Fishery Data Series No. 95-29

Production of Coho Salmon from the Taku River, 1993–1994

by

Scott A. McPherson

and

David R. Bernard

November 1995

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd
Spell out acre and ton.	

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s
Spell out year, month, and week.	

Physics and chemistry

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

General

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

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, 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

FISHERY DATA SERIES NO. 95-29

PRODUCTION OF COHO SALMON FROM THE TAKU RIVER, 1993-1994

by

Scott A. McPherson
Division of Sport Fish, Douglas
and
David R. Bernard
Division of Sport Fish, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, AK 99518-1599

November 1995

This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Projects F-10-8 and F-10-10, Job No. S-1-3.

The Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

Scott A. McPherson
Alaska Department of Fish and Game, Division of Sport Fish
P. O. Box 240020, Douglas, AK 99824-0020, USA
and
David R. Bernard
Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, AK 99518-1599, USA

This document should be cited as:
McPherson, Scott A. and David R. Bernard. 1995. Production of coho salmon from the Taku River, 1993–1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-29, Anchorage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

As part of an ongoing study of the production of coho salmon *Oncorhynchus kisutch* from Taku River, near Juneau, Alaska, the Division of Sport Fish implanted coded wire tags in smolt leaving the river in spring 1993. Subsequent recovery of these fish was used to estimate the harvest, production, exploitation rate in 1994, and abundance of smolt in 1993. In 1993 two 12' diameter and one 8' diameter rotary smolt traps were fished near Canyon Island on the Taku River. A total of 5,549 coho salmon smolt were caught from 9 May to 27 June. Of these, 683 were coded wire tagged and released with tag code 04-38-01, and 4,361 were tagged and released with tag code 04-38-02, for a total of 5,044. Of the remainder (505 fish), 271 were <70 mm and were not tagged, 189 died in traps prior to tagging, an estimated 10 died after tagging and 35 shed tags. Smolt sampled from the catch averaged 98 mm fork length and were 78% age 1.0 and 22% age 2.0. In 1994, 178 adult coho salmon bearing coded wire tags implanted near Canyon Island (in 1993) were recovered in random sampling of marine fisheries to produce an estimate of total marine harvest of 228,607 (SE = 36,734). Of this harvest, the troll fishery took an estimated 42%, drift gillnet fisheries took 38%, seine fisheries took 12% and recreational fisheries took about 8%. A mark-recapture experiment conducted by the Commercial Fisheries Management and Development Division and the Canadian Department of Fisheries and Oceans estimated the inriver run of coho salmon past Canyon Island at 111,036 (SE = 6,529) fish. Of this total, 14,693 fish were harvested by inriver fishers above the U.S./Canada border. The estimated total run, the sum of escapement and harvest, in 1994 for coho salmon originating above Canyon Island was 339,643 (SE = 37,310) and the marine exploitation rate was an estimated 67% (SE = 4%). The estimated total run, the sum of escapement and harvest, in 1994 for coho salmon from the entire Taku River drainage was 435,440 (SE = 47,833), accounting for those fish originating below Canyon Island. The estimated smolt abundance in 1993 from above Canyon Island was 1,475,874 (SE = 368,411) and marine survival of coho salmon smolt from above Canyon Island was estimated at 23% (SE = 6.3%).

Key words: Coho salmon, *Oncorhynchus kisutch*, Taku River, harvest, troll fishery, drift gillnet fishery, recreational fishery, seine fishery, escapement, migratory timing, timing, production, return, exploitation rate.

INTRODUCTION

The Taku River produces an estimated 150,000–450,000 adult coho salmon *Oncorhynchus kisutch* annually, many of which are caught in commercial and recreational fisheries in northern Southeast Alaska (PSC 1993; Elliott and Bernard 1994). Coho salmon returning to the Taku River first pass through an offshore troll fishery before entering inside waters through Icy Strait (Figure 1). These fish then pass through a seine fishery in Icy and Chatham straits and a drift gillnet fishery in lower Lynn Canal. They next transit the recreational fishery near Juneau and the drift gillnet fishery in Taku Inlet/Stephens Passage before ascending the Taku River (Figure 2). After entering the river, the remaining coho salmon are exposed to a drift/set gillnet fishery just inside Canada (Figure 2). Due to the potential production of coho salmon from the Taku River and because of the many fisheries that utilize this production, the Alaska Department of Fish and Game, the U.S. National Marine Fisheries Service, and the Canadian Department of Fisheries and Oceans have all recently studied this stock, primarily to estimate harvest or escapement to specific tributaries of the Taku River (see Appendix A1).

Because coho salmon returning to the Taku River annually are treated as a single stock in management of fisheries, and because data from a single tributary may not reflect trends of overall production, the emphasis of our work shifted from tributaries to assessment of production of all coho salmon from the Taku River in 1991 (Elliott and Bernard 1994) and has continued since.

Objectives of this study were to estimate (1) the abundance of coho salmon smolt leaving the Taku River in 1993, (2) the mean length of these smolt, (3) age composition of these smolt, and (4) the harvest of adults returning to the Taku River in

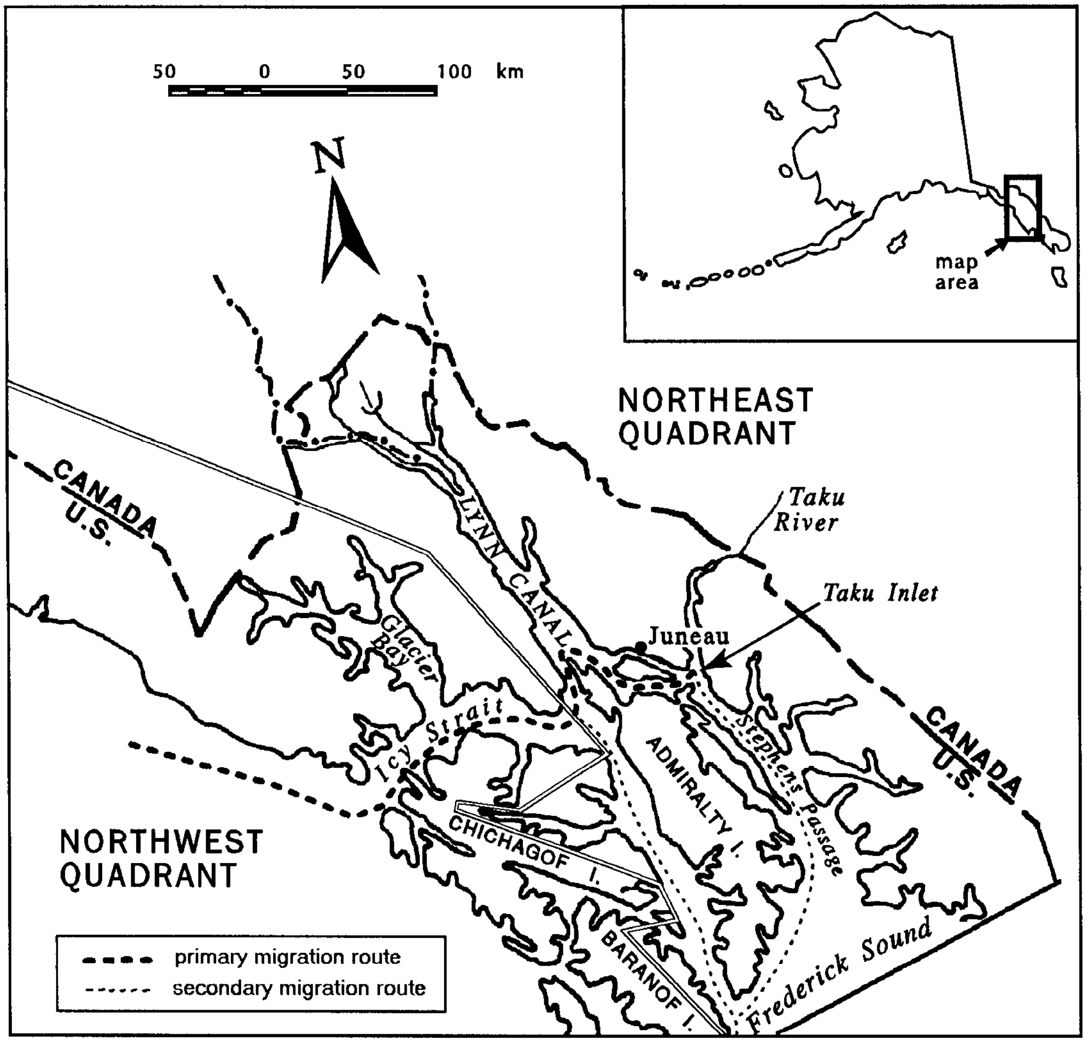

Figure 1.–Migration routes through northern Southeast Alaska of coho salmon bound for Taku River.

marine fisheries in 1994. These objectives were accomplished by tagging and sampling smolt in 1993 in the lower Taku River. Other projects in our agency or in Canada supplied data on returning adults that were harvested or escaped in 1994.

METHODS

SMOLT CAPTURE, CODED WIRE TAGGING, AND SAMPLING

Three rotary smolt traps, constructed by E.G. Solutions of Corvallis, Oregon, were fished just above Canyon Island (approximately 3 km below the Canadian border) on the Taku River to capture smolt (Figure 3). In 1991 and 1992, rotary screw traps were fished at Barrel Point, approximately 12 km downriver. Because of difficulties in catching smolt and damage to traps from debris, operations were moved upriver to Canyon Island in 1993. At this location the Taku River is narrower and is confined principally to a single channel; it was anticipated that these confines would increase the numbers of smolt captured and tagged. The locations fished for each trap will be described

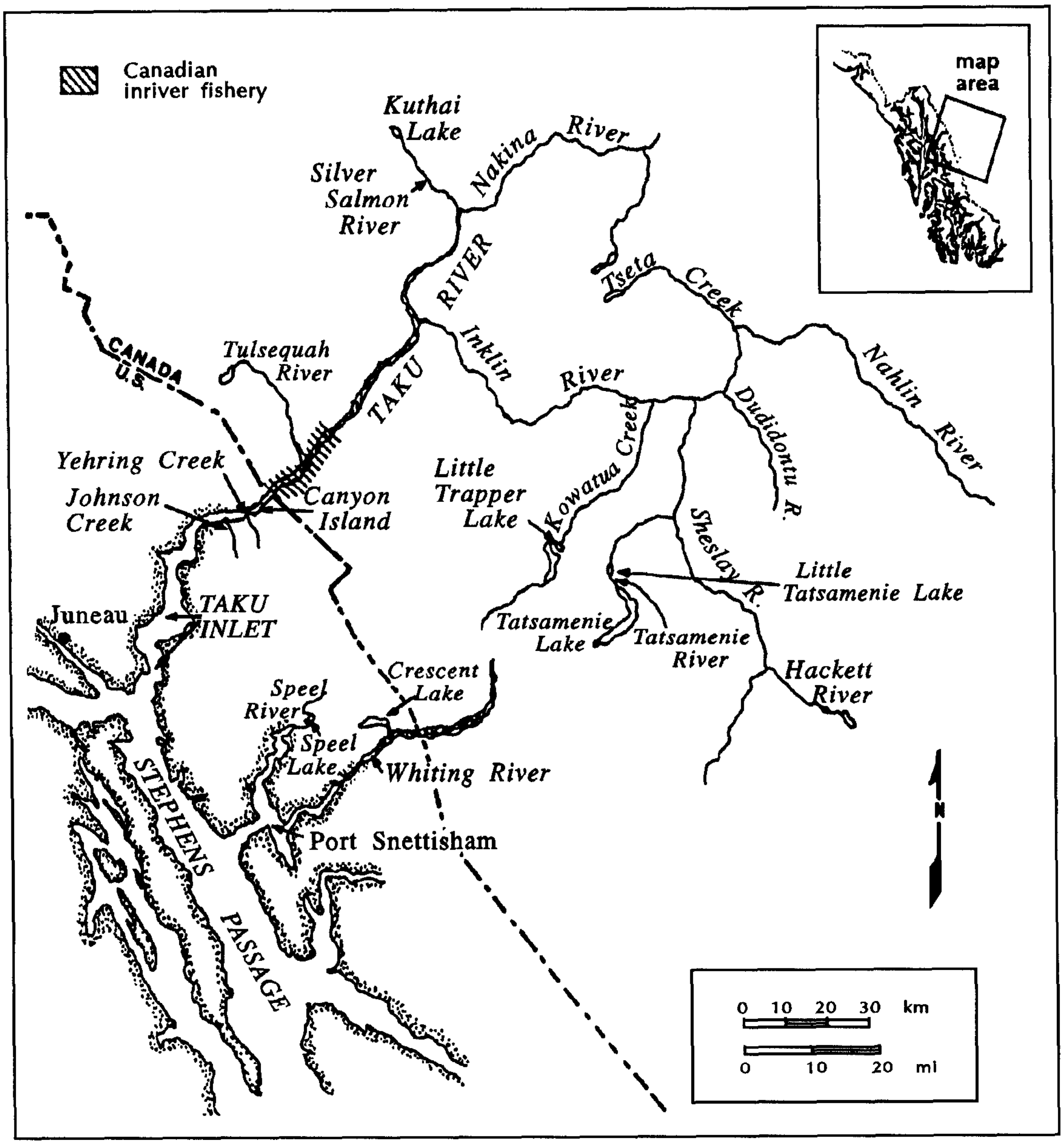

Figure 2.–Taku River drainage, northwestern British Columbia and Southeast Alaska.

separately, but some similarities applied to all three traps. Each trap consisted of a cone, a livebox, two pontoons for flotation, an apparatus to lift the cone from the water, and a mechanism to clean debris from the livebox. The cone (12′ or 8′ in diameter) faced upriver, and blades within the cone corkscrew backed to a narow exit to a livebox; the junction between exit and livebox was sealed with a rubber collar to prevent fish from escaping. All three traps were held offshore 2–10 m by boom logs fixed to the bank and tied off by a tag line off the front pontoons. In addition, each trap was secured by a safety line of ¾″ polypropylene line tied to the inshore pontoon.

One 12′ trap was fished from 8 May to 27 June at a site approximately ¼ km above Canyon Island on the West riverbank, site 1 on Figure 3. The riverbank at this location was a steeply cut gravel bank. The trap was held offshore 2–5 m by the boom log or was trailed 10–20 m behind the boom log. The trap was approximately 4–10 m

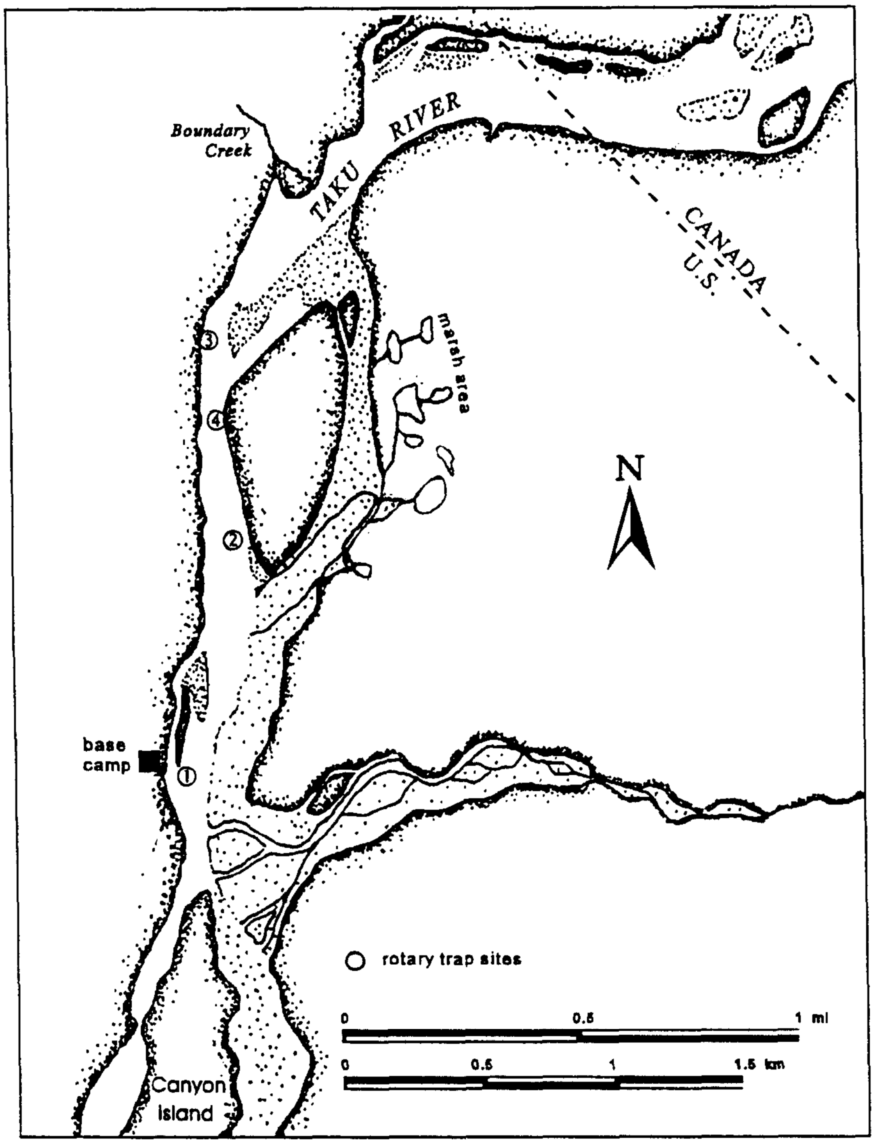

Figure 3.–Location of study area on Taku River near Canyon Island.

inshore from the main debris line. River current was intermediate at this site, and this screw trap generally turned at 2–5 rpm.

A second 12′ trap was fished from 18 May to 27 June at a site approximately 1 km above Canyon Island on the East riverbank, site 4 on Figure 3. The riverbank at this location was a gentle gravel/silt slope. Current at this location is less than at the other two sites, and this screw trap generally turned at 2–3 rpm. This location was opposite the main debris line and mainstem current.

An 8′ trap was fished from 28 May to 27 June at a site approximately 1¼ km above Canyon Island on the West riverbank. The riverbank at this location is steeply cut to bedrock or large substrate and current was fast. The rotary screw traps move to port because of the force from corkscrewing, so this trap generally was held inshore with a line tied to the rear (downstream end) of the inshore pontoon. This trap was fished just inside the main current and debris line. Current was fastest of the three sites, and this trap generally turned at 5–7 rpm.

Two members of a three- to six-person crew were on duty or on call at all times to keep the trap fishing 24 hours a day. Early in the season, the first trap was fished with little difficulty, but with increased spring runoff, debris became a constant problem from 14 May to 25 May, until most debris had been flushed out of upriver locations. Logs and sticks frequently jammed the cones and halted rotation. At times, debris clogged the throat of the cone, and smolt were damaged or escaped. Technicians visited traps about every 4–6 hours at the beginning of the season, and every 2–4 hours at the peak of the migration, or whenever debris stopped rotation. Each morning and evening, fine debris was removed from the cone by a high pressure jet of water supplied by a gasoline-powered water pump.

Salmonid smolt and fry were removed from trap liveboxes during each visit and were transported to holding boxes at camp to await processing each morning. Coho and chinook salmon *Oncorhynchus tshawytscha* smolt were separated by inspection from other species of Oncorhynchus, Dolly Varden *Salvelinus malma*, etc., which were released. Coho and chinook salmon smolt were carefully examined, and species were separated using a combination of external morphological characteristics. A clear 'window' in the pigmentation of the adipose fin (Meehan and Vania 1961) indicated a chinook salmon smolt.

All coho salmon smolt ≥ 70 mm fork length (FL) were tranquilized in a buffered solution of tricainmethane sulfonate (MS 222). The solution was buffered with sodium bicarbonate until the pH was neutral, as measured with a Hach kit. The MS 222 solution was maintained at a constant river temperature by pumping the solution through a continuous loop containing a coil of aluminum tubing submerged in the river. All fish were tagged with a CWT and marked by excision of the adipose fin, following methods in Koerner (1977), and released. All chinook salmon smolt >60 mm FL were also tagged.

A random batch of 100 fish from each day's catch, selected midway through a day's tagging, was held in a separate livebox and checked 24 hours later for retention of CWTs and tagging mortality. When less than 100 fish of a species were caught in a day, the entire catch was held for 24 hours. The number of fish tagged, number of tagging-related mortalities, and number of fish that had shed their tags were compiled and recorded on an *ADF&G CWT Tagging Summary and Release Information Form.* Completed forms were submitted to the Commercial Fisheries Management and Development Division Tag Lab in Juneau when field work ended.

Age composition of emigrating coho salmon smolts in 1993 was estimated by systematically sampling every 36th smolt captured above Canyon Island. Each sampled smolt was measured to the nearest mm FL. A smear of scales was taken two rows above the lateral line on the left side of each sampled smolt just ahead of the adipose fin (the 'preferred area' for sampling scales from coho smolt described in Scarnecchia [1979]). Scales were mounted between two 25-mm by 75-mm glass slides and viewed through a microfiche reader at 70x magnification. Age was determined once for each fish and are reported in European notation. Proportions in the age composition and their variances were estimated as

$$\hat{p}_i = \frac{y_i}{n_s} \qquad V[\hat{p}_i] = \frac{\hat{p}_i(1 - \hat{p}_i)}{n_s - 1} \qquad (1)$$

where y_i = the number of smolts in the sample determined to be of age i (see Table 1 for definitions of the remaining notation in Equation 1).

Estimate of Smolt Abundance

An abundance estimate of smolt leaving the Taku River in 1993 (and originating above Canyon Island) was done with a mark-recapture experiment using a Petersen estimate with Bailey's modifications (Bailey 1951, 1952):

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

$$V[\hat{N}_s] = \frac{n_c^2\,(n_e + 1)(n_e - m_e)}{(m_e + 1)^2(m_e + 2)} \qquad (2)$$

where N_s = number of smolts emigrating from the Taku River in 1993 (originating above Canyon Island), n_c = number of smolt CWTd in 1993, n_e = number of adults sampled in 1994 to estimate θ and m_e = number of adults past Canyon Island in 1994 with missing adipose fins and valid coded wire tags from smolt tagging in 1993.

ESTIMATE OF HARVEST

Harvest of coho salmon from the Taku River (originating above Canyon Island) in 1994 was estimated from fish sampled from catches in commercial and recreational fisheries (Figure 1) and from the escapement taken at Canyon Island (Figure 2). Because several fisheries exploited coho salmon over several months in 1994, the harvest of coho salmon from the Taku River 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 fisheries were stratified by week and by fishing district. Statistics from the recreational fishery were stratified by fortnight An estimate of the harvest $\hat{n}_l$ was calculated for each stratum, then summed across strata and across fisheries to obtain an estimate of the total harvest:

$$\hat{N}_c = \sum_{h=1}^{L} \hat{n}_{lh} \qquad V[\hat{N}_c] = \sum_{h=1}^{L} V[\hat{n}_{lh}] \quad (3)$$

where L is the number of strata. The variance of the sum of the estimates was calculated as the sum of the variances across strata because sampling was independent across strata and across fisheries. A subset of the catch was counted and inspected to find recaptured fish, those salmon without adipose fins. Heads of all recaptured salmon were retrieved, marked, and sent to Juneau for dissection. Heads that arrived in Juneau were passed through a magnetometer to detect a CWT and were dissected if the presence of metal was indicated. If a CWT was found and the tag was undamaged, its code was read under a microscope. Oliver (1990) and Hubartt et al. (1994) present details of sampling commercial and recreational fisheries, respectively. The fraction of the return to the Taku River carrying CWTs was estimated from catches in fish wheels located at Canyon Island and from the inriver fishery in Canada, described by McGregor et al. (1991).

Information from catch and field sampling programs was expanded to estimate harvest of coho salmon bound for the Taku River for each stratum. The harvest in a stratum was calculated as

$$\hat{n}_l = \frac{m_l\, a_l\, H\, m_c}{m_2\, a_2\, n_2\, \hat{\theta}} = H\, \hat{\theta}^{-1} \hat{M} \qquad (4)$$

where $\hat{M}$ is the final statistic obtained through sampling catches (remaining notation is defined in Table 1). All CWTs with codes corresponding to smolts tagged above Canyon Island in 1993 were tallied to calculate m_c. The bootstrap of Efron (1982) as modified by Buckland and Garthwaite (1991) was used to estimate M, its variance, and bias. Each fish inspected during a catch sampling program was placed into one of six capture histories depending on its fate in the program (Table 2). A multinomial, empirical density distribution with six cells was created with the data from the catch sampling program. With respect to the capture histories in Table 2, the probabilities of drawing a single sample from this distribution were calculated from the original data as follows:

$$\frac{n_2 - a_1}{n_2} \quad \frac{a_1 - a_2}{n_2} \quad \frac{a_2 - m_1}{n_2} \quad \frac{m_1 - m_2}{n_2} \quad \frac{m_2 - m_c}{n_2} \quad \frac{m_c}{n_2}$$

The bootstrap began with drawing a sample of size n_2 with replacement from the empirical distribution according to the probabilities based on the original data. Two thousand such samples were drawn, and the results of each (say the b^{th} sample) were tallied to obtain a new set of statistics $\{a_1^*, a_2^*, m_1^*, m_2^*, m_c^*\}_b$ and a value of M_b. The mean of M_b ($\overline{M}$) and its variance $V[\overline{M}]$were calculated for each stratum

$$V[\overline{M}] = \frac{\sum_{b=1}^{B}(M_b - \overline{M})^2}{B-1} \quad \text{with} \quad \overline{M} = \frac{\sum_{b=1}^{B} M_b}{B}$$

Table 1.–Notation used to describe parameters involved in estimators of harvest, escapement and smolt abundance of coho salmon from the Taku River. Coded wire tags are abbreviated as CWTs.

a_1	=	Number of adults missing adipose fins in a sample from a 1994 harvest in a stratum
a_2	=	Number of heads that arrive at Juneau for dissection (subset of a_1) in a stratum
E	=	Exploitation rate of adults in commercial and sport fisheries in 1994
H	=	Number of adults in a harvest in 1994 in a stratum
λ	=	Fraction of harvest in District 111 prior to 22 September 1994
m_1	=	Number of heads with CWTs detected magnetically (subset of a_2) in a stratum
m_2	=	Number of CWTs found through dissection and decoded (subset of m_1) in a stratum
m_c	=	Number of CWTs with the appropriate code(s) (subset of m_2) in a stratum
m_e	=	Number of adults past Canyon Island with missing adipose fins in 1994
n_1	=	Number of adults in a harvest from the appropriate stock in 1994 in a stratum
n_2	=	Number of adults in a harvest inspected (the sample) in 1994 in a stratum
n_c	=	Number of smolt CWTd in 1993
n_e	=	Number of adults sampled in 1994 to estimate θ
n_s	=	Number of smolt sampled to estimate age composition in 1993
N_e	=	Number of adults in escapement past Canyon Island in 1994
N	=	Number of adults in escapement prior to 22 September 1994
N_c	=	Number of adults harvested in all strata and all fisheries in 1994
N_f	=	Number of adults harvested in fishery f in 1994
N_r	=	Number of adults returning to the Taku River in 1994
N_s	=	Number of smolts emigrating from the Taku River in 1993
p_i	=	Fraction of smolt with freshwater age i in 1993
P_{tf}	=	Fraction of catch in stratum t in fishery f in 1994
θ	=	Fraction of the stock tagged with CWTs

where B is the number of bootstrap samples drawn (=2000). From Efron (1982), $\hat{M}-\overline{M}$ is a measure of bias in the statistic $\hat{M}$.

In the case of wild stocks harvested in commercial fisheries where H is known and θ is

Table 2.–Possible capture histories for salmon inspected in 1994 during a catch sampling program based on CWTs.

1. Adipose fin was present
2. Adipose fin was missing, but head never reached the lab
3. Head arrived at lab, but was not dissected
4. Head was dissected, but no tag was decoded
5. Tag was decoded, but did not carry the appropriate code
6. Tag did carry the appropriate code

estimated with error, the variance of the estimated harvest was calculated according to the procedures of Goodman (1960):

$$V[\hat{n}_1] = H^2 \begin{pmatrix} V[\overline{M}]\hat{\theta}^{-2} + V[\hat{\theta}^{-1}]\hat{M}^2 \\ - V[\overline{M}]V[\hat{\theta}^{-1}] \end{pmatrix} \quad (5)$$

Note that $\hat{M}$ and not $\overline{M}$ was used in Equation (5) even though $V[\overline{M}]$ was used as an approximation to $V[\hat{M}]$. Whenver H and θ were both estimated with error (as in the case of wild stocks in sport fisheries where harvest is estimated), the variance was estimated for each stratum:

$$\begin{aligned} V[\hat{n}_1] &= V[\hat{H}]\ M^2\ \hat{\theta}^{-2} + V[\overline{M}]\ \hat{H}^2\ \hat{\theta}^{-2} + V[\hat{\theta}^{-1}]\hat{H}^2 M^2 \\ &- V[\hat{H}]\ V[\overline{M}]\ \hat{\theta}^{-2} - V[\overline{M}]V[\hat{\theta}^{-1}]\ \hat{H}^2 \\ &- V[\hat{H}]V[\hat{\theta}^{-1}]\ M^2 + V[\hat{H}]\ V[\overline{M}]\ V[\hat{\theta}^{-1}] \end{aligned} \quad (6)$$

where V[H] can be estimated from the angler surveys, $V[\hat{\theta}^{-1}]$ can be estimated from a Monte Carlo simulation (e.g., Geiger 1990), and $V[\overline{M}]$ can be estimated using the bootstrap technique (Efron 1982). In this study, equation (5) was used when CWT's were recovered in commercial fishery strata, and (6) was used when CWTs were recovered in sport fishery strata.

The statistic $V[\hat{\theta}^{-1}]$ was estimated from a Monte Carlo simulation (see Geiger 1990). Since sampling with the fish wheels at Canyon Island was continuous with equal sampling effort expended throughout the passage of the escapement, the binomial probability distribution was considered an adequate model for the recovery of tagged fish. A large set of simulated statistics $\{\theta_1^*, \theta_2^*, \dots \theta_B^*\}$ was drawn from Binom $(\hat{\theta}, n_e)$ from which

$$\left\{\frac{1}{\theta_1^*}, \frac{1}{\theta_1^*}, \dots \frac{1}{\theta_B^*}\right\} = \left\{y_1^*, y_2^*, \dots y_B^*\right\};$$

$$V[\theta^{-1}] = \frac{\sum_{b=1}^{B}\left(y_b^* - \bar{y}^*\right)^2}{B-1} \qquad (7)$$

where y = the subset of n_e that had no adipose fins and valid Canyon Island tags.

ESTIMATE OF ESCAPEMENT

An estimate of escapement of coho salmon past Canyon Island in 1994 was calculated by expanding a partial estimate available from an ongoing mark-recapture experiment in another division of the Department (see McGregor et al. [1989] for a description of this experiment). Coho salmon in this experiment were captured in two fish wheels at Canyon Island, tagged through the back with individually numbered plastic spaghetti tags, released, and recovered along with unmarked fish in set gillnet fisheries 5 to 10 km upstream in Canada. The estimated escapement past Canyon Island through 22 September was obtained directly from the mark-recapture experiment (M. S. Kelley, ADF&G, Douglas; P. Milligan, DFO, Whitehorse, Canada, personal communication). On 22 September a major flood damaged fish wheels and tagging of coho salmon ceased. Under these circumstances, our mark-recapture experiment to estimate passage after 22 September was not successful. This partial estimate was expanded by the estimated fraction of the escapement that had passed Canyon Island by 22 September:

$$\hat{N}_e = \hat{N}_e^* \lambda^{-1} \qquad V[\hat{N}_e] = V[\hat{N}_e^*]\lambda^{-2} \qquad (8)$$

The statistic λ is the fraction of the harvest in the drift gillnet fishery in Taku Inlet (District 111) during 1994 that occurred prior to 22 September (transit time of coho salmon between Taku Inlet and Canyon Island was considered negligible). The statistic $V[\hat{N}_e]$ is a minimum, because the measurement error in λ is unknown.

ESTIMATES OF RUN SIZE, RATE OF EXPLOITATION AND MARINE SURVIVAL

Estimates of total run size (harvest plus escapement) of coho salmon returning to the Taku River in 1994 and the associated exploitation rate in commercial and sport fisheries are based on the sum of estimated harvest and estimated escapement ($\hat{N}_r = \hat{N}_H + \hat{N}_e$). The variance of the estimated run was calculated as the sum of the variances for estimated escapement and estimated harvest ($V[\hat{N}_r] = V[\hat{N}_e] + V[\hat{N}_c]$). The estimate of exploitation rate was calculated as

$$\hat{E} = \frac{\hat{N}_c}{\hat{N}_r}$$

$$V[\hat{E}] \approx \frac{V[\hat{N}_c]\hat{N}_e^2}{\hat{N}_r^4} + \frac{V[\hat{N}_e]\hat{N}_c^2}{\hat{N}_r^4} \qquad (9)$$

The variance in Equation (9) was approximated with the delta method (Seber 1982).

The estimated survival rate of smolts to adults was calculated as

$$\hat{S} = \frac{\hat{N}_r}{\hat{N}_s}$$

$$V[\hat{S}] \approx \left[\frac{V[\hat{N}_r]}{\hat{N}_r^2} + \frac{V[\hat{N}_s]}{\hat{N}_s^2}\right]\hat{S}^2 \qquad (10)$$

The variance in Equation (10) was approximated with the delta method (Seber 1982).

ESTIMATES OF 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):

$$P_{tf} = \frac{n_{tf}}{N_{cf}} \qquad (11)$$

where n_{tf} is the estimated catch of Taku River coho salmon in stratum t and fishery f; remaining notation is given in Table 1.

For a migration over a time interval of *n* strata, the mean of *t*:

$$\bar{t} = \sum_{t=1}^{n} t\, P_{tf} \qquad (12)$$

is the mean date of harvest.

RESULTS

SMOLT TAGGING, AGE AND LENGTH IN 1993

From 9 May to 27 June 1993, 5,549 coho salmon smolt were captured in three rotary smolt traps, located just above Canyon Island on the Taku River (Figure 3). Five thousand forty-four (5,044) fish were marked, implanted with CWTs, and released carrying tags (Table 3). This total included 683 fish tagged with code 04-38-01 between 10 May and 25 May and 4,361 fish tagged with coded 04-38-02 between 26 May and 27 June.

It was estimated that 99% of the released fish retained their tags for at least 24 hours. Of the 5,549 fish caught, 505 were not tagged and released with valid tags: 271 were <70 mm FL (and were not tagged), 189 died in traps prior to tagging, an estimated 35 shed tags and an estimated 10 died after tagging. Frequency of catches of coho salmon smolt reflected a very short duration of abundance (Figure 4; Table 3), with catches of over 100 coho smolt recorded for 16 continuous days from 28 May to 12 June. Approximately 72% of the total coho smolt for the season were caught during this 16-day period. With one exception (23 May), catches were <100 coho smolt for the periods before and after the peak. The peak catches were approximately one week later than those observed by Meehan and Siniff (1962), when a modified scoop trap was operated in the narrows of Canyon Island from 12 April through 15 June.

Fishing effort in 1993 was not constant. One 12′ trap was fished beginning 8 May, the second 12′ was added 18 May and a third trap, 8′ in diameter, was started 28 May (Table 4). Effort was relatively constant from 28 May to 27 June. Realizing that each trap was not fished the same number of hours, Trap #1 accounted for 35%, Trap #2 for 20% and Trap #3 for 45% of the total CPUE for coho salmon.

Coho salmon smolt averaged 98 mm FL (Table 5; Figure 5). Age composition of captured coho salmon smolts was 78% age 1.0 and 22% age 2.0 (Table 5).

Smolts and young of other species of salmon were also captured. Of 10,540 chinook salmon smolt captured (Table 4), 10,015 were tagged and released with valid tags, 8,872 with tag code 04-28-53 and 1,143 with tag code 04-37-62. Analyses of these tagging data will be published when catches from that brood (1991) are completed after the 1998 calendar year. Also captured, but not marked or tagged, were 6,118 sockeye salmon *O. nerka*, about 158 steelhead salmon *O. mykiss*, chum salmon *O. keta*, pink salmon *O. gorbuscha,* and Dolly Varden. No eulachon *Thaleichthys pacificus* were caught at the Canyon Island site; scores of this species were caught at the Barrel Point site in 1991 and 1992. This species does not migrate upriver as far as Canyon Island, apparently.

CODED WIRE TAG RECOVERY

In 1994, 178 CWTs with tag codes 04-38-01 and 04-38-02 were recovered in the various fisheries as random recoveries associated with port or creel sampling (Appendix A2). The greatest number

Table 3.–Daily catches and releases of salmon smolt in three rotary traps near Canyon Island on the Taku River, 1993

	Lower 12' trap		Upper 12' trap		8' trap		Coho		No. coho	No. chinook	Air temp (°C)		Water	Water
Date	Coho	Chinook	Coho	Chinook	Coho	Chinook	total	Total	CWTd	CWTd	Min	Max	temp (°C)	depth (in.)
10 May	20	133					21	140	14	126	-0.2	12	8	37
11 May	18	86					18	88	14	83	-0.2	12	6	34
12 May	11	58					11	59	3	51	-0.1	13	6.5	34
13 May	15	57					15	57	13	53	0	12	6.5	35
14 May	32	77					33	79	28	75	3	24	7.5	49
15 May	65	69					70	75	51	64	3	22	7.0	73
16 May	93	129					99	152	86	113	7	21	7.0	103
17 May	17	32					17	32	16	30	9	20	7.0	123
18 May	9	16					9	16	9	13	2	21	7.0	135
19 May	4	32	29	159			36	223	33	176	4	21	8.0	123
20 May	9	30	79	267			89	300	87	276	9	22	7.0	121
21 May	7	48	47	214			54	262	54	249	7	15	6.0	132
22 May	28	90	29	75			60	170	56	155	6	10	6.0	142
23 May	36	68	69	237			106	307	104	295	7	16	7.5	128
24 May	43	62	29	155			72	220	70	215	3	18	8.0	132
25 May	52	78	11	97			63	176	62	175	4	19	8.0	130
26 May	35	46	12	77			47	124	47	122	4	19	8.0	130
27 May	43	89	17	112			61	202	60	200	4	20	8.0	127
28 May	63	79	47	243			111	322	108	320	3	19	8.0	128
29 May	49	99	28	182	141	108	218	393	216	384	4	23	8.0	126
30 May	154	181	38	209	157	82	420	528	342	465	12	22	9.0	124
31 May	201	183	27	240	242	88	474	513	464	502	12	22	9.0	122
01 Jun	149	151	25	228	243	86	422	468	416	464	12	23	8.0	123
02 Jun	107	129	30	234	259	204	436	598	396	563	9	22	8.0	126
03 Jun	97	123	37	309	150	121	296	565	278	551	8	15	9.0	131
04 Jun	83	80	32	168	135	30	251	280	250	273	5	15	9.0	126
05 Jun	57	85	29	187	108	45	194	317	192	315	7	22	8.5	124
06 Jun	32	50	21	233	96	65	149	348	149	345	11	11	9.0	128
07 Jun	38	56	39	179	97	52	175	288	174	286	7	14	8.0	128
08 Jun	32	71	40	236	104	132	178	441	175	438	5	13	8.0	114
09 Jun	49	83	37	213	104	56	193	353	187	350	4	15	8.0	84
10 Jun	32	73	36	140	105	112	176	329	168	322	10	21	8.0	72

-continued-

Table 3.–page 2 of 2.

Date	Lower 12' trap		Upper 12' trap		8' trap		Coho		No. coho	No. chinook	Air temp (°C)		Water	Water
	Coho	Chinook	Coho	Chinook	Coho	Chinook	total	Total	CWTd	CWTd	Min	Max	temp (°C)	depth (in.)
11 Jun	31	76	57	57	86	64	179	199	153	196	10.0	17.0	8.0	73
12 Jun	30	94	42	86	49	44	121	224	108	224	8.0	17.0	8.0	76
13 Jun	13	47	49	111	32	42	97	204	92	190	9	18	9	72
14 Jun	10	33	38	56	41	34	92	125	75	122	8	20	9	76
15 Jun	15	64	18	76	48	30	86	176	78	170	2	24	9	79
16 Jun	8	60	10	104	27	36	46	202	42	200	11	20	9	96
17 Jun	10	49	16	119	19	29	46	198	41	195	10	20	9	102
18 Jun	6	21	13	185	7	12	26	219	25	217	7	15	7	114
19 Jun	0	0	7	123	0	0	7	124	7	123	11	15	5	132
20 Jun	4	7	11	75	4	1	19	83	14	83	11	17	9	78
21 Jun	8	11	9	7	18	6	35	24	23	21	8	13	8.5	73
22 Jun	5	18	1	34	14	7	22	59	15	59	3	13	8.5	71
23 Jun	9	19	12	43	32	7	54	69	32	67	10	20	9	65
24 Jun	8	25	9	29	11	1	29	55	19	54	8	21	9.5	67
25 Jun	8	26	10	30	18	4	36	60	15	59	7	14	9	65
26 Jun	7	14	18	40	11	1	36	56	15	47	4	11	9	64
27 Jun	4	18	13	18	25	2	44	38	15	31	9	20	9	65
Totals	1,856	3,225	1,121	5,587	2,383	1,501	5,549	10,540	5,091	10,107				

[a] Coho total includes 189 trap mortalities and chinook total includes 227 mortalities.

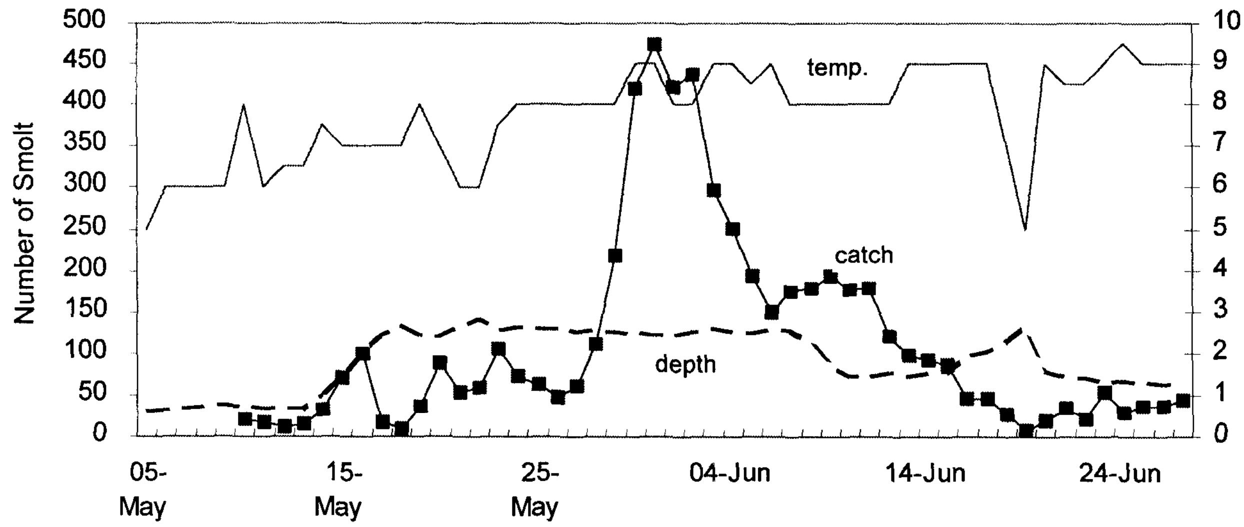

Figure 4.–Catch of coho salmon smolt, daily water temperature, and depth near Canyon Island, 1993.

(80) of tags were recovered from marine gillnet fisheries, with 76 from District 111 (Taku Inlet/Stephens Passage), three in Prince William Sound, and one from District 115 (Lynn Canal). In the troll fishery, 70 tags were recovered—66 from the Northwest Quadrant on the outside coast (see Figure 1). Sixteen CWTs were recovered in the seine fisheries in upper Chatham Strait, Icy Strait and Frederick Sound; 10 were recovered in marine recreational fisheries around Juneau during August and early September.

Coho salmon bearing Canyon Island tags were recovered with similar relative frequencies throughout the duration of the District 111 gillnet fishery, though the fraction marked was slightly higher during the middle portion of the catch (0.16%), compared to the first and last segments (0.13%) (Table 6).

Both tag codes were recovered throughout this fishery, but a greater percentage of tag code 04-38-02 was recovered during the first two-thirds of the gillnet coho season. The opposite was true in the Northwest Quadrant of the troll fishery, where most recoveries of tag code 04-38-01 occurred before 27 August. These data indicate that significant mixing of the two tag codes did occur in marine waters.

ESTIMATES OF θ AND SMOLT ABUNDANCE

The estimate of θ was 0.003191 (=14/4388) with SE = 0.00851, and the estimate of smolt abundance N_s in 1993 was 1,475,874 [=5,044(4,388+1)(14+1)$^{-1}$] with SE = 368,411. Both estimates were based on 4,388 coho salmon adults inspected in 1994 from catches in two fish wheels operated at Canyon Island (Appendix A3). Twenty-one (21) of the fish inspected were missing adipose fins, and all were sacrificed to determine the tag codes present; 14 contained Canyon Island tags implanted the previous year, and 7 had no tag (33%).

We believe the difference to be due primarily to the small incidence of naturally missing adipose fins. In 1995, naturally missing adipose fins were observed in Taku River coho and chinook smolt; additionally, a two-week tag retention trial was implemented and tag retention was 100%, similar to the 24-hour rates (S. McPherson, unpublished data). This phenomenon was observed in only a small fraction of 1 % of captured smolt, but when less than 1% of the migration is captured and tagged it can adversely affect estimates of smolt production and marine survival.

Table 4.–Locations, hours fished, and CPUE of coho and chinook salmon smolt in three rotary traps fished near Canyon Island on the Taku River, 1993.

	Rotary trap #1 (12' diameter)				Rotary trap #2 (12' diameter)				Rotary trap #3 (8' diameter)				Total 3 rotary traps			Water
Date	Location	Hours	CPUE coho	CPUE chinook	Location	Hours	CPUE coho	CPUE chinook	Location	Hours	CPUE coho	CPUE chinook	Total hours	CPUE coho	CPUE chinook	depth (feet)
04-May													0.0			
05-May													0.0			2.5
06-May													0.0			2.7
07-May													0.0			2.9
08-May	Site #1	12.0	13	12									12.0	13	12	3.1
09-May	Site #1	24.0	13	24									24.0	13	24	3.2
10-May	Site #1	24.0	18	86									24.0	18	86	3.1
11-May	Site #1	24.0	11	58									24.0	11	58	2.8
12-May	Site #1	24.0	15	57									24.0	15	57	2.8
13-May	Site #1	22.0	35	84									22.0	35	84	2.9
14-May	Site #1	19.0	82	87									19.0	82	87	4.1
15-May	Site #1	17.0	131	182									17.0	131	182	6.1
16-May	Site #1	18.0	23	43									18.0	23	43	8.6
17-May	Site #1	24.0	9	16									24.0	9	16	10.3
18-May	Site #1	23.0	4	33	Site #4	8.0	44	239					31.0	48	272	11.3
19-May	Site #1	17.0	13	42	Site #4	24.0	94	347					41.0	106	389	10.3
20-May	Site #1	24.0	7	48	Site #4	24.0	47	214					48.0	54	262	10.1
21-May	Site #1	21.0	32	103	Site #4	24.0	29	75					45.0	61	178	11.0
22-May	Site #1	24.0	36	68	Site #4	24.0	69	237					48.0	105	305	11.8
23-May	Site #1	24.0	43	62	Site #4	24.0	29	155					48.0	72	217	10.7
24-May	Site #1	24.0	52	78	Site #4	24.0	11	97					48.0	63	175	11.0
25-May	Site #1	24.0	35	46	Site #4	24.0	12	77					48.0	47	123	10.8
26-May	Site #1	24.0	43	89	Site #4	24.0	17	112					48.0	60	201	10.8
27-May	Site #1	24.0	63	79	Site #4	24.0	47	243					48.0	110	322	10.6
28-May	Site #1	24.0	49	99	Site #4	24.0	28	182	Site #2	6.0	282	216	54.0	359	497	10.7
29-May	Site #1	22.0	168	197	Site #4	24.0	38	209	Site #2	24.0	228	136	70.0	434	542	10.5
30-May	Site #1	19.0	254	231	Site #4	24.0	27	240	Site #2	24.0	242	88	67.0	523	559	10.3
31-May	Site #1	24.0	149	151	Site #4	24.0	25	228	Site #2	21.0	278	98	69.0	452	477	10.2
01-Jun	Site #1	24.0	107	129	Site #4	24.0	30	234	Site #2	22.0	283	223	70.0	420	586	10.3
02-Jun	Site #1	21.0	111	141	Site #4	23.0	39	322	Site #2	22.0	164	132	66.0	313	595	10.5
03-Jun	Site #1	24.0	83	80	Site #4	21.0	37	192	Site #2	24.0	135	30	69.0	255	302	10.9
04-Jun	Site #1	24.0	57	85	Site #4	24.0	29	187	Site #2	24.0	108	45	72.0	194	317	10.5
05-Jun	Site #1	24.0	32	50	Site #4	24.0	21	233	Site #2	24.0	96	65	72.0	149	348	10.3
06-Jun	Site #1	24.0	38	56	Site #4	24.0	39	179	Site #2	24.0	97	52	72.0	174	287	10.7
07-Jun	Site #1	19.0	40	90	Site #4	24.0	40	236	Site #2	24.0	104	132	67.0	184	458	10.7
08-Jun	Site #1	21.0	56	95	Site #4	24.0	37	213	Site #2	24.0	104	56	69.0	197	364	9.5
09-Jun	Site #1	24.0	32	73	Site #4	24.0	36	140	Site #2	24.0	105	112	72.0	173	325	7.0

-continued-

Table 4. (page 2 of 2).

Date	Rotary trap #1 (12' diameter)				Rotary trap #2 (12' diameter)				Rotary trap #3 (8' diameter)				Total 3 rotary traps			Water depth (feet)
	Location	Hours	CPUE coho	CPUE chinook	Location	Hours	CPUE coho	CPUE chinook	Location	Hours	CPUE coho	CPUE chinook	Total hours	CPUE coho	CPUE chinook	
10-Jun	Site #1	24.0	31	76	Site #4	24.0	57	57	Site #2	24.0	86	64	72.0	174	197	6.0
11-Jun	Site #1	24.0	30	94	Site #4	24.0	42	86	Site #2	24.0	49	44	72.0	121	224	6.1
12-Jun	Site #1	24.0	13	47	Site #4	24.0	49	111	Site #2	24.0	32	42	72.0	94	200	6.3
13-Jun	Site #1	24.0	10	33	Site #4	24.0	38	56	Site #2	24.0	41	34	72.0	89	123	6.0
14-Jun	Site #1	24.0	15	64	Site #4	24.0	18	76	Site #2	24.0	48	30	72.0	81	170	6.3
15-Jun	Site #1	21.0	9	69	Site #4	24.0	10	104	Site #2	24.0	27	36	69.0	46	209	6.6
16-Jun	Site #1	24.0	10	49	Site #4	24.0	16	119	Site #2	24.0	19	29	72.0	45	197	8.0
17-Jun	Site #1	21.0	7	24	Site #4	24.0	13	185	Site #2	24.0	7	12	69.0	27	221	8.5
18-Jun	Site #1	14.0	0	0	Site #4	23.0	7	128	Site #2	18.0	0	0	55.0	7	128	9.5
19-Jun	Site #1	13.5	7	12	Site #4	14.5	18	124	Site #2	24.0	4	1	52.0	29	138	11.0
20-Jun	Site #1	24.0	8	11	Site #4	9.0	24	19	Site #2	24.0	18	6	57.0	50	36	6.5
21-Jun	Site #1	24.0	5	18	Site #2	9.5	3	86	Site #2	24.0	14	7	57.5	22	111	6.1
22-Jun	Site #1	24.0	9	19	Site #2	24.0	12	43	Site #2	24.0	32	7	72.0	53	69	5.9
23-Jun	Site #1	24.0	8	25	Site #2	23.0	9	30	Site #2	24.0	11	1	71.0	28	56	5.4
24-Jun	Site #1	24.0	8	26	Site #2	24.0	10	30	Site #2	24.0	18	4	72.0	36	60	5.6
25-Jun	Site #1	21.5	8	16	Site #2	24.0	18	40	Site #2	24.0	11	1	69.5	37	57	5.4
26-Jun	Site #1	24.0	4	18	Site #2	24.0	13	18	Site #2	24.0	25	2	72.0	42	38	5.3
Total		1110.0	2,037	3,375		899.0	1,181	5,903		689.0	2,666	1,705	2698.0	5,884	10,982	
Average		22.2	41	67		22.5	30	148		23.0	89	57	47.3	118	220	7.7
Percentage of species total			35%	31%			20%	54%			45%	16%		100%	100%	

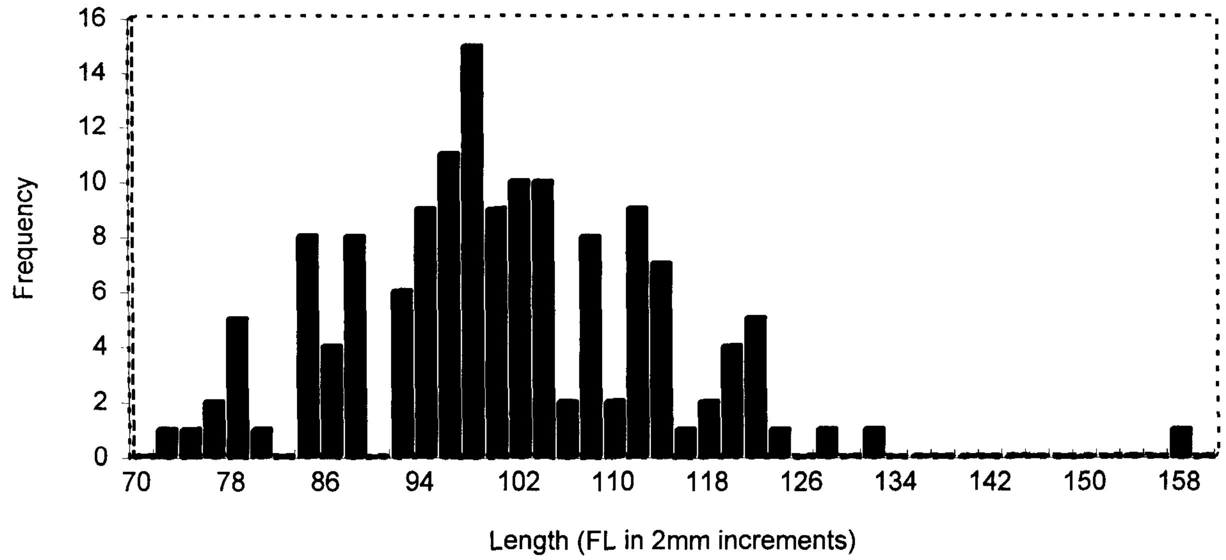

Figure 5. –Length frequency of coho salmon smolt captured and measured at Canyon Island, 1993.

Table 5.–Mean fork length and age composition of coho salmon smolts sampled from three rotary smolt traps near Canyon Island, Taku River, 1993 and mean length (mid-eye to fork of tail) and age composition of adult coho salmon sampled from fishwheels at Canyon Island in 1994

SMOLT SAMPLED IN 1993			
	Parent year		
	1991	1990	
	Age 1.	Age 2.	Total
Number sampled	109	31	140
Mean length (mm)	94	111	98
SD	10	12	13
SE	1	2	1
Percent composition	77.9	22.1	100.0
SE	3.5	3.5	

ADULTS SAMPLED IN 1994					
	Parent year				
	1991		1990	1989	
	Age 1.1	Age 2.0	Age 2.1	Age 3.1	Total
Number sampled	240	2	295	1	538
Mean length	592	333	608	555	600
SD	71	24	75		74
SE	4	17	4		3
% comp.	47.7	0.2	51.9	0.2	100.0
SE	2.5	0.1	2.5	0.2	

ESTIMATES OF HARVEST, ESCAPEMENT AND EXPLOITATION IN 1994

On the basis of CWT recoveries, it was estimated that 228,607 (SE = 36,734) Taku River coho salmon originating from above Canyon Island were harvested in marine commercial and sport fisheries in 1994 (Table 7). Estimates of relative bias in $\hat{M}$ across strata ranged from 0.0% to 5.9%. The troll fishery in the Northwest, Northeast and Southwest Quadrants took 42% of the estimated harvest, and the drift gillnet fisheries in Taku Inlet/Stephens Passage, Lynn Canal and Prince William Sound took 38% of the harvest (Table 8). Harvests in these fisheries occurred from July through September. Almost all of the troll harvest occurred in July and August and the gillnet harvests were spread over July, August and September with a peak in the last week of August and the first week of September (Figure 6). The estimated mean date of harvest in the troll fishery was 3 August, compared to 31 August for the gillnet fishery (Appendix A4), dates that were approximately two weeks earlier

Table 6.–Frequency of CWTs recovered during sampling of the harvest of coho salmon in the drift gillnet fishery in District 111 and in the troll fishery in the Northwest Quadrant in 1994. Recoveries are from smolt marked at Canyon Island in 1993 with codes 04-38-01 and 04-38-02.

PANEL A: District 111 Gillnet Fishery

Stat week	Dates	Tag code 04-38-01	Tag code 04-38-02	Total tags	Sampled harvest	Percent marked	Total harvest	Percent sampled
26	Jun 19-25	0	1	1	32	3.13	30	106.7
27	26-02	0	0	0	60	0.00	71	84.5
28	Jul 03-09	0	0	0	305	0.00	1,197	25.5
29	10-16	0	0	0	522	0.00	3,180	16.4
30	17-23	0	1	1	1,023	0.10	3,896	26.3
31	24-30	1	7	8	2,343	0.34	6,264	37.4
32	31-06	0	0	0	1,085	0.00	7,885	13.8
33	Aug 07-13	0	1	1	1,606	0.06	11,841	13.6
34	14-20	0	10	10	9,782	0.10	18,016	54.3
35	21-27	0	8	8	8,341	0.10	23,803	35.0
36	28-03	0	14	14	5,794	0.24	22,791	25.4
37	Sep 04-10	4	14	18	10,833	0.17	33,214	32.6
38	11-17	0	4	4	3,587	0.11	23,134	15.5
39	18-24	3	5	8	3,794	0.21	11,392	33.3
40	25-01	2	2	4	4,236	0.09	15,337	27.6
41	Oct 02-08	0	1	1	1,553	0.06	6,450	24.1
Total		10	68	78	54,896	0.14	188,501	29.1

Stat weeks	Dates	Tag code 04-38-01	Tag code 04-38-02	Total tags	Sampled harvest	Percent marked	Total harvest	Percent sampled
26-34	Jun 19-Aug 20	1	20	21	16,758	0.125	52,380	32.0
35-37	Aug 21-Sep 10	4	36	40	24,968	0.160	79,808	31.3
38-41	Sep 11-Oct 08	5	12	17	13,170	0.129	56,313	23.4
Total		10	68	78	54,896	0.142	188,501	29.1

PANEL B: Northwest Quadrant Troll Fishery

Stat weeks	Dates	Tag code 04-38-01	Tag code 04-38-02	Total tags	Sampled harvest	Percent marked	Total harvest	Percent sampled
28-35	6/03-8/27	9	55	64	428,710	0.015	1,962,244	21.8
36-40	8/28-10/8	1	5	6	125,548	0.005	459,558	27.3
Total		10	60	70	554,258	0.013	2,421,802	22.9

than observed in 1993 for both fisheries (McPherson et al. 1994). Taku River coho salmon contributed an estimated 44% (82,181 fish) of the District 111 gillnet catch (188,501 fish). Fifty percent of the estimated total harvest was taken by 15 August, when most of the troll (66%) and seine (85%) catch had occurred (Appendix A3; Figure 6). Most (70%) of the estimated gillnet harvest occurred after 1 Sept. The estimated contribution to the Juneau marine recreational fishery was 19,018 fish or 8.3% of the total Taku River harvest; this equates to 31% of the estimated 62,218 coho salmon caught in the Juneau marine fishery, using harvest and sampling data from Hubartt et al. (*In press*). The seine fishery in northern Southeast Alaska caught an estimated 11.5% of the total Taku River harvest (of fish from above Canyon Island).

The estimated exploitation rate for coho salmon from the Taku River in marine commercial and sport fisheries ($\hat{E}$) of 67.3% (SE = 3.8%) (Table 8) was based on an estimated total run ($\hat{N}_r$) of 339,643 (SE = 37,310) for fish above Canyon Island. In sampling in the 1994 mark-recapture experiment at Canyon Island, inriver abundance (above Canyon Island) was estimated at 98,643

Table 7.–Estimated harvest of adult coho salmon bound for the Taku River in 1994 with $\hat{\theta}$ = 0.003191 and $V[1/\hat{\theta}]$ = 11,371. Random seed for bootstrap estimation of the SE was 554,764,062. In fishing periods and fishing quadrants for which no CWT was recovered with the appropriate code, harvest was assumed to be zero.

TROLL FISHERY

Weeks	Dates	Period	Quad.	H	n_2	a_1	a_2	m_1	m_2	m_c	n_1	Bias (%)	SE
28-35	6/03-8/27	3	NW	1,962,244	428,710	8,021	7,961	6,912	6,906	60	86,799	0.1%	31,128
28-35	6/03-8/27	3	SW	495,522	189,763	2,177	2,141	1,785	1,784	1	833	0.1%	842
28-35	6/03-8/27	3	NE	207,029	81,118	1,152	1,140	912	910	3	2,430	0.2%	1533
36-40	8/28-10/8	4	NW	459,558	125,548	2,024	1,997	1,743	1,743	6	6,977	0.0%	3610
Subtotal troll fishery				3,124,353	825,139	13,374	13,239	11,352	11,343	70	97,039	0.2%	31,385

GILLNET FISHERY

Stat. wk	Dates	District	H	n_2	a_1	a_2	m_1	m_2	m_c	n_1	Bias	SE
26	6/19-6/25	111	30	32	1	1	1	1	1	313	1.6%	302
26	6/19-6/25	212	34	34	1	1	1	1	1	313	-1.9%	311
29	7/10-7/16	212/223	2,251	498	2	2	2	2	1	1,417	0.8%	1,427
30	7/17-7/23	111	3,896	1,023	3	3	1	1	1	1,194	-5.4%	1,281
31	7/24-7/30	111	6,264	2,343	12	12	10	10	8	6,704	-1.7%	3,211
31	7/24-7/30	115	1,536	651	9	9	8	8	1	740	1.5%	710
33	8/07-8/13	111	11,841	1,606	5	5	4	4	1	2,311	-0.2%	2,300
34	8/14-8/20	111	18,016	9,782	69	69	63	63	10	5,773	0.6%	2,632
35	8/21-8/27	111	23,803	8,341	100	100	86	86	8	7,156	1.7%	3,388
36	8/28-9/03	111	22,791	5,794	112	98	93	93	14	19,726	0.5%	8,315
37	9/04-9/10	111	33,214	10,833	129	128	117	117	18	17,433	-1.4%	7,104
37	9/04-9/10	200	60,019	12,158	17	17	8	8	1	1,547	1.6%	1,572
38	9/11-9/17	111	23,134	3,587	111	109	104	104	4	8,234	1.5%	4,783
39	9/18-9/24	111	11,392	3,794	59	59	56	56	8	7,529	-2.8%	3,586
40	9/25-10/1	111	15,272	4,236	195	195	188	188	4	4,520	1.6%	2,560
41	10/2-10/8	111	6,383	1,553	55	55	53	53	1	1,288	-0.9%	1,285
Subtotal gillnet fishery			239,876	66,265	880	863	795	795	82	86,198	-0.2%	14,297

SEINE FISHERY

Stat. wk	Dates	District	H	n_2	a_1	a_2	m_1	m_2	m_c	n_1	Bias	SE
29	7/10-7/16	112	6,486	918	11	11	10	10	1	2,214	-0.2%	2,243
30	7/17-7/23	112	8,426	1,491	24	24	19	19	1	1,771	4.3%	1,751
31	7/24-7/30	110	7,594	1,973	7	7	6	6	1	1,206	-2.8%	1,181
31	7/24-7/30	112	8,688	1,681	26	26	20	20	1	1,620	-0.9%	1,640
32	7/31-8/06	114	7,755	2,414	39	39	29	29	2	2,014	0.2%	1,482
33	8/07-8/13	110	12,955	574	3	3	3	3	1	7,074	-1.1%	7,179
33	8/07-8/13	112	18,103	2,556	41	41	30	30	2	4,440	-0.7%	3,351
33	8/07-8/13	114	6,045	1,971	34	34	25	25	2	1,923	0.9%	1,419
34	8/14-8/20	112	11,208	6,289	110	110	88	88	3	1,676	1.5%	1,072
35	8/21-8/27	112	26,460	4,036	70	70	62	62	1	2,055	1.6%	2,057
36	8/28-9/03	114	13,004	11,345	315	315	274	274	1	359	-1.1%	367
Subtotal seine fishery			126,724	35,248	680	680	566	566	16	26,352	0.0%	9,202

SPORT FISHERY

Bi-week	Dates	Derby	Area	$\hat{H}$	$Var[\hat{H}]$	n_2	a_1	a_2	m_1	m_2	m_c	n_1	Bias	SE
16	7/31-8/13		Juneau	18,326	13,054,951	2,802	52	46	40	40	3	6,952	-0.5%	4,476
17	8/14-8/27		Juneau	16,287	36,165,515	1,207	24	22	22	22	2	9,228	-0.2%	7,258
18	8/28-9/10		Juneau	5,688	1,353,587	1,467	45	41	41	41	1	1,334	5.9%	1,305
17	8/19-8/21	yes	Juneau	8,358	241,457	6,967	223	223	211	211	4	1,504	0.6%	908
Subtotal sport fishery				48,659	50,815,510	12,443	344	332	314	314	10	19,018	0.2%	8,674
Total				3,539,612	50,815,510	939,095	15,278	15,114	13,027	13,018	178	228,607	0.0%	36,734

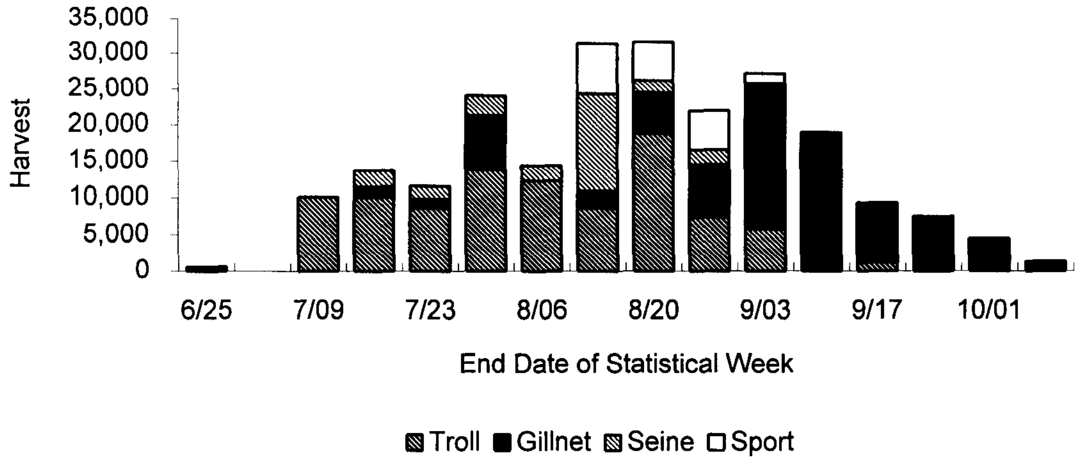

Figure 6. –Estimated harvest of coho salmon bound for Taku River by marine commercial and recreational fisheries in 1994 by statistical week. Weekly estimates of harvest in the troll fishery are approximated.

(SE[$\hat{N}_e^*$] = 5,800) coho salmon prior to 22 September (M. S. Kelley, ADF&G, Douglas, and P. Milligan, DFO, Whitehorse, Douglas, personal communication). Because 88.8% (= λ100) of the CPUE in District 111 drift gillnet fishery occurred prior to 27 September (after subtracting hatchery fish), the estimate for inriver abundance of coho salmon for the season past Canyon Island in 1994 is then 111,036 (SE[$\hat{N}_e$]= 6,529) and includes 14,693 fish taken in the Canadian inriver set/drift gillnet and aboriginal food fisheries. Age composition of adult coho salmon sampled from catches in Canyon Island fish wheels was 47.7% age 1.1, 0.2% age 2.0, 51.9% age 2.1 and 0.2% age 3.1 (Table 5), and the mean length of adults at Canyon Island was 600 mm mid-eye to fork of tail.

DISCUSSION

Smolt captured and tagged in 1993 were slightly smaller than smolt captured and tagged in 1992 and 1991 on the Taku River, most likely due to interannual variability. In 1993, smolt captured at Canyon Island averaged 98 mm FL, compared to 105 mm at Barrel Point in 1992 (McPherson et al. 1994) and 100 mm at Barrel Point in 1991 (Elliott and Bernard 1994). These differences can be attributed to differences in age structure and associated size characteristics, since the same gear (rotary traps) and tagging strategy (fish ≥70 mm FL) was used each year. Coho salmon smolt in 1993 were 78% age 1.0 and 22% age 2.0, compared to 34.5% age 1.0 and 65% age 2.0 in 1992 and 56% age 1.0 and 43% age 2.0 in 1991. These data suggest stronger production from the 1989 and 1991 broods than from the 1988 or 1990 broods.

Smolt caught and tagged from rotary traps from 1991-1993 were larger than from earlier studies. Coho smolt averaged 93 mm at Canyon Island in 1960 (Meehan and Siniff 1962), and 74 mm in May 1987 and 85 mm in June 1987 two miles below Canyon Island (Murphy et al. 1988). Differences in other years are a result of gear differences, inclusion of fish <70 mm, or interannual variability. Meehan and Siniff (1962) used an incline plane trap and reported that about 10% of catches were <70 mm. Murphy et al. (1988) used a fyke net to capture fish, and 15-35% of fish captured were <70 mm. It is not likely that rotary traps caught only large fish, for Elliott and Bernard (1994) found that rotary smolt traps were not size-selective, though the power in that test was low.

Age composition of coho salmon sampled from rotary smolt catches in 1993 at Canyon Island were

Table 8.–Harvest and exploitation rate of Taku River coho salmon in Southeast Alaska fisheries in 1994.

Fishery	Area	Estimated harvest	SE	Percent of harvest	Exploitation rate
U.S. troll fishery	NE Quad	2,430	842	1.1%	0.7%
	SW Quad	833	1,533	0.4%	0.2%
	NW Quad	93,776	31,337	41.0%	27.6%
Subtotal		97,039	22,666	42.4%	28.6%
Drift gillnet	Dist. 111	82,181	14,117	35.9%	24.2%
	Dist. 115	740	710	0.3%	0.2%
	Prince William Sound	3,277	2,146	1.4%	1.0%
Subtotal		86,198	14,297	37.7%	25.4%
Seine fishery	Dist. 110	8,280	7,275	3.6%	2.4%
	Dist. 112	13,776	5,234	6.0%	4.1%
	Dist. 114	4,296	2,084	1.9%	1.3%
Subtotal		26,352	9,202	11.5%	7.8%
Recreational	Juneau	19,018	8,674	8.3%	5.6%
Total marine harvest		228,607	36,734	100.0%	67.3%
Escapement		96,343			
Canadian catch		14,693			
Total inriver run		111,036	6,529		
TOTAL RUN		339,643	37,310		

significantly different (P<0.001) from adults sampled from fish wheel catches in 1994 at Canyon Island; e.g., smolts were 77.9% (SE = 3.5) age 1. while adults were 47.7% (SE = 2.5) age 1. We believe this difference is due to rearing below Canyon Island of projeny of spawners above Canyon Island that migrate to the lower river midsummer and spend a second year rearing before smoltification as documented by Murphy (et al). Note that coho salmon smolt captured in 1992 at Barrel Point (near tidewater) were not different from adults in 1993 at Canyon Island in age compositon.

Our estimates of escapement (96,343), catch (228,607+14,693) and total run (339,643) are minimum estimates of those parameters for the Taku River because many fish spawn downstream of Canyon Island. As much as 22% of the spawning occurs below the Canadian border (Eiler et al. *In press*), and only a small portion of the U.S. population spawns above Canyon Island. Using that expansion, total escapement in the Taku River in 1994 was 127,661 ([96,343+14,693]/0.78 – 14,693), total marine harvest was 293,086 (228,607/0.78), and total run was 435,440. Exploitation rate (67.3%) and marine survival (23%) remained the same as for estimates for fish from above Canyon Island. Total Taku River contributions to the Juneau area marine boat fishery would be 24,382 (19,018/0.78) or 39% of the total harvest of 62,218 coho salmon in this area.

The recovery data and patterns of migration indicate that the estimate of smolt production was unbiased. Bailey's modification of the Petersen estimate was used because of the systematic nature of the sampling of smolts and adults (see below). While the population in this experiment was not closed to losses from mortality, it was closed to recruitment, because salmon return to their natal stream to spawn. Under these conditions, the experiment produced an unbiased estimate of the number of smolt leaving Taku River above Canyon Island in 1993, so long as

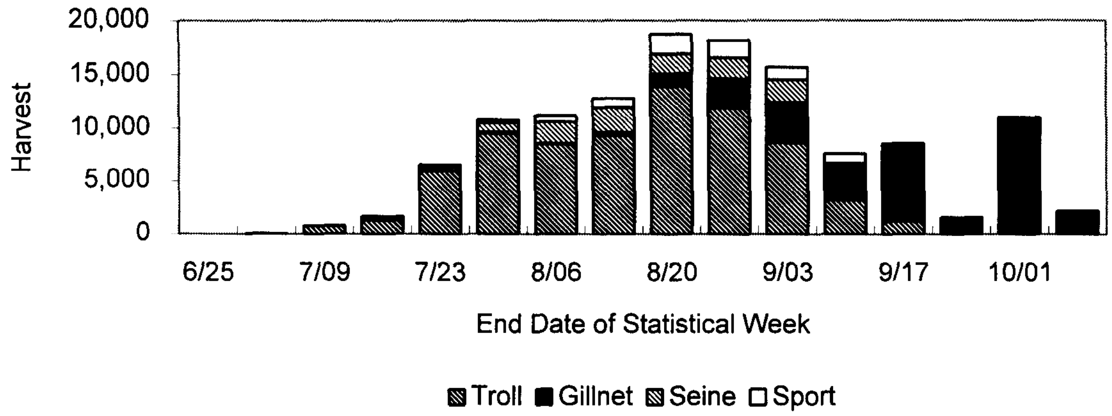

Figure 7.–Estimated harvest of coho salmon bound for Gastineau Hatchery by marine commercial and recreational fisheries in 1994 by statistical week. Weekly estimates of harvest in the troll fishery are approximated.

marked fish (those carrying CWTs implanted at Canyon Island) had mixed completely with unmarked fish during their 14 to 16 months at sea. The pattern of recovery of CWTs in commercial fisheries indicates that marked fish did mix significantly with unmarked fish (see Table 6 and below).

The recovery of CWTs in commercial fisheries is indicative of the representative sampling needed to produce accurate estimates of harvest. The models we used to estimate harvest of coho salmon from the Taku River are based on sampling as a random process, yet our capture of smolts at Canyon Island and the catch sampling of harvests were not random, but systematic.

Like two-event mark-recapture experiments, representative samples can be drawn with a systematic process only if: 1) every smolt has an equal chance of being marked, 2) every adult has an equal chance of being sampled, or 3) marked and unmarked fish mix completely between sampling events. Although our sampling effort at Canyon Island was relatively constant once all three traps were started in 1993, the probability of catching smolt was less prior to 28 May. Fortunately, the drawn-out recovery of CWTs indicated considerable mixing of marked and unmarked coho salmon while at sea. Recoveries of CWTs in District 111 from coho salmon tagged at Canyon Island did not come from later harvests, but were spread throughout this fishery in rough proportion to harvests.

While evidence of mixing between marked and unmarked fish can be detected through inspecting the temporal pattern of recovered tags, the sufficiency of that mixing cannot. If mixing had been complete, $\hat{\theta}$ would be time invariant. Too few coho salmon were recaptured at the fish wheels at Canyon Island in 1994 to look for changes in $\hat{\theta}$ with time, and, while many fish were recovered in the samples from the harvest in District 111, harvest of any coho salmon in District 111 not bound for the Taku River would cloud any inference drawn from the fishery as to variability in θ. For example, coho salmon bound for Gastineau Hatchery (a private non-profit hatchery operated by Douglas Island Pink and Chum Inc. [DIPAC]) near Juneau were intercepted during the later days of the gillnet fishery in District 111 (Appendix A4), and certainly other wild and hatchery stocks contribute to this fishery as well.

The Taku River wild (expanded to total Taku drainage) and DIPAC (Gastineau and Sheep Creek releases) coho salmon should prove to be reliable indicator stocks for the Juneau area. Together, these populations contributed an estimated 71% of the District 111 gillnet harvests (compares to 61%

in 1993) and 52% of the Juneau marine boat harvest (compares to 29% in 1993) (Table 8; Appendix A5). Exploitation rates were similar—67% for Taku fish and 70% for DIPAC fish. Distribution of harvests were similar (Figures 6, 7); however, a greater percentage of DIPAC harvests was taken in the troll fishery (42% vs. 58%) and a lesser percentage was taken in the District 111 gillnet fishery (26% vs. 38%). Mean dates of overall harvest were different by one week—15 August for Taku fish and 22 August for DIPAC fish (Appendices A3 and A6). It is anticipated that data taken from these two runs can be developed to assess run strength of coho salmon in the Juneau area on an inseason basis.

The estimated harvest of coho salmon from the Taku River in the sport fishery near Juneau in 1994 was higher than in 1992 and 1993, probably because of increased abundance in the fishery and increased sampling. The 1994 total run was the highest estimated to date and was reflected by the 62,218 coho harvested in the Juneau area marine boat fishery; this compares to about 16,000 harvested in 1993. A man-month of time was dedicated to "extra" sampling added to normal creel census sampling in the Juneau area to boost the sampled fraction. These factors combined to produce 10 random recoveries in the recreational fishery and, while still a small number, compare to 4 and 1 recoveries in 1993 and 1992. Recoveries in 1994 all came from bi-weekly strata in the central portion of the harvest (August and early September). No tags were recovered in strata early and late in the season, even though there were undoubtedly Taku River fish contributing to those strata, based on entry patterns seen at Canyon Island.

CONCLUSION AND RECOMMENDATIONS

Results from this project are contributing to development of a long-term database. We estimated smolt production in 1993 and adult production in 1994, the third year of these parameter estimates for this population. Escapements have been estimated since 1987 by CFMADD and DFO. We feel that this program, in the future, will enable us to provide valuable management tools, such as inseason assessment of run strength, evaluation of adult production parameters, and refinement of escapement goals.

Since this project is planned to be continued annually, we recommend some strategies to improve the precision of smolt and adult parameter estimates. First, estimates of harvest and smolt abundance can be improved by tagging more smolt with CWTs. This can be accomplished by starting earlier to cover a greater proportion of smolt emigration and by deploying more trapping gear; a greater number of tags would then be recovered from the fisheries, increasing the precision of θ, estimated from sampling adults inriver.

Additionally, we can test whether θ is time invariant during the return migration. Second, the estimate of harvest in the sport fishery can be improved by sampling a greater fraction of the harvest. We recommend that a small portion of project funds be devoted to this activity, similar to what was done in 1994. Third, the estimate of escapement can be improved by operating the mark-recapture experiment through the duration of the immigration of adults. We recommend a design be developed for a fish wheel that can be operated during the low-water conditions which often prevail during the fall season.

ACKNOWLEDGMENTS

We thank Jarbo Crete, Jerry Owens, Cliff Kemmerling, Heather Stilwell, Britt Lobdell and Todd Brocius for developing some innovative ideas for placing and operating the rotary screw traps, collecting the smolt data and tagging the smolt with coded wire; M. Scott Kelley and Pat Milligan for providing estimates of escapement; M. Scott Kelley for assistance with obtaining CWT data for Taku River adults; Heather Stilwell, Jerry Owens, Chris Staroska, Terry Jack, Sandra Bietz, Steve Smith, M. Scott Kelley and Pat Milligan for collecting theta data from adults and operating the fish wheels and mark-recapture experiment for adults; Glen Oliver and his port sampling crews for commercial fisheries CWT recoveries; Paul Suchanek, Dennis Hubartt and

Dean Beers for recreational fishery harvests; Dean Beers and his creel census crews for CWT recoveries from the Juneau area recreational fishery; Rick Focht for providing terminal run data for DIPAC releases; Sam Bertoni, Karen Crandall and the CFMADD Tag Lab in Juneau for dissecting and decoding heads and providing data on CWT recoveries; Sue Millard for aging smolt scales; Iris Frank for aging adult scales; and Steve Elliott for providing editorial review and assistance in designing the project.

LITERATURE CITED

Bailey, N. J. T. 1951. On estimating the size of mobile populations from capture-recapture data. Biometrika 38, 293-306.

Bailey, N. J. T. 1952. Improvements in the interpretation of recapture data. Journal of Animal Ecology 21:120-127.

Buckland, S. T., and P. H. Garthwaite. 1991. Quantifying precision of mark-recapture estimates using the bootstrap and related methods. Biometrics 47:255-268.

Efron, B. I. 1982. The jackknife, the bootstrap and other resampling plans. Society for Industrial and Applied Mathematics, CBMS-NSF Regional Conference Series in Applied Mathematics, No. 38.

Eiler, J. H., M. M. Masuda, and H. R. Carlson. *In press*. Stock composition, timing and move-ment patterns of adult coho salmon in the Taku River drainage, 1992. National Marine Fisheries Service Technical Report. Juneau.

Elliott, S. T. 1987. Coho salmon (*Oncorhynchus kisutch*) research: Chilkat Lake, Chilkoot Lake, and Yehring Creek. Alaska Department of Fish and Game, Fishery Management Report, Juneau.

Elliott, S. T. 1992. A trough trap for catching coho salmon smolts emigrating from beaver ponds. North American Journal of Fisheries Management 12:837-840.

Elliott, S. and D. R. Bernard. 1994. Production of Taku River coho salmon, 1991-1992. Alaska Department of Fish and Game, Fishery Data Series No. 94-1, Anchorage.

Elliott, S. T. and K. J. Kuntz. 1988. A study of coho salmon in Southeast Alaska: Chilkat Lake, Chilkoot Lake, Yehring Creek, and Vallenar Creek. Alaska Department of Fish and Game, Fishery Data Series No. 62, Juneau.

Elliott, S. T. and D. A. Sterritt. 1990. A study of coho salmon in Southeast Alaska, 1989: Chilkoot Lake, Yehring Creek, Auke Lake, Vallenar Creek. Alaska Department of Fish and Game, Fishery Data Series No. 90-53, Anchorage.

Elliott, S. T. and D. A. Sterritt. 1991. Coho salmon studies in southeast Alaska, 1990: Auke Lake, Chilkoot Lake, Nahlin River, and Yehring Creek. Alaska Department of Fish and Game, Fishery Data Series No. 91-43, Anchorage.

Elliott, S. T., A. E. Schmidt, and D. A. Sterritt. 1989. A study of coho salmon in Southeast Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 113, Juneau.

Geiger, H. J. 1990. Parametric bootstrap confidence intervals for estimating contri-butions of to fisheries from marked salmon populations, p. 667-676 *in* Parker, N. C., A. E. Giorgi, R. C. Heidinger, D. B. Jester, Jr., E. D. Prince, and G. A. Winans, editors. Fish Marking Techniques, American Fisheries Society Symposium No. 7, American Fisheries Society, Bethesda, Maryland.

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

Gray, P. L., K. R. Florey, J. F. Koerner, and R. A. Marriott. 1978. Coho salmon (*Oncorhynchus kisutch*) fluorescent pigment mark-recovery program for the Taku, Berners, and Chilkat Rivers in Southeastern Alaska (1972-1974). Alaska Department of Fish and Game, Division of Commercial Fisheries, Information Leaflet 176, Juneau.

Hubartt, D. J., A. E. Bingham, and P. M. Suchanek. *In press*. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 1994. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Koerner, J. F. 1977. The use of the coded-wire tag injector under remote field conditions. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 172, Juneau.

LITERATURE CITED (Continued)

McGregor, A. J. and J. E. Clark. 1991. Migratory timing and escapement of Taku River salmon stocks in 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J88-26, Juneau.

McGregor, A. J. and J. E. Clark. 1989. Migratory timing and escapement of Taku River salmon stocks in 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J89-40, Juneau.

McGregor, A. J., P. A. Milligan, and J. E. Clark. 1991. Adult mark-recapture studies of Taku River salmon stocks in 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report 91-05, Juneau.

McPherson, S.A., S. Elliott and D. R. Bernard. 1994. Production of coho salmon from the Taku River, 1992-1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-38, Anchorage.

Meehan, W. R. and D. B. Siniff. 1962. A study of downstream migrant anadromous fishes in the Taku River, Alaska. Transactions of the American Fisheries Society 91:399-407.

Meehan, W. R. and J. S. Vania. 1961. An external characteristic to differentiate between king and silver salmon juveniles in Alaska. Alaska Department of Fish and Game. Informational Leaflet No. 1. March 20, 1961.

Murphy, M. L., K. V. Koski, J. M. Lorenz, and J. F. Thedinga. 1988. Migrations of juvenile salmon in the Taku River, Southeast Alaska. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, Auke Bay Laboratory. NWAFC Processed Report 88-91.

Oliver, G. T. 1990. Southeast Alaska port samp-ling project. Annual report for the period July 1, 1989 to June 30, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 1J90-34, Juneau.

PSC (Pacific Salmon Commission). 1993. Trans-boundary river salmon production, harvest, and escapement estimates. 1992. Transboundary Technical Committee Report (93-3).

Scarnecchia, D. L. 1979. Variation of scale characteristics of coho salmon with sampling location on the body. Progressive Fish Culturist 41(3):132-135.

Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, second edition. MacMillan and Company, New York.

Shaul, L. D. 1987. Taku and Stikine River coho salmon (*Oncorhynchus kisutch*) adult escapement and juvenile tagging investiga-tions, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Completion Report for National Marine Fisheries Service Cooperative Agreement No. NA-85-ABH-00050, Juneau.

Shaul, L. D. 1988. Taku River coho salmon (*Oncorhynchus kisutch*) adult escapement and juvenile tagging investigations, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Completion Report for National Marine Fisheries Service Cooperative Agreement No. NA-87-ABH-00025, Juneau.

Shaul, L. D. 1989. Taku River Coho Salmon Investigations, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J89-33, Juneau.

Shaul, L. D. 1990. Taku River Coho Salmon Investigations, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J90-19, Juneau.

Shaul, L. D. 1992. Taku River Coho Salmon Investigations, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Manuscript Report, Juneau.

APPENDIX A

Appendix A1.–Bibliography of stock assessment studies conducted on the Taku River.

CITATION	LOCATION	OBJECTIVE
Eiler et al. *in press*	Taku River	Spawning distribution
Elliott 1987	Yehring Creek	1986 escapement
Elliott and Kuntz 1988	Yehring Creek	1987 smolt samples
		1987 escapement
Elliott et al. 1989	Yehring Creek	1988 harvest and escapement
		1987 smolt abundance and survival
		1988 smolt abundance
	Nahlin River	1988 harvest and escapement
		1988 juvenile tagging
Elliott and Sterritt 1990	Yehring Creek	1989 harvest and escapement
		1988 smolt abundance and survival
		1989 smolt abundance
Elliott and Sterritt 1991	Yehring Creek	1990 harvest and escapement
		1989 smolt abundance and survival
	Nahlin River	1990 smolt tagging
Elliott 1992	Yehring Creek	Smolt capture methods
Elliott and Bernard 1994	Taku River	1991 smolt abundance and 1992 adult harvest and escapement
Gray et al. 1978	Moose Creek	Harvest estimate
	Johnson Creek	Harvest estimate
	Yehring Creek	Harvest estimate
	Other tribs.	Harvest estimate
McGregor and Clark 1988	Taku River	Estimated escapement
McGregor and Clark 1989	Taku River	Estimated escapement
McGregor et al. 1991	Taku River	Estimated escapement
Murphy et al. 1988	Taku River	1987 smolt tagging
PSC 1993	Taku River	Estimated escapement
Shaul 1987	Nahlin River	1986 escapement
		1986 juvenile tagging
	Tatsamenie L.	1986 escapement
Shaul 1987	Tatsamenie L.	1986 juvenile tagging
	Dudidontu R.	1986 escapement
Shaul 1988	Tatsamenie L.	1987 juvenile tagging
Shaul 1989	Nahlin River	1988 harvest
	Mainstem	1988 harvest
	Tatsamenie L.	1988 harvest
	Sheslay R.	1988 harvest
	Yehring Creek	1988 harvest
	U.S. tribs.	1988 escapement
Shaul 1990	Nahlin River	1989 harvest
	Mainstem	1989 harvest
	Tatsameni L.	1989 harvest
	Yehring Creek	1989 harvest
	U.S. tribs.	1989 escapement
Shaul 1992	Nahlin River	1990 harvest
	Mainstem	1990 harvest
	Tatsameni L.	1990 harvest
	Yehring Creek	1990 harvest
	U.S. tribs.	1990 escapement

Appendix A2.–Random and select recoveries of coded wire tagged coho salmon bound for Taku River above Canyon Island in 1994.

Head number	Tag code	Release location	Gear	Date	Stat. week	Troll period	Quad-rant	District	SD	Length	H	n2	a1	a2	m1	m2
20236	43802	TAKU R	GILLNET	6/21/94	26	2	NE	111		490	30	32	1	1	1	1
71141	43802	TAKU R	GILLNET	6/24/94	26	2	PW	212		600	34	34	1	1	1	1
71432	43802	TAKU R	GILLNET	7/16/94	29	3	PW	212+223		616	2251	498	2	2	2	2
21483	43802	TAKU R	GILLNET	7/21/94	30	3	NE	111		744	3,896	1,023	3	3	1	1
20456	43802	TAKU R	GILLNET	7/26/94	31	3	NE	111		650	6,264	2,343	12	12	10	10
21616	43802	TAKU R	GILLNET	7/26/94	31	3	NE	111	32	721	6,264	2,343	12	12	10	10
30760	43802	TAKU R	GILLNET	7/27/94	31	3	NE	111		620	6,264	2,343	12	12	10	10
30798	43802	TAKU R	GILLNET	7/27/94	31	3	NE	111		683	6,264	2,343	12	12	10	10
30799	43802	TAKU R	GILLNET	7/27/94	31	3	NE	111		642	6,264	2,343	12	12	10	10
30903	43802	TAKU R	GILLNET	7/27/94	31	3	NE	111		620	6,264	2,343	12	12	10	10
30905	43801	TAKU R	GILLNET	7/27/94	31	3	NE	111		756	6,264	2,343	12	12	10	10
30906	43802	TAKU R	GILLNET	7/27/94	31	3	NE	111		645	6,264	2,343	12	12	10	10
30787	43801	TAKU R	GILLNET	7/26/94	31	3	NE	115		681	1,536	651	9	9	8	8
24598	43802	TAKU R	GILLNET	8/10/94	33	3	NE	111	32	765	11,841	1,606	5	5	4	4
22196	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111		739	18,016	9,782	69	69	63	63
24600	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111		752	18,016	9,782	69	69	63	63
24620	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111	32	644	18,016	9,782	69	69	63	63
24621	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111	32	604	18,016	9,782	69	69	63	63
24629	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111		752	18,016	9,782	69	69	63	63
24644	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111	32	695	18,016	9,782	69	69	63	63
24647	43802	TAKU R	GILLNET	8/18/94	34	3	NE	111	32	788	18,016	9,782	69	69	63	63
31969	43802	TAKU R	GILLNET	8/19/94	34	3	NE	111		710	18,016	9,782	69	69	63	63
31974	43802	TAKU R	GILLNET	8/19/94	34	3	NE	111		669	18,016	9,782	69	69	63	63
31997	43802	TAKU R	GILLNET	8/19/94	34	3	NE	111		671	18,016	9,782	69	69	63	63
22490	43802	TAKU R	GILLNET	8/24/94	35	3	NE	111		672	23,803	8,341	100	100	86	86
22494	43802	TAKU R	GILLNET	8/24/94	35	3	NE	111		636	23,803	8,341	100	100	86	86
24674	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32	768	23,803	8,341	100	100	86	86
24696	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32		23,803	8,341	100	100	86	86
24700	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32	674	23,803	8,341	100	100	86	86
24703	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32	674	23,803	8,341	100	100	86	86
24704	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32	847	23,803	8,341	100	100	86	86
24723	43802	TAKU R	GILLNET	8/26/94	35	3	NE	111	32	625	23,803	8,341	100	100	86	86
22877	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		671	22,791	5,794	112	98	93	93
22886	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		670	22,791	5,794	112	98	93	93
22887	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		690	22,791	5,794	112	98	93	93
22957	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		729	22,791	5,794	112	98	93	93
22959	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		695	22,791	5,794	112	98	93	93
22961	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111		700	22,791	5,794	112	98	93	93
24736	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	699	22,791	5,794	112	98	93	93
24738	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	704	22,791	5,794	112	98	93	93
24740	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	696	22,791	5,794	112	98	93	93
24749	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	646	22,791	5,794	112	98	93	93
24767	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	722	22,791	5,794	112	98	93	93
24771	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	602	22,791	5,794	112	98	93	93
24779	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	578	22,791	5,794	112	98	93	93

-continued-

Appendix A2.-Page 2 of 5.

Head number	Tag code	Release location	Gear	Date	Stat. week	Troll period	Quad-rant	District	SD	Length	H	n2	a1	a2	m1	m2
24792	43802	TAKU R	GILLNET	8/31/94	36	4	NE	111	32	752	22,791	5,794	112	98	93	93
24809	43802	TAKU R	GILLNET	9/6/94	37	4	NE	111	32	699	33,214	10,833	129	128	117	117
22792	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		637	33,214	10,833	129	128	117	117
22800	43801	TAKU R	GILLNET	9/7/94	37	4	NE	111		785	33,214	10,833	129	128	117	117
22984	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		694	33,214	10,833	129	128	117	117
22986	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		605	33,214	10,833	129	128	117	117
24062	43801	TAKU R	GILLNET	9/7/94	37	4	NE	111		765	33,214	10,833	129	128	117	117
24065	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		727	33,214	10,833	129	128	117	117
24133	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		757	33,214	10,833	129	128	117	117
24137	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		652	33,214	10,833	129	128	117	117
24139	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111		660	33,214	10,833	129	128	117	117
24149	43801	TAKU R	GILLNET	9/7/94	37	4	NE	111		540	33,214	10,833	129	128	117	117
24843	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	731	33,214	10,833	129	128	117	117
24844	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	701	33,214	10,833	129	128	117	117
24846	43801	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	700	33,214	10,833	129	128	117	117
24847	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	765	33,214	10,833	129	128	117	117
24855	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	706	33,214	10,833	129	128	117	117
24870	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	743	33,214	10,833	129	128	117	117
24876	43802	TAKU R	GILLNET	9/7/94	37	4	NE	111	32	725	33,214	10,833	129	128	117	117
80028	43802	TAKU R	GILLNET	9/9/94	37	4	PW	200	10	694	60,019	12,158	17	17	8	8
24879	43802	TAKU R	GILLNET	9/13/94	38	4	NE	111		725	23,134	3,587	111	109	104	104
24902	43802	TAKU R	GILLNET	9/13/94	38	4	NE	111		737	23,134	3,587	111	109	104	104
24175	43802	TAKU R	GILLNET	9/15/94	38	4	NE	111		751	23,134	3,587	111	109	104	104
24180	43802	TAKU R	GILLNET	9/15/94	38	4	NE	111		737	23,134	3,587	111	109	104	104
24961	43802	TAKU R	GILLNET	9/21/94	39	4	NE	111	32	774	11,392	3,794	59	59	56	56
24962	43802	TAKU R	GILLNET	9/21/94	39	4	NE	111	32	813	11,392	3,794	59	59	56	56
24964	43801	TAKU R	GILLNET	9/21/94	39	4	NE	111		717	11,392	3,794	59	59	56	56
24966	43801	TAKU R	GILLNET	9/21/94	39	4	NE	111		835	11,392	3,794	59	59	56	56
24971	43802	TAKU R	GILLNET	9/21/94	39	4	NE	111		683	11,392	3,794	59	59	56	56
23224	43802	TAKU R	GILLNET	9/22/94	39	4	NE	111		782	11,392	3,794	59	59	56	56
23254	43802	TAKU R	GILLNET	9/22/94	39	4	NE	111		744	11,392	3,794	59	59	56	56
24983	43801	TAKU R	GILLNET	9/23/94	39	4	NE	111		740	11,392	3,794	59	59	56	56
23053	43802	TAKU R	GILLNET	9/27/94	40	4	NE	111		752	15,337	4,236	195	195	188	188
35901	43802	TAKU R	GILLNET	9/27/94	40	4	NE	111		795	15,337	4,236	195	195	188	188
35996	43801	TAKU R	GILLNET	9/29/94	40	4	NE	111		605	15,337	4,236	195	195	188	188
35854	43801	TAKU R	GILLNET	9/30/94	40	4	NE	111		825	15,337	4,236	195	195	188	188
35887	43802	TAKU R	GILLNET	10/4/94	41	4	NE	111		734	6,383	1,553	55	55	53	53
30390	43802	TAKU R	SEINE	7/15/94	29	3	NE	112		693	6,486	918	11	11	10	10
30392	43802	TAKU R	SEINE	7/18/94	30	3	NE	112	16	644	8,426	1,491	24	24	19	19
21610	43802	TAKU R	SEINE	7/26/94	31	3	NE	110	31	648	7,594	1,973	7	7	6	6
30752	43802	TAKU R	SEINE	7/25/94	31	3	NE	112	16	641	8,688	1,681	26	26	20	20
30850	43802	TAKU R	SEINE	8/1/94	32	3	NW	114	27	629	7,755	2,414	39	39	29	29
31257	43802	TAKU R	SEINE	8/2/94	32	3	NW	114	27	616	7,755	2,414	39	39	29	29
21439	43802	TAKU R	SEINE	8/9/94	33	3	NE	110	24	696	12,955	574	3	3	3	3

-continued-

Appendix A2.-Page 3 of 5.

Head number	Tag code	Release location	Gear	Date	Stat. week	Troll period	Quad-rant	District	SD	Length	H	n2	a1	a2	m1	m2
31731	43802	TAKU R	SEINE	8/12/94	33	3	NE	112	16	709	18,103	2,556	41	41	30	30
31738	43802	TAKU R	SEINE	8/12/94	33	3	NE	112	16	577	18,103	2,556	41	41	30	30
31480	43802	TAKU R	SEINE	8/9/94	33	3	NW	114		643	6,045	1,971	33	33	24	24
31508	43802	TAKU R	SEINE	8/9/94	33	3	NW	114	27	728	6,045	1,971	33	33	24	24
31900	43802	TAKU R	SEINE	8/16/94	34	3	NE	112	16	640	19,231	6,289	109	109	87	87
31947	43802	TAKU R	SEINE	8/18/94	34	3	NE	112	16	678	19,231	6,289	109	109	87	87
31952	43802	TAKU R	SEINE	8/17/94	34	3	NE	112		742	19,231	6,289	109	109	87	87
97074	43802	TAKU R	SEINE	8/24/94	35	3	NE	112	16	727	18,437	4,036	70	70	62	62
66148	43801	TAKU R	SEINE	9/2/94	36	4	NW	114	27	730	13,004	11,345	315	314	274	274
2329	43802	TAKU R	SPORT	8/7/94	16	3	NE	115	10		18,326	2,802	52	46	40	40
2505	43802	TAKU R	SPORT	8/7/94	16	3	NE	112	15		18,326	2,802	52	46	40	40
2506	43802	TAKU R	SPORT	8/7/94	16	3	NE	111	50		18,326	2,802	52	46	40	40
2261	43802	TAKU R	SPORT D	8/19/94	17	3	NE	111	50		8,358	6,967	223	223	211	211
2377	43802	TAKU R	SPORT D	8/21/94	17	3	NE	111		620	8,358	6,967	223	223	211	211
2579	43801	TAKU R	SPORT D	8/21/94	17	3	NE	111		695	8,358	6,967	223	223	211	211
6636	43802	TAKU R	SPORT D	8/19/94	17	3	NE	111		650	8,358	6,967	223	223	211	211
2219	43802	TAKU R	SPORT	8/15/94	17	3	NE	111	50		16,287	1,207	24	22	22	22
2470	43802	TAKU R	SPORT	8/27/94	17	3	NE	112	15		16,287	1,207	24	22	22	22
3102	43802	TAKU R	SPORT	9/1/94	18	4	NE	111	50	670	5,688	1,467	45	41	41	41
24565	43802	TAKU R	TROLL	7/7/94	28	3	NW	114	25	598	1,962,244	428,710	8,021	7,961	6,912	6,906
30228	43802	TAKU R	TROLL	7/3/94	28	3	NW			628	1,962,244	428,710	8,021	7,961	6,912	6,906
30289	43802	TAKU R	TROLL	7/3/94	28	3	NW			700	1,962,244	428,710	8,021	7,961	6,912	6,906
34056	43802	TAKU R	TROLL	7/7/94	28	3	NW	189	30	651	1,962,244	428,710	8,021	7,961	6,912	6,906
40633	43802	TAKU R	TROLL	7/4/94	28	3	NW	113	45	610	1,962,244	428,710	8,021	7,961	6,912	6,906
41744	43802	TAKU R	TROLL	7/8/94	28	3	NW			633	1,962,244	428,710	8,021	7,961	6,912	6,906
41776	43802	TAKU R	TROLL	7/9/94	28	3	NW	116		489	1,962,244	428,710	8,021	7,961	6,912	6,906
32491	43802	TAKU R	TROLL	7/15/94	29	3	NW			703	1,962,244	428,710	8,021	7,961	6,912	6,906
87108	43802	TAKU R	TROLL	7/12/94	29	3	NW	114	27	650	1,962,244	428,710	8,021	7,961	6,912	6,906
87117	43801	TAKU R	TROLL	7/12/94	29	3	NW	113	91	678	1,962,244	428,710	8,021	7,961	6,912	6,906
87121	43802	TAKU R	TROLL	7/13/94	29	3	NW	114	25	622	1,962,244	428,710	8,021	7,961	6,912	6,906
87132	43801	TAKU R	TROLL	7/14/94	29	3	NW	114	27	566	1,962,244	428,710	8,021	7,961	6,912	6,906
87139	43802	TAKU R	TROLL	7/15/94	29	3	NW	114	27	733	1,962,244	428,710	8,021	7,961	6,912	6,906
30463	43801	TAKU R	TROLL	7/20/94	30	3	NW			671	1,962,244	428,710	8,021	7,961	6,912	6,906
30549	43801	TAKU R	TROLL	7/20/94	30	3	NW			575	1,962,244	428,710	8,021	7,961	6,912	6,906
30596	43802	TAKU R	TROLL	7/20/94	30	3	NW			706	1,962,244	428,710	8,021	7,961	6,912	6,906
30642	43802	TAKU R	TROLL	7/20/94	30	3	NW			659	1,962,244	428,710	8,021	7,961	6,912	6,906
32706	43802	TAKU R	TROLL	7/21/94	30	3	NW			616	1,962,244	428,710	8,021	7,961	6,912	6,906
87174	43802	TAKU R	TROLL	7/21/94	30	3	NW	116		663	1,962,244	428,710	8,021	7,961	6,912	6,906
30815	43802	TAKU R	TROLL	7/26/94	31	3	NW			588	1,962,244	428,710	8,021	7,961	6,912	6,906
30920	43802	TAKU R	TROLL	7/27/94	31	3	NW			726	1,962,244	428,710	8,021	7,961	6,912	6,906
31017	43802	TAKU R	TROLL	7/27/94	31	3	NW			708	1,962,244	428,710	8,021	7,961	6,912	6,906
31059	43802	TAKU R	TROLL	7/28/94	31	3	NW			651	1,962,244	428,710	8,021	7,961	6,912	6,906
32759	43802	TAKU R	TROLL	7/24/94	31	3	NW	116	12	630	1,962,244	428,710	8,021	7,961	6,912	6,906
32882	43802	TAKU R	TROLL	7/29/94	31	3	NW	114	21	739	1,962,244	428,710	8,021	7,961	6,912	6,906
87202	43802	TAKU R	TROLL	7/25/94	31	3	NW	114		661	1,962,244	428,710	8,021	7,961	6,912	6,906

-continued-

Head number	Tag code	Release location	Gear	Date	Stat. week	Troll period	Quad- rant	District	SD	Length	H	n2	a1	a2	m1	m2
87224	43802	TAKU R	TROLL	7/26/94	31	3	NW	114	27	576	1,962,244	428,710	8,021	7,961	6,912	6,906
87234	43802	TAKU R	TROLL	7/26/94	31	3	NW	114	27	629	1,962,244	428,710	8,021	7,961	6,912	6,906
7953	43802	TAKU R	TROLL	7/24/94	31	3	SW	103	70	725	495,522	189,763	2,177	2,141	1,785	1,785
87502	43802	TAKU R	TROLL	8/4/94	32	3	NE	112	65	713	207,029	81,118	1,152	1,140	912	910
31190	43802	TAKU R	TROLL	8/2/94	32	3	NW			638	1,962,244	428,710	8,021	7,961	6,912	6,906
31316	43802	TAKU R	TROLL	8/4/94	32	3	NW			708	1,962,244	428,710	8,021	7,961	6,912	6,906
31318	43802	TAKU R	TROLL	8/4/94	32	3	NW			717	1,962,244	428,710	8,021	7,961	6,912	6,906
31329	43802	TAKU R	TROLL	8/4/94	32	3	NW			696	1,962,244	428,710	8,021	7,961	6,912	6,906
31357	43802	TAKU R	TROLL	8/4/94	32	3	NW			657	1,962,244	428,710	8,021	7,961	6,912	6,906
44811	43802	TAKU R	TROLL	8/4/94	32	3	NW			704	1,962,244	428,710	8,021	7,961	6,912	6,906
87537	43801	TAKU R	TROLL	8/5/94	32	3	NW	116	11	719	1,962,244	428,710	8,021	7,961	6,912	6,906
87544	43802	TAKU R	TROLL	8/5/94	32	3	NW	114	27	638	1,962,244	428,710	8,021	7,961	6,912	6,906
31622	43802	TAKU R	TROLL	8/10/94	33	3	NW			708	1,962,244	428,710	8,021	7,961	6,912	6,906
33030	43802	TAKU R	TROLL	8/7/94	33	3	NW	116		654	1,962,244	428,710	8,021	7,961	6,912	6,906
33128	43802	TAKU R	TROLL	8/11/94	33	3	NW	116		708	1,962,244	428,710	8,021	7,961	6,912	6,906
34311	43802	TAKU R	TROLL	8/11/94	33	3	NW	189	30	665	1,962,244	428,710	8,021	7,961	6,912	6,906
44914	43802	TAKU R	TROLL	8/8/94	33	3	NW	113		695	1,962,244	428,710	8,021	7,961	6,912	6,906
87607	42853	TAKU R	TROLL	8/12/94	33	3	NW	114	25	720	1,962,244	428,710	8,021	7,961	6,912	6,906
31756	43802	TAKU R	TROLL	8/15/94	34	3	NW			730	1,962,244	428,710	8,021	7,961	6,912	6,906
31759	43802	TAKU R	TROLL	8/15/94	34	3	NW			772	1,962,244	428,710	8,021	7,961	6,912	6,906
32019	43802	TAKU R	TROLL	8/19/94	34	3	NW			754	1,962,244	428,710	8,021	7,961	6,912	6,906
32114	43802	TAKU R	TROLL	8/19/94	34	3	NW			734	1,962,244	428,710	8,021	7,961	6,912	6,906
32202	43801	TAKU R	TROLL	8/19/94	34	3	NW			689	1,962,244	428,710	8,021	7,961	6,912	6,906
33212	43801	TAKU R	TROLL	8/16/94	34	3	NW	116	12	705	1,962,244	428,710	8,021	7,961	6,912	6,906
33319	43802	TAKU R	TROLL	8/19/94	34	3	NW	116		670	1,962,244	428,710	8,021	7,961	6,912	6,906
34341	43802	TAKU R	TROLL	8/15/94	34	3	NW			721	1,962,244	428,710	8,021	7,961	6,912	6,906
34381	43802	TAKU R	TROLL	8/17/94	34	3	NW	181	60	740	1,962,244	428,710	8,021	7,961	6,912	6,906
34414	43802	TAKU R	TROLL	8/19/94	34	3	NW			756	1,962,244	428,710	8,021	7,961	6,912	6,906
87659	43801	TAKU R	TROLL	8/15/94	34	3	NW			631	1,962,244	428,710	8,021	7,961	6,912	6,906
87708	43802	TAKU R	TROLL	8/17/94	34	3	NW	114	27	745	1,962,244	428,710	8,021	7,961	6,912	6,906
87748	43802	TAKU R	TROLL	8/18/94	34	3	NW			667	1,962,244	428,710	8,021	7,961	6,912	6,906
46764	43802	TAKU R	TROLL	8/22/94	35	3	NE	112		689	207,029	81,118	1,152	1,140	912	910
46770	43802	TAKU R	TROLL	8/22/94	35	3	NE	112		715	207,029	81,118	1,152	1,140	912	910
46501	43801	TAKU R	TROLL	8/22/94	35	3	NW	113		711	1,962,244	428,710	8,021	7,961	6,912	6,906
46745	43802	TAKU R	TROLL	8/22/94	35	3	NW	113	41	707	1,962,244	428,710	8,021	7,961	6,912	6,906
87799	43802	TAKU R	TROLL	8/24/94	35	3	NW	116	11	622	1,962,244	428,710	8,021	7,961	6,912	6,906
97186	43802	TAKU R	TROLL	8/23/94	35	3	NW			727	1,962,244	428,710	8,021	7,961	6,912	6,906
33523	43802	TAKU R	TROLL	8/30/94	36	4	NW			720	459,558	125,548	2,024	1,997	1,743	1,743
34800	43802	TAKU R	TROLL	8/28/94	36	4	NW	189	30	744	459,558	125,548	2,024	1,997	1,743	1,743
87967	43802	TAKU R	TROLL	9/1/94	36	4	NW			660	459,558	125,548	2,024	1,997	1,743	1,743
97531	43802	TAKU R	TROLL	8/30/94	36	4	NW			752	459,558	125,548	2,024	1,997	1,743	1,743
97674	43802	TAKU R	TROLL	8/30/94	36	4	NW			717	459,558	125,548	2,024	1,997	1,743	1,743
88206	43801	TAKU R	TROLL	9/16/94	38	4	NW			704	459,558	125,548	2,024	1,997	1,743	1,743

-continued-

Appendix A2.-Page 5 of 5.

Head number	Tag code	Release location	Gear	Date	Stat. week	Troll period	Quad-rant	District	SD	Length	H	n2	a1	a2	m1	m2
27754	43802	TAKU R	ESC SUR	7/17/94	30	3	NE	111	32	600						
27756	43802	TAKU R	ESC SUR	8/2/94	32	3	NE	111	32	640						
27757	43802	TAKU R	ESC SUR	8/12/94	33	3	NE	111	32	550						
27759	43802	TAKU R	ESC SUR	8/12/94	33	3	NE	111	32	480						
27760	43802	TAKU R	ESC SUR	8/12/94	33	3	NE	111	32	650						
27761	43802	TAKU R	ESC SUR	8/13/94	33	3	NE	111	32	625						
27762	43802	TAKU R	ESC SUR	8/13/94	33	3	NE	111	32	460						
27763	43802	TAKU R	ESC SUR	8/15/94	34	3	NE	111	32	610						
27764	43801	TAKU R	ESC SUR	8/18/94	34	3	NE	111	32	530						
27765	43802	TAKU R	ESC SUR	8/18/94	34	3	NE	111	32	615						
27767	43802	TAKU R	ESC SUR	8/21/94	35	3	NE	111	32	395						
27768	43802	TAKU R	ESC SUR	8/22/94	35	3	NE	111	32	525						
27771	43802	TAKU R	ESC SUR	8/29/94	36	4	NE	111	32	540						
27772	43802	TAKU R	ESC SUR	8/30/94	36	4	NE	111	32	580						
Select Recoveries																
87390	43801	TAKU R	TROLL	8/3/94	32	3				723						
50279	43802	TAKU R	TROLL	8/5/94	32	3										
50236	43802	TAKU R	TROLL	8/10/94	33	3										
50258	43802	TAKU R	TROLL	8/10/94	33	3										
45503	43802	TAKU R	TROLL	8/12/94	33	3										
34577	43801	TAKU R	TROLL	8/13/94	33	3	NW	181	60							
34623	43801	TAKU R	TROLL	8/13/94	33	3	NW	181	60							
50213	43801	TAKU R	TROLL	8/30/94	36	4										
24832	43802	TAKU R	GILLNET	9/6/94	37	4	NE	111	32	725						

Appendix A3.–Numbers of coded wire tagged and untagged coho salmon in samples of immigrating salmon at Canyon Island fish wheels in 1994.

Date	Number examined	Number of clips	Valid tags	Head number	Tag code	Comments
27-Jun	1					
28-Jun	0					
29-Jun	0					
30-Jun	0					
01-Jul	0					
02-Jul	1					
03-Jul	1					
04-Jul	3					
05-Jul	3					
06-Jul	3					
07-Jul	2					
08-Jul	2					
09-Jul	1					
10-Jul	2					
11-Jul	5					
12-Jul	5					
13-Jul	1					
14-Jul	14	1	0	27753		No Tag
15-Jul	15					
16-Jul	28					
17-Jul	25	1	1	27754	04-38-02	Canyon Island
18-Jul	36					
19-Jul	30					
20-Jul	21					
21-Jul	33					
22-Jul	16					
23-Jul	17					
24-Jul	20					
25-Jul	52					
26-Jul	44					
27-Jul	61	1	0	27755		No Tag
28-Jul	10					
29-Jul						Tulsequah Flood
30-Jul						Tulsequah Flood
31-Jul	4					
01-Aug	73					
02-Aug	77	1	1	27756	04-38-02	Canyon Island
03-Aug	73					
04-Aug	47					
05-Aug	46					
06-Aug	45					
07-Aug	69					
08-Aug	74					
09-Aug	35					
10-Aug	38					
11-Aug	69					
12-Aug	79	3	1	27757	04-38-02	Canyon Island

-continued-

Appendix A3.-Page 2 of 2.

Date	Number examined	Number of clips	Valid tags	Head number	Tag code	Comments
			1	27759	04-38-02	Canyon Island
			1	27760	04-38-02	Canyon Island
13-Aug	110					
14-Aug	182	2	1	27761	04-38-02	Canyon Island
			1	27762	04-38-02	Canyon Island
15-Aug	182	1	1	27763	04-38-02	Canyon Island
16-Aug	110					
17-Aug	171					
18-Aug	166	2	1	27764	04-38-01	Canyon Island
			1	27765	04-38-02	Canyon Island
19-Aug	165					
20-Aug	117	1	0	27766		No Tag
21-Aug	153	1	1	27767	04-38-02	Canyon Island
22-Aug	186	2	1	27768	04-38-02	Canyon Island
			0	27769		No Tag
23-Aug	147					
24-Aug	123	1	0	27770		No Tag
25-Aug	109					
26-Aug	92					
27-Aug	81					
28-Aug	64					
29-Aug	77	1	1	27771	04-38-02	Canyon Island
30-Aug	66	1	1	27772	04-38-02	Canyon Island
31-Aug	96					
01-Sep	7					
02-Sep						Wheel down flood
03-Sep	28					
04-Sep						Wheel down flood
05-Sep						Wheel down flood
06-Sep						Wheel down flood
07-Sep	4					
08-Sep	26					
09-Sep	26					
10-Sep	13					
11-Sep	7					
12-Sep	19					
13-Sep	50					
14-Sep	140	1	0	27774		No Tag
15-Sep	69					
16-Sep	45					
17-Sep	68					
18-Sep	109	1	0	27775		No Tag
19-Sep	81					
20-Sep	77					
21-Sep	41					
Total	4,388	21	14			
Marked/unmarked ratio			0.0031905			

Appendix A4.–Harvests of coho salmon bound for Taku River above Canyon Island in 1994 in marine commercial and sport fisheries by statistical week. Harvest in the troll fishery (NW Quadrant) was approximated by weighting period catches by the number of tags recovered in a statistical week.

		Estimated harvest by fishery											
		Troll Northwest Quadrant											
Stat week	Ending date	NW troll tags	NW Quad. troll period	NW Quad. troll stat. wk	NE/SW Quad. troll	Troll	Gillnet	Seine	Sport	TOTAL	Estimated weekly prop. harvest	Estimated cum. total harvest	Estimated cum. prop. harvest
26	6/25			0		0	626			626	0.003	626	0.003
27	7/02			0						0	0.000	626	0.003
28	7/09	7		10,127		10,127				10,127	0.044	10,753	0.047
29	7/16	7		10,127		10,127	1,417	2,214		13,758	0.060	24,510	0.107
30	7/23	6		8,680		8,680	1,194	1,771		11,645	0.051	36,155	0.158
31	7/30	9		13,020	833	13,853	7,444	2,826		24,123	0.106	60,278	0.264
32	8/06	8		11,573	802	12,375		2,014		14,389	0.063	74,667	0.327
33	8/13	6		8,680		8,680	2,311	13,437	6,952	31,380	0.137	106,047	0.464
34	8/20	13		18,806		18,806	5,773	1,676	5,366	31,621	0.138	137,668	0.602
35	8/27	4	86,799	5,787	1,628	7,415	7,156	2,055	5,366	21,992	0.096	159,660	0.698
36	9/03	5		5,814		5,814	19,726	359	1,334	27,233	0.119	186,893	0.818
37	9/10			0		0	18,980			18,980	0.083	205,873	0.901
38	9/17	1		1,163		1,163	8,234			9,397	0.041	215,270	0.942
39	9/24			0			7,529			7,529	0.033	222,799	0.975
40	10/01		6,977	0		0	4,520			4,520	0.020	227,319	0.994
41	10/08					0	1,288			1,288	0.006	228,607	1.000
Total		66	93,776	93,776	3,263	97,039	86,198	26,352	19,018	228,607	1.000		
Estimated mean date of harvest						8/03	8/31	8/6	8/17	8/15			

Appendix A5.–Number of coho salmon released in 1993 by DIPAC (Panel A) and estimated harvests from recoveries of CWTs in fisheries in 1994 (Panel B).

PANEL A: Number of coho salmon released and tagged in 1993 by DIPAC at Gastineau Hatchery and the Sheep Creek net pen site

Tag code	Species	Brood year	Release site	Marked & tagged	Total fish released	Ratio marked:unmarked
04-40-39	COHO	91	Gastineau Hatchery	18,595	195,42	0.095
04-40-40	COHO	91	Gastineau Hatchery	19,226	282,57	0.068
04-40-41	COHO	91	Sheep Creek	18,198	173,27	0.105
04-40-42	COHO	91	Sheep Creek	18,811	194,70	0.096
04-40-43	COHO	91	Sheep Creek	18,805	194,17	0.096
TOTAL				93,635	1,040,14	0.0900

PANEL B: Estimated harvest of adult coho salmon bound for Gastineau Hatchery in 1994 with $\hat{\theta}$ = 0.09002100 and $V[1/\hat{\theta}]$ = 0.00119900. Random seed for bootstrap estimation of the SE was 710544435. In fishing periods and fishing quadrants for which no CWT was recovered with the appropriate code, harvest was assumed to be zero.

Fishery	Catch N	Var[N]	n2	a1	a2	m1	m2	mc	n1	Contrib-Boot-Est	SE
TROLL 29-35 3 SW	495,522	0	189,763	2,177	2,141	1,785	1,785	22	649	646	142
TROLL 29-35 3 SE	237,893	0	106,646	1,244	1,224	1,017	1,017	10	252	247	78
TROLL 29-35 3 NW	1,962,244	0	428,710	8,021	7,961	6,912	6,906	1,150	58,963	58,841	1,561
TROLL 29-35 3 NE	207,029	0	81,118	1,152	1,140	912	910	44	1,263	1,290	199
TROLL 36-40 4 NW	459,558	0	125,548	2,024	1,997	1,743	1,743	305	12,570	12,492	712
TROLL 36-40 4 NE	34,022	0	19,187	226	224	171	171	26	517	511	95
	3,396,268	0	950,972	14,844	14,687	12,540	12,532	1,557	74,214	74,027	
SPORT 30 14 111 50 MB	2,668	366,929	404	4	1	1	1	1	293	216	210
SPORT 31 15 111 50 MB	8,354	2,491,459	964	7	5	3	3	2	270	263	184
SPORT 34 16 111 50 MB	18,326	13,054,951	2,802	52	46	40	40	25	2,053	2,073	544
SPORT 34 17 111 50 DE	6,686	0	6,686	215	215	204	204	151	1,677	1,687	142
SPORT 35 17 111 50 DT	1,672	241,457	281	8	8	7	7	3	198	194	122
SPORT 34 17 111 50 MB	16,287	36,165,515	1,207	24	22	22	22	11	1,799	1,793	808
SPORT 36 18 111 50 MB	5,688	1,353,587	1,467	45	41	41	41	26	1,229	1,230	331
SPORT 38 19 111 50 MB	1,393	487,894	95	2	2	2	2	2	326	313	253
	61,074	54,161,792	13,906	357	340	320	320	221	7,845	7,769	

-continued-

Appendix A5.-Page 2 of 3.

Fishery			Catch N	Var[N]	n2	a1	a2	m1	m2	mc	n1	Contrib-Boot-Est	SE
SEINE	27	112	1,311	0	197	2	2	2	2	1	74	67	68
SEINE	28	112	2,590	0	610	3	3	3	3	1	47	47	47
SEINE	29	110 24	4,434	0	897	5	5	3	3	3	165	164	92
SEINE	29	112	6,486	0	918	11	11	10	10	2	157	161	107
SEINE	30	112	8,426	0	1,491	24	24	19	19	4	251	239	121
SEINE	30	113 51	1,445	0	195	5	4	3	3	1	103	97	98
SEINE	31	104	51,795	0	17,588	188	183	165	165	1	34	33	34
SEINE	31	110	7,594	0	1,973	7	7	6	6	1	43	40	42
SEINE	31	112	8,688	0	1,681	26	26	20	20	7	402	406	156
SEINE	31	114 27	3,852	0	564	12	12	9	9	5	379	387	173
SEINE	32	110 31	22,916	0	3,848	21	21	17	17	3	198	185	109
SEINE	32	112	23,920	0	949	16	16	14	14	5	1,400	1,361	589
SEINE	32	114 27	7,755	0	2,414	39	39	29	29	11	393	401	118
SEINE	33	110 24	12,955	0	574	3	3	3	3	1	251	218	239
SEINE	33	112 16	18,103	0	2,556	41	41	30	30	19	1,495	1,479	342
SEINE	33	114 27	6,045	0	1,971	33	33	24	24	16	545	546	135
SEINE	34	101 29	4,605	0	673	13	12	9	9	1	82	86	89
SEINE	34	103 23	5,244	0	508	6	6	5	5	1	115	128	114
SEINE	34	109	34,599	0	2,598	35	35	25	25	1	148	144	143
SEINE	34	112 16	19,231	0	6,289	109	109	87	87	30	1,019	1,033	192
SEINE	34	114 27	5,495	0	142	5	5	5	5	1	430	447	413
SEINE	35	109 20	69,755	0	5,620	86	86	73	73	1	138	142	136
SEINE	35	112 16	18,437	0	4,036	70	70	62	62	23	1,167	1,197	245
SEINE	35	114 27	9,058	0	2,266	54	54	48	48	14	622	619	169
SEINE	36	109 61	51,228	0	3,521	32	32	25	25	2	323	301	204
SEINE	36	112	18,294	0	1,605	14	14	9	9	1	127	136	144
SEINE	36	114 27	13,004	0	11,345	315	314	274	274	129	1,648	1,633	143
			437,265	0	77,029	1,175	1,167	979	979	285	11,756	11,697	
GILLNET	29	101 28	2,843	0	1,864	122	121	86	86	1	17	18	17
GILLNET	31	111	6,264	0	2,343	12	12	10	10	2	59	63	42
GILLNET	31	115	1,536	0	651	9	9	8	8	3	79	84	49
GILLNET	32	111	7,885	0	1,085	2	2	1	1	1	81	73	79
GILLNET	32	115	2,102	0	913	5	5	3	3	1	26	23	24
GILLNET	33	111	11,841	0	1,606	5	5	4	4	1	82	85	85
GILLNET	33	115	4,843	0	1,773	26	26	25	25	7	212	211	89
GILLNET	34	111	18,016	0	9,782	69	69	63	63	57	1,166	1,168	152
GILLNET	35	111	23,803	0	8,341	100	100	86	86	76	2,409	2,405	287
GILLNET	35	115	16,935	0	5,174	120	119	117	117	9	330	330	120

-continued-

Appendix A5.-Page 3 of 3.

Fishery			Catch N	Var[N]	n2	a1	a2	m1	m2	mc	n1	Contrib-Boot-Est	SE
GILLNET	36	111	22,791	0	5,794	112	98	93	93	74	3,695	3,695	379
GILLNET	36	115	17,105	0	6,380	106	105	99	98	4	121	120	60
GILLNET	37	111	33,214	0	10,833	129	128	117	117	90	3,089	3,074	312
GILLNET	37	115	23,103	0	6,577	194	192	175	175	9	355	360	118
GILLNET	38	111	23,134	0	3,587	111	109	104	104	92	6,712	6,717	683
GILLNET	38	115	26,518	0	5,074	353	351	340	340	8	467	460	171
GILLNET	39	111	11,392	0	3,794	59	59	56	56	32	1,067	1,091	185
GILLNET	39	115	23,055	0	2,653	221	220	215	215	4	388	388	188
GILLNET	40	111	15,337	0	4,236	195	195	188	188	184	7,400	7,395	516
GILLNET	40	115	13,032	0	2,067	160	160	153	153	51	3,572	3,553	499
GILLNET	41	111	6,383	0	1,553	55	55	53	53	49	2,237	2,211	312
			311,132	0	86,080	2,165	2,140	1,996	1,995	755	33,564	33,524	
Total			4,205,739	54,161,792	1,127,987	18,541	18,334	15,835	15,826	2,818	127,379	2,636	

Appendix A6.– Harvest and exploitation rate of coho salmon from DIPAC in Southeast Alaska fisheries in 1994.

Fishery	Area	Estimated harvest	SE	Percent of harvest	Exploitation rate
U.S. Troll Fishery	SW Quad	649	142	0.5%	0.4%
	SE Quad	252	78	0.2%	0.1%
	NW Quad	71,533	1,716	56.2%	39.1%
	NE Quad	1,780	221	1.4%	1.0%
	Subtotal	74,214	1,737	58.3%	40.6%
Drift Gillnet	Dist. 101	17	17	0.0%	0.0%
	Dist. 111	27,997	1,107	22.0%	15.3%
	Dist. 115	5,550	597	4.4%	3.0%
	Subtotal	33,564	1,258	26.3%	18.4%
Seine Fishery	Dist. 101	82	89	0.1%	0.0%
	Dist. 103	115	114	0.1%	0.1%
	Dist. 104	34	34	0.0%	0.0%
	Dist. 109	609	284	0.5%	0.3%
	Dist. 110	657	281	0.5%	0.4%
	Dist. 112	6,139	799	4.8%	3.4%
	Dist. 113	103	98	0.1%	0.1%
	Dist. 114	4,017	531	3.2%	2.2%
	Subtotal	11,756	1,054	9.2%	6.4%
Recreational	Juneau	7,845	1,111	6.2%	4.3%
	Subtotal	7,845	1,111	6.2%	4.3%
Total Harvest		127,379	36,734	100.0%	69.6%
Terminal Run	Sport	3,509 [a]			
	Cost recovery	47,624 [b]			
	Brood stock	1,265 [b]			
	Charitable	3,119 [b]			
	Subtotal	55,517			
TOTAL RUN		182,896	36,734		

[a] From Beers (1995).

[b] From Rick Fochte (DIPAC, personal communication).

Appendix A7.–Harvests of coho salmon bound for Gastineau Hatchery in 1994 in marine commercial and sport fisheries by statistical week. Harvest in the troll fishery was approximated by weighting period catches by the number of tags recovered in a statistical week.

		Estimated harvest by fishery											
		Troll Northwest Quadrant									Estimated	Estimated	Estimated
		NW	NW Quad.	NW Quad.							weekly	cum.	cum.
Stat	Ending	troll	troll	troll	NE/SW/SE Quad.						prop.	total	prop.
week	date	tags	period	stat. wk	troll	Troll	Gillnet	Seine	Sport	TOTAL	harvest	harvest	harvest
26	6/25			0		0	0			0	0.000	0	0.000
27	7/02			0				74		74	0.001	74	0.001
28	7/09	15		769		769		47		816	0.006	890	0.007
29	7/16	23		1,179	148	1,327	17	322		1,666	0.013	2,556	0.020
30	7/23	110		5,640	265	5,905	0	354	293	6,552	0.051	9,108	0.072
31	7/30	177		9,075	443	9,518	138	858	270	10,784	0.085	19,892	0.156
32	8/06	156		7,998	504	8,502	107	1,991	575	11,175	0.088	31,068	0.244
33	8/13	176		9,024	287	9,311	294	2,291	903	12,799	0.100	43,867	0.344
34	8/20	267		13,690	230	13,920	1,166	1,794	1,838	18,718	0.147	62,584	0.491
35	8/27	226	58,963	11,588	287	11,875	2,739	1,927	1,607	18,148	0.142	80,732	0.634
36	9/03	198		8,160	457	8,617	3,816	2,098	1,148	15,679	0.123	96,411	0.757
37	9/10	77		3,173	60	3,233	3,444		898	7,575	0.059	103,987	0.816
38	9/17	30		1,236		1,236	7,179		157	8,572	0.067	112,559	0.884
39	9/24			0			1,455		156	1,611	0.013	114,170	0.896
40	10/01		12,570	0		0	10,972			10,972	0.086	125,142	0.982
41	10/08					0	2,237			2,237	0.018	127,379	1.000
Total		1,455	71,533	71,533	2,681	74,214	33,564	11,756	7,845	127,379	1.000		
Estimated mean date of harvest						8/13	9/15	8/13	8/21	8/22			

Appendix A8.–Computer data files concerning data on smolt in 1993 and subsequent estimates for adults in 1994.

File name	Description
94DIPAC1.xls	Spreadsheet of random and select recoveries of CWTd DIPAC coho salmon in 1994.
43SMOCI.93r	ASCII data file of age and length data for coho salmon smolt caught at Canyon Island in 1993.
94TAKREP.xls	Spreadsheet of inriver recovery from Canyon Island fish wheels and associated theta estimate, smolt estimate, exploitation rate and marine survival calculations, frequency of CWT recoveries by fishery, harvest by fishery, mean date of harvest calculations, output from CWT4.exe for Taku and DIPAC (sheet 1), daily smolt catches and tagging totals (sheet 2), random and select recoveries from Taku (sheet 3), DIPAC releases for 1991 and 1992 (sheet 4), and rotary trap locations, hours fished and CPUE for smolt (sheet 6).
CWT4.EXE	Program to estimate harvests from CWT recovery data.
TAKUCO94.doc	WORD 6.0 (Windows) file of this FDS report.