Fishery Data Series No. 97-24

Production of Coho Salmon from the Taku River, 1995–1996

by

Scott A. McPherson,

David R. Bernard,

and

M. Scott Kelley

October 1997

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. 97-24

PRODUCTION OF COHO SALMON FROM THE TAKU RIVER, 1995-1996

by

Scott A. McPherson
Division of Sport Fish, Douglas

David R. Bernard
Division of Sport Fish, Anchorage

and
M. Scott Kelley
Division of Commercial Fisheries and Development, Douglas

Alaska Department of Fish and Game
Division of Sport Fish
P. O. Box 240020
Douglas, AK 99824-0020

October 1997

This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Projects F-10-11 and F-10-12, 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 [1]
Alaska Department of Fish and Game, Division of Sport Fish, Region I
P. O. Box 240020, Douglas, AK 99824-0020, USA

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

M. Scott Kelley
Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development
P. O. Box 240020, Douglas, AK 99824-0020, USA

[1] *Author to whom all correspondence should be addressed: e-mail: scottym@fishgame.state.ak.us*

This document should be cited as:
McPherson, Scott A., David R. Bernard and M. Scott Kelley. 1997. Production of coho salmon from the Taku River, 1995–1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-24, Anchorage.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

Recovery of coded wire tags from adults in 1996 tagged as smolts in 1995 was used to estimate smolt abundance, harvest, exploitation rate, and production of coho salmon *Oncorhynchus kisutch* from the Taku River, near Juneau, Alaska. Two 12′ diameter and two 8′ diameter rotary smolt traps were fished near Canyon Island on the Taku River from 1 May to 22 June; additionally, 15–40 baited G-40 minnow traps were fished daily from 6 May to 22 June. From 1 May to 22 June, 10,406 coho salmon smolt ≥70 mm fork length were tagged and released alive with valid tags with tag code 04-42-32. Sampled smolt averaged 94 mm fork length and were 79% age 1.0 and 21% age 2.0. In 1996, 136 adult coho salmon bearing coded wire tags were recovered in random sampling of marine fisheries corresponding to an estimated harvest of 44,529 (SE = 6,494) in U. S. marine waters. Of this harvest, the troll fishery took an estimated 56%, drift gillnet fisheries took 38%, seine fisheries 1%, and recreational fisheries 6%. An estimated 49,687 (SE = 3,650) adults passed by Canyon Island according to a mark-recapture experiment partially funded by Sport Fish Division that was conducted by the Commercial Fisheries Management and Development Division and the Canadian Department of Fisheries and Oceans. Of this inriver return, 5,052 were harvested by inriver fishers above the U.S./Canada border, leaving an estimated escapement past all fisheries of 44,635. Estimated return (escapement plus harvest) in 1996 for coho salmon originating above Canyon Island is 94,219 (SE = 7,449); marine exploitation rate on this return is an estimated 47% (SE = 4%). Estimated return in 1996 for all coho salmon from the Taku River is 120,790 (SE ≅ 9,551), accounting for those fish originating below Canyon Island. Contribution of all Taku River coho salmon to the Juneau marine sport fishery was an estimated 3,155 fish, or 17% of the estimated harvest in that fishery. Estimated smolt abundance in 1995 from above Canyon Island was 986,489 (SE = 214,152), obtained by using a modified Petersen estimator, and marine survival rate of coho salmon smolt from above Canyon Island is an estimated 9.6% (SE = 2%).

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 100,000–450,000 adult coho salmon *Oncorhynchus kisutch* annually, many of which are caught in commercial and recreational fisheries in northern Southeast Alaska (PSC 1996; Elliott and Bernard 1994; McPherson and Bernard 1995, 1996).

Run sizes vary depending on escapements and on freshwater and marine survival rates. Coho salmon returning to the Taku River pass through an offshore troll fishery before entering inside waters through Icy Strait (Figure 1), 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 large 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 (ADF&G) and the Canadian Department of Fisheries and Oceans (DFO) operate a cooperative program of stock assessment and management. Past studies of Taku River coho salmon stocks are listed in Appendix A1. Taku River coho salmon are currently managed as a single stock, and the stock assessment program has mirrored that emphasis since 1991 (McPherson and Bernard 1996; PSC 1996).

Objectives of this year's study were to estimate (1) abundance, mean length and age composition of coho salmon smolt leaving the Taku River in 1995, (2) harvest of adults returning to the Taku River in 1996; and (3) escapement and age composition of returning adults in 1996. These objectives were accomplished by tagging and sampling smolt in 1995 in the lower Taku River. Other projects in our agency or in Canada supplied data on returning adults which were harvested or escaped in 1996.

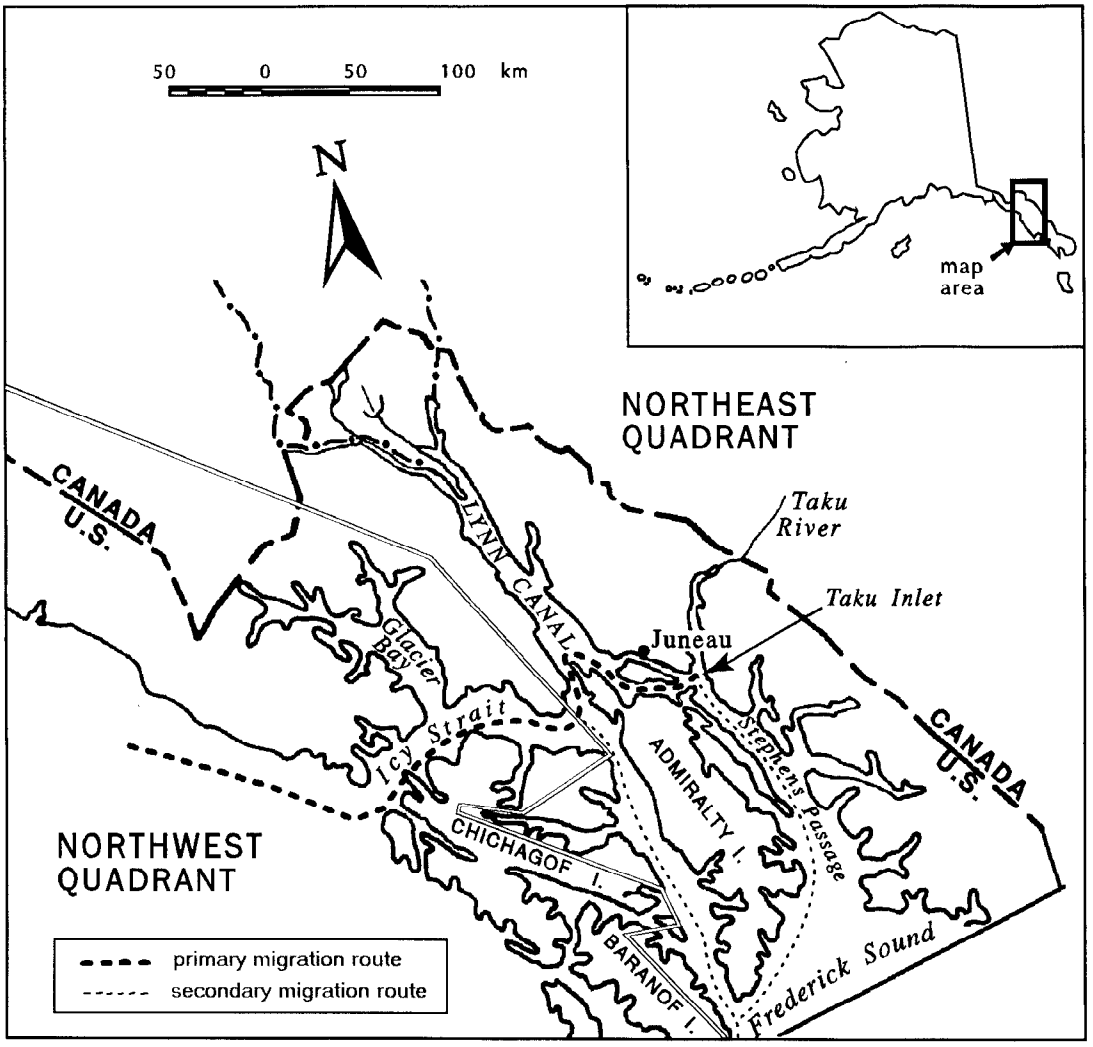

Figure 1.–Migration routes through northern Southeast Alaska of coho salmon bound for the Taku River.

METHODS

SMOLT CAPTURE, CODED WIRE TAGGING, AND SAMPLING

Four rotary smolt traps (two 12′ in diameter and two 8′ in diameter), constructed by E.G. Solutions of Corvallis, Oregon, were fished above Canyon Island (approximately 3 km below the U.S./ Canada border) and below the border (Figure 3). Operations and configurations of screw traps were similar to those in 1994 (McPherson and Bernard 1996). One 12′-diameter cone trap (trap #1) was fished at site 2 (Figure 3) from 1 May to 22 June. The other 12′ trap (trap #2) was fished from 3 to 25 May at site 3, from 29 May to 1 June at site 4 and from 2 to 22 June at site 7. Trap #3 (8′ diameter cone) was fished from 1 May to 22 June at site 3, except for 2 days (16–17 May) when it was fished at site 9. The other 8′ trap (trap #4) was fished from 11 to 26 May at site 8 and from 27 May to 22 June at site 3. From 3 to 25 May, traps #2 and #3 were fished in tandem at site 3 (except for 2 days), with the 8′ trap inshore. From 27 May to 22 June, traps 3 and 4 (both 8′ traps) were fished in tandem at site 3.

Site 2 consisted of several naturally embedded drift logs and rootwads about 20 m offshore of the

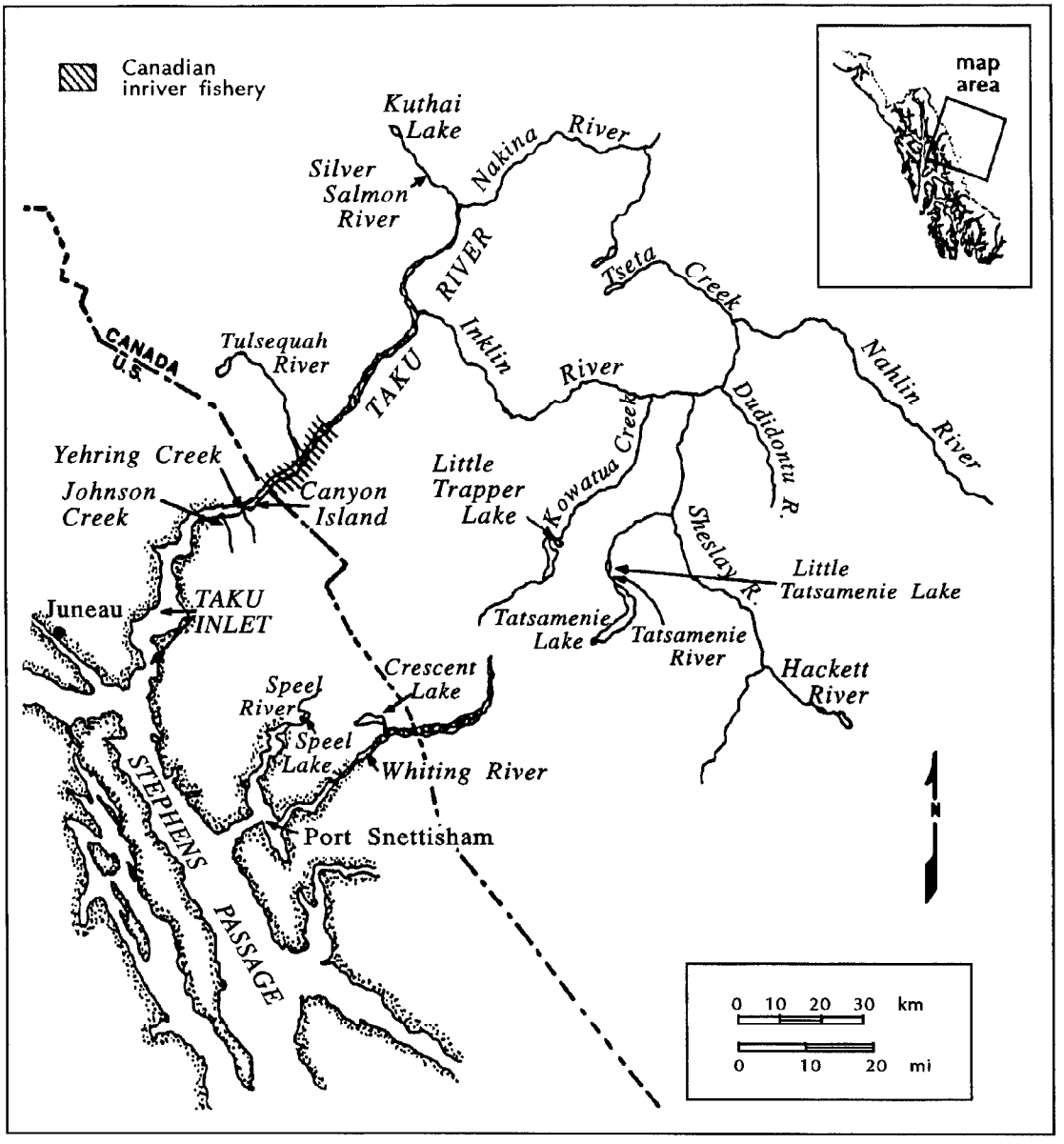

Figure 2.–Taku River drainage, northwestern British Columbia and Southeast Alaska.

east riverbank, located outside (east) of the mainstem and along a gently sloping gravel/silt substrate (Figure 3). Site 3 was located next to a relatively steep bank on the western side with large substrate and fast current; traps at this location were fished just inside the main debris line and mainstem current. Site 4 was located about 5 m offshore of the east riverbank, with slow current and a gravel/silt substrate. Site 7 was located at a rock point with fast current and a steep bedrock bank on the western side of the river. Site 8 was located just below the Canadian border on the east side, inside the mainstem current in deep water along a steeply sloping gravel cutbank. Site 9 was on the west bank well inside the mainstem current, with a large boulder substrate, and was located in clear water from Boundary Creek.

Between 15 and 40 G-40 minnow traps, baited with salmon roe, were fished daily for 24 hours

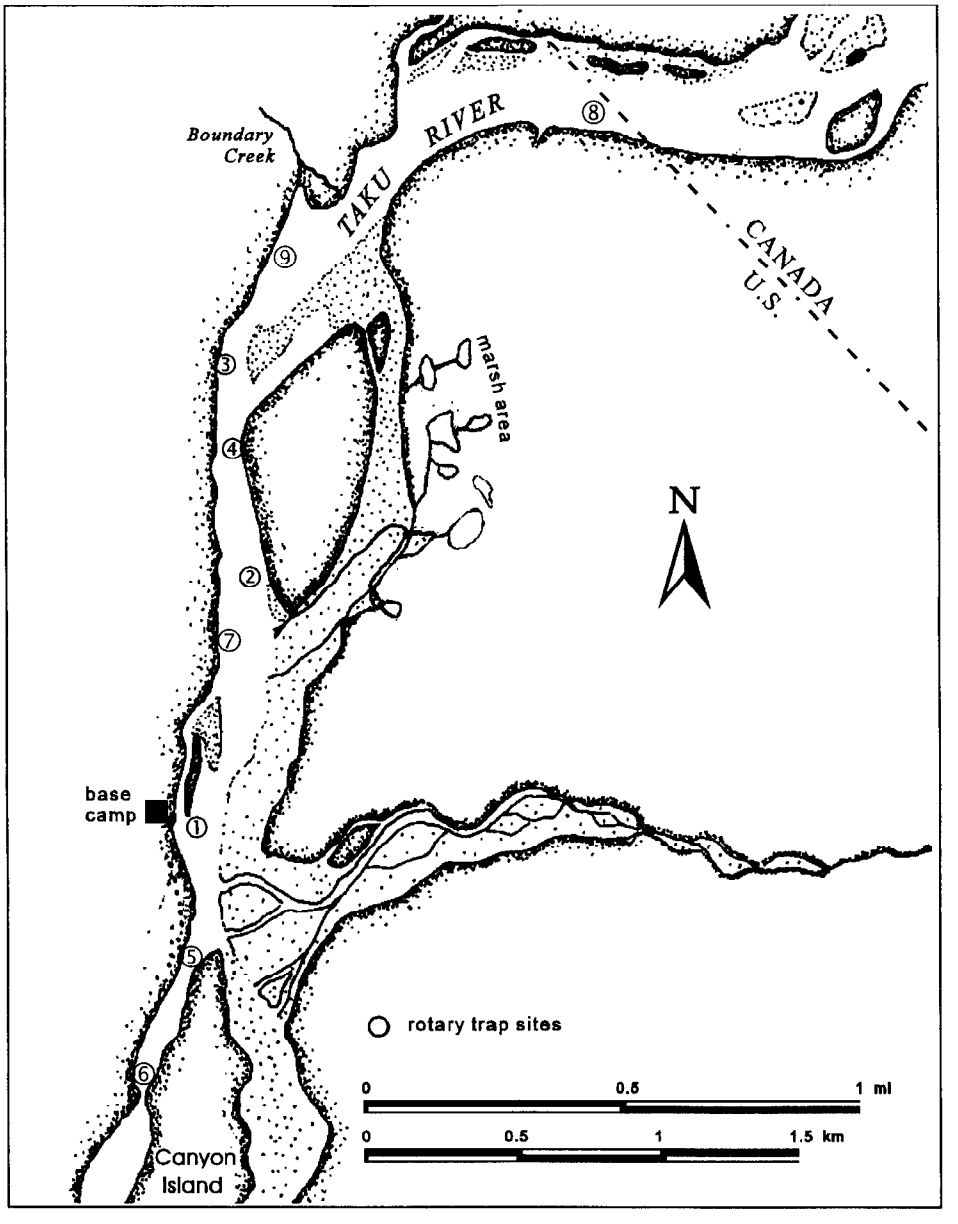

Figure 3.–Location of study area on Taku River near Canyon Island.

from 6 May to 22 June between Canyon Island and the border along both sides of the river. Traps were located along mainstem banks and in some backwater areas, depending on river levels. Minnow traps were checked daily when water levels were stable and more frequently when water levels were unstable.

Two members of a four- to six-person crew were on duty or on call at all times to keep the rotary traps fishing 24 hours a day. Early in the season, all four traps were fished with little difficulty, but with increased spring runoff from 10 to 16 May, debris became a constant problem. Large and small woody debris tended to jam traps. Smaller organic debris (decaying grass, leaves, seed pods, moss and algae) tended to cling to the mesh on the inside of the trap cones, causing traps to become partially submerged and requiring a power wash of the cones with a gasoline-powered water pump.

After 16 May, most debris had been flushed downstream and frequency of maintenance declined. Technicians visited traps about every 4–6 hours at the beginning of the season, every 1–4 hours at the peak of migration, or whenever debris stopped rotation.

Salmonid smolt and fry were removed from rotary trap liveboxes and minnow traps during each visit, transported to holding boxes at camp, and processed each morning. Coho and chinook salmon *Oncorhynchus tshawytscha* smolt were separated by inspection from other species of salmon and Dolly Varden *Salvelinus malma*. 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; McConnell and Snyder 1972) indicated a chinook salmon smolt. Chinook salmon smolt are also more 'silver' in sheen from a side view; whereas coho salmon smolt have more narrow par marks, show a greater number of small, darkly pigmented spots from a dorsal view, and have longer anterior rays on their anal fins.

All live coho salmon smolt ≥ 70 mm FL were tranquilized in a buffered solution of tricaine-methane 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 coded wire tag (CWT) and marked by excision of the adipose fin, following methods in Koerner (1977), and released. All live coho salmon smolt 50–69 mm FL were also tagged, but with a separate tag code. All chinook salmon smolt >50 mm FL were also tagged with separate tag codes.

Fifty fish from each day's catch, selected midway through a day's tagging, were held in a separate livebox and checked 24 hours later for retention of CWTs and tagging mortality. When fewer than 50 fish of a species were caught in a day, half the 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 *ADF&G CWT Tagging Summary and Release Information Forms* which were submitted to the Commercial Fisheries Management and Development Division (CFMD) Tag Lab in Juneau when field work ended.

Age composition of emigrating coho salmon smolts in 1995 was estimated by systematically sampling every 20th 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 70× magnification. Age was determined once for each fish; ages are reported in European notation. Proportions q_i in the age composition and their variances were estimated as:

$$\hat{q}_i = \frac{n_{si}}{n_s} \quad (1a)$$

$$v[\hat{q}_i] = \frac{\hat{q}_i(1 - \hat{q}_i)}{n_s - 1} \quad (1b)$$

where n_s is the number of smolts sampled and n_{si} the subset of these smolts determined to be of age i (see Table 1 for definitions of all notation).

Estimate of Smolt Abundance

Abundance of smolt originating above Canyon Island in 1995 was estimated in a two-sample, mark-recapture experiment with Petersen's estimator as modified by Bailey (1951, 1952):

$$\hat{N}_s = \frac{n_c\,(n_e - 1)}{m_a + 1} \quad (2a)$$

$$v[\hat{N}_s] = \frac{n_c^2\,(n_e + 1)(n_e - m_a)}{(m_a + 1)^2 (m_a + 2)} \quad (2b)$$

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_i	=	Number of adults missing adipose fins in a sample from catch in a stratum
a_i'	=	Number of heads that arrive at Juneau for dissection (subset of a_i) in a stratum
E	=	Exploitation rate of adults in commercial and sport fisheries in 1996
H_i	=	Number of adults caught in a stratum in 1996
λ_i	=	Decoding rate [$= (a_i' t_i')/(a_i t_i)$]
m_{ci}	=	Number of CWTs with the appropriate code(s) (subset of t_i') in a stratum
m_a	=	Number of adults sampled at Canyon Island in 1996 with missing adipose fins
m_e	=	Number of adults sampled at Canyon Island in 1996 with detected tags (a subset of m_a)
n_i	=	Number of adults caught in a stratum inspected for missing adipose fins
n_c	=	Number of smolt tagged in 1995
n_e	=	Number of adults sampled in 1996 to estimate θ
n_s	=	Number of smolt sampled to estimate age composition in 1995
N_D	=	Number of adults in escapement prior to 27 September 1996
N_e	=	Number of adults in escapement to Taku River past Canyon Island in 1996
N_R	=	Number of adults returning to the Taku River past Canyon Island in 1996
N_s	=	Number of smolts emigrating from the Taku River past Canyon Island in 1995
q_i	=	Fraction of smolt with freshwater age i in 1995
p_i	=	Fraction of catch with a CWT from a stratum in 1996
P_d	=	Fraction of catch in fishery made on day d
π	=	Fraction of migration past Canyon Island prior to 27 September 1996
ϕ_i	=	Fraction of catch sampled in a stratum in 1996
r_i	=	Harvest in 1996 of coho salmon originating above Canyon Island in a stratum
S	=	Survival rate from smolts in 1995 to adults in 1996
t_i	=	Number of heads with tags detected magnetically (subset of a_i') in a stratum
t_i'	=	Number of CWTs found through dissection and decoded (subset of t_i) in a stratum
T	=	Number of adults harvested in all strata and all fisheries in 1996
θ	=	Fraction of the stock tagged with CWTs

where N_S is number of smolts emigrating past Canyon Island in 1995, n_C is the number of smolt tagged in 1995, n_e the number of adults sampled in 1996 at Canyon Island, and m_a the number of adults in that sample with missing adipose fins.

Estimate of Harvest

Harvest in 1996 of coho salmon originating from the Taku River above Canyon Island was estimated from fish sampled from catches in commercial and recreational fisheries and from the escapement past Canyon Island. Because several fisheries exploited coho salmon over several months in 1996, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by fishing period and by fishing quadrant. Statistics from drift gillnet fisheries were stratified by week and by fishing district. Statistics from the recreational fishery were stratified by fortnight. Estimates of

harvest $\hat{r}_i$ were calculated for each stratum, then summed across strata and across fisheries to obtain an estimate of the total $\hat{T}$:

$$\hat{T} = \sum_i \hat{r}_i \quad (3a)$$

$$v[\hat{T}] = \sum_i v[\hat{r}_i] \quad (3b)$$

Variance of the sum of estimates was estimated as the sum of variances across strata, because sampling was independent across strata and across fisheries.

A subset n_i of the catch in each stratum was counted and inspected to find recaptured fish. Of those a_i salmon in this sample without adipose fins, heads were retrieved from a subset, marked, and sent to Juneau for dissection. Of the a_i' heads that arrived in Juneau, all were passed through a magnetometer to detect a CWT. Of the t_i tags detected, t_i' were successfully decoded under a microscope, after dissection of which m_{ci} had come from the Taku River. Oliver (1990) and Hubartt et al. (1995) present details of sampling commercial and recreational fisheries, respectively. The fraction θ of the return to the Taku River with tags was estimated from catches in fish wheels located at Canyon Island, operations of which are described by Kelley and Milligan 1997), as the fraction of the sample composed of adults with CWTs ($\hat{\theta} = m_e / n_e$).

Information from catch and field sampling programs was expanded to estimate harvest of coho salmon bound for the Taku River for each stratum. From Bernard and Clark (1996), estimated harvest and an estimate of its variance for a stratum were calculated as

$$\hat{r}_i = \hat{H}_i \hat{p}_i \hat{\theta}^{-1} \quad (4a)$$

$$v[\hat{r}_i] = \hat{r}_i^2 (G[\hat{H}_i] + G[\hat{p}_i] + G[\hat{\theta}^{-1}] - G[\hat{H}_i]G[\hat{p}_i] - G[\hat{H}_i]G[\hat{\theta}^{-1}] - G[\hat{p}_i]G[\hat{\theta}^{-1}] + G[\hat{H}_i]G[\hat{p}_i]G[\hat{\theta}^{-1}] \quad (4b)$$

where G( ) is the squared coefficient of variation for the specified variable and $\hat{H}_i$ the estimated catch for a stratum. Note that $G[\hat{H}_i] = 0$ for commercial and inriver fisheries. Estimated fraction of catch composed of recovered, tagged fish $\hat{p}_i$ and $G[\hat{p}_i]$ were calculated per Table 2 in Bernard and Clark (1996):

$$\hat{p}_i = \frac{m_i}{\lambda_i n_i} \quad (5a)$$

$$G[\hat{p}_i] = \frac{1 - \lambda_i \hat{\phi}_i \hat{\theta}}{m_i} \quad (5b)$$

where ϕ_i is the fraction of catch sampled ($= n_i / H_i$) and $\lambda_i = (a_i' t_i') / (a_i t_i)$. Monte Carlo simulation was used to estimate precision from field sampling programs (see Geiger 1990). Since sampling with 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 vector of B simulated statistics $\{\theta_1^*, \theta_2^*, \ldots \theta_B^* 1\}$ was generated by drawing B samples each of size n_e from Binom $(\hat{\theta}, n_e)$ where $\theta_b^* = m_e^* / n_e$. Calculations followed as

$$\left\{\theta_1^{*-1}, \theta_2^{*-1}, \ldots, \theta_B^{*-1}\right\} = \left\{y_1^*, y_2^*, \ldots, y_B^*\right\}$$

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

$$\hat{G}[\theta^{-1}] = \hat{v}[\theta^{-1}])\hat{\theta}^2$$

ESTIMATE OF ESCAPEMENT

An estimate of escapement of coho salmon past Canyon Island in 1996 was calculated by expanding a partial estimate available from an ongoing mark-recapture experiment in another division of the Department (see Kelley and Milligan [1997] 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 5–10 km upstream in Canada. The estimated escapement past Canyon Island through 20 September was obtained directly from the mark-recapture experiment, using a maximum likelihood Darroch estimator with five capture and five recapture strata (Kelley and Milligan 1997).

On 20 September fish wheels were stopped, and tagging of coho salmon ceased, while gillnetting ceased 2 October. Under these circumstances, our mark-recapture experiment to estimate passage after 20 September was not successful. This partial estimate was expanded by the estimated fraction of the escapement that had passed Canyon Island by 20 September:

$$\hat{N}_e = \frac{\hat{N}_D}{\pi} \tag{6a}$$

$$v[\hat{N}_e] = \frac{v[\hat{N}_D]}{\pi^2} \tag{6b}$$

where $\hat{N}_e$ is the estimated escapement above Canyon Island in all of 1996 and $\hat{N}_D$ is the estimated escapement above Canyon Island prior to 20 September (from Kelley and Milligan 1997). The statistic π is the fraction of the migration estimated to have passed Canyon Island during 1996 that occurred prior to 20 September, based on previous years' run timing as estimated from CPUE in the District 111 commercial gillnet fishery through statistical week 39 using data from 1979 to 1996. The point estimate was 88.9% and the range across all years was 87.7% to 90.3%. Estimated variance $v[\hat{N}_e]$ is a minimum, because the measurement error in π 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 above Canyon Island in 1996 and the associated exploitation rate in commercial and sport fisheries are based on the sum of estimated harvest and estimated escapement

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

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

$$v[\hat{N}_R] = v[\hat{T}] + v[\hat{N}_e]$$

The estimate of exploitation rate was calculated as

$$\hat{E} = \frac{\hat{T}}{\hat{N}_R} \tag{7a}$$

$$v[\hat{E}] \approx \frac{v[\hat{T}]\hat{N}_e^2}{\hat{N}_R^4} + \frac{v[\hat{N}_e]\hat{T}^2}{\hat{N}_R^4} \tag{7b}$$

The variance in equation (7) was approximated with the delta method (Seber 1982). The estimated survival rate of smolts to adults was calculated as

$$\hat{S} = \frac{\hat{N}_R}{\hat{N}_s} \tag{8a}$$

$$v[\hat{S}] \approx \hat{S}^2 \left[\frac{v[\hat{N}_R]}{\hat{N}_R^2} + \frac{v[\hat{N}_s]}{\hat{N}_s^2} \right] \tag{8b}$$

The variance in equation (8) 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):

$$\hat{P}_d = \frac{\hat{H}_d}{\sum_i H_i} \tag{9}$$

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

$$\hat{\bar{d}} = \sum_d d\hat{P}_d \qquad (10)$$

RESULTS

SMOLT TAGGING, AGE, AND LENGTH IN 1995

From 1 May to 22 June 1995, 10,750 coho salmon smolt ≥70 mm FL were captured at Canyon Island (Figure 3) of which 10,495 were marked and tagged (Table 3). Of those, 86 were estimated to have died after tagging and 3 were estimated to have shed tags, leaving 10,406 (= n_C) coho salmon smolt released with valid CWTs with code 04-42-32. An additional 1,835 coho salmon 50–69 mm FL were tagged and released with code 04-42-12. None of these undersize coho salmon were observed to have returned in 1996 and were not used in any subsequent calculations.

Ninety percent of captured smolt were taken between 6 May and 16 June (Figure 4; Table 3). Peak catches occurred from 18 May to 1 June, when 50% of the catch occurred. Similar timing was 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 1995 was relatively constant throughout the season, with minor outages (Table 2). Trap #1 accounted for 48%, trap #2 for 20%, trap #3 for 14%, and trap #4 for 28% of smolt caught. Even though much less effort was invested in fishing minnow traps, this gear accounted for 25% of the coho salmon smolts caught (Table 3).

Coho salmon smolt averaged an estimated 95 mm FL in 1995 (Table 4; Figure 5). Estimated age composition of coho salmon smolts in that year is 78.8% (SE = 1.8%) age 1.0 and 21.2% (SE = 1.8%) age 2.0 (Table 5).

Smolts and young of other species of salmon were also captured. Of 11,557 chinook salmon smolt captured (Table 3), 11,121 were tagged and released, 9,780 with code 04-42-29 and 1,341 with code 04-42-30. Analyses of these tagging data will be published when catches from that brood (1993) are completed after calendar year 2000.

Also captured, but not marked or tagged, were 6,606 sockeye salmon *O. nerka*, 417 steelhead salmon *O. mykiss*, and uncounted numbers of chum salmon *O. keta*, pink salmon *O. gorbuscha*, and Dolly Varden.

CODED WIRE TAG RECOVERY

In 1996, 136 CWTs with codes from Canyon Island were recovered from coho salmon in the various fisheries as random recoveries in port or creel sampling programs. The greatest number (72) of tags were recovered from the commercial troll fishery, all in the Northwest Quadrant on the outside coast (see Figure 1). In marine gillnet fisheries, 53 tags were recovered, 47 from District 111 (Taku Inlet/Stephens Passage) and six from District 115 (Lynn Canal). Ten were recovered in the marine recreational fishery around Juneau in July and August. One CWT was recovered in the seine fishery in upper Chatham Strait.

Coho salmon bearing Canyon Island tags were recovered at higher frequencies early and late in the season over the course of the District 111 gillnet fishery. Estimated fraction $\hat{p}_i$ of catch carrying marks is 0.51% from 16 June to 17 August, 0.35% from 18 to 31 August, and 0.45% from 1 to 21 September (Table 5).

In the Northwest Quadrant of the troll fishery, recoveries of tag code 04-42-32 occurred in equal rates after mid-July and were almost nonexistent before then.

Table 2.–Number of salmon smolt caught and tagged in four rotary screw traps and minnow traps near Canyon Island on the Taku River, 1995. Coho total includes 255 trap mortalities; coho total does not include 1,864 fish 50–69mm FL tagged nor 118 fish <50mm FL not tagged. Chinook total includes 214 trap mortalities and 86 fish <50mm FL.

Date	#1 – 12′ trap		#2 – 12′ trap		#3 – 8′ trap		#4 – 8′ trap		Minnow traps		Coho total	Chinook total	Coho CWTd	Chinook CWTd	Air temp (°C)		Water temp	Precip	Water depth	
	Coho	Chinook	Coho	Chinook	Coho	Chinook	Coho	Chinook	Coho	Chinook					Min	Max			(in.)	(ft)
01-May	97	95									97	95								
02-May	97	96									97	96								
03-May	83	96									86	99	277	287	4.0	16.0	5.5	0.75	35	2.9
04-May	81	127	13	34	10	16					104	177	104	177	0.0	16.0	6.0	0.00	35	2.9
05-May	71	136	2	17	3	3					76	156	76	156	4.0	17.0	8.0	0.00	38	3.2
06-May	51	90	1	3	6	6			121	24	193	130	179	121	0.0	15.0	6.0	0.00	40	3.3
07-May	115	175	3	17	9	7			86	43	229	257	213	242	0.0	14.0	6.0	0.00	42	3.5
08-May	54	179	9	49	2	2			44	8	110	241	109	236	1.0	17.0	6.0	0.00	40	3.3
09-May	71	230	13	40	5	18			87	47	177	336	176	335	3.0	20.0	7.0	0.00	46	3.8
10-May	41	135	17	46	9	12			66	27	134	222	133	220	0.0	22.0	8.0	0.00	57	4.8
11-May	27	99	37	41	34	21			68	42	174	211	166	203	9.0	21.0	9.0	0.00	74	6.2
12-May	47	187	78	56	26	20	23	12	31	23	207	300	205	298	6.0	21.0	8.0	0.00	89	7.4
13-May	37	110	60	63	18	23	42	54	33	14	190	264	190	264	4.0	20.0	8.0	0.00	102	8.5
14-May	59	223	44	59	13	17	27	25	10	10	153	334	153	334	8.0	20.0	8.0	0.12	110	9.2
15-May	78	359	8	30	5	9	7	15	4	8	103	422	102	421	5.0	13.0	7.5	0.02	108	9.0
16-May	95	446	41	32	5	3	16	20	7	20	164	521	164	521	6.0	14.0	7.0	0.25	90	7.5
17-May	79	209	53	38	10	15	9	5	5	11	164	289	156	278	3.0	11.0	7.0	0.20	78	6.5
18-May	152	117	55	56	0	2	40	23	16	17	268	220	263	215	3.0	10.0	8.0	0.25	62	5.2
19-May	144	232	46	56	21	16	41	12	21	43	293	384	273	359	2.0	12.0	7.0	0.04	65	5.4
20-May	122	193	73	69	40	14	29	10	95	28	366	319	359	314	-1.0	9.0	9.0	0.00	42	3.5
21-May	118	147	48	84	30	16	11	5	136	74	348	330	343	325	0.0	17.0	8.0	0.00	41	3.4
22-May	84	180	45	56	12	5	5	4	154	32	301	278	300	277	6.0	19.0	8.0	0.00	38	3.2
23-May	106	206	70	140	10	10	21	14	202	36	411	408	409	405	3.0	13.0	9.0	0.00	37	3.1
24-May	67	171	38	94	18	12	23	13	184	40	332	331	330	330	2.0	20.0	10.0	0.00	41	3.4
25-May	111	248	63	82	17	13	27	8	143	55	362	406	361	405	4.0	20.0	11.0	0.00	47	3.9
26-May	233	359	50	62	62	14	39	7	111	26	496	469	495	468	7.0	25.0	10.0	0.00	47	3.9
27-May	242	358	0	0	96	24	136	93	98	35	574	511	572	510	8.0	22.0	9.0	0.01	65	5.4
28-May	170	214	0	0	90	24	122	62	49	13	456	333	431	313	9.0	16.0	9.0	0.60	72	6.0
29-May	182	271	0	0	119	26	136	70	45	15	489	388	482	382	7.0	12.0	9.0	0.21	71	5.9
30-May	78	106	14	58	92	16	107	56	66	5	360	243	357	241	9.0	12.0	7.5	0.11	62	5.2
31-May	117	149	14	51	46	10	112	49	62	4	352	263	351	263	6.0	12.0	9.0	0.22	51	4.3
01-Jun	91	133	4	10	27	6	76	81	42	12	241	243	240	238	6.0	15.0	9.0	0.12	46	3.8
02-Jun	59	66	0	2	25	8	46	54	48	8	183	141	178	138	6.0	15.0	9.0	0.11	41	3.4

-continued-

Table 2.–Page 2 of 2.

Date	#1 – 12′ trap		#2 – 12′ trap		#3 – 8′ trap		#4 – 8′ trap		Minnow traps		Coho total	Chinook total	Coho CWTd	Chinook CWTd	Air temp (°C)		Water temp	Precip	Water depth	
	Coho	Chinook	Coho	Chinook	Coho	Chinook	Coho	Chinook	Coho	Chinook					Min	Max			(in.)	(ft)
03-Jun	50	56	28	13	8	7	48	65	61	10	196	151	195	147	4.0	13.0	9.0	0.05	37	3.1
04-Jun	48	46	19	12	2	2	13	24	46	7	128	92	128	91	6.0	15.0	9.0	0.00	29	2.4
05-Jun	21	23	18	12	4	2	16	11	28	4	87	52	87	51	5.0	15.0	9.0	0.15	31	2.6
06-Jun	29	50	13	10	1	0	7	21	49	6	160	126	99	87	7.0	15.0	9.0	0.09	35	2.9
07-Jun	31	37	14	5	1	1	29	61	29	5	107	111	104	109	5.0	15.0	9.0	0.03	35	2.9
08-Jun	39	38	18	11	7	5	27	61	22	8	116	125	113	123	7.0	20.0	10.0	0.00	38	3.2
09-Jun	41	103	33	12	5	3	14	22	15	3	127	163	108	143	8.0	24.0	10.0	0.00	51	4.3
10-Jun	70	145	73	27	32	10	26	15	10	1	214	200	211	197	7.0	26.0	11.0	0.00	65	5.4
11-Jun	30	186	46	24	22	11	27	14	43	1	172	240	168	234	11.0	29.0	11.0	0.00	84	7.0
12-Jun	11	62	22	21	20	7	24	9	28	3	110	107	105	102	11.0	29.0	9.0	0.42	94	7.8
13-Jun	24	37	17	54	26	11	25	10	12	0	106	114	104	109	9.0	14.0	9.0	0.50	90	7.5
14-Jun	41	46	24	69	17	8	19	11	14	0	116	134	115	129	12.0	12.0	9.0	0.23	90	7.5
15-Jun	100	77	22	46	40	16	28	12	21	0	213	152	211	151	8.0	14.0	10.0	0.01	73	6.1
16-Jun	34	48	28	13	20	8	12	10	20	0	114	80	114	79	8.0	11.0	9.0	0.00	64	5.3
17-Jun	22	25	25	14	15	3	13	35	24	8	100	86	99	79	11.0	16.0	10.0	0.00	58	4.8
18-Jun	14	33	20	10	13	1	4	2	21	2	73	48	72	40	8.0	23.0	10.0	0.00	62	5.2
19-Jun	14	16	11	3	14	4	2	3	29	1	70	27	70	22	10.0	17.0	10.0	0.00	65	5.4
20-Jun	5	28	14	5	8	5	4	6	46	5	78	50	77	41	8.0	20.0	10.0	0.00	70	5.8
21-Jun	7	21	7	8	5	0	2	1	34	3	58	35	55	24	7.0	21.0	10.0	0.00	68	5.7
22-Jun	5	37	1	4	2	0	2	1	103	4	115	47	113	23	9.0	22.0	10.0	0.00	67	5.6
Totals	3,895	7,256	1,352	1,718	1,122	492	1,437	1,086	2,689	791	10,750	11,557	10,495	11,257				4.49		
Average	73	137	27	34	22	10	34	26	56	16	203	218	206	221	5.7	17.2	8.7	0.09	59	4.9

Table 3.–Locations, hours fished, and CPUE of coho and chinook salmon smolt in four rotary traps near Canyon Island on the Taku River, 1995.

	Rotary trap #1 (12′ cone)				Rotary trap #2 (12′ cone)				Rotary trap #3 (8′ cone)				Rotary trap #4 (8′ cone)							Water
Date	Site	Hours	CPUE Coho	CPUE Chinook	Site	Hours	CPUE Coho	CPUE Chinook	Site	Hours	CPUE coho	CPUE chinook	Site	Hours	CPUE coho	CPUE chinook	Total hrs	CPUE coho	CPUE chinook	depth (ft)
01-May	#2	30.7	76	75					#3	11.5	0	0					42.2	76	75	
02-May	#2	24.0	83	96					#3	24.0	0	0					48.0	83	96	
03-May	#2	24.0	81	127	#3	6.3	16	43	#3	24.0	10	16					54.3	107	186	2.9
04-May	#2	24.0	71	136	#3	24.0	11	71	#3	24.0	3	3					72.0	85	210	2.9
05-May	#2	24.0	51	90	#3	22.0	1	3	#3	24.0	6	6					70.0	58	99	3.2
06-May	#2	14.0	197	300	#3	14.0	5	29	#3	12.0	18	14					40.0	220	343	3.3
07-May	#2	24.0	54	179	#3	16.0	14	74	#3	24.0	2	2					64.0	70	255	3.5
08-May	#2	22.0	77	251	#3	24.0	13	40	#3	23.0	5	19					69.0	96	310	3.3
09-May	#2	24.0	41	135	#3	24.0	17	46	#3	24.0	9	12					72.0	67	193	3.8
10-May	#2	21.0	31	113	#3	22.0	40	45	#3	24.0	34	21					67.0	105	179	4.8
11-May	#2	17.0	66	264	#3	24.0	78	56	#3	24.0	26	20	#8	7.5	23	12	72.5	193	352	6.2
12-May	#2	17.0	52	155	#3	24.0	60	63	#3	24.0	18	23	#8	24.0	42	54	89.0	172	295	7.4
13-May	#2	17.0	83	315	#3	24.0	44	59	#3	12.0	26	34	#8	24.0	27	25	77.0	180	433	8.5
14-May	#2	16.0	117	539	#3	24.0	8	30	#3	24.0	5	9	#8	24.0	7	15	88.0	137	593	9.2
15-May	#4	24.0	95	446	#3	22.0	45	35	#3	22.0	5	3	#8	24.0	16	20	92.0	161	504	9.0
16-May	#4	24.0	79	209	#3	22.0	58	41	#9	22.5	11	16	#8	24.0	9	5	92.5	156	271	7.5
17-May	#4	23.0	159	122	#3	24.0	55	56	#9	24.0	0	2	#8	24.0	40	23	95.0	254	203	6.5
18-May	#2	24.0	144	232	#3	23.5	47	57	#3	20.0	25	19	#8	24.0	41	12	91.5	257	320	5.2
19-May	#2	24.0	122	193	#3	24.0	73	69	#3	24.0	40	14	#8	24.0	29	10	96.0	264	286	5.4
20-May	#2	24.0	118	147	#3	24.0	48	84	#3	24.0	30	16	#8	24.0	11	5	96.0	207	252	3.5
21-May	#2	24.0	84	180	#3	24.0	45	56	#3	24.0	12	5	#8	24.0	5	4	96.0	146	245	3.4
22-May	#2	24.0	106	206	#3	24.0	70	140	#3	24.0	10	10	#8	22.0	23	15	94.0	209	371	3.2
23-May	#2	24.0	67	171	#3	24.0	38	94	#3	24.0	18	12	#8	24.0	23	13	96.0	146	290	3.1
24-May	#2	24.0	111	248	#3	24.0	63	82	#3	24.0	17	13	#8	24.0	27	8	96.0	218	351	3.4
25-May	#2	24.0	233	359	#3	22.0	55	68	#3	24.0	62	14	#8	24.0	39	7	94.0	389	448	3.9
26-May	#2	24.0	242	358	down				#3	24.0	96	24	#8	23.5	139	95	71.5	477	477	3.9
27-May	#2	24.0	170	214	down				#3	24.0	90	24	#3	24.0	122	62	72.0	382	300	5.4
28-May	#2	24.0	182	271	down				#3	24.0	119	26	#3	24.0	136	70	72.0	437	367	6.0
29-May	#2	24.0	78	106	#4	5.0	67	278	#3	24.0	92	16	#3	24.0	107	56	77.0	344	456	5.9
30-May	#2	24.0	117	149	#4	24.0	14	51	#3	24.0	46	10	#3	24.0	112	49	96.0	289	259	5.2
31-May	#2	24.0	91	133	#4	12.0	8	20	#3	24.0	27	6	#3	24.0	76	81	84.0	202	240	4.3
01-Jun	#2	24.0	59	66	#4	12.0	0	4	#3	24.0	25	8	#3	24.0	46	54	84.0	130	132	3.8
02-Jun	#2	24.0	50	56	#7	7.5	90	42	#3	24.0	8	7	#3	24.0	48	65	79.5	196	170	3.4

-continued-

Table 3.–Page 2 of 2.

	Rotary trap #1 (12′ cone)				Rotary trap #2 (12′ cone)				Rotary trap #3 (8′ cone)				Rotary trap #4 (8′ cone)							Water
Date	Site	Hours	CPUE Coho	CPUE Chinook	Site	Hours	CPUE Coho	CPUE Chinook	Site	Hours	CPUE coho	CPUE chinook	Site	Hours	CPUE coho	CPUE chinook	Total hrs	CPUE coho	CPUE chinook	depth (ft)
03-Jun	#2	24.0	48	46	#7	24.0	19	12	#3	24.0	2	2	#3	24.0	13	24	96.0	82	84	3.1
04-Jun	#2	24.0	21	23	#7	24.0	18	12	#3	24.0	4	2	#3	24.0	16	11	96.0	59	48	2.4
05-Jun	#2	24.0	29	50	#7	22.0	14	11	#3	24.0	1	0	#3	22.0	8	23	92.0	52	84	2.6
06-Jun	#2	24.0	31	37	#7	16.0	21	8	#3	16.0	2	2	#3	16.0	44	92	72.0	97	138	2.9
07-Jun	#2	24.0	39	38	#7	24.0	18	11	#3	23.5	7	5	#3	24.0	27	61	95.5	91	115	2.9
08-Jun	#2	24.0	41	103	#7	24.0	33	12	#3	22.0	5	3	#3	24.0	14	22	94.0	93	140	3.2
09-Jun	#2	24.0	70	145	#7	24.0	73	27	#3	16.0	48	15	#3	24.0	26	15	88.0	217	202	4.3
10-Jun	#2	23.0	31	194	#7	23.0	48	25	#3	24.0	22	11	#3	21.5	30	16	91.5	131	246	5.4
11-Jun	#2	16.5	16	90	#7	17.5	30	29	#3	24.0	20	7	#3	24.0	24	9	82.0	90	135	7.0
12-Jun	#2	24.0	24	37	#7	23.5	17	55	#3	24.0	26	11	#3	24.0	25	10	95.5	92	113	7.8
13-Jun	#2	24.0	41	46	#7	24.0	24	69	#3	24.0	17	8	#3	24.0	19	11	96.0	101	134	7.5
14-Jun	#2	24.0	100	77	#7	22.0	24	50	#3	24.0	40	16	#3	24.0	28	12	94.0	192	155	7.5
15-Jun	#2	24.0	34	48	#7	5.0	134	62	#3	24.0	20	8	#3	24.0	12	10	77.0	200	128	6.1
16-Jun	#2	24.0	22	25	#7	24.0	25	14	#3	24.0	15	3	#3	24.0	13	35	96.0	75	77	5.3
17-Jun	#2	24.0	14	33	#7	24.0	20	10	#3	24.0	13	1	#3	20.0	5	2	92.0	52	46	4.8
18-Jun	#2	24.0	14	16	#7	24.0	11	3	#3	24.0	14	4	#3	24.0	2	3	96.0	41	26	5.2
19-Jun	#2	24.0	5	28	#7	22.0	15	5	#3	24.0	8	5	#3	24.0	4	6	94.0	32	44	5.4
20-Jun	#2	24.0	7	21	#7	16.0	11	12	#3	24.0	5	0	#3	24.0	2	1	88.0	25	34	5.8
21-Jun	#2	24.0	4	37	#7	24.0	1	4	#3	24.0	2	0	#3	24.0	2	1	96.0	9	42	5.7
22-Jun	#2	9.0	4	0	#7	9.0	0	0	#3	9.0	0	0	#3	9.0	0	0	36.0	4	0	5.6
Total		1,210	3,982	7,735		982	1,639	2,167		1,194	1,167	527		982	1,461	1,124	4,368	8,249	11,553	
Average		22.8	75	146		20.5	34	45		22.5	22	10		22.8	34	26	82.4	156	218	4.9
Percent of species total			48	67			20	19			14	5			18	10		100	100	

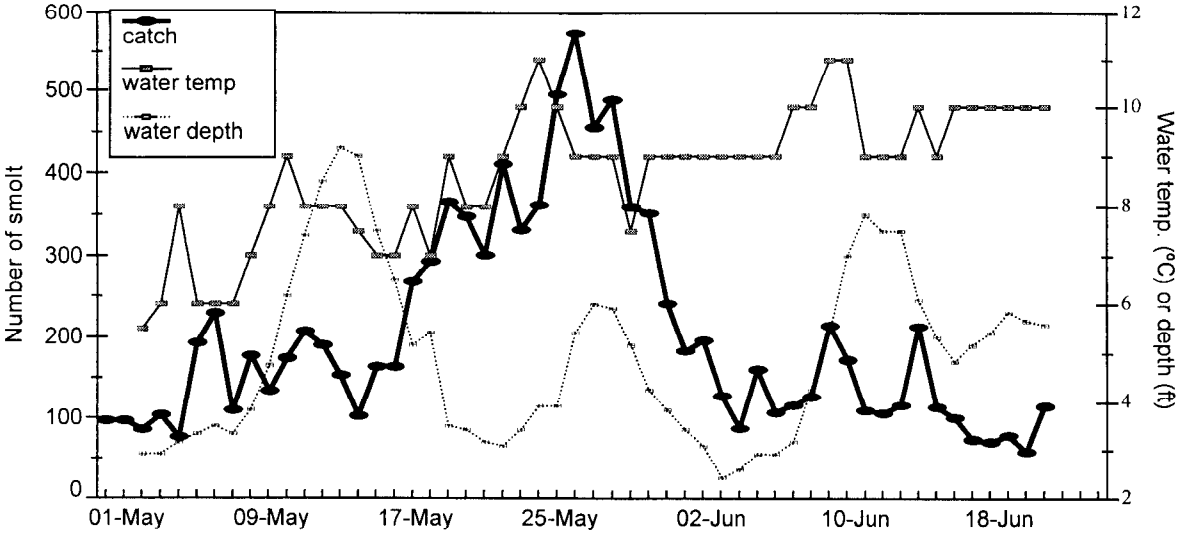

Figure 4.–Catch of coho salmon smolt, daily water temperature, and water depth near Canyon Island, Taku River, 1995.

ESTIMATES OF θ AND SMOLT ABUNDANCE

The estimate of θ was 0.010026 (= 19/1,895) with SE = 0.00229, and the estimate of smolt abundance $\hat{N}_s$ for 1995 is 986,489 [= 10,406 $(1{,}895+1)(19+1)^{-1}$] with SE = 214,152. Both estimates were based on 1,895 coho salmon adults inspected in 1996 from catches in two fish wheels operated at Canyon Island (Appendix A3). Twenty-two (22) of the fish inspected were missing adipose fins, and all were sacrificed to determine the tag codes present; 19 contained Canyon Island tags implanted the previous year, and 3 (14%) had no tag. We believe the difference to be due primarily to the small incidence of naturally missing adipose fins. In 1996, 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% (0.1% to 0.2%) of captured smolt, but when about 1% or less of the smolt migration is captured and tagged it can adversely affect estimates of smolt production and marine survival. On this basis we reset $m_e \rightarrow m_a$.

Table 4.–Mean fork length and age composition of coho salmon smolt sampled from rotary and minnow traps near Canyon Island, Taku River, 1995 and mean length (mid-eye to fork of tail) and age composition of mature coho salmon sampled from fish wheels at Canyon Island in 1996.

SMOLT SAMPLED IN 1995

	Parent year		
	1993 Age 1.0	1992 Age 2.0	Total
Number sampled	419	113	532
Mean length (mm)	89	112	94
SD	11	13	15
SE	0.5	1.2	0.6
Percent composition	78.8%	21.2%	100.0%
SE	1.8%	1.8%	

ADULTS SAMPLED IN 1996

	Parent year			
	1993 Age 1.1	1992 Age 2.1	1992 Age 3.1	Total
Number sampled	337	259	3	599
Mean length (mm)	573	607	608	588
SD	84	72	37	81
SE	5	5	21	3
Percent composition	56.3%	43.2%	0.5%	100.0%
SE	2.0%	2.0%	0.3%	

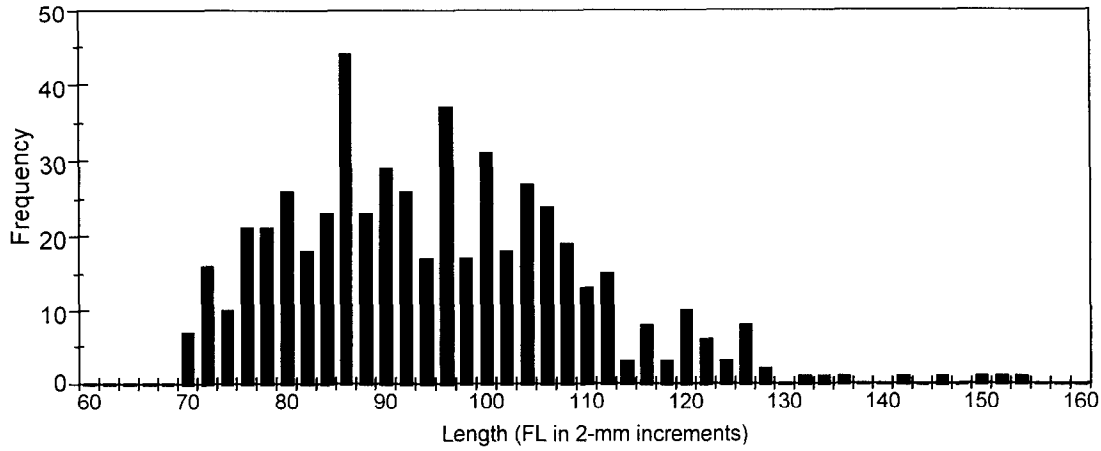

Figure 5. –Length frequency of coho salmon smolt captured and measured at Canyon Island, Taku River, 1995.

Table 5.–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 1996. Recoveries are from smolt marked at Canyon Island in 1995 with tag code 04-42-32.

PANEL A: District 111 Gillnet Fishery

Stat week	Dates	Tag code 04-42-32	Sampled harvest	Percent marked	Total harvest	Percent sampled
25	Jun 16-22	0	16	0.00	26	61.5
26	23-29	0	227	0.00	85	267.1
27	30-06	0	65	0.00	161	40.4
28	Jul 7-13	0	9	0.00	206	4.4
29	14-20	1	295	0.34	403	73.2
30	21-27	2	435	0.46	1,074	40.5
31	28-03	4	227	1.76	790	28.7
32	Aug 04-10	4	1,401	0.29	2,027	69.1
33	11-17	10	1,438	0.70	4,085	35.2
34	18-24	2	875	0.23	4,186	20.9
35	25-31	11	2,798	0.39	6,640	42.1
36	Sep 01-07	12	2,136	0.56	7,860	27.2
37	08-14	1	593	0.17	4,761	12.5
38	15-21	0	167	0.00	1,329	12.6
Total		47	10,682	0.44	33,633	31.8
25–33	Jun 16-Aug 17	21	4,113	0.511	8,857	46.4
34–35	Aug 18-31	13	3,673	0.354	10,826	33.9
36–38	Sep 1-21	13	2,896	0.449	13,950	20.8
Total		47	10,682	0.440	33,633	31.8

PANEL B: Northwest Quadrant Troll Fishery

27–28	7/01-7/13	1	32,236	0.003	162,700	19.8
29–33	7/14-8/17	50	243,464	0.021	730,940	33.3
34–38	8/18-9/22	21	79,837	0.026	336,475	23.7
Total		72	355,537	0.020	1,230,115	28.9

ESTIMATES OF HARVEST, ESCAPEMENT AND EXPLOITATION IN 1996

An estimated 44,529 (SE = 6,494) coho salmon originating above Canyon Island were harvested in marine commercial and sport fisheries in 1996 (Table 6). The troll fishery in the Northwest Quadrant took 56% of the estimated marine harvest, and the drift gillnet fisheries in Taku Inlet/Stephens Passage and Lynn Canal took 38% (Table 7). Harvests in these fisheries occurred from July through September. The troll harvest was spread over a long period (July to Sept.), and most of the gillnet harvests occurred in August and September with a peak in September (Figure 6). Estimated mean date of harvest in the troll fishery was 10 August, compared to 24 August for the gillnet fishery (Appendix A4). Coho salmon originating above Canyon Island contributed an estimated 43% (14,491 fish) of the District 111 gillnet catch (33,633 fish). Fifty percent of the estimated harvest was taken by 17 August (Figure 6), about the same as in 1994 and about 10 days earlier than in 1995 (McPherson and Bernard 1995, 1996). Estimated harvest in the Juneau marine recreational fishery is 2,461 fish or 5.5% of all estimated harvest and 13% of the estimated 18,816 coho salmon caught in the Juneau marine fishery, using harvest and sampling data from Hubartt et al. (1997).

An estimated 94,216 (SE = 7,449) coho salmon bound for Canyon Island returned in 1996, making the estimated marine survival rate 9.6% (SE = 2.2%) and the estimated exploitation rate in marine commercial and sport fisheries 47.3% (SE = 4.1) (Table 7). An estimated 44,172 (SE2 = 3,245) adult coho salmon migrated past Canyon Island prior to 20 September (Kelley and Milligan 1997) and 49,687 (SE 3= 3,650) for the year. Inriver harvest above Canyon Island was 5,052 in 1996, making 44,635 (SE = 3,650) the estimated escapement for the year.

Age composition of adult coho salmon sampled from catches in Canyon Island fish wheels was 56.3% (SE = 2.0%) age 1.1 and 43.2% (SE = 2.0%) age 2.1 (Table 4), and the mean length of adults at Canyon Island was 588 mm (SE = 3) mid-eye to fork of tail.

DISCUSSION

Smolt captured and tagged in 1995 were similar in size to smolt captured and tagged from 1991–1994 on the Taku River. In 1995, smolt captured at Canyon Island averaged 94 mm FL, compared to 101 mm FL in 1994 (McPherson and Bernard 1996), 98 mm in 1993 (McPherson and Bernard 1995), 105 mm at Barrel Point in 1992 (McPherson et al. 1994) and 100 mm at Barrel Point in 1991 (Elliott and Bernard 1994). The same gear (rotary traps primarily) and tagging strategy (fish $\geq$70 mm FL) was used each year.

Age composition of coho salmon sampled from rotary smolt catches in 1995 at Canyon Island were significantly different ($\chi^2 = 65.4$, df = 2, P <0.001) from adults sampled from fish wheel catches in 1996 at Canyon Island; e.g., smolt captured were 79% age 1. whereas adults were 56% age 1. This difference may be due to:

- outmigration of age-2. smolt prior to trap operation;
- size selection for smaller (younger) smolt;
- rearing below Canyon Island of progeny 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. (1988); or
- younger smolt survive at a lower rate than do older smolt.

If this last explanation is true, our estimate of smolt abundance is biased high and our estimate of marine survival rate is biased low. Our estimated marine survival rate does, however, closely approximate estimates for other wild and hatchery stocks in Southeast Alaska for 1996 (L. Shaul, ADF&G, CMDD, Douglas; personal communication).

Circumstances and results indicate that the other conditions for obtaining accurate estimates of smolt abundance with mark-recapture experiments were met. Bailey's modification of the Petersen estimate was used because of the systematic nature of sampling smolts and adults

Table 6.–Estimated marine harvest of adult coho salmon bound for the Taku River in 1996, with $\hat{\theta}$ = 0.010026 and $G[\hat{\theta}^{-1}]$ = 0.075. In fishing periods and fishing quadrants for which no CWT was recovered with the appropriate code, harvest was assumed to be zero.

TROLL FISHERY

Stat. wks.	Dates	Period	Quad.	N	v[$\hat{N}$]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
27–28	7/01-7/13	3	NW	162,700	0	32,236	510	498	419	418	1	517	516	195.8%
29–33	7/14-8/17	4	NW	730,940	0	243,464	4,439	4,340	3,406	3,403	50	15,327	4,691	60.0%
34–38	8/18-9/22	5	NW	336,475	0	79,837	1,401	1,384	1,145	1,145	21	8,936	3,085	67.7%
Subtotal troll fishery				1,230,115	0	355,537	6,350	6,222	4,970	4,966	72	24,779	5,638	44.6%

GILLNET FISHERY

Stat. wk.	Dates	District	N	v[$\hat{N}$]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
29	7/14-7/20	111	403	0	295	2	1	1	1	1	273	272	195.7%
30	7/21-7/27	111	1,074	0	435	2	2	2	2	2	492	360	143.5%
31	7/28-8/03	111	790	0	227	6	6	6	6	4	1,388	768	108.4%
32	8/04-8/10	111	2,027	0	1,401	18	18	13	13	4	577	319	108.2%
33	8/11-8/17	111	4,085	0	1,438	35	35	33	33	10	2,833	1,159	80.2%
34	8/18-8/24	111	4,186	0	875	30	30	26	26	2	954	699	143.6%
35	8/25-8/31	111	6,640	0	2,798	82	82	72	72	11	2,604	1,038	78.1%
36	9/01-9/07	111	7,860	0	2,136	100	97	91	91	12	4,540	1,771	76.4%
37	9/08-9/14	111	4,761	0	593	29	28	25	25	1	829	829	195.9%
34	8/18-8/24	115	5,167	0	1,010	17	17	13	13	1	510	510	195.8%
35	8/25-8/31	115	8,579	0	2,439	66	66	64	64	1	351	350	195.7%
37	9/08-9/14	115	12,521	0	2,372	92	92	87	87	3	1,579	977	121.3%
39	9/15-9/21	115	3,394	0	2,467	77	77	72	72	1	137	137	195.3%
Subtotal gillnet fishery			61,487	0	18,486	556	551	505	505	53	17,069	2,997	34.4%

SPORT FISHERY

Biweek	Dates	Derby	Area	$\hat{N}$	v[$\hat{N}$]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
16	7/29-8/11		Juneau	3,546	564,446	372	6	6	6	6	1	951	950	195.9%
17	8/12-8/25	yes	Juneau	4,505	106,920	3,594	114	113	102	102	8	1,009	445	86.4%
18	8/26-9/08		Juneau	3,344	727,095	938	31	22	18	18	1	501	501	195.8%
Subtotal sport fishery				11,395	1,398,461	4,904	151	141	126	126	10	2,461	1,162	92.6%

SEINE FISHERY

Stat. wk.	Dates	District	$\hat{N}$	v[$\hat{N}$]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
32	8/04-8/10	112	6,655	0	3,070	60	59	39	39	1	220	219	195.6%
Subtotal seine fishery			6,655	0	3,070	60	59	39	39	1	220	219	195.6%
TOTAL			1,309,652	1,398,461	381,997	7,117	6,973	5,640	5,636	136	44,529	6,494	28.6%

Table 7.–Estimated harvest, exploitation, and total run of Taku River coho salmon from above Canyon Island in 1996.

Fishery	Area	Estimated harvest	SE	Percent of marine harvest	Percent of total run	Removal rate[a]
U.S. troll fishery	NW Quad	24,779	5,638	55.6	26.3	
	Subtotal	24,779	5,638	55.6	26.3	26.3%
Drift gillnet	Dist. 111	14,491	2,762	32.5	15.4	
	Dist. 115	2,578	1,165	5.8	2.7	
	Subtotal	17,069	7,621	38.3	18.1	25.6%
Seine fishery	Dist. 112	220	219	0.5	0.2	
	Subtotal	220	219	0.5	0.2	0.3%
Recreational	Juneau	2,461	1,162	5.5	2.6	
	Subtotal	2,461	1,162	5.5	2.6	3.6%
Total marine harvest		44,529	6,494	100.0	47.3	47.3%
Escapement		44,635			47.4	
Canadian catch		5,052			5.4	10.2%
Inriver run		49,687	3,650			
TOTAL RUN		94,216	7,449			

[a] Percent of available population harvested by a fishery.

(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. 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 catch sampling of harvests were not random, but systematic. 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. Our fishing effort near Canyon Island for smolt was relatively constant once all four rotary and minnow traps were started in 1995, and it is unlikely that much of the migration occurred prior to 1 May. Also, the drawn-out recovery of CWTs indicated considerable mixing of marked and unmarked coho salmon during their 14 to 16 months at sea (see Table 6). Recoveries of CWTs in the troll and District 111 gillnet fisheries from coho salmon tagged at Canyon Island were spread throughout this fishery in rough proportion to harvests.

Tagging a representative sample of smolts or having tagged and untagged fish mix completely are also crucial to accurately estimating harvest of adult coho salmon. 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, $\theta 4$ would be time invariant. Too few marked coho salmon were recaptured at Canyon Island in 1996 to test for temporal changes in θ, and, while many fish were recovered in samples from the catch in District 111, harvest of any coho salmon in District 111 not bound for the Taku River would confound any inference drawn from the fishery concerning variability in θ.

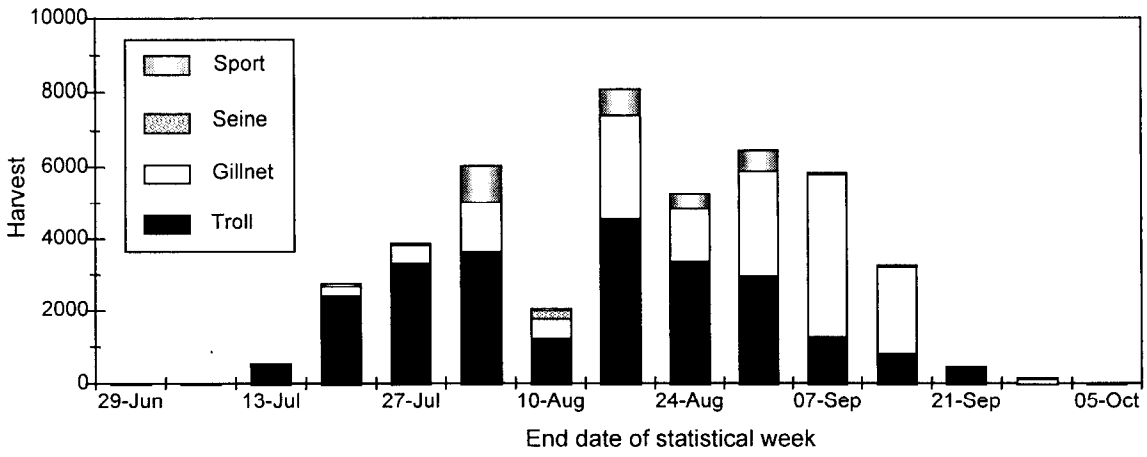

Figure 6.–Estimated harvest of coho salmon bound for Taku River by marine commercial and recreational fisheries in 1996 by statistical week. Weekly estimates of harvest in the troll fishery are approximated.

Our estimates of escapement (44,635), catch (44,529 + 5052) and total run (94,216) 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 is believed to spawn above Canyon Island. Using that expansion, we estimated escapement in the entire Taku River in 1996 at 58,649 ([44,635 + 5,052]/0.78 – 5,052), marine harvest at 57,088 (44,529/0.78), and return at 120,790. Exploitation rate (47.3%) and marine survival (9.6%) remain the same as for estimates for fish from above Canyon Island. Estimated harvest of all coho salmon from the Taku River to the Juneau area marine boat fishery are 3,155 (2,461/0.78) or 17% of the sport harvest of 18,816 coho salmon. The percentage of estimated harvest of coho salmon from the Taku River contributing to the sport fishery near Juneau in 1996 was lower than in 1995, probably due to lower smolt production in 1995 and lower marine survival and because of low probability of tag recoveries in strata early and late in the season.

CONCLUSION AND RECOMMENDATIONS

Results from this project are contributing to development of a long-term database. We estimated smolt production in 1995 and adult production in 1996, the fifth consecutive year these parameters have been estimated for this population (see Appendix A5). Escapements have been estimated since 1987 by CFMD and DFO (see Appendices A6 and A7). 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, and refinement of escapement goals.

Since this project is planned to continue annually, we recommend some strategies to improve the precision of smolt and adult parameter estimates. First, precision of estimates of harvest, particularly in the sport fishery, and smolt abundance can be improved by tagging more smolt with CWTs. This may be accomplished by starting slightly earlier to cover a greater proportion of smolt emigration and by deploying more or different trapping gear and improving the gear currently deployed; a greater number of tags would then be recovered from the

fisheries. Also the precision of θ would be improved during recovery of adults from inriver fish wheels. Second, we can test whether θ is time invariant during the return migration. Third, the estimate of escapement can be improved by operating the mark-recapture experiment through the duration of the immigration of adults, though this may not be possible due to lack of inriver commercial fishing effort late in the season and a lack of funding to operate a test fishery. We also need to determine if the rotary screw traps select for a particular size of smolt.

ACKNOWLEDGMENTS

We thank the many individuals who helped complete this study; personnel are from ADF&G unless noted otherwise. We thank Jarbo Crete, Mark Olsen, Cliff Kemmerling, Sherrie Duncan, Britt Lobdell and Brian Hancock for smolt trapping, coded wire tagging and smolt data; Heather Stilwell, Jerry Owens, Britt Lobdell, Sandra Bietz (DFO) and Jane Williams (DFO) for collecting θ data from adults, constructing and operating the fish wheels, and tagging and recovery data for the adult mark-recapture experiment; Gordon Garcia, Ron Josephson and Clyde Andrews for fishwheel construction; Clyde Andrews for project expediting; Glen Oliver and his port sampling crews for commercial fisheries CWT recoveries; Paul Suchanek, Dennis Hubartt and Dean Beers and his creel census crews for CWT recoveries from the Juneau area recreational fishery; Karen Crandall, David Petree and the CFMD Tag Lab in Juneau for dissecting and decoding heads and providing sampling supplies and data on CWT recoveries; Sue Millard for aging smolt and adult scales; and Steve Elliott for providing editorial review and assistance in designing the project. A special thanks is due Sam Bertoni at the CFMD Tag Lab for providing accurate inseason and postseason data for the CWTs and preseason training sessions on operations of the Mark IV tagging machines from Northwest Marine Technology. Alma Seward helped prepare the final manuscript.

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.

Bernard, D. R., and J. E. Clark. 1996. Estimating salmon harvest with coded-wire tags. Canadian J. Fisheries and Aquatic Sciences2323-2332.

Eiler, J. H., M. M. Masuda, and H. R. Carlson. *In press.* Stock composition, timing and movement 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 contributions to fisheries from

LITERATURE CITED (Continued)

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.

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. 1997. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-16, Anchorage.

Hubartt, D. J., A. E. Bingham, and P. M. Suchanek. 1995. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-23, Anchorage.

Kelley, M. S., and P. A. Milligan. 1997. Adult mark-recapture studies of Taku River salmon stocks in 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 1J97-22, Douglas.

Kelley, M. S., A. J. McGregor, and P. A. Milligan. 1997. Adult mark-recapture studies of Taku River salmon stocks in 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 1J97-01, Douglas.

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.

McConnell, J. M. and G. R. Snyder. 1972. Key to field identification of anadromous juvenile salmonids in the Pacific Northwest. National Oceanic and Atmospheric Administration Technical Report NMFS CIRD-366, Seattle, WA.

McGregor, A. J. and J. E. Clark. 1988. 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. and D. 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.

McPherson, S. A. and D. R. Bernard. 1996. Production of coho salmon from the Taku River, 1994-1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-25, Anchorage.

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 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.

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.

Mundy, P. R. 1982. Computation of migratory timing statistics for adult chinook salmon in the Yukon River, Alaska, and their relevance to fisheries management. North American Journal of Fisheries Management 2:359-370.

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 sampling 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.

LITERATURE CITED (Continued)

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

PSC (Pacific Salmon Commission). 1996. Transboundary river salmon production, harvest, and escapement estimates. 1995. Trans-boundary Technical Committee Report (96-1).

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 investigations, 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 historical 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	Taku River	Estimated escapement
McGregor and Clark	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 1996.

RANDOM RECOVERIES

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub dist.	Length	*N*	*n*	*a*	*a'*	*t*	*t'*
070208	044232	Esc. Surv.	7/9/96	28	NE	111	32	680						
070209	044232	Esc. Surv.	7/10/96	28	NE	111	32	590						
070210	044232	Esc. Surv.	7/10/96	28	NE	111	32	605						
070211	044232	Esc. Surv.	7/22/96	30	NE	111	32	480						
070213	044232	Esc. Surv.	7/24/96	30	NE	111	32	420						
070214	044232	Esc. Surv.	7/25/96	30	NE	111	32	490						
070215	044232	Esc. Surv.	7/27/96	30	NE	111	32	590						
070217	044232	Esc. Surv.	8/8/96	32	NE	111	32	400						
070218	044232	Esc. Surv.	8/19/96	34	NE	111	32	595						
070219	044232	Esc. Surv.	8/21/96	34	NE	111	32	580						
070220	044232	Esc. Surv.	8/23/96	34	NE	111	32	520						
070221	NO TAG	Esc. Surv.	8/23/96	34	NE	111	32	655						
070222	044232	Esc. Surv.	8/26/96	35	NE	111	32	620						
070223	044232	Esc. Surv.	8/30/96	35	NE	111	32	430						
070224	044232	Esc. Surv.	8/30/96	35	NE	111	32	565						
070225	044232	Esc. Surv.	8/31/96	35	NE	111	32	650						
070226	044232	Esc. Surv.	9/4/96	36	NE	111	32	630						
070227	044232	Esc. Surv.	9/5/96	36	NE	111	32	600						
070228	044232	Esc. Surv.	9/14/96	37	NE	111	32	565						
070229	NO TAG	Esc. Surv.	9/16/96	38	NE	111	32	640						
070230	044232	Esc. Surv.	9/20/96	38	NE	111	32	595						
070231	NO TAG	Esc. Surv.	9/20/96	38	NE	111	32	790						
030224	044232	Gillnet	7/17/96	29	NE	111		669	403	295	2	1	1	1
030373	044232	Gillnet	7/25/96	30	NE	111		596	1,074	435	2	2	2	2
030374	044232	Gillnet	7/25/96	30	NE	111		675	1,074	435	2	2	2	2
012835	044232	Gillnet	7/30/96	31	NE	111	32	602	790	227	6	6	6	6
012838	044232	Gillnet	7/30/96	31	NE	111	32	553	790	227	6	6	6	6
017825	044232	Gillnet	7/31/96	31	NE	111		619	790	227	6	6	6	6
017828	044232	Gillnet	7/31/96	31	NE	111		713	790	227	6	6	6	6
012844	044232	Gillnet	8/7/96	32	NE	111	32	795	2,027	1,401	18	18	13	13
012848	044229	Gillnet	8/7/96	32	NE	111	32	746	2,027	1,401	18	18	13	13
018468	044232	Gillnet	8/7/96	32	NE	111		630	2,027	1,401	18	18	13	13
012851	044232	Gillnet	8/8/96	32	NE	111	32	625	2,027	1,401	18	18	13	13
034072	044232	Gillnet	8/14/96	33	NE	111		680	4,085	1,438	35	35	33	33
018481	044232	Gillnet	8/13/96	33	NE	111		496	4,085	1,438	35	35	33	33
018486	044232	Gillnet	8/13/96	33	NE	111		475	4,085	1,438	35	35	33	33
018487	044232	Gillnet	8/13/96	33	NE	111		695	4,085	1,438	35	35	33	33
034077	044232	Gillnet	8/14/96	33	NE	111	32	610	4,085	1,438	35	35	33	33
034080	044232	Gillnet	8/14/96	33	NE	111	32	590	4,085	1,438	35	35	33	33
034084	044232	Gillnet	8/14/96	33	NE	111	32	704	4,085	1,438	35	35	33	33
034090	044232	Gillnet	8/15/96	33	NE	111	32	684	4,085	1,438	35	35	33	33
034093	044232	Gillnet	8/15/96	33	NE	111	32	614	4,085	1,438	35	35	33	33
034096	044232	Gillnet	8/15/96	33	NE	111	32	726	4,085	1,438	35	35	33	33
034006	044232	Gillnet	8/22/96	34	NE	111	32	574	4,186	875	30	30	26	26
034032	044232	Gillnet	8/22/96	34	NE	111	32	741	4,186	875	30	30	26	26
018597	044232	Gillnet	8/28/96	35	NE	111		762	6,640	2,798	82	82	72	72
018842	044232	Gillnet	8/28/96	35	NE	111		635	6,640	2,798	82	82	72	72
018844	044232	Gillnet	8/28/96	35	NE	111		744	6,640	2,798	82	82	72	72
018845	044232	Gillnet	8/28/96	35	NE	111		692	6,640	2,798	82	82	72	72
018870	044232	Gillnet	8/28/96	35	NE	111		652	6,640	2,798	82	82	72	72
018872	044232	Gillnet	8/28/96	35	NE	111		713	6,640	2,798	82	82	72	72
018882	044232	Gillnet	8/28/96	35	NE	111		729	6,640	2,798	82	82	72	72
034122	044232	Gillnet	8/28/96	35	NE	111	32	733	6,640	2,798	82	82	72	72
034126	044232	Gillnet	8/28/96	35	NE	111	32	604	6,640	2,798	82	82	72	72
034151	044232	Gillnet	8/28/96	35	NE	111	32	721	6,640	2,798	82	82	72	72
034154	044232	Gillnet	8/28/96	35	NE	111	32	610	6,640	2,798	82	82	72	72
018942	044232	Gillnet	9/4/96	36	NE	111		793	7,860	2,136	100	97	91	91
019255	044232	Gillnet	9/4/96	36	NE	111		656	7,860	2,136	100	97	91	91
019257	044232	Gillnet	9/4/96	36	NE	111		688	7,860	2,136	100	97	91	91
019207	044232	Gillnet	9/4/96	36	NE	111		740	7,860	2,136	100	97	91	91
019346	044232	Gillnet	9/4/96	36	NE	111		790	7,860	2,136	100	97	91	91
019349	044232	Gillnet	9/4/96	36	NE	111		785	7,860	2,136	100	97	91	91
034161	044232	Gillnet	9/4/96	36	NE	111	32	666	7,860	2,136	100	97	91	91
034162	044232	Gillnet	9/4/96	36	NE	111	32	705	7,860	2,136	100	97	91	91
034169	044232	Gillnet	9/4/96	36	NE	111	32	712	7,860	2,136	100	97	91	91
034174	044232	Gillnet	9/4/96	36	NE	111	32	585	7,860	2,136	100	97	91	91
034195	044232	Gillnet	9/4/96	36	NE	111	32	743	7,860	2,136	100	97	91	91

-continued-

Appendix A2.–Page 2 of 3.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub dist.	Length	N	n	a	a'	t	t'
034196	044232	Gillnet	9/4/96	36	NE	111	32	756	7,860	2,136	100	97	91	91
034231	044232	Gillnet	9/10/96	37	NE	111	32	770	4,761	593	29	28	25	25
034086	044229	Gillnet	8/22/96	34	NE	115		652	5,167	1,010	17	17	13	13
034133	044232	Gillnet	8/28/96	35	NE	115		604	8,579	2,439	66	66	64	64
019273	044232	Gillnet	9/10/96	37	NE	115		775	12,521	2,372	92	92	87	87
019280	044232	Gillnet	9/10/96	37	NE	115		709	12,521	2,372	92	92	87	87
019288	044232	Gillnet	9/10/96	37	NE	115		737	12,521	2,372	92	92	87	87
034287	044232	Gillnet	9/25/96	39	NE	115		777	3,394	2,467	77	77	72	72
030594	044232	Seine	8/7/96	32	NE	112		791	6,655	3,070	60	59	39	39
012123	044229	Sport	7/29/96	31	NE	111	50		3,546	372	6	6	6	6
012355	044232	Sport	8/16/96	33	NE	111	32	645	3,445	3,445	114	113	102	102
061209	044232	Sport	8/16/96	33	NE	111	50	670	3,445	3,445	114	113	102	102
061313	044232	Sport	8/16/96	33	NE	111		570	3,445	3,445	114	113	102	102
012321	044232	Sport	8/17/96	33	NE	111		714	3,445	3,445	114	113	102	102
061335	044229	Sport	8/17/96	33	NE	111		680	3,445	3,445	114	113	102	102
061241	044232	Sport	8/18/96	34	NE	111	50	655	3,445	3,445	114	113	102	102
061247	044232	Sport	8/18/96	34	NE	111	50	605	3,445	3,445	114	113	102	102
061343	044232	Sport	8/18/96	34	NE	111		550	3,445	3,445	114	113	102	102
012176	044232	Sport	8/31/96	35	NE	111	40		3,344	938	31	22	18	18
060137	044232	Troll	7/8/96	28	NW			505	162,700	32,236	510	498	419	418
030327	044232	Troll	7/17/96	29	NW			607	730,940	243,464	4,439	4,340	3,406	3,403
038229	044232	Troll	7/17/96	29	NW			712	730,940	243,464	4,439	4,340	3,406	3,403
060258	044232	Troll	7/14/96	29	NW			682	730,940	243,464	4,439	4,340	3,406	3,403
060260	044232	Troll	7/14/96	29	NW			638	730,940	243,464	4,439	4,340	3,406	3,403
060269	044232	Troll	7/16/96	29	NW	116	12	592	730,940	243,464	4,439	4,340	3,406	3,403
060313	044232	Troll	7/18/96	29	NW	113	91	580	730,940	243,464	4,439	4,340	3,406	3,403
060320	044232	Troll	7/18/96	29	NW	113	91	612	730,940	243,464	4,439	4,340	3,406	3,403
079819	044232	Troll	7/18/96	29	NW	114	21	700	730,940	243,464	4,439	4,340	3,406	3,403
030198	044232	Troll	7/22/96	30	NW			634	730,940	243,464	4,439	4,340	3,406	3,403
032325	044229	Troll	7/22/96	30	NW	116	12	678	730,940	243,464	4,439	4,340	3,406	3,403
037893	044232	Troll	7/23/96	30	NW	116		625	730,940	243,464	4,439	4,340	3,406	3,403
037900	044232	Troll	7/23/96	30	NW	116		745	730,940	243,464	4,439	4,340	3,406	3,403
038080	044232	Troll	7/23/96	30	NW			601	730,940	243,464	4,439	4,340	3,406	3,403
038304	044232	Troll	7/23/96	30	NW			555	730,940	243,464	4,439	4,340	3,406	3,403
038349	044232	Troll	7/23/96	30	NW			679	730,940	243,464	4,439	4,340	3,406	3,403
038541	044232	Troll	7/26/96	30	NW	116	11	645	730,940	243,464	4,439	4,340	3,406	3,403
060353	044232	Troll	7/22/96	30	NW			691	730,940	243,464	4,439	4,340	3,406	3,403
060364	044232	Troll	7/22/96	30	NW			594	730,940	243,464	4,439	4,340	3,406	3,403
079860	044232	Troll	7/25/96	30	NW	114	21	605	730,940	243,464	4,439	4,340	3,406	3,403
030465	044232	Troll	7/29/96	31	NW			670	730,940	243,464	4,439	4,340	3,406	3,403
030467	044232	Troll	7/29/96	31	NW			691	730,940	243,464	4,439	4,340	3,406	3,403
030571	044232	Troll	8/1/96	31	NW			576	730,940	243,464	4,439	4,340	3,406	3,403
032501	044232	Troll	7/28/96	31	NW			673	730,940	243,464	4,439	4,340	3,406	3,403
032546	044232	Troll	7/29/96	31	NW	113		601	730,940	243,464	4,439	4,340	3,406	3,403
032677	044232	Troll	8/3/96	31	NW	116	11	590	730,940	243,464	4,439	4,340	3,406	3,403
038927	044232	Troll	7/31/96	31	NW			634	730,940	243,464	4,439	4,340	3,406	3,403
039014	044232	Troll	8/3/96	31	NW			665	730,940	243,464	4,439	4,340	3,406	3,403
039031	044232	Troll	8/3/96	31	NW			750	730,940	243,464	4,439	4,340	3,406	3,403
039155	044232	Troll	8/3/96	31	NW			615	730,940	243,464	4,439	4,340	3,406	3,403
079879	044232	Troll	8/1/96	31	NW	114	21	485	730,940	243,464	4,439	4,340	3,406	3,403
079883	044232	Troll	8/1/96	31	NW	116	14	750	730,940	243,464	4,439	4,340	3,406	3,403
030624	044232	Troll	8/5/96	32	NW			789	730,940	243,464	4,439	4,340	3,406	3,403
039422	044232	Troll	8/9/96	32	NW			556	730,940	243,464	4,439	4,340	3,406	3,403
114122	044232	Troll	8/10/96	32	NW			606	730,940	243,464	4,439	4,340	3,406	3,403
114152	044232	Troll	8/10/96	32	NW			703	730,940	243,464	4,439	4,340	3,406	3,403
028148	044232	Troll	8/14/96	33	NW			640	730,940	243,464	4,439	4,340	3,406	3,403
032741	044232	Troll	8/13/96	33	NW	116	11	700	730,940	243,464	4,439	4,340	3,406	3,403
032774	044232	Troll	8/14/96	33	NW	116	11	705	730,940	243,464	4,439	4,340	3,406	3,403
032826	044232	Troll	8/14/96	33	NW				730,940	243,464	4,439	4,340	3,406	3,403
032845	044232	Troll	8/13/96	33	NW	113		602	730,940	243,464	4,439	4,340	3,406	3,403
034059	044232	Troll	8/14/96	33	NW			757	730,940	243,464	4,439	4,340	3,406	3,403
060774	044232	Troll	8/13/96	33	NW			727	730,940	243,464	4,439	4,340	3,406	3,403
060826	044232	Troll	8/14/96	33	NW	116	11	695	730,940	243,464	4,439	4,340	3,406	3,403
060829	044232	Troll	8/14/96	33	NW			629	730,940	243,464	4,439	4,340	3,406	3,403
060847	044232	Troll	8/14/96	33	NW			641	730,940	243,464	4,439	4,340	3,406	3,403
114223	044232	Troll	8/14/96	33	NW	113		699	730,940	243,464	4,439	4,340	3,406	3,403
114263	044232	Troll	8/13/96	33	NW	113		514	730,940	243,464	4,439	4,340	3,406	3,403

-continued-

Appendix A2.–Page 3 of 3.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub dist.	Length	N	n	a	a'	t	t'
114507	044232	Troll	8/13/96	33	NW	113	91	679	730,940	243,464	4,439	4,340	3,406	3,403
114515	044232	Troll	8/13/96	33	NW	113	91	669	730,940	243,464	4,439	4,340	3,406	3,403
114864	044232	Troll	8/13/96	33	NW	113		619	730,940	243,464	4,439	4,340	3,406	3,403
029029	044232	Troll	8/21/96	34	NW	189	30	710	336,475	79,837	1,401	1,384	1,145	1,145
030927	044232	Troll	8/21/96	34	NW			662	336,475	79,837	1,401	1,384	1,145	1,145
032922	044232	Troll	8/22/96	34	NW	113	91	641	336,475	79,837	1,401	1,384	1,145	1,145
032931	044232	Troll	8/23/96	34	NW	116	12	655	336,475	79,837	1,401	1,384	1,145	1,145
060918	044232	Troll	8/21/96	34	NW	116	11	643	336,475	79,837	1,401	1,384	1,145	1,145
061501	044232	Troll	8/19/96	34	NW	114	21	630	336,475	79,837	1,401	1,384	1,145	1,145
116126	044232	Troll	8/24/96	34	NW			732	336,475	79,837	1,401	1,384	1,145	1,145
116147	044232	Troll	8/24/96	34	NW			687	336,475	79,837	1,401	1,384	1,145	1,145
028258	044232	Troll	8/29/96	35	NW	189	30	688	336,475	79,837	1,401	1,384	1,145	1,145
030871	044232	Troll	8/27/96	35	NW			627	336,475	79,837	1,401	1,384	1,145	1,145
032975	044232	Troll	8/25/96	35	NW	114	25	667	336,475	79,837	1,401	1,384	1,145	1,145
033064	044232	Troll	8/30/96	35	NW	114		690	336,475	79,837	1,401	1,384	1,145	1,145
104059	044232	Troll	8/26/96	35	NW	116	11	594	336,475	79,837	1,401	1,384	1,145	1,145
104070	044232	Troll	8/28/96	35	NW	116	12	667	336,475	79,837	1,401	1,384	1,145	1,145
116442	044232	Troll	8/28/96	35	NW			690	336,475	79,837	1,401	1,384	1,145	1,145
028286	044232	Troll	9/4/96	36	NW	189		590	336,475	79,837	1,401	1,384	1,145	1,145
104120	044232	Troll	9/4/96	36	NW	181	60	700	336,475	79,837	1,401	1,384	1,145	1,145
116723	044232	Troll	9/6/96	36	NW	181		808	336,475	79,837	1,401	1,384	1,145	1,145
061593	044232	Troll	9/13/96	37	NW	114	21	675	336,475	79,837	1,401	1,384	1,145	1,145
033251	044232	Troll	9/17/96	38	NW	114		674	336,475	79,837	1,401	1,384	1,145	1,145
033199	044232	Troll	9/14/96	37	NW			820	336,475	79,837	1,401	1,384	1,145	1,145
SELECT RECOVERIES														
034047	044232	Gillnet	8/28/96	35	NE	111	32							
033007	044232	Troll	8/26/96	35	NW	113		704						
033197	044232	Troll	9/10/96	37	NW			685						
033216	044232	Troll	9/13/96	37	NW			725						
033258	044232	Troll	9/15/96	38	NW			649						
038546	044232	Troll	7/26/96	30	NW	116								
115083	044232	Troll	8/6/96	32										
115095	044232	Troll	8/6/96	32										
115242	044232	Troll	8/12/96	33	NW	181								
115495	044232	Troll	8/14/96	33										
115501	044232	Troll	8/14/96	33										
115510	044232	Troll	8/14/96	33										
115545	044232	Troll	8/7/96	32										
115808	044232	Troll	8/11/96	33										
115810	044232	Troll	8/11/96	33										
116547	044232	Troll	9/7/96	36										
116591	044232	Troll	9/1/96	36										
116593	044232	Troll	9/1/96	36										

Appendix A3.–Numbers of coded wire tagged and untagged coho salmon in samples of immigrating salmon at Canyon Island fish wheels in 1996.

Date	Number examined	Number of clips	Valid tags	Head number	Tag code	Release site
14-Jun	1					
15-Jun	1					
16-Jun	0					
17-Jun	0					
18-Jun	0					
19-Jun	0					
20-Jun	0					
21-Jun	0					
22-Jun	0					
23-Jun	0					
24-Jun	0					
25-Jun	0					
26-Jun	1					
27-Jun	1					
28-Jun	2					
29-Jun	1					
30-Jun	0					
01-Jul	0					
02-Jul	1					
03-Jul	1					
04-Jul	0					
05-Jul	2					
06-Jul	1					
07-Jul	5					
08-Jul	10					
09-Jul	12	1	1	70208	04-42-32	Canyon Island
10-Jul	10	1	1	70209	04-42-32	Canyon Island
		1	1	70210	04-42-32	Canyon Island
11-Jul	6					
12-Jul	6					
13-Jul	3					
14-Jul	5					
15-Jul	1					
16-Jul	0					
17-Jul	4					
18-Jul	4					
19-Jul	15					
20-Jul	14					
21-Jul	9					
22-Jul	16	1	1	70211	04-42-32	Canyon Island
23-Jul	13					
24-Jul	8	1	1	70213	04-42-32	Canyon Island
25-Jul	13	1	1	70214	04-42-32	Canyon Island
26-Jul	12					
27-Jul	31	1	1	70215	04-42-32	Canyon Island
28-Jul	17					
29-Jul	26					
30-Jul	33					
31-Jul	32					
01-Aug	29					
02-Aug	16					
03-Aug	7					

-continued-

Appendix A3.–Page 2 of 2.

Date	Number examined	Number of clips	Valid tags	Head number	Tag code	Release site
04-Aug	19					
05-Aug	19					
06-Aug	25					
07-Aug	10					
08-Aug	17	1	1	70217	04-42-32	Canyon Island
09-Aug	24					
10-Aug	33					
11-Aug	20					
12-Aug	16					
13-Aug	41					
14-Aug	40					
15-Aug	22					
16-Aug	22					
17-Aug	23					
18-Aug	32					
19-Aug	64	1	1	70218	04-42-32	Canyon Island
20-Aug	68					
21-Aug	56	1	1	70219	04-42-32	Canyon Island
22-Aug	24					
23-Aug	72	1	1	70220	04-42-32	Canyon Island
		1		70221	NO TAG	
24-Aug	23					
25-Aug	45					
26-Aug	31	1	1	70222	04-42-32	Canyon Island
27-Aug	24					
28-Aug	55					
29-Aug	56					
30-Aug	85	1	1	70223	04-42-32	Canyon Island
		1	1	70224	04-42-32	Canyon Island
31-Aug	33	1	1	70225	04-42-32	Canyon Island
01-Sep	58					
02-Sep	54					
03-Sep	48					
04-Sep	53	1	1	70226	04-42-32	Canyon Island
05-Sep	51	1	1	70227	04-42-32	Canyon Island
06-Sep	39					
07-Sep	12					
08-Sep	17					
09-Sep	7					
10-Sep	6					
11-Sep	14					
12-Sep	18					
13-Sep	45					
14-Sep	22	1	1	70228	04-42-32	Canyon Island
15-Sep	21					
16-Sep	15	1	1	70229	NO TAG	Canyon Island
17-Sep	31					
18-Sep	0					
19-Sep	0					
20-Sep	16	1	1	70230	04-42-32	Canyon Island
		1	1	70231	NO TAG	
Total	1,895	22	19			
Marked fraction [$\hat{\theta}$]			0.0100264	0.0022893	=SE[$\hat{\theta}$]	

Appendix A4.–Estimated harvests of coho salmon bound for Taku River above Canyon Island in 1996 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. week	Gillnet	Seine	Sport	TOTAL	Estimated weekly prop. harvest	Estimated cum. total harvest	Estimated cum. prop. harvest
25	22-Jun			0	0			0	0.000	0	0.000
26	29-Jun	0		0	0			0	0.000	0	0.000
27	6-Jul	0		0	0			0	0.000	0	0.000
28	13-Jul	1	517	517	0			517	0.012	517	0.012
29	20-Jul	8		2,452	273			2,725	0.061	3,242	0.073
30	27-Jul	11		3,372	492			3,864	0.087	7,106	0.160
31	3-Aug	12		3,678	1,388		951	6,017	0.135	13,124	0.295
32	10-Aug	4		1,226	577	220		2,023	0.045	15,147	0.340
33	17-Aug	15	15,327	4,598	2,833		631	8,062	0.181	23,209	0.521
34	24-Aug	8		3,404	1,464		378	5,247	0.118	28,455	0.639
35	31-Aug	7		2,979	2,955		501	6,435	0.145	34,890	0.784
36	7-Sep	3		1,277	4,540			5,817	0.131	40,706	0.914
37	14-Sep	2		851	2,408			3,259	0.073	43,965	0.987
38	21-Sep	1	8,936	426	0			426	0.010	44,391	0.997
39	28-Sep			0	137			137	0.003	44,528	1.000
40	5-Oct			0	0			0	0.000	44,528	1.000
Total		72	24,780	24,780	17,067	220	2,461	44,528	1.000		
Estimated mean date of harvest				10-Aug	24-Aug	7-Aug	12-Aug	15-Aug			

Appendix A5.–Summary of population parameters for the Taku River coho salmon run, 1987–1996.

COHO SALMON FROM ABOVE CANYON ISLAND NEAR CANADIAN BORDER

Calendar year	Escapement	Canadian harvest	Inriver run	Est. U.S. marine harvest	Estimated total run	Total harvest rate	U.S. marine harvest rate	Smolt in year t-1	Marine survival
1987	55,312	6,406	61,718						
1988	51,225	3,545	54,770						
1989	64,574	3,887	68,461						
1990	88,504	3,679	92,183						
1991	127,504	5,419	132,923						
1992	84,545	5,354	89,899	96,283	186,182	54.6%	51.7%	743,000	NE
1993	119,338	4,626	123,964	97,758	221,722	46.2%	44.1%	1,510,000	14.7%
1994	96,343	14,693	111,036	228,607	339,643	71.6%	67.3%	1,476,000	23.0%
1995	55,710	13,738	69,448	111,571	181,019	69.2%	61.6%	1,525,000	11.9%
1996	44,635	5,052	49,687	44,529	94,216	52.6%	47.3%	986,489	9.6%
Standard Errors									
1992			19,182	27,181	36,264		8.0%	247,000	
1993			15,617	19,256	31,786		5.8%	418,000	4.4%
1994			6,529	36,734	47,833		3.8%	368,000	6.3%
1995			3,244	12,186	16,167		2.8%	340,000	2.8%
1996			3,650	6,494	7,449		4.1%	214,152	2.2%

COHO SALMON FROM ENTIRE TAKU RIVER DRAINAGE

Calendar year	Escapement	Canadian harvest	Inriver run	Est. U.S. marine harvest	Estimated total run	Total harvest rate	U.S. marine harvest rate	Smolt in year t-1	Marine survival
1987	72,720	6,406	79,126						
1988	66,673	3,545	70,218						
1989	83,884	3,887	87,771						
1990	114,504	3,679	118,183						
1991	164,995	5,419	170,414						
1992	109,901	5,354	115,255	123,440	238,695	54.0%	51.7%	991,000	NE
1993	154,302	4,626	158,928	125,331	284,259	45.7%	44.1%	1,936,000	14.7%
1994	127,661	14,693	142,354	298,086	440,440	71.0%	67.7%	1,892,000	23.0%
1995	75,298	13,738	89,036	143,040	232,076	67.6%	61.6%	1,956,000	11.9%
1996	58,649	5,052	63,701	57,088	120,790	51.4%	47.3%	1,264,729	9.6%
Standard Errors									
1992			19,182	30,776	36,264		8.0%	374,000	
1993			15,617	24,687	31,786		5.8%	536,000	4.4%
1994			6,529	47,095	47,833		3.8%	472,000	6.3%
1995			3,244	15,623	16,167		2.8%	436,000	2.8%
1996			3,650	8,356	9,551		4.1%	274,553	2.2%

Appendix A6.–Weekly and season estimates of inriver abundance, harvest and escapement of coho salmon in the Taku River, 1987–1996.

Recovery week	Year											87–96 average
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
27										45		45
28										464		464
29									1,460	853		1,156
30		548	1,425	1,479	2,517	3,298	641	3,348	2,628	1,525		1,934
31	3,841	1,060	878	2,186	2,209	1,741	2,386	5,026	4,582	2,159		2,607
32	2,529	1,526	2,693	1,051	4,157	10,040	3,186	3,988	2,100	6,216		3,749
33	3,623	1,257	300	1,910	4,867	4,875	4,550	4,308	5,299	5,337		3,633
34	4,721	7,412	9,598	11,095	1,740	500	12,759	9,827	8,764	6,589		7,301
35	3,503	8,366	8,385	17,739	27,296	2,170	3,424	15,029	10,565	7,861		10,434
36	4,061	5,583	14,038	17,855	5,924	13,332	19,703	7,904	10,951	7,362		10,671
37	3,843	11,371	10,181	12,563	17,411	14,601	15,427	34,400	7,118	2,900		12,982
38	6,009	1,446	3,351	9,596	4,708			13,583	5,889	1,312		5,737
39	11,440	4,524	8,031	407	9,100			787	2,109	1,549		4,743
40			1,960		33,009			443	273			8,921
41					11,371							11,371
42					4,410							4,410
43					4,204							4,204
MR total	43,570	43,093	60,841	75,881	132,923	50,557	62,076	98,643	61,738	44,172		67,349
SE	3,096	7,162	11,174	21,813	19,051	10,645	9,523	5,800	2,882	3,405		9,455
Total inriver catch	6,519	3,643	4,033	3,685	5,439	5,541	4,634	14,693	13,738	5,052		6,698
Expanded total [a]	61,976	43,093	60,841	75,881	132,923	90,442	114,091	111,036	69,448	49,687		80,942
Escapement above Canyon Island	55,457	39,450	56,808	72,196	127,484	84,901	109,457	96,343	55,710	44,635		74,244

[a] Expansions may be revised pending further studies.

Appendix A7.–Estimated age compostition of coho salmon sampled from catches in fish wheels at Canyon Island, 1983–1996.

Year	Sample size	Percent by age class[a]							
		1.0	1.1	2.0	2.1	3.1	4.0	4.1	5.0
1983	477	0.0	56.0	0.0	44.2	0.0	0.0	0.4	0.0
1984	630	0.3	43.2	0.5	56.2	6.0	0.0	0.0	0.0
1985	825	0.0	44.5	0.2	51.4	4.0	0.0	0.5	0.0
1986	475	0.6	44.0	0.4	52.8	2.7	0.0	0.6	0.0
1987	1,700	0.1	32.4	0.3	65.1	2.4	0.1	0.0	0.1
1988	1,338	1.1	32.3	0.8	59.0	6.8	0.0	0.4	0.0
1989	1,826	0.0	49.3	0.1	48.5	2.1	0.0	0.3	0.0
1990	1,463	0.0	29.3	0.0	67.9	2.9	0.1	0.0	0.0
1991	523	0.4	31.4	0.0	67.7	1.3	0.0	0.0	0.0
1992	534	0.4	51.5	0.0	48.1	0.0	0.0	0.0	0.0
1993	498	0.0	39.4	0.6	60.0	0.8	0.0	0.0	0.0
1994	539	0.0	44.8	0.6	55.0	0.4	0.0	0.0	0.0
1995	582	0.0	52.6	0.0	47.8	0.0	0.0	0.0	0.0
1996	599	0.0	56.3	0.0	43.2	0.5	0.0	0.0	0.0
Average(83–95)		0.2	42.4	0.3	55.7	2.3	0.0	0.2	0.0
SD(83–95)		0.3	8.8	0.3	7.9	2.2	–	0.2	–
CV(83–95)		150.0%	20.9%	105.5%	14.1%	99.0%	–	137.3%	–

[a] Estimates by age class may change pending age validation studies.

Appendix A8.–Computer data files on 1995 Taku River coho salmon smolt and subsequent estimates of 1996 Taku River adult coho salmon run parameters.

FILE NAME	DESCRIPTION
96TAKCWT.xls	Excel (5.0) workbook with spreadsheets of (1) random and select recoveries of CWTs in 1996, (2) estimated harvest calculations by strata and season.
96TAKREP.xls	Excel (5.0) workbook with spreadsheets of (1) CWT sampling in Canyon Island fish wheels; estimation of smolt, total runs, marine survival, Table 5, Table 7, Appendix A4, (2) smolt catches, (3) Appendix A2, (4) historical population parameters.
TAKCOH96.DOC	WORD 6.0 file of this FDS report.