Spawning Abundance of Chinook Salmon in the Taku River in 2003

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March 2006

Pacific Salmon Commission
Technical Report No. 19

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Prepared for:

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Transboundary Technical Committee

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ABSTRACT

A cooperative study involving the Department of Fisheries and Oceans Canada, the Alaska Department of Fish and Game, and the Taku River Tlingit First Nation was conducted to estimate the number of spawning Chinook salmon *Oncorhynchus tshawytscha* in the Taku River in 2003 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. All tagged fish were also batch marked 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. The estimated spawning abundance of small Chinook salmon (< 400 mm long; mid-eye to fork of tail) was 3,489 (SE = 1,052). Spawning abundance of medium-size Chinook salmon (401–659 mm) was estimated to be 16,780 (SE = 2,274). Finally, spawning abundance of large-size fish (≥660 mm) was estimated to be 36,435 (SE = 6,705), and the estimated total of all fish was 56,704 (SE = 7,158). The sum of the peak aerial survey counts of large spawning Chinook salmon conducted at five index tributaries of the Taku River was 16% of the mark-recapture estimate. Age 1.3 fish (1998 brood year) constituted an estimated 40% of the spawning population, followed by age 1.2 fish (1999 brood year), which constituted an estimated 29% 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 British Columbia north of the Skeena River, and in Southeast Alaska (Pahlke and Bernard 1996; McPherson et al. 1997; Pahlke 1997). 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). As part of a program to rebuild stocks of Chinook salmon in northern British Columbia and Southeast Alaska, various restrictions were placed on all intercepting fisheries (troll, gillnet and recreational) beginning in 1976. This rebuilding effort has been combined with a coast-wide 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 a 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 1997). Only "large" Chinook salmon (typically 3-ocean age [age-.3] and older or approximately larger than 659 mm mid-eye to fork of tail [MEF]) 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 sufficient large Chinook salmon in the Taku River to estimate escapement (McGregor and Clark 1989). Information from tagging and radio-telemetry studies in 1989 and 1990 by the Commercial Fisheries Division (CFD), the Department of Fisheries and Oceans Canada (DFO), and the U.S. National Marine Fisheries Service (NMFS) was used to estimate the abundance of large Chinook salmon in the Taku River: 40,329 (SE = 5,646) in 1989 and 52,142 (SE = 9,326) in 1990 (Pahlke and Bernard 1996; Eiler et al. *personal communication*). Chinook salmon were captured in fish wheels at Canyon Island, well below the upriver spawning grounds where Chinook salmon were inspected for marks.

Chinook salmon from the Taku River are a "spring run" of salmon. Most returning adults are present in terminal marine areas from late April through early July, with a few present into August. Spawning occurs from late July to late September. Nearly all juveniles rear for one year in fresh water after emergence, smolt at age 1 (Kissner and Hubartt 1986), then rear in offshore waters where they are not subjected to exploitation by fisheries in Southeast Alaska. Returning adults have spent 1–5 years at sea, with younger fish (age-.1 and -.2) being mostly males, and the older fish (ages-.3, -.4 and -.5) being of both sexes. 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 2003 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 nearly 300 km downstream, emptying into the Taku Inlet about 30 km east of Juneau, Alaska. The Taku River drains approximately 17,094 km^2 of land (Bigelow et al. 1995). Two principal tributaries, the Inklin and the Nakina rivers, merge at 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 an average of 60 m^3/sec in February to 1,097 m^3/sec in June (Bigelow et al. 1995). The mainstem is glacially turbid; however, the tributaries where most Chinook salmon spawn are relatively clear waters, notably the Nahlin, Nakina, Tatsamenie, Dudidontu and Hackett rivers, and Kowatua Creek.

Canyon Island

Adult Chinook salmon were captured using two fish wheels located at Canyon Island, approximately 4 km downstream from the International border (Figure 1). The two fish wheels were approximately 200 m apart on the opposite banks. These fish wheel sites have been in use since 1984. Fish wheel configurations and fish wheel operations are discussed in detail in Kelley and Milligan (1999).

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 May 20 through early October for sampling Chinook, sockeye (*O. nerka*), and coho (*O. Kisutch*) salmon except during extreme high or low water levels and during maintenance or sampling (Appendix A1).

In order to supplement fish wheel catches a gillnet (5 3/8 or 7 ¼ stretched mesh) was set in an eddy just downstream of the lower fish wheel site. This net was fished up to six hours per day when fish wheels were not operational due to low water or maintenance, or when fish wheel catches were low. The first and last days of gillnetting for Chinook salmon were 20 April and 12 June respectively (Appendix A2).

Individual fish were carefully removed from the gillnet or dipnetted from the fish wheel live boxes, and transferred to a tote or trough partially filled with river water where they were processed. Fish were handled with bare hands to prevent injury. While one person held the fish, another took samples and measurements, and a third recorded data. Length was measured to the nearest mm MEF, and gender determined from inspection of external characteristics. Four scales from every fourth fish handled were taken from the "preferred area," consistent with procedures described by Welander (1940).

Scales were mounted onto gummed cards which held scales from 10 fish. The age of each fish was determined later from annual growth patterns of circuli (Olsen 1992) on images of scales impressed onto acetate magnified 70× (Clutter and Whitesel 1956). In cooperation with another project, the presence or absence of an adipose fin was noted for each fish sampled.

All captured Chinook salmon judged uninjured were 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 2¼″ section of laminated plastic tubing shrunk onto a 15″ piece of 80-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 by crimping both ends of the monofilament in a line crimp. Excess monofilament was trimmed. Each tag was individually numbered and stamped with a contact phone number.

As secondary marks, each fish was batch marked by a $^{5}/_{16}$″ hole punched in the upper one-third of the left operculum (UOP) and by excision of the left axillary appendage (LAA).

Sampling on the Spawning Grounds

In 2003, Chinook salmon from Tseta and Kowatua creeks, and the Nahlin, Dudidontu, Nakina, and Tatsatua (Tatsamenie) rivers were sampled as representative stocks of early-, mid-, and late-season migrants (ADF 1951; Eiler et al.*, personal communication;* Pahlke and Bernard 1996). A carcass weir was used to obtain samples on the Nakina River from 1 August to 21 August. Angling was conducted to obtain samples from 28 July to 31 July on the Nahlin River; on 3 August on Tseta Creek; from 3 August to 6 August on the Dudidontu River; and from 30 August to 18 September on the upper Tatsamenie River (Tatsatua system). Carcass weirs were used on the lower Tatsamenie River and Kowatua Creek from 27 August to 8 September and 19 August to 10 September respectively. On the lower Tatsamenie River, additional samples were obtained through angling; on Kowatua Creek, additional samples (post-spawn) were obtained using spears. Sampled fish 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 (secondary marks) and for the absence of the adipose fin, then measured to the nearest millimeter MEF. Scale samples were taken from a systematically drawn subset of inspected fish from each tributary according to procedures described above for Canyon Island.

Sampling Inriver Fisheries

Chinook were also sampled in three riverine gillnet fisheries located upstream of Canyon Island and the International border. These were: a scientific or "test" fishery designed to provide inseason estimates of Chinook salmon abundance; an Aboriginal Food, Social and Ceremonial (FSC) fishery; and a directed commercial fishery for sockeye salmon. The test fishery was conducted from 29 April to 11 June; gillnet mesh size was 7¼". The Aboriginal fishery took place from approximately 18 May to 6 June. The commercial fishery commenced on June 15 and continued through September. Both the Aboriginal and commercial fisheries deployed gillnets with a maximum mesh size of maximum mesh size of $5^7/_8$ inches.

Abundance by Size

Abundance on the spawning grounds of "small" (≤401 mm MEF), "medium" (401–659 mm MEF) and "large" (≥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 and Vania 1961; Pahlke and Bernard 1996). Estimated abundance ($\hat{N}_i$) of small, medium and large fish on the spawning grounds was calculated as

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

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). Length distributions of small, medium and large fish tagged and released at Canyon Island were also compared with the length distributions of small, medium and large fish recaptured in all tributaries to detect potential size-selective sampling on the spawning grounds.

Estimated numbers of tagged small, 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 CFD of catches from the Alaska gillnet fishery in Taku Inlet/Stephens Passage was expanded by the fraction of the catch of Chinook salmon sampled (21.2% for 2003). No tags were recovered from a creel survey of the U.S. recreational fishery near Juneau (19.8% of the harvest was sampled); however, participants in this fishery voluntarily returned one tag. Two tags were voluntarily returned from the inriver recreational fishery in Canada. Sampling rates were 100% in the test fishery as well as in the component of the aboriginal fishery associated with this study. Because of a reward (CDN$5) for each tag returned from the inriver Canadian gillnet fishery, tags recovered from 101 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 described in Buckland and Garthwaite (1991). Small, medium and large Chinook salmon passing by Canyon Island were divided into seven capture histories (Table 1). The estimated number of fish passing 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 $\overline{\hat{N}}_i^*$ 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).

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 all sizes was estimated as $\hat{N} = \hat{N}_{ss} + \hat{N}_{ms} + \hat{N}_{ls}$. Confidence intervals for $\hat{N}$ and $v(\hat{N})$ were estimated as described above.

Age and Sex Composition

The proportion of the spawning population composed of a given age for small, medium or large fish was estimated as a binomial variable from fish sampled on the spawning grounds:

$$\hat{p}_{ij} = \frac{n_{ij}}{n_i} \qquad (3)$$

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.

Information taken at Canyon Island was not used to estimate age or sex composition of the spawning population, because fish wheels have been shown to selectively capture smaller salmon (Meehan and Vania 1961; Pahlke and Bernard 1996). Spawning ground samples were pooled, because investigations showed sampling on the spawning grounds had not been size-selective within a size group (McPherson et al. 1997). Sample variance was calculated as:

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

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

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

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

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

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

$$\hat{p}_j = \frac{\hat{N}_j}{\hat{N}} \qquad (7)$$

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

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

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 spawning ground samples were 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

A total of 1,330 Chinook of known size were caught at Canyon Island. Of these, 63 were small (≤400 mm MEF), 678 were medium-sized (401–659 mm MEF) and 589 were large (≥660 mm MEF). Ninety-five percent (95%) of catches occurred between 24 April and 29 June.

Of the 589 large (≥660 mm MEF) Chinook salmon caught at Canyon Island, 568 were tagged and released (Table 2). Of these, 442 were captured in gillnets (Appendix A2) and 126 (Appendix A1) were caught in fish wheels. One fish released from a gill net was recaptured in poor condition twenty-five days later. This fish was deemed unlikely to reach the spawning grounds and removed from the study.

Of the 678 medium (401-659 mm MEF) Chinook salmon caught at Canyon Island, 618 were tagged and released (Table 2). Of these, 388 were captured in gill nets (Appendix A2) and 230 were caught in fish wheels. One fish released from a gill net was recaptured in poor condition twelve days later. This fish was removed from the study. Fifty-seven (57) of the 63 small (≤400 mm MEF) Chinook salmon caught were also tagged; all but two of the tagged fish were captured in fish wheels.

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). In 2003, water levels and flows at Canyon Island generally remained lower than average. A strongly increasing trend was observed throughout May; a weaker, decreasing trend was observed throughout June. Major fluctuations were observed throughout the study.

Sampling on the spawning grounds has been selective towards smaller Chinook salmon. This is consistent with previous findings (McPherson et al. 1997, 1998). Cumulative density functions for both censored and uncensored marked fish were significantly larger than the corresponding function for fish recaptured on the spawning grounds (P=0.00; Figure 2 for censored fish). This is a result of the large number of samples from the carcass weir on the Nakina River, which is biased towards capturing younger and smaller fish. Because the Nakina River represents a considerable amount of the production in the Taku River, estimates of abundance were stratified by size class to retain samples from the Nakina River in the analyses. Separate comparisons of length distributions for medium and large Chinook salmon showed that size-selective sampling was not significant within each size group (P=0.64, P=0.16 and P=0.16, Figures 3, 4 and 5). Note that only removals of known length were censored from the analyses.

In 2003, the estimated spawning abundance of small-sized Chinook salmon $\hat{N}_{ms}$ was 3,489 (SE = 1,052). This is based on 795 fish inspected for marks ($=C_{ms}$) at five tributaries, 12 of which were recaptured fish ($=R_{ms}$) (Table 2). One (8.3%) of the small-sized fish recaptured had lost its primary tag. Fisheries censored an estimated one (1.8%) tagged fish ($=\hat{H}_{ms}$), making the estimated number of small-sized tagged fish that survived to spawn 56 ($=\hat{M}_{ms}$). The fractions of marked fish across the different tributaries (Table 2) did not differ significantly, indicating that the Petersen estimator based on data pooled across tributaries is a consistent estimator for the mark-recapture experiment (χ^2 = 0.2, df = 4, P = 1.00). Estimated abundance of small-sized fish has a 95% confidence interval of 2,387 to 6,161, with an estimated relative bias of 7.3%.

The estimated spawning abundance of medium-sized Chinook salmon $\hat{N}_{ms}$ was 16,780 (SE = 2,274). This is based on 1,646 fish inspected for marks ($=C_{ms}$) at seven tributaries, 52 of which were recaptured fish ($=R_{ms}$) (Table 2). None of the medium-sized fish inspected had lost its primary tag. Fisheries censored an estimated 79 (12.8%) tagged fish ($=\hat{H}_{ms}$), making the estimated number of medium-sized tagged fish that survived to spawn 539 ($=\hat{M}_{ms}$). The fractions of marked fish across the different tributaries (Table 2) did not differ significantly, indicating that the Petersen estimator based on data pooled across tributaries is a consistent estimator for the mark-recapture experiment (χ^2 = 8.7, df = 7, P = 0.15). Estimated abundance of medium-sized fish has a 95% confidence interval of 13,118 to 22,297, with an estimated relative bias of 0.4%.

Estimated abundance of large Chinook salmon $\hat{N}_{ls}$ on the spawning grounds in 2003 was 36,435 (SE = 6,705). This estimate is based on 2,151 fish inspected for marks ($=C_{ls}$) in seven tributaries, 28 of which were recaptured fish ($=R_{ls}$) (Table 2). One (3.6%) of the 28 recaptured large fish had lost its primary tag (this was observed at Nakina carcass weir), but was detected as a tagged fish from its secondary marks.

Fisheries censored an estimated 78 (13.7%) tagged fish ($=\hat{H}_{ls}$) making the estimated number of large tagged fish that survived to spawn 490 ($=\hat{M}_{ls}$). Similarities in the marked fractions among fish inspected in the different tributaries indicate that the Petersen estimator based on data pooled across tributaries is a consistent estimator for the mark-recapture experiment (χ^2 = 6.4, df = 6, P = 0.38). Estimated abundance of large fish has a 95% confidence interval of 25,627 to 50,849 and an estimated relative bias of 2.0%.

The estimated abundance of all Chinook salmon ($\hat{N} = \hat{N}_{ss} + \hat{N}_{ms} + \hat{N}_{ls}$) on the spawning grounds for 2003 was 56,704 (SE = 7,158). The estimated 95% confidence interval for $\hat{N}$ was 45,284 to 72,641.

Estimates of Age and Sex Composition

Age-1.3 fish were the most abundant Chinook salmon on the spawning grounds of the Taku River in 2003. They constituted 40.0% (SE = 2.8%) of the estimated escapement (Table 3). Age-1.2 fish constituted 28.8% (SE = 3.6%), of the estimated escapement and age-1.4 fish constituted 22.4% (SE = 1.9%). Age data from specific locations is presented in Appendix 3.

The sex composition of the estimated escapement was 66.2% (SE = 2.8%) male (Table 3). All small fish were male, and 96.1% were age-1.1. Males accounted for more than 99% of medium fish, 84.9% of which were age 1.2.

Slightly more than half (52.3%) of large fish were female and 1.3 fish accounted for 58.9% of large fish.

Of the large fish sampled at Canyon Island, 60.9% were age-1.3 fish and 34.7% were age-1.4 fish. Amongst medium fish sampled, 91.0% were age-1.2 and 4.8% were age-1.3 fish. Within size groups, the age compositions from samples taken at Canyon Island are very close to those from the combined tributary samples.

DISCUSSION

Inriver fisheries were not used as part of the mark-recapture experiment to estimate abundance because marked fractions in their catches did not represent those in the population. Although marked fractions in the test fishery were similar to those observed on the spawning grounds ($\chi2$ = 0.38, 2.18; df = 2; P = 0.538, 0.140 for large and medium-sized fish respectively), commercial fishery marked fractions were significantly higher ($\chi2$ = 12.93, 8.01; df = 2; P = 0.003, 0.005).

Differences in marked fractions between fisheries is likely due to the timing of the fisheries and sulking behavior of handled Chinook salmon. Such behavior has been reported elsewhere (Bendock and Alexandersdottir 1993; Bernard et al. 1999) and has been observed in this project in previous years (McPherson et al. 1998). Handled Chinook salmon, particularly early migrants, have a tendency to delay their upstream migration. Consequently, the test fishery had a lower marked fraction than the commercial fishery because it took place earlier (May until mid-June). This also was the case for the aboriginal fishery.

Pooling data from test, aboriginal and commercial fisheries would lessen the effect from sulking fish on the marked fraction, but not eliminate it. These fisheries used different mesh sizes and different amounts of fishing effort. This means that weighted sums, not simple sums, would be needed when pooling data. The weights would be related to the effective fishing effort in hours as adjusted for different mesh sizes between test and commercial fisheries. Since these weights must be estimated, their use would contribute additional uncertainty to an estimate of abundance. Considering that sampling on the spawning grounds did not require any weighting at all, data from fisheries were not used to estimate abundance.

In contrast to the fisheries, the marked fraction did not vary significantly across the different spawning areas. This indicates that tag application (less fishery removals) was not biased spatially across the tributaries examined. Although these tributaries are only a sub-set of those that support Taku River Chinook salmon, they support the earliest through the latest fish to pass Canyon Island (ADF 1951; Eiler et al. *personal communication.*) Therefore, the estimates of abundance pertain to all Chinook salmon spawning in the Taku River watershed.

Censorship of intercepted fish was incomplete, because there were only minimal estimates of the number caught in recreational fisheries. However, considering that no tags were found when 20% of the spring harvest in the U.S. recreational fishery was inspected, and considering the size of the Canadian recreational harvest (<300 Chinook salmon), this bias from partial censoring should be negligible.

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. Regardless, the loss rate of primary tags was low – two out of 92 (2.2%) recoveries (a large male carcass at the Nakina River weir, and a small male carcass on the Tatsatua River).

In estimating abundance and age and sex composition for the watershed, we presumed that our combined tributary sample within each size group was 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.

The aerial survey counts of five index areas in 2003 of 5,581 represented 16% of the abundance estimated from the mark-recapture experiment. Details can be found in Pahlke 2005.

CONCLUSION AND RECOMMENDATIONS

Since this project is to continue, we recommend that a greater number of large Chinook salmon should be tagged to maintain or improve the precision of the estimate. To this end, fish wheel catches should continue to be supplemented with seine or gillnet gear during periods of low abundance or low water levels. Net gear has been used successfully to capture Chinook salmon without harm in projects on the Chilkat, Unuk, Chickamin, Alsek, and Kenai rivers. We also recommend escapement goals for Taku River Chinook salmon be examined in the near future to reflect the knowledge gained from recent spawning escapements.

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Table 1.–Capture histories for small, medium and large Chinook salmon in the population spawning in the Taku River in 2003.

Capture history	Small	Medium	Large	Source of Statistics
Marked, but censored in recreational fisheries	1	1	2	Returned
Marked, but censored in the U.S. marine commercial fishery	0	4	16	Observed/0.25
Marked, but censored in the Canadian inriver commercial, test and aboriginal fisheries	0	73	59	Returned
Marked and not sampled in tributaries	44	487	462	$\hat{M}_i - R_i$
Marked and recaptured in tributaries	12	52	28	R_i
Not marked, but captured in tributaries	783	1,594	2,123	$C_i - R_i$
Not marked and not sampled in tributaries	2,650	14,647	33,822	$\hat{N}_i - \hat{M}_i - C_i + R_i$
Effective population for simulations	3,490	16,858	36,512	$\hat{N}_i^+$

Table 2.–Numbers of Chinook salmon marked at Canyon Island, removed by fisheries and inspected for marks in tributaries and fisheries in 2003 by size group.

		Small 0-400 mm	Medium 401-659 mm	Large ≥660 mm	Total
EVENT 1 - FISH MARKED WITH SPAGHETTI TAGS AT CANYON ISLAND					
A. Total Initially Tagged		57	618	568	1,243
1. Captured using Fishwheels		55	230	126	411
2. Captured using Set Gillnets		2	388	442	832
B. Total Removals by:		1	79	78	158
1. Sport Fisheries [a]		1	1	2	4
2. U.S. Commercial Fishery [b]		0	4	16	20
Gillnet		0	4	16	20
Troll		0	0	0	0
3. Total Canadian Fisheries		0	73	59	132
Test Fishery		0	7	15	22
Aboriginal Fishery		0	6	3	9
Commercial Fishery		0	60	41	101
4. Recaptured as Mortality at Canyon Island FW/GN[c]		0	1	1	2
C. Final Total Tagged in Event 1 (n_1)		**56**	**539**	**490**	1,085
EVENT 2 - FISH INSPECTED FOR SPAGHETTI TAGS					
A. Upper River (All Spawning Grounds)	Inspected	795	1,646	2,151	4,592
	Marked	12	52	28	92
	Marked/Inspected	0.02	0.03	0.01	0.02
1. Nahlin River	Inspected	1	54	228	283
	Marked	0	4	3	7
	Marked/Inspected	0.00	0.07	0.01	0.02
2. Nakina River	Inspected	620	1,152	906	2,678
	Marked	9	37	14	60
	Marked/Inspected	0.01	0.03	0.02	0.02
3. Lower Tatsamenie (Tatsatua River)	Inspected	170	339	515	1,024
	Marked	3	7	7	17
	Marked/Inspected	0.02	0.02	0.01	0.02
4. Upper Tatsamenie (Tatsatua River)	Inspected	3	15	8	26
	Marked	0	0	0	0
	Marked/Inspected	0.00	0.00	0.00	0.00
5. Dudidontu River	Inspected	0	20	234	254
	Marked	0	2	1	3
	Marked/Inspected		0.10	0.00	0.01
6. Kowatua Creek	Inspected	1	55	214	270
	Marked	0	1	1	2
	Marked/Inspected	0.00	0.02	0.00	0.01
7. Tseta Creek	Inspected	0	11	46	57
	Marked	0	1	2	3
	Marked/Inspected		0.09	0.04	0.05
B. Lower River Canadian Fisheries (Test, Aboriginal and Commercial)	Inspected	11	1,785	3,010	4,806
	Marked	0	75	59	134
	Marked/Inspected	0.00	0.04	0.02	0.03

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Table 2.–Page 2 of 2.

		Small 0-400 mm	Medium 401-659 mm	Large ≥660 mm	Total
1. Test Fishery	Inspected	3	395	1,401	1,799
	Marked	0	7	15	22
	Marked/Inspected	0.00	0.02	0.01	0.01
2. Aboriginal Fishery	Inspected	0	218	259	477
	Marked	0	6	3	9
	Marked/Inspected		0.03	0.01	0.02
3. Commercial Fishery	Inspected	8	1,172	1,350	2,522
	Marked	0	60	41	103
	Marked/Inspected	0.00	0.05	0.03	0.04

[a] One from U.S. sport fishery and three from Canadian sport fishery (Nakina and Nahlin rivers).

[b] Estimated by expanding random recoveries in the U.S. gillnet fishery District 111 (Taku Inlet/Stephens Passage); in this fishery approximately 25% of Chinook salmon harvested in this fishery were sampled, yielding four large and one medium tagged Chinook salmon.

[c] Includes one medium and one large fish recaptured at Canyon Island in poor condition and deemed unlikely to reach the spawning grounds

Table 3.–Estimated abundance and composition by age, sex, and size class of the spawning population of Chinook salmon in the Taku River in 2003.

PANEL A: AGE AND SEX COMPOSITION OF SMALL CHINOOK SALMON											
		Brood year and age class									
		2000	1999	1999	1998	1998	1997	1997	1996	1996	
		1.1	2.1	1.2	2.2	1.3	2.3	1.4	1.5	2.4	**Total[a]**
Males	n	221	1	8							**230**
	%	96.1%	0.4%	3.5%							**100.0%**
	SE of %	1.3%	0.4%	1.2%							**0.0%**
	Escapement	3,352	15	121							**3,489**
	SE of Esc.	1,012	15	54							**1,052**
Females	n										**0**
	%										**0.0%**
	SE of %										**0.0%**
	Escapement										**0**
	SE of Esc.										**0**
Sexes Combined	n	221	1	8							**230**
	%	96.1%	0.4%	3.5%							**100.0%**
	SE of %	1.3%	0.4%	1.2%							**0.0%**
	Escapement	3,352	15	121							**3,489**
	SE of Esc.	1,012	15	54							**1,052**
PANEL B: AGE AND SEX COMPOSITION OF MEDIUM CHINOOK SALMON											
Males	n	48		596	1	53		5			**703**
	%	6.8%		84.3%	0.1%	7.5%		0.7%			**99.4%**
	SE of %	0.9%		1.4%	0.1%	1.0%		0.3%			**0.3%**
	Escapement	1,139		14,146	24	1,258		119			**16,685**
	SE of Esc.	220		1,930	24	237		55			**2,262**
Females	n			4							**4**
	%			0.6%							**0.6%**
	SE of %			0.3%							**0.3%**
	Escapement			95							**95**
	SE of Esc.			49							**49**
Sexes Combined	n	48		600	1	53		5			**707**
	%	6.8%		84.9%	0.1%	7.5%		0.7%			**100.0%**
	SE of %	0.9%		1.3%	0.1%	1.0%		0.3%			**0.0%**
	Escapement	1,139		14,240	24	1,258		119			**16,780**
	SE of Esc.	220		1,943	24	237		55			**2,274**

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Table 3.–Page 2 of 2.

		Brood year and age class									
		2000	1999	1999	1998	1998	1997	1997	1996	1996	
		1.1	2.1	1.2	2.2	1.3	2.3	1.4	1.5	2.4	**Total[a]**
PANEL C: AGE AND SEX COMPOSITION OF LARGE CHINOOK SALMON											
Males	n			63	2	392	6	194			**657**
	%			4.6%	0.1%	28.4%	0.4%	14.1%			**47.6%**
	SE of %			0.6%	0.1%	1.2%	0.2%	0.9%			**1.3%**
	Escapement			1,663	53	10,350	158	5,122			**17,346**
	SE of Esc.			366	38	1,954	70	1,000			**3,228**
Females	n			12	1	420	3	283	2	2	**723**
	%			0.9%	0.1%	30.4%	0.2%	20.5%	0.1%	0.1%	**52.4%**
	SE of %			0.3%	0.1%	1.2%	0.1%	1.1%	0.1%	0.1%	**1.3%**
	Escapement			317	26	11,089	79	7,472	53	53	**19,089**
	SE of Esc.			107	26	2,088	47	1,429	38	38	**3,546**
Sexes Combined	n			75	3	812	9	477	2	2	**1,380**
	%			5.4%	0.2%	58.8%	0.7%	34.6%	0.1%	0.1%	**100.0%**
	SE of %			0.6%	0.1%	1.3%	0.2%	1.3%	0.1%	0.1%	**0.0%**
	Escapement			1,980	79	21,439	238	12,594	53	53	**36,435**
	SE of Esc.			425	47	3,974	89	2,363	38	38	**6,705**
PANEL D: AGE AND SEX COMPOSITION OF SMALL, MEDIUM AND LARGE CHINOOK SALMON											
Males	n		1	667	3	445	6	199			**1,590**
	%	7.9%	0.0%	28.1%	0.1%	20.5%	0.3%	9.2%			**66.2%**
	SE of %	1.9%	0.0%	3.7%	0.1%	1.4%	0.1%	0.9%			**2.8%**
	Escapement	4,492	15	15,930	77	11,608	158	5,241			**37,520**
	SE of Esc.	1,035	15	1,966	45	1,968	70	1,002			**4,080**
Females	n			16	1	420	3	283	2	2	**727**
	%			0.7%	0.0%	19.6%	0.1%	13.2%	0.1%	0.1%	**33.8%**
	SE of %			0.2%	0.0%	1.7%	0.1%	1.3%	0.1%	0.1%	**2.8%**
	Escapement			412	26	11,089	79	7,472	53	53	**19,184**
	SE of Esc.			117	26	2,088	47	1,429	38	38	**3,546**
Sexes Combined	n	269	1	683	4	865	9	482	2	2	**2,317**
	%	7.9%	0.0%	28.8%	0.2%	40.0%	0.4%	22.4%	0.1%	0.1%	**100.0%**
	SE of %	1.9%	0.0%	3.6%	0.1%	2.8%	0.1%	1.9%	0.1%	0.1%	
	Escapement	4,492	15	16,342	103	22,696	238	12,713	53	53	**56,704**
	SE of Esc.	1,035	15	1,990	53	3,981	89	2,363	38	38	**7,158**

[a] Totals may not sum due to rounding.

Average length by age of fish sampled on the spawning grounds is presented in Table 4.

Table 4.–Estimated average length by age of the spawning population in the Taku River in 2003.

		Brood Year and age class								
		2000	1999		1998		1997		1996	
		1.1	2.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4
PANEL D. LENGTH COMPOSITION OF CHINOOK SALMON.										
Males	n	268	1	665	444	3	199	6		
	Average	375	375	579	747	698	873	802		
	SD	56		66	76	116	72	52		
	SE	3		3	4	67	5	21		
Females	n			16	419	1	282	3	2	2
	Average			719	768	760	824	753	858	803
	SD			75	42		40	23	74	11
	SE			19	2		2	13	52	7
Sexes	n	268	1	680	862	4	480	9	3	2
Combined	Average	375	375	583	757	714	845	785	775	803
	SD	56		70	62	100	61	49	74	11
	SE	3		3	2	50	3	16	43	7

Table 5.–Marked fractions of Chinook observed in commercial and test fisheries and on the spawning grounds in the Taku River in 2003.

LARGE	**Unmarked**	**Marked**	**Fraction Marked**
Spawning Grounds	2123	23	0.013
Test Fishery	1386	15	0.011
Commercial Fishery	1309	41	0.030

MEDIUM	**Unmarked**	**Marked**	**Fraction Marked**
Spawning Grounds	1594	52	0.032
Test Fishery	388	7	0.018
Commercial Fishery	1110	62	0.053

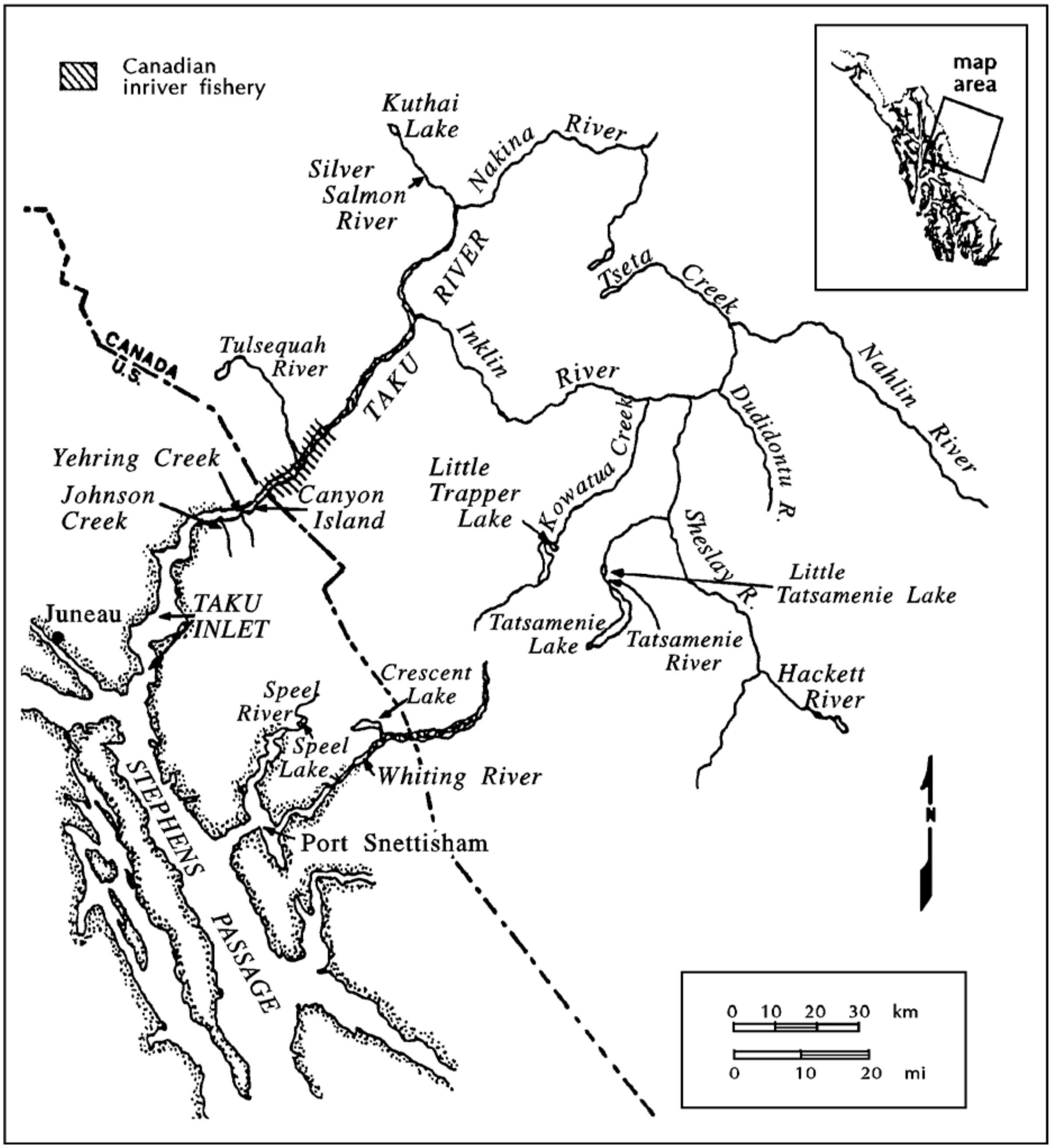

Figure 1.–Taku Inlet and Taku River drainage

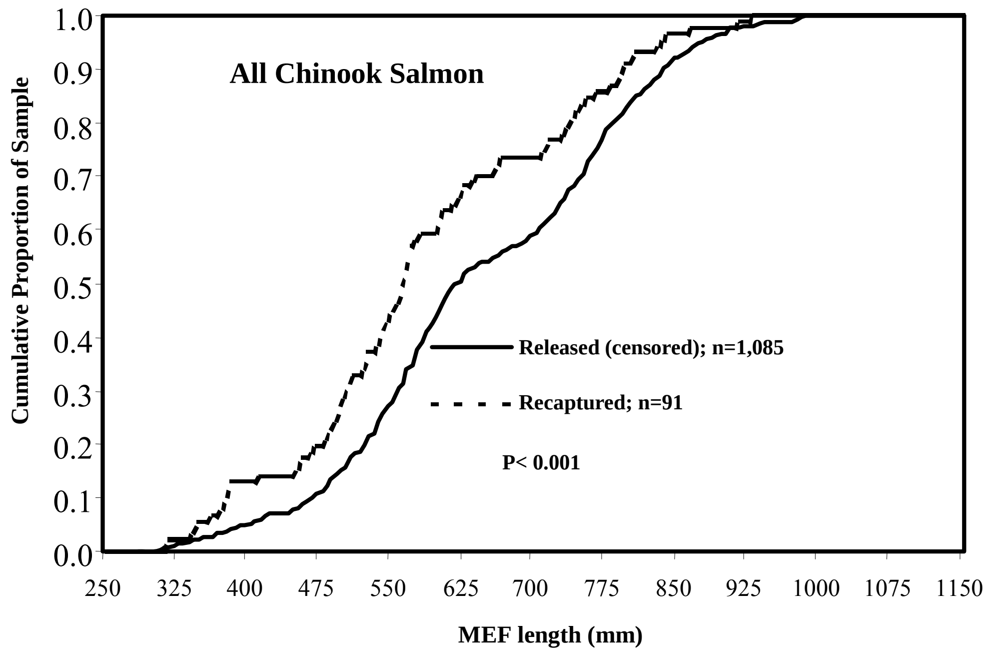

Figure 2.–Cumulative relative frequencies of Chinook salmon marked at Canyon Island that survived past all lower river fisheries versus those recaptured in sampling at tributaries in 2003.

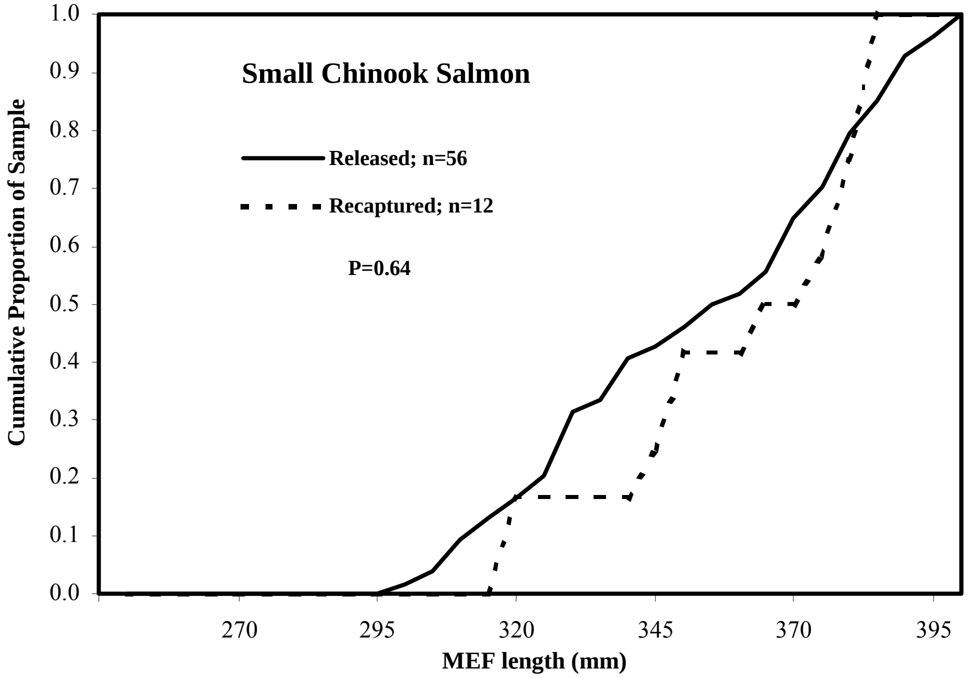

Figure 3.–Cumulative relative frequencies of small Chinook salmon marked at Canyon Island that survived past all lower river fisheries versus those recaptured in sampling at tributaries in 2003.

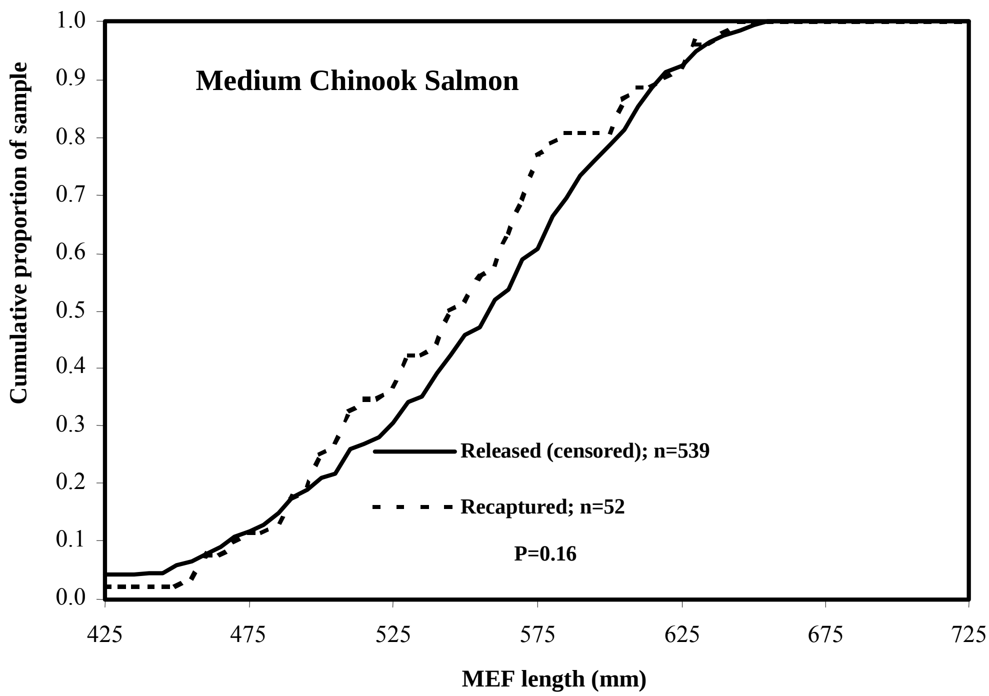

Figure 4.–Cumulative relative frequencies of medium Chinook salmon marked at Canyon Island that survived past all lower river fisheries versus those recaptured in sampling at tributaries in 2003.

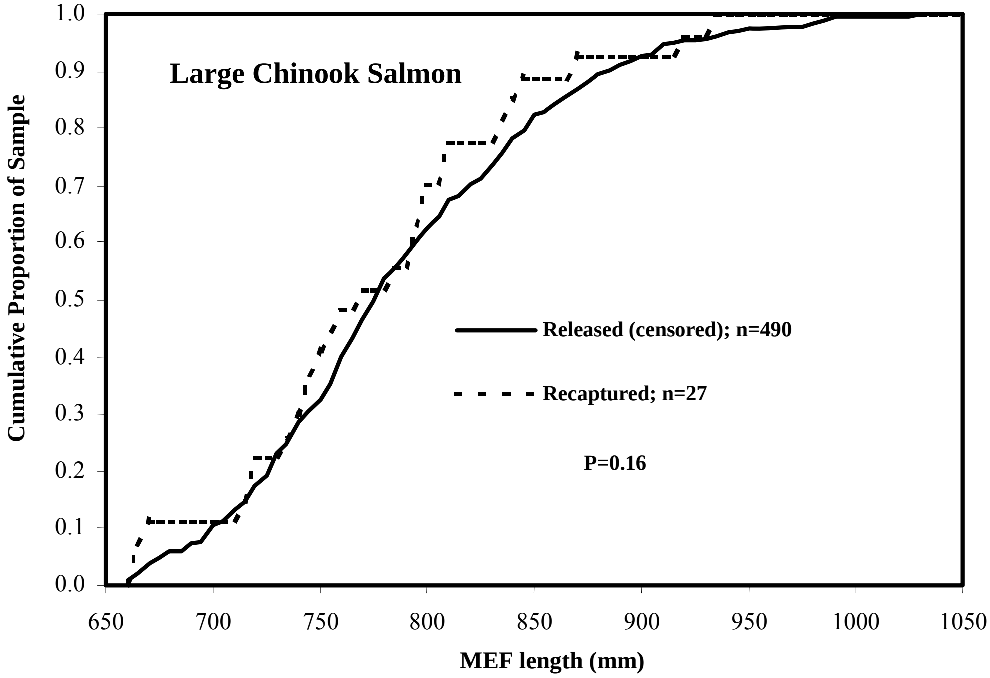

Figure 5.–Cumulative relative frequencies of large Chinook salmon marked at Canyon Island that survived past all lower river fisheries versus those recaptured in sampling at tributaries in 2003.

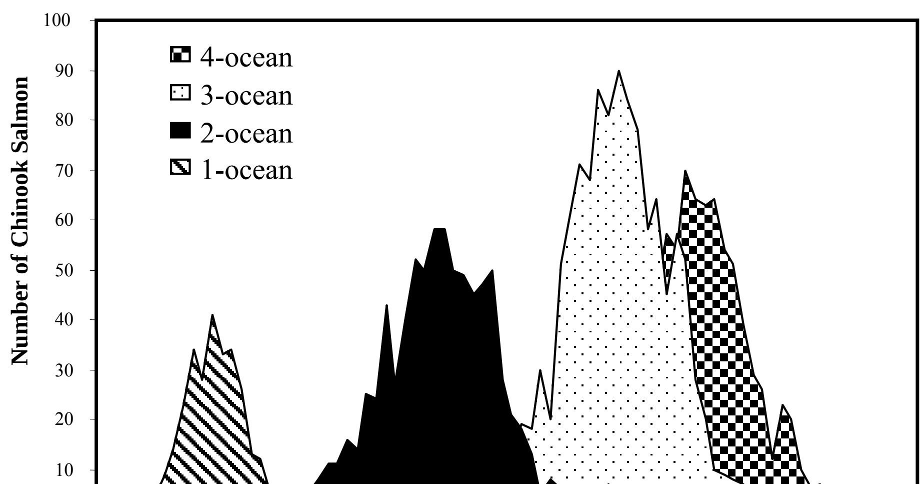

Figure 6.–Numbers of Chinook salmon by ocean-age from fish sampled at spawning grounds in all five tributaries in 2003.

APPENDIX A

Appendix A1.–Fish wheel effort for Chinook salmon, including water level, catches, numbers tagged, CPUE, and daily proportions in 2003.

	Fish wheel #1		Fish wheel #2			Fish wheels combined													
Date	Hours fished	FW 1 RPM	Hours fished	FW 2 RPM	Water Level (in.)	Tagged Small daily	Tagged small cum.	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.
26-Apr					17														
27-Apr					26														
28-Apr					32														
29-Apr					32														
30-Apr					37														
1-May					44														
2-May					46														
3-May					36														
4-May					25														
5-May					18														
6-May					12														
7-May					10														
8-May					7														
9-May					10														
10-May					14														
11-May					22														
12-May					30														
13-May					34														
14-May					30														
15-May					23														
16-May					23														
17-May					16														
18-May					14														
19-May					16														
20-May			12.67	1.5	18										0	0.00	0.00		0.00
21-May			23.92	2.0	22										0	0.00	0.00		0.00
22-May			23.59	2.3	26	1	1	3	3	2	2	6	6	7	7	3.04	3.04	0.03	0.03
23-May			19.70	2.5	40		1	1	4	1	3	2	8	3	10	1.20	4.24	0.01	0.04
24-May			23.30	2.5	42		1	5	9	2	5	7	15	8	18	3.20	7.44	0.03	0.06
25-May			22.80	2.5	54		1	1	10	2	7	3	18	3	21	1.20	8.64	0.01	0.07
26-May			23.59	2.4	54	1	2	1	11	2	9	4	22	4	25	1.67	10.31	0.01	0.09
27-May			23.30	2.1	48	3	5	6	17	2	11	11	33	12	37	5.71	16.02	0.05	0.13
28-May			23.15	2.1	46		5	7	24	2	13	9	42	9	46	4.29	20.31	0.04	0.17
29-May			23.40	2.0	48	2	7	4	28	6	19	12	54	13	59	6.50	26.81	0.05	0.22
30-May			23.45	2.5	54		7	2	30	3	22	5	59	5	64	2.00	28.81	0.02	0.24
31-May			23.32	3.0	67		7		30		22	0	59	1	65	0.33	29.14	0.00	0.24
1-Jun			23.79	3.5	97		7		30	2	24	2	61	2	67	0.57	29.71	0.00	0.25
2-Jun			23.59	2.7	70		7	2	32	2	26	4	65	5	72	1.85	31.57	0.02	0.26
3-Jun			23.42	2.2	56	1	8	6	38	3	29	10	75	10	82	4.55	36.11	0.04	0.30
4-Jun			22.77	2.0	50	1	9	5	43	1	30	7	82	8	90	4.00	40.11	0.03	0.34
5-Jun			23.90	2.3	50	1	10	12	55	5	35	18	100	19	109	8.26	48.37	0.07	0.41
6-Jun	4.00	2.3	22.92	2.8	62	4	14	9	64	3	38	16	116	20	129	3.92	52.29	0.03	0.44
7-Jun	22.90	2.8	23.39	2.8	88	1	15	15	79	8	46	24	140	26	155	4.64	56.94	0.04	0.48

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	Fish wheel #1		Fish wheel #2			Fish wheels combined													
Date	Hours fished	FW 1 RPM	Hours fished	FW 2 RPM	Water Level (in.)	Tagged Small daily	Tagged small cum.	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.
8-Jun	22.99	2.5	23.50	2.6	83		15	14	93	6	52	20	160	24	179	4.71	61.64	0.04	0.52
9-Jun	22.87	2.3	22.57	2.5	77	9	24	17	110	3	55	29	189	30	209	6.25	67.89	0.05	0.57
10-Jun	22.87	2.5	23.50	2.2	76	1	25	7	117	3	58	11	200	15	224	3.19	71.08	0.03	0.60
11-Jun	23.47	2.3	23.19	2.5	82	2	27	4	121	8	66	14	214	14	238	2.92	74.00	0.02	0.62
12-Jun	21.90	2.8	23.22	2.8	83		27	5	126	4	70	9	223	9	247	1.61	75.61	0.01	0.63
13-Jun	23.64	2.8	23.70	2.6	82		27	3	129	1	71	4	227	5	252	0.93	76.53	0.01	0.64
14-Jun	23.40	2.8	23.48	2.8	82	3	30	1	130	1	72	5	232	6	258	1.07	77.61	0.01	0.65
15-Jun	22.60	2.3	22.29	2.3	73		30		130	5	77	5	237	5	263	1.09	78.69	0.01	0.66
16-Jun	22.87	2.5	22.70	2.7	67	2	32	15	145	3	80	20	257	21	284	4.04	82.73	0.03	0.69
17-Jun	23.20	2.2	22.87	2.5	62	5	37	4	149	5	85	14	271	14	298	2.98	85.71	0.02	0.72
18-Jun	23.32	2.6	23.30	2.6	66	4	41	6	155	2	87	12	283	14	312	2.69	88.40	0.02	0.74
19-Jun	23.67	2.6	23.52	2.6	68	3	44	2	157	1	88	6	289	6	318	1.15	89.56	0.01	0.75
20-Jun	23.62	2.4	23.42	2.4	60	1	45	3	160	1	89	5	294	5	323	1.04	90.60	0.01	0.76
21-Jun	22.44	1.5	22.97	1.8	53	4	49	4	164		89	8	302	8	331	2.42	93.02	0.02	0.78
22-Jun	23.14	2.0	22.97	2.0	50	2	51	4	168	1	90	7	309	8	339	2.00	95.02	0.02	0.80
23-Jun	23.27	2.2	23.15	2.1	52	1	52	5	173		90	6	315	6	345	1.40	96.42	0.01	0.81
24-Jun	23.19	2.1	23.27	2.0	50		52	2	175		90	2	317	2	347	0.49	96.91	0.00	0.81
25-Jun	23.90	2.0	22.92	2.3	50	1	53		175	1	91	2	319	4	351	0.93	97.84	0.01	0.82
26-Jun	23.10	2.5	23.55	2.8	56		53	3	178		91	3	322	3	354	0.57	98.40	0.00	0.82
27-Jun	22.97	2.3	23.38	2.8	56		53	4	182	4	95	8	330	8	362	1.57	99.97	0.01	0.84
28-Jun	23.00	1.8	22.58	2.4	52		53	9	191	2	97	11	341	11	373	2.62	102.59	0.02	0.86
29-Jun	22.80	1.8	21.90	2.5	53		53	6	197	6	103	12	353	13	386	3.02	105.61	0.03	0.88
30-Jun	22.37	1.7	22.17	2.8	56	1	54	7	204	2	105	10	363	10	396	2.22	107.83	0.02	0.90
1-Jul	22.10	2.3	21.90	2.9	64		54	3	207	4	109	7	370	7	403	1.35	109.18	0.01	0.91
2-Jul	21.55	3.0	2.82	3.3	76		54	2	209	2	111	4	374	4	407	0.63	109.82	0.01	0.92
3-Jul	22.39	3.0	21.89	3.3	82	1	55	1	210		111	2	376	2	409	0.32	110.13	0.00	0.92
4-Jul	23.30	3.0	22.72	3.0	86		55	3	213	2	113	5	381	5	414	0.83	110.97	0.01	0.93
5-Jul	22.82	3.0	22.37	3.0	80		55	6	219		113	6	387	7	421	1.17	112.13	0.01	0.94
6-Jul	21.95	3.0	19.30	3.1	78		55	4	223	4	117	8	395	8	429	1.31	113.44	0.01	0.95
7-Jul	21.80	2.5	21.25	2.5	74		55	3	226	4	121	7	402	7	436	1.40	114.84	0.01	0.96
8-Jul	21.92	2.5	21.42	2.5	74		55	2	228		121	2	404	2	438	0.40	115.24	0.00	0.97
9-Jul	21.82	3.0	21.20	2.5	74		55	1	229	4	125	5	409	5	443	0.91	116.15	0.01	0.97
10-Jul	22.69	3.1	22.32	2.5	88		55	1	230	1	126	2	411	2	445	0.36	116.51	0.00	0.98
11-Jul	22.57	3.0	22.38	2.5	90		55		230		126	0	411	4	449	0.73	117.24	0.01	0.98
12-Jul	22.29	2.8	22.25	2.8	91		55		230		126	0	411	1	450	0.18	117.42	0.00	0.98
13-Jul	21.75	3.1	18.95	2.8	89		55		230		126	0	411	2	452	0.34	117.76	0.00	0.99
14-Jul	21.90	2.8	19.67	2.8	90		55		230		126	0	411	5	457	0.89	118.65	0.01	0.99
15-Jul	21.67	2.8	19.83	2.8	89		55		230		126	0	411	2	459	0.36	119.01	0.00	1.00
16-Jul	21.50	2.8	2.41	2.5	86		55		230		126	0	411	1	460	0.19	119.19	0.00	1.00
17-Jul	21.75	3.0	22.62	2.4	82		55		230		126	0	411	1	461	0.19	119.38	0.00	1.00

Appendix A2.–Gillnet effort for Chinook salmon, including water level, catches, numbers tagged, CPUE, and daily proportions in 2003.

Date	Gill net hours fished	Water level (in.)	Tagged small daily	Tagged small cum.	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.
20-Apr	2.0										0	0	0.00	0.00	0.00	0.00
21-Apr											0	0		0.00	0.00	0.00
22-Apr											0	0		0.00	0.00	0.00
23-Apr											0	0		0.00	0.00	0.00
24-Apr	6.0						1	1			1	1	0.17	0.17	0.00	0.00
25-Apr	5.4						5	6			5	6	0.93	1.09	0.00	0.01
26-Apr	6.0	17					2	8			2	8	0.33	1.43	0.00	0.01
27-Apr	6.0	26					6	14			6	14	1.00	2.43	0.00	0.01
28-Apr	6.0	32			1	1	8	22			9	23	1.50	3.93	0.01	0.02
29-Apr	6.0	32			1	2	8	30			12	35	2.00	5.93	0.01	0.03
30-Apr	6.0	37			5	7	6	36			11	46	1.83	7.76	0.01	0.04
1-May	6.0	44			3	10	6	42			10	56	1.67	9.43	0.01	0.05
2-May	6.0	46			2	12	8	50			11	67	1.83	11.26	0.01	0.05
3-May	6.0	36			5	17	12	62			17	84	2.83	14.09	0.01	0.07
4-May	6.0	25			4	21	5	67			9	93	1.50	15.59	0.01	0.08
5-May	4.0	18			3	24	7	74			11	104	2.75	18.34	0.01	0.09
6-May	6.0	12			8	32	17	91			26	130	4.33	22.68	0.02	0.11
7-May	6.0	10			16	48	27	118			43	173	7.17	29.84	0.03	0.15
8-May	6.0	7			7	55	27	145			34	207	5.67	35.51	0.03	0.17
9-May		10				55		145				207		35.51	0.00	0.17
10-May	3.0	14			3	58	8	153			11	218	3.67	39.18	0.02	0.19
11-May	3.0	22			8	66	9	162			19	237	6.33	45.51	0.03	0.22
12-May	4.0	30			7	73	8	170			16	253	4.00	49.51	0.02	0.24
13-May	6.0	34			19	92	11	181			33	286	5.50	55.01	0.03	0.27
14-May	4.0	30			3	95	6	187			9	295	2.25	57.26	0.01	0.28
15-May		23				95		187				295		57.26	0.00	0.28
16-May	4.0	23			23	118	15	202			38	333	9.50	66.76	0.05	0.32
17-May		16				118		202				333		66.76	0.00	0.32
18-May	6.0	14			35	153	27	229			63	396	10.50	77.26	0.05	0.38
19-May	6.0	16			27	180	22	251			52	448	8.67	85.93	0.04	0.42
20-May	6.0	18			24	204	14	265			41	489	6.83	92.76	0.03	0.45
21-May	5.0	22			16	220	10	275			34	523	6.80	99.56	0.03	0.48
22-May	3.0	26			17	237	8	283	25	25	26	549	8.67	108.23	0.04	0.53
23-May		40				237		283	0	25		549		108.23	0.00	0.53
24-May		42				237		283	0	25		549		108.23	0.00	0.53

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Date	Gill net hours fished	Water level (in.)	Tagged small daily	Tagged small cum.	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.
25-May	4.0	54			14	251	11	294	25	50	28	577	7.00	115.23	0.03	0.56
26-May	4.0	54	1	1	26	277	14	308	41	91	44	621	11.00	126.23	0.05	0.61
27-May		48		1		277		308	0	91		621		126.23	0.00	0.61
28-May	3.5	46		1	18	295	22	330	40	131	42	663	12.00	138.23	0.06	0.67
29-May	2.5	48		1	10	305	13	343	23	154	28	691	11.20	149.43	0.05	0.73
30-May	1.45	54		1	4	309	3	346	7	161	9	700	6.21	155.63	0.03	0.76
31-May		67		1		309		346	0	161		700		155.63	0.00	0.76
1-Jun		97		1		309		346	0	161		700		155.63	0.00	0.76
2-Jun		70		1		309		346	0	161		700		155.63	0.00	0.76
3-Jun	4.0	56		1	19	328	15	361	34	195	39	739	9.75	165.38	0.05	0.80
4-Jun	4.5	50	1	2	12	340	30	391	43	238	47	786	10.44	175.83	0.05	0.85
5-Jun	1.5	50		2	9	349	11	402	20	258	22	808	14.67	190.49	0.07	0.93
6-Jun		62		2		349		402	0	258		808		190.49	0.00	0.93
7-Jun		88		2		349		402	0	258		808		190.49	0.00	0.93
8-Jun		83		2		349		402	0	258		808		190.49	0.00	0.93
9-Jun	3.5	77		2	11	360	2	404	13	271	13	821	3.71	194.21	0.02	0.94
10-Jun	6.0	76		2	8	368	12	416	20	291	22	843	3.67	197.87	0.02	0.96
11-Jun	6.0	82		2	13	381	9	425	22	313	23	866	3.83	201.71	0.02	0.98
12-Jun	6.0	83		2	7	388	17	442	24	337	24	890	4.00	205.71	0.02	1.00

Appendix A3.–Age composition by sex and age from samples aged from Chinook salmon in the Taku River in 2003 by size group and location.

			AGE CLASS									
			1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.5	Total
Nakina	Male	n			10		149	2	71			232
Large Fish		%			2.5%		36.5%	0.5%	17.4%			56.9%
	Female	n			1		96		77	1	1	176
		%			0.2%		23.5%		18.9%	0.2%	0.2%	43.1%
	Total	n			11		245	2	148	1	1	408
		%			2.7%		60.0%	0.5%	36.3%	0.2%	0.2%	
Nakina	Male	n	17		270	1	25		1			314
Medium Fish		%	5.4%		86.0%	0.3%	8.0%		0.3%			100.0%
	Female	n										
		%										
	Total	n	17		270	1	25		1			314
		%	5.4%		86.0%	0.3%	8.0%		0.3%			
Nakina	Male	n	86	1	6							93
Small Fish		%	92.5%	1.1%	6.5%							100.0%
	Female	n										
		%										
	Total	n	86	1	6							93
		%	92.5%	1.1%	6.5%							
Nakina	Male	n	103	1	286	1	174	2	72			639
All Fish		%	12.6%	0.1%	35.1%	0.1%	21.3%	0.2%	8.8%			78.4%
	Female	n			1		96		77	1	1	176
		%			0.6%		11.8%		9.4%	0.1%	0.1%	21.6%
	Total	n	103	1	287	1	270	2	149	1	1	815
		%	12.6%	0.1%	35.2%	0.1%	33.1%	0.2%	18.3%	0.1%	0.1%	
Lower	Male	n			41	1	112	1	47			202
Tatsamenie		%			10.0%	0.2%	27.5%	0.2%	11.5%			49.5%
Large Fish	Female	n			1	1	123	2	78		1	206
		%			0.2%	0.2%	30.1%	0.5%	19.1%		0.5%	50.5%
	Total	n			42	2	235	3	125		1	408
		%			10.3%	0.5%	57.6%	0.7%	30.6%		0.2%	
Lower	Male	n	30		221		17		1			269
Tatsamenie		%	11.1%		81.5%		6.3%		0.4%			99.3%
Medium Fish	Female	n			2							2
		%			0.7%							0.7%
	Total	n	30		223		17		1			271
		%	11.1%		82.3%		6.3%		0.4%			
Lower	Male	n	131		2							133
Tatsamenie		%	98.5%		1.5%							100.0%
Small Fish	Female	n										
		%										
	Total	n	131		2							133
		%	98.5%		1.5%							
Lower	Male	n	161		264	1	129	1	48			604
Tatsamenie		%	19.8%		32.5%	0.1%	15.9%	0.1%	5.9%			74.4%
All Fish	Female	n			3	1	123	2	78		1	208
		%			0.4%	0.1%	15.1%	0.2%	9.6%		0.1%	25.6%
	Total	n	161		267	2	252	3	126		1	812
		%	19.8%		32.9%	0.2%	31.0%	0.4%	15.5%		0.1%	

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			AGE CLASS									
			1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.5	Total
Upper	Male	n			1				1			2
Tatsamenie		%			12.5%				12.5%			25.0%
Large Fish	Female	n			1		5					6
		%			12.5%		62.5%					75.0%
	Total	n			2		5		1			8
		%			25.0%		62.5%		12.5%			
Upper	Male	n	1		13							14
Tatsamenie		%	7.1%		92.9%							100.0%
Medium Fish	Female	n										
		%										
	Total	n	1		13							14
		%	7.1%		92.9%							
Upper	Male	n	2									2
Tatsamenie		%	100.0%									100.0%
Small Fish	Female	n										
		%										
	Total	n	2									2
		%	100.0%									
Upper	Male	n	1		14				1			16
Tatsamenie		%	4.5%		63.6%				4.5%			72.7%
All Fish	Female	n			1		5					6
		%			4.5%		22.7%					27.3%
	Total	n	1		15		5		1			22
		%	4.5%		68.2%		22.7%		4.5%			
Dudidontu	Male	n			2		53	2	42			99
Large Fish		%			1.0%		25.4%	1.0%	20.1%			47.4%
	Female	n			1		63		47		1	112
		%			0.5%		30.1%		22.5%		0.5%	53.6%
	Total	n			3		116		89		1	209
		%			1.4%		55.5%		42.6%		0.5%	
Dudidontu	Male	n			19							19
Medium Fish		%			95.0%							95.0%
	Female	n			1							1
		%			5.0%							5.0%
	Total	n			20							20
		%			100.0%							
Dudidontu	Male	n										
Small Fish		%										
	Female	n										
		%										
	Total	n										
		%										
Dudidontu	Male	n			21		53	2	42			118
All Fish		%			9.1%		22 .9%	0 .9%	18.2%			51 .1%
	Female	n			2		63		47		1	113
		%			0.9%		27%.3		20.3%		0.4%	48 .9%
	Total	n			23		116	2	89		1	231
		%			10.0%		50.2%	0.9%	38.5%		0.4%	

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			AGE CLASS									
			1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.5	Total
Nahlin	Male	n			4	1	45		18			68
Large Fish		%			2.5%	0.6%	28.7%		11.5%			43.3%
	Female	n			6		60		23			89
		%			3.8%		38.2%		14.6%			56.7%
	Total	n			10	1	105		41			157
		%			6.4%	0.6%	66.9%		26.1%			
Nahlin	Male	n			24		10		3			37
Medium Fish		%			64.9%		27.0%		8.1%			108.8%
	Female	n										
		%										
	Total	n			24		10		3			34
		%			64.9%		27.0%		8.1%			
Nahlin	Male	n	1									1
Small Fish		%	100.0%									100.0%
	Female	n										
		%										
	Total	n	1									1
		%	100.0%									
Nahlin	Male	n	1		28	1	55		21			106
All Fish		%	0.5%		14.4%	0.5%	28.2%		10.8%			54.4%
	Female	n			6		60		23			89
		%			3.1%		30.8%		11.8%			45.6%
	Total	n	1		34	1	115		44			195
		%	0.5%		17.4%	0.5%	59.0%		22.6%			
Kowatua	Male	n			4		24	1	11			40
Large Fish		%			2.8%		16.6%	0 .7%	7.6%			28.8%
	Female	n			2		53	1	49			105
		%			1.4%		36.6%	0 .7%	33.8%			75.5%
	Total	n			6		77	2	60			139
		%			4.1%		53.1%	1 .4%	41.4%			
Kowatua	Male	n			40		1					41
Medium Fish		%			97.6%		2.4%					102.5%
	Female	n										
		%										
	Total	n			40		1					40
		%			97.6%		2 .4%					
Kowatua	Male	n	1									1
Small Fish		%	100.0%									100.0%
	Female	n										
		%										
	Total	n	1									1
		%	100.0%									
Kowatua	Male	n	1		44		25	1	11			82
All Fish		%	0.5%		23.5%		13.4%	0 .5%	5.9%			43.9%
	Female	n			2		53	1	49			105
		%			1.1%		28.3%	0 .5%	26.2%			56.1%
	Total	n	1		46		78	2	60			187
		%	0.5%		24%.6		41.7%	1 .1%	32 .1%			

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			AGE CLASS									
			1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.5	Total
Tseta	Male	n			1		9		4			14
Large Fish		%			2.4%		21.4%		9.5%			33.3%
	Female	n					20		9			29
		%					47.6%		21.4%			69.0%
	Total	n					29		13			42
		%					69.0%		31.0%			
Tseta	Male	n			9							9
Medium Fish		%			90.0%							90.0%
	Female	n			1							1
		%			10.0%							10.0%
	Total	n			10							10
		%			100.0%							
Tseta	Male	n										
Small Fish		%										
	Female	n										
		%										
	Total	n										
		%										
Tseta	Male	n			10		9		4			23
All Fish		%			18.9%		17.0%		7.5%			43.4%
	Female	n			1		20		9			30
		%			1.9%		37.7%		17.0%			56.6%
	Total	n			11		29		13			53
		%			20.8%		54.7%		24.5%			
All Tributaries	Male	n			63	2	392	6	194			657
Large Fish		%			4.6%	0.1%	28.4%	0.4%	14.1%			47.6%
	Female	n			12	1	420	3	283	2	2	723
		%			0.9%	0.1%	30.4%	0.2%	20.5%	0.1%	0.1%	52.4%
	Total	n			75	3	812	9	477	2	2	1,380
		%			5.4%	0.2%	58.8%	0.7%	34.6%	0.1%	0.1%	
All Tributaries	Male	n	48		596	1	53		5			703
Medium Fish		%	6.8%		84.3%	0.1%	7.5%		0.7%			99.4%
	Female	n			4							4
		%			0.6%							0.6%
	Total	n	48		600	1	53		5			707
		%	6.8%		84.9%	0.1%	7.5%		0.7%			
All Tributaries	Male	n	221	1	8							230
Small Fish		%	96.1%	0.4%	3.5%							100.0%
	Female	n										
		%										
	Total	n	221	1	8							230
		%	96.1%	0.4%	3.5%							
All Tributaries	Male	n	269	1	667	3	445	6	199			1,590
All Fish		%	11.6%	0.0%	28.8%	0.1%	19.2%	0.3%	8.6%			68.6%
	Female	n			16	1	420	3	283	2	2	727
		%			0.7%	0.0%	18.1%	0.1%	12.2%	0.1%	0.1%	31.4%
	Total	n	269	1	683	4	865	9	482	2	2	2,317
		%	11.6%	0.0%	29.5%	0.2%	37.3%	0.4%	20.8%	0.1%	0.1%	

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			AGE CLASS									
			1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.5	Total
Canyon Island	Male	n			6	1	104	3	49	1		164
Large Fish		%			1.2%	0 .2%	21.0%	0.6%	9.9%	0.2%		33.1%
Tagged	Female	n			6	1	196	5	120	3		331
		%			1.2%	0 .2%	39.6%	1.0%	24.2%	0.6%		66.9%
	Total	n			12	2	300	8	169	4		495
		%			2.4%	0.4%	60.6%	1.6%	34.1%	0.8%		
Canyon Island	Male	n	20		470	4	26					520
Medium Fish		%	3.8%		89.7%	0.8%	5.0%					99.2%
Tagged	Female	n			4							4
		%			0.8%							0.8%
	Total	n	20		474	4	26					524
		%	3.8%		90.5%	0.8%	5.0%					
Canyon Island	Male	n	50		3							53
Small Fish		%	94.3%		5.7%							100.0%
Tagged	Female	n										
		%										
	Total	n	50		3							53
		%	94.3%		5.7%							
Canyon Island	Male	n	70		479	5	130	3	49	1		737
All Fish		%	6.5%		44.7%	0.5%	12.1%	0.3%	4.6%	0.1%		68.8%
Tagged	Female	n			10	1	196	5	120	3		335
		%			3.0%	0.3%	58.5%	1.5%	35.8%	0.9%		31.3%
	Total	n	70		489	6	326	8	169	4		1072
		%	6.5%		45.6%	0.6%	30.4%	0.7%	15.8%	0.4%		

Appendix A4.–Computer files used to estimate the spawning abundance of Chinook salmon in the Taku River in 2003.

File Name	Description
TakuChinookMarkRecaptureData03.xls	Data file for all primary mark and recovery data. Age, sex, and length composition tables.
CanyonIslandCatch&Effort03.xls	Canyon Island gill net and fish wheel catch and effort data.
TakuChinookEstimate03.xls	Abundance estimate.
TakuChinookChiSquareLarge03.xls	Bias tests for large fish.
TakuChinookChiSquareMedium03.xls	Bias tests for medium fish.
TakuChinookChiSquareSmall03.xls	Bias tests for small fish.
TakChinookKolmogorovSmirnovTest03.xls	Tests for size bias.