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# Spawning Abundance of Chinook Salmon in the Taku River in 1996

by

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Alaska Department of Fish and Game

Division of Sport Fish

## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

**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 |

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# SPAWNING ABUNDANCE OF CHINOOK SALMON IN THE TAKU RIVER IN 1996

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# ABSTRACT

A cooperative study involving the Alaska Department of Fish and Game, the Taku River Tlingit First Nation, and the Canadian Department of Fisheries and Oceans was conducted to estimate the number of spawning chinook salmon *Oncorhynchus tshawytscha* in the Taku River in 1996 with a mark-recapture experiment. Fish were captured at Canyon Island on the lower Taku River with fish wheels from May through August and were individually marked with back-sewn, solid-core spaghetti tags and were batch marked as well with an opercle punch plus removal of the left axillary appendage. Sampling on the spawning grounds in tributaries was used to estimate the fraction of the population that had been marked. Spawning abundance of medium-size chinook salmon (401–659 mm long; mid-eye to fork of tail) was estimated to be 10,402 (SE = 1,553). Estimated spawning abundance of large-size fish (≥660 mm) was 79,019 (SE = 9,048), and the estimated total of medium and large fish was 89,421 (SE = 9,180). Estimated abundance of the larger fish from aerial surveys of parts of the Taku River was 25% of the mark-recapture estimate, a trend repeated from similar studies in 1989, 1990 and 1995. The 1991 brood year (mostly age 1.3) constituted an estimated 78% of the age-.2 to age-.5 spawning population, followed by the 1990 brood year (mostly age 1.4), which constituted an estimated 12% of the population.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Taku River, spawning abundance, mark-recapture; age, sex and length composition.

# INTRODUCTION

The Taku River produces the largest population of chinook salmon *Oncorhynchus tshawytscha* in Southeast Alaska (Pahlke 1996; Pahlke and Bernard 1996; McPherson et al. 1996). Prior to the mid-1970s, these fish were exploited in directed commercial and recreational fisheries, with annual commercial harvests estimated to have reached approximately 15,000 or more fish (Kissner 1976). Various restrictions were placed on all intercepting fisheries (troll, gillnet and recreational) beginning in 1976, as part of a program to rebuild stocks of chinook salmon in Southeast Alaska. This rebuilding effort has been combined with a coastwide rebuilding program for chinook salmon in conjunction with the Pacific Salmon Treaty, since 1985.

Presently, migrating chinook salmon from the Taku River are caught incidentally in a commercial gillnet fishery located in U.S. waters near the river, and in an inriver Canadian gillnet fishery (Figure 1). Chinook salmon from the Taku River also constitute an unknown, but thought to be large, component of the spring catch in the recreational fishery in marine waters near Juneau and are caught in recreational fisheries in Canadian reaches of the drainage. Exploitation of this population is jointly managed by the U.S. and Canada through a subcommittee of the Pacific Salmon Commission (PSC).

Since 1975, escapements to the Taku River have been assessed by counting chinook salmon on the spawning grounds in six clearwater tributaries from helicopters (Pahlke 1996). Only large (typically 3-ocean age [age-.3] and older or fish approximately larger than 660 mm mid-eye to fork of tail [MEF]) chinook salmon are counted in these surveys. Fish age-.1 and age-.2 (1- and 2-ocean age) are not counted because of the difficulty of distinguishing these fish from other species from the air. Survey counts of large chinook salmon have been expanded to account for fish not present or observed during surveys and for unsurveyed tributaries (Mecum and Kissner 1989; PSC 1993). Factors used in the expansion have been based mostly on professional opinions of the ability to see fish during surveys and the distribution of spawners in the watershed.

Expansions were established in 1981 and were revised in 1991. In 1988, a study demonstrated that it was possible to mark and recapture enough large chinook salmon in the Taku River to estimate escapement (McGregor and Clark 1989).

In 1989 and 1990, the Commercial Fisheries Division (now Commercial Fisheries Management and Development Division [CFMDD]), the Canadian Department of Fisheries and Oceans (DFO), and the U.S. National Marine Fisheries Service (NMFS) estimated abundance of large chinook salmon in the Taku River from a mark-recapture and radio telemetry study (Pahlke and Bernard 1996; Eiler et al. *In prep.*). Results from those studies estimated the abundance of large chinook at 40,329 (SE = 5,646) in 1989 and 52,142 (SE = 9,326) in 1990. Chinook salmon were captured in fish wheels at Canyon Island, a location which is well below the spawning grounds in upriver tributaries where chinook salmon were inspected for marks.

Chinook salmon from the Taku River are a "spring run" of fish in that returning fish are present in terminal marine areas from late April through early July. Spawning occurs from late July to mid-September. Almost all juveniles rear for one year in fresh water after emergence and smolt at age 1 (Kissner and Hubartt 1986).

This stock rears offshore out of reach of fisheries in Southeast Alaska until they reach maturity and migrate to their spawning grounds. These fish mature after one to five years at sea, age-.1 and -.2 fish being mostly males, and age-.3, -.4 and -.5 fish being of both sexes but mostly females. Ages-.2, -3, and -.4 dominate the annual spawning population; age-.5 fish are uncommon (<5% of the run).

The objectives of this study were to estimate abundance of large chinook salmon spawning in the Taku River in 1996 and to estimate the age and sex composition of these fish.

# METHODS

## STUDY AREA

The Taku River originates in the Stikine Plateau of northwestern British Columbia, Canada (Figure 1), and flows approximately 300 km downstream, emptying into the Taku Inlet about 30 km east of Juneau, Alaska, through a drainage of approximately 17,094 $km^2$ (Bigelow et al. 1995). Two principal tributaries, the Inklin and the Nakina rivers, merge about 55 km above the U.S./Canada border to form the main body of the lower river. Discharge past Canyon Island (Figure 1) increases from a winter low on average of 60 $m^3$/sec in February to 1,097 $m^3$/sec in June (Bigelow et al. 1995). The mainstem is turbid, with a large volume of discharge from glacial melt in Alaska and Canada; however, the tributaries where most chinook salmon spawn have relatively clear waters, notably the Nakina, King Salmon, Kowatua, Hackett and Nahlin rivers.

## CANYON ISLAND

Chinook salmon returning to the Taku River and migrating upstream were captured with two fish wheels placed on opposite banks of the Taku River approximately 200 m apart at Canyon Island, about 4 km downstream from the International border (Figure 1). The sites for the two fish wheels were the same ones used since 1984. The Taku River narrows significantly at Canyon Island, and much of the river, under low to medium water levels, is forced between a deep channel with bedrock on both banks, making it an ideal location for fish wheel operation. Fish wheels were operated continuously from 3 May through 20 September except during extreme high or low water levels and during maintenance or sampling.

Fish wheel configurations and fish wheel operations are discussed in detail in Kelley et al. (1997). In brief, each fish wheel consisted of a framework with two aluminum pontoons and wooden or aluminum collection baskets (two, three, or four) mounted on an axle, which turned from water force acting on the baskets and/or wooden paddles. Fish that were scooped up by the baskets were guided by V-shaped slides into wooden live boxes bolted to the outer edge of each pontoon.

Four scales were taken from each chinook salmon captured at Canyon Island, the length of each captive measured, and its sex recorded. Individual fish were dipnetted from live boxes, elevated, and transferred to a trough partially filled with river water. Fish were handled with bare hands to prevent injury. While one person held the fish, another removed scales and took measurements, while and a third recorded data. Measurements of

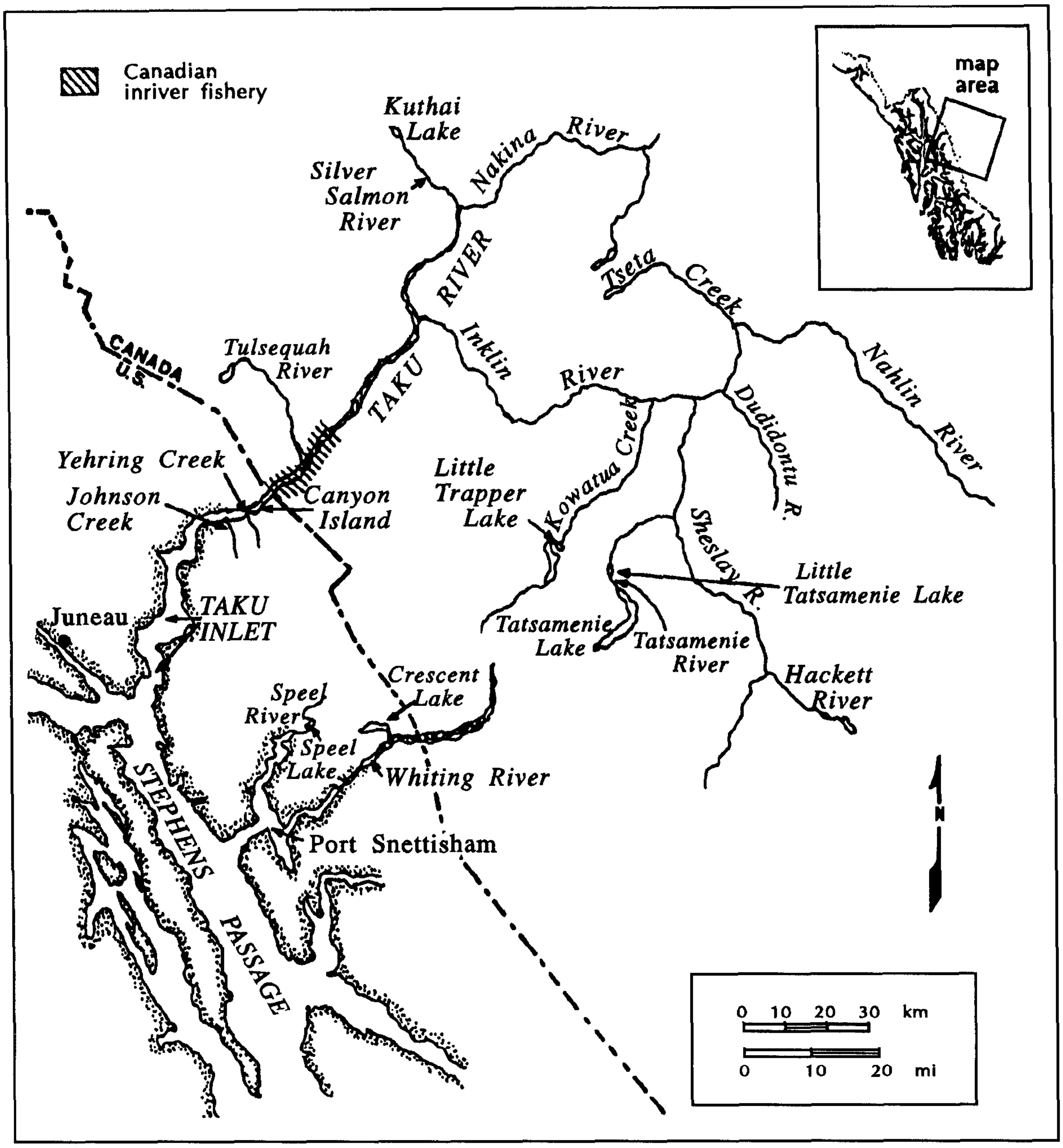



**Figure 1.–Taku Inlet and Taku River drainage.**

length were recorded as MEF. Gender of each sampled fish was determined from inspection of its external characteristics. Four scales from each fish were taken from the "preferred area" two rows above the lateral line on the left side of the fish across a diagonal running from the posterior terminus of the dorsal fin to the anterior margin of the anal fin (Welander 1940). Scales were mounted onto gummed cards which held scales from 10 fish. The age of each fish was determined later from the pattern of circuli (Olsen 1992) on images of scales impressed onto acetate magnified 70× (Clutter and Whitesel 1956). In cooperation with another project, presence or absence of an adipose fin was noted for each sampled fish.

All captured chinook salmon judged uninjured were also tagged and marked for the first-event of a mark-recapture experiment to estimate abundance. We tagged each subject with a "solid-core" spaghetti tag, which consisted of a 2 1/4″ section of laminated Floy tubing shrunk onto a 15″ piece of 50-lb-test monofilament fishing line; an improved design over that used by Johnson on the Chilkat River in 1991 (Johnson et al. 1992). The monofilament was back-sewn just behind the dorsal fin and secured with by crimping both ends of the monofilament in a line crimp. The excess monofilament was trimmed. Each tag was individually numbered and stamped with a contact phone number.

Besides the individually numbered tag (the primary mark), each fish was also batch marked by a 5/16″ hole punched in the upper one-third of their left operculum (UOP) and by excision of the left axillary appendage (LAA) with a canine nail clipper.

### SAMPLING ON THE SPAWNING GROUNDS

Chinook salmon were sampled on the Nahlin, Nakina, Kowatua and Tatsatua (Tatsamenie) rivers in 1996 as representative stocks of early, mid-season, and late-season migrants (ADF 1951; Eiler et al. *In prep*; Pahlke and Bernard 1996). Fish were also sampled on the Dudidontu River for the first time; these fish appear to have mid or late timing. All fish captured live at a weir situated below most spawning areas on the Nahlin River from 23 June to 24 August were inspected for marks. A carcass weir was used to inspect fish on the Nakina River from 3 to 24 August. Carcass surveys of spawned-out fish were conducted periodically from 1 August to 10 September on the Kowatua River, from 20 August to 6 October on the upper Tatsamenie River (Tatsatua system). Carcasses and spent live fish were sampled from 25 August to 4 September on the lower Tatsamenie River (Tatsatua system) and from 13 to 15 August on the Dudidontu River. Sampled carcasses were marked with a lower opercle punch to prevent their being resampled at a later date.

All inspected fish were closely examined for the presence of the primary tag, the UOP and the LAA, for the absence of their adipose fin, and were measured to the nearest millimeter MEF. Scale samples were taken from a systematically drawn subset of inspected fish at each tributary according to procedures described for similar sampling at Canyon Island.

### ABUNDANCE BY SIZE

Abundance on the spawning grounds of "medium-size" (401–659 mm MEF) and "large-size" (≥660 mm MEF) chinook salmon was estimated separately with Chapman's modified Petersen mark-recapture estimator (Seber 1982, p.60). The population was divided into size groups because fish wheels are selective for smaller fish (Meehan 1961; Pahlke and Bernard 1996). "Small" chinook salmon were < 401 mm MEF. Estimated abundance ($\hat{N}_i$) of medium and large fish on the spawning grounds was calculated as

$$\hat{N}_i = \frac{(\hat{M}_i + 1)(C_i + 1)}{(R_i + 1)} - 1 \qquad (1)$$

where $\hat{M}_i$ is the estimated number of marked fish that survived to spawn of size $i$, $C_i$ is the number of fish of size $i$ inspected for marks on spawning grounds, and $R_i$ is the number of these inspected fish with marks.

The estimated number of marked fish on the spawning grounds was $\hat{M}_i = T_i - \hat{H}_i$, where $T_i$ is the number of tagged fish released at Canyon Island and $\hat{H}_i$ is the estimated number of tagged fish removed by fishing (censored from the experiment). The fraction of samples composed of recaptured fish ($R_i / C_i$) were compared across tributaries to determine if the estimator was consistent (Seber 1982, p. 439). The length distributions of medium and large fish tagged and released at Canyon Island was also compared with the length distributions of medium and large fish recaptured in all tributaries to detect size-selective sampling on the spawning grounds.

Estimated numbers of tagged medium and large fish censored from the experiment ($\hat{H}_i$) were tallies of returned tags and expanded samples from fisheries downstream and upstream of Canyon Island. The number of tagged chinook salmon recovered through sampling by

CFMDD of catches from the Alaska gillnet fisheries for sockeye salmon *O. nerka* in Taku Inlet/Stephens Passage was expanded by the fraction of the catch of chinook salmon sampled (38.21% for 1996). No tags were recovered from a creel survey of the U.S. recreational fishery near Juneau; however, participants in this fishery voluntarily returned two tags. Two tags were voluntarily returned from the U.S. personal use fishery in July below Canyon Island inriver. Another five tags were voluntarily returned from the inriver recreational fishery in Canada. One tag was found by a U.S. fishery protection officer on a bear-killed carcass below Canyon Island. Because of a reward (US$2) for each tag returned from the inriver Canadian gillnet fishery, tags recovered from 181 fish probably represented all marked fish caught in this fishery.

Variance, bias, and confidence intervals for $\hat{N}_i$ were estimated with modifications of bootstrap procedures in Buckland and Garthwaite (1991). Medium-sized and large chinook salmon passing by Canyon Island were divided into seven capture histories (Table 1). The estimated number of fish past Canyon Island $\hat{N}_i^+$ was greater than the estimate of abundance on the spawning grounds $\hat{N}_i$ by the number of marked fish censored in fisheries ($\hat{H}_i$).

A bootstrap sample was built by drawing with replacement a sample of size $\hat{N}_i^+$ from the empirical distribution defined by the capture histories. A new set of statistics from each bootstrap sample $\{\hat{M}_i^*, C_i^*, R_i^*, \hat{H}_i^*, T_i^*\}$ was generated, along with a new estimate $\hat{N}_i^*$ for abundance on the spawning grounds, and 1,000 such bootstrap samples were drawn creating the empirical distribution $\hat{F}(\hat{N}_i^*)$, which is an estimate of $F(\hat{N}_i)$. The difference between the average $\hat{N}_i^*$ of bootstrap estimates and $\hat{N}_i$ is an estimate of statistical bias in the latter statistic (Efron and Tibshirani 1993, Section 10.2). Confidence intervals were estimated from $\hat{F}(\hat{N}_i^*)$ with the percentile method (Efron and Tibshirani 1993, Section 13.3).

**Table 1.–Capture histories for medium-sized and large chinook salmon in the population spawning in the Taku River in 1996.** Notation explained in text.

| Capture history | Medium | Large | Source of statistics |
|---|---|---|---|
| Marked, but censored in recreational fisheries | 5 | 5 | Returned |
| Marked, but censored in the U.S. marine commercial fishery | 5 | 13 | Observed/0.3821 |
| Marked, but censored in the Candiand inriver commercial fishery | 48 | 133 | Returned |
| Marked and not sampled in tributaries | 396 | 1039 | $\hat{M}_i - R_i$ |
| Marked and recaptured in tributaries | 42 | 74 | $R_i$ |
| Not marked, but captured in tributaries | 976 | 5,245 | $C_i - R_i$ |
| Not marked and not sampled in tributaries | 8,988 | 72,661 | $\hat{N}_i - \hat{M}_i - C_i + R_i$ |
| Effective population for simulations | 10,460 | 79,170 | $\hat{N}_i^+$ |

Variance was estimated as

$$v(\hat{N}_i^*) = (B-1)^{-1}\sum_{b=1}^{B}(\hat{N}_{i(b)}^* - \overline{\hat{N}}_i^*)^2 \qquad (2)$$

where $B$ is the number of bootstrap samples.

Abundance of spawning chinook salmon of both large and medium size was estimated as $\hat{N} = \hat{N}_{med} + \hat{N}_{lg}$. Confidence intervals for $\hat{N}$ and $v(\hat{N})$ were estimated as described above. Because few small fish were recaptured on the spawning grounds, we did not estimate their abundance directly or indirectly through expansion, because sampling on the spawning grounds was not designed to produce a representative sample of small fish.

### AGE AND SEX COMPOSITION

The proportion of the spawning population composed of a given age within medium-sized or large fish was estimated as a binomial variable from fish sampled at Nahlin, Nakina, Kowatua, Tatsatua and Dudidontu rivers:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_i} \tag{3}$$

where $\hat{p}_{ij}$ is the estimated proportion of the population of age $j$ in sized group $i$, $n_{ij}$ is the number of chinook salmon of age $j$ of size group $i$, and $n_i$ is the number of chinook salmon in the sample $n$ of size group $i$ taken on the spawning grounds. Note $\sum_j \hat{p}_{ij} = 1$. Information taken at Canyon Island was not used to estimate age or sex composition of the spawning population, because fish wheels are size-selective for smaller salmon (Meehan 1961). Samples taken at the Nahlin, Nakina, Kowatua, Tatsatua and Dudidontu rivers were pooled, because investigations showed sampling on the spawning grounds had not been size-selective within a size group. Sample variance was calculated as:

$$v(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_i - 1} \tag{4}$$

Numbers of spawning fish by age were estimated as the summation of products of estimated age composition and estimated abundance within a size category:

$$\hat{N}_j = \sum_i \left(\hat{p}_{ij}\hat{N}_i\right) \tag{5}$$

with a sample variance calculated according to procedures in Goodman (1960):

$$v(\hat{N}_j) = \sum_i \begin{pmatrix} v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)\hat{p}_{ij}^2 \\ - v(\hat{p}_{ij})v(\hat{N}_i) \end{pmatrix} \tag{6}$$

The proportion of the spawning population >400 mm MEF composed of a given age was estimated as the summed totals across size categories:

$$\hat{p}_j = \frac{\hat{N}_j}{\hat{N}} \tag{7}$$

with a variance approximated according to procedures in Seber (1982, p. 8-9):

$$v(\hat{p}_j) = \frac{\sum_i \left( v(\hat{p}_{ij})\hat{N}_i^2 + v(\hat{N}_i)(\hat{p}_{ij} - \hat{p}_j)^2 \right)}{\hat{N}^2} \tag{8}$$

Sex composition and age-sex composition for the entire spawning population and its associated variances were also estimated with the equations above by first redefining the binomial variables in samples to produce estimated proportions by sex $\hat{p}_k$, where $k$ denotes gender (male or female), such that $\sum_k \hat{p}_k = 1$, and by age-sex $\hat{p}_{jk}$, such that $\sum_{jk} \hat{p}_{jk} = 1$. Estimated sex composition for stocks in the Nahlin, Nakina, Kowatua, Tatsatua and Dudidontu rivers were again combined, and estimates from the Canyon Island fish wheels were excluded because of difficulty in accurately sexing fish (most are ocean-bright and have not developed secondary maturation characteristics).

## RESULTS

### TAGGING, RECOVERY AND ABUNDANCE

Of 1,904 chinook salmon caught at Canyon Island (Appendix A1), 1,770 were tagged and released (Table 2). Ninety-five percent (95%) of catches occurred between 14 May and 8 July. Of fish tagged, 10 were small (≥400 mm MEF), 496 were medium-sized (401–659 mm MEF) and 1,264 were large (≥660 mm MEF). All fisheries, recreational and commercial, removed an estimated 209 tagged fish (11.8% of all tagged) of all sizes (Table 2).

Although changes in water velocity can adversely affect catchability of migrating salmon in fish wheels, especially during periodic flooding from sudden releases of glacially retained water from the Tulsequah River (Kerr 1948; Marcus 1960), water levels and flows remained lower than average and relatively stable throughout the project in 1996 (Kelley et al. *In prep.*).

Sampling on the spawning ground proved to be selective towards smaller chinook salmon. Cumulative density functions for uncensored, marked fish ≥400 mm MEF was significantly larger than the corresponding function for fish recaptured on the spawning grounds (Kolmogorov-Smirnov Two Sample Test, P = 0.03; Figure 2). If samples from the carcass weir on the Nakina River are excluded from the comparison, differences are no longer significant (P = 0.56; Figure 3). Because the Nakina River represents a considerable amount of the production in the Taku River, estimates of abundance were stratified into medium-sized and large chinook salmon to keep samples from the Nakina River in the analysis. Separate comparisons of length distributions for medium-sized and large chinook salmon showed no significant size-selective sampling within each size group (P = 0.54 and P = 0.89; Figure 4).

Estimated abundance of medium-sized chinook salmon $\hat{N}_{ms}$ on the spawning grounds in 1996 was 10,402 (SE = 1,553), based on 1,018 fish inspected for marks ($=C_{ms}$) at five tributaries, 42 of which were recaptured fish ($=R_{ms}$) (Tables 2 and 3). Eleven (26%) of the 42 recovered medium-sized fish had lost their primary tag, but were detected as marked fish from the upper opercle punch (UOP) and/or a missing left axillary appendage (LAA). All medium-sized fish that had shed their primary tags were inspected as carcasses on the Nakina (9) or Tatsatua/Tatsamenie (2) rivers. Fisheries censored an estimated 58 (11.7%) tagged fish ($=\hat{H}_{ms}$) making the estimated number of medium-sized tagged fish that survived to spawn 438 ($=\hat{M}_{ms}$). Similarities in the fraction marked among fish inspected in different tributaries (Nahlin River: 0.031; Nakina River: 0.045; Kowatua/Tatsatua/Dudidontu rivers pooled: 0.038) indicate that the Petersen estimator based on data pooled across tributaries is a consistent estimator for the mark-recapture experiment ($\chi^2 = 0.84$, df = 2, P = 0.66). Estimated abundance of medium-sized fish has a 95% confidence interval of 8,018 to 14,064, and an estimated relative bias of 1.99%.

Estimated abundance of large chinook salmon $\hat{N}_{ls}$ on the spawning grounds in 1996 was 79,019 (SE = 9,048), based on 5,319 fish inspected for marks ($=C_{ls}$) at five tributaries, 74 of which were recaptured fish ($=R_{ls}$) (Tables 2 and 3). Thirteen (18%) of the 74 recovered large fish had lost their primary tag, but were detected as marked fish from the upper opercle punch (UOP) and/or a missing left axillary appendage (LAA). All large fish that had shed their primary tags were inspected as carcasses on the Nakina (10), Tatsatua/Tatsamenie (2) or Dudidontu (1) rivers. Fisheries censored an estimated 58 (11.9%) tagged fish ($=\hat{H}_{ls}$) making the estimated number of large tagged fish that survived to spawn 1,113 ($=\hat{M}_{ls}$). Similarities in the fraction marked among fish inspected in different tributaries (Nahlin River: 0.013; Nakina River: 0.017; and Kowatua/Tatsatua/Dudidontu rivers pooled: 0.011) indicate that the Petersen estimator based on data pooled across tributaries is a consistent estimator for the mark-recapture experiment. ($\chi^2 = 2.26$, df = 2, P = 0.32). Estimated abundance of large fish has a 95% confidence interval of 64,388 to 99,866, and an estimated relative bias of 1.23%.

The estimated abundance of all chinook salmon >400 mm MEF ($\hat{N} = \hat{N}_{ms} + \hat{N}_{ls}$) on the spawning grounds for 1996 was 89,421 (SE = 9,200). The estimated 95% confidence interval for $\hat{N}$ was 74,683 to 110,173.

Table 2.–Numbers of chinook salmon marked at Canyon Island, removed by fisheries and inspected for marks in tributaries in 1996 by size group.

| | 0–400 mm MEF | 401–659 mm | ≥660 mm | Total |
|---|---|---|---|---|
| **A.** Released at Canyon Island with marks | 10 | 496 | 1,264 | 1,770 |
| **B.** Removed by: | | | | |
| **1.** Sport fisheries [a] | 0 | 5 | 5 | 10 |
| **2.** U.S. gillnet [b] | 0 | 5 | 13 | 18 |
| **3.** Canadian gillnet | 0 | 48 | 133 | 181 |
| Total removals | 0 | 58 | 151 | 209 |
| **C.** Estimated $\hat{M}$ | 10 | 438 | 1,113 | 1561 |
| **D.** Inspected at: | | | | |
| **1.** Nakina River | | | | |
| Inspected | 22 | 640 | 2,017 | 2,679 |
| Recaptured | 1 | 29 | 34 | 64 |
| Recaptured/captured | 0.0455 | 0.0453 | 0.0169 | 0.0239 |
| **2.** Nahlin River | | | | |
| Inspected | 0 | 194 | 1,856 | 2,050 |
| Recaptured | 0 | 6 | 24 | 30 |
| Recaptured/captured | | 0.0309 | 0.0129 | 0.0146 |
| **3.** Kowatua/Tatsatua/Dudidontu | | | | |
| Inspected | 1 | 184 | 1,446 | 1,631 |
| Recaptured | 0 | 7 | 16 | 23 |
| Recaptured/captured | | 0.0380 | 0.0111 | 0.0141 |
| Total inspected | | | | |
| Inspected | 23 | 1,018 | 5,319 | 6,360 |
| Recaptured | 1 | 42 | 74 | 117 |
| Recaptured/captured | 0.0435 | 0.0413 | 0.0139 | 0.0184 |

[a] Includes two fish from U.S. sport fishery, five fish from Canadian sport fishery, two from U.S. personal use fishery, and one bear kill below Canyon Island, equaling 10 total.

[b] Estimated by expanding random recoveries in the U.S. gillnet fishery District 111 (Taku Inlet/Stephens Passage); in this fishery 38.21% of chinook salmon harvested in this fishery were sampled, yielding two medium and five large tagged chinook salmon.

## ESTIMATES OF AGE AND SEX COMPOSITION

Age-1.3 chinook salmon dominated the age and sex compositions of chinook salmon >400 mm MEF on the spawning grounds of the Taku River in 1996. Age-1.3 fish constituted 78% (SE = 1.3%) of the estimated escapement (Table 3), age-1.4 fish constituted 11% (SE = 0.8%), and age-1.2 fish constituted 9% (SE = 1.3%); 54% (SE = 1.4%) were males. Of the medium-sized fish, which ordinarily are primarily age-.2 fish, age-1.3 fish constituted 31%; the abundance in 1996 of age-.3 fish was abnormally strong, and the size distribution of this group of fish overlapped that of age-.2 and -.4 fish to a greater extent (Figure 5). Age-1.2 fish constituted 67% of medium fish, and males accounted for 96% of all medium fish. Age-1.3 fish accounted for 84% of all large fish and females constituted 52% of large fish. Age-.1 fish were excluded from estimates of age and sex composition because of their scarcity and the difficulties in obtaining a representative sample of these small fish on the spawning grounds to estimate abundance.

Of the large fish sampled at Canyon Island, 88% were age-1.3 fish and 8% were age-1.4 fish (Appendix A2); amongst medium fish sampled, 68% were age-1.2 and 28% were age-1.3 fish. The percentages show that within size groups the age proportions from samples taken at

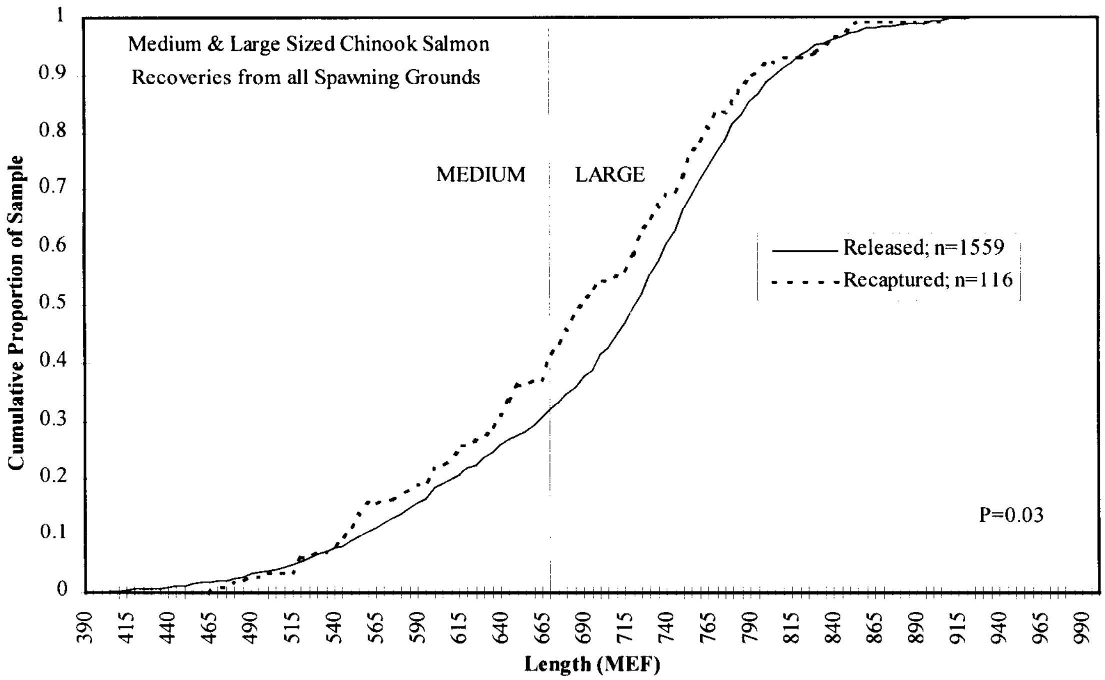



**Figure 2.–Cumulative relative frequencies of medium-sized and large chinook salmon (combined) marked at Canyon Island in 1996 versus those subsequently recaptured in sampling at all five tributaries.**

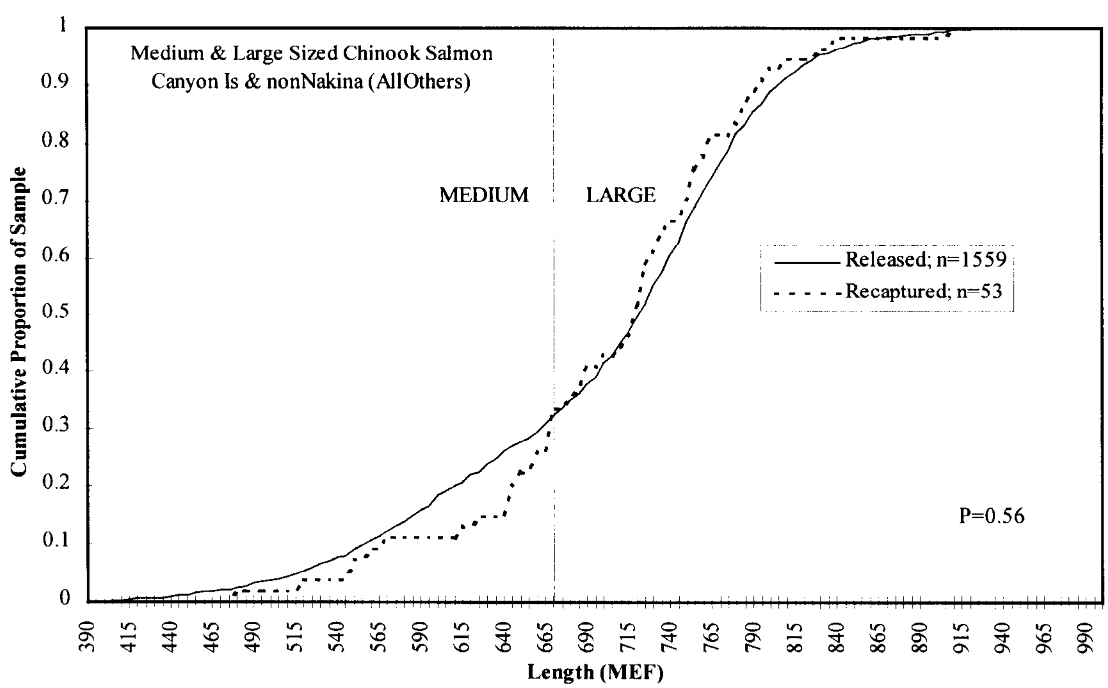
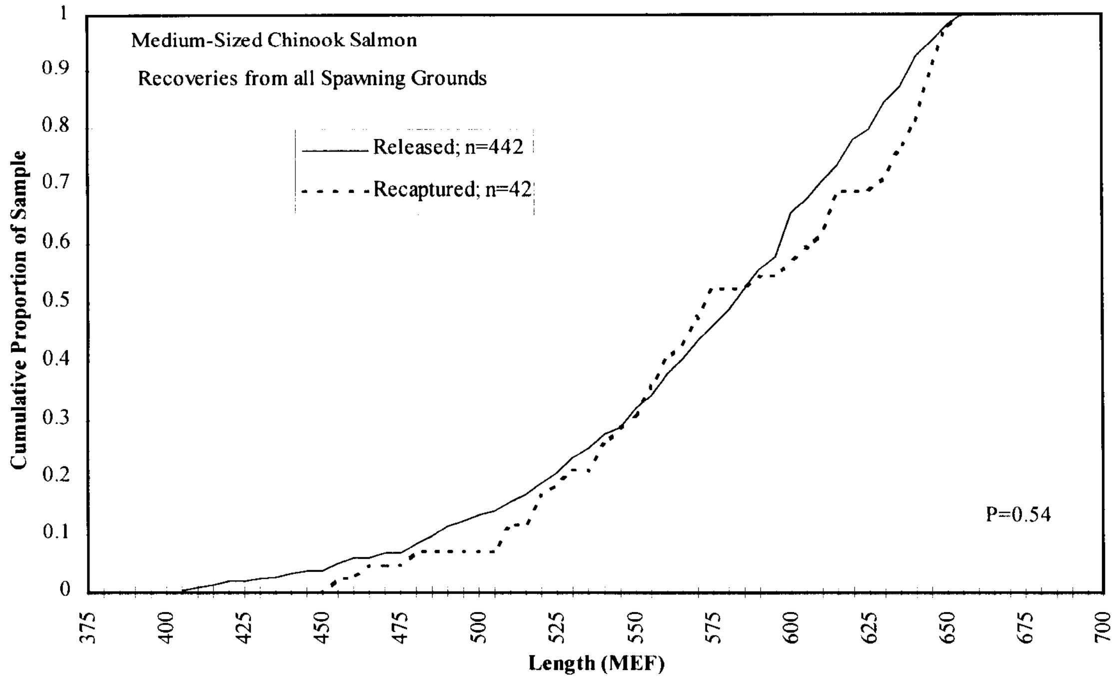



**Figure 3.–Cumulative relative frequencies of medium-sized and large chinook salmon (combined) marked at Canyon Island in 1996 versus those subsequently recaptured in sampling at all tributaries except Nakina.**



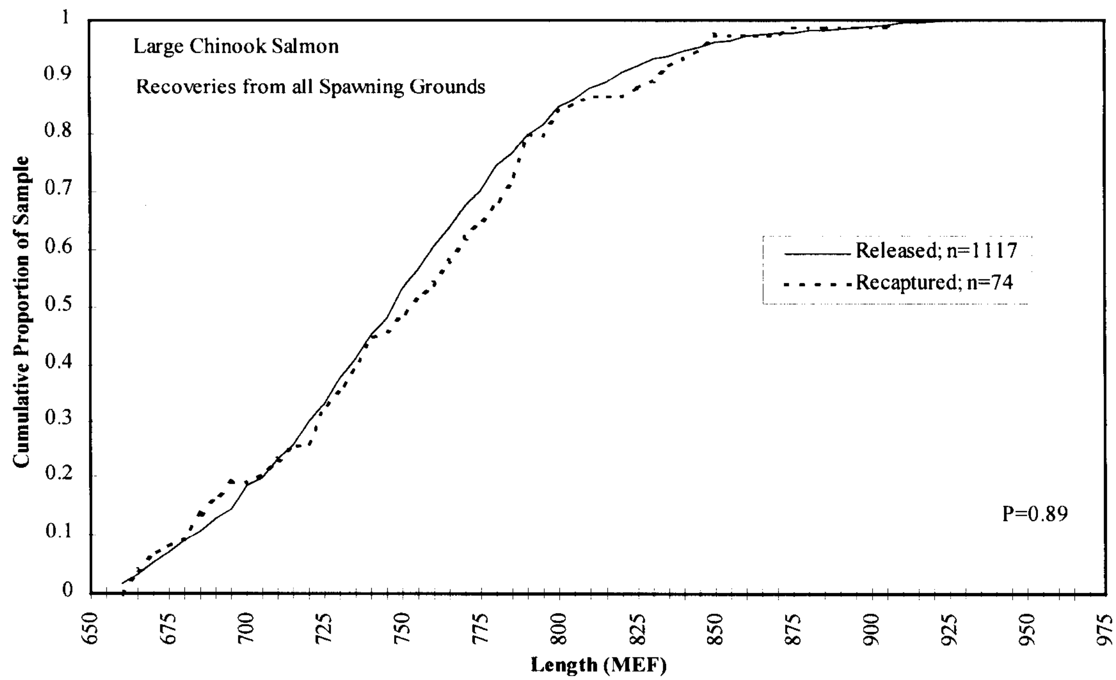




**Figure 4.–Cumulative relative frequencies of medium-sized and large chinook salmon (separate) marked at Canyon Island in 1996 versus those subsequently recaptured in sampling at all tributaries except Nakina.**

Table 3.–Estimated abundance and composition by age and sex of the spawning population in the Taku River in 1996 for medium-sized and large chinook salmon.

| | | Brood year and age class | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1992 | 1991 | 1991 | 1990 | 1990 | 1989 | 1989 | |
| | | 1.2 | 2.2 | 1.3 | 2.3 | 1.4 | 2.4 | 1.5 | Total |
| **PANEL A: AGE AND SEX COMPOSITION OF MEDIUM-SIZED CHINOOK SALMON** | | | | | | | | | |
| **Males** | n | 218 | 6 | 92 | 1 | 0 | 0 | 0 | **317** |
| | % | 65.7% | 1.8% | 27.7% | 0.3% | 0.0% | 0.0% | 0.0% | **95.5%** |
| | SE | 2.6% | 0.7% | 2.5% | 0.3% | 0.0% | 0.0% | 0.0% | **1.1%** |
| | Number | 6,830 | 188 | 2,882 | 31 | 0 | 0 | 0 | **9,932** |
| | SE | 1,054 | 80 | 499 | 31 | 0 | 0 | 0 | **1,487** |
| **Females** | n | 4 | 0 | 10 | 1 | 0 | 0 | 0 | **15** |
| | % | 1.2% | 0.0% | 3.0% | 0.3% | 0.0% | 0.0% | 0.0% | **4.5%** |
| | SE | 0.6% | 0.0% | 0.9% | 0.3% | 0.0% | 0.0% | 0.0% | **1.1%** |
| | Number | 125 | 0 | 313 | 31 | 0 | 0 | 0 | **470** |
| | SE | 64 | 0 | 107 | 31 | 0 | 0 | 0 | **137** |
| **Sexes combined** | n | 222 | 6 | 102 | 2 | 0 | 0 | 0 | **332** |
| | % | 66.9% | 1.8% | 30.7% | 0.6% | 0.0% | 0.0% | 0.0% | **100.0%** |
| | SE | 2.6% | 0.7% | 2.5% | 0.4% | 0.0% | 0.0% | 0.0% | **0.0%** |
| | Number | 6,956 | 188 | 3,196 | 63 | 0 | 0 | 0 | **10,402** |
| | SE | 1,072 | 80 | 544 | 45 | 0 | 0 | 0 | **1,553** |
| **PANEL B: AGE AND SEX COMPOSITION OF LARGE CHINOOK SALMON** | | | | | | | | | |
| **Males** | n | 15 | 1 | 710 | 7 | 60 | 2 | 2 | **797** |
| | % | 0.9% | 0.1% | 43.0% | 0.4% | 3.6% | 0.1% | 0.1% | **48.2%** |
| | SE | 0.2% | 0.1% | 1.2% | 0.2% | 0.5% | 0.1% | 0.1% | **1.2%** |
| | Number | 717 | 48 | 33,961 | 335 | 2,870 | 96 | 96 | **38,122** |
| | SE | 201 | 48 | 4,005 | 131 | 488 | 68 | 68 | **4,471** |
| **Females** | n | 2 | 0 | 684 | 23 | 144 | 1 | 1 | **855** |
| | % | 0.1% | 0.0% | 41.4% | 1.4% | 8.7% | 0.1% | 0.1% | **51.8%** |
| | SE | 0.1% | 0.0% | 1.2% | 0.3% | 0.7% | 0.1% | 0.1% | **1.2%** |
| | Number | 96 | 0 | 32,717 | 1,100 | 6,888 | 48 | 48 | **40,897** |
| | SE | 68 | 0 | 3,865 | 259 | 959 | 48 | 48 | **4,781** |
| **Sexes combined** | n | 17 | 1 | 1,394 | 30 | 204 | 3 | 3 | **1,652** |
| | % | 1.0% | 0.1% | 84.4% | 1.8% | 12.3% | 0.2% | 0.2% | **100.0%** |
| | SE | 0.2% | 0.1% | 0.9% | 0.3% | 0.8% | 0.1% | 0.1% | **0.0%** |
| | Number | 813 | 48 | 66,678 | 1,435 | 9,758 | 143 | 143 | **79,019** |
| | SE | 216 | 48 | 7,667 | 306 | 1,285 | 84 | 84 | **9,048** |
| **PANEL C: AGE AND SEX COMPOSITION OF MEDIUM-SIZED AND LARGE CHINOOK SALMON** | | | | | | | | | |
| **Males** | n | 233 | 7 | 802 | 8 | 60 | 2 | 2 | **1,114** |
| | % | 8.4% | 0.3% | 41.2% | 0.4% | 3.2% | 0.1% | 0.1% | **53.7%** |
| | SE | 1.3% | 0.1% | 1.2% | 0.1% | 0.4% | 0.1% | 0.1% | **1.4%** |
| | Number | 7,548 | 236 | 36,843 | 366 | 2,870 | 96 | 96 | **48,054** |
| | SE | 1,073 | 94 | 4,036 | 135 | 488 | 68 | 68 | **4,712** |
| **Females** | n | 6 | 0 | 694 | 24 | 144 | 1 | 1 | **870** |
| | % | 0.2% | 0.0% | 36.9% | 1.3% | 7.7% | 0.1% | 0.1% | **46.3%** |
| | SE | 0.1% | 0.0% | 1.3% | 0.3% | 0.6% | 0.1% | 0.1% | **1.4%** |
| | Number | 221 | 0 | 33,031 | 1,131 | 6,888 | 48 | 48 | **41,367** |
| | SE | 94 | 0 | 3,867 | 261 | 959 | 48 | 48 | **4,783** |
| **Sexes combined** | n | 239 | 7 | 1,496 | 32 | 204 | 3 | 3 | **1,984** |
| | % | 8.7% | 0.3% | 78.1% | 1.7% | 10.9% | 0.2% | 0.2% | **100.0%** |
| | SE | 1.3% | 0.1% | 1.3% | 0.3% | 0.8% | 0.1% | 0.1% | **0.0%** |
| | Number | 7,769 | 236 | 69,874 | 1,498 | 9,758 | 143 | 143 | **89,421** |
| | SE | 1,093 | 94 | 7,686 | 309 | 1,285 | 84 | 84 | **9,180** |

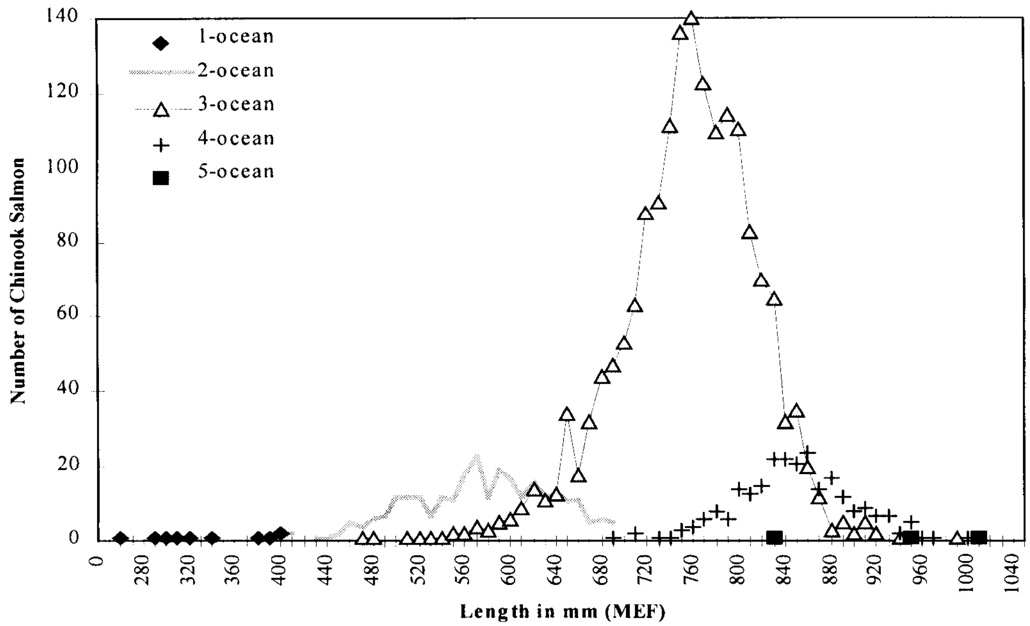



**Figure 5.–Numbers of chinook salmon by ocean-age from chinook salmon sampled at spawning grounds in all five tributaries in 1996.**

Canyon Island are very close to those from the combined tributary samples. Average length by age of all fish sampled for length and successfully aged on the spawning grounds are listed in Table 4.

## DISCUSSION

Our censoring of tagged fish caught in fisheries reduced bias in estimated abundance and its variance, but did not eliminate it completely. If there is mortality between sampling events in a mark-recapture experiment such as ours, estimated abundance will still be unbiased so long as marked and unmarked fish die at the same rate (Seber 1982, p. 71). However, at least some of the fish tagged and released at Canyon Island "backed down" to be caught in fisheries downstream, an estimated 18 of 1,770 tagged in 1996. This "backing-down" phenomenon of tagged chinook salmon has been observed in other studies (Milligan et al. 1984; Johnson et al. 1992, 1993; Bendock and Alexandersdottir 1993; Eiler et al. *In prep*). If this phenomenon occurs only with handled fish, tagged fish caught in fisheries downstream of Canyon Island represent a source of inflationary bias in estimated abundance. Although the inriver commercial fishery is upstream of Canyon Island, incidental catches of delayed chinook salmon in this fishery would also inflate estimated abundance, because the fishery opened 16 June, well after most unmarked fish would have passed upstream. Our censoring of these intercepted fish was incomplete, because we had only minimal estimates of the number caught in recreational fisheries. However, considering that no tags were found when 11% of the spring harvest and 17% of the season's harvest in the U.S. recreational fishery was inspected (Hubartt et al. *In prep*), and considering the size of the Canadian recreational harvest (<100 chinook salmon of all sizes), this bias from partial censoring should be negligible. Uncertainty from sampling to estimate the number of censored fish was included in the sample variance for estimated abundance through bootstrapping.

One capture history was excluded from the simulations: fish not captured at Canyon Island but caught in the inriver commercial fishery. Because we had no estimates of size composition of unmarked chinook salmon caught in this fishery, these fish were not represented in the

**Table 4.–Estimated average length by age and sex on the spawning grounds in the Taku River in 1996.**

| | | PANEL A: SPAWNING GROUNDS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Brood year and age class | | | | | | |
| | | 1992 | 1991 | 1991 | 1990 | 1990 | 1989 | 1989 |
| | | 1.2 | 2.2 | 1.3 | 2.3 | 1.4 | 2.4 | 1.5 |
| **Males** | n | 233 | 7 | 802 | 8 | 60 | 2 | 2 |
| | Average length | 571 | 595 | 743 | 781 | 874 | 943 | 978 |
| | SD | 62 | 50 | 69 | 104 | 66 | 4 | 39 |
| | SE | 4 | 19 | 2 | 37 | 8 | 3 | 28 |
| **Females** | n | 6 | | 694 | 24 | 144 | 1 | 1 |
| | Average length | 622 | | 764 | 777 | 836 | 860 | 830 |
| | SD | 46 | | 45 | 56 | 45 | | |
| | SE | 19 | | 2 | 11 | 4 | | |
| **Sexes combined** | n | 239 | 7 | 1496 | 32 | 204 | 3 | 3 |
| | Average length | 572 | 595 | 753 | 778 | 847 | 915 | 928 |
| | SD | 62 | 50 | 60 | 69 | 55 | 48 | 89 |
| | SE | 4 | 19 | 2 | 12 | 4 | 28 | 52 |

simulations. Because so few fish shared this history (3,294 all sizes; total catch minus 181 recoveries), their exclusion probably did not meaningfully bias statistics.

While the loss rate of primary tags was unsettling, it did not bias estimates of abundance. Solid-core spaghetti tags were shed on 26% of medium recoveries (11/42), which were all males, and on 18% (13/74) of large recoveries. Highest tag loss rates were recorded from carcasses at the Nakina, Kowatua, Tatsatua (Tatsamenie) and Dudidontu rivers. No live fish recaptured at the NahlinRiver had shed its primary tag. Recognition of secondary marks proved sufficient insurance to avoid bias in estimates of abundance from tag loss. No recaptured fish with a primary mark was observed to be missing both the secondary or tertiary mark.

Success of the mark-recapture experiment in 1996 depended heavily on marking chinook salmon at Canyon Island in proportion, or nearly in proportion, to their passing abundance. For our estimates of abundance to be unbiased (consistent), every fish must have had an equal chance of being marked at Canyon Island, or every fish on the spawning grounds must have had an equal chance of being inspected, or marked and unmarked fish must have mixed completely between Canyon Island and tributaries (from Seber 1982, pp. 437–9).

Fish in tributaries other than the Nakina, Nahlin, Kowatua, Tatsatua and Dudidontu rivers had no chance of being inspected, and differences in migratory timing of fish bound for different tributaries precludes complete mixing of marked and unmarked fish. Only by marking fish in proportion to their abundance at Canyon Island could we meet the assumption of proportionally tagging all stocks in the river. Changes in flow rates and censoring of marked fish removed by fisheries could have affected our ability to proportionally mark chinook salmon.

Still, our data for both medium-sized and large fish easily passed the test of consistency (Seber 1982, p. 439; see Figure 5), indicating that our marking had been proportional (or nearly so) for these fish, similar to mark-recapture studies of chinook salmon on the Taku River in 1989, 1990 and 1995 (Pahlke and Bernard 1996; McPherson et al. 1996). Because our samples came from populations that represented the earliest through the latest fish to pass by Canyon Island (ADF 1951; Eiler et al. *In prep.*), our estimates of abundance pertain to all chinook salmon spawning in the Taku River watershed.

In estimating abundance and age and sex composition for the watershed, we presumed that our combined tributary samples within the two size groups were representative of the total population. What differences there have been could be attributed to different methods of capturing chinook salmon employed in different tributaries. Because males tend to drift downstream in a moribund state after spawning, whereas females tend to die near their redds (Kissner and Hubartt 1986), estimates of age/sex/size composition for fish "caught" at carcass weirs tend to be biased towards males, which tend to be younger, smaller chinook salmon, whereas estimates from carcass-only surveys tend to be biased towards females, which are larger fish. Chinook salmon encountered at weirs passing live fish prior to their spawning are more likely to be of a representative size, age, and sex; as do spawning grounds surveys which employ gear to capture carcasses and live fish—i.e., collection of carcasses combined with netting of live fish.

Estimated abundance of large chinook salmon on the spawning grounds of the Taku River was considerably greater in 1996 than the corresponding estimate from the aerial survey, a pattern seen on the Taku River in 1989, 1990 and 1995 (Table 5; Pahlke and Bernard 1996; McPherson et al. 1996) and in other studies of chinook salmon in Southeast Alaska and in northern British Columbia (Johnson et al. 1992; Pahlke et al. 1996).

The unexpanded survey counts, 9,480 for 1989, 12,249 for 1990, 8,757 for 1995 (Pahlke 1996), and 19,777 for 1996, represent 23.5% (1989), 23.5% (1990), 25.9% (1995) and 25.0% (1996) of the abundance estimates from mark-recapture experiments (Table 5). In light of these comparisons, expansions used in aerial stock assessment will be changed. As past estimates of escapements to these rivers are changed to higher, more realistic levels, associated estimates of exploitation rates will be lowered, which will then need to be included in re-evaluation of escapement goals and overall stock status.

# CONCLUSION AND RECOMMENDATIONS

Since this project is to continue, we recommend some strategies to improve the precision of estimates. First, the same number of large chinook as in 1996 or a greater number of large chinook salmon should be tagged. Fish wheels of an improved design (all aluminum pontoons and basket frames that can be configured for two or four baskets) will be used in 1997 to increase catches, especially during low-water conditions which often prevail in May. Additionally, seine gear at Canyon Island may be used to increase catches. Net gear has been used successfully to capture chinook salmon without harm in projects on the Chilkat, Unuk, Chickamin, and Kenai rivers.

Second, an improved primary tag is needed. The primary mark will again be a solid-core spaghetti tag sewn through the back of chinook salmon, but with monofilament increased from 50 lb- to 80 lb-test. The design is an improvement over the one pioneered on the Chilkat River by Johnson et al. (1992). The secondary (left axillary removal) and tertiary (upper opercle punch) marks will be used on all sizes of fish, as the combination of the three proved failsafe in detecting marked fish.

We also recommend abundance of large (≥660 mm MEF) chinook salmon as estimated from aerial surveys in past years be adjusted upward in line with information gathered with mark-recapture experiments in 1989, 1990, 1995 and 1996. We recommend that aerial survey counts for other years be summed across all six index tributaries and that the total escapement of large chinook be estimated by dividing the sum of the aerial counts by 0.245 (the average fraction counted in 1989, 1990, 1995 and 1996). We also recommend escapement goals for Taku River chinook salmon be examined by fall of 1997 to reflect the knowledge gained from mark-recapture studies.

**Table 5.–Comparison of estimated abundance of large chinook (≥660 mm MEF) in the Taku River in 1989, 1990, 1995 and 1996 between estimates from expanding aerial surveys and through mark-recapture experiments.** Methods of expansions of counts from aerial surveys are described in Pahlke (1996). Confidence intervals for 1989 and 1990 are described in Pahlke and Bernard (1996), those for 1995 and 1996 are described in this document.

| | 1989 | 1990 | 1995 | 1996 | Average | SD | CV |
|---|---|---|---|---|---|---|---|
| Raw aerial survey counts | 9,480 | 12,249 | 8,757 | 19,777 | 12,566 | 5,038 | 40.1% |
| summed across 6 tribs (Nakina, Nahlin, Tseta, Kowatua, Dudidontu and Tatsamenie) | | | | | | | |
| Mark-recapture estimate(M-R) | 40,329 | 52,142 | 33,805 | 79,019 | 51,324 | 19,962 | 38.9% |
| **Aerial survey counts/(M-R)** | **23.5%** | **23.5%** | **25.9%** | **25.0%** | **24.5%** | **1.2%** | **4.9%** |
| Previous expansions | 25,481 | 32,622 | 23,861 | 54,116 | 34,020 | 13,927 | 40.9% |
| Previous expansion/(M-R) | 63.2% | 62.6% | 70.6% | 68.5% | 66.2% | 3.9% | 6.0% |
| M-R Standard Error | 5,646 | 9,326 | 5,060 | 9,048 | 7,270 | 2,229 | 30.7% |
| M-R lower 95% CI | 30,936 | 37,072 | 25,455 | 64,388 | 39,463 | 17,281 | 43.8% |
| M-R upper 95% CI | 56,995 | 80,784 | 45,216 | 99,866 | 70,715 | 24,424 | 34.5% |

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# APPENDIX A

Appendix A1.–Fish wheel effort for chinook salmon, including water level, catches, numbers tagged, CPUE, and daily proportions in 1996.

| | Fish wheel #1 | | Fish wheel #2 | | Water | Fish wheels combined | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours | | Hours | | level | Tagged medium | Tagged medium | Tagged large | Tagged large | Total tagged | Tagged | Total catch | Total catch | CPUE | CPUE | Daily | Cum. |
| Date | fished | RPM | fished | RPM | (in.) | daily | cum. | daily | cum. | daily | cum. | daily | cum. | daily | cum. | prop. | prop. |
| 20-Apr | | | | | -24 | | | | | | | | | | | | |
| 21-Apr | | | | | -24 | | | | | | | | | | | | |
| 22-Apr | | | | | -22 | | | | | | | | | | | | |
| 23-Apr | | | | | -20 | | | | | | | | | | | | |
| 24-Apr | | | | | -18 | | | | | | | | | | | | |
| 25-Apr | | | | | -16 | | | | | | | | | | | | |
| 26-Apr | | | | | -12 | | | | | | | | | | | | |
| 27-Apr | | | | | -12 | | | | | | | | | | | | |
| 28-Apr | | | | | -12 | | | | | | | | | | | | |
| 29-Apr | | | | | -12 | | | | | | | | | | | | |
| 30-Apr | | | | | -12 | | | | | | | | | | | | |
| 1-May | | | | | -8 | | | | | | | | | | | | |
| 2-May | | | | | -8 | | | | | | | | | | | | |
| 3-May | | | 10.42 | 1.0 | -8 | | | | | 0 | 0 | 1 | 1 | 0.10 | 0.10 | 0.002 | 0.002 |
| 4-May | | | 23.92 | 1.0 | -12 | | | | | 0 | 0 | 0 | 1 | 0.00 | 0.10 | 0.000 | 0.002 |
| 5-May | | | 23.50 | 1.0 | 2 | 1 | 1 | 6 | 6 | 7 | 7 | 7 | 8 | 0.30 | 0.39 | 0.006 | 0.008 |
| 6-May | | | 23.50 | 1.1 | 2 | 2 | 3 | 2 | 8 | 4 | 11 | 4 | 12 | 0.17 | 0.56 | 0.004 | 0.012 |
| 7-May | | | 23.75 | 0.9 | 0 | 1 | 4 | 2 | 10 | 3 | 14 | 3 | 15 | 0.13 | 0.69 | 0.003 | 0.015 |
| 8-May | | | 23.92 | 0.8 | -3 | 0 | 4 | 0 | 10 | 0 | 14 | 0 | 15 | 0.00 | 0.69 | 0.000 | 0.015 |
| 9-May | | | 23.92 | 0.5 | -6 | 0 | 4 | 1 | 11 | 1 | 15 | 1 | 16 | 0.04 | 0.73 | 0.001 | 0.015 |
| 10-May | | | 23.92 | 0.5 | -8 | 1 | 5 | 1 | 12 | 2 | 17 | 2 | 18 | 0.08 | 0.82 | 0.002 | 0.017 |
| 11-May | | | 22.50 | 0.6 | -7 | 0 | 5 | 0 | 12 | 0 | 17 | 0 | 18 | 0.00 | 0.82 | 0.000 | 0.017 |
| 12-May | | | 23.92 | 0.8 | -3 | 0 | 5 | 1 | 13 | 1 | 18 | 1 | 19 | 0.04 | 0.86 | 0.001 | 0.018 |
| 13-May | | | 24.00 | 1.4 | -5 | 0 | 5 | 0 | 13 | 0 | 18 | 0 | 19 | 0.00 | 0.86 | 0.000 | 0.018 |
| 14-May | | | 23.08 | 1.7 | 14 | 1 | 6 | 17 | 30 | 18 | 36 | 18 | 37 | 0.78 | 1.64 | 0.016 | 0.035 |
| 15-May | | | 23.00 | 1.8 | 20 | 3 | 9 | 23 | 53 | 27 | 63 | 30 | 67 | 1.30 | 2.94 | 0.028 | 0.062 |
| 16-May | 5.00 | 2.0 | 23.00 | 2.1 | 25 | 2 | 11 | 15 | 68 | 18 | 81 | 20 | 87 | 0.71 | 3.66 | 0.015 | 0.077 |
| 17-May | 23.67 | 2.2 | 8.83 | 2.1 | 29 | 4 | 15 | 9 | 77 | 13 | 94 | 13 | 100 | 0.40 | 4.06 | 0.008 | 0.086 |
| 18-May | 23.50 | 2.2 | 6.00 | 1.5 | 31 | 2 | 17 | 7 | 84 | 9 | 103 | 10 | 110 | 0.34 | 4.40 | 0.007 | 0.093 |
| 19-May | 23.67 | 2.3 | 23.08 | 1.6 | 34 | 7 | 24 | 23 | 107 | 30 | 133 | 30 | 140 | 0.64 | 5.04 | 0.014 | 0.106 |
| 20-May | 23.42 | 2.3 | 21.50 | 2.2 | 41 | 4 | 28 | 20 | 127 | 24 | 157 | 26 | 166 | 0.58 | 5.62 | 0.012 | 0.118 |
| 21-May | 23.75 | 2.2 | 15.33 | 2.2 | 47 | 5 | 33 | 14 | 141 | 19 | 176 | 20 | 186 | 0.51 | 6.13 | 0.011 | 0.129 |
| 22-May | 22.25 | 2.6 | 22.58 | 2.3 | 51 | 7 | 40 | 11 | 152 | 18 | 194 | 19 | 205 | 0.42 | 6.55 | 0.009 | 0.138 |
| 23-May | 22.92 | 3.0 | 7.83 | - | 61 | 6 | 46 | 14 | 166 | 20 | 214 | 24 | 229 | 0.78 | 7.33 | 0.016 | 0.155 |
| 24-May | 22.83 | 2.9 | 0.00 | - | 65 | 11 | 57 | 18 | 184 | 29 | 243 | 29 | 258 | 1.27 | 8.60 | 0.027 | 0.181 |
| 25-May | 22.50 | 2.9 | 6.50 | 2.6 | 66 | 11 | 68 | 25 | 209 | 36 | 279 | 37 | 295 | 1.28 | 9.88 | 0.027 | 0.208 |
| 26-May | 22.92 | 2.6 | 21.75 | 2.2 | 61 | 29 | 97 | 54 | 263 | 83 | 362 | 86 | 381 | 1.93 | 11.80 | 0.041 | 0.249 |
| 27-May | 23.58 | 2.3 | 23.08 | 2.4 | 61 | 10 | 107 | 21 | 284 | 31 | 393 | 32 | 413 | 0.69 | 12.49 | 0.014 | 0.263 |
| 28-May | 23.67 | 2.2 | 23.25 | 1.9 | 54 | 3 | 110 | 11 | 295 | 14 | 407 | 16 | 429 | 0.34 | 12.83 | 0.007 | 0.271 |
| 29-May | 23.50 | 2.1 | 23.25 | 2.2 | 56 | 7 | 117 | 11 | 306 | 18 | 425 | 18 | 447 | 0.39 | 13.21 | 0.008 | 0.279 |
| 30-May | 22.83 | 2.8 | 22.08 | 2.6 | 64 | 8 | 125 | 45 | 351 | 54 | 479 | 55 | 502 | 1.22 | 14.44 | 0.026 | 0.305 |
| 31-May | 21.50 | 3.1 | 21.33 | 2.5 | 72 | 39 | 164 | 103 | 454 | 143 | 622 | 151 | 653 | 3.53 | 17.97 | 0.074 | 0.379 |
| 1-Jun | 21.83 | 3.3 | 22.08 | 2.6 | 78 | 32 | 196 | 75 | 529 | 107 | 729 | 115 | 768 | 2.62 | 20.58 | 0.055 | 0.434 |
| 2-Jun | 23.08 | 3.4 | 22.50 | 3.0 | 86 | 16 | 212 | 45 | 574 | 61 | 790 | 63 | 831 | 1.38 | 21.97 | 0.029 | 0.463 |

-continued-

Appendix A1.–(Page 2 of 2)

| | Fish wheel #1 | | Fish wheel #2 | | | Fish wheels combined | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Hours fished | RPM | Hours fished | RPM | Water level (in.) | Tagged medium daily | Tagged medium cum. | Tagged large daily | Tagged large cum. | Total tagged daily | Tagged cum. | Total catch daily | Total catch cum. | CPUE daily | CPUE cum. | Daily prop. | Cum. prop. |
| 3-Jun | 23.08 | 3.0 | 16.25 | 3.2 | 98 | 17 | 229 | 66 | 640 | 83 | 873 | 88 | 919 | 2.24 | 24.20 | 0.047 | 0.510 |
| 4-Jun | 23.08 | 3.0 | 4.00 | 3.4 | 102 | 6 | 235 | 28 | 668 | 34 | 907 | 35 | 954 | 1.29 | 25.50 | 0.027 | 0.538 |
| 5-Jun | 22.75 | 2.5 | 13.67 | 2.9 | 98 | 17 | 252 | 46 | 714 | 63 | 970 | 68 | 1,022 | 1.87 | 27.36 | 0.039 | 0.577 |
| 6-Jun | 22.67 | 2.7 | 21.83 | 3.0 | 94 | 21 | 273 | 61 | 775 | 82 | 1,052 | 94 | 1,116 | 2.11 | 29.48 | 0.045 | 0.622 |
| 7-Jun | 22.25 | 2.6 | 21.25 | 2.7 | 88 | 35 | 308 | 49 | 824 | 85 | 1,137 | 89 | 1,205 | 2.05 | 31.52 | 0.043 | 0.665 |
| 8-Jun | 22.58 | 3.0 | 22.00 | 2.8 | 87 | 39 | 347 | 67 | 891 | 107 | 1,244 | 113 | 1,318 | 2.53 | 34.06 | 0.053 | 0.718 |
| 9-Jun | 17.00 | 2.7 | 22.00 | 2.8 | 81 | 22 | 369 | 51 | 942 | 74 | 1,318 | 80 | 1,398 | 2.05 | 36.11 | 0.043 | 0.761 |
| 10-Jun | 22.92 | 2.6 | 23.16 | 2.6 | 74 | 16 | 385 | 16 | 958 | 32 | 1,350 | 37 | 1,435 | 0.80 | 36.91 | 0.017 | 0.778 |
| 11-Jun | 23.33 | 2.5 | 21.42 | 2.8 | 67 | 24 | 409 | 48 | 1,006 | 72 | 1,422 | 78 | 1,513 | 1.74 | 38.65 | 0.037 | 0.815 |
| 12-Jun | 23.16 | 2.5 | 22.92 | 2.4 | 61 | 13 | 422 | 24 | 1,030 | 37 | 1,459 | 41 | 1,554 | 0.89 | 39.54 | 0.019 | 0.834 |
| 13-Jun | 23.75 | 2.4 | 20.83 | 2.5 | 57 | 10 | 432 | 20 | 1,050 | 30 | 1,489 | 30 | 1,584 | 0.67 | 40.22 | 0.014 | 0.848 |
| 14-Jun | 20.67 | 2.0 | 23.25 | 2.0 | 50 | 4 | 436 | 13 | 1,063 | 17 | 1,506 | 19 | 1,603 | 0.43 | 40.65 | 0.009 | 0.857 |
| 15-Jun | 23.75 | 2.2 | 23.08 | 2.0 | 46 | 1 | 437 | 5 | 1,068 | 6 | 1,512 | 7 | 1,610 | 0.15 | 40.80 | 0.003 | 0.860 |
| 16-Jun | 23.42 | 2.1 | 22.92 | 2.3 | 46 | 6 | 443 | 11 | 1,079 | 18 | 1,530 | 21 | 1,631 | 0.45 | 41.25 | 0.010 | 0.870 |
| 17-Jun | 22.33 | 2.1 | 23.00 | 2.7 | 49 | 5 | 448 | 7 | 1,086 | 12 | 1,542 | 13 | 1,644 | 0.29 | 41.54 | 0.006 | 0.876 |
| 18-Jun | 23.42 | 2.1 | 22.83 | 2.8 | 54 | 9 | 457 | 13 | 1,099 | 22 | 1,564 | 26 | 1,670 | 0.56 | 42.10 | 0.012 | 0.888 |
| 19-Jun | 23.33 | 2.6 | 22.00 | 2.7 | 60 | 1 | 458 | 21 | 1,120 | 22 | 1,586 | 26 | 1,696 | 0.57 | 42.67 | 0.012 | 0.900 |
| 20-Jun | 23.58 | 2.6 | 23.67 | 2.5 | 66 | 2 | 460 | 2 | 1,122 | 4 | 1,590 | 4 | 1,700 | 0.08 | 42.76 | 0.002 | 0.902 |
| 21-Jun | 23.33 | 2.5 | 23.67 | 2.7 | 70 | 2 | 462 | 5 | 1,127 | 7 | 1,597 | 7 | 1,707 | 0.15 | 42.91 | 0.003 | 0.905 |
| 22-Jun | 19.33 | 2.8 | 22.16 | 2.7 | 79 | 4 | 466 | 11 | 1,138 | 16 | 1,613 | 17 | 1,724 | 0.41 | 43.32 | 0.009 | 0.914 |
| 23-Jun | 22.92 | 2.9 | 23.00 | 2.6 | 87 | 0 | 466 | 9 | 1,147 | 9 | 1,622 | 10 | 1,734 | 0.22 | 43.54 | 0.005 | 0.918 |
| 24-Jun | 19.58 | 2.6 | 22.16 | 3.0 | 93 | 3 | 469 | 8 | 1,155 | 12 | 1,634 | 15 | 1,749 | 0.36 | 43.89 | 0.008 | 0.926 |
| 25-Jun | 16.92 | 2.8 | 21.92 | 2.8 | 96 | 2 | 471 | 10 | 1,165 | 12 | 1,646 | 14 | 1,763 | 0.36 | 44.26 | 0.008 | 0.933 |
| 26-Jun | 22.67 | 2.8 | 23.33 | 2.7 | 97 | 2 | 473 | 6 | 1,171 | 8 | 1,654 | 10 | 1,773 | 0.22 | 44.47 | 0.005 | 0.938 |
| 27-Jun | 22.67 | 3.0 | 23.25 | 2.8 | 91 | 0 | 473 | 6 | 1,177 | 6 | 1,660 | 6 | 1,779 | 0.13 | 44.60 | 0.003 | 0.941 |
| 28-Jun | 23.25 | 2.9 | 23.33 | 2.7 | 88 | 0 | 473 | 9 | 1,186 | 9 | 1,669 | 9 | 1,788 | 0.19 | 44.80 | 0.004 | 0.945 |
| 29-Jun | 22.08 | 2.4 | 23.33 | 2.7 | 78 | 4 | 477 | 4 | 1,190 | 8 | 1,677 | 9 | 1,797 | 0.20 | 44.99 | 0.004 | 0.949 |
| 30-Jun | 23.25 | 2.5 | 23.42 | 2.6 | 67 | 0 | 477 | 4 | 1,194 | 4 | 1,681 | 5 | 1,802 | 0.11 | 45.10 | 0.002 | 0.951 |
| 1-Jul | 23.00 | 2.4 | 22.58 | 2.5 | 67 | 0 | 477 | 2 | 1,196 | 2 | 1,683 | 3 | 1,805 | 0.07 | 45.17 | 0.001 | 0.953 |
| 2-Jul | 23.25 | 2.3 | 23.16 | 2.5 | 58 | 1 | 478 | 8 | 1,204 | 9 | 1,692 | 9 | 1,814 | 0.19 | 45.36 | 0.004 | 0.957 |
| 3-Jul | 23.42 | 2.0 | 23.25 | 2.2 | 51 | 3 | 481 | 5 | 1,209 | 8 | 1,700 | 11 | 1,825 | 0.24 | 45.60 | 0.005 | 0.962 |
| 4-Jul | 23.33 | 2.1 | 23.67 | 2.3 | 53 | 0 | 481 | 0 | 1,209 | 0 | 1,700 | 0 | 1,825 | 0.00 | 45.60 | 0.000 | 0.962 |
| 5-Jul | 23.16 | 2.6 | 23.50 | 2.9 | 61 | 4 | 485 | 2 | 1,211 | 6 | 1,706 | 6 | 1,831 | 0.13 | 45.73 | 0.003 | 0.964 |
| 6-Jul | 23.08 | 2.7 | 22.00 | 2.8 | 71 | 3 | 488 | 6 | 1,217 | 9 | 1,715 | 9 | 1,840 | 0.20 | 45.93 | 0.004 | 0.969 |
| 7-Jul | 22.50 | 2.8 | 22.67 | 2.6 | 65 | 1 | 489 | 9 | 1,226 | 10 | 1,725 | 11 | 1,851 | 0.24 | 46.17 | 0.005 | 0.974 |
| 8-Jul | 22.67 | 2.7 | 21.25 | 2.7 | 63 | 1 | 490 | 9 | 1,235 | 10 | 1,735 | 10 | 1,861 | 0.23 | 46.40 | 0.005 | 0.978 |
| 9-Jul | 22.25 | 2.7 | 22.67 | 2.7 | 64 | 1 | 491 | 6 | 1,241 | 8 | 1,743 | 7 | 1,868 | 0.16 | 46.55 | 0.003 | 0.982 |
| 10-Jul | 22.67 | 2.7 | 23.08 | 2.8 | 66 | 1 | 492 | 7 | 1,248 | 8 | 1,751 | 11 | 1,879 | 0.24 | 46.79 | 0.005 | 0.987 |
| 11-Jul | 23.25 | 3.0 | 22.92 | 2.9 | 67 | 0 | 492 | 3 | 1,251 | 3 | 1,754 | 6 | 1,885 | 0.13 | 46.92 | 0.003 | 0.990 |
| 12-Jul | 22.00 | 2.6 | 14.75 | 2.5 | 72 | 0 | 492 | 1 | 1,252 | 1 | 1,755 | 1 | 1,886 | 0.03 | 46.95 | 0.001 | 0.990 |
| 13-Jul | 22.92 | 2.6 | 0.00 | - | 71 | 2 | 494 | 1 | 1,253 | 2 | 1,757 | 3 | 1,889 | 0.13 | 47.08 | 0.003 | 0.993 |
| 14-Jul | 22.33 | 2.5 | 6.75 | 2.6 | 71 | 0 | 494 | 0 | 1,253 | 0 | 1,757 | 0 | 1,889 | 0.00 | 47.08 | 0.000 | 0.993 |
| 15-Jul | 22.33 | 2.6 | 21.67 | 2.5 | 67 | 0 | 494 | 1 | 1,254 | 1 | 1,758 | 1 | 1,890 | 0.02 | 47.10 | 0.000 | 0.993 |
| 16-Jul | 22.25 | 2.5 | 22.83 | 2.4 | 58 | 0 | 494 | 0 | 1,254 | 0 | 1,758 | 0 | 1,890 | 0.00 | 47.10 | 0.000 | 0.993 |
| 17-Jul | 23.16 | 2.5 | 23.08 | 2.7 | 60 | 0 | 494 | 1 | 1,255 | 1 | 1,759 | 1 | 1,891 | 0.02 | 47.13 | 0.000 | 0.994 |
| 18-Jul | 23.67 | 2.8 | 22.92 | 2.7 | 65 | 0 | 494 | 1 | 1,256 | 1 | 1,760 | 1 | 1,892 | 0.02 | 47.15 | 0.000 | 0.994 |
| 19-Jul | 23.08 | 2.9 | 22.58 | 2.6 | 65 | 0 | 494 | 1 | 1,257 | 1 | 1,761 | 1 | 1,893 | 0.02 | 47.17 | 0.000 | 0.995 |
| 20-Jul | 23.00 | 2.8 | 22.25 | 2.6 | 65 | 0 | 494 | 2 | 1,259 | 2 | 1,763 | 2 | 1,895 | 0.04 | 47.21 | 0.001 | 0.996 |
| 21-Jul | 22.42 | 2.6 | 21.75 | 2.7 | 62 | 0 | 494 | 0 | 1,259 | 0 | 1,763 | 1 | 1,896 | 0.02 | 47.24 | 0.000 | 0.996 |
| 22-Jul | 21.42 | 2.9 | 21.75 | 3.0 | 63 | 1 | 495 | 4 | 1,263 | 5 | 1,768 | 6 | 1,902 | 0.14 | 47.37 | 0.003 | 0.999 |
| 23-Jul | 21.92 | 2.8 | 19.00 | 2.2 | 69 | 0 | 495 | 0 | 1,263 | 0 | 1,768 | 0 | 1,902 | 0.00 | 47.37 | 0.000 | 0.999 |
| 24-Jul | 22.00 | 2.8 | 22.33 | 2.5 | 62 | 0 | 495 | 1 | 1,264 | 1 | 1,769 | 1 | 1,903 | 0.02 | 47.40 | 0.000 | 1.000 |
| 25-Jul | 22.16 | 3.0 | 22.75 | 2.7 | 66 | 0 | 495 | 0 | 1,264 | 0 | 1,769 | 0 | 1,903 | 0.00 | 47.40 | 0.000 | 1.000 |
| 26-Jul | 22.42 | 2.9 | 22.92 | 2.8 | 71 | 1 | 496 | 0 | 1,264 | 1 | 1,770 | 1 | 1,904 | 0.02 | 47.42 | 0.000 | 1.000 |

**Appendix A2.–Age composition by sex and age from samples aged from chinook salmon in the Taku River in 1996 by size group and location.**

| | | | AGE CLASS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.2 | 2.2 | 1.3 | 2.3 | 1.4 | 2.4 | 1.5 | Total |
| Nakina Large fish | Male | n | 9 | 1 | 283 | 5 | 31 | 2 | 2 | 333 |
| | | % | 2.7% | 0.3% | 85.0% | 1.5% | 9.3% | 0.6% | 0.6% | 54.9% |
| | Female | n | | | 196 | 10 | 66 | 1 | 1 | 274 |
| | | % | | | 71.5% | | 24.1% | 0.4% | 0.4% | 45.1% |
| | Total | n | 9 | 1 | 479 | 15 | 97 | 3 | 3 | 607 |
| | | % | 1.5% | 0.2% | 78.9% | 2.5% | 16.0% | 0.5% | 0.5% | |
| Nakina Medium fish | Male | n | 134 | 2 | 57 | 1 | | | | 194 |
| | | % | 69.1% | 1.0% | 29.4% | 0.5% | | | | 100.0% |
| | Female | n | | | | | | | | |
| | | % | | | | | | | | |
| | Total | n | 134 | 2 | 57 | 1 | | | | 194 |
| | | % | 69.1% | 1.0% | 29.4% | 0.5% | | | | |
| Nakina Large + medium | Male | n | 143 | 3 | 340 | 6 | 31 | 2 | 2 | 527 |
| | | % | 27.1% | 0.6% | 64.5% | 1.1% | 5.9% | 0.4% | 0.4% | 65.8% |
| | Female | n | 0 | 0 | 196 | 10 | 66 | 1 | 1 | 274 |
| | | % | 0.0% | 0.0% | 71.5% | 3.6% | 24.1% | 0.4% | 0.4% | 34.2% |
| | Total | n | 143 | 3 | 536 | 16 | 97 | 3 | 3 | 801 |
| | | % | 17.9% | 0.4% | 66.9% | 2.0% | 12.1% | 0.4% | 0.4% | |
| Nahlin Large fish | Male | n | 3 | 0 | 184 | 1 | 7 | 0 | 0 | 195 |
| | | % | 1.5% | 0.0% | 94.4% | 0.5% | 3.6% | 0.0% | 0.0% | 43.0% |
| | Female | n | 1 | 0 | 227 | 6 | 25 | 0 | 0 | 259 |
| | | % | | | 87.6% | | 9.7% | 0.0% | 0.0% | 57.0% |
| | Total | n | 4 | 0 | 411 | 7 | 32 | 0 | 0 | 454 |
| | | % | 0.9% | 0.0% | 90.5% | 1.5% | 7.0% | 0.0% | 0.0% | |
| Nahlin Medium fish | Male | n | 20 | 0 | 13 | 0 | | | | 33 |
| | | % | 60.6% | 0.0% | 39.4% | 0.0% | | | | 75.0% |
| | Female | n | 4 | | 7 | | | | | 11 |
| | | % | 36.4% | | 63.6% | | | | | 25.0% |
| | Total | n | 24 | 0 | 20 | 0 | | | | 44 |
| | | % | 54.5% | 0.0% | 45.5% | 0.0% | | | | |
| Nahlin Large + medium | Male | n | 23 | 0 | 197 | 1 | 7 | 0 | 0 | 228 |
| | | % | 10.1% | 0.0% | 86.4% | 0.4% | 3.1% | 0.0% | 0.0% | 45.8% |
| | Female | n | 5 | 0 | 234 | 6 | 25 | 0 | 0 | 270 |
| | | % | 1.9% | 0.0% | 86.7% | 2.2% | 9.3% | 0.0% | 0.0% | 54.2% |
| | Total | n | 28 | 0 | 431 | 7 | 32 | 0 | 0 | 498 |
| | | % | 5.6% | 0.0% | 86.5% | 1.4% | 6.4% | 0.0% | 0.0% | |
| Dudidontu Large fish | Male | n | 0 | 0 | 36 | 0 | 4 | 0 | 0 | 40 |
| | | % | 0.0% | 0.0% | 90.0% | 0.0% | 10.0% | 0.0% | 0.0% | 55.6% |
| | Female | n | | | 31 | 0 | 1 | 0 | 0 | 32 |
| | | % | | | 96.9% | | 3.1% | 0.0% | 0.0% | 44.4% |
| | Total | n | 0 | 0 | 67 | 0 | 5 | 0 | 0 | 72 |
| | | % | 0.0% | 0.0% | 93.1% | 0.0% | 6.9% | 0.0% | 0.0% | |
| Dudidontu Medium fish | Male | n | 1 | 0 | 2 | 0 | | | | 3 |
| | | % | 33.3% | 0.0% | 66.7% | 0.0% | | | | 100.0% |
| | Female | n | | | | | | | | 0 |
| | | % | | | | | | | | 0.0% |
| | Total | n | 1 | 0 | 2 | 0 | | | | 3 |
| | | % | 33.3% | 0.0% | 66.7% | 0.0% | | | | |
| Dudidontu Large + medium | Male | n | 1 | 0 | 38 | 0 | 4 | 0 | 0 | 43 |
| | | % | 2.3% | 0.0% | 88.4% | 0.0% | 9.3% | 0.0% | 0.0% | 57.3% |
| | Female | n | 0 | 0 | 31 | 0 | 1 | 0 | 0 | 32 |
| | | % | 0.0% | 0.0% | 96.9% | 0.0% | 3.1% | 0.0% | 0.0% | 42.7% |
| | Total | n | 1 | 0 | 69 | 0 | 5 | 0 | 0 | 75 |
| | | % | 1.3% | 0.0% | 92.0% | 0.0% | 6.7% | 0.0% | 0.0% | |

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**Appendix A2.–(Page 2 of 3)**

| | | | AGE CLASS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.2 | 2.2 | 1.3 | 2.3 | 1.4 | 2.4 | 1.5 | Total |
| Lower Tatsamenie | Male | n | 0 | 0 | 74 | 0 | 6 | 0 | 0 | 80 |
| Large fish | | % | 0.0% | 0.0% | 92.5% | 0.0% | 7.5% | 0.0% | 0.0% | 43.7% |
| | Female | n | | | 76 | 2 | 25 | 0 | 0 | 103 |
| | | % | | | 73.8% | | 24.3% | 0.0% | 0.0% | 56.3% |
| | Total | n | 0 | 0 | 150 | 2 | 31 | 0 | 0 | 183 |
| | | % | 0.0% | 0.0% | 82.0% | 1.1% | 16.9% | 0.0% | 0.0% | |
| Lower Tatsamenie | Male | n | 14 | 0 | 5 | 0 | | | | 19 |
| Medium fish | | % | 73.7% | 0.0% | 26.3% | 0.0% | | | | 100.0% |
| | Female | n | 0 | | 0 | | | | | 0 |
| | | % | | | | | | | | 0.0% |
| | Total | n | 14 | 0 | 5 | 0 | | | | 19 |
| | | % | 73.7% | 0.0% | 26.3% | 0.0% | | | | |
| Lower Tatsamenie | Male | n | 14 | 0 | 79 | 0 | 6 | 0 | 0 | 99 |
| Large + medium | | % | 14.1% | 0.0% | 79.8% | 0.0% | 6.1% | 0.0% | 0.0% | 49.0% |
| | Female | n | 0 | 0 | 76 | 2 | 25 | 0 | 0 | 103 |
| | | % | 0.0% | 0.0% | 73.8% | 1.9% | 24.3% | 0.0% | 0.0% | 51.0% |
| | Total | n | 14 | 0 | 155 | 2 | 31 | 0 | 0 | 202 |
| | | % | 6.9% | 0.0% | 76.7% | 1.0% | 15.3% | 0.0% | 0.0% | |
| Upper Tatsamenie | Male | n | 1 | 0 | 57 | 0 | 4 | 0 | 0 | 62 |
| Large fish | | % | 1.6% | 0.0% | 91.9% | 0.0% | 6.5% | 0.0% | 0.0% | 47.3% |
| | Female | n | 1 | 0 | 58 | 0 | 10 | 0 | 0 | 69 |
| | | % | 1.4% | 0.0% | 84.1% | | 14.5% | 0.0% | 0.0% | 52.7% |
| | Total | n | 2 | 0 | 115 | 0 | 14 | 0 | 0 | 131 |
| | | % | 1.5% | 0.0% | 87.8% | 0.0% | 10.7% | 0.0% | 0.0% | |
| Upper Tatsamenie | Male | n | 22 | 1 | 4 | 0 | | | | 27 |
| Medium fish | | % | 81.5% | 3.7% | 14.8% | 0.0% | | | | 90.0% |
| | Female | n | 0 | 0 | 2 | 1 | | | | 3 |
| | | % | 0.0% | | 66.7% | 33.3% | | | | 10.0% |
| | Total | n | 22 | 1 | 6 | 1 | | | | 30 |
| | | % | 73.3% | 3.3% | 20.0% | 3.3% | | | | |
| Upper Tatsamenie | Male | n | 23 | 1 | 61 | 0 | 4 | 0 | 0 | 89 |
| Large + medium | | % | 25.8% | 1.1% | 68.5% | 0.0% | 4.5% | 0.0% | 0.0% | 55.3% |
| | Female | n | 1 | 0 | 60 | 1 | 10 | 0 | 0 | 72 |
| | | % | 1.4% | 0.0% | 83.3% | 1.4% | 13.9% | 0.0% | 0.0% | 44.7% |
| | Total | n | 24 | 1 | 121 | 1 | 14 | 0 | 0 | 161 |
| | | % | 14.9% | 0.6% | 75.2% | 0.6% | 8.7% | 0.0% | 0.0% | |
| Kowatua | Male | n | 2 | 0 | 76 | 1 | 8 | 0 | 0 | 87 |
| Large fish | | % | 2.3% | 0.0% | 87.4% | 1.1% | 9.2% | 0.0% | 0.0% | 42.4% |
| | Female | n | | | 96 | 5 | 17 | 0 | 0 | 118 |
| | | % | | | 81.4% | | 14.4% | 0.0% | 0.0% | 57.6% |
| | Total | n | 2 | 0 | 172 | 6 | 25 | 0 | 0 | 205 |
| | | % | 1.0% | 0.0% | 83.9% | 2.9% | 12.2% | 0.0% | 0.0% | |
| Kowatua | Male | n | 27 | 3 | 11 | 0 | | | | 41 |
| Medium fish | | % | 65.9% | 7.3% | 26.8% | 0.0% | | | | 97.6% |
| | Female | n | 0 | | 1 | | | | | 1 |
| | | % | 0.0% | | 100.0% | | | | | 2.4% |
| | Total | n | 27 | 3 | 12 | 0 | | | | 42 |
| | | % | 64.3% | 7.1% | 28.6% | 0.0% | | | | |
| Kowatua | Male | n | 29 | 3 | 87 | 1 | 8 | 0 | 0 | 128 |
| Large + medium | | % | 22.7% | 2.3% | 68.0% | 0.8% | 6.3% | 0.0% | 0.0% | 51.8% |
| | Female | n | 0 | 0 | 97 | 5 | 17 | 0 | 0 | 119 |
| | | % | 0.0% | 0.0% | 81.5% | 4.2% | 14.3% | 0.0% | 0.0% | 48.2% |
| | Total | n | 29 | 3 | 184 | 6 | 25 | 0 | 0 | 247 |
| | | % | 11.7% | 1.2% | 74.5% | 2.4% | 10.1% | 0.0% | 0.0% | |

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**Appendix A2.–(Page 3 of 3)**

| | | | AGE CLASS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.2 | 2.2 | 1.3 | 2.3 | 1.4 | 2.4 | 1.5 | Total |
| **Canyon Island** | Male | n | 5 | 3 | 428 | 7 | 29 | 3 | 1 | 476 |
| Large fish | | % | 1.1% | 0.6% | 89.9% | 1.5% | 6.1% | 0.6% | 0.2% | 50.4% |
| **Tagged** | Female | n | | | 401 | 19 | 47 | 0 | 2 | 469 |
| | | % | | | 85.5% | | 10.0% | 0.0% | 0.4% | 49.6% |
| | Total | n | 5 | 3 | 829 | 26 | 76 | 3 | 3 | 945 |
| | | % | 0.5% | 0.3% | 87.7% | 2.8% | 8.0% | 0.3% | 0.3% | |
| **Canyon Island** | Male | n | 252 | 13 | 101 | 1 | | | | 367 |
| Medium fish | | % | 68.7% | 3.5% | 27.5% | 0.3% | | | | 98.9% |
| **Tagged** | Female | n | 1 | | 3 | | | | | 4 |
| | | % | 25.0% | | 75.0% | | | | | 1.1% |
| | Total | n | 253 | 13 | 104 | 1 | | | | 371 |
| | | % | 68.2% | 3.5% | 28.0% | 0.3% | | | | |
| **Canyon Island** | Male | n | 257 | 16 | 529 | 8 | 29 | 3 | 1 | 843 |
| Large + medium | | % | 30.5% | 1.9% | 62.8% | 0.9% | 3.4% | 0.4% | 0.1% | 64.1% |
| **Tagged** | Female | n | 1 | 0 | 404 | 19 | 47 | 0 | 2 | 473 |
| | | % | 0.2% | 0.0% | 85.4% | 4.0% | 9.9% | 0.0% | 0.4% | 35.9% |
| | Total | n | 258 | 16 | 933 | 27 | 76 | 3 | 3 | 1316 |
| | | % | 19.6% | 1.2% | 70.9% | 2.1% | 5.8% | 0.2% | 0.2% | |
| **All tributaries** | Male | n | 15 | 1 | 710 | 7 | 60 | 2 | 2 | 797 |
| Large fish | | % | 1.9% | 0.1% | 89.1% | 0.9% | 7.5% | 0.3% | 0.3% | 48.2% |
| **Inspected** | Female | n | 2 | 0 | 684 | 23 | 144 | 1 | 1 | 855 |
| | | % | | | 80.0% | | 16.8% | 0.1% | 0.1% | 51.8% |
| | Total | n | 17 | 1 | 1394 | 30 | 204 | 3 | 3 | 1652 |
| | | % | 1.0% | 0.1% | 84.4% | 1.8% | 12.3% | 0.2% | 0.2% | |
| **All tributaries** | Male | n | 218 | 6 | 92 | 1 | 0 | 0 | 0 | 317 |
| Medium fish | | % | 68.8% | 1.9% | 29.0% | 0.3% | | | | 95.5% |
| **Inspected** | Female | n | 4 | 0 | 10 | 1 | 0 | 0 | 0 | 15 |
| | | % | 26.7% | | 66.7% | | | | | 4.5% |
| | Total | n | 222 | 6 | 102 | 2 | | | | 332 |
| | | % | 66.9% | 1.8% | 30.7% | 0.6% | | | | |
| **All tributaries** | Male | n | 233 | 7 | 802 | 8 | 60 | 2 | 2 | 1114 |
| Large + medium | | % | 20.9% | 0.6% | 72.0% | 0.7% | 5.4% | 0.2% | 0.2% | 56.1% |
| **Inspected** | Female | n | 6 | 0 | 694 | 24 | 144 | 1 | 1 | 870 |
| | | % | 0.7% | 0.0% | 79.8% | 2.8% | 16.6% | 0.1% | 0.1% | 43.9% |
| | Total | n | 239 | 7 | 1496 | 32 | 204 | 3 | 3 | 1984 |
| | | % | 12.0% | 0.4% | 75.4% | 1.6% | 10.3% | 0.2% | 0.2% | |

**Appendix A3.–Computer files used to estimate the spawning abundance of chinook salmon in the Taku River in 1996.**

| File Name | Description |
|---|---|
| TAKUKI96.xls | Spreadsheet with chi-square tests, bootstrap setup and output, U.S. gillnet sampling, fish wheel catch and effort data. |
| 41TAKU96.exe | BASIC compiled program for bootstrapping abundance estimates to estimate variance and bias. |
| LGTAKU96.dat | Data file for large chinook for 41TAKU96.exe. |
| MDTAKU96.dat | Data file for medium-sized chinook for 41TAKU96.exe. |
| 96CI41SM.xls | Spreadsheet of chinook salmon caught and tagged at Canyon Island: tagging data; spaghetti tags recovered; age, sex and length data for chinook tagged. |
| 96DUDI41.xls | Spreadsheet of chinook salmon sampled for tag recovery on the Dudidontu River: fish inspected; tag recoveries; age, sex and length data; CWT recovery data. |
| 96KOWA41.xls | Spreadsheet of chinook salmon sampled for tag recovery on the Kowatua River: fish inspected; tag recoveries; age, sex and length data. |
| 96NAHLSM.xls | Spreadsheet of chinook salmon sampled for tag recovery at the Nahlin River live weir: fish inspected; tag recoveries; age, sex and length data; CWT recovery data. |
| 96NAKINA.xls | Spreadsheet of chinook salmon sampled for tag recovery at the Nakina River carcass weir: fish inspected; tag recoveries; age, sex and length data; CWT recovery data. |
| 96LTAT41.xls | Spreadsheet of chinook salmon sampled for tag recovery on the lower Tatsamenie River: fish inspected; tag recoveries; age, sex and length data. |
| 96UTAT41.xls | Spreadsheet of chinook salmon sampled for tag recovery on the upper Tatsamenie River: fish inspected; tag recoveries; age, sex and length data; CWT recovery data. |
| 41TAKU96.doc | WORD 6.0 (Windows) file of this FDS report. |