Fishery Data Series No. 00-31

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

by

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November 2000

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

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TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

The 1998 smolt abundance and the 1999 harvest, exploitation rate, and production of coho salmon *Oncorhynchus kisutch* from the Taku River, near Juneau, Alaska were estimated using coded-wire tag methodology and an inriver mark-recapture abundance program. From 7 April through 15 June 1998, between 18 and 227 baited G-40 minnow traps were fished daily near Canyon Island on the Taku River. During this period, 19,854 coho salmon smolt ≥70 mm fork length were marked with an adipose fin clip and a coded wire tag of code 04-46-42 or 04-46-43, and released alive. Smolt averaged 87 mm in fork length (SE = 0.62) and 6.8 g (SE = 0.15) in weight. In 1999, 252 adult coho salmon bearing coded wire tags of Taku River origin were recovered in random sampling of marine fisheries, which produced an estimated harvest of 50,789 (SE = 6,097) in U. S. marine waters. Of this harvest, the troll fishery took an estimated 71%, drift gillnet fisheries took 15%, recreational fisheries 8.2%, and seine fisheries 5.7%. An estimated 66,343 (SE = 7,049) adults passed by Canyon Island, as determined by a separate mark-recapture experiment. Of this inriver run, 5,575 were harvested by inriver fishers above the U.S./Canada border, leaving an estimated escapement past all fisheries of 60,768 (SE = 7,049). The estimated run (escapement plus harvest) in 1999 for coho salmon originating above Canyon Island was 117,132 (SE = 9,320); marine exploitation rate on this run was an estimated 43.4% (SE = 3.9%). The estimated run in 1999 for coho salmon from the entire Taku River drainage was 150,169 (SE ≅ 11,949), accounting for those fish originating below Canyon Island. The contribution of all Taku River coho salmon to the Juneau marine recreational fishery was estimated at 4,350 fish (SE = 1,129), or 16% of the estimated harvest in that fishery. Estimated smolt abundance in 1998 from above Canyon Island was 1,184,195 (SE = 207,576), obtained by using a modified Petersen estimator, and marine survival rate of coho salmon smolt from above Canyon Island was estimated at 9.9% (SE = 1.9%).

Key words: coho salmon, *Oncorhynchus kisutch*, Taku River, harvest, troll fishery, drift gillnet fishery, recreational fishery, seine fishery, escapement, migratory timing, production, return, exploitation rate, marine survival, coded wire tag, mark-recapture experiment, bibliography

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 (Elliott and Bernard 1994; McPherson and Bernard 1995, 1996; PSC 1996; McPherson et al. 1997, 1998; Yanusz et al. 1999).

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 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). Because of the large 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), Fisheries and Oceans Canada (DFO), and the Taku River Tlinglit First Nation (TRTFN) 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 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 and mean length and weight of coho salmon smolt leaving the Taku River in 1998, (2) harvest of adults returning to the Taku River in 1999, and (3) escapement and age composition of returning adults in 1999. These objectives were accomplished by tagging and sampling smolt in 1997 and 1998 in the lower Taku River and operating a cooperative inriver

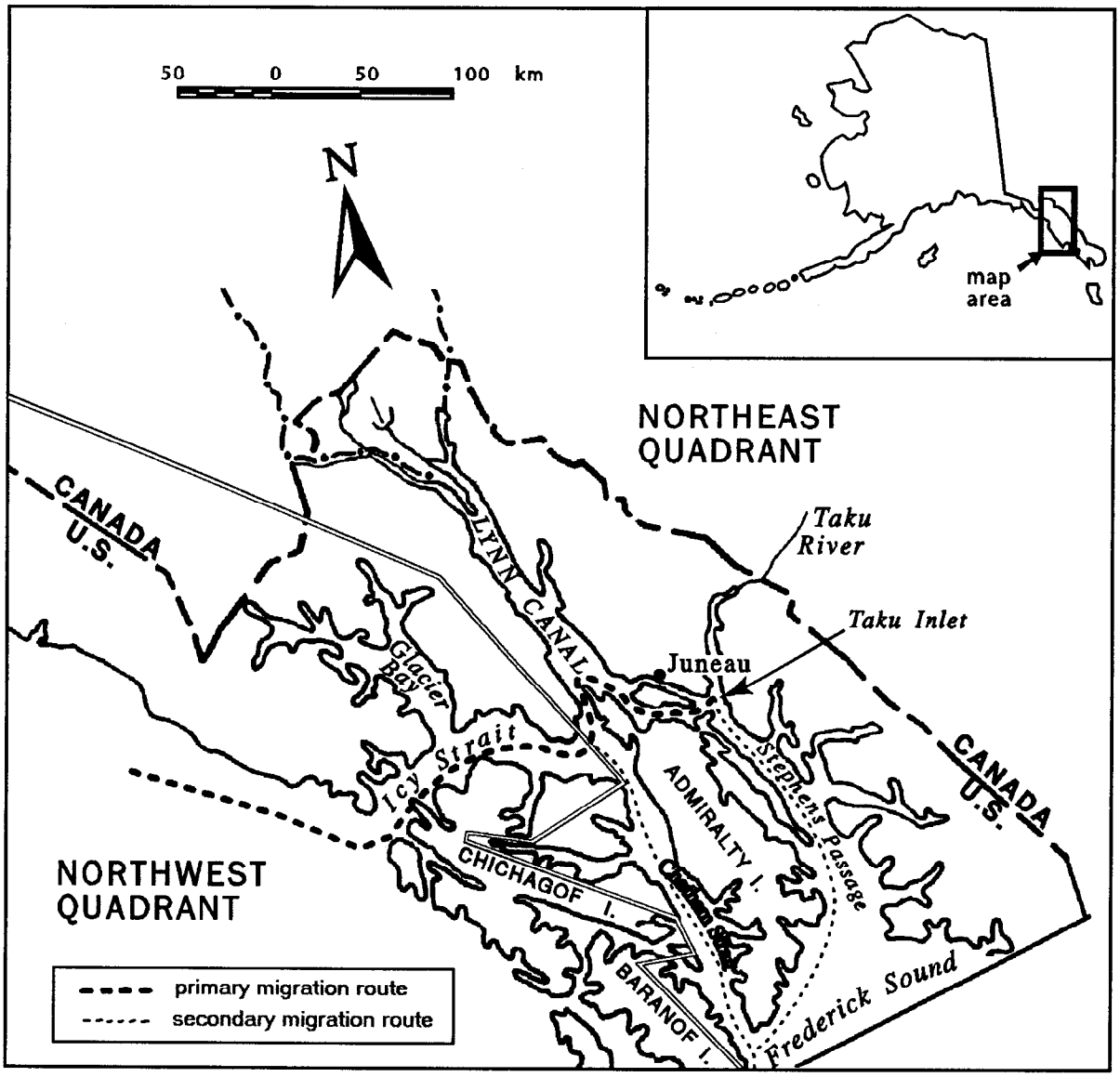

Figure 1.–Migration routes through northern Southeast Alaska of coho salmon bound for the Taku River.

abundance program for adult coho salmon in 1999. Other projects in our agency or in Canada supplied additional data on returning adults which were harvested or escaped in 1999.

METHODS

SMOLT CAPTURE, CODED WIRE TAGGING, AND SAMPLING

Between 18 and 227 G-40 minnow traps baited with salmon roe were fished daily for 24 h/d from 7 April to 15 June 1998. Traps were distributed along mainstem banks and in some backwater areas (depending on river stage) along both sides of the Taku River about 6 km above and below Canyon Island. Minnow traps were checked daily when the river stage was stable and more frequently when the stage was unstable.

Salmonid smolt and fry were removed from minnow traps during each daily visit, transported to holding boxes at camp, and processed each afternoon. Coho and chinook salmon *O. tshawytscha* smolt were separated by inspection

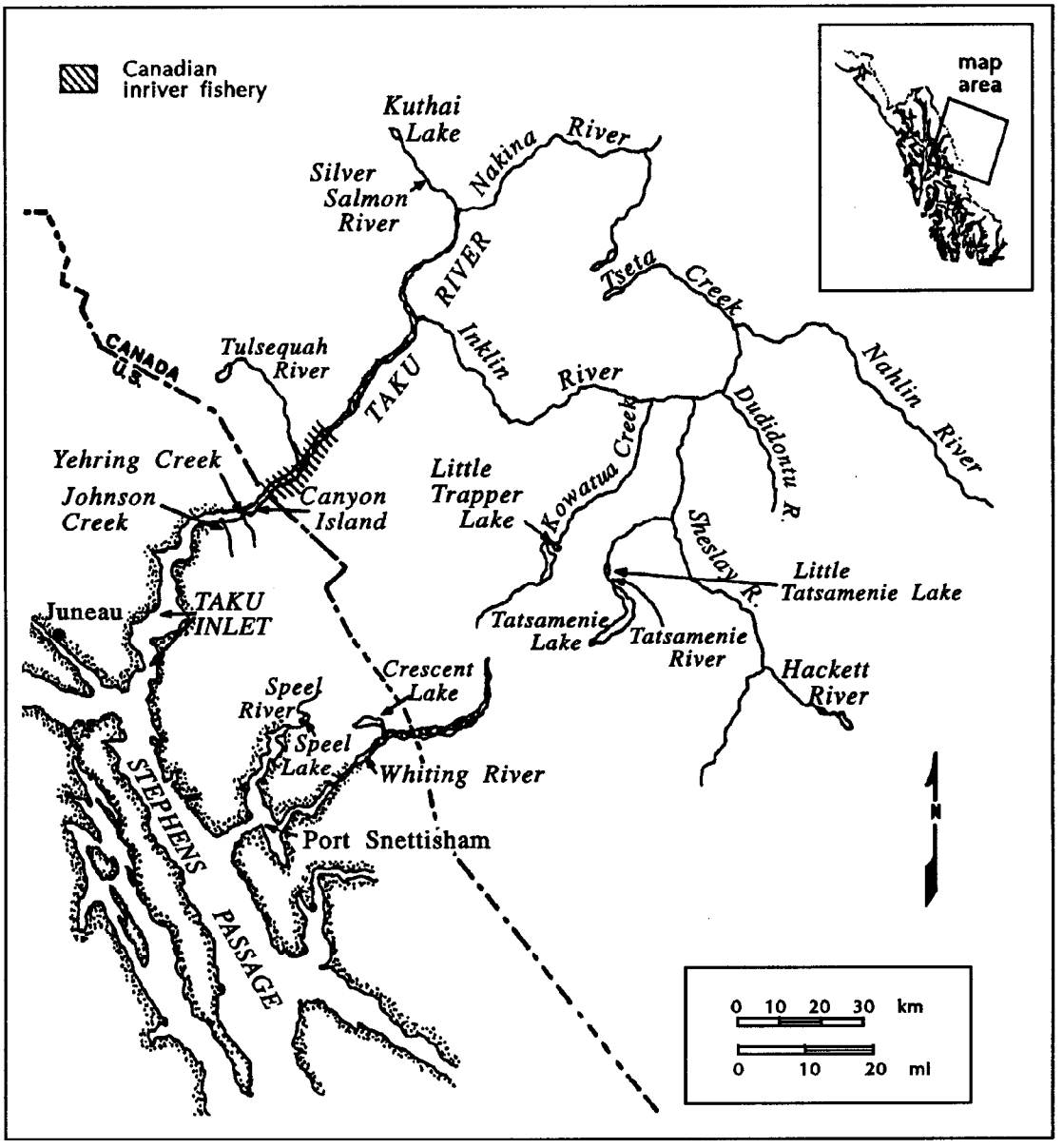

Figure 2.–Taku River drainage, northwestern British Columbia and Southeast Alaska.

from other species of salmon and Dolly Varden *Salvelinus malma*. Coho and chinook salmon smolt were carefully examined to distinguish species 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) and a more 'silver' sheen from a side view indicated a chinook salmon smolt. Coho salmon smolt had more narrow parr marks, showed a greater number of small, darkly pigmented spots from a dorsal view, had pigmentation throughout the adipose fin, and had longer anterior rays on the anal fin.

All live coho salmon smolt ≥ 70 mm fork length (FL) were tranquilized in a buffered solution of tricain-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 circulating it

through 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 chinook salmon smolt >50 mm FL were also tagged with separate tag codes.

All tagged fish were held for 24 h and inspected for mortalities prior to release, of which 50 representative coho salmon from each day's catch were checked 24 h later for retention of CWTs. When fewer than 50 fish of a species were caught in a day, half the catch was tested. 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 ADF&G Division of Commercial Fisheries (CF) Tag Lab in Juneau when field work ended. Proportional sampling of smolt to measure FL to the nearest 1 mm and weight to the nearest 0.1 g was done by measuring a sample of smolt one day per week, where the sample size was 1 in 40 for that week's catch. Every coho salmon smolt that was recaptured, i.e. already missing the adipose fin when captured, was tested for the presence of a CWT and the FL was recorded.

SMOLT ABUNDANCE ESTIMATE

Abundance of smolt originating above Canyon Island in 1998 was estimated in a two-sample, mark-recapture experiment with Petersen's estimator as modified by Bailey (1951, 1952).

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

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

See Table 1 for definitions of all notation.

HARVEST ESTIMATE

Harvest in 1999 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 1999, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by fishing period and by fishing quadrant. Statistics from drift gillnet 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 $\hat{T}$:

$$\hat{T} = \sum_i \hat{r}_i \tag{2a}$$

$$v[\hat{T}] = \sum_i v[\hat{r}_i] \tag{2b}$$

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 the adipose fin, heads were retrieved from a subset, marked, and sent to Juneau for dissection. Of the a_i' heads that arrived in Juneau, all were passed through a magnetometer to detect a CWT. Of the t_i tags detected, t_i' were successfully dissected and decoded with a microscope, of which m_{ci} had come from the Taku River. Oliver (1990) and Hubartt et al. (1999) present details of sampling commercial and recreational fisheries, respectively. The fraction of the return to the Taku River with tags was estimated as the fraction of the escapement sample of adults with valid, decoded CWTs $(\theta = t_i'/n_e)$.

The escapement was sampled in fish wheels located at Canyon Island, as described by Kelley and Milligan (1999).

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 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 1999
H_i	=	number of adults caught in a stratum in 1999
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 1999 with missing adipose fins
m_e	=	number of adults sampled at Canyon Island in 1999 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 marked in 1998
n_e	=	number of adults sampled in at Canyon Island in 1999 to estimate θ
N_D	=	number of adults in escapement through 3 October 1999
N_e	=	number of adults in escapement to Taku River past Canyon Island in 1999
N_R	=	number of adults returning to the Taku River past Canyon Island in 1999
N_s	=	number of smolts emigrating from the Taku River past Canyon Island in 1998
q_i	=	fraction of smolt with freshwater age i in 1998
p_i	=	fraction of catch with a CWT from a stratum in 1999
P_d	=	fraction of catch in fishery made on day d
π	=	fraction of migration past Canyon Island prior to 3 October 1999
ϕ_i	=	fraction of catch sampled in a stratum in 1999
r_i	=	harvest in 1999 of coho salmon originating above Canyon Island in a stratum
S	=	survival rate from smolts in 1998 to adults in 1999
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 1999
θ	=	fraction of the stock tagged with valid CWTs
θ_e	=	fraction of the stock tagged with spaghetti tags, for estimating adult salmon abundance above Canyon Island

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

$$\hat{r}_i = \hat{H}_i \hat{p}_i \hat{\theta}^{-1} \tag{3a}$$

$$v[\hat{r}_i] = \hat{r}_i^2 \left(G[\hat{H}_i] + G[\hat{p}_i] + G[\hat{\theta}^{-1}] - G[\hat{H}_i]G[\hat{p}_i] - G[\hat{H}_i]G[\hat{\theta}^{-1}] - G[\hat{p}_i]G[\hat{\theta}^{-1}] + G[\hat{H}_i]G[\hat{p}_i]G[\hat{\theta}^{-1}]\right), \tag{3b}$$

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):

$$\hat{p}_i = \frac{m_i}{\lambda_i n_i} \tag{4a}$$

$$G[\hat{p}_i] = \frac{1 - \lambda_i \hat{\phi}_i \hat{\theta}}{m_i} \tag{4b}$$

where $\hat{\phi}_i$ 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). Because 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 $\{\theta_1^*, \theta_2^*, \ldots \theta_B^*\}$ 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

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

$$\hat{v}[\theta^{-1}]) = \frac{\sum_{b=1}^{B} (y_b^* - \bar{y}^*)^2}{B-1} \tag{5}$$

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

ESCAPEMENT ESTIMATE

Coho salmon escapement at or above Canyon Island in 1999 was estimated with a mark-recapture experiment co-conducted by ADFG Sport Fish Division, CF, TRTFN, and DFO. Coho salmon were captured in two fish wheels at Canyon Island, tagged with individually numbered plastic spaghetti tags, measured for length to the nearest 5 mm from mideye to tail fork (MEF), sampled for scales, and released at the fish wheels. A set gillnet (127 mm stretch mesh) was also used at Canyon Island to capture coho salmon when warranted by water conditions.

Coho salmon were examined for spaghetti tags in the Canadian commercial gillnet and test fisheries 3–20 km upstream. See Kelley and Milligan (1999) for a detailed description of the field methods. Mark-recapture data were grouped into statistical weeks (SW) for analysis to avoid the variability associated with day-to-day statistics and to reflect the weekly periods that are used to manage U.S. and Canadian fisheries. Darroch's (1961) method was used for estimating coho salmon abundance to incorporate the changing catchability of fish and the mixing of tagged fish between SW. Statistical weeks were pooled into strata based upon fish catchability and fishing methods. To allow for travel time from the tagging area to the recovery area, the recovery strata were lagged one week from the release strata. A matrix of fish released and recovered in each stratum was input into the computer program SPAS (Arnason et al. 1996) to perform the abundance and variance calculations. Since the coho salmon run usually continues beyond the end of field sampling, the direct estimate was expanded by dividing it by the estimated fraction of the migration that had passed Canyon Island by the end of field operations in 1999 (Appendix A2).

Scale samples consisted of four scales from near the "preferred area" from each sampled fish—i.e. the left side of the fish two scales above the lateral line and on an imaginary line from the posterior dorsal fin to the anterior anal fin (Scarneccia 1979). The scales were glued to a gum card in the field and later impressed onto acetate cards. Ages were determined by examining the impressions under 70× magnification. Criteria used to assign ages were similar to those of Moser (1968) and were supplemented with results from recent coho salmon age validation studies (C. Farrington, CFD, Douglas, AK—unpublished data). Ages are reported in European notation (Koo 1962).

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 1999 and the associated exploitation rate in commercial and sport fisheries are based on the sum of estimated harvest and estimated escapement

$$\hat{N}_R = \hat{T} + \hat{N}_e \tag{6a}$$

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

$$v[\hat{N}_R] = v[\hat{T}] + v[\hat{N}_e] \tag{6b}$$

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 (7b) was approximated by 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 (8a) was approximated by the delta method (Seber 1982).

MEAN DATE OF HARVEST ESTIMATES

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:

$$\hat{\bar{d}} = \sum_d d\hat{P}_d \tag{10}$$

RESULTS

SMOLT TAGGING, LENGTH, AND WEIGHT IN 1998

From 7 April through 15 June 1998, we captured and tagged 19,874 coho salmon smolt ≥70 mm FL (Table 2); 20 of these died within 24 h of tagging, leaving a total release of 19,854 marked smolts, comprising 10,275 coho salmon smolt bearing code 04-46-42 and 9,579 bearing code 04-46-43. An estimated two (2) coho smolt shed their tags within 24 h.

Ninety percent (90%) of coho smolt were captured between 21 April and 30 May (Figure 3; Table 2). Peak catches occurred from 10 to 23 May, and 50% of the catch occurred by 5 May. The average FL of coho salmon smolt was 87 mm (SE = 0.62) and average weight was 6.8 g (SE = 0.15) in 1998 (Figure 4). Length frequencies of coho salmon smolt captured the first time and those recaptured were marginally different (P = 0.051; Figure 5).

Of 32,916 chinook salmon smolt captured and tagged, 78 died within 24 h of tagging, leaving a total release of 32,838 marked smolts, comprising 10,375 chinook salmon smolts bearing code 04-46-36, 11,183 bearing code 04-46-37, 10,680 bearing code 04-46-44, and 600 bearing code 04-46-38 (Table 2). An estimated five (5) chinook salmon shed their tags within 24 h. Analyses of chinook salmon tagging data will be published when catches from that brood (1996) are completed after calendar year 2004.

Table 2.–Number of salmon smolt caught and tagged in minnow traps near Canyon Island on the Taku River during 1998. Coho salmon ≥70 mm FL total includes 20 overnight tagging mortalities and two shed tags. Chinook salmon total includes 78 overnight tagging mortalities and five shed tags. Days with trap sets but no catches indicate that fish caught were held one, two, or three days until enough were accumulated for tagging.

Date	Trap sets	Catches		Catch per trap		Air temperature (°C)		Precipitation	Water	
		Coho	Chinook	Coho	Chinook	Min.	Max.	(inches)	Temp. (°C)	Stage
4/7/98	51									
4/8/98	51									
4/9/98	81									
4/10/98	82	510	1,069	1.9	4.0	-8	14	0.0	2	-2'3"
4/11/98	81									
4/12/98	110	587	944	3.1	4.9				2	-2'3"
4/13/98	96	492	772	5.1	8.0	-6	12	0.0	3	-2'4"
4/14/98	111	488	738	4.4	6.6	0	15	0.0	4	-2'3"
4/15/98	120								4	-2'1"
4/16/98	122	587	1,914	2.4	7.9	1	13	0.0	4	-1'11"
4/17/98	131	729	1,028	5.6	7.8	2	14	0.1	4	-1'9"
4/18/98	135	735	909	5.4	6.7	3	16	0.3	5	-1'6"
4/19/98	111					1	16	0.0	4	-1'
4/20/98	129					-3	13	0.0	4	-10"
4/21/98	125	775	579	2.1	1.6	2	12	0.0	4	-10"
4/22/98	133	492	309	3.7	2.3	1	16	0.0	4	-10"
4/23/98	131	599	428	4.6	3.3	1	20	0.0	4	-10"
4/24/98	133	930	908	7.0	6.8	3	16	0.1	5	-10"
4/25/98	139	722	671	5.2	4.8	3	14	0.0	5	-7"
4/26/98	133					1	14	0.1	5	-4"
4/27/98	128	773	522	3.0	2.0	3	15	0.2	5	-2"
4/28/98	123					1	13	0.2	5	0
4/29/98	131	817	569	3.2	2.2	1	11	0.0	5	-2"
4/30/98	131	783	1,095	6.0	8.4	4	19	0.0	6	-2"
5/1/98	130	730	1,029	5.6	7.9	5	15	0.0	4	4"
5/2/98	30					6	20	0.0	5	6"
5/3/98	29					5	21	0.0	6	2'
5/4/98	0	598	395	10.1	6.7	8	21	0.0	7.5	1'6"
5/5/98	65					1	13	0.0	6	2'
5/6/98	59					5	16	0.4	6	2'5"
5/7/98	112	579	256	2.5	1.1	3	13	0.4	5.5	2'4"
5/8/98	127	640	453			2	13	0.2	6	1'8"
5/9/98	202					0	16	0.0	7	1'5"
5/10/98	141	1,609	2,522	3.4	5.4	-2	18	0.0	7	1'6"
5/11/98	239					2	22	0.0	7	1'7"
5/12/98	144	1,351	2,959	3.5	7.7	4	15	0.0	6	1'9"
5/13/98	277					2	22	0.0	6	1'10"
5/14/98	162	1,098	2,919	2.5	6.6	3	20	0.0	6.5	1'10"
5/15/98	243	347	900	1.4	3.7	-2	20	0.0	7	1'9"
5/16/98	162	632	2,256	3.9	13.9	6	24	0.0	9	2'3"
5/17/98	146	637	2,147	4.4	14.7	3	24	0.0	8	3'1"
5/18/98	120					4	23	0.0	8	4'9"
5/19/98	39	489	875	3.1	5.5	6	21	0.0	7	
5/20/98	41					5	14	0.2	8	5'2"
5/21/98	122					5	14	0.1	7	3'5"
5/22/98	128	514	1,305	1.8	4.5	6	18	0.3	7	3'5"
5/23/98	133	271	948	2.0	7.1	0	18	0.1	7	4'
5/24/98	126					5	23	0.0	7.5	5'6"
5/25/98	0					8	21	0.1	8	6'6"

-continued-

Table 2.–(Page 2 of 2).

Date	Trap sets	Daily catch Coho	Daily catch Chinook	Catch per trap Coho	Catch per trap Chinook	Air temperature (°C) Min.	Air temperature (°C) Max.	Precipitation (inches)	Water Temp. (°C)	Water Stage (ft)
5/26/98	0	243	897	0.9	3.5	6	21	0.0	7.5	7'9"
5/27/98	0					6	28	0.0	8	
5/28/98	0									
5/29/98	0					5	27	0.0		
5/30/98	0					4	25	0.0	9	10'6"
5/31/98	0					7	25	0.0	9	10'3"
6/1/98	28					7	27	0.0	8	9'9"
6/2/98	32					3	23	0.0	8	8'6"
6/3/98	39					4	24	0.0	8	7'4"
6/4/98	47	66	135	0.5	0.9	5	24	0.0	9	7'5"
6/5/98	51					7	22	0.0		
6/6/98	50					6	25	0.0	8.5	8'8"
6/7/98	57					5	25	0.0	9	8'2"
6/8/98	55	10	296	0.0	1.4	6	28	0.0	9	8'2"
6/9/98	51					10	28	0.1	9	9'1"
6/10/98	48					7	20	0.0	8	8'4"
6/11/98	29					8	18	0.0	8	6'9"
6/12/98	20	35	85	0.2	0.6	8	18	0.0	9.5	5'11"
6/13/98	20					8	21	0.0	9.5	5'3"
6/14/98	18					7	22	0.1	8.5	4'9"
6/15/98	18	6	84	0.1	1.5	7	21	0.4	8	4'9"
Total	6,258	19,874	32,916					3.7		
Mean				5.3	3.2					

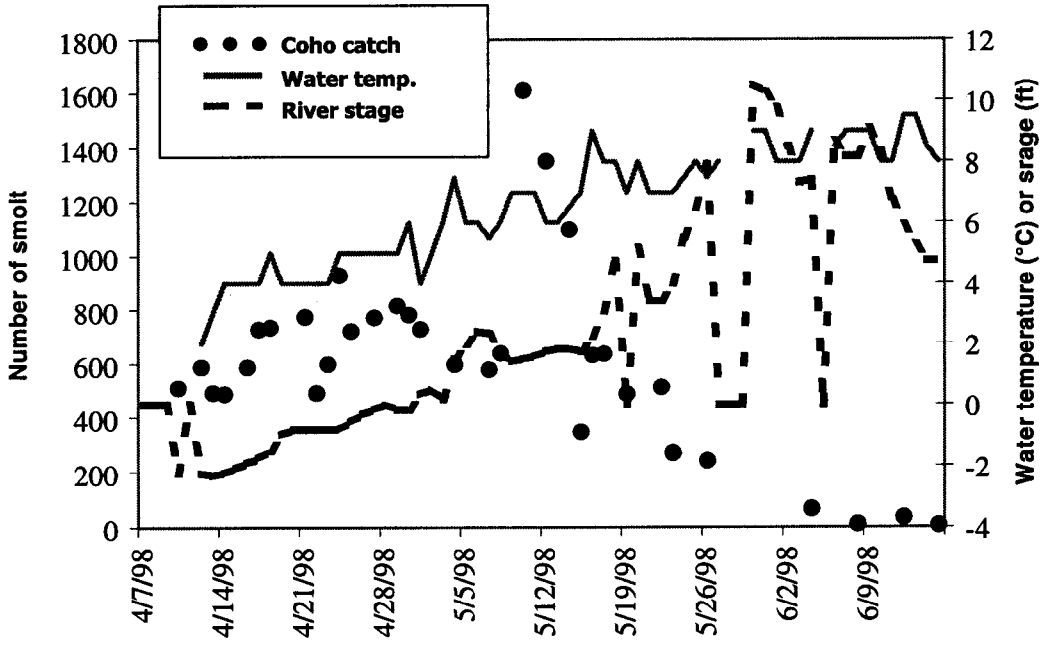

Figure 3.–Daily catch of coho salmon smolt ≥70 mm FL and daily water temperature and depth near Canyon Island, Taku River, during 1998.

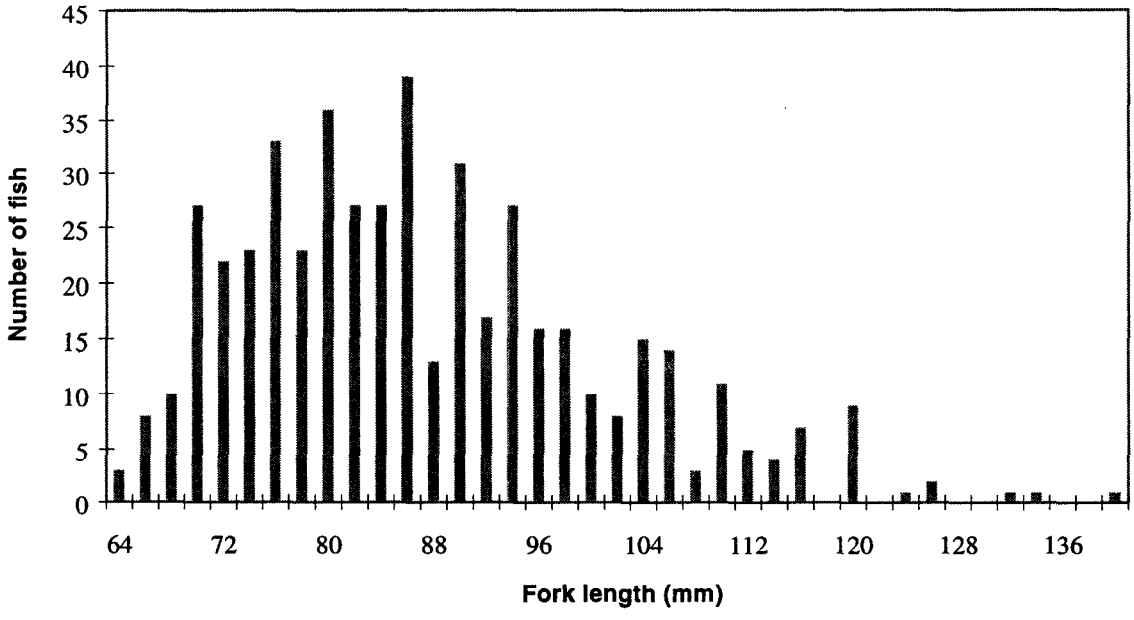

Figure 4.–Length frequency of coho salmon smolt ≥70 mm FL captured and measured at Canyon Island, Taku River, during 1998.

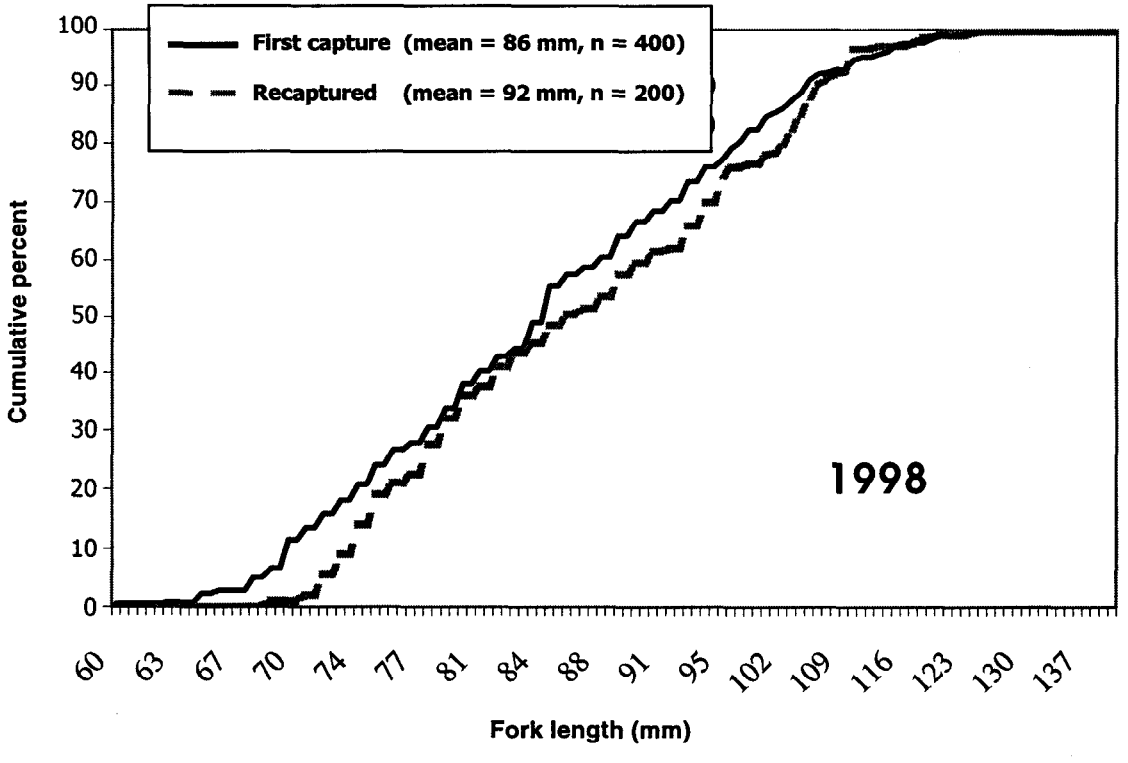

Figure 5.–*Length frequency distributions of coho salmon smolt at the time of first* capture and again during recapture at Canyon Island on the Taku River during 1998. The distributions are not significantly different (P = 0.051, K-S test, $D_{max} = 0.1150$).

CODED WIRE TAG RECOVERY

In 1999, 252 CWTs with codes from Canyon Island were recovered from coho salmon in the various fisheries during random sampling of catches (Appendix A3). The greatest number of tags (152) were recovered from the commercial troll fishery, nearly all from the Northwest Quadrant on the outside coast (Figure 1). In the marine gillnet fisheries, 69 tags were recovered, most of them from District 111 (Taku Inlet/Stephens Passage), and the others from District 115. Twenty (20) tags were recovered in the marine recreational fishery around Juneau in July and August. Seven (7) CWTs were recovered in the seine fishery in Chatham Strait and Frederick Sound.

Coho salmon bearing Canyon Island tags were recovered at slightly higher frequencies late in the season over the course of the District 111 gillnet fishery (Table 3). In the Northwest Quadrant of the troll fishery, recoveries appeared to be uniform throughout the season.

ESTIMATES OF θ AND SMOLT ABUNDANCE

Thirty (30) of the 1,848 coho salmon inspected in the escapement were missing the adipose fin and all were sacrificed to search for CWTs; 27 contained Canyon Island tags implanted in 1998 and three contained Canyon Island tags implanted in 1997 (Appendix A4). Thus, θ for the 1998 smolt tagging and the 1999 harvest calculation is 0.0162 (SE = 0.0029). The estimate of coho salmon smolt abundance above Canyon Island ($\hat{N}_s$) for 1998 is 1,184,195 (n_c = 19,854, n_e = 1,848, m_a = 30) with its SE = 207,576.

ESTIMATES OF HARVEST, ESCAPEMENT AND EXPLOITATION IN 1999

An estimated 50,789 (SE = 6,097) coho salmon originating above Canyon Island were harvested in marine commercial and recreational fisheries in 1999 (Table 4). The troll fishery in the Northwest Quadrant took 30% of the estimated marine harvest, and the drift gillnet fisheries in Taku Inlet/Stephens Passage and Lynn Canal took 6.4% (Table 5). Harvests in these fisheries occurred from July through early October. The troll harvest was spread over a long period (July to late September), and the peak of the gillnet harvests occurred in September and continued into October (Figure 6). Estimated mean date of harvest in the troll fishery was 18 August, compared to 13 September for the gillnet fishery (Appendix A5). Coho salmon originating above Canyon Island contributed an estimated 32% (5,572 fish) to the District 111 gillnet catch (17,218 fish). Fifty percent (50%) of the estimated 1999 harvest occurred by 28 August, about one week later than is typical (McPherson and Bernard 1995, 1996; McPherson et al. 1997, 1998; Yanusz et al. 1999). Estimated harvest in the Juneau marine recreational fishery was 3,393 fish or 2.9% of all estimated harvest and 13% of the estimated 26,604 coho salmon caught in the Juneau marine fishery, according to harvest and sampling data from Hubartt et al. (1999).

Between 3 July and 3 October, 1,848 coho salmon were captured at Canyon Island, consisting of 1,163 fish in the fish wheels and 685 in the gillnets; 1,739 coho salmon were marked with spaghetti tags and released at Canyon Island (Table 6; Appendix A6). Three (3) coho salmon were removed from the experiment because they were recovered in other fisheries before they could enter the Canadian commercial and/or test fishery upstream, leaving 1,736 tagged fish at large. During the same period, 5,575 coho salmon were examined in the upstream fisheries, and 140 spaghetti tags were recovered (Table 7). As the run dwindled, marking effort ended on 3 October and recovery effort ended on 6 October.

Significant variation in the marked fraction during recovery (θ_e; P=0.016, χ^2 test, 2 df; Table 6) and changing river stage and fishing methods were criteria used for stratifying the abundance estimate into early, middle, and late periods. During the early period θ_e was stable once the number tagged per week increased (Figure 7). During the middle period the river stage fell and θ_e also decreased. During the late period θ_e and the river stage fluctuated greatly, a gill net was used at Canyon Island to supplement the fish wheel catches for marking fish, and the commercial fishery was replaced by a test fishery for recovering tags.

Table 3.–Frequency of CWTs recovered during sampling of coho salmon harvests from the drift gillnet fishery in District 111 and the troll fishery in the Northwest Quadrant in 1999. Recoveries are from smolt marked at Canyon Island in 1998 with tag codes 04-46-42 or 04-46-43, and in 1997 with codes 04-46-40 or 04-46-41.

PANEL A:
DISTRICT 111 GILLNET FISHERY

Stat. week	Dates	Tag code: 04-46-40 and 04-46-41	Tag code: 04-46-42	Tag code: 04-46-43	Sampled harvest	Percent marked	Total harvest	Percent sampled
26	20–26 Jun				1	0.00	4	25
27	27 Jun–3 Jul						7	0
28	4–10 Jul				12	0.00	134	9
29	11–17 Jul		1		72	1.39	281	26
30	18–24 Jul				318	0.00	1,204	26
31	25-31 Jul				765	0.00	1,071	71
32	1–7 Aug		1		682	0.15	2,386	29
33	8–14 Aug		1		866	0.12	1,415	61
34	15–21 Aug			2	253	0.79	707	36
35	22–28 Aug		1		404	0.25	633	64
36	29 Aug–4 Sep		5	4	1,278	0.70	1,700	75
37	5–11 Sep	2	2	5	1,369	0.66	2,508	55
38	12–18 Sep		3	3	914	0.66	1,175	78
39	19–25 Sep			1	301	0.33	1,256	24
40	26 Sep-2 Oct	3	12	10	1,779	1.41	1,721	103
41	3-9 Oct		2		301	0.66	406	74
42	10-16 Oct						25	0
TOTAL		5	28	25	9,315	0.006	16,633	56
26–35	20 Jun–28 Aug	0	4	2	3,373	0.002	7,482	43
36–37	29 Aug–11 Sep	2	7	9	2,647	0.007	4,208	63
38–39	12 Sep-16 Oct	3	17	14	3,295	0.010	4,583	72
TOTAL		5	28	25	9,315	0.006	16,633	56

PANEL B:
NORTHWEST QUADRANT TROLL FISHERY

Stat. week	Dates	Tag code: 04-46-40 and 04-46-41	Tag code: 04-46-42	Tag code: 04-46-43	Sampled harvest	Percent marked	Total harvest	Percent sampled
27–33	27 Jun–14 Aug	5	29	32	239,684	0.028	762,167	26
34–40	15 Aug–2 Oct	5	42	34	144,191	0.056	314,676	26
TOTAL		10	71	66	383,875	0.038	1,076,843	26

Table 4.–Estimated marine harvest of adult coho salmon bound for the Taku River in 1999, where $\hat{\theta} = 0.0162$ and $G[\hat{\theta}^{-1}] = 0.039$. 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. weeks	Dates	Per.	Quad.	H	v[H]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
27–33	6/27-8/14	3	NW	934,237	0	239,684	4,776	4,695	3,953	3,947	66	16,145	3,744	45.5%
27–33	6/27-8/14	3	NE	205,680	0	72,468	925	910	723	723	1	178	177	195.5%
34–41	8/15-10/9	4	NW	546,484		144,191	3,606	3,566	3,100	3,095	82	19,390	4,377	44.2%
34–41	8/15-10/9	4	NE	100,452	0	36,415	563	554	462	462	3	518	310	117.2%
Subtotal troll fishery				1,786,853	0	492,758	9,870	9,725	8,238	8,227	152	36,231	1,206	6.5%

SEINE FISHERY

Stat. week	Dates	District	H	v[H]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
31	7/28-7/31	112	13,501	0	1,570	18	17	14	14	1	561	560	196%
32	8/1-8/7	112	13,772	0	1,336	20	20	17	17	2	1,270	915	141%
33	8/8-8/14	109	15,419	0	2,532	27	27	24	24	1	375	375	196%
34	8/15-8/21	112	8,370	0	3,035	69	69	64	64	1	170	169	195%
35	8/22-8/28	109	21,518	0	4,279	56	56	51	51	1	310	309	196%
35	8/22-8/28	112	13,648	0	4,308	74	74	61	61	1	195	195	196%
Subtotal seine fishery			86,228	0	17,060	264	263	231	231	7	2,881	1,206	82%

SPORT FISHERY

Biweek	Dates	Derby	Area	H	v[H]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
11	5/24-6/6	No	Sitka	10	83	2	1	1	1	1	1	308	308	196%
15	7/19-8/1	No	Juneau	4,579	510,384	1,512	18	18	15	15	2	373	271	143%
16	8/2-8/15	No	Juneau	6,789	3,255,448	1,608	35	34	30	30	2	535	398	146%
16	8/2-8/15	No	Sitka	17,932	10,350,428	5,582	154	146	131	131	1	209	208	196%
17	8/16-8/29	Yes	Juneau	2,851	0	2,038	112	111	98	98	11	956	339	69%
17	8/16-8/29	No	Juneau	1,593	302,186	830	29	26	22	22	2	264	200	148%
17	8/16-8/29	No	Sitka	19,224	13,962,805	4,650	153	151	137	136	1	260	259	196%
17	8/16-8/29	No	Yakutat	0[a]	0	0	0	0	0	0	1	0	0	
18	8/30-9/12	No	Juneau	4,934	2,486,433	1,103	33	27	26	26	2	674	507	148%
19	9/13-9/26	No	Juneau	941	64,186	98	5	5	5	5	1	591	591	196%
Subtotal sport fishery				58,853	30,931,953	17,423	540	519	465	464	24	4,170	1,095	51%

GILLNET FISHERY

Stat. week	Dates	District	H	v[H]	n	a	a'	t	t'	m_c	$\hat{r}$	SE[$\hat{r}$]	RP[$\hat{r}$]
29	7/11-7/17	111	281	0	72	1	1	1	1	1	240	240	196%
32	8/1-8/7	111	2,386	0	682	2	2	2	2	1	216	215	196%
33	8/8-8/14	111	1,415	0	866	10	10	8	8	1	101	100	195%
34	8/15-8/21	111	707	0	253	3	3	3	3	2	344	248	141%
35	8/22-8/28	111	633	0	404	4	4	4	4	1	97	96	195%
36	8/29-9/4	111	1,700	0	1,278	17	17	16	16	9	737	281	75%
36	8/29-9/4	115	2,733	0	1,027	54	54	52	52	1	164	163	195%
37	9/5-9/11	111	2,508	0	1,369	35	32	29	29	9	1,111	423	75%
38	9/12-9/18	111	1,175	0	914	12	12	11	11	6	475	211	87%
38	9/12-9/18	115	5,587	0	2,942	133	129	122	122	3	362	216	117%
39	9/19-9/25	111	1,256	0	301	8	7	3	3	1	294	293	196%
39	9/19-9/25	115	5,364	0	1,752	108	107	105	105	4	761	402	103%
40	9/26-10/2	111	1,721	0	1,779	62	52	48	48	25	1,776	493	54%
40	9/26-10/2	115	10,173	0	2,971	215	210	197	197	3	648	388	117%
41	10/3-10/9	111	406	0	301	12	11	11	11	2	181	130	141%
Subtotal gillnet fishery			38,045	0	16,911	676	651	612	612	69	7,507	1,104	29%
TOTAL			1,969,979	30,931,953	544,152	11,350	11,158	9,546	9,534	252	50,789	6,097	24%

[a] Harvest not estimated in Yakutat, only catch composition.

Table 5.–Estimated harvest, exploitation, and total run of Taku River coho salmon from above Canyon Island in 1999.

Fishery	Area	Estimated harvest	SE	Percent of marine harvest	Percent of total run	Removal rate[a]
U.S. troll fishery	NW Quad	35,535	5,724	70.0	30.3	
	NE Quad	696	357	1.4	0.6	
	Subtotal	35,994	5,735	71.3	30.9	30.9%
Seine fishery	Dist. 109	685	486	1.3	0.6	
	Dist. 112	2,196	1,103	4.3	1.9	
	Subtotal	2,881	437	5.7	2.5	3.6%
Recreational	Juneau	3,393	997	6.7	2.9	
	Sitka	777	453	1.5	0.7	
	Subtotal	4,170	1,095	8.2	3.6	5.3%
Drift gillnet	Dist. 111	5,572	913	11.0	4.8	
	Dist. 115	1,935	620	3.8	1.7	
	Subtotal	7,507	1,104	14.8	6.4	10.2%
Total marine harvest		50,789	6,097	100.0	43.4	43.4%
Escapement		60,768	7,049		51.9	
Canadian catch		5,575			4.8	8.4%
Inriver run		66,343	7,049			
TOTAL RUN		117,132	9,320			

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

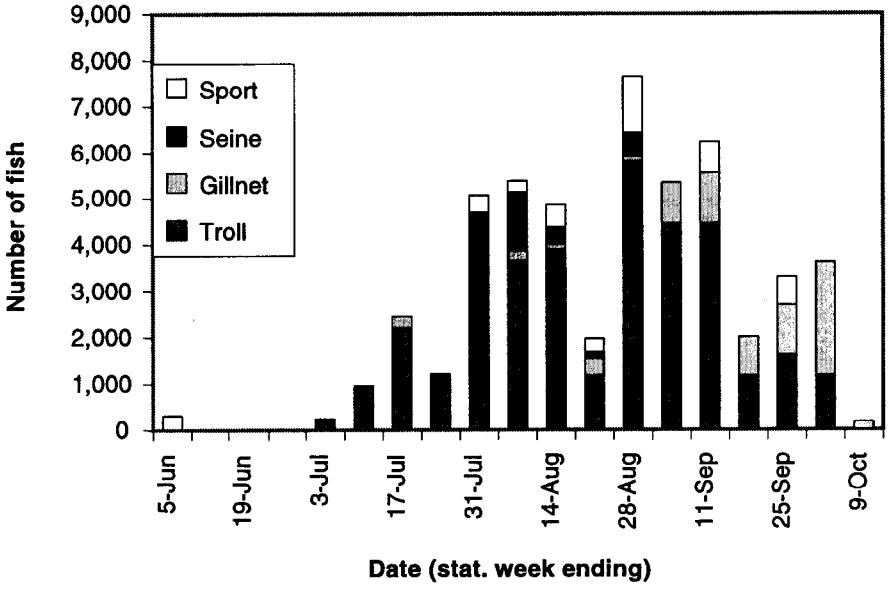

Figure 6.–Estimated harvests of coho salmon bound for Taku River in 1999, assigned to marine commercial and recreational fishery by statistical week (weekly estimates of harvest in the troll fishery approximated).

Table 6.–Number of adult coho salmon tagged and recovered and recovery effort to estimate abundance at Canyon Island during 1999. Number tagged does not include 3 tagged coho salmon caught in other fisheries prior to reaching the recovery area.

Statistical week	Dates	Number tagged	Fishery openings		Number examined	Tags recovered	
			Days	Permits			
			EARLY				
27	6/27-7/3	1	3	9	1[a]	0	
28	7/4-7/10	2	3	11	8	1	
29	7/11-7/17	12	2	11.5	9	0	
30	7/18-7/24	28	3	11.33	51	1	
31	7/25-7/31	65[b]	3	11	203	6	
32	8/1-8/7	79	3	10	200	7	
33	8/18-8/14	74	3	10	381	13	
34	8/15-8/21		3	10	498	20	
	Subtotal	261			1,350	48	θ_e= 0.0356
			MIDDLE				
34	8/15-8/21	57					
35	8/22-8/28	105	3	7	865	16	
36	8/29-9/4	158	4	5	2,062	39	
37	9/5-9/11		5	2[d]	454	9	
	Subtotal	320			3,381	64	θ_e = 0.0189
			LATE				
37	9/5-9/11	295					
38	9/12-9/18	355[c]	4.8	1[d]	382	13	
39	9/19-9/25	231	2	1[d]	68	6	
40	9/26-10/2	242	2.75	1[d]	284	4	
41	10/3-10/9	32	2	1[d]	109	5	
	Subtotal	1,155	1	1	843	28	θ_e = 0.0333
	TOTAL	1,736			5,574	140	

[a] Ignored this value; too small a sample size.

[b] Two releases were subsequently caught in other fisheries and not included.

[c] One release was subsequently caught in other fisheries and not included.

[d] Test fishery.

Table 7.–Relationship between the release week and recovery week of tagged fish in the mark-recapture experiment to estimate the coho salmon escapement at Canyon Island in 1999.

Release week	Dates	Recovery week														All
		28	29	30	31	32	33	34	35	36	37	38	39	40	41	
		Number of tags recovered														
27	6/27-7/3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
28	7/4-7/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	7/11-7/17		0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	7/18-7/24			1	4	0	0	0	0	0	0	0	0	0	0	5
31	7/25-7/31				2	6	0	0	0	0	0	0	0	0	0	8
32	8/1-8/7					1	12	0	0	0	0	0	0	0	0	13
33	8/18-8/14						1	14	0	1	0	0	0	0	0	16
34	8/15-8/21							6	5	0	0	0	0	0	0	11
35	8/22-8/28								11	8	0	0	0	0	0	19
36	8/29-9/4									30	2	0	0	0	0	32
37	9/5-9/11										7	8	0	0	0	15
38	9/12-9/18											5	3	1	2	11
39	9/19-9/25												3	0	1	4
40	9/26-10/2													3	1	4
41	10/3-10/9														1	1
All		1	0	1	6	7	13	20	16	39	9	13	6	4	5	140

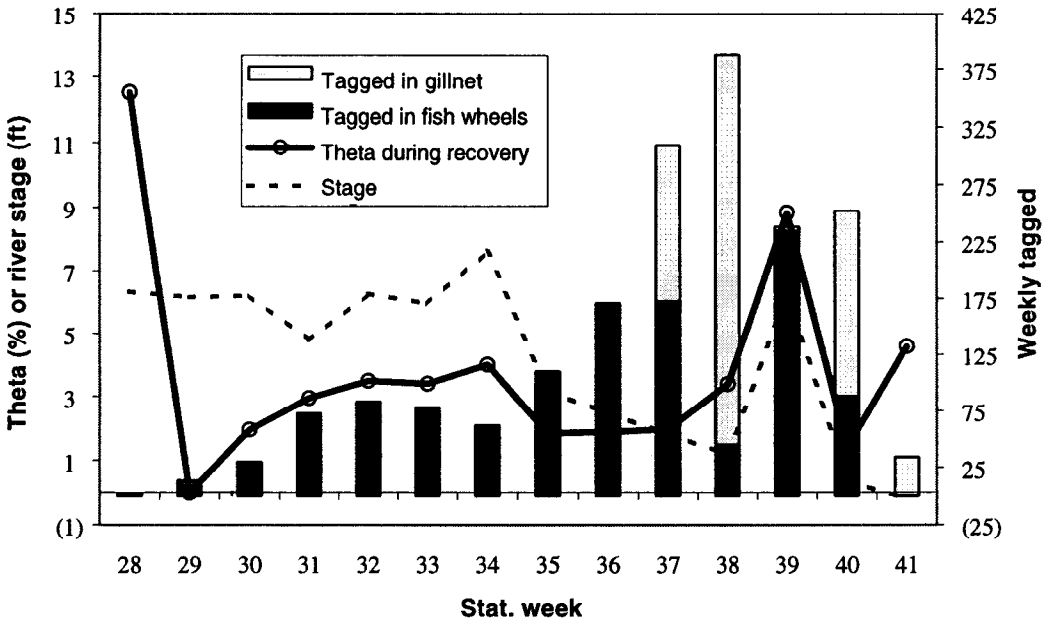

Figure 7.–Marked fraction (θ), river stage, and number of adult coho salmon tagged during the mark-recapture experiment at Canyon Island during 1999.

Size-selective sampling was not apparent in the pooled data (P = 0.16; Figure 8). Thus, the abundance estimate for coho salmon passing Canyon Island through 3 October is 59,052 (SE = 6,650). We expanded the direct estimate by dividing it by 0.8901 (the estimated fraction of the migration that passed Canyon Island through 3 October (see Appendix A2 for the derivation) to arrive at an estimate of 66,343 (SE = 7,049) for the entire migration past Canyon Island.

On the basis of an estimated run in 1999 of 117,132 (SE = 9,320) coho salmon bound for above Canyon Island, we estimated the marine survival rate at 9.9% (SE = 1.9%) and the exploitation rate in marine commercial and recreational fisheries at 43.4% (SE = 3.9%; Appendix A7). Inriver harvest above Canyon Island was 5,575 coho salmon in 1999, from which we estimate an escapement of 60,768 (SE = 7,049) coho salmon above Canyon Island for the year.

Age composition of adult coho salmon sampled from catches in Canyon Island fish wheels was 79% (SE = 1.6%) age 1.1 and 21% (SE = 1.6%) age 2.1 (Mark Olson, Alaska Department of Fish and Game, Douglas, personal communication; Appendix A9), and the mean MEF length of adults at Canyon Island was 574 mm (SE = 3.3).

DISCUSSION

Coho salmon smolt captured and tagged in 1998 were similar in size to those captured in 1996 and 1997 and were smaller than those captured from 1991–1995 on the Taku River. In 1998, smolt captured at Canyon Island averaged 87 mm FL, compared to 86 mm in 1997 (Yanusz et al. 1999), 89 mm in 1996 (McPherson et al. 1999), 94 mm FL in 1995 (McPherson et al. 1998), 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). Only G-40 minnow traps were used to capture smolt in 1997 and 1998, whereas rotary traps were used partly or wholly in previous years. The relative size selectivity of these gear types is unknown. The same tagging strategy (fish ≥70 mm FL) was used each year.

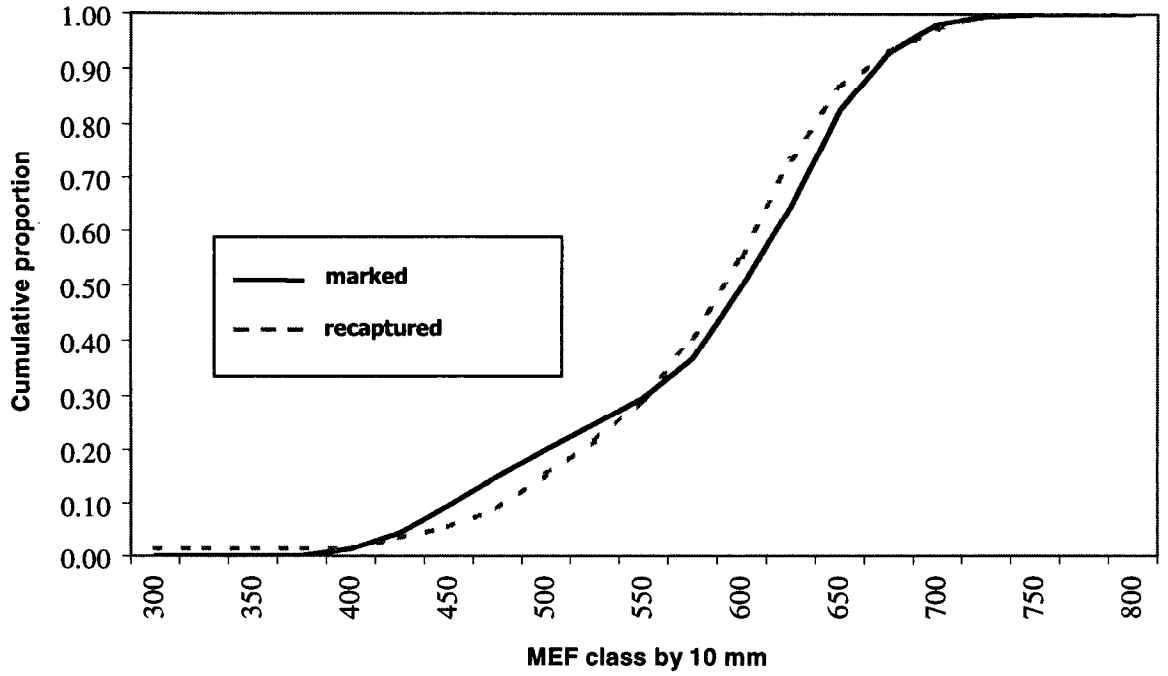

Figure 8.–Length distributions of marked and recaptured adult coho salmon in the mark-recapture experiment at Canyon Island during 1999. Length distributions were not different ($P_{2\text{-tail}} = 0.16$; $D_{max} = 0.0737$; $n_{(marked)} = 1{,}746$; $n_{(recaptured)} = 143$, K-S test).

Comparing the sizes of smolt captured the first time to those recaptured in 1998 gave encouraging, but marginal, results. Some bias toward recaptured smolt being larger is to be expected, since by design those fish have been at large, feeding and growing, for some unknown time between their initial and recapture measurements. Further evidence that growth caused the size discrepancy is that the length distribution curves are generally parallel (Figure 5). Smolt emigration timing in 1998 was similar to that 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.

Our estimated marine survival rate (9.9%) is similar to or lower than estimates for other wild and hatchery stocks in Southeast Alaska for 1998; estimated marine survivals were 14% for Auke Lake and 13% for Berners River (L. Shaul, Alaska Department of Fish and Game, Douglas, personal communication). The 1998 rate is low compared to historical survival rates for Taku River smolt (Appendix A7).

Circumstances and results indicate that conditions for obtaining an accurate estimate of smolt abundance with the mark-recapture experiment were met. Bailey's modification of the Petersen estimate was used because of the systematic nature of sampling 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. 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, and it is unlikely that much of the migration

occurred prior to 7 April. Also, the drawn-out recovery of CWTs indicated considerable mixing of marked and unmarked coho salmon during their 14 to 16 months at sea (Table 3, Appendix A4). 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 is also crucial for an accurate estimate of adult coho salmon harvests. In catches at the Canyon Island fish wheels, the fraction of adult coho salmon with marks (a missing adipose fin) did not vary over time; this indicates that one or both of these conditions was satisfied (P = 0.99, χ^2 = 0.358, df = 2). As shown in Appendix A4, 1.52% (9/593) of coho salmon caught during 3 July-3 September lacked an adipose fin, 1.45% (8/552) during 4-15 September, and 1.85% (13/703) during 16 September-3 October.

Necessary assumptions were largely met, also, for the mark-recapture experiment on adult coho salmon abundance. Marking effects on the catchability of fish were extremely unlikely, because active capture methods were used in mark and recapture events, and gear types were usually different. Mortality of marked fish was minimized by tagging only healthy fish and recapturing them soon (1–3 weeks). No fish with tag scars only were noted when examining for tags, so tag loss was inconsequential. Mortality and downstream movement were very infrequent (<3%) for coho salmon marked with spaghetti tags and radio transmitters at Canyon Island in a 1992 study (John Eiler, National Marine Fisheries Service, Auke Bay, personal communication), demonstrating that those particular handling effects on coho salmon were unlikely. Recruitment of coho salmon to the population above Canyon Island was impossible, because the river is constricted to a single channel at Canyon Island where all coho salmon must pass to reach the recapture site.

The experimental design precluded equal temporal mixing of marked and unmarked fish, as they passed through the mark and recapture sites on their upstream migration and were out of the experiment in a few weeks. We assumed the distance between mark and recapture sites to be sufficient for spatial mixing of marked and unmarked fish, but this assumption cannot be directly tested, because upstream fisheries occur over a small stretch of the river.

We attempted to establish equal probability of marking each fish by operating both fish wheels continuously for most of the season, but a freshet during late September and low water during early September and early October interrupted fish wheel operation (Appendix A6). The marking gear was a mixture of fish wheels and gillnet starting on 9 September. It appears the gill net was much more effective at capturing adult coho salmon, as variations in θ are related to the number of fish tagged by gillnet the previous week (Figure 7). Equal probability of recapture was attempted by weekly openings of the Canadian commercial fishery throughout the run, but this fishery ceased by 4 September and a test fishery was operated by TRTFN thereafter (Table 6). We feel that the Darroch model with three strata adequately addressed the varying conditions.

Our estimates of escapement (60,768), catch (50,789 + 5,575) and total run (117,132) are minimum estimates of those parameters for the entire 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 1999 at 79,480 ([60,768 + 5,575]/0.78 – 5,575), marine harvest at 65,114 (50,789/0.78), and total run at 150,169. Exploitation rate (43.4%) and marine survival (9.9%) remain the same as estimates for fish from above Canyon Island. Estimated harvest for all Taku River coho salmon in the Juneau-area marine boat sport fishery is 4,350 (3,393/0.78), or 16% of the recreational harvest of 26,604 coho salmon, the lowest ever documented (McPherson and Bernard 1995, 1996; McPherson et al. 1998, Yanusz et al. 1999).

CONCLUSIONS AND RECOMMENDATIONS

Results from this project are contributing to development of a long-term database. We estimated smolt production in 1998 and adult production in 1999, the eighth consecutive year these parameters have been estimated for this population (Appendix A7). Escapements have been estimated since 1987 by CF and DFO (Appendices A7 and A8). This program has already provided valuable management tools, such as inseason assessment of run strength (see McPherson et al. 1999), and in the future will allow evaluation of smolt and 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 recreational fishery, and smolt abundance can be improved by tagging more smolt with CWTs. This was accomplished in 1998 by starting slightly earlier to cover a greater proportion of smolt emigration and by deploying more trapping gear and improving the trapping methodology. The precision of θ improved also during recovery of adults from inriver fish wheels. Secondly, the escapement estimate can be improved by operating the mark-recapture experiment through the duration of the immigration of adults, though this has been difficult in the past due to lack of inriver commercial fishing effort late in the season and uncertain funding to operate a test fishery. Gillnetting worked well as a means to capture fish when river levels late in the season became too low for fish wheels. We also need to continue evaluating if the minnow traps select for a particular size of smolt.

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LITERATURE CITED

Arnason, A.N., C.W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996. Computer analysis of data from stratified mark-recovery experiments for estimation of salmon escapements and other populations. Canadian Technical Report of Fisheries and Aquatic Sciences 2106.

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 Sciences 53: 2323-2332.

Darroch, J.N., 1961. Two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-60.

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 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. 1998. 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. 1999. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-15, Anchorage.

Kelley, M. S., A. J. McGregor, and P. A. Milligan. 1998. 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.

Kelley, M. S., and P. A. Milligan. 1998 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., and P. A. Milligan. 1999. Mark-recapture studies of Taku River adult salmon stocks in 1998. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 1J99-21, 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.

Koo, T. S. Y. 1962. Age designation in salmon. Pages 37–48 in Studies of Alaska red salmon. University of Washington Publications in Fisheries, Volume I, Seattle, WA.

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., D. R. Bernard, and M. S. Kelley. 1998. Production of coho salmon from the Taku River, 1995-1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-24, 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.

McPherson, S. A., R. J. Yanusz, D. R. Bernard, and M. S. Kelley. 1999. Production of coho salmon from the Taku River, 1996-1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-18, 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.

Moser, K. H. 1968. Photographic atlas of sockeye salmon scales. Fishery Bulletin 67(2):243–279.

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.

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. Transboundary 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.

Yanusz, R. J., S. A. McPherson, and D. R. Bernard. 1999. Production of coho salmon from the Taku River, 1997-1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-34, Anchorage.

APPENDIX A

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

Citation	Location	Objective(s)
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
Kelley et al. 1997	Taku River	1995 escapement
Kelley and Milligan 1997	Taku River	1996 escapement
Kelley and Milligan 1998	Taku River	1997 escapement
McGregor and Clark 1988	Taku River	Estimated escapement
McGregor and Clark 1989	Taku River	Estimated escapement
McGregor et al. 1991	Taku River	Estimated escapement
McPherson et al. 1994	Taku River	1992 smolt abundance and survival 1993 harvest and escapement
McPherson and Bernard 1995	Taku River	1993 smolt abundance and survival 1994 harvest and escapement
McPherson and Bernard 1996	Taku River	1994 smolt abundance and survival 1995 harvest and escapement
McPherson et al. 1997	Taku River	1995 smolt abundance and survival 1996 harvest and escapement
McPherson et al. 1998	Taku River	1996 smolt abundance and survival 1997 harvest and 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

-continued-

Appendix A1.–Page 2 of 2.

Citation	Location	Objective(s)
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
	Tatsamenie L.	1989 harvest
	Yehring Creek	1989 harvest
	U.S. tribs.	1989 escapement
Shaul 1992	Nahlin River	1990 harvest
	Mainstem	1990 harvest
	Tatsamenie L.	1990 harvest
	Yehring Creek	1990 harvest
	U.S. tribs.	1990 escapement
Yanusz et al. 1999	Taku River	1997 smolt abundance and survival
		1998 harvest and escapement

Appendix A2.–Derivation of the expansion factor for run timing of the Taku River coho salmon return.

The estimated escapement of the 59,052 coho salmon past Canyon Island through 3 October 1999 was obtained directly from the mark-recapture experiment (see Methods), but fish continued to migrate upstream after 3 October. The direct escapement estimate was expanded by the estimated fraction of the escapement that had passed Canyon Island through 3 October by:

$$\hat{N}_e = \frac{\hat{N}_D}{\pi} \tag{11a}$$

$$v[\hat{N}_e] = \frac{v[\hat{N}_D]}{\pi^2} \tag{11b}$$

where $\hat{N}_e$ is the estimated escapement above Canyon Island for all of 1999 and $\hat{N}_D$ is the estimated escapement above Canyon Island through 3 October 1999. The statistic π is the fraction of the migration estimated to have passed Canyon Island through 3 October 1999. This fraction is based on the timing of fish at Canyon Island through 3 October in relation to the timing of those fish through the commercial troll fishery. The troll fishery was used because, compared to other fisheries, it occurs over the longest period and across the broadest geographic area, and experiences relatively few management actions to affect its performance. In 1999, 3 October occurred at the beginning of statistical week 41. We estimate, as seen from "fishery shadows" in past Canyon Island fish wheel catches, that coho salmon take three to four days to migrate to Canyon Island from the commercial gillnet fishery in Taku Inlet. This puts the timing for fish at Canyon Island on 3 October in the gillnet fishery at SW 40.5 (30 September). It appears that the migration timing from the commercial troll fishery to the Taku Inlet gillnet fishery was approximately 3.5 weeks (Table A1, Figure A1). Consequently, we estimate the difference in timing between the commercial troll fishery and Canyon Island fish wheel catches to be four weeks in 1999, meaning that fish passing Canyon Island during SW 41 were passing through the troll fishery during SW 37. The cumulative proportion of the harvest in the troll fishery through SW 37 was about 89%, which is the statistic π, making $\hat{N}_e$ = 66,343. Estimated variance ($v[\hat{N}_e]$ = 55,816,630) is a minimum, because the measurement error in π is unknown.

Table A1.–Estimated mean dates of harvest in the commercial troll fishery and the Taku Inlet gillnet fishery, 1993–1999, using harvest estimates generated from recoveries of CWTs. Data from Yanusz et al. (1999), McPherson et al. (1994, 1997, 1998), and McPherson and Bernard (1995 and 1996).

Year	Troll	Gillnet	Difference (days)
1993	18 Aug	11 Sep	24
1994	3 Aug	31 Aug	28
1995	15 Aug	31 Aug	16
1996	10 Aug	24 Aug	14
1997	11 Aug	no estimate	
1998	15 Aug	1 Sep	17
1999	18 Aug	13 Sep	26
Average	12 Aug	3 Sep	21

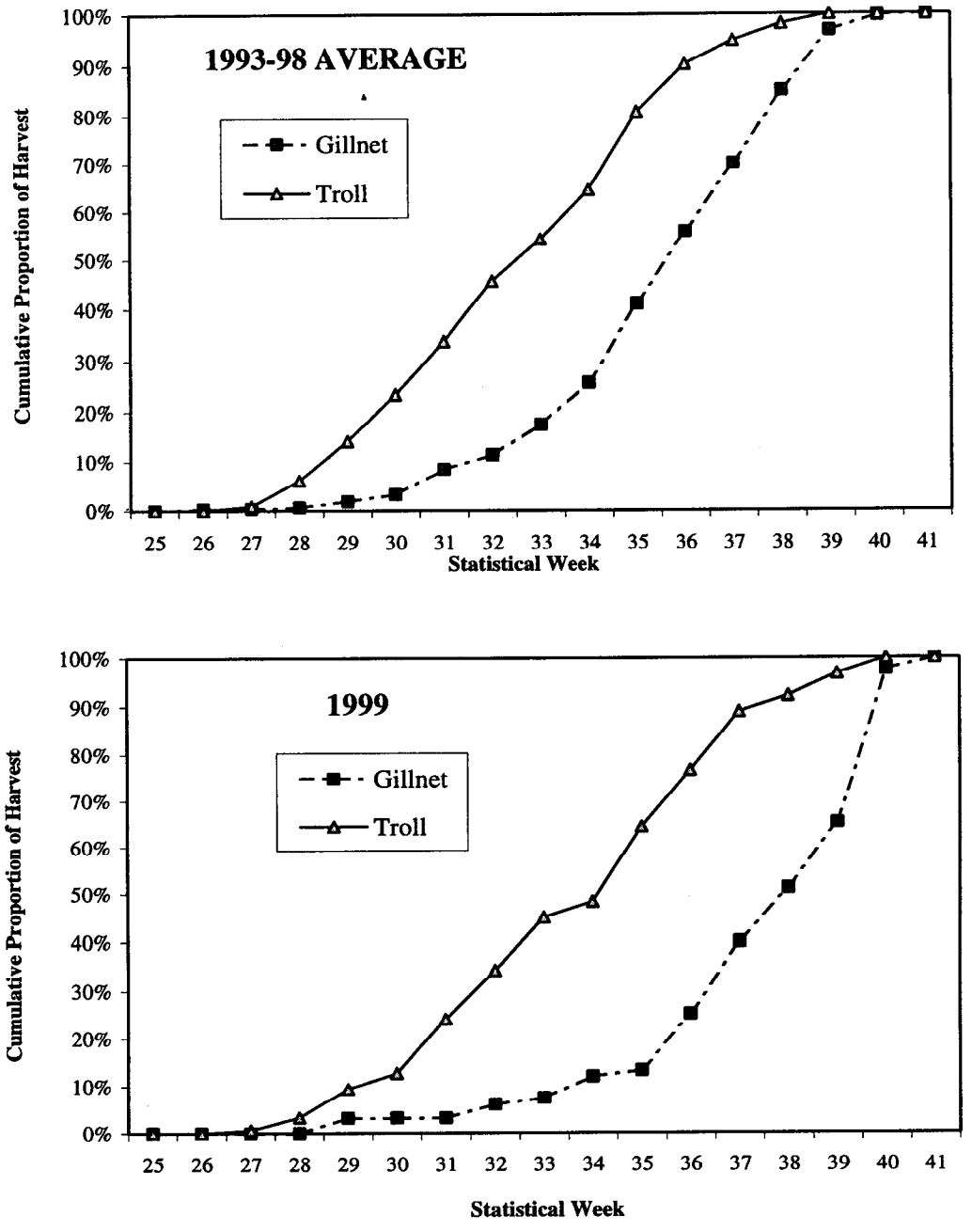

Figure A1.–Harvest timing for the commercial troll fishery versus the commercial gillnet fishery in Taku Inlet, on average for 1993–1998 (top graph) and during 1999 (bottom graph). Data from McPherson et al. (1994, 1997, 1998), McPherson and Bernard (1995 and 1996) Yanusz et al (1999).

Appendix A3.–Random and select recoveries of coded wire tagged coho salmon bound for Taku River above Canyon Island in 1999.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
RANDOM RECOVERIES								
50950	44643	TROLL	2-Jul-99	27	NW	113	91	660
50979	44642	TROLL	6-Jul-99	28	NW	113	91	610
26039	44642	TROLL	7-Jul-99	28	NW			610
142007	44642	TROLL	9-Jul-99	28	NW	114	21	620
46845	44642	TROLL	9-Jul-99	28	NW	114	27	540
26434	44642	TROLL	13-Jul-99	29	NW			650
50583	44643	TROLL	14-Jul-99	29	NW	113	91	495
50593	44643	TROLL	15-Jul-99	29	NW	114		525
50748	44641	TROLL	16-Jul-99	29	NW	116	13	610
50711	44642	TROLL	16-Jul-99	29	NW	116	11	560
50596	44643	TROLL	16-Jul-99	29	NW	116	11	635
50712	44643	TROLL	16-Jul-99	29	NW	116	11	
50825	44643	TROLL	17-Jul-99	29	NW	116	13	525
50793	44643	TROLL	17-Jul-99	29	NW	116	13	650
26435	44643	TROLL	18-Jul-99	30	NW			540
142050	44642	TROLL	19-Jul-99	30	NW	114	21	690
50841	44643	TROLL	19-Jul-99	30	NW	116	13	580
88243	44642	TROLL	20-Jul-99	30	NW	116	12	625
28569	44642	TROLL	22-Jul-99	30	NW			550
97643	44642	TROLL	27-Jul-99	31	NW			0
97635	44642	TROLL	27-Jul-99	31	NW			604
97639	44642	TROLL	27-Jul-99	31	NW			623
97640	44642	TROLL	27-Jul-99	31	NW			720
88328	44643	TROLL	27-Jul-99	31	NW			510
97625	44643	TROLL	27-Jul-99	31	NW			648
97621	44643	TROLL	27-Jul-99	31	NW			667
97642	44643	TROLL	27-Jul-99	31	NW			
28493	44643	TROLL	28-Jul-99	31	NW			651
138198	44642	TROLL	29-Jul-99	31	NW	113	91	648
90073	44642	TROLL	29-Jul-99	31	NW	181	40	599
53626	44643	TROLL	29-Jul-99	31	NW	114	23	695
90057	44643	TROLL	29-Jul-99	31	NW	183	10	587
16402	44642	TROLL	30-Jul-99	31	NE	109	61	664
142122	44643	TROLL	30-Jul-99	31	NW	114	40	625
54126	44642	TROLL	31-Jul-99	31	NW	116	14	600
54131	44643	TROLL	31-Jul-99	31	NW	116	14	620
54840	44643	TROLL	1-Aug-99	32	NW	113		595
54149	44643	TROLL	1-Aug-99	32	NW	113		605
54133	44642	TROLL	2-Aug-99	32	NW	114	27	615
28804	44643	TROLL	2-Aug-99	32	NW			610
97686	44642	TROLL	3-Aug-99	32	NW	181	60	629
133285	44643	TROLL	3-Aug-99	32	NW			669
54847	44642	TROLL	4-Aug-99	32	NW	114	23	645
54829	44643	TROLL	4-Aug-99	32	NW	114	23	635

-continued-

Appendix A3.–Page 2 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
55078	44641	TROLL	6-Aug-99	32	NW	116	13	645
29191	44641	TROLL	6-Aug-99	32	NW			600
55084	44642	TROLL	6-Aug-99	32	NW	116	13	715
90285	44643	TROLL	6-Aug-99	32	NW	116	12	599
29166	44643	TROLL	6-Aug-99	32	NW			630
137745	44642	TROLL	7-Aug-99	32	NW			663
137744	44643	TROLL	7-Aug-99	32	NW			540
90290	44642	TROLL	9-Aug-99	33	NW	116	12	703
29368	44642	TROLL	9-Aug-99	33	NW			630
55098	44643	TROLL	9-Aug-99	33	NW	114	23	655
75219	44642	TROLL	10-Aug-99	33	NW			697
136403	44641	TROLL	12-Aug-99	33	NW			597
90322	44642	TROLL	12-Aug-99	33	NW	113	91	529
142238	44642	TROLL	12-Aug-99	33	NW	114	40	625
137416	44643	TROLL	12-Aug-99	33	NW	116	12	507
136569	44643	TROLL	12-Aug-99	33	NW			517
90369	44641	TROLL	13-Aug-99	33	NW	116		515
75250	44642	TROLL	13-Aug-99	33	NW	116	14	585
142401	44642	TROLL	13-Aug-99	33	NW	181	60	732
136553	44642	TROLL	13-Aug-99	33	NW			637
55625	44643	TROLL	13-Aug-99	33	NW	113	91	741
55183	44643	TROLL	13-Aug-99	33	NW	116	13	650
79890	44643	TROLL	13-Aug-99	33	NW			644
142601	44643	TROLL	19-Aug-99	34	NW	189	30	686
29531	44641	TROLL	20-Aug-99	34	NW			520
142298	44642	TROLL	20-Aug-99	34	NW	114	21	690
145043	44642	TROLL	20-Aug-99	34	NW	114	23	625
142621	44643	TROLL	21-Aug-99	34	NW	189	30	696
137847	44642	TROLL	22-Aug-99	35	NW			711
136879	44642	TROLL	22-Aug-99	35	NW			736
137829	44643	TROLL	22-Aug-99	35	NW			540
145105	44642	TROLL	23-Aug-99	35	NW	114	23	610
29447	44642	TROLL	23-Aug-99	35	NW			688
91096	44643	TROLL	23-Aug-99	35	NW	113	91	660
145099	44643	TROLL	23-Aug-99	35	NW	114	23	660
142320	44641	TROLL	24-Aug-99	35	NW	114	21	730
29668	44642	TROLL	24-Aug-99	35	NW			625
29670	44643	TROLL	24-Aug-99	35	NW			745
142335	44642	TROLL	25-Aug-99	35	NW	113	91	712
29671	44643	TROLL	25-Aug-99	35	NW			702
142351	44643	TROLL	26-Aug-99	35	NW	114	21	696
145192	44643	TROLL	26-Aug-99	35	NW	114	23	715
141848	44642	TROLL	27-Aug-99	35	NW	113	91	550
141505	44642	TROLL	27-Aug-99	35	NW	116	12	643

-continued-

Appendix A3.–Page 3 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
29646	44642	TROLL	27-Aug-99	35	NW			712
141931	44640	TROLL	28-Aug-99	35	NW			726
145307	44642	TROLL	28-Aug-99	35	NW	113		630
141963	44642	TROLL	28-Aug-99	35	NW			608
141919	44642	TROLL	28-Aug-99	35	NW			630
141928	44642	TROLL	28-Aug-99	35	NW			660
91346	44643	TROLL	28-Aug-99	35	NW	114	21	612
141996	44643	TROLL	28-Aug-99	35	NW			577
91443	44643	TROLL	28-Aug-99	35	NW			650
91603	44642	TROLL	30-Aug-99	36	NW	116	11	657
91594	44643	TROLL	30-Aug-99	36	NW	114	21	587
145358	44642	TROLL	31-Aug-99	36	NW	114	25	610
145369	44643	TROLL	31-Aug-99	36	NE	112	16	555
91627	44643	TROLL	31-Aug-99	36	NW	114	21	716
91640	44642	TROLL	1-Sep-99	36	NW	116	11	715
91655	44642	TROLL	1-Sep-99	36	NW			698
142382	44643	TROLL	1-Sep-99	36	NW	114	21	770
91644	44643	TROLL	1-Sep-99	36	NW	116	11	699
91645	44643	TROLL	1-Sep-99	36	NW	116	11	755
145396	44642	TROLL	2-Sep-99	36	NW	114	25	650
145436	44642	TROLL	2-Sep-99	36	NW	114	25	705
145418	44642	TROLL	2-Sep-99	36	NW	114	27	580
142503	44642	TROLL	2-Sep-99	36	NW	181	60	700
142504	44643	TROLL	2-Sep-99	36	NW	181	60	706
91680	44643	TROLL	2-Sep-99	36	NW			567
145454	44643	TROLL	2-Sep-99	36	NW			590
141775	44643	TROLL	3-Sep-99	36	NW	113	41	704
29884	44642	TROLL	4-Sep-99	36	NW			710
138657	44642	TROLL	6-Sep-99	37	NW			675
138673	44643	TROLL	6-Sep-99	37	NW			703
138644	44643	TROLL	6-Sep-99	37	NW			720
145470	44641	TROLL	7-Sep-99	37	NW	114	25	675
27177	44642	TROLL	7-Sep-99	37	NE	109	51	747
91549	44642	TROLL	7-Sep-99	37	NW			475
145498	44643	TROLL	7-Sep-99	37	NW	114	21	665
145500	44642	TROLL	8-Sep-99	37	NW	114		620
29716	44642	TROLL	8-Sep-99	37	NW	114		666
142511[a]	44644	TROLL	9-Sep-99	37	NW	181	60	652
91865	44642	TROLL	9-Sep-99	37	NW	116	11	700
29931	44642	TROLL	9-Sep-99	37	NW			670
145539	44643	TROLL	9-Sep-99	37	NW	114		805
29922	44643	TROLL	9-Sep-99	37	NW			695
138689	44643	TROLL	9-Sep-99	37	NW			700
133938	44642	TROLL	10-Sep-99	37	NE	109		536

-continued-

Appendix A3.–Page 4 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
138877	44643	TROLL	10-Sep-99	37	NW	116	11	726
145600	44642	TROLL	11-Sep-99	37	NW			655
145589	44642	TROLL	11-Sep-99	37	NW			675
91888	44642	TROLL	14-Sep-99	38	NW	113	91	711
91898	44642	TROLL	14-Sep-99	38	NW	114		644
145666	44641	TROLL	15-Sep-99	38	NW			695
145614	44642	TROLL	15-Sep-99	38	NW	114	21	730
133995	44642	TROLL	17-Sep-99	38	NW	113	91	743
139590	44642	TROLL	20-Sep-99	39	NW	113	91	675
139564	44642	TROLL	20-Sep-99	39	NW	113	91	715
95900	44642	TROLL	20-Sep-99	39	NW			710
139583	44643	TROLL	20-Sep-99	39	NW	113	91	626
145684	44643	TROLL	20-Sep-99	39	NW	113	91	645
145234	44643	TROLL	22-Sep-99	39	NW	114	21	745
98829	44642	TROLL	23-Sep-99	39	NW			675
142392	44643	TROLL	26-Sep-99	40	NW	114	21	750
145255	44643	TROLL	27-Sep-99	40	NW	114	25	720
145750	44642	TROLL	1-Oct-99	40	NW	114	21	690
145755	44642	TROLL	1-Oct-99	40	NW	114	21	690
145736	44643	TROLL	1-Oct-99	40	NW	114	21	720
28487	44643	SEINE	27-Jul-99	31	NE	112		525
29104	44642	SEINE	3-Aug-99	32	NE	112		665
28799	44643	SEINE	3-Aug-99	32	NE	112		600
24699	44642	SEINE	8-Aug-99	33	NE	109	30	516
29430	44642	SEINE	18-Aug-99	34	NE	112		676
68145	44643	SEINE	23-Aug-99	35	NE	109	30	687
29567	44642	SEINE	28-Aug-99	35	NE	112		702
73872	44643	SPORT	3-Jun-99	23	NW	113		505
54600	44642	SPORT	1-Aug-99	32	NE	111	50	670
56819	44643	SPORT	1-Aug-99	32	NE	111	50	
69733	44643	SPORT	6-Aug-99	32	NW	113	41	510
54290	44642	SPORT	8-Aug-99	33	NE	111	50	650
56865	44643	SPORT	13-Aug-99	33	NE	111	50	680
69782	44642	SPORT	18-Aug-99	34	NW	113	41	655
54945	44643	SPORT	18-Aug-99	34	NE	111	50	610
61823	44642	SPORT	21-Aug-99	34	NW	183	10	675
85182	44642	SPORT	22-Aug-99	35	NE			620
85173	44642	SPORT	22-Aug-99	35	NE			635
85199	44642	SPORT	22-Aug-99	35	NE			660
85126	44642	SPORT	22-Aug-99	35	NE			710
85159	44643	SPORT	22-Aug-99	35	NE			435
85145	44643	SPORT	22-Aug-99	35	NE			660
85102	44643	SPORT	22-Aug-99	35	NE			690
85192	44643	SPORT	22-Aug-99	35	NE			710

-continued-

Appendix A3.–Page 5 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
98228	44642	SPORT	23-Aug-99	35	NE			530
98241	44642	SPORT	23-Aug-99	35	NE			615
98249	44643	SPORT	23-Aug-99	35	NE			735
57486	44643	SPORT	26-Aug-99	35	NE	111	50	550
53443	44642	SPORT	5-Sep-99	37	NE	111	50	735
56789	44642	SPORT	5-Sep-99	37	NE	111	50	
58105	44643	SPORT	19-Sep-99	39	NE	112	16	730
26422	44642	GILLNET	12-Jul-99	29	NE	111		578
29152	44642	GILLNET	5-Aug-99	32	NE	111		573
97411	44642	GILLNET	11-Aug-99	33	NE	111	32	572
29414	44643	GILLNET	17-Aug-99	34	NE	111		656
29337	44643	GILLNET	19-Aug-99	34	NE	111		636
55628	44642	GILLNET	25-Aug-99	35	NE	111	32	628
55478	44642	GILLNET	31-Aug-99	36	NE	111	32	500
55640	44642	GILLNET	31-Aug-99	36	NE	111	32	651
55645	44642	GILLNET	31-Aug-99	36	NE	111	32	659
55644	44642	GILLNET	31-Aug-99	36	NE	111	32	732
55647	44643	GILLNET	31-Aug-99	36	NE	111	32	651
55477	44643	GILLNET	31-Aug-99	36	NE	111	32	683
29829	44643	GILLNET	1-Sep-99	36	NE	115		688
29838	44642	GILLNET	2-Sep-99	36	NE	111		782
29840	44643	GILLNET	2-Sep-99	36	NE	111		500
29837	44643	GILLNET	2-Sep-99	36	NE	111		661
55481	44641	GILLNET	7-Sep-99	37	NE	111	32	724
55700	44642	GILLNET	7-Sep-99	37	NE	111	32	713
55496	44642	GILLNET	7-Sep-99	37	NE	111	32	745
55494	44643	GILLNET	7-Sep-99	37	NE	111	32	545
55705	44643	GILLNET	7-Sep-99	37	NE	111	32	628
55483	44643	GILLNET	7-Sep-99	37	NE	111	32	766
29708	44640	GILLNET	8-Sep-99	37	NE	111		759
29710	44643	GILLNET	8-Sep-99	37	NE	111		685
29711	44643	GILLNET	8-Sep-99	37	NE	111		731
55726	44642	GILLNET	14-Sep-99	38	NE	111	32	704
55723	44643	GILLNET	14-Sep-99	38	NE	111	32	519
55727	44643	GILLNET	14-Sep-99	38	NE	111	32	660
55734	44642	GILLNET	15-Sep-99	38	NE	111	32	658
55735	44642	GILLNET	15-Sep-99	38	NE	111	32	786
55732	44643	GILLNET	15-Sep-99	38	NE	111	32	671
55847	44642	GILLNET	16-Sep-99	38	NE	115		674
55838	44642	GILLNET	16-Sep-99	38	NE	115		709
55807	44642	GILLNET	16-Sep-99	38	NE	115		725
55882	44643	GILLNET	22-Sep-99	39	NE	111	32	721
55918	44642	GILLNET	23-Sep-99	39	NE	115		672
55906	44642	GILLNET	23-Sep-99	39	NE			684

-continued-

Appendix A3.–Page 6 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
55965	44643	GILLNET	23-Sep-99	39	NE	115		660
55908	44643	GILLNET	23-Sep-99	39	NE			656
148150	44640	GILLNET	28-Sep-99	40	NE	111	32	714
55991	44642	GILLNET	29-Sep-99	40	NE	111	32	652
148293	44642	GILLNET	29-Sep-99	40	NE	111	32	678
55990	44642	GILLNET	29-Sep-99	40	NE	111	32	688
148295	44642	GILLNET	29-Sep-99	40	NE	111	32	692
148296	44642	GILLNET	29-Sep-99	40	NE	111	32	712
55993	44642	GILLNET	29-Sep-99	40	NE	111	32	720
55985	44643	GILLNET	29-Sep-99	40	NE	111	32	694
148294	44643	GILLNET	29-Sep-99	40	NE	111	32	709
148291	44643	GILLNET	29-Sep-99	40	NE	111	32	710
148286	44643	GILLNET	29-Sep-99	40	NE	111	32	714
55992	44643	GILLNET	29-Sep-99	40	NE	111	32	735
148374	44640	GILLNET	30-Sep-99	40	NE	111	32	760
148354	44641	GILLNET	30-Sep-99	40	NE	111	32	748
148371	44642	GILLNET	30-Sep-99	40	NE	111	32	670
148368	44642	GILLNET	30-Sep-99	40	NE	111	32	720
148311	44642	GILLNET	30-Sep-99	40	NE	111	32	724
148348	44642	GILLNET	30-Sep-99	40	NE	111	32	750
148366	44642	GILLNET	30-Sep-99	40	NE	111	32	773
148361	44642	GILLNET	30-Sep-99	40	NE	111		730
148312	44643	GILLNET	30-Sep-99	40	NE	111	32	659
148350	44643	GILLNET	30-Sep-99	40	NE	111	32	694
148365	44643	GILLNET	30-Sep-99	40	NE	111	32	764
148355	44643	GILLNET	30-Sep-99	40	NE	111		645
148356	44643	GILLNET	30-Sep-99	40	NE	111		670
148380	44642	GILLNET	1-Oct-99	40	NE	115		647
148379	44642	GILLNET	1-Oct-99	40	NE	115		673
148392	44642	GILLNET	1-Oct-99	40	NE	115		698
104582	44642	GILLNET	6-Oct-99	41	NE	111	32	629
104587	44642	GILLNET	6-Oct-99	41	NE	111	32	779
75101	44641	ESC. SURV.	1-Aug-99	32	NE	111	32	625
75102	44642	ESC. SURV.	4-Aug-99	32	NE	111	32	575
75103	44642	ESC. SURV.	6-Aug-99	32	NE	111	32	445
75104	44642	ESC. SURV.	12-Aug-99	33	NE	111	32	500
75105	44643	ESC. SURV.	16-Aug-99	34	NE	111	32	430
75106	44642	ESC. SURV.	17-Aug-99	34	NE	111	32	610
75107	44643	ESC. SURV.	23-Aug-99	35	NE	111	32	445
75108	44643	ESC. SURV.	28-Aug-99	35	NE	111	32	640
75109	44642	ESC. SURV.	3-Sep-99	36	NE	111	32	610
75110	44642	ESC. SURV.	5-Sep-99	37	NE	111	32	690
75111	44642	ESC. SURV.	6-Sep-99	37	NE	111	32	640
75113	44642	ESC. SURV.	7-Sep-99	37	NE	111	32	630

-continued-

Appendix A3.–Page 7 of 7.

Head. number	Tag code	Gear	Recovery date	Stat. week	Quad-rant	District	Sub-dist.	Length
75112	44642	ESC. SURV.	7-Sep-99	37	NE	111	32	660
75114	44643	ESC. SURV.	7-Sep-99	37	NE	111	32	455
75115	44642	ESC. SURV.	11-Sep-99	37	NE	111	32	620
75117	44642	ESC. SURV.	14-Sep-99	38	NE	111	32	720
75116	44642	ESC. SURV.	14-Sep-99	38	NE	111	32	735
75118	44642	ESC. SURV.	16-Sep-99	38	NE	111	32	580
75119	44640	ESC. SURV.	17-Sep-99	38	NE	111	32	640
75121	44642	ESC. SURV.	18-Sep-99	38	NE	111	32	575
75120	44642	ESC. SURV.	18-Sep-99	38	NE	111	32	685
75123	44641	ESC. SURV.	20-Sep-99	39	NE	111	32	690
75122	44642	ESC. SURV.	20-Sep-99	39	NE	111	32	630
75124	44642	ESC. SURV.	22-Sep-99	39	NE	111	32	560
75125	44642	ESC. SURV.	26-Sep-99	40	NE	111	32	665
75126	44642	ESC. SURV.	29-Sep-99	40	NE	111	32	665
75128	44643	ESC. SURV.	1-Oct-99	40	NE	111	32	615
75127	44643	ESC. SURV.	1-Oct-99	40	NE	111	32	650
75129	44642	ESC. SURV.	2-Oct-99	40	NE	111	32	695
75130	44642	ESC. SURV.	3-Oct-99	41	NE	111	32	625
			SELECT RECOVERIES					
136764	44642	TROLL	11-Aug-99	33	NW	156		
79514	44642	TROLL	11-Aug-99	33	NW	189		
136768	44643	TROLL	11-Aug-99	33	NW	156		
77703	44643	TROLL	11-Aug-99	33	NW	189		
79538	44643	TROLL	11-Aug-99	33	NW	189		
141071	44640	TROLL	12-Aug-99	33	NW			
141056	44642	TROLL	12-Aug-99	33	NW			
141070	44643	TROLL	12-Aug-99	33	NW			
136373	44643	TROLL	13-Aug-99	33	NW	116		
138845	44641	TROLL	7-Sep-99	37	NW	116	11	
138849	44643	TROLL	7-Sep-99	37	NW	116	11	
139972	44643	TROLL	10-Sep-99	37	NW	116	11	
139984	44643	TROLL	10-Sep-99	37	NW	116	11	
139961	44642	TROLL	11-Sep-99	37	NW	113	91	
139741	44643	TROLL	11-Sep-99	37	NW	116	11	
91964	44642	TROLL	15-Sep-99	38	NW	113	91	
139421	44642	TROLL	20-Sep-99	39				
97076	44642	SPORT	12-Sep-99	38	NE	111	50	
97081	44642	ESC. SURV.	26-Sep-99	40	NE	111	32	470
97079	44642	ESC. SURV.	26-Sep-99	40	NE	111	32	540
70300	44643	ESC. SURV.	26-Sep-99	40	NE	111	32	585
97080	44643	ESC. SURV.	26-Sep-99	40	NE	111	32	690
97082	44641	ESC. SURV.	27-Sep-99	40	NE	111	32	530
97083	44642	ESC. SURV.	30-Sep-99	40	NE	111	32	715

[a] Tagged with a chinook salmon code.

Appendix A4.–Numbers of coded wire tagged and untagged coho salmon in samples of immigrating salmon at Canyon Island in 1999.

Date	Number examined		Number of clips		Head numbers	Valid tags	Tag codes	Release site
	Fish wheels	Gillnet	Fish wheels	Gillnet				
3-Jul	1							
4-Jul	0							
5-Jul	0							
6-Jul	1							
7-Jul	0							
8-Jul	0							
9-Jul	0							
10-Jul	1							
11-Jul	0							
12-Jul	1							
13-Jul	1							
14-Jul	0							
15-Jul	1							
16-Jul	3							
17-Jul	8							
18-Jul	7							
19-Jul	6							
20-Jul	5							
21-Jul	2							
22-Jul	3							
23-Jul	5							
24-Jul	2							
25-Jul	4							
26-Jul	7							
27-Jul	7							
28-Jul	11							
29-Jul	14							
30-Jul	13							
31-Jul	17							
1-Aug	16		1		75101	1	04-46-41	Canyon Island
2-Aug	12							
3-Aug	14							
4-Aug	14		1		75102	1	04-46-42	Canyon Island
5-Aug	16							
6-Aug	4		1		75103	1	04-46-42	Canyon Island
7-Aug	7							
8-Aug	10							
9-Aug	9							
10-Aug	10							
11-Aug	16							
12-Aug	15		1		75104	1	04-46-42	Canyon Island
13-Aug	10							
14-Aug	8							
15-Aug	17							
16-Aug	15		1		75105	1	04-46-43	Canyon Island
17-Aug	15		1		75106	1	04-46-42	Canyon Island
18-Aug	7							
19-Aug								
20-Aug								
21-Aug	8							
22-Aug	40							
23-Aug	8		1		75107	1	04-46-43	Canyon Island

-continued-

Appendix A4.–Page 2 of 2.

Date	Number examined		Number of clips		Head numbers	Valid tags	Tag codes	Release site
	Fish wheels	Gillnet	Fish wheels	Gillnet				
24-Aug	11							
25-Aug	13							
26-Aug	10							
27-Aug	12							
28-Aug	16		1		75108	1	04-46-43	Canyon Island
29-Aug	37							
30-Aug	36							
31-Aug	20							
1-Sep	19							
2-Sep	11							
3-Sep	17		1		75109	1	04-46-42	Canyon Island
4-Sep	31							
5-Sep	72		1		75110	1	04-46-42	Canyon Island
6-Sep	45		1		75111	1	04-46-42	Canyon Island
7-Sep	22		3		75112, 75113, 74114	3	04-46-42, 04-46-42, 04-46-43	all Canyon Island
8-Sep	16							
9-Sep	3	33						
10-Sep	11	51						
11-Sep	4	53		1	75115	1	04-46-42	Canyon Island
12-Sep	3	52						
13-Sep	3	44						
14-Sep	8	58		2	75116, 75117	2	04-46-42	both Canyon Island
15-Sep	0	43						
16-Sep	11	30		1	75118	1	04-46-42	Canyon Island
17-Sep	11	80		1	75119	1	04-46-40	Canyon Island
18-Sep	9	36	1	1	75120, 75121	2	04-46-42	both Canyon Island
19-Sep	72	0						
20-Sep	40	0	2		75122, 75123	2	04-46-42, 04-46-41	both Canyon Island
21-Sep	37	0						
22-Sep	28	0						
23-Sep	12	0	1		75124	1	04-46-42	Canyon Island
24-Sep	20	0						
25-Sep	26	4						
26-Sep	38	0	1		75125	1	04-46-42	Canyon Island
27-Sep	22	0						
28-Sep	26	0						
29-Sep	0	22		1	75126	1	04-46-42	Canyon Island
30-Sep	0	45						
1-Oct	0	46		2	75127, 75128	2	04-46-43	both Canyon Island
2-Oct	0	54		1	75129	1	04-46-42	Canyon Island
3-Oct	0	34		1	75130	1	04-46-42	Canyon Island
All	1,163	685	19	11		30		

Appendix A5.–Estimated harvests of coho salmon bound for Taku River above Canyon Island in 1999 in marine commercial and sport fisheries by statistical week. Harvest in the troll fishery was approximated by weighting period catches by the number of coded wire tags recovered in a statistical week.

		Estimated harvest by fishery									
		Troll							Estimated	Estimated	Estimated
Stat week	Ending date	Troll tags	Troll period	Troll stat. week	Gillnet	Seine	Sport	Total	weekly prop. harvest	cum. total harvest	cum. prop. harvest
23	6/5						308	308	0.01	308	0.01
24	6/12								0.00	308	0.01
25	6/19								0.00	308	0.01
26	6/26								0.00	308	0.01
27	7/3	1		244				244	0.00	552	0.01
28	7/10	4		974				974	0.02	1,526	0.03
29	7/17	9		2,193	240			2,433	0.05	3,959	0.08
30	7/24	5		1,218				1,218	0.02	5,177	0.10
31	7/31	17		4,141		561	373	5,075	0.10	10,252	0.20
32	8/7	15		3,654	216	1,270	248	5,388	0.11	15,640	0.31
33	8/14	16	16,323	3,898	101	375	496	4,869	0.10	20,509	0.40
34	8/21	5		1,171	344	170	296	1,981	0.04	22,490	0.44
35	8/28	25		5,855	97	505	1,184	7,641	0.15	30,131	0.59
36	9/4	19		4,450	901		0	5,351	0.11	35,483	0.70
37	9/11	19		4,450	1,111		674	6,235	0.12	41,718	0.82
38	9/18	5		1,171	837		0	2,008	0.04	43,726	0.86
39	9/25	7		1,639	1,055		591	3,286	0.06	47,011	0.93
40	10/2	5		1,171	2,424			3,595	0.07	50,607	1.00
41	10/9	0	19,908	0	181			181	0.00	50,789	1.00
Total		152	36,231	36,231	7,507	2,881	4,170	50,789			
Estimated mean date of harvest				8/18/99	9/13/99	8/8/99	8/20/99	8/21/99			

Appendix A6.–Marking effort and river stage for the adult coho salmon mark-recapture experiment at Canyon Island during 1999.

Statistical week	Date	River stage (m)	Hours fished: Fish wheels	Hours fished: Gillnet	Fish tagged
27	7/1/99	1.60	45.9		
27	7/2/99	1.63	45.0		
27	7/3/99	1.88	42.8		1
28	7/4/99	2.03	43.2		0
28	7/5/99	2.16	43.6		0
28	7/6/99	2.03	44.2		1
28	7/7/99	1.96	43.5		0
28	7/8/99	1.80	45.4		0
28	7/9/99	1.75	45.6		0
28	7/10/99	1.78	47.1		1
29	7/11/99	1.85	46.7		0
29	7/12/99	1.83	46.2		1
29	7/13/99	1.73	46.0		1
29	7/14/99	1.65	45.7		0
29	7/15/99	1.96	45.4		1
29	7/16/99	2.06	45.6		2
29	7/17/99	2.06	44.4		7
30	7/18/99	2.06	43.5		7
30	7/19/99	1.96	44.1		5
30	7/20/99	1.85	45.2		4
30	7/21/99	1.83	46.2		2
30	7/22/99	2.06	46.3		3
30	7/23/99	1.88	44.8		5
30	7/24/99	1.60	45.4		2
31	7/25/99	1.42	45.9		3
31	7/26/99	1.30	43.8		7
31	7/27/99	1.50	45.3		7
31	7/28/99	1.57	44.8		9
31	7/29/99	1.55	44.6		12
31	7/30/99	1.47	45.3		12
31	7/31/99	1.40	45.3		17
32	8/1/99	1.55	45.3		15
32	8/2/99	1.80	45.3		12
32	8/3/99	1.93	45.5		14
32	8/4/99	1.91	45.5		13
32	8/5/99	1.98	46.3		15
32	8/6/99	2.08	45.7		3
32	8/7/99	2.13	46.7		7
33	8/8/99	2.16	46.5		9
33	8/9/99	2.11	46.4		9
33	8/10/99	1.80	46.3		10
33	8/11/99	1.52	46.3		16
33	8/12/99	1.52	45.9		14
33	8/13/99	1.70	46.1		8
33	8/14/99	1.88	46.6		8
34	8/15/99	1.80	44.2		16
34	8/16/99	1.70	46.6		14
34	8/17/99	1.73	46.7		14
34	8/18/99	2.18	24.8		7
34	8/19/99	3.18	0.0		0
34	8/20/99	3.96	0.0		0
34	8/21/99	1.70	19.8		6
35	8/22/99	1.40	46.3		38
35	8/23/99	1.37	46.0		7
35	8/24/99	1.02	46.6		10
35	8/25/99	0.91	46.9		13
35	8/26/99	0.76	46.8		10
35	8/27/99	0.64	46.9		12
35	8/28/99	0.66	46.8		15
36	8/29/99	1.07	46.5		34
36	8/30/99	0.89	46.3		36
36	8/31/99	0.66	47.0		18
36	9/1/99	0.61	47.2		18
36	9/2/99	0.53	47.3		9
36	9/3/99	0.56	46.8		16
36	9/4/99	0.97	46.3		27
37	9/5/99	0.81	46.0		70
37	9/6/99	0.53	46.7		43
37	9/7/99	0.51	46.6		17
37	9/8/99	0.48	47.4		15
37	9/9/99	0.56	44.9	2.8	35
37	9/10/99	0.56	45.9	3.3	61
37	9/11/99	0.46	46.3	5.9	54
38	9/12/99	0.30	46.8	4.2	50
38	9/13/99	0.30	46.8	5.0	42
38	9/14/99	-0.08	47.0	5.1	59
38	9/15/99	0.08	39.9	5.0	39
38	9/16/99	0.61	39.6	6.1	38
38	9/17/99	0.58	38.8	2.1	85
38	9/18/99	0.71	40.4	2.7	43
39	9/19/99	1.93	45.7		70
39	9/20/99	2.31	46.8		38
39	9/21/99	1.91	46.3		36
39	9/22/99	1.52	46.9		26
39	9/23/99	2.36	47.4		11
39	9/24/99	2.01	47.4		20
39	9/25/99	1.32	45.3	2.5	30
40	9/26/99	0.84	23.3		37
40	9/27/99	0.30	23.5		21
40	9/28/99	0.10	9.0	5.0	26
40	9/29/99	0.00		2.0	20
40	9/30/99	0.00		5.0	44
40	10/1/99	-0.15		5.0	43
40	10/2/99	-0.30		5.0	51
41	10/3/99	-0.46		5.0	32
Total					1,739

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Appendix A7.–Summary of population parameters for the full duration of the Taku River coho salmon run, 1987–1999.

COHO SALMON ABOVE CANYON ISLAND

Calendar year	Escape-ment	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	55,457	6,519	61,976						
1988	39,450	3,643	43,093						
1989	56,808	4,033	60,841						
1990	72,196	3,685	75,881						
1991	127,484	5,439	132,923						
1992	84,853	5,541	90,394	96,283	186,677	54.5	51.6	743,000	NE
1993	109,457	4,634	114,091	97,758	211,849	48.3	46.1	1,510,000	14.0
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
1997	32,345	2,690	35,035	15,825	50,860	36.4	31.1	759,763	6.7
1998	61,382	5,090	66,472	53,368	119,840	48.8	44.5	853,662	14.0
1999	60,768	5,575	66,343	50,789	117,132	48.1	43.4	1,184,195	9.9
Standard errors									
1992			19,033	24,005	30,635		8.2	247,000	
1993			17,503	19,256	26,022		6.2	418,051	4.2
1994			6,529	36,734	37,310		3.8	368,411	6.3
1995			3,242	12,186	12,610		2.8	339,822	2.8
1996			3,650	6,494	7,449		4.1	214,152	2.2
1997			4,120	2,691	4,921		4.4	154,051	1.5
1998			5,394	7,435	9,186		4.0	147,260	2.6
1999			7,049	6,097	9,320		3.9	207,576	1.9

COHO SALMON FROM ENTIRE TAKU RIVER DRAINAGE

Calendar year	Escape-ment	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	72,937	6,519	79,456						
1988	51,604	3,643	55,247						
1989	73,968	4,033	78,001						
1990	93,598	3,685	97,283						
1991	164,975	5,439	170,414						
1992	110,349	5,541	115,890	123,440	239,330	53.9	51.6	952,774	NE
1993	141,637	4,634	146,271	125,331	271,601	47.9	46.1	1,935,938	14.0
1994	127,661	14,693	142,354	293,086	435,440	70.7	67.3	1,892,147	23.0
1995	75,298	13,738	89,036	143,040	232,076	67.6	61.6	1,955,551	11.9
1996	58,649	5,052	63,701	57,088	120,790	51.4	47.3	1,264,729	9.6
1997	42,227	2,690	44,917	20,288	65,205	35.2	31.1	974,055	6.7
1998	80,131	5,090	85,221	68,421	153,641	47.8	44.5	1,094,438	14.0
1999	79,480	5,575	85,055	65,114	150,169	47.1	43.4	1,518,199	9.9
Standard errors									
1992			24,401	30,776	39,275		8.2	374,000	
1993			22,440	24,687	33,362		6.2	535,963	4.2
1994			8,371	47,095	47,833		3.8	472,321	6.3
1995			4,156	15,623	16,167		2.8	435,669	2.8
1996			4,679	8,326	9,551		4.1	274,554	2.2
1997			5,282	3,450	6,309		4.4	197,501	1.5
1998			6,915	9,532	11,776		4.0	188,795	2.6
1999			9,037	7,817	11,949		3.9	266,123	1.9

Appendix A8.–Weekly and season estimates of inriver run, harvest and escapement of coho salmon above Canyon Island in the Taku River, 1987–1999.

Recovery week	Year													87–98 Avg.
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
27										45		11	7	19
28										464	5	55	44	131
29									1,460	853	106	337	83	551
30		548	1,425	1,479	2,517	3,298	641	3,348	2,628	1,525	134	1,968	275	1,626
31	3,841	1,060	878	2,186	2,209	1,741	2,386	5,026	4,582	2,159	843	2,932	1,127	2,487
32	2,529	1,526	2,693	1,051	4,157	10,040	3,186	3,988	2,100	6,216	738	5,226	1,221	3,621
33	3,623	1,257	300	1,910	4,867	4,875	4,550	4,308	5,299	5,337	1,265	4,116	2,327	3,476
34	4,721	7,412	9,598	11,095	1,740	500	12,759	9,827	8,764	6,589	1,542	4,428	3,148	6,581
35	3,503	8,366	8,385	17,739	27,296	2,170	3,424	15,029	10,565	7,861	2,589	6,007	1,984	9,411
36	4,061	5,583	14,038	17,855	5,924	13,332	19,703	7,904	10,951	7,362	3,028	5,508	4,725	9,604
37	3,843	11,371	10,181	12,563	17,411	14,601	15,427	34,400	7,118	2,900	10,211	5,758	10,403	12,149
38	6,009	1,446	3,351	9,596	4,708			13,583	5,889	1,312	10,236	3,265	8,225	5,940
39	11,440	4,524	8,031	407	9,100			787	2,109	1,549	1,462	4,384	3,582	4,379
40			1,960		33,009			443	273		2,875	5,293	10,654	
41					11,371								11,245	
42					4,410									
43					4,204									
Mark-recapture period estimate	43,570	43,093	60,841	75,881	132,923	50,557	62,076	98,643	61,738	44,172	35,035	49,290	59,052	63,152
SE	3,096	7,162	11,174	21,813	19,051	10,645	9,523	5,800	2,882	3,405	4,160	4,485	6,650	
Total inriver catch	6,519	3,643	4,033	3,685	5,439	5,541	4,634	14,693	13,738	5,052	2,690	5,090	5,575	6,230
Expanded inriver run [a]	61,976	43,093	60,841	75,881	132,923	90,394	114,091	111,036	69,448	49,687	35,035	66,472	66,343	75,906
Escapement above Canyon Island	55,457	39,450	56,808	72,196	127,484	84,901	109,457	96,343	55,710	44,635	32,345	61,382	60,768	69,677
SE	4,053	7,162	11,174	21,813	19,051	19,033	17,503	6,529	3,242	3,650	4,120	5,394	7,049	

[a] Expansions for run timing may be revised pending further studies.

Appendix A9.–Estimated age composition of coho salmon sampled from catches in fish wheels at Canyon Island, 1983–1999.

Year	Sample size	Percent by age class					
		1.0	1.1	2.0	2.1	3.1	4.0
1983	477	0.0	56.0	0.0	44.2	0.0	0.0
1984	630	0.3	43.2	0.5	56.2	6.0	0.0
1985	825	0.0	44.5	0.2	51.4	4.0	0.0
1986	475	0.6	44.0	0.4	52.8	2.7	0.0
1987	1,700	0.1	32.4	0.3	65.1	2.4	0.1
1988	1,338	1.1	32.3	0.8	59.0	6.8	0.0
1989	1,826	0.0	49.3	0.1	48.5	2.1	0.0
1990	1,463	0.0	29.3	0.0	67.9	2.9	0.1
1991	523	0.4	31.4	0.0	67.7	1.3	0.0
1992	534	0.4	51.5	0.0	48.1	0.0	0.0
1993	498	0.0	39.4	0.6	60.0	0.8	0.0
1994	539	0.0	44.8	0.6	55.0	0.4	0.0
1995	582	0.0	52.6	0.0	47.8	0.0	0.0
1996	599	0.0	56.3	0.0	43.2	0.5	0.0
1997	481	0.0	64.7	0.0	35.3	0.0	0.0
1998	610	0.0	67.7	0.0	32.3	0.0	0.0
1999	617	0.0	79.3	0.0	20.7	0.0	0.0
Average(83–99)		0.1	55.8	0.1	43.8	0.2	0.0
SD(83–99)		0.14	10.1	0.15	10.1	0.21	0.05
CV(83–99)		233%	18%	169%	23%	122%	412%

Year	Sample size	Average length by age class in MEF (mm)					Total
		1.0	1.1	2.0	2.1	3.1	
1983	476		589		610		596
1984	620		566	320	608	565	582
1985	765		584		616	625	599
1986	455	320	577		598	645	587
1987	633	330	568	310	592	596	582
1988	607		595		612	655	604
1989	621		581		601	623	589
1990	639		569		623		600
1991	592		607		623		614
1992	524	303	574	325	606		587
1993	567		578	270	592	680	584
1994	553		592	333	611		599
1995	597		584		588		586
1996	592		575		602	588	588
1997	478		575		603		585
1998	609		601		616		606
1999	617		569		594		574
Average(83–99)	581	318	581	312	606	622	592
SD(83–99)		14	12	25	11	38	10
CV(83–99)		4%	2%	8%	2%	6%	2%

Appendix A10.–Computer data files on 1998 Taku River coho salmon smolt and subsequent estimates of 1999 Taku River adult coho salmon run parameters.

File name	Description
99TAKCWT.xls	Excel (Office 97 version) workbook with spreadsheets of random and select recoveries of CWTs in 1999 and estimated harvest calculations by strata and season.
99TAKREP.xls	Excel (Office 97 version) workbook with spreadsheets of CWT sampling in Canyon Island fish wheels, estimation of smolt abundance, total runs, marine survival, Table 5, Table 7, Appendix A4, and Appendix A2.
98SMOLT.xls	Excel (Office 97 version) workbook with spreadsheets of smolt catches and lengths during 1998.