Fishery Data Series No. 01-10

Production of Coho Salmon from the Unuk River, 1998–1999

by

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and

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July 2001

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



Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
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, χ^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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ABSTRACT

In 1999, a full stock assessment study of coho salmon *Oncorhynchus kisutch* was conducted on the Unuk River near Ketchikan, Alaska. A smolt coded-wire-tagging and an adult mark-recapture study were conducted to estimate a number of population parameters. Information based on recoveries of adult coho salmon with coded wire tags tagged as smolt during the spring of 1998 was used to estimate smolt abundance and adult exploitation rate and production from the Unuk River. Baited G-40 minnow traps were fished daily on the Unuk River from 27 March through 12 April 1998. During this period, 16,773 coho salmon smolt ≥70 mm fork length (FL) were marked with valid coded wire tags having code 04-47-16. Sampled smolt averaged 89 mm FL and 6.9 g in weight. In 1999, 269 adult coho salmon were recovered bearing coded wire tags, 231 of which were random fishery recoveries. These random recoveries represent an estimated harvest of 29,270 (SE = 3,011) coho salmon in U.S. marine waters. Of this harvest, the troll fishery took an estimated 62%, drift gillnet fisheries took 19%, purse seine fisheries took 14%, and recreational fisheries took 6%. An estimated 25,523 (SE = 10,011) adults escaped into the Unuk River, as determined by a mark-recapture study coupled with a radiotelemetry study that estimated 255 coho salmon were inriver mortalities as a result of the tagging event. Estimated total run (i.e., escapement, harvest, and inriver mortality) in 1999 for all coho salmon bound for the Unuk River was 55,048 (SE = 10,454); marine exploitation rate on this run was an estimated 53% (SE = 10.0%). Contribution of Unuk River coho salmon to the Ketchikan marine sport fishery was about 4% of the estimated harvest in that fishery. Smolt abundance in 1998 was 562,217 (SE = 101,016), as determined using Chapman's modification of the Peterson estimator, and the estimated marine survival rate was 9.8% (SE = 2.6%).

Key words: coho salmon, *Oncorhynchus kisutch*, Unuk River, harvest, troll fishery, seine fishery, drift gillnet fishery, recreational fishery, mark-recapture, radiotelemetry, inriver mortality, escapement, total run, exploitation rate, marine survival

INTRODUCTION

The Unuk River originates in a heavily glaciated area of northern British Columbia and flows for 129 km, where it empties into Burroughs Bay 85 km northeast of Ketchikan, Alaska; the lower 39 km of the river are in Southeast Alaska (Figure 1). The percentage of coho salmon *Oncorhynchus kisutch* production originating from the Canadian portion of the river has not been estimated directly; however, most (>70%) of the production likely occurs in lower river tributaries of the United States—i.e., Cripple, Gene's Lake, Kerr, Clear, and Lake Creeks and the Eulachon River (Jones et al. 1999). Field observations from juvenile coded-wire-tagging (CWT) projects lead us to believe that most rearing takes place in the lower 39 km of the river (Dave Magnus, Alaska Department of Fish and Game, Douglas, personal communication); yet no substantial trapping has occurred above the border. Typically, the Eulachon River is the only system on the Unuk River annually surveyed by helicopter for peak coho salmon spawning abundance. Peak counts in the 1990s have ranged from 235 to 860 fish and averaged 495 fish.

The first CWTs placed on coho salmon in the Unuk River occurred in 1983 and continued through 1986 (Hubartt and Kissner 1987). These efforts combined with recent efforts, 1996–1999, indicate that Unuk River coho salmon contribute significantly to commercial and recreational fisheries in Southeast Alaska. Coho salmon returning to the Unuk River swim through the commercial troll fishery in Southeast Alaska and then through the commercial seine and drift gillnet fisheries. They also contribute to the recreational fisheries in Sitka and Ketchikan before entering the Unuk River (Figure 2). There is also a small freshwater sport fishery on the Unuk River in which approximately 100 coho salmon are harvested annually. In 1998, coho salmon originating from the Unuk River produced a total run of 57,811 adult coho salmon and contributed an estimated 7.3% of the District 101 gillnet catch and 19.5% of the Ketchikan

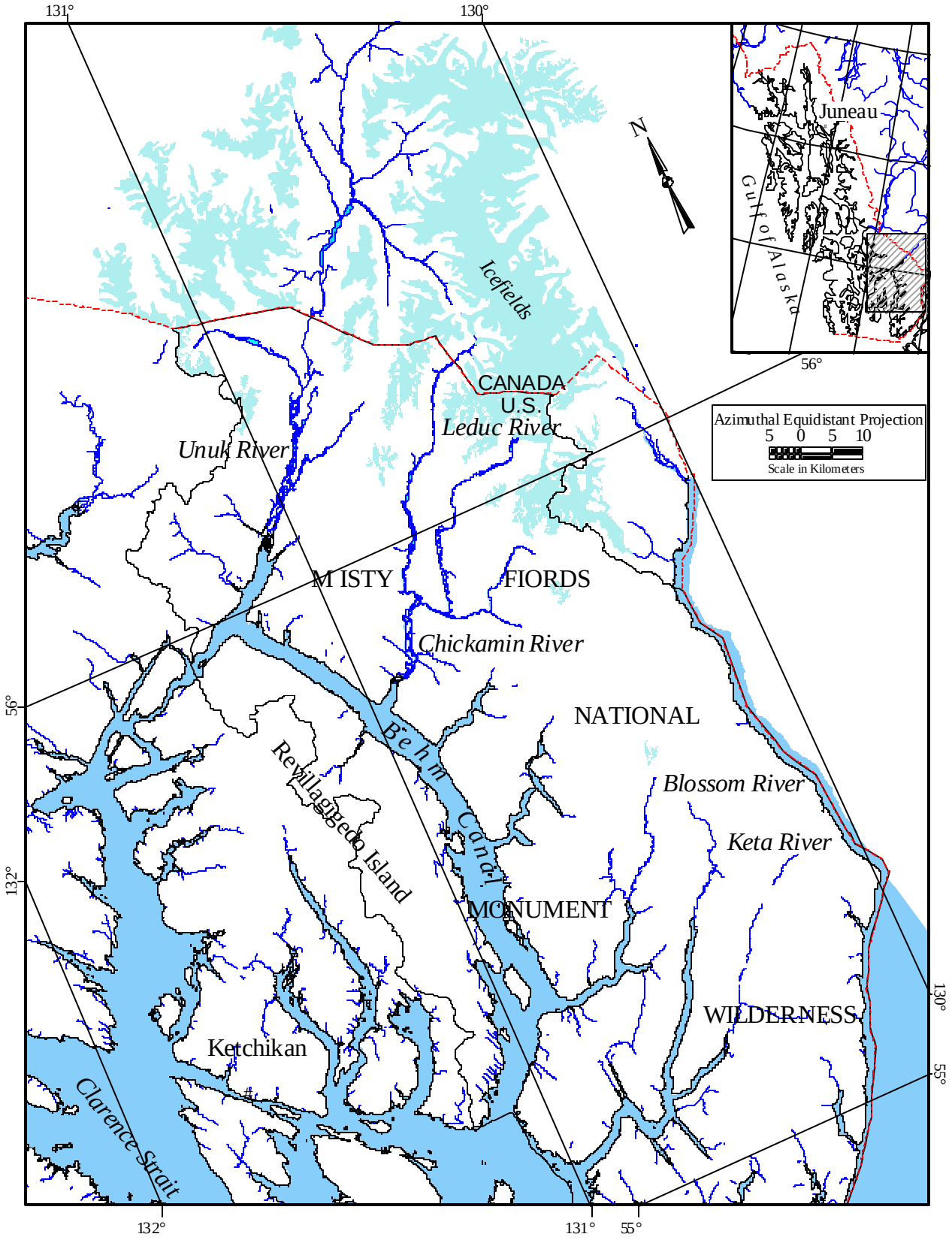

Figure 1.–Behm Canal area in Southeast Alaska and location of major coho salmon systems.

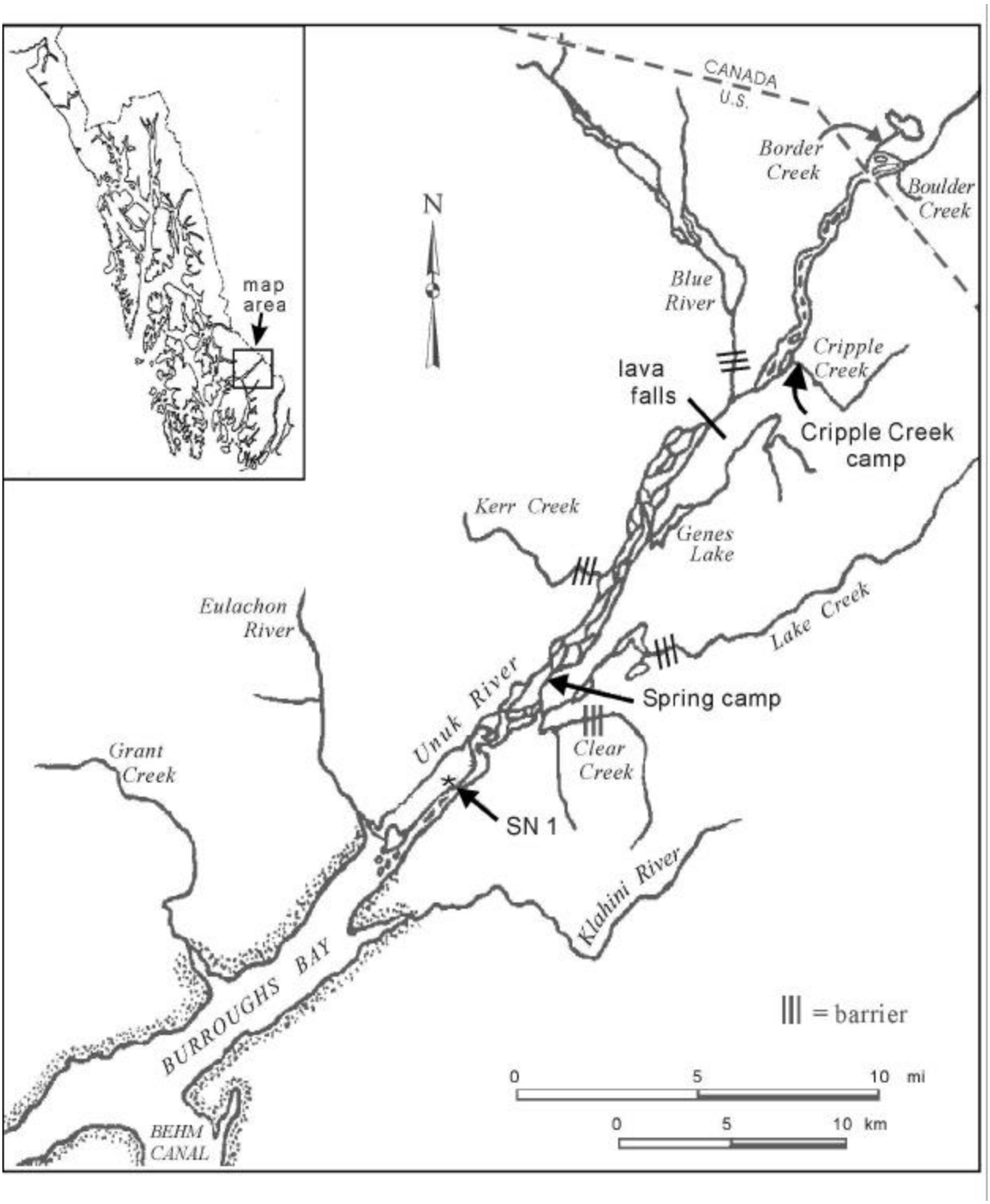

Figure 2.–Unuk River area in Southeast Alaska, showing major tributaries, barriers to salmon migration, and location of ADF&G research sites.

marine recreational fishery (Jones et al. 1999). This is the second year of a full stock assessment study designed to estimate the production of coho salmon from the Unuk River.

Objectives of the 1998–1999 study were to estimate: (1) abundance, mean length, and age composition of coho salmon smolt leaving the Unuk River in 1998; (2) harvest of adult coho salmon intercepted in the fisheries that were bound for the Unuk River in 1999; and (3) escapement and age composition of returning adult coho salmon in 1999. These objectives were accomplished by tagging and sampling smolt in the spring of 1998 and through the operation of an adult coho salmon mark-recapture study in 1999.

METHODS

SMOLT CAPTURE, CODED-WIRE-TAGGING, AND LENGTH-WEIGHT SAMPLING

Between 65 and 185 G-40 minnow traps, baited with salmon roe, were fished daily for 24 hours from 27 March to 12 April between approximately river km 10 and 26 along both sides of the Unuk River. Traps were located along mainstem banks and in some backwater areas, depending on river levels. Minnow traps were checked daily when water levels were stable and more frequently when water levels were unstable. Two teams consisting of two personnel each were used to set and fish traps on a regular basis. Generally, one crew was responsible for traps set upstream of Spring Camp (at river km 14) and one crew was responsible for traps downstream of camp. Early in the season, water levels were low and ice and snow restricted fishing to the mainstem banks. Spring melt occurred quickly and all available habitat was accessible after about the first week.

Salmonid smolt and fry were removed from minnow traps during each visit, transported to holding pens at camp, and CWTd each day. Coho and chinook salmon *O. tshawytscha* smolt were separated by inspection from other species of salmon and Dolly Varden *Salvelinus malma*. Smolt were carefully examined, and species were separated by using a combination of external morphological characteristics. Absence of pigmentation or a clear 'window' in the adipose fin (Meehan and Vania 1961; McConnell and Snyder 1972) indicates a chinook salmon smolt, whereas a coho salmon smolt has a mottled or speckled adipose fin. In addition, chinook salmon smolt generally appear silvery when viewed from the side, in contrast to coho salmon smolt, which are often darker and purplish. Coho salmon smolt have narrower par marks, a greater number of small, darkly pigmented spots when viewed dorsally, and have longer anterior rays on their anal fins (Pollard et al. 1997). All live coho salmon smolt ≥70 mm FL were tranquilized in a water solution of tricain methane-sulfonate (MS 222) buffered with sodium bicarbonate. To alleviate stress on fish, effort was made to keep the MS 222 solution at a constant river temperature by frequent water changes, and tranquilized fish were kept at small numbers for quick sampling and tagging. All fish were tagged with a CWT and externally marked by removal of the adipose fin as described in Koerner (1977). All chinook salmon smolt ≥50 mm FL were tagged also, but with different tag codes.

Tagged fish were held overnight and released the following morning after being checked for tag retention and mortality. The number of fish tagged, number of holding pen mortalities, and number of fish that had shed their tags were compiled and recorded on *ADF&G CWT Tagging Summary and Release Information Form.* These forms are submitted to the Commercial Fisheries Division (CFMD) Tag Lab in Juneau after the field work has ended. Length and weight composition of emigrating coho salmon smolt in 1998 was estimated by systematically sampling every 25th smolt captured. Each sampled smolt was measured to the nearest mm FL and weighed to the nearest 0.1 g.

ESTIMATE OF SMOLT ABUNDANCE

Abundance of Unuk River coho salmon smolt in 1998 was estimated with a two-event mark-recapture study using Chapman's modification of the Petersen estimate (Chapman 1951):

$$\hat{N}_s = \frac{(n_c+1)(n_e+1)}{(m_a+1)} - 1 \qquad (1)$$

$$\mathrm{var}\left[\hat{N}_s\right] = \frac{(n_c+1)(n_e+1)(n_c-m_a)(n_e-m_a)}{(m_a+1)^2(m_a+2)} \qquad (2)$$

where N_s is number of smolt emigrating in 1998, n_c is the number of smolt tagged in 1998, n_e the number of adults sampled during Event 1 in 1999, and m_a the number of adults in that sample with missing adipose fins. General assumptions (Seber 1982) that must hold for $\hat{N}$ to be a suitable estimate of abundance may be cast as follows:

(a) every fish has an equal probability of being marked in Event 1, or every fish has an equal probability of being captured in Event 2, or marked fish mix completely with unmarked fish;

(b) both recruitment and death (emigration) do not occur between sampling events;

(c) marking does not affect the catchability of an animal;

(d) animals do not lose their marks in the time between the two events;

(e) all marks are reported on recovery in Event 2; and

(f) double sampling does not occur.

The validity of these assumptions is evaluated in the Discussion section below.

RADIOTELEMETRY

In 1999, the rate of mortality associated with capturing, handling, and marking mature coho salmon in set gillnets was estimated from a radiotelemetry study. Between 21 August and 13 September, Advanced Telemetry Systems (ATS) radio transmitters (150-151 MHz) were inserted esophageally into the stomachs of healthy adult coho salmon (Eiler 1990). Radio tags were placed in one out of approximately every 20 coho salmon captured in the set gillnet in an effort to distribute them in proportion to the immigration. Every fish that received a radio transmitter was also tagged with a spaghetti tag, given secondary marks, and sampled for age, sex, and length (ASL).

Aerial tracking surveys were flown on 30 August, 14 September, 14 October, 17 November, and 2 December to locate each radio transmitter. The pilot and an experienced member of the crew surveyed the entire U.S. portion of the Unuk River and as far into Canada as river km 56, searching for transmitters. In addition to aerial surveys, two remote tracking stations were placed just upstream of camp on each bank directly across from each other near river km 15. Radiotagged fish that swam past these stations were recorded on remote data loggers. The tracking stations were constructed and operated as described in Eiler (1995), except that they did not have satellite uplink capabilities. A reference tag was used to check whether or not each station was operational, and data loggers were checked periodically for the indication of fish movement. Fates of the radiotagged fish were determined by whether they were tracked upstream of the tagging site above river km 6 or to the Eulachon River by aerial survey or by a positive reading at one of the remote tracking stations. Fish "not found" by either method or located below the set gillnet site (SN1; Figure 3, 4), or located outside the system, were considered mortalities.

ESTIMATE OF ESCAPEMENT

A two-event mark-recapture study was used to estimate the escapement of adult coho salmon into the Unuk River in 1999. The data suggest that size-selective sampling of fish less than 455 mm MEF occurs between events; therefore, the data was truncated such that the estimate of escapement was germane to adult coho salmon 450 mm MEF and larger. In Event 1, fish were captured in the lower river at SN1 with set gillnets between 26 July and 10 October. Gillnets were 37 m (120 ft) long by 4 m (14 ft) deep, with 14 cm (5? ?) stretch mesh. In the 1998 coho salmon study (Jones et al. 1999) and in previous studies on chinook salmon (Jones et al. 1998; Jones and McPherson 1999, 2000), sufficiently high numbers of fish have been caught in gillnets fished at SN1. SN1 is located on the south channel of the lower Unuk River at approximately river km 3 and is downstream of all known coho salmon spawning tributaries with the exception of the Eulachon River (Figure 3). Later, in Event 2, fish were sampled on the spawning grounds for primary and secondary marks and sampled for ASL with a variety of gear types.

In Event 1, using a two member crew, set gillnets were fished at SN1 (Figure 4) six hours per day, six days per week. One net (a cross net) was attached to the shore and ran directly across a

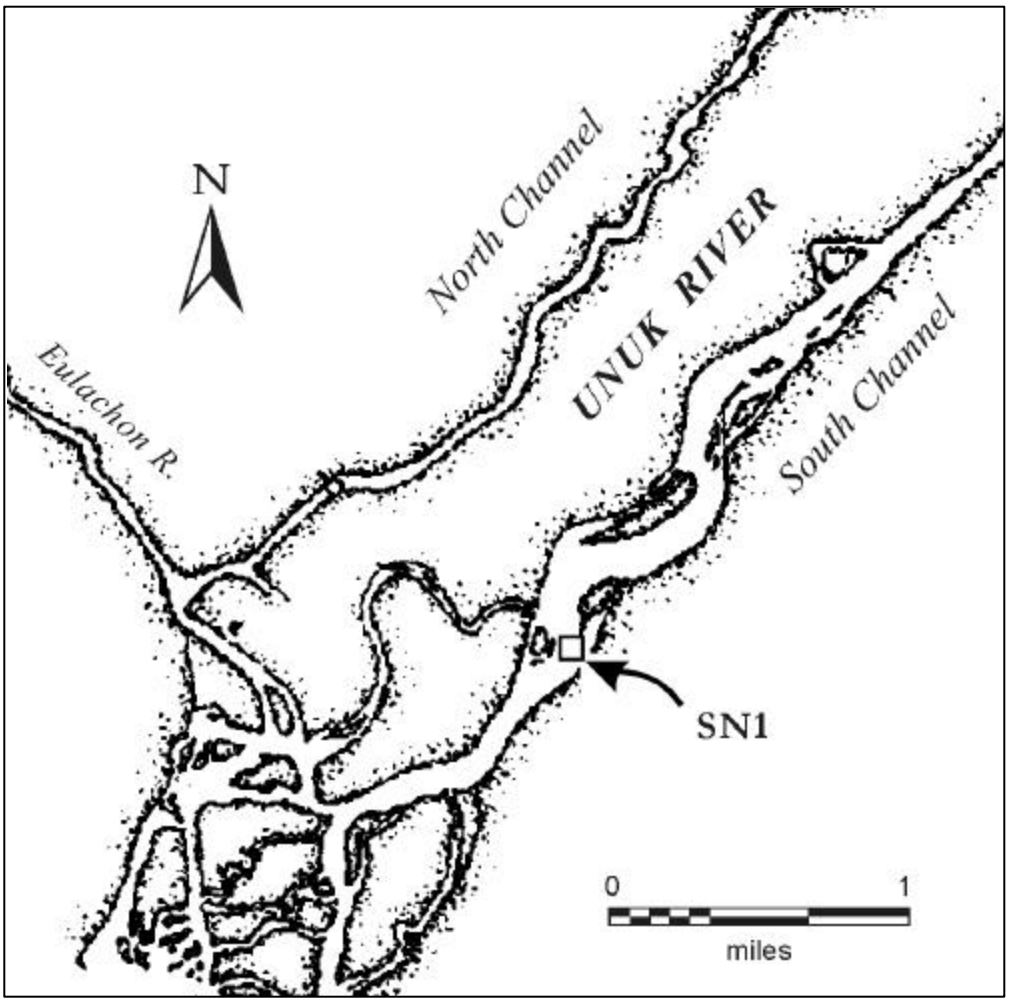

Figure 3.–Location of the set gillnet site (SN1) on the lower Unuk River in 1999.

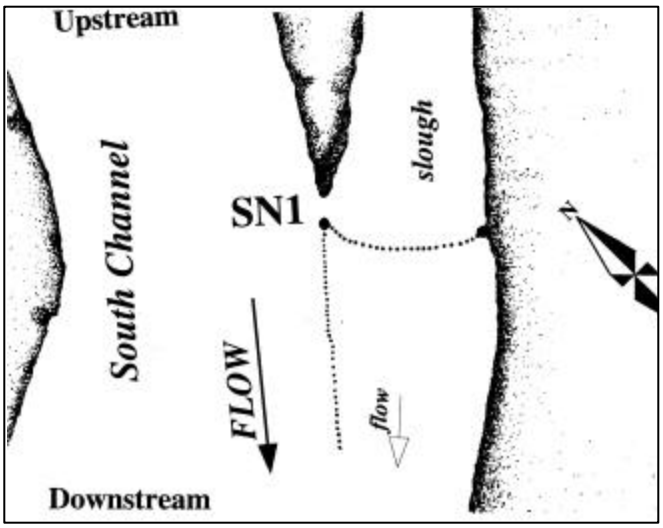

Figure 4.–Detailed drawing of the net placement used at the set gillnet site (SN1) on the lower Unuk River in 1999.

small slough to a fixed buoy placed just downstream of a small island (perpendicular to the main flow of the Unuk River). Another net (a lead net) was attached to the same buoy and fished downstream along the eddy line created between the mainstem flow and the side slough.

All fish captured, regardless of condition, were sampled for ASL prior to their release. Length in MEF was measured to the nearest 5 mm and sex was determined from secondary maturation characteristics. Four scales approximately 2 cm apart were taken from the preferred area on the left side of the fish. The preferred area is two to three rows above the lateral line and between the posterior terminus of the dorsal fin and the anterior margin of the anal fin (Scarnecchia 1979). Scales were mounted on gum cards capable of holding scales from ten fish as described in ADF&G (1993). The age of each fish was later determined from the pattern of circuli as seen on images of scales impressed into acetate cards (Clutter and Whitesel 1956; Moser 1968) under 70× magnification. The presence of an adipose fin was also noted for each sampled fish, and those missing adipose fins were sacrificed by having their heads removed and sent to the Tag Lab in Juneau for detection and decoding of the CWTs.

Each captured fish possessing an adipose fin and not previously sampled was given three different marks: a uniquely numbered solid-core spaghetti tag, a clip of the left axillary appendage (LAA), and a left upper operculum punch (LUOP) ¼? in diameter. The two secondary marks enable detection of primary tag loss. The spaghetti tag (primary tag) consisted of a 5.71-cm (2¼?) section of laminated Floy tubing shrunk onto a 38-cm (15?) piece of 80-lb test monofilament fishing line. The monofilament was sewn through the back just behind the dorsal fin and secured by crimping both ends of the monofilament in an aluminum line crimp and excess line was cut off. Each spaghetti tag was printed with an individual number and an ADF&G contact phone number.

In Event 2, salmon were sampled for the presence of spaghetti tags and secondary marks on the spawning grounds, specifically at Gene's Lake, Clear, Lake, and Kerr creeks, the Eulachon River and in the mainstem of the Unuk River (Figure 2). Sampling at upriver locations such as Cripple and Boundary creeks was not performed due to hazardous river conditions above the confluence of Gene's Lake Creek and the Unuk River. Various gear types, such as rod and reel snagging, bait and lures, and short sections of gillnet were used to sample fish. The use of multiple gear types has been shown to reduce bias in estimates of age, sex, and length composition when sampling chinook salmon (Jones et al. 1998; Jones et al. 1999; Jones and McPherson 1999, 2000). All fish inspected during Event 2 were given a left lower operculum punch (LLOP) to prevent double sampling of fish. Sampled fish were closely examined for the presence of adipose fins, the primary tag and LUOPs, LLOPs, and LAAs. All fish were sampled for ASL data using the same techniques applied at SN1.

Escapement of Unuk River coho salmon adults in 1999 was estimated using Chapman's modification of the Petersen estimate (Seber 1982):

$$\hat{N}_e = \frac{(\hat{n}_1 + 1)(n_2 + 1)}{(m_2 + 1)} - 1 \qquad (3)$$

where $\hat{N}_e$ is the number of adult coho salmon immigrating into the Unuk River in 1999, $\hat{n}_1$ is the estimated number of fish marked during Event 1 that immigrated to the river, n_2 is the number inspected for marks during Event 2, and m_2 is the number of n_2 that possessed unique marks applied during Event 1. To adjust for the loss of tags from the study area associated with Event 1 capture and tagging (i.e., determined by the radiotelemetry study), $\hat{n}_1$ was estimated:

$$\hat{n}_1 = n_1(1 - \hat{y}) \qquad (4)$$

where $\hat{y}$ is the loss of tags expressed as a proportion. The general assumptions of the Petersen estimate are shown above, under the Estimate of Smolt Abundance section. To provide evidence that assumption *a* was met, two $?^2$ tests were performed: (1) for equal marked fractions by sampling location in Event 2; and (2) equal probabilities of recapture in Event 2 independent of the stratum of origin. If the null hypothesis of either test was accepted,

the pooled Petersen estimator (equation 3) would be used to model the mark-recapture data; otherwise a temporally or spatially stratified estimator would be employed. Tests were made separately using the SPAS software program (Arnason et al. 1996). We also tested the hypothesis that the marked fraction sampled in Event 2 did not vary with time. If it did, stratification of the experiment by time might be appropriate if the first $?^2$ test above was rejected.

The possibility of size and sex selective sampling was also investigated, because assumption *a* can also be violated in this manner. The hypothesis that fish of different sizes were captured with equal probabilities was tested by using two Kolmogorov-Smirnov (K-S) 2-sample tests ($\alpha = 0.1$) (Appendix A1). To investigate the possibility of sex-selective sampling, we used a $?^2$ test to compare the number of males and females caught in the lower river with those caught on the spawning grounds. If significant differences in recorded sex compositions were observed, the abundance estimate could be further stratified by sex to reduce bias. If sex compositions differed significantly, either marking or spawning grounds samples alone could be used to estimate sex composition, although sex determination is known to be more difficult early in the season while marking fish (Ericksen 1999).

Because sampling in the lower river spanned the known immigration of coho salmon into the Unuk River and continued uninterrupted, the study is essentially closed to recruitment (assumption *b*). Assumption *c* was tested by the radiotelemetry study described earlier in the Radiotelemetry section. The effect of tag loss (assumption *d*) is virtually eliminated by using the two secondary marks, and all fish captured during Event 2 were inspected for all marks (assumption *e*). Double sampling (assumption *f*) was avoided by marking all fish captured in Event 2 with the LLOP.

Variance, bias, and confidence intervals for $\hat{N}_e$ were estimated with modifications of bootstrap procedures in Buckland and Garthwaite (1991). First, a stochastic value for $\hat{n}_1$ was obtained by drawing a value for $\hat{q} = (1 - \hat{y})$ using the distribution binomial (t; s, $\hat{q}$), where t is the number of radiotagged fish associated with successful spawning and s is the sample size (=39) to compute $\hat{q} = t / s$. Then a bootstrap sample was drawn with replacement from a sample of size $\hat{N}_e^+$ using the empirical distribution defined by the capture histories (Table 1).

Table 1.–Capture histories for coho salmon in the population spawning in the Unuk River in 1999 (notation explained in text).

Capture history	Sample size	Source of statistics
Number that died due to capture and tagging	258	$n_1 \hat{y}$
Marked and not sampled in tributaries	650	$\hat{n}_1 - m_2$
Marked and recaptured in tributaries	8	m_2
Not marked, but captured in tributaries	344	$n_2 - m_2$
Not marked and not sampled in tributaries	24,844	$\hat{N}_e - \hat{n}_1 - n_2 + m_2$
Effective population for simulations	26,104	$\hat{N}_e^+ = \hat{N}_e + n_1 \hat{y}$

A new set of statistics was generated from each bootstrap sample $\{\hat{n}_1^*, n_2^*, m_2^*\}$, along with a new estimate for abundance $\hat{N}_e^*$. One thousand such bootstrap samples were drawn, creating the empirical distribution $\hat{F}(\hat{N}^*)$, which is an estimate of $\hat{F}(\hat{N}_e)$. The difference between the average $\hat{N}_e^*$ of bootstrap estimates and $\hat{N}_e$ is an estimate of statistical bias in the latter statistic (Efron and Tibshirani 1993, Section 10.2). Confidence intervals were estimated from $\hat{F}(\hat{N}_e^*)$ with the percentile method (Efron and Tibshirani 1993, Section 13.3). Variance was estimated as

$$\mathrm{var}(\hat{N}_e^*) = (B-1)^{-1} \sum_{b=1}^{B} (\hat{N}_{eb}^* - \overline{\hat{N}}_e^*)^2 \qquad (5)$$

where B is the number of bootstrap samples.

AGE, SEX, AND LENGTH COMPOSITION

The proportion of the spawning population ($\hat{N}_e$) composed of a given age was estimated as a binomial variable from fish sampled during Event 1 using set gillnets:

$$\hat{p}_j = \frac{n_j}{n} \tag{6}$$

$$\text{var}(\hat{p}_j) = \frac{\hat{p}_j(1-\hat{p}_j)}{n-1} \tag{7}$$

where $\hat{p}_j$ is the estimated proportion of the sample of age j, n_j is the number of coho salmon of age j, and n is the number of coho salmon sampled during Event 1 that were successfully aged.

Sex composition and age-sex composition for the escapement 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 $\sum_{jk} \hat{p}_{jk} = 1$. Average lengths by age and sex were calculated using standard procedures.

ESTIMATE OF HARVEST

The harvest of coho salmon in 1999 originating from the Unuk River was estimated from catch samples in the U.S. and Canadian marine commercial and U.S. recreational fisheries and from the escapement. Because several fisheries harvested coho salmon bound for the Unuk River over several months in 1999, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by fishing period and by fishing quadrant. Statistics from drift gillnet and seine fisheries were stratified by week and by fishing district. Statistics from the recreational fishery were stratified by fortnight. Estimates of harvest $\hat{r}_i$ were calculated for each stratum and summed across strata and across fisheries to obtain an estimate of the total $\hat{T}$:

$$\hat{T} = \sum_i \hat{r}_i \tag{8}$$

$$\text{var}[\hat{T}] = \sum_i \text{var}[\hat{r}_i] \tag{9}$$

Variance of the sum of estimates was estimated as the sum of variances across strata, because sampling was independent across strata and across fisheries. A subset n_i of the catch (H) in each stratum was counted and inspected to find fish missing their adipose fins. Of those a_i salmon in this sample without the adipose fin, heads were retrieved from a subset, marked, and sent to Juneau for dissection. Of the a_i' heads that arrived in Juneau, all were passed through a magnetometer to detect a CWT. Of the t_i tags detected, t_i' were successfully decoded under a microscope, after dissection of which m_i had come from the Unuk River. Oliver (1990) and Hubartt et al. (1999) present details of sampling commercial and recreational fisheries, respectively. The marked fraction with tags that returned to the Unuk River was estimated as $q_h = m_e / n_e$ where m_e is the number of adults sampled at SN1 in 1999 that possessed valid detectable CWTs and n_e is the total number of adults sampled at SN1 in 1999. Information from catch and field sampling programs was expanded to estimate harvest and the associated variance of coho salmon bound for the Unuk River for each stratum, using methods and equations from Bernard and Clark (1996, Table 2).

MEAN DATE OF HARVEST

Estimates of the mean dates of harvest for commercial and sport fisheries were calculated from the time series of estimated proportions of catches by strata within a fishery following the methods of Mundy (1982)

$$\hat{P}_d = \frac{\hat{H}_d}{\sum_i H_i} \tag{10}$$

where P_d is the fraction of Unuk River coho salmon in a fishery on day d. The mean date of harvest $\bar{d}$ in each fishery was calculated as

$$\hat{\bar{d}} = \sum_d d\hat{P}_d \tag{11}$$

ESTIMATES OF TOTAL RUN, EXPLOITATION, AND MARINE SURVIVAL

Estimates of total run (i.e., harvest and escapement) for coho salmon returning to the Unuk River in 1999 and the associated exploitation rate in commercial and sport fisheries are based on the sum of the estimated harvest and escapement

$$\hat{N}_R = \hat{T} + \hat{N}_e \tag{12}$$

The variance of the estimated run was calculated as the sum of the variances for estimated escapement and harvest

$$\text{var}[\ \hat{N}_R\ ] = \text{var}[\ \hat{T}\ ] + \text{var}[\ \hat{N}_e\ ] \tag{13}$$

The estimate of exploitation rate was calculated as

$$\hat{U} = \frac{\hat{T}}{\hat{N}_R} \tag{14}$$

$$\text{var}[\hat{U}] \approx \frac{\text{var}[\hat{T}]\hat{N}_e^2}{\hat{N}_R^4} + \frac{\text{var}[\hat{N}_e]\hat{T}^2}{\hat{N}_R^4} \tag{15}$$

The estimated survival rate of smolt to adults was calculated by

$$\hat{S} = \frac{\hat{N}_R}{\hat{N}_s} \tag{16}$$

$$\text{var}[\ \hat{S}\ ] \approx \hat{S}^2 \left[\frac{\text{var}[\ \hat{N}_R\ ]}{\hat{N}_R^2} + \frac{\text{var}[\ \hat{N}_s\ ]}{\hat{N}_s^2} \right] \tag{17}$$

Variances in equations (14) and (16) were approximated using the delta method (Seber 1982).

RESULTS

SMOLT CAPTURE, CODED-WIRE-TAGGING, AND SAMPLING

From 27 March to 12 April 1998, 16,802 coho salmon smolt ≥ 70 mm FL were captured and tagged with CWT code 04-47-16. These fish were held overnight for 24 hrs then tested the following morning for mortality and the presence of valid tags. With the exception of a lull around 10 April, catches increased over time (Figure 5). Water level initially was high, likely

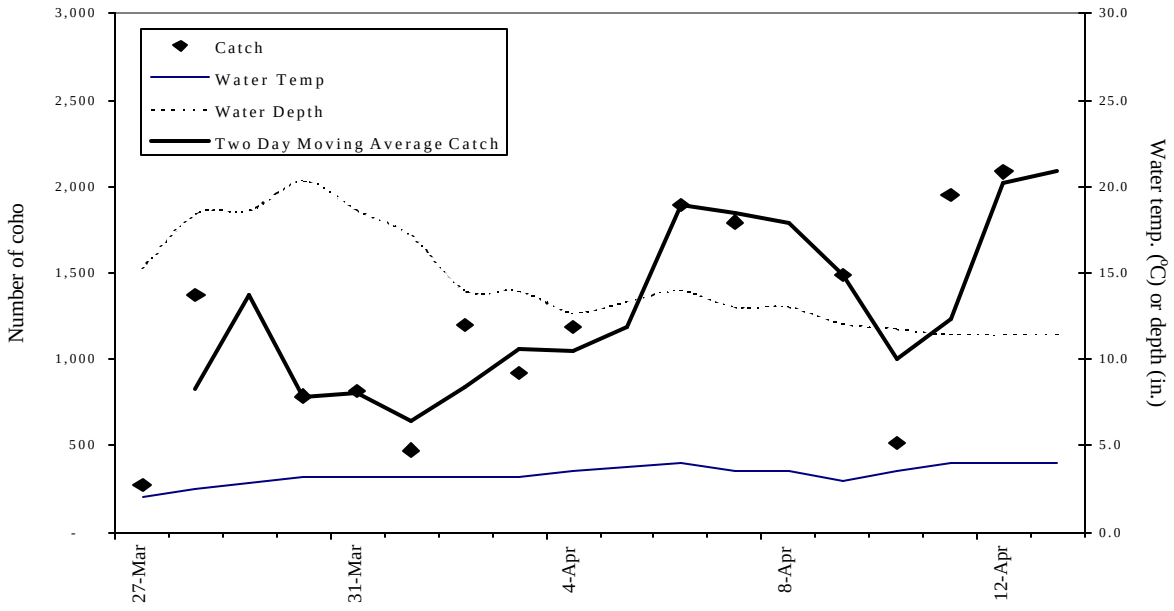

Figure 5.–Catch of coho salmon smolt ≥ 70 mm FL, daily water temperature, and water depth in the Unuk River in 1998.

Table 2.–Number of salmon smolt caught and coded-wire tagged using baited minnow traps on the Unuk River in 1998. Coho and chinook salmon totals include an estimated 0 and 54 shed tags, respectively.

		Coho salmon			Chinook salmon			Water conditions	
Date	Traps checked	Number	Avg. length (mm)	Weight (g)	Number	Avg. length (mm)	Weight (g)	Temp. (°C)	Depth (cm)
27-Mar	37								
28-Mar	185								
29-Mar		1,651	88.92	6.86	2,941	64.58	2.63	2.0	15.2
30-Mar	149								
31-Mar	155				3,478	67.46	3.06	3.0	21.6
1-Apr	90	2,083	85.13	6.05				3.5	19.1
2-Apr	175								
3-Apr	135				1,915			3.0	15.2
4-Apr	173								
5-Apr		3,306	90.56	7.36	2,854	66.16	2.89	3.5	12.7
6-Apr	184								
7-Apr	174								
8-Apr		3,693	63.65	2.53	3,106			4.0	14.0
9-Apr	78								
10-Apr	27	2,005			1,325			3.0	12.1
11-Apr	131								
12-Apr	140								
13-Apr		4,035			1,556			4.0	11.4
Total	1,833	16,773			17,175				
Average	131	2,796	88.87	6.92	2,454	65.79	2.82		
SD			10.28	2.44		7.86	1.14		
SE			0.62	0.15		0.38	0.06		

from snowmelt, and water temperature steadily increased over time (Table 2). Of the 16,802 coho salmon smolt tagged, 29 overnight mortalities were noted and none lost their tags, so 16,773 valid tags were released (Table 2; Figure 5). Tagged coho salmon smolt averaged 89 mm FL (Table 2; Figure 6).

In addition, chinook salmon smolt were captured and tagged. A total of 11,193 were tagged with CWT code 04-46-46; of these, 5 died overnight and 53 lost their tags. Another 5,991 were tagged with code 04-43-39; of these, 4 died overnight and none lost their tags. For the two tag codes combined, 17,175 valid tags were released (Table 2; Figure 5). The average size of chinook salmon smolt tagged was 66 mm FL (Table 2; Figure 6). Detailed analysis of the chinook data will be reported in a separate document in future years.

ESTIMATE OF SMOLT ABUNDANCE

The fraction of fish with adipose finclips that returned to the Unuk River was estimated as $q_s = m_a / n_e$, where m_a is the number of adults sampled in the Unuk River in 1999 during Event 1 that possessed adipose finclips. The estimate of q_s was 0.0268 (SE = 0.005) and the estimate of smolt abundance $\hat{N}_s$ for 1998 is 562,217 (SE = 101,016). Both estimates were based on the 971 unique adult coho salmon handled during Event 1 in 1999 on the Unuk River while sampling for the two-event mark-recapture study (Appendix A2). Twenty-eight (28) fish inspected were missing adipose fins, and all were sacrificed to determine the tag codes present; 26 contained valid Unuk River tags and two heads had lost their

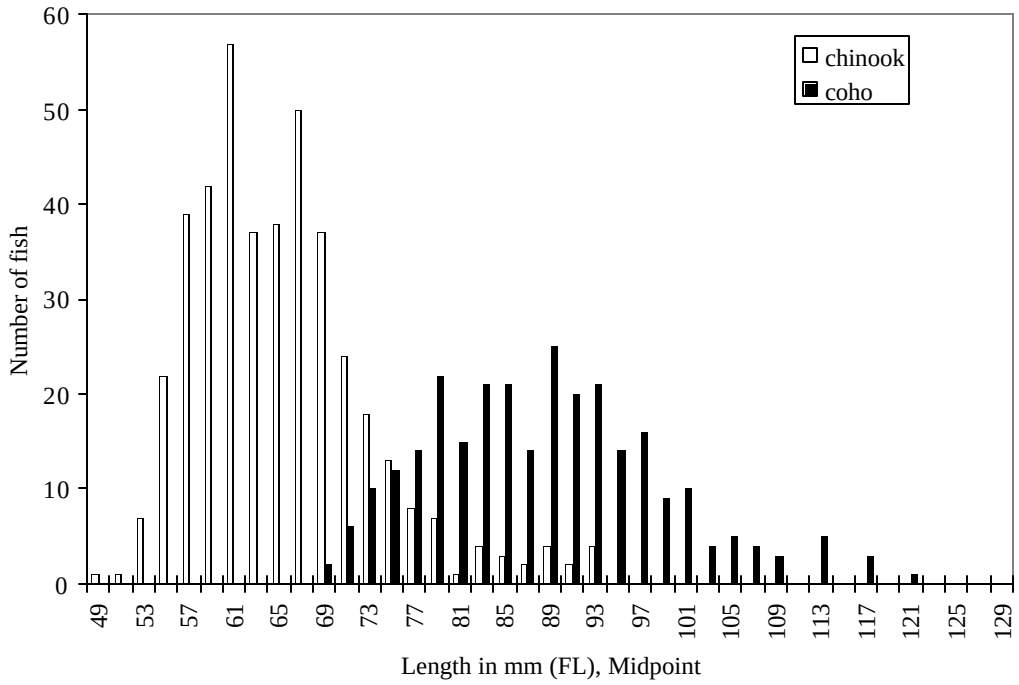

Figure 6.–Length frequency of coho salmon smolt ³70 mm FL and chinook salmon smolt captured and measured in the spring in the Unuk River in 1998.

tags after release. We assumed these two heads bore valid Unuk River tags, as 100% of the valid tags were of Unuk River origin and previous studies performed on the Taku River (McPherson et al. 1997) have shown the incidence of naturally missing adipose fins in coho salmon (less than 1 in 1,000) to be lower than the rate here (2 in 972).

RADIOTELEMETRY

Thirty-nine (39) fish were tagged with radio tags. These fish were tracked from Grant Creek, which flows into Burroughs Bay approximately 7 km west of the mouth of the Unuk River, to river km 47 on the Unuk River in Canada (Figure 7; Appendix A3). Out of the 39 radio tags released, 28 fish were found in areas of the Unuk River (Appendix A3). Thus, we estimate $\hat{y}$ = 11/39 to adjust for the rate of mortality described in equation 4. Fifty-seven percent (57%) of the 28 fish which remained to spawn in the Unuk River were found in the main channel, 21% in the Eulachon River, and 11%, 7%, and 4% in Lake, Gene's Lake, and Kerr creeks; 7% were tracked into Canada. Twenty-two (22) fish were found passing river km 15 where the remote tracking stations were located. Of these, 8 were never recorded at the remote tracking stations but were seen during aerial surveys and 4 were never seen during aerial surveys but were recorded at the remote tracking stations. Thus, neither tracking method is failsafe. Of the 11 fish that did not spawn in the Unuk River, 5 were located at or near SN1, 1 was tracked to Grant Creek, and 5 were not found at all.

ESTIMATE OF ESCAPEMENT

We sampled 971 coho salmon during Event 1 in the lower Unuk River, and 960 were greater than 450 mm MEF; 905 of these were tagged and released (n_1) with spaghetti tags, and 650 were estimated to survive and spawn (Table 3). Ninety-five percent (95%) of the catch occurred between 16 August and 27 September (Figure 8). Twenty-eight (28) of the captured fish were in

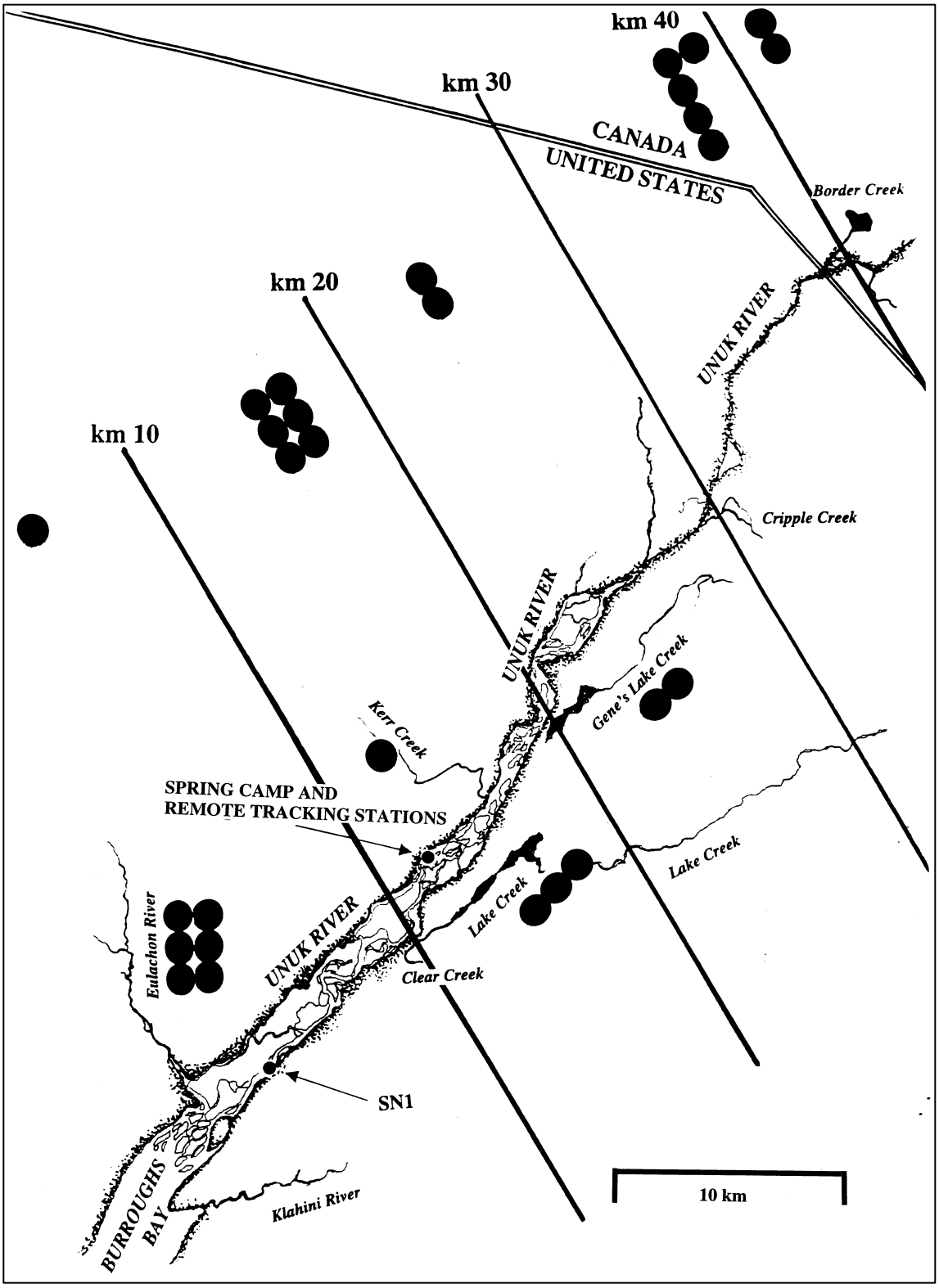

Figure 7.–Radiotelemetry index map showing the Unuk River (measured per 10 river km) and the main coho salmon spawning tributaries. Each circle refers to the farthest upstream location identified for a radiotagged fish in 1999; dots on top indicate mainstem spawning and dots below refer to spawning in tributaries.

Table 3.–Number of marked coho salmon released in the lower Unuk River and recaptured by marking period and recovery location and the number examined for marks at each recovery location, 1999.

Marking dates	Estimated number marked[a]	Estimated fraction recovered	RECOVERY LOCATION					Total
			Eulachon River	Lake Creek	Boundary Creek	Gene's Lake Creek	Kerr Creek	
7/26–8/28	196	0.0102	1	1				2
8/29–9/9	241	0.0083	1			1		2
9/10–9/18	138	0.0145	1	1				2
9/18–10/10	75	0.0268		1			1	2
Total/average	650	0.0123	3	3		1	1	8
Number inspected			141	121	33	32	25	352
Fraction marked			0.021	0.025	0	0.031	0.040	0.023

[a] Number marked discounted by the rate of mortality (y = 11/39) as determined by the radiotelemetry study to get the actual number available for sampling during Event 2.

poor condition and not tagged, and 28 more were missing adipose fins and subsequently sacrificed. Of the 28 fish sacrificed in Event 1, 26 carried valid CWTs applied during smolt tagging operations on the Unuk River in spring of 1998 and 2 others had lost their tags (Appendix A.2).

We sampled a total of 352 coho salmon during Event 2 by various methods at the Eulachon River and Lake, Boundary, Gene's Lake, and Kerr creeks, and 311 of these were greater than 450 mm MEF (Table 3). Eight (8) of these fish were previously marked during Event 1, and all possessed the primary tag with easily identifiable secondary marks. We obtained the largest samples with various gear types at the Eulachon River (141 fish with 3 recoveries) and at Lake Creek (121 fish with 3 recoveries). Fish were sampled 16 August through 19 October (Figure 9). Two fish were missing adipose fins and sacrificed. Both of these fish carried CWTs from smolt tagging on the Unuk River in 1998.

The length distributions of fish marked at SN1 were not significantly different from the length distributions for fish recaptured on the spawning grounds (P = 0.73, Figure 10) an indication that sampling on the spawning grounds was not size-selective. However, the length distributions of marked fish were marginally comparable to those inspected on the spawning grounds (P = 0.08, Figure 10). This test suggests that sampling during Event 1 was size-selective for larger fish (Appendix A1) yet with only 8 recaptures this test has very low power.

Coho salmon marked early in the experiment (before 10 September) and late in the experiment were equally likely to be recaptured ($?^2$ = 1.15, df = 1, P = 0.28). Similarly, the recapture rate during Event 2 did not vary by sampling date (before or after 16 September; $?^2$ = 0.006, df = 1, P = 0.94) or sampling location (downstream or upstream—i.e., Eulachon River vs. Lake, Boundary, Gene's Lake, and Kerr Creeks; $?^2$ = 0.022, df = 1, P = 0.88).

There is some indication that Event 2 sampling was not in proportion to abundance. For instance, 21% of the radiotagged fish were tracked to the Eulachon River; however, the Eulachon River comprised 41% of the total Event 2 sample. In addition, half of the radiotagged fish were tracked to mainstem spawning locations not sampled during Event 2.

The number of marked coho salmon (n_1 = 905) was discounted by the rate of mortality (y = 11/39), as determined by the radiotelemetry study, to get the actual number of marked fish escaping ($\hat{n}_1$ = 650). Fish were divided into five capture histories (Table 1) and bootstrap procedures were performed to estimate variance, bias, and confidence intervals for $\hat{N}_e$. The estimated

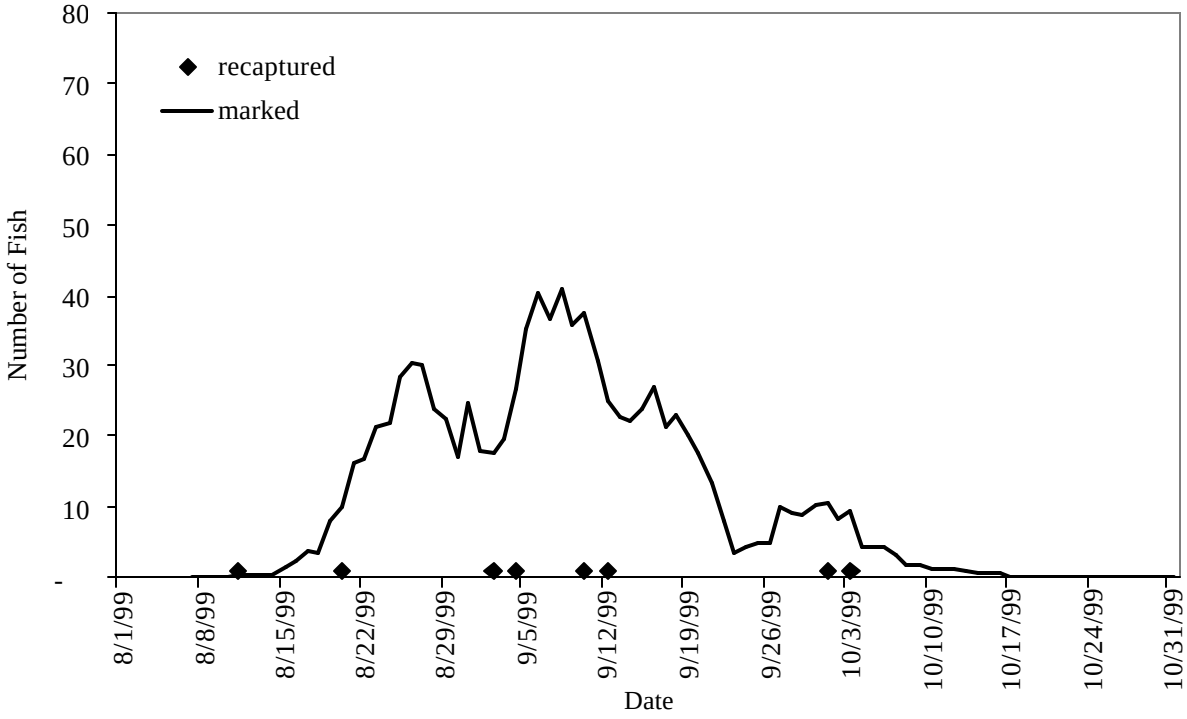

Figure 8.–Event 1 samples of coho salmon marked (line**) by date and the subset later recaptured (**8**) in Event 2 (**dots**) in the Unuk River in 1999.**

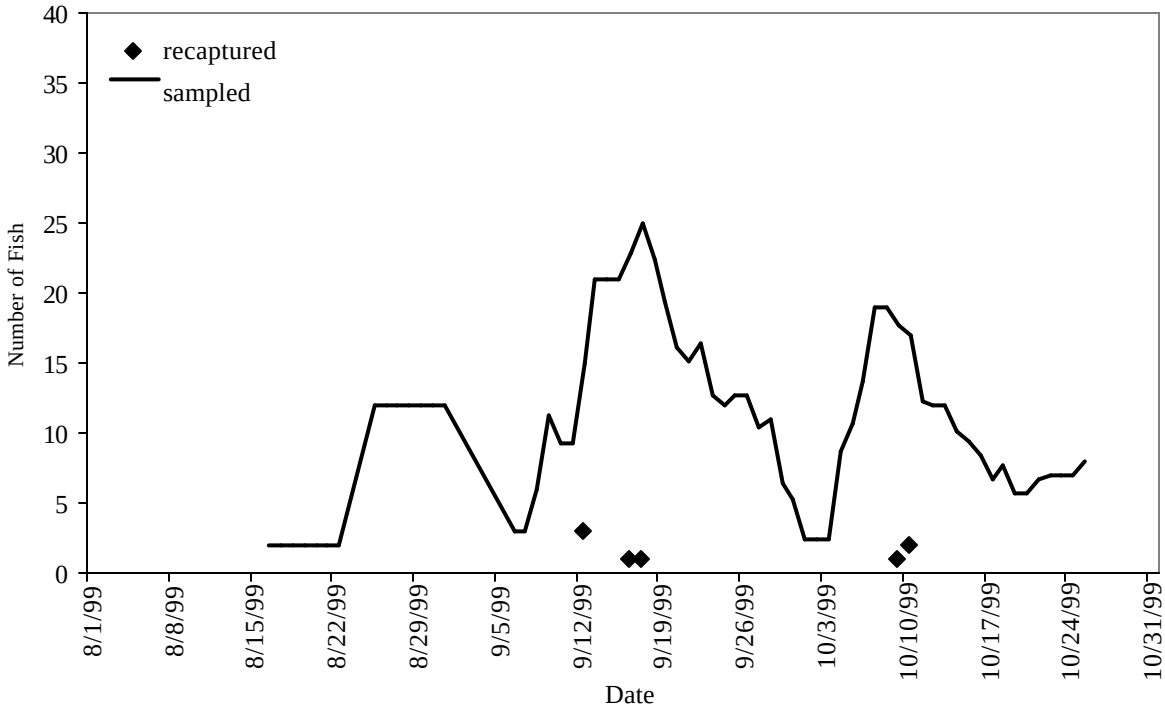

Figure 9.–Event 2 weekly moving averages of coho salmon sampled (line**) and those recaptured (**dots**) by date.**

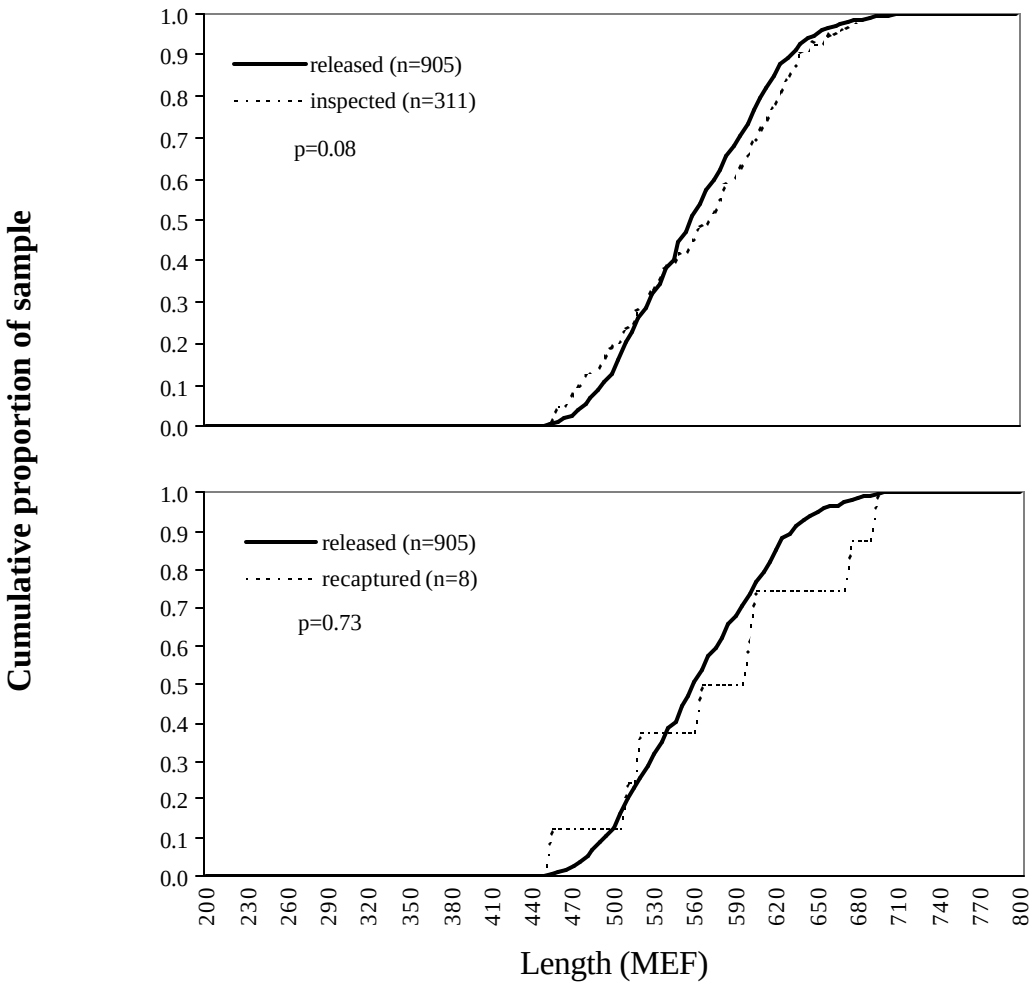

Figure 10.–Cumulative relative frequencies of adult coho salmon greater than 450 mm MEF marked in the lower Unuk River in 1999 compared with those inspected and recaptured on the spawning grounds.

escapement of coho salmon in the Unuk River in 1999 was 25,523 (SE = 10,011). From bootstrapping, statistical bias in $\hat{N}$ was estimated at 3.1% and the 90% confidence interval for the estimate was 13,710 to 42,531 (RP ± 65%).

ESTIMATES OF AGE, SEX, AND LENGTH COMPOSITION

Tests for sex-selective sampling indicate that Event 2 was highly selective for males ($?^2$ = 54.91, df = 1, P < 0.001). Differences were also found in the age composition between events: more age-1.1 fish were sampled during Event 1 than in Event 2 ($?^2$ = 7.51, df = 1, P = 0.006). We found no reason to suspect disproportional sampling during Event 1, so Event 1 samples were used to estimate the age, sex, and length composition (Table 4). Of the 960 fish greater than 450 mm MEF sampled in Event 1, 944 had scales sampled and age was determined on 816 of these.

For scales in which age was determined, 77% (SE = 1.5%) were age-1.1 and 23% (SE = 1.5%) were age-2.1. Males composed 55% (SE = 1.7%) of the sample in Event 1 (Table 4; Appendix A4). Of the 960 fish greater than 450 mm MEF sampled in Event 1, the largest fish was 715 mm and on average fish were 565 mm (SE = 1.8 mm) MEF in length. For the total run of 55,147 coho salmon bound for the Unuk River,

Table 4.–Age and sex composition of Unuk River coho salmon escapement, harvest, and run in 1999 based on samples gathered during Event 1 sampling on the spawning grounds.

		Age		
		1.1	2.1	Total
Females	n	276	92	368
	%	33.9	11.3	45.2
	SE of %	1.7	1.1	1.7
	Escapement	8,643	2,881	11,524
	SE	3,413	1,160	6,727
	Harvest	9,912	3,304	13,217
	SE	1,128	469	2,023
	Total run	18,642	6,214	24,856
	SE	3,652	1,324	7,025
Males	n	349	98	447
	%	42.8	12.0	54.8
	SE of %	1.7	1.1	1.7
	Escapement	10,929	3,069	13,998
	SE	4,306	1,233	7,414
	Harvest	508	334	16,054
	SE	1,385	491	2,230
	Total run	23,573	6,619	30,192
	SE	4,574	1,400	7,742
Total	n	625	190	815
	%	76.7	23.3	100.0
	SE of %	1.5	1.5	
	Escapement	19,573	5,950	25,523
	SE	7,685	2,360	10,011
	Harvest	22,447	6,824	29,270
	SE	2,349	824	3,011
	Total run	42,215	12,833	55,048
	SE	8,057	2,565	10,454

an estimated 42,215 (SE = 8,057) were age-1.1 and 12,833 (SE = 2,565) were age-2.1, and 30,192 (SE = 7,742) were estimated to be males (Table 4).

In comparison, of the 311 fish tagged and released during Event 2 greater than 450 mm MEF, 305 had scales sampled and age was determined on 282 of those with 68% (SE = 2.8%) were age-1.1 and 32% (SE = 2.8%) were age-2.1. Males composed 80% (SE = 2.4%) of the successfully aged scale sample (Appendix A4). The largest fish sampled during Event 2 was 695 mm (Appendix A4). For Events 1 and 2 combined, age-1.1 fish accounted for 75% (SE = 1.3%), age-2.1 fish for 25% (SE = 1.3%) and 62% (SE = 1.5%) of the escapement were males (Appendix A4). Note that Event 2 samples were rich in males and depleted in age-1.1 fish relative to the escapement.

ESTIMATES OF HARVEST, MEAN DATE OF HARVEST, TOTAL RUN, EXPLOITATION RATE, AND MARINE SURVIVAL

In 1999, 231 coho salmon with CWTs released in the Unuk River in 1998 were recovered from various fisheries as random recoveries in the port and creel census sampling programs and another 29 were from escapement sampling (Table 5; Appendix A5). There were no recoveries reported for marine commercial fisheries in Canada. Recoveries in 1999 were primarily from troll gear (62%) and to a lesser extent from drift gillnet (19%), purse seine (14%), and sport (6%) gear. Southeast Alaska is divided into four main quadrants (Figure 3 in Jones et al. 1999) and recoveries were mostly from the Southeast (53%) and Northwest (33%) quadrants with the remainder being from the Southwest (8%) and Northeast (6%) quadrants. Of the 148 CWTs recovered in the commercial troll fishery, 53%, 27%, 11%, and 9% were from the Northwest, Southeast, Southwest, and Northeast quadrants, respectively. In the commercial gillnet fisheries, all 52 CWTs recovered were from the Southeast Quadrant and offloaded in Ketchikan (26), Petersburg (22), or Metlakatla (4). They were harvested in District 101 (16) and in District 106 (36). Twenty (20) CWTs were recovered in the marine recreational fishery, 14 from the Ketchikan area and 6 from the Sitka area. Fourteen (14) CWTs were recovered in seine fisheries, 6 from the Southeast, 5 from the Southwest, and 3 from the Northeast quadrants.

An estimated 29,270 (SE = 3,011) coho salmon originating from the Unuk River were harvested in marine commercial and sport fisheries in 1999 throughout Southeast Alaska (Tables 5, 6). The troll fishery in the Northwest Quadrant took 40%, the drift gillnet fishery in District 106 took 14%, and the seine fishery in District 101 near Ketchikan took 8% of the estimated marine harvest (Table 6). The troll harvest was spread over a long period (i.e., July through October) and 69% of the gillnet harvest occurred during a three week period (i.e.,

Table 5.–Estimated marine harvest of adult coho salmon bound for the Unuk River in 1999, where $\hat{q}_h$ = 0.027 and $G(\hat{q}_h^{-1})$ = 0.0541.

TROLL FISHERY

Stat.wk	Dates (period)	Quad	H	var(H)	n	a	a'	t	t'	m	$\hat{r}$	$SE(\hat{r})$	$RP(\hat{r})$
19–33	5/2–8/14 (3)	NE	205,680	0	72,468	925	910	723	723	12	1,293	509	77%
34–41	8/15–9/9 (4)	NE	100,892	0	36,415	563	554	462	462	1	105	105	195%
19–33	5/2–8/14 (3)	NW	934,245	0	239,684	4,776	4,695	3,953	3,950	48	7,113	2,224	61%
34–41	8/15–9/9 (4)	NW	547,199	0	144,191	3,606	3,566	3,100	3,095	31	4,450	1,464	64%
19–33	5/2–8/14 (3)	SE	121,202	0	65,626	1,172	1,163	877	876	14	974	369	74%
34–41	8/15–9/9 (4)	SE	91,203	0	35,346	811	800	589	589	26	2,540	857	66%
19–33	5/2–8/14 (3)	SW	217,193	0	85,717	1,033	1,020	779	778	15	1,439	538	73%
34–41	8/15–9/9 (4)	SW	42,754	0	17,534	249	242	175	175	1	94	93	195%
	Subtotal troll fishery		2,260,368	0	696,981	13,135	12,950	10,658	10,648	148	18,009	2,921	32%

SEINE FISHERY

Stat.wk	Date	District	H	var(H)	n	a	a'	t	t'	m	$\hat{r}$	$SE(\hat{r})$	$RP(\hat{r})$
30	7/18–7/24	101	4,265	0	628	13	13	11	11	1	254	253	196%
31	7/25–7/31	101	6,127	0	1,614	54	50	43	43	1	153	153	195%
33	8/8–8/14	101	1,827	0	292	7	7	5	5	1	234	233	196%
34	8/15–8/21	101	4,538	0	147	4	4	3	3	1	1,153	1,152	196%
35	8/22–8/28	101	3,638	0	285	6	6	4	4	1	477	476	196%
32	8/1–8/7	104	18,254	0	4,529	70	70	49	49	2	301	217	141%
34	8/15–8/21	104	15,738	0	2,427	41	41	33	33	3	727	438	118%
35	8/22–8/28	106	6,410	0	658	8	8	6	6	1	364	363	196%
32	8/1–8/7	109	35,870	0	5,022	80	80	61	61	1	267	266	196%
34	8/15–8/21	109	7,455	0	2,269	38	38	36	36	2	245	177	141%
	Subtotal seine fishery		104,122	0	17,871	321	17,871	321	317	251	251	14	4,174

SPORT FISHERY

Biweek	Date	Area	H	var(H)	n	a	a'	t	t'	m	$\hat{r}$	$SE(\hat{r})$	$RP(\hat{r})$
13	6/21–7/4	Sitka	5,506	392,042	1,473	30	28	26	26	2	299	217	142%
14	7/5–7/18	Sitka	8,417	3,092,095	2,835	42	41	35	35	3	341	213	122%
16	8/2–8/15	Sitka	17,932	10,350,428	5,582	154	146	131	131	1	127	126	195%
15	7/19–8/1	Ketchikan	3,722	1,802,584	1,070	34	34	31	31	1	130	129	195%
16	8/2–8/15	Ketchikan	2,068	306,070	971	13	13	13	13	1	80	79	195%
17	8/16–8/29	Ketchikan	2,147	274,727	1,015	22	21	19	19	3	248	157	124%
18	8/30–9/12	Ketchikan	4,301	750,077	2,846	86	83	66	66	6	351	170	95%
19	9/13–9/26	Ketchikan	4,262	1,722,623	2,250	87	85	75	75	1	72	72	195%
	Subtotal sport fishery		48,355	18,690,646	18,042	468	18,042	468	451	396	396	18	1,647

GILLNET FISHERY

Stat.wk	Date	District	H	var(H)	n	a	a'	t	t'	m	$\hat{r}$	$SE(\hat{r})$	$RP(\hat{r})$
29	7/11–7/17	101	2,795	0	904	17	16	13	13	1	123	122	195%
34	8/15–8/21	101	3,783	0	1,448	26	26	21	21	2	195	141	141%
36	8/29–9/4	101	6,286	0	2,221	55	55	43	43	3	317	191	118%
37	9/5–9/11	101	5,059	0	2,890	83	82	71	71	3	199	119	118%
38	8/23–8/29	101	7,793	0	3,181	161	158	125	125	2	186	134	141%
39	8/30–9/5	101	7,791	0	3,126	113	111	89	88	3	287	173	118%
40	9/12–9/18	101	3,556	0	1,905	74	74	52	52	2	139	100	141%
27	6/27–7/3	106	2,991	0	1,837	85	84	78	78	1	62	61	194%
28	7/4–7/10	106	4,722	0	2,085	117	117	106	106	1	85	84	195%
29	7/11–7/17	106	5,616	0	2,594	111	110	101	101	1	82	81	195%
31	7/25–7/31	106	12,674	0	4,758	105	105	96	96	2	199	143	141%
32	8/1–8/7	106	7,659	0	3,913	78	78	63	63	1	73	73	195%
33	8/8–8/14	106	11,523	0	4,493	47	46	38	38	2	196	141	141%
34	8/15–8/21	106	13,519	0	7,651	98	98	79	79	3	198	119	118%
35	8/22–8/28	106	10,749	0	3,839	49	48	42	42	1	107	106	195%
36	8/29–9/4	106	22,000	0	9,256	177	177	156	156	5	444	215	95%
37	9/5–9/11	106	24,104	0	4,405	120	120	103	103	4	817	435	104%
38	9/12–9/18	106	34,655	0	10,982	408	403	343	343	8	954	388	80%
39	9/19–9/25	106	18,529	0	5,273	190	189	162	161	4	531	283	104%
40	9/26–10/2	106	9,596	0	4,019	172	172	144	143	2	180	129	141%
41	10/3–10/9	106	9,852	0	5,459	193	193	165	165	1	67	67	195%
	Subtotal gillnet fishery		225,252	0	86,239	2,479	86,239	2,479	2,462	2,090	2,087	52	5,441
TOTAL ALL FISHERIES			2,638,097	18,690,646	819,133	16,403	16,180	13,395	13,382	232	29,270	3,407	23%

Table 6.–Estimated harvest, exploitation, and total run of Unuk River coho salmon in 1999.

Fishery	Area	Estimated harvest	SE	Percent of marine harvest	Percent of total run
U. S. TROLL	NE Quadrant	1,398	520	4.8	2.5
FISHERY	NW Quadrant	11,563	2,663	39.5	21.0
	SE Quadrant	3,514	933	12.0	6.4
	SW Quadrant	1,533	546	5.2	2.8
	Subtotal	18,009	2,921	61.5	32.7
SEINE	District 101	2,270	1,303	7.8	4.1
	District 104	1,028	489	3.5	1.9
	District 106	364	363	1.2	0.7
	District 109	512	320	1.7	0.9
	Subtotal	4,174	1,473	14.3	7.6
SPORT	Sitka	766	329	2.6	1.4
	Ketchikan	881	286	3.0	1.6
	Subtotal	1,647	436	5.6	3.0
GILLNET	District 101	1,447	378	4.9	2.6
	District 106	3,994	759	13.6	7.3
	Subtotal	5,441	848	18.6	9.9
Total marine harvest		29,270	3,407	100.0	53.2
Inriver mark-recapture mortality		255			
Total escapement		25,523	12,867		46.4
Total run		55,048	13,311		100.0
Estimated marine survival		9.8%	2.6%		
Estimated exploitation rate		53.2%	10.0%		

4 September through 25 September) (Figure 11). Estimated mean date of harvest in the troll fishery was 6 August, compared to 29 August for the gillnet fishery (Appendix A6). Coho salmon originating from the Unuk River contributed an estimated 2.0% (3,994 fish; SE = 759) of the District 106 gillnet catch (203,262 fish). Eighty percent (80%) of the estimated harvest occurred by 18 September. The estimated harvest of coho salmon bound for the Unuk River in the Ketchikan marine recreational fishery was 881 (SE = 286) or 4% of the Ketchikan marine recreational fishery (20,718 fish), based on harvest and sampling data from Hubartt et al. (2000). The total escape-ment estimate (25,523), total inriver mortality estimate (255), and total harvest estimate (29,270), when added together, yield a total run estimate of 55,147 (SE = 13,314) coho salmon bound for the Unuk River in 1999. The estimated marine survival rate was 9.8% (SE = 2.6%)(Table 6), higher than what was seen in 1998 (7.1%; SE = 2.0%) (Jones et al. 1999), yet substantially lower than the average (1984-1997) seen at nearby Hugh Smith Lake (13.4%) located approximately 100 km south (Shaul 1998). The estimated exploitation rate in marine commercial and recreational fisheries was 53.2% (SE = 10.0%)(Table 6), much lower than what was seen in 1998 (78.5%; SE = 5.3%) and in recent years from Hugh Smith Lake (70%)(Shaul 1998).

DISCUSSION

Results from coho salmon studies in 1998 and 1999 (Jones et al. 1999) and chinook salmon studies since 1997 (Jones et al. 1998; Jones and McPherson 1999, 2000) suggest that fish bound for the various spawning tributaries of the Unuk River could be proportionately sampled during Event 1 using set gillnets operated at SN1. The

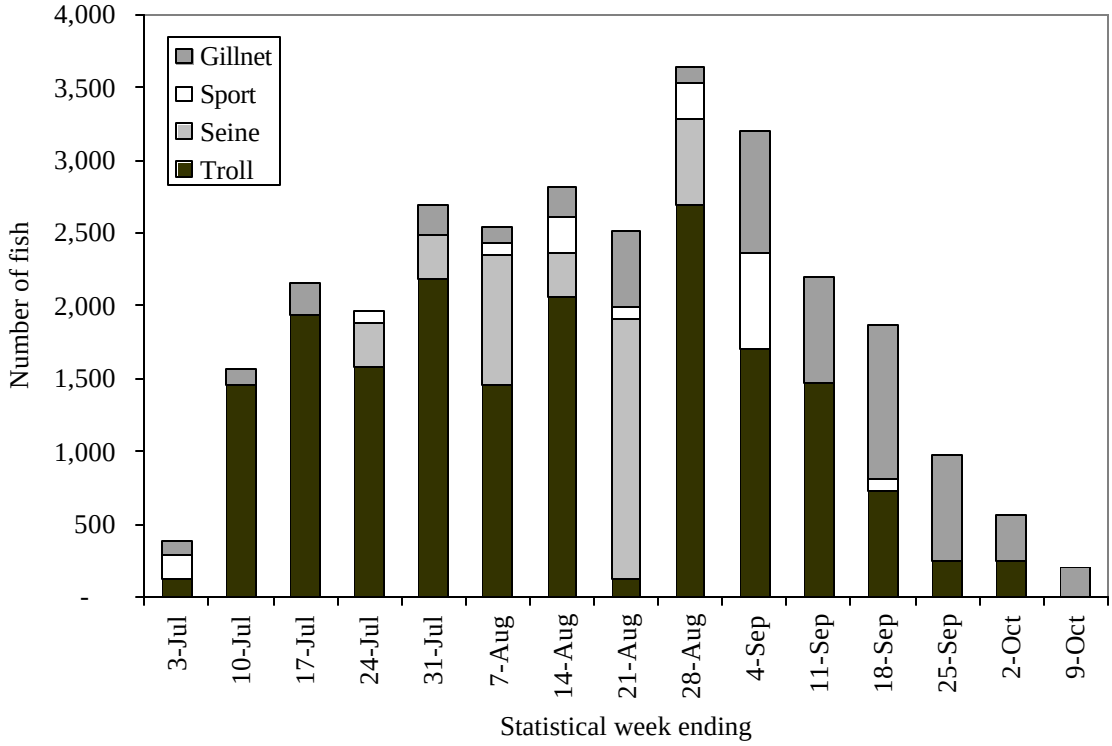

Figure 11.–Estimated harvest of coho salmon bound for the Unuk River, by statistical week, in marine commercial and recreational fisheries in 1999. Weekly estimates of harvest in the troll fishery are approximated.

radiotelemetry data (Appendix A3; Figure 7) shows that fish are distributed throughout the drainage after marking and fish marked throughout Event 1 are recovered in all segments of Event 2 (Figure 8). However, sampling during Event 2 was not in proportion to abundance. Loss of primary tags in this study was not a problem, as none of the recoveries were missing their primary tags and secondary marks were clearly visible on all recaptured fish.

During Event 2, two obvious peaks in sampling occurred around the 12th through the 16th of September and the 4th through the 12th of October, and sampling was poor during the last week of September and the first week of October (Figure 9). The bimodal distributions could be the result of heavy fishing pressures on the central portion of the return. Such bimodal distributions in coho salmon have been seen at Steep Creek near Juneau (Jones and McPherson 1997) and at Hugh Smith Lake near Ketchikan (Leon Shaul, Alaska Department of Fish and Game, Douglas, personal communication).

In 1999, some fish moved quickly to their spawning areas and remained there until dying, while others seemed to spend prolonged periods of time milling in areas that likely afforded some kind of ripening habitat such as deep pools or eddies before moving to their spawning areas (Appendix A3). Fish that move quickly to their spawning areas may gain an advantage by reaching an otherwise unattainable spawning location during high water (which is common early in the run), or a distant spawning location that requires a great deal of time to reach. Fish that spend prolonged periods of time milling may gain an advantage by ripening in deep glacial waters, pools, or in lake areas, thus minimizing contact with predators such as brown bears *Ursus arctos*, black bears *U. americana*, river otters

Lutra canadensis, and even bald eagles *Haleaetus leucocephalus.* A run timing strategy that occurs after bears go into hybernation would be particularly beneficial to fish especially when spawning in small, shallow water streams. It is fairly common to see coho salmon spawning in the small tributaries of Mendenhall Lake in early November and not prior (Brian Glynn, Alaska Department of Fish and Game, Douglas, personal communication).

Stream life between sampling events for recaptures varied greatly, and in general, fish marked early were recaptured early and vice versa. However, two fish showed excessive stream life between sampling events, 28 and 36 days each, and both fish were small pre-spawn males sampled during Event 2 at Lake Creek. The shortest stream life seen for a recaptured fish was 2 days on a large male sampled at the Eulachon River (Appendix A3).

A "sulking" behavior, as a result of capture and marking, was evident in data gathered on coho salmon from the Unuk River in 1998 (Jones et. al. 1999) and this has been noted in another study of coho salmon performed on the Taku River (Eiler et al. *In prep*) and repeatedly in studies of chinook salmon (Bernard et al. 1999). Some "sulking" was noticeable this year with a few radiotagged fish not being found for prolonged periods of time after tagging and then showing up later (Appendix A3). These fish probably backed-out to nearby Burroughs Bay and were not recorded during telemetry flights as the radio transmitters do not work in salt water. Some fish were also recaptured at SN1 having been previously marked at SN1 in prior weeks.

In the radiotelemetry study, some fish were not found at all or were found emitting a mortality signal at or near SN1. It is important to understand that although some of these fish did indeed die as a result of tagging, some are probably strays from other systems. For instance, one fish marked on the 2 September was not located again in the Unuk River but was found 76 days later in Grant Creek (Figure 2). A small number of radiotagged fish may have actually entered the Unuk River but might have not been detected by either survey method. In 1999, 22 radiotagged fish were successfully tracked upstream of the radio towers by either a positive hit at one of the radio towers or identification during one of the five aerial surveys. However, 36% of these fish were never recorded by aerial survey and 18% were never recorded at one of the radio towers indicating the importance of using both survey methods. These results also suggest that a small percentage, around 6% (0.36*0.18), of the radio tags not found previously actually entered the Unuk River to spawn.

Although the population of spawning adults in this study was not strictly closed to losses from mortality, it was considered closed to recruitment, as tagging appeared to span the immigration. Similarly, the smolt population estimate was closed to recruitment, because Pacific salmon typically return to their natal streams to spawn. The models used to estimate adult and smolt population sizes rely on the complex assumption that every fish has an equal probability of being marked, or that every fish has an equal chance of being sampled as an adult, or that marked and unmarked fish mix completely between sampling events. The estimate of smolt abundance relies largely on the latter portion of the assumption, as effort to capture smolt cannot be proportionally allocated to rearing areas. Thus, we note that distribution of CWT recoveries obtained during marine harvest sampling illustrates considerable mixing of marked and unmarked fish during their 14 to 16 months at sea (Table 5). Fractions of adults escaping to the Unuk River over time (before and after September 10) contained similar fractions of CWTs ($?^2 < 0.221$, df = 1, P = 0.64): 2.72% (19/699) for the first period and 3.30% (9/273) for the later period. In contrast, the estimate of adult abundance relies largely on the first part of the assumption, because adults could not be captured in proportion to their abundance on the spawning grounds over time or by area. Evidence supporting this assumption comes from the radiotelemetry study.

The knowledge gained over successive years of study often leads to increases in precision over time. During the first year of study in 1998, we achieved a RP of $\pm$44% (CV = 27%) for a 90% confidence interval. This year our goal was to achieve a similar RP yet because of the low number of recoveries obtained during Event 2 sampling, we achieved a RP of $\pm$65% (CV = 39%) for a 90% confidence interval.

Marking of fish probably began early enough to avoid missing any immigrating fish; however, the inherent tendency of most coho salmon stocks is toward prolonged immigrations. Although marking in 1999 ceased on 10 October, probably before the last immigrants entered the river, the immigration appeared largely complete (Figure 8). Thus, estimates of escapement, catch, and total run are most likely biased low by a small percent. From a practical perspective, this small bias is likely insignificant.

This is an ongoing study designed to estimate total escapement, harvest, run, marine survival, and exploitation rate of Unuk River coho salmon. Concern over the status of coho salmon in southern Southeast Alaska has been prompted by recent changes in run strength of stocks near Ketchikan. It has long been thought that the Unuk River produced total runs between 20,000 and 40,000 adult coho salmon yet results from these last two years of study have shown this range to be low, considering total runs of 58,540 and 55,048 in 1998 and 1999, respectively. Coho salmon in southern Southeast Alaska undergo the highest exploitation rates seen in the region and this project is one of only two full stock assessment projects conducted annually in southern Southeast Alaska. The other, Hugh Smith Lake, is much smaller producing runs of 2,000 to 5,000 fish annually (Shaul 1998). This study has further shown that coho salmon from the Unuk River contribute significantly to the marine and recreational fisheries of Southeast Alaska. Results of these studies and future year's studies are crucial components for better managing coho salmon, not only in the Ketchikan Management Area, but for Southeast Alaska as a whole.

CONCLUSION AND RECOMMENDATIONS

We recommend the following strategies for continued success of this project on the Unuk River in upcoming years.

The use of both radio towers and several radiotelemetry aerial survey flights must continue since neither method has been shown to be failsafe for tracking fish. The fraction of radio tags not accounted for is a crucial component necessary in order to estimate escapement accurately and precisely.

By tagging more smolt each spring with CWTs, we can improve the precision of smolt abundance and harvest estimates, especially those in the sport fishery. Therefore, we recommend that at least 21,000 smolt be tagged annually to meet a target RP of 25%. In most years, this can be accomplished by running the smolt tagging project longer thus covering a greater proportion of the smolt emigration. Typically, chinook salmon smolt catches decline dramatically by the end of April whereas coho salmon catches remain consistent. Thus, concentrating efforts to capture coho salmon after this time should further boost the numbers of coho salmon tagged each spring and ultimately lead to a greater number of tags recovered from the fisheries in the following year.

Obvious sex-selective sampling occurred this year during Event 2, where males composed 80% of the total sample. The most reasonable explanation for this bias lies in the aggressive behavior of males versus females when it comes to striking a bait or lure during rod and reel fishing—the primary gear used during Event 2 sampling. Thus, to gain a more representative sample of the true abundance during Event 2, other non-selective sampling gear must be investigated and used in future years. Some evidence suggests that either Event 1 was biased for larger fish or that Event 2 was biased for smaller fish. To investigate this further, we recommend that instead of fishing two nets of 5? ? mesh during Event 1, one net be switched to 4½? mesh and alternated between the cross and downstream sets daily.

In an effort to improve the RP of the adult escapement estimate, effort needs to be increased during both sampling events. Event 1 gillnetting should be increased from 6 h per day to at least 10 h per day. This should in effect double the number of tags available for recapture in Event 2. In addition, Event 2 sampling effort should be increased thus increasing the numbers of fish sampled. Ideally, these changes should at least double the number of recoveries seen annually.

Finally, the rate of naturally missing adipose fins should continue to be scrutinized during smolt tagging. Our results suggest either high rates of

CWT loss (31% in 1998; 9% in 1999) or high rates of naturally missing adipose fins (0.42% in 1998; 0.20% in 1999). It has been shown in other coho salmon studies that the rate of missing adipose fins is typically less than 0.10% (McPherson and Bernard 1996). Therefore, we assume that all fish sampled in the Unuk River with missing adipose fins were previously marked as smolt with CWTs. However, if the rate of naturally missing adipose fins is found to be much higher than 1 in 1,000, or if the CWT marked fraction of sampled adults becomes much lower than it is at present (about 3 per 100), then difficulties may arise in distinguishing between the two rates.

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APPENDIX A

Appendix A1.–Detection of size-selectivity in sampling and its effects on estimation of abundance and age and size composition.

RESULTS OF HYPOTHESIS TESTS, K-S AND χ^2 on lengths of fish

MARKED during Event 1 and **RECAPTURED** during Event 2	**MARKED** during Event 1 and **INSPECTED** during Event 2
Case I:	
Accept H_O	Accept H_O
There is no size-selectivity during either sampling event.	
Case II:	
Accept H_O	Reject H_O
There is no size-selectivity during Event 2 but there is during the Event 1.	
Case III:	
Reject H_O	Accept H_O
There is size-selectivity during both sampling events.	
Case IV:	
Reject H_O	Reject H_O
There is size-selectivity during Event 2; the status of size-selectivity during Event 1 is unknown.	

Case I: Calculate one unstratified abundance estimate, and pool lengths, sexes, and ages from both sampling events to improve precision of proportions in estimates of composition.

Case II: Calculate one unstratified abundance estimate, and only use lengths, sexes, and ages from Event 2 to estimate proportions in compositions.

Case III: Completely stratify both sampling events, and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Pool lengths, ages, and sexes from both sampling events to improve precision of proportions in estimates of composition, and apply formulae to correct for size bias to the pooled data (p. 17).

Case IV: Completely stratify both sampling events and estimate abundance for each stratum. Add abundance estimates across strata to get a single estimate for the population. Use lengths, ages, and sexes from only Event 2 to estimate proportions in compositions, and apply formulae to correct for size bias to the data from Event 2.

Whenever the results of the hypothesis tests indicate that there has been size-selective sampling (Case III or IV), there is still a chance that the bias in estimates of abundance from this phenomenon is negligible. Produce a second estimate of abundance by not stratifying the data as recommended above. If the two estimates (stratified and unbiased vs. biased and unstratified) are dissimilar, the bias is meaningful, the stratified estimate should be used, and data on compositions should be analyzed as described above for Cases III or IV. However, if the two estimates of abundance are similar, the bias is negligible in the UNSTRATIFIED estimate, and analysis can proceed as if there were no size-selective sampling during Event 2 (Cases I or II).

Appendix A2.–Numbers of coded-wire tagged and untagged adult coho salmon sampled in the Unuk River during Event 1 of the mark-recapture study using set gillnets in 1999.

Date	Number examined	Number of clips	Valid tags	Head number	Tag code
26-Jul-99	1				
11-Aug-99	3				
15-Aug-99	7				
16-Aug-99	6				
17-Aug-99	11				
19-Aug-99	33	1	1	82027	44716
20-Aug-99	16				
21-Aug-99	43				
22-Aug-99	10	1		82028	not valid
23-Aug-99	39				
24-Aug-99	15				
25-Aug-99	47	1	1	82029	44716
26-Aug-99	50	1		82030	not valid
27-Aug-99	14	1	1	82031	44716
28-Aug-99	1				
31-Aug-99	67	1	1	82032	44716
		1	1	82034	44716
2-Sep-99	44	1	1	82035	44716
		1	1	82036	44716
		1	1	82037	44716
3-Sep-99	28	1	1	82038	44716
		1	1	82039	44716
		1	1	82040	44716
4-Sep-99	49				
5-Sep-99	59				
6-Sep-99	37	1	1	82041	44716
7-Sep-99	41	1	1	82042	44716
		1	1	82043	44716
		1	1	82044	44716
8-Sep-99	29	1	1	82045	44716
		1	1	82046	44716
9-Sep-99	9				
10-Sep-99	40				
12-Sep-99	21	1	1	82047	44716
13-Sep-99	19	1	1	82048	44716
14-Sep-99	36				
15-Sep-99	42	1	1	82049	44716
		1	1	82050	44716
		1	1	82051	44716
		1	1	82052	44716
16-Sep-99	31				
18-Sep-99	13				
20-Sep-99	2				
21-Sep-99	6	1	1	82053	44716
22-Sep-99	3				

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Date	Number examined	Number of clips	Valid tags	Head number	Tag code
24-Sep-99	7				
25-Sep-99	18	1	1	82054	44716
27-Sep-99	36	1	1	82055	44716
30-Sep-99	12				
1-Oct-99	9				
3-Oct-99	9				
6-Oct-99	2				
7-Oct-99	2				
10-Oct-99	5				
Total	972	28	26		
Marked Fraction (θ)		0.0288	0.0267		
SE (θ)		0.0054	0.0052		

Appendix A3.–Fates and locations of fish possessing radio transmitters as recorded at two remote radiotracking stations and seen during five fixed-wing aircraft surveys flown on the Unuk River in 1999.

		Remote tracking station		Location by tracking flight					Assumed
Date	Frequency	North Bank	South Bank	30-Aug-99	14-Sep-99	14-Oct-99	17-Nov-99	2-Dec-99	fate
8/21/99	151.044			not found	not found	not found	not found	not found	Lost
8/21/99	151.065	9/3/99		6	not found	not found	not found	X	Spawned
8/19/99	151.085			Eulachon R.	not found	not found	not found	not found	Spawned
8/21/99	151.104	9/4/99		11	27	35	29	X	Spawned
8/22/99	151.125			8	not found	not found	not found	not found	Lost
8/23/99	151.146	9/1/99		3	29	45	45	X	Spawned
8/24/99	151.163			not found	21	not found	not found	X	Spawned
8/25/99	151.183	9/6/99		not found	19	not found	not found	X	Spawned
8/25/99	151.203	9/6/99		not found	24	16	11	X	Spawned
8/25/99	151.244			not found	not found	not found	not found	not found	Lost
8/25/99	151.265			2	not found	not found	not found	Gene's Lk. Ck.	Spawned
8/26/99	151.285	9/3/99		not found	27	16	16	X	Spawned
8/26/99	151.304			not found	Lake Ck.	Lake Ck.	Clear Ck.	X	Spawned
8/26/99	151.325	9/6/99		not found	24	37	37	X	Spawned
8/27/99	151.344			2*		not found	not found	not found	Lost
8/31/99	151.363	9/14/99			13	14	Lake Ck.	X	Spawned
8/31/99	151.383				not found	Kerr Ck.	47	X	Spawned
8/31/99	151.403	9/6/99			not found	not found	not found	X	Spawned
8/31/99	151.425	9/6/99			5	8	8	X	Spawned
9/2/99	151.442	9/6/99			26	not found	not found	X	Spawned
9/2/99	151.463				31	37	37	X	Spawned
9/3/99	151.485				not found	not found	not found	not found	Lost
9/4/99	151.504	9/7/99			24	10	Eulachon R.	X	Spawned
9/2/99	151.523				not found	not found	Grant Ck.	X	Lost
9/3/99	151.543				not found	not found	not found	not found	Lost
9/4/99	151.562				Eulachon R.	not found	not found	not found	Spawned
9/4/99	151.583				2	2	2	2	Lost
9/4/99	151.602				32	23	Lake Ck.	X	Spawned
9/5/99	151.623				24	18	18	X	Spawned
9/8/99	151.643					34	26	X	Spawned
9/6/99	151.663				2	5*	5*	1*	Lost
9/5/99	151.683		9/24/99		18	not found	Gene's Lk. Ck.	X	Spawned
9/5/99	151.744				Eulachon R.	6	not found	X	Spawned
9/5/99	151.803				3	5	Eulachon R.	X	Spawned
9/13/99	151.883				2	39	35	X	Spawned
9/9/99	151.904				6	not found	not found	not found	Lost
9/7/99	151.923		9/18/99		19	Kerr Ck.	Kerr Ck.	X	Spawned
9/10/99	151.944				2	Eulachon R.	Eulachon R.	X	Spawned
9/8/99	151.703				X	X	not found	not found	Lost

***** Indicates that a mortality signal was recorded and **X** indicates the frequency was not tracked.

Appendix A4.–Age and sex composition of adult coho salmon sampled during the two-event mark-recapture study performed on the Unuk River in 1999.

		AGE		
		1.1	2.1	Total
AGE COMPOSITION OF ADULT COHO SALMON				
PANEL A: ALL SAMPLES COMBINED				
{Biased with respect to escapement}				
Female	n	312	113	435
	%	28.4%	10.3%	39.7%
	SE of %	1.4%	0.9%	1.5%
	Avg. Length	567	576	569
	SE Len.	2.7	5.2	2.4
Male	n	506	166	672
	%	46.1%	15.1%	61.3%
	SE of %	1.5%	1.1%	1.5%
	Avg. Length	560	575	563
	SE Len.	2.5	4.6	2.2
Total	n	818	279	1097
	%	74.6%	25.4%	100.0%
	SE of %	1.3%	1.3%	
	Avg. Length	562	575	566
	SE Len.	1.9	3.5	1.7
		Unique fish		1,263
PANEL B: EVENT 1-MARKING IN THE LOWER RIVER				
{Unbiased with respect to escapement}				
		SN1		
Female	n	276	92	368
	%	33.9%	11.3%	45.2%
	SE of %	1.7%	1.1%	1.7%
	Escapement	5,705	1,902	7,606
	SE of Esc.	1,976	676	3,885
	Avg. Length	565	571	567
	SE Len.	2.9	5.6	2.6
Male	n	349	98	447
	%	42.8%	12.0%	54.8%
	SE of %	1.7%	1.1%	1.7%
	Escapement	7,213	2,026	9,239
	SE of Esc.	2,491	718	4,282
	Avg. Length	559	578	563
	SE Len.	2.8	6.1	2.6
Total	n	625	190	815
	%	76.7%	23.3%	100.0%
	SE of %	1.5%	1.5%	
	Escapement	12,918	3,927	16,845
	SE of Esc.	4,440	1,368	5,782
	Avg. Length	561	575	565
	SE Len.	2.0	4.2	1.8
			Total sampled	960
			Spaghetti tags recovered	905

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PANEL C: EVENT 2-SAMPLING FOR MARKS

{Biased with respect to escapement}

TOTAL

Female	n	36	21	57
	%	12.8%	7.4%	20.2%
	SE of %	2.0%	1.6%	2.4%
	Avg. Length	560	586	569
	SE Len.	1.9	3.4	1.2
Male	n	157	68	225
	%	55.7%	24.1%	79.8%
	SE of %	3.0%	2.6%	2.4%
	Avg. Length	544	559	548
	SE Len.	0.4	1.0	0.3
Total	n	193	89	282
	%	68.4%	31.6%	100.0%
	SE of %	2.8%	2.8%	
	Avg. Length	547	565	552
	SE Len.	0.4	0.8	0.2
			Total sampled	311
			Spaghetti tags recovered	8

EULACHON RIVER

Female	n	20	8	28
	%	16.8%	6.7%	23.5%
	SE of %	3.4%	2.3%	3.9%
	Avg. Length	584	579	582
	SE Len.	12.0	14.3	9.4
Male	n	71	20	91
	%	59.7%	16.8%	76.5%
	SE of %	4.5%	3.4%	3.9%
	Avg. Length	562	569	563
	SE Len.	7.2	12.9	6.3
Total	n	91	28	119
	%	76.5%	23.5%	100.0%
	SE of %	3.9%	3.9%	
	Avg. Length	567	572	568
	SE Len.	6.3	10.0	5.3
			Total sampled	141
			Spaghetti tags recovered	3

LAKE CREEK

Female	N	12	8	20
	%	11.8%	7.8%	19.6%
	SE of %	3.2%	2.7%	4.0%
	Avg. Length	568	608	584
	SE Len.	14.3	26.1	13.8
Male	n	62	20	82
	%	60.8%	19.6%	80.4%
	SE of %	4.9%	4.0%	4.0%
	Avg. Length	561	594	569
	SE Len.	7.5	12.2	6.5
Total	n	74	28	102
	%	72.5%	27.5%	100.0%
	SE of %	4.4%	4.4%	
	Avg. Length	562	598	572
	SE Len.	6.6	11.2	5.9
			Total sampled	121
			Spaghetti tags recovered	3

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BOUNDARY CREEK				
Female	n	1		1
	%	4.0%		4.0%
	SE of %	4.0%		4.0%
	Avg. Length	620		620
	SE Len.			
Male	n	15	9	24
	%	60.0%	36.0%	96.0%
	SE of %	10.0%	9.8%	4.0%
	Avg. Length	569	549	561
	SE Len.	19.5	21.9	14.5
Total	n	16	9	25
	%	64.0%	36.0%	100.0%
	SE of %	9.8%	9.8%	
	Avg. Length	572	549	564
	SE Len.	18.5	21.9	14.1
			Total sampled	33
			Spaghetti tags recovered	0
KERR CREEK				
Female	N	1	3	4
	%	5.9%	17.6%	23.5%
	SE of %	5.9%	9.5%	10.6%
	Avg. Length	550	583	575
	SE Len.		49.2	35.8
Male	N	3	10	13
	%	17.6%	58.8%	76.5%
	SE of %	9.5%	12.3%	10.6%
	Avg. Length	607	548	562
	SE Len.	58.9	12.6	16.6
Total	N	4	13	17
	%	23.5%	76.5%	100.0%
	SE of %	10.6%	10.6%	
	Avg. Length	593	556	565
	SE Len.	44.0	14.3	14.7
			Total sampled	25
			Spaghetti tags recovered	1
GENE'S LAKE CREEK				
Female	n	2	2	4
	%	10.5%	10.5%	21.1%
	SE of %	7.2%	7.2%	9.6%
	Avg. Length	618	628	623
	SE Len.	12.5	12.5	7.8
Male	n	6	9	15
	%	31.6%	47.4%	78.9%
	SE of %	11.0%	11.8%	9.6%
	Avg. Length	540	563	554
	SE Len.	29.9	20.5	16.8
Total	N	8	11	19
	%	42.1%	57.9%	100.0%
	SE of %	11.6%	11.6%	
	Avg. Length	559	575	568
	SE Len.	25.4	18.5	14.8
			Total sampled	32
			Spaghetti tags recovered	1

Appendix A5.–Random and select recoveries of coded-wire tagged coho salmon bound for the Unuk River in 1999.

Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
RANDOM RECOVERIES										
84233	44716	TROLL	5-Jul-99	28	NE	109	63	570	PORT ALEXANDER	99080017
10558	44716	TROLL	6-Jul-99	28	NE	109	61	631	PETERSBURG	99050319
84318	44716	TROLL	16-Jul-99	29	NE	109	63	625	PORT ALEXANDER	99080045
84450	44716	TROLL	23-Jul-99	30	NE	109	63	625	PORT ALEXANDER	99080082
3830	44716	TROLL	24-Jul-99	30	NE	109	61	608	PETERSBURG	99050575
16256	44716	TROLL	27-Jul-99	31	NE			608	PETERSBURG	99050603
84534	44716	TROLL	28-Jul-99	31	NE	109	10	655	PORT ALEXANDER	99080103
16366	44716	TROLL	31-Jul-99	31	NE			611	PETERSBURG	99050656
84646	44716	TROLL	5-Aug-99	32	NE	109	61	630	PORT ALEXANDER	99080136
84704	44716	TROLL	8-Aug-99	33	NE	109	10	608	PORT ALEXANDER	99080149
54691	44716	TROLL	11-Aug-99	33	NE			607	PETERSBURG	99050808
68033	44716	TROLL	13-Aug-99	33	NE	109	61	588	PETERSBURG	99050872
68493	44716	TROLL	30-Aug-99	36	NE	109	61	627	PETERSBURG	99051078
46983	44716	TROLL	5-Jul-99	28	NW	113	91	635	HOONAH	99110122
128557	44716	TROLL	5-Jul-99	28	NW	113	41	574	SITKA	99030403
50976	44716	TROLL	6-Jul-99	28	NW	113	91	600	ELFIN COVE	99020064
50200	44716	TROLL	6-Jul-99	28	NW	113		540	HOONAH	99110135
84242	44716	TROLL	6-Jul-99	28	NW	113	11	550	PORT ALEXANDER	99080020
88101	44716	TROLL	9-Jul-99	28	NW	113	91	553	PELICAN	99010017
50516	44716	TROLL	10-Jul-99	28	NW	113	91	615	HOONAH	99110138
50573	44716	TROLL	12-Jul-99	29	NW	113		595	HOONAH	99110144
50564	44716	TROLL	12-Jul-99	29	NW	113		785	HOONAH	99110144
133175	44716	TROLL	13-Jul-99	29	NW	113	91	622	SITKA	99030492
142022	44716	TROLL	14-Jul-99	29	NW	113	91	570	ELFIN COVE	99020088
133578	44716	TROLL	14-Jul-99	29	NW	113		540	SITKA	99030517
128974	44716	TROLL	14-Jul-99	29	NW	113		560	SITKA	99030517
128975	44716	TROLL	14-Jul-99	29	NW	113		568	SITKA	99030517
128891	44716	TROLL	17-Jul-99	29	NW			647	SITKA	99030528
133486	44716	TROLL	18-Jul-99	30	NW	113	41	650	SITKA	99030530
133631	44716	TROLL	19-Jul-99	30	NW			615	SITKA	99030554
133657	44716	TROLL	19-Jul-99	30	NW			682	SITKA	99030554
142069	44716	TROLL	20-Jul-99	30	NW			740	ELFIN COVE	99020129
88204	44716	TROLL	20-Jul-99	30	NW	116	12	590	PELICAN	99010043
133339	44716	TROLL	20-Jul-99	30	NW			410	SITKA	99030568
138220	44716	TROLL	21-Jul-99	30	NW	116	13	652	SITKA	99030558
28468	44716	TROLL	25-Jul-99	31	NW			663	EXCURSION INLET	99100036
138040	44716	TROLL	25-Jul-99	31	NW	113	41	590	SITKA	99030592
138171	44716	TROLL	26-Jul-99	31	NW			610	SITKA	99030623
138183	44716	TROLL	26-Jul-99	31	NW			640	SITKA	99030623
88327	44716	TROLL	27-Jul-99	31	NW			610	PELICAN	99010066
97644	44716	TROLL	27-Jul-99	31	NW			654	YAKUTAT	99140027
28497	44716	TROLL	28-Jul-99	31	NW			672	EXCURSION INLET	99100045
133206	44716	TROLL	29-Jul-99	31	NW	113	91	717	SITKA	99030641
138449	44716	TROLL	1-Aug-99	32	NW	113	41	600	SITKA	99030665
138450	44716	TROLL	1-Aug-99	32	NW	113	41	607	SITKA	99030665
88448	44716	TROLL	2-Aug-99	32	NW	116	12	570	PELICAN	99010084
88493	44716	TROLL	3-Aug-99	32	NW	113	91	680	PELICAN	99010091
133273	44716	TROLL	3-Aug-99	32	NW			558	SITKA	99030701
54871	44716	TROLL	5-Aug-99	32	NW	116	13	625	HOONAH	99110224
54865	44716	TROLL	5-Aug-99	32	NW	116	13	685	HOONAH	99110224
137638	44716	TROLL	5-Aug-99	32	NW	113		666	SITKA	99030706

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Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
137239	44716	TROLL	7-Aug-99	32	NW	113	45	597	SITKA	99030729
137672	44716	TROLL	8-Aug-99	33	NW	113	41	649	SITKA	99030731
137480	44716	TROLL	10-Aug-99	33	NW			608	SITKA	99030799
137596	44716	TROLL	11-Aug-99	33	NW	113	31	643	SITKA	99030759
136925	44716	TROLL	11-Aug-99	33	NW	113	41	624	SITKA	99030763
138349	44716	TROLL	11-Aug-99	33	NW	113	45	624	SITKA	99030754
137597	44716	TROLL	11-Aug-99	33	NW	113	91	659	SITKA	99030760
137784	44716	TROLL	11-Aug-99	33	NW	113		536	SITKA	99030766
137401	44716	TROLL	12-Aug-99	33	NW	113	41	661	SITKA	99030781
55443	44716	TROLL	13-Aug-99	33	NW			546	JUNEAU	99040081
91034	44716	TROLL	22-Aug-99	35	NW			632	PELICAN	99010130
141486	44716	TROLL	22-Aug-99	35	NW	113	11	685	SITKA	99030890
141449	44716	TROLL	22-Aug-99	35	NW	113	21	668	SITKA	99030886
136269	44716	TROLL	22-Aug-99	35	NW	113	41	600	SITKA	99030867
136276	44716	TROLL	22-Aug-99	35	NW	113	41	671	SITKA	99030868
141459	44716	TROLL	22-Aug-99	35	NW	113	91	660	SITKA	99030887
136452	44716	TROLL	22-Aug-99	35	NW	154		677	SITKA	99030876
137929	44716	TROLL	22-Aug-99	35	NW			615	SITKA	99030912
141278	44716	TROLL	22-Aug-99	35	NW			663	SITKA	99030912
91084	44716	TROLL	23-Aug-99	35	NW			650	PELICAN	99010136
136863	44716	TROLL	23-Aug-99	35	NW	113	21	513	SITKA	99030907
91042	44716	TROLL	24-Aug-99	35	NW	113	91	642	PELICAN	99010143
141851	44716	TROLL	27-Aug-99	35	NW	113	91	692	SITKA	99030932
145333	44716	TROLL	28-Aug-99	35	NW	113		690	HOONAH	99110321
136054	44716	TROLL	28-Aug-99	35	NW	113	41	525	SITKA	99030924
141930	44716	TROLL	28-Aug-99	35	NW			724	SITKA	99030934
141936	44716	TROLL	28-Aug-99	35	NW			749	SITKA	99030934
29581	44716	TROLL	30-Aug-99	36	NW			720	EXCURSION INLET	99100125
91633	44716	TROLL	31-Aug-99	36	NW	114	21	625	PELICAN	99010178
91656	44716	TROLL	1-Sep-99	36	NW			673	PELICAN	99010183
141755	44716	TROLL	2-Sep-99	36	NW	113	31	640	SITKA	99030942
141622	44716	TROLL	2-Sep-99	36	NW	113	41	608	SITKA	99030949
141644	44716	TROLL	2-Sep-99	36	NW	113	41	681	SITKA	99030952
138613	44716	TROLL	6-Sep-99	37	NW			685	SITKA	99030970
133877	44716	TROLL	7-Sep-99	37	NW			651	SITKA	99030981
133898	44716	TROLL	7-Sep-99	37	NW			698	SITKA	99030981
91875	44716	TROLL	9-Sep-99	37	NW	113	91	746	PELICAN	99010201
133819	44716	TROLL	9-Sep-99	37	NW			742	SITKA	99030978
139921	44716	TROLL	11-Sep-99	37	NW	113		615	SITKA	99030984
139408	44716	TROLL	21-Sep-99	39	NW	113	91	664	SITKA	99031013
98833	44716	TROLL	23-Sep-99	39	NW	113	91	707	PELICAN	99010234
39451	44716	TROLL	7-Jul-99	28	SE	102	10	590	KETCHIKAN	99060123
78185	44716	TROLL	17-Jul-99	29	SE	101	21	596	KETCHIKAN	99060163
67312	44716	TROLL	20-Jul-99	30	SE	105		574	CRAIG	99070211
67307	44716	TROLL	20-Jul-99	30	SE	105		610	CRAIG	99070211
39584	44716	TROLL	20-Jul-99	30	SE	102	10	637	KETCHIKAN	99060191
74995	44716	TROLL	25-Jul-99	31	SE	102	10	656	KETCHIKAN	99060224
65527	44716	TROLL	27-Jul-99	31	SE	105	10	622	CRAIG	99070266
79921	44716	TROLL	27-Jul-99	31	SE	102	10	635	KETCHIKAN	99060247
70073	44716	TROLL	27-Jul-99	31	SE			591	KETCHIKAN	99060246
70591	44716	TROLL	31-Jul-99	31	SE			619	KETCHIKAN	99060269
68036	44716	TROLL	12-Aug-99	33	SE	106	41	648	PETERSBURG	99050875
81577	44716	TROLL	13-Aug-99	33	SE	101	29	508	KETCHIKAN	99060373
81575	44716	TROLL	13-Aug-99	33	SE	101	29	665	KETCHIKAN	99060373

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Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
81582	44716	TROLL	13-Aug-99	33	SE			629	KETCHIKAN	99060376
82105	44716	TROLL	22-Aug-99	35	SE	101	23	613	KETCHIKAN	99060426
23795	44716	TROLL	22-Aug-99	35	SE	107	10	557	KETCHIKAN	99060425
90470	44716	TROLL	22-Aug-99	35	SE	106	30	635	WRANGELL	99120070
80134	44716	TROLL	23-Aug-99	35	SE			661	KETCHIKAN	99060435
25671	44716	TROLL	26-Aug-99	35	SE	101	25	604	KETCHIKAN	99060455
27853	44716	TROLL	2-Sep-99	36	SE			630	KETCHIKAN	99060493
27852	44716	TROLL	2-Sep-99	36	SE		30	641	KETCHIKAN	99060493
27863	44716	TROLL	3-Sep-99	36	SE	101	29	652	KETCHIKAN	99060502
27622	44716	TROLL	3-Sep-99	36	SE	105		678	KETCHIKAN	99060507
27655	44716	TROLL	3-Sep-99	36	SE			674	KETCHIKAN	99060496
25726	44716	TROLL	4-Sep-99	36	SE	101	21	620	KETCHIKAN	99060513
27650	44716	TROLL	6-Sep-99	37	SE		32	634	KETCHIKAN	99060519
27183	44716	TROLL	8-Sep-99	37	SE	101	29	496	KETCHIKAN	99060533
27184	44716	TROLL	8-Sep-99	37	SE	101	29	555	KETCHIKAN	99060533
25752	44716	TROLL	10-Sep-99	37	SE	101	25	562	KETCHIKAN	99060538
27188	44716	TROLL	10-Sep-99	37	SE	101	25	653	KETCHIKAN	99060537
48047	44716	TROLL	10-Sep-99	37	SE	105	41	670	PETERSBURG	99051170
27288	44716	TROLL	13-Sep-99	38	SE	101	29	645	KETCHIKAN	99060542
25767	44716	TROLL	13-Sep-99	38	SE			604	KETCHIKAN	99060546
77599	44716	TROLL	15-Sep-99	38	SE	101	21	606	KETCHIKAN	99060552
66250	44716	TROLL	16-Sep-99	38	SE	105	50	638	CRAIG	99070516
39936	44716	TROLL	16-Sep-99	38	SE	106	41	503	PETERSBURG	99051213
27072	44716	TROLL	17-Sep-99	38	SE	101	25	596	KETCHIKAN	99060558
82971	44716	TROLL	28-Sep-99	40	SE	101	29	517	KETCHIKAN	99060583
82956	44716	TROLL	28-Sep-99	40	SE	101	29	619	KETCHIKAN	99060581
77916	44716	TROLL	3-Jul-99	27	SW	103		543	KETCHIKAN	99060082
65084	44716	TROLL	5-Jul-99	28	SW			598	CRAIG	99070051
62576	44716	TROLL	6-Jul-99	28	SW	104		585	CRAIG	99070056
67133	44716	TROLL	12-Jul-99	29	SW	103	70	505	CRAIG	99070119
67146	44716	TROLL	13-Jul-99	29	SW	104	35	562	CRAIG	99070140
49526	44716	TROLL	13-Jul-99	29	SW			593	KETCHIKAN	99060147
67456	44716	TROLL	14-Jul-99	29	SW	104	40	599	CRAIG	99070157
67007	44716	TROLL	14-Jul-99	29	SW	104		628	CRAIG	99070158
67026	44716	TROLL	16-Jul-99	29	SW			605	CRAIG	99070170
67232	44716	TROLL	19-Jul-99	30	SW	104	40	615	CRAIG	99070190
65568	44716	TROLL	27-Jul-99	31	SW	104	40	611	CRAIG	99070271
65541	44716	TROLL	29-Jul-99	31	SW	104	40	640	CRAIG	99070293
65774	44716	TROLL	2-Aug-99	32	SW			662	CRAIG	99070328
65842	44716	TROLL	4-Aug-99	32	SW	103	70	622	CRAIG	99070346
65890	44716	TROLL	12-Aug-99	33	SW	104	35	534	CRAIG	99070391
66136	44716	TROLL	30-Aug-99	36	SW	104	40	539	CRAIG	99070496
24603	44716	PURSE	4-Aug-99	32	NE	109	51	491	PETERSBURG	99050740
16703	44716	PURSE	16-Aug-99	34	NE	109	51	479	PETERSBURG	99050898
68117	44716	PURSE	16-Aug-99	34	NE	109	61	603	PETERSBURG	99050893
78134	44716	PURSE	21-Jul-99	30	SE	101	41	619	KETCHIKAN	99060199
70416	44716	PURSE	25-Jul-99	31	SE	101		660	KETCHIKAN	99060227
74423	44716	PURSE	10-Aug-99	33	SE	101	41	546	KETCHIKAN	99060346
23790	44716	PURSE	19-Aug-99	34	SE	101		595	KETCHIKAN	99060407
81598	44716	PURSE	22-Aug-99	35	SE	101		670	KETCHIKAN	99060427
16613	44716	PURSE	24-Aug-99	35	SE	106	30	560	PETERSBURG	99050994
77536	44716	PURSE	3-Aug-99	32	SW	104	20	528	KETCHIKAN	99060284
74495	44716	PURSE	7-Aug-99	32	SW	104		610	KETCHIKAN	99060328
78461	44716	PURSE	15-Aug-99	34	SW	104		575	KETCHIKAN	99060391

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Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
67615	44716	TROLL	21-Aug-99	34	SE			660	CRAIG	99070440
82887	44716	PURSE	15-Aug-99	34	SW	104		624	KETCHIKAN	99060388
23767	44716	PURSE	18-Aug-99	34	SW	104	40	667	KETCHIKAN	99060403
52347	44716	SPORT	21-Jun-99	26	NW	113	45	480	SITKA	99035185
73991	44716	SPORT	27-Jun-99	27	NW	113	45	660	SITKA	99035222
69735	44716	SPORT	6-Aug-99	32	NW	113	41	660	SITKA	99035464
69695	44716	SPORT	7-Aug-99	32	NW	113	41	590	SITKA	99035455
69557	44716	SPORT	9-Aug-99	33	NW	113	45	590	SITKA	99035500
69795	44716	SPORT	24-Aug-99	35	NW	113	31	610	SITKA	99035660
86708	44716	SPORT	22-Jul-99	30	SE	101	29	510	KETCHIKAN	99065193
86735	44716	SPORT	7-Aug-99	32	SE	101	85	550	KETCHIKAN	99065235
86764	44716	SPORT	16-Aug-99	34	SE	102	80	575	KETCHIKAN	99065246
86763	44716	SPORT	16-Aug-99	34	SE	102	80	685	KETCHIKAN	99065246
86576	44716	SPORT	22-Aug-99	35	SE	102	80	660	KETCHIKAN	99065253
86863	44716	SPORT	1-Sep-99	36	SE	102	80	700	KETCHIKAN	99065264
86769	44716	SPORT	4-Sep-99	36	SE	101	90	630	KETCHIKAN	99065282
86768	44716	SPORT	4-Sep-99	36	SE	102	80	540	KETCHIKAN	99065284
86774	44716	SPORT	5-Sep-99	37	SE	101	29	615	KETCHIKAN	99065272
86772	44716	SPORT	5-Sep-99	37	SE	101	85	605	KETCHIKAN	99065271
86894	44716	SPORT	10-Sep-99	37	SE	101	90	720	KETCHIKAN	99065315
86893	44716	SPORT	10-Sep-99	37	SE	102	80	640	KETCHIKAN	99065316
86627	44716	SPORT	12-Sep-99	38	SE	101	29	670	KETCHIKAN	99065314
86935	44716	SPORT	14-Sep-99	38	SE	101	90	660	KETCHIKAN	99065378
10414	44716	DRIFT	29-Jun-99	27	SE	106	41	551	PETERSBURG	99050221
10579	44716	DRIFT	6-Jul-99	28	SE	106	41	630	PETERSBURG	99050314
49506	44716	DRIFT	12-Jul-99	29	SE	101	11	605	KETCHIKAN	99060142
78294	44716	DRIFT	13-Jul-99	29	SE	106	30	643	KETCHIKAN	99060145
5745	44716	DRIFT	28-Jul-99	31	SE	106	41	653	PETERSBURG	99050638
16117	44716	DRIFT	29-Jul-99	31	SE	106	30	675	PETERSBURG	99050643
74722	44716	DRIFT	2-Aug-99	32	SE	106	30	450	KETCHIKAN	99060278
74767	44716	DRIFT	9-Aug-99	33	SE	106	30	588	KETCHIKAN	99060337
82882	44716	DRIFT	12-Aug-99	33	SE	106	30	520	KETCHIKAN	99060364
74446	44716	DRIFT	17-Aug-99	34	SE	106	30	523	KETCHIKAN	99060396
80387	44716	DRIFT	18-Aug-99	34	SE	101	11	582	KETCHIKAN	99060400
23863	44716	DRIFT	18-Aug-99	34	SE	101	11	696	KETCHIKAN	99060399
68162	44716	DRIFT	19-Aug-99	34	SE	106	30	639	PETERSBURG	99050923
54960	44716	DRIFT	19-Aug-99	34	SE	106	41	648	PETERSBURG	99050934
74798	44716	DRIFT	26-Aug-99	35	SE	106	30	655	KETCHIKAN	99060456
73424	44716	DRIFT	31-Aug-99	36	SE	101	11	586	KETCHIKAN	99060478
73423	44716	DRIFT	31-Aug-99	36	SE	101	11	600	KETCHIKAN	99060478
16185	44716	DRIFT	31-Aug-99	36	SE	106	41	715	PETERSBURG	99051088
73443	44716	DRIFT	1-Sep-99	36	SE	101	11	727	KETCHIKAN	99060487
16556	44716	DRIFT	1-Sep-99	36	SE	106	41	681	PETERSBURG	99051102
25713	44716	DRIFT	2-Sep-99	36	SE	106	30	608	KETCHIKAN	99060491
68599	44716	DRIFT	2-Sep-99	36	SE	106	41	623	PETERSBURG	99051112
68590	44716	DRIFT	2-Sep-99	36	SE	106	41	675	PETERSBURG	99051111
27162	44716	DRIFT	6-Sep-99	37	SE	106		652	KETCHIKAN	99060516
27163	44716	DRIFT	6-Sep-99	37	SE	106		656	KETCHIKAN	99060516
27701	44716	DRIFT	8-Sep-99	37	SE	101	11	565	KETCHIKAN	99060531
27677	44716	DRIFT	8-Sep-99	37	SE	101	11	660	KETCHIKAN	99060532
27886	44716	DRIFT	8-Sep-99	37	SE	106	30	603	KETCHIKAN	99060529
39335	44716	DRIFT	8-Sep-99	37	SE	106	41	630	PETERSBURG	99051151
41859	44716	DRIFT	9-Sep-99	37	SE	101	28	676	METLAKATLA	99090310
25789	44716	DRIFT	13-Sep-99	38	SE	106		688	KETCHIKAN	99060540

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Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
27908	44716	DRIFT	15-Sep-99	38	SE	101	11	624	KETCHIKAN	99060555
25842	44716	DRIFT	15-Sep-99	38	SE	101	11	636	KETCHIKAN	99060555
39923	44716	DRIFT	15-Sep-99	38	SE	106	41	641	PETERSBURG	99051200
56176	44716	DRIFT	15-Sep-99	38	SE	106	41	660	PETERSBURG	99051187
39918	44716	DRIFT	15-Sep-99	38	SE	106	41	665	PETERSBURG	99051200
39817	44716	DRIFT	15-Sep-99	38	SE	106	41	667	PETERSBURG	99051207
39765	44716	DRIFT	15-Sep-99	38	SE	106	41	680	PETERSBURG	99051208
39808	44716	DRIFT	15-Sep-99	38	SE	106	41	683	PETERSBURG	99051207
39979	44716	DRIFT	15-Sep-99	38	SE	106	41	693	PETERSBURG	99051190
27095	44716	DRIFT	20-Sep-99	39	SE	106	30	605	KETCHIKAN	99060563
41964	44716	DRIFT	21-Sep-99	39	SE	101	28	681	METLAKATLA	99090377
41948	44716	DRIFT	21-Sep-99	39	SE	101	28	712	METLAKATLA	99090369
68884	44716	DRIFT	22-Sep-99	39	SE	101	11	690	KETCHIKAN	99060574
56102	44716	DRIFT	22-Sep-99	39	SE	106	41	665	PETERSBURG	99051233
56101	44716	DRIFT	22-Sep-99	39	SE	106	41	673	PETERSBURG	99051233
56112	44716	DRIFT	22-Sep-99	39	SE	106		682	PETERSBURG	99051234
211417	44716	DRIFT	28-Sep-99	40	SE	106	30	683	KETCHIKAN	99060587
211398	44716	DRIFT	28-Sep-99	40	SE	106	30	740	KETCHIKAN	99060587
69122	44716	DRIFT	29-Sep-99	40	SE	101	11	708	KETCHIKAN	99060588
1530	44716	DRIFT	5-Oct-99	41	SE	101	28	697	METLAKATLA	99090476
56451	44716	DRIFT	5-Oct-99	41	SE	106	41	637	PETERSBURG	99051263
82027	44716	ESCAPE	19-Aug-99	34	SE	101	75	540	Unuk Mainstem	99930043
82028	Not Valid	ESCAPE	22-Aug-99	35	SE	101	75	495	Unuk Mainstem	99930046
82029	44716	ESCAPE	25-Aug-99	35	SE	101	75	620	Unuk Mainstem	99930049
82030	Not Valid	ESCAPE	26-Aug-99	35	SE	101	75	585	Unuk Mainstem	99930050
82031	44716	ESCAPE	27-Aug-99	35	SE	101	75	560	Unuk Mainstem	99930051
82041	44716	ESCAPE	31-Aug-99	36	SE	101	75	550	Unuk Mainstem	99930053
82042	44716	ESCAPE	31-Aug-99	36	SE	101	75	620	Unuk Mainstem	99930053
82044	44716	ESCAPE	2-Sep-99	36	SE	101	75	495	Unuk Mainstem	99930054
82045	44716	ESCAPE	2-Sep-99	36	SE	101	75	540	Unuk Mainstem	99930054
82043	44716	ESCAPE	2-Sep-99	36	SE	101	75	565	Unuk M ainstem	99930054
82032	44716	ESCAPE	3-Sep-99	36	SE	101	75	500	Unuk Mainstem	99930055
82046	44716	ESCAPE	3-Sep-99	36	SE	101	75	510	Unuk Mainstem	99930055
82047	44716	ESCAPE	3-Sep-99	36	SE	101	75	560	Unuk Mainstem	99930055
82034	44716	ESCAPE	6-Sep-99	37	SE	101	75	480	Unuk Mainstem	99930058
82037	44716	ESCAPE	7-Sep-99	37	SE	101	75	560	Unuk Mainstem	99930059
82035	44716	ESCAPE	7-Sep-99	37	SE	101	75	565	Unuk Mainstem	99930059
82036	44716	ESCAPE	7-Sep-99	37	SE	101	75	575	Unuk Mainstem	99930059
82040	44716	ESCAPE	8-Sep-99	37	SE	101	75	525	Unuk Mainstem	99930060
82038	44716	ESCAPE	8-Sep-99	37	SE	101	75	615	Unuk Mainstem	99930060
82039	44716	ESCAPE	12-Sep-99	38	SE	101	75	630	Unuk Mainstem	99930063
82048	44716	ESCAPE	13-Sep-99	38	SE	101	75	660	Unuk Mainstem	99930064
82049	44716	ESCAPE	15-Sep-99	38	SE	101	75	550	Unuk Mainstem	99930066
82051	44716	ESCAPE	15-Sep-99	38	SE	101	75	605	Unuk Mainstem	99930066
82052	44716	ESCAPE	15-Sep-99	38	SE	101	75	630	Unuk Mainstem	99930066
82050	44716	ESCAPE	15-Sep-99	38	SE	101	75	660	Unuk Mainstem	99930066
82053	44716	ESCAPE	21-Sep-99	39	SE	101	75	535	Unuk Mainstem	99930070
82054	44716	ESCAPE	25-Sep-99	39	SE	101	75	600	Unuk Mainstem	99930073
82055	44716	ESCAPE	27-Sep-99	40	SE	101	75	595	Unuk Mainstem	99930074
80858	Head Lost	ESCAPE	4-Oct-99	41	SE	101	75	550	Unuk Lake Ck.	99934008
80859	Not Valid	ESCAPE	15-Oct-99	42	SE	101	75	575	Unuk Kerr Ck.	99936005

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Head number	Tag code	Gear	Recovery date	Stat. week	Quad.	Dist.	Sub-dist.	Length	Port survey site	Sample number
SELECT RECOVERIES										
73948	44716	SPORT	12-Jul-99	29	NW	113	31		SITKA	99035491
128930	44716	TROLL	14-Jul-99	29	NW	113		551	SITKA	99030516
137028	44716	TROLL	24-Jul-99	30	NW	181	60		SITKA	99030631
138425	44716	TROLL	24-Jul-99	30	NW	189	30		SITKA	99030647
97657	44716	TROLL	31-Jul-99	31	NW	181	40		YAKUTAT	99140032
136957	44716	TROLL	12-Aug-99	33	NW	113		647	SITKA	99030771
141082	44716	TROLL	12-Aug-99	33	NW				SITKA	99030821
136337	44716	TROLL	13-Aug-99	33	NW	116			SITKA	99030811

Appendix A6.–Estimated harvests of coho salmon bound for the Unuk River in 1999 in marine commercial and sport fisheries by statistical week.

Stat.	Ending	Troll		Seine		Sport		Gillnet		Total		Estimated weekly prop.	Estimated cumulative	Estimated cum. prop.
week	date	Tags	Harvest[a]	Tags	Harvest	Tags	Harvest	Tags	Harvest	Tags	Harvest	harvest	harvest	harvest
27	3-Jul-99	1	121			2	165	1	105	4	391	0.013	391	0.01
28	10-Jul-99	12	1,457					1	105	13	1,561	0.053	1,952	0.07
29	17-Jul-99	16	1,942					2	209	18	2,152	0.074	4,104	0.14
30	24-Jul-99	13	1,578	1	298	1	82			15	1,959	0.067	6,063	0.21
31	31-Jul-99	18	2,185	1	298			2	209	21	2,693	0.092	8,755	0.30
32	7-Aug-99	12	1,457	3	894	1	82	1	105	17	2,538	0.087	11,294	0.39
33	14-Aug-99	17	2,064	1	298	3	247	2	209	23	2,818	0.096	14,112	0.48
34	21-Aug-99	1	122	6	1,789	1	82	5	523	13	2,516	0.086	16,628	0.57
35	28-Aug-99	22	2,686	2	596	3	247	1	105	28	3,634	0.124	20,262	0.69
36	4-Sep-99	14	1,709			8	659	8	837	30	3,205	0.110	23,468	0.80
37	11-Sep-99	12	1,465					7	732	19	2,198	0.075	25,665	0.88
38	18-Sep-99	6	733			1	82	10	1,046	17	1,861	0.064	27,526	0.94
39	25-Sep-99	2	244					7	732	9	977	0.033	28,503	0.97
40	2-Oct-99	2	244					3	314	5	558	0.019	29,061	0.99
41	9-Oct-99							2	209	2	209	0.007	29,270	1.00
	Total	148	18,009	14	4,174	20	1,647	52	5,441	234	29,270	1.000		
Est. mean date of harvest			6-Aug		8-Aug		15-Aug		29-Aug		12-Aug			

[a] Harvest in the troll fishery was approximated by weighting catches for each period by the number of tags recovered in a statistical week.

Appendix A7.–Computer data files on 1998 Unuk River coho salmon smolt and subsequent estimates of 1999 Unuk River adult coho salmon run parameters.

File name	Description
99UNK43.XLS	Spreadsheet containing all the mark-recapture data, various pivot table results, Tables 1-6, Figures 6-12, Appendices A2-A6, harvest estimation calculations, abundance estimates, smolt tagging numbers and length and weight data, bootstrap results, and various c^2 hypothesis test results.
99UNK43KS.XLS	Spreadsheet containing the Kolmogorov-Smirnov (K-S) 2-sample test results and the various data sets used in these calculations.
43Unuk99. BAS	BASIC compiled program for bootstrapping abundance estimates for estimation of variance and bias.
43Unuk99.DAT	Data file with 1999 Unuk River coho salmon data for use in 43Unuk99.exe.
SPAS.EXE	Stratified Population Analysis (SPAS) program used to perform computer analysis of 2-sample mark-recovery data where each sample is from a geographically or temporally stratified population.
99Spas43.DAT	Data file containing the 1999 Unuk River coho salmon data for use in SPAS.exe.
UnukSml98.XLS	Spreadsheet containing smolt trapping effort, catch, coded-wire tagging, and length/weight data for coho and chinook smolt on the Unuk River in spring of 1998.
99Spas43.OUT	Output from SPAS.EXE for the 1999 Unuk River coho salmon data.