-July	Poor	868
1992	27-July	Poor	148
1993	26 July	Fair	224
1994	31-July	Fair	1,392
1995	27-July	Fair	621
1996	NA	NA	NA
1997	27-July	Poor-Incomplete	31
1998	15-July, 2-Aug	Fair	591
1998	5 Aug	NA	477[e]
1999	5-Aug	Good	1,743[f]
2000	31-July	Good	2,240[f,g]

[a] Data not available.

[b] Aerial survey flown by Commercial Fisheries Division unless otherwise noted.

[c] Unpublished helicopter flight by Steve Tack, ADF&G.

[d] Boat survey by Tack (1975) from mouth to just below Slate Creek.

[e] Teck Resources, Inc. helicopter flight from South Fork to Slate Creek.

[f] Helicopter survey flown by Teck Resources, Inc. to Eisenmenger Fork.

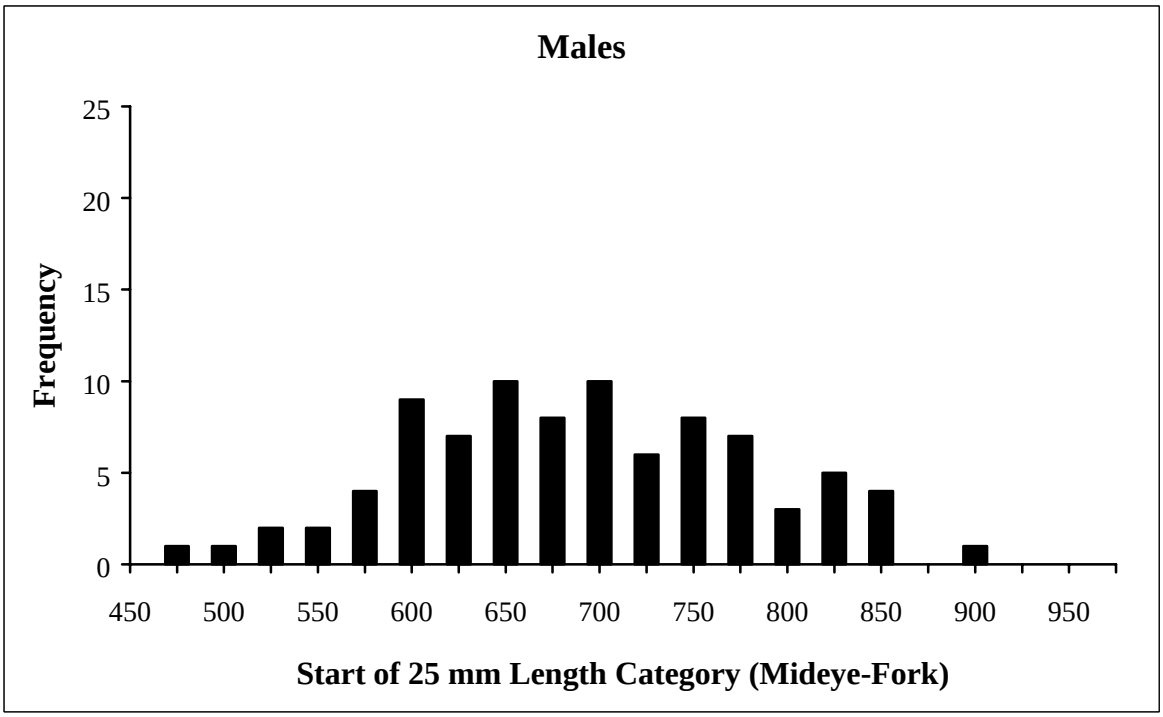
[g] Includes 65 chinook salmon observed in the South Fork.

Table 16.-Number sampled, estimated proportions, and mean length by sex and age class of chinook salmon in the Goodpaster River, 2000.

Age[a]	Sample Size	Proportion	SE	Length Mean	Length SE	Length Min	Length Max
			Male				
1.2	9	0.13	0.04	540	19	470	650
1.3	49	0.68	0.06	688	9	580	840
1.4	14	0.19	0.05	785	17	680	880
Total Aged	72	1.00					
Total[b]	88	0.49	0.04	679	9	470	880
			Female				
1.3	27	0.33	0.05	752	14	604	890
1.4	53	0.64	0.05	829	6	730	930
1.5	3	0.04	0.02	892	7	880	905
Total Aged	83	1.00					
Total[b]	90	0.51	0.04	802	7	590	930

[a] Age represents the number of annuli formed during river residence and ocean residence (i.e. an age of 2.4 represents two annuli formed during river residence and four annuli formed during ocean residence).

[b] Totals include those chinook salmon which could not be aged.



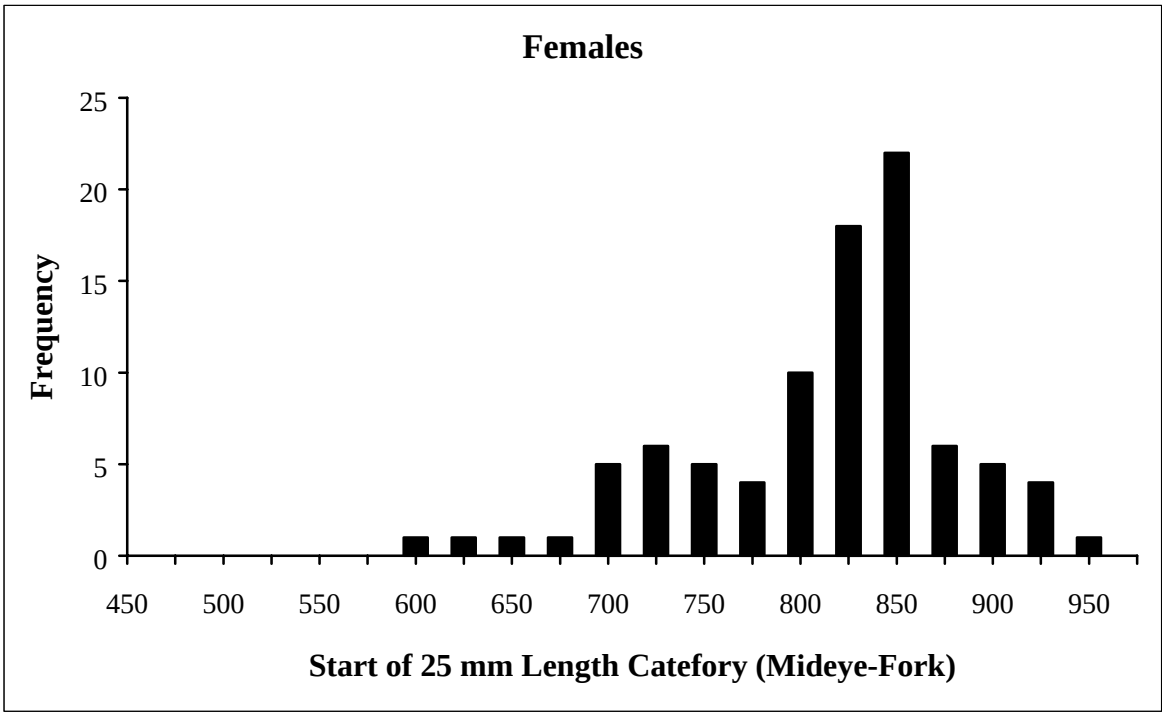


Figure 14.-Length frequency distributions of male and female chinook salmon carcasses sampled from the Goodpaster River, 2000.

total escapement remains necessary, a mark-recapture experiment may be planned as a back-up means of estimating escapement.

Mark-recapture experiments likely do not provide a complete estimate of escapement for the Chena River because spawning occurs in areas upstream from the upper boundaries of the study areas. For this reason, tower-count estimates are considered more complete estimates of escapement when successful. In 1997 a tower-count and mark-recapture experiment for chinook salmon were successfully conducted on the Chena River (Stuby and Evenson 1998). In this case the estimate of total escapement from tower counts was 19% higher than the mark-recapture estimate. The difference, however, was not significant given the precision for each estimate.

Mark-recapture techniques, however, are considered a secondary means of estimating escapement because the precision of the estimates obtained from the tower-counts has been substantially better than the precision of mark-recapture estimates obtained from prior years. Because the marking event occurs late into the run, in-season management is minimal with this method. Without the tower-counts, managers would have to rely on aerial survey estimates to provide in-season escapement information. Also, in order for the mark-recapture experiment to be successful, a large number of fish relative to population size needs to be examined. During a 1997 mark-recapture study in the Chatanika River, an insufficient number of marked fish led to few recaptures and this along with the need to stratify by sex led to an abundance estimate with a large standard error (Stuby and Evenson 1998). For the 2000 mark-recapture experiment performed on the Chena River, a relatively low number of recaptures weakened the power of the K-S two-sample test, which compared the distribution of the lengths of all fish that were marked and later recaptured. Nevertheless, the number of recaptures relative to the number marked and sampled during the carcass survey resulted in a viable estimate for 2000.

Another reason to avoid mark-recapture estimates is that electroshocking methods can potentially harm the eggs both within the spawning female during capture and when the electrodes skim over the redds. Considering both types of egg mortality, Roach (1996) concluded that the cost in egg mortality of using electrofishing to sample a population of 10,000 chinook salmon under the conditions similar to those in the Chena River is equivalent to removing 51 prespawning females or 1.3% of the female population. Although, the harm may be offset by the gain of valuable escapement information, it should be avoided when possible.

Past mark-recapture techniques allowed for the detection of size and sex selective sampling associated with electrofishing (marking event) and the carcass surveys (capture event). Contingency table analyses indicated bias in estimates of size and sex composition derived from carcass surveys in six of nine experiments. One of the six carcass surveys that was biased (1992), however, did not amount to much of a change from the unbiased estimate. Thus, the length data was not stratified for that estimate of abundance (Evenson 1993). The extent of the bias associated with estimates of sex composition from carcass surveys in terms of its affect on estimates of population proportions have not yet been estimated.

Chinook salmon were electrofished in 1999 near the peak to sample for age and sex data to compare with similar data collected from the carcass survey. The carcass survey showed a greater selectivity for females than for males, while electrofishing showed similar probabilities of capture for males and females (Stuby 2000). The same degree of bias was seen in the carcass survey during the mark-recapture in 2000. Carcass surveys on the Chena River tend to be biased toward capture of large, particularly female fish (D. Bernard, Alaska Department of Fish &

Game, Anchorage, personal communication). In general, males mature at a younger age than females (Healey 1991). Because marine age and chinook size are positively correlated (Pahlke and Bernard 1996), males tend to be smaller. Small-sized carcasses may be more likely to be consumed or carried away by scavengers, more difficult for surveyors to detect, and more readily washed away (Zhou and Williams 1999). Smaller salmon are also harder to detect from a distance and can resemble chum salmon carcasses that have become red from lying in the sun. Hubartt and Kissner (1987) found that most female chinook salmon in the Taku River died in shallow water near their redds, whereas males tended to float downstream in a moribund condition after spawning. This sexual trait may be the cause of size-selectivity in sampling. For 2000, age, sex, and length data were estimated from electroshocked chinook salmon as dictated by statistical tests for evaluating gear, sex, and length biases; and given the aforementioned history of sex and length biases for carcass samples.

Some managers use aerial surveys to manage salmon fisheries in-season and these are usually less expensive than tower-counts. Aerial counts conducted during peak escapements are sometimes used as an index of total escapement. However, aerial surveys are dependent on weather and water visibility, and in these systems do not appear to provide a consistent index of abundance. Also, aerial survey estimates with good visibility still tend to be much lower than both tower and mark-recapture estimates.

Tower counting methods were implemented in 1998 for the Chatanika River. Compared to the Chena River, the Chatanika River sports a much smaller run of chinook salmon. The tower-count estimate for 2000 was incomplete due to the uncertainty of the number of salmon that passed between 11 and 15 July. In 1998, 10% of the run passed by the counting tower between these dates and in 1999, which was a relatively late run for the Chena and Salcha rivers, none were seen during this period. With only two seasons of complete tower estimates, run data from previous years could not be used to estimate escapement for the missing days.

During 1998, chinook salmon escapements into the Salcha and Chena rivers were lower than in 1999. It was expected that the Chatanika River would have followed a similar pattern, however, the tower estimate was much lower for 1999 (503) than 1998 (864). Sport harvest for the Chatanika River for 1998 and 1999 was small and supposedly nonexistent for 2000 (Table 12). Because escapement objectives have not been established for this river and harvests from sport fishermen have been large relative to index measures of abundance, continuation of enumeration projects to acquire precise escapement estimates is especially important for managing this stock.

Chinook salmon carcasses were sampled on the North Fork of the Goodpaster River. Van Wyhe (1964) described the area below the confluence of the South Fork of the Goodpaster River as low in productivity due to little aquatic vegetation and a sandy substrate. He described the river above the South Fork confluence as having a predominantly coarse gravel substrate with a high density of aquatic vegetation and productivity. Much of the North Fork of the Goodpaster River upstream confluence of the South Fork is used for spawning by chinook salmon (Morsell 1999). The South Fork of the Goodpaster River contains essentially no good spawning habitat. Morsell (1999) noted a uniform distribution of spawning areas from the confluence to below Slate Creek. Not much spawning occurs between Slate Creek and Eisemmenger Fork. Parker (Alaska Department of Fish and Game, Delta Junction, personal communication) did not see any chinook salmon carcasses from Tibbs to Slate creeks and commented that future carcass surveys should begin at Slate Creek. Given the fishery has been closed since 1975, it is important to ascertain

spawning habitat extents on this river in order to garner good aerial count information and for future carcass surveys.

Results from aerial surveys conducted by Teck Resources, Inc. showed that the 2000 count of chinook salmon for the Goodpaster River was larger than the 1999 count (Table 15), even though other interior rivers such as the Chena and Salcha rivers showed an opposite trend. Teck Resources, Inc. data also indicated that chinook spawners were more than three times as abundant in the Goodpaster River in 1999 as in 1998. According to Morsell (1999), while differences in visibility and survey timing may have accounted for some difference between 1999 and prior years, the relatively large number of fish observed in 1999 showed an actual increase in chinook salmon numbers compared to 1998.

Historical Age Sex-Length Compositions

The average length-at-age for chinook salmon sampled in the Chena River has varied over the years from 1989 - 2000. Most of the age, sex and length samples were gathered from carcasses. The most common ages sampled for male chinook were 1.2, 1.3, and 1.4 (Appendices E1 and E2). Mean length at age for age 1.2 has varied from 524 mm in 1988 to 600 mm in 1995. Age 1.3 has varied from 698 mm in 1993 to 772 mm in 1989, and age 1.4 has varied from 766 mm in 2000 to 892 mm in 1996 (Appendix E3). The most common ages sampled since 1989 for female chinook salmon were 1.3, 1.4, and 1.5. Mean length-at-age for age 1.3 has varied from 738 mm in 1991 to 857 mm in 1997. Age 1.4 has varied from 825 mm in 1998 and 1999 to 888 mm in 1997, and age 1.5 has varied from 901 mm in 1997 to 995 mm in 1992 (Appendix E4).

Chinook carcasses have been collected from the Chatanika River since 1995 for determining age, sex, and length compositions. The most common ages sampled for male chinook salmon were 1.2, 1.3, and 1.4 (Appendices E5 and E6). Similar to the Chena River population, Chatanika River chinook salmon have shown variations in mean length between the years (Appendix E7). Mean length-at-age for age 1.2 has varied from 569 mm in 2000 to 596 mm in 1997. Age 1.3 has varied from 712 mm in 1997 to 775 mm in 1995 and age 1.4 has varied from 662 mm in 1999 to 885 mm in 1995. The most common ages seen for female chinook salmon were 1.3 and 1.2. Mean length-at-age 1.3 has varied from 685 mm in 1996 to 855 mm in 1995. Age 1.4 has varied from 785 mm in 1998 to 862 mm in 1997.

The most common ages sampled for male chinook salmon in the three years of collection on the Goodpaster River were 1.2, 1.3 and 1.4 (Appendix E8). Mean length-at-age has varied from 540 mm in 2000 to 570 mm in 1991 (Appendix E9); age 1.3 has varied from 688 mm in 2000 to 743 in 1991, and age 1.4 has varied from 785 mm in 2000 to 975 mm in 1991. The most common ages sampled for female chinook in the three years of collection were 1.3 and 1.4. Mean length-at-age for 1.3 has varied from 752 mm in 2000 to 852 mm in 1992, while age 1.4 has varied from 729 mm in 2000 to 885 mm in 1992.

SALCHA RIVER CHINOOK SALMON STUDIES

The Salcha River, similar to the Chena River, has some of the largest chinook salmon escapements in the Yukon Drainage (Schultz et al. 1994) and has a popular chinook salmon sport fishery. Sport Fish Division conducted mark-recapture surveys on the Salcha River between 1987 and 1992. Tower-counting techniques were implemented in 1993 and continued through 1998. Sport Fish Division did not conduct a tower count on the Salcha River during 1999 and 2000. Instead, counts were conducted by the Bering Sea Fishermen's Association (BSFA).

METHODS

In 2000, tower counts were conducted from 30 June to 12 August (Appendix F1). A single tower was erected approximately 0.25 miles downstream from the Richardson Highway Bridge (Figure 15). Set-up, enumeration, and data analysis procedures for chinook and chum salmon returning to the Salcha River were similar to that for the Chatanika River.

The Salcha River, similar to the Chatanika and Chena rivers, experienced high water and subsequent poor visibility from 11-16 July. Because only five periods were counted during the graveyard shift on 11 July and no counts were conducted during 12-16 July, an expanded estimate for the missing days was calculated using past, complete tower estimates from 1993-1995 and 1997-1999. Estimates of abundance and age, sex, and length values were calculated using the procedures for the Chena and Chatanika rivers.

During the five previous years with complete tower data, the proportion (p_i) of the total run which passed the site during that time period ranged from 0.05 to 0.42 (Table 17). Escapement of chinook salmon for the 2000 season $\left(\hat{N}\right)$ was estimated by expansion for days with missing counts based on previous data, as follows:

$$\hat{N} = \hat{N}_t \overline{X} \tag{21}$$

where $\hat{N}_t$ is the incomplete passage estimate and $\overline{X}$ is the mean expansion factor ($X_i = 1/(1-p_i)$).

For the n_Y previous years of complete data:

$$\overline{X} = \frac{\sum_{i=1}^{n_Y} \frac{1}{1-p_i}}{n_Y} . \tag{22}$$

The variance of $\hat{N}$ was estimated following Goodman (1960):

$$\hat{V}\left(\hat{N}\right) = \left[\hat{N}_t^{\,2} * \hat{V}\left(\overline{X}\right) + \overline{X}^2 * \hat{V}\left(\hat{N}_t\right) - \hat{V}\left(\overline{X}\right) * \hat{V}\left(\hat{N}_t\right)\right]. \tag{23}$$

The variance of the expansion factor $\overline{X}$ was estimated as the sample variance of X during the n_Y years of complete data.

$$\hat{V}(\overline{X}) = \frac{\sum_{i=1}^{n} \left(\left(\frac{1}{1-p_i} \right) - \overline{X} \right)^2}{n-1} . \tag{24}$$

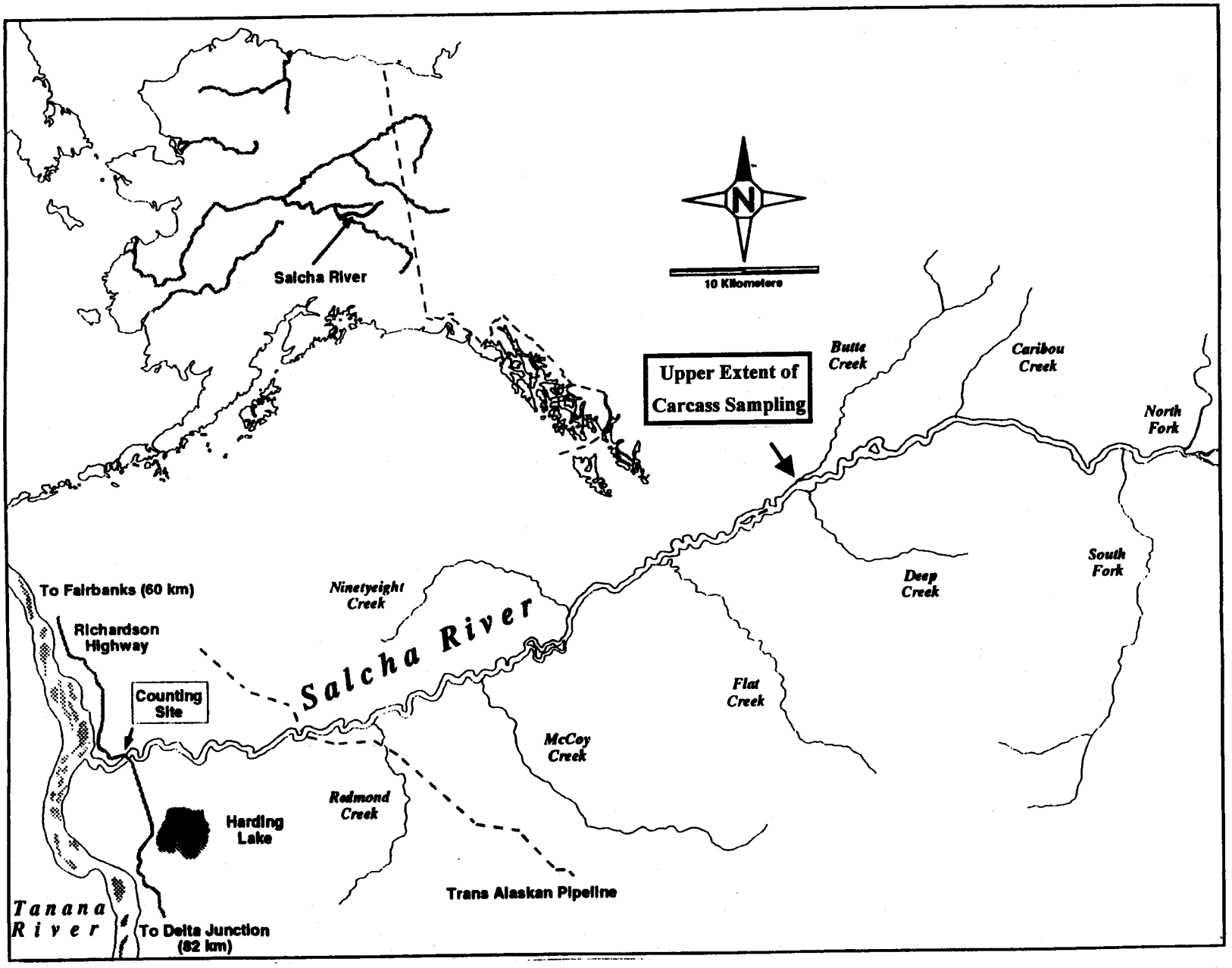


Figure 15.-Salcha River study area.

Table 17.-Estimate of escapement and proportion of total run passing the counting site during 11-16 July for years of complete tower estimates for the Salcha River.

Year	Estimate of Escapement	SE	Proportion of Total Run during 11-16 July (p_i)	Expansion Factor (X_i)
1993	10,007	360	0.42	1.72
1994	18,399	549	0.37	1.60
1995	13,643	471	0.34	1.51
1997	18,396	1,043	0.37	1.59
1998	5,027	331	0.23	1.30
1999	9,198	290	0.05	1.06
Average			0.30	1.46

RESULTS

Tower Estimates

The escapement of chinook salmon not including estimates for missed days was estimated to be 3,140 (SE = 165). A total escapement estimate including the expansion for missed days was 4,595 (SE = 802) chinook salmon. The largest daily expanded count of chinook salmon, for the days in which counts could be conducted, was 483 (SE=65) on 18 July (Table 18). The largest number of chinook salmon to pass during any one 20 minute count was 21 at 0900 and 1400 hours on 18 July (Appendix F2). Daily passage of chinook salmon was zero when counts were terminated on 12 August. Visual inspection of the average hourly passage (Figure 16) showed no distinct diurnal variation for chinook salmon.

Run timing of chinook salmon in the Salcha River in 2000 (Figure 17) was similar to that of the Chena River (Figure 6). Escapement may have reached 50% of the total on 20 July although, like the Chena River, the peak count may have taken place during the high water events. The average total escapement estimated from tower-counts for 1993-1995 and 1997-1999 was 12,564. Escapement for 1996 was estimated through a mark-recapture experiment because high water precluded acquisition of a reliable tower estimate. The estimated total escapement in 2000 of 4,595 is within the recommended range of the BEG (Figure 18).

The BSFA attempted to acquire a total escapement for summer chum salmon, but were unable to due to adverse counting conditions. The incomplete estimate for chum salmon was 20,516 (SE=403). The largest expanded daily count of chum salmon for days which could be counted was 2,076 (SE = 126) on 31 July (Table 18). The largest number of chum salmon to pass during any one 20 minute count was 59 at 2100 hours on 1 August (Appendix F3). Visual inspection of Figure 16 shows that passage of chum salmon was generally higher in the early morning and late evenings.

An aerial survey was completed by CFD on 31 July. A total of 2,478 chinook salmon were counted. Conditions were poor and the count was incomplete.

Age, Sex, and Length Compositions

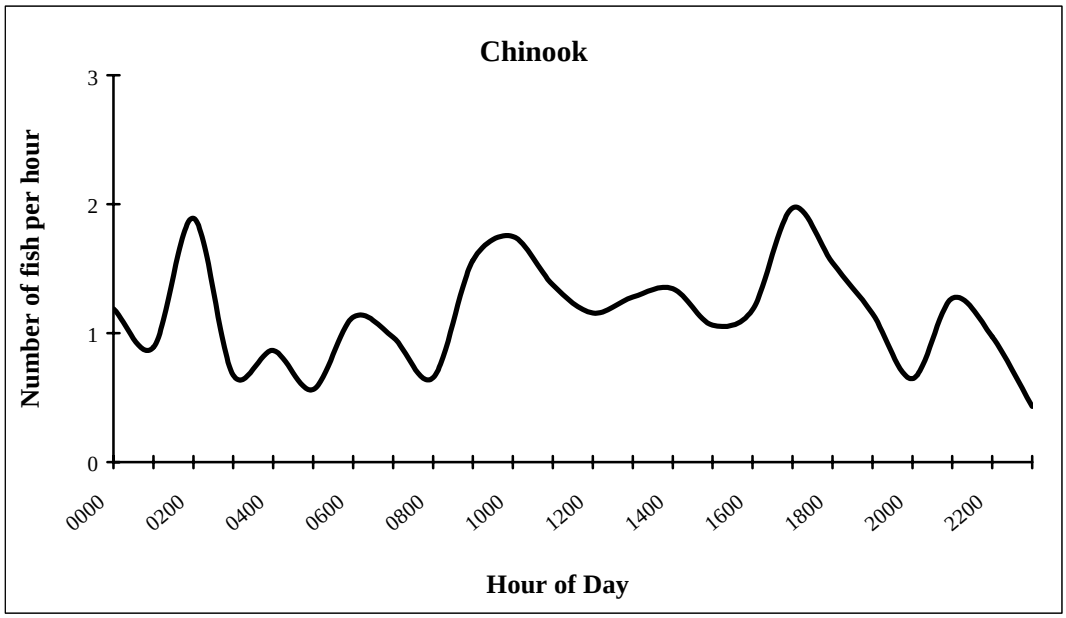
Forty-eight chinook salmon carcasses were collected and examined during 7 and 8 August. The sex composition for this sample including those fish not aged was 0.60 (SE=0.07) males and 0.40 (SE=0.07) females. Ages were determined for 0.85 of the sample. The dominant age class for males sampled in 2000 was 1.3 (0.57; Table 19). Males were also represented by ages 1.2 (0.30) and 1.4 (0.13). The majority of females were represented by ages 1.3 (0.39) and 1.4 (0.39). The sample also contained ages 1.2 (0.11) and 1.5 (0.11). Lengths of males ranged from 460 to 860 mm (Figure 19). Lengths of females ranged from 560 to 1,000 mm.

DISCUSSION

Similar to the Chena River, the tower escapement estimate was incomplete due to poor visibility as a result of heavy rainfall. Past escapement and associated age composition, and commercial, subsistence, and sport harvest estimates were analyzed with a spawner-recruit model for the Salcha River in order to develop a biological escapement goal (BEG). The Board of Fish approved a BEG for the Salcha River, which will be applied to the 2001 fishery of 3,300 to 6,500 chinook salmon. Because the BEG will be refined in future years, it was important to have a total estimate of escapement for 2000. BSFA was unable to conduct a mark-recapture estimate using electrofishing techniques. Thus, the incomplete estimate was expanded using historical

Table 18.-Number of counts, daily counts, and expanded number of chinook and chum salmon passing by the counting site by date in the Salcha River, 2000. Shaded dells indicate days with no counts.

	Number of	Chinook			Chum		
	20 min		Expanded			Expanded	
Date	Counts	Count	Count	SE	Count	Count	SE
30-Jun-00	4	0	0	0	0	0	0
1-Jul-00	9	0	0	0	0	0	0
2-Jul-00	9	0	0	0	0	0	0
3-Jul-00	9	0	0	0	0	0	0
4-Jul-00	15	1	3	2	0	0	0
5-Jul-00	24	2	6	3	0	0	0
6-Jul-00	24	12	36	12	0	0	0
7-Jul-00	24	14	42	14	0	0	0
8-Jul-00	24	4	12	5	0	0	0
9-Jul-00	24	15	45	14	0	0	0
10-Jul-00	24	58	174	36	0	0	0
11-Jul-00	5	6	86	24	0	0	0
12-Jul-00	0	0	0	N/A	0	0	N/A
13-Jul-00	0	0	0	N/A	0	0	N/A
14-Jul-00	0	0	0	N/A	0	0	N/A
15-Jul-00	0	0	0	N/A	0	0	N/A
16-Jul-00	0	0	0	N/A	0	0	N/A
17-Jul-00	8	47	423	117	0	0	0
18-Jul-00	24	161	483	65	20	60	16
19-Jul-00	24	27	81	15	6	18	6
20-Jul-00	24	53	159	23	22	66	17
21-Jul-00	24	79	237	33	83	249	49
22-Jul-00	24	52	156	32	93	279	37
23-Jul-00	24	60	180	23	103	309	39
24-Jul-00	24	61	183	22	99	297	26
25-Jul-00	24	53	159	27	166	498	51
26-Jul-00	24	37	111	14	148	444	94
27-Jul-00	24	38	114	18	288	864	89
28-Jul-00	24	64	192	30	322	966	113
29-Jul-00	24	40	120	20	552	1,656	109
30-Jul-00	24	6	18	11	614	1,842	136
31-Jul-00	24	13	39	8	692	2,076	126
1-Aug-00	24	4	12	5	484	1,452	133
2-Aug-00	24	17	51	12	498	1,494	120
3-Aug-00	24	4	12	5	301	903	93
4-Aug-00	24	2	6	3	359	1,077	50
5-Aug-00	24	0	0	0	302	906	93
6-Aug-00	24	0	0	0	234	702	60
7-Aug-00	24	0	0	0	233	699	84
8-Aug-00	24	1	0	3	255	765	70
9-Aug-00	24	0	0	0	297	891	63
10-Aug-	24	0	0	0	273	819	77
11-Aug-	24	0	0	0	175	525	53
12-Aug-	14	0	0	0	140	659	259
Total	817	931	3,140	165	6,759	20,516	403



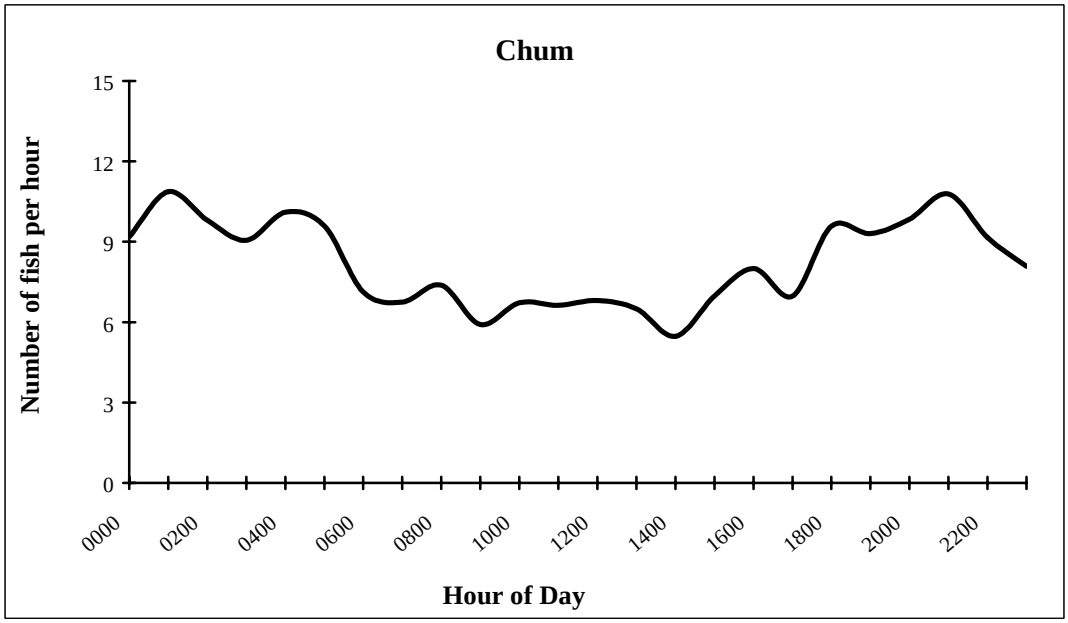


Figure 16.-Average hourly escapement of chinook and chum salmon in the Salcha River, 2000.

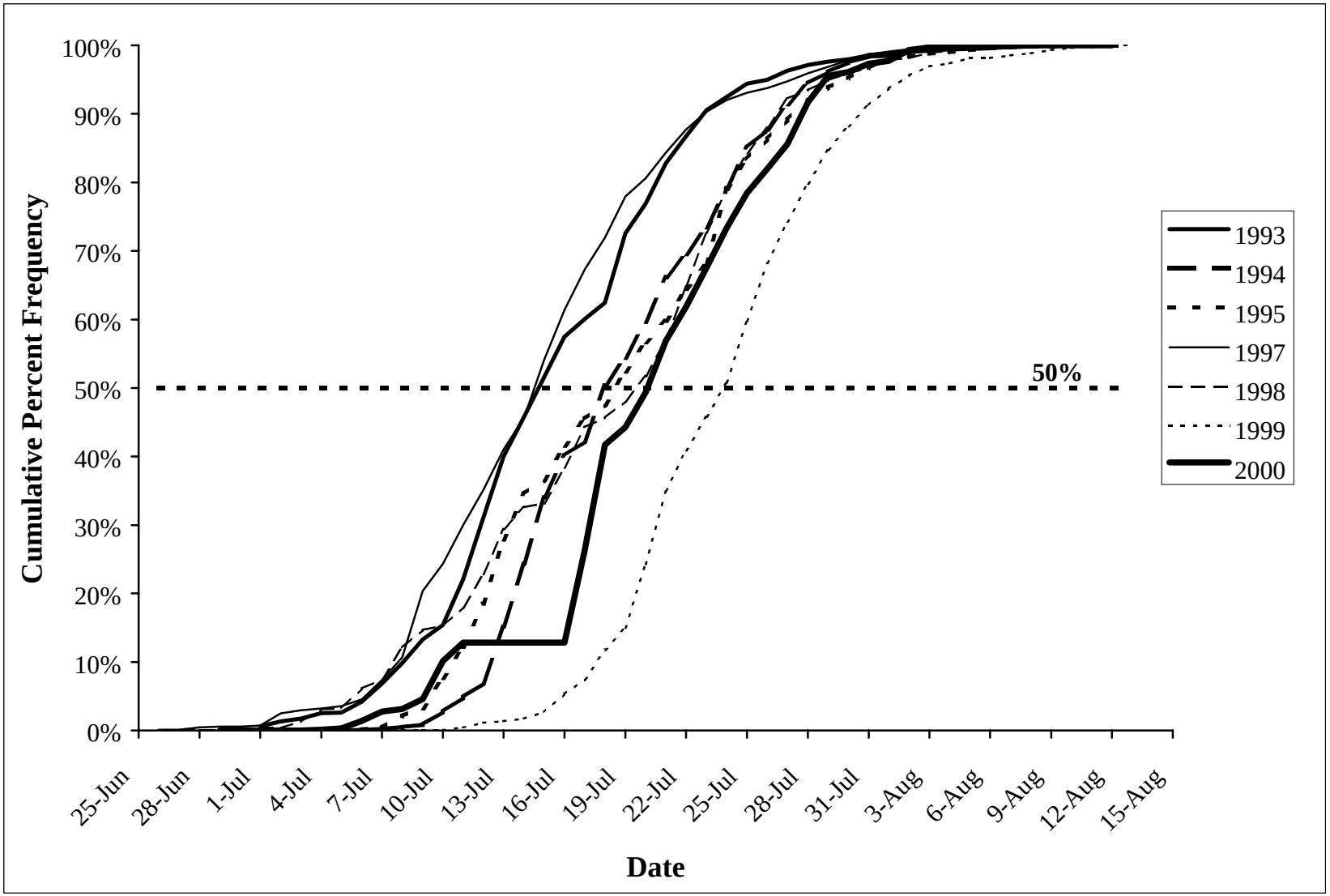


Figure 17.-Run timing of chinook salmon for 1993 - 1995 and 1997 – 2000 for the Salcha River. Data for 2000 is incomplete.

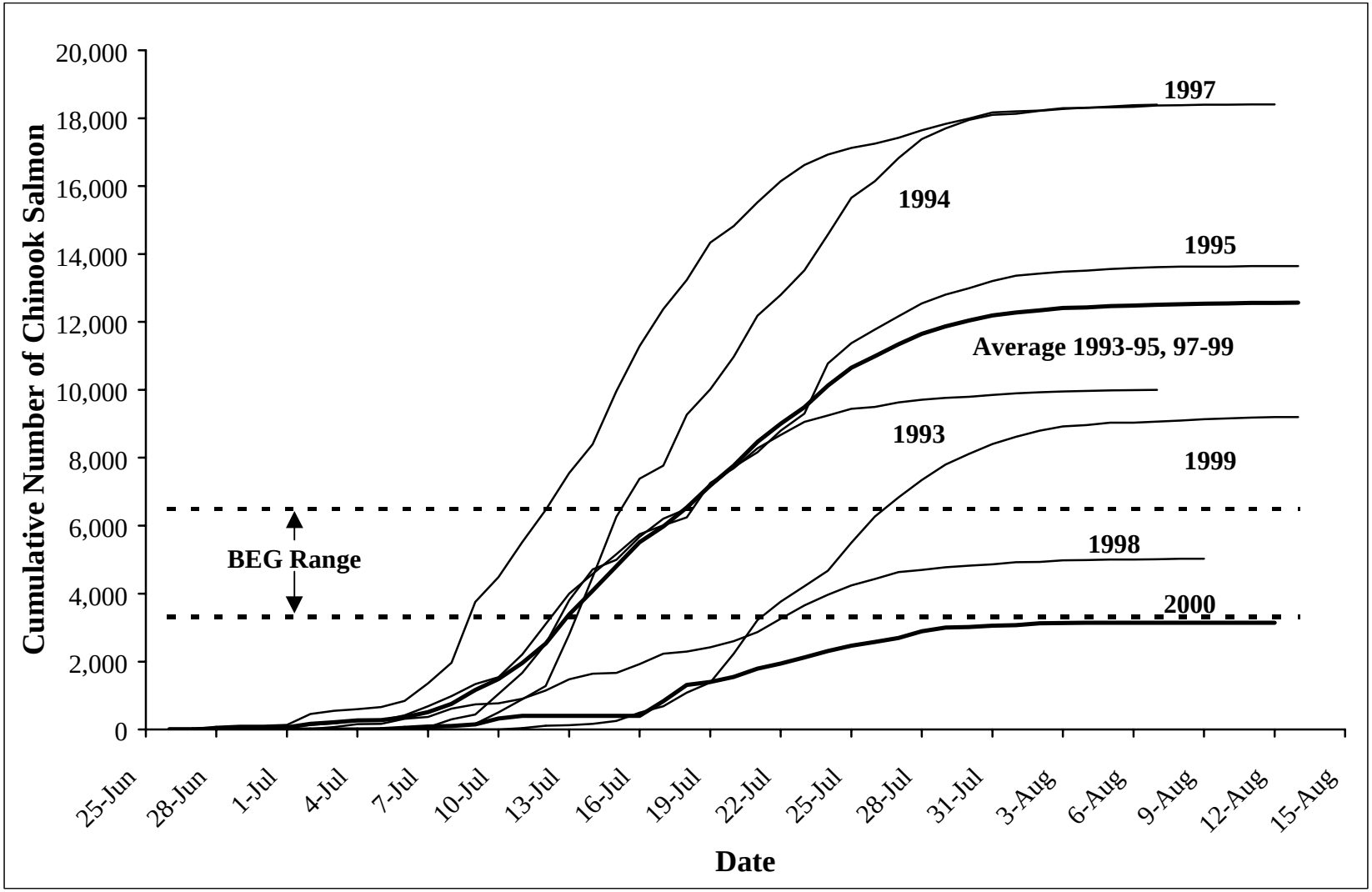


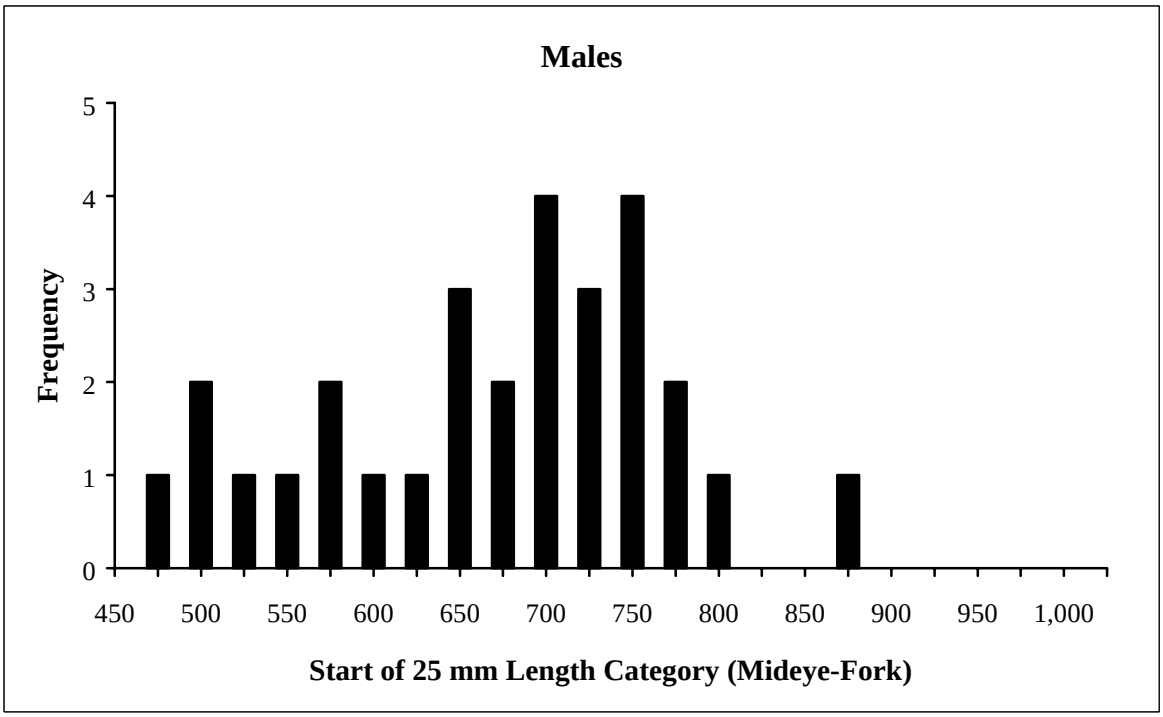
Figure 18.-Cumulative passage of chinook salmon for 1993 - 1994 and 1997 – 2000 from tower-counts for the Salcha River. Data for 2000 is incomplete.

Table 19.-Number sampled, estimated proportions, and mean length by sex and age class of chinook salmon in the Salcha River, 2000.

Age[a]	Sample Size	Proportion	SE	Length Mean	Length SE	Length Min	Length Max
			Male				
1.2	7	0.30	0.10	521	16	460	590
1.3	13	0.57	0.11	689	14	560	745
1.4	3	0.13	0.07	807	27	770	860
Total Aged	23	1.00					
Total[b]	29	0.60	0.07	659	18	460	860
			Female				
1.2	2	0.11	0.08	565	5	560	570
1.3	7	0.39	0.12	729	19	660	800
1.4	7	0.39	0.12	811	14	740	850
1.5	2	0.11	0.08	950	N/A	900	1,000
Total Aged	18	1.00					
Total[b]	19	0.40	0.07	770	24	560	1,000

[a] Age represents the number of annuli formed during river residence and ocean residence (i.e. an age of 2.4 represents two annuli formed during river residence and four annuli formed during ocean residence).

[b] Totals include those chinook salmon which could not be aged.



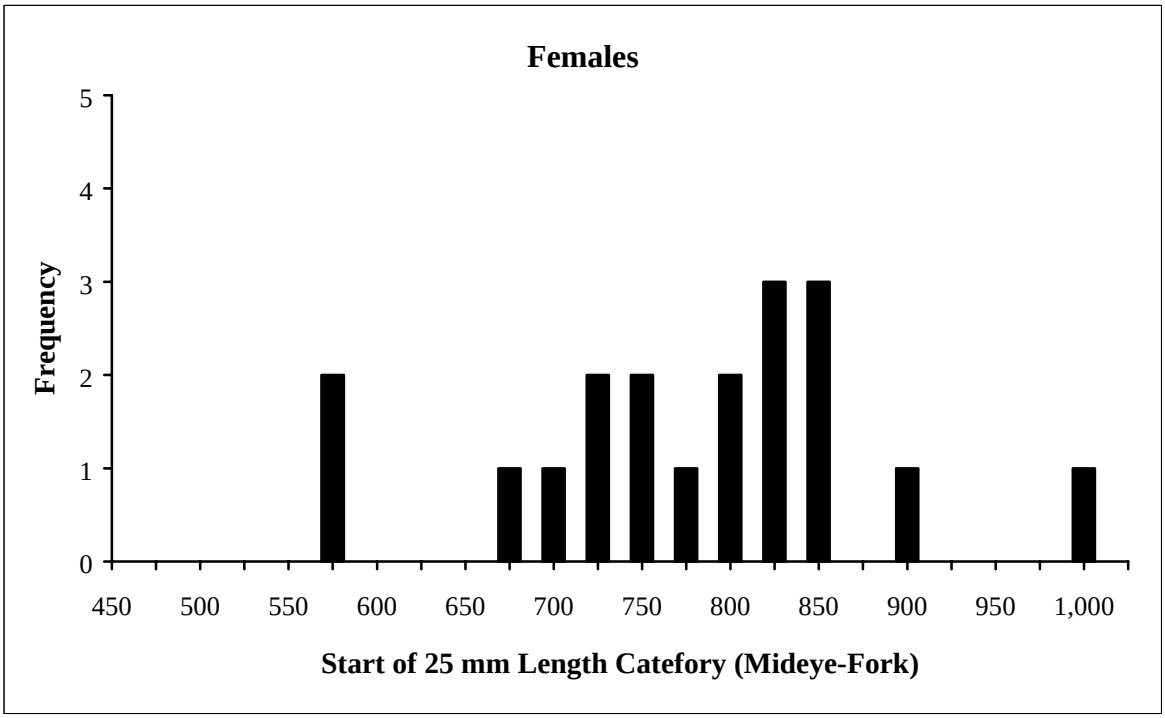


Figure 19.-Length frequency distributions of male and female chinook salmon carcasses sampled on the Salcha River, 2000.

data on the proportion of fish that swam by the tower during the missed days of counts. The uncertainty of the missing counts is reflected in the relatively large standard error.

The 2000 escapement did not meet the old minimum guideline of 7,100 chinook salmon. However, the estimate would have fallen within the new BEG range. As a result, the sport fishery was closed in 2000 to all catch and harvest of chinook salmon on 14 July because of restrictions to the Tanana River subsistence fishery.

Carcass sampling of chinook salmon on the Salcha River was conducted by Region III Sport Fish Division from 1987-1998 and by BSFA in 1999 and 2000. The mean length at age for chinook salmon sampled has varied among years for a given age and sex. However, no consistent upward or downward trends have been apparent. The most common ages sampled for male chinook salmon were 1.2, 1.3, and 1.4 (Appendices F4 and F5). Mean length at age for age 1.2 has varied from 503 mm in 1998 to 592 mm in 1990. Age 1.3 has varied from 689 mm in 2000 to 790 mm in 1989 and age 1.4 has varied from 787 mm in 1998 to 933 mm in 1990 (Appendix F6). The most common ages sampled for female chinook salmon were 1.3, 1.4, and 1.5. Mean length at age for age 1.3 has varied from 729 mm in 2000 to 860 mm in 1997. Age 1.4 has varied from 782 in 1998 to 898 mm in 1990 and age 1.5 has varied from 833 mm in 1997 to 960 mm in 1989 (Appendix F7).

Since the earliest years of chinook study, run strength, run timing, and age and sex proportions in carcass sampling have shown similar trends between the Chena and Salcha rivers. Past enumeration procedures for the Salcha and Chena rivers have shown that for approximately 80% of the time, if one river attains its minimum escapement objective, the other will too and vice versa. Similar to the Chena River, the majority of males sampled from the carcass survey for 2001 were 1.3 and females were 1.4. Comparison of Appendices F4 and E1 show similar yearly trends in age composition for males and females for these two rivers.

COHO SALMON STUDY IN THE DELTA CLEARWATER AND RICHARDSON CLEARWATER RIVERS

INTRODUCTION

The Delta Clearwater River has the largest known coho salmon escapements in the Yukon River drainage (Parker 1991). The river is a spring-fed tributary to the Tanana River located near Delta Junction about 160 km southeast of Fairbanks (Figure 20). The main river spans 32 km, with a 10-km north fork. There are a number of small, shallow spring areas adjacent to the mainstem river. Spawning occurs throughout the mainstem river and in areas where springs are found. Coho salmon in the Delta Clearwater River support a popular fall sport fishery. Annual harvests exceeded 1,000 coho salmon from 1986-1991. In recent years catch has been high, but harvest relatively low (Mills 1979-1994; Howe et al. 1995-1996, 2001; Table 20).

The Richardson Clearwater River is also a spring-fed tributary of the Tanana River and is 19.2 km in length (Figure 21). Unlike the Delta Clearwater River, the Richardson Clearwater River is semi-remote and access is limited to riverboats and float-equipped aircraft. Subsequently, the coho salmon fishery is small (Table 21). Before reaching spawning grounds, the coho salmon travel about 1,700 km from the ocean and pass through six different commercial fishing districts in the Yukon and Tanana rivers (Figure 4). Subsistence and personal use fishing also occur in

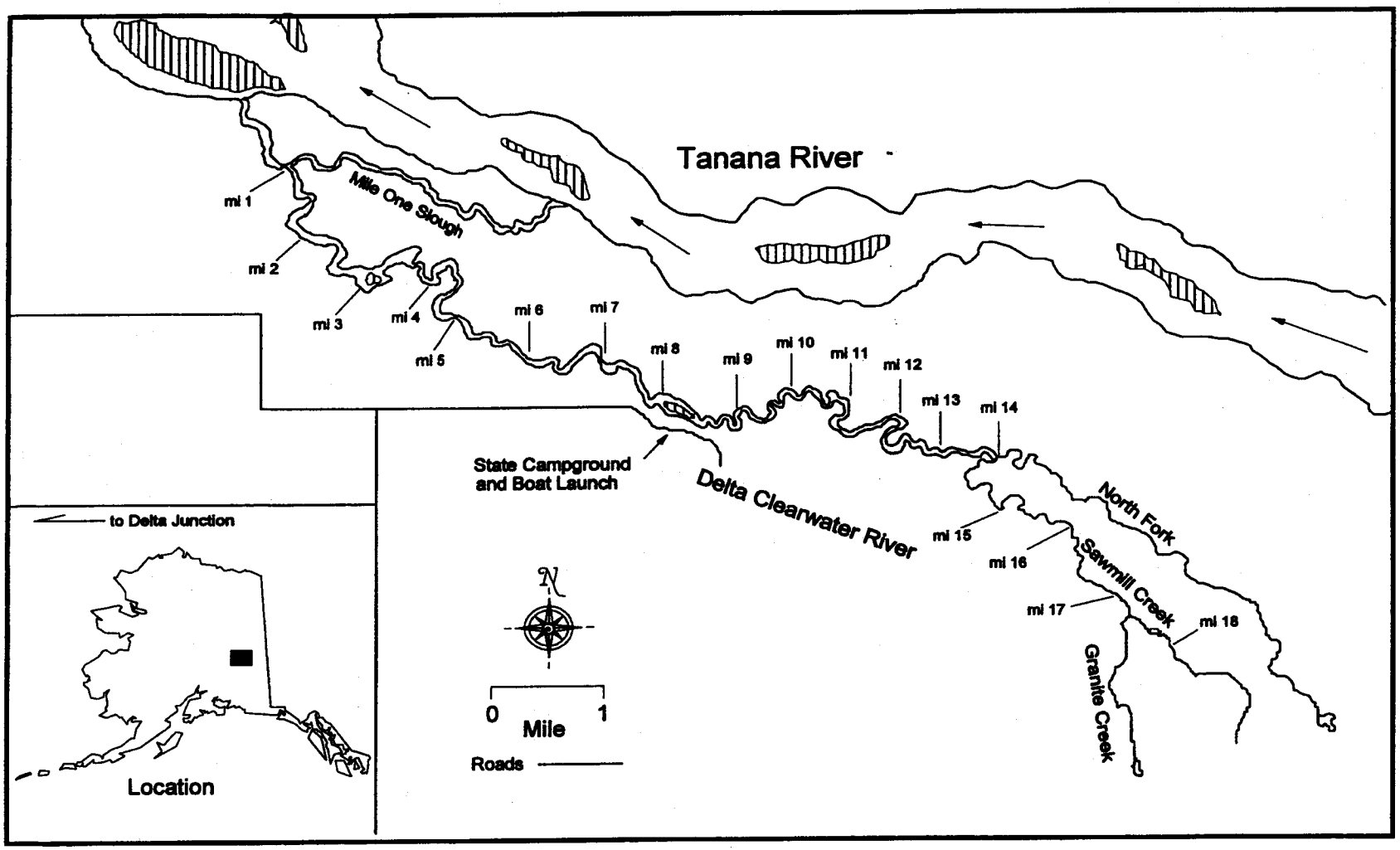


Figure 20.-Delta Clearwater River study area.

Table 20.-Peak escapements, harvests, and catch of coho salmon in the Delta Clearwater River from boat and aerial surveys conducted from 1972-2000.

Delta Clearwater River								
	Peak Escapement Counts							
Year	Survey Date	Lower River[a]	Upper River[b]	Spring Areas	Total[c]	Previous 5 yr	Sport Harvest	Sport Catch[d]
1972	9 Nov	NA[e]	NA	NA	632		NA	NA
1973	20 Oct	NA	NA	NA	3,322		NA	NA
1974	NA	NA	NA	NA	3,954[f]		NA	NA
1975	24 Oct	NA	NA	NA	5,100		NA	NA
1976	22 Oct	NA	NA	NA	1,920		NA	NA
1977	25 Oct	2,331	2,462	NA	4,793	2,986	31	NA
1978	26 Oct	2,470	2,328	NA	4,798	3,818	126	NA
1979	23 Oct	3,407	5,563	NA	8,970	4,113	0	NA
1980	28 Oct	2,206	1,740	NA	3,946	5,116	25	NA
1981	21 Oct	4,110	4,453	NA	8,563[g]	4,885	45	NA
1982	3 Nov	4,015	4,350	NA	8,365[g]	6,214	21	NA
1983	25 Oct	3,849	4,170	NA	8,019[g]	6,928	63	NA
1984	6 Nov	5,434	5,627	NA	11,061	7,573	571	NA
1985	13 Nov	NA	NA	NA	6,842[f]	7,991	722	NA
1986	21 Oct	5,490	5,367	NA	10,857	8,570	1,005	NA
1987	27 Oct	11,700	10,600	NA	22,300	9,029	1,068	NA
1988	28 Oct	5,300	16,300	NA	21,600	11,816	1,291	NA
1989	25 Oct	5,400	7,200	NA	12,600	14,532	1,049	NA
1990	26 Oct	4,525	3,800	NA	8,325	14,840	1,375	3,271
1991	23 Oct	11,525	12,375	NA	23,900	15,136	1,721	4,382
1992	26 Oct	1,118	2,845	NA	3,963	17,745	615	1,555
1993	21 Oct	3,425	7,450	NA	10,875	14,078	48	1,695
1994	24 Oct	19,450	43,225	17,565[h]	80,240[i]	11,933	509	3,009
1995	23 Oct	7,850	12,250	6,283[h]	26,383[i]	25,461	391	5,195
1996	29 Oct	4,000	10,075	3,300[h]	17,375[i]	29,072	937	2,435
1997	24 Oct	4,975	6,550	2,375[h]	13,900[i]	27,767	794	3,776
1998	20 Oct	7,700	3,400	2,775[h]	13,875[i]	29,755	479	1,932
1999	28 Oct	4,250	6,725	2,799[j]	13,774[i]	24,798	76	1,634
2000	24 Oct	4,025	5,200	12,364[j]	11,589[i]	27,371	252	1,890

[a] Mile 0 to Mile 8.

[b] Mile 8 to Mile 17.5.

[c] Boat survey by Alaska Department of Fish and Game, Sport Fish Division unless otherwise noted.

[d] Data were obtained from Mills (1979-1994) and Howe et al. (1995-2000a-d).

[e] Data are not available.

[f] Survey by Alaska Department of Fish and Game, Commercial Fisheries Division.

[g] Mark-recapture population estimate.

[h] Helicopter Survey by Alaska Department of Fish and Game, Division of Sport Fish.

[i] Combination of boat survey and helicopter survey.

[j] Expansion for the non-navigable portion is based on the average proportion observed in these areas from 5-years of aerial survey data.

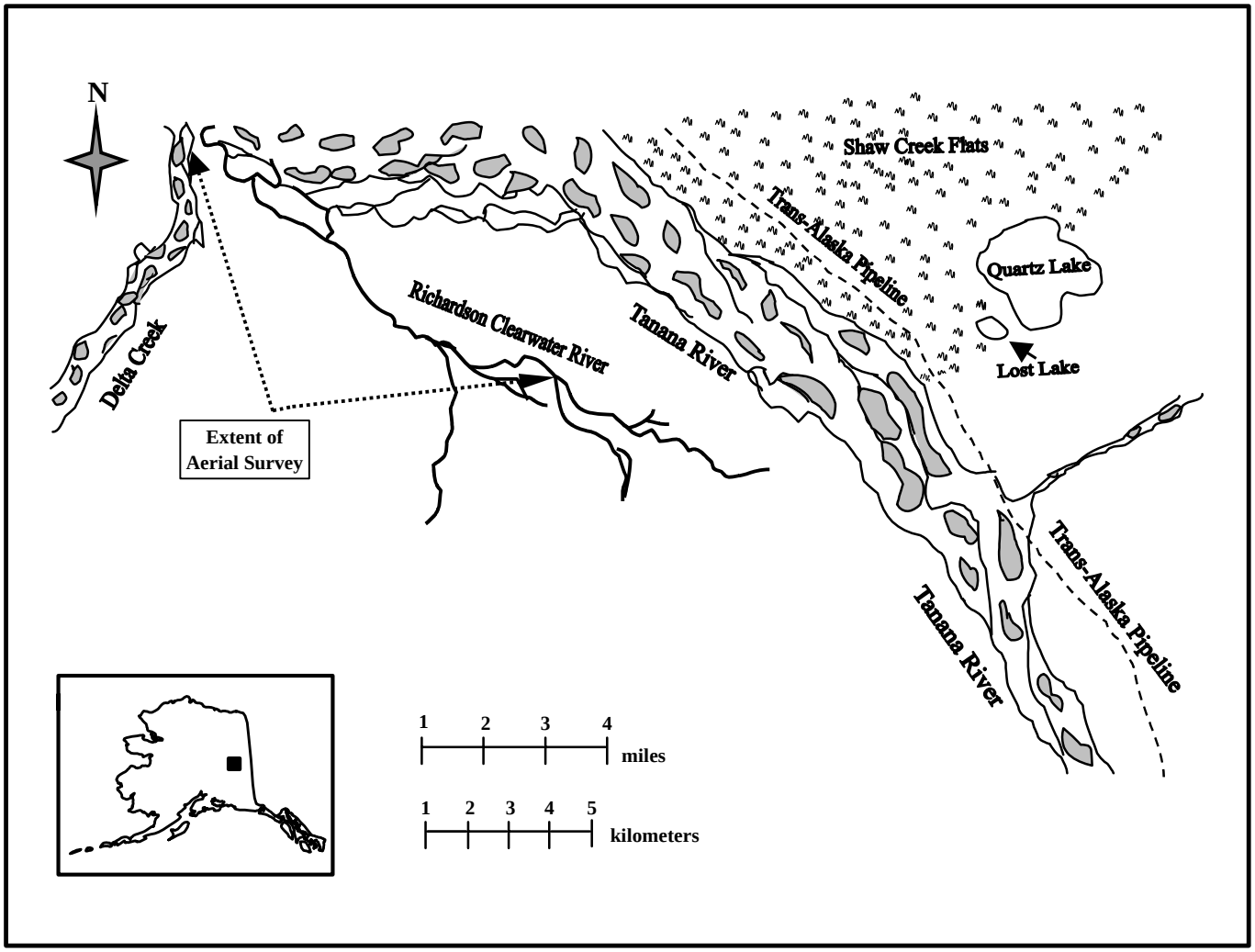


Figure 21.-Richardson Clearwater River study area.

Table 21.-Peak escapements, harvest, and catch of coho salmon for the Richardson Clearwater River from aerial surveys conducted from 1972-2000.

Year	Escapement[a]	Sport Harvest[b]	Sport Catch[b]
1972	454[c,d]	NA[e]	NA[e]
1973	375	NA	NA
1974	652	NA	NA
1975	4[c,d]	NA	NA
1976	80[c,d]	NA	NA
1977	327[c]	0	NA
1978	NA[e]	NA	NA
1979	372[c]	0	NA
1980	611[c]	0	NA
1981	550[c]	0	NA
1982	NA	0	NA
1983	88[c]	0	NA
1984	428[c]	0	NA
1985	NA	49	NA
1986	146[c,d]	0	NA
1987	NA	163	NA
1988	NA	18	NA
1989	483[c]	0	NA
1990	NA	0	0
1991	NA	106	106
1992	500	40	89
1993	NA	9	9
1994	5,800	63	164
1995	NA	143	238
1996	NA	0	0
1997	NA	11	36
1998	NA	0	0
1999	NA	0	0
2000	2,175[f]	0	0

[a] Aerial surveys conducted by fixed-wing aircraft unless otherwise noted.

[b] Data were obtained from Mills (1979-1994) and Howe et al. (1995-1996, 2000a-d).

[c] Survey by Alaska Department of Fish and Game, Commercial Fisheries Division.

[d] Poor survey conditions.

[e] Data not available

[f] Helicopter survey

each district. Aerial surveys have been conducted sporadically since 1972 (Table 21). Values for fixed-wing airplane surveys have varied from 88 in 1983 to 5,800 in 1994.

Escapements of coho salmon into the Delta Clearwater River have been historically monitored by counting fish from a drifting riverboat (Parker 1991). In recent years aerial surveys have been conducted to enumerate escapement into non-boatable portions of the river (Evenson 1995 and 1996; Evenson and Stuby 1997; Stuby and Evenson 1998, Stuby 1999, 2000). This information has been used to evaluate management of the commercial, subsistence, and personal use fisheries, in addition to regulating the sport harvest of coho salmon by opening and closing the season and changing the bag limit. The daily bag and possession limit is three coho salmon. The Alaska Department of Fish and Game has established a biological escapement goal of 9,000 coho salmon, measured with boat counts, for the Delta Clearwater River. When counts indicate that the goal may not be achieved, the bag limit may be reduced, or the fishery closed. If the count exceeds the minimum escapement, the bag limit may be increased. There is currently no escapement goal for the Richardson Clearwater River. The main objective of the interior coho salmon escapement project was to:

> count coho salmon in the Delta Clearwater River from a drifting river boat at weekly intervals during the run.

In addition, coho salmon were counted on the Richardson Clearwater River at peak escapement using aerial counting techniques.

METHODS

Adult coho salmon were counted from a drifting riverboat equipped with an observation platform elevated 2 m above the water. The Delta Clearwater River was divided into 1.6-km (1-mi.) sections and fish were counted by section (Figure 20). The sections were numbered from the mouth (mile 0) upstream. Many coho salmon spawn in shallow spring areas adjacent to the mainstem river. Prior to 1994, these areas were not included in the surveys. Between 1994 and 1998, aerial helicopter surveys of the areas inaccessible by boat were conducted in order to determine the proportion of fish that spawn in these areas relative to the main river. No aerial survey was conducted in 2000. Instead, an expansion factor was used to estimate aerial count escapement based on the relationship between aerial and boat counts. Past proportions of the aerial count to the boat count, which ranged from 0.17 to 0.24 (average = 0.204), were used to expand the boat-count to obtain a total measure of what would have been counted in an aerial survey.

An aerial survey of the Richardson Clearwater River was conducted on 26 October using an R-22 helicopter. The aerial survey proceeded from the mouth to 19 km upstream where the spring upwelling of the northern tributaries enter. The survey did not include the three tributaries that drain in from the south.

RESULTS

A boat survey of the mainstem Delta Clearwater River was conducted on 24 October. A total of 9,225 coho salmon were counted during this survey. Survey conditions were fair. This count was expanded by 0.204 (2,364) to account for differences in boat counts and aerial surveys, thus making total escapement 11,589 coho salmon. Coho salmon were distributed throughout the entire stretch in densities varying from 150 to 900 fish per mile during the boat survey

(Table 22). Survey conditions for the Richardson Clearwater River were excellent. A total of 2,175 coho salmon were counted.

DISCUSSION

Survey counts of escapement for 2000 in the Delta Clearwater River were lower than the previous five-year average, but still in excess of the minimum escapement goal of 9,000 salmon. It remains unknown why this escapement was moderate. The 1996 parent year, from which most of this escapement originated, was strong (Table 20). For those years such as 1992 when the escapement goal was not met, the sport fishery was closed. For years of large abundance, modifying sport fishing bag limits would likely be of little consequence since most of the coho salmon are caught and then released.

No escapement goal has been established for the Richardson Clearwater River due to a paucity of survey data and relatively low harvest values (F. Parker, Delta ADF&G, personal communication). The 2000 season was the first time a helicopter was used to conduct an aerial survey of this river.

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Table 22.-Counts of adult coho salmon in the Delta Clearwater River, 2000.

River Mile	Mainstem River Boat Survey Count (24 Oct)
17.5-16	250
16-15	425
15-14	700
14-13	900
13-12	650
12-11	600
11-10	900
10-9	525
9-8	250
8-7	500
7-6	150
6-5	825
5-4	650
4-3	550
3-2	250
2-1	825
1-0	275
Summary	
17.5-8	5,200
8-0	4,025
14-0	7,850
17.5-0	**9,225**
Tributaries	2,364[a]
Clearwater Lake Inlet	N/A
Clearwater Lake Outlet	1,025
Total Count (i.e. boat-count of mainstream plus tributary estimate)	**11,589**

[a] Expansion for the non-navigable portion is based on the average proportion observed in these areas from 5-years of aerial survey data.

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APPENDIX A
COUNTING SCHEDULES

Appendix A1.-Schedule for counting salmon in the Chena River, 2000. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility.

June 26 – July 2	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800					COUNT		
0800-1600				COUNT	COUNT	COUNT	COUNT
1600-0000						COUNT	COUNT

July 3 – July 9	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT	COUNT		
0800-1600	COUNT	COUNT	COUNT	COUNT		COUNT	COUNT
1600-0000	COUNT			COUNT	COUNT	COUNT	COUNT

July 10 – July 16	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800							
0800-1600	COUNT						
1600-0000	COUNT						

July 17 – July 23	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT		COUNT	COUNT
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT		COUNT	COUNT	COUNT	COUNT	COUNT

July 24 – July 30	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

July 31 – Aug 6	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT	COUNT	COUNT	
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

Aug 7 – Aug 13	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	

Appendix A2.-Schedule for counting salmon in the Chatanika River, 2000. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility or schedule conflicts.

July 3 – July 9	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT	COUNT		
0800-1600		COUNT	COUNT			COUNT	COUNT
1600-0000				COUNT	COUNT	COUNT	COUNT

July 10 – July 16	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT						
0800-1600	COUNT						
1600-0000	COUNT						COUNT

July 17 – July 23	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800			COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600	COUNT	COUNT			COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT			

July 24 – July 30	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT			COUNT	COUNT
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT		
1600-0000			COUNT	COUNT	COUNT	COUNT	COUNT

July 31 – Aug 6	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800			COUNT	COUNT	COUNT		
0800-1600	COUNT	COUNT			COUNT		
1600-0000	COUNT	COUNT	COUNT				

APPENDIX B
STATISTICAL TESTS

Appendix B.-Statistical tests for analyzing data for gear bias, and for evaluating the assumptions of a two-event mark-recapture experiment.

The following statistical tests will be used to analyze the data for significant bias due to gear selectivity by sex and length:

1. A test for significant gear bias by sex will be based on a contingency table of the number of males and females that were recaptured and were not recaptured. The chi-square statistic will be used to evaluate the bias.

If Test 1 indicates a significant bias, the following tests will be done for males and females, separately. If Test 1 does not indicate a significant bias, males and females will be combined and the following tests will be done:

2. Tests for significant gear bias by size will be based on: (A) Kolmogorov-Smirnov two sample test comparing the distributions of the lengths of all fish that were captured and marked during electrofishing and all marked fish (recaptures) that were collected during the carcass survey; and, (B) Kolmogorov-Smirnov two sample test comparing the distributions of the lengths of all fish that were captured and marked during electrofishing and all fish (including recaptures) that were collected during the carcass survey. The null hypothesis is no difference between the distributions of lengths for Test A or for Test B.

For these two tests there are four possible outcomes:

Case I: Accept H_0(A) Accept H_0(B)

There is no size-selectivity during the first sampling event (when fish were marked) or during the second sampling event (when carcasses were collected).

Case II: Accept H_0(A) Reject H_0(B)

There is no size-selectivity during the second sampling event but there is size-selectivity during the first sampling event.

Case III: Reject H_0(A) Accept H_0(B)

There is size-selectivity during both sampling events.

Case IV: Reject H_0(A) Reject H_0(B)

There is size-selectivity during the second sampling event; the status of size-selectivity during the first event is unknown.

Depending on the outcome of the tests, the following procedures will be used to estimate the abundance of the population:

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

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

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

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

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

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

-continued-

TESTS OF CONSISTENCY FOR PETERSEN ESTIMATOR

The following two assumptions must have been fulfilled:

1. Catching and handling the fish did not affect the probability of recapture; and,
2. Marked fish did not lose their mark.

It was assumed that catching and handling the fish did not affect the probability of recapture because the experiment was designed to mark live fish and later recover carcasses. If the jaw tag was lost, the fin clip given each fish would identify the river section where it was marked.

Of the following assumptions, only one must have been fulfilled:

1. Every fish had an equal probability of being marked and released during electrofishing;
2. Every fish had an equal probability of being collected during the carcass survey; or,
3. Marked fish mixed completely with unmarked fish between electrofishing and carcass surveys.

To evaluate these three assumptions, the chi-square statistic were used to examine the following contingency tables as recommended by Seber (1982). At least one null hypothesis needed to be accepted for the Petersen model (Chapman 1951) to be valid. If all three hypotheses were rejected, a geographically stratified estimator (Darroch 1961) was used to estimate abundance by river section.

	First Event	Second Event		
	River Section	River Section Recaptured		
	Released	Upper	Lower	Not Recaptured
TEST I[a]	Upper			
	Middle			
	Lower			

		Second Event: River Section	
		Upper	Lower
TEST II[b]	Recaptured		
	Not Recaptured		

		Captured During Second Event	
		River Section	
		Upper	Lower
TEST III[c]	Marked		
	Unmarked		

[a] This tested the hypothesis that movement probabilities were the same among sections: H_1: $\theta_{ij} = \theta_j$. Theta applied to both marked and unmarked salmon.

[b] This tested the hypothesis of homogeneity on the columns of this 2-by-2 contingency table with respect to recapture probabilities between the two river sections: H_2: $\Sigma_j \theta_{ij} p_j = d$. Theta applied to both marked and unmarked salmon.

[c] This tested the homogeneity on the columns of the 2-by-2 contingency table with respect to the probability of movement of marked fish in stratum *i* to the unmarked fraction in *j*: H_4: $\Sigma_i a_i \theta_{ij} = kU_j$. Theta did not apply to both marked and unmarked salmon.

APPENDIX C

DATA FILES

Appendix C.-Data files used to estimate parameters of chinook and chum salmon populations in the Chena, Chatanika, and Goodpaster rivers, 2000.

Data File	Description
Chena00.FBanks.asl.xls[a]	Data file of length, sex, and age data for electrofished chinook salmon and chinook salmon carcasses collected from the Chena River, 2000.
Cht41cr00.asl.asl[a]	Data file of length, sex, and age data for chinook salmon carcasses collected from the Chatanika River, 2000.
Gdp41cr00.asl.asl[a]	Data file of length, sex, and age data for chinook salmon carcasses collected from the Goodpaster River, 2000.
CHENATOW00.XLS[b]	Excel spreadsheet of hourly counts of chinook and chum salmon, daily expansions of escapement, and variance estimates for the Chena River, 2000.
CHATTOW00.XLS[b]	Excel spreadsheet of hourly counts of chinook and chum salmon, daily expansions of escapement, and variance estimates for the Chatanika River, 2000.
Chena00.xls[b]	Excel spreadsheets with analysis of mark-recapture data from the Chena River, 2000.
Chena00.Fbanks.asl.xls[b]	Excel spreadsheets with analysis of tower-count and age, sex and length data for the Chena River. File includes spreadsheets of hourly escapement, run timing, daily counts and estimates, expanded cumulative passage, estimated proportions of age, sex and length, length frequency distributions, average length per age class by sex from 1987-2000, and percent age composition from 1987-2000.
Cht41cr00.Wkal.xls[b]	Excel spreadsheets with analysis of tower-count and age, sex and length data for the Chatanika River. File includes spreadsheets of hourly escapement, daily counts and estimates, expanded cumulative passage, estimated proportions of age, sex and length, length frequency distributions, average length per age class by sex from 1987-1999, and percent age composition from 1987-1999.
GPR00.xls[b]	Excel spreadsheets with analysis of age, sex and length data for the Goodpaster River. File includes estimated proportions of age, sex and length, length frequency distributions, average length per age class by sex from 1991-2000, and percent age composition from 1991-2000.

[a] Data files have been archived at, and are available from, the Alaska Department of Fish and Game, Commercial Fisheries Division, 333 Raspberry Road, Anchorage, 99518-1599.

[b] Data files are available from the author and are have been archived at the Alaska Department of Fish and Game, Research and Technical Services, 333 Raspberry Road, Anchorage, 99518-1599.

APPENDIX D

TOWER COUNTS

Appendix D1.-Numbers of chinook salmon counted during 10 min periods for the left side of the Chena River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/29									0			0	0	0	0	0									0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/1									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0									1
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
7/7	0	0	0	0	0	0	0	1									0	0	1	1	0	0	0	0	3
7/8									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9									0	0	0	3	0	0	0	0	0	1	0	0	0	1	0	0	5
7/10									0	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	5
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17									0	2	1	1	8		0	8			12	2	0	2	1		37
7/18	2	1	0	2	1	3	2	0	6	1	2	0	0	0	7	1									28
7/19	1	0	2	1	0	1	0	2	1	0	0	1	-1	0	0	2	0	0	0	0	0	2	0	0	12
7/20	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0	-2
7/21									0	1	0	0	0	0	1	1	1	0	0	0	0	2	0	0	6
7/22	4	0	1	2	1	1	0	0	1	1	2	0	0	1	0	2	1	0	2	0	0	0	0	0	19
7/23	2	1	1	0	0	3	0	0	0	1	0	1	0	0	1	1	0	1	0	0	0	1	0	0	13
7/24										0	0	0	1	1	1	1	0	1	0	0	0	0	0	1	6
7/25	2	2	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	8
7/26	0	1	2	0	0	0	2	0		0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	9
7/27	0	0	0	1	0	0	2	0	0	0	0	0	-1	0	0	1	0	0	1	0	0	0	0	0	4
7/28	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	5
7/29	0	0	-1	0	0	0	0	0	1	1	0	1	2	1	0		0	1	1	0	0	0	0	0	7
7/30	0	0	0	0	0	0	0	0	1	1	0	-1	0	1	1	1	0	0	0	0	0	0	0	0	4
7/31									0	0	0	1	0	0	-1	0	0	0	0	3	0	0	0	0	3
8/1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2
8/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	-1
8/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	-1	-1	0	-2	0	-6
8/4	-1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8/5	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	1	0	0	0	0	0	0	0	0	0	1
8/6									0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	-1
8/7	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	2
8/8	0	0	0	0	0	1	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	1
8/9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	-1	0	1	0	1	-1	0
8/10	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	-1	0	0	0	0	0	-2
8/11	0	0	0		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8/12	0	0	-2	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-3
Total	9	6	5	6	2	10	6	5	10	10	5	7	12	5	10	20	4	6	16	7	0	8	0	0	169

Appendix D2.-Numbers of chinook salmon counted during 10 min periods for the right side of the Chena River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/29									0			0	0	0	0	0									0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/1									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	0	1	0	0	0	0	0	0									0	0	0	0	0	0	0	0	1
7/8									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17									1	0	0	0	0		1	1			0	0	0	0	0		3
7/18	0	0	0	2	0	0	3	0	2	0	0	2	2	0	0	1									12
7/19	0	0	1	2	0	1	1	0	2	2	0	1	0	2	0	0	0	0	0	1	0	2	0	0	15
7/20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
7/21									0	0	0	0	0	0	0	3	0	1	2	0	0	0	0	0	6
7/22	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	4
7/23	0	0	0	0	0	0	1	0	0	2	3	1	0	0	0	0	0	0	0	1	0	0	0	0	8
7/24										0	0	0	1	0	0	0	2	0	0	0	0	0	0	1	4
7/25	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7/26	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7/27	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7/28	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
7/29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
7/30	0	0	4	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	2
7/31									0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	-1
8/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
8/2	0	0	0	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-1	0	0	0	-3
8/3	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1
8/4	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	-2
8/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/6									0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	0	-2
8/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	-1
8/8	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	3
8/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	-1
8/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
8/11	0	0	0		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	6	3	0	1	6	-1	5	5	2	5	4	2	0	7	2	0	3	2	-4	4	-1	1	54

Appendix D3.-Numbers of chum salmon counted during 10 min periods for the left side of the Chena River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/29									0			0	0	0	0	0									0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/1									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0									0	0	0	0	0	0	0	0	0
7/8									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17									0	0	0	0	0		0	0			0	0	0	0	0		0
7/18	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0									2
7/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	5
7/21									0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3
7/22	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4
7/23	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3
7/24										0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	4
7/25	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
7/26	0	-1	-1	1	0	1	0	0		0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
7/27	0	1	0	4	2	0	0	1	0	0	0	0	0	13	0	5	0	0	0	0	0	3	1	0	30
7/28	1	0	0	4	4	0	0	0	4	0	0	1	0	4	1	2	0	-1	0	0	0	0	0	0	20
7/29	0	0	3	0	0	1	0	0	0	2	2	0	0	2	8		0	0	0	11	2	0	4	4	39
7/30	0	7	-1	1	3	1	0	0	1	1	0	0	0	2	0	0	0	1	0	9	3	0	0	1	29
7/31									0	0	0	0	0	0	0	2	7	0	3	0	0	3	0	0	15
8/1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	4	-1	2	0	8	0	0	0	0	16
8/2	2	0	0	0	0	3	0	1	2	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	14
8/3	0	3	0	0	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	10
8/4	0	0	2	0	2	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	8
8/5	1	0	1	1	0	2	0	10	6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	23
8/6									0	0	0	1	0	0	14	0	0	0	0	0	0	0	0	0	15
8/7	0	-1	3	0	-1	-1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
8/8	0	0	0	0	0	0	-1	0	2	0	0	-1	9	0	4	0	0	0	0	1	0	0	0	0	14
8/9	1	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	7
8/10	0	3	4	0	2	0	0	0	4	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	18
8/11	0	8	2		0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	13
8/12	1	1	0	0	1	0	0	0	2	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Total	8	23	14	11	13	10	2	12	21	9	1	16	11	22	32	16	11	5	3	32	5	9	7	8	301

Appendix D4.-Numbers of chum salmon counted during 10 min periods for the right side of the Chena River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																							
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/29									0			0	0	0	0	0									0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/1									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0									0	0	0	0	0	0	0	0	0
7/8									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17									0	0	0	0	0		0	0			0	0	0	1	0		1
7/18	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0									1
7/19	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	3
7/20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	1	0	0	7
7/21									0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
7/22	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	5
7/23	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	0	5
7/24										0	0	0	0	0	0	0	2	0	0	1	0	0	0	2	5
7/25	1	0	0	1	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	2	7
7/26	0	0	1	0	0	0	1	0		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
7/27	1	0	1	0	0	0	0	1	1	0	2	0	0	0	9	0	1	0	1	0	0	0	0	4	21
7/28	0	1	0	0	0	2	0	1	2	0	0	0	0	0	1	0	0	1	0	0	2	3	0	0	13
7/29	0	0	0	0	0	0	1	0	0	0	4	9	0	0	1		0	2	5	5	0	0	2	1	30
7/30	0	2	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	1	8	0	0	0	0	15
7/31									0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	-1	2
8/1	0	0	0	0	2	0	2	2	2	2	0	0	1	0	7	2	0	0	1	0	0	0	0	0	21
8/2	1	0	0	3	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	7
8/3	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4
8/4	0	4	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	6	2	0	-1	0	15
8/5	0	0	0	1	3	0	0	0	0	0	3	0	2	6	0	6	0	0	0	0	0	0	8	0	29
8/6									0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2
8/7	-1	1	-1	1	0	1	0	1	0	0	0	0	0	-2	2	0	0	0	0	0	0	0	0	1	3
8/8	1	0	3	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	8
8/9	1	0	-1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	-2	13	0	-1	13
8/10	0	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	8
8/11	4	0	0		2	0	0	0	2	0	3	0	0	0	0	1	0	0	0	3	0	1	0	0	16
8/12	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	1	0	7
Total	9	11	5	8	11	6	4	7	16	4	14	12	6	6	23	10	7	7	10	28	4	23	13	8	252

Appendix D5.-Numbers of chinook salmon counted during 20 min periods for the Chatanika River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/6	0	0	0	0	0	0	0	0									0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0											0	0	0	0	0	0	0	0	0
7/8									0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
7/9									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0					0	0	0	0	0	0	0	0	0	0	0	0	0
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																	0	1	2	1	2	2	1	0	9
7/17									0	1	0	0	2	0	0	2	-1	0	0	4	1	1	4	0	14
7/18									0	2	1	0	0	0	2	0	3	1	2	0	1	0	1	0	13
7/19	0	3	1	1	1	0	0	0									1	3	0	0	0	1	1	-1	11
7/20	0	1	0	0	0	3	0	0									0	0	0	0	0	0	4	1	9
7/21	0	1	0	1	3	0	0	-1	0	0	0	1	0	0	0	-1									4
7/22	0	4	0	0	1	0	0	1	0	2	0	0	-1	-2	0	0									5
7/23	0	1	0	0	1	0	0	0	0	0	0	-2	0	0	0	1									1
7/24	6	0	0	0	0	0	0	0	0	-1	0	-2	0	0	3	0									6
7/25	0	0	0	0	-1	-2	-1	1	-2	-1	0	1	0	0	0	0									-5
7/26	0	0	0	0	0	0	1	0	-2	0	0	-1	0	0	0	0	1	-1	1	1	0	0	1	-1	0
7/27									0	0	0	-1	-3	2	1	1	1	0	1	-1	-1	-1	0	1	0
7/28									0	1	0	-1	1	0	0	2	1	0	0	1	3	1	-1	1	9
7/29	0	0			0	-1	0	0									0	0	1	1	0	0	2	0	3
7/30	0			0	0	0	0	-1									0	0	-3	-1	1	-1	2	0	-3
7/31									0	0	0	0	0	0	0	1	0	0	0	0	0	1			2
8/1									0	0	2	1	0	-1	0	0	0	0	0	0	0	-1	0	0	1
8/2	0	0		0	0	0	0	1									0	0	0	0	0	1	0	0	2
8/3		0	0	0	0	0	-1	0																	-1
8/4	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0									0
Total	6	11	0	2	5	0	-1	1	-4	4	3	-4	-1	-1	6	6	7	4	4	6	7	4	15	1	81

Appendix D6.-Numbers of chum salmon counted during 20 min periods for the Chatanika River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/6	0	0	0	0	0	0	0	0									0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0											0	0	0	0	0	0	0	0	0
7/8									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0					0	0	0	0	0	0	0	0	0	0	0	0	0
7/11																									0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																	0	0	0	0	1	0	0	2	3
7/17									0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	3
7/18									0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
7/19	0	1	10	0	0	2	0	0									0	0	0	0	0	1	0	0	14
7/20	2	0	0	0	1	0	0	0									0	0	0	1	0	0	0	0	4
7/21	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0									1
7/22	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0									3
7/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									0
7/24	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									4
7/25	0	0	4	3	2	0	0	1	0	0	0	0	0	0	0	0									10
7/26	4	1	2	0	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	10	29
7/27									0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2
7/28									0	0	0	0	0	0	1	0	0	0	0	0	6	0	5	15	27
7/29	0	7			1	4	2	0									1	0	0	0	0	0	0	2	17
7/30	2			0	4	2	0	0									0	1	1	0	0	12	13	0	35
7/31									0	1	0	2	2	0	0	0	0	0	4	0	0	0			9
8/1									0	0	0	3	0	0	0	0	0	0	0	0	6	0	0	7	16
8/2	0	0		1	0	0	1	0									0	0	0	0	0	8	6	1	17
8/3		1	0	0	0	1	0	0																	2
8/4	0	1	1	4	0	0	0	0	0	0	0	0	1	0	1	0									8
Total	12	12	18	8	13	9	5	2	0	1	1	7	3	1	2	0	1	2	5	2	16	23	25	37	205

APPENDIX E
HISTORICAL AGE, SEX, AND LENGTH DATA

Appendix E1.-Age composition proportions of male and female chinook salmon from the Chena River, 1986-2000.

		Age Composition											
Escapement	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1986[b]	1983	0.00	0.09	0.00	0.47	0.00	0.15	0.01	0.02	0.00	0.00	0.00	0.75
1987[b]	1984	0.00	0.03	0.00	0.12	0.00	0.26	0.00	0.01	0.00	0.00	0.00	0.42
1988[b]	1985	0.01	0.11	0.00	0.14	0.00	0.11	0.00	0.03	0.00	0.00	0.00	0.39
1989[b]	1986	0.01	0.07	0.00	0.30	0.01	0.21	0.01	0.01	0.00	0.00	0.00	0.61
1990[c]	1987	0.00	0.22	0.00	0.16	0.00	0.13	0.00	0.01	0.00	0.00	0.00	0.53
1991[c]	1988	0.00	0.09	0.00	0.33	0.00	0.21	0.00	0.05	0.00	0.00	0.00	0.68
1992[c]	1989	0.02	0.47	0.00	0.14	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.69
1993[d]	1990	0.01	0.29	0.00	0.37	0.00	0.16	0.00	0.01	0.00	0.00	0.00	0.83
1994[d]	1991	0.00	0.03	0.00	0.35	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.55
1995[c]	1992	0.00	0.04	0.00	0.12	0.00	0.17	0.00	0.01	0.00	0.00	0.00	0.34
1996[c]	1993	0.03	0.08	0.00	0.46	0.00	0.10	0.00	0.06	0.00	0.00	0.00	0.73
1997[c]	1994	0.00	0.45	0.00	0.14	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.74
1998[d]	1995	0.00	0.04	0.00	0.50	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.59
1999[d]	1996	0.02	0.12	0.00	0.21	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.50
2000[c]	1997	0.00	0.30	0.00	0.36	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.78
Females													
1986[b]	1983	0.00	0.00	0.00	0.03	0.00	0.14	0.00	0.08	0.00	0.00	0.00	0.25
1987[b]	1984	0.00	0.00	0.00	0.01	0.00	0.50	0.00	0.07	0.00	0.00	0.00	0.58
1988[b]	1985	0.00	0.00	0.00	0.04	0.00	0.36	0.00	0.21	0.00	0.00	0.00	0.61
1989[b]	1986	0.00	0.00	0.00	0.07	0.00	0.25	0.00	0.06	0.00	0.00	0.00	0.39
1990[c]	1987	0.00	0.00	0.00	0.09	0.00	0.34	0.00	0.03	0.00	0.00	0.00	0.47
1991[c]	1988	0.00	0.00	0.00	0.04	0.00	0.20	0.00	0.07	0.00	0.00	0.00	0.32
1992[c]	1989	0.00	0.00	0.00	0.09	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.31
1993[d]	1990	0.00	0.00	0.00	0.04	0.00	0.12	0.00	0.01	0.00	0.00	0.00	0.17
1994[d]	1991	0.00	0.00	0.00	0.08	0.00	0.35	0.00	0.02	0.00	0.00	0.00	0.45
1995[c]	1992	0.00	0.00	0.00	0.09	0.00	0.54	0.00	0.03	0.00	0.00	0.00	0.66
1996[c]	1993	0.00	0.00	0.00	0.06	0.00	0.10	0.00	0.11	0.00	0.00	0.00	0.27
1997[c]	1994	0.00	0.00	0.00	0.01	0.00	0.24	0.00	0.01	0.00	0.00	0.00	0.26
1998[d]	1995	0.00	0.00	0.00	0.22	0.00	0.16	0.00	0.03	0.00	0.00	0.00	0.41
1999[d]	1996	0.00	0.00	0.00	0.04	0.00	0.45	0.00	0.01	0.00	0.00	0.00	0.50
2000[c]	1997	0.00	0.00	0.00	0.03	0.00	0.17	0.00	0.02	0.00	0.00	0.00	0.22

[a] All data acquired by Sport Fish Division unless otherwise noted.

[b] Data collected from a mark-recapture experiment conducted by CFD.

[c] Ages from carcass survey.

[d] Samples from electroshocked fish.

Appendix E2.-Age composition of male and female chinook salmon from the Chena River, 1986-2000.

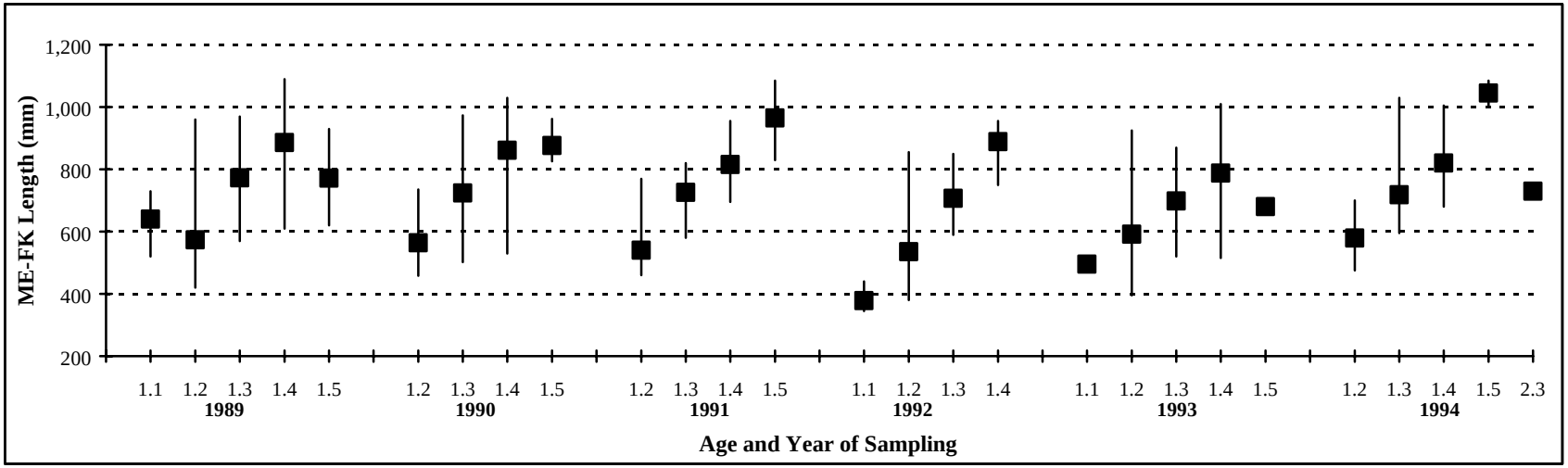
		Age Composition											
Escapement	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1986[b]	1983	13	855	0	4,300	0	1,333	126	138	0	0	0	6,765
1987[b]	1984	0	172	0	755	0	1,647	23	91	0	0	0	2,688
1988[b]	1985	20	351	0	465	0	365	0	107	0	0	0	1,308
1989[b]	1986	16	177	0	806	32	564	16	16	0	0	0	1,627
1990[c]	1987	0	1,255	0	920	10	756	0	34	0	0	0	2,975
1991[c]	1988	0	259	0	1,008	0	642	0	152	0	0	0	2,061
1992[c]	1989	113	2,470	0	740	13	276	13	0	0	0	0	3,625
1993[d]	1990	65	3,600	0	4,517	0	1,964	0	65	0	0	0	10,211
1994[d]	1991	0	348	0	4,199	0	1,902	23	46	0	0	0	6,518
1995[c]	1992	0	430	0	1,181	0	1,611	0	49	12	0	0	3,284
1996[c]	1993	202	568	0	3,297	0	714	0	458	0	0	0	5,239
1997[c]	1994	38	4,910	0	1,479	0	1,573	0	19	19	0	0	8,038
1998[d]	1995	0	208	0	2,393	0	125	0	62	0	0	0	2,788
1999[d]	1996	138	782	0	1,380	0	920	0	0	0	0	0	3,220
2000[c]	1997	15	1,403	0	1,627	0	508	0	13	0	0	0	3,566
Females													
1986[b]	1983	0	0	0	302	0	1,270	0	704	13	0	13	2,302
1987[b]	1984	0	11	0	80	0	3,179	0	423	23	0	0	3,716
1988[b]	1985	0	0	0	120	0	1,188	0	716	0	0	13	2,038
1989[b]	1986	0	6	0	194	0	678	0	161	0	0	0	1,039
1990[c]	1987	0	22	0	510	0	1,927	0	174	0	0	0	2,633
1991[c]	1988	0	0	0	116	0	598	0	223	9	9	9	964
1992[c]	1989	0	0	0	457	0	1,132	9	9	0	0	0	1,607
1993[d]	1990	0	0	0	524	0	1,440	0	65	0	0	0	2,029
1994[d]	1991	0	0	0	974	0	4,129	23	232	0	0	0	5,358
1995[c]	1992	0	0	0	836	0	5,252	0	283	25	0	0	6,396
1996[c]	1993	0	8	0	401	0	685	0	819	0	0	0	1,913
1997[c]	1994	0	19	0	119	0	2,570	0	64	0	0	0	2,772
1998[d]	1995	0	0	0	1,041	0	749	0	166	0	0	0	1,956
1999[d]	1996	0	0	0	276	0	2,898	0	92	0	0	0	3,266
2000[c]	1997	0	0	0	130	0	688	0	78	0	0	0	896

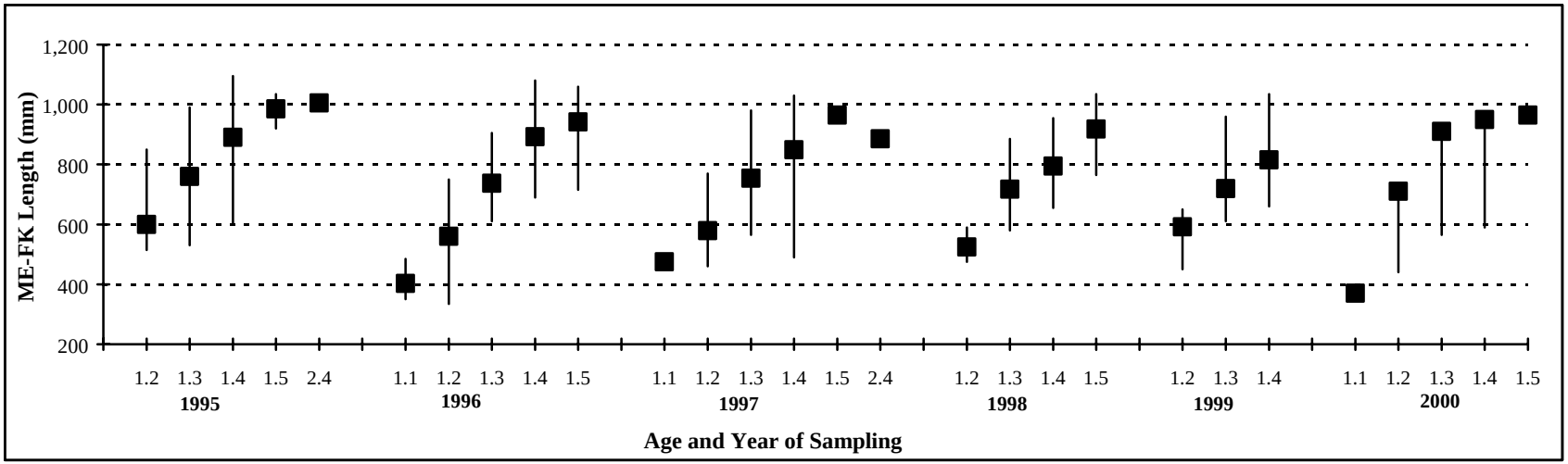
[a] All data acquired by Sport Fish Division unless otherwise noted.

[b] Data collected from a mark-recapture experiment conducted by CFD.

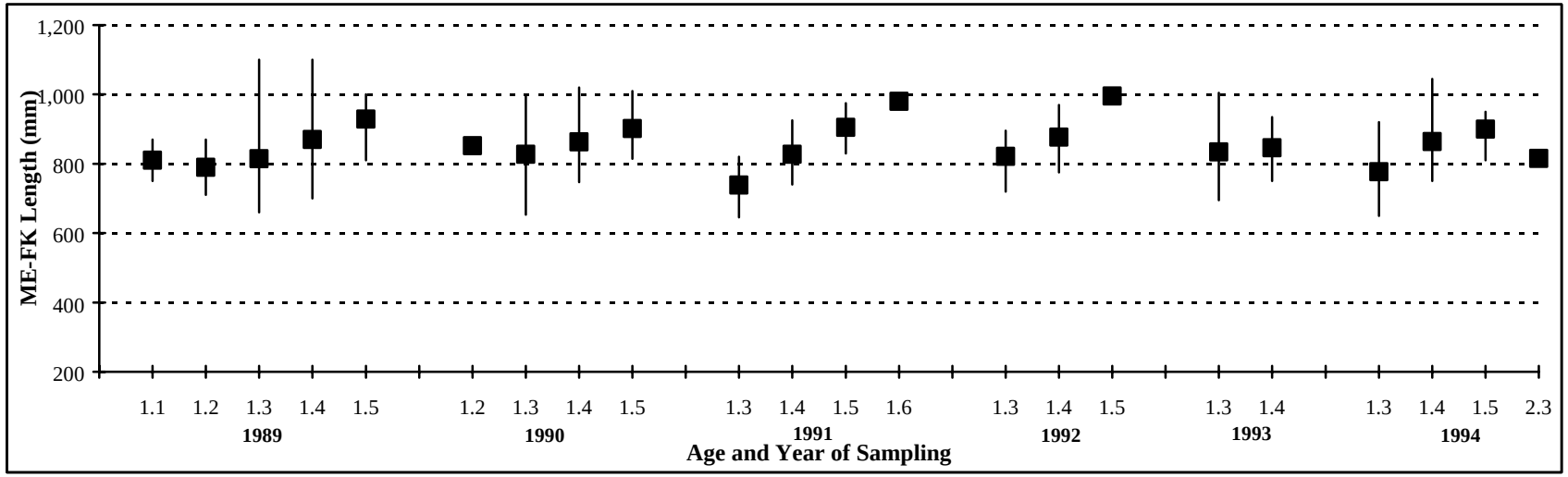
[c] Escapement estimated from mark-recapture experiment.

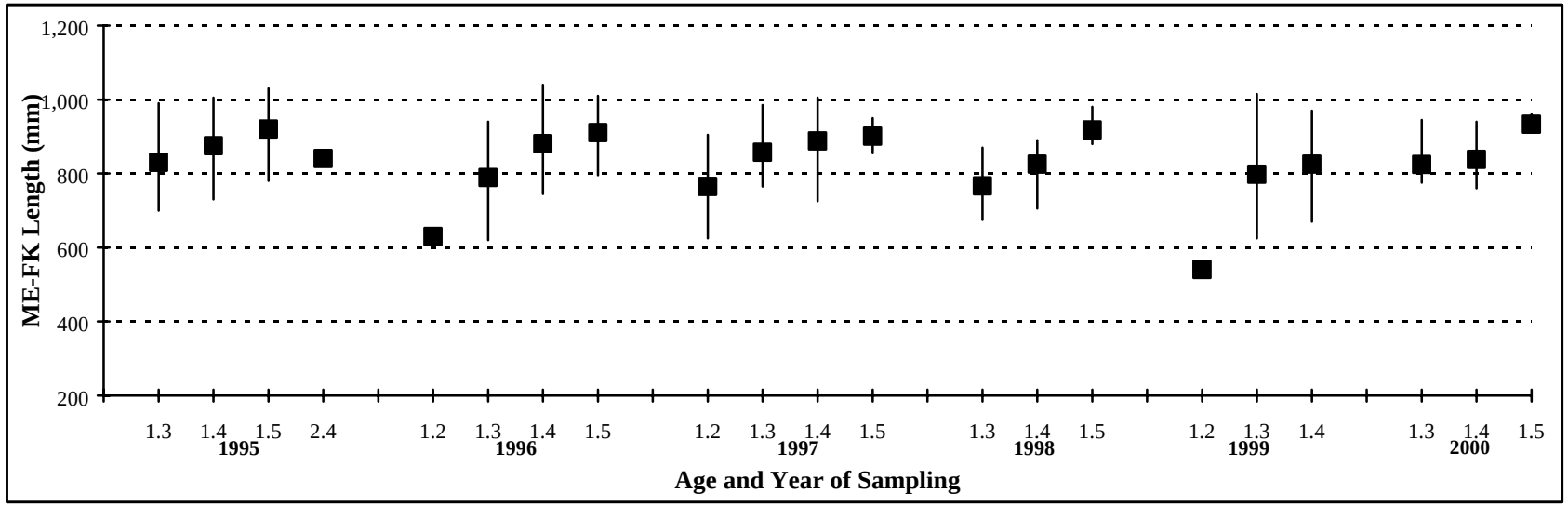
[d] Escapement estimated from tower-counts.





Appendix E3.-Average length at age for male chinook salmon sampled from the Chena River, 1989-2000. Vertical bars represent ranges.





Appendix E4.-Average length at age for female chinook salmon sampled from the Chena River, 1989-2000. Vertical bars represent ranges.

Appendix E5.-Age composition proportions of male and female chinook salmon from the Chatanika River, 1995-2000.

		Age Composition Proportions											
Escapemen	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1995	1992	0.05	0.10	0.00	0.17	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.37
1996	1993	0.00	0.06	0.00	0.42	0.00	0.07	0.00	0.01	0.00	0.00	0.00	0.56
1997[b]	1994	0.00	0.56	0.00	0.12	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.75
1998	1995	0.00	0.00	0.00	0.56	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.64
1999	1996	0.00	0.00	0.00	0.05	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.19
2000	1997	0.00	0.17	0.00	0.46	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.69
Females													
1995	1992	0.00	0.02	0.00	0.37	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.63
1996	1993	0.00	0.02	0.00	0.35	0.00	0.06	0.00	0.01	0.00	0.00	0.00	0.44
1997[b]	1994	0.00	0.00	0.00	0.04	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.25
1998	1995	0.00	0.02	0.00	0.14	0.00	0.16	0.00	0.04	0.00	0.00	0.00	0.36
1999	1996	0.00	0.00	0.00	0.19	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.81
2000	1997	0.00	0.00	0.00	0.11	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.31

[a] All ages from carcass surveys unless otherwise noted.

[b] Ages from combination carcass survey and electroshocked salmon.

Appendix E6.-Age composition of male and female chinook salmon from the Chatanika River, 1995-2000.

		Age Composition											
Escapemen	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1995[b]	1992	-	-	-	-	-	-	-	-	-	-	-	N/A
1996[b]	1993	-	-	-	-	-	-	-	-	-	-	-	N/A
1997[c]	1994	0	2,133	0	457	0	267	0	0	0	0	0	2,857
1998[d]	1995	0	0	0	484	0	69	0	0	0	0	0	553
1999[d]	1996	0	0	0	25	0	70	0	0	0	0	0	96
2000[e]	1997	-	-	-	-	-	-	-	-	-	-	-	N/A
Females													
1995[b]	1992	-	-	-	-	-	-	-	-	-	-	-	N/A
1996[b]	1993	-	-	-	-	-	-	-	-	-	-	-	N/A
1997[c]	1994	0	0	0	152	0	762	0	38	0	0	0	952
1998[d]	1995	0	17	0	121	0	138	0	35	0	0	0	311
1999[d]	1996	0	0	0	96	0	312	0	0	0	0	0	407
2000[e]	1997	-	-	-	-	-	-	-	-	-	-	-	N/A

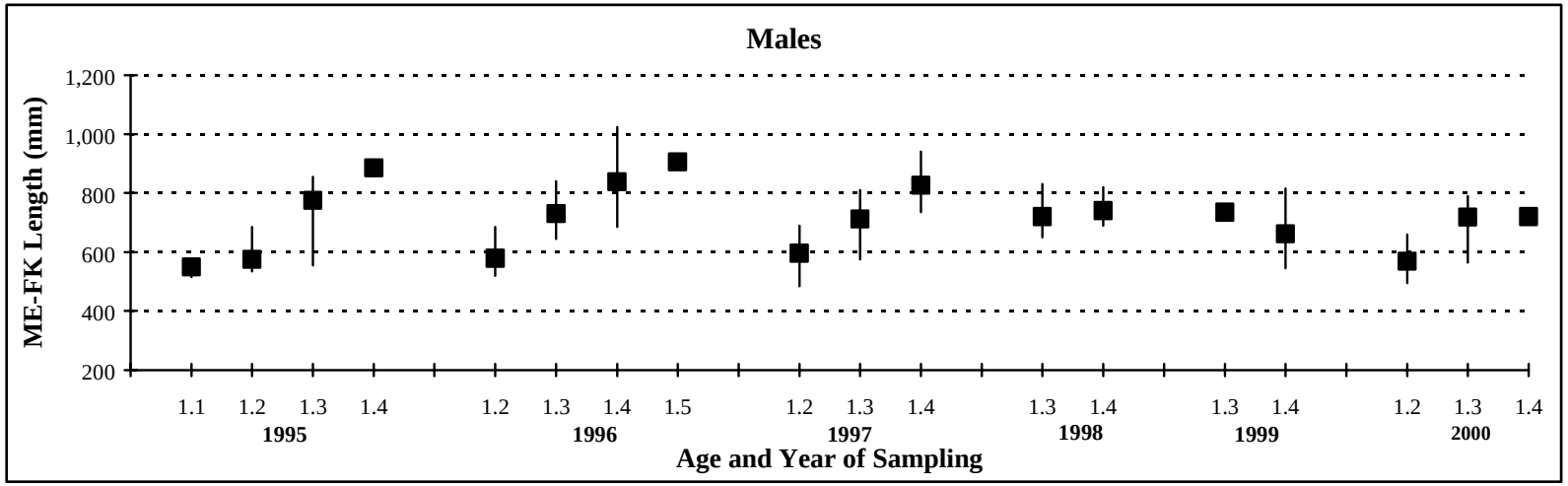
[a] All ages from carcass surveys unless otherwise noted.

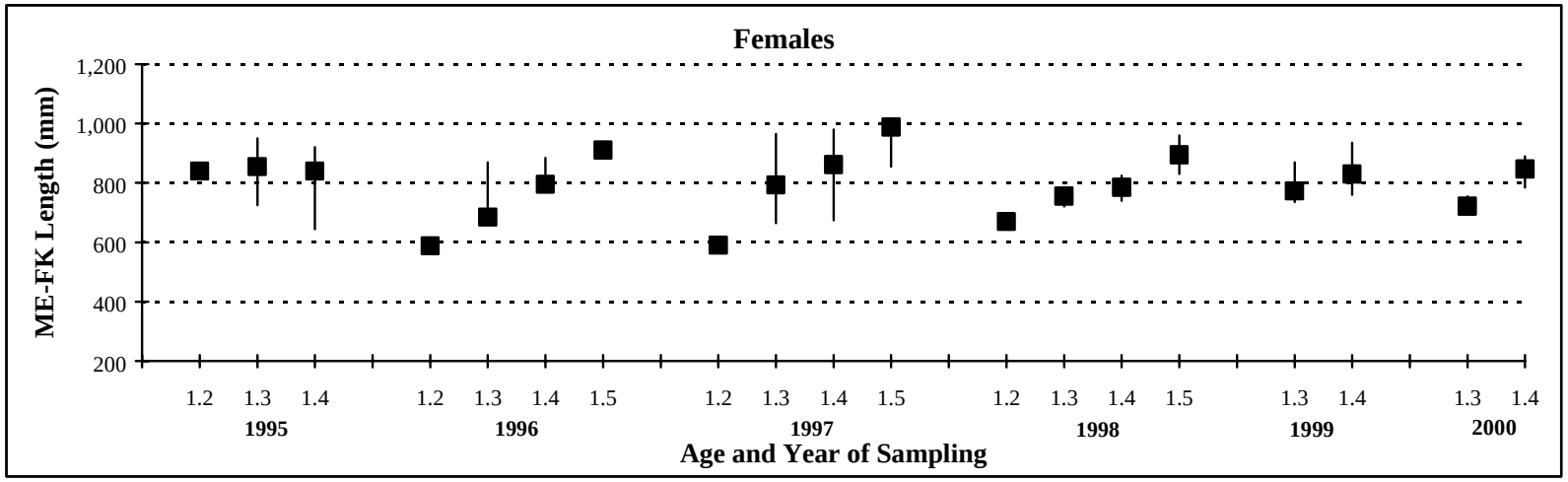
[b] Incomplete boat survey.

[c] Estimate from a mark-recapture experiment.

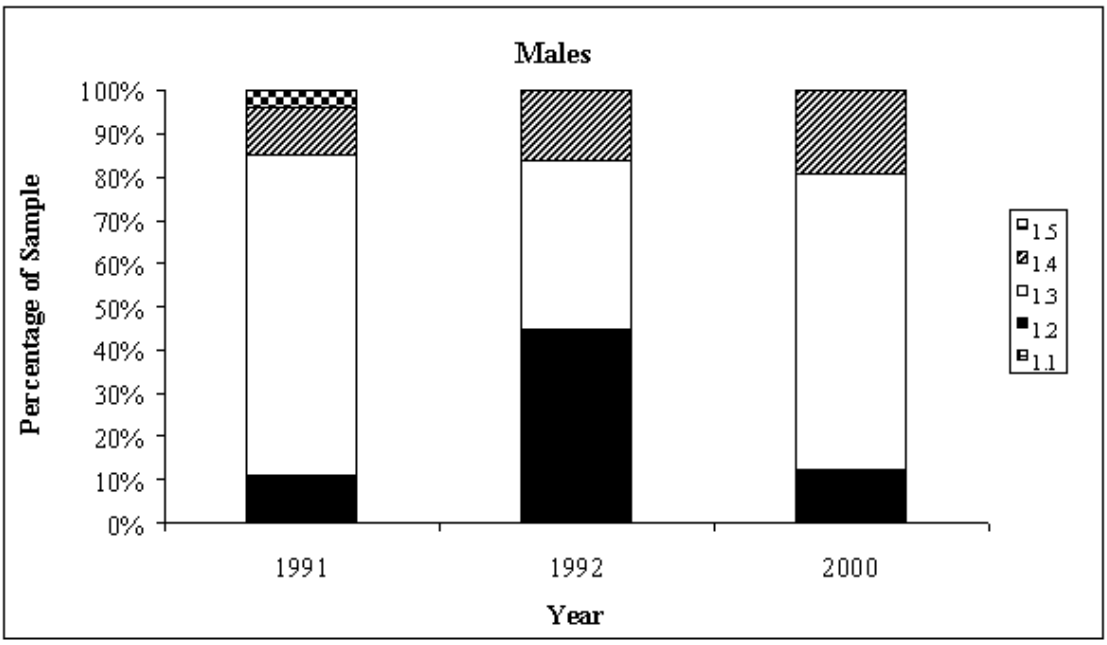
[d] Tower estimate.

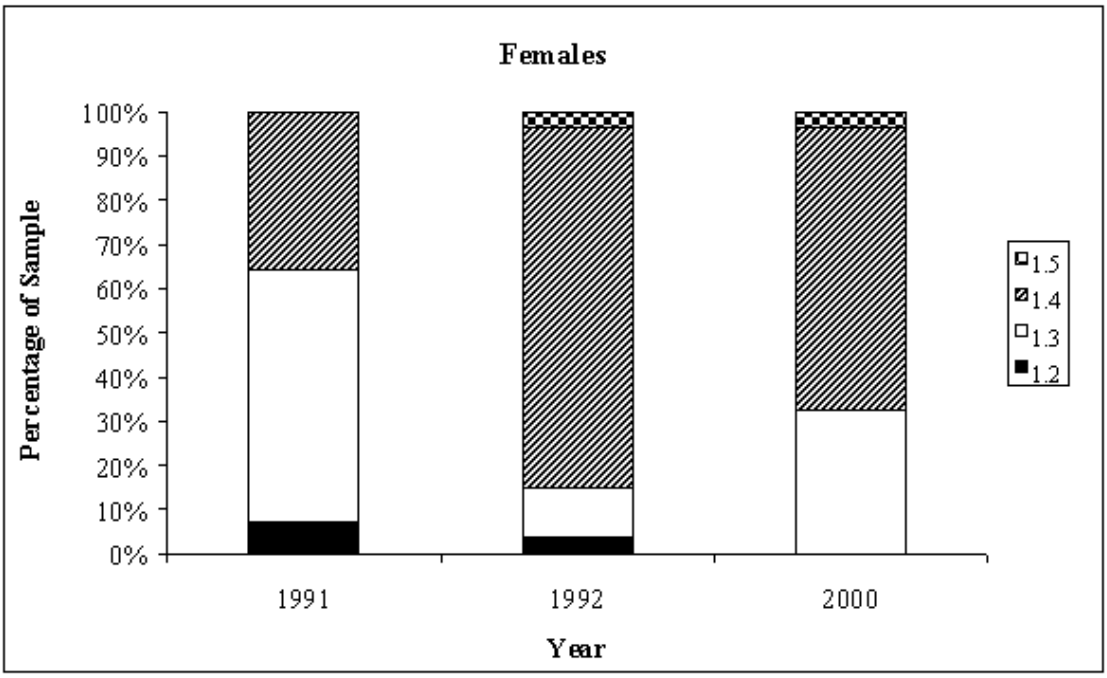
[e] Incomplete tower estimate.



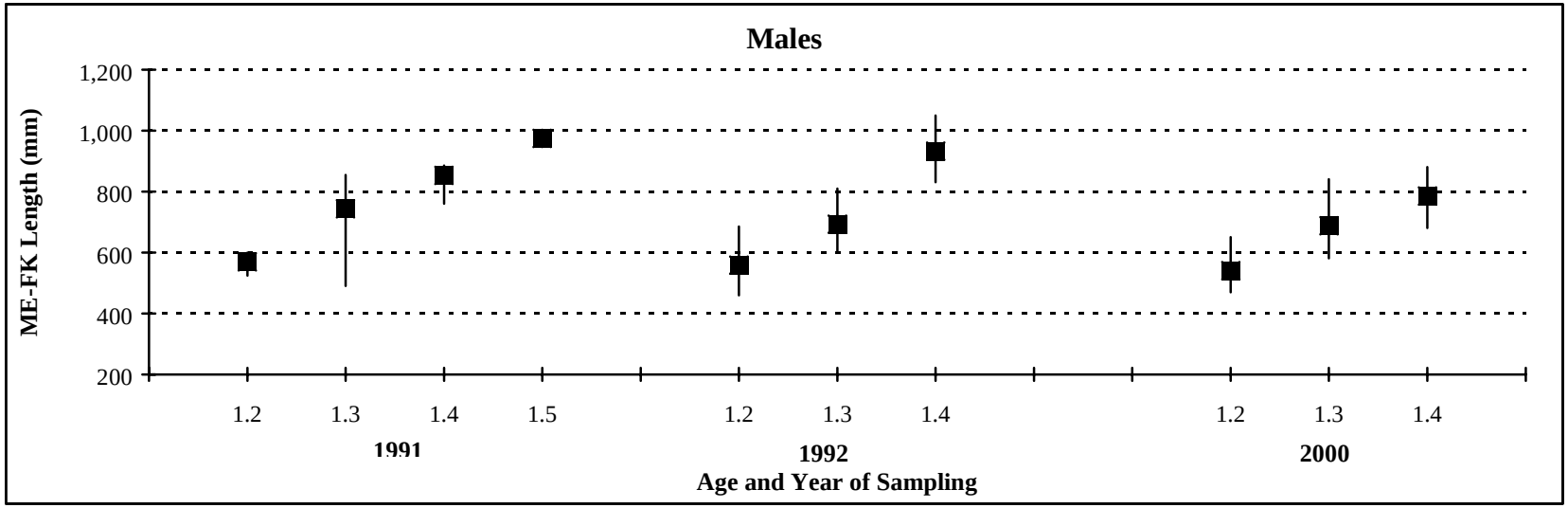


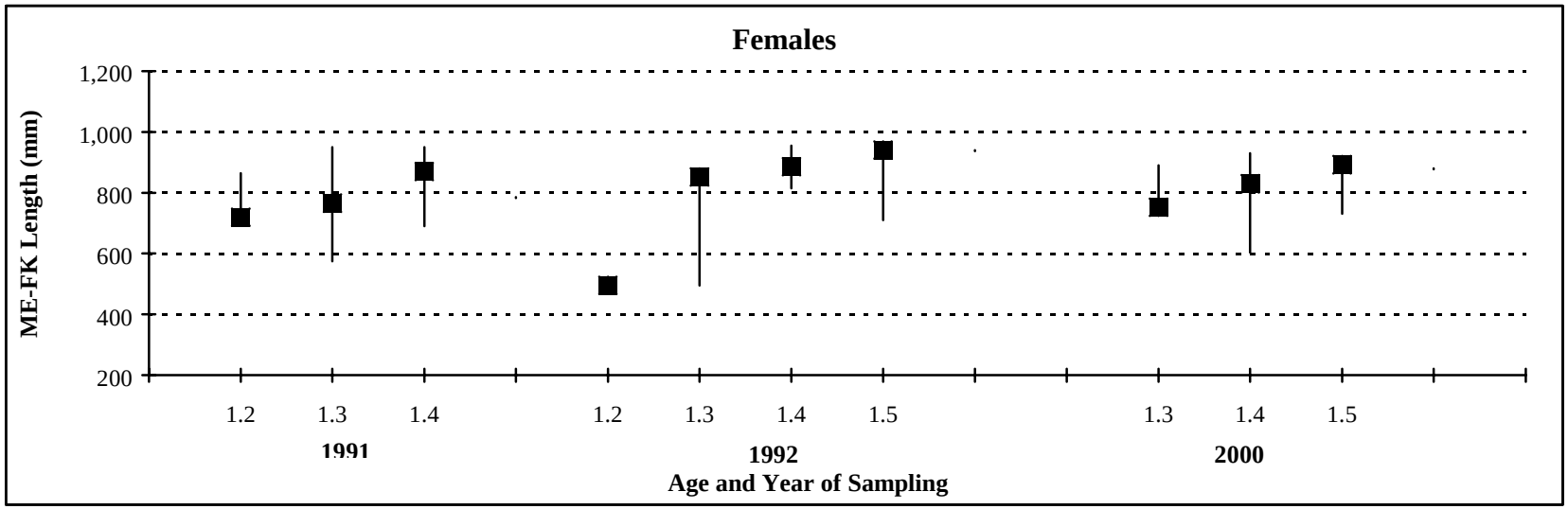
Appendix E7.-Average length at age for male and female chinook salmon sampled from the Chatanika River, 1995-2000. Vertical bars represent ranges.





Appendix E8.-Age composition of male and female chinook salmon from the Goodpaster River from carcasses sampled in 1991, 1992 and 2000.





Appendix E9.-Average length at age for male and female chinook salmon sampled from the Goodpaster River in 1991, 1992 and 2000. Vertical bars represent ranges.

APPENDIX F
SALCHA RIVER DATA

Appendix F1.-Schedule for counting salmon in the Salcha River, 2000. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility.

June 26 – July 2	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800						COUNT	COUNT
0800-1600							
1600-0000					COUNT	COUNT	COUNT

July 3 – July 9	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600			COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

July 10 – July 16	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT					
0800-1600	COUNT						
1600-0000	COUNT						

July 17 – July 23	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800		COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600		COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

July 24 – July 30	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

July 31 – Aug 6	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT

Aug 7 – Aug 13	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0000-0800	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	
0800-1600	COUNT	COUNT	COUNT	COUNT	COUNT	COUNT	
1600-0000	COUNT	COUNT	COUNT	COUNT	COUNT		

Appendix F2.-Numbers of chinook salmon counted during 20 min periods for the Salcha River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/30																					0	0	0	0	0
7/1	0	0	0	0	0																0	0	0	0	0
7/2	0	0	0	0	0																0	0	0	0	0
7/3	0	0	0	0	0																0	0	0	0	0
7/4	0	0	0	0	0										0	0	1	0	0	0	0	0	0	0	1
7/5	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7/6	0	0	0	0	0	0	0	0	0	2	4	0	3	1	0	0	2	0	0	0	0	0	0	0	12
7/7	0	0	2	0	0	0	0	0	0	3	0	0	0	0	4	1	3	1	0	0	0	0	0	0	14
7/8	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
7/9	0	0	1	0	5	3	0	1	0	1	3	0	0	0	0	0	0	0	0	0	0	0	1	0	15
7/10	5	5	14	0	0	1	7	4	2	6	4	1	0	0	0	3	0	1	1	1	0	3	0	0	58
7/11	0	0	3	2	1																				6
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17																	4	16	6	1	1	10	4	5	47
7/18	16	4	13	6	4	2	5	6	5	21	15	12	1	6	21	6	1	4	3	7	4	-1	0	0	161
7/19	3	1	4	2	1	0	3	1	0	2	3	0	1	0	1	1	0	0	0	0	0	0	3	1	27
7/20	1	0	2	1	3	0	1	4	0	4	4	5	4	3	0	0	0	0	4	7	1	6	3	0	53
7/21	3	4	4	4	3	2	3	6	1	0	0	1	3	0	0	3	0	12	7	8	4	2	8	1	79
7/22	2	0	6	1	2	1	1	0	3	1	1	0	0	10	2	6	4	8	3	1	0	0	0	0	52
7/23	3	3	4	4	1	0	1	0	2	1	2	2	11	6	6	3	1	2	2	2	1	0	3	0	60
7/24	2	2	3	1	0	1	2	1	0	2	5	2	3	7	0	1	11	7	3	3	2	1	0	2	61
7/25	1	2	2	1	1	2	9	1	1	0	5	2	2	1	3	3	3	2	4	0	4	4	0	0	53
7/26	1	2	0	1	1	0	0	1	3	2	1	3	0	4	5	3	2	2	3	0	1	2	0	0	37
7/27	2	2	4	0	3	1	2	0	2	1	1	6	3	0	0	0	1	3	3	1	0	1	2	0	38
7/28	0	0	3	0	1	0	2	3	1	0	0	4	2	0	1	1	2	5	7	1	4	14	7	6	64
7/29	2	1	0	0	0	3	0	2	0	3	6	2	0	0	0	1	3	1	2	6	2	4	2	0	40
7/30	0	0	0	0	2	0	0	0	0	0	0	0	0	0	-1	0	0	0	2	0	0	0	3	0	6
7/31	3	2	3	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	13
8/1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	-1	0	0	0	0	1	0	0	4
8/2	0	4	2	0	3	1	0	0	1	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	17
8/3	0	1	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	4
8/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
8/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/8	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
8/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0											0
Total	44	33	70	25	32	18	36	31	21	50	56	44	37	41	43	34	39	65	51	38	24	47	36	16	931

Appendix F3.-Numbers of chum salmon counted during 20 min periods for the Salcha River, 2000. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.

	Hour																								
Date	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
6/30																					0	0	0	0	0
7/1	0	0	0	0	0																0	0	0	0	0
7/2	0	0	0	0	0																0	0	0	0	0
7/3	0	0	0	0	0																0	0	0	0	0
7/4	0	0	0	0	0										0	0	0	0	0	0	0	0	0	0	0
7/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0																				0
7/12																									0
7/13																									0
7/14																									0
7/15																									0
7/16																									0
7/17																	0	0	0	0	0	0	0	0	0
7/18	0	2	6	3	0	0	0	0	0	3	0	1	0	3	1	0	0	0	0	1	0	0	0	0	20
7/19	1	1	0	1	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6
7/20	1	1	4	0	0	2	0	3	1	0	1	1	1	1	2	0	0	0	0	0	0	4	0	0	22
7/21	3	2	12	1	11	0	2	7	5	1	7	2	3	2	2	0	0	5	0	2	9	2	3	2	83
7/22	1	0	1	2	1	3	1	1	0	4	3	0	8	12	4	13	3	5	14	8	5	4	0	0	93
7/23	5	4	4	3	5	2	5	3	4	0	11	4	6	0	6	1	0	3	8	4	9	3	6	7	103
7/24	8	1	3	2	2	4	1	1	2	5	8	4	5	6	4	4	10	3	3	2	7	5	3	6	99
7/25	3	3	4	4	8	13	12	3	2	11	9	6	2	7	0	4	7	5	18	5	13	9	7	11	166
7/26	0	3	0	2	5	12	8	3	3	2	3	0	2	10	1	7	5	7	5	12	18	2	34	4	148
7/27	16	14	15	9	12	7	13	4	20	2	9	4	22	2	7	2	20	20	10	29	11	17	17	6	288
7/28	13	22	8	18	4	12	9	7	1	2	5	13	18	9	8	14	10	12	11	7	2	52	34	31	322
7/29	28	26	17	12	41	21	14	9	12	0	12	9	6	8	9	22	11	30	26	54	58	57	39	31	552
7/30	32	31	23	21	18	34	27	7	26	25	16	36	10	29	15	11	40	37	49	14	40	28	35	10	614
7/31	26	38	36	28	43	35	20	23	12	13	34	25	5	19	17	52	41	31	44	30	48	21	27	24	692
8/1	16	41	24	31	23	17	13	34	3	16	9	14	12	8	6	20	24	8	22	28	29	59	17	10	484
8/2	15	35	26	38	23	36	16	21	33	16	14	12	30	39	8	17	6	13	7	9	25	29	8	22	498
8/3	16	13	23	9	20	11	11	25	8	5	18	18	10	2	6	1	4	0	4	33	32	9	7	16	301
8/4	25	21	24	19	21	14	11	8	20	20	14	23	17	14	6	13	14	5	10	4	8	6	19	23	359
8/5	8	15	19	11	21	9	14	10	15	12	7	12	20	9	21	9	17	4	9	11	1	27	5	16	302
8/6	26	17	12	6	8	13	15	1	16	5	4	8	7	4	2	2	10	3	3	8	1	12	28	23	234
8/7	7	16	8	8	5	9	4	0	5	6	5	1	10	7	8	13	16	6	27	8	31	14	10	9	233
8/8	34	25	26	16	21	6	13	9	17	5	6	1	1	2	22	8	7	7	2	4	10	11	1	1	255
8/9	20	27	18	9	14	8	3	19	14	17	5	7	10	4	7	6	17	10	15	9	2	15	16	25	297
8/10	14	12	35	28	28	6	0	0	9	4	3	4	8	5	11	0	2	15	15	17	5	12	18	22	273
8/11	10	15	7	24	17	12	13	9	2	7	9	6	5	4	2	4	0	1	14	8	0	1	5	0	175
8/12	12	17	8	30	23	21	3	7	6	8	2	1	0	2											140
Total	340	402	363	335	374	307	228	216	236	189	215	212	218	208	175	223	264	230	316	307	364	399	339	299	6,759

Appendix F4.-Age composition proportions of male and female chinook salmon from the Salcha River, 1987-2000.

		Age Composition											
Escapement	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1987	1984	0.00	0.07	0.00	0.13	0.00	0.26	0.00	0.01	0.00	0.00	0.00	0.48
1988	1985	0.01	0.30	0.00	0.18	0.00	0.13	0.00	0.04	0.00	0.00	0.00	0.67
1989	1986	0.01	0.05	0.00	0.26	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.48
1990	1987	0.00	0.17	0.00	0.17	0.00	0.13	0.00	0.02	0.00	0.00	0.00	0.50
1991	1988	0.00	0.08	0.00	0.26	0.00	0.16	0.00	0.03	0.00	0.00	0.00	0.53
1992	1989	0.01	0.36	0.00	0.22	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.66
1993	1990	0.01	0.28	0.00	0.33	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.72
1994	1991	0.01	0.02	0.00	0.31	0.00	0.20	0.00	0.02	0.00	0.00	0.00	0.55
1995	1992	0.00	0.13	0.00	0.13	0.00	0.17	0.00	0.01	0.00	0.00	0.00	0.44
1996	1993	0.04	0.09	0.00	0.42	0.00	0.13	0.00	0.06	0.00	0.00	0.00	0.74
1997	1994	0.00	0.13	0.00	0.12	0.00	0.24	0.00	0.01	0.00	0.00	0.00	0.50
1998	1995	0.02	0.05	0.00	0.53	0.00	0.09	0.00	0.01	0.00	0.00	0.00	0.70
1999[b]	1996	0.00	0.09	0.00	0.17	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.45
2000[b]	1997	0.00	0.17	0.00	0.32	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.56
Females													
1987	1984	0.00	0.00	0.00	0.02	0.00	0.44	0.00	0.06	0.00	0.00	0.00	0.52
1988	1985	0.00	0.00	0.00	0.02	0.00	0.23	0.00	0.08	0.00	0.00	0.00	0.33
1989	1986	0.00	0.00	0.00	0.07	0.00	0.38	0.00	0.07	0.00	0.00	0.00	0.52
1990	1987	0.00	0.00	0.00	0.07	0.00	0.36	0.00	0.07	0.00	0.00	0.00	0.50
1991	1988	0.00	0.00	0.00	0.06	0.00	0.32	0.00	0.09	0.00	0.00	0.00	0.47
1992	1989	0.00	0.00	0.00	0.11	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.34
1993	1990	0.00	0.00	0.00	0.06	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.28
1994	1991	0.00	0.01	0.00	0.08	0.00	0.32	0.00	0.03	0.00	0.00	0.00	0.45
1995	1992	0.00	0.01	0.00	0.08	0.00	0.46	0.00	0.02	0.00	0.00	0.00	0.56
1996	1993	0.00	0.00	0.00	0.05	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.26
1997	1994	0.00	0.02	0.00	0.02	0.00	0.45	0.00	0.01	0.00	0.00	0.00	0.50
1998	1995	0.00	0.00	0.00	0.20	0.00	0.09	0.00	0.02	0.00	0.00	0.00	0.30
1999[b]	1996	0.00	0.00	0.00	0.07	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.55
2000[b]	1997	0.00	0.05	0.00	0.17	0.00	0.17	0.00	0.05	0.00	0.00	0.00	0.44

[a] All age data acquired by carcass surveys conducted by Sport Fish Division unless otherwise noted.

[b] Carcass survey conducted by Bering Sea Fishermen's Association.

Appendix F5.-Age composition of male and female chinook salmon from the Salcha River, 1987-2000.

		Age Composition											
Escapement	Brood	3	4		5		6		7		8		
Year[a]	Year	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
Males													
1987[b]	1984	11	348	0	629	0	1,245	0	57	0	0	0	2,290
1988[b]	1985	29	1,380	0	834	14	580	0	192	8	0	0	3,037
1989[b]	1986	19	170	0	871	0	530	0	0	0	0	0	1,590
1990[b]	1987	20	1,774	0	1,876	0	1,428	0	224	0	0	0	5,322
1991[b]	1988	11	426	0	1,454	0	918	0	153	0	11	0	2,973
1992[b]	1989	97	2,799	0	1,765	37	438	24	24	0	0	0	5,184
1993[c]	1990	88	2,783	0	3,291	0	1,060	22	0	0	0	0	7,245
1994[c]	1991	106	354	0	5,697	0	3,715	0	283	0	0	0	10,155
1995[c]	1992	0	1,777	0	1,752	0	2,328	0	125	25	0	0	6,007
1996[b]	1993	303	661	0	3,166	0	991	0	468	0	0	0	5,589
1997[c]	1994	0	2,366	0	2,263	0	4,526	0	103	0	0	0	9,257
1998[c]	1995	123	245	0	2,657	0	450	0	41	0	0	0	3,515
1999[d]	1996	0	839	0	1,558	0	1,768	0	0	0	0	0	4,165
2000[d]	1997	0	781	0	1,470	0	322	0	0	0	0	0	2,573
Females													
1987[b]	1984	0	7	0	94	0	2,107	0	273	0	0	0	2,481
1988[b]	1985	0	8	0	106	0	1,050	0	361	0	0	0	1,525
1989[b]	1986	0	0	0	224	0	1,244	0	236	0	0	0	1,704
1990[b]	1987	0	41	0	795	0	3,856	0	714	0	0	0	5,406
1991[b]	1988	0	0	0	350	0	1,793	0	481	0	11	0	2,635
1992[b]	1989	0	12	0	876	0	1,740	0	37	12	0	0	2,677
1993[c]	1990	0	22	0	619	0	2,032	0	88	0	0	0	2,761
1994[c]	1991	0	142	0	1,521	0	5,944	35	602	0	0	0	8,244
1995[c]	1992	0	75	0	1,051	0	6,233	0	225	50	0	0	7,634
1996[b]	1993	0	9	0	406	0	774	0	793	0	0	0	1,982
1997[c]	1994	0	309	0	411	0	8,331	0	206	0	0	0	9,257
1998[c]	1995	0	0	0	981	0	450	0	82	0	0	0	1,512
1999[d]	1996	0	0	0	659	0	4,344	0	30	0	0	0	5,033
2000[d]	1997	0	230	0	781	0	781	0	230	0	0	0	2,022

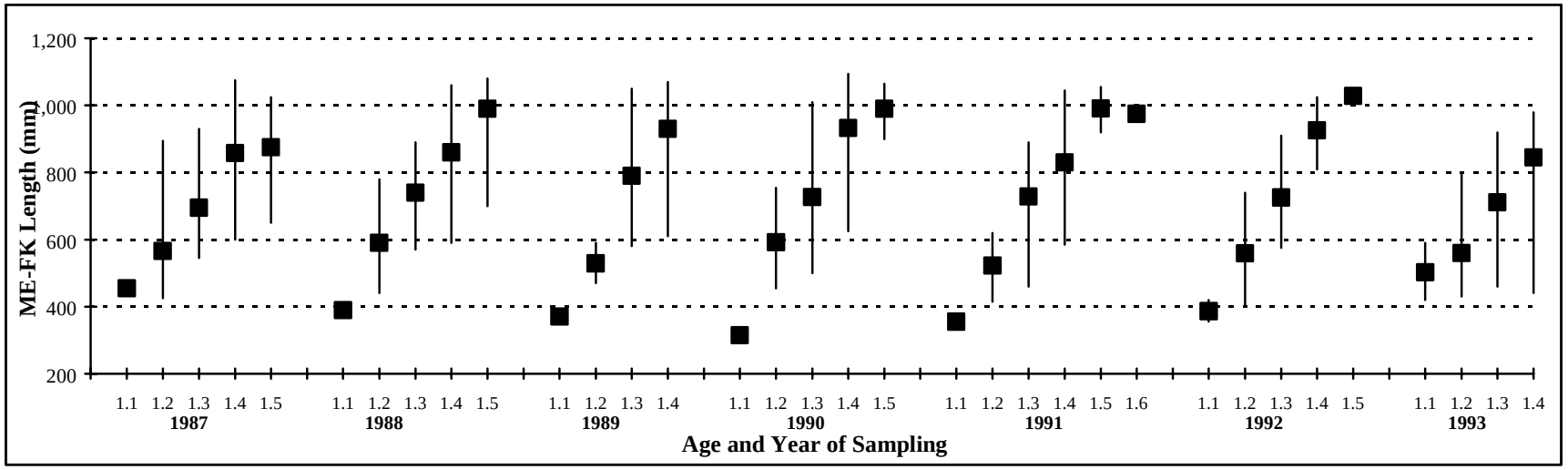
[a] All age data acquired by carcass surveys conducted by Sport Fish Division unless otherwise noted.

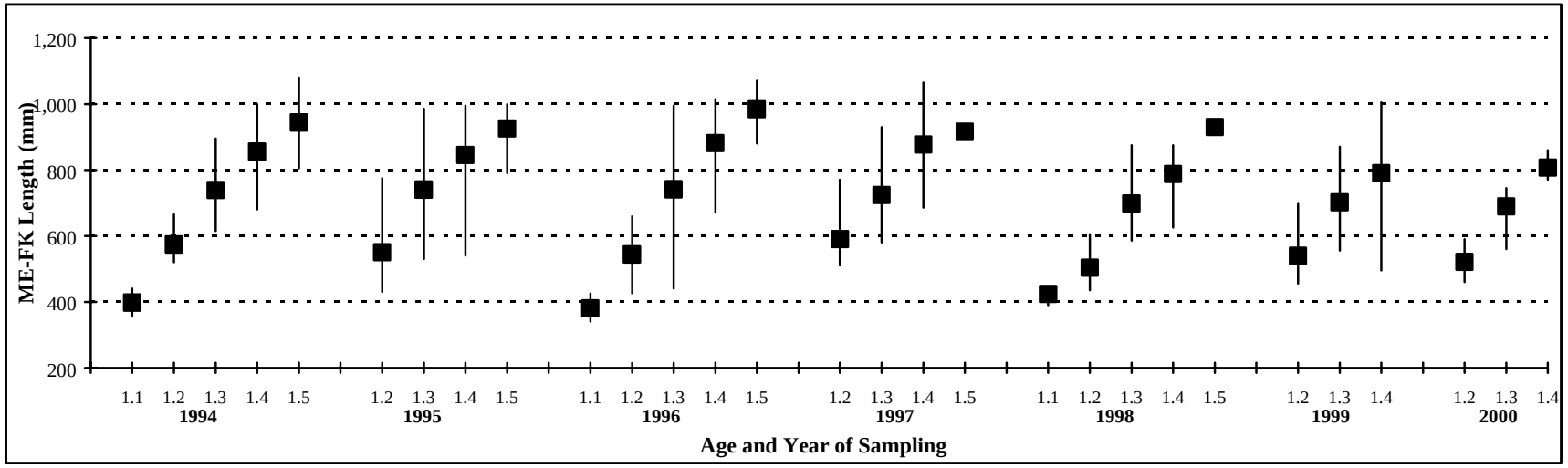
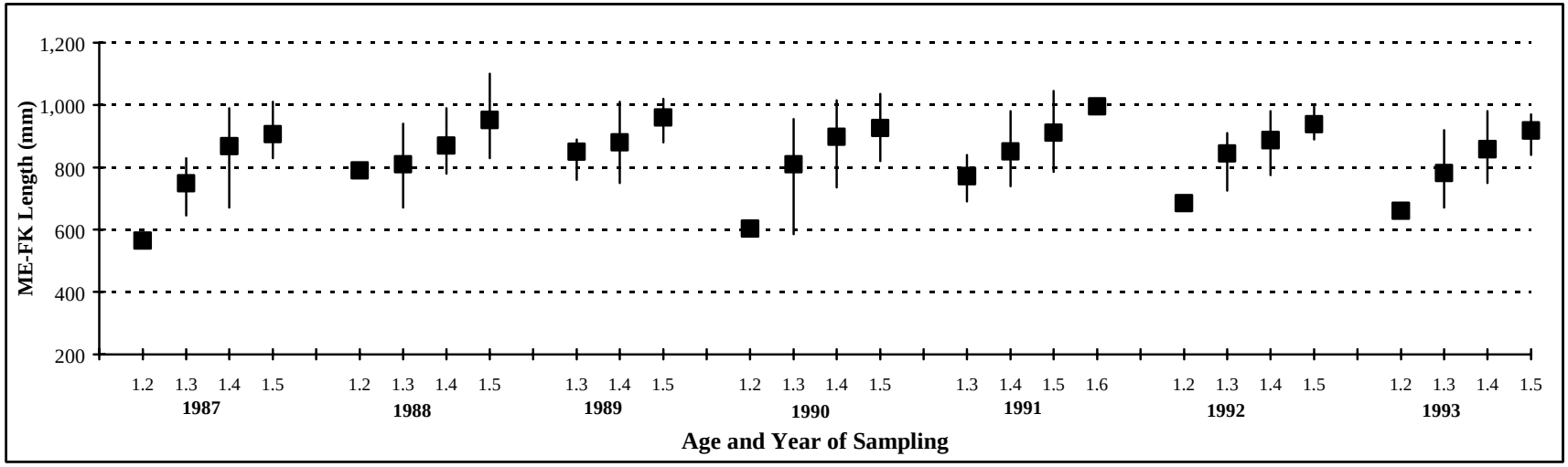
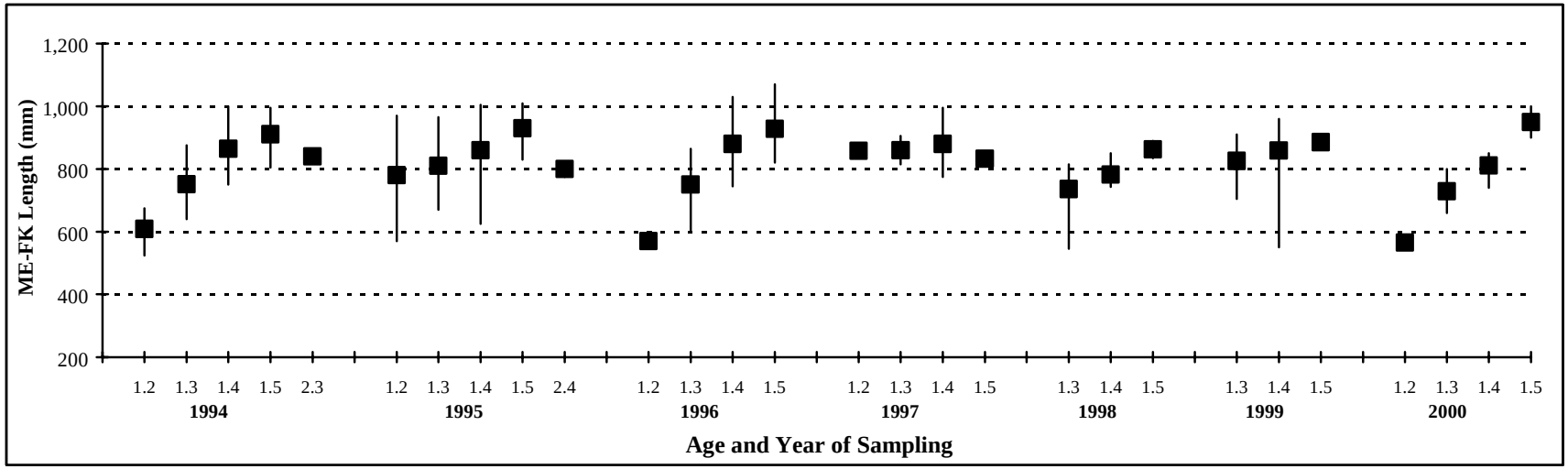
[b] Escapement estimated from mark-recapture experiment.

[c] Escapement estimated from tower-counts.

[d] Tower estimate and carcass survey conducted by Bering Sea Fishermen's Association.

Appendix F6.-Average length at age for male chinook salmon sampled from the Salcha River from 1987-2000. Error bars represent ranges.





Appendix F7.-Average length at age for female chinook salmon sampled from the Salcha River from 1987-2000. Error bars represent ranges.