Fishery Data Series No. 05-65

Salmon Studies in the Chena, Chatanika, Delta Clearwater, and Salcha Rivers, 2002 and 2003

by
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December 2005

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

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

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

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 05-65

SALMON STUDIES IN THE CHENA, CHATANIKA, DELTA CLEARWATER, AND SALCHA RIVERS, 2002 AND 2003

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ABSTRACT

Escapements of Chinook salmon *Oncorhynchus tshawytscha* in the Chena, Chatanika, and Salcha rivers near Fairbanks, Alaska are typically estimated using tower-count methodology. During 2002 and 2003, heavy rain raised water levels and precluded counting of salmon on all three rivers during portions of the run, resulting in incomplete Chinook salmon abundance estimates from the counting towers. This report summarizes results from the 2002 and 2003 Chinook salmon enumeration projects on the Chena, Chatanika, and Salcha rivers, and the coho *Oncorhynchus kisutch* enumeration project on the Delta Clearwater River.

Chena River: In 2002 high water and poor viewing conditions during a large portion of the run precluded an accurate estimate of Chinook salmon escapement from the counting tower; therefore, a two sample mark-recapture experiment was conducted to estimate abundance. Chinook salmon were sampled along a 80 km stretch of the river on or near their spawning areas. During the marking event fish were captured using electrofishing techniques. Chinook salmon carcasses were collected along the same section of river to constitute the recapture event. Total Chinook salmon escapement was estimated at 6,967 fish (SE=2,466) using a temporally stratified Darroch model after stratifying by sex. Chena River Chinook salmon age, sex, and length (ASL) compositions were examined from both electrofishing and carcass surveys. Male Chinook salmon composed 76% of the electrofished samples, and 56% of the carcass samples while the abundance estimation procedures provided an estimate of 73% males; therefore, the electrofished sample was used to estimate age composition and size at age for each gender. The dominant age classes (and corresponding proportions) for males were 1.2, (0.42), 1.3 (0.36), and 1.4 (0.21). The dominant age class for females was 1.4 (0.80).

During 2003, a minimum estimate of escapement of Chinook salmon was generated using tower-count methodology. The counts were conducted when possible from 24 June to 27 July. During that period counts could not be conducted during 11 days due to high water and poor viewing conditions, and counting was terminated prior to the end of the run. The estimated escapement for all days when counting was conducted successfully, not including expansions for days when counts could not be conducted was 8,739 fish (SE=653). Successful counts on the Chena River during Days 1 – 20 of the run allowed comparison with previously acquired datasets, suggesting a likely total escapement of about 11,100 Chinook salmon. Age and sex compositions of the Chena River 2003 Chinook escapement were determined after carcass surveys. The proportion of males in the sample (after correction for gender bias) was 0.66 (SE=0.04). The majority of males examined were age 1.3 (0.62). The majority of females were age 1.4 (0.63).

A portion of the Chena River chum salmon *Oncorhynchus keta* escapement was also estimated during the tower-counts. The incomplete estimates for the 2002 and 2003 Chena River chum salmon escapements were 1,021 and 573 fish respectively.

Chatanika River: High water and poor viewing conditions also resulted in limited days of successful counting on the Chatanika River during 2002 and 2003. In 2002, counting was not conducted on nine of 29 days and seven of those days were in the period that corresponds to the normal peak of the run. A minimum estimate of abundance for days when counts were conducted was 719 fish (SE=75). During 2003, counts were conducted successfully from 30 June to 15 July and from 22 July to 26 July, but counts were terminated before the run was complete. A minimum estimate for all days when counting was conducted successfully, not including expansions for days when counts could not be conducted, was 1,088 Chinook salmon (SE=141).

A portion of the Chatanika River chum salmon escapement was also estimated during the tower-counts. The incomplete estimates for Chatanika River chum salmon escapements were 963 in 2002 and 44 fish in 2003.

Salcha River: Chinook salmon enumeration and carcass surveys were conducted by staff from the Bering Sea Fishermen's Association (BSFA) in 2002 and 2003. The counts were impacted by high water and suspended during periods similar to those of the Chena and Chatanika rivers by the same basin-wide rain events and subsequent high water. During 2002, counts were completely suspended for 11 days and were hindered by turbidity during eight days of the 32-day run. A minimum escapement for days when counting occurred was 4,644 fish (SE=160). It is likely that escapement was within the range of 6,000 – 12,000 Chinook salmon.

During 2003, counts continued uninterrupted on the Salcha River until Day 20 of the Chinook salmon run and then were suspended due to flooding. Estimated escapement up to that time was 11,758 (SE=747) Chinook salmon. Total escapement was estimated to be about 15,500 Chinook salmon and was calculated by assuming that escapement on Day 20 was about 0.73 of total escapement based on historical run timing information. Age and sex compositions of the Salcha River Chinook escapement were determined after carcass surveys. In 2002 323 carcasses were collected. The proportion of males in the sample (after correction for gender bias) was 0.74 (SE=0.07). Males were most represented by age 1.2 (0.55). The majority of females were age 1.4 (0.78). In 2003 166 carcasses were collected, the proportion of males in the sample (after correction for gender bias) was 0.68 (SE=0.09). The majority of males examined were age 1.3 (0.60), and the majority of females were age 1.4 (0.75).

Delta Clearwater River: Escapements of coho salmon *Oncorhynchus kisutch* were enumerated during boat surveys in 2002 and 2003. Counts of coho salmon in the mainstem river, which were expanded by a factor based on 5 years of aerial survey data of river tributaries that were not boat accessible, produced total escapement estimates of 49,067 and 133,641 coho salmon for 2002 and 2003 respectively.

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

CHINOOK AND CHUM SALMON STUDIES IN THE CHENA AND CHATANIKA 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), and supports a popular sport fishery in the lower 72 km of the river. Annual sport harvest estimates from the Alaska Department of Fish and Game (ADF&G) Statewide Harvest Survey (SWHS) since 1978 have ranged from 0 to 1,270 Chinook salmon (Mills 1979-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003; Jennings et al. 2004, *In prep a-b*; Table 1). Angler harvests of Chinook salmon in the Chena River during 1988 - 1990 were monitored with creel surveys (Table 1; Evenson 1995). However, such inseason surveys have not been conducted recently due to their high cost and the difficulty of obtaining more meaningful estimates of harvest and effort than those estimated by the SWHS.

The Chatanika River (Figure 2) sustains a small stock of Chinook salmon. Historical annual sport harvest estimates of up to 373 fish (Table 1) indicate the possibility of large relative exploitation, but recent harvests have been low as indicated by results from the SWHS.

Before reaching their spawning grounds in the mid- to upper reaches of these rivers, Chinook salmon travel about 1,500 km from the Bering Sea and pass through several commercial fishing districts in the Yukon and Tanana rivers (Figure 3). Subsistence and/or personal use fishing also occur in each district. In recent years commercial fishing has been curtailed on both the Yukon and Tanana rivers to allow sufficient numbers of Chinook salmon upriver and meet established escapement goals.

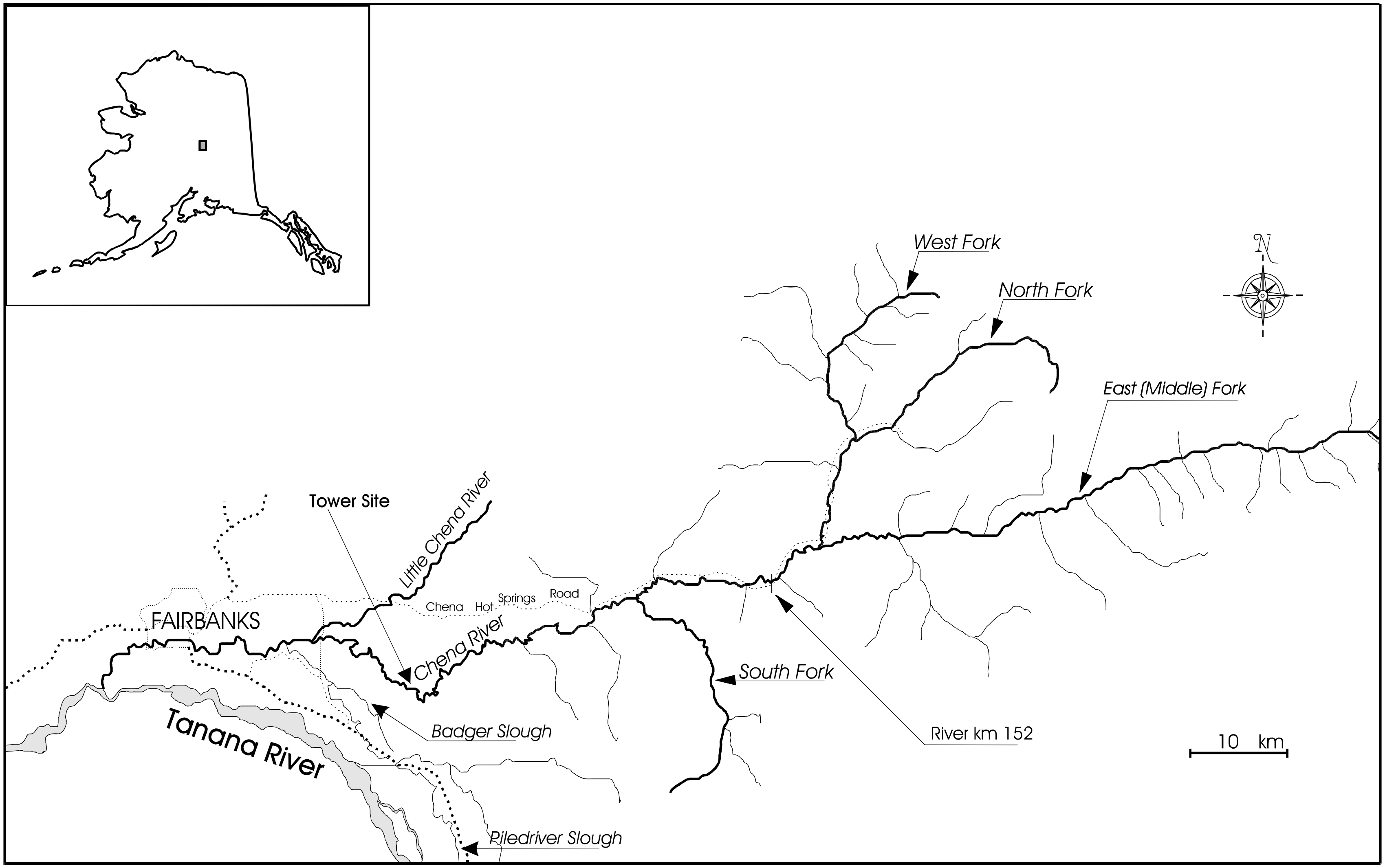

Figure 1.–Chena River drainage.

Table 1.–Estimated sport, commercial, and subsistence harvests of Chinook salmon in the Tanana River drainage, 1978 - 2003.[f]

	Sport Harvest								Commercial	Subsistence and Personal Use	Total Estimated
	Creel Survey[a]		Statewide Survey[b]								
Year	Chena River	Salcha River	Chena River	Salcha River	Chatanika River	Nenana River	Other Streams	Tanana Drainage	Harvest[c] (Tanana Drainage)	Harvest [c, e] (Tanana Drainage)	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	1,136	348	53	118	2,925	447	1,392	4,764
1997	-	-	1,029	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	1,225
2001	-	-	425	108	23	0	0	556	0	2,571	3,127
2002	-	-	178	269	0	0	0	447	836	1,193	2,923
2003	-	-	970	1,127	13	11	0	2,127	1,813	2,349	6,289

[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, 2001 a-d), Walker et al. (2003), and Jennings et al. (2004, *In prep a, b*).

[c] Commercial, subsistence, and personal use estimates (Schultz et al. 1994; Borba and Hamner 1998, 1999; K. Schultz, Commercial Fish Biologist, ADF&G, Fairbanks; personal communication; B. Busher, Commercial Fish Biologist, ADF&G, Fairbanks; personal communication).

[d] Preliminary data and subject to change.

[e] The personal use designation was established in 1988 to account for fishermen analogous to subsistence users fishing in the Tanana River within the Fairbanks Non-Subsistence Area.

[f] Totals do not include Chinook salmon harvests from stocked lakes in the Tanana River area.

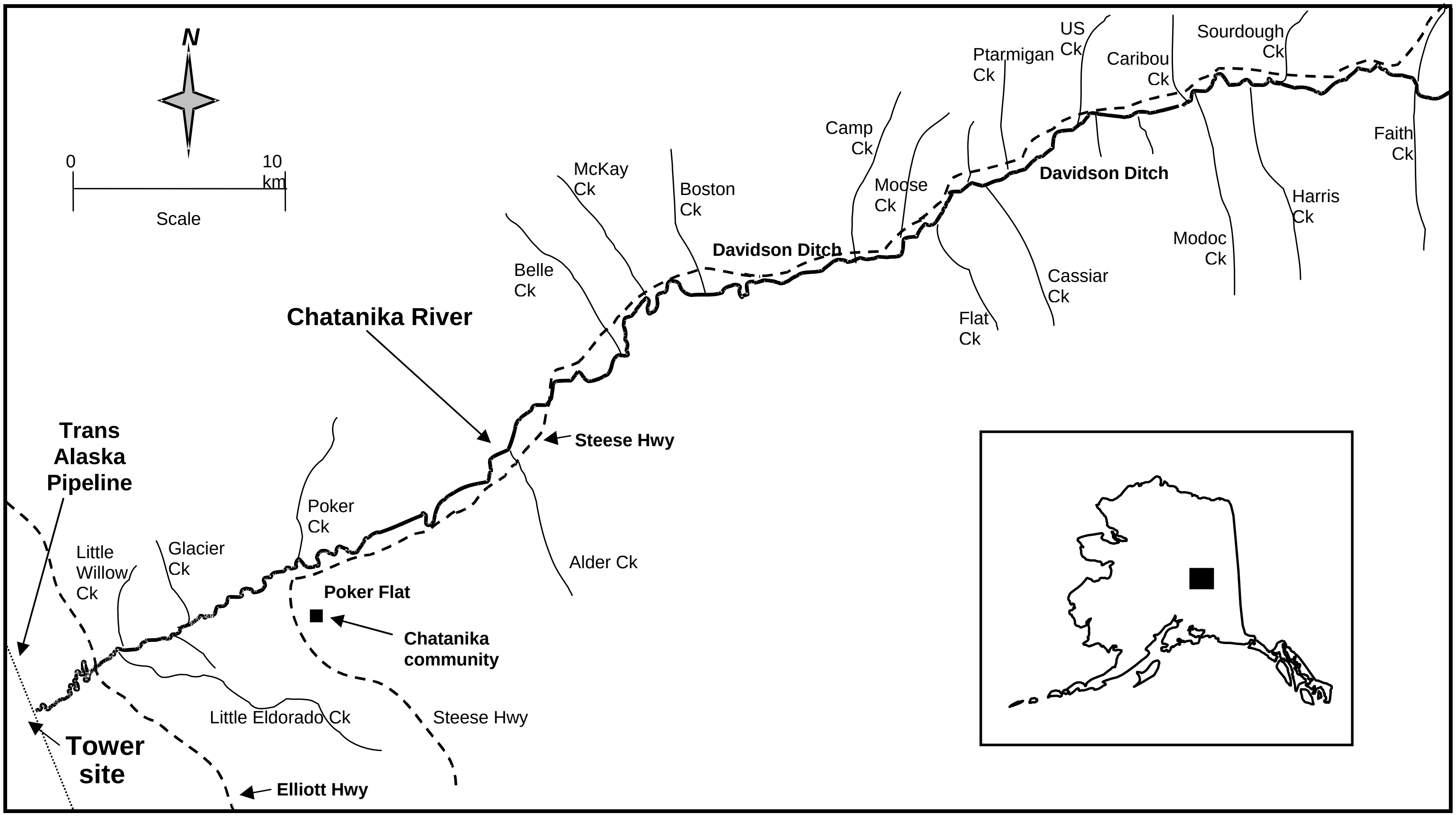

Figure 2.-Chatanika River drainage with location of counting tower site.

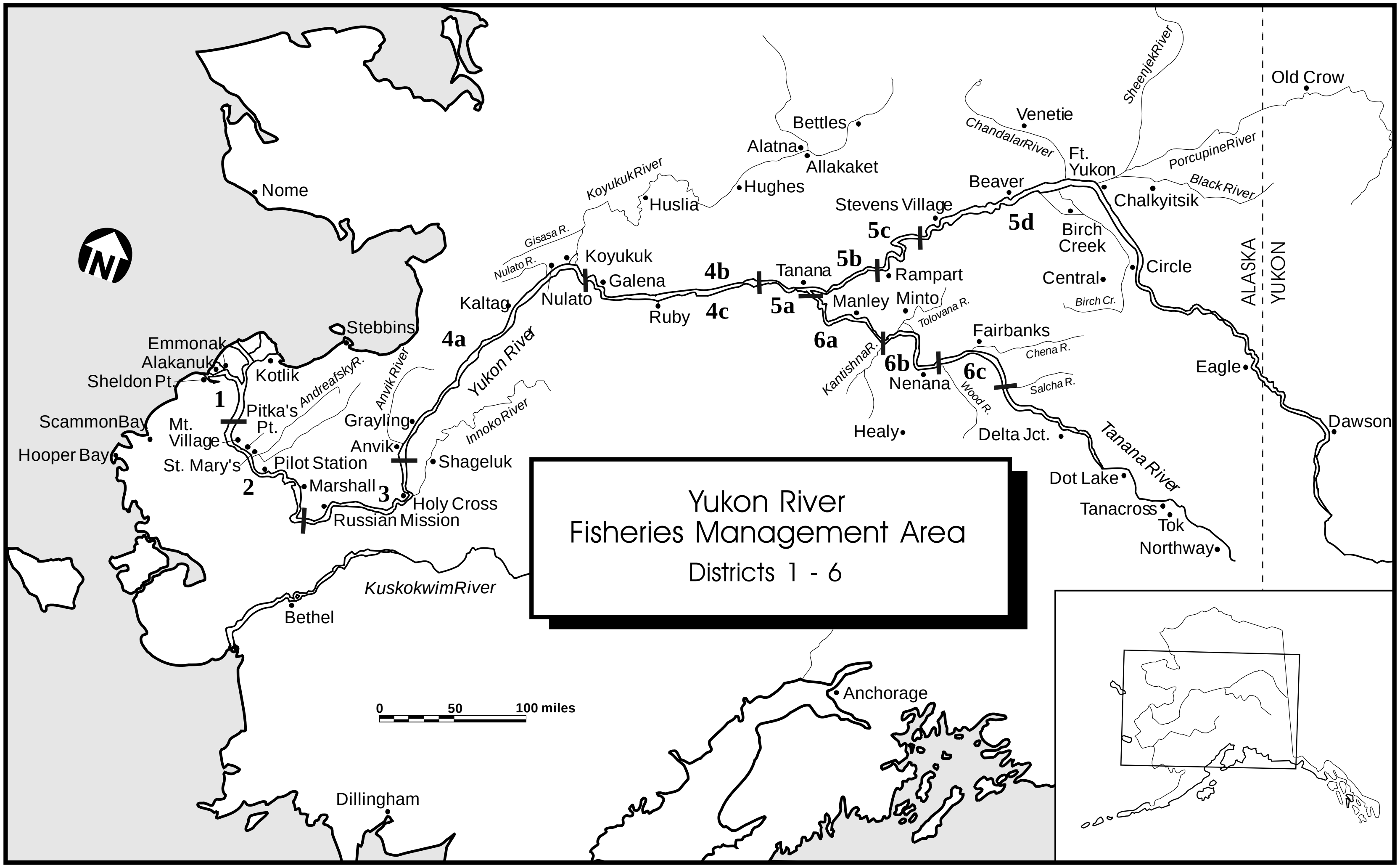

Figure 3.–Commercial fishing districts and subdistricts in the Yukon River drainage.

From 1986 to 1993, Chinook salmon escapements to the Chena and Salcha rivers were estimated using mark-recapture experiments, and monitored with aerial surveys (Barton 1987a, 1988; Barton and Conrad 1989; Evenson 1991, 1992, 1993; Skaugstad 1990b, 1994). These results were used to evaluate management of the commercial, subsistence, personal use, and sport fisheries on Tanana River stocks. However, these methods only provided fishery managers with limited in-season information. Mark-recapture experiments occurred after most of the escapement had passed through the various fisheries. Aerial surveys do not always provide consistent indices of escapement due to varied survey conditions and experience of the observer. Consequently, tower-counts were initiated on the Chena and Salcha rivers in 1993 to provide additional inseason escapement information.

Escapements of Chinook salmon to the Chatanika River prior to 1997 were assessed on a semi-annual basis with aerial surveys from fixed wing aircraft (ADF&G 2002). This methodology was inadequate, as evidenced by harvest estimates that exceeded the escapement counts in some years. A mark-recapture experiment was conducted in 1997 (Stuby and Evenson 1998), but difficulties in capturing adequate numbers of fish precipitated the switch to tower counting beginning in 1998.

In 1992, ADF&G established an aerial survey escapement goal of 1,700 Chinook salmon for the Chena River. Using counts from aerial surveys and mark recapture and tower-count abundance estimates, the escapement goal for aerial surveys was expanded into actual abundance (Evenson 1996). This expansion equated to a minimum escapement objective of 6,300 fish. In 1987 the Alaska Board of Fisheries (BOF) established a sport harvest guideline of 300 to 600 Chinook salmon for the Chena River.

In January of 2001, the BOF adopted the ADF&G recommended biological escapement goal (BEG) range of 2,800 to 5,700 Chinook salmon for the Chena River. The BEG was developed using a spawner-recruit model which incorporated past mark-recapture and tower-count escapement values, harvest estimates, and stock composition data from escapements and harvest (Evenson 2002). Also in January 2001, an escapement-based management strategy replaced the interim management strategy of using a guideline sport harvest level. The department was directed to manage the fisheries to achieve the BEG range (Doxey *In prep*). Neither escapement goals nor harvest management plans have been established for the Chatanika River salmon stocks.

Summer chum salmon *Oncorhynchus keta* also return annually to the Chena and Chatanika rivers. Chum salmon migration timing overlaps but is later than that of Chinook salmon. Some chum salmon are taken incidentally in the sport fisheries, primarily by anglers targeting Chinook salmon. Chum salmon escapements are monitored throughout the duration of the Chinook salmon run, but counts are typically terminated prior to the end of the chum salmon run. The incomplete escapement counts are used by ADF&G Commercial Fisheries Division (CFD) for inseason management of commercial and subsistence chum salmon fisheries in the Tanana River. Currently there are no established sport or commercial harvest guidelines or escapement goals for chum salmon in either the Chena or Chatanika rivers.

OBJECTIVES

The research objectives of the Interior Chinook salmon projects in 2002 and 2003 were to:

1. Estimate the total escapement of Chinook salmon in the Chena and Chatanika rivers using tower-counting techniques such that the estimates are within 15% of the actual value 95% of the time;
2. Estimate age and sex composition of the escapement of Chinook salmon in the Chena River by means of a carcass sample such that all estimated proportions are within 5 percentage points of the actual proportions 95% of the time, and the estimated proportion of females in the escapement from either electro-fish sampling or correcting the carcass survey estimate is within 10 percentage points of the actual proportion 95% of the time; and,
3. If the tower-counts become unreliable due to poor viewing conditions and an estimate is required to maintain the integrity of the biological escapement goal analysis program, estimate the total escapement of Chinook salmon in the Chena River such that the estimates are within 25% of the actual value 95% of the time using mark-recapture techniques.

In addition to the objectives there were six tasks:

1. Support a Yukon River Commercial Fisheries Division experiment by collecting length data from all Chinook salmon carcasses sampled for age and sex;
2. Provide logistical support as time and circumstances allow (boat transportation during planned carcass surveys) to researchers from other agencies collecting tissue samples from Chinook salmon for various projects;
3. Count chum salmon from the Chena and Chatanika counting towers;
4. Conduct an aerial count of Chena River Chinook salmon after peak escapement from a helicopter as time and circumstances allow;
5. Count coho salmon in the Delta Clearwater River from a drifting river boat at weekly intervals throughout the run; and,
6. Present results from the Salcha River Chinook salmon counting tower project.

METHODS

Tower-Counts

Daily escapements of Chinook and chum salmon were estimated by visually counting them at fixed intervals as they passed through the Moose Creek Dam on the Chena River (Figure 1), and in front of a scaffold tower located on the bank of the Chatanika River immediately downstream from the Trans-Alaska Pipeline crossing (Figure 2). Little or no spawning occurs downstream from these sites. No harvest of salmon is allowed upstream from the dam on the Chena River, so completed estimates from tower-counts represent total escapement. Most sport fishing for Chatanika River salmon occurs upstream from the tower, so complete tower-count estimates represent the total inriver return for the Chatanika River.

Technicians stood on the deck of the dam looking down at the salmon in the Chena River, and sat on a platform atop the scaffold tower looking down and across the Chatanika River. Passing fish were highlighted by an array of white fabric panels placed across the bottom of the rivers from bank to bank adjacent to the counting platforms. A string of lights suspended over the panels provided supplemental illumination during periods of low ambient light. When the lights were switched on, they remained on until salmon crossing the panels could be seen with existing ambient light, ensuring that salmon passed over the panels at the same rate during counting and non-counting periods.

The start and duration of the counting portion of the project was somewhat flexibly scheduled to begin prior to the arrival of the Chinook salmon in late June and continue through the anticipated end of the run in late July or early August.

Sampling Design

A stratified systematic sampling design was used to estimate daily passage of Chinook and chum salmon. Personnel were assigned to 8-h shifts in which salmon were counted for only the first 20 minutes of each hour. Counts were limited to 20 minutes to alleviate eyestrain and fatigue. The width of the Chena River made it possible for fish to pass unseen by a single observer, so the river was bisected by placing a red strip across the panels near the center of the channel, and 10 minute counts were conducted on each side. The count on the left side of the river (facing upstream) began within the first 10 minutes of the hour, and the count of the right side immediately followed. In contrast, the Chatanika River channel was sufficiently narrow to permit a single 20-min count over the entire width. A week consisted of 21 possible 8-h shifts (three shifts per day). Shift I started at 2400 hours and ended at 0759 hours; shift II started at 0800 hours and ended at 1559 hours; and, shift III started at 1600 hours and ended at 2359 hours.

Four fisheries technicians were assigned to count on the Chena River, and 20 out of 21 possible 8-h shifts were scheduled each week. Three fisheries technicians were assigned to count on the Chatanika River and 15 out of the 21 possible 8-h shifts were scheduled each week.

The total number of fish passing over the panels during any single 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 were not counted. If 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 Chinook salmon abundance for the Chena River were stratified by day. Daily estimates of abundance were considered a two-stage direct expansion where the first stage was the 8-h shifts within a day and the second stage was the 10 min counting periods within a shift. The second stage was considered systematic sampling because the 10 min counting periods were not chosen randomly. The formulas (1-10) in this section for parameter estimates and variances necessary to calculate escapement from counting tower data were taken directly or modified from those provided in Cochran (1977). The expanded shift passage on day *d* and shift *i* 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:

$$\bar{Y}_d = \frac{\sum_{i=1}^{h_d} Y_{di}}{h_d}. \quad (2)$$

The expanded daily passage was:

$$\hat{N}_d = \bar{Y}_d H_d. \quad (3)$$

The period sampled was systematic, because a period was sampled every hour in a shift. The sample variance associated with periods was approximated using the successive difference approach:

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

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

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

The variance for the expanded daily passage was estimated by:

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

where:

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

$$f_{2di} = \frac{m_{di}}{M_{di}} \quad (8)$$

and,

d = day;

i = 8-h shift;

j = 10-min (Chena) or 20-min (Chatanika) counting period;

y_{dij} = observed 20-min period count (Chatanika) or sum of 10-min period counts (Chena);

Y_{di} = expanded shift passage;

m_{di} = number of 10-min or 20-min counting periods sampled;

M_{di} = total number of possible 10-min or 20-min counting periods;

h_d = number of 8-h shifts sampled;

H_d = total number of possible 8-h shifts; and,

D = total number of possible days.

Passage for the entire run and variance was estimated by:

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

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

For the Chena River, the daily-expanded shift passage and the associated variance were calculated using data from 10 min counting periods after summing counts within periods from each side of the river to arrive at a total estimate for the river. For the Chatanika River, the same estimator and variance equations were used except that data from the 20 min counting periods were used. Equation 5, the sample variance across shifts, required data from more than one shift per day. In the event that water conditions and/or personnel constraints did not permit at least two shifts during a day, a coefficient of variation (*CV*) was calculated for each river and species using all days when more than one shift was worked. The average *CV* for each river and species was then used to approximate the daily variation for those days when fewer than two shifts were worked. The coefficient of variation was used because it is independent of the magnitude of the estimate and is relatively constant throughout the run (Evenson 1995). The daily *CV* was calculated for each river and species as:

$$CV = \sqrt{s_{1d}^2} \Big/ \hat{N}_d \text{ .} \quad (11)$$

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

$$\hat{N}_i = \frac{\sum_{j=i-k}^{i+k} I(day\, j \text{ } was\, sampled)\hat{N}_j}{\sum_{j=i-k}^{i+k} I(day \text{ } j\, was\, sampled)} \quad (12)$$

where:

$$I(\cdot) = \begin{cases} 1 & when\, the\, condition\, is\, true \\ 0 & otherwise \end{cases} \quad (13)$$

was an indicator function.

The moving average procedure was only applied for data gaps of 4 days (12 consecutive shifts) or less. Other procedures, described below, were used for estimating Chinook salmon escapement when significant data losses occurred due to adverse viewing conditions or other factors beyond our control.

The approximation of the daily variation for missed days was the maximum variance of the *k* days before and the *k* days after the missed day *i*.

Mark-Recapture Experiment

In 2002, heavy rain and subsequent high water for 15 days during the peak Chinook salmon passage dates precluded obtaining a complete abundance estimate from the Chena River counting tower. Therefore, a two-sample mark-recapture experiment was conducted to develop an estimate of total Chinook salmon escapement.

Marking Event

A river boat equipped for electrofishing as described in Clark (1985) was used to capture adult Chinook salmon. The approximately 80 km reach of the Chena River where the majority of the Chinook salmon spawning occurs was divided into two sections that were roughly equal in length. The first section began at the Chena River dam and spanned river km 72 – 115; the second section spanned river km 116 –150. The boundary between the two sections was a substantial logjam located between Grange Hall Road and the South Fork Chena River (Figure 1).

The marking event was timed to correspond with the short period after completion of Chinook salmon immigration and spawning and before the fish began to die. Fish were marked during two complete passes through the study section. The first pass occurred during 23 – 26 July, and the second during 30 July – 2 August. All fish were individually tagged with a uniquely numbered jaw tag and measured to the nearest 5 mm from mid-eye to fork of the tail (MEF). In addition to the jaw tag, a secondary fin clip was applied which varied according to the week and river section of tagging. Sex was determined for all captured fish from external characteristics and when possible was verified by partially extruding gametes.

Recapture Event/2002 Carcass Survey

After the marking events, carcasses were collected and inspected for tags and fin clips during two complete surveys of the study area. The first pass occurred during 5 – 9 August, and the second during 12 – 14 August, after which few additional carcasses were available. Areas of recapture were noted for later examination of movement from the tagging areas. Presence of tags and/or missing fins was recorded, sex and length were recorded, and three scales were removed from each carcass and placed directly on gum cards to be aged at a later date.

Estimation of Abundance

The experiment was designed to estimate the abundance of Chinook salmon escaping to spawn in the Chena River using two-sample mark-recapture techniques for a closed population. For the estimate of abundance to be unbiased, certain assumptions must be met (Seber 1982). These assumptions, expressed in the circumstances of this study, along with their respective design considerations and test procedures will be that:

Assumption I: The population is closed to births, deaths, immigration and emigration.

This assumption might have been violated because carcasses may have drifted out of the study area. However, we assumed that marked and unmarked fish were removed from the study area at the same rate. Thus, provided there was no immigration of fish between events, the estimate is unbiased with respect to the time and area of the first event. First event sampling occurred when virtually all of the fish had returned to spawn, and any immigration of Chinook salmon into the study area after the marking event was assumed to be negligible.

Assumption II: Marking and handling did not affect the catchability of Chinook salmon in the second event.

There is no explicit test for this assumption because the behavior of unhandled fish could not be observed. The experiment was designed to mark live fish and examine fish for tags after they have died. Therefore, provided marked fish died at the same rate and in the same places as unmarked fish (i.e., handling did not make them more or less vulnerable to being collected as a carcass), this assumption was met.

Assumption III: Tagged fish did not lose their tags between the two sampling events.

Jaw tags attached to the maxillary are persistent marks, in that they remain attached to the fish and are identifiable even when carcasses are in moderate stages of decomposition. Secondary marks (fin clips) allowed sampling personnel to determine if a fish was marked, if a jaw scar was detected that may indicate a lost primary mark.

Assumption IV: One of the following three conditions needed to be met:

(1) All Chinook salmon had the same probability of being caught in the first event;

(2) All Chinook salmon had the same probability of being captured in the second event; or,

(3) Marked fish mixed completely with unmarked fish between samples.

Chinook salmon were captured and tagged after virtually the entire run had entered the study area. Tags were implanted in all Chinook salmon captured during the first event, and electrofishing ensured non-zero probability of capture for all sizes of Chinook salmon in the river. All possible holding water that was accessible or approachable by boat was sampled during the first event. Carcass sampling can, under certain conditions, favor sampling of larger fish, as smaller fish are more prone to drift out of the study area or may not be as easy to detect during sampling.

Equal probability of capture was evaluated by size, sex, time, and area. The procedures used to analyze sex and length data for statistical bias due to gear selectivity are described in Appendix B1. To further evaluate the three conditions of this assumption, contingency table analyses recommended by Seber (1982) and described in Appendix B2 were used to detect significant temporal or geographic violations of assumptions of equal probability of capture.

Estimator

Stratification by gender was necessary to estimate abundance. The partially stratified estimator (Darroch 1961) was selected to estimate abundance for both males and females.

Age-Sex-Length Compositions

During the mark-recapture experiment in 2002, age, sex, and length data were collected from all marked fish (captured by electrofishing during 23 July – 2 August) and from carcasses collected during the recapture event (5 – 14 August).

Because estimated escapement was derived from tower counts in 2003, a standard carcass survey was conducted during the period 6 – 14 August. Collection method, area surveyed, sampling and ageing technique were identical to the methodology described for the 2002 recapture event previously described in this report (except that fish were not examined for marks) and as described in Doxey (2004).

The abundance estimates were apportioned by gender prior to estimating age class abundance within each sex.

In 2002, sex ratio was based on the separate estimates of abundance (derived from the mark-recapture experiment) of the number of males and females in the escapement.

In 2003, the estimates of the proportions of females and males within the estimated Chena River escapement abundance were based on the carcass survey and adjusted by an electrofishing correction factor. In that case the initial estimated proportions of males and females from carcass surveys were (Cochran 1977):

$$\hat{p}_{sc} = \frac{y_{sc}}{n_c}; \qquad (11)$$

with variance:

$$\hat{V}[\hat{p}_{sc}] = \frac{\hat{p}_{sc}(1 - \hat{p}_{sc})}{n_c - 1}; \qquad (12)$$

where y_{sc} is the number of salmon of sex s sampled during carcass surveys and n_c is the total number of salmon of either sex sampled during carcass surveys for $s = m$ or f.

Biased estimates of sex composition have been noted during previous carcass sampling events when sex ratios of Chinook salmon collected during carcass surveys were compared with those collected by electrofishing (Stuby 2000). Therefore, when the estimated proportion of females in the escapement is based on data collected during a carcass survey, that proportion is corrected to an electrofishing "standard". The correction factor was developed using data from multiple years when paired data sets were collected using both electrofishing and carcass sampling from the same escapement, as described in Stuby (2001) and Doxey (2004).

The estimate of the proportion of females observable during electro-fishing, $\tilde{p}_{fe}$, and its variance (Goodman 1960) were:

$$\tilde{p}_{fe} = \hat{p}_{fc} R_p \text{ and } \hat{V}(\tilde{p}_{fe}) = \hat{p}_{fc}^2 \hat{V}(R_p) + R_p^2 \hat{V}(\hat{p}_{fc}) - \hat{V}(R_p)\hat{V}(\hat{p}_{fc}) \qquad (13)$$

where carcass survey parameters, $\hat{p}_{fc}$ and $\hat{V}(\hat{p}_{fc})$ were estimated as in Equations (11) and (12). Confidence intervals for $\tilde{p}_{fe}$ were constructed by using a Students t-value with seven degrees of freedom. It follows that the estimate and variance of the proportion of males observable during electrofishing are $\tilde{p}_{me} = 1. - \tilde{p}_{fe}$ and $\hat{V}(\tilde{p}_{me}) = \hat{V}(\tilde{p}_{fe})$.

The correction factor necessary to adjust estimates of the proportion of females in the Chena River escapement from carcass surveys in years when no electrofishing is conducted is R_p = 0.76153 with $\hat{V}(R_p)$ = 0.00754092.

In 2002, age composition of live male and female Chinook salmon sampled during electrofishing was used to apportion the estimated abundances of males and females into age classes. Age composition of sampled carcasses was virtually identical to the electrofished sample. In 2003, age composition was developed from the standard carcass survey.

In both 2002 and 2003 the proportion of males and females in each age class within the population of sampled live fish or carcasses was calculated as:

$$\hat{p}_k = \frac{y_k}{n} \tag{14}$$

where: $\hat{p}_k =$ the estimated proportion of Chinook salmon that are age k; y_k = the number of Chinook salmon sampled that are age k; and, n = the total number of Chinook salmon sampled.

The variance of this proportion was estimated as:

$$\hat{V}[\hat{p}_k] = \frac{\hat{p}_k(1-\hat{p}_k)}{n-1}. \tag{15}$$

Abundance of age class k was estimated by:

$$\hat{N}_k = \hat{p}_k \hat{N}. \tag{16}$$

The variance for $\hat{N}_k$ was provided by Goodman (1960):

$$Var(\hat{N}_k) = Var(\hat{p}_k)\hat{N}^2 + Var(\hat{N})\hat{p}_k^2 - Var([\hat{p}_k])Var(\hat{N}). \tag{17}$$

Aerial Counts

In both 2002 and 2003, aerial survey counts of Chinook salmon in the Chena River were attempted by CFD staff after peak escapement had passed the dam. Barton (1987b) described the methods used for this survey. The daily tower counts of Chinook salmon and weather conditions were considered when determining the optimum day for the survey. Due to turbid river conditions, there were no optimum days in mid-to late July. The count was made from a low flying, fixed-wing aircraft. The proportion of the total estimated escapement counted by the aerial survey was calculated.

RESULTS

2002 Chena River Chinook Salmon Abundance

In 2002, Chinook salmon were first observed and counted (Day 1 of the run) on 29 June (Table 2). By the end of Day 5 (July 3) an estimated 342 Chinook salmon had passed the counting tower. Counts were suspended after Day 5 for 11 days due to flooding. On Day 17 (15 July), counts resumed but were hampered by turbidity. Counts continued intermittently until Day 28 of the run (26 July), by which time the run was ending. Complete counts were only accomplished during 10 of the 28 days of the run, and the peak of the run was not included. The decision was made to proceed with a mark-recapture experiment to estimate escapement abundance, and mobilization began toward that task.

Table 2.–Daily Chinook salmon passage at the Chena River counting site, 2002. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Day of Run	Number of 10 min Counts/Side	Left Side Number Counted	Left Side Estimated Passage	Left Side SE	Right Side Number Counted	Right Side Estimated Passage	Right Side SE	Total Number Counted	Total Estimated Passage	Total SE
27-Jun-02		16	0	0	0	0	0	0	0	0	0
28-Jun-02		16	0	0	0	0	0	0	0	0	0
29-Jun-02	1	8	0	0	0	1	18	N/A	1	18	N/A
30-Jun-02	2	16	0	0	0	0	0	0	0	0	0
01-Jul-02	3	24	15	90	50	3	18	10	18	108	51
02 Jul-02	4	24	9	54	23	4	24	14	13	78	27
03-Jul-02	5	24	19	114	29	4	24	11	23	138	31
04-Jul-02	6	1	0	0	N/A	1	144		1	144	N/A
05-Jul-02	7	0									
06-Jul-02	8	0									
07-Jul-02	9	0									
08-Jul-02	10	0									
09-Jul-02	11	0									
10-Jul-02	12	0									
11-Jul-02	13	0									
12-Jul-02	14	0									
13-Jul-02	15	0									
14-Jul-02	16	0									
15-Jul-02	17	12	6	54	43	7	63	20	13	117	47
16-Jul-02	18	15	23	222	54	13	84	24	36	306	59
17-Jul-02	19	24	28	168	48	44	264	30	72	432	57
18-Jul-02	20	24	37	222	49	16	96	21	53	318	53
19-Jul-02	21	24	32	192	37	19	114	35	51	306	50
20-Jul-02	22	16	18	162	38	21	189	115	39	351	121
21-Jul-02	23	16	0	135	42	5	45	23	20	180	48
22-Jul-02	24	0									
23-Jul-02	25	0									
24-Jul-02	26	24	6	36	14	1	6	6	7	42	15
25-Jul-02	27	24	3	18	10	3	18	13	6	36	17
26-Jul-02	28	0									
Total		308	211	1,467	135	143	1,116	134	354	2,583	190

During the marking event (23 July – 2 August), 634 Chinook salmon were captured, tagged, and released. Before release, each fish was measured, sex was noted, and scales were collected. During the recapture event (5 – 14 August), 493 Chinook salmon carcasses were collected and age, sex, and length data was gathered from each carcass. All carcasses were examined for tags and secondary marks (Table 3). Of the 59 recaptured Chinook salmon, one had lost a jaw tag, but was easily recognized by the secondary clip.

Table 3.-Summary of capture histories of Chinook salmon caught during the mark-recapture experiment in the Chena River, 2002.

Section Tagged	Section Recaptured Upper	Lower	Total Recaptured	Number not Recaptured	Total Marked	Unmarked Carcasses Examined	Total Carcasses Examined
				Total Fish			
Upper	55	0	55	522	526	359	414
Lower	2	2	4	53	108	76	80
Total	-	-	59	575	634	435[a]	494[a]
				Males			
Upper	33	0	33	365	398	204	237
Lower	2	1	3	85	86	37	40
Total	-	-	36	448	484	241	277
				Females			
Upper	22	0	22	106	128	154	176
Lower	0	1	1	21	22	39	40
Total	-	-	23	127	150	193	216

[a] Sex could not be determined for one fish.

The recapture rates for males (0.07) and females (0.15) were significantly different (χ^2 = 8.46, df = 1, P = 0.0036; Table 4) and the ratio of males to females was significantly different between the first and second sampling events (χ^2 = 51.37, df = 1, P < 0.001). Therefore, stratification by gender was necessary to ensure an unbiased abundance estimate and K-S two sample tests were performed for males and females separately to test for significant gear bias by size. Results of the K-S tests indicated that there were no significant differences between the length distributions of marked male Chinook salmon and the recaptured male Chinook salmon obtained during the carcass survey (D = 0.191, P = 0.147; Figure 4), nor were there significant differences between the length distributions of marked male Chinook salmon and all male Chinook salmon sampled during the carcass survey (D = 0.055, P = 0.613). Similar results were found for female Chinook salmon; there were no significant differences between the length distributions of marked female Chinook salmon and the recaptured female Chinook salmon obtained during the carcass survey (D = 0.236, P = 0.166; Figure 5), and there were no significant differences between the length distributions of marked female Chinook salmon and all female Chinook salmon sampled during the carcass survey (D = 0.106, P = 0.263).

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, 2002.

Capture History	Male	Female	Total
Recaptured	36	23	59
Not Recaptured	448	127	575
Total	484	150	634
Recapture Rate	0.07	0.15	0.09

χ^2 = 8.46, df = 1, P = 0.0036

Pr(M)/Pr(F) = 0.47[a]

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

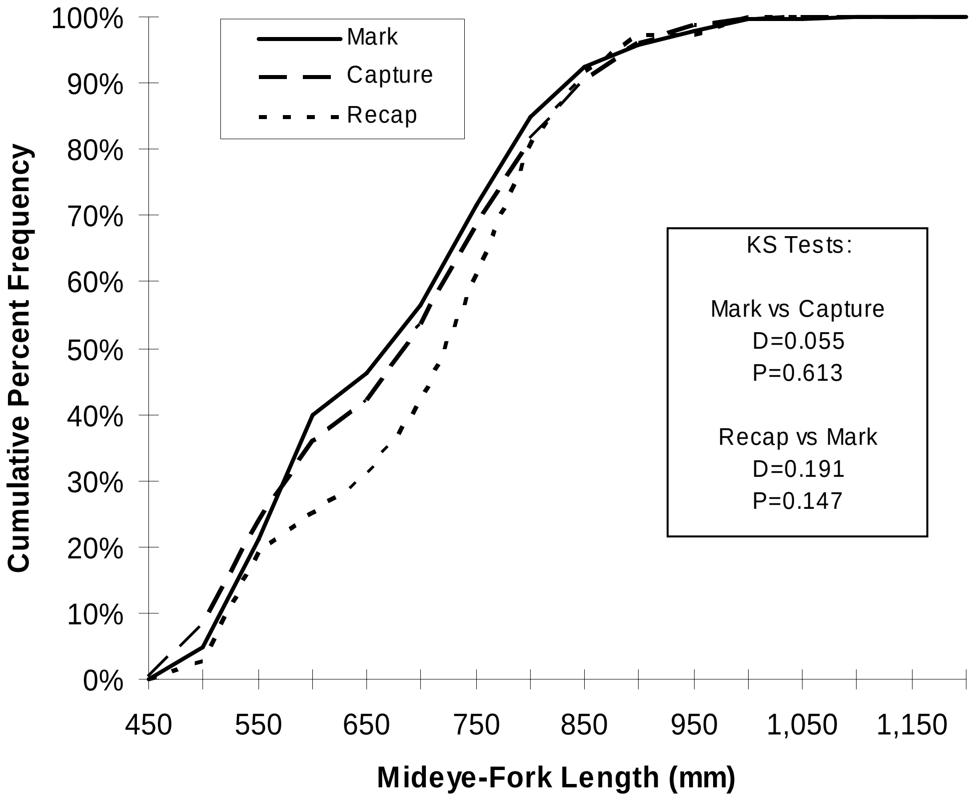

Figure 4.–Cumulative length frequency distributions comparing all male Chinook salmon caught during the first (Mark) and second (Capture) events, and all recaptured (Recap) male Chinook salmon caught during the second event from the mark-recapture experiment in the Chena River, 2002.

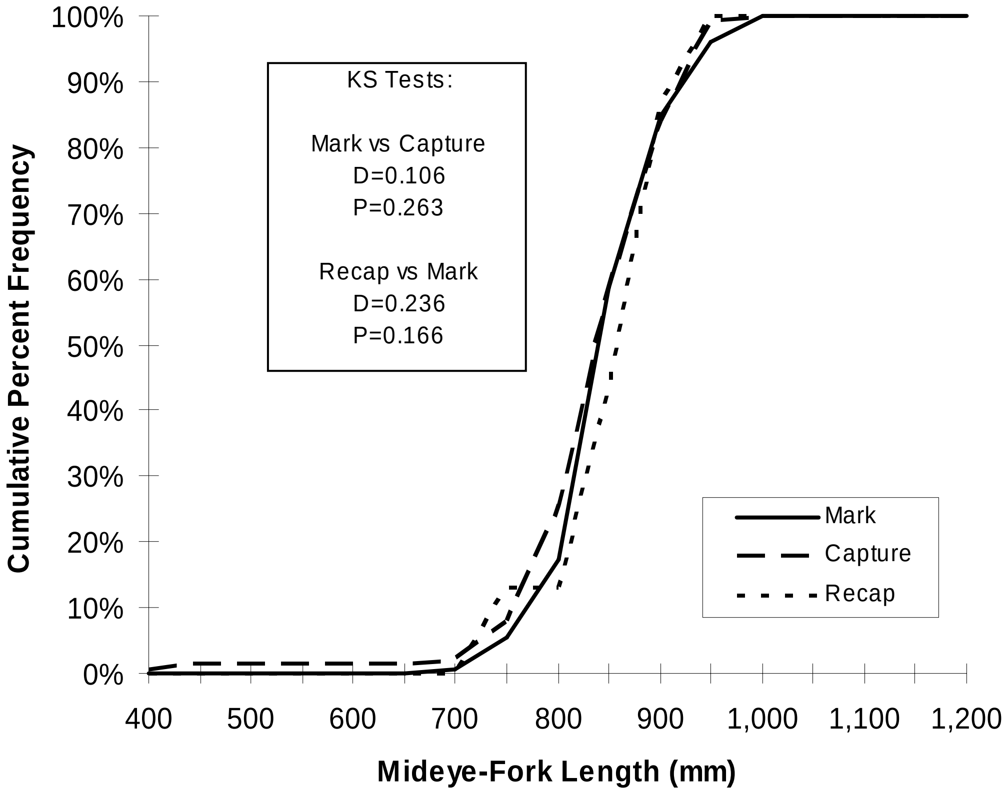

Figure 5.–Cumulative length frequency distributions comparing all female Chinook salmon caught during the first (Mark) and second (Capture) events, and all recaptured (Recap) female Chinook salmon caught during the second event from the mark-recapture experiment in the Chena River, 2002.

Tests of independence between capture probability and capture location for each sampling event, and for complete mixing between sampling events were conducted separately for females and males. For females, the hypothesis of complete mixing was rejected (χ^2 = 9.95, df = 2, P = 0.007; Table 5), the hypothesis of independence between marking location and probability of recapture was not rejected (χ^2 = 2.31, df = 1, P = 0.128; Table 6), and that of independence between second event sampling location and probability of being marked was rejected (χ^2 = 3.43, df = 1, P = 0.064; Table 7). For males, the hypothesis of complete mixing was rejected (χ^2 = 8.07, df = 2, P = 0.018; Table 8), the hypothesis of independence between marking location and probability of recapture was rejected (χ^2 = 5.98, df = 1, P = 0.014; Table 9), and that of independence between second event sampling location and probability of being marked was not rejected (χ^2 = 1.25, df=1, P = 0.264; Table 10). Nominally, these results suggest that Chapman estimators would be appropriate for estimating abundance of both genders. However, the tests are interpreted as suggesting that sampling for females was random during the first event but sampling for males was not, while sampling for males was random during the second event but sampling for females was not. Inspection of the raw data indicates that the directional deviation from the null hypotheses was similar for both genders for both tests. When the tests are conducted on the pooled data, the hypothesis of complete mixing was rejected (χ^2 = 15.17, df = 2, P < 0.001; Table 11), the hypothesis of independence between marking location and probability of recapture was rejected (χ^2 = 8.57, df = 1, P = 0.003; Table 12), and that of independence between second event sampling location and probability of being marked was also rejected (χ^2 = 4.40, df = 1, P = 0.036; Table 13).

While not conclusive, the results of these pooled tests indicate that failure to reject the null hypothesis in the gender specific tests may be due to lack of power. Therefore, we elected to employ a geographically stratified estimator (Darroch 1961) to estimate abundance of both males and females. While this estimator will yield results with less apparent precision, the potential for bias from using the Chapman estimator when inappropriate is avoided. The 2002 estimate of total Chena River Chinook salmon abundance was 6,967 fish (SE=2,466).

Table 5.–Results of a chi-square test that examined the hypothesis of complete mixing of female Chinook salmon between the sampling events in the upper and lower sections of the Chena River, 2002.

Marking Location	Recapture Location: Upper Section	Lower Section	Not Recaptured
Upper Section	22	0	106
Lower Section	0	1	21
	χ^2 = 9.95, df = 2, P = 0.007		

Table 6.–Results of a chi-square test that examined the hypothesis of independence between the marking location and the probability of recapture of female Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Number of Marked Fish	
Marking Location	Captured	Not Recaptured
Upper Section	22	106
Lower Section	1	21
$\chi^2 = 2.31$, df = 1, P = 0.128		

Table 7.–Results of a chi-square test that examined the hypothesis of independence between the recapture event location and the probability of recapture of female Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Recapture Location	
	Upper Section	Lower Section
Marked Fish	22	1
Unmarked Fish	154	39
$\chi^2 = 3.43$, df = 1, P = 0.064		

Table 8.–Results of a chi-square test that examined the hypothesis of complete mixing of male Chinook salmon between the sampling events in the upper and lower sections of the Chena River, 2002.

	Recapture Location		
Marking Location	Upper Section	Lower Section	Not Recovered
Upper Section	33	2	363
Lower Section	0	1	85
$\chi^2 = 8.07$, df = 2, P = 0.018			

Table 9.–Results of a chi-square test that examined the hypothesis of independence between the marking location and the probability of recapture of male Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Number of Marked Fish	
Marking Location	Captured	Not Recaptured
Upper Section	35	363
Lower Section	1	85
$\chi^2 = 5.98$, df = 1, P = 0.014		

Table 10.–Results of a chi-square test that examined the hypothesis of independence between the recapture event location and the probability of recapture of male Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Recapture Location	
	Upper Section	Lower Section
Marked Fish	33	3
Unmarked Fish	204	37
$\chi^2 = 1.25$, df = 1, P = 0.264		

Table 11.–Results of a chi-square test that examined the hypothesis of complete mixing of pooled male and female Chinook salmon between the sampling events in the upper and lower sections of the Chena River, 2002.

	Recapture Location		
Marking Location	Upper Section	Lower Section	Not Recovered
Upper Section	55	2	469
Lower Section	0	2	106
	$\chi^2 = 15.17$, df = 2, P < 0.001		

Table 12.–Results of a chi-square test that examined the hypothesis of independence between the marking location and the probability of recapture of pooled male and female Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Number of Marked Fish	
Marking Location	Captured	Not Recaptured
Upper Section	57	469
Lower Section	2	106
$\chi^2 = 8.57$, df = 1, P = 0.003		

Table 13.–Results of a chi-square test that examined the hypothesis of independence between the recapture event location and the probability of recapture of pooled male and female Chinook salmon in the upper and lower sections of the Chena River, 2002.

	Recapture Location	
	Upper Section	Lower Section
Marked Fish	55	4
Unmarked Fish	358	76
$\chi^2 = 4.40$, df = 1, P = 0.036		

2003 Chena River Chinook Salmon Abundance

In 2003 Chinook salmon were first observed and counted on 26 June. As the run was peaking and rising above the long term average escapement on Day 20 (15 July), flooding brought on by heavy rain forced suspension of counts (Figure 6). The largest expanded daily count of Chinook salmon for the Chena River was 1,416 fish (SE=260) on 11 July. Full 24-hour counts were next completed on 25 and 26 July (Days 30 and 31), after which the counting phase of the project was terminated with the onset of more high water. Passage during those last counts demonstrated that the run was ending. Documented escapement (escapement during days when counting was conducted, with no interpolation for missed counts) was 8,739 (SE=653) Chinook salmon (Table 14). This represents a minimum estimate of escapement.

The calendar date at which 50% of the Chinook salmon escapement passes the Moose Creek Dam on the Chena River has varied from 14 July to 24 July (Day 13 to Day 25) for the 5 years during which total escapement has been estimated using tower counts. The 2003 escapement could not be so assessed or added to the 5-year database because the passage was steady at the apparent peak of the run when the counts were suspended. However, long-term average cumulative passage by Day 20 is 76.52% (Figure 7). If cumulative escapement on that day (8,436 fish) was about 76%, total escapement may be estimated at 11,100 Chinook salmon. In future years this estimate may be refined as more complete sets of escapement counts are combined into the averages.

Chena River Age-Sex-Length (ASL) Compositions

In 2002, the sex ratio was 0.73 male and 0.27 female (Table 15) based on the ratio of the estimated abundance of males (5,063; Table 16) and the estimated abundance of females (1,904; Table 16).

During 2002, a total of 634 salmon were captured during the marking event (23 July – 2 August) and used as the ASL sample. Ages were determined for 87% of that sample. The dominant age classes for males were 1.2, with an abundance of 2,138 (SE=980), 1.3 with an abundance of 1,844 (SE=847), and 1.4 with an abundance of 1,045 (SE=485) Chinook salmon (Table 16). Ages 1.1 (abundance=12, SE=12) and 1.5 (abundance=23, SE=18) were also present. The dominant age class for females was 1.4 with an abundance of 1,526 (SE=699) Chinook salmon. Females at ages 1.3 (abundance=262, SE=130), and 1.5 (abundance=116, SE=64) were also present. The large standard errors are a carry-over from the standard error of the Darroch estimate of total abundance. Mean lengths and length ranges for age classes of males and females are also listed in Table 16.

During the 2003 carcass survey (6 – 14 August), 459 Chinook salmon carcasses were collected and examined. The uncorrected sex composition for this sample, including those fish not aged, was 0.55 males and 0.45 females (Table 17). The average (uncorrected for gender bias) male to female ratio of all sampled fish during 1989-2002 was 0.54 to 0.46 (Table 15). The estimated proportion of females in the 2003 escapement, based on carcass survey data corrected to the electrofishing standard, was 0.34 (SE=0.04; 95% CI = 0.24-0.44).

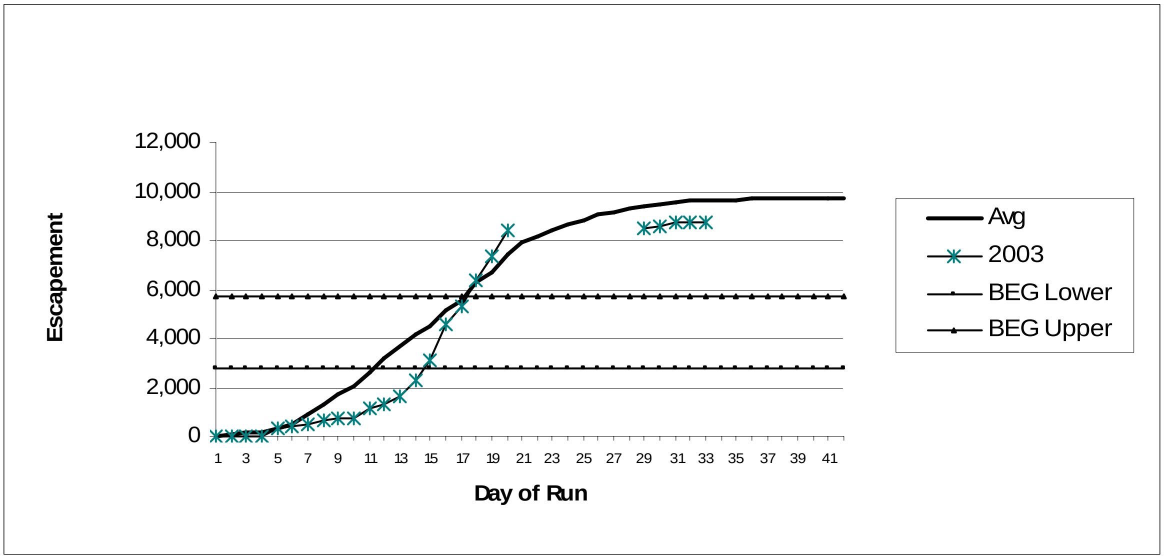

Figure 6.–Cumulative passage by day of run of Chena River Chinook salmon in 2003 compared to the 1993-94, 1997-99 and 2001 average.

Table 14.–Daily Chinook salmon passage at the Chena River counting site, 2003. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

			Left Side			Right Side			Total		
Date	Day Of Run	Number of 10 min Counts/Side	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE
24-Jun-03		7	0	0		0	0		0	0	
25-Jun-03		16	0	0	0	0	0	0	0	0	0
26-Jun-03	1	24	0	0	0	1	6	6	1	6	6
27-Jun-03	2	24	1	6	6	1	6	6	2	12	8
28-Jun-03	3	16	0	0	0	0	0	0	0	0	0
29-Jun-03	4	16	0	0	0	0	0	0	0	0	0
30-Jun-03	5	24	56	336	135	1	6	6	57	342	135
01-Jul-03	6	24	6	36	15	0	0	0	6	36	15
02 Jul-03	7	24	22	132	68	0	0	0	22	132	68
03-Jul-03	8	24	22	132	40	0	0	0	22	132	40
04-Jul-03	9	24	9	54	23	0	0	0	9	54	23
05-Jul-03	10	24	6	54	33	0	0	0	6	54	33
06-Jul-03	11	24	54	324	88	3	18	18	57	342	90
07-Jul-03	12	24	32	192	74	1	6	6	33	198	74
08-Jul-03	13	24	51	306	164	2	12	7	53	318	164
09-Jul-03	14	24	112	672	136	0	0	0	112	672	136
10-Jul-03	15	12	81	747	401	9	81	57	90	828	405
11-Jul-03	16	24	228	1,368	259	8	48	14	236	1,416	260
12-Jul-03	17	24	118	708	158	3	18	9	121	726	159
13-Jul-03	18	24	172	1,032	131	8	48	21	180	1,080	132
14-Jul-03	19	24	162	972	143	7	42	21	169	1,014	144
15-Jul-03	20	18	91	870	204	10	204	17	101	1,074	205
16-Jul-03	21	0									
17-Jul-03	22	0									
18-Jul-03	23	0									
19-Jul-03	24	0									

-continued-

Table 14.–Page 2 of 2.

Date	Day Of Run	Number of 10 min Counts/Side	Left Side			Right Side			Total		
			Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE
20-Jul-03	25	0									
21-Jul-03	26	0									
22-Jul-03	27	0									
23-Jul-03	28	10	1	9		1	36	35	2	45	
24-Jul-03	29	16	7	63	36	1	9	9	8	72	37
25-Jul-03	30	24	23	138	39	1	6	6	24	144	40
26-Jul-03	31	24	5	30	12	2	12	7	7	42	14
27-Jul-03	32	8	0	0		0	0		0	0	
28-Jul-03	33	0									
Total		551	1,239	8,181	648	59	558	81	1,318	8,739	653

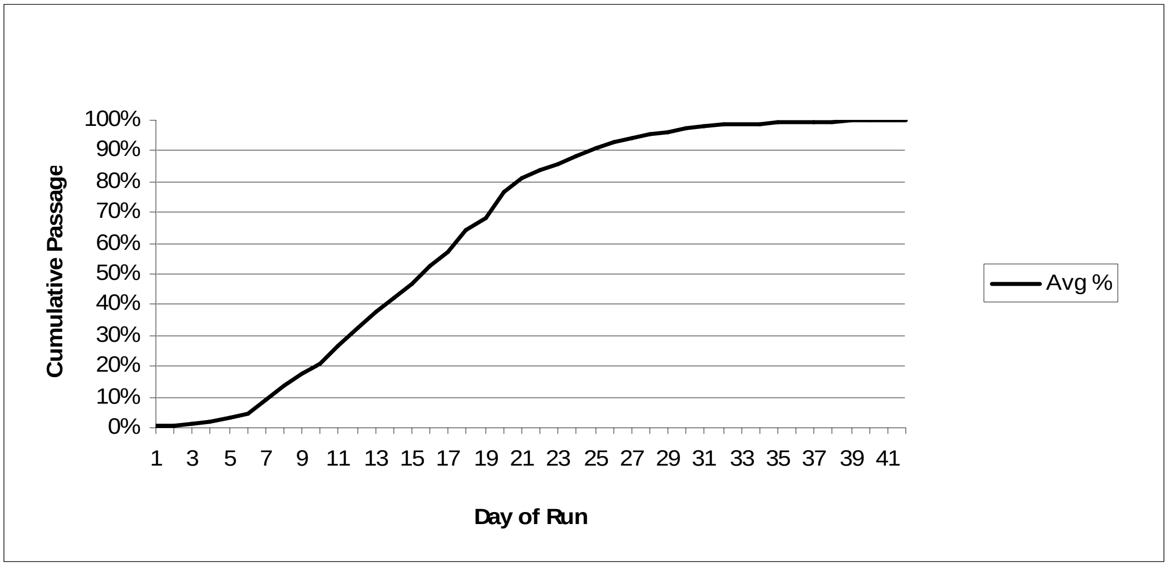

Figure 7.–Average cumulative percent passage by day of run of Chena River Chinook salmon using escapements from 1993-94, 1997-99 and 2001.

Table 15.–Proportions of male and female Chinook salmon sampled from the Chena and Chatanika rivers, 1989-2003.

	Sample Size			Sample Proportion		Corrected Proportion [c]	
Year	Males	Females	Total	Males	Females	Males	Females
Chena River							
1989[a]	119	218	337	0.35	0.65	0.62	0.38
1990[a]	291[b]	258[b]	549[b]	0.53[b]	0.47[b]	0.64	0.36
1991	632[d]	294[d]	926[d]	0.68[d]	0.32[d]	Not Corrected	Not Corrected
1992[a]	369	212	581	0.64	0.36	0.72	0.28
1993[a]	205	38	243	0.84	0.16	0.88	0.12
1994[a]	326	275	601	0.54	0.46	0.65	0.35
1995[a]	305	593	898	0.34	0.66	0.5	0.5
1996[e]	268	346	614	0.44	0.56	0.73	0.27
1997[a]	524	150	674	0.78	0.22	0.83	0.17
1998[a]	160	107	267	0.6	0.4	0.69	0.31
1999[f]	83	75	158	0.52	0.47	Not Corrected	Not Corrected
2000[f]	286	72	358	0.8	0.2	Not Corrected	Not Corrected
2001[a]	342	253	595	0.57	0.43	0.68	0.32
2002 [e]	N/A	N/A	N/A	0.73	0.27	Not Corrected	Not Corrected
2003[a]	253	209	462	0.55	0.45	0.66	0.34
Average 1989-2002	301	222	523	0.57	0.43	0.69	0.31
Chatanika River[g]							
1995[a]	21	49	70	0.3	0.7		
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	0.7	0.3		
2001[a]	20	24	44	0.45	0.55		
2002[a]	15	16	31	0.48	0.52		
Average 1995-2001	58	35	92	0.63	0.37		

a Samples collected during carcass surveys.

b Subsample of total carcasses that were aged were used for M-F proportions.

c Where from carcass surveys, proportions corrected to electrofishing standard for the Chena River.

d Samples from electrofishing and carcasses were pooled to develop M-F proportions.

e Sex ratio developed from estimated abundances of males and females derived from mark-recapture abundance estimate.

f Samples collected during electroshock surveys used for M:F proportions.

g Carcass (ASL) surveys were discontinued in the Chatanika River after 2002

Table 16.–Proportions, estimated abundance, and mean length by age and sex of Chinook salmon sampled during the Chena River mark-recapture abundance estimate, 2002.

	Sample	Estimated			Length			
Age[a]	Size	Proportion	Abundance	SE	Mean	SE	Min	Max
				Male				
1.1	1	0.00	12	12			480	
1.2	182	0.42	2,138	980	553	3	465	695
1.3	157	0.36	1,844	847	719	5	525	950
1.4	89	0.21	1,045	485	827	7	695	1,030
1.5	2	0.02	23	18	1,020	50	970	1,070
Total Aged	431	1.00						
Total Males	484	0.73[b]	5,063	2,307				
				Female				
1.2	0	0.00	0	0				
1.3	18	0.14	262	130	807	15	700	970
1.4	105	0.80	1,526	699	852	5	745	970
1.5	8	0.06	116	64	909	11	870	955
Total Aged	131	1.00						
Total Females	150	0.27[b]	1,904	869				

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents one annulus formed during river residence and four annuli formed during ocean residence for a total age of 6 years).

[b] Estimated proportions were derived from age samples collected during the electrofishing event of the mark-recapture estimate.

Table 17.–Proportions and mean length by age and sex of Chinook salmon sampled during the Chena River carcass survey, 2003.

Age[a]	Sample Size	Sample Proportion	Corrected Abundance	SE	Length Mean	Length SE	Length Min	Length Max
				Male				
1.1	0							
1.2	18	0.09	N/A[d]	N/A[d]	555	12	475	675
1.3	127	0.62	N/A[d]	N/A[d]	748	6	385	905
1.4	49	0.24	N/A[d]	N/A[d]	965	10	705	1,000
1.5	10	0.05	N/A[d]	N/A[d]	927	33	710	1,090
Total Aged	204	1.00						
Total Males[b]	253	0.55						
Corrected Total[c]		0.66	N/A[d]	N/A[d]				
				Female				
1.2	1	0.01	N/A[d]	N/A[d]			500	
1.3	45	0.27	N/A[d]	N/A[d]	803	8	650	890
1.4	105	0.63	N/A[d]	N/A[d]	872	5	740	895
1.5	15	0.09	N/A[d]	N/A[d]	933	7	890	980
Total Aged	166	1.00						
Total Females[b]	206	0.45						
Corrected Total[c]		0.34	N/A[d]	N/A[d]				

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents one annulus formed during river residence and four annuli formed during ocean residence for a total age of 6 years).

[b] Totals include those Chinook salmon which could not be aged. Sample size exceeded criteria for determining sex ratio (384 fish) but did not meet criteria for apportioning age classes (509 aged fish).

[c] Estimated proportion of females was corrected by a factor of 0.7615.

[d] Abundance by gender and age is not estimated because total escapement was not estimated using statistical procedures.

Ages were determined for 81% of the sample collected in 2003. Age class abundances for 2003 were not calculated, but carcass age composition is considered representative of the entire escapement. The dominant age class for males was 1.3 (0.62, Table 17). Ages 1.2 (0.09), 1.4 (0.24) and 1.5 (0.05) were also present. The dominant age class for females was 1.4 (0.63). Females at ages 1.2 (0.01), 1.3 (0.27), and 1.5 (0.15) were also present. Mean lengths and length ranges for age classes of males and females are also listed in Table 17.

Chena River Aerial Survey

Aerial surveys with fixed-wing aircraft were attempted in late July of both 2002 and 2003. Fish visibility was poor due to high water and turbidity. Aerial counts for the 2 years were 181 and 139 Chinook salmon (K. Boeck, Commercial Fish Biologist, ADF&G, Fairbanks; personal communication), representing 0.03 and 0.02 of the abundance estimates. True proportion of the 2003 abundance is even lower, because the abundance estimate derived from the tower count is a minimum. Since 1986, the proportion of the Chinook salmon population observed during aerial surveys has ranged from 0.02 to 0.59 of the tower/mark-recapture estimates and averaged 0.23 (Table 18). Inclusion of the 2002 and 2003 counts within this range and average adds little to the utility of the dataset. Due to poor visibility conditions no aerial survey using a helicopter was attempted.

Chena River Chum Salmon Counts

Chum salmon are counted incidentally to the Chinook salmon counts, and escapement estimates are always incomplete because the Chinook salmon run ends and the counting crew is assigned to the Chinook salmon carcass survey as the chum salmon run is building. During both 2002 and 2003 chum salmon counts were hampered by the high water events and corresponding turbidity (Tables 19 and 20). Documented minimum chum salmon escapement was 1,021 (SE=121) in 2002 and 573 (SE=104) in 2003.

Chatanika River Chinook Salmon Abundance

From 1980 – 1996, abundance of Chinook salmon in the Chatanika River was assessed with aerial or boat-counts (Table 21). In 1997, a mark-recapture experiment was performed. After 1997, escapements were estimated from tower counts.

During 2002 and 2003, counting efforts on the Chatanika River were hampered by the same basin – wide high water events that created difficulties during the counts on the Chena River (Tables 22 and 23).

During 2002, counts were scheduled to begin at the Chatanika River tower on 3 July, but due to high water, a sequence of consecutive days during which all scheduled shifts were completed did not begin until 15 July. Chinook salmon were passing the tower by that date (Table 22). Passage pattern between 15 and 25 July may indicate that the peak of the run occurred during that period. After the flooding of 26 – 31 July, counts were made as conditions allowed or in conformance with the schedule until 8 August to evaluate anecdotal evidence of surges of “late run” Chinook salmon into the Chatanika River. Total documented minimum escapement past the Chatanika River tower in 2002 was 719 (SE=75) Chinook salmon.

Table 18.–Estimated Chinook salmon abundance compared to the highest counts observed during aerial surveys, aerial survey conditions, and the proportion of the population observed during aerial surveys of the Chena River, 1986 - 2003.

Year	Estimated Abundance[a]	SE	Enumeration Method[c]	Aerial Survey Count	Aerial Survey Condition[b]	Proportion of Total Escapement
1986	9,065	1,080	M-R	2,031	Fair	0.22
1987	6,404	557	M-R	1,312	Fair	0.20
1988	3,346[d]	556	M-R	1,966	Fair-Poor	0.59
1989	2,666	249	M-R	1,180	Fair-Good	0.44
1990	5,603	1,164	M-R	1,436	Fair-Poor	0.26
1991	3,025	282	M-R	1,276	Poor	0.42
1992	5,230	478	M-R	825	Fair-Poor	0.16
1993	12,241	387	Tower	2,943	Fair	0.24
1994	11,877	479	Tower	1,570	Fair-Poor	0.13
1995	9,680	958	M-R	3,567	Fair	0.37
1996	7,153	913	M-R	2,233	Poor-Good	0.31
1997	10,811	1,160	M-R	3,495	Fair-Good	0.32
1997	13,390	699	Tower	3,495	Fair-Good	0.26
1998	4,745	503	Tower	386	Incomplete	0.08
1999	6,485	427	Tower	2,412	Fair	0.37
2000	4,694	1,184	M-R	906	Poor - Incomplete	0.19
2001	9,696	565	Tower	1,487	Good	0.15
2002	6,967	2,466	M-R	181	Poor - Incomplete	0.03
2003	8,739[e]	653	Tower	139	Poor - Incomplete	0.02
						Average = 0.23

[a] Details of estimates can be found in 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 (1999-2001), Doxey (2004).

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

[c] Estimate was obtained from either mark-recapture (M-R) or tower-counting (Tower) techniques.

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

[e] Minimum documented abundance with large gaps in counts due to flooding.

Table 19.–Daily chum salmon passage at the Chena River counting site, 2002. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Number of 10 min Counts/Side	Left Side			Right Side			Total		
		Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE
27-Jun-02	16	0	0	0	0	0	0	0	0	0
28-Jun-02	16	0	0	0	0	0	0	0	0	0
29-Jun-02	8	0	0	0	0	0	0	0	0	0
30-Jun-02	16	0	0	0	0	0	0	0	0	0
01-Jul-02	24	0	0	0	0	0	0	0	0	0
02-Jul-02	24	0	0	0	0	0	0	0	0	0
03-Jul-02	24	0	0	0	0	0	0	0	0	0
04-Jul-02	1	0	0	0	0	0	0	0	0	0
05-Jul-02	0									
06-Jul-02	0									
07-Jul-02	0									
08-Jul-02	0									
09-Jul-02	0									
10-Jul-02	0									
11-Jul-02	0									
12-Jul-02	0									
13-Jul-02	0									
14-Jul-02	0									
15-Jul-02	12	2	18	18	0	0	0	2	18	18
16-Jul-02	15	4	39	15	9	62	15	13	100	21
17-Jul-02	24	2	12	8	1	6	4	3	18	9
18-Jul-02	24	2	12	8	5	30	15	7	42	18
19-Jul-02	24	6	36	20	9	54	43	15	90	47
20-Jul-02	16	7	63	32	5	45	24	12	108	40
21-Jul-02	16	9	81	38	12	108	33	21	189	50
22-Jul-02	0									
23-Jul-02	0									
24-Jul-02	24	6	36	14	22	132	55	28	168	57
25-Jul-02	24	10	60	21	38	228	60	48	288	63
Total	308	48	357	65	101	665	103	149	1,021	121

Table 20.–Daily chum salmon passage at the Chena River counting site, 2003. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

	Number of	Left Side			Right Side			Total		
Date	10 min Counts/Side	Number Counte	Estimate Passage	SE	Number Counted	Estimate Passage	SE	Number Counte	Estimated Passage	SE
24-Jun-03	7	0	0	0	0	0	0	0	0	0
25-Jun-03	16	0	0	0	0	0	0	0	0	0
26-Jun-03	24	0	0	0	0	0	0	0	0	0
27-Jun-03	24	0	0	0	0	0	0	0	0	0
28-Jun-03	16	0	0	0	0	0	0	0	0	0
29-Jun-03	16	0	0	0	0	0	0	0	0	0
30-Jun-03	24	0	0	0	0	0	0	0	0	0
01-Jul-03	24	1	6	4	0	0	0	1	6	4
02-Jul-03	24	0	0	0	0	0	0	0	0	0
03-Jul-03	24	0	0	0	0	0	0	0	0	0
04-Jul-03	24	0	0	0	0	0	0	0	0	0
05-Jul-03	24	0	0	0	0	0	0	0	0	0
06-Jul-03	24	0	0	0	0	0	0	0	0	0
07-Jul-03	24	0	0	0	1	6	6	1	6	6
08-Jul-03	24	1	6	6	0	0	0	1	6	6
09-Jul-03	24	0	0	0	0	0	0	0	0	0
10-Jul-03	12	1	6	6	0	0	0	1	6	6
11-Jul-03	24	4	24	11	1	6	4	5	30	12
12-Jul-03	24	7	42	24	1	6	6	8	48	25
13-Jul-03	24	8	48	23	2	12	8	10	60	24
14-Jul-03	24	4	24	12	0	0	0	4	24	12
15-Jul-03	18	11	120	72	1	24	23	12	144	76
16-Jul-03	0									
17-Jul-03	0									
18-Jul-03	0									
19-Jul-03	0									
20-Jul-03	0									
21-Jul-03	0									
22-Jul-03	0									
23-Jul-03	10	1	36	35	1	9	7	2	45	36
24-Jul-03	16	1	9	9	1	9	9	2	18	13
25-Jul-03	24	4	24	14	10	60	22	14	84	26
26-Jul-03	24	4	24	11	12	72	34	16	96	35
27-Jul-03	8	0	0	0	0	0		0	0	0
28-Jul-03	0									
Total	551	47	369	91	30	204	49	77	573	104

Table 21.–Aerial survey, boat and tower counts, and a mark-recapture abundance estimate of Chinook salmon in the Chatanika River, 1980-2003.

Year	Method	Lower[a]	Middle[b]	Upper[c]	Total	Survey Condition
1980	Aerial	NA[d]	NA	NA	37	Fair
1981				No Survey		
1982	Aerial	NA	NA	NA	159	Fair-Good
1983				No Survey		
1984	Aerial	NA	NA	NA	9	Poor
1985				No Survey		
1986	Aerial	NA	NA	NA	79	Fair
1987				No Survey		
1988				No Survey		
1989	Aerial	NA	NA	NA	75	Fair
1990	Aerial	10	46	5	61	Fair-Poor
1991	Aerial	2	84	18	104	Fair
1992	Aerial	NC[e]	78	NC	78[f]	Fair
1993	Aerial	6	46	23	75	Fair
1993	Boat	NC	253	NC	253[f]	Good
1994	Aerial	49	NC	NC	372	Fair
1995	Boat	NC	326	118	444[f]	Fair-Good
1996	Boat	NC	147	51	198[f]	Fair-Good
1997	M-R				3,809	
1998	Tower				864	
1999	Tower				503	
2000	Tower				398[g]	
2001	Tower				964	
2002	Tower				719[g]	
2003	Tower				1,088[g]	

a Lower section extends from the Trans Alaska Pipeline upstream to the Elliott Highway Bridge.

b Middle section extends from the Elliott Highway Bridge upstream to the Steese Highway Bridge.

c Upper section extends from the Steese Highway Bridge upstream to the confluence of Faith and McManus creeks (Figure 4).

d NA = section subtotals are not available.

e NC = no count was conducted during this survey.

f Incomplete survey.

g Incomplete tower estimate.

Table 22.–Daily Chinook and chum salmon passage at the Chatanika River counting site, 2002. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Number of Counts	Chinook Number Counted	Chinook Estimated Passage	Chinook SE	Chum Number Counted	Chum Estimated Passage	Chum SE
03-Jul-02	0						
04-Jul-02	0						
05-Jul-02	0						
06-Jul-02	0						
07-Jul-02	0						
08-Jul-02	0						
09-Jul-02	0						
10-Jul-02	0						
11-Jul-02	8	0	0	N/A[a]	0	0	N/A[a]
12-Jul-02	8	1	9	9	1	9	
13-Jul-02	16	4	18	8	1	5	4
14-Jul-02	10	1	5	4	0	0	0
15-Jul-02	16	2	9	7	1	3	3
16-Jul-02	24	4	12	4	1	5	4
17-Jul-02	24	15	45	16	13	59	37
18-Jul-02	16	9	41	26	3	14	10
19-Jul-02	16	23	104	42	3	14	9
20-Jul-02	16	6	27	11	3	14	10
21-Jul-02	14	3	20	21	1	6	6
22-Jul-02	16	4	18	17	1	5	4
23-Jul-02	23	44	133	24	3	9	8
24-Jul-02	12	8	59	23	7	59	30
25-Jul-02	16	9	41	14	34	153	49
26-Jul-02	4	0	0		4	72	
27-Jul-02	0						
28-Jul-02	0						
29-Jul-02	0						
30-Jul-02	0						
31-Jul-02	0						
01-Aug-02	18	6	18	5	3	18	12
02-Aug-02	23	16	52	12	4	12	6
03-Aug-02	13	4	18	15	0	0	0
04-Aug-02	16	2	9	15	1	5	4
05-Aug-02	8	6	54	N/A[a]	28	252	N/A[a]
06-Aug-02	3	2	48	N/A[a]	8	192	N/A[a]
07-Aug-02	4	-1	-18	N/A[a]	0	0	N/A[a]
08-Aug-02	8	0	0	N/A[a]	14	63	N/A[a]
Total	332	168	719	75	134	965	72

[a] N/A – Standard errors are not calculated for days in which only one shift or less than one shift are staffed.

Table 23.–Daily Chinook and chum salmon passage at the Chatanika River counting site, 2003. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Number Of Counts	Chinook Number Counted	Chinook Estimated Passage	Chinook SE	Chum Number Counted	Chum Estimated Passage	Chum SE
30-Jun-03	24	0	0	0	0	0	0
01-Jul-03	24	13	39	24	0	0	0
02-Jul-03	16	2	9	7	0	0	0
03-Jul-03	16	0	0	0	0	0	0
04-Jul-03	16	3	14	10	0	0	0
05-Jul-03	16	9	41	26	0	0	0
06-Jul-03	16	29	131	59	0	0	0
07-Jul-03	16	10	45	23	0	0	0
08-Jul-03	12	5	32	9	0	0	0
09-Jul-03	24	78	234	68	0	0	0
10-Jul-03	16	37	167	54	0	0	0
11-Jul-03	16	13	59	37	0	0	0
12-Jul-03	16	5	23	14	2	9	32
13-Jul-03	19	7	21	9	1	3	7
14-Jul-03	16	24	108	35	0	0	0
15-Jul-03	9	6	122	55	0	0	0
16-Jul-03	0						
17-Jul-03	0						
18-Jul-03	0						
19-Jul-03	0						
20-Jul-03	0						
21-Jul-03	0						
22-Jul-03	15	6	30	16	4	18	273
23-Jul-03	16	4	18	11	2	9	48
24-Jul-03	16	1	5	12	0	0	0
25-Jul-03	24	-5	-15	7	0	0	0
26-Jul-03	16	2	9	13	1	5	17
Total	359	249	1,088	141	10	44	19

In 2003, the first part of the Chatanika River Chinook salmon escapement was well documented. Two surges of Chinook salmon had passed and a third was underway when counts were suspended as a flood event began on 15 July (Table 23). Counts resumed for a few days starting on 22 July. By 27 July, when another high water event began, the run was ending and the project was terminated. Total documented minimum escapement past the Chatanika River Tower in 2003 was 1,088 (SE=141) Chinook salmon.

In 2002 documented minimum escapement of chum salmon was 965 fish (SE=72). A total of 542 of these chum salmon passed during the period 1 – 8 August, while the Chinook counting was essentially in a monitoring status and then was terminated (Table 22).

In 2003 the documented minimum Chatanika River chum salmon escapement was 44 fish (SE=19). Typically chum salmon numbers are building during the period 22 – 26 July. During 2003 when counts were performed during that period, almost no chum salmon passed (Table 23).

Chatanika River Chinook Salmon Age-Sex Composition 2002

In 2002 a total of 31 Chinook salmon carcasses were sampled for sex and age from the Chatanika River. Ages were determined for 74% of the sample (Table 24). The sex ratio of the total sample was 0.48 male and 0.52 female. The average sampled male to female ratio during 1995-2001 was 0.63 males and 0.37 females (Table 9). The majority of males (0.46 of the sample) examined in 2002 were age 1.3. Males age 1.2 (0.23), and 1.4 (0.31) were also sampled. The majority (0.50) of females were age 1.4. Age 1.3 females comprised 0.30 of the sample.

Table 24.–Number and proportions of Chinook salmon by age and sex that were sampled during the Chatanika River carcass survey, 2002.

Age[a]	Sample Size	Proportion
	Male	
1.2	3	0.23
1.3	6	0.46
1.4	4	0.31
1.5	0	0.0
Total Aged	13	
Total Fish [b]	15	0.48
	Female	
1.2	1	0.10
1.3	3	0.30
1.4	5	0.50
1.5	1	0.10
Total Aged	10	
Total Fish[b]	16	0.52

[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.

Difficulties obtaining adequate sample sizes over the years led to the decision to discontinue carcass sampling and ASL data collection on the Chatanika River after 2002.

DISCUSSION

There are two primary goals driving the Chena River Chinook salmon enumeration project. For management purposes, escapement status relative to the BEG (2,800 - 5,700 fish) must be tracked. Inseason documented and projected escapement estimates provide the foundation for in-season management of the Chinook salmon sport fishery in the Chena River and add to the body of information used to manage the subsistence, personal use, and commercial fisheries for Chinook salmon in the Tanana River downstream from the Chena River. For research purposes, the total abundance and age-sex composition information is used to build brood tables that, over time, will be used to refine the BEG.

Anticipated poor Chinook salmon returns to the Yukon drainage in 2002 precipitated a pre-season drainage-wide emergency order (EO) restricting the Chinook salmon sport fishing bag and possession limit to one fish. This had no impact on Tanana drainage fisheries, including the Chena River Chinook salmon fishery, because the existing limit is one fish. In view of run indicators of stronger Chinook salmon returns to the Tanana drainage and to the Chena River, and the fact that the sport fishery completely stopped when the river was at flood stage, no additional conservation actions were undertaken in 2002.

In 2003, the Yukon River Chinook salmon run was generally stronger than expected, and no pre-season actions were contemplated in the Tanana drainage and Chena River. By 11 July (Day 16 of the run), cumulative escapement to the Chena River stood at about 4,500 Chinook salmon and was increasing sharply each day. It was apparent that the upper boundary of the BEG range (5,700) would be exceeded by a substantial margin. An EO was issued raising the sport fishing bag and possession limit to three Chinook salmon for the duration of the fishery. Immediately after the issuance of that EO the river rose and effectively ended sport fishing for Chinook salmon for most of the remaining duration of the run.

Details of management actions may be found in the 2000 – 2002 Fishery Management Report for the Lower Tanana Management Area (Doxey *In prep*).

Estimates of total escapement from tower counts may not always be needed for management of the sport fishery. Even when periods of high, turbid water create breaks in the counts that are too lengthy (several days) to be bridged by interpolated estimates, the cumulative abundance from uninterrupted counts (documented escapement) may be sufficient to evaluate whether the BEG was achieved. If total documented escapement is within or exceeding the BEG range there would be no reason to restrict fisheries.

The estimated escapements in 2002 and 2003 were within the range of previous documented escapements for the Chena River (2,666 - 13,390; Table 8) and in excess of the BEG range (2,800 – 5,700). The escapement estimates and age composition information provide a dataset that will prove useful as part of the long term database for the Chena River. They describe a stock that showed increasing strength in two seasons when the Yukon River Chinook salmon run, as a whole, was generally considered to be weak but slowly recovering from the very poor runs of 1998, 1999 and 2000.

In this report, run timing, proportional escapement, and cumulative escapement on a given day are described by day-of-run instead of by calendar dates (i.e., Day 1 is the day of first passage of a Chinook salmon during a scheduled counting period). Anchoring escapement curves on Day 1 of the run (rather than a range of calendar dates) and aligning cumulative escapement curves by day of run facilitates comparison of passage rates between years and comparisons of proportional passage compared to the long-term average (Figures 6 and 7). It also facilitates inseason escapement projections.

Over time, annual escapement estimates of the Chatanika River Chinook salmon stock may allow for development of an escapement goal for the Chatanika River. While both 2002 and 2003 counts are incomplete and represent only documented minimum escapement, they add to both the range of potential escapements and to a long-term database of run timing information. In past years, sport harvests have occasionally been proportionally high relative to index measures of abundance. Since no escapement goals have been established for this river, continuation of enumeration projects to acquire abundance estimates is important for managing this stock.

Sampling to accurately estimate age-sex compositions of the Chatanika River Chinook salmon stock has been problematic due to small sample sizes and gender bias associated with sampling carcasses. Consequently, no estimates of age or sex-specific abundance derived from the 2002 carcass survey were presented in this report. Because the Chinook salmon run in this river is usually small, and spawning areas are relatively dispersed, sufficiently large samples of carcasses cannot be collected in a cost-effective manner. If brood tables are developed in the future for Chatanika River Chinook salmon, either different age-sex sampling strategies should be investigated, or an evaluation undertaken to determine whether surrogate stocks (such as the Chena or Salcha rivers) can be used to estimate Chatanika River age-sex compositions.

SALCHA RIVER CHINOOK SALMON STUDIES

INTRODUCTION

The Salcha River, like the Chena River, has some of the largest Chinook salmon escapements in the Yukon drainage (Schultz et al. 1994), and supports a popular Chinook salmon sport fishery. ADF&G Sport Fish Division conducted mark-recapture abundance estimates on the Salcha River from 1987 to 1992 (Table 25), then conducted tower-count estimates from 1993 to 1998. After developing evidence that the Chena and Salcha rivers Chinook escapement magnitudes paralleled each other and that Chinook salmon sport fisheries could be adequately managed with escapement data from one of the two rivers, Sport Fish Division discontinued a Chinook salmon abundance estimation project in the Salcha River. Starting in 1999, Bering Sea Fishermen's Association (BSFA) began contracting with a Fairbanks fisheries consultant to conduct tower counts. Funding was provided by a grant administered by the US Fish and Wildlife Service (USFWS). The contractor's infrastructure, counting methodology, and data management is essentially identical to the methods previously used by ADF&G on the Salcha River and presently used on the Chena River. This provides a consistently comparable set of escapement estimates over the years for the Salcha River Chinook stock (within the constraints created by river conditions) and allows continued comparison of Chena and Salcha rivers Chinook salmon escapements. Counts of Salcha River Chinook salmon are provided to ADF&G after each 8-hour shift. Results are presented in this report.

Table 25.–Estimated abundance, highest counts during aerial surveys, aerial survey conditions, and proportion of the population observed during aerial surveys for Chinook salmon escapement in the Salcha River, 1987 - 2003.

	Estimated		Aerial Survey		% of Total
Year	Abundance[a]	SE	Count	Condition[b]	Escapement
1987	4,771[c]	504	1,898	Fair	0.40
1988	4,562[c]	556	2,761	Good	0.61
1989	3,924[c]	630	2,333	Good	0.71
1990	10,728[c]	1,404	3,744	Good	0.35
1991	5,608[c]	664	2,212	Poor	0.39
1992	7,862[c]	975	1,484	Fair-Poor	0.19
1993	10,007[d]	360	3,636	Fair	0.36
1994	18,339[d]	549	11,823	Good	0.64
1995	13,643[d]	471	3,978	Fair-Good	0.29
1996	7,570[c]	1,238	4,866	Fair-Good	0.64
1997	18,514[d]	1,043	3,458	Poor	0.19
1998	5,027[d]	331	1,985	Poor	0.39
1999	9,198[d]	290	3,570	Fair	0.39
2000	4,595[d]	802	2,478	Poor	0.53
2001	13,328[e]	N/A	2,990	Good	N/A
2002	4,644[f]	160	2,416	Fair	N/A
2003	15,942[g]	N/A	N/A	N/A	N/A
					1987-2000 Avg. = 0.43

[a] Details of estimates can be found in Barton (1987a and 1988); Barton and Conrad (1989); Burkholder (1991); Evenson (1991-1993; 1995-1996); Evenson and Stuby (1997), Skaugstad (1988, 1989, 1990a, 1992, 1993, and 1994), Stuby and Evenson (1998), Stuby (1999, 2000, and 2001).

[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] Estimate was obtained from expansion of interrupted tower-count based on day-of-run average proportion (counts effectively ended on Day 19 of run, when 6 year average proportional passage was 67.38%).

[f] Minimum estimate based only on counts when visibility was good or questionable. During the 32 days of the run when the majority of the Chinooks passed, there were no counts on 11 days and visibility precluded complete counts on 7 additional days. Best guess is that escapement was 6,000 – 12,000 Chinook salmon.

[g] Estimate was obtained from expansion of interrupted tower-count based on day-of-run average proportion (counts effectively ended on Day 19 of run, when 6 year average proportional passage was 73.75%).

METHODS

Two towers were erected on opposite sides of the Salcha River approximately 0.25 miles downstream from the Richardson Highway Bridge (Figure 8). Project mobilization, escapement enumeration, and data analysis procedures for Salcha River Chinook and chum salmon were similar to those for the Chena and Chatanika rivers.

RESULTS

During 2002, counts on the Salcha River were conducted when possible from 29 June through the end of the Chinook salmon run in late July. Chinook salmon were observed when counts began on 29 June, indicating that they may have been passing before counts began. However, 29 July was designated as Day 1 of the run (Table 26). Passage was steady at a low level until July 4 (Day 6), when the same rainstorm that caused the flooding at the Chena and Chatanika rivers' Chinook salmon enumeration projects caused a nine-day suspension of the count on the Salcha River. Continuous counts unhindered by turbidity did not resume until the day shift of 15 July (Day 17). Counts began to be hindered by turbidity on 21 July and were suspended or hindered intermittently through 28 July. During Days 1 – 32, the counts were completely suspended for 11 days, and hindered by turbidity during eight days. The gaps and questionable counts during the run-up to the probable peak and after make it extremely difficult to develop a point estimate of abundance. Total documented Chinook salmon escapement was 4,644 fish. It is likely that escapement exceeded the top boundary of the BEG range (6,500), and total escapement was between 6,000 and 12,000 Chinook salmon.

In 2003 counts began on the Salcha River on 24 June. The first Chinook salmon were observed and counted on 25 June. Counts continued uninterrupted until 15 July (Day 20), when a major flood event began (Table 20). Counts resumed briefly on 26 July (Day 31) but were immediately suspended due to high water. By the time the water cleared up in August the Chinook salmon run had ended. Documented minimum escapement was 11,758 fish (SE=647). However, unlike in 2002, continuous counts during Days 1 – 19 allowed a rough projection of total escapement. Based on the 6-year (1993-95 and 1997-1999) day-of-run average proportions (Figure 9), cumulative passage is into the 73rd percentile by Day 20 of the Salcha River Chinook salmon run. Cumulative abundance at day-of-run when counts ended exceeded the long term average (Figure 10) and was indicative of a robust escapement. If 11,758 fish were 73% of total escapement, projected escapement was 15,942 Chinook salmon. The highest expanded daily count of Chinook salmon for the Salcha River was 1,929 fish (SE=403) on Day 15 (10 July; Table 27). The upper boundary of the BEG range (6,500) was exceeded by both the documented minimum escapement and the projected escapement.

Chum salmon were enumerated during and after the Chinook salmon run in both 2002 and 2003. This project documents only the early part of the chum salmon run during the Chinook salmon run, and with the same gaps in count sequences (Tables 26 and 27). Raw count data are available as electronic files described in Appendix A.

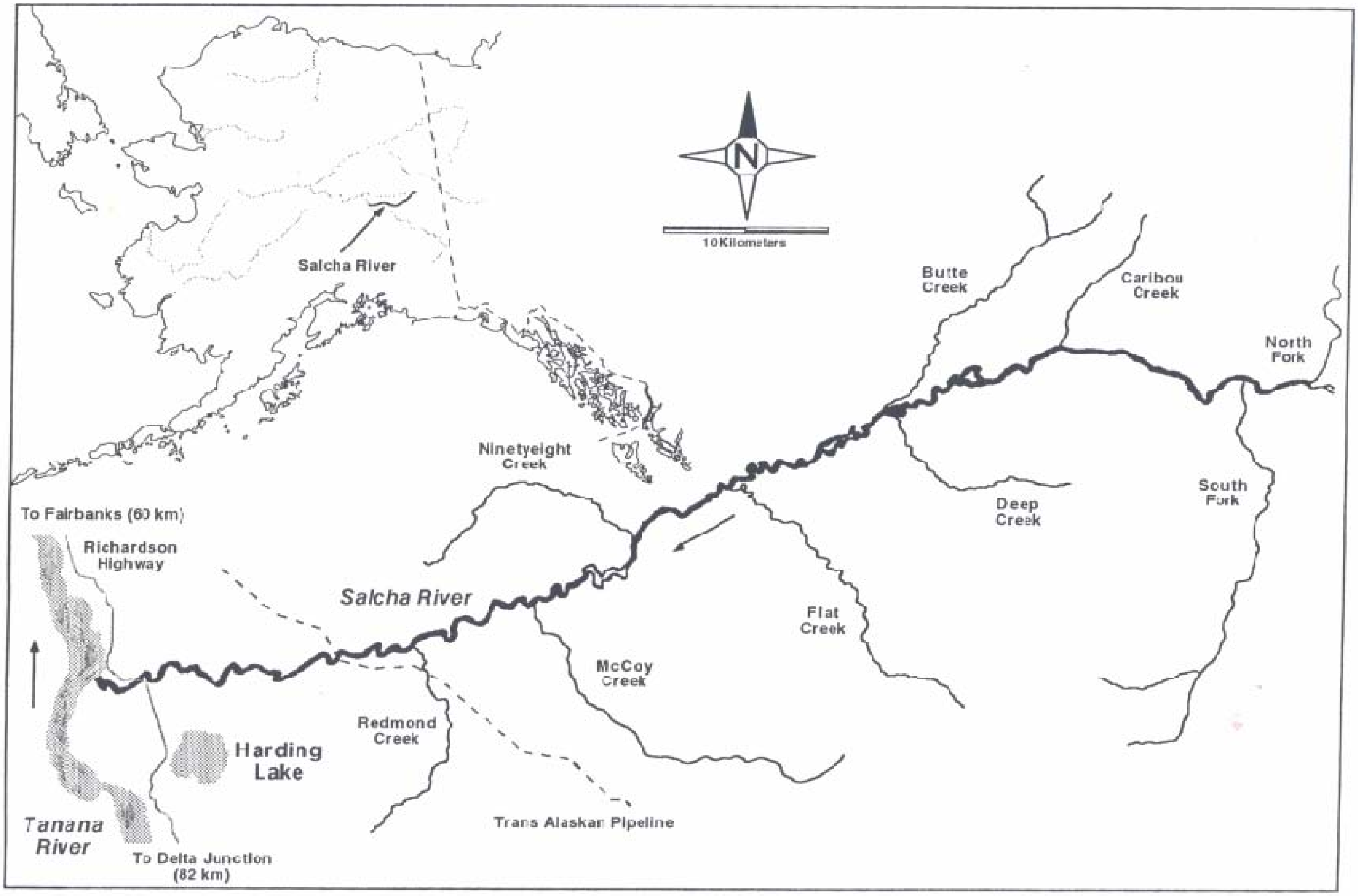

Figure 8.–Salcha River drainage.

Table 26.–Daily Chinook and chum salmon passage at the counting site on the Salcha River, 2002. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Day of Run (Chinook)	Number of Counts	Chinook Salmon			Chum Salmon		
			Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE
29-Jun-02	1[a]	8	1	9	21	0	0	0
30-Jun-02	2	24	22	66	20	0	0	0
01-Jul-02	3	24	52	156	28	0	0	0
02-Jul-02	4	24	41	123	16	0	0	0
03-Jul-02	5	16	28	126	15	0	0	0
04-Jul-02	6							
05-Jul-02	7							
06-Jul-02	8							
07-Jul-02	9							
08-Jul-02	10							
09-Jul-02	11							
10-Jul-02	12							
11-Jul-02	13							
12-Jul-02	14							
13-Jul-02	15	8	7	63	206	0	0	0
14-Jul-02	16	8	4	36	62	0	0	0
15-Jul-02	17	16	71	320	36	1	5	4
16-Jul-02	18	24	106	318	41	16	48	13
17-Jul-02	19	24	161	483	45	44	132	24
18-Jul-02	20	24	133	399	43	16	48	13
19-Jul-02	21	24	224	672	88	12	36	16
20-Jul-02	22	24	146	438	51	14	42	10
21-Jul-02	23	24	84	252	43	12	36	13
22-Jul-02	24					0	0	N/A
23-Jul-02	25	24	68	204	24	152	456	40
24-Jul-02	26	24	156	468	47	240	720	58
25-Jul-02	27	24	104	312	28	317	951	62
26-Jul-02	28	22	40	123	19	213	672	54
27-Jul-02	29					0	0	N/A
28-Jul-02	30	16	10	45	15	146	657	315
29-Jul-02	31	16	4	18	11	262	1179	272
30-Jul-02	32	16	3	14	9	193	869	451
Total		414	1,465	4,644	160	1,638	5,850	624

[a] Day 1 of documented passage. Because a Chinook salmon was seen during the first shift of the project, Day 1 may have occurred earlier.

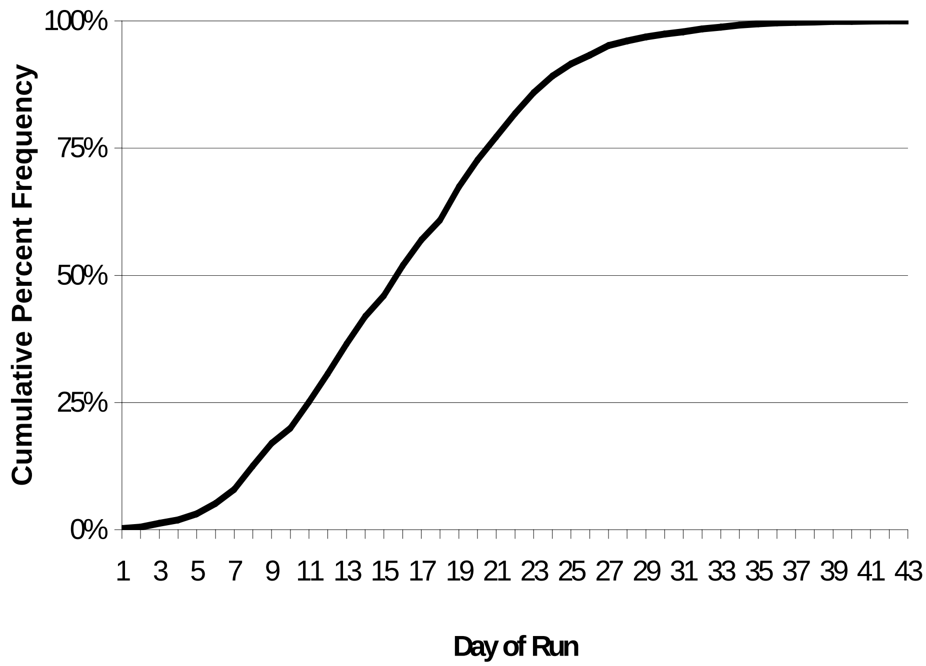

Figure 9.–Average proportional cumulative passage by day of run of Salcha River Chinook salmon, 1993-95, 1997-99. Data for other years is incomplete and not included.

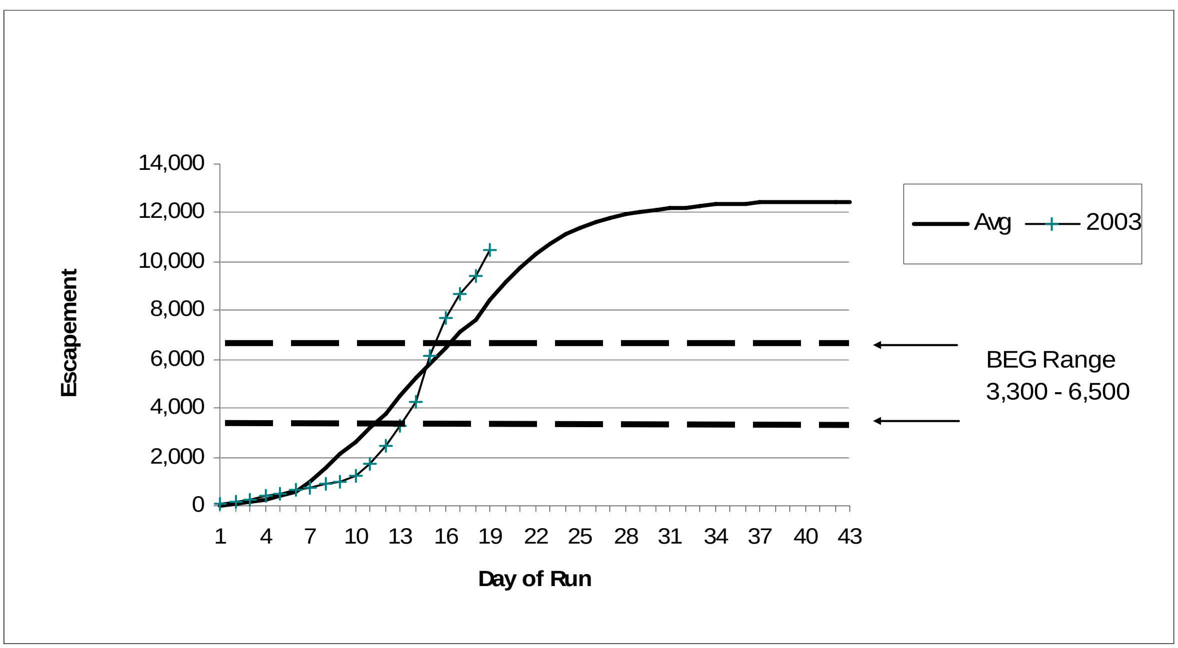

Figure 10.–Expanded cumulative passage by day of run of Salcha River Chinook salmon comparing 2003 with the 1993-95, 1997-99 average.

Table 27.–Daily Chinook and chum salmon passage at the counting site on the Salcha River, 2003. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Day of Run (Chinook)	Number of Counts	Chinook Salmon Number Counted	Chinook Salmon Estimated Passage	Chinook Salmon SE	Chum Salmon Number Counted	Chum Salmon Estimated Passage	Chum Salmon SE
24-Jun-03		8	0	0	0	0	0	0
25-Jun-03		8	0	0	0	0	0	0
26-Jun-03	1	24	14	42	12	0	0	0
27-Jun-03	2	24	50	150	41	0	0	0
28-Jun-03	3	24	10	30	13	0	0	0
29-Jun-03	4	24	52	156	26	0	0	0
30-Jun-03	5	24	38	114	27	0	0	0
01-Jul-03	6	24	55	165	50	0	0	0
02-Jul-03	7	24	33	99	18	0	0	0
03-Jul-03	8	24	53	159	58	0	0	0
04-Jul-03	9	24	14	42	14	0	0	0
05-Jul-03	10	24	97	291	96	0	0	0
06-Jul-03	11	24	170	510	68	0	0	0
07-Jul-03	12	24	221	663	128	0	0	0
08-Jul-03	13	24	290	870	108	0	0	0
09-Jul-03	14	24	315	945	185	1	3	3
10-Jul-03	15	24	643	1,929	403	8	24	8
11-Jul-03	16	24	514	1,542	355	31	93	35
12-Jul-03	17	24	322	966	152	14	42	16
13-Jul-03	18	24	258	774	100	41	123	22
14-Jul-03	19	24	343	1,029	100	72	216	33
15-Jul-03	20	5	89	1,282	NA	27	389	41
16-Jul-03	21	0						
17-Jul-03	22	0						
18-Jul-03	23	0						
19-Jul-03	24	0						
20-Jul-03	25	0						
Total		477	3,581	11,758[a]	647	194	890	56

[a] Minimum documented escapement when counts were terminated due to flooding. Projected total escapement is based on day-of-run proportional passage is 15,492.

Age-Sex-Length Compositions

In 2002 Chinook salmon carcasses were collected along the Salcha River on 29 July and 1, 5, 8 and 12 August. A total of 323 Chinook salmon carcasses were collected (Table 28). The sex composition for this sample, including those fish not aged, was 0.66 males and 0.34 females. The gender bias correction factor, R_p, for the Salcha River has been estimated to be 0.75 (SE=0.19). The estimated proportion of females in the 2002 escapement, based on carcass survey data corrected to the electrofishing standard, was 0.26 (SE=0.07, 95% CI = 0.09 – 0.43). The correction factor for the Salcha River is very imprecise due to large annual variation in selectivity between years.

Ages were determined for 282 (87%) of the fish collected in 2002. The largest age class for males sampled and aged in 2002 was age 1.2 (0.55; Table 28). Males were also represented by ages 1.3 (0.19), 1.4 (0.18) and 1.5 (0.08). Age 1.4 dominated among aged females (0.78; Table 21). Females were also represented by ages 1.3 (0.04) and 1.5 (0.18). Mean lengths and length ranges for age classes of males and females are also listed in Table 28.

During 2003 Chinook salmon carcasses were collected along the Salcha River on 3 August. A total of 166 Chinook salmon carcasses were sampled (Table 29). Sex composition was 0.58 males and 0.42 females. The estimated proportion of females in the 2003 escapement, based on carcass survey data corrected for gender bias was 0.32 (SE=0.09, 95% CI = 0.11 – 0.53).

Ages were determined for 144 fish (87%) of the 2003 sample. Age 1.3 predominated among males (0.60), followed by ages 1.4 (0.24), 1.2 (0.13) and 1.5 (0.02; Table 29). Among females the majority were age 1.4 (0.75; Table 29), followed by ages 1.3 (0.21) and 1.5 (0.04). Mean lengths and length ranges for age classes of males and females are listed in Table 29.

Table 28.–Number sampled, estimated proportions, abundance and mean length by sex and age class of Chinook salmon in the Salcha River, 2002.

	Sample	Sample	Corrected		Length			
Age[b]	Size	Proportion	Abundance	SE	Mean	SE	Min	Max
			Male					
1.1	0							
1.2	102	0.55	N/A[a]	N/A[a]	544	4	460	660
1.3	35	0.19	N/A[a]	N/A[a]	706	11	530	850
1.4	33	0.18	N/A[a]	N/A[a]	872	14	720	1,030
1.5	14	0.08	N/A[a]	N/A[a]	978	17	880	1,070
Total Aged	184	1.00						
Total Males[c]	212	0.66	N/A[a]	N/A[a]				
Corrected Total[d]		0.74	N/A[a]	N/A[a]				
			Female					
1.2	0							
1.3	4	0.04	N/A[a]	N/A[a]	749	29	670	795
1.4	76	0.78	N/A[a]	N/A[a]	865	6	740	970
1.5	18	0.18	N/A[a]	N/A[a]	910	12	820	975
Total Aged	98	1.00						
Total Females[c]	111	0.34	N/A[a]	N/A[a]				
Corrected Total[d]		0.26	N/A[a]	N/A[a]				

[a] Flooding precluded development of a usable abundance estimate.

[b] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents one annulus formed during river residence and four annuli formed during ocean residence).

[c] Totals include those Chinook salmon which could not be aged. Sample size was near criteria for determining sex ratio (384 fish) but did not meet criteria for apportioning age classes (509 fish).

[d] Corrected by a factor of 0.7541 (for females, with correction factor for males following suit) to reduce carcass survey gender bias identified by comparing data collected during carcass surveys and electrofishing.

Table 29.–Number sampled proportions, and mean length by sex and age class of Chinook salmon in the Salcha River, 2003.

Age[b]	Sample Size	Sample Proportion	Corrected Abundance	SE	Length Mean	Length SE	Length Min	Length Max
			Male					
1.1	1	0.01	N/A[a]	N/A[a]			450	
1.2	11	0.13	N/A[a]	N/A[a]	538	24	400	660
1.3	52	0.60	N/A[a]	N/A[a]	753	9	610	1,000
1.4	21	0.24	N/A[a]	N/A[a]	839	18	610	980
1.5	2	0.02	N/A[a]	N/A[a]	925	55	870	980
Total Aged	87	1.00						
Total Males[c]	96	0.58						
Corrected Total[d]		0.68	N/A[a]	N/A[a]				
			Female					
1.2	0							
1.3	12	0.21	N/A[a]	N/A[a]	720	890	790	18
1.4	43	0.75	N/A[a]	N/A[a]	690	980	885	9
1.5	2	0.04	N/A[a]	N/A[a]	720	980	886	25
Total Aged	57	1.00						
Total Females[c]	70	0.42						
Corrected Total[d]		0.32	N/A[a]					

[a] Abundance by gender and age is not estimated because total escapement was not estimated using statistical procedures

[b] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents one annulus formed during river residence and four annuli formed during ocean residence).

[c] Totals include those Chinook salmon which could not be aged. Sample size did not meet criteria for determining sex ratio (384 fish) or for apportioning age classes (509 aged fish).

[d] Corrected by a factor of 0.7541 (for females, with correction factor for males following suit) to reduce carcass survey gender bias identified by comparing data collected during carcass surveys and electrofishing.

COHO SALMON COUNTS IN THE DELTA CLEARWATER RIVER

INTRODUCTION

The Delta Clearwater River (DCR) is a spring-fed tributary to the Tanana River, located near Delta Junction about 160 km southeast of Fairbanks (Figure 11). Length of the mainstem is about 32 km, the north fork is approximately 10 km in length, and there are a number of shallow spring areas adjacent to the main channel.

The DCR has the largest known coho salmon escapements in the Yukon River drainage (Parker 1991). Spawning occurs throughout the main channel and in the spring areas. Before reaching the spawning grounds of the DCR, coho salmon travel about 1,700 km from the ocean and pass through several different commercial fishing districts in the Yukon and Tanana rivers (Figure 3). Subsistence or personal use fishing also occurs in each district.

Coho salmon in the DCR support a popular fall coho salmon sport fishery with a daily bag and possession limit of three fish. The average annual harvest 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, 2001a-d; Walker et al 2003; Jennings et al. 2004 *In prep a, b*; Table 30).

Historically, escapements of coho salmon into the DCR have been monitored by counting fish from a drifting riverboat (Parker 1991). From 1994-98 aerial surveys were also conducted to estimate escapement in non-boatable portions of the river (Evenson 1995, 1996; Evenson and Stuby 1997; Stuby and Evenson 1998; Stuby 1999-2001). Escapement information is 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. In 1993 the ADF&G established a minimum escapement goal of 9,000 coho salmon for the DCR (measured with boat counts; Parker 2001). 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 escapement goal, the bag limit may be liberalized. However, given the observed low harvest rates, such an increase would result in little additional harvest.

METHODS

Adult coho salmon in the mainstem of the Delta Clearwater River were counted from a drifting riverboat equipped with an observation platform elevated 2 m above the water. Beginning at the mouth, the river was divided into sequentially numbered 1.6-km (1-mi.) sections (Figure 11). Counts were made at approximately weekly intervals until the run was judged to have peaked.

Prior to 1994, the shallow spring areas adjacent to the mainstem river 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. Aerial surveys were discontinued after 1998. Instead, an expansion factor was used to approximate abundance of spawning coho salmon in the spring areas. Expansion for the tributaries/spring areas is based on the average proportion of total escapement (0.213) observed in these areas during five annual aerial surveys. The calculated abundance of coho salmon in the spring areas is added to the number of coho salmon counted during the boat survey to calculate escapement for the entire system.

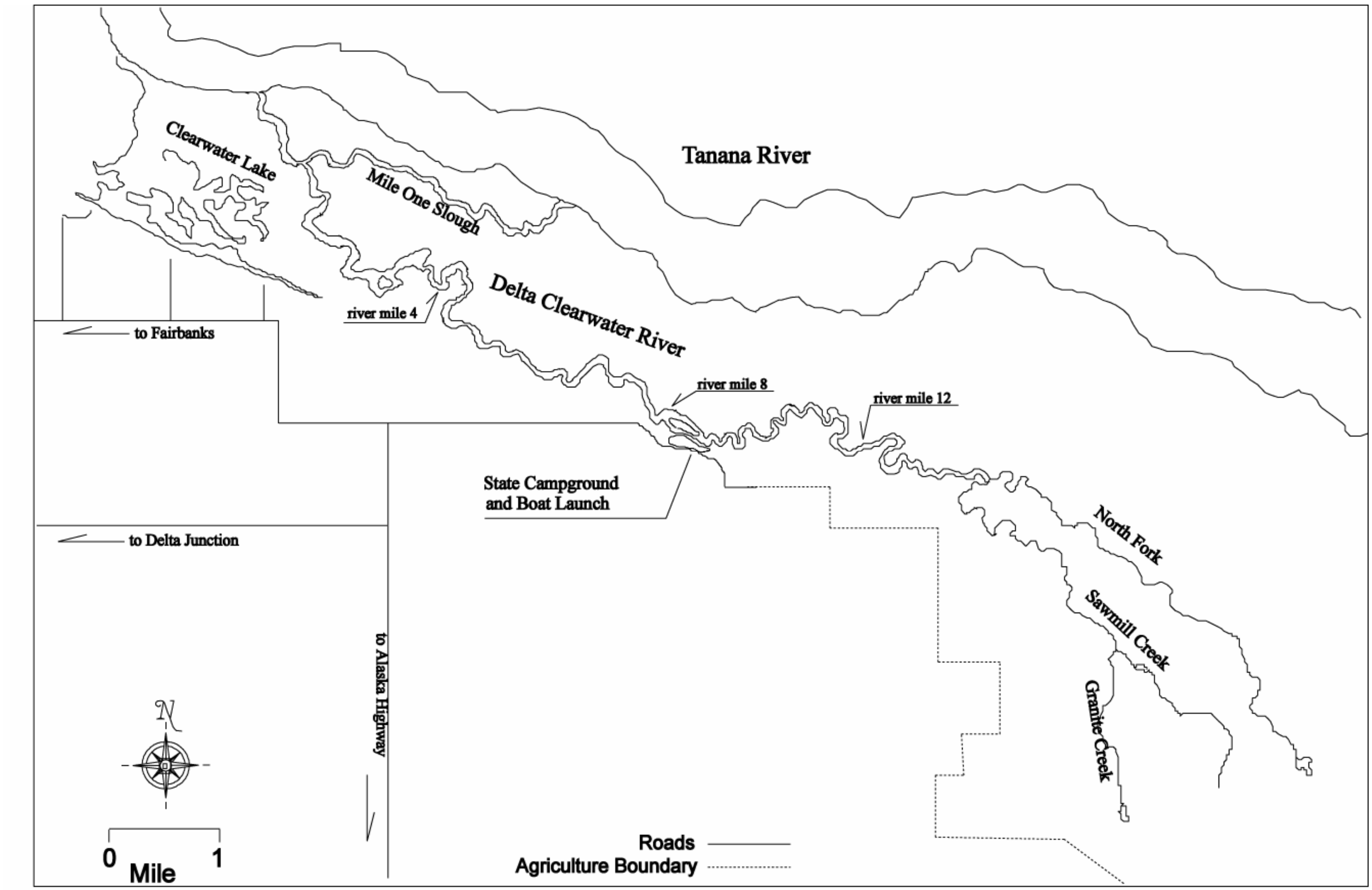

Figure 11.–Delta Clearwater River drainage.

Table 30.–Peak escapements, harvests, and catch of coho salmon in the Delta Clearwater River, 1972-2003.

	Peak Escapement Counts							
Year	Survey Date	Lower River[a]	Upper River[b]	Spring Areas	Total[c]	Previous 5 Yr. Avg	Sport Harvest[d]	Sport Catch[d]
1972	09 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	03 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	06 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	9,002	1,005	NA
1987	27 Oct	11,700	10,600	NA	22,300	9,576	1,068	NA
1988	28 Oct	5,300	16,300	NA	21,600	13,059	1,291	NA
1989	25 Oct	5,400	7,200	NA	12,600	16,455	1,049	NA
1990	26 Oct	4,525	3,800	NA	8,325	13,471	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[k]	30,355	76	1,634

-continued-

Table 30.-Page 2 of 2.

	Peak Escapement Counts							
Year	Survey Date	Lower River[a]	Upper River[b]	Spring Areas	Total[c]	Previous 5 Yr. Avg	Sport Harvest[d]	Sport Catch[d]
2000	24 Oct	4,025	5,200	12,364[j]	11,589[k]	17,061	252	1,890
2001	19 Oct	27,500	19,375	12,672[j]	59,547[k]	16,103	816	5,392
2002	31 Oct	17,700	20,925	10,422[j]	49,067[k]	24,537	517	5,311
2003	21 Oct	41,575	61,225	30,841[j]	133,641[k]	31,570	1,272	14,665

[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), Howe et al. (1995-2001a-d); Walker et al. 2003; Jennings et al. 2004, *In prep a, b*.

[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.

[k] Total includes expansion for non-navigable portions of the river.

RESULTS

In 2002 the peak boat survey of the mainstem river was conducted on 31 October. Coho salmon were distributed throughout the entire mainstem at varying densities (Table 31) and a total of 38,625 fish were counted. The count was expanded by 0.213 (10,442 fish) to account for fish spawning in adjacent spring areas. Total calculated escapement was 49,067 coho salmon.

In 2003 the peak boat surveys of the mainstem river was conducted on 21 October. Coho salmon were distributed throughout the entire mainstem at varying densities (Table 32) and a total of 102,800 fish were counted. The count was expanded by 0.213 (30,841 fish) to account for fish spawning in adjacent spring areas. Total calculated escapement was 133,641 coho salmon.

Table 31.–Counts of adult coho salmon in the Delta Clearwater River, 2002.

River Mile	Mainstem River (Boat Survey)
	Count (31 Oct)
17.5-16	550
16-15	1,725
15-14	2,475
14-13	3,575
13-12	3,300
12-11	3,000
11-10	3,550
10-9	2,025
9-8	725
8-7	1,600
7-6	725
6-5	1,750
5-4	3,275
4-3	3,400
3-2	1,225
2-1	4,225
1-0	1,500
Summary	
17.5-0 (Mainstem)	38,625
Tributaries[a]	10,442
Total Count (boat-count of mainstream plus tributary expansion)	49,067

[a] Expansion for the tributaries/spring areas (mainstem count x 1.27) is based on the average proportion of total escapement (0.213) observed in these areas during five annual aerial surveys.

DISCUSSION

The 2003 escapement to the DCR was the largest on record and the 2002 escapement was the fourth largest. The 1998 and 1999 parent years, from which most of the 2002 and 2003 escapements originated were average in size (Table 30). In both 2002 and 2003, during the time when coho salmon were moving up the Yukon River, there were restrictions on commercial, subsistence, and personal use fishing for fall chum salmon. Both coho and fall chum salmon are harvested during the fall season salmon fisheries, therefore it is likely these restrictions contributed to the large escapements.

Table 32.–Counts of adult coho salmon in the Delta Clearwater River, 2003.

River Mile	Mainstem River (Boat Survey)
	Count (21 Oct)
17.5-16	5,325
16-15	8,975
15-14	10,850
14-13	8,475
13-12	8,475
12-11	4,700
11-10	6,875
10-9	5,125
9-8	2,425
8-7	5,225
7-6	2,450
6-5	5,975
5-4	7,425
4-3	8,375
3-2	4,400
2-1	6,500
1-0	1,225
Summary	
17.5-0 (Mainstem)	102,800
Tributaries[a]	30,841
Total Count (boat-count of mainstream plus tributary expansion)	133,641

[a] Expansion for the tributaries/spring areas (mainstem count x 1.27) is based on the average proportion of total escapement (0.213) observed in these areas during 5 annual aerial surveys.

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APPENDIX A

Appendix A1.–Archived project data and operational files germane to this 2002 - 2003 report.

Plans, Schedules, and Typical Count Forms.
Chena-Chat KS opplan 2002 version 5-20-02.doc
Salmon-Studies-in-Interior-Alaska-2003-Final.Doc
Chena-Chat. KS 2002 Sched & Assignments A.doc
Chatanika River KS 2002 Sched & Assignments.doc
Chatanika River Late KS 2002 Sched & Assignments.doc
Chinook Electrofishing Crew Schedule 7-22.doc
2002 Count Forms.doc

Tower Count Data Spreadsheets (Chinook)
CHENATOW02.xls
CHENATOW03.xls
SALCHATOW02.xls
SALCHATOW03.xls
CHATTOW02.xls
CHATTOW03.xls

Summaries Tabulating Daily (Chinook) Counts from the Chena and Chatanika Rivers
Dailyking 2002.xls
Dailyking 2003.xls

Historic and 2002 – 2003 Daily Cumulative Counts and Run Timing Analysis for the Chena and Salcha Rivers
Salcha and Chena KS run timing 03.xls

2002 Chena (Chinook) Mark-Recapture and ASL Data and Analysis
Chena KS Mark-Recapture Raw Data 2002.xls
Chena 2002 KS ASLMaster (Electromark).xls
Chena 2002 KS ASLMaster (Carcassrecap).xls
Chena KS 02 Abund-Age Prop.Summary w Formulas.xls
MRLatLongDist Calc.XLS

2003 Chena (Chinook) ASL Data and Analysis
Chena 2003 KS ASLMaster.xls
Chena Sex Ratio and Age Class abundance 2003.xls

2002 (Chinook) Run Status Updates for the Chena and Salcha Rivers
Fbks KS Update 01-2002.doc
Fbks KS Update 03-2002.doc
Fbks KS Update 05-2002.doc
Fbks KS Update 06-2002.doc
Fbks KS Update 07-2002.doc
Fbks KS Update 08-2002.doc
Fbks KS Update 09-2002.doc
Update for October 20 CF Staff Mtng.doc

-continued-

2003 (Chinook) Run Status Updates for the Chena and Salcha Rivers
Fbks KS Update 01-2003.doc
Fbks KS Update 02-2003.doc
Fbks KS Update 03-2003.doc
Fbks KS Update 04-2003.doc
Fbks KS Update 05-2003.doc

2002 - 2003 Salcha (Chinook) ASL Data and Analysis
Salcha 2002 KS ASLMaster.xls
Salcha 2003 KS ASLMaster.xls

Historic and 2002 – 2003 Chena – Salcha ASL/Abundance Products
Chena – Salcha Sex Ratio and Age Class Abundance Master.XLS

2002 Chatanika (Chinook) ASL Data
Chat R. 2002 ASL Sampling.xls

2002-2003 Delta Clearwater River (Coho) counts and expansion spreadsheets
DCR-coho counts2002.xls
DCR-coho counts2003.xls

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

APPENDIX B
STATISTICAL TESTS FOR TWO-EVENT MARK-RECAPTURE

Appendix B1.–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 goodness of fit test comparing the distributions of the lengths of all fish that were marked during electrofishing and all marked fish 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 during electrofishing and all fish 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 Ho(A) Accept Ho(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 Ho(A) Reject Ho(B)

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

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

There is size-selectivity during both sampling events.

Case IV: Reject Ho(A) Reject Ho(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 (See Adjustments in Compositions for Gear Selectivity) 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.

Appendix B2.–Tests of consistency for Petersen estimator.

The following two assumptions must be fulfilled:

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

Catching and handling the fish should not affect the probability of recapture because the experiment is designed to mark live fish and later recover carcasses. If the jaw tag is lost, the fin clip given each fish will identify the river section where it was marked.

Of the following assumptions, only one must be fulfilled:

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

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

TEST I[b]

First Event River Section Released	Second Event		
	River Section Recaptured		
	Upper	Lower	Not Recaptured
Upper			
Lower			

TEST II[c]

	Second Event: River Section	
	Upper	Lower
Recaptured		
Not Recaptured		

TEST III[d]

	Captured During Second Event	
	Upper	Lower
Marked		
Unmarked		

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 movement probabilities are the same among sections: H_1: $\theta_{ij} = \theta_j$. Theta applies to both marked and unmarked salmon.

c This tests the hypothesis of homogeneity on the columns of this 2-by-s contingency table with respect to recapture probabilities between the three river areas: H_2: $\Sigma_j \theta_{ij} p_j = d$. Theta applies to both marked and unmarked salmon.

d This tests the homogeneity on the columns of the 2-by-t 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 does not apply to both marked and unmarked salmon.