Fishery Data Series No. 12-01

Chinook and Coho Salmon Escapement in the Chena, Delta Clearwater, Goodpaster and Salcha Rivers, 2006

by

Audra L. J. Brase

February 2012

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 12-01

CHINOOK AND COHO SALMON ESCAPEMENT IN THE CHENA, DELTA CLEARWATER, GOODPASTER AND SALCHA RIVERS, 2006

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ABSTRACT

In 2006, salmon counting tower enumeration projects were conducted on the Chena, Salcha, and Goodpaster rivers to estimate Chinook salmon *Oncorhynchus tshawytscha* escapement. Chum salmon *O. keta* , were also counted, but counts were terminated before the end of the run so escapement estimates were considered minimum. Coho salmon *O. kisutch* escapement was estimated on the Delta Clearwater by a visual survey from a riverboat.

The Chena River counting tower was in operation from 30 June to 6 August. During that period counts were impacted for 10 days at the beginning of the run due to high water conditions. The estimated Chinook salmon escapement was 2,936 fish (SE=163) and the incomplete chum salmon escapement estimate was 35,109 fish (SE=946). Age and sex compositions of the Chena River Chinook escapement were estimated from data collected during carcass surveys. In 2006, 404 carcasses were collected. The estimated proportion of females in the sample (after correction for gender bias) was 0.35 (SE = 0.04). Males were most represented by age 1.3 (59%). The majority of females were age 1.4 (71%).

In 2006, Salcha River Chinook salmon enumeration and carcass surveys were conducted by staff from the Bering Sea Fishermen's Association (BSFA). Counts occurred from 11 July through 17 August. Escapement estimates were 11,183 Chinook salmon (SE=348) and a minimum of 113,960 chum salmon (SE=1,190). Age and sex compositions of the Salcha River Chinook salmon escapement were estimated from 567 carcasses that were collected. The estimated proportion of females in the sample (after correction for gender bias) was 0.34 (SE=0.09). Males were most represented by age 1.3 (72%). The majority of females were age 1.4 (76%).

In 2006, staff from Tanana Chiefs Conference (TCC) and BSFA operated a counting tower on the Goodpaster River. This was the third year this project had been in operation. Counts of Chinook salmon were conducted from 7 July through 2 August. The 2006 estimate of Chinook salmon escapement was 2,365 fish (SE=97).

Escapement of coho salmon to the Delta Clearwater River was estimated during boat surveys. Count of coho salmon in the mainstem portion of the river was 16,748. This count was expanded to account for non-navigable sections of the river to yield a total escapement estimate of 21,029 coho salmon.

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

REPORT OVERVIEW

Some of the most important Yukon River Chinook salmon *Oncorhynchus tshawytscha* and coho salmon *O. kisutch* spawning rivers are located in the vicinity of Fairbanks, Alaska. The Chena and Salcha rivers support the largest spawning populations of Chinook salmon in the Tanana River drainage, while the Delta Clearwater River (DCR) supports the largest spawning population of coho salmon in the entire Yukon River drainage. Other nearby river systems that support important spawning populations of salmon include the Chatanika, Goodpaster, and Nenana rivers.

Chinook and coho salmon are harvested during commercial, subsistence and personal use fisheries throughout the Yukon and Tanana rivers (Figure 1) and both species are targeted in inriver sport fisheries. Sport anglers value the opportunity to catch these large salmon, even though they are only available for a limited time each year. The recent 5 year (2001–2005) average sport catch of Chinook salmon in the Chena River was 2,317 fish, and the corresponding average harvest was 502 fish (Table 1; Brase 2006). The recent 5 year average sport catch of coho salmon in the Delta Clearwater River was 6,414 fish, and the corresponding average harvest was 677 fish (Parker 2006). Most sport anglers target Interior Alaska salmon for catch and release fishing as the flesh is relatively deteriorated by the time the fish have traveled the ~1,000 miles from the mouth of the Yukon River to their natal stream.

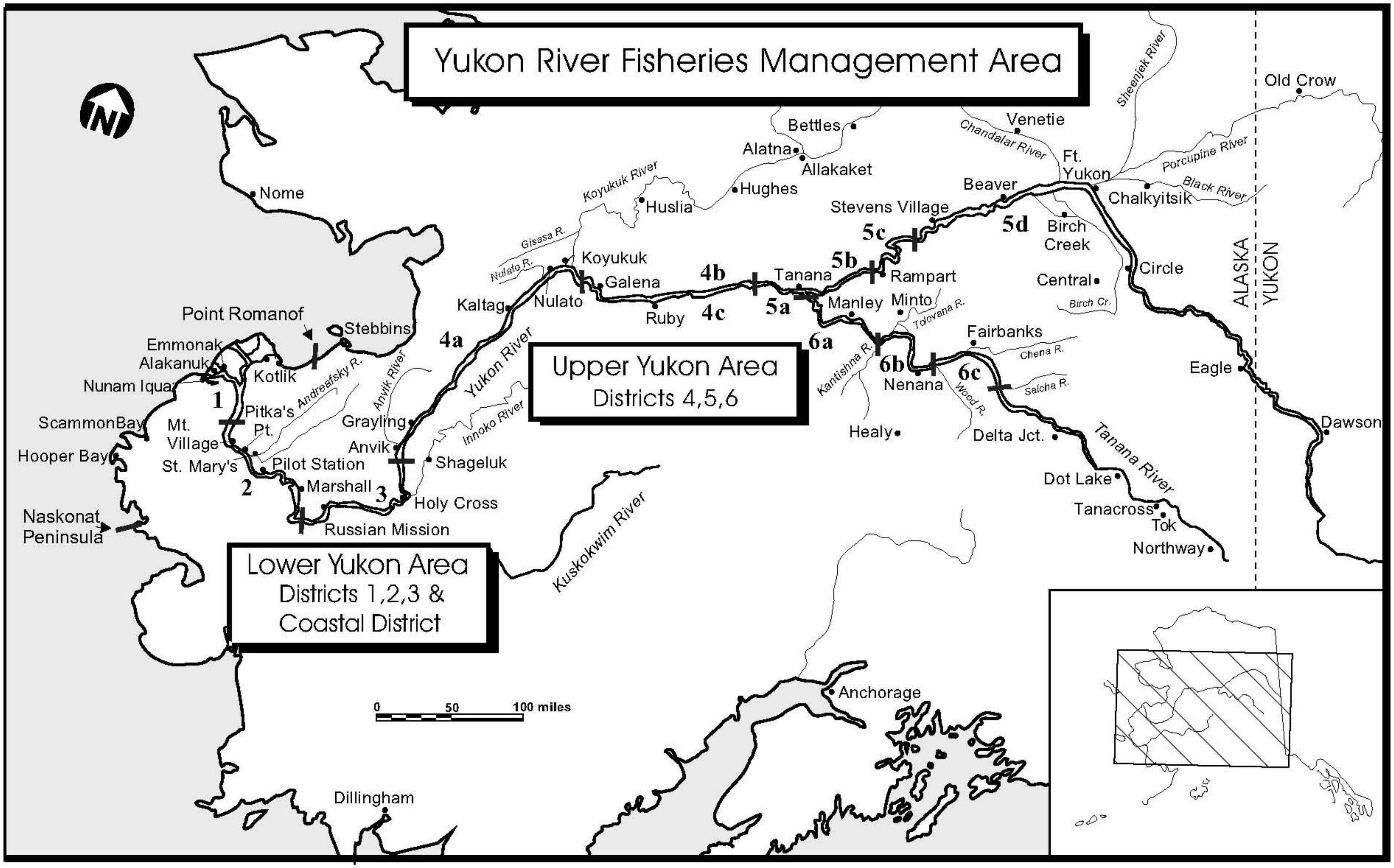

Figure 1–Map of Yukon River commercial fishing districts.

Table 1.–Estimated sport, commercial, and subsistence harvests of Chinook salmon in the Tanana River drainage, 1990–2006.

	Sport Harvest										
	Creel Survey[a]		Statewide Survey[b]					Total Tanana Drainage	Commercial Harvest[c]	Subsistence and Personal Use Harvest [c,d]	Total Estimated Harvest
Year	Chena River	Salcha River	Chena River	Salcha River	Chatanika River	Nenana River	Other Streams		Tanana Drainage		
1990	24	200	64	291	37	0	0	420	2,989	3,069	6,478
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	137	1,691	1,445	2,098	5,234
1994	-	776	993	714	105	0	20	1,832	2,606	2,370	6,808
1995	-	811	662	1,448	58	0	213	2,381	2,747	2,178	7,306
1996	-	-	1,270	1,136	348	53	118	3,085	447	1,392	4,924
1997	-	-	1,029	719	155	10	0	1,943	2,728	3,025	7,696
1998	-	-	299	121	6	15	0	441	963	2,276	3,680
1999	-	-	442	445	63	11	0	1,006	690	1,955	3,651
2000	-	-	71	72	0	24	11	178	0	1,058	1,236
2001	-	-	536	108	23	0	0	667	0	2,449	3,116
2002	-	-	178	269	0	0	0	466	1,066	1,193	2,725
2003	-	-	976	1,127	13	11	0	2,136	1,813	2,349	6,298
2004	-	-	762	481	37	0	27	1,315	2,057	1,589[e]	4,961
2005	-	-	57	351	0	0	75	483	453	2,169[e]	3,105
2006	-	-	N/A	N/A	N/A	N/A	N/A	N/A	84	N/A	-
5 Year Average 2001-05			502	467	15	2	20	1,013	1,078	1,950	4,041

Note: Totals do not include Chinook salmon harvests from stocked lakes in the Tanana River area.

a Creel census estimates from Hallberg and Bingham (1991-1996).

b Sport fishery harvest estimates from Mills (1991-1994) Howe et al. (1995, 1996, 2001 a-d), Walker et al. (2003), and Jennings et al. (2004, 2006 a-b, 2007, 2009).

c Commercial, subsistence, and personal use estimates from: Schultz et al. 1994; Borba and Hamner 1998, 2000, 2001; Brase and Hamner 2002, 2003; Busher et al. 2007; Busher and Hamazaki 2004; Vania et al. 2002.

d 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.

e Preliminary data and subject to change.

The Alaska Department of Fish and Game (ADF&G) has established biological escapement goal (BEG) ranges for Chinook salmon in the Chena and Salcha rivers and a sustainable escapement goal (SEG) range for coho salmon in the Delta Clearwater River (DCR). The BEGs are based on spawner-recruit analyses of run reconstruction data. BEGs are set as ranges which provide for maximum sustained yield. In 2001, the Alaska Board of Fisheries (BOF) adopted policy directing ADF&G to manage harvest so that escapements fall within the BEG ranges (*Policy for Statewide Salmon Escapement Goals*; 5 AAC 39.223, 2001). Escapement goals are evaluated and modified as needed on a 3-year cycle in synchrony with the 3 year BOF meeting cycle for addressing fisheries issues within the Yukon drainage. The Chinook salmon BEG range for the Chena River is 2,800–5,700 fish, and for the Salcha River is 3,300–6,500 fish. The DCR coho salmon SEG range is 5,200–17,000 fish.

The monitoring studies described in this report enable fisheries managers to collect and evaluate "real-time" data of run magnitude and fish passage. ADF&G Sport Fish Division operates the counting tower on the Chena River and also conducts the annual DCR coho salmon boat surveys.

The Salcha River was monitored by ADF&G prior to 1998. Results of ADF&G Division of Commercial Fisheries (CFD) aerial surveys of the Salcha and Chena rivers from 1986–1993 indicated a correlation between Chinook salmon escapement index counts in the two rivers (Vania et al. 2002). This correlation, in conjunction with reduced funding levels, caused ADF&G to discontinue monitoring operations on the Salcha River. The Bering Sea Fishermen's Association (BSFA) has obtained US-Canada Yukon River Salmon Treaty funds to operate a counting tower and perform a carcass survey on the Salcha River. The results of the Salcha River tower counts are provided to ADF&G throughout the season.

In 2004, Tanana Chiefs Conference (TCC) in conjunction with BSFA began operating a Chinook salmon counting tower on the Goodpaster River with funding support from Teck-Pogo, Incorporated (the company, now Sumitomo Metal Mining Pogo LLC, operates a gold mine located in the upper part of the Goodpaster drainage). This report will present results from the first three years of operation of the Goodpaster Tower.

This report is broken into four sections as follows:

1) Chena River counting tower and Chinook salmon ASL;
2) Salcha River counting tower and Chinook salmon ASL;
3) Goodpaster River counting tower; and,
4) Delta Clearwater River coho salmon survey.

CHENA RIVER SALMON COUNTING TOWER

INTRODUCTION

Prior to 1986, aerial survey index counts conducted by ADF&G-CFD were the only Chinook salmon escapement data available for the Chena River. Aerial survey counts likely underestimated total escapement, but the amount and consistency of underestimation was unknown. From 1986 to 1988 CFD estimated abundance of Chinook salmon in the Chena River using mark-recapture (M-R) techniques to examine the relationship between aerial survey counts and actual abundance (Barton 1987a, 1988; Barton and Conrad 1989). Beginning in 1989 the Division of Sport Fish took over operations of the annual Chena River Chinook salmon M-R study. The relationship between the Chena River aerial survey counts and M-R abundance estimates from 1986–1992 was examined. The percentage of the total Chinook salmon abundance observed during aerial surveys ranged from 16% to 58% in the Chena River, with the data showing no clear linear trends, demonstrating that aerial survey counts did not provide a reliable index of escapement (Evenson 1993).

Beginning in 1993, counting tower techniques were initiated to estimate escapements of Chinook salmon in the Chena River. Because some spawning occurred upstream of the M-R study section, it was believed that the M-R estimates did not represent total escapement, whereas tower-counts enumerate all migrants. In 1997, a paired M-R and complete tower-count estimate was obtained for the Chena River and the two estimates were deemed to be statistically similar (Stuby and Evenson 1998). Although tower-counts are the preferred method for estimating salmon escapement, M-R techniques may be the only method available to estimate escapement during years of high rainfall and high river stages.

The run timing of Chinook salmon and chum salmon *Oncorhynchus keta* overlaps on the Chena River, therefore chum salmon are also annually counted from the counting tower. The chum salmon run overlap is not complete with Chinook salmon; chum salmon arrive slightly later and persist for about three weeks after the Chinook salmon have completed their run. Chinook salmon counts were completed before the end of the chum salmon run. Therefore, the chum salmon escapement estimates provided in this report are considered minimum estimates.

There are two primary objectives driving the annual 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 Chinook salmon subsistence, personal use, and commercial fisheries in the Tanana River downstream from the Chena River. Second, for research purposes, the total abundance and age-sex composition information is used to build brood tables that, over time, will be used to further refine the BEG.

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 (>4 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.

2006 OBJECTIVES

1. estimate the total escapement of Chinook salmon in the Chena River using tower-counting techniques such that the expected 95% confidence interval for the Chena River is within 15% of the point estimate of escapement;
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 electrofishing samples or correcting the carcass survey estimate is within 10 percentage points of the actual proportion 95% of the time;
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; and,
4. count coho salmon in the Delta Clearwater River from a drifting river boat at weekly intervals during the run to estimate total escapement.

In addition to the objectives there were four tasks:

1. collect length data from all Chinook salmon carcasses sampled for age and sex, and provide these data to CFD to support a Chinook salmon disease study being performed in the Yukon River;
2. as time and circumstances allow, provide logistical support and sampling assistance to other agencies conducting salmon research on the Chena River;
3. count chum salmon in the Chena River throughout the duration of the Chinook salmon run;
4. investigate the possibilities for a new counting tower site on the Chena River that meets the preferred criteria (low flow, even bottom profile, road accessible, $\leq$4 feet deep, down river from spawning grounds, upriver from sport fishery); and,
5. report the results from the Salcha and Goodpaster Chinook salmon counting tower projects operated by BSFA and TCC.

METHODS

Daily escapements of Chinook and chum salmon were estimated by visually counting fish as they passed through the Moose Creek Dam on the Chena River (Figure 2). Virtually all Chinook salmon spawning activity occurs upstream of this site. No harvest of salmon is allowed upstream from the dam on the Chena River, so completed estimates from tower-counts represent total escapement.

Construction of the tower infrastructure was completed prior to the beginning of counts. White fabric panels (8218 LTA manufactured by Seaman Corp., Canal Fulton, Ohio[1]) were placed across the bottom of the river immediately upstream from the dam in order to highlight crossing

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

salmon. Lights were suspended over the panels to provide illumination during periods of low ambient light. Since salmon often avoid areas with unusual substrate or those illuminated with artificial lighting, once the lights were turned on they were not shut off until salmon were again visible in ambient light. Counting was scheduled to begin on or about 30 June and continue until 6 August. Based on previous tower-counting studies in this system, passage of Chinook salmon outside of this counting period was considered negligible.

Four technicians were assigned to the Chena River. Counts were scheduled throughout the entire day in order to monitor 24-h migration patterns. For analysis, each day was divided into three 8-h shifts; however, a technicians' work-shift was 7.5 h. Each technician was scheduled for a maximum of five shifts per week (Monday–Sunday). Almost all shifts were staffed on the Chena River with counts scheduled 20 or 21 shifts per week after July 2. Shift I began at 0000 hour (midnight) and ended at 0730 hour; Shift II began at 0800 hour and ended at 1530 hour; Shift III began at 1600 hours and ended at 2330 hours. Salmon were counted during 20 min of every hour. The start time for all counts during each shift began between the top of the hour and 10 min past. 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 min counts were conducted on each side. The count on the left side of the river (facing upstream) was initiated during the first 10 min of the hour, with the count of the right side immediately following.

Numbers of Chinook salmon and chum salmon counted were recorded on field forms at the end of each hourly count. At the end of each shift the counting technician phoned in counts to a 24-hour answering machine at the project leader's office and the data sheets were returned to the office at the end of each day. The recorded messages were transcribed each morning and were subsequently entered into a spreadsheet. Recorded data included river, name of counter, date and time of counting shift, numbers of each species counted (total upstream and total downstream) for each side of the river during each counting period, and any noteworthy events (rising river level, logs trapped on the dam, panel damage, etc.).

Carcasses of spawned-out Chinook salmon were collected on the Chena River from the Moose Creek Dam (river mile 45) to river mile 90 (intersection of North and Middle Forks) in order to estimate age, sex, and length (ASL) composition of the escapement. The survey was scheduled to occur during the first or second week in August depending on the timing of the salmon run, weather, and river conditions. Chinook salmon carcasses were collected and inspected during two complete surveys of the study area. Two riverboats were used with crews consisting of three people in each boat with one person driving and the other two people collecting carcasses.

After collection, the carcasses were laid out in rows of 10 with their left sides facing up. Each carcass was measured to the nearest 5 mm MEF, and sex was determined from internal inspection. Three scales were removed from the left side of the carcass approximately two rows above the lateral line along a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander 1940). If no scales were present in the preferred area due to decomposition, scales were removed from the same area on the right side of the carcass or, if necessary, from any location other than along the lateral line where there were any scales remaining and placed directly on gum cards. After sampling, all carcasses were cut in half to avoid resampling and returned to the river. Ages were determined from scale patterns as described by Mosher (1969).

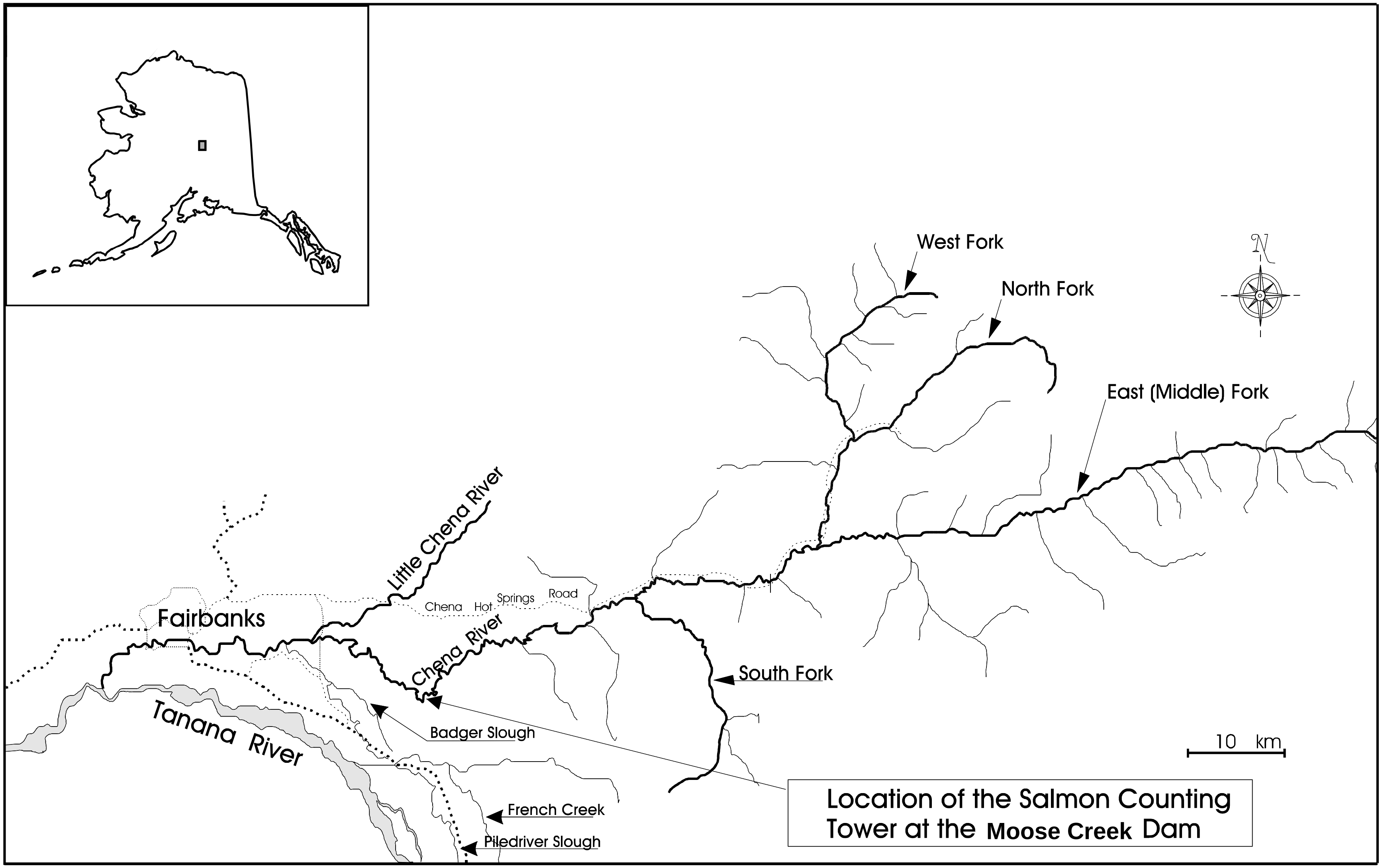

Figure 2.–Chena River drainage with location of counting tower.

DATA ANALYSIS

Estimates of Chinook salmon abundance were stratified by day. Daily estimates of abundance were considered a two-stage direct expansion where the first stage was 8-h shifts within a day and the second stage was 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:

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

The expanded daily passage was:

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

The period sampled was systematic, because a period was sampled every hour in a shift. The sample variance associated with periods was approximate using the successive difference approach (Wolter 1985):

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

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

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

The variance for the expanded daily passage was estimated by:

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

where:

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

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

and

d = day;

i = 8-h shift;

j = 10-min counting period;

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

Y_{di} = expanded shift passage;

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

M_{di} = total number of possible 10-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 were estimated by:

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

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

The daily-expanded shift passage and the associated variance were calculated using data from 10 min counting periods after summing counts within period from each side of the river to arrive at total estimates for the river. Equation 5, the sample variance across shifts, requires data from more than one shift per day. If 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 species using all days when more than one shift was worked. The average *CV* for each species will then be used to approximate the daily variation for those days when fewer than two shifts were worked. The coefficient of variation was used because it was independent of the magnitude of the estimate and was relatively constant throughout the run (Evenson 1995). The daily *CV* was calculated for each species as:

$$CV = \sqrt{s_{1d}^2} \Big/ \hat{N}_d \ . \tag{11}$$

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

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

where:

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

is an indicator function.

The moving average procedure was only applied for data gaps that did not exceed 4 days (12 consecutive shifts). 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*.

In previous years of this study it was stipulated that if full tower counts could not be performed due to adverse river conditions for more than four consecutive days (12 consecutive shifts) between Day 9 and Day 30 of the Chinook salmon run, then a mark-recapture experiment would be conducted. As escapement estimates and passage data have accumulated over the years and a BEG has been developed, the need for an unbroken series of escapement estimates has become less critical. This is important because electrofishing during the Chinook spawning run should be avoided if possible due to the probability of exposing salmon adults and eggs, as well as all other organisms in the 25+ foot wide path of the boat, to potentially damaging levels of electricity as described by Roach (1996).

The current Chena River Chinook salmon BEG is based on 11 pairs of spawner-return estimates (for brood years 1986–1996) with a spawning contrast of 4.59 (estimates range from 2,666–13,390; Evenson 2002). Estimates of abundance that fall within the middle of the range of previous estimates have little effect on the estimate of optimal spawning escapement (escapement that produces maximum sustained yield that is used to estimate the BEG range). However, extremely large or small escapements (outside the observed range) will improve the spawning contrast in the spawner-recruit relationship and provide for more certainty in the estimate of optimal spawning escapement.

Therefore, it was decided prior to the Chinook salmon season that a mark-recapture experiment would only be undertaken on the Chena River when tower counting failed and:

1. escapement was projected to be less than 3,000 or greater than 13,000 Chinook salmon;
2. abundance estimates were not obtained during the preceding two consecutive years (regardless of projected run size in the current year), or,
3. escapements less than 3,000 or more than 13,000 Chinook salmon were observed 5 or 6 years (dominant age classes in the brood-year return) prior to the current year.

Gender-selective sampling has been noted when comparing sex ratios of Chinook salmon collected during carcass surveys with those collected by electrofishing (Stuby 2001). Correcting the estimated sex composition estimates from a carcass survey to estimates we might observe in a completely random sample required analysis of data from previous years when mark-recapture experiments were conducted. Paired electrofishing and carcass survey data from mark recapture studies are available for 8 years from the Chena River (1989–1992, 1995–1997, 2000 and 2002). Abundance estimates were generated for each gender and the ratio of the abundance estimate of females to the total abundance was used to generate an unbiased estimate of the proportion of females in the population. A “correction factor” was calculated and applied to the estimated proportion of females in the carcass sample (in years when only carcass samples were collected) based on the average relationship between the proportion estimate from the mark recapture estimates and the proportion estimates from the carcass samples for all eight years (Appendix A).

Aerial Counts

In 2006, aerial survey counts of Chinook salmon in the Chena River were attempted by CFD staff after peak escapement was thought to have 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. 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.

Table 2.–Daily Chinook salmon passage at the Chena River counting site, 2006. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

	Total	Left Side			Right Side			Total		
Date	10 min Counts/Day	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE	Number Counted	Estimated Passage	SE
30-Jun-06	17	0	0	0	0	0	0	0	0	0
1-Jul-06	36	0	0	0	0	0	0	0	0	0
2-Jul-06	48	0	0	0	0	0	0	0	0	0
3-Jul-06	48	0	0	0	0	0	0	0	0	0
4-Jul-06	38	0	0	0	0	0	0	0	0	0
5-Jul-06	38	0	0	0	0	0	0	0	0	0
6-Jul-06	47	1	6	6	0	0	0	1	6	6
7-Jul-06	48	4	24	14	0	0	0	4	24	14
8-Jul-06	6	-	-	-	0	0	0	0	0	0
9-Jul-06	0	-	-	-	-	-	-	-	-	-
10-Jul-06	0	-	-	-	-	-	-	-	-	-
11-Jul-06	0	-	-	-	-	-	-	-	-	-
12-Jul-06	12	-	-	-	0	0	0	0	0	0
13-Jul-06	39	9	87	25	3	18	7	12	105	26
14-Jul-06	45	26	173	45	1	6	6	27	179	45
15-Jul-06	40	12	78	31	0	0	0	12	78	31
16-Jul-06	48	22	132	29	0	0	0	22	132	29
17-Jul-06	48	39	234	58	1	6	6	40	240	58
18-Jul-06	48	22	132	30	0	0	0	22	132	30
19-Jul-06	48	40	240	41	0	0	0	40	240	41
20-Jul-06	48	25	150	35	0	0	0	25	150	35
21-Jul-06	48	35	210	32	0	0	0	35	210	32
22-Jul-06	48	51	306	66	0	0	0	51	306	66
23-Jul-06	48	34	204	33	3	18	13	37	222	35
24-Jul-06	48	39	234	41	0	0	0	39	234	41
25-Jul-06	48	33	198	52	0	0	0	33	198	52
26-Jul-06	48	26	156	22	1	6	6	27	162	23
27-Jul-06	48	13	78	29	0	0	0	13	78	29
28-Jul-06	48	9	54	29	0	0	0	9	54	29
29-Jul-06	48	7	42	19	0	0	0	7	42	19
30-Jul-06	48	7	42	15	0	0	0	7	42	15
31-Jul-06	48	6	36	16	0	0	0	6	36	16
1-Aug-06	48	7	42	22	0	0	0	7	42	22
2-Aug-06	48	1	6	6	0	0	0	1	6	6
3-Aug-06	48	0	0	0	0	0	0	0	0	0
4-Aug-06	48	0	0	0	0	0	0	0	0	0
5-Aug-06	32	2	18	9	0	0	0	2	18	9
6-Aug-06	48	0	0	0	0	0	0	0	0	0
Total	1,502	470	2,883	162	9	54	18	479	2,936	163

Table 3.–Daily chum salmon passage at the Chena River counting site, 2006. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Total 10 min Counts/Day	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
30-Jun-06	17	0	0	0	0	0	0	0	0	0
1-Jul-06	36	0	0	0	0	0	0	0	0	0
2-Jul-06	48	0	0	0	0	0	0	0	0	0
3-Jul-06	48	0	0	0	0	0	0	0	0	0
4-Jul-06	38	0	0	0	0	0	0	0	0	0
5-Jul-06	38	0	0	0	0	0	0	0	0	0
6-Jul-06	47	0	0	0	0	0	0	0	0	0
7-Jul-06	48	1	6	10	0	0	0	1	6	10
8-Jul-06	6	0	0	0	0	0	0	0	0	0
9-Jul-06	0	-	-	-	-	-	-	-	-	-
10-Jul-06	0	-	-	-	-	-	-	-	-	-
11-Jul-06	0	-	-	-	-	-	-	-	-	-
12-Jul-06	12	-	-	-	0	0	0	0	0	0
13-Jul-06	39	5	46	24	2	12	12	7	58	27
14-Jul-06	45	4	27	19	1	6	4	5	33	20
15-Jul-06	40	12	78	31	4	26	10	16	104	33
16-Jul-06	48	18	108	26	11	66	40	29	174	48
17-Jul-06	48	35	210	33	3	18	10	38	228	35
18-Jul-06	48	50	300	87	9	54	19	59	354	89
19-Jul-06	48	148	888	217	14	84	40	162	972	221
20-Jul-06	48	112	672	93	8	48	22	120	720	95
21-Jul-06	48	257	1,542	264	6	36	12	263	1,578	264
22-Jul-06	48	361	2,166	272	13	78	23	374	2,244	273
23-Jul-06	48	265	1,590	149	25	150	51	290	1,740	157
24-Jul-06	48	354	2,124	188	9	54	24	363	2,178	190
25-Jul-06	48	423	2,538	223	27	162	68	450	2,700	233
26-Jul-06	48	360	2,160	291	48	288	39	408	2,448	294
27-Jul-06	48	335	2,010	138	16	96	38	351	2,106	143
28-Jul-06	48	327	1,962	267	14	84	48	341	2,046	271
29-Jul-06	48	449	2,694	265	0	0	0	449	2,694	265
30-Jul-06	48	372	2,232	285	0	0	0	372	2,232	285
31-Jul-06	48	240	1,440	229	17	102	72	257	1,542	240
1-Aug-06	48	344	2,064	202	28	168	57	372	2,232	209
2-Aug-06	48	336	2,016	202	17	102	67	353	2,118	213
3-Aug-06	48	296	1,776	216	24	144	84	320	1,920	232
4-Aug-06	48	238	1,428	155	10	60	23	248	1,488	157
5-Aug-06	32	104	936	73	0	0	0	104	936	73
6-Aug-06	48	43	258	48	0	0	0	43	258	48
Total	1,502	5,489	33,272	926	306	1,838	197	5,795	35,109	946

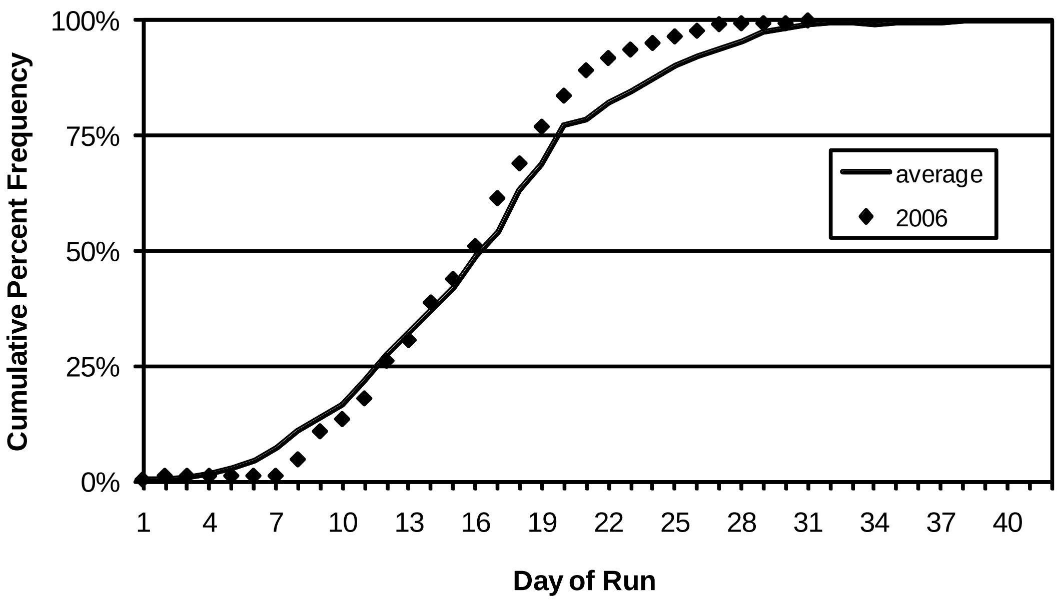

Figure 3.–Day of run cumulative percent frequency for Chena River Chinook salmon comparing 2006 with the 1993–1994, 1997–1999 average.

RESULTS

Chena River Chinook and Chum Salmon Abundance

Salmon counting began on the Chena River on 30 June and the first Chinook salmon was seen on 6 July (Table 2), and chum salmon on 7 July (Table 3). Counting continued until 8 July when heavy rainfall in the Fairbanks area created a high water event which resulted in poor viewing conditions. Complete counts resumed on 14 July and counting conditions remained good and continued until 6 August. Based on historic passage rates it is believed that no more than 10% of the total escapement was missed during the high water period (Days 3–8). Because fish were known to have passed upriver during the high water conditions, and counting tower operations ceased before the end of the chum salmon run, the 2006 escapement estimates of 2,936 Chinook salmon (SE=163) and 35,109 chum salmon (SE=946) are biased low and considered minimums. Because more than 12 consecutive shifts were missed during the high water conditions; the days when counting could not occur were not interpolated for. The 2006 Chena River Chinook salmon escapement was just above the lower end of the BEG range (Figure 3).

Chena River Age-Sex-Length Compositions

Carcasses were sampled on the Chena River from 26 July through 15 August, with assistance from Sport Fish staff from 8–11 August. During the survey 404 Chinook salmon carcasses were sampled for age-sex-length (ASL) data. The uncorrected sex composition for this sample, including those fish not aged, was 0.54 males and 0.46 females (Table 4). The average (uncorrected for gender bias) male to female ratio of all sampled fish during 1986–2005 was 0.56 to 0.44 (Table 5). The estimated proportion of females in the 2006 escapement corrected for gender selectivity was 0.34 (SE=0.04).

Ages were determined for 90% of the samples collected in 2006. Because the predetermined sample size was not met, abundance by age class was not calculated. However, the age composition from the carcasses was considered representative of the escapement because the carcass sample was very thorough both temporally and spatially. The dominant age class for males was 1.3 (59%; Tables 4 and 6). Ages 1.2, 2.2, 1.4, 2.3 and 1.5 were also present. The dominant age class for females was 1.4 (71%). Females at ages 1.3 and 1.5 were also present. Mean lengths and length ranges for age classes of males and females are listed in Table 4.

Chena River Aerial Survey

In 2006, Commercial Fisheries Division staff performed two aerial surveys for the Chena River drainage. The first survey was performed on 17 July and was rated as good to poor visibility as the surveyor traveled downriver. The first survey was considered incomplete with only 133 Chinook and 54 chum salmon counted. The second survey was flown on 21 July and was rated as having excellent visibility; however, it was thought to be early, as only 628 Chinook and 468 chum salmon were observed (K. Clark, Commercial Fish Biologist, ADF&G, Fairbanks; personal communication). 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 0.25 (Table 7).

Table 4.–Proportions and mean length by age and sex of Chinook salmon sampled during the Chena River carcass survey, 2006.

Age[a]	Sample Size	Sample Proportion	Length Mean	Length SE	Length Min	Length Max
Male						
1.2	46	0.235	566	7	480	720
1.3	116	0.592	723	7	480	915
2.2	1	0.005	550	-	-	-
1.4	29	0.148	854	18	675	1,000
2.3	1	0.005	750	-	-	-
1.5	3	0.015	908	-	840	1,020
Total Aged	196	-	707	9	480	1,020
Total Males[b]	221	0.55	707	9	480	1,020
Corrected Total[c]	-	0.68	-	-	-	-
Female						
1.3	48	0.289	789	7	675	890
1.4	117	0.705	862	5	615	975
1.5	1	0.006	860	-	-	-
Total Aged	166	-	841	5	615	975
Total Females[b]	183	0.45	840	5	615	975
Corrected Total[c]	-	0.32	-	-	-	-

[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.

[c] Estimated proportion of females was corrected by a factor of 0.708.

Table 5.–Proportions of male and female Chinook salmon sampled from carcass surveys on the Chena River, 1986–2006.

	Sexed Sample Size		Sexed Sample Proportion		Sexed and Aged Sample Size		Sexed and Aged Sample Proportion		Adjusted Proportion		Total	
Year	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Escapement	Method
1986	987	365	0.73	0.27	538	183	0.75	0.25	0.75	0.25	9,065	MR
1987	438	592	0.43	0.57	235	325	0.42	0.58	0.52	0.48	6,404	MR
1988	347	543	0.39	0.61	183	285	0.39	0.61	0.66	0.34	3,346	MR
1989	119	218	0.35	0.65	101	187	0.35	0.65	0.55	0.45	2,730	MR
1990	412	376	0.52	0.48	291	258	0.53	0.47	0.64	0.36	5,603	MR
1991	684	315	0.68	0.32	231	108	0.68	0.32	0.68	0.32	3,172	MR
1992	368	210	0.64	0.36	289	176	0.62	0.38	0.78	0.22	5,580	MR
1993	205	38	0.84	0.16	156	31	0.83	0.17	0.88	0.12	12,241	CT
1994	326	275	0.54	0.46	281	231	0.55	0.45	0.68	0.32	11,877	CT
1995	305	593	0.34	0.66	267	520	0.34	0.66	0.48	0.52	11,394	MR
1996	346	268	0.56	0.44	286	229	0.56	0.44	0.73	0.27	7,153	MR
1997	524	354	0.60	0.40	424	278	0.60	0.40	0.74	0.26	10,810	MR
1998	160	107	0.60	0.40	134	94	0.59	0.41	0.72	0.28	4,745	CT
1999	74	134	0.36	0.64	61	116	0.34	0.66	0.54	0.46	6,485	CT
2000	113	56	0.67	0.33	99	50	0.66	0.34	0.78	0.22	4,694	MR
2001	342	253	0.57	0.43	292	229	0.56	0.44	0.70	0.30	9,696	CT
2002	277	216	0.56	0.44	207	167	0.55	0.45	0.73	0.27	6,967	MR
2003	253	206	0.55	0.45	204	166	0.55	0.45	0.68	0.32	11,100[d]	CT
2004	98	160	0.38	0.62	88	151	0.37	0.63	0.56	0.44	9,645	CT
2005	352	268	0.57	0.43	319	234	0.58	0.42	0.69	0.31	-[e]	-
2006	221	183	0.55	0.45	196	166	0.54	0.46	0.68	0.32	2,936	CT
Average	331	273	0.54	0.46	232	199	0.54	0.46	0.68	0.32	7,129	

[a] Estimated proportions were all derived from carcass samples.

[b] In years when counting tower assessments (CT) were conducted and only carcass surveys were conducted, proportions of males and females were adjusted using the methods shown in Appendix A. In years when mark-recapture experiments (MR) were conducted, proportions of males and females were estimated as the ratio of the abundance estimate of each gender to the abundance estimate of all fish.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. CV is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundance with large gaps in counts due to flooding, was 8,739 (SE=653) fish.

[e] Escapement was not estimated due to multiple flood events.

Table 6.–Age composition and escapement estimates by gender and by all fish combined (unadjusted and adjusted) of Chena River Chinook salmon, 1986–2006.

Males	Total Age (years)/European Age (freshwater years/ocean years)										Male	Male
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.002	0.126	0.636	0.000	0.197	0.019	0.020	0.000	0.000	0.000	6,618	6,764
1987	0.000	0.064	0.281	0.000	0.613	0.009	0.034	0.000	0.000	0.000	2,723	3,320
1988	0.016	0.268	0.355	0.000	0.279	0.000	0.082	0.000	0.000	0.000	1,305	2,212
1989	0.010	0.109	0.495	0.020	0.347	0.010	0.010	0.000	0.000	0.000	964	1,492
1990	0.000	0.423	0.309	0.003	0.254	0.000	0.010	0.000	0.000	0.000	2,929	3,569
1991	0.000	0.126	0.489	0.000	0.312	0.000	0.074	0.000	0.000	0.000	2,172	2,172
1992	0.031	0.682	0.208	0.000	0.080	0.000	0.000	0.000	0.000	0.000	3,553	4,373
1993	0.006	0.353	0.442	0.000	0.192	0.000	0.006	0.000	0.000	0.000	10,327	10,804
1994	0.000	0.053	0.644	0.000	0.292	0.004	0.007	0.000	0.000	0.000	6,442	8,029
1995	0.000	0.131	0.360	0.000	0.491	0.000	0.015	0.004	0.000	0.000	3,870	5,509
1996	0.038	0.108	0.629	0.000	0.136	0.000	0.087	0.000	0.000	0.000	4,031	5,239
1997	0.005	0.611	0.184	0.000	0.196	0.000	0.002	0.002	0.000	0.000	6,452	8,038
1998	0.000	0.075	0.858	0.000	0.045	0.000	0.022	0.000	0.000	0.000	2,843	3,399
1999	0.000	0.115	0.377	0.000	0.508	0.000	0.000	0.000	0.000	0.000	2,307	3,527
2000	0.004	0.386	0.458	0.000	0.149	0.000	0.004	0.000	0.000	0.000	3,139	3,675
2001	0.010	0.154	0.462	0.000	0.353	0.000	0.021	0.000	0.000	0.000	5,573	6,777
2002	0.002	0.422	0.364	0.000	0.206	0.000	0.005	0.000	0.000	0.000	3,915	5,063
2003	0.000	0.088	0.623	0.000	0.240	0.000	0.049	0.000	0.000	0.000	6,118	7,573
2004	0.000	0.295	0.318	0.000	0.364	0.000	0.023	0.000	0.000	0.000	3,664	5,410
2005	0.000	0.110	0.571	0.000	0.292	0.000	0.016	0.013	0.000	0.000	-[e]	-[e]
2006	0.000	0.235	0.592	0.005	0.148	0.005	0.015	0.000	0.000	0.000	1,606	1,994
Average	0.006	0.235	0.460	0.001	0.271	0.002	0.024	0.001	0.000	0.000	3,946	4,846

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Table 6.–Page 2 of 4.

Females	Total Age (years)/European Age (freshwater years/ocean years)										Female	Female
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.000	0.000	0.131	0.000	0.546	0.000	0.311	0.005	0.000	0.005	2,447	2,301
1987	0.000	0.003	0.022	0.000	0.855	0.000	0.114	0.006	0.000	0.000	3,681	3,084
1988	0.000	0.000	0.060	0.000	0.582	0.000	0.351	0.000	0.000	0.007	2,041	1,134
1989	0.000	0.005	0.187	0.000	0.652	0.000	0.155	0.000	0.000	0.000	1,766	1,238
1990	0.000	0.008	0.194	0.000	0.733	0.000	0.066	0.000	0.000	0.000	2,674	2,034
1991	0.000	0.000	0.120	0.000	0.620	0.000	0.231	0.009	0.009	0.009	1,000	1,000
1992	0.000	0.000	0.284	0.000	0.710	0.000	0.006	0.000	0.000	0.000	2,027	1,207
1993	0.000	0.000	0.258	0.000	0.710	0.000	0.032	0.000	0.000	0.000	1,914	1,437
1994	0.000	0.000	0.182	0.000	0.771	0.004	0.043	0.000	0.000	0.000	5,435	3,848
1995	0.000	0.000	0.131	0.000	0.821	0.000	0.044	0.004	0.000	0.000	7,524	5,885
1996	0.000	0.004	0.210	0.000	0.358	0.000	0.428	0.000	0.000	0.000	3,122	1,914
1997	0.000	0.007	0.058	0.000	0.914	0.000	0.022	0.000	0.000	0.000	4,358	2,772
1998	0.000	0.000	0.532	0.000	0.383	0.000	0.085	0.000	0.000	0.000	1,902	1,346
1999	0.000	0.009	0.181	0.000	0.810	0.000	0.000	0.000	0.000	0.000	4,178	2,958
2000	0.000	0.000	0.145	0.000	0.768	0.000	0.087	0.000	0.000	0.000	1,555	1,019
2001	0.000	0.022	0.175	0.000	0.716	0.000	0.087	0.000	0.000	0.000	4,123	2,919
2002	0.000	0.000	0.137	0.000	0.802	0.000	0.061	0.000	0.000	0.000	3,052	1,904
2003	0.000	0.006	0.271	0.000	0.633	0.000	0.090	0.000	0.000	0.000	4,982	3,527
2004	0.000	0.000	0.086	0.000	0.881	0.000	0.033	0.000	0.000	0.000	5,981	4,235
2005	0.000	0.004	0.402	0.000	0.530	0.004	0.043	0.017	0.000	0.000	-[e]	-[e]
2006	0.000	0.000	0.289	0.000	0.705	0.000	0.006	0.000	0.000	0.000	1,330	942
Average	0.000	0.003	0.193	0.000	0.690	0.000	0.109	0.002	0.000	0.001	3,184	2,283

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Table 6.–Page 3 of 4.

Unadjusted[a]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1986	0.001	0.094	0.508	0.000	0.286	0.014	0.094	0.001	0.000	0.001	9,065	MR
1987	0.000	0.029	0.130	0.000	0.754	0.004	0.080	0.004	0.000	0.000	6,404	MR
1988	0.006	0.105	0.175	0.000	0.464	0.000	0.246	0.000	0.000	0.004	3,346	MR
1989	0.003	0.042	0.295	0.007	0.545	0.003	0.104	0.000	0.000	0.000	2,730	MR
1990	0.000	0.228	0.255	0.002	0.479	0.000	0.036	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.372	0.000	0.410	0.000	0.124	0.003	0.003	0.003	3,172	MR
1992	0.019	0.424	0.234	0.002	0.316	0.002	0.002	0.000	0.000	0.000	5,580	MR
1993	0.005	0.294	0.412	0.000	0.278	0.000	0.011	0.000	0.000	0.000	12,241	CT
1994	0.000	0.029	0.436	0.000	0.508	0.004	0.023	0.000	0.000	0.000	11,877	CT
1995	0.000	0.044	0.208	0.000	0.709	0.000	0.034	0.004	0.000	0.000	11,394	MR
1996	0.021	0.062	0.443	0.000	0.235	0.000	0.239	0.000	0.000	0.000	7,153	MR
1997	0.003	0.372	0.134	0.000	0.480	0.000	0.010	0.001	0.000	0.000	10,810	MR
1998	0.000	0.044	0.724	0.000	0.184	0.000	0.048	0.000	0.000	0.000	4,745	CT
1999	0.000	0.045	0.249	0.000	0.706	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.000	0.201	0.356	0.000	0.356	0.000	0.087	0.000	0.000	0.000	4,694	MR
2001	0.006	0.096	0.336	0.000	0.512	0.000	0.050	0.000	0.000	0.000	9,696	CT
2002	0.000	0.238	0.278	0.000	0.444	0.000	0.040	0.000	0.000	0.000	6,967	MR
2003	0.000	0.051	0.465	0.000	0.416	0.000	0.068	0.000	0.000	0.000	11,100[d]	CT
2004	0.000	0.109	0.172	0.000	0.690	0.000	0.029	0.000	0.000	0.000	9,645	CT
2005	0.000	0.065	0.499	0.000	0.392	0.002	0.027	0.014	0.000	0.000	-[e]	-
2006	0.000	0.127	0.453	0.003	0.403	0.003	0.011	0.000	0.000	0.000	2,936	CT
Average	0.003	0.133	0.340	0.001	0.456	0.002	0.065	0.001	0.000	0.000	7,129	

-continued-

Table 6.–Page 4 of 4.

Adjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1986	0.001	0.094	0.508	0.000	0.286	0.014	0.094	0.001	0.000	0.001	9,065	MR
1987	0.000	0.035	0.156	0.000	0.730	0.004	0.072	0.003	0.000	0.000	6,404	MR
1988	0.011	0.177	0.255	0.000	0.382	0.000	0.173	0.000	0.000	0.002	3,346	MR
1989	0.005	0.062	0.355	0.011	0.485	0.005	0.076	0.000	0.000	0.000	2,730	MR
1990	0.000	0.272	0.267	0.002	0.428	0.000	0.030	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.373	0.000	0.409	0.000	0.123	0.003	0.003	0.003	3,172	MR
1992	0.027	0.574	0.194	0.000	0.204	0.000	0.001	0.000	0.000	0.000	5,580	MR
1993	0.006	0.311	0.421	0.000	0.253	0.000	0.009	0.000	0.000	0.000	12,241	CT
1994	0.000	0.036	0.494	0.000	0.447	0.004	0.019	0.000	0.000	0.000	11,877	CT
1995	0.000	0.063	0.241	0.000	0.661	0.000	0.030	0.004	0.000	0.000	11,394	MR
1996	0.028	0.081	0.517	0.000	0.196	0.000	0.179	0.000	0.000	0.000	7,153	MR
1997	0.004	0.456	0.152	0.000	0.380	0.000	0.007	0.002	0.000	0.000	10,810	MR
1998	0.000	0.053	0.766	0.000	0.141	0.000	0.040	0.000	0.000	0.000	4,745	CT
1999	0.000	0.066	0.288	0.000	0.646	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.003	0.302	0.390	0.000	0.283	0.000	0.022	0.000	0.000	0.000	4,694	MR
2001	0.007	0.114	0.376	0.000	0.462	0.000	0.041	0.000	0.000	0.000	9,696	CT
2002	0.002	0.307	0.302	0.000	0.369	0.000	0.020	0.000	0.000	0.000	6,967	MR
2003	0.000	0.062	0.511	0.000	0.365	0.000	0.062	0.000	0.000	0.000	11,100[d]	CT
2004	0.000	0.166	0.216	0.000	0.591	0.000	0.027	0.000	0.000	0.000	9,645	CT
2005	0.000	0.077	0.519	0.000	0.364	0.001	0.024	0.014	0.000	0.000	-[e]	-
2006	0.000	0.159	0.495	0.003	0.327	0.003	0.012	0.000	0.000	0.000	2,936	CT
Average	0.004	0.169	0.371	0.001	0.400	0.002	0.051	0.001	0.000	0.000	6,749	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using the methods described in Appendix A and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. CV is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundance with large gaps in counts due to flooding, was 8,739 (SE=653) fish.

[e] Escapement was not estimated due to multiple flood events.

Table 7.–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, 1986–2006.

Year	Estimated Abundance	SE	Enumeration Method[a]	Aerial Survey Count	Aerial Survey Condition[b]	Proportion of Total Escapement
1986	9,065	1,080	MR	2,031	Fair	0.22
1987	6,404	557	MR	1,312	Fair	0.20
1988	3,346[c]	556	MR	1,966	Fair–Poor	0.59
1989	2,730	501	MR	1,180	Fair–Good	0.44
1990	5,603	1,164	MR	1,436	Fair-Poor	0.26
1991	3,172	575	MR	1,276	Poor	0.42
1992	5,580	791	MR	825	Fair–Poor	0.16
1993	12,241	387	CT	2,943	Fair	0.24
1994	11,877	479	CT	1,570	Fair–Poor	0.13
1995	11,394	1,210	MR	3,567	Fair	0.37
1996	7,153	913	MR	2,233	Poor–Good	0.31
1997	10,810	1,160	MR	3,495	Fair–Good	0.26
1998	4,745	503	CT	386	Incomplete	0.08
1999	6,485	427	CT	2,412	Fair	0.37
2000	4,694	1,184	MR	906	Poor–Incomplete	0.19
2001	9,696	565	CT	1,487	Good	0.15
2002	6,967	2,466	MR	181	Poor–Incomplete	0.03
2003	11,100[d]	666	CT	139	Poor–Incomplete	0.02
2004	9,645	532	CT	No surveys due to fires in the area.		–
2005	-[e]	-	-	1,608	Poor–Good[f]	
2006	2,936	163	CT	628	Excellent–but early	0.21
					1986–2003 Average	0.25

[a] Estimate was obtained from either mark-recapture (MR) or counting tower (CT) techniques.

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

[c] 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.

[d] Estimate includes an expansion for missed counting days. CV is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundance with large gaps in counts due to flooding, was 8,739 (SE=653) fish.

[e] Escapement was estimated from a predictive regression of Salcha River against Chena River escapements.

[f] Poor – Good as proceeded upriver.

DISCUSSION

In 2006, the Yukon River Chinook salmon preseason outlook was for an average size run that would meet escapement goals, subsistence fishermen's needs, and provide for a small commercial fishery. Midway through the run, it was projected that the lower end of the escapement goal would be met. Therefore, sport fishing bag and possession limits remained status quo. The 2006 estimated escapement of 2,936 Chinook salmon did meet the lower end of the Chena River escapement goal range, but it was significantly less than the 2000–2004 average annual escapement of 7,948 Chinook salmon.

It is unclear why the 2006 Chena River escapement was so low. The majority of the Chinook salmon that returned to the Chena and Salcha rivers in 2006 were ages 1.3 and 1.4 (5 and 6 year old fish) that originated from the 2001 and 2000 brood years, respectively. Chena River Chinook salmon escapements were approximately 9,700 fish in 2001 and 4,700 fish in 2000.

The 2006 age composition estimates did not indicate a lower than average proportion of age-1.4 fish (2000 brood year), but there was a higher than average proportion of age 1.3 (5 year old) males in the escapement (Table 6). Correspondingly, there was a smaller than average proportion of age 1.4 (6 year old) male Chinook salmon. The age composition of females appeared to be similar to the 1995–2005 average. It is unclear why there were higher proportions of young male Chinook salmon returning in 2006. This same pattern of higher than average proportions of age 1.4 Chinook salmon was noted at ASL collection sites throughout the Yukon drainage (Larry DuBois, fishery biologist, ADF&G Division of Commercial Fisheries, Anchorage, personal communication).

One hypothesis for the low returning numbers of Chena River Chinook salmon in 2006 suggested that the Moose Creek Dam closures may have prevented upstream passage of some adult Chinook salmon or caused excessive mortality of juvenile salmon by trapping them in the dam's spillway. However, this is unlikely as the dam gates have only been closed twice since 2000. From August 15–17, 2000 the dam was closed due to a large rainfall event. The majority of adult Chinook salmon would have already passed the dam by that point, and as previously stated there is not a gap in the age structure analysis to indicate a depressed year-class. On May 2, 2002 when the 2000 brood year would have been outmigrating, the dam was closed again, but for less than 15 hours, making it unlikely that a significant number of juvenile Chinook salmon were stranded in the spillway of the dam when it was reopened.

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 (where Day 7 is the day that 1% of the total escapement passed the counting tower). Anchoring escapement curves on a particular day 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. In 2006, the timing of the Chena River Chinook salmon run appears "late" when compared to the average run timing (Figure 3); however this is due to the six days of incomplete or missed counts at the beginning of the run.

The 2006 Chena River carcass survey was more thorough and complete than typical carcass surveys conducted in prior years (Brase and Doxey 2006). Carcass collection was conducted for a total of 21 days from 26 July through 15 August, and two crews were operating on the river for five of those days. Therefore it is questionable if "correcting" the estimated male/female proportions for gender selectivity is appropriate for these survey data. The gender correction is based on years when mark-recapture experiments using electrofishing was conducted, providing data for which size and gender bias could be evaluated and biases in composition estimates could be removed by the choice of estimation model. We speculate that the selectivity associated with carcass surveys, which are usually conducted during or after the peak of spawning, are usually the result of smaller fish (predominantly male) having a lower probability of being sampled during carcass surveys. The lower probability may be a result of lower detectability of small carcasses present in the survey area (difficult to see and/or mistaken for chum salmon) or due to smaller carcasses "washing out" and not being available for sampling. The potential for bias from these sources was lower during the 2006 carcass survey because surveys were conducted regularly throughout the spawning period. However, the raw and "corrected" survey proportions were both estimated for this report because there has not been an analysis to determine under what circumstances the correction factor is necessary. It is suggested that an analysis be performed as part of the spawner-recruit analysis planned for the 2010 escapement goal review.

The final task for the Chena River project in 2006 was to investigate a possible new location for the counting tower. Approximately 10 miles of river were examined upriver from the Moose Creek Dam; however there was no single spot that met all of our criteria of low flow, smooth bottom profile and easy access. We propose that the tower remain in its current location at least through 2007. The Division of Commercial Fisheries plans to install and operate a DIDSON sonar unit on the Chena River in 2007. The sonar will be installed near the dam and used to provide estimates of fish passage during high water periods.

SALCHA RIVER SALMON COUNTING TOWER

INTRODUCTION

The Salcha River, like the Chena River, has some of the largest Chinook salmon escapements in the Yukon drainage 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, then conducted tower-count estimates from 1993 to 1998 (Table 8). A comparison of Chena and Salcha rivers Chinook salmon escapements from 1987–1998 indicated escapements in the two systems were strongly correlated and that Chinook salmon sport fisheries could be adequately managed with escapement data from one of the two rivers. Therefore, Sport Fish Division discontinued a Chinook salmon abundance estimation project in the Salcha River following the 1998 season. Starting in 1999, Bering Sea Fishermen's Association employees began to conduct tower counts. Funding was provided by a grant administered by the US Fish and Wildlife Service (USFWS). The BSFA'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 salmon stock (within the constraints created by river conditions) and allows continued comparison of Chena and Salcha rivers Chinook salmon escapements. Throughout the season, the counts of Salcha River Chinook salmon are provided to ADF&G after each 8-hour shift, and results are presented in this report. Further details regarding this project can be obtained by contacting the USFWS – Fairbanks Fish and Wildlife Field Office referencing study number USRM-07-05.

METHODS

In 2006, one 12-foot tall tower was erected on the right bank (looking upriver) of the Salcha River approximately 0.5 mile upstream of the Richardson Highway Bridge (Figure 4). Project mobilization, escapement enumeration, and data analysis procedures for the Salcha River counting tower were virtually identical to those used for the Chena River.

RESULTS

In 2006, conditions for accurately counting salmon in the Salcha River were similar to those on the Chena River. The Salcha tower did not begin operations until 6 July, so it is likely some fish were missed at the very beginning of the run. Tower counts were impacted for four days near the beginning of the run due to damaged equipment. After the equipment was repaired, tower operations continued through 18 August (Table 9). The 2006 Salcha River escapements were estimated at 11,183 Chinook salmon (SE=348) and 113,960 chum salmon (SE=1,190). The Chinook salmon escapement surpassed the upper end of the BEG range. Mean day of passage was similar to the average with 50% of the run passing the tower by Day 20; however, the run was more compressed than average (Figure 5).

Table 8.–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, 1987–2006.

Year	Estimated Abundance	SE	Estimation Method[a]	Aerial Survey Count	Aerial Survey Condition[b]	Proportion of Total Escapement
1987	4,771	504	MR	1,898	Fair	0.40
1988	4,322	376	MR	2,761	Good	0.61
1989	3,294	630	MR	2,333	Good	0.71
1990	10,728	1,404	MR	3,744	Good	0.35
1991	5,608	664	MR	2,212	Poor	0.39
1992	7,862	975	MR	1,484	Fair-Poor	0.19
1993	10,007	360	CT	3,636	Fair	0.36
1994	18,399	549	CT	11,823	Good	0.64
1995	13,643	471	CT	3,978	Fair-Good	0.29
1996	7,570	1,238	MR	4,866	Fair-Good	0.64
1997	18,514	1,043	CT	3,458	Poor	0.19
1998	5,027	331	CT	1,985	Poor	0.39
1999	9,198	290	CT	3,570	Fair	0.39
2000	4,595	802	CT	2,478	Poor	0.53
2001	13,328	2,163	CT	2,990	Good	N/A
2002	9,000[c]	160	CT	2,416	Fair	N/A
2003	15,500[c]	775	CT	N/A	N/A	N/A
2004	15,761	612	CT	No survey		N/A
2005	5,988	163	CT	5,295	Good	0.88
2006	11,183	348	CT	492	Fair - early	0.044

[a] MR indicates that estimate was obtained from mark-recapture techniques, CT indicates counting tower.

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

[c] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundances with large gaps in counts due to flooding were 4,644 (SE=160) in 2002 and 11,758 (SE=747) in 2003.

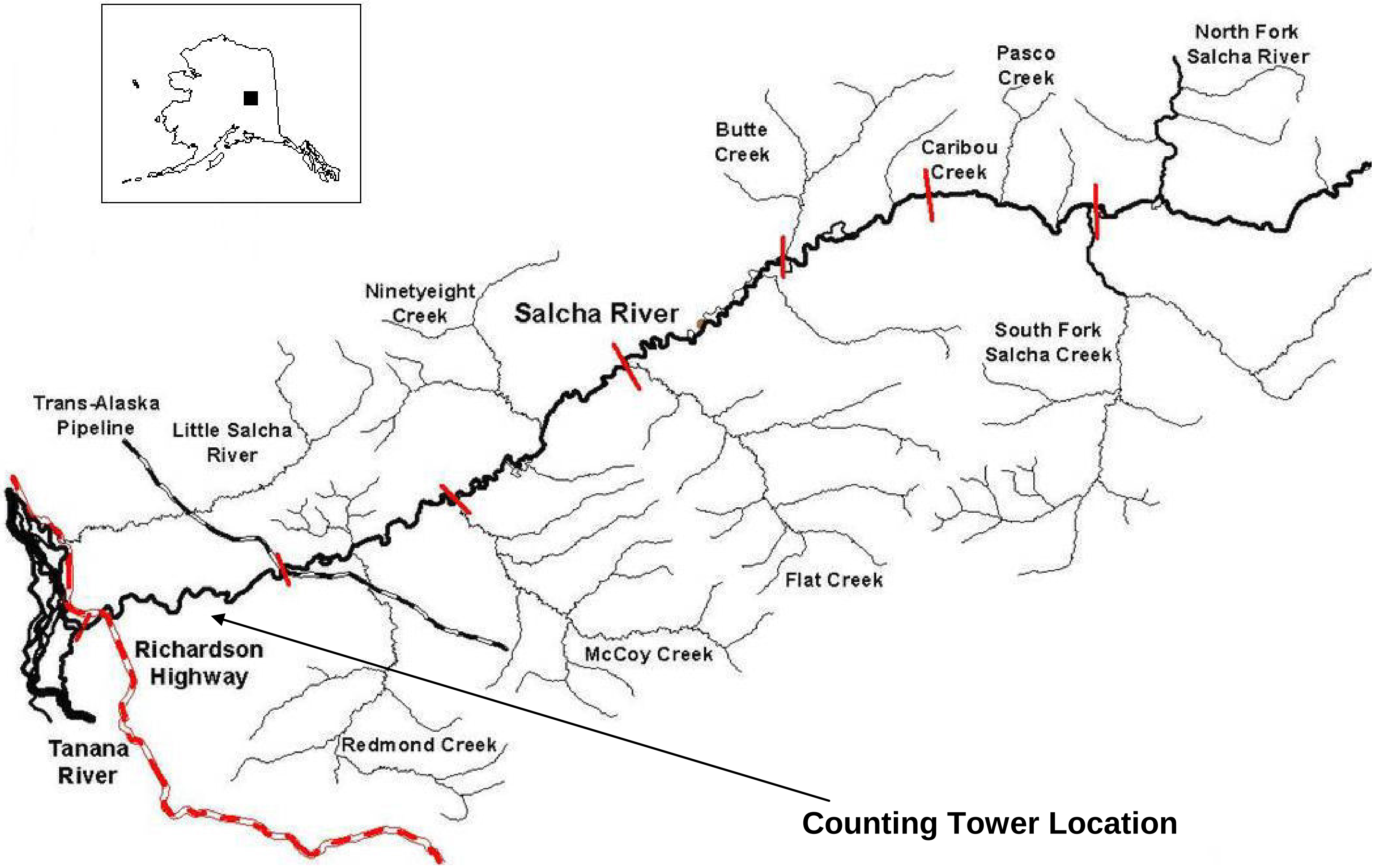

Figure 4.–Salcha River drainage with location of counting tower.

Table 9.–Daily Chinook and chum salmon passage at the counting site on the Salcha River, 2006. Shaded cells indicate days with missing or incomplete counts.

Date	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
6-Jul-06	8	2	18	5	0	0	0
7-Jul-06	24	4	12	4	0	0	0
8-Jul-06	24	0	0	0	0	0	0
9-Jul-06	0	0	0	N/A	0	0	N/A
10-Jul-06	8	6	54	14	0	0	0
11-Jul-06	24	14	42	8	2	6	3
12-Jul-06	24	17	51	16	1	3	3
13-Jul-06	11	14	86	24	0	0	0
14-Jul-06	0	0	**184**	**49**	0	**22**	**2**
15-Jul-06	0	0	**321**	**86**	0	**25**	**3**
16-Jul-06	8	46	414	111	7	63	7
17-Jul-06	24	154	462	62	4	12	5
18-Jul-06	24	288	864	77	37	111	20
19-Jul-06	24	415	1,245	94	50	150	24
20-Jul-06	24	216	648	66	179	537	96
21-Jul-06	24	97	291	95	524	1,572	104
22-Jul-06	24	305	915	172	648	1,944	191
23-Jul-06	24	200	600	78	849	2,547	247
24-Jul-06	24	188	564	73	1,551	4,653	206
25-Jul-06	24	541	1,623	113	2,707	8,121	387
26-Jul-06	24	494	1,482	65	2,157	6,471	168
27-Jul-06	24	139	417	66	2,070	6,210	441
28-Jul-06	24	115	345	42	2,055	6,165	375
29-Jul-06	24	61	183	27	2,668	8,004	330
30-Jul-06	24	26	78	9	2,844	8,532	433
31-Jul-06	24	30	90	16	2,286	6,858	291
1-Aug-06	24	17	51	8	1,627	4,881	160
2-Aug-06	24	10	30	8	1,820	5,460	291
3-Aug-06	24	10	30	11	2,080	6,240	223
4-Aug-06	24	20	60	15	1,717	5,151	159
5-Aug-06	24	2	6	5	1,674	5,022	188
6-Aug-06	24	2	6	6	1,240	3,720	197
7-Aug-06	24	4	12	5	1,087	3,261	118
8-Aug-06	24	0	0	0	806	2,418	116
9-Aug-06	24	1	3	3	814	2,442	78
10-Aug-06	24	0	0	0	781	2,343	112
11-Aug-06	24	0	0	0	744	2,232	139
12-Aug-06	24	0	0	0	579	1,737	74
13-Aug-06	24	0	0	0	382	1,146	73
14-Aug-06	24	-1	-3	3	393	1,179	81
15-Aug-06	24	0	0	0	351	1,053	45
16-Aug-06	24	0	0	0	551	1,653	88
17-Aug-06	24	0	0	0	337	1,011	71
18-Aug-06	24	0	0	0	335	1,005	61
Totals	923	3,437	11,183	348	37,957	113,960	1,190

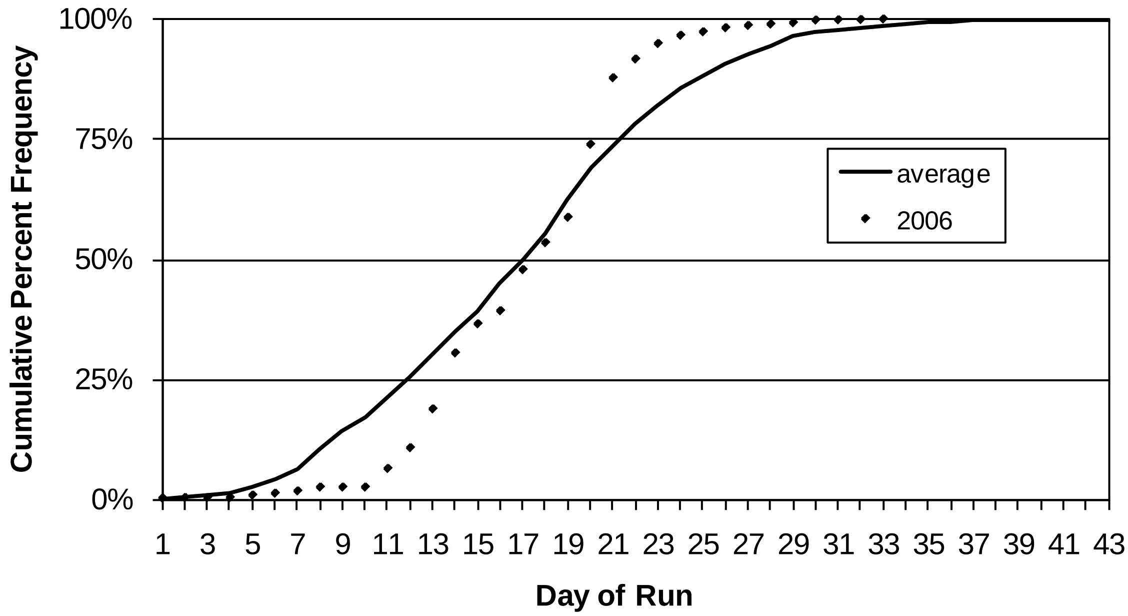

Figure 5.–Day of run cumulative percent frequency for Salcha River Chinook salmon comparing 2006 with the 1993–1995, 1997–2000, 2004–2005 average.

AGE-SEX-LENGTH COMPOSITIONS

In 2006, Chinook salmon carcasses were collected along the Salcha River from 28 July through 14 August. A total of 567 Chinook salmon carcasses were collected. The sex composition for this sample, including those fish not aged, was 0.56 males and 0.44 females (Table 10). The Salcha River gender bias correction factor has been estimated at 0.867 (Appendix A). The estimated proportion of females in the 2006 escapement, adjusted for gender selectivity, was 0.34 (SE=0.09). However, the correction factor for the Salcha River is very imprecise due to large annual variation in selectivity between years.

Ages were determined for 509 (90%) of the fish collected in 2006. The largest age class for males sampled and aged was age 1.3 (72%; Tables 10 & 11). Males were also represented by ages 1.2, 1.4, and 1.5. Age 1.4 dominated among aged females (76%). Females were also represented by ages 1.3, 2.3, and 1.5.

DISCUSSION

As previously stated, the 2006 Yukon drainage Chinook salmon preseason outlook was for an average to below average run. However, by late July, it was apparent that the Salcha River was going to exceed the upper end of the BEG range. Therefore, on July 27 a sport fish emergency order was issued that liberalized the Salcha River Chinook salmon daily bag and possession limit from 1 to 2 Chinook salmon 20 inches or greater in length (Brase 2006). This emergency order was only issued for the Salcha River, as the Chena River Chinook salmon run did not appear to have a large enough surplus to warrant liberalizing the sport fishery.

Historically, Chinook salmon escapements to the Salcha and Chena rivers have roughly mirrored one another, with high or low escapements being seen in both rivers in a given year (Figure 6). However in 2006 the Chena River barely made the lower end of the BEG range, whereas the Salcha River escapement was significantly higher than the upper end of the BEG range. Because the run timing of Chena and Salcha River Chinook salmon is about the same, it is unlikely that the Chena River stock was exploited at a higher rate than the Salcha River stock in the downriver fisheries. It is more likely that some inriver condition varied between the two locations. As previously stated in this report, the majority of the Chinook salmon that returned to the Chena and Salcha rivers in 2006 were age 1.3 and 1.4 (5 and 6 year old) fish that would have come from the 2001 and 2000 brood years respectively. Chena River Chinook salmon escapements were approximately 9,700 fish in 2001 and 4,700 fish in 2000. Salcha River Chinook salmon escapements were approximately 13,300 fish in 2001 and 4,600 fish in 2000. Therefore, there was not a large discrepancy in the escapements between the two years. The 2006 age composition of the two rivers was similar (Tables 6 and 11) although the Salcha River had a lower proportion of 4 year old (age 1.2) male Chinook salmon than the Chena River.

It is suggested that in future Chinook salmon escapement goal examinations an analysis be performed to determine whether the Chena and Salcha rivers are indeed good surrogates for each other's escapement. The Salcha River sex composition "correction factor" should also be assessed along with the Chena River as part of the spawner-recruit analysis planned for the 2010 escapement goal review.

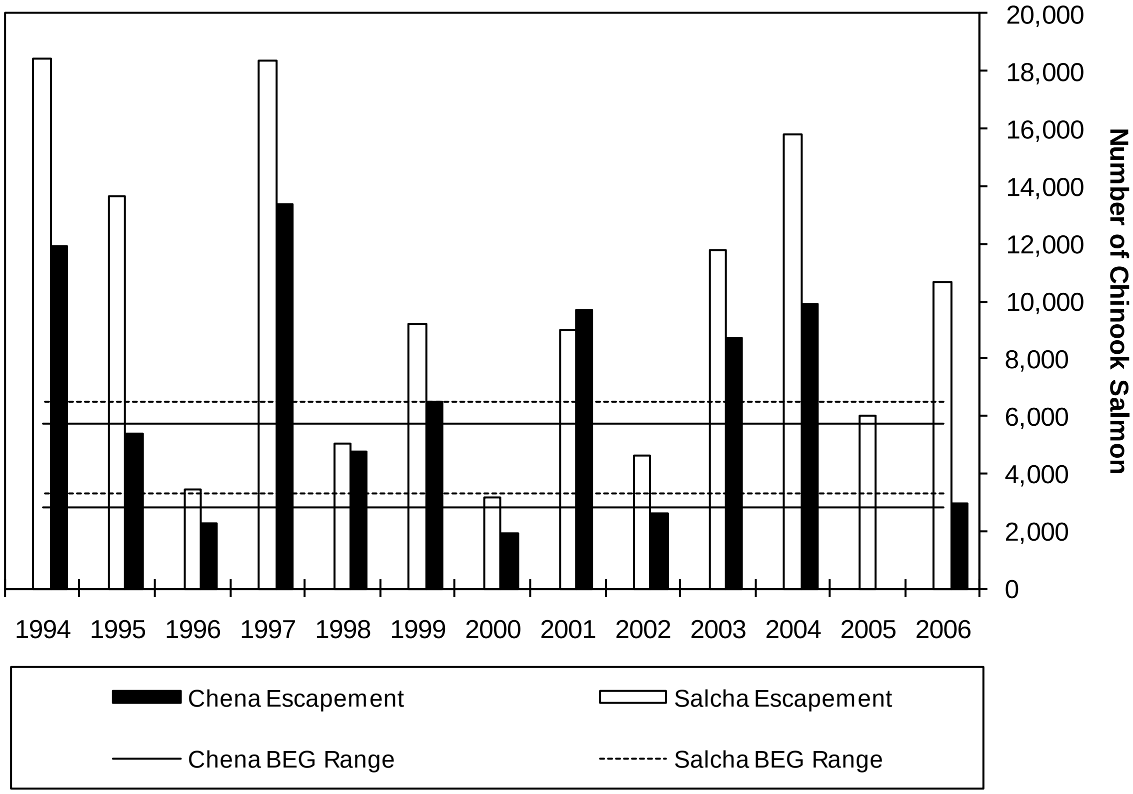

Figure 6.–Comparison of Chena and Salcha rivers' Chinook salmon escapements and their respective escapement goal ranges, 1994–2006. Escapements were estimated using counting tower or mark-recapture methodologies.

Table 10.–Age composition and mean length by sex and age class of Chinook salmon in the Salcha River, 2006.

Age[a]	Sample Size	Sample Proportion	Length			
			Mean	SE	Min	Max
Male						
1.2	29	0.101	557	10	460	660
1.3	206	0.715	709	5	460	915
1.4	50	0.174	828	15	540	1,000
1.5	3	0.010	930	-	885	970
Total Aged	288	-	717	6	460	1,000
Total Males[b]	318	0.57	717	6	415	1,000
Corrected Total[c]	-	0.62	-	-	-	-
Female						
1.3	45	0.204	803	7	710	960
1.4	168	0.760	869	4	660	995
2.3	1	0.005	625	-	-	-
1.5	7	0.032	936	26	850	1,010
Total Aged	221	-	857	4	625	1,010
Total Females[b]	249	0.43	856	4	625	1,010
Corrected Total[c]	-	0.38	-	-	-	-

[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).

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

[c] Estimated proportion of females was corrected by a factor of 0.867.

Table 11.–Proportions of male and female Chinook salmon sampled from carcass surveys on the Salcha River, 1987–2006.

	Sexed Sample Size		Sexed Sample Proportion[a]		Sexed and Aged Sample Size		Sexed and Aged Sample Proportion[a]		Adjusted Proportion[b]		Total	
Year	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Escapement	Method[c]
1987	315	536	0.37	0.63	204	345	0.37	0.63	0.48	0.52	4,771	MR
1988	448	423	0.51	0.49	300	197	0.60	0.40	0.55	0.45	4,322	MR
1989	139	171	0.45	0.55	84	137	0.38	0.62	0.56	0.44	3,294	MR
1990	716	601	0.54	0.46	261	265	0.50	0.50	0.64	0.36	10,728	MR
1991	388	318	0.55	0.45	272	241	0.53	0.47	0.59	0.41	5,608	MR
1992	606	343	0.64	0.36	429	220	0.66	0.34	0.64	0.36	7,862	MR
1993	418	150	0.74	0.26	328	125	0.72	0.28	0.76	0.24	10,007	CT
1994	330	288	0.53	0.47	287	233	0.55	0.45	0.61	0.39	18,399	CT
1995	290	368	0.44	0.56	240	305	0.44	0.56	0.51	0.49	13,643	CT
1996	235	236	0.50	0.50	203	210	0.49	0.51	0.74	0.26	7,570	MR
1997	113	105	0.52	0.48	90	90	0.50	0.50	0.57	0.43	18,514	CT
1998	104	44	0.70	0.30	86	37	0.70	0.30	0.74	0.26	5,027	CT
1999	175	185	0.49	0.51	139	168	0.45	0.55	0.53	0.47	9,198	CT
2000	29	19	0.60	0.40	23	18	0.56	0.44	0.62	0.38	4,595	CT
2001	194	114	0.63	0.37	120	72	0.63	0.38	0.67	0.33	13,328	CT
2002	212	111	0.66	0.34	184	98	0.65	0.35	0.70	0.30	9,000[d]	CT
2003	96	70	0.58	0.42	87	57	0.60	0.40	0.66	0.34	15,500[d]	CT
2004	90	150	0.38	0.63	85	144	0.37	0.63	0.45	0.55	15,761	CT
2005	295	357	0.45	0.55	275	327	0.46	0.54	0.53	0.47	5,988	CT
2006	318	249	0.56	0.44	288	221	0.57	0.43	0.62	0.38	10,679	CT
Average	276	242	0.54	0.46	199	176	0.54	0.46	0.61	0.39	9,690	

[a] Estimated proportions were all derived from carcass samples.

[b] In years when counting tower assessments (CT) were conducted and only carcass surveys were conducted, proportions of males and females were adjusted using the methods shown in Appendix A. In years when mark-recapture experiments (MR) were conducted, proportions of males and females were estimated as the ratio of the abundance estimate of each gender to the abundance estimate of all fish.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundances with large gaps in counts due to flooding were 4,644 (SE=160) in 2002 and 11,758 (SE=747) in 2003.

Table 12.–Age composition and escapement estimates by gender and combined (unadjusted and adjusted) of Salcha River Chinook salmon, 1987–2006.

Males	Total Age (years)/European Age (freshwater years/ocean years)										Male	Male
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.005	0.152	0.275	0.000	0.544	0.000	0.025	0.000	0.000	0.000	1,766	2,290
1988	0.007	0.333	0.330	0.000	0.243	0.000	0.083	0.003	0.000	0.000	2,223	2,363
1989	0.012	0.107	0.548	0.000	0.333	0.000	0.000	0.000	0.000	0.000	1,477	1,853
1990	0.004	0.333	0.352	0.000	0.268	0.000	0.042	0.000	0.000	0.000	5,832	6,845
1991	0.004	0.143	0.489	0.000	0.309	0.000	0.051	0.000	0.004	0.000	3,082	3,325
1992	0.019	0.543	0.338	0.007	0.084	0.005	0.005	0.000	0.000	0.000	5,020	5,031
1993	0.012	0.384	0.454	0.000	0.146	0.003	0.000	0.000	0.000	0.000	7,364	7,613
1994	0.010	0.035	0.561	0.000	0.366	0.000	0.028	0.000	0.000	0.000	9,825	11,251
1995	0.000	0.296	0.292	0.000	0.388	0.000	0.021	0.004	0.000	0.000	6,013	7,023
1996	0.054	0.118	0.567	0.000	0.177	0.000	0.084	0.000	0.000	0.000	3,777	5,588
1997	0.000	0.256	0.244	0.000	0.489	0.000	0.011	0.000	0.000	0.000	9,597	10,488
1998	0.035	0.070	0.756	0.000	0.128	0.000	0.012	0.000	0.000	0.000	3,532	3,716
1999	0.000	0.201	0.374	0.000	0.424	0.000	0.000	0.000	0.000	0.000	4,471	4,834
2000	0.000	0.304	0.565	0.000	0.130	0.000	0.000	0.000	0.000	0.000	2,776	2,846
2001	0.008	0.167	0.425	0.000	0.400	0.000	0.000	0.000	0.000	0.000	8,395	8,995
2002	0.000	0.554	0.190	0.000	0.179	0.000	0.076	0.000	0.000	0.000	5,907	6,288
2003	0.011	0.126	0.598	0.000	0.241	0.000	0.023	0.000	0.000	0.000	8,964	10,181
2004	0.000	0.247	0.176	0.000	0.576	0.000	0.000	0.000	0.000	0.000	5,910	7,168
2005	0.000	0.204	0.516	0.000	0.265	0.000	0.011	0.004	0.000	0.000	2,709	3,168
2006	0.000	0.101	0.715	0.000	0.174	0.000	0.010	0.000	0.000	0.000	5,989	6,659
Average	0.009	0.234	0.438	0.000	0.293	0.000	0.024	0.001	0.000	0.000	5,232	5,876

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Table 12.–Page 2 of 4.

Females	Total Age (years)/European Age (freshwater years/ocean years)										Female	Female
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.000	0.003	0.038	0.000	0.849	0.000	0.110	0.000	0.000	0.000	3,005	2,481
1988	0.000	0.005	0.066	0.000	0.690	0.000	0.239	0.000	0.000	0.000	2,099	1,959
1989	0.000	0.000	0.131	0.000	0.730	0.000	0.139	0.000	0.000	0.000	1,817	1,441
1990	0.000	0.008	0.147	0.000	0.713	0.000	0.132	0.000	0.000	0.000	4,896	3,883
1991	0.000	0.000	0.133	0.000	0.680	0.000	0.183	0.000	0.004	0.000	2,526	2,283
1992	0.000	0.005	0.327	0.000	0.650	0.000	0.014	0.005	0.000	0.000	2,842	2,831
1993	0.000	0.008	0.224	0.000	0.736	0.000	0.032	0.000	0.000	0.000	2,643	2,394
1994	0.000	0.017	0.185	0.000	0.721	0.004	0.073	0.000	0.000	0.000	8,574	7,148
1995	0.000	0.010	0.138	0.000	0.816	0.000	0.030	0.007	0.000	0.000	7,630	6,620
1996	0.000	0.005	0.205	0.000	0.390	0.000	0.400	0.000	0.000	0.000	3,793	1,982
1997	0.000	0.033	0.044	0.000	0.900	0.000	0.022	0.000	0.000	0.000	8,917	8,026
1998	0.000	0.000	0.649	0.000	0.297	0.000	0.054	0.000	0.000	0.000	1,495	1,311
1999	0.000	0.000	0.131	0.000	0.863	0.000	0.006	0.000	0.000	0.000	4,727	4,364
2000	0.000	0.111	0.389	0.000	0.389	0.000	0.111	0.000	0.000	0.000	1,819	1,749
2001	0.000	0.000	0.194	0.000	0.722	0.000	0.083	0.000	0.000	0.000	4,933	4,333
2002	0.000	0.000	0.041	0.000	0.776	0.000	0.184	0.000	0.000	0.000	3,093	2,712
2003	0.000	0.000	0.211	0.000	0.754	0.000	0.035	0.000	0.000	0.000	6,536	5,319
2004	0.000	0.000	0.028	0.000	0.958	0.000	0.014	0.000	0.000	0.000	9,851	8,593
2005	0.000	0.000	0.330	0.000	0.627	0.000	0.043	0.000	0.000	0.000	3,279	2,820
2006	0.000	0.000	0.204	0.000	0.760	0.005	0.032	0.000	0.000	0.000	4,690	4,020
2007	0.000	0.009	0.100	0.000	0.882	0.000	0.009	0.000	0.000	0.000	2,295	1,989
2008	0.000	0.000	0.303	0.000	0.655	0.000	0.042	0.000	0.000	0.000	2,108	1,844
2009	0.000	0.000	0.056	0.000	0.939	0.000	0.006	0.000	0.000	0.000	5,000	4,328
Average	0.000	0.010	0.191	0.000	0.701	0.000	0.097	0.001	0.000	0.000	4,458	3,813

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Table 12.–Page 3 of 4.

Unadjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.058	0.126	0.000	0.736	0.000	0.078	0.000	0.000	0.000	4,771	MR
1988	0.004	0.203	0.225	0.000	0.421	0.000	0.145	0.002	0.000	0.000	4,322	MR
1989	0.005	0.041	0.290	0.000	0.579	0.000	0.086	0.000	0.000	0.000	3,294	MR
1990	0.002	0.169	0.249	0.000	0.492	0.000	0.087	0.000	0.000	0.000	10,728	MR
1991	0.002	0.076	0.322	0.000	0.483	0.000	0.113	0.000	0.004	0.000	5,608	MR
1992	0.012	0.361	0.334	0.005	0.276	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.280	0.391	0.000	0.309	0.002	0.009	0.000	0.000	0.000	10,007	CT
1994	0.006	0.027	0.392	0.000	0.525	0.002	0.048	0.000	0.000	0.000	18,399	CT
1995	0.000	0.136	0.206	0.000	0.628	0.000	0.026	0.006	0.000	0.000	13,643	CT
1996	0.027	0.061	0.383	0.000	0.286	0.000	0.245	0.000	0.000	0.000	7,570	MR
1997	0.000	0.144	0.144	0.000	0.694	0.000	0.017	0.000	0.000	0.000	18,514	CT
1998	0.024	0.049	0.724	0.000	0.179	0.000	0.024	0.000	0.000	0.000	5,027	CT
1999	0.000	0.091	0.241	0.000	0.664	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.220	0.488	0.000	0.244	0.000	0.049	0.000	0.000	0.000	4,595	CT
2001	0.005	0.104	0.339	0.000	0.521	0.000	0.031	0.000	0.000	0.000	13,328	CT
2002	0.000	0.362	0.138	0.000	0.387	0.000	0.113	0.000	0.000	0.000	9,000[d]	CT
2003	0.007	0.076	0.444	0.000	0.444	0.000	0.028	0.000	0.000	0.000	15,500[d]	CT
2004	0.000	0.092	0.083	0.000	0.817	0.000	0.009	0.000	0.000	0.000	15,761	CT
2005	0.000	0.093	0.415	0.000	0.462	0.000	0.028	0.002	0.000	0.000	5,988	CT
2006	0.000	0.057	0.493	0.000	0.428	0.002	0.020	0.000	0.000	0.000	10,679	CT
Average	0.005	0.135	0.321	0.000	0.479	0.000	0.058	0.001	0.000	0.000	9,690	

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Table 12.–Page 4 of 4.

Adjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.074	0.151	0.000	0.703	0.000	0.069	0.000	0.000	0.000	4,771	MR
1988	0.004	0.185	0.210	0.000	0.446	0.000	0.154	0.002	0.000	0.000	4,322	MR
1989	0.007	0.060	0.366	0.000	0.507	0.000	0.061	0.000	0.000	0.000	3,294	MR
1990	0.002	0.215	0.278	0.000	0.429	0.000	0.075	0.000	0.000	0.000	10,728	MR
1991	0.002	0.085	0.344	0.000	0.460	0.000	0.105	0.000	0.004	0.000	5,608	MR
1992	0.012	0.349	0.334	0.004	0.288	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.298	0.402	0.000	0.281	0.002	0.007	0.000	0.000	0.000	10,007	CT
1994	0.006	0.028	0.409	0.000	0.509	0.002	0.046	0.000	0.000	0.000	18,399	CT
1995	0.000	0.158	0.217	0.000	0.595	0.000	0.025	0.005	0.000	0.000	13,643	CT
1996	0.040	0.089	0.472	0.000	0.233	0.000	0.167	0.000	0.000	0.000	7,570	MR
1997	0.000	0.163	0.161	0.000	0.661	0.000	0.016	0.000	0.000	0.000	18,514	CT
1998	0.026	0.052	0.728	0.000	0.172	0.000	0.023	0.000	0.000	0.000	5,027	CT
1999	0.000	0.112	0.266	0.000	0.620	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.238	0.505	0.000	0.219	0.000	0.038	0.000	0.000	0.000	4,595	CT
2001	0.006	0.113	0.351	0.000	0.503	0.000	0.027	0.000	0.000	0.000	13,328	CT
2002	0.000	0.389	0.146	0.000	0.357	0.000	0.108	0.000	0.000	0.000	9,000[d]	CT
2003	0.007	0.080	0.456	0.000	0.429	0.000	0.027	0.000	0.000	0.000	15,500[d]	CT
2004	0.000	0.113	0.096	0.000	0.783	0.000	0.008	0.000	0.000	0.000	15,761	CT
2005	0.000	0.107	0.428	0.000	0.437	0.000	0.026	0.002	0.000	0.000	5,988	CT
2006	0.000	0.062	0.520	0.000	0.397	0.002	0.019	0.000	0.000	0.000	10,679	CT
Average	0.006	0.148	0.342	0.000	0.451	0.000	0.050	0.001	0.000	0.000	9,690	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using the methods described in Appendix A and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundances with large gaps in counts due to flooding were 4,644 (SE=160) in 2002 and 11,758 (SE=747) in 2003.

GOODPASTER RIVER SALMON COUNTING TOWER

INTRODUCTION

The mainstem Goodpaster River is approximately 132 miles long and has a drainage area of 2,417 square miles. The Goodpaster River is a rapid run-off stream that ranges from clear in the upper reaches to slightly tannin stained below the South Fork. The GPR may become turbid during periods of heavy run-off (Tack 1980). The Goodpaster River is believed to be the furthest upriver Chinook salmon spawning location in the Tanana River drainage. In 2007, a proposal was passed by the Alaska Board of Fisheries to allow sport fishing for Chinook salmon on the Goodpaster River below the South Fork for catch and release fishing only.

Aerial surveys have been conducted intermittently by ADF&G and/or independent contractors since 1990 (Table 13). The Chinook salmon counting tower on the Goodpaster River began operations in 2004. It is operated by staff from Tanana Chiefs Conference and the Bering Sea Fisherman's Association with funding provided by the Teck-Pogo, Inc.

Unlike the Chena and Salcha rivers, the Goodpaster River does not have an escapement goal and counts are not provided to the fisheries managers on a daily basis. In the future, as a longer time series is developed, an escapement goal may be developed and managed for.

METHODS

The Goodpaster counting tower is located on the North Fork Goodpaster River approximately 42 miles upstream from the mouth of the Goodpaster River (Figure 7). Salmon are counted from an elevated tower located on the right bank of the river (going upriver). White flash panels, identical to what are currently used on the Chena and Salcha river counting towers, are placed in the river and the salmon are enumerated as they pass over the panels. Counting protocols are nearly identical to what are used on the Chena and Salcha rivers (20 minutes per hour for 24 hours a day). The Goodpaster tower is in a remote area, and the technicians assigned to work at the tower live on-site throughout the duration of the Chinook salmon run.

It is unknown what proportion of the Goodpaster River Chinook salmon stock may spawn up the South Fork of the river, but various aerial surveys suggest little if any spawning occurs there. Therefore the estimates of escapements produced by this project should not be considered totally inclusive, but rather representative of the Goodpaster River, until such time as the significance of the South Fork can be ascertained.

The Goodpaster River has not been sampled for Chinook salmon ASL composition, although samples have been taken for genetic identification.

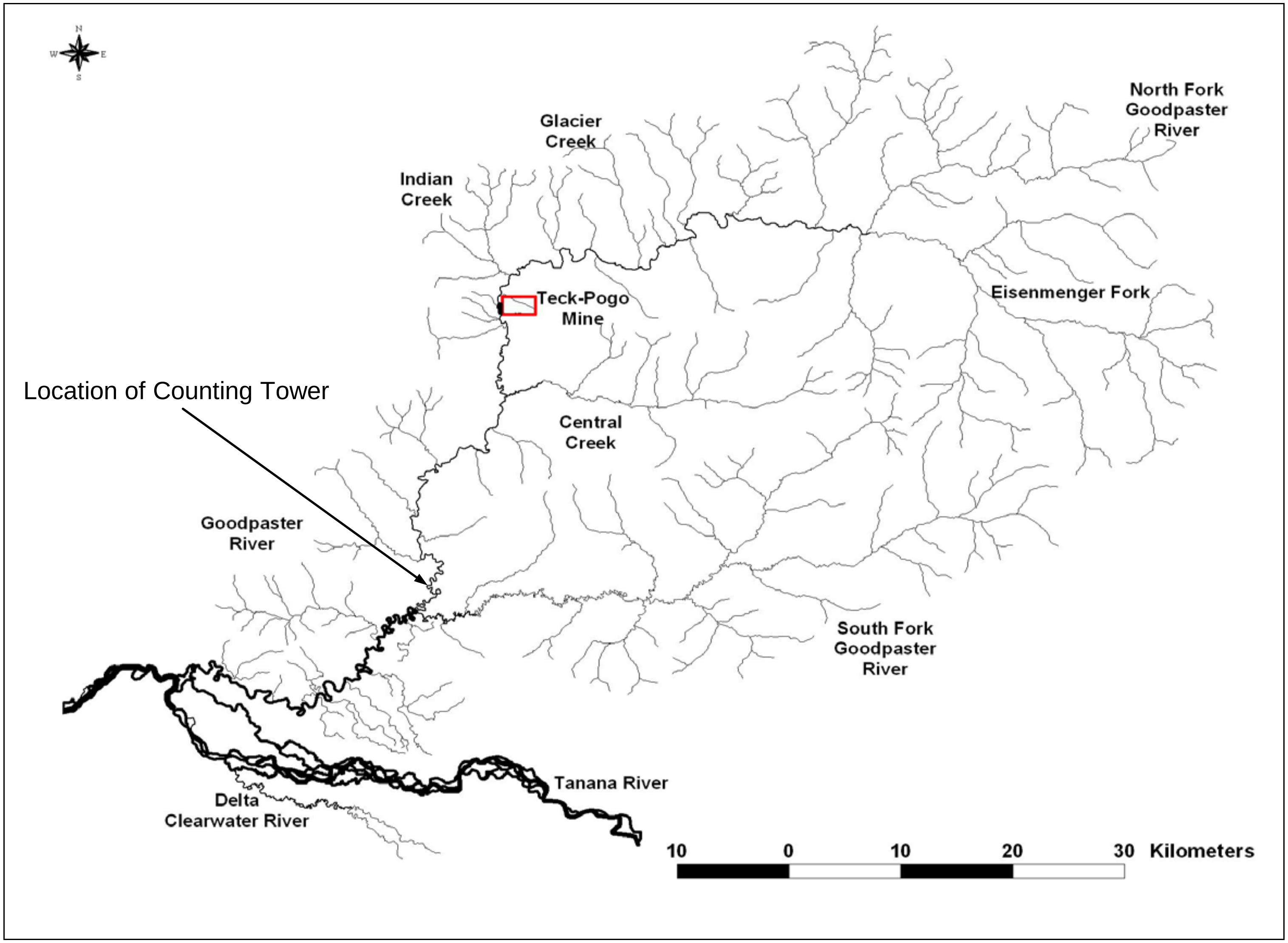

Figure 7–Goodpaster River drainage and location of salmon counting tower.

RESULTS

In 2004 counting tower operations occurred from 30 June through 31 July (Table 14). The first fish was seen on 8 July and there were no missed days of counts. The estimate of escapement was 3,686 Chinook salmon (SE = 106).

Counting tower operations in 2005 ran from 15–31 July (Table 15). Operations did not begin prior to 15 July due to high water in the area and the projected late run of salmon. The estimate of escapement was 1,122 Chinook salmon (SE = 69). Historical indications are that the run does not arrive in the Goodpaster River until after the 4th of July, so it was assumed that the first 10 days of the run was missed.

The 2006 counting operations ran from 7 July to 2 August (Table 16). The first fish was seen on 9 July and there were no missed days of counts. The estimate of escapement was 2,365 Chinook salmon (SE = 97).

Table 13.–Estimated Chinook salmon abundance from counting tower and highest counts of Chinook salmon during aerial surveys of the Goodpaster River, 1998–2006.

Year	Estimated Abundance	SE	Estimation Method	Aerial Survey[b] Count	Condition[a]
1990	-	-	-	510	unknown
1991	-	-	-	868	unknown
1992	-	-	-	148	unknown
1993	-	-	-	224	unknown
1994	-	-	-	1,392	unknown
1995	-	-	-	621	unknown
1996	-	-	-	No Survey	-
1997	-	-	-	No Survey	-
1998	-	-	-	477	fair
1999	-	-	-	1,743	good
2000	-	-	-	2,175	good
2001	-	-	-	1,457	good
2002	-	-	-	1,440	excellent
2003	-	-	-	3,004	fair-good
2004	3,686	106	Tower	480	fair-good
2005	1,034	54	Tower	No Survey	-
2006	2,365	97	Tower	884	good

[a] Survey conditions were rated as excellent, good, fair or poor.

[b] Surveys from fixed wing aircraft 1990–1995, helicopter 1998–current year.

Table 14.–Daily Chinook salmon passage at the counting site on the Goodpaster River, 2004.

Date	Number Of Counts	Chinook Salmon Number Counted	Estimated Passage	SE
30-Jun-04	24	0	0	0
1-Jul-04	24	0	0	0
2-Jul-04	24	0	0	0
3-Jul-04	24	0	0	0
4-Jul-04	24	0	0	0
5-Jul-04	24	0	0	0
6-Jul-04	24	0	0	0
7-Jul-04	24	0	0	0
8-Jul-04	24	1	3	3
9-Jul-04	24	4	12	5
10-Jul-04	24	7	21	7
11-Jul-04	24	26	78	16
12-Jul-04	24	45	135	20
13-Jul-04	24	123	369	28
14-Jul-04	24	132	396	40
15-Jul-04	24	149	447	34
16-Jul-04	24	111	333	38
17-Jul-04	24	123	369	33
18-Jul-04	24	120	360	30
19-Jul-04	24	82	246	25
20-Jul-04	24	66	198	21
21-Jul-04	24	55	165	25
22-Jul-04	24	37	111	17
23-Jul-04	24	24	72	15
24-Jul-04	24	46	138	22
25-Jul-04	24	22	66	12
26-Jul-04	24	18	54	13
27-Jul-04	24	10	30	8
28-Jul-04	24	13	39	14
29-Jul-04	24	8	24	7
30-Jul-04	24	4	12	6
31-Jul-04	19	1	8	6
Totals	763	1,227	3,686	106

Table 15.–Daily Chinook salmon passage at the counting site on the Goodpaster River, 2005. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Number Of Counts	Chinook Salmon Number Counted	Chinook Salmon Estimated Passage	Chinook Salmon SE
15-Jul-05	11	24	67	19
16-Jul-05	24	33	99	21
17-Jul-05	24	47	141	16
18-Jul-05	24	38	114	21
19-Jul-05	21	16	48	18
20-Jul-05	6	1	3	-
21-Jul-05	24	19	57	9
22-Jul-05	22	29	91	15
23-Jul-05	24	25	75	10
24-Jul-05	24	20	60	10
25-Jul-05	24	28	84	13
26-Jul-05	24	25	75	11
27-Jul-05	24	16	48	10
28-Jul-05	24	14	42	9
29-Jul-05	24	5	15	7
30-Jul-05	24	5	15	6
31-Jul-05	24	0	0	0
Totals	372	345	1,122	69

Table 16.–Daily Chinook salmon passage at the counting site on the Goodpaster River, 2006. Shaded cells indicate days with missing or incomplete counts due to high and/or turbid water.

Date	Number Of Counts	Chinook Salmon		
		Number Counted	Estimated Passage	SE
7-Jul-06	5	0	0	0
8-Jul-06	24	0	0	0
9-Jul-06	24	1	3	3
10-Jul-06	24	2	6	4
11-Jul-06	24	6	18	5
12-Jul-06	24	3	9	4
13-Jul-06	24	12	36	10
14-Jul-06	24	10	30	7
15-Jul-06	24	26	78	21
16-Jul-06	24	52	156	21
17-Jul-06	24	49	147	30
18-Jul-06	24	69	207	30
19-Jul-06	24	51	153	30
20-Jul-06	24	62	186	33
21-Jul-06	24	93	279	30
22-Jul-06	24	75	225	29
23-Jul-06	24	54	162	21
24-Jul-06	24	55	165	24
25-Jul-06	24	36	108	18
26-Jul-06	24	30	90	15
27-Jul-06	24	31	93	15
28-Jul-06	24	24	72	20
29-Jul-06	24	20	60	10
30-Jul-06	17	7	35	16
31-Jul-06	24	6	18	8
1-Aug-06	21	5	17	9
2-Aug-06	20	4	12	6
Totals	615	783	2,365	97

DELTA CLEARWATER RIVER COHO SALMON COUNTS

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 8). 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 1). Subsistence or personal use fishing also occurs in each district.

Coho salmon in the DCR support a popular fall 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 (Table 17).

Historically, escapements of coho salmon into the DCR have been monitored by counting fish from a drifting riverboat (Parker 1991). From 1994–1998 aerial surveys (using a helicopter) 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 2003 the Alaska Board of Fisheries established a sustainable escapement goal (SEG) range of 5,200–17,000 coho salmon for the DCR (measured with boat counts; Parker 2006). 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 likely result in little additional harvest.

OBJECTIVE

Count coho salmon in the Delta Clearwater River from a drifting river boat at weekly intervals during the run to estimate total escapement.

METHODS

Counts of adult coho salmon were conducted by two persons (a boat operator and a counter) from jet-powered river boat equipped with a 5 ft elevated viewing platform. Surveys were conducted once a week starting when coho salmon began entering the system (typically in late September), and continued until peak escapement was documented. Beginning at the upstream end of the DCR, surveys were conducted by slowly drifting the boat, under power, along the lower 18 miles of the river to within 0.5 mile of the Clearwater Lake outlet. Numbers of salmon observed were recorded every 1.0 mile at mile markers posted on the river bank. The counter wore polarized glasses to facilitate viewing the brightly colored coho salmon and counts of coho salmon were recorded with tally counters that were zeroed out at the start of each new section.

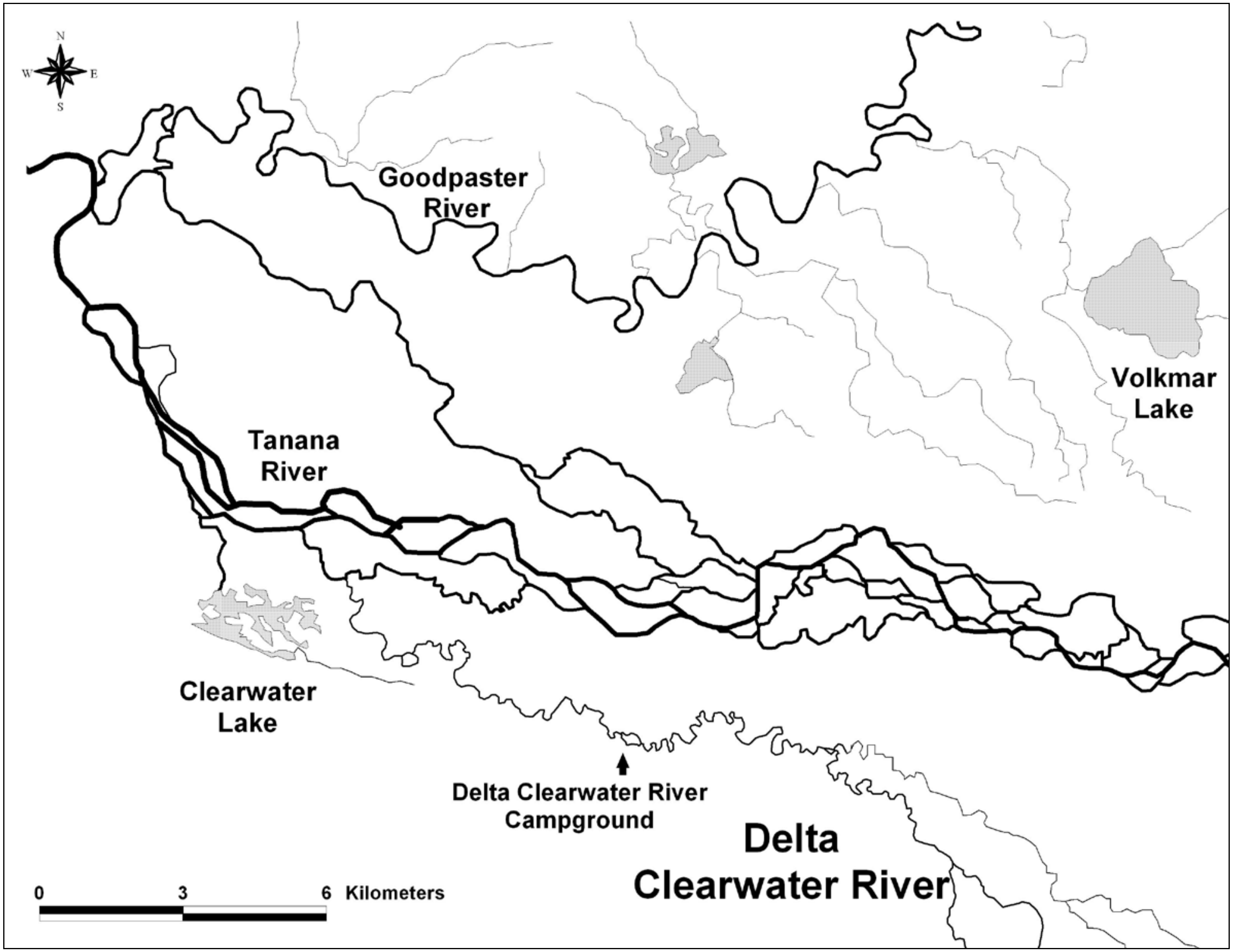

Figure 8.-Delta Clearwater River drainage.

Table 17.-Peak escapements, harvests, and catch of coho salmon in the Delta Clearwater River, 1980–2006.

		Peak Escapement Counts				
Year	Survey Date	Mainstem	Non Navigable Tributaries	Total[d]	Sport Harvest[e]	Sport Catch[e]
1980	28 Oct	3,946	-	3,946	25	NA
1981	21 Oct	8,563	-	8,563	45	NA
1982	3 Nov	8,365	-	8,365	21	NA
1983	25 Oct	8,019	-	8,019	63	NA
1984	6 Nov	11,061	-	11,061	571	NA
1985	13 Nov	6,842	-	6,842 [c]	722	NA
1986	21 Oct	10,857	-	10,857	1,005	NA
1987	27 Oct	22,300	-	22,300	1,068	NA
1988	28 Oct	21,600	-	21,600	1,291	NA
1989	25 Oct	12,600	-	12,600	1,049	NA
1990	26 Oct	8,325	-	8,325	1,375	3,271
1991	23 Oct	23,900	-	23,900	1,721	4,382
1992	26 Oct	3,963	-	3,963	615	1,555
1993	21 Oct	10,875	-	10,875	48	1,695
1994	24 Oct	62,675	17,565 [a]	80,240	509	3,009
1995	23 Oct	20,100	6,283 [a]	26,383	391	5,195
1996	29 Oct	14,075	3,300 [a]	17,375	937	2,435
1997	24 Oct	11,525	2,375 [a]	13,900	794	3,776
1998	20 Oct	11,100	2,775 [a]	13,875	479	1,932
1999	28 Oct	10,975	2,805 [b]	13,780	76	1,634
2000	24 Oct	9,225	2,358 [b]	11,583	252	1,890
2001	19 Oct	46,875	11,982 [b]	58,857	816	5,392
2002	31 Oct	38,625	9,873 [b]	48,498	517	5,311
2003	21 Oct	105,850	27,057 [b]	132,907	1,272	14,665
2004	27 Oct	37,950	9,701 [b]	47,651	511	4,061
2005	25 Oct	34,293	8,766 [b]	43,059	267	2,640
2006	24 Oct	16,748	4,281 [b]	21,029	N/A	N/A
2001–2005 Average		52,719	13,476	66,194	677	6,414

[a] Escapement in non-navigable tributaries was estimated by helicopter survey ADF&G, Division of Sport Fish.

[b] Expansion for the non-navigable portion is based on the average proportion of the total escapement observed in these areas from 5-years of aerial survey data. The aerial counts ranged from 0.17-0.24 and averaged $\bar{\hat{p}}_{tr} = 0.204$ as a proportion of the total escapement. The escapement in the inaccessible tributaries is estimated by multiplying the mainstem boat survey counts by $\bar{\hat{p}}_{tr} / \left(1 - \bar{\hat{p}}_{tr}\right)$.

[c] Survey by ADF&G, Commercial Fisheries Division.

[d] Boat survey by ADF&G, Sport Fish Division unless otherwise noted.

[e] Data were obtained from Mills (1981a-b, 1990-1994); Howe et al. (1995, 1996, 2001a-d); Walker et al. 2003; Jennings et al. 2004, 2006 a-b, 2007, 2009.

From 1994 to 1998, aerial surveys of the tributaries inaccessible by boat were conducted in order to determine the proportion of coho salmon that were counted in these areas relative to the proportion counted within the main river. An expansion factor based on five years of aerial surveys was developed which allows for estimation of total escapement without aerial surveys of inaccessible areas. The aerial counts ranged from 0.17–0.24 and averaged $\bar{\hat{p}}_{tr} = 0.204$ as a proportion of the total escapement. The escapement in the inaccessible tributaries is estimated by multiplying the mainstem boat survey counts by $\bar{\hat{p}}_{tr} / \left(1 - \bar{\hat{p}}_{tr}\right)$. Those estimated tributary escapements added to the numbers of fish counted in the mainstem during the boat surveys are the estimate of total escapement.

RESULTS

In 2006, the peak boat survey of the river's mainstem was conducted on 24 October. Coho salmon were distributed throughout the entire mainstem at varying densities (Table 18) and a total of 16,748 fish were counted. The count was expanded by 0.204 (4,281 fish) to account for fish spawning in adjacent spring areas. Total calculated escapement was 21,029 coho salmon.

DISCUSSION

In 2006, commercial fishing occurred in the mainstem Tanana River from mid-August through late-September. Although the fishery typically targets fall chum salmon, coho salmon are caught incidentally in the fish wheels and gillnets used by the fishermen. The 2006 Tanana River (District 6) fall season commercial salmon harvest was approximately 23,353 fall chum and 11,137 coho salmon (W. Busher, Fishery Biologist, ADF&G CFD, Fairbanks; personal communication). The commercial fishery likely reduced the numbers of coho salmon returning to the DCR; however, the escapement was still above the SEG range of 5,200–17,000 fish.

Table 18.–Counts of adult coho salmon in the Delta Clearwater River, 2006.

	Mainstem River(Boat Survey)
River Mile	Count (24 Oct)
18-17	750
17-16	375
16-15	700
15-14	875
14-13	725
13-12	475
12-11	575
11-10	675
10-9	450
9-8	250
8-7	875
7-6	150
6-5	925
5-4	1,500
4-3	3,300
3-2	675
2-1	2,575
1-0	100
carcasses	798
Summary	
18-0 (Mainstem)	16,748
Tributaries[a]	4,281
Total Count (boat-count of mainstream plus tributary expansion)	21,029

[a] Expansion for the tributaries/spring areas is based on the average proportion of total escapement (0.204) observed in these areas during five annual aerial surveys.

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REFERENCES CITED

Barton, L. H. 1987a. Population estimate of Chinook salmon escapement in the Chena River in 1986 based upon mark and recapture techniques. Alaska Department of Fish and Game, Division of Commercial Fisheries. Arctic, Yukon, and Kuskokwim Region, Yukon River Salmon Escapement Report No. 31, Fairbanks.

Barton, L. H. 1987b. Yukon area salmon escapement aerial survey manual. Alaska Department of Fish and Game, Division of Commercial Fisheries. Arctic, Yukon, and Kuskokwim Region, Yukon River Salmon Escapement Report No. 33., Fairbanks.

Barton, L. H. 1988. Population estimate of chinook salmon escapement in the Chena River in 1987 based upon mark and recapture techniques. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3F88-05, Fairbanks.

Barton, L. H., and R. Conrad. 1989. Population estimate of chinook salmon escapement in the Chena River in 1988 based upon mark and recapture techniques. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3F89-13, Fairbanks.

Borba, B. M., and H. H. Hamner. 1998. Subsistence and personal use salmon harvest estimates, Yukon area, 1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A98-23, Anchorage.

Borba, B. M., and H. H. Hamner. 2000. Subsistence and personal use salmon harvest estimates, Yukon area, 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 3A00-23, Anchorage.

Borba, B. M., and H. H. Hamner. 2001. Subsistence and personal use salmon harvest estimates Yukon Area, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A01-27, Anchorage.

Brase, A. L. J. 2006. Fishery management report for sport fisheries in the Lower Tanana River management area, 2003 - 2005. Alaska Department of Fish and Game, Fishery Management Report No. 06-62, Anchorage.

Brase, A. L. J., and M. Doxey. 2006. Salmon studies in the Chena, Chatanika, Delta Clearwater, and Salcha rivers, 2004 and 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-61, Anchorage.

Brase, A. L. J., and H. H. Hamner. 2002. Subsistence and personal use salmon harvests in the Alaska Portion of the Yukon River drainage, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-32, Anchorage.

Brase, A. L. J., and H. H. Hamner. 2003. Subsistence and personal use salmon harvests in the Alaska portion of the Yukon River Drainage, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-13, Anchorage.

Busher, W. H., and T. Hamazaki. 2004. Subsistence and personal use salmon harvests in the Alaska portion of the Yukon River drainage, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-33, Anchorage.

Busher, W. H., T. Hamazaki, and A. M. Marsh. 2007. Subsistence and personal use salmon harvests in the Alaskan portion of the Yukon River Drainage, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-52, Anchorage.

Cochran, W. G. 1977. Sampling techniques. 3rd edition. John Wiley and Sons, New York.

Evans, D. G., J. B. Browning, and B. G. Bue. 2000. A simulation model for sockeye salmon in the Wood and Nushagak Rivers: A tool for evaluating escapement and harvest levels. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A00-40, Anchorage.

Evenson, M. J. 1993. Abundance, egg production, and age-sex-length composition of the Chinook salmon escapement in the Chena River, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-6, Anchorage.

REFERENCES CITED (Continued)

Evenson, M. J. 1995. Salmon studies in interior Alaska, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-05, Anchorage.

Evenson, M. J. 1996. Salmon studies in interior Alaska, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-17, Anchorage.

Evenson, M. J. 2002. Optimal production of Chinook salmon from the Chena and Salcha rivers. Alaska Department of Fish and Game, Fishery Manuscript No. 02-1, Anchorage.

Evenson, M. J., and L. Stuby. 1997. Salmon studies in interior Alaska, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-31, Anchorage.

Gilks, W. R., A. Thomas, and D. J. Spiegelhalter. 1994. A language and program for complex Bayesian modeling. The Statistician 43:169-178.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Hallberg, J. E., and A. E. Bingham. 1991. Creel surveys conducted in Interior Alaska during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-56, Anchorage.

Hallberg, J. E., and A. E. Bingham. 1992. Creel surveys conducted in Interior Alaska during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-7, Anchorage.

Hallberg, J. E., and A. E. Bingham. 1993. Creel surveys conducted in interior Alaska during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-7, Anchorage.

Hallberg, J. E., and A. E. Bingham. 1994. Creel surveys conducted in interior Alaska during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-27, Anchorage.

Hallberg, J. E., and A. E. Bingham. 1995. Creel surveys conducted in Interior Alaska during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-21, Anchorage.

Hallberg, J. E., and A. E. Bingham. 1996. The Delta Clearwater and Salcha River creel surveys conducted in 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-20, Anchorage.

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage.

Howe, A. L., G. Fidler, and M. J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage.

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29 (revised), Anchorage.

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Revised Edition. Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25 (revised), Anchorage.

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001c. Revised Edition. Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-41 (revised), Anchorage.

Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001d. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series No. 01-08, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2007. Participation, catch, and harvest in Alaska sport fisheries during 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-40, Anchorage.

REFERENCES CITED (Continued)

Jennings, G. B., K. Sundet, and A. E. Bingham. 2009a. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2005. Alaska Department of Fish and Game, Fishery Data Series No. 09-47, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2009b. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2006. Alaska Department of Fish and Game, Fishery Data Series No. 09-54, Anchorage.

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2004. Participation, catch, and harvest in Alaska sport fisheries during 2001. Alaska Department of Fish and Game, Fishery Data Series No. 04-11, Anchorage.

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-34, Anchorage.

Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-44, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2007. Participation, catch, and harvest in Alaska sport fisheries during 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-40, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2009. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2005. Alaska Department of Fish and Game, Fishery Data Series No. 09-47, Anchorage.

Mills, M. J. 1981a. Alaska statewide sport fish harvest studies. 1979 data. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13(22a)SW-I-A, Juneau.

Mills, M. J. 1981b. Alaska statewide sport fish harvest studies. 1980 data. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1980-1981, Project F-9-13(22b)SW-I-A, Juneau.

Mills, M. J. 1982. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1981-1982, Project F-9-14(23)SW-I-A, Juneau.

Mills, M. J. 1983. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1982-1983, Project F-9-15(24)SW-I-A, Juneau.

Mills, M. J. 1984. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1983-1984, Project F-9-16(25)SW-I-A, Juneau.

Mills, M. J. 1985. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1984-1985, Project F-9-17(26)SW-I-A, Juneau.

Mills, M. J. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report 1985-1986, Project F-10-1(27)RT-2, Juneau.

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

REFERENCES CITED (Continued)

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage.

Mosher, K. H. 1969. Identification of Pacific salmon and steelhead trout by scale characteristics. U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Circular 317.

Neter, J., W. Wasserman, and M. H. Kutner. 1990. Applied linear statistical models. 3rd edition. Irwin Publishing Company. Homewood, IL.

Parker, J. F. 1991. Status of coho salmon in the Delta Clearwater River of Interior Alaska. Alaska Department of Fish and Game, Fishery Manuscript No. 91-4, Anchorage.

Parker, J. F. 2006. Fishery management report for sport fisheries in the Upper Tanana River drainage in 2005. Alaska Department of Fish and Game, Fishery Management Report No. 06-67, Anchorage.

Roach, S. M. 1996. Influence of electrofishing on the survival of Arctic grayling, Chinook salmon, least cisco, and humpback whitefish eggs. Alaska Department of Fish and Game, Fishery Manuscript No. 96-1, Anchorage.

Schultz, K., D. Bergstrom, R. Holder, and B. Borba. 1994. Salmon fisheries in the Yukon area, Alaska 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A94-31, Anchorage.

Stuby, L. 1999. Salmon studies in interior Alaska, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-13, Anchorage.

Stuby, L. 2000. Salmon studies in the Chena, Chatanika, and Delta Clearwater rivers, 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-4, Anchorage.

Stuby, L. 2001. Salmon studies in interior Alaska, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-24, Anchorage.

Stuby, L., and M. J. Evenson. 1998. Salmon studies in interior Alaska, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-11, Anchorage.

Tack, S. L. 1980. Distribution, abundance, and natural history of the Arctic grayling in the Tanana River drainage. Alaska Department of Fish and Game, Sport Fish Division. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-12(21)R-I, Juneau.

Vania, T. D., V. Golembeski, B. M. Borba, T. L. Lingnau, J. S. Hayes, K. R. Boeck, and W. H. Busher. 2002. Annual management report Yukon and northern areas, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-29, Anchorage.

Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series No. 03-05, Anchorage.

Welander, A. D. 1940. A study of the development of the scale of Chinook salmon *Oncorhynchus tshawytscha*. Master's thesis. University of Washington, Seattle.

Wolter, K. M. 1985. Introduction to variance estimation. Springer-Verlag, New York.

APPENDIX A

Appendix A1.– Procedures used for correcting the proportion of females in samples obtained during carcass surveys.

Biased estimates of sex composition have been noted during sampling when sex ratios of Chinook salmon collected during carcass surveys were compared with those estimated with mark-recapture methods. In the mark-recapture studies, the ratio of the abundance estimates of females to total abundance is used to estimate the percent females in the population. Diagnostic testing associated with the analysis of the mark-recapture data dictated whether first event samples (taken with electrofishing gear), second event samples (collected from carcasses), or both samples were used to estimate sex and age compositions, and whether those estimates could be considered unbiased. A comparison of sex composition estimates from mark recapture methods to straight sample proportions from carcass surveys revealed that carcass surveys tended to overestimate the proportions of females in the population (and conversely tended to underestimate the proportion of males). A "correction factor" was developed to apply to sex composition estimates (specifically the proportion of females) in years when only a carcass survey was conducted based on the average of ratios of unbiased estimates from mark-recapture experiments to estimates from carcass samples over those years when mark-recapture studies were conducted. Mark-recapture data are available for nine years from the Chena River (1989–1992, 1995–1997, 2000, and 2002) and seven years from the Salcha River (1987–1992, 1996).

The correction factor is estimated:

$$\hat{Q}_p = \frac{1}{n}\sum_{i=1}^{n}\hat{Q}_i \, ; \tag{A-1}$$

where $\hat{Q}_i$ is the ratio of the two estimates for year *i* and is calculated:

$$\hat{Q}_i = \hat{p}_{f,i(MR)} \big/ \hat{p}_{f,i(car)} \, ; \tag{A-2}$$

where $\hat{p}_{f,i(MR)}$ is the unbiased estimate of the proportion of females in the escapement for year *i* from the mark-recapture experiment data, $\hat{p}_{f,i(car)}$ is the estimate of the proportion of females for year *i* from the carcass survey data, and *n* is the number of years of paired observations for either the Chena or Salcha rivers.

Estimating the prediction variance for the correction factor is more complex due to the many sources of experimental and sampling error. The variance for prediction is estimated (Neter et al. 1990):

$$v\hat{a}r\left(\hat{Q}_p\right) = v\hat{a}r(Q) + v\hat{a}r\left(\overline{Q}\right); \tag{A-3}$$

Where $v\hat{a}r(Q)$ reflects inter-annual variability between true values of Q and $v\hat{a}r\left(\overline{Q}\right)$ is the sampling variance of our estimate of central tendency (mean) of all values of Q. Because of uncertainty in our estimates of the $\hat{Q}_i$, the term $v\hat{a}r(Q)$ cannot be directly estimated, but can be calculated as:

$$v\hat{a}r(Q) = v\hat{a}r\left(\hat{Q}\right) - \frac{1}{n}\sum_{i=1}^{n} v\hat{a}r\left(\hat{Q}_i\right); \tag{A-4}$$

Markov Chain Monte Carlo (MCMC) methods were employed to estimate the variance components $v\hat{a}r(\overline{Q})$, $v\hat{a}r(\hat{Q})$, and each of the $v\hat{a}r(\hat{Q}_i)$. MCMC algorithms were implemented using WinBUGS (Gilks et. al 1994), which is a Bayesian software program. This methodology allows for appropriate inclusion of the effects of all sources of uncertainty.

Uncertainty for the two components of each $\hat{Q}_i$ are modeled independently, as well as independently between the *i* years. The uncertainty in each of the $\hat{p}_{f,i(car)}$ is modeled using a Binomial distribution with a parameter $p_f = n_f / n_{f+m}$ with a sample size of n_{f+m} where n_{f+m} is the total number of carcasses for which sex was determined and n_f are those of n_{f+m} that were females.

The modeling of uncertainty in each of the $\hat{p}_{f,i(MR)}$ varied between years *i* and was dependent on the model selection diagnostics (Appendix B1) and the final models selected to estimated abundance and composition. When diagnostic tests indicated no size bias or gender biased sampling during either 1st event sampling or 2nd event sampling or both, uncertainty in $\hat{p}_{f,i(MR)}$ was modeled as described above for $\hat{p}_{f,i(car)}$ using unbiased data. When potential gender bias was detected during both sampling events, independent estimates of escapement and variance were calculated for fish of each gender. The uncertainty for male and female escapement estimates was modeled using a Gamma distribution (Evans et al 2000) with an expected value of $\hat{N}_{m\,or\,f}$ and variance $v\hat{a}r(\hat{N}_{m\,or\,f})$, where these values are taken directly from the experimental results. When size stratification was required, more complex modeling was required with abundance estimates being modeled with the Gamma distribution and proportions being modeled with the Binomial distribution, and results combined according the estimation procedure consistent with the model selected for estimating abundance and compostion.

At each MCMC iteration, a realization of each of the $\hat{p}_{f,i(MR)}$ and $\hat{p}_{f,i(car)}$ are generated, allowing the calculation of realizations of the $\hat{Q}_i$. After discarding the first 1 thousand MCMC iterations, an MCMC series of length 1 million was genereated for each of these values, called a posterior distribution. The variance of the posterior distribution for each of the $\hat{Q}_i$ was used as an estimate of $v\hat{a}r(\hat{Q}_i)$. At each MCMC iteration, the mean of the *n* $\hat{Q}_i$ realizations was calculated, providing a posterior distribution for $\overline{Q}$. The variance of the posterior distribution of $\overline{Q}$ was used and as estimate of $v\hat{a}r(\overline{Q})$. At each MCMC iteration, one of the *n* $\hat{Q}_i$ realizations was chosen at random (with equal probability for each *i*) and stored, providing a posterior distribution for *Q*. The variance of the posterior distribution of *Q* was used and as estimate of $v\hat{a}r(Q)$.

Based on these estimates (see below), the correction factor necessary to adjust estimates of the proportion of females in the Chena River escapement from carcass surveys in years when no mark-recapture study is conducted is $\hat{Q}_p$ = 0.708 with a prediction variance $v\hat{a}r(\hat{Q}_p)$ = 0.018345. Similarly, for the Salcha River, $\hat{Q}_p$ = 0.867 with $v\hat{a}r(\hat{Q}_p)$ = 0.029592.

Chena River

Year	MR Estimate P(Female)	SE	Carcass Sample Estimate P(Female)	SE	Ratio
1989	0.453	0.028	0.649	0.028	0.698
1990	0.363	0.027	0.470	0.021	0.773
1991	0.315	0.015	0.319	0.025	0.990
1992	0.216	0.027	0.365	0.020	0.593
1995	0.517	0.016	0.653	0.016	0.792
1996	0.268	0.043	0.436	0.020	0.613
1997	0.256	0.041	0.403	0.017	0.636
2000	0.217	0.023	0.31	0.036	0.655
2002	0.273	0.128	0.438	0.022	0.624
Average	**0.320**		**0.452**		**0.708**

Salcha River

Year	MR Estimate P(Female)	SE	Carcass Sample Estimate P(Female)	SE	Ratio
1987	0.520	0.053	0.628	0.021	0.828
1988	0.453	0.023	0.486	0.017	0.933
1989	0.563	0.022	0.552	0.028	1.020
1990	0.362	0.020	0.456	0.014	0.793
1991	0.407	0.014	0.450	0.019	0.905
1992	0.385	0.014	0.361	0.016	1.066
1996	0.262	0.056	0.501	0.023	0.523
Average	**0.422**		**0.491**		**0.867**

Abundance estimates are apportioned by sex and subsequently apportioned by age categories within each sex. Estimates of the proportion of females and males in an escapement based on carcass surveys were adjusted, using the correction factors, to more closely approximate population proportions.

The estimated proportions of males and females from carcass surveys was (Cochran 1977):

$$\hat{p}_{sc} = \frac{y_{sc}}{n_c}; \qquad \text{(A-5)}$$

with variance:

$$v\hat{a}r[\hat{p}_{sc}] = \frac{\hat{p}_{sc}(1-\hat{p}_{sc})}{n_c - 1}; \qquad \text{(A-6)}$$

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

The "corrected" estimate and variance (Goodman 1960) of the proportion of females in the population, $\tilde{p}_{fe}$, is:

$$\tilde{p}_{fe} = \hat{p}_{fc}\hat{Q}_p \text{ with } v\hat{a}r(\tilde{p}_{fe}) = \hat{p}_{fc}^2 v\hat{a}r(\hat{Q}_p) + R_p^2 v\hat{a}r(\hat{p}_{fc}) - v\hat{a}r(\hat{Q}_p)v\hat{a}r(\hat{p}_{fc}). \qquad \text{(A-7)}$$

The "corrected" estimate and variance of the proportion of males are $\tilde{p}_{me} = 1. - \tilde{p}_{fe}$ and $v\hat{a}r(\tilde{p}_{me}) = v\hat{a}r(\tilde{p}_{fe})$.

Abundance of each sex is then estimated by:

$$\hat{N}_s = \tilde{p}_{se}\hat{N} \tag{A-8}$$

The estimated variance for $\hat{N}_s$ in this case is (Goodman 1960):

$$v\hat{a}r(\hat{N}_s) = v\hat{a}r(\tilde{p}_{se})\hat{N}_s^{\ 2} + v\hat{a}r(\hat{N}_s)\tilde{p}_{se}^2 - v\hat{a}r(\tilde{p}_{se})v\hat{a}r(\hat{N}_s). \tag{A-9}$$

The proportion of fish at age by sex *s* was calculated as:

$$\hat{p}_{sk} = \frac{y_{sk}}{n_s} \tag{A-10}$$

where: $\hat{p}_{sk}$ = the estimated proportion of chinook salmon that are age *k*; y_{sk} = the number of chinook salmon sampled that are age *k*; and, n_s = the total number of chinook salmon sampled.

The variance of this proportion was estimated as:

$$v\hat{a}r[\hat{p}_{sk}] = \frac{\hat{p}_{sk}(1 - \hat{p}_{sk})}{n_s - 1}. \tag{A-11}$$

Abundance of age or size class *k* for each sex was then estimated by:

$$\hat{N}_{sk} = \hat{p}_{sk}\hat{N}_s \tag{A-12}$$

The variance for $\hat{N}_{sk}$ in this case was (Goodman 1960):

$$v\hat{a}r(\hat{N}_{sk}) = v\hat{a}r(\hat{p}_{sk})\hat{N}_s^{\ 2} + v\hat{a}r(\hat{N}_s)\hat{p}_{sk}^2 - v\hat{a}r(\hat{p}_{sk})v\hat{a}r(\hat{N}_s). \tag{A-13}$$

APPENDIX B

Appendix B1.–Archived project data and operational files germane to this report.

Tower Count Data Spreadsheets (Chinook & Chum)

CHENATOW06.xls

SALCHATOW06.xls

GOODPASTER04.xls

GOODPASTER05.xls

GOODPASTER06.xls

ASL Data

2006 KS ASL Master Calculations.xls

2006 Chena-Salcha KS Sex Ratio, Age Class abundance, Brood Table master.xls

Delta Clearwater River (Coho) counts and expansion spreadsheets

DCR-coho counts2006.xls

Note: Data files have been archived at, and are available from, the Alaska Department of Fish and Game, Division of Sport Fish, 1300 College Road, Fairbanks, 99701-1599.