Fishery Data Series No. 05-28

Production of Coho Salmon from Chuck Creek in Southeast Alaska, 2001–2003

by

Steven J. McCurdy

May 2005

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

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

General

Alaska Department of Fish and Game	ADF&G
Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
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
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
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	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
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.
minute (angular)	'
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
variance	
population	Var
sample	var

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ABSTRACT

The purpose of this study was to estimate smolt production, marine survival, exploitation rates, and escapements of coho salmon *Oncorhynchus Kisutch* from the Chuck Creek watershed in Southeast Alaska. Emigrating coho smolt were captured during the spring of 2002, and tagged with a coded wire tag (CWT) and marked with adipose fin removal. Commercial and sport fisheries were sampled for coho salmon marked with CWTs in 2003. Escapements were counted through a weir at Chuck Creek in 2001, 2002, and 2003 and coho salmon were examined for marks.

In 2002 a total of 8,995 coho salmon smolt > 75 mm fork length were tagged and released alive after being captured in a smolt weir when emigrating from the Chuck Creek watershed between April 19 and June 1. In 2003, 192 random recoveries of coho salmon bearing CWTs of Chuck Creek origin were recovered in sampled marine fisheries, and correspond to an estimated marine harvest of 874 fish (SE = 95). A total of 637 jack and 614 adult coho salmon returned to Chuck Creek from the 2002 smolt emigration. An estimated 12,487 (SE = 208) coho salmon smolt emigrated from Chuck Creek in 2002. Marine survival to adult of the 2002 smolt emigration was estimated at 11.9% (SE = 0.8%) and the exploitation rate in marine fisheries was estimated at 58.2% (SE = 2.6%).

Key words: coho salmon, *Oncorhynchus kisutch*, Chuck Creek, Warm Chuck, Heceta Island, Southeast Alaska, mark-recapture, coded wire tag, recreational fishery, troll fishery, seine fishery, smolt production, marine survival, exploitation rate, escapement, weir, jack.

INTRODUCTION

Exploitation of wild coho salmon (*Oncorhynchus kisutch*) in Southeast Alaska is important to numerous commercial, sport and subsistence users (Shaul et al. 2003, Halupka et al. 2000). Wild coho salmon stocks are widely distributed in Southeast Alaska and are believed to be present in over 2,500 streams (Shaul et al. 2003). The Alaska Department of Fish and Game (ADF&G) has recently expanded a stock assessment program to better understand and manage coho salmon stocks in Southeast Alaska. ADF&G's effort to monitor the status of coho salmon stocks in Southeast Alaska includes a number of *full indicator stocks* where juvenile coho are marked with coded wire tags (CWTs). Systematically sampling escapements and harvest in fisheries for coho salmon with CWTs allows for estimates of total smolt production as well as marine survival, exploitation rates and contributions to various fisheries from the monitored stocks.

Chuck Creek was chosen as a *full indicator stock* in 2001 to fill the geographical gap in coverage in Southeast Alaska for the southern outside coast. The Chuck Creek watershed, located on Heceta Island in southern Southeast Alaska, is thought to produce about 3,000 adult coho salmon annually (Shaul et al. 1991). An adult salmon weir was operated successfully on Chuck Creek in 1950 (Edgington et al. 1981) as well as 1982, 1983 and 1985 (Shaul et al. 1991). Code wire tagging of presmolt coho salmon from Chuck Creek over several years in the early 1980s allowed for estimates of survival, fisheries contributions and exploitation rates (reported in Shaul et al. 1991). Recoveries of coded wire tagged coho salmon in commercial fisheries in the 1980s indicate that the Chuck Creek stock has an ocean distribution and exploitation pattern similar to that of coho salmon released from the Klakas River and the Klawock River Hatchery on nearby Prince of Wales (POW) Island. `

The Chuck Creek watershed is located on Heceta Island (Figure 1), 35 km northwest of the town of Craig. The watershed drains an area of approximately 750 hectares (1,853 acres), and contains Chuck Lake that has a surface area of approximately 63 hectares (155 acres). Chuck Lake drains to the south into Warm Chuck Inlet by way of the 1.5-km long outlet stream, Chuck Creek. Four separate streams that are tributary to the lake contain spawning and rearing habitat for anadromous fish. The watershed is generally low gradient with the highest point of elevation in the drainage being 169 meters (553 feet) above sea level. The topography of the watershed is predominately Karst (formed on carbonated bedrock, mostly limestone) and there are numerous springs and ground water sources present, indicating a well-developed subsurface drainage pattern that are typically associated with

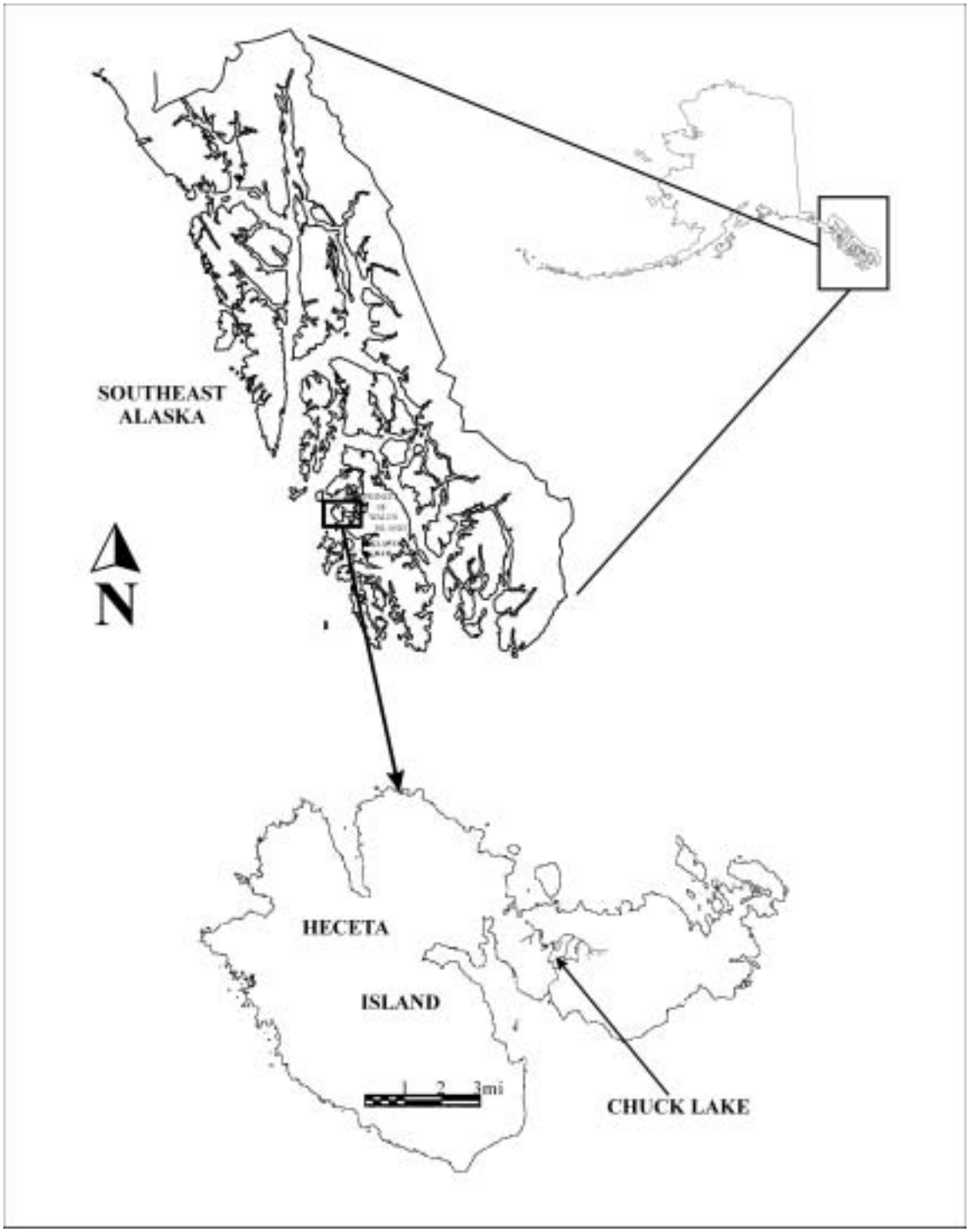

Figure 1.– Location of Heceta Island and the Chuck Creek watershed.

Karst geology (Baichtal and Swanston 1996). The majority of the watershed was logged in the 1970s and 1980s, which included extensive timber harvest in riparian areas and along the lakeshore. A vast network of logging roads is present throughout the watershed. The watershed contains numerous beaver dams and ponds, and vegetation in the riparian area is significantly influenced by beaver *Castor canadensis* activity. In addition to coho salmon, Chuck Creek contains sockeye salmon *O. nerka*, pink salmon *O. gorbuscha*, chum salmon *O. keta*, Dolly Varden char *Salvelinus malma*, Steelhead *O. mykiss*, cutthroat trout *O. clarki*, stickleback *Gasterosteus aculeatus*, and sculpin *Cottus sp.*

Objectives of this study were:

- Count the escapement of coho salmon returning to Chuck Creek in 2001, 2002, and 2003.
- Estimate the age and sex composition, and mean length at age of the escapement of coho salmon to Chuck Creek in 2001, 2002, and 2003.
- Estimate the marine harvest of coho salmon from Chuck Creek in 2003 via recovery of CWTs.
- Estimate the number of coho salmon smolt emigrating from Chuck Creek in 2002.
- Estimate the age composition, and mean length and weight of coho salmon smolt emigrating from Chuck Creek in 2002.

An added benefit of this study is the monitoring of coho salmon production over time with the possibility of identifying factors that effect coho salmon production. Factors that could influence smolt production include escapement magnitudes, abiotic factors, and anthropogenic changes to the watershed (such as large scale timber harvesting and road building).

METHODS

Coded wire tags (CWTs) were applied to coho salmon smolts that were captured when emigrating from Chuck Creek in the spring of 2002. Adult coho salmon were sampled in the harvest of commercial and sport fisheries in 2003 for the presence of CWTs. The escapement of mature coho salmon was monitored through a weir on Chuck Creek in 2001, 2002, and 2003 and fish were inspected for missing adipose fins and CWTs to determine the fraction that was marked. The term "adult" is used to describe coho salmon that mature and return to spawn the year following their emigration from fresh water (noted as age x.1 or 1-ocean fish), and the term "jack" is used to describe male coho salmon that mature and return to spawn in the same year as their emigration from fresh water (noted as age x.0 or 0-ocean fish). The term "mature" refers to all coho salmon (both jack and adult) that are sexually mature and returning to spawn.

SMOLT CAPTURE AND CODED WIRE TAGGING

Smolt were captured in the spring of 2002 as they were emigrating from the Chuck Creek watershed using a weir and "trough" trap similar to that described by Elliott (1992) for catching coho salmon smolt emigrating from beaver ponds. This was the first attempt to capture coho smolt from the Chuck Creek watershed and it was uncertain if the smolt weir would capture a large percentage of the emigration. A limited amount of minnow trapping was also conducted (with G-40 minnow traps baited with disinfected salmon roe) in the outlet stream at the beginning of the season to determine whether there were many smolt below the weir site, and to boost sample sizes if needed. Once it became evident that a large portion of smolt did not exist below the weir, and the weir would capture a large portion of the smolt emigration, minnow trapping was discontinued.

The weir and trough trap was constructed on Chuck Creek at the site of a blown-out beaver dam located approximately 500 meters upstream from salt water. The opening in the beaver dam was repaired using 2"x 8" rough-cut lumber planks to raise the water level upstream of the dam approximately 1 meter. A "V" shaped perforated fence upstream of the dam extended from both banks and funneled emigrating smolt to the entrance of the trough located on the top of the rebuilt dam. The fence was constructed using two 50' rolls of 5' wide, 3/16" mesh vexar, held in place with iron pipe pounded into the substrate. The bottom 12"of the fence were folded facing upstream on the bottom of the stream and

weighted down with rocks and sand bags to seal any openings large enough for fish passage. The top of the fence extended above the water surface.

The trough was prefabricated out of aluminum and was approximately 8' long and 12" wide. Four-inch diameter flexible sewer hose was attached to the downstream end of the trough to funnel fish into a live box located just downstream of the beaver dam. The live box was prefabricated aluminum and had perforated aluminum on one side to allow for water flow. The trap was fished continuously from April 19 until June 1.

Coded wire tagging usually occurred daily, but during periods when few fish were captured, fish would be held overnight (up to three days) until a sufficient number were available to make tagging cost effective. Captured fish were removed from the live box several times a day and sorted by species. The number of coho salmon smolt captured was estimated when the trap was checked, but the actual number captured was derived from the number of smolt tagged. The logistics of sorting through large quantities of juvenile salmon and trout in a short period of time made precise counts unpractical until the fish could be identified by species and counted at the time of tagging. All non-coho species, other than young of the year (YOY) salmonid fry, which could freely pass through the trap fence and perforated live box wall, were counted and released at the trap site.

All captured coho salmon ≥ 75 mm fork length (FL) that appeared healthy were tranquilized with a solution of tricain-methane-sulfonate (MS 222), had a 1.1 mm CWT injected into their snout, their adipose fin removed, and were counted. Mark IV tagging machines (Northwest Marine Technology, INC.)[1] were used for tagging. Tag placement was checked at the beginning of tagging operations, and periodically throughout the operation using methods suggested in Koerner (1977). Short-term (16 hr) CWT loss and mortality due to the handling and tagging procedure was evaluated by holding all fish overnight, at which time they were inspected for mortalities and the presence of a CWT using a metal (tag) detector, then released downstream of the trap. Tag retention procedures required that a random sample of at least 100 fish have a retention rate of 98% or greater. If the sample had less than 98% retention of their CWTs, then the entire batch of fish being held overnight was checked for the presence of CWTs and retagged if found missing a tag. The number of fish tagged, the number of overnight mortalities following tagging, and the number of fish that had shed their tags was recorded on *ADF&G Tagging Summary and Release Information Forms,* which were submitted (along with a sample of the CWT wire used) to ADF&G Tag Lab in Juneau at the end of field operations. The tag code used in 2002 was 04-05-27. Water temperatures were recorded daily at approximately 8:00 a.m. at the weir site.

ESTIMATION OF SMOLT AGE, WEIGHT AND LENGTH

A random sample of coho salmon smolt was collected from the fish that had been held overnight following tagging, and were measured to the nearest mm for fork length, weighed to the nearest g, and had a scale sample taken for age determination. The sampled fish were collected following each tagging session, by gently mixing all the fish in the holding pen with a dip net then randomly scooping up a sample of fish in the net, and sampling all the fish in the scoop. Although the sampling goal was to sample every 40th fish, the actual sampling rate was close to every 30th fish. Only fish that were captured as emigrants in the trough trap were selected for sampling to avoid any size selective bias from fish captured using minnow traps. Scale samples were taken from the preferred area as described by Scarnecchia (1979), and mounted between two 25-mm x 75-mm microscope slides. Slides and scale samples were labeled to match corresponding recorded length and weight data. Scale samples were viewed at magnification and ages recorded in European notation. Ages were determined one time by one reader. Standard sample summary statistics were used to calculate estimates of mean length and weight at age and its variance (Cochran 1977).

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

ESTIMATION OF SMOLT ABUNDANCE

A two-event mark-recapture experiment for a closed population was used to estimate the abundance of coho salmon smolt emigrating from the Chuck Creek watershed in 2002. Event 1 consisted of sampling to mark fish ≥ 75 mm FL with CWTs in 2002. Event 2 involved sampling mature coho salmon in 2002 (jacks) and 2003 (adults) to determine the marked fraction (θ) for the returning fish. The abundance of coho salmon smolt emigrating from Chuck Creek in 2002 was estimated using Chapman's modified Petersen estimator for a closed population (Seber 1982):

$$\hat{N} = \frac{(n_1 + 1)(n_2 + 1)}{(m_2 + 1)} - 1 \qquad (1)$$

$$\mathrm{var}[\hat{N}] = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2 (m_2 + 2)} \qquad (2)$$

Where:

n_1 was the number of smolt marked in 2002 by removing their adipose fin,

n_2 was the number of returning coho salmon inspected for marks in 2002 (jacks only) and 2003 (adults only), and,

m_2 was the subset of n_2 missing their adipose fins from the 2002 tagging on Chuck Creek.

The conditions for an accurate estimate of smolt abundance using this methodology were:

(1) all fish had an equal probability of being marked as smolt in event 1, *or* all fish had an equal probability of being inspected for marks in event 2, *or* marked fish mixed completely with unmarked fish in the population between events;

(2) both recruitment and death (emigration) did not occur between events;

(3) marking did not effect catchability (or mortality) of fish;

(4) fish did not lose their marks between events; and

(5) all marks were reported on recovery in event 2 (Seber 1982).

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

MARINE HARVEST

Estimates of the harvest of coho salmon originating from Chuck Creek and its variance were derived from fish sampled from harvest in commercial and recreational fisheries using standard methods (Bernard and Clark 1996). Because several fisheries exploited coho salmon bound for Chuck Creek over several months in 2003, 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 the purse seine fishery were stratified by week and fishing district. Statistics from the recreational fishery were stratified by fortnight. Hubartt et al. (1999) present details of sampling recreational fisheries. An ADF&G Commercial Fisheries Division manuscript (ADF&G Unpublished) details sampling of commercial fisheries in southeast Alaska. Commercial fisheries samplers stationed at fish processors throughout Southeast Alaska attempt to sample 20% of the commercial coho salmon harvest for missing adipose fins.

Estimates of the 2003 harvest r_{ij} of Chuck Creek coho salmon from the 2002 smolt emigration j to one fishery stratum i were calculated:

$$\hat{r}_{ij} = \hat{H}_i \left(\frac{m_{ij}}{\lambda_i n_i} \right) \hat{\theta}_j^{-1} \qquad (3)$$

Where H_i is the estimated harvest in stratum i,

θ_j is the fraction of stock j marked with CWTs (the portion of the *adult* escapement sampled *found to have CWTs* . Note that the portion of the jack escapement with CWTs is not used in harvest estimate calculations as jacks do not constitute part of the marine harvest and jacks and adults may be marked at different rates, have differential survival, and marked jacks and adults may have different CWT retention rates),

n_i is the subset of H_i examined for missing adipose fins,

m_{ij} is the number of decoded CWTs recovered from stock j in stratum i,

$\lambda_i=(a_i' t_i')/(a_i t_i)$ is the decoding rate for CWTs from recovered salmon (a_i is the number of adipose clipped fish in the sample from stratum *i,* a_i' is the subset of a_i for which heads reach the laboratory, t_i is the subset of a_i' with CWTs detected and t_i' is the subset of t_i with CWTs decoded).

Estimates of harvest were summed across strata and fisheries to obtain an estimate of the total harvest $T = \sum \hat{r}_{ij}$. Because sampling was independent across strata and across fisheries the variance of the total harvest was estimated by summing the variances across strata. See Bernard and Clark (1996) for further details.

ESTIMATES OF ESCAPEMENT AND ADULT AGE, SEX, AND LENGTH COMPOSITION

An aluminum bipod and picket weir was installed across the lower end of Chuck Creek (approximately 500 meters from salt water) from August 7 until November 2 in 2001, from August 14 until October 15 in 2002 and from August 14 until October 16 in 2003. Pickets were 18-mm in diameter with a maximum gap of 31 mm. The bottom and sides of the weir were sealed with sandbags and the weir was monitored continuously. A 2.4-m square trap was built into the weir to capture and hold all immigrating salmon. All immigrating salmon had to enter the trap to pass upstream.

All migrating adult salmon were identified and counted by species as they passed the weir. All coho salmon were examined for missing adipose fins and a systematic sample of coho salmon missing an adipose fin was examined for CWTs using a magnetometer. Coho salmon were systematically sampled throughout the entire migration for age, sex, and length (ASL). Total escapement was the number of coho salmon counted through the weir. These numbers were divided into the number of jacks and the number of adults.

Age, sex, and length composition of the immigrant coho salmon population enumerated at the weir was estimated using time and life history type (adult, jack) as strata. Immigrants were sampled systematically, and sampling rates changed over time in response to the run being much larger (in 2001 and 2002) or smaller (2003) than expected. Life-history type was determined for each fish enumerated at the weir. Fish that were 400 mm in FL or larger were considered adults and those less than 400 mm FL were considered jacks. Any fish between 380 mm and 450 mm were sampled to verify age. In 2001 every-other fish (adult or jack) was sampled until September 21 when the rate was changed to every 4th adult and every 8th jack encountered at the weir. In 2002 every 5th fish encountered at the weir was sampled until September 11 when the rate changed to every 10th fish. In 2003 every 8th fish encountered at the weir was sampled until September 14 when the rate was changed to every fourth fish.

The fraction of the migration from each life-history type *s* that belong to each age, sex, or length group *a* in each temporal strata *h* was estimated:

$$\hat{p}_{s,a,h} = \frac{n_{s,a,h}}{n_{s,h}} \tag{4}$$

$$\mathrm{var}(\hat{p}_{s,a,h}) = \left[1 - \frac{n_{s,h}}{N_{s,h}}\right] \frac{\hat{p}_{s,a,h}\left(1-\hat{p}_{s,a,h}\right)}{n_{s,h}-1} \tag{5}$$

Where:

$n_{s,h}$ is the number of fish of life-history type *s* successfully aged (measured or sexed) in strata *h*,

$n_{s,a,h}$ is the subset of $n_{s,h}$ belonging to group *a*, and

$N_{s,h}$ is the total number of fish of stage *s* enumerated at the weir in stratum *h*.

The estimated migration $\hat{N}$ by age, sex, or length group from each life-history type is:

$$\hat{N}_a = \sum_s \sum_h N_{s,h}\, \hat{p}_{s,a,h} \tag{6}$$

$$\mathrm{var}\left(\hat{N}_a\right) = \sum_s \sum_h N_{s,h}^2\, \mathrm{var}\left(\hat{p}_{s,a,h}\right) \tag{7}$$

The fraction of the migration that belong to each age, sex, or length group is:

$$\hat{p}_a = \frac{\hat{N}_a}{N} \quad (8)$$

$$\mathrm{var}(\hat{p}_a) = N^{-2}\ \mathrm{var}(\hat{N}_a) \quad (9)$$

where N is the total migration (weir count).

MEAN LENGTH-AT-AGE

Mean length-at-age ($\bar{\ell}_a$) for the sampled coho salmon population was estimated using the estimated number of fish at age by time period passing the weir ($\hat{N}_{a,h}$) as weights:

$$\bar{\ell}_{a,h} = \frac{1}{n_{a,h}} \sum_i \ell_{a,h,i} \quad (10)$$

$$\mathrm{var}(\bar{\ell}_{a,h}) = \left[1 - \frac{n_{a,h}}{\hat{N}_{a,h}}\right] \sum_i \frac{(\ell_{a,h,i} - \bar{\ell}_{a,h})^2}{n_{a,h}(n_{a,h}-1)} \quad (11)$$

$$\bar{\ell}_a = \frac{1}{\hat{N}_a} \sum_h \hat{N}_{a,h}\ \bar{\ell}_{a,h} \quad (12)$$

$$\mathrm{var}(\bar{\ell}_a) = \sum_h \frac{\left(\bar{\ell}_{a,h}\hat{N}_a - \left(\sum_k \bar{\ell}_{a,k}\hat{N}_{a,k}\right)\right)^2}{\hat{N}_a^4} \mathrm{var}(\hat{N}_{a,h}) + \sum_h \frac{\hat{N}_{a,h}^2}{\hat{N}_a^2} \mathrm{var}(\bar{\ell}_{a,h}) \quad (13)$$

where $\ell_{a,h,i}$ is the length of individual fish i and equation (13) is an approximation derived using the delta method (Mood et al. 1974, p. 181). The finite population correction factor (fpc, $0 \le (1 - n_{a,h}/\hat{N}_{a,h}) \le 1$) in equation (11) is omitted if $\hat{N}_{a,h}$ is relatively imprecise and/or the fpc is small. Referring to equations 11 and 13 above, $\hat{N}_{a,h}$ and its variance are:

$$\hat{N}_{a,h} = N_h\ \hat{p}_{a,h} \quad (14)$$

$$\mathrm{var}(\hat{N}_{a,h}) = N_h^2\ \mathrm{var}(\hat{p}_{a,h}) \quad (15)$$

ESTIMATES OF TOTAL RUN, EXPLOITATION, AND MARINE SURVIVAL

The total run of the coho salmon bound for Chuck Creek in 2003 and its variance was calculated by summing estimates of total harvest (T) and the adult escapement (N_e):

$$\hat{N}_R = \hat{T} + N_e \quad (16)$$

$$\mathrm{var}[\hat{N}_R] = \mathrm{var}[\hat{T}] \quad (17)$$

Where $\mathrm{var}[N_e]$ is not added into (17) because it is 0.

The estimate of exploitation rate was calculated:

$$\hat{E} = \frac{\hat{T}}{\hat{N}_R} \quad (18)$$

$$\mathrm{var}[\hat{E}] \approx \frac{\mathrm{var}[\hat{T}]\hat{N}_e^2}{\hat{N}_R^4} \quad (19)$$

where variance was approximated with the delta method (Seber 1982), recalling that $\mathrm{var}[N_e] = 0$.

Smolt to adult survival rate was estimated as:

$$\hat{S} = \frac{\hat{N}_R}{\hat{N}_s} \quad (20)$$

$$\mathrm{var}[\hat{S}] \approx \hat{S}^2 \left[\frac{\mathrm{var}[\hat{N}_R]}{\hat{N}_R^2} + \frac{\mathrm{var}[\hat{N}_s]}{\hat{N}_s^2}\right] \quad (21)$$

where N_s is the smolt abundance from (1) and variance was approximated with the delta method.

RESULTS

SMOLT TAGGING, AGE, LENGTH, AND WEIGHT

A total of 9,003 coho salmon smolt ≥ 75 mm FL were captured and tagged between April 19 and June 1, 2002 (Table 1). Three fish died after tagging and an estimated 5 fish shed their tags within 24 hours, leaving a total of 9,000 smolt that were released with adipose clips and 8,995 with valid coded wire tags in 2002. The number of captured smolt was slightly underestimated while checking the trough trap (Table 2). The under-estimation likely occurred near the peak of the coho smolt migration, and the peak of the sockeye salmon smolt migration. Run timing of the coho smolt emigration (Figure 2) was derived from the

Table 1.–Summary of coho salmon smolt tagged with coded wire tags, held overnight, and released following sampling for 24-hour tag retention at Chuck Creek in 2002.

Date	Total tagged	Overnight mortality	Live tagged	# Released with	
				Valid tags	Shed tags
4/21/2002	68	0	68	68	0
4/23/2002	5	0	5	5	0
4/26/2002	221	0	221	221	0
4/29/2002	206	0	206	206	0
5/3/2002	405	0	405	405	0
5/4/2002	129	0	129	129	0
5/5/2002	638	0	638	638	0
5/6/2002	301	0	301	301	0
5/7/2002	117	0	117	117	0
5/8/2002	214	0	214	214	0
5/9/2002	280	0	280	280	0
5/10/2002	253	0	253	253	0
5/11/2002	150	0	150	150	0
5/12/2002	199	0	199	199	0
5/13/2002	465	1	464	464	0
5/14/2002	1,211	1	1,210	1,210	0
5/15/2002	736	0	736	736	0
5/16/2002	308	0	308	308	0
5/17/2002	338	0	338	338	0
5/18/2002	653	0	653	653	0
5/19/2002	708	0	708	703	5
5/20/2002	404	0	404	404	0
5/22/2002	168	1	167	167	0
5/24/2002	192	0	192	192	0
5/25/2002	333	0	333	333	0
5/27/2002	59	0	59	59	0
5/30/2002	78	0	78	78	0
6/1/2002	164	0	164	164	0
Total	**9003**	**3**	**9000**	**8995**	**5**

estimated number of fish captured in the trough trap. Emigrating smolt were first captured in the trough trap on April 21 and catches peaked on May 13 when over 16% of all captured smolt were captured in one 24-hour period. Ninety five percent of all smolt captured were caught between May 2 and May 24. Catches had slowed by June 1, however smolt were still migrating when the weir and trap were dismantled for the season (Figure 2, Table 2).

Three hundred and two (302) coho salmon smolt ≥ 75 mm FL were sampled for age, length and weight (Table 3, Figure 3). Age-1 coho smolt constituted 76.5% of sampled smolt and averaged 103.9 mm in FL (SE=0.6) and 11.0 g in weight (SE=0.2). Age-2 coho smolt constituted the remaining percentage of sampled smolt and averaged 118.6 mm in FL (SE=1.1) and 15.7 g in weight (SE=0.5). The largest coho salmon smolt that was captured was not part of the random sample, but was aged because of its exceptional size. The smolt was 190 mm in FL and 57.3 g in weight and was aged as a 3-year old smolt.

SMOLT ABUNDANCE

Surviving fish from the 2002 smolt emigration returned to Chuck Creek in both 2002 (as jacks) and in 2003 as adults, and each returning fish was examined for a missing adipose fin to determine the marked fraction (θ). In the 2002 escapement,

Table 2.–Estimated daily catch and actual number of coho salmon smolt tagged at Chuck Creek by date, 2002.

Date	Estimated catch		Number of smolt tagged
	Trough trap	Minnow traps	
4/20/2002	0		
4/21/2002	1	73	68
4/22/2002	0		
4/23/2002	1		5
4/24/2002	0		
4/25/2002	1	110	
4/26/2002	4	100	221
4/27/2002	3	50	
4/28/2002	11	60	
4/29/2002	13	43	206
4/30/2002	15		
5/1/2002	19		
5/2/2002	184		
5/3/2002	187		405
5/4/2002	386		129
5/5/2002	432		638
5/6/2002	370		301
5/7/2002	178		117
5/8/2002	291		214
5/9/2002	264		280
5/10/2002	155		253
5/11/2002	121		150
5/12/2002	163		199
5/13/2002	1,396		465
5/14/2002	604		1,211
5/15/2002	466		736
5/16/2002	459		308
5/17/2002	534		338
5/18/2002	746		653
5/19/2002	333		708
5/20/2002	206		404
5/21/2002	54		
5/22/2002	57		168
5/23/2002	150		
5/24/2002	346		192
5/25/2002	26		333
5/26/2002	21		
5/27/2002	24		59
5/28/2002	26		
5/29/2002	27		
5/30/2002	57		78
5/31/2002	78		
6/1/2002	41		164
Total	**8,450**	**436**	**9,003**

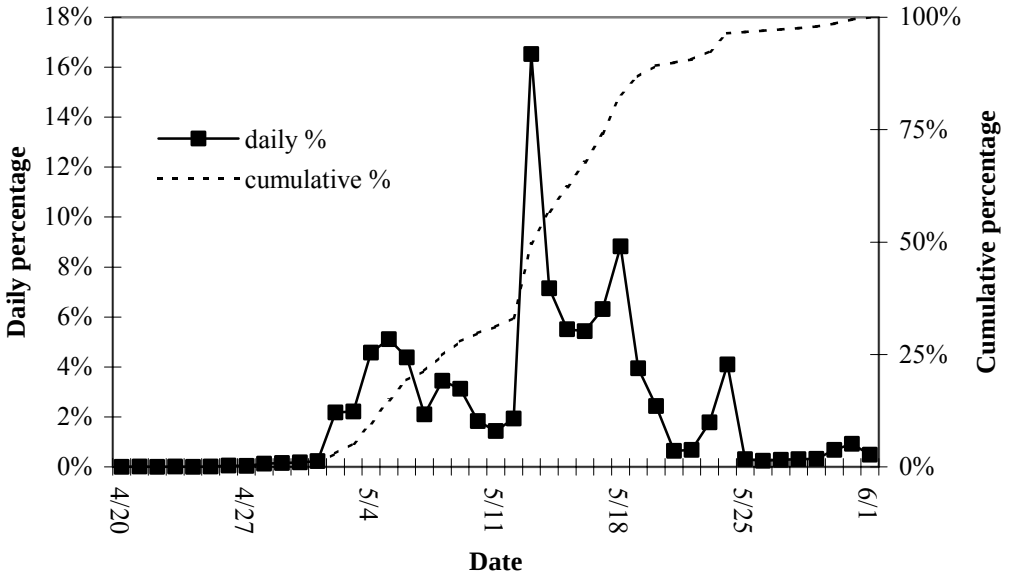

Figure 2.–Estimated daily and cumulative percentage of the coho salmon smolt emigration captured in the trough trap at Chuck Creek in 2002.

479 of 637 jacks (θ =0.752) were missing their adipose fin. In the 2003 escapement, 421 of 612 adults examined (θ =0.688) were missing their fin. These two marked fractions are significantly different (χ^2 = 6.36, df = 1, P = 0.01167, see discussion for details). Pooling both escapement samples (900 in 1,249 marked) yields an estimate of θ =0.721 for the fraction of the 2002 smolt emigration marked. Using Chapman's modified Peterson formula, an estimated 12,487 (SE = 208) coho salmon smolt emigrated from Chuck Creek in 2002 (n_1 = 9,000, n_2 = 1,249, m_2 = 900).

ESCAPEMENT

In 2001 a total of 1,350 adult and 1,084 jack coho salmon were counted and passed through the weir on Chuck Creek between August 7 and November 2 (Appendix A1). In 2002 a total of 2,189 adult and 637 jack coho salmon passed through the weir on Chuck Creek between August 14 and October 15. In 2003 a total of 614 adult and 481 jack coho salmon were counted through the weir on Chuck Creek between August 14 and October 16. Life-history type (adult, jack) was determined on all mature fish, as no overlap in FL between jacks and adults was detected by aging all fish between 380 and 450 mm FL. A total of 1,552 fish were successfully sampled for ocean age (for all three years combined) and the smallest adult was 400 mm in FL and the largest jack was 395 mm in FL (Figure 4). The temporal pattern of immigration of the escapement was similar in all three years, with the escapement in 2002 occurring about a week earlier than 2001 and 2003 (Figure 5). The escapement was at least 95% complete by October 1 in all three years. Timing of the adult coho salmon immigration was similar to that reported during weir operations in 1982, 1983, and 1985 (Integrated Fisheries Database, Commercial Fisheries Division, Douglas), and in 1950 (Edgington et al. 1981).

Table 3.–Estimated age composition and mean length and weight at age of emigrating coho salmon smolt captured at Chuck Creek in 2002.

	Age 1	Age 2	Combined
Sample size	231	71	302
Percentage	76.5%	23.5%	
SE	2.4%	2.4%	
Mean Length (mm)	103.9	118.6	107.4
SE (mean length)	0.6	1.1	0.7
Mean Weight (g)	11	15.7	12.1
SE (mean weight)	0.2	0.5	0.2

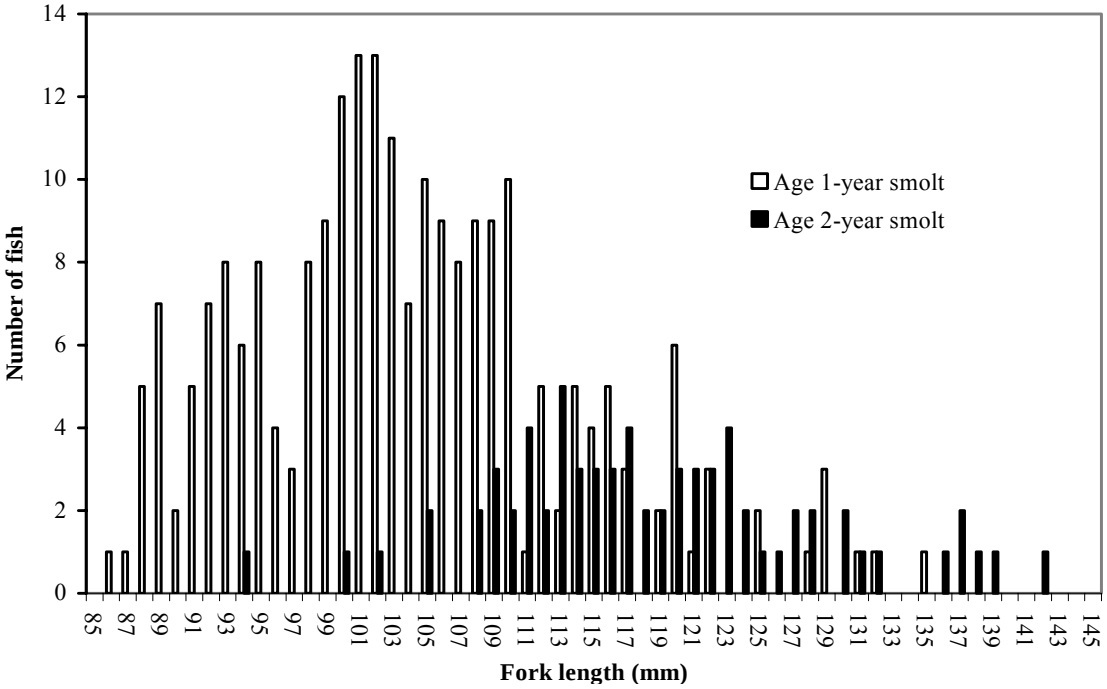

Figure 3.–Length frequency of sampled coho salmon smolt emigrating from Chuck Creek in 2002.

From 14% to 35% of the annual adult escapement and 14% to 21% of the annual jack escapement that was passed through the weir was successfully sampled for length and age for the three years of operations (Table 4). Sample sizes were slightly higher for sex determination than age determination, as sex was estimated on all fish sampled, but not all scale samples were readable due to some regenerated or otherwise unreadable scale samples.

The freshwater age of both jacks and adults was predominately age 1.x (1-year old smolt, Table 5). The proportion of jacks in the annual escapement averaged 37% over the study, compared to 45% in 2001, 23% in 2002, and 44% in 2003. Jacks outnumbered adult males in 2001 and 2003 at a ratio of 1.8:1 to 2.6:1 respectively, but adult males outnumber jacks in 2002 at a ratio of 1.5:1. Adult females outnumbered adult males in all three years (Table 6).

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

Because fish marked with CWTs do not always retain their tag, the marked fraction of adult coho salmon (for harvest estimations) was determined by sampling the adult escapement for the presence of CWTs in 2003. In a random sample of adult coho salmon captured at the weir in the 2003 escapement, all adults found to be missing an adipose fin (84), also tested positive for the presence of a CWT in their snout. Harvest was estimated based on the fraction of the adult escapement without adipose fins (θ =0.688. as all adults missing an adipose fin were assumed to have retained their CWT).

A total 207 adult coho salmon tagged as smolt emigrating from Chuck Creek in 2002 were recovered in creel and port sampling programs in 2003 (Appendix A2). There were no recoveries reported for marine fisheries in Canada. Of this total, 192 recoveries were random samples that were useful for estimating marine harvest in various fisheries. The greatest number (167) of the random CWT recoveries of Chuck Creek coho was in the troll fishery and the remainder was in the seine fishery (13), and the sport fishery (12). In addition, there were 8 random recoveries in the commercial fishery where the fishing area was not designated and 7 non-random select recoveries in the commercial and sport fisheries (Appendix A2). Of the random troll recoveries, 133 were recovered

Table 4.–Escapement (weir count) and sample sizes for sex and age by temporal strata, ocean age (adult/jack), and freshwater age of mature coho salmon passed through the Chuck Creek weir 2001-2003.

Year	Strata (date)	Weir count		Number Sampled							
		Adults	Jacks	Adult male			Adult female			Jack-male	
				1.1	2.1	All[1]	1.1	2.1	All[1]	1.0	2.0
2001	1 (8/7-9/20)	890	734	155	2	178	204	12	255	144	56
	2 (9/21-11/2)	460	350	49	4	60	39	5	53	26	8
	Total	1,350	1,084	204	6	238	243	17	308	170	64
2002	1 (8/14-9/10)	1,192	330	88	6	108	97	23	134	53	9
	2 (9/11-10/15)	997	307	34	4	45	47	3	54	28	2
	Total	2,189	637	122	10	153	144	26	188	81	11
2003	1 (8/14-9/14)	268	83	11	1	13	15	3	22	7	0
	2 (9/15-10/16)	346	398	21	1	24	68	3	75	74	2
	Total	614	481	32	2	37	83	6	97	81	2

[1] Includes fish not successfully aged for freshwater age

Table 5.–Estimated number at age, age composition and mean length (mm) at age of adult and jack coho salmon in the escapement at Chuck Creek 2001-2003.

		Adults			Jacks		
		Age 1.1	Age 2.1	All[1]	Age 1.0	Age 2.0	All[1]
2001	Estimated Number	1,270	80	1,350	796	288	1,084
	Percent	94.0%	6.0%	100%	73.4%	26.6%	100%
	SE Percent	1.1%	1.1%	0%	2.9%	2.9%	0%
	Mean Length	622.2	622.7	621.4	301.1	312.2	304.3
	SE Mean Length	2.2	19.0	1.7	1.7	3.3	1.3
2002	Estimated Number	1,948	241	2,189	569	68	637
	Percent	89.0%	11.0%	100%	89.3%	10.7%	100%
	SE Percent	1.7%	1.7%	0%	3.0%	3.0%	0%
	Mean Length	621.8	631.2	622.3	309.4	324.2	311.0
	SE Mean Length	2.7	5.8	2.5	2.7	4.9	2.4
2003	Estimated Number	563	51	614	471	10	481
	Percent	91.8%	8.2%	100%	97.8%	2.2%	100%
	SE Percent	2.8%	2.8%	0%	1.4%	1.4%	0%
	Mean Length	629.3	660.4	632.3	321.4	352.5	322.4
	SE Mean Length	4.6	17.0	4.0	2.3	11.2	2.2

[1] Includes fish not successfully aged for freshwater age

Table 6.–Estimated sex composition of adult coho salmon (age x.1) through the Chuck Creek weir 2001–2003.

Year	% Males	SE
2001	45.2%	1.8%
2002	45.0%	2.7%
2003	29.9%	4.0%

in the SW quadrant, and the remainder was recovered in the NW quadrant (17) and the SE quadrant (17). Seine recoveries were in fishing districts 103, 104, and 105. Sport fish recoveries were sampled in the ports of Sitka and Craig/Klawock.

An estimated 874 (SE=95) coho salmon originating from Chuck Creek were harvested in marine commercial and sport fisheries in 2003 (Table 7). The commercial troll fishery harvest an estimated 539 fish (62% of the total harvest) and the purse seine fishery harvested an estimated 252 fish or 29% of the total harvest (Table 8). The sport fishery harvested an estimated 83 fish or 9% of the total. Harvested fish were sampled from late June through mid September (Figure 6, Appendix A2).

The total run of Chuck Creek adult coho salmon was estimated at 1,488 fish (SE = 95) in 2003. Marine survival to adult of the 2002 smolt emigration was estimated at 11.9% (SE = 0.8%) and the exploitation rate in marine fisheries was estimated at 58.2% (SE = 2.6%). An additional 637 fish, or 5.1% (SE =0.09%) of the estimated 12,487 smolt that emigrated in 2002 survived to return as jacks in the same year as their emigration.

DISCUSSION

I believe that our smolt weir was operational prior to significant emigration (Table 2, Figure 2), and it appeared to be virtually 100% effective at capturing coho salmon smolt while it was operating. However, an estimated 28% of the escapement from this smolt emigration was unmarked. I conclude that almost all of these unmarked fish left as smolt after the juvenile weir was removed in 2002. Therefore, it appears that all coho salmon smolt did not have an equal probability of being marked in this study.

The unequal probability of marking described above could lead to bias in our smolt abundance estimate if the marked and unmarked fish survived at different rates. I cannot test for differences in survival rates between marked and unmarked smolt in this study, but simple simulations were conducted to illustrate the magnitude of potential bias. If survival of untagged fish varied by as much as 25% from survival of tagged fish, bias in our abundance estimate would be 4.2% (if untagged fish survived better) or –10.6% (if untagged fish survival worse). These simulations demonstrate that it would require a very large difference in survival rates between marked and unmarked fish to greatly bias our smolt abundance estimate.

Survival and life history type (jack or adult) of coho salmon can be a function of smolt emigration timing and/or size at the time of emigration (Bilton et al. 1982, Lum 2003). In a study at Rosewall Creek on Vancouver Island, Bilton et al. (1982) reported that hatchery coho salmon smolt that are larger and released earlier are more likely to be jacks than those that are smaller and released later. Lum (2003) reported that for wild coho salmon at Auke Creek near Juneau, almost all jacks came from smolt that emigrated early in the emigration, and that larger smolt produced significantly more jacks than smaller smolt. In Chuck Creek, I did not detect that smolt size was related to emigration date (Figure 7), for the portion of the emigration that was captured.

At Chuck Creek the marked fractions for jacks (=0.752) and adults (=0.688) were statistically different (P=0.01). If the life history type (jack or adult) was a function of emigration date in this study, that could explain the different marked fractions that were encounter at Chuck Creek, as the two life history types would have likely been marked at different rates. I hypothesize that this was the case and jacks and adults returning to Chuck Creek from the 2002 smolt emigration did have different emigration schedules (jacks tended to emigrate earlier) and that they were marked at different rates (jacks were marked at higher rates). However, another possible explanation for the different marked fractions of adults and jacks could have been that smolt that were destined to become either adults or jacks had different

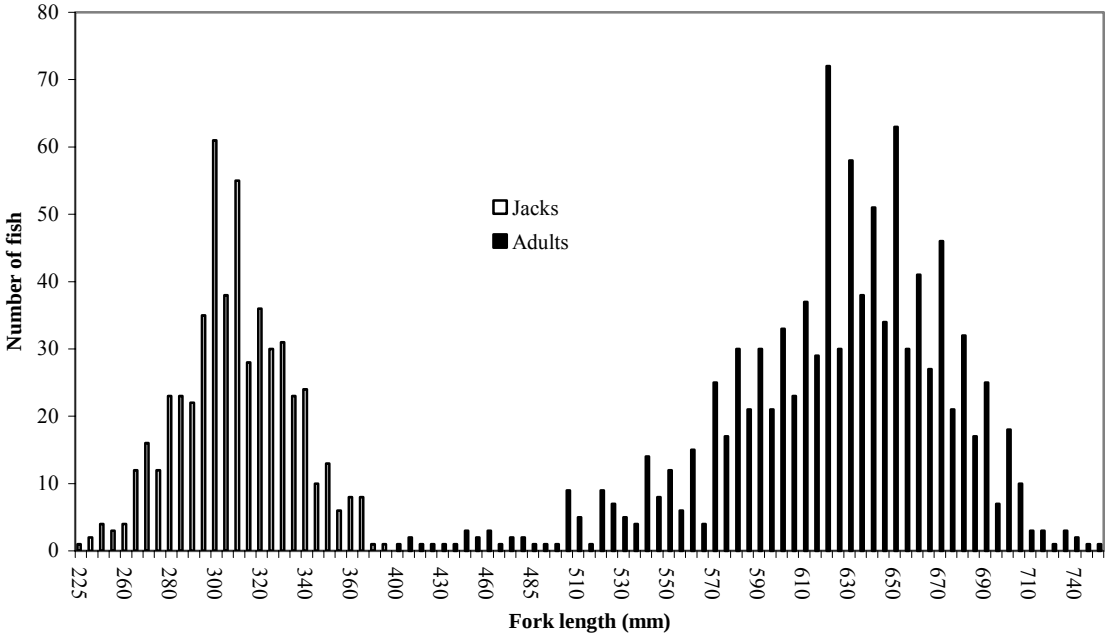

Figure 4.–Lengths of 1,552 mature coho salmon sampled at the Chuck Creek weir 2001-2003 by ocean age.

survival rates among their respective marked and unmarked groups. The difference in the marked fractions between jacks and adults, although statistically significant, was not large and suggest that marked and unmarked smolt did not differ greatly in life history type. This suggest survival may also not have differed greatly between marked and unmarked fish (and therefore bias in our smolt abundance estimate is low).

Although I don't believe it is uncommon for a portion of coho salmon smolt to emigrate after June 1 the magnitude of the unmarked fraction at Chuck Creek was surprising. I speculate that many of the unmarked fish may have been delayed in emigration due to low flows impeding emigration past beaver dams on upper watershed tributaries. Water levels remained relatively low in the spring of 2002 and the stream level near the weir site never rose more than 2.5 cm (one inch) from the level at the time of weir installation until it was dismantled.

We also notice that marked fish may not have mixed completely with unmarked fish in the population between migrations of smolt and mature fish, as both jacks and adults that returned earlier in the escapement (before 9/16) were marked at a higher rate ($P < 0.001$) than those that returned later (Figure 8). The reason for this is unclear, but the return date of immigration may be related to the date of smolt emigration (i.e. smolt that migrated earlier and were apparently marked at a higher rate return as jacks and adults earlier).

As only one tag code was used for all of the 2002 smolt emigration there is no way to test this theory. As an aside, I estimate that 95% of the coho salmon returning to Chuck Creek are captured within 24 hours of entering fresh water (based on personal observations and observations of the field crews), so capture date is a good indicator of run timing.

The adult weir was not breached in any of the years of operation and it appears that nearly the entire escapement entered the stream between August 14 and October 15 (Appendix A1). A small number of fish may return after October 15, however this number is likely very small (Appendix A1). I believe that no coho returned before the weir was installed in all three years, as weir data from the 1980s indicates no coho immigration before mid August and in the period 2001-2003 upstream migration to adult salmon was blocked by beaver dams (coupled with low

Table 8.–Estimated marine harvest (r_i) of adult coho salmon bound for Chuck Creek in 2003.

TROLL FISHERY													
Stat week	**Dates (period)**	**Quad**	**Harvest**	**Var(H)**	**n_i**	**a_i**	**a_i'**	**t_i**	**t_i'**	**m_i**	**r_i**	**SE(r_i)**	**RP(r_i)**
27-33	6/29-8/16 (3)	NW	261,309	0	73,397	1,389	1,377	1,142	1140	11	58	16	55%
34-40	8/17-10/4 (4)	NW	438,499	0	128,461	3,480	3,451	2,960	2959	6	30	11	73%
27-33	6/29-8/16 (3)	SW	164,830	0	81,032	1,424	1,395	1,138	1136	96	290	31	21%
34-40	8/17-10/4 (4)	SW	29,461	0	21,083	498	495	431	431	37	76	10	27%
27-33	6/29-8/16 (3)	SE	83,806	0	26,656	402	383	291	291	6	29	11	72%
34-40	8/17-10/4 (4)	SE	107,787	0	31,011	759	748	632	631	11	56	16	55%
Troll subtotal			1,085,692	0	361,640	7,952	7,849	6,594	6,588	167	539	43	16%
PURSE SEINE FISHERY													
Stat week	**Dates**	**District**	**Harvest**	**Var(H)**	**n_i**	**a_i**	**a_i'**	**t_i**	**t_i'**	**m_i**	**r_i**	**SE(r_i)**	**RP(r_i)**
wk 31	7/27-8/2	103	2,479	0	185	5	5	5	5	1	19	19	191%
wk 32	8/3-8/9	103	2,883	0	248	9	9	9	9	2	34	23	135%
wk 33	8/10-8/16	103	11,178	0	312	4	4	4	4	1	52	52	194%
wk 34	8/17-8/23	103	6,647	0	481	10	10	9	9	3	60	34	111%
wk 30	7/20-7/26	104	8,965	0	2,594	25	25	20	20	3	15	8	102%
wk 31	7/27-8/2	104	20,029	0	935	21	21	18	18	1	31	31	193%
wk 33	8/10-8/16	104	7,864	0	1,177	16	16	12	12	1	10	9	186%
wk 31	7/27-8/2	105	4,606	0	218	3	3	3	3	1	31	30	193%
Purse Seine subtotal			64,651	0	6,150	93	93	80	80	13	252	82	64%
SPORT FISHERY													
Biweek	**Dates**	**Area**	**Harvest**	**Var(H)**	**n_i**	**a_i**	**a_i'**	**t_i**	**t_i'**	**m_i**	**r_i**	**SE(r_i)**	**RP(r_i)**
bw 14	7/6-7/19	Craig	12,004	0	2,288	29	29	28	28	2	15	10	130%
bw 15	7/20-8/2	Craig	11,609	0	2,261	29	29	26	26	3	22	12	106%
bw 16	8/3-8/16	Craig	13,715	0	2,756	35	35	33	33	4	29	14	92%
bw 13	6/22-7/5	Sitka	5,529	2,635,075	1,657	35	35	31	29	1	5	5	176%
bw 15	7/20-8/2	Sitka	15,148	9,760,054	4,196	121	121	105	104	1	5	5	177%
bw 16	8/3-8/16	Sitka	17,850	10,354,589	4,407	134	132	123	123	1	6	5	179%
Sport subtotal			75,855	22,749,718	17,565	383	381	346	343	12	83	22	53%
TOTAL ALL FISHERIES			1,226,198	22,749,718	385,355	8,428	8,323	7,020	7,011	192	874	95	21%

See text for details concerning notation**.**

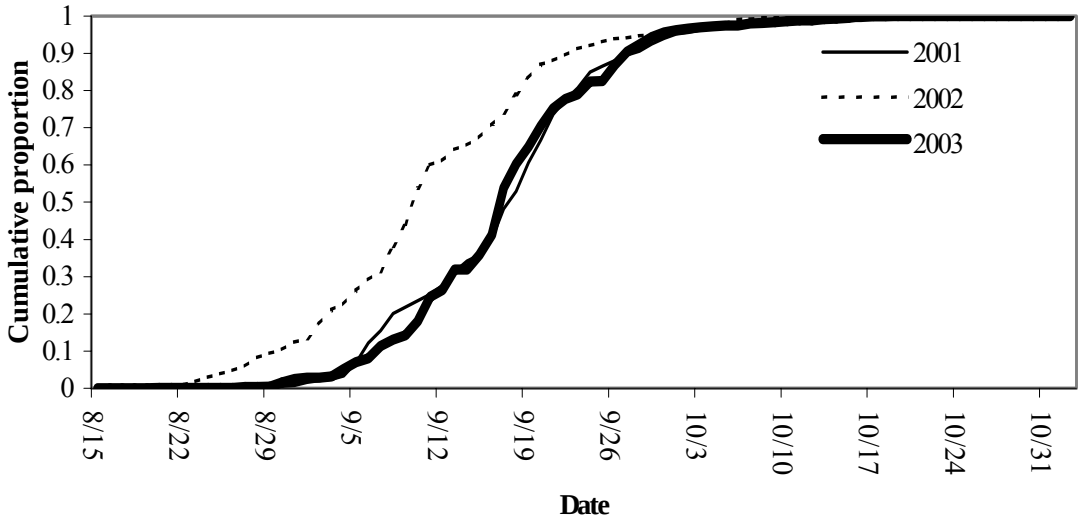

Figure 5.–Cumulative proportion of the coho salmon escapement (adults and jacks combined) passed through the Chuck Creek weir by date 2001-2003.

flows) in the outlet stream near the location of the weir. Also, field crews probably would have observed any coho that entered the stream before this time. Although the weir may not have been fish tight for smaller jacks, field crews did not detect any coho being able to pass through the weir without entering the cage. The large number of jacks that were captured in the cage (including jacks as small as 225 mm FL) indicated that jacks were unable to find passage through the weir and entered the cage instead.

We assume there was no recruitment to the population between events (condition 2 for an accurate smolt abundance estimate) as almost all salmon return to their natal streams to spawn. Examination for adipose clips or tags of 3,539 adult and 1,084 jack coho salmon at the Chuck Creek weir in 2001 and 2002 (before marked Chuck Creek fish would have returned) detected no marked or tagged fish from any other study. A random sample of 60 adipose-clipped jacks sacrificed at the weir in 2002 was all tagged as smolt in Chuck Creek the previous spring.

We believe conditions 4 and 5 for a smolt abundance estimate were met as all tagged fish were also marked with a secondary mark (an adipose fin clip) that was recognizable (condition4), and the crew carefully examined and recorded all mature coho salmon at the weir (condition 5).

An estimated exploitation rate of 58.2% for Chuck Creek coho salmon in 2003 is very similar to the estimated average exploitation rate of 62.3% (range 48.6-75.1%) for this stock in the years 1982, 1983, and 1985 (Shaul et al. 1991). Marine harvest spatial patterns for Chuck Creek coho salmon are similar to those reported by Shaul et al. (1985; 1986) for this stock and were confined mostly to the outside coast. Harvest in the seine and troll fisheries reported for the SE quadrant came from fishing district 105 and usually in sub districts (when reported) closer to the outside. These recoveries are not an exception to the pattern of coho salmon being harvested as they migrate from North to South along the outside coast, but are likely fish moving from the southern tip of Baranof Island to the west coast of Kosciusko Island on their return to Heceta Island.

The estimated total adult run of 1,488 coho salmon in 2003 is only about half of the average total run of approximately 3,000 fish from the three years of estimates in the 1980s. This is likely due to a below average smolt emigration in 2002 (along with average marine survival of this cohort) rather than an overall decline in productivity of the Chuck Creek watershed.

Table 9.–Estimated harvest, exploitation, and total run of Chuck Creek coho salmon in 2003.

Fishery	Area	Estimated harvest	SE	Percent of marine harvest	Percent of total run
Troll	NW Quadrant	88	20	10.1%	5.9%
	SW Quadrant	366	33	41.9%	24.6%
	SE Quadrant	85	19	9.7%	5.7%
	subtotal	539	43	61.7%	36.2%
Seine	District 103	165	69	18.9%	11.1%
	District 104	56	33	6.4%	3.8%
	District 105	31	30	3.5%	2.1%
	subtotal	252	82	28.8%	16.9%
Sport	Craig/Klawock	67	21	7.7%	4.5%
	Sitka	16	9	1.8%	1.1%
	subtotal	83	22	9.5%	5.6%
Total harvest		874	95	100.0%	58.7%
Escapement		614	0		41.3%
Total Run		1,488	95		100.0%

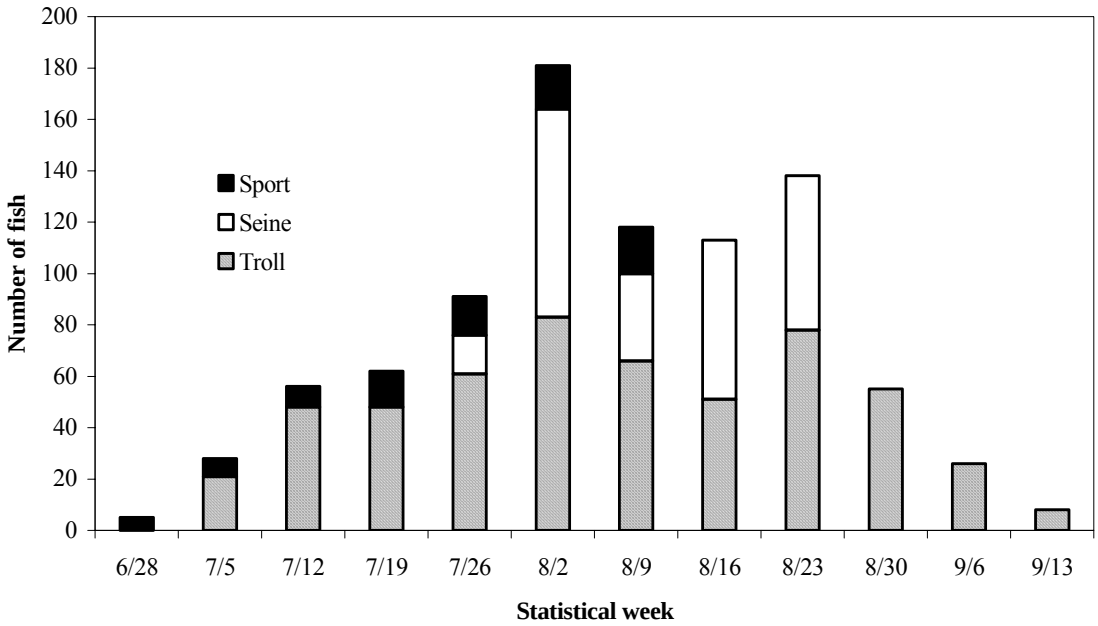

Figure 6.–Estimated marine harvest of coho salmon bound for Chuck Creek by statistical week and fishery in 2003.

Weekly estimates of harvest in the troll and sport fisheries are approximated.

Escapements in both 2001 and 2002 were much larger than 2003 and also larger than any escapements reported from the 1980s. Shaul et al. (1986) estimated the *juvenile* rearing population (at the time of coded wire tagging) in the summers of 1980 and 1981 was 49,132 (95% C. I. 41,319-62,090) for 1980, and 81,538 (95% C. I. 59,279-112,880) for 1981. These estimates seem high in comparison to a smolt estimate of approximately 12,500 fish in 2002. However, over- winter mortality could be high and a smolt emigration of 12,500 fish might be on the low range of average smolt production. The brood year escapement that produced the 2002 smolt emigration (2000 for age-1 smolt, and 1999 for age-2 smolt) is unknown.

The limited data collected to date makes evaluation, and identifying the factors that affect the long-term productivity of the Chuck Creek watershed difficult. Future work at Chuck Creek will aid us in understanding annual variability in production and help us make some quantitative comparisons. Despite obvious changes to the watershed from large scale logging and road building in the 1970s and 80s multiple factors that are interrelated likely play a role in the ability of the Chuck Creek watershed to produce coho salmon, and effects from anthropogenic changes may be difficult to detect. Obvious factors that likely contribute to coho production in the watershed include its relatively low gradient, a lake and numerous ponds in the system, and the surrounding geology among others.

Shaul compared estimated juvenile rearing populations and adult returns per hectare of lake surface area for eight watersheds in Southeast Alaska (Auke Lake, Berners River, Speel Lake, Ford Arm Lake, Politofski Lake, Chuck Lake, Klakas Lake, and Hugh Smith Lake) in the early 1980s and only Ford Arm Lake had higher juvenile densities and adult returns per hectare than Chuck Lake (Shaul et al. 1985). Bryant et al. (1998) reported in a study of coho populations of north Prince of Wales Island that streams flowing through karst landscapes appear to support more fish and contain bigger coho salmon juveniles compared to what is found in nonkarst streams.

Age data from the 2002 smolt emigration as well as that collected from the escapements of 2001-2003 show that the majority of coho salmon from the Chuck Creek watershed smolt as one-year old

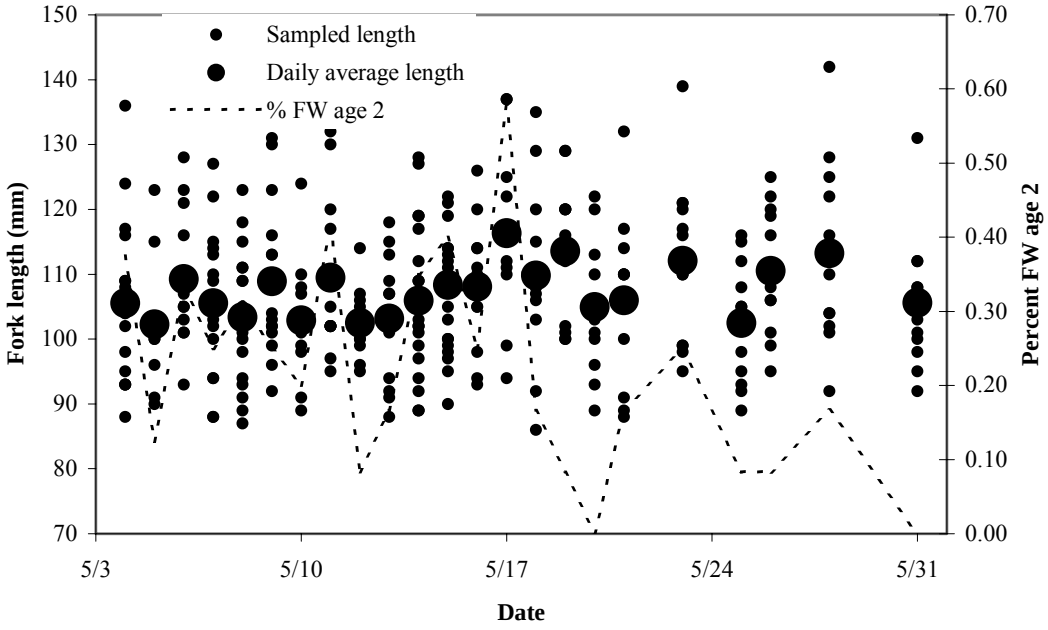

Figure 7.–Fork lengths plotted by date of capture and percent of 2-year old smolt of 302 coho salmon smolt sampled emigrating from Chuck Creek in 2002.

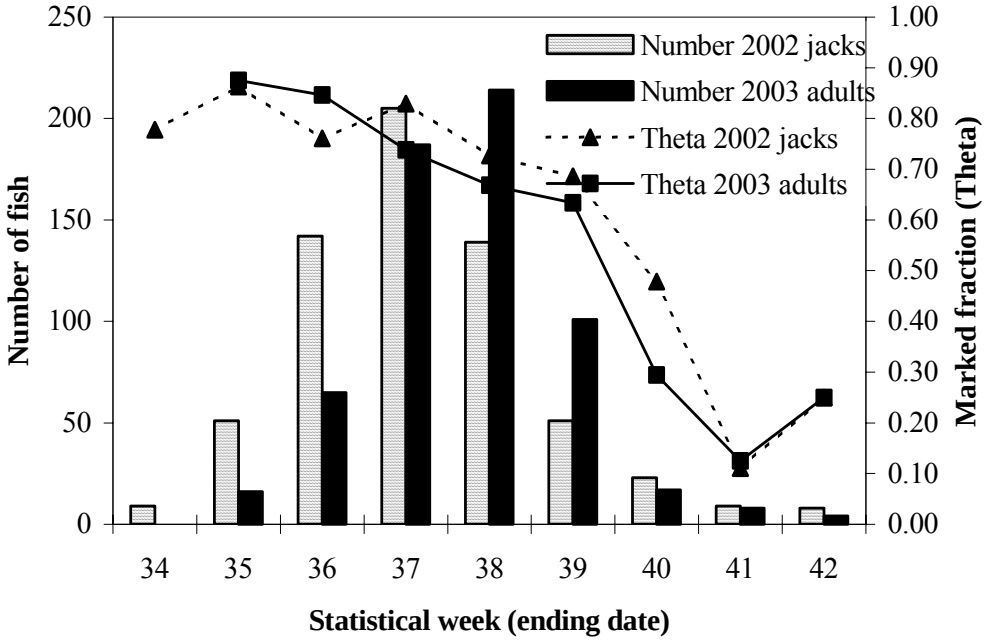

Figure 8.–Marked fraction and number of jack and adult coho salmon sampled from the 2002 smolt emigration at the Chuck Creek weir by statistical week.

Note: stat wk 34 starts 8/18 in 2002 and on 8/17 in 2003.

fish. Tschaplinski (Knudsen et al. 2000) reported that although summer rearing coho salmon juveniles declined in Carnation Creek, British Columbia following large scale logging in the watershed, the number of smolt actually increased and the number of age-2 smolt went from being nearly 50% of the annual smolt emigration to being relatively rare. Tschaplinski attributes increased over-winter survival of coho juveniles and more coho reaching a size threshold to smolt at age-1 instead of age-2 due to increased water temperatures and fish growth in Carnation Creek following logging. Although both the Carnation Creek and Chuck Creek watersheds share similar attributes (located on the Pacific Coast in a temperate rainforest with similar weather patterns), Chuck Creek differs from Carnation Creek in several aspects, including the presence of a lake in the system, karst geology and extensive alterations to the aquatic and riparian habitat from beaver activity. Although beaver activity has greatly increased following logging, and water temperature and flow regimes may have been influenced, it is likely that the majority of Chuck Creek coho have always smolted at age-1.

Alterations to the aquatic and riparian habitat from beaver activity appear to have increased dramatically following logging activities in the watershed. Photos and detailed sketches of the entire length of Chuck Creek from salt water to the lake from June 1978 reported by Edgington et al. (1981) show no sign of any beaver activity although they note "bear, deer and wolf sign" in their report. Clear-cutting had begun in the riparian area by 1978, as Edgington's photos and sketches show the lower west side of the stream completely clear-cut to the waters edge. By 1983 over 80% of both banks of the outlet stream had been clear-cut to the waters edge. ADF&G staff noted no beaver dams in the outlet stream during weir operations in 1983 (Glenn Freeman ADF&G, Ketchikan, personal communications). By June 2001, three major beaver dams were obstructing upstream migration to anadromous fish between the salt water and the lake. The dams were composed of a combination of logging slash,

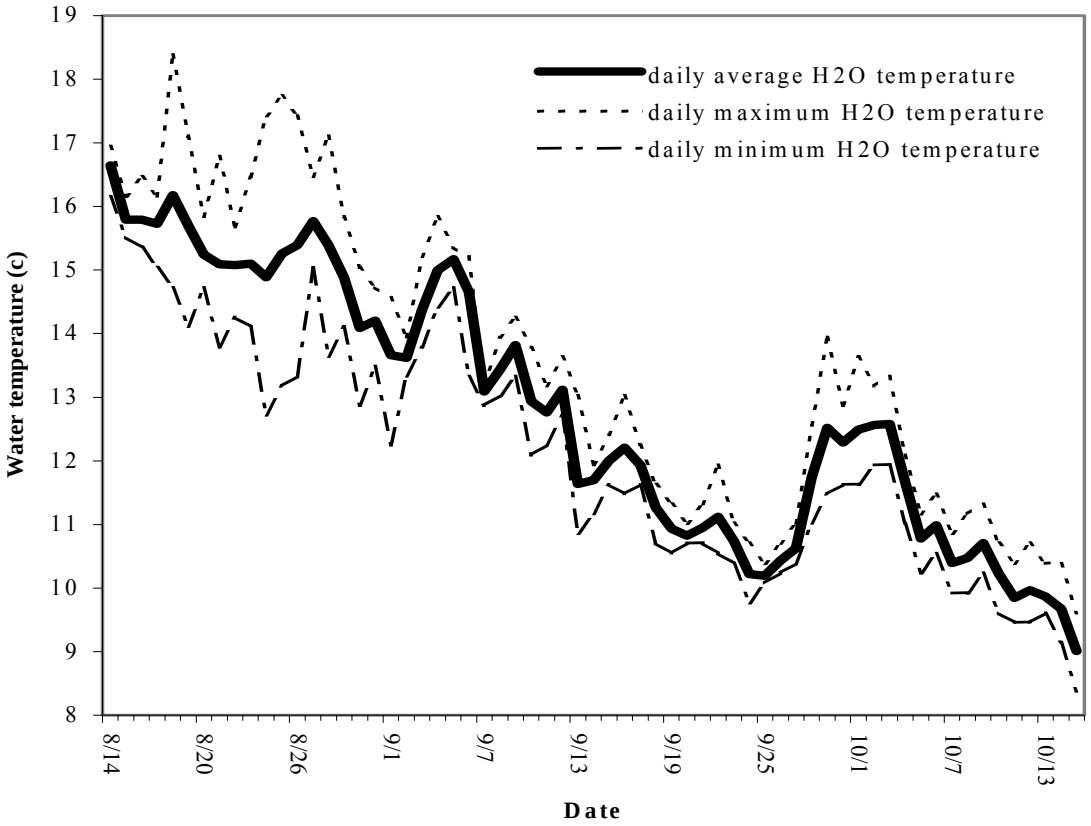

Figure 9.–Daily, average, minimum, and maximum water temperatures recorded at the Chuck Creek weir (measured hourly) during the 2003 adult escapement of coho salmon.

second growth conifer, brush, cobbles and a small amount of finer sediment. This lack of sediment allowed most of the stream flow to percolate through the dam rather than spill over the top at all but the highest flows. Numerous unspawned adult sockeye carcasses were found entangled in the dams when weir operations began in August of 2001 and 2002. ADF&G personnel maintained openings in the dams for fish passage while the weir was in operation. At the start of weir operations on August 13, 2003 salmon were prevented from migrating upstream due to low flows and at least a third of the estimated 150 adult sockeye that had entered the stream in the previous few days were dead or dying from being stranded in shallow riffles and/or the warm water temperatures (Figure 9). The crew rearranged debris and cobbles in the streambed to allow for upstream passage of fish. Beaver dams in the outlet stream were not obstacles to fish migration during the coho escapement as the crew maintained openings in the dams. However as is the case with sockeye, it is likely that in the past, some mortality occurred during the coho immigration at the beaver dams, and that coho salmon could only migrate past the dams at higher flows. The overall impact of increased beaver activity in the watershed to coho salmon production is not known.

Delays to immigration and mortality of adults may be outweighed by increased (both in quantity and quality) rearing and over winter habitat for juveniles. Personal observations of the outlet stream in the summer and fall showed that juvenile coho salmon were extremely abundant. However over-winter habitat appeared marginal, as the ponds were relatively shallow, with little quality cover. This observation was also supported by the extremely low catch rates in these habitats from minnow trapping in the early spring of 2002 before smolt emigration had begun. Tributaries to the lake have not been evaluated as to changes to the aquatic community following logging, or effects on salmonids, other

than it appears that upstream migration is obstructed by beaver dams in some cases and one of the major spawning streams may have significantly less spawning habitat available than pre-logging conditions, as many riffles have been flooded by ponds. Regardless of the impacts that the beaver activity has had on the aquatic community and salmonid fishes, current conditions are likely to persist for some time. Moreover, vegetation in the riparian zone will likely be prevented from returning to old growth conditions as the second growth conifers are either directly killed by the beavers or die as a result of the raised water table from dam building.

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APPENDIX A

Appendix A1.– Daily escapement counts of mature coho salmon through the salmon weir on Chuck Creek by life-history type, 2001-2003.

	Adults (age x.1)			Jacks (age x.0)		
Date	**2001**	**2002**	**2003**	**2001**	**2002**	**2003**
8/7	0			0		
8/8	0			0		
8/9	0			0		
8/10	0			0		
8/11	0			0		
8/12	0			0		
8/13	0			0		
8/14	0	1	0	0	0	0
8/15	0	1	0	0	0	0
8/16	0	1	0	0	0	0
8/17	0	0	0	0	0	0
8/18	0	0	0	0	0	0
8/19	1	0	0	0	1	0
8/20	0	0	0	0	0	1
8/21	2	3	0	0	1	0
8/22	1	16	0	0	1	0
8/23	0	23	0	0	5	0
8/24	0	29	0	0	1	0
8/25	0	22	0	0	4	0
8/26	0	22	0	0	4	0
8/27	2	30	2	3	4	1
8/28	0	51	0	1	13	0
8/29	0	21	1	0	12	0
8/30	2	24	13	1	6	0
8/31	6	45	10	0	8	0
9/1	17	22	3	3	10	0
9/2	10	95	0	0	14	0
9/3	9	82	3	2	24	1
9/4	14	33	20	6	9	2
9/5	64	73	18	23	31	1
9/6	96	47	11	32	34	1
9/7	50	45	33	33	20	3
9/8	63	148	17	49	44	2
9/9	20	122	12	22	43	1
9/10	19	236	31	23	41	10
9/11	15	139	41	27	36	30
9/12	40	21	13	18	10	7

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	Adults (age x.1)			Jacks (age x.0)		
Date	**2001**	**2002**	**2003**	**2001**	**2002**	**2003**
9/13	24	67	40	66	19	21
9/14	19	19	0	49	12	0
9/15	9	38	15	30	22	28
9/16	31	75	38	73	19	20
9/17	81	76	77	118	18	61
9/18	74	114	28	41	24	43
9/19	115	102	25	71	22	25
9/20	106	77	31	43	26	31
9/21	121	23	31	47	8	20
9/22	59	32	10	34	11	17
9/23	56	32	4	24	14	10
9/24	39	18	16	63	7	22
9/25	26	19	0	15	8	1
9/26	15	18	20	20	5	28
9/27	22	6	20	14	3	19
9/28	11	13	5	15	3	16
9/29	21	4	6	26	3	16
9/30	18	3	3	20	3	10
10/1	16	9	1	10	2	6
10/2	7	8	0	6	4	4
10/3	9	5	2	7	2	3
10/4	5	31	0	4	4	2
10/5	5	11	0	4	5	2
10/6	2	21	0	5	7	1
10/7	1	4	3	1	0	3
10/8	0	7	1	4	1	0
10/9	2	2	2	3	0	1
10/10	1	0	0	2	0	2
10/11	1	2	2	4	0	1
10/12	5	1	0	2	1	0
10/13	2	0	1	2	4	2
10/14	0	0	1	0	0	1
10/15	2	0	2	3	4	0
10/16	0		2	0		3
10/17	6			0		
10/18	1			1		
10/19	1			0		

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Appendix A1.–Page 3 of 3

	Adults (age x.1)			Jacks (age x.0)		
Date	**2001**	**2002**	**2003**	**2001**	**2002**	**2003**
10/20	0			1		
10/21	1			1		
10/22	1			1		
10/23	0			0		
10/24	0			0		
10/25	0			0		
10/26	0			0		
10/27	0			1		
10/28	0			3		
10/29	4			5		
10/30	0			1		
10/31	0			1		
11/1	0			0		
11/2	0			0		
Totals	1,350	2,189	614	1,084	637	481

Appendix A2.–Random and select recoveries of coded wire tagged coho salmon from the Chuck Creek watershed harvested in marine commercial and sport fisheries in 2003.

Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
RANDOM RECOVERIES								
526767	Ketchikan	Seine	7/22/2003	30	SW	104		625
526949	Ketchikan	Seine	7/23/2003	30	SW	104		586
526950	Ketchikan	Seine	7/23/2003	30	SW	104		640
516382	Petersburg	Seine	7/24/2003	30	SW			551
516388	Petersburg	Seine	7/24/2003	30	SW			689
521138	Petersburg	Seine	7/28/2003	31	SW	104	40	628
521276	Petersburg	Seine	7/31/2003	31	SW	103	80	651
521295	Petersburg	Seine	8/2/2003	31	SE	105		643
521195	Petersburg	Seine	8/6/2003	32	SW	103	80	590
521197	Petersburg	Seine	8/6/2003	32	SW	103	80	605
521446	Petersburg	Seine	8/11/2003	33	SW	104	40	654
521724	Petersburg	Seine	8/13/2003	33	SW	103	90	650
521728	Petersburg	Seine	8/19/2003	34	SW	103	80	525
516050	Petersburg	Seine	8/20/2003	34	SW	103	80	659
519000	Petersburg	Seine	8/20/2003	34	SW	103	80	697
242718	Sitka	Sport	6/27/2003	26	NW	113	41	650
241227	Craig	Sport	7/5/2003	27	SW	103	70	605
241228	Craig	Sport	7/5/2003	27	SW	103	70	675
241247	Craig	Sport	7/13/2003	29	SW	103	70	615
242770	Sitka	Sport	7/15/2003	29	NW	113	45	620
241251	Craig	Sport	7/17/2003	29	SW	104	40	645
241258	Craig	Sport	7/20/2003	30	SW	104	40	660
241112	Craig	Sport	7/29/2003	31	SW	103	70	630
241271	Craig	Sport	8/1/2003	31	SW	103	70	665
241275	Craig	Sport	8/1/2003	31	SW	104	40	665
241288	Craig	Sport	8/2/2003	31	SW			685
254811	Sitka	Sport	8/22/2003	34	NW	113	45	680
197677	Sitka	Troll	7/3/2003	27	NW	113	41	640
197673	Sitka	Troll	7/3/2003	27	NW	113	41	669
206026	Sitka	Troll	7/3/2003	27	NW	113	45	618
527192	Craig	Troll	7/4/2003	27	SW	104	40	519
206109	Sitka	Troll	7/5/2003	27	NW	113	45	576
527591	Craig	Troll	7/9/2003	28	SW	104	35	631
527594	Craig	Troll	7/9/2003	28	SW	104	35	635
527265	Craig	Troll	7/10/2003	28	SW	103	90	579
206196	Sitka	Troll	7/10/2003	28	NW	113	41	599
527507	Craig	Troll	7/11/2003	28	SW	104	40	587
523850	Craig	Troll	7/11/2003	28	SW	104	40	630
527517	Craig	Troll	7/11/2003	28	SW	104		603
527513	Craig	Troll	7/11/2003	28	SW	104		606

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Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
RANDOM RECOVERIES								
527610	Craig	Troll	7/11/2003	28	SE	105	50	585
527607	Craig	Troll	7/11/2003	28	SE	105	50	612
527639	Craig	Troll	7/12/2003	28	SW	104	35	594
527646	Craig	Troll	7/12/2003	28	SW	104	35	625
523705	Craig	Troll	7/12/2003	28	SW	104	40	644
523723	Craig	Troll	7/12/2003	28	SW	152		615
527447	Craig	Troll	7/13/2003	29	SW	104	35	625
527753	Craig	Troll	7/14/2003	29	SW	104	40	582
527867	Craig	Troll	7/15/2003	29	SW	103	70	598
527047	Craig	Troll	7/15/2003	29	SW	103	90	603
527045	Craig	Troll	7/15/2003	29	SW	103	90	643
527342	Craig	Troll	7/16/2003	29	SW	103	50	648
527306	Craig	Troll	7/16/2003	29	SW	103	70	585
527305	Craig	Troll	7/16/2003	29	SW	103	70	631
527309	Craig	Troll	7/16/2003	29	SW	103	70	802
527710	Craig	Troll	7/16/2003	29	SW	104	40	594
527930	Craig	Troll	7/17/2003	29	SW	152		603
527870	Craig	Troll	7/17/2003	29	SW	152		614
527747	Craig	Troll	7/18/2003	29	SW	103	90	596
527890	Craig	Troll	7/18/2003	29	SW	104	35	627
527399	Craig	Troll	7/18/2003	29	SW	104	35	643
527880	Craig	Troll	7/18/2003	29	SW	104	35	655
527460	Craig	Troll	7/18/2003	29	SW	104	40	626
527090	Craig	Troll	7/19/2003	29	SW			624
220360	Sitka	Troll	7/20/2003	30				634
514290	Ketchikan	Troll	7/21/2003	30	SW	104	40	647
523609	Craig	Troll	7/22/2003	30	SW	103	90	625
523045	Craig	Troll	7/22/2003	30	SW	103	90	642
523032	Craig	Troll	7/22/2003	30	SW	104	35	619
523632	Craig	Troll	7/24/2003	30	SW	103	70	646
527344	Craig	Troll	7/24/2003	30	SW	104	35	626
523974	Craig	Troll	7/24/2003	30	SW	104	35	630
523255	Craig	Troll	7/25/2003	30	SW	104	35	636
523263	Craig	Troll	7/25/2003	30	SW	104	35	646
523986	Craig	Troll	7/25/2003	30	SW	104	35	677
523083	Craig	Troll	7/25/2003	30	SW	104		619
246474	Hoonah	Troll	7/25/2003	30	NW	113	93	570
523066	Craig	Troll	7/25/2003	30	SW			634
523057	Craig	Troll	7/25/2003	30	SW			647
523064	Craig	Troll	7/25/2003	30	SW			825
220454	Sitka	Troll	7/26/2003	30	NW	113	31	627

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Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
RANDOM RECOVERIES								
160896	Port Alexander	Troll	7/26/2003	30				626
180551	Sitka	Troll	7/27/2003	31	NW	113		652
526865	Ketchikan	Troll	7/28/2003	31	SW	103	70	620
523750	Craig	Troll	7/29/2003	31	SW	103	70	661
523189	Craig	Troll	7/29/2003	31	SW	104	40	628
523168	Craig	Troll	7/29/2003	31	SW	104	40	635
523193	Craig	Troll	7/29/2003	31	SW	104	40	660
523162	Craig	Troll	7/29/2003	31	SW	104	40	674
526889	Ketchikan	Troll	7/29/2003	31	SW			592
526878	Ketchikan	Troll	7/29/2003	31	SW			725
524017	Craig	Troll	7/30/2003	31	SW	103	11	631
523580	Craig	Troll	7/30/2003	31	SW	103	70	676
524014	Craig	Troll	7/30/2003	31	SW			681
524013	Craig	Troll	7/30/2003	31	SW			682
526553	Ketchikan	Troll	7/31/2003	31	SW			638
526561	Ketchikan	Troll	7/31/2003	31	SW			654
526557	Ketchikan	Troll	7/31/2003	31	SW			669
524058	Craig	Troll	8/1/2003	31	SW	103	50	646
523586	Craig	Troll	8/1/2003	31	SW	103	70	652
523507	Craig	Troll	8/2/2003	31	SW			597
523503	Craig	Troll	8/2/2003	31	SW			610
523508	Craig	Troll	8/2/2003	31	SW			616
523528	Craig	Troll	8/2/2003	31	SW			637
526814	Ketchikan	Troll	8/3/2003	32	SW	103		618
526829	Ketchikan	Troll	8/3/2003	32	SW	103		621
526683	Ketchikan	Troll	8/3/2003	32	SW	103		630
526813	Ketchikan	Troll	8/3/2003	32	SW	103		645
526843	Ketchikan	Troll	8/3/2003	32	SW	103		665
180798	Sitka	Troll	8/3/2003	32	NW	113	41	633
523600	Craig	Troll	8/4/2003	32	SW	103	90	620
524029	Craig	Troll	8/4/2003	32	SW	103	90	850
523530	Craig	Troll	8/4/2003	32	SW	104	35	650
524115	Craig	Troll	8/5/2003	32	SW	103	50	595
524117	Craig	Troll	8/5/2003	32	SW	103	50	633
523231	Craig	Troll	8/5/2003	32	SW	103	50	678
524300	Craig	Troll	8/6/2003	32	SW	103	50	593
523305	Craig	Troll	8/6/2003	32	SW	104	35	628
524134	Craig	Troll	8/6/2003	32	SW	104	40	634
523329	Craig	Troll	8/7/2003	32	SW	103	80	610
523327	Craig	Troll	8/7/2003	32	SW	103	80	650
526459	Ketchikan	Troll	8/7/2003	32	SW	103	90	633

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Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
RANDOM RECOVERIES								
526462	Ketchikan	Troll	8/7/2003	32	SW	103	90	639
523342	Craig	Troll	8/7/2003	32	SW			565
235082	Sitka	Troll	8/9/2003	32	NW	113	41	665
206675	Sitka	Troll	8/9/2003	32	NW	113		684
526272	Ketchikan	Troll	8/10/2003	33	SW			488
526266	Ketchikan	Troll	8/10/2003	33	SW			648
526275	Ketchikan	Troll	8/10/2003	33	SW			648
523110	Craig	Troll	8/11/2003	33	SW	103	50	677
527500	Craig	Troll	8/11/2003	33	SW	104	30	669
523120	Craig	Troll	8/11/2003	33				637
526631	Ketchikan	Troll	8/12/2003	33	SW			588
526641	Ketchikan	Troll	8/12/2003	33	SW			628
523137	Craig	Troll	8/13/2003	33	SW	104	40	660
524179	Craig	Troll	8/13/2003	33	SW	104		623
526236	Ketchikan	Troll	8/13/2003	33	SW			586
526235	Ketchikan	Troll	8/13/2003	33	SW			645
524197	Craig	Troll	8/14/2003	33	SW	103	11	571
524427	Craig	Troll	8/15/2003	33	SE	105		603
524419	Craig	Troll	8/15/2003	33	SE	105		639
524434	Craig	Troll	8/15/2003	33	SE	105		647
524430	Craig	Troll	8/15/2003	33	SE	105		665
524216	Craig	Troll	8/20/2003	34	SW	103	90	614
524212	Craig	Troll	8/20/2003	34	SW	103	90	673
524348	Craig	Troll	8/20/2003	34	SW	104	40	640
524339	Craig	Troll	8/20/2003	34	SW	104	40	655
524329	Craig	Troll	8/20/2003	34	SW	104	40	685
524337	Craig	Troll	8/20/2003	34	SW	104	40	685
524335	Craig	Troll	8/20/2003	34	SW	104	40	700
524204	Craig	Troll	8/20/2003	34	SW	104	50	664
524208	Craig	Troll	8/20/2003	34	SW	104	50	681
220093	Sitka	Troll	8/20/2003	34	NW	113	45	680
524502	Craig	Troll	8/21/2003	34	SW	103	70	594
524593	Craig	Troll	8/21/2003	34	SW	103	70	641
524598	Craig	Troll	8/21/2003	34	SW	103	70	659
524233	Craig	Troll	8/21/2003	34	SW	104	50	681
235241	Sitka	Troll	8/21/2003	34	NW	113	41	672
524569	Craig	Troll	8/21/2003	34				543
524574	Craig	Troll	8/21/2003	34				675
524614	Craig	Troll	8/22/2003	34	SW	103	80	607
524071	Craig	Troll	8/22/2003	34	SW	103		643
524601	Craig	Troll	8/22/2003	34	SW	104	40	603

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Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
RANDOM RECOVERIES								
524065	Craig	Troll	8/22/2003	34	SE	105	50	596
524062	Craig	Troll	8/22/2003	34	SE	105	50	725
524074	Craig	Troll	8/22/2003	34	SW			700
524078	Craig	Troll	8/22/2003	34	SW			716
524706	Craig	Troll	8/23/2003	34	SE	105	50	672
220817	Sitka	Troll	8/23/2003	34	NW	113	45	661
220827	Sitka	Troll	8/25/2003	35	NW	113	45	612
524740	Craig	Troll	8/26/2003	35	SW	104	35	671
524748	Craig	Troll	8/26/2003	35	SW	104	50	668
524630	Craig	Troll	8/27/2003	35	SE	105	50	613
525156	Ketchikan	Troll	8/27/2003	35	SE	105		601
524788	Craig	Troll	8/27/2003	35				648
524680	Craig	Troll	8/28/2003	35	SE	105	10	667
524673	Craig	Troll	8/28/2003	35	SE	105	50	654
524664	Craig	Troll	8/28/2003	35	SE	105	50	680
524661	Craig	Troll	8/28/2003	35	SW			650
524639	Craig	Troll	8/28/2003	35	SW			678
524858	Craig	Troll	8/29/2003	35	SW	104	35	535
524695	Craig	Troll	8/29/2003	35	SW	104	35	613
524685	Craig	Troll	8/29/2003	35	SW	104	35	655
524854	Craig	Troll	8/29/2003	35	SW	104	35	679
524867	Craig	Troll	8/29/2003	35	SW	104	40	677
525165	Ketchikan	Troll	8/29/2003	35	SW	104	50	590
525173	Ketchikan	Troll	8/29/2003	35	SW	104	50	608
525171	Ketchikan	Troll	8/29/2003	35	SW	104	50	633
525164	Ketchikan	Troll	8/29/2003	35	SW	104	50	643
525172	Ketchikan	Troll	8/29/2003	35	SW	104	50	684
525032	Ketchikan	Troll	8/29/2003	35	SE	105		699
524396	Craig	Troll	9/2/2003	36	SE	105	50	630
179820	Port Alexander	Troll	9/3/2003	36	NW	113	11	681
179877	Port Alexander	Troll	9/4/2003	36	NW	113	11	681
524806	Craig	Troll	9/5/2003	36	SW	103	70	646
523455	Craig	Troll	9/6/2003	36	SW	104	40	704
518667	Petersburg	Troll	9/7/2003	37	SE			668
523471	Craig	Troll	9/8/2003	37	SW	104	40	700
524847	Craig	Troll	9/9/2003	37	SW	104	40	684
523380	Craig	Troll	9/10/2003	37	SW			633
SELECT RECOVERIES								
242664	Sitka	Sport	8/8/2003	32	NW	113	41	655
527989	Craig	Troll	7/9/2003	28	SW	104		582
527990	Craig	Troll	7/9/2003	28	SW	104		660
514968	Ketchikan	Troll	7/21/2003	30	SW	103	90	642

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Head Number	Sampling Port	Gear	Recovery Date	Stat Week	Quad.	District	Sub-Dist.	Length
SELECT RECOVERIES								
524640	Craig	Troll	8/28/2003	35	SW			625
903117	Sitka	Troll	9/1/2003	36	NE	109		
900785	Sitka	Troll	9/1/2003	36	NW	113		

Appendix A3.–Computer files used in the analysis of data for this report.

File Name	Description
01Chuck adult weir.xls	Excel workbook containing 2001 Chuck Creek adult weir data
02Chuck adult weir.xls	Excel workbook containing 2002 Chuck Creek adult weir data
03Chuck adult weir.xls	Excel workbook containing 2003 Chuck Creek adult weir data
02Chuck smolt data.xls	Excel workbook containing 2002 Chuck Creek smolt and coded wire tagging data.
Chuck harvest 03.xls	Excel workbook used to compute marine harvest in 2003