**Fishery Data Series No. 00-4**

# Salmon Studies in the Chena, Chatanika, and Delta Clearwater Rivers, 1999

**by**
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**May 2000**

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

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**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| metric ton | mt |
| milliliter | ml |
| millimeter | mm |

**Weights and measures (English)**

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

Spell out acre and ton.

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| hour (spell out for 24-hour clock) | h |
| minute | min |
| second | s |

Spell out year, month, and week.

**Physics and chemistry**

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

**General**

| | |
|---|---|
| All commonly accepted abbreviations. | e.g., Mr., Mrs., a.m., p.m., etc. |
| All commonly accepted professional titles. | e.g., Dr., Ph.D., R.N., etc. |
| and | & |
| at | @ |
| Compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| Copyright | © |
| Corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| et alii (and other people) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g., |
| id est (that is) | i.e., |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| number (before a number) | # (e.g., #10) |
| pounds (after a number) | # (e.g., 10#) |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S. state and District of Columbia abbreviations | use two-letter abbreviations (e.g., AK, DC) |

**Mathematics, statistics, fisheries**

| | |
|---|---|
| alternate hypothesis | $H_A$ |
| base of natural logarithm | e |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | F, t, $\chi^2$, etc. |
| confidence interval | C.I. |
| correlation coefficient | R (multiple) |
| correlation coefficient | r (simple) |
| covariance | cov |
| degree (angular or temperature) | ° |
| degrees of freedom | df |
| divided by | ÷ or / (in equations) |
| equals | = |
| expected value | E |
| fork length | FL |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_2$, etc. |
| mideye-to-fork | MEF |
| minute (angular) | ' |
| multiplied by | x |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| standard length | SL |
| total length | TL |
| variance | Var |

*FISHERY DATA SERIES NO. 00-4*

# SALMON STUDIES IN THE CHENA, CHATANIKA, AND DELTA CLEARWATER RIVERS, 1999

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# ABSTRACT

Escapements of chinook salmon *Oncorhynchus tshawytscha* in the Chena and Chatanika rivers near Fairbanks, Alaska were estimated using tower-count methodology. The counts were conducted from 2 July to 8 August for both rivers. Tower-count estimates for chinook salmon were 6,485 (SE=427) for the Chena River and 503 (SE=68) for the Chatanika River. An aerial survey count of chinook salmon during the period of maximum escapement was 2,412 for the Chena River, which was 0.37 of the tower estimate. For the Chena River, age, sex and length compositions were examined by means of carcass and electroshock surveys, with the latter showing less bias with respect to gender. Males comprised 0.36 (0.03) of the carcass samples and 0.53 (0.04) of the electroshocked samples. The majority of males examined from the carcass survey were age 1.4 (0.51) with the rest comprising ages 1.2 (0.11) and 1.3 (0.38). The majority of females were age 1.4 (0.81) with the rest comprising 1.2 (0.01) and 1.3 (0.18). For the electroshock survey, the majority of males were aged 1.3 (0.43), with the rest comprising 1.1 (0.04), 1.2 (0.24), and 1.4 (0.29). The majority of females were aged 1.4 (0.89) with the rest comprising 1.3 (0.08), 1.5 (0.03). A carcass survey was also conducted for the Chatanika River. The majority of males were aged 1.4 (0.75) with the rest 1.3 (0.25). The majority of females were aged 1.4 (0.76) with the rest 1.3 (0.24). Age and sex ratios have varied over the years in both rivers since the inception of carcass surveys.

A portion of the chum salmon *Oncorhynchus keta* escapements for the Chena and Chatanika rivers were also estimated during the tower-counts. Estimated escapement of chum salmon was 9,165 (SE=496) for the Chena River and 966 (SE=146) for the Chatanika River.

This season, the Division of Sport Fish did not supervise a counting tower on the Salcha River. Instead, the Bering Sea Fishermen's Association conducted salmon counts from 6 July to 30 August along with a carcass survey of this river. Salcha River chinook salmon escapement was estimated to be 9,198 (SE=290). The majority of males were aged 1.4 (0.42) with the rest comprising 1.2 (0.20) and 1.3 (0.37). The majority of females were aged 1.4 (0.86) with the rest comprising 1.3 (0.13) and 1.5 (0.01). An incomplete survey of chum salmon was estimated to be 23,221 (SE=460).

Escapement of coho salmon *Oncorhynchus kisutch* was estimated in the Delta Clearwater River near Delta Junction, Alaska, by means of boat-counts. The boat survey of the mainstem river was 10,975 on 28 October. An expansion of 2,799, which was based on five years of aerial survey data, was added to the boat count for a total estimated escapement of 13,774 coho salmon.



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


# CHINOOK AND CHUM SALMON STUDIES IN THE CHENA AND CHATANIKA RIVERS

## INTRODUCTION

The Chena River (Figure 1) has some of the largest chinook salmon *Oncorhynchus tshawytscha* escapements in the Yukon River drainage (Schultz et al. 1994). A popular sport fishery occurs in the lower 72 km of this river. Annual harvest estimates since 1978 have ranged from 0 to 1,280 chinook salmon (Mills 1979-1994 and Howe et al. 1995-1999; Table 1). The Chatanika River (Figure 2) supports a small run of chinook, however recent estimates of sport harvests (0-499; Table 1) have indicated that relative exploitation can be large. Before reaching their spawning grounds in the mid to upper reaches of these rivers, the chinook salmon travel about 1,500 km from the Bering Sea and pass through six different commercial fishing districts in the Yukon and Tanana rivers (Figure 3). Subsistence and personal use fishing also occur in each district.

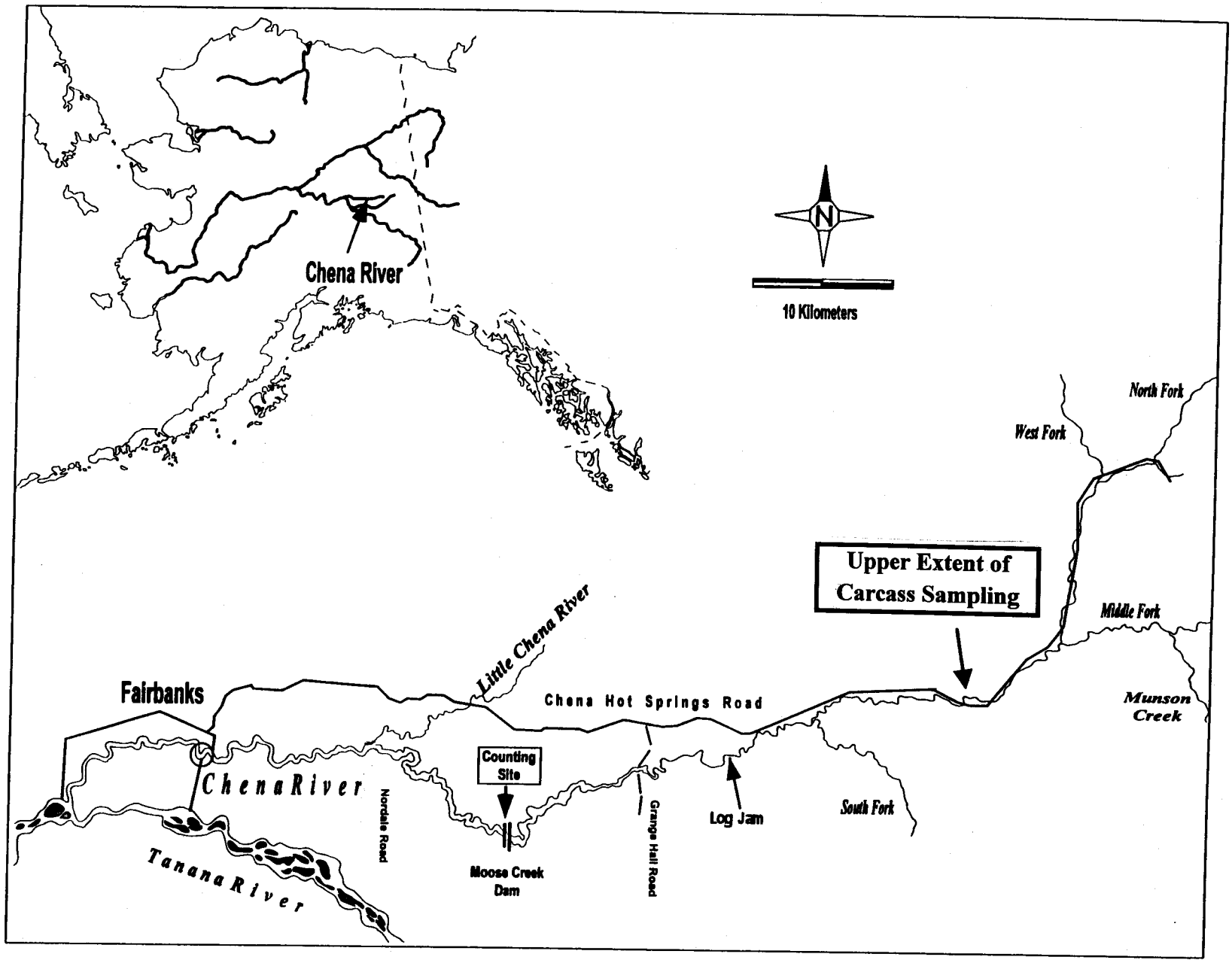



**Figure 1.-Chena River study area.**

**Table 1.-Harvests of anadromous chinook salmon by sport, commercial, subsistence, and personal use fisheries in the Tanana River drainage, 1978 - 1999.**

| | On Site Sport Harvest Estimates[a] | | Statewide Survey Estimates of Sport Harvest[b] | | | | | | Estimated Harvest by User Group | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Chena River | Salcha River | Chena River | Salcha River | Chatanika River | Nenana River | Other Streams | All Waters | Commercial Harvests[c] | Subsistence and Personal Use Harvests[c] | Total Known Harvest |
| 1978 | None | None | 23 | 105 | 35 | None | 0 | 163 | 635 | 1,231 | 2,029 |
| 1979 | None | None | 10 | 476 | 29 | None | 0 | 515 | 772 | 1,333 | 2,620 |
| 1980 | None | None | 0 | 904 | 37 | None | 0 | 941 | 1,947 | 1,826 | 4,714 |
| 1981 | None | None | 39 | 719 | 5 | None | 0 | 763 | 987 | 2,085 | 3,835 |
| 1982 | None | None | 31 | 817 | 136 | None | 0 | 984 | 981 | 2,443 | 4,408 |
| 1983 | None | None | 31 | 808 | 147 | None | 10 | 1,048 | 911 | 2,706 | 4,665 |
| 1984 | None | None | 0 | 260 | 78 | None | 0 | 338 | 867 | 3,599 | 4,804 |
| 1985 | None | None | 37 | 871 | 373 | None | 75 | 1,356 | 1,142 | 7,375 | 9,873 |
| 1986 | None | 526 | 212 | 525 | 0 | None | 44 | 781 | 950 | 3,701 | 5,432 |
| 1987 | None | 111 | 195 | 244 | 21 | 7 | 7 | 474 | 3,338 | 4,096 | 7,908 |
| 1988 | 567 | 19 | 73 | 236 | 345 | 36 | 54 | 744 | 786 | 5,507[e] | 7,037 |
| 1989 | 685 | 123 | 375 | 231 | 231 | 39 | 87 | 963 | 2,181 | 2,999[e] | 6,143 |
| 1990 | 24 | 200 | 64 | 291 | 37 | 0 | 0 | 439 | 2,989 | 3,069[e] | 6,497 |
| 1991 | None | 362 | 110 | 373 | 82 | 11 | 54 | 630 | 1,163 | 2,515[e] | 4,308 |
| 1992 | None | 4 | 39 | 47 | 16 | 0 | 0 | 118 | 785 | 2,438[e] | 3,341 |
| 1993 | None | 54 | 733 | 601 | 192 | 0 | 19 | 1,573 | 1,445 | 2,098 | 5,116 |
| 1994 | None | 776 | 993 | 714 | 105 | 0 | 59 | 1,871 | 2,606 | 2,370 | 6,847 |
| 1995 | None | 811 | 622 | 1,448 | 58 | 0 | 320 | 2,488 | 2,747 | 2,178 | 7,413 |
| 1996 | None | None | 1,280 | 1,136 | 499 | 49 | 138 | 3,102 | 447 | 1,392 | 4,941 |
| 1997 | None | None | 936 | 695 | 225 | 11 | 0 | 1,878 | 2,728 | 3,025 | 7,631 |
| 1998 | None | None | 341 | 130 | 6 | 15 | 0 | 451 | 963 | 2,276 | 3,690 |
| 1999 | None | None | N/A[f] | N/A[f] | N/A[f] | N/A[f] | N/A[f] | N/A[f] | 690[d] | N/A[f] | N/A[f] |

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

b Sport fishery harvest estimates from Mills (1979-1994) and Howe et al. 1995-1999.

c Commercial, subsistence, and personal use estimates (Schultz 1994, and, Keith Schultz, Personal Communication. Alaska Department of Fish and Game, Sport Fish Division, 1300 College Road, Fairbanks, AK 99701).

d Preliminary data and subject to change.

e The personal use designation was implemented in 1988 to account for non-rural fishermen participating in this fishery. Harvests by personal use fishermen were 623, 453, 451, 0, and 0 for 1988-1992, respectively.

f NA means data not available at this time.

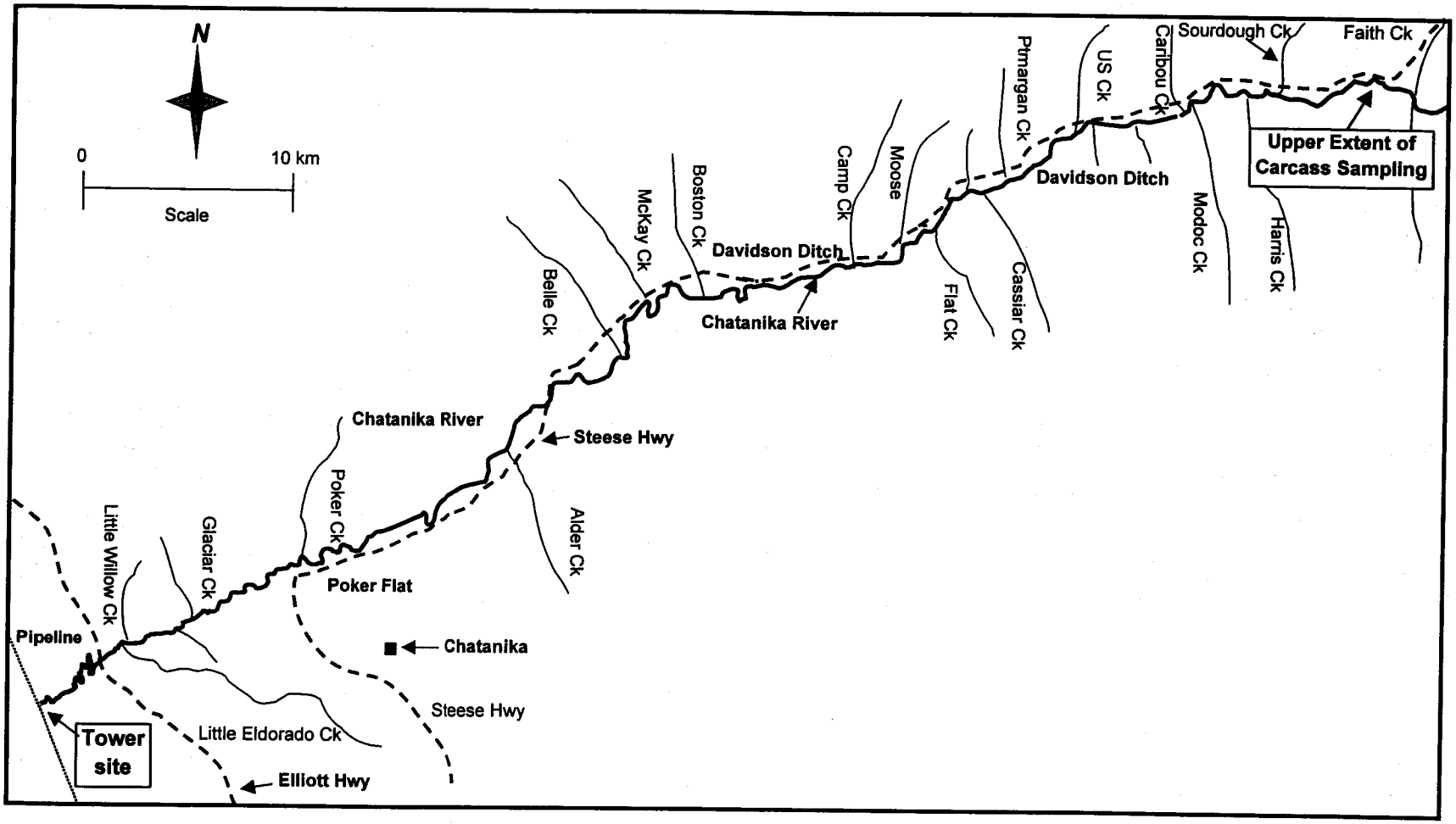



**Figure 2.-Chatanika River study area.**

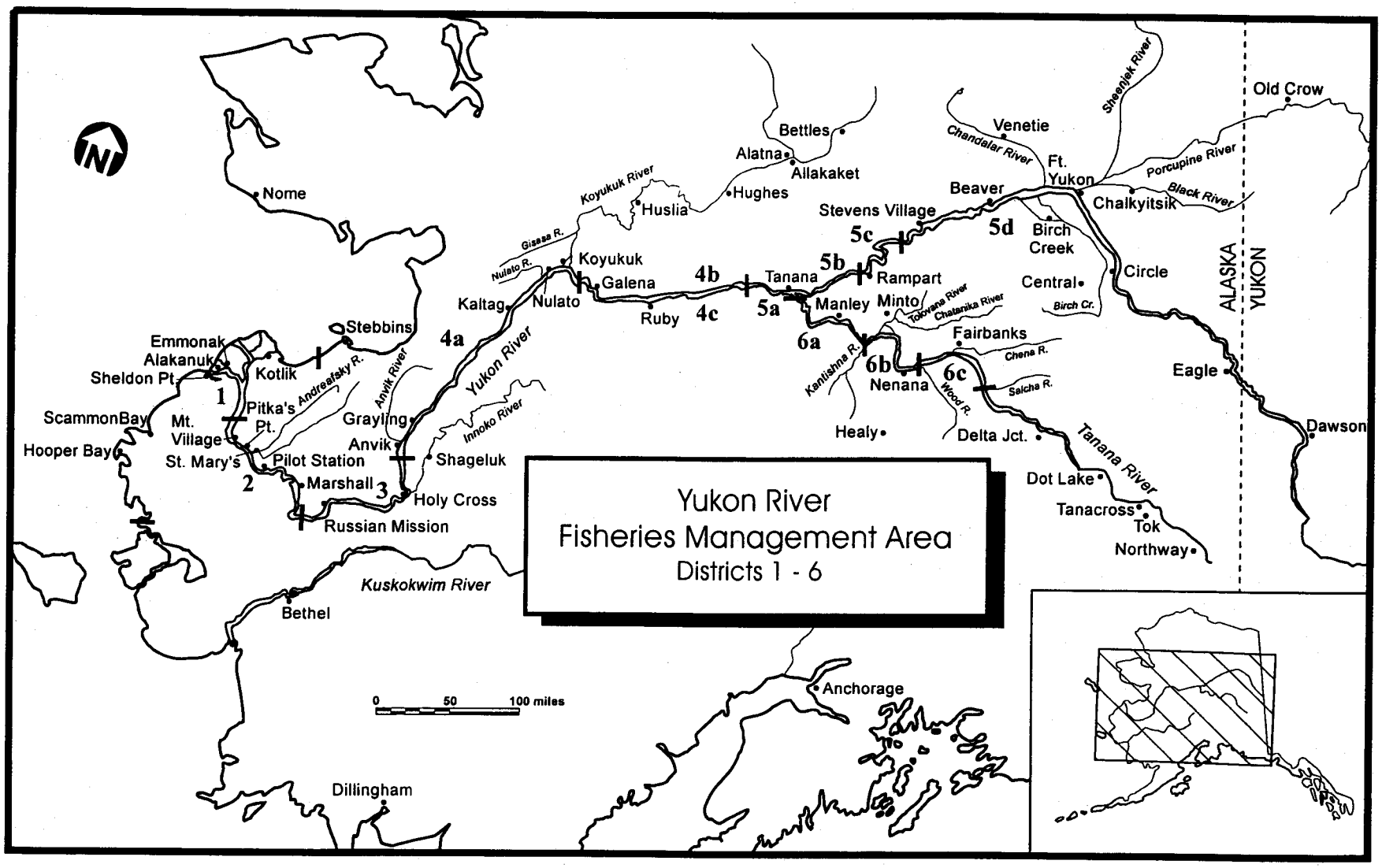



**Figure 3.-Fishing districts in the Yukon River drainage.**

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

Escapements of chinook salmon in the Chatanika River prior to 1997 had been assessed on a semi-annual basis with aerial surveys from fixed wing aircraft. This methodology was inadequate, as survey estimates from some years were less than harvest estimates for the same years. A mark- recapture experiment was conducted in 1997. This was the second season tower-counting methods were applied to the Chatanika River.

The Alaska Department of Fish and Game (ADF&G) has established an aerial survey escapement objective of 1,700 chinook salmon for the Chena River. Using counts from aerial surveys and abundance estimates of escapement, the minimum escapement guidelines for aerial surveys were expanded into actual abundance (Evenson 1996). The minimum escapement guideline using these expansions is 6,300 for the Chena River. Escapement guidelines have not yet been developed based on tower-count estimates for the Chena River, nor have escapement objectives of any kind been established for the Chatanika River.

In 1987 the Alaska Board of Fisheries imposed a sport harvest guideline of 300 to 600 chinook salmon for the Chena River. No guideline harvest ranges exist for the Chatanika River. The harvests by anglers in the Chena River have been monitored in past years with creel surveys. However, the last creel survey for the Chena River was conducted in 1990 (Evenson 1995). Creel surveys have not been conducted recently due to the relative success of tower-counts/carcass surveys and the high cost of creel surveys.

Chum salmon returning to the Chena River are also harvested in the sport fishery. The migration timing of chum salmon is later than that of chinook salmon, but does overlap the chinook salmon migration. Because sport fisheries exploit these stocks, chum salmon escapements were also monitored throughout the duration of the chinook salmon counts in order to ensure that sport harvests do not adversely impact escapement. Currently there are no established harvest guidelines for chum salmon in the Chena and Chatanika rivers. The research objectives of the chinook salmon projects in 1999 were to:

1. estimate the escapement of chinook salmon in the Chena and Chatanika rivers using tower-count methodology,
2. estimate age, sex, and length compositions of the escapement of chinook salmon in the Chena and Chatanika rivers, and;
3. examine the degree of sex bias between electrofishing and carcass survey techniques for chinook salmon collected from the Chena River.

In addition, a project task was to count chum salmon in the Chena and Chatanika rivers while subsequently estimating escapement of chinook salmon using tower-counting techniques.

# METHODS

## Tower-counts

Daily escapements of chinook and chum salmon returning to the Chena and Chatanika rivers were estimated by counting fish at fixed intervals as they passed beneath elevated counting sites. The counts were conducted from 2 July to 8 August for both rivers. The Moose Creek Dam was used as a counting structure for the Chena River (Figure 1). The counting site for the Chatanika River was located immediately downstream from the Alyeska pipeline (Figure 2). Little or no spawning occurs downstream from these sites. Sport fishing is restricted to areas downstream of the counting site in the Chena River. Therefore, for the Chena River, the estimates from tower-counts represented total escapement. In the Chatanika River, most sport fishing occurs upstream from the counting site since there is no road access to areas below this site. Thus, tower-count estimates represented the total in-river return for the Chatanika River.

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

### Sampling Design

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

Three technicians were assigned to count on each river. For the Chena River, counts were conducted during 16-17 out of 21 possible shifts each week from 2 July-18 July. Afterwards, all shifts were covered. Out of 21 possible shifts, 15-16 were conducted each week for the Chatanika River. High, murky water prevented some of the scheduled counts for both rivers (Appendix A).

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

**Abundance Estimator**

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

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

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

The average shift passage for day d was:

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

The expanded daily passage was:

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

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

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

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

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

The variance for the expanded daily passage was estimated by:

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

where:

$$f_{1d} = \frac{h_d}{H_d} \tag{7}$$

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

d = day;
i = 8-h shift;
j = 10-min counting period;
y = observed period count;
Y = expanded shift passage;
m = number of 10-min counting periods sampled;
M = total number of possible 10-min counting periods;
h = number of 8-h shifts sampled;
H = total number of possible 8-h shifts;
D = total number of possible days;
$f_1$ = fraction of 8-h shifts sampled;
$f_2$ = fraction of 10-min counting periods sampled;
$s_2^2$ = estimated variance of total across counting periods; and,
$s_1^2$ = estimated variance of total across shifts.

Passage for the entire run was estimated by:

$$\hat{N} = \sum_{d=1}^{D} \hat{N}_d \tag{9}$$

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

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

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

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

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

where:

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

is an indicator function.

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

## Age-Sex-Length Compositions

Age, sex and length data were obtained from salmon carcasses. For the Chena River, carcasses were collected with long handled spears from a jet-powered boat. These samples were collected from the Moose Creek Dam to approximately 76 km upriver (Figure 1). Carcasses were collected from a canoe on the Chatanika River from the Alyeska Pipeline to approximately 85 km upriver (Figure 2). For the Chena River, a target sample size of 600 carcasses was developed in order to obtain age-sex-length proportions that were within $\pm$ 5 percentage points 95% of the time (Thompson 1987). The fish were measured, three scales were taken for aging, and sex was determined from external characteristics and, in questionable cases, by examining the gonads. Sampling took place on the Chena River from 13-19 August and from 17-19 August for the Chatanika River. All length measurements were made from mid-eye to fork-of-tail. Three scales were removed from the left side of the fish approximately two rows above the lateral line along a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander 1940). Scale impressions were later made on acetate cards and viewed at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Ages were determined from scale patterns as described by Mosher (1969). After examination, all carcasses were sliced on their left sides in order to prevent resampling and were returned to the river.

In addition to the carcass survey, chinook salmon were sampled for age and sex in the Chena River from the Moose Creek Dam to approximately 10 mi upriver by means of electrofishing. Electrofishing has been shown from previous mark-recapture surveys to be relatively bias free with respect to sex composition compared to carcass surveys, which tend to select for females. During past mark-recapture studies, fish were captured for the marking event by means of

electroshocking and recaptured by means of a carcass survey. In 1999, salmon were sampled by electrofishing on 20, 22, 26, 28, and 30 July. This river section was selected because the majority of chinook salmon spawn upriver of this section. Thus, electroshocking near redds was avoided, which could adversely affect egg survival (Roach 1996). For the Chena River, a target sample size of 150 fish was developed in order to obtain age-sex-length proportions that were within $\pm$ 10 percentage points 95% of the time (Thompson 1987). The relative bias with respect to sex was examined between samples acquired with the two methods.

Mean lengths were estimated for combinations of age and sex using the sample mean and sample variance of the mean (Zar 1984). For the Chena and Chatanika rivers, chinook salmon sampled from a carcass survey and/or by means of electrofishing were proportioned by ocean-age using:

$$\hat{p}_{sg} = \frac{n_{sg}}{n_s} \tag{13}$$

The associated variances for each river were calculated separately for each sex using:

$$\hat{V}(\hat{p}_{sg}) = \frac{\hat{p}_{sg}\left(1-\hat{p}_{sg}\right)}{n_s - 1} \tag{14}$$

where:

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

$n_s$ = number of chinook salmon of sex *s*.

## Aerial Counts

Commercial Fisheries Division personnel conducted aerial survey counts near peak escapement for the Chena River. The daily tower-counts of chinook salmon and weather conditions dictated optimum flying days. The surveys were conducted on 31 July. Counts were made from low flying, fixed-wing aircraft. Barton (1987b) described the methods used for these aerial surveys. The proportion of salmon counted by the aerial survey to the total estimated escapement was calculated.

# RESULTS

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

## Chena River Chinook Salmon Studies

Total escapement was estimated at 6,485 (SE=427) chinook salmon. Poor counting conditions prevented counts from being conducted on 28 and 29 July. The largest expanded daily count of chinook salmon for the Chena River was 819 (SE=123) on 26 July (Table 2). Daily passage of

**Table 2.-Daily counts and estimates of the number of chinook salmon passing by the counting site in the Chena River, 1999.**

| Date | Count Periods | Left Side | | | Right Side | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] |
| 2-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Jul-99 | 24 | 1 | 6 | 6 | 0 | 0 | 0 | 1 | 6 | 6 |
| 10-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-Jul-99 | 23 | 4 | 27 | 19 | 0 | 0 | 0 | 4 | 27 | 19 |
| 12-Jul-99 | 24 | 4 | 24 | 18 | 0 | 0 | 0 | 4 | 24 | 18 |
| 13-Jul-99 | 16 | 3 | 27 | 27 | 0 | 0 | 0 | 3 | 27 | 27 |
| 14-Jul-99 | 24 | 5 | 30 | 26 | 0 | 0 | 0 | 5 | 30 | 26 |
| 15-Jul-99 | 16 | 2 | 18 | 9 | 0 | 0 | 0 | 2 | 18 | 9 |
| 16-Jul-99 | 16 | 8 | 72 | 26 | 0 | 0 | 0 | 8 | 72 | 26 |
| 17-Jul-99 | 16 | 14 | 126 | 84 | 0 | 0 | 0 | 14 | 126 | 84 |
| 18-Jul-99 | 16 | 15 | 135 | 88 | 0 | 0 | 0 | 15 | 135 | 88 |
| 19-Jul-99 | 16 | 44 | 396 | 135 | 11 | 99 | 37 | 55 | 495 | 140 |
| 20-Jul-99 | 24 | 63 | 378 | 110 | 2 | 12 | 7 | 65 | 390 | 110 |
| 21-Jul-99 | 24 | 70 | 420 | 133 | 16 | 96 | 88 | 86 | 516 | 160 |
| 22-Jul-99 | 23 | 41 | 274 | 137 | 13 | 86 | 30 | 54 | 360 | 140 |
| 23-Jul-99 | 24 | 69 | 414 | 138 | 14 | 84 | 35 | 83 | 498 | 142 |
| 24-Jul-99 | 24 | 90 | 540 | 111 | 32 | 192 | 44 | 122 | 732 | 120 |
| 25-Jul-99 | 24 | 85 | 510 | 81 | 19 | 114 | 35 | 104 | 624 | 88 |
| 26-Jul-99 | 14 | 62 | 636 | 102 | 19 | 183 | 68 | 81 | 819 | 123 |
| 27-Jul-99 | 22 | 30 | 196 | 49 | 18 | 132 | 53 | 48 | 328 | 72 |
| 28-Jul-99 | 0 | 0 | 290 | 102 | 0 | 132 | 68 | 0 | 422 | 123 |
| 29-Jul-99 | 0 | 0 | 118 | 49 | 0 | 81 | 53 | 0 | 199 | 72 |
| 30-Jul-99 | 23 | 6 | 38 | 19 | 13 | 81 | 22 | 19 | 119 | 29 |
| 31-Jul-99 | 24 | 20 | 120 | 37 | 5 | 30 | 11 | 25 | 150 | 39 |
| 1-Aug-99 | 24 | 4 | 24 | 15 | 1 | 6 | 4 | 5 | 30 | 16 |
| 2-Aug-99 | 24 | 7 | 42 | 18 | 5 | 30 | 13 | 12 | 72 | 22 |
| 3-Aug-99 | 24 | 7 | 42 | 19 | 3 | 18 | 11 | 10 | 60 | 22 |
| 4-Aug-99 | 24 | 5 | 30 | 19 | 1 | 6 | 4 | 6 | 36 | 20 |
| 5-Aug-99 | 24 | 5 | 30 | 12 | 0 | 0 | 8 | 5 | 30 | 14 |
| 6-Aug-99 | 23 | 6 | 39 | 13 | 0 | -1 | 9 | 6 | 38 | 16 |
| 7-Aug-99 | 24 | 5 | 30 | 12 | 0 | 0 | 0 | 5 | 30 | 12 |
| 8-Aug-99 | 24 | 10 | 60 | 23 | 2 | 12 | 8 | 12 | 72 | 25 |
| Total | 744 | 685 | **5,092** | **390** | 174 | **1,394** | **174** | 859 | **6,485** | **427** |

[a] Shaded cells are estimates for days with no counts, and for SE are days with only one counting period or less. See Methods section for a description of how estimates for expanded count's and SE's are calculated for these days.

chinook was minimal by 8 August when the count was terminated. The largest number of chinook salmon to pass during one 10-min count was 24 at 0500 on 21 July and the same at 1500 on 7/19 for the left side. Typically counts were larger for the left side of the Chena River (Appendices C1-C2). On visual inspection, passage of chinook salmon for the Chena River showed some diurnal variation with peaks between 0400 and 0600, 1400 and 1600, and 1700 and 2000 (Figure 4).

The dates where 50% escapement of chinook salmon travelling past the Moose Creek Dam during 1993-1998 have varied from 14 to 22 July (Figure 5). However, in 1999, escapement reached the 50% point on 24 July, which was the latest since the inception of the tower-counts. The average expanded cumulative escapement estimated from tower-counts for 1993, 1994, 1997, and 1998 was 10,864. The tower escapements were unreliable for 1995 and 1996 due to high water events and mark-recapture experiments had to be performed in order to acquire estimates. Every year since the inception of the tower-counts, the escapement has exceeded the minimum guideline of 6,300 chinook salmon except for 1998 (Figure 6).

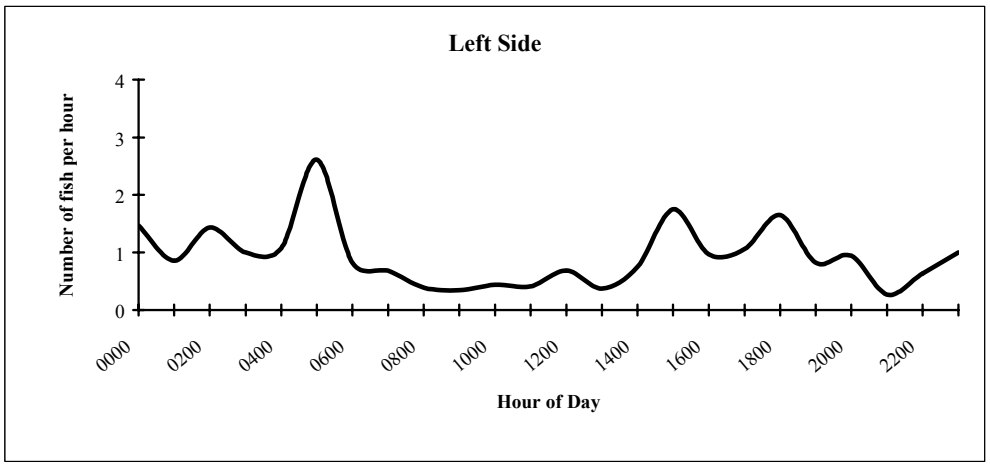
**Age-Sex-Length Compositions-Carcass Survey**

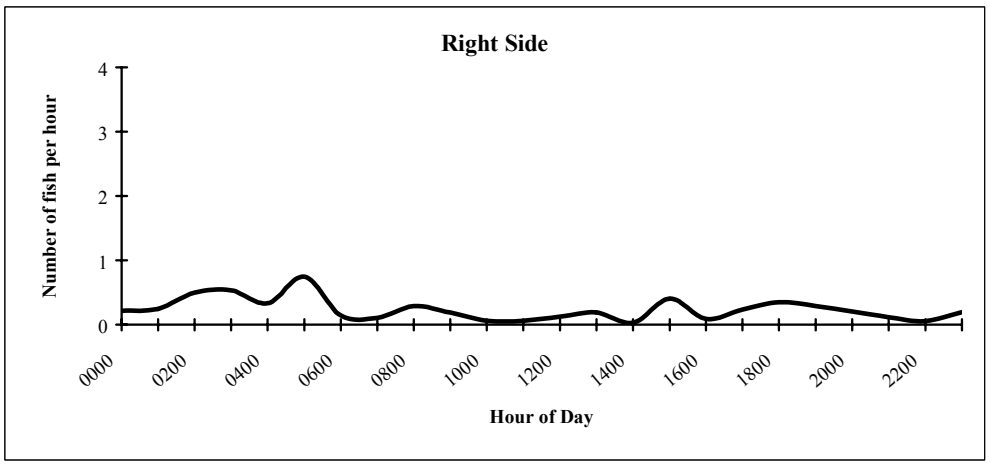
Two hundred eight chinook salmon carcasses were collected and examined from the Chena River. The sex composition for this sample, including those fish not aged was 0.36 (SE=0.03) males and 0.64 (SE=0.03) females. Ages were determined for 85% of the sample. The average male/female ratio of aged fish from 1989-1999 was 0.54 males and 0.46 females (Table 3). The dominant age class for males and females collected in 1999 was 1.4 with respective proportions of 0.51 (SE=0.07) and 0.81 (SE=0.04, Table 4). Males were also represented by ages 1.2 (0.11), and 1.3 (0.38). Females were also represented by ages 1.2 (0.01) and 1.3 (0.18). Lengths of males ranged from 420 to 1,035 mm (Figure 7). Lengths of females ranged from 540 to 1,015 mm.

Carcass sampling of chinook salmon on the Chena River by Region III Sport Fish Division has taken place since 1989. Similar to the Salcha River, the average length at age for chinook salmon sampled in the Chena River has varied over the years from 1989-1999. The most common ages sampled for male chinook were 1.2, 1.3, and 1.4 (Appendix D1). Mean length at age for age 1.2 has varied from 524 mm in 1988 to 600 mm in 1995. Age 1.3 has varied from 698 mm in 1993 to 772 mm in 1989, and age 1.4 has varied from 788 mm in 1993 to 892 mm in 1996 (Appendix D2). The most common ages sampled since 1989 for female chinook salmon were 1.3, 1.4 and 1.5. Mean length at age for age 1.3 has varied from 738 mm in 1991 to 857 mm in 1997. Age 1.4 has varied from 825 mm in 1998 and 1999 to 888 mm in 1997, and age 1.5 has varied from 901 mm in 1997 to 995 mm in 1992 (Appendix D3).

## Electrofishing and Test for Sex Bias

One-hundred fifty eight chinook salmon were collected and examined from the Chena River by means of electroshocking. Ages were determined for 90% of the sample. The sex composition for this sample, including those fish not aged was 0.53 (SE=0.04) males and 0.47 (SE=0.04) females. The dominant age class for males collected in 1999 with electrofishing equipment was 1.3 and for females, 1.4 with respective proportions of 0.43 (SE=0.06) and 0.89 (SE=0.04, Table 5). Males were also represented by ages 1.1 (0.04), 1.2 (0.24), 1.3, and 1.4 (0.29). Females were also represented by ages 1.3 (0.08) and 1.5 (0.03). A chi-square test for gender by



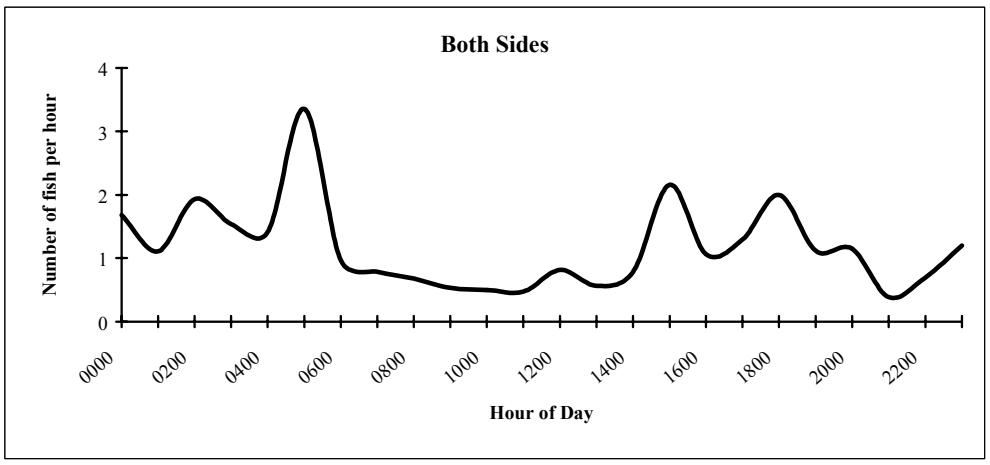




**Figure 4.-Average hourly escapement of chinook salmon in the Chena River, 1999.**

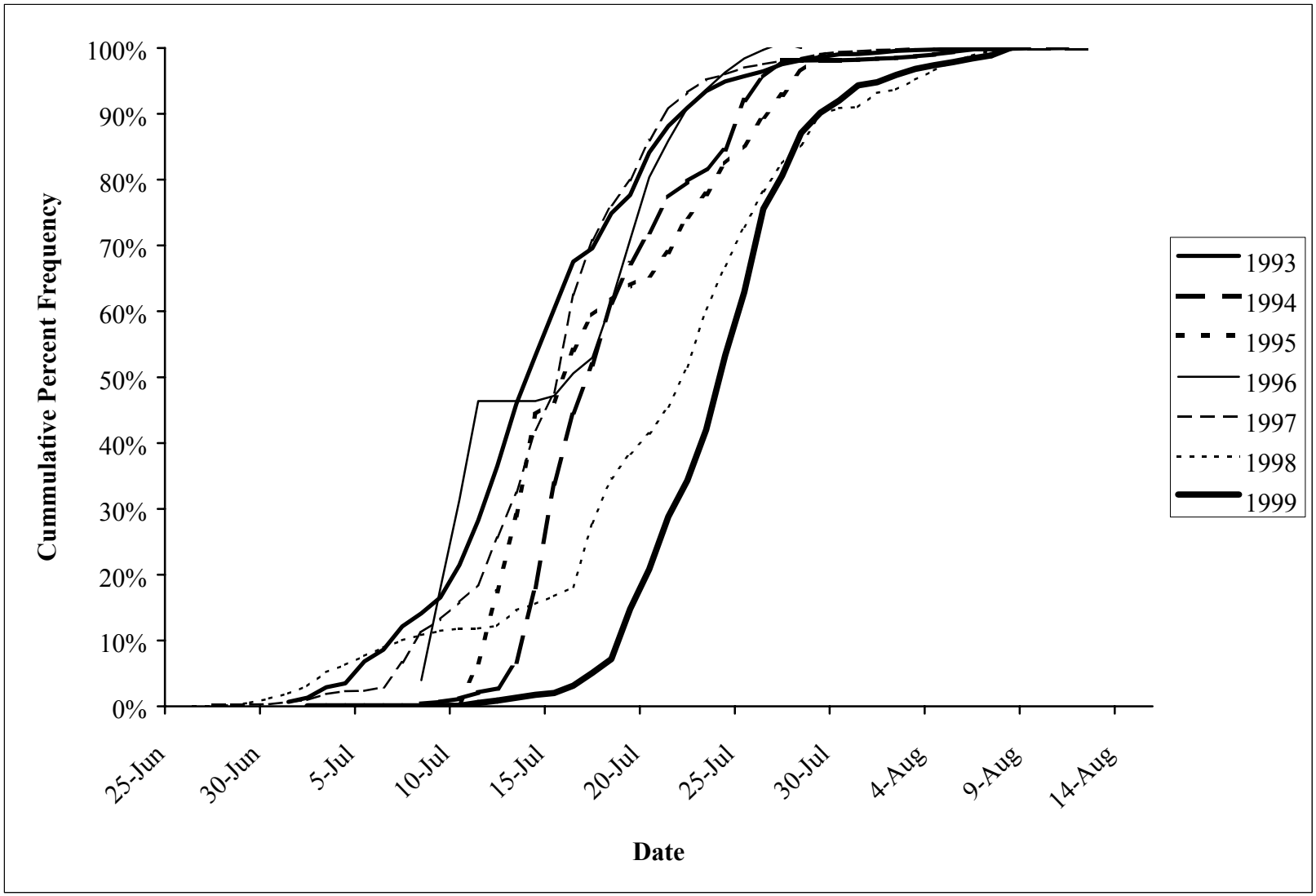



**Figure 5.-Run timing of chinook salmon from 1993-1999 for the Chena River.**

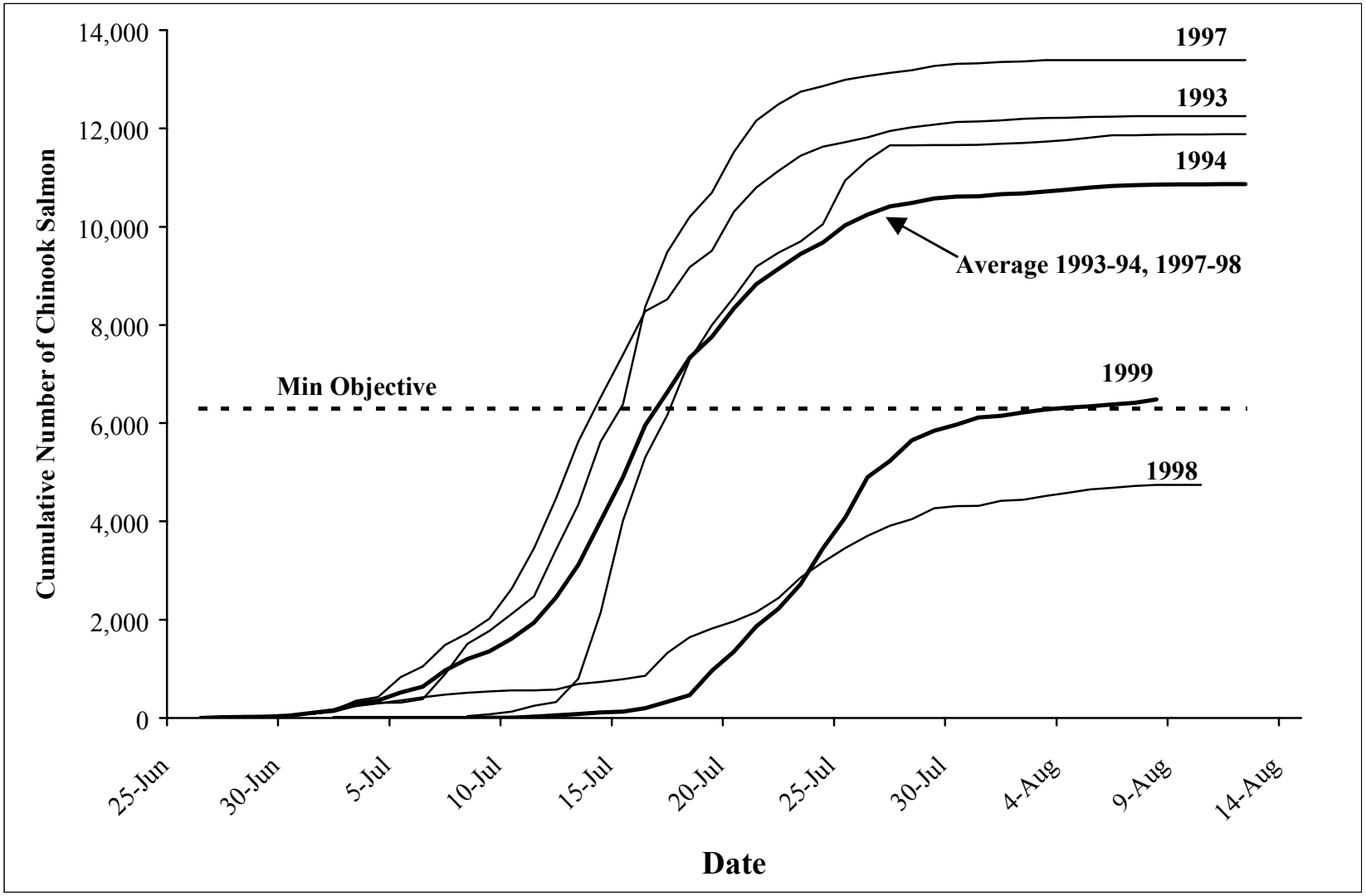



**Figure 6.-Average expanded cumulative passage of chinook salmon for 1993, 1994, 1997 and 1998 tower-counts compared to 1999 for the Chena River.**

**Table 3.-Percent male and female chinook salmon sampled and aged for the Chena and Chatanika rivers from 1987-1999.**

| | Sample Size | | | | |
|---|---|---|---|---|---|
| Year | Males | Females | Total | % Males | % Females |
| **Chena River** | | | | | |
| 1989[a] | 115 | 196 | 311 | 37% | 63% |
| 1990[a] | 291 | 258 | 549 | 53% | 47% |
| 1991[a] | 231 | 108 | 339 | 68% | 32% |
| 1992[a] | 289 | 177 | 466 | 62% | 38% |
| 1993[a] | 155 | 30 | 185 | 84% | 16% |
| 1994[a] | 281 | 231 | 512 | 55% | 45% |
| 1995[a] | 267 | 520 | 787 | 34% | 66% |
| 1996[a] | 286 | 229 | 515 | 56% | 44% |
| 1997[a] | 424 | 278 | 702 | 60% | 40% |
| 1998[a] | 134 | 94 | 228 | 59% | 41% |
| 1999[a] | 61 | 116 | 177 | 34% | 66% |
| 1999[b] | 70 | 71 | 141 | 50% | 50% |
| Average | 217 | 192 | 409 | 54% | 46% |
| **Chatanika River** | | | | | |
| 1995[a] | 22 | 37 | 59 | 37% | 63% |
| 1996[a] | 45 | 36 | 81 | 56% | 44% |
| 1997[a] | 98 | 43 | 141 | 70% | 30% |
| 1997[b] | 109 | 24 | 133 | 82% | 18% |
| 1998[a] | 32 | 18 | 50 | 64% | 36% |
| 1999[a] | 4 | 17 | 21 | 19% | 81% |
| Average | 52 | 29 | 81 | 55% | 45% |

[a] Samples collected during carcass surveys.

[b] Samples collected during electroshocking events.

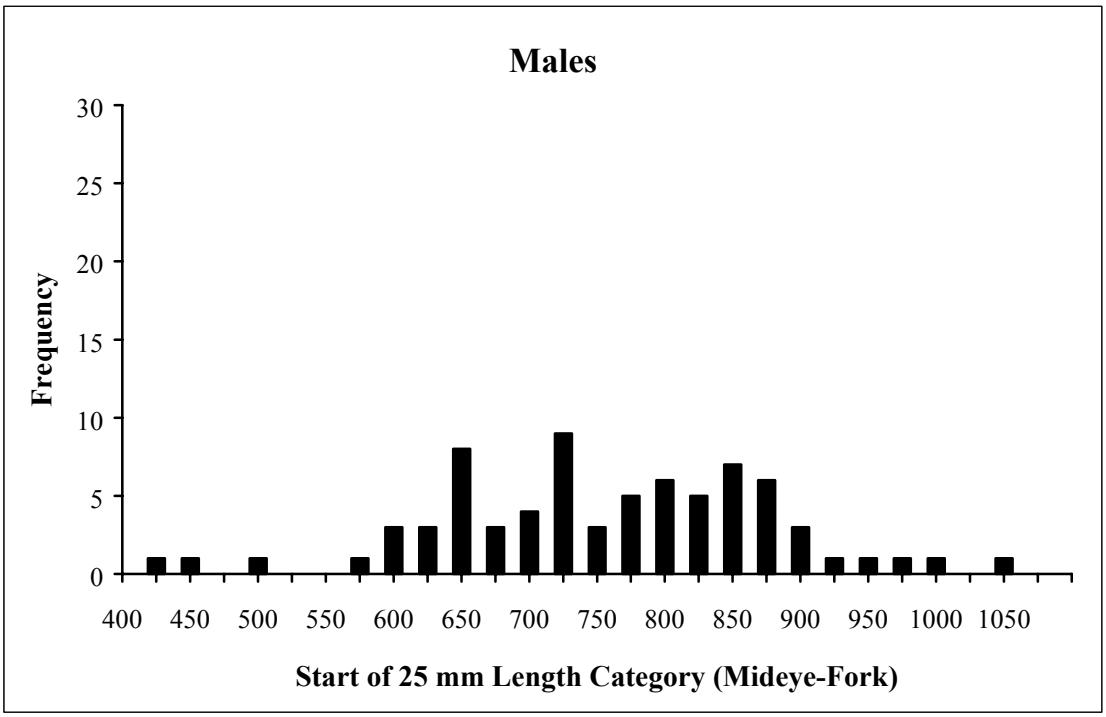
**Table 4.-Estimated proportions and mean length by age class of male and female chinook salmon in the Chena River, 1999.**

| | | Sample | | | Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Age[a] | Size | Proportion | SE | Mean | SE | Min | Max |
| **Male** | 1.2 | 7 | 0.11 | 0.041 | 592 | 27 | 450 | 650 |
| | 1.3 | 23 | 0.38 | 0.063 | 719 | 20 | 610 | 960 |
| | 1.4 | 31 | 0.51 | 0.065 | 815 | 15 | 660 | 1,035 |
| | Total | 61 | 1.00 | | | | | |
| **Total[b]** | | **74** | **0.36** | **0.033** | **747** | **14** | **420** | **1,035** |
| **Female** | | | | | | | | |
| | 1.2 | 1 | 0.01 | 0.009 | 540 | N/A | 540 | 540 |
| | 1.3 | 21 | 0.18 | 0.036 | 798 | 24 | 625 | 1,015 |
| | 1.4 | 94 | 0.81 | 0.037 | 825 | 6 | 670 | 970 |
| | Total | 116 | 1.00 | | | | | |
| **Total[b]** | | **134** | **0.64** | **0.033** | **821** | **6** | **540** | **1,015** |

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

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

[c] Proportion and corresponding SE are based on total number (208) of carcasses sampled.



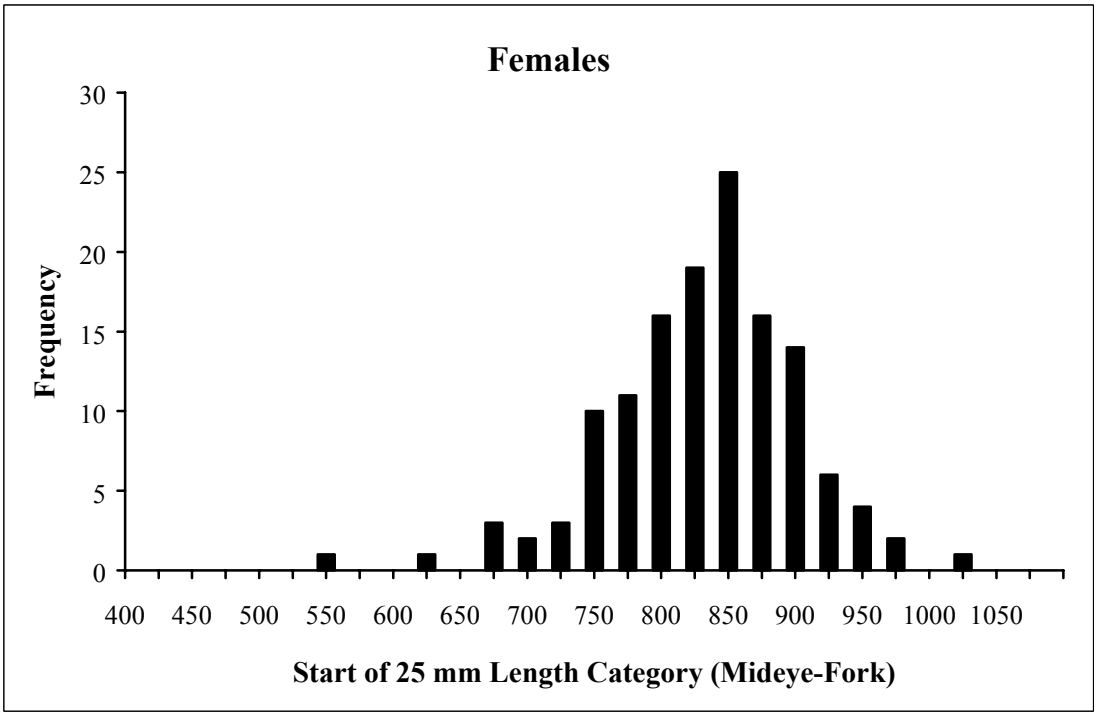




**Figure 7.-Length frequency distributions of male and female chinook salmon carcasses sampled on the Chena River, 1999**

gear rejected the null hypothesis of equal sex proportions ($\chi^2$ = 10.537, df = 1, P $\leq$ 0.01). The odds-ratio between sex and capture year was used to evaluate probability of capture for males and females with respect to the gear type. Accordingly, males were found to be twice as likely to be sampled with electroshocking gear than during a carcass survey ($\hat{\alpha}$ = 2.004).

## Aerial Survey for the Chena River

The peak Chena River aerial survey was conducted on 31 July and counted 2,412 chinook salmon. Visibility for the Chena River was rated as fair. The Chena River count represented 0.37 of the tower-counts. Since 1986, the proportion of the population observed during aerial surveys has ranged from 0.08 to 0.59 of tower/mark-recapture estimates and averaged 0.29 (Table 6).

## Chena River Chum Salmon Studies

Chum salmon were first counted on 19 July. The chum salmon migration was still underway when counting ended. Escapement through 8 August was 9,165 (SE=496, Table 7). The largest daily-expanded count was 1,092 on 4 Aug. The largest number of chum salmon passing during any one 10-min count was 29 for the left side of the Chena River at 1500 on 4 August. Overall, counts tended to be much higher for the left side of the Chena River (Appendices C3-C4). Similar to the chinook salmon, passage of chum salmon for the Chena River showed some diurnal variation with peak migration occurring during the very early and late hours (Figure 8).

## Chatanika River Chinook/Chum Salmon Studies

From 1980-1996, chinook salmon abundance for the Chatanika River was assessed with aerial or boat-counts (Table 8). For 1997, a mark-recapture experiment was performed. For 1998 and 1999, a counting tower was used to estimate escapement (Table 9). Total escapement of chinook salmon was estimated to be 503 (SE=68). The largest daily expanded count of chinook for the Chatanika River was 113 (SE=50) for 23 July. The largest number of chinook salmon to pass during one 20-min count was 10 at 1500-h on 23 July (Appendix C5). Daily passage of chinook salmon was minimal when counts were terminated on 8 August.

The main objective of the tower-count was to estimate chinook salmon escapement; counting chum salmon was ancillary. Similar to the Chena River, the salmon count was concluded while the chum salmon were still traveling to their spawning grounds. The estimate of chum salmon from 2 July through 8 August was 966 (SE=146). The largest daily-expanded count of chum salmon was 252 (SE=75) on 8 August (Table 9). The largest number of chum salmon to pass during one 20-min count was 16 at 2100-h on 4 August (Appendix C6). From visual inspection, neither chum nor chinook salmon showed a distinct diurnal migration pattern (Figure 9).

### Age-Sex-Length Compositions

A total of 26 chinook salmon carcasses were collected, measured, sex determined and a scale taken for later aging from the study area. Ages were determined for 83% of the sample and sex was determined for all fish (Table 10). Of the fish examined, 0.27 (SE=0.09) were male and 0.73 (SE=0.09) were female. The average male/female ratio from 1995-1999 of fish aged was 0.55 males and 0.45 females (Table 3). The majority of males examined were age 1.4 (0.75), while age 1.3 (0.25) was the only other age class in the sample. The majority of females were age 1.4

**Table 5.-Estimated proportions and age of chinook salmon sampled by means of electroshocking from a boat and a carcass survey for the Chena River, 1999.**

| Sex | Age[a] | Sample Size | | Proportion | | SE | |
|---|---|---|---|---|---|---|---|
| | | Electroshock | Carcass | Electroshock | Carcass | Electroshock | Carcass |
| **Male** | 1.1 | 3 | | 0.04 | | 0.024 | |
| | 1.2 | 17 | 7 | 0.24 | 0.11 | 0.052 | 0.041 |
| | 1.3 | 30 | 23 | 0.43 | 0.38 | 0.060 | 0.063 |
| | 1.4 | 20 | 31 | 0.29 | 0.51 | 0.054 | 0.065 |
| | Total | 70 | 61 | 1.00 | 1.00 | | |
| **Total**[b] | | 83 | 74 | 0.53[c] | 0.36[c] | 0.040[c] | 0.033[c] |
| **Female** | 1.2 | | 1 | | 0.01 | | 0.009 |
| | 1.3 | 6 | 21 | 0.08 | 0.18 | 0.033 | 0.036 |
| | 1.4 | 63 | 94 | 0.89 | 0.81 | 0.038 | 0.037 |
| | 1.5 | 2 | | 0.03 | | 0.020 | |
| | Total | 71 | 116 | 1.00 | 1.00 | | |
| **Total**[b] | | 75 | 134 | 0.47[c] | 0.64[c] | 0.040[c] | 0.033[c] |

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

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

[c] Proportion and corresponding SE are based on total number of carcasses (208) and electrofished (158) salmon sampled.

**Table 6.-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 Chena River.**

| River Year | Estimated Abundance[a] | SE | Aerial Survey Count | Aerial Survey Condition[b] | Proportion of Total Escapement | Sport Harvest[f] | Sport Catch[f] |
|---|---|---|---|---|---|---|---|
| **Chena:** | | | | | | | |
| 1986 | 9,065[c] | 1,080 | 2,031 | Fair | 0.22 | 212 | NE[g] |
| 1987 | 6,404[c] | 557 | 1,312 | Fair | 0.20 | 195 | NE[g] |
| 1988 | 3,346[c,e] | 556 | 1,966 | Fair-Poor | 0.59 | 73 | NE[g] |
| 1989 | 2,666[c] | 249 | 1,180 | Fair-Good | 0.44 | 375 | NE[g] |
| 1990 | 5,603[c] | 1,164 | 1,436 | Fair-Poor | 0.26 | 64 | 401 |
| 1991 | 3,025[c] | 282 | 1,276 | Poor | 0.42 | 110 | 258 |
| 1992 | 5,230[c] | 478 | 825 | Fair-Poor | 0.16 | 39 | 71 |
| 1993 | 12,241[d] | 387 | 2,943 | Fair | 0.24 | 733 | 2,545 |
| 1994 | 11,877[d] | 479 | 1,570 | Fair-Poor | 0.13 | 993 | 1,308 |
| 1995 | 9,680[c] | 958 | 3,567 | Fair | 0.37 | 622 | 1,095 |
| 1996 | 7,153[c] | 913 | 2,233 | Poor-Good | 0.31 | 1,280 | 3,692 |
| 1997 | 10,811[c] | 1,160 | 3,495 | Fair-Good | 0.32 | 936 | 2,680 |
| 1997 | 13,390[d] | 699 | 3,495 | Fair-Good | 0.26 | | |
| 1998 | 4,745[d] | 503 | 386 | Incomplete | 0.08 | 341[g] | NE[g] |
| 1999 | 6,485[d] | 427 | 2,412 | Fair | 0.37 | NE[g] | NE[g] |
| | | | | | Avg=0.29 | | |

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

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

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

[d] Estimate was obtained from tower-counts.

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

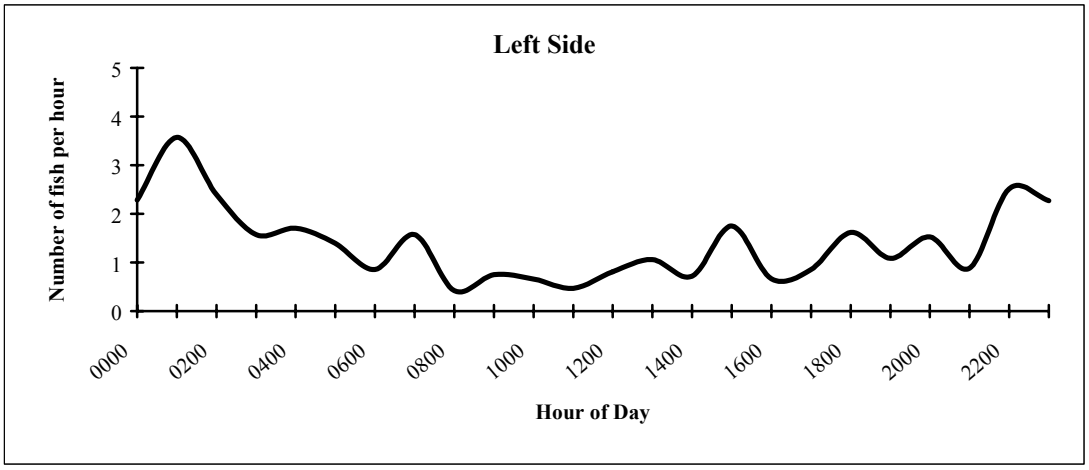
[f] Data from Mills (1981-1994) and Howe et al. (1995-1999).

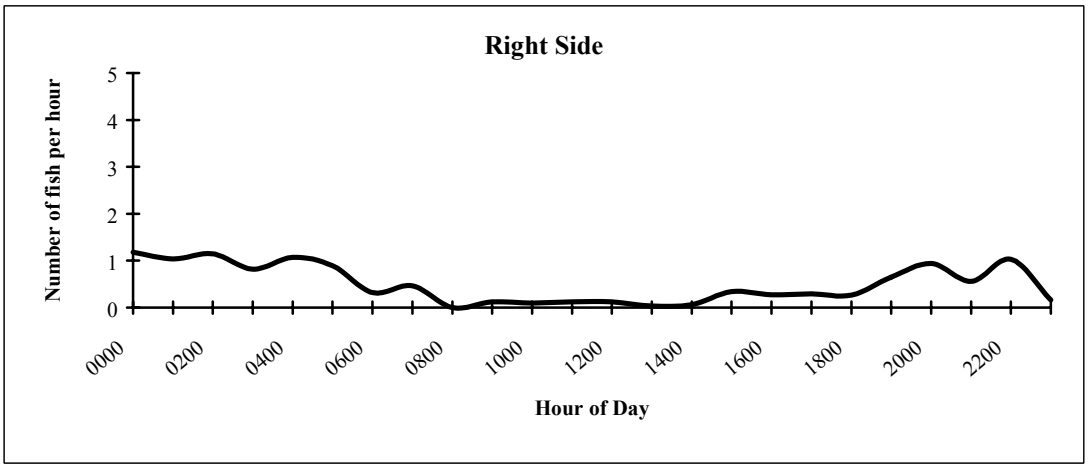
[g] NE = no estimate is available.

**Table 7.-Daily counts and estimates of the number of chum salmon passing by the counting site in the Chena River, 1999.**

| Date | Count Periods | Left Side | | | Right Side | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] |
| 2-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-Jul-99 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-Jul-99 | 16 | 2 | 18 | 15 | 0 | 0 | 0 | 2 | 18 | 15 |
| 20-Jul-99 | 24 | 3 | 18 | 10 | 2 | 12 | 6 | 5 | 30 | 12 |
| 21-Jul-99 | 24 | 8 | 48 | 29 | 0 | 0 | 0 | 8 | 48 | 29 |
| 22-Jul-99 | 23 | 4 | 25 | 13 | 1 | 7 | 7 | 5 | 32 | 15 |
| 23-Jul-99 | 24 | 16 | 96 | 40 | 2 | 12 | 12 | 18 | 108 | 42 |
| 24-Jul-99 | 24 | 68 | 408 | 68 | 11 | 66 | 36 | 79 | 474 | 76 |
| 25-Jul-99 | 24 | 48 | 288 | 79 | 13 | 78 | 37 | 61 | 366 | 87 |
| 26-Jul-99 | 14 | 34 | 357 | 73 | 7 | 78 | 49 | 41 | 435 | 88 |
| 27-Jul-99 | 22 | 13 | 82 | 32 | 23 | 162 | 56 | 36 | 244 | 64 |
| 28-Jul-99 | 0 | 0 | 151 | 73 | 0 | 137 | 57 | 0 | 287 | 92 |
| 29-Jul-99 | 0 | 0 | 144 | 75 | 0 | 177 | 57 | 0 | 320 | 94 |
| 30-Jul-99 | 23 | 2 | 13 | 12 | 28 | 171 | 57 | 30 | 183 | 58 |
| 31-Jul-99 | 24 | 56 | 336 | 75 | 33 | 198 | 67 | 89 | 534 | 101 |
| 1-Aug-99 | 24 | 86 | 516 | 101 | 33 | 198 | 44 | 119 | 714 | 110 |
| 2-Aug-99 | 24 | 74 | 444 | 96 | 19 | 114 | 36 | 93 | 558 | 103 |
| 3-Aug-99 | 24 | 58 | 348 | 89 | 20 | 120 | 52 | 78 | 468 | 103 |
| 4-Aug-99 | 24 | 114 | 684 | 154 | 68 | 408 | 143 | 182 | 1,092 | 210 |
| 5-Aug-99 | 24 | 73 | 438 | 138 | 15 | 90 | 43 | 88 | 528 | 145 |
| 6-Aug-99 | 23 | 112 | 717 | 182 | 28 | 183 | 63 | 140 | 901 | 192 |
| 7-Aug-99 | 24 | 111 | 666 | 120 | 31 | 186 | 71 | 142 | 852 | 140 |
| 8-Aug-99 | 24 | 134 | 804 | 173 | 28 | 168 | 39 | 162 | 972 | 177 |
| Total | 744 | 1,016 | **6,600** | **430** | 362 | **2,565** | **248** | 1,378 | **9,165** | **496** |

[a] Shaded cells are estimates for days with no counts, and for SE are days with only one counting period or less. See Methods section for a description of how estimates for expanded count's and SE's are calculated for these days.



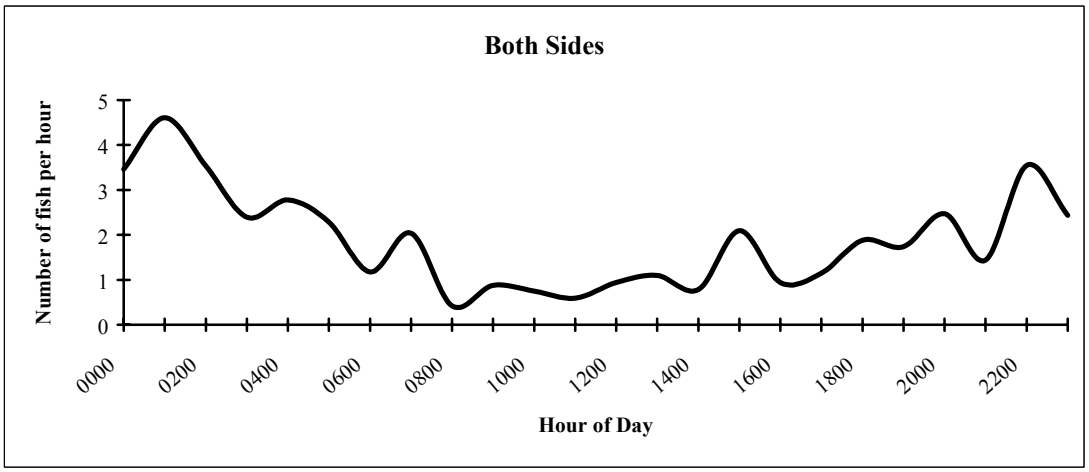




**Figure 8.-Average hourly escapement of chum salmon in the Chena River, 1999.**

**Table 8.-Aerial survey counts, boat-counts, abundance estimates, and sport harvest and catch estimates of chinook salmon in the Chatanika River, 1980-1999.**

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

[a] Lower section runs from the Trans Alaska Pipeline upstream to the Elliott Highway Bridge.

[b] Middle section runs form the Elliott Highway Bridge upstream to the Steese Highway Bridge.

[c] Upper section runs from the Steese Highway Bridge upstream to the confluence of Faith and McManus Creeks (Figure 4).

[d] Data from Mills (1981-1994) and Howe et al. (1995-1999).

[e] NA = section subtotals are not available.

[f] NE = no estimate is available.

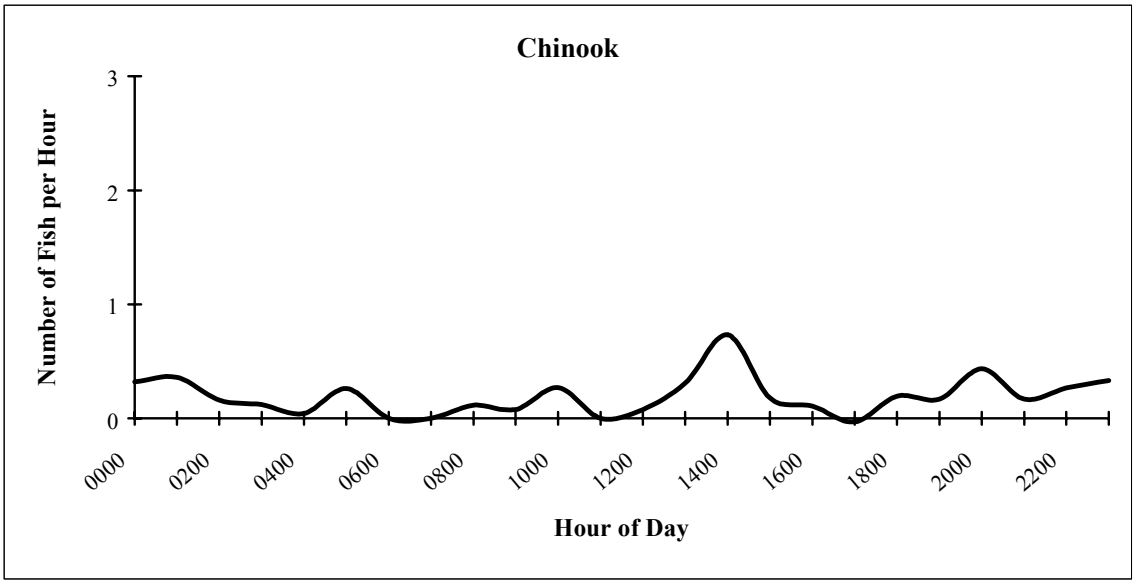
[g] NC = no count was conducted during this survey.

[h] Incomplete survey.

**Table 9.-Daily counts and estimates of the number of chinook and chum salmon passing by the counting site in the Chatanika River, 1999.**

| | | Chinook | | | Chum | | |
|---|---|---|---|---|---|---|---|
| Date | Count Periods | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] |
| 2-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4-Jul-99 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16-Jul-99 | 16 | 2 | 9 | 7 | 0 | 0 | 0 |
| 17-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-Jul-99 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-Jul-99 | 16 | 5 | 23 | 17 | 0 | 0 | 0 |
| 20-Jul-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21-Jul-99 | 24 | 3 | 9 | 8 | 0 | 0 | 0 |
| 22-Jul-99 | 16 | 2 | 9 | 8 | 0 | 0 | 0 |
| 23-Jul-99 | 16 | 25 | 113 | 50 | 0 | 0 | 0 |
| 24-Jul-99 | 16 | 13 | 59 | 9 | 0 | 0 | 0 |
| 25-Jul-99 | 16 | 1 | 5 | 4 | 0 | 0 | 0 |
| 26-Jul-99 | 16 | 11 | 50 | 13 | 0 | 0 | 0 |
| 27-Jul-99 | 16 | 15 | 68 | 20 | 14 | 63 | 48 |
| 28-Jul-99 | 11 | 1 | 6 | 6 | 0 | 0 | 0 |
| 29-Jul-99 | 22 | 1 | 3 | 7 | 4 | 12 | 7 |
| 30-Jul-99 | 24 | 5 | 15 | 4 | 15 | 45 | 28 |
| 31-Jul-99 | 16 | 5 | 23 | 15 | 14 | 63 | 44 |
| 1-Aug-99 | 20 | 8 | 36 | 17 | 12 | 60 | 25 |
| 2-Aug-99 | 16 | 4 | 18 | 8 | 0 | 0 | 0 |
| 3-Aug-99 | 24 | 3 | 9 | 4 | 10 | 30 | 9 |
| 4-Aug-99 | 24 | 4 | 12 | 5 | 38 | 114 | 56 |
| 5-Aug-99 | 16 | 4 | 18 | 10 | 9 | 41 | 28 |
| 6-Aug-99 | 14 | 4 | 21 | 12 | 38 | 212 | 76 |
| 7-Aug-99 | 17 | 6 | 18 | 10 | 11 | 75 | 14 |
| 8-Aug-99 | 12 | -3 | -18 | 9 | 37 | 252 | 75 |
| Total | 639 | 119 | **503** | **68** | 202 | **966** | **146** |

[a] Shaded cells are estimates for days with no counts, and for SE are days with only one counting period or less. See Methods section for a description of how estimates for expanded count's and SE's are calculated for these days.



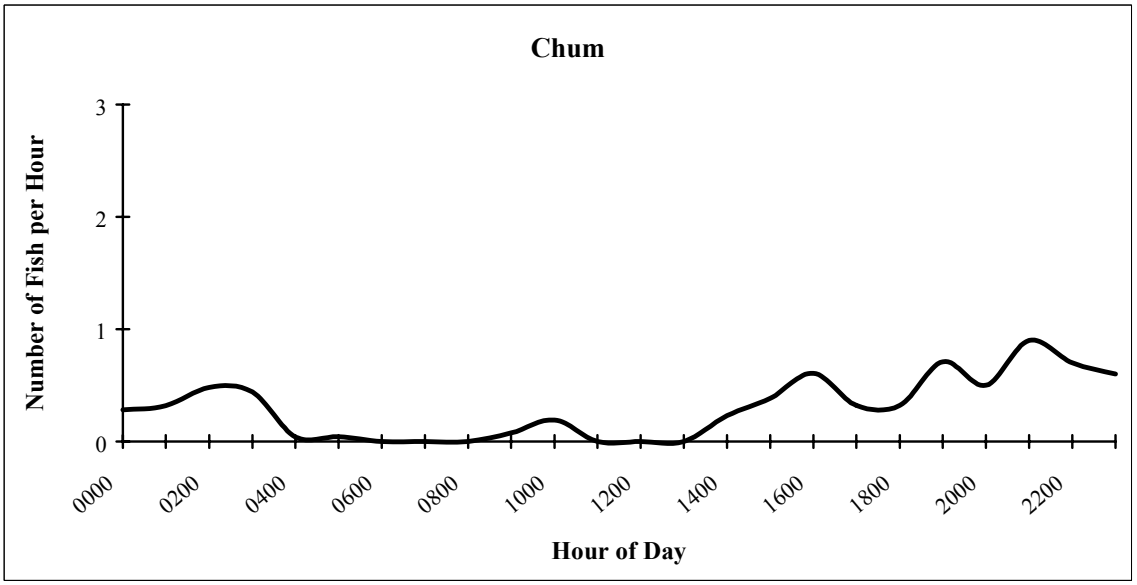




**Figure 9.-Average hourly escapement of chinook and chum salmon in the Chatanika River, 1999.**

**Table 10.-Estimated proportions and mean length by age class of male and female chinook salmon in the Chatanika River, 1999.**

| | | Sample | | | Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Age[a] | Size | Proportion | SE | Mean | SE | Min | Max |
| **Male** | 1.3 | 1 | 0.25 | 0.250 | 735 | N/A | 735 | 735 |
| | 1.4 | 3 | 0.75 | 0.250 | 662 | 80 | 545 | 815 |
| | Total | 4 | 1.00 | | | | | |
| **Total[b]** | | 7 | 0.27[c] | 0.089[c] | 635 | 44 | 490 | 815 |
| **Female** | 1.3 | 4 | 0.24 | 0.106 | 773 | 33 | 735 | 870 |
| | 1.4 | 13 | 0.76 | 0.106 | 830 | 15 | 760 | 935 |
| | Total | 17 | 1.00 | | | | | |
| **Total[b]** | | 19 | 0.73[c] | 0.089[c] | 817 | 13 | 735 | 935 |

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

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

[c] Proportion and corresponding SE are based on total number (26) of carcasses sampled.

(0.76) and 1.3 (0.24). Male lengths varied from 545 mm to 815 mm, and female lengths varied from 735 mm to 935 mm (Figure 10).

Chatanika River chinook carcasses have been collected since 1995 for determining age, sex, and length compositions. The most common ages sampled for male chinook salmon were 1.2, 1.3, and 1.4 (Appendix D4). Similar to the Chena River population, Chatanika River chinook salmon have shown variations in mean length between the years (Appendix D5). Mean length at age for age 1.2 has varied from 575 mm in 1995 to 596 mm in 1997. Age 1.3 has varied from 712 mm in 1997 to 775 mm in 1995 and age 1.4 has varied from 662 mm in 1999 to 885 mm in 1995. The most common ages seen for female chinook salmon were 1.3 and 1.2. Mean length at age 1.3 has varied from 685 mm in 1996 to 855 mm in 1995. Age 1.4 has varied from 785 mm in 1998 to 862 mm in 1997.

## DISCUSSION

Tower-count methodology has been used for seven consecutive years as a means of estimating daily and seasonal abundance of chinook salmon for the Chena River. Tower-counts offer a few advantages over mark-recapture techniques and aerial surveys. For one, tower-counts are an on-going process throughout the salmon run. Thus, they provide in-season information that can be used by fishery managers to help regulate harvest on the fisheries. Based on historical run-timing data shown in Figure 5, managers can predict when a salmon run is due to reach a particular percentage mark. Based on timing and escapement, a manager can take measures to increase or decrease harvest. For example, the sport fishing bag limit was increased by emergency order regulation from one to two chinook salmon per day in 1993 and 1994 as a result of large, early escapements. In 1998, due to poor escapement into the Salcha and Chena rivers by what should have been the 50% mark of the minimum escapement objective, the chinook salmon fisheries were restricted to catch-and-release only on 14 July for the duration of the season.

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

The precision of the estimates obtained from the tower-counts has been substantially better than the precision of mark-recapture estimates obtained from prior years. However, this precision may be misleading. The variance estimator assumes that during a count all salmon that pass over the panels are correctly identified and counted. Counting errors have been apparent during past tower-count estimates. During the 1996 season, duplicate counts with two counters showed small discrepancies between counters (Evenson and Stuby 1997). Although these discrepancies appear to be slight in magnitude, the cumulative effect on the overall estimates of abundance and variance may be significant over time. Some of the errors may result from poor visibility as a result of adverse weather and/or water conditions, fish passing through a poorly illuminated portion of the panels, more than one group passing at a time, counter fatigue during the late evening/early morning shifts, and different experience levels of the counters in differentiating chum from chinook salmon. The bias resulting from fish not seen passing over the panels is negative and therefore makes the estimates conservative. The extent of the counting errors resulting from misidentification is unknown and could potentially over or underestimate the

escapement. Another drawback to the tower-count method is that it can only be assumed that a representative carcass sample is being taken to estimate age-sex-length compositions.

The greatest limitation of tower-counting methodology is that it requires low water conditions (good visibility) for most of the run. High water events persisting for more than two days add a great deal of uncertainty to the estimate, especially during peak portions of the runs. Of the seven total attempted tower-count estimates performed for the Chena River, five were successful. For those years when a total estimate of escapement cannot be generated from tower-counts, the daily estimates can still be used for in-season management purposes, especially during the early portion of the run. If estimating total escapement remains an objective, then mark-recapture experiments should continue to be planned as a back up means of estimating escapement in the event of inadequate tower-counts.

Mark-recapture experiments likely do not provide a total estimate of escapement for the Chena River because spawning occurs in areas upstream from the upper boundaries of the study areas, whereas tower-count estimates are considered total estimates. In 1997 a tower-count and mark-recapture experiment were successfully conducted on the Chena River (Stuby and Evenson, 1998). Although the Chena River tower-count estimate for total escapement of chinook salmon was 24% higher than the mark-recapture estimate, the difference was not significant given the precision for each estimate.

Mark-recapture techniques should, however, be considered a secondary means of estimating escapement. The marking event occurs late into the run at the end of the chinook fishery. Without the tower-counts, managers would have to rely on aerial survey estimates to provide in-season escapement information. Also, in order for the experiment to be successful, a large sample relative to population size needs to be examined. During a 1997 mark-recapture study in the Chatanika River, an insufficient number of recaptures and the need to stratify by sex led to an abundance estimate with a large standard error (Stuby and Evenson, 1998).

Electroshocking methods can potentially harm the eggs within the spawning female during capture and when the electrodes skim over the redds. Considering both types of egg mortality, Roach (1996) concluded that the cost in egg mortality of using electrofishing to sample a population of 10,000 chinook salmon under the conditions similar to an M-R experiment is equivalent to removing 51 prespawning females or 1.3% of the female population. However, the potential harm is offset by the gain of valuable escapement information if the tower-count becomes invalid.

Tower counting methods were implemented in 1998 for the Chatanika River. Compared to the Chena River, the Chatanika River sports a much smaller run of chinook salmon. The salmon run for 1999 was approximately 60% of what was estimated in 1998. During 1998, chinook salmon escapements into the Salcha and Chena rivers were below minimum escapement goals. These goals were met in 1999 and it was expected that the Chatanika River would follow a similar pattern. Reported subsistence chinook salmon harvest for the nearby Tolovana River was minimal. During 1997, 0 fish were harvested from the Tolovana River and during 1998, one chinook salmon was reported (Borba and Hamner, 1998, 1999). Sport harvest for the Chatanika

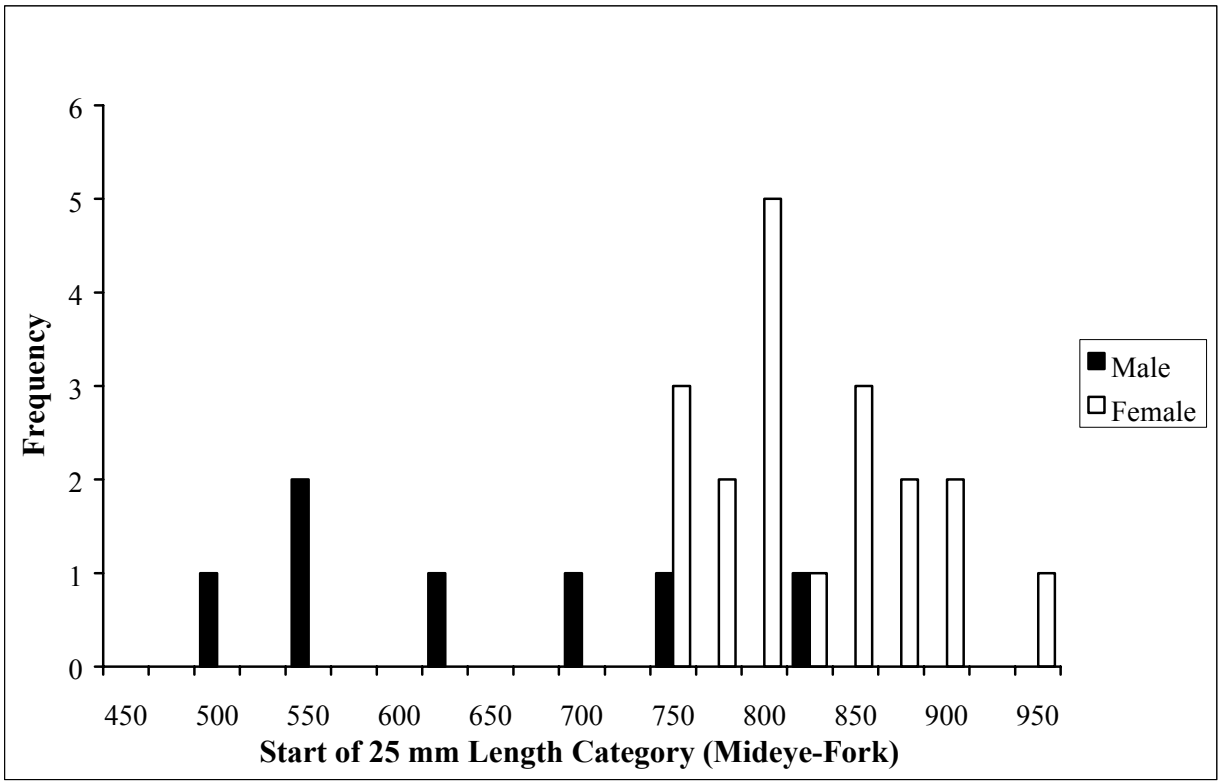



**Figure 10.-Length frequency distributions of male and female chinook salmon carcasses sampled on the Chatanika River, 1999.**

River for 1998 was small (Table 8) and for 1999 is yet unknown. In past years, harvests from sport fishermen have been large relative to index measures of abundance. Given no escapement objectives yet exist for this river, continuation of enumeration projects to acquire precise estimates is especially important for managing this stock.

Past mark-recapture techniques allowed for the detection of size bias between electrofishing (mark) and the carcass survey (recapture) and sex bias within each survey. Through examination of contingency table analyses, mark-recapture experiments for the Chena River have shown that size and sex composition estimates from carcass surveys were biased during five experiments. Analyses of marked/unmarked ratios corresponded to the probabilities of capture during the first event, and recaptured/not recaptured ratios corresponded to the probabilities of capture during the second event. However, bias in size composition was not substantial enough to alter the estimated abundance and was thus not considered biologically significant (Evenson 1993). The extent of the bias associated with sex composition in terms of its affect on estimates of population proportions is not known.

Chinook salmon were electrofished in 1999 during the height of the run for age and sex in addition to the carcass survey for the purpose of comparing sex bias. The carcass survey showed a much higher degree of sex bias than what was gleaned from electrofishing. Carcass surveys on the Chena River tend to be biased toward capture of large, particularly female fish (D. Bernard, ADF&G, Anchorage, personal communication). In general, because males mature at a younger average age than females (Healey, 1991), and because marine age and chinook size are positively correlated (Pahlke and Bernard, 1996), males tend to be smaller on average. Smaller salmon decompose faster and are harder to detect from a distance. Hubartt and Kissner (1987) found that most female chinook salmon in the Taku River died in shallow water near their redds, whereas males tended to wash downstream in a moribund condition.

Inclement weather and near-flood conditions during the first week washed and/or buried chinook salmon carcasses in the Chena River. As a result, the target sample size was not achieved. A relatively small escapement precluded achieving the target carcass sample for the Chatanika River.

# SALCHA RIVER CHINOOK SALMON STUDIES

The Salcha River, similar to the Chena River, has some of the largest chinook salmon escapements in the Yukon Drainage (Schultz et al. 1994). The Sport Fish Division conducted mark-recapture surveys on the Salcha River between 1987 and 1992. Tower-count estimates were implemented in 1993 and continued through 1998. The Sport Fish Division did not conduct a tower count on the Salcha River during 1999. Instead, the Bering Sea Fishermen's Association conducted tower counts from 6 July to 30 August. A single tower was erected approximately 0.25 miles downstream from the Richardson Bridge (Figure 11). Set-up and enumeration procedures for chinook and chum salmon returning to the Salcha River were similar to that for the Chatanika River.

## CHINOOK AND CHUM SALMON ESTIMATES

Total escapement of chinook salmon was estimated to be 9,198 (SE=290) for the Salcha River. The largest expanded daily count of chinook salmon for the Salcha River was 984 (SE=111) on 21 July (Table 11). High water due to rainfall prevented counts on 27-31 July and 9-12 August

(Appendix E1). The largest number of chinook salmon to pass during any one 20-min count was 49 at 0300-h on 20 July (Appendix E2). Daily passage of chinook salmon was zero when counts were terminated on 30 August.

Run timing of 1999 chinook salmon was similar to the Chena River (Figure 12). The run was much later than for previous years. Escapement reached 50% of the total on 24 July. The average total escapement estimated from tower-counts for 1993-1995 and 1997-1998 was 13,321. Total escapement from tower counts for 1996 was unreliable due to high water events, and a mark-recapture experiment was conducted in order to acquire an estimate of total escapement. The 1999 escapement surpassed the minimum escapement goal of 7,100 (Figure 13).

The Bering Sea Fishermen's Association attempted to acquire a total escapement for summer chum salmon, but were unable to due to adverse counting conditions. The final, but incomplete estimate for chum salmon was 23,221 (SE=460). The largest expanded daily count of chum salmon for the Salcha River was 1,629 (SE=117) on 1 August (Table 11). The largest number of chum salmon to pass during any one 20-min count was 57 at 2000-h on 3 August (Appendix E3). Visual inspection of Figure 14 shows a diurnal pattern for both chinook and chum salmon that was similar to the Chena River. Passage of salmon was generally higher in the early morning and late evenings.

### AGE-SEX-LENGTH COMPOSITIONS

Three hundred sixty chinook salmon carcasses were collected and examined during 7 and 8 August. The sex composition for this sample including those fish not aged was 0.49 (SE=0.03) males and 0.51 (SE=0.03) females. Ages were determined for 0.85 of the sample. The dominant age class for males and females sampled in 1999 was 1.4 with proportions of 0.42 (SE=0.04) and 0.86 (SE=0.03), respectively, (Table 12). Males were also represented by ages 1.2 (0.20) and 1.3 (0.37). Females were also represented by ages 1.3 (0.13) and 1.5 (0.01). Lengths of males ranged from 455 to 1,005 mm (Figure 15). Lengths of females ranged from 550 to 960 mm.

Carcass sampling of chinook salmon on the Salcha River by Region III Sport Fish Division has taken place from 1987-1998. The mean length at age for chinook salmon sampled has varied between years for a given age and sex. However, no consistent upward or downward trends have been apparent. The most common ages sampled for male chinook salmon were 1.2, 1.3 and 1.4 (Appendix E4). Mean length at age for age 1.2 has varied from 503 mm in 1998 to 592 mm in 1990. Age 1.3 has varied from 695 mm in 1998 to 790 mm in 1989 and age 1.4 has varied from 787 mm in 1998 to 933 mm in 1990 (Appendix E5). The most common ages sampled for female chinook salmon were 1.3, 1.4 and 1.5. Mean length at age for age 1.3 has varied from 736 mm in 1998 to 860 mm in 1997. Age 1.4 has varied from 782 in 1998 to 898 mm in 1990 and age 1.5 has varied from 833 mm in 1997 to 960 mm in 1989 (Appendix E6).

## COHO SALMON STUDY IN THE DELTA CLEARWATER RIVER

### INTRODUCTION

The Delta Clearwater River has the largest known coho salmon escapements in the Yukon River drainage (Parker 1991). The river is a spring-fed tributary to the Tanana River located near Delta

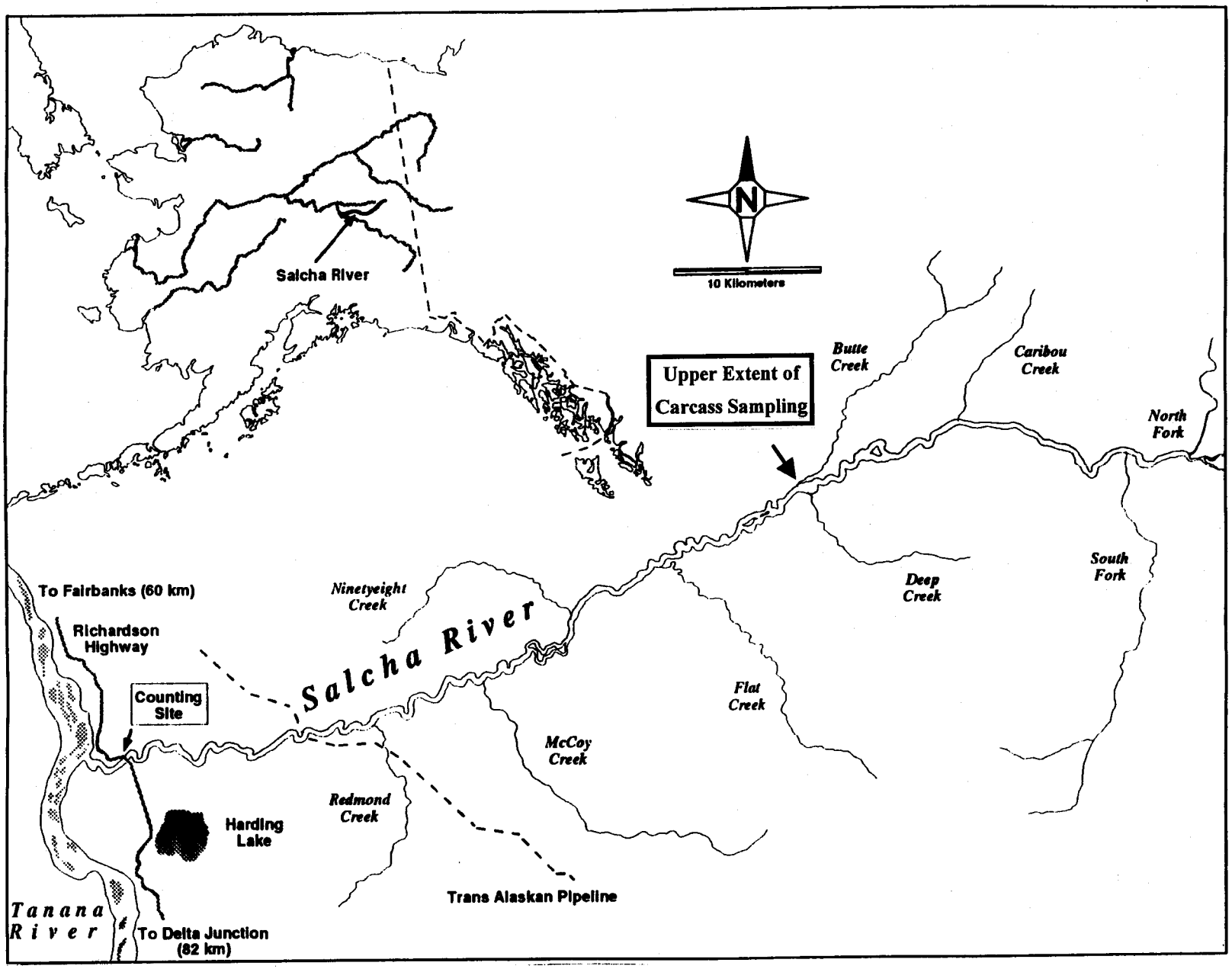



**Figure 11.-Salcha River study area.**

**Table 11.-Daily counts and estimates of the number of chinook and chum salmon passing by the counting site in the Salcha River, 1999.**

| Date | Count Periods | Chinook | | | Chum | | |
|---|---|---|---|---|---|---|---|
| | | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] |
| 6-Jul-99 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-Jul-99 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-Jul-99 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-Jul-99 | 24 | 1 | 3 | 3 | 0 | 0 | 0 |
| 11-Jul-99 | 23 | 13 | 39 | 16 | 0 | 0 | 0 |
| 12-Jul-99 | 24 | 21 | 63 | 15 | 0 | 0 | 0 |
| 13-Jul-99 | 24 | 7 | 21 | 10 | 0 | 0 | 0 |
| 14-Jul-99 | 24 | 12 | 36 | 10 | 0 | 0 | 0 |
| 15-Jul-99 | 24 | 28 | 84 | 28 | 0 | 0 | 0 |
| 16-Jul-99 | 24 | 82 | 246 | 49 | 0 | 0 | 0 |
| 17-Jul-99 | 24 | 64 | 192 | 35 | 0 | 0 | 0 |
| 18-Jul-99 | 24 | 133 | 399 | 73 | 0 | 0 | 0 |
| 19-Jul-99 | 24 | 98 | 294 | 51 | 0 | 0 | 0 |
| 20-Jul-99 | 24 | 285 | 855 | 105 | 0 | 0 | 0 |
| 21-Jul-99 | 24 | 328 | 984 | 111 | 0 | 0 | 0 |
| 22-Jul-99 | 24 | 182 | 546 | 47 | 0 | 0 | 0 |
| 23-Jul-99 | 24 | 151 | 453 | 43 | 46 | 138 | 59 |
| 24-Jul-99 | 24 | 152 | 456 | 69 | 106 | 318 | 32 |
| 25-Jul-99 | 22 | 264 | 825 | 61 | 99 | 319 | 39 |
| 26-Jul-99 | 20 | 243 | 774 | 55 | 99 | 342 | 44 |
| 27-Jul-99 | 0 | 0 | 559 | 74 | 0 | 403 | 126 |
| 28-Jul-99 | 0 | 0 | 512 | 74 | 0 | 702 | 126 |
| 29-Jul-99 | 0 | 0 | 456 | 74 | 0 | 906 | 126 |
| 30-Jul-99 | 0 | 0 | 316 | 74 | 0 | 1,083 | 154 |
| 31-Jul-99 | 8 | 32 | 288 | 74 | 100 | 900 | 126 |

-continued-

**Table 11.-Page 2 of 2.**

| Date | Count Periods | Chinook | | | Chum | | |
|---|---|---|---|---|---|---|---|
| | | Count | Expanded Count[a] | SE[a] | Count | Expanded Count[a] | SE[a] |
| 1-Aug-99 | 24 | 73 | 219 | 22 | 543 | 1,629 | 117 |
| 2-Aug-99 | 24 | 58 | 174 | 20 | 446 | 1,338 | 62 |
| 3-Aug-99 | 24 | 41 | 123 | 16 | 402 | 1,206 | 154 |
| 4-Aug-99 | 24 | 13 | 39 | 9 | 315 | 945 | 94 |
| 5-Aug-99 | 24 | 24 | 72 | 16 | 342 | 1,026 | 88 |
| 6-Aug-99 | 24 | 0 | 0 | 10 | 371 | 1,168 | 104 |
| 7-Aug-99 | 24 | 11 | 33 | 8 | 410 | 1,230 | 89 |
| 8-Aug-99 | 24 | 10 | 30 | 9 | 297 | 891 | 88 |
| 9-Aug-99 | 11 | 10 | 45 | 27 | 121 | 710 | 126 |
| 10-Aug-99 | 0 | 0 | 28 | 27 | 0 | 780 | 126 |
| 11-Aug-99 | 0 | 0 | 20 | 27 | 0 | 492 | 126 |
| 12-Aug-99 | 0 | 0 | 12 | 27 | 0 | 277 | 126 |
| 13-Aug-99 | 24 | 1 | 3 | 2 | 96 | 288 | 28 |
| 14-Aug-99 | 24 | 0 | 0 | 0 | 26 | 78 | 13 |
| 15-Aug-99 | 24 | 0 | 0 | 0 | 11 | 33 | 12 |
| 16-Aug-99 | 16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17-Aug-99 | 24 | 0 | 0 | 0 | 31 | 93 | 16 |
| 18-Aug-99 | 24 | 0 | 0 | 0 | 73 | 219 | 34 |
| 19-Aug-99 | 24 | 0 | 0 | 0 | 92 | 276 | 38 |
| 20-Aug-99 | 24 | 0 | 0 | 0 | 118 | 354 | 48 |
| 21-Aug-99 | 24 | 0 | 0 | 0 | 139 | 417 | 42 |
| 22-Aug-99 | 24 | 0 | 0 | 0 | 129 | 387 | 43 |
| 23-Aug-99 | 24 | 0 | 0 | 0 | 278 | 834 | 49 |
| 24-Aug-99 | 24 | 0 | 0 | 0 | 255 | 765 | 47 |
| 25-Aug-99 | 24 | 0 | 0 | 0 | 196 | 588 | 52 |
| 26-Aug-99 | 8 | 0 | 0 | 0 | 101 | 909 | 128 |
| 27-Aug-99 | 24 | 0 | 0 | 0 | 88 | 264 | 36 |
| 28-Aug-99 | 3 | 0 | 0 | 0 | 17 | 408 | 57 |
| 29-Aug-99 | 8 | 0 | 0 | 0 | 19 | 258 | 106 |
| 30-Aug-99 | 24 | 0 | 0 | 0 | 83 | 249 | 23 |
| Total | 1,059 | 2,337 | **9,198** | **290** | 5,449 | **23,221** | **460** |

[a] Shaded cells are estimates for days with no counts, and for SE are days with only one counting period or less. See Methods section for a description of how estimates for expanded count's and SE's are calculated for these days.

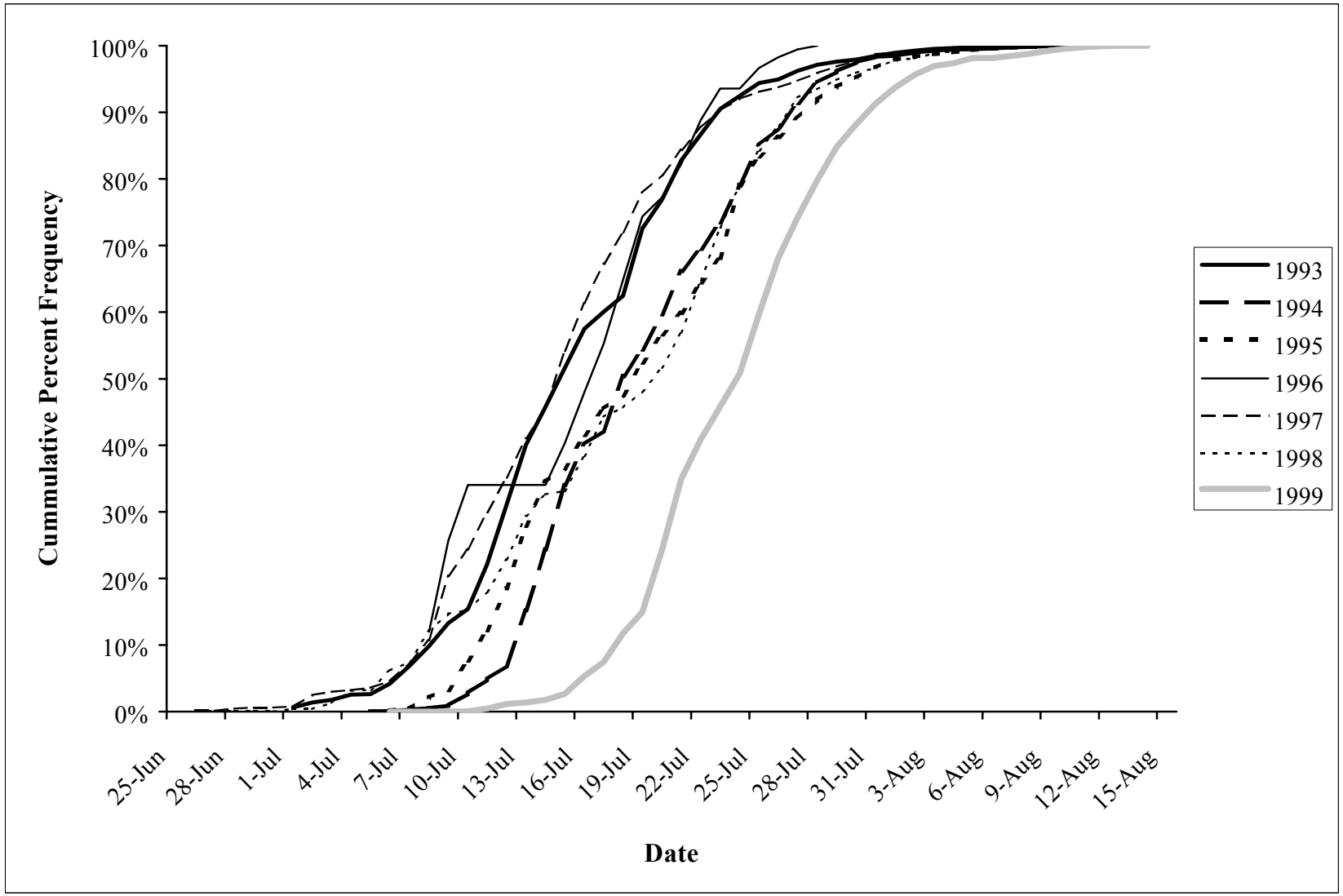



**Figure 12.-Run timing of chinook salmon from 1993-1999 for the Salcha River.**

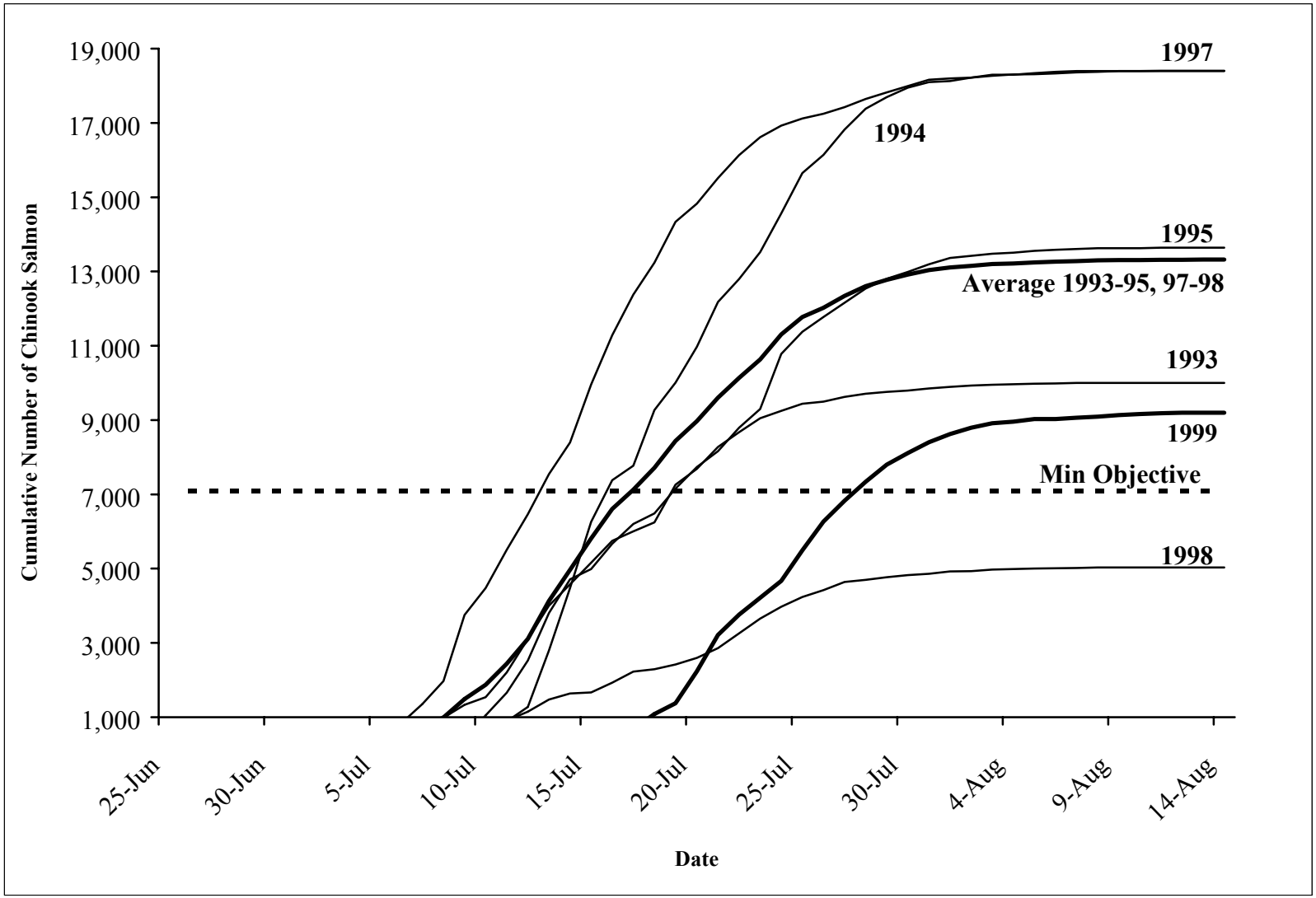
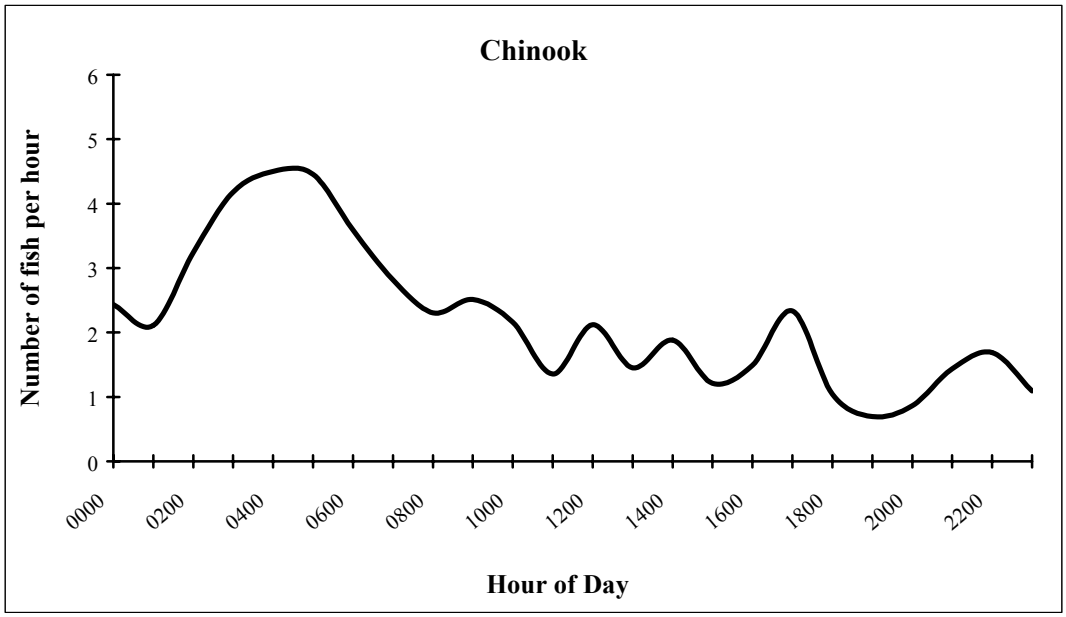



**Figure 13.-Average expanded cumulative passage of chinook salmon for 1993-1995 and 1997-1998 tower-counts compared to 1999 for the Salcha River.**



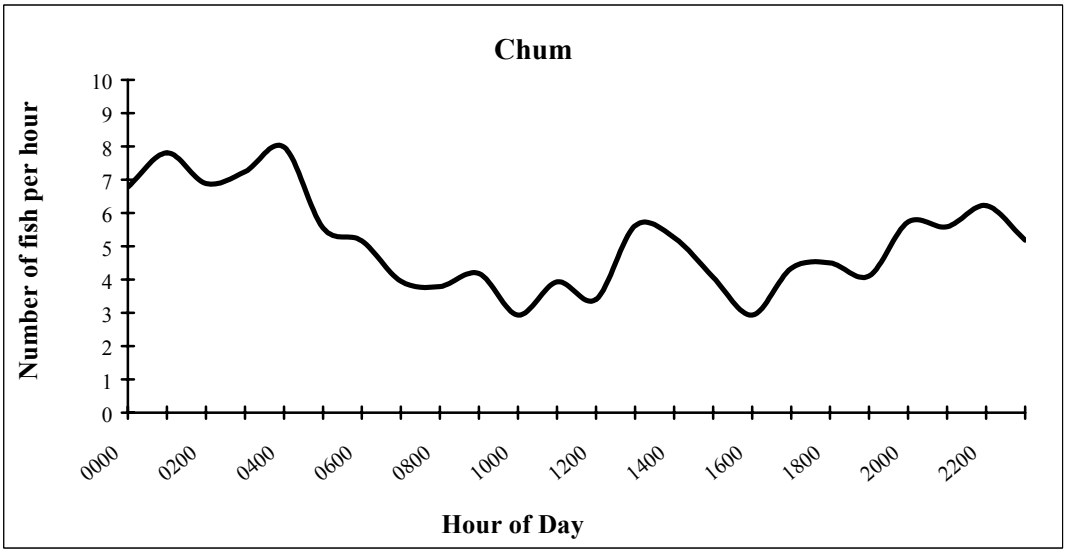




**Figure 14.-Average hourly escapement of chinook and chum salmon in the Salcha River, 1999.**

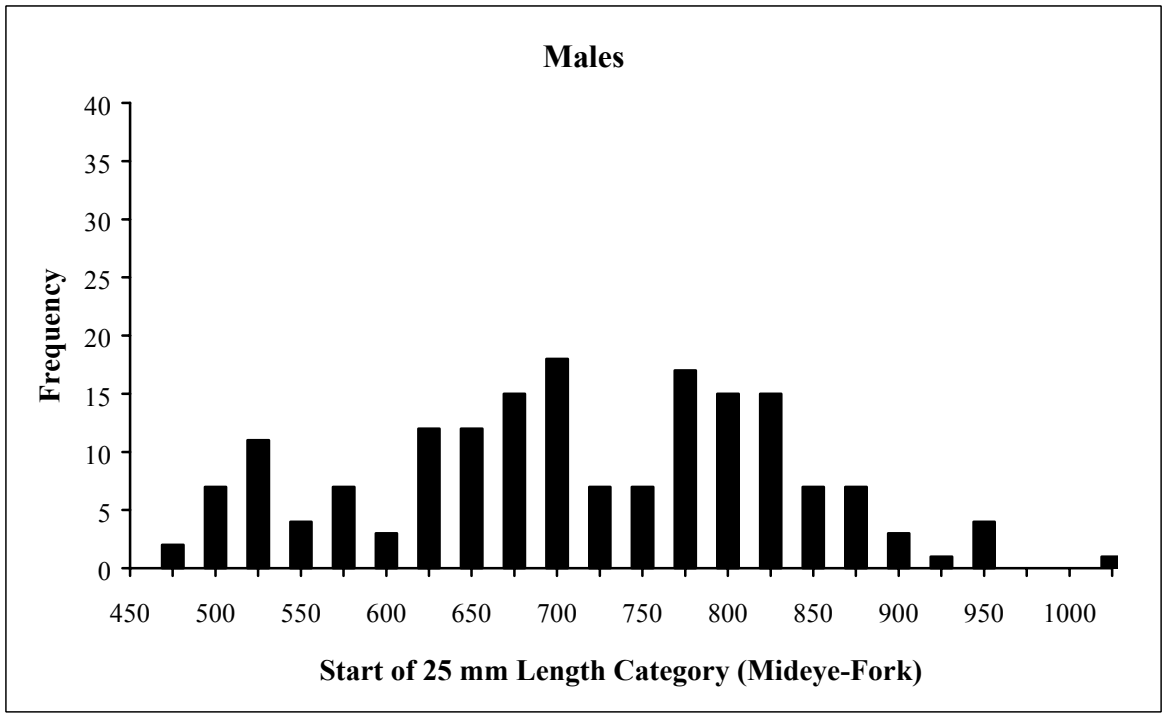
**Table 12.-Estimated proportions and mean length by age class of male and female chinook salmon in the Salcha River, 1999.**

| | | Sample | | | Length | | | |
|---|---|---|---|---|---|---|---|---|
| | Age[a] | Size | Proportion | SE | Mean | SE | Min | Max |
| **Male** | 1.2 | 28 | 0.20 | 0.034 | 539 | 11 | 455 | 700 |
| | 1.3 | 52 | 0.37 | 0.041 | 701 | 10 | 555 | 870 |
| | 1.4 | 59 | 0.42 | 0.042 | 789 | 13 | 495 | 1,005 |
| | Total | 139 | 1.00 | | | | | |
| **Total[b]** | | 175 | 0.49[c] | 0.026[c] | 703 | 9 | 455 | 1,005 |
| **Female** | 1.3 | 22 | 0.13 | 0.026 | 826 | 12 | 705 | 910 |
| | 1.4 | 145 | 0.86 | 0.027 | 859 | 4 | 550 | 960 |
| | 1.5 | 1 | 0.01 | 0.006 | 885 | N/A | 885 | 885 |
| | Total | 168 | 1.00 | | | | | |
| **Total[b]** | | 185 | 0.51[c] | 0.026[c] | 856 | 4 | 550 | 960 |

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

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

[c] Proportion and corresponding SE are based on total number (360) of carcasses sampled.



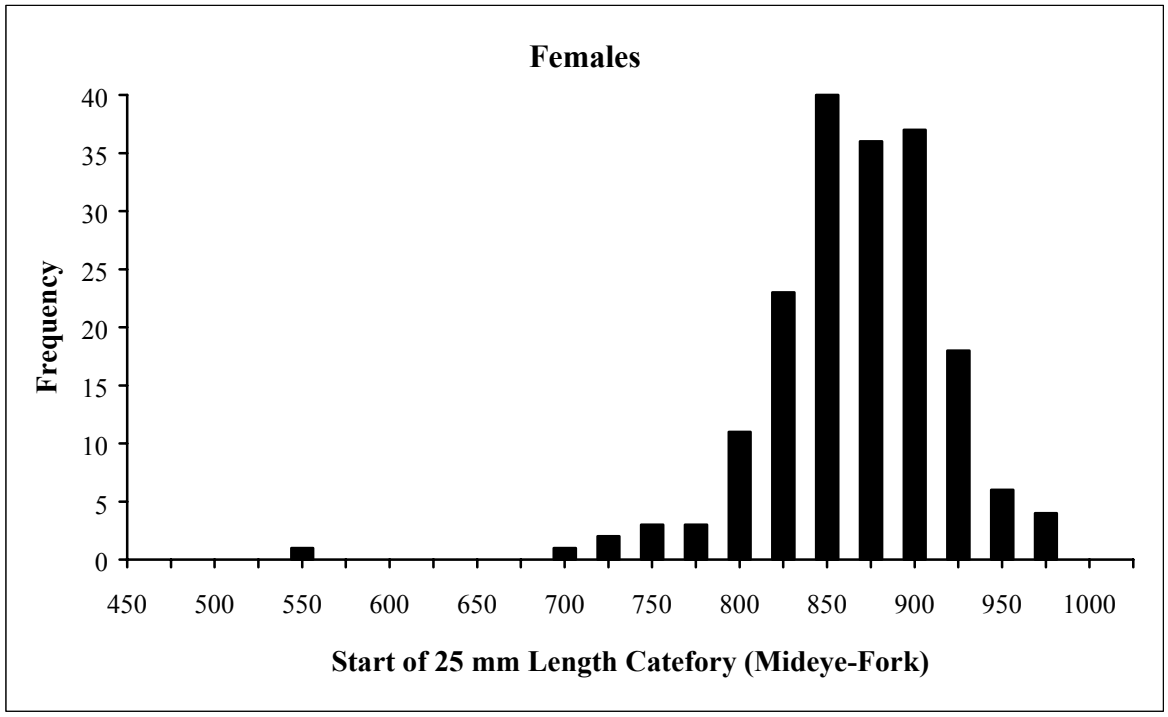




**Figure 15.-Length frequency distributions of male and female chinook salmon carcasses sampled on the Salcha River, 1999.**

Junction about 160 km southeast of Fairbanks (Figure 16). The main river spans 32 km, with a 10-km north fork. There are a number of small, shallow spring areas adjacent to the mainstream river. Spawning occurs throughout the mainstream river and in the spring areas. The river supports a popular fall sport fishery. Annual harvests exceeded 1,000 coho salmon from 1986 to 1991. In recent years catch has been high, but harvest relatively low (Mills 1979-1994; Howe et al. 1995 -1999; Table 13). Before reaching spawning grounds, the coho salmon travel about 1,700 km from the ocean and pass through six different commercial fishing districts in the Yukon and Tanana rivers (Figure 3). Subsistence and personal use fishing also occur in each district.

Escapements of coho salmon into the Delta Clearwater River have been historically monitored by counting fish from a drifting riverboat (Parker 1991). In recent years aerial surveys have been conducted to estimate escapement into non-boatable portions of the river (Evenson 1995, 1996; Evenson and Stuby 1997; Stuby and Evenson 1998, and Stuby 1999). This information has been used to evaluate management of the commercial, subsistence, and personal use fisheries, in addition to regulating the sport harvest of coho salmon by opening and closing the season and changing the bag limit. The daily bag and possession limit is three coho salmon. The Alaska Department of Fish and Game has established a biological escapement goal of 9,000 coho salmon for the Delta Clearwater River. When counts indicate that the goal may not be achieved, the bag limit may be reduced, or the fishery closed. If the count exceeds the minimum escapement, the bag limit may be increased. The objectives of the coho salmon escapement project for the Delta Clearwater River in 1999 were:

1. count coho salmon from a drifting riverboat at approximately weekly intervals throughout the run, and;
2. estimate age, sex, and length compositions of the escapement.

## METHODS

### Counts

Adult coho salmon were counted from a drifting riverboat equipped with an observation platform elevated 2 m above the water. The Delta Clearwater River was divided into 1.6-km (1-mi.) sections and fish were counted by section (Figure 16). The sections were numbered from the mouth (mile 0) upstream. Many coho salmon spawn in shallow spring areas adjacent to the mainstream river. Prior to 1994, these areas were not included in the surveys. Between 1994 and 1998, aerial surveys of the areas inaccessible by boat were conducted in order to determine the proportion of fish that spawn in these areas relative to the main river. No aerial survey was conducted in 1999. Instead, an expansion factor was estimated, which was based on the five years of aerial surveys. Past proportions of the aerial count to the total run which ranged from 0.17-0.24 (average = 0.204), were used to expand the boat-count to obtain a total estimate of escapement.

### Age-Sex-Length Compositions

A carcass survey was attempted on 23 November. As a result of cold weather, the steering on the jet-boat which was to be used for collecting carcasses became inoperable. As a result, no coho salmon carcasses were sampled.

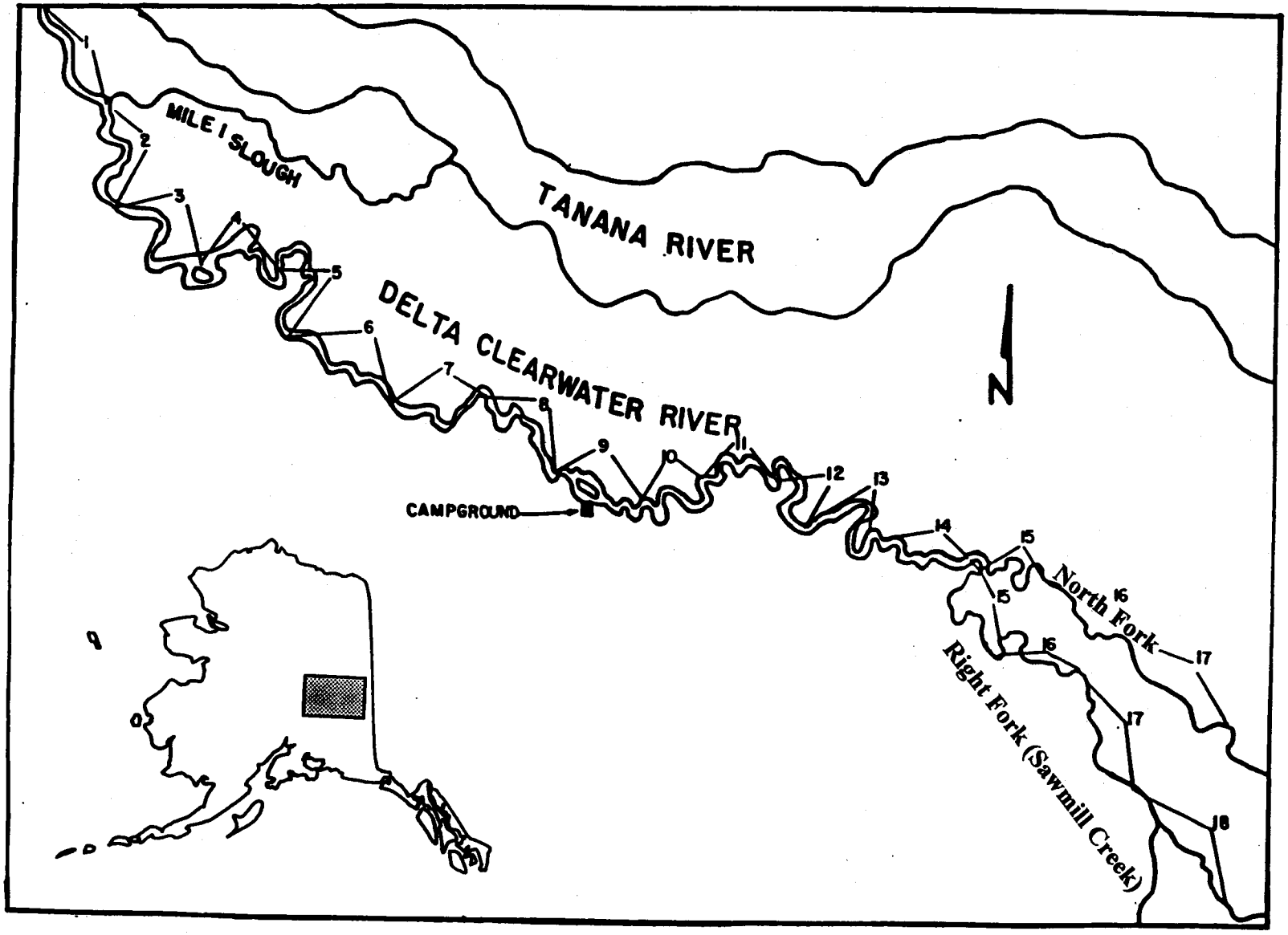



**Figure 16.-Delta Clearwater River study area.**

**Table 13.-Peak escapements, harvests, and catch of coho salmon in the Delta Clearwater River from boat surveys conducted from 1972-1999.**

| | Peak Escapement Counts | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Survey Date | Lower River[a] | Upper River[b] | Spring Areas | Total[c] | Previous 5 yr Avg. | Sport Harvest[d] | Sport Catch[d] |
| 1972 | 9 Nov | NA[e] | NA | NA | 632 | | NA | NA |
| 1973 | 20 Oct | NA | NA | NA | 3,322 | | NA | NA |
| 1974 | NA | NA | NA | NA | 3,954[f] | | NA | NA |
| 1975 | 24 Oct | NA | NA | NA | 5,100 | | NA | NA |
| 1976 | 22 Oct | NA | NA | NA | 1,920 | | NA | NA |
| 1977 | 25 Oct | 2,331 | 2,462 | NA | 4,793 | 2,986 | 31 | NA |
| 1978 | 26 Oct | 2,470 | 2,328 | NA | 4,798 | 3,818 | 126 | NA |
| 1979 | 23 Oct | 3,407 | 5,563 | NA | 8,970 | 4,113 | 0 | NA |
| 1980 | 28 Oct | 2,206 | 1,740 | NA | 3,946 | 5,116 | 25 | NA |
| 1981 | 21 Oct | 4,110 | 4,453 | NA | 8,563[g] | 4,885 | 45 | NA |
| 1982 | 3 Nov | 4,015 | 4,350 | NA | 8,365[g] | 6,214 | 21 | NA |
| 1983 | 25 Oct | 3,849 | 4,170 | NA | 8,019[g] | 6,928 | 63 | NA |
| 1984 | 6 Nov | 5,434 | 5,627 | NA | 11,061 | 7,573 | 571 | NA |
| 1985 | 13 Nov | NA | NA | NA | 6,842[f] | 7,991 | 722 | NA |
| 1986 | 21 Oct | 5,490 | 5,367 | NA | 10,857 | 8,570 | 1,005 | NA |
| 1987 | 27 Oct | 11,700 | 10,600 | NA | 22,300 | 9,029 | 1,068 | NA |
| 1988 | 28 Oct | 5,300 | 16,300 | NA | 21,600 | 11,816 | 1,291 | NA |
| 1989 | 25 Oct | 5,400 | 7,200 | NA | 12,600 | 14,532 | 1,049 | NA |
| 1990 | 26 Oct | 4,525 | 3,800 | NA | 8,325 | 14,840 | 1,375 | 3,271 |
| 1991 | 23 Oct | 11,525 | 12,375 | NA | 23,900 | 15,136 | 1,721 | 4,382 |
| 1992 | 26 Oct | 1,118 | 2,845 | NA | 3,963 | 17,745 | 615 | 1,555 |
| 1993 | 21 Oct | 3,425 | 7,450 | NA | 10,875 | 14,078 | 48 | 1,695 |
| 1994 | 24 Oct | 19,450 | 43,225 | 17,565[h] | 80,240[i] | 11,933 | 509 | 3,009 |
| 1995 | 23 Oct | 7,850 | 12,250 | 6,283[h] | 26,383[i] | 25,461 | 391 | 5,195 |
| 1996 | 29 Oct | 4,000 | 10,075 | 3,300[h] | 17,375[i] | 29,072 | 983 | 2,543 |
| 1997 | 24 Oct | 4,975 | 6,550 | 2,375[h] | 13,900[i] | 27,767 | 866 | 4,174 |
| 1998 | 20 Oct | 7,700 | 3,400 | 2,775[h] | 13,875[i] | 29,755 | 603 | NA[e] |
| 1999 | 28 Oct | 4,250 | 6,725 | 2,799[j] | 13,774[i] | 24,798 | NA[e] | NA[e] |

[a] Mile 0 to Mile 8.

[b] Mile 8 to Mile 17.5.

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

[d] Data were obtained from Mills (1979-1994) and Howe et al. (1995-1999).

[e] Data are not available.

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

[g] Mark-recapture population estimate.

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

[i] Combination of boat survey and helicopter survey.

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

### RESULTS

A boat survey of the mainstem river was conducted on 28 October. A total of 11,100 fish were counted during this survey. This count was expanded by 0.204 (2,799) to account for fish spawning in adjacent spring areas, thus making total escapement 13,774 coho salmon. Coho salmon were distributed throughout the entire stretch in densities varying from 75 to 1,125 fish per mile during the boat survey (Table 14). Survey conditions were fair. Due to the presence of shelf ice and subsequent clogging of the jet units on the survey boat, steering was difficult and visibility was compromised.

### DISCUSSION

Escapement survey counts for 1999 were lower than the previous five-year average, but still well in excess of the minimum escapement goal of 9,000 salmon. The reasons for this moderate escapement are not known. The 1995 parent year, from which most of this escapement originated, was strong (Table 13). For those years such as 1992 when the escapement goal was not met, the sport fishery can be closed. For large abundance years, modifying sport fishing bag limits would likely be of little consequence since most of the coho salmon are caught and then released.

## ACKNOWLEDGMENTS

Sally Anderson, Mike Doxey, Nicole Hill, Tony Hollis, Amber Koscis, Margo Kramer, Olav Ormseth, Fronty Parker, Amy Prosser, Audrey Rasumussen, Bill Ridder, Rick Queen, Dave Stoller, Tim Viavant, and Klaus Wuttig assisted with field work and data collection. Richard Price aged all the samples. Mike Wallendorf assisted with data analysis and project design. Matt Evenson was the Project Leader. Mike Doxey assisted in supervising the project. Peggy Merritt and Matt Evenson reviewed the report. Sara Case prepared the final report. The U.S. Army Corps of Engineers provided access to the Moose Creek Dam and assistance with installing equipment. Alyeska Pipeline Service Co. provided access to the pipeline workpad at pipeline milepost 438.2 for the Chatanika River tower. The U.S. Fish and Wildlife Service provided partial funding for this work. Bering Sea Fishermen's Association readily shared tower count and age, sex and length composition data on chinook salmon with Sport Fish Division.

**Table 14.-Counts of adult coho salmon in the Delta Clearwater River, 1999.**

| River Mile | Mainstem River (Boat Survey) |
|---|---|
| | Count (28 Oct) |
| 17.5-16 | 350 |
| 16-15 | 825 |
| 15-14 | 1,025 |
| 14-13 | 1,125 |
| 13-12 | 825 |
| 12-11 | 675 |
| 11-10 | 1,050 |
| 10-9 | 650 |
| 9-8 | 200 |
| 8-7 | 675 |
| 7-6 | 75 |
| 6-5 | 950 |
| 5-4 | 875 |
| 4-3 | 575 |
| 3-2 | 150 |
| 2-1 | 725 |
| 1-0 | 225 |
| **Summary** | |
| 17.5-8 | 6,725 |
| 8-0 | 4,250 |
| 14-0 | 8,775 |
| **17.5-0** | **10,975** |
| **Tributaries** | N/A |
| Clearwater Lake Inlet | N/A |
| Clearwater Lake Outlet | 2,799[a] |
| **Total Count (i.e. boat-count of mainstream and tributary estimate)** | **13,774** |

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

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# APPENDIX A

**Appendix A1.-Schedule for counting salmon in the Chena River, 1999. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility or schedule conflicts.**

| July 28 – July 4 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | | | COUNT | | |
| 0800-1600 | | | | | | COUNT | COUNT |
| 1600-0000 | | | | | COUNT | COUNT | COUNT |

| July 5 – July 11 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | | COUNT |

| July 12 – July 18 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | | COUNT | | | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | | |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 19 – July 25 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 26 – Aug 1 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 2 – Aug 8 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

**Appendix A2.-Schedule for counting salmon in the Chatanika River, 1999. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility or schedule conflicts.**

| July 28 – July 4 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | | | | | COUNT |
| 0800-1600 | | | | | COUNT | COUNT | COUNT |
| 1600-0000 | | | | | COUNT | COUNT | |

| July 5 – July 11 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | COUNT | COUNT | COUNT | COUNT | |
| 0800-1600 | COUNT | COUNT | COUNT | | | | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 12 – July 18 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | | | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | | | |

| July 19 – July 25 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | | | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | | |
| 1600-0000 | | | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 26 – Aug 1 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | | COUNT |
| 0800-1600 | | | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 2 – Aug 8 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | | |
| 0800-1600 | COUNT | COUNT | COUNT | | | COUNT | COUNT |
| 1600-0000 | | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

# APPENDIX B

**Appendix B.-Data files used to estimate parameters of chinook and chum salmon populations in the Chena and Chatanika rivers, 1999.**

| Data File | Description |
|---|---|
| Che41cr99.asl[a] | Data file of length, sex, and age data for chinook salmon carcasses collected from the Chena River, 1999. |
| Che41es99.asl[a] | Data file of sex and age data for chinook salmon collected with electroshocking equipment from the Chena River, 1999. |
| Cht41cr99.asl[a] | Data file of length, sex, and age data for chinook salmon carcasses collected from the Chatanika River, 1999. |
| CHENATOW99.XLS[b] | Excel spreadsheet of hourly counts of chinook and chum salmon, daily expansions of escapement, and variance estimates for the Chena River, 1999. |
| CHATTOW99.XLS[b] | Excel spreadsheet of hourly counts of chinook and chum salmon, daily expansions of escapement, and variance estimates for the Chatanika River, 1999. |
| CHENA99.XLS[b] | Excel spreadsheets with analysis of tower-count and age, sex, and length data. File includes spreadsheets of hourly escapement, run timing, daily counts and estimates, expanded cumulative passage, estimated proportions of age, sex and length, length frequency distributions, average length per age class by sex from 1987-1999, and percent age composition from 1987-1999. |
| CHAT99.XLS[b] | Excel spreadsheets with analysis of tower-count and age, sex, and length data. File includes spreadsheets of hourly escapement, daily counts and estimates, expanded cumulative passage, estimated proportions of age, sex and length, length frequency distributions, average length per age class by sex from 1987-1999, and percent age composition from 1987-1999. |

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

[b] Data files are available from the author.

# APPENDIX C

**Appendix C1.-Numbers of chinook salmon counted during 10 min periods for the left side of the Chena River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | | 4 |
| 7/12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| 7/14 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 |
| 7/15 | | | | | | | | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 7/16 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 8 |
| 7/17 | 1 | 0 | 1 | 1 | 0 | 9 | 0 | 0 | | | | | | | | | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 14 |
| 7/18 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 15 |
| 7/19 | 6 | 0 | 6 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 24 | | | | | | | | | 44 |
| 7/20 | 8 | 0 | 1 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 4 | 4 | 7 | 4 | 17 | 0 | 7 | 0 | 3 | 0 | 63 |
| 7/21 | 0 | 0 | 4 | 5 | 3 | 24 | 3 | 0 | 2 | 0 | 4 | 2 | 4 | 0 | 0 | 1 | 9 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 70 |
| 7/22 | 0 | 17 | 1 | -1 | | 15 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 41 |
| 7/23 | 19 | 1 | 4 | 4 | 0 | 17 | 0 | 7 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 69 |
| 7/24 | 4 | 2 | 6 | 6 | 4 | 0 | 9 | 0 | 0 | 4 | 1 | 3 | 0 | 2 | 0 | 12 | 2 | 11 | 16 | 2 | 3 | 0 | 3 | 0 | 90 |
| 7/25 | 2 | 2 | 13 | 11 | 3 | 1 | 0 | 1 | 3 | 3 | 1 | 2 | 1 | 0 | 6 | 1 | 1 | 3 | 6 | 10 | 2 | 1 | 6 | 6 | 85 |
| 7/26 | | | | | | | | | 1 | 0 | 0 | 0 | 13 | 3 | 7 | 12 | | 4 | 9 | 6 | 4 | 1 | 2 | | 62 |
| 7/27 | 0 | 1 | 0 | 0 | 6 | 3 | 4 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 5 | 0 | | | 30 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | 0 | 0 | 1 | 0 | 0 | 0 | -1 | 0 | | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 6 |
| 7/31 | 0 | 1 | 0 | 2 | 5 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 1 | 0 | 5 | 1 | 0 | 20 |
| 8/1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 8/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | -1 | 0 | -1 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 7 |
| 8/3 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 7 |
| 8/4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 5 |
| 8/5 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 8/6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | | 6 |
| 8/7 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 5 |
| 8/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 10 |
| Total | 41 | 24 | 40 | 28 | 29 | 73 | 23 | 19 | 12 | 11 | 14 | 13 | 22 | 12 | 24 | 56 | 32 | 36 | 56 | 28 | 32 | 9 | 21 | 30 | 685 |



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**Appendix C2.-Numbers of chinook salmon counted during 10 min periods for the right side of the Chena River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 7/12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/19 | 0 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | | | | | | | | | 11 |
| 7/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| 7/21 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 7/22 | 0 | 4 | 2 | 0 | | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 13 |
| 7/23 | 4 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 14 |
| 7/24 | 0 | 0 | 1 | 8 | 4 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | 1 | 0 | 2 | 1 | 3 | 32 |
| 7/25 | 0 | 1 | 1 | 5 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 2 | 0 | 2 | 19 |
| 7/26 | | | | | | | | | 0 | 0 | 0 | 0 | 5 | 6 | 0 | 4 | | 1 | 2 | 1 | 0 | 0 | 0 | | 19 |
| 7/27 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 | 0 | 5 | 0 | | | 18 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 13 |
| 7/31 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 5 |
| 8/1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8/2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 8/3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | -1 | 3 |
| 8/4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8/5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 8/6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | | 0 |
| 8/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/8 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Total | 6 | 7 | 14 | 15 | 9 | 21 | 4 | 3 | 9 | 6 | 2 | 2 | 4 | 6 | 1 | 13 | 3 | 8 | 12 | 10 | 7 | 4 | 2 | 6 | 174 |

**Appendix C3.-Numbers of chum salmon counted during 10 min periods for the left side of the Chena River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 7/12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/19 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 2 |
| 7/20 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 7/21 | 0 | 0 | 5 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| 7/22 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 |
| 7/23 | 9 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 16 |
| 7/24 | 14 | 9 | 4 | 11 | 11 | 3 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 7 | 1 | 68 |
| 7/25 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 4 | 0 | 0 | 11 | 4 | 0 | 8 | 2 | 2 | 3 | 0 | 3 | 1 | 48 |
| 7/26 | | | | | | | | | 2 | 5 | 0 | 0 | 3 | 4 | 1 | 2 | | 3 | 8 | 4 | 0 | 0 | 2 | | 34 |
| 7/27 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 4 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | | | 13 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | -1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 7/31 | 0 | 2 | 1 | 2 | 0 | 6 | 2 | 10 | 3 | 0 | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 0 | 4 | 15 | 56 |
| 8/1 | 10 | 2 | 5 | 4 | 1 | 1 | 1 | 0 | 2 | 2 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 7 | 14 | 3 | 0 | 13 | 5 | 9 | 86 |
| 8/2 | 2 | 8 | 2 | 1 | 0 | 6 | 6 | 0 | 3 | 7 | 0 | 0 | 6 | 12 | 0 | 0 | 10 | 0 | 1 | 3 | 3 | 3 | 1 | 0 | 74 |
| 8/3 | 0 | 0 | 12 | 6 | 0 | 7 | 6 | 3 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 2 | 0 | 11 | 58 |
| 8/4 | 12 | 12 | 1 | 4 | 5 | 4 | 6 | 9 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 29 | 1 | 0 | 9 | 0 | 0 | 0 | 13 | 6 | 114 |
| 8/5 | 0 | 0 | 13 | 1 | 3 | 0 | 0 | 7 | 1 | 0 | 0 | 0 | 7 | 7 | 0 | 20 | 0 | 1 | 12 | 1 | 0 | 0 | 0 | 0 | 73 |
| 8/6 | 7 | 23 | 11 | 5 | 0 | 5 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 10 | 19 | 0 | 22 | | 112 |
| 8/7 | 3 | 14 | 3 | 3 | 13 | 0 | 0 | 7 | 0 | 1 | 1 | 1 | 4 | 9 | 0 | 0 | 5 | 2 | 0 | 0 | 12 | 10 | 10 | 13 | 111 |
| 8/8 | 3 | 28 | 6 | 4 | 13 | 4 | 0 | 2 | 0 | 3 | 10 | 0 | 1 | 0 | 2 | 0 | 4 | 5 | 6 | 9 | 7 | 2 | 16 | 9 | 134 |
| Total | 64 | 100 | 67 | 44 | 46 | 39 | 24 | 44 | 13 | 24 | 21 | 15 | 26 | 34 | 23 | 56 | 22 | 29 | 55 | 37 | 52 | 30 | 83 | 68 | 1,016 |

**Appendix C4.-Numbers of chum salmon counted during 10 min periods for the right side of the Chena River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 7/12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/20 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 7/21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/22 | 0 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7/23 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 7/24 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 11 |
| 7/25 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 1 | 13 |
| 7/26 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | | 0 | 0 | 0 | 4 | 0 | 1 | | 7 |
| 7/27 | 1 | 0 | 2 | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 5 | 7 | 0 | 0 | 0 | | | 23 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | 0 | 2 | 2 | 2 | 1 | 0 | 5 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 1 | 8 | 0 | 0 | 1 | 28 |
| 7/31 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 8 | 0 | 3 | 6 | 1 | 33 |
| 8/1 | 2 | 1 | 3 | 4 | 1 | 5 | 2 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 5 | 0 | 3 | 1 | 0 | 0 | 2 | 0 | 0 | 33 |
| 8/2 | 3 | 0 | 2 | 1 | 4 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 19 |
| 8/3 | 1 | 2 | 9 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 20 |
| 8/4 | 3 | 13 | 0 | 5 | 10 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | 13 | 0 | 16 | 0 | 68 |
| 8/5 | 9 | 0 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 |
| 8/6 | 0 | 1 | 0 | 4 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 11 | 3 | | 28 |
| 8/7 | 6 | 4 | 1 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 0 | 31 |
| 8/8 | 7 | 1 | 4 | 6 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 28 |
| Total | 33 | 29 | 32 | 23 | 29 | 25 | 9 | 13 | 0 | 4 | 3 | 4 | 4 | 1 | 2 | 11 | 9 | 10 | 9 | 22 | 32 | 19 | 34 | 5 | 362 |

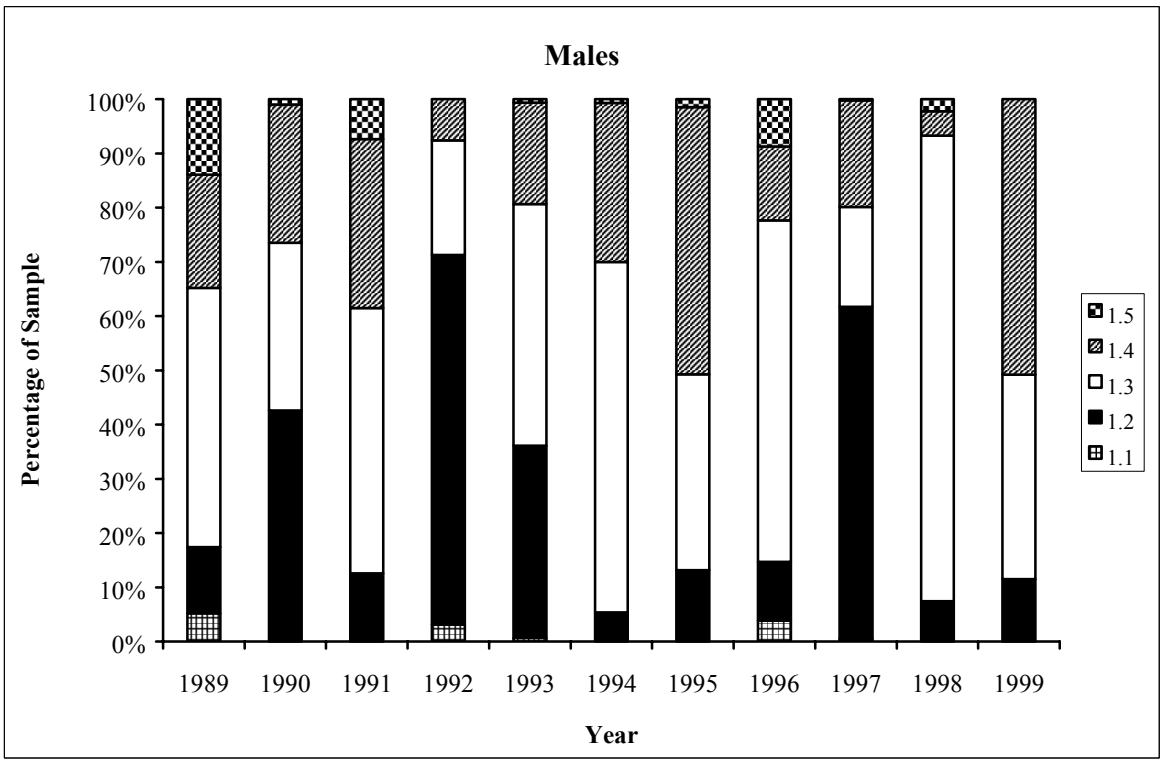
**Appendix C5.-Numbers of chinook salmon counted during 20 min periods for the Chatanika River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

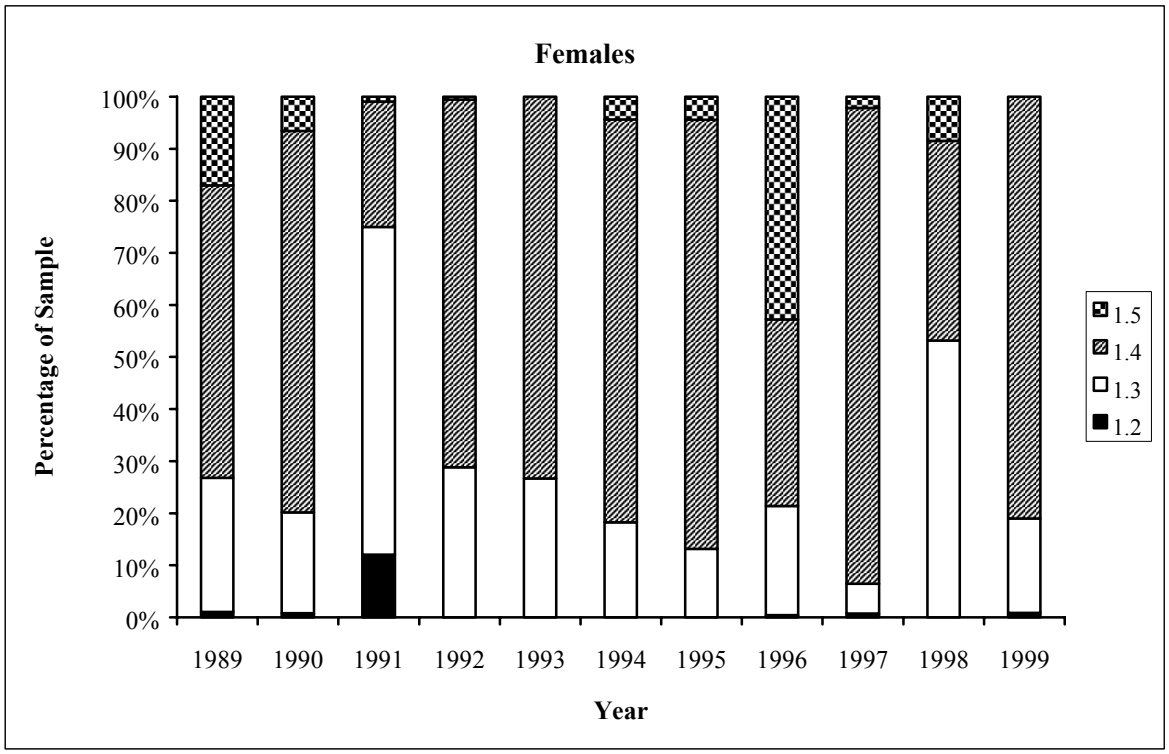
| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/11 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/12 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | | | | | | | | | 2 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/18 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | | | | | | | | | 5 |
| 7/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/21 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| 7/22 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 7/23 | | | | | | | | | 0 | 0 | 0 | 7 | 0 | 0 | 3 | 10 | 0 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 25 |
| 7/24 | 2 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 13 |
| 7/25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 7/26 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | | | | | | | | | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 11 |
| 7/27 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | | | | | | | | 1 | 0 | 0 | 1 | 4 | 4 | 0 | 0 | 15 |
| 7/28 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 7/29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | | 0 | 0 | 0 | 0 | -1 | 1 | 1 |
| 7/30 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 |
| 7/31 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 5 |
| 8/1 | 0 | 2 | 0 | 2 | | | | | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 |
| 8/2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | 4 |
| 8/3 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| 8/4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| 8/5 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | | | | | | | | | 0 | 0 | -1 | 1 | 0 | 2 | 0 | 0 | 4 |
| 8/6 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | | | | | | | | | | 0 | -1 | 0 | 2 | 0 | 1 | 4 |
| 8/7 | 0 | | | | | | | | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 6 |
| 8/8 | | | | | | | | | 0 | 0 | 0 | 0 | -1 | 0 | 0 | -1 | 0 | 0 | -1 | 0 | | | | | -3 |
| Total | 8 | 9 | 4 | 3 | 1 | 6 | 0 | 3 | 0 | 3 | 2 | 7 | 0 | 2 | 8 | 19 | 5 | 3 | -1 | 6 | 5 | 13 | 5 | 8 | 119 |

**Appendix C6.-Numbers of chum salmon counted during 20 min periods for the Chatanika River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

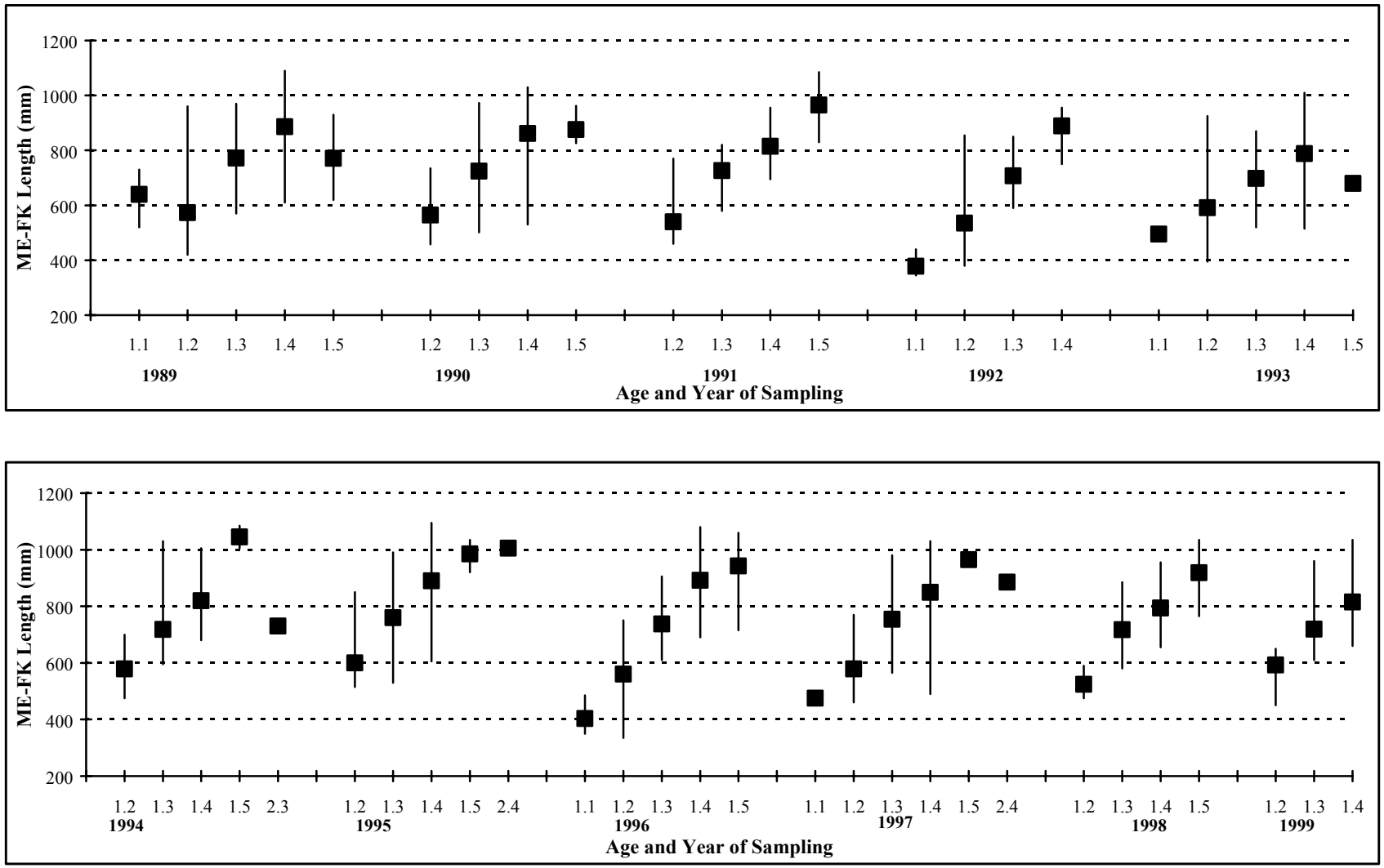
| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/2 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/3 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/4 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/5 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/6 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/11 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/12 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/18 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 7/21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/22 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/23 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 7/28 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/29 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 7/30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 5 | 15 |
| 7/31 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 9 | 3 | 14 |
| 8/1 | 3 | 1 | 4 | 0 | | | | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 12 |
| 8/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 |
| 8/3 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 2 | 10 |
| 8/4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 15 | 0 | 16 | 0 | 0 | 38 |
| 8/5 | 0 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| 8/6 | 2 | 6 | 1 | 2 | 0 | 0 | 0 | 0 | | | | | | | | | | | 0 | 0 | 0 | 10 | 11 | 6 | 38 |
| 8/7 | 2 | | | | | | | | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 2 | 11 |
| 8/8 | | | | | | | | | 0 | 2 | 1 | 0 | 0 | 0 | 5 | 10 | 3 | 9 | 7 | 0 | | | | | 37 |
| Total | 7 | 8 | 12 | 11 | 1 | 1 | 0 | 0 | 0 | 2 | 5 | 0 | 0 | 0 | 6 | 10 | 17 | 9 | 10 | 22 | 15 | 27 | 21 | 18 | 202 |

# APPENDIX D

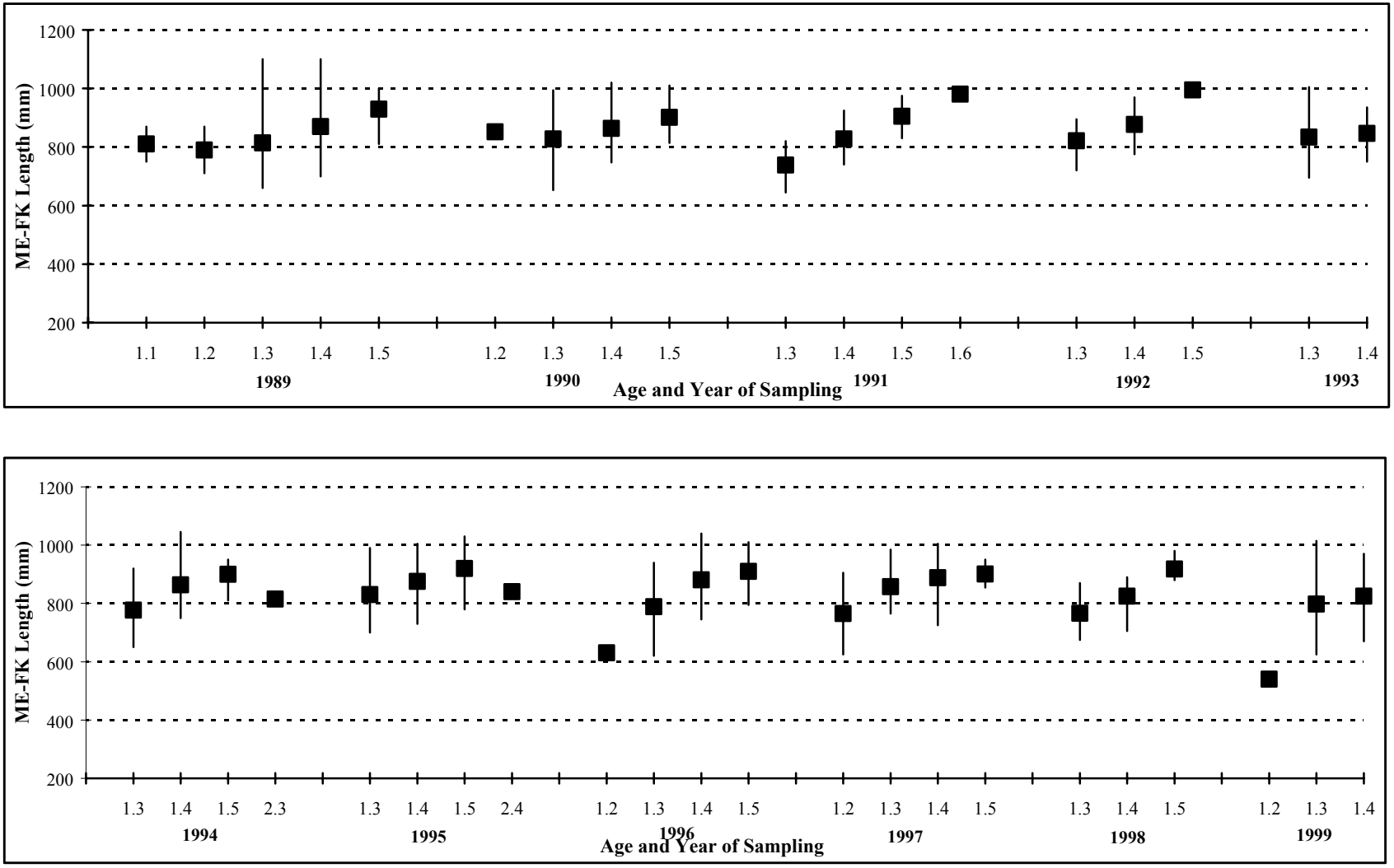


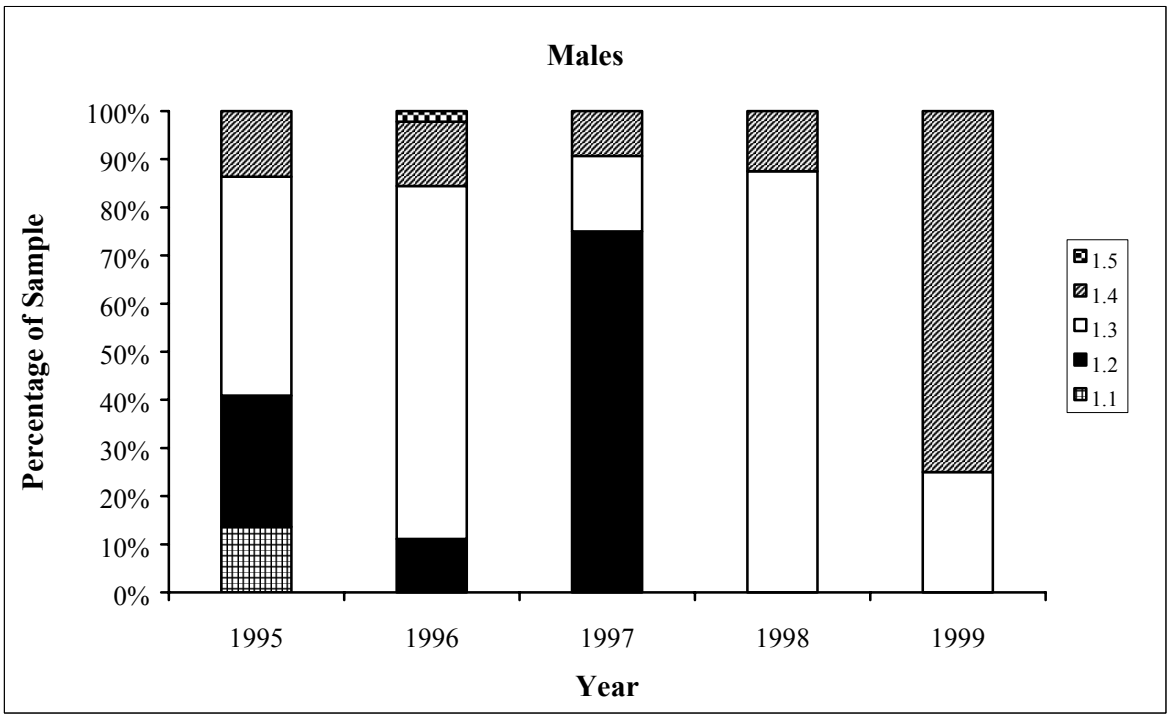

**Appendix D1.-Age composition of male and female chinook salmon from the Chena River from carcasses sampled during 1989-1999.**

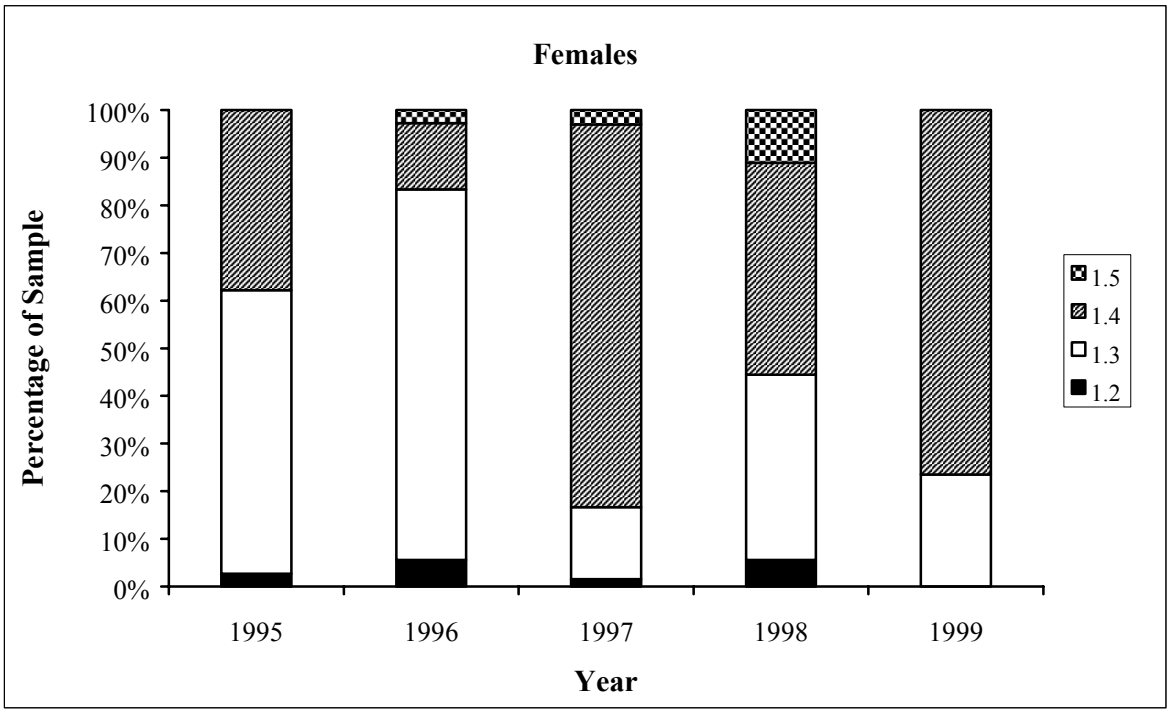



**Appendix D2.-Average length at age for male chinook salmon sampled from the Chena River from 1989-1999. Vertical bars represent ranges.**

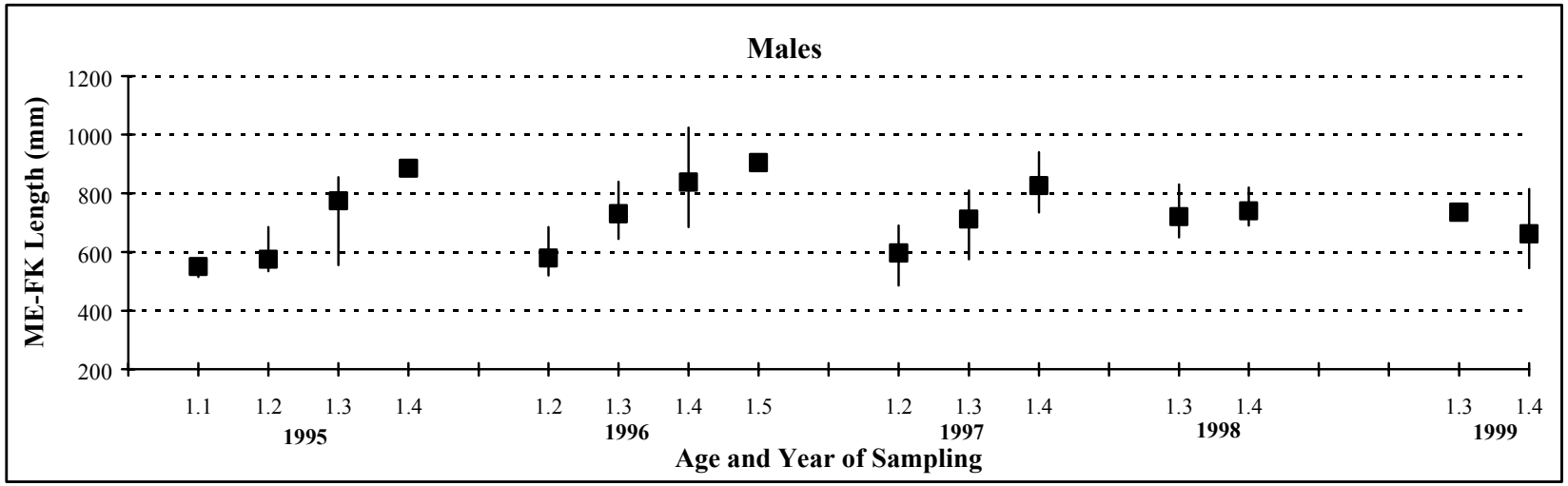


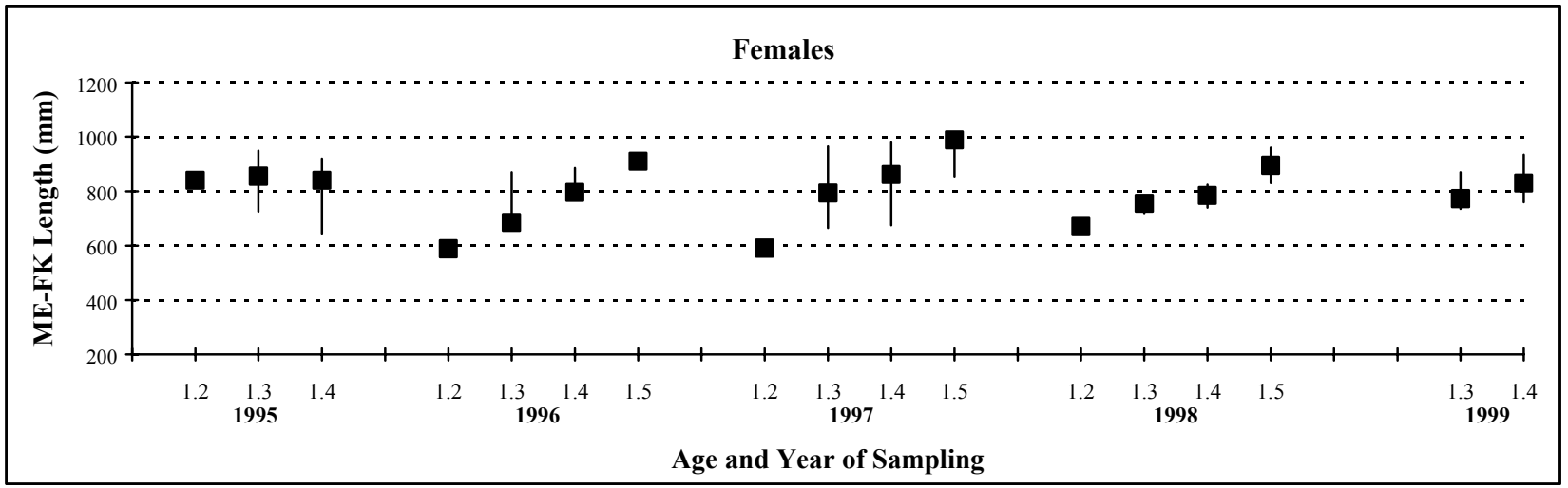

**Appendix D3.-Average length at age for female chinook salmon sampled from the Chena River from 1989-1999. Vertical bars represent ranges.**




**Appendix D4.-Age composition of male and female chinook salmon from the Chatanika River from carcasses sampled from 1995-1999.**




**Appendix D5.-Average length at age for male and female chinook salmon sampled from the Chatanika River during 1995-1999. Vertical bars represent ranges.**

# APPENDIX E

**Appendix E1.-Schedule for counting salmon in the Salcha River, 1999. Shaded boxes indicate periods of time when counting was not possible due to high water and poor visibility or schedule conflicts.**

| July 5 – July 11 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | | | | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | | | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 12 – July 18 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 19 – July 25 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| July 26 – Aug 1 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 2 – Aug 8 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 9 – Aug 15 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 16 – Aug 22 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 23 – Aug 29 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 0800-1600 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |
| 1600-0000 | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT | COUNT |

| Aug 30 – Sept 5 | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 0000-0800 | COUNT | | | | | | |
| 0800-1600 | COUNT | | | | | | |
| 1600-0000 | COUNT | | | | | | |

**Appendix E2.-Numbers of chinook salmon counted during 20 min periods for the Salcha River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/6 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7/11 | 0 | 2 | 4 | 0 | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 13 |
| 7/12 | 1 | 1 | 1 | 4 | 4 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 21 |
| 7/13 | 0 | 1 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 7/14 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 12 |
| 7/15 | 0 | 1 | 2 | 7 | 2 | 10 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 28 |
| 7/16 | 2 | 5 | 1 | 1 | 0 | 13 | 3 | 2 | 5 | 1 | 4 | 4 | 1 | 2 | 0 | 0 | 12 | 17 | 0 | 0 | 1 | 0 | 6 | 2 | 82 |
| 7/17 | 8 | 2 | 5 | 5 | 7 | 2 | 9 | 4 | 3 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 1 | 2 | 0 | 64 |
| 7/18 | 1 | 7 | 0 | 2 | 26 | 29 | 19 | 7 | 1 | 4 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 6 | 22 | 4 | 133 |
| 7/19 | 0 | 7 | 11 | 7 | 0 | 12 | 9 | 2 | 5 | 2 | 13 | 3 | 1 | 8 | 1 | 0 | 0 | 2 | 5 | 0 | 0 | 4 | 6 | 0 | 98 |
| 7/20 | 17 | 4 | 16 | 49 | 22 | 29 | 20 | 23 | 4 | 14 | 10 | 0 | 17 | 5 | 1 | 1 | 7 | 5 | 6 | 2 | 2 | 15 | 6 | 10 | 285 |
| 7/21 | 14 | 16 | 40 | 28 | 27 | 11 | 22 | 3 | 1 | 11 | 15 | 12 | 27 | 6 | 11 | 16 | 11 | 30 | 5 | 0 | 2 | 15 | 5 | 0 | 328 |
| 7/22 | 15 | 5 | 4 | 14 | 15 | 14 | 6 | 19 | 10 | 6 | 12 | 7 | 4 | 1 | 3 | 9 | 6 | 9 | 2 | 1 | 3 | 4 | 7 | 6 | 182 |
| 7/23 | 12 | 5 | 14 | 13 | 17 | 12 | 7 | 6 | 3 | 1 | 3 | 0 | 0 | 6 | 0 | 5 | 4 | 16 | 13 | 5 | 4 | 3 | 1 | 1 | 151 |
| 7/24 | 3 | 4 | 5 | 2 | 18 | 12 | 3 | 1 | 13 | 2 | 3 | 4 | 10 | 14 | 27 | 2 | 2 | 1 | 2 | 4 | 5 | 2 | 6 | 7 | 152 |
| 7/25 | 15 | 8 | 15 | 26 | 23 | 21 | 18 | 21 | 24 | 25 | 10 | 2 | 4 | 6 | 11 | 2 | 2 | 7 | 0 | 4 | 13 | 7 | | | 264 |
| 7/26 | 11 | 15 | 12 | 18 | 21 | 20 | 27 | 23 | 19 | 15 | 4 | 8 | 11 | 3 | 10 | 11 | 9 | 1 | 4 | 1 | | | | | 243 |
| 7/27 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/31 | | | | | | | | | | | | | | | | | 5 | 7 | 5 | 6 | 2 | 0 | 3 | 4 | 32 |
| 8/1 | 3 | 6 | 8 | 4 | 1 | 6 | 4 | 2 | 2 | 3 | 5 | 2 | 1 | 0 | 4 | 0 | 3 | 1 | 1 | 0 | 1 | 4 | 5 | 7 | 73 |
| 8/2 | 5 | 0 | 2 | 1 | 3 | 0 | 3 | 2 | 3 | 7 | 4 | 5 | 2 | 5 | 4 | 2 | 0 | 2 | 1 | 1 | 1 | 0 | 3 | 2 | 58 |
| 8/3 | 0 | 1 | 4 | 3 | 0 | 0 | 2 | 2 | 1 | 1 | 2 | 2 | 5 | 1 | 3 | 4 | 0 | 1 | 0 | 1 | 3 | 0 | 2 | 3 | 41 |
| 8/4 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 13 |
| 8/5 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 5 | 1 | 5 | 4 | -1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 24 |
| 8/6 | -1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/7 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 11 |
| 8/8 | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 10 |
| 8/9 | 3 | 2 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | 10 |
| 8/10 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/11 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/12 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/13 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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**Appendix E2.-Page 2 of 2.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/26 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | 0 |
| 8/27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/28 | | | | | | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 |
| 8/29 | 0 | 0 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 112 | 97 | 146 | 188 | 198 | 196 | 158 | 124 | 99 | 108 | 93 | 57 | 89 | 61 | 79 | 51 | 67 | 105 | 48 | 32 | 39 | 66 | 76 | 48 | 2,337 |

**Appendix E3.-Numbers of chum salmon counted during 20 min periods for the Salcha River, 1999. Counts were conducted near the top of each hour. Negative counts indicate fish movement down river. Shaded areas indicate hours not counted.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/6 | | | | | | | | | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/7 | 0 | 0 | 0 | 0 | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 |
| 7/12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7/23 | 0 | 0 | 0 | 22 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4 | 3 | 3 | 5 | 3 | 2 | 0 | 46 |
| 7/24 | 0 | 3 | 2 | 3 | 14 | 6 | 7 | 8 | 3 | 3 | 4 | 5 | 7 | 5 | 5 | 0 | 4 | 2 | 0 | 4 | 2 | 4 | 5 | 10 | 106 |
| 7/25 | 3 | 4 | 6 | 2 | 7 | 2 | 6 | 7 | 4 | 8 | 6 | 4 | 1 | 4 | 12 | 1 | 2 | 2 | 2 | 3 | 9 | 4 | | | 99 |
| 7/26 | 4 | 5 | 4 | 1 | 5 | 2 | 9 | 6 | 14 | 5 | 3 | 3 | 5 | 1 | 4 | 13 | 7 | 1 | 2 | 5 | | | | | 99 |
| 7/27 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/28 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/29 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/30 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7/31 | | | | | | | | | | | | | | | | | 5 | 17 | 16 | 16 | 6 | 4 | 12 | 24 | 100 |
| 8/1 | 30 | 41 | 29 | 51 | 48 | 23 | 45 | 24 | 9 | 2 | 22 | 19 | 11 | 12 | 9 | 7 | 9 | 12 | 17 | 39 | 23 | 12 | 27 | 22 | 543 |
| 8/2 | 24 | 26 | 31 | 33 | 33 | 17 | 22 | 12 | 24 | 26 | 13 | 9 | 16 | 18 | 15 | 28 | 14 | 18 | 15 | 10 | 17 | 13 | 2 | 10 | 446 |
| 8/3 | 24 | 33 | 29 | 27 | 30 | 14 | 11 | 4 | 14 | 9 | 0 | 13 | 15 | 8 | 6 | 23 | 6 | 5 | 6 | 4 | 57 | 10 | 35 | 19 | 402 |
| 8/4 | 17 | 20 | 23 | 9 | 27 | 6 | 3 | 6 | 3 | 1 | 0 | 9 | 12 | 28 | 12 | 15 | 8 | 4 | 26 | 21 | 13 | 25 | 21 | 6 | 315 |
| 8/5 | 19 | 13 | 3 | 9 | 11 | 8 | 10 | 8 | 12 | 6 | 7 | 19 | 11 | 38 | 40 | 15 | 16 | 16 | 12 | 3 | 17 | 24 | 13 | 12 | 342 |
| 8/6 | 24 | 26 | 21 | 18 | 15 | 13 | 8 | 7 | 6 | 16 | 1 | 15 | 8 | 34 | 26 | 5 | 3 | 23 | 15 | 22 | 30 | 13 | 22 | | 371 |
| 8/7 | 19 | 25 | 17 | 11 | 26 | 19 | 8 | 11 | 9 | 5 | 17 | 15 | 8 | 22 | 33 | 18 | 8 | 24 | 32 | 21 | 8 | 23 | 22 | 9 | 410 |
| 8/8 | 8 | 19 | 13 | 21 | 24 | 16 | 33 | 16 | 3 | 26 | 8 | 3 | 9 | 8 | 0 | 6 | 7 | 5 | 10 | 4 | 10 | 21 | 19 | 8 | 297 |
| 8/9 | 12 | 25 | 14 | 17 | 15 | 3 | 7 | 6 | 12 | 7 | 3 | | | | | | | | | | | | | | 121 |
| 8/10 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/11 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/12 | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8/13 | 4 | 8 | 7 | 10 | 6 | 4 | 2 | 2 | 0 | 1 | 4 | 7 | 1 | 2 | 2 | 1 | 3 | 9 | 7 | 0 | 0 | 4 | 7 | 5 | 96 |
| 8/14 | 2 | 0 | 4 | 1 | 3 | 5 | 3 | 3 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 26 |

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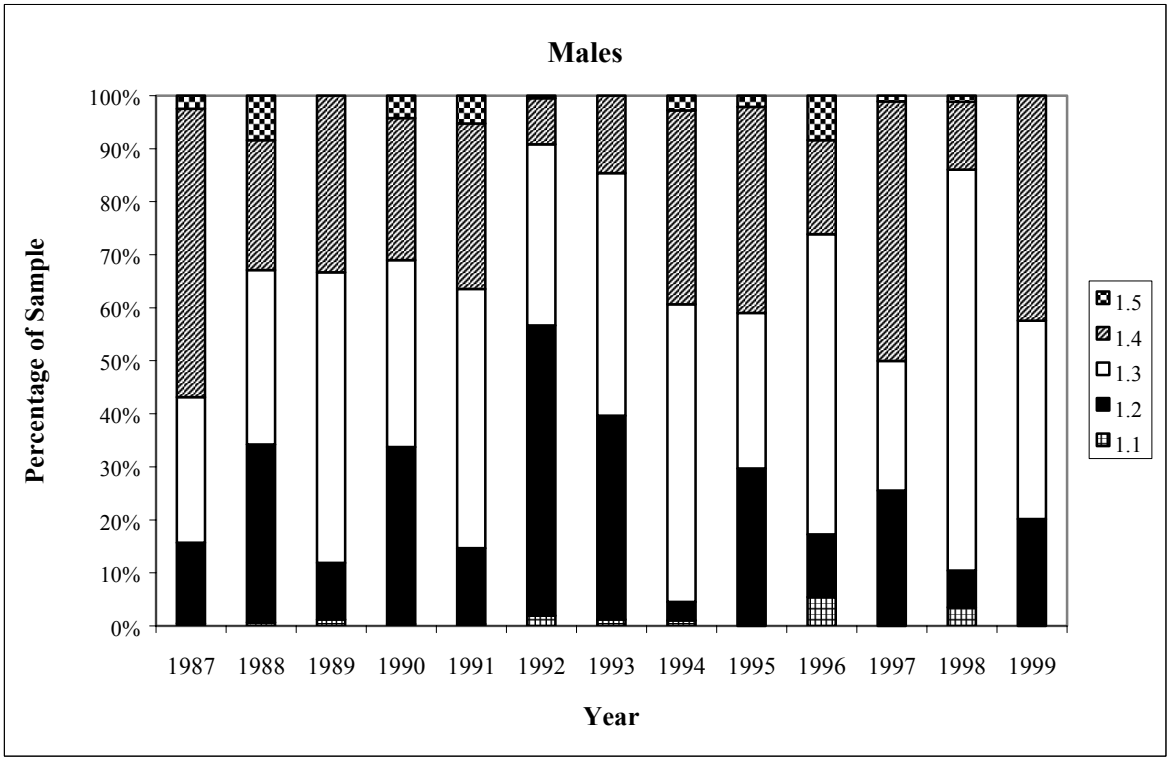
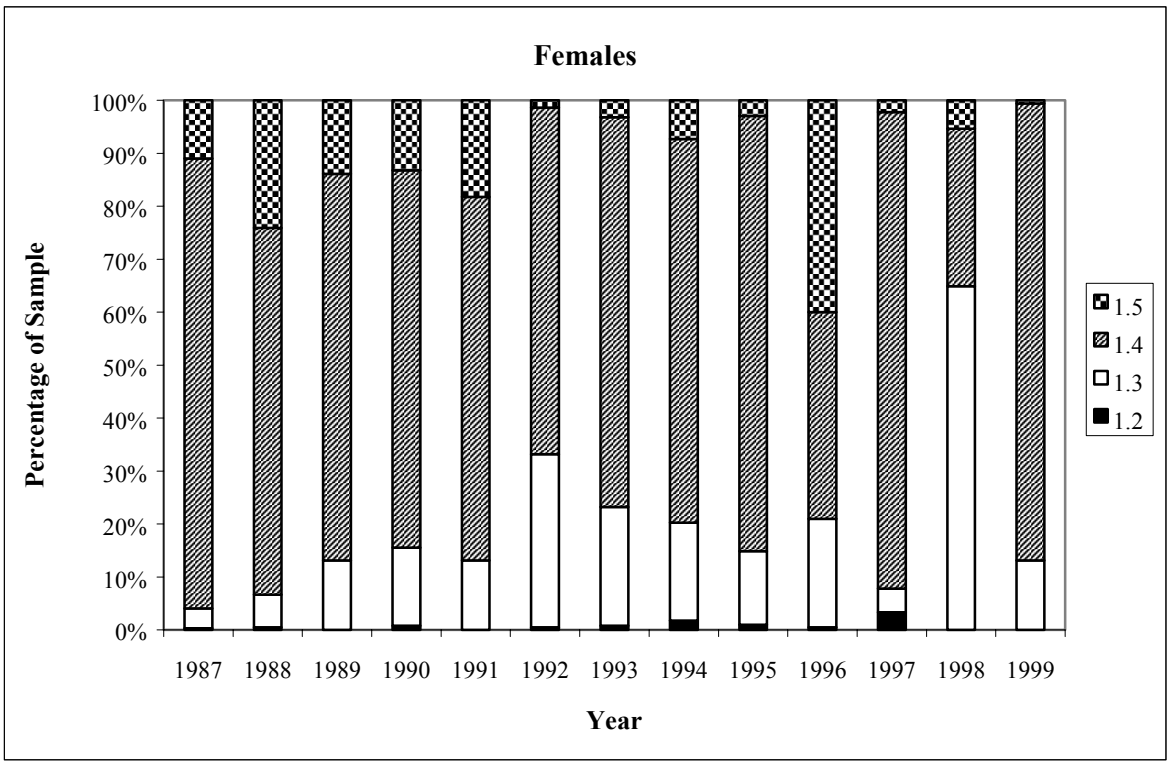
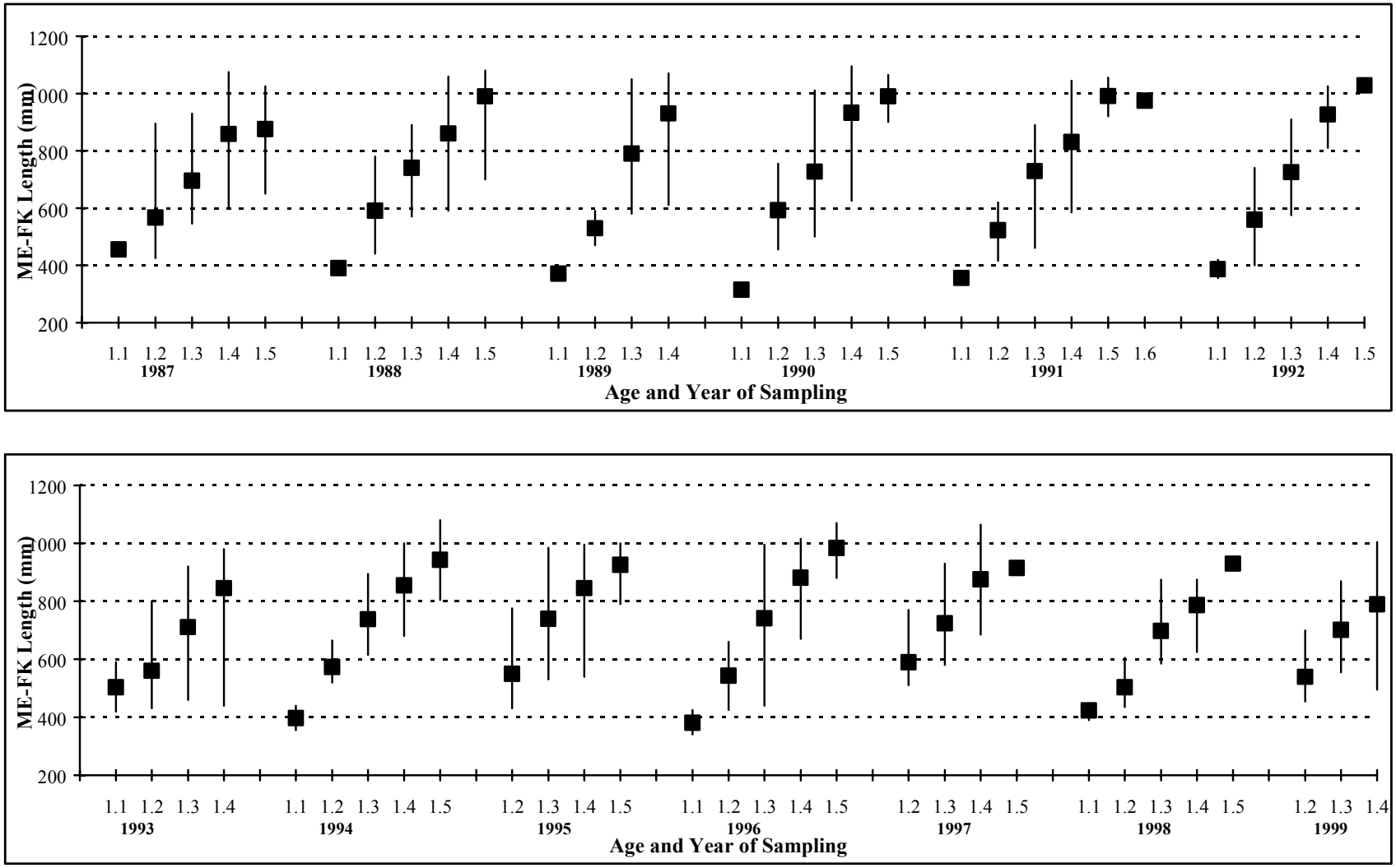
**Appendix E3.-Page 2 of 2.**

| Date | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/15 | 0 | 2 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 11 |
| 8/16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8/17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 7 | 4 | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 31 |
| 8/18 | 2 | 0 | 8 | 0 | 3 | 1 | 0 | 0 | 1 | 3 | 2 | 4 | 6 | 12 | 6 | 0 | 3 | 3 | 0 | 1 | 6 | 6 | 6 | 0 | 73 |
| 8/19 | 5 | 2 | 0 | 3 | 8 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 2 | 2 | 1 | 3 | 0 | 7 | 4 | 17 | 11 | 9 | 5 | 8 | 92 |
| 8/20 | 6 | 1 | 4 | 4 | 2 | 0 | 5 | 11 | 2 | 8 | 1 | 9 | 1 | 5 | 12 | 0 | 3 | 0 | 8 | 1 | 5 | 9 | 11 | 10 | 118 |
| 8/21 | 7 | 3 | 6 | 6 | 2 | 9 | 0 | 4 | 8 | 5 | 13 | 5 | 2 | 6 | 7 | 5 | 8 | 6 | 5 | 0 | 7 | 12 | 5 | 8 | 139 |
| 8/22 | 6 | 8 | 3 | 8 | 0 | 4 | 6 | 7 | 7 | 14 | 8 | 4 | 2 | 5 | 9 | 6 | 0 | 0 | 0 | 0 | 2 | 15 | 6 | 9 | 129 |
| 8/23 | 32 | 24 | 23 | 17 | 16 | 20 | 9 | 10 | 15 | 16 | 4 | 3 | 8 | 4 | 6 | 5 | 12 | 4 | 6 | 0 | 7 | 13 | 8 | 16 | 278 |
| 8/24 | 17 | 20 | 15 | 11 | 16 | 23 | 9 | 13 | 9 | 5 | 4 | 6 | 10 | 3 | 7 | 5 | 9 | 13 | 6 | 3 | 7 | 17 | 14 | 13 | 255 |
| 8/25 | 17 | 23 | 17 | 13 | 9 | 16 | 2 | 6 | 4 | 7 | 0 | 3 | 1 | 8 | 4 | 6 | 3 | 12 | 7 | 0 | 6 | 8 | 15 | 9 | 196 |
| 8/26 | 12 | 15 | 16 | 9 | 23 | 11 | 12 | 3 | | | | | | | | | | | | | | | | | 101 |
| 8/27 | 7 | 2 | 9 | 14 | 5 | 11 | 4 | 0 | 1 | 2 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 2 | 3 | 6 | 0 | 0 | 6 | 9 | 88 |
| 8/28 | | | | | | | | | | | | | | | | | | | | | | 1 | 8 | 8 | 17 |
| 8/29 | 5 | 7 | | | | | | | | | | | | | | | | | 0 | 2 | 0 | 0 | 0 | 5 | 19 |
| 8/30 | 6 | 4 | 6 | 5 | 2 | 7 | 4 | 0 | 0 | 4 | 0 | 1 | 2 | 0 | 0 | 4 | 2 | 4 | 5 | 4 | 5 | 7 | 8 | 3 | 83 |
| Total | 312 | 359 | 310 | 326 | 351 | 244 | 227 | 174 | 163 | 180 | 126 | 165 | 143 | 236 | 221 | 171 | 132 | 195 | 207 | 189 | 258 | 257 | 280 | 223 | 5449 |

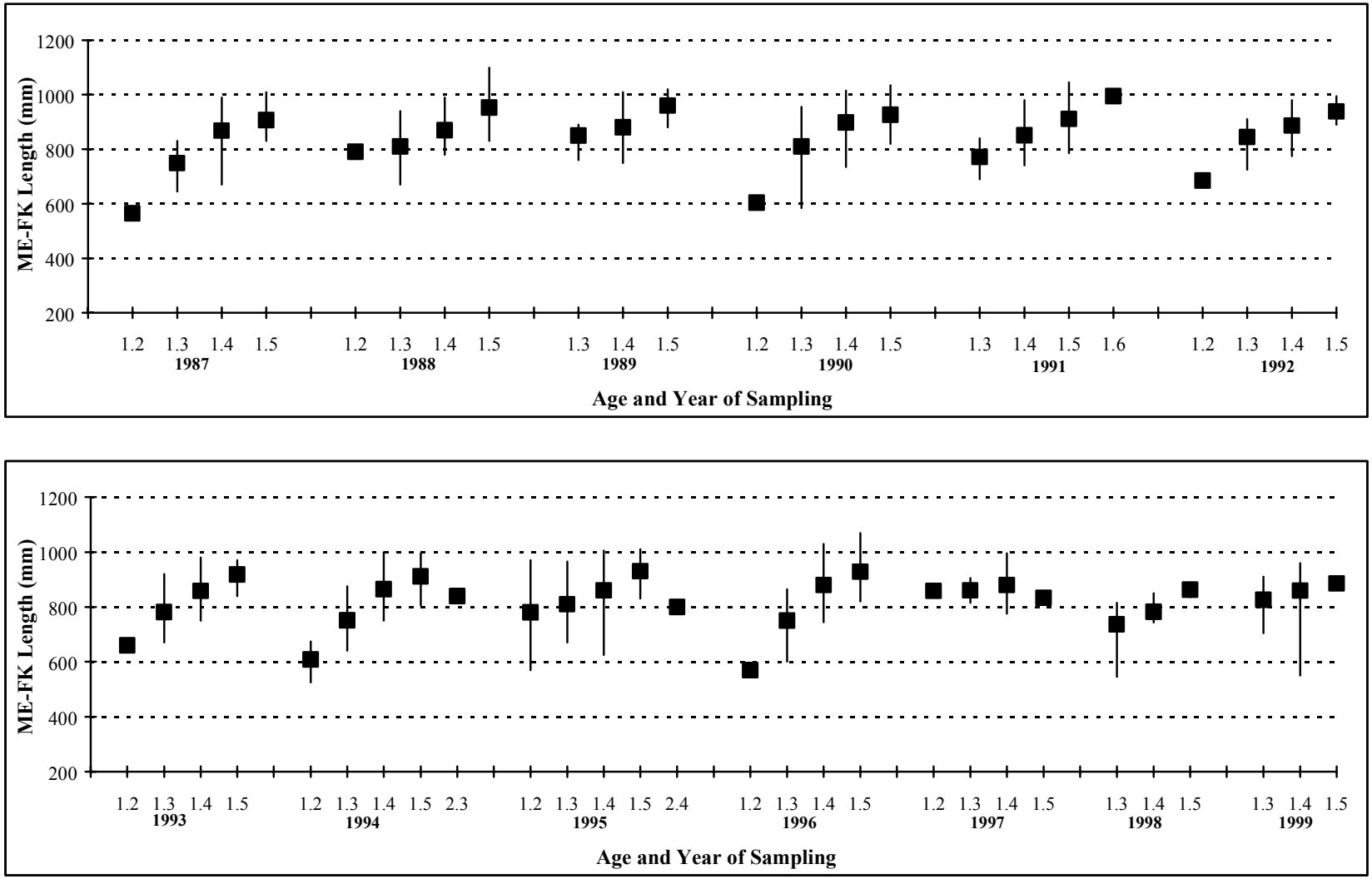



**Appendix E4.-Age composition of male and female chinook salmon from the Salcha River from carcasses sampled during 1987-1999.**




**Appendix E5.-Average length at age for male chinook salmon sampled from the Salcha River from 1987-1999. Error bars represent ranges.**




**Appendix E6.-Average length at age for female chinook salmon sampled from the Salcha River from 1987-1999. Error bars represent ranges.**