Fishery Data Series No. 08-04

Production of Coho Salmon from the 2005 Smolt Emigration from Chuck Creek in Southeast Alaska

by

Steven J. McCurdy

February 2008

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

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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 primary purpose of this study was to estimate smolt production, marine survival, exploitation rates, and escapements of coho salmon *Oncorhynchus kisutch* from the 2005 smolt emigration from the Chuck Creek watershed in Southeast Alaska. Additional objectives were to determine if the date of smolt emigration influenced survival to maturity, and/or the date of return to freshwater (of jacks). Emigrating coho smolt were captured during the spring of 2005, tagged with a sequentially numbered coded wire tag (CWT), and marked by removing their adipose fin. Commercial and sport fisheries were sampled for coho salmon marked with CWTs in 2006. Escapements were counted through a weir at Chuck Creek in 2005 and 2006 and coho salmon were examined for marks.

In 2005, a smolt weir was installed in Chuck Creek to capture coho smolt as they emigrated from the watershed. A total of 7,762 coho salmon smolt were tagged and released alive between April 19 and June 4. In 2006, 84 random recoveries of coho salmon bearing CWTs of Chuck Creek origin were recovered in sampled marine fisheries, and the estimated marine harvest was 448 fish (SE = 46). A total of 367 jacks (in 2005) and 409 adults (in 2006) returned to Chuck Creek from the 2005 smolt emigration. An estimated 10,306 (SE = 204) coho salmon smolt emigrated from Chuck Creek in 2005. Marine survival to adult of the 2005 smolt emigration was estimated at 8.3% (SE = 0.5%) and the exploitation rate in marine fisheries was estimated at 52.3% (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

Harvest of wild coho salmon *Oncorhynchus kisutch* in Southeast Alaska is important to numerous commercial, sport and subsistence users (Halupka et al. 2000; Shaul et al. 2003; Thedinga and Koski 1984). 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) maintains a stock assessment program in Southeast Alaska to better understand and manage coho salmon stocks in the region. ADF&G's stock assessment program includes monitoring a number of key coho salmon stocks in Southeast Alaska where juvenile coho are tagged 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 (harvest) rates and contributions to various fisheries from the monitored stocks. Data collected from the stock assessment program helps managers assess the effectiveness of regulations to ensure sustained yield of these and neighboring stocks of coho salmon.

Chuck Creek was selected to be part of the coho salmon stock assessment program in 2001 to fill the geographical gap in coverage in Southeast Alaska for the southern outside coast. The Chuck Creek watershed is located on Heceta Island (Figure 1), about 35 km northwest of the town of Craig, and it is believed to produce between 1,500 and 3,000 adult coho salmon annually (Shaul et al. 1991; McCurdy 2005, 2006a, 2006b). Prior to this study, 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). Also, pre-smolt juvenile coho salmon from Chuck Creek were marked with CWTs in the early 1980s to enable estimates of survival, fishery contributions and exploitation rates (Shaul et al. 1991). Recoveries of coho salmon with CWTs 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 from the Klakas River (Shaul et al. 1991) on nearby Prince of Wales Island.

The Chuck Creek 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 tributary streams to the lake contain spawning and rearing habitat for

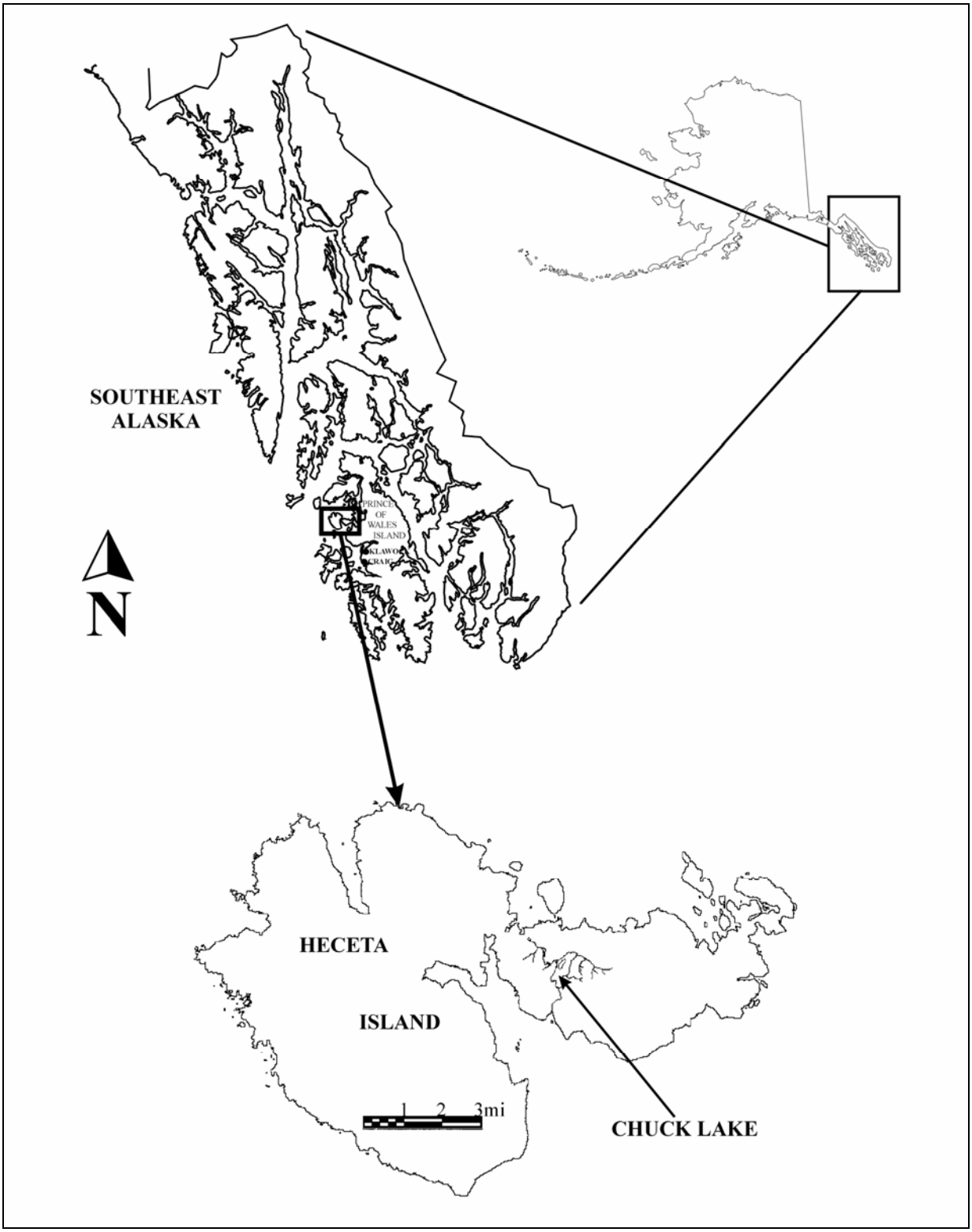

Figure 1.–Location of Heceta Island and the Chuck Creek watershed.

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 typically associated with Karst geology (Baichtal and Swanston 1996). The majority of the watershed was logged in the 1970s and 1980s, at which time extensive timber harvest occurred 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*, and chum salmon *O. keta*, as well as Dolly Varden *Salvelinus malma*, steelhead *O. mykiss* and cutthroat trout *O. clarki*, three-spine stickleback *Gasterosteus aculeatus*, and sculpin *Cottus* sp.

Objectives of this study were to:

1. Estimate the number of coho salmon smolt emigrating from Chuck Creek in 2005;
2. Estimate the age composition, and mean length and weight of coho salmon smolt captured emigrating from Chuck Creek in 2005;
3. Count the escapement of coho salmon returning to Chuck Creek from the 2005 smolt emigration;
4. Estimate the age and sex composition, and mean length at age of the escapement of coho salmon to Chuck Creek from the 2005 smolt emigration;
5. Estimate the marine harvest of coho salmon from Chuck Creek in 2006 via recovery of CWTs;
6. Investigate the relationship between date of smolt emigration from the watershed and survival to maturity; and
7. Investigate the relationship between date of smolt emigration from the watershed and immigration date back to the watershed of age x.0 jacks.

In addition, all other adult and juvenile salmonids of other species (other than young-of-the-year fry) were counted through the adult weir and smolt weir, respectively.

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

METHODS

A mark–recapture (m-r) experiment was used to estimate smolt abundance. Chuck Creek coho salmon were marked and recaptured with the use of weirs as they migrated from (emigrated) and returned (immigrated) to the watershed. Coho salmon smolt were captured as they were emigrating from Chuck Creek in the spring of 2005. Captured smolt were injected with a CWT and had their adipose fin removed. Adult coho salmon were sampled in the harvest of commercial and sport fisheries in 2006 for the presence of CWTs. The escapement of mature coho salmon was monitored through a weir on Chuck Creek in 2005 and 2006 and fish were inspected for missing adipose fins and CWTs to determine the fraction missing adipose fins (θ), and the fraction containing CWTs (θ_{cwt}). Unless otherwise defined in this report, the term “marked” is used to describe a fish with its adipose fin removed, and the term “tagged” is used to describe a fish containing a CWT. The marked fraction and tagged fraction could differ as smolt marked with an adipose fin clip may not retain their CWT. The marked fraction of mature fish was used in estimating smolt abundance, and the tagged fraction of adult fish was used for estimating harvest in marine fisheries. Harvest of coho salmon in marine waters of Southeast Alaska is limited to adult fish that have spent one winter in the marine environment. 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

Coho salmon smolt were captured in the spring of 2005 as they were emigrating from the Chuck Creek watershed using a weir and "trough" trap similar to that described by Elliott (1992). The weir and trough trap were constructed on Chuck Creek at the site of a blown-out beaver dam located approximately 500 m 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, plastic 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" rigid, plastic mesh fence (Memphis Net & Twine Co., Inc.[1]), held in place with iron pipe pounded into the substrate. The bottom 12" of the fence was 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 4.

Captured fish were removed from the live box several times a day and sorted by species. All non-coho salmon species other than young-of-the-year salmonid fry, which could freely pass through the trap fence and perforated live box wall, were counted and released at the trap site. Coho salmon smolt were counted and tagged daily with sequentially numbered CWTs. All captured coho salmon ≥ 70 mm FL that appeared healthy were anesthetized with a solution of tricain-methane-sulfonate (MS 222), had a 1.1 mm CWT injected into their snout, had their adipose fin removed, and were counted. Before tagging the first fish and after tagging the last fish on each day fish were tagged, one tag was ejected from the machine and the unique sequential number on the tag was read and recorded. Subsequently recovered tagged fish could then be identified as to their date of emigration from the unique sequential number on their respective CWT. Mark IV tagging machines (Northwest Marine Technology, INC.[2]) 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 and the information submitted (along with a sample of the coded wire used) to ADF&G Mark, Tag and Age Laboratory (Tag Lab) in Juneau at the end of field operations. The tags used in 2005 contained the code 04-11-58 plus a unique sequential number. Water temperatures were recorded hourly with the use of a WTA08 Optic Stow Away (Onset Computer Corporation[3]) data logger placed in the stream at the weir site.

Note: Product names are included in this report for scientific completeness, but do not constitute a product endorsement.

[1] Memphis Net & Twine Co., Inc. 2481 Matthews Ave., PO Box 80331, Memphis, TN 38108, USA

[2] Northwest Marine Technology, Corporate Office, PO Box 427, Ben Nevis Loop Road, Shaw Island, WA 98286, USA.

[3] Onset Computer Corporation, 470 MacArthur Blvd., Bourne, MA 02532, USA

ESTIMATION OF SMOLT AGE, WEIGHT AND LENGTH

A sample of the emigrating coho salmon smolt was obtained from the fish held overnight in net pens following tagging. The sample was obtained by gently mixing all the fish in the holding pen with a dip net, then scooping up fish in the net, and sampling all netted fish. Each sampled fish was measured to the nearest mm FL, weighed to the nearest gram, and had a scale sample taken for age determination. The goal was to sample one-fortieth ($1/40^{th}$) of the smolt emigration each day. 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 were recorded in European notation (where number of winters in freshwater after hatching and number of years in salt water are separated by a period, Sandercock [*In*] Groot and Margolis 1991, p. 395–445). 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).

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 2005. Event 1 consisted of marking captured coho salmon smolt ≥ 70 mm FL by removing their adipose fin in 2005. Event 2 consisted of sampling returning mature coho salmon in 2005 (jacks) and 2006 (adults) to determine the marked fraction.

The abundance of coho salmon smolt emigrating from Chuck Creek in 2005 was estimated using Chapman's modification of the 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 2005 by removing their adipose fin, n_2 was the number of returning coho salmon inspected for marks in 2005 (jacks only) and 2006 (adults only), and m_2 was the subset of n_2 missing their adipose fins.

The conditions for an accurate estimate of smolt abundance using this methodology were: (1) all fish had an equal probability of being marked 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 affect catchability of fish; (4) fish did not lose their marks between events; and (5) all marks were reported on recovery in event 2 (Seber 1982, p. 59).

Physiological and life history traits of coho salmon, along with the design of this experiment, allow for discounting concerns over several of these conditions. Because coho salmon return to their natal stream to spawn, the population was closed to recruitment (condition 2); all immigrating fish in the escapement were obligated to pass through the salmon weir when returning to spawn, so catchability in event 2 was unaffected by marking (condition 3); adipose fins do not regenerate when completely removed (condition 4), and missing adipose fins were easy to note when examining the captured fish (condition 5).

Removal of adipose fins has been shown to have no significant effect on mortality (Vincent-Lang 1993; condition 1). However, because smolt capture and marking (event 1) in this study did not occur for the entire duration of the emigration, and smolt emigration date has been shown to affect survival to maturity (event 2; Bilton et al. 1982: Lum 2003) it is almost assured that condition 1 was violated in this study. However, the impact of this violation on the abundance estimate is low, as shown in the Discussion section below.

ESTIMATION OF MARINE HARVEST

Estimates of the harvest and its variance of coho salmon originating from Chuck Creek were derived from fish sampled in commercial and recreational sport fisheries using standard methods (Bernard and Clark 1996). Because several fisheries exploited coho salmon bound for

Chuck Creek over several months in 2006, 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 (Appendix A1). Statistics from the purse seine fishery were stratified by week and fishing district. Statistics from the sport fishery were stratified by fortnight (biweek). Hubartt et al. (1999) present details of sampling sport fisheries. An ADF&G Commercial Fisheries Division manuscript (ADF&G *Unpublished*) describes sampling of commercial fisheries in Southeast Alaska in which samplers stationed at fish processors throughout the region attempt to sample 20% of the commercial coho salmon harvest for missing adipose fins. Databases from the Pacific States Marine Fisheries Commission (PSMFC) were also queried for any reported recoveries of coho salmon containing CWTs from Chuck Creek in Canadian fisheries.

Estimates of the 2006 harvest r_{ij} of Chuck Creek coho salmon from the 2005 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 marked fraction of stock j possessing CWTs (the portion of the *adult* escapement sampled *found to have CWTs*), 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, and $\lambda_i=(a_i' \, t_i')/(a_i \, t_i)$ 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 ESCAPEMENTS

An aluminum bipod and picket weir was installed across the lower end of Chuck Creek (approximately 500 m from salt water) and operated from August 16 until October 16 in 2005 (McCurdy 2006b), and from August 15 until October 15 in 2006. Pickets were 18 mm in diameter and the maximum gap between them was 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 migrating salmon. All migrating salmon had to enter the trap to pass upstream.

All migrating mature salmon were identified and counted by species and date as they passed the weir. All coho salmon were counted by life history type (adult or jack) and examined for missing adipose fins. Life history type was assumed to be accurately determined for each fish enumerated at the weir. Fish that were 400 mm mid eye to fork (MEF) in length or larger were considered adults and those less than 400 mm were considered jacks, and any fish between 380 mm and 450 mm had a scale sample taken to verify the assumed ocean age.

Coho salmon were systematically sampled throughout the entire migration for age, sex, and length (ASL). In 2005, every 4th coho salmon (adult or jack) encountered at the weir was sampled. In addition, every 4th adipose-clipped jack encountered at the weir was sacrificed for retrieval of its CWT in 2005, and these fish were also sampled for ASL. In 2006, every 3rd adult and jack coho salmon was sampled for ASL and additionally, every 4th adipose-clipped jack encountered at the weir was sacrificed for retrieval of its CWT. In both years, fish were measured to the nearest 5 mm MEF. Sex was estimated by external characteristics. All sampled coho salmon missing an adipose fin were also examined for CWTs using a magnetometer (hand held CWT detector from Northwest Marine Technology, Inc.). 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.

The fraction of the adult and jack migrations that belong to each age or sex group is:

$$\hat{p}_a = \frac{n_a}{n} \tag{4}$$

$$var[\hat{p}_a] = \left(1 - \frac{n}{N}\right)\frac{\hat{p}_a(1 - \hat{p}_a)}{n - 1} \tag{5}$$

where n is the number of fish successfully aged (or sexed), n_a is the number from this sample that belong to age (or sex) group a, and N is the total migration (weir count). Abundance of age or sex group ($\hat{N}_a$) is estimated:

$$\hat{N}_a = \hat{p}_a N \tag{6}$$

$$var(\hat{N}_a) = N^2 var(\hat{p}_a) \tag{7}$$

Standard sample summary statistics were used to calculate estimates of mean length at age and its variance (Cochran 1977). The relationship between jack emigration and immigration date was analyzed using a simple linear regression model.

ESTIMATES OF TOTAL RETURN, EXPLOITATION RATE, AND MARINE SURVIVAL

The total adult return (i.e., harvest and escapement) of the coho salmon bound for Chuck Creek in 2006 and its variance was calculated by summing estimates of total harvest (T) and the adult escapement (N_e):

$$\hat{N}_R = \hat{T} + N_e \tag{8}$$

$$\text{var}[\hat{N}_R] = \text{var}[\hat{T}] \tag{9}$$

where $\text{var}[N_e]$ is not added into (9) because it is 0. The estimate of the adult exploitation rate was calculated:

$$\hat{E} = \frac{\hat{T}}{\hat{N}_R} \tag{10}$$

$$\text{var}[\hat{E}] \approx \frac{\text{var}[\hat{T}]N_e^2}{\hat{N}_R^4} \tag{11}$$

where variance was approximated with the delta method (Seber 1982), recalling that $\text{var}[N_e] = 0$. Smolt to adult survival rate was estimated as:

$$\hat{S} = \frac{\hat{N}_R}{\hat{N}_s} \tag{12}$$

$$\text{var}[\hat{S}] \approx \hat{S}^2\left[\frac{\text{var}[\hat{N}_R]}{\hat{N}_R^2} + \frac{\text{var}[\hat{N}_s]}{\hat{N}_s^2}\right] \tag{13}$$

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

RESULTS

SMOLT EMIGRATION IN 2005

A total of 7,768 coho salmon smolt ≥ 70 mm FL were tagged between April 16 and June 2, 2005 (Appendix A2). Two fish died after tagging and an estimated 4 fish shed their tags within 24 hours, leaving a total of 7,766 smolt that were released with adipose clips and 7,762 with valid CWTs in 2005.

Emigrating coho salmon smolt were first captured in the trough trap on April 20 (Appendix A3). The timing of the coho salmon smolt emigration was pulsed throughout the migration period with peak catches occurring in early May (Figure 2).

A total of 196 captured coho salmon smolt ≥ 70 mm FL were sampled for age, length and weight. Age-1 coho smolt constituted 77.0% (SE=3.0%) of the sample and averaged 100.1 mm FL (SE=0.7) and 9.7 g (SE=0.2). Age-2 coho smolt constituted 23.0% (SE=3.0%) of the sample and averaged 121.1 mm FL (SE=1.6) and 17.2 g (SE=0.8) (Table 1, Figure 3).

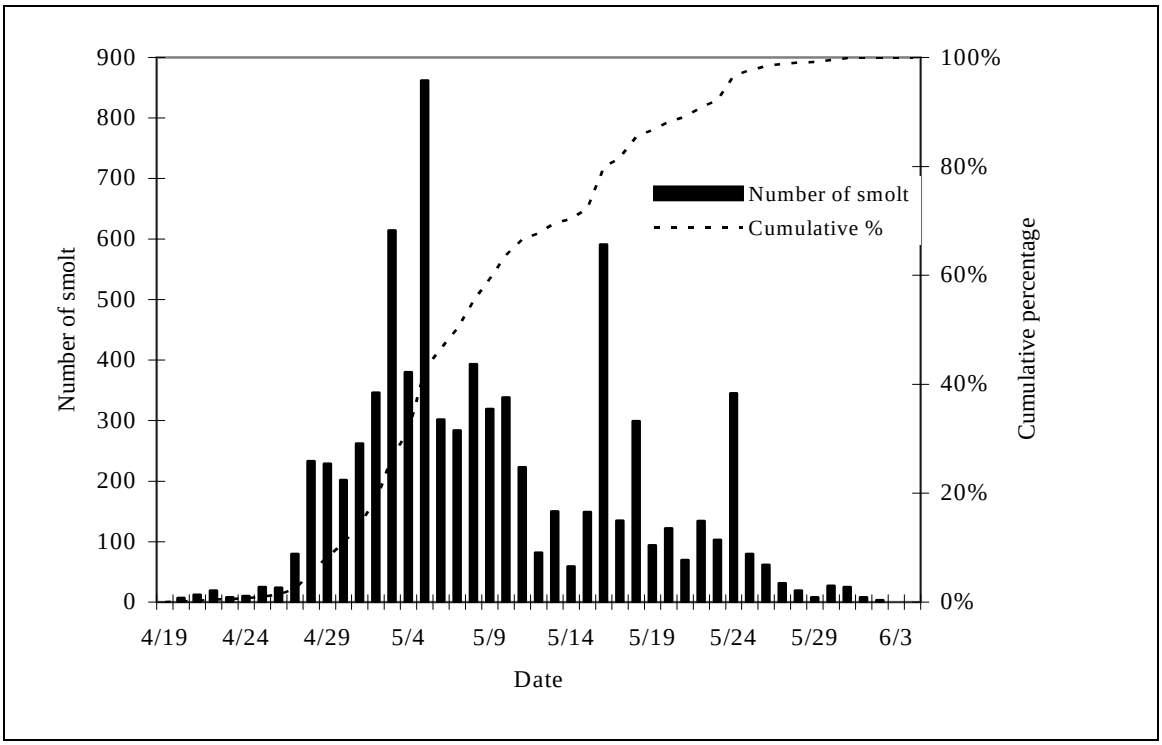

Figure 2.–Daily catch and cumulative percentage of the coho salmon smolt emigration passing the Chuck Creek weir in 2005.

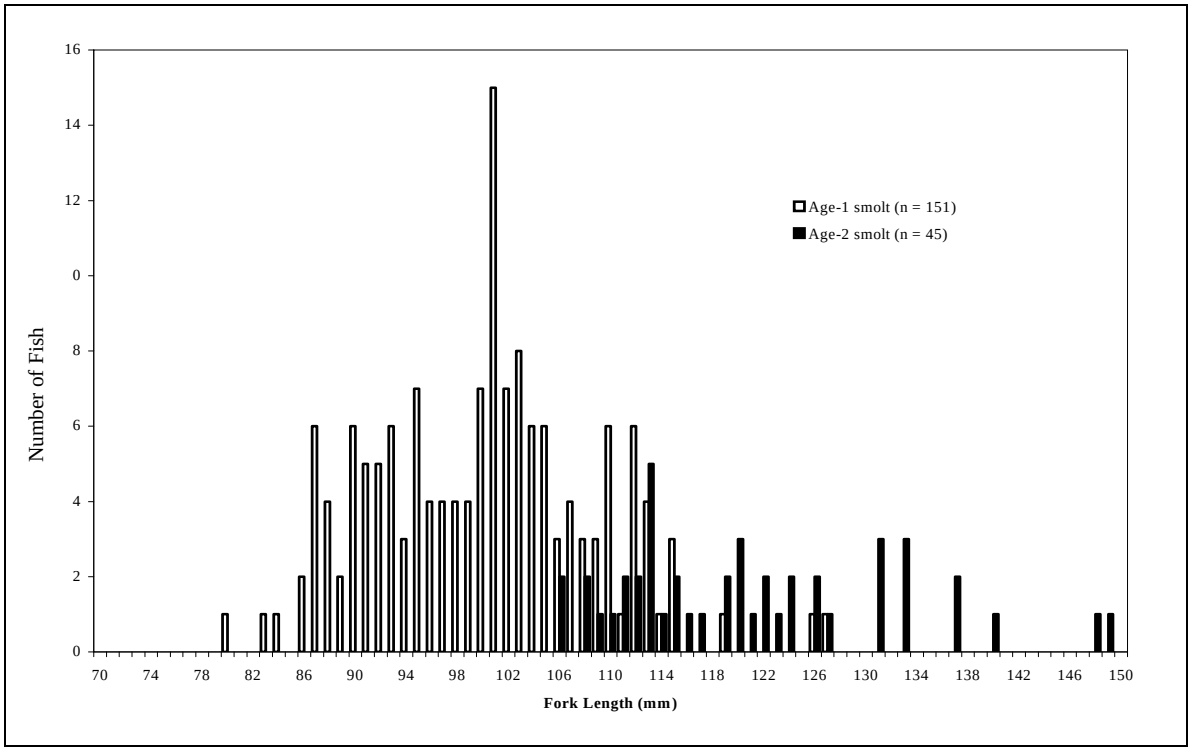

Figure 3.–Length frequency of the coho salmon smolt emigration sampled at Chuck Creek in 2005, by freshwater age.

Table 1.–Estimated freshwater age composition, and mean length and weight at age of emigrating coho salmon smolt captured at Chuck Creek in 2005.

	Age 1	Age 2	Combined
Sample size	151	45	196
Estimated composition	77.0%	23.0%	
SE composition	3.0%	3.0%	
Mean length (mm)	100.1	121.1	105.0
SE Mean length	0.7	1.6	0.9
Mean weight (g)	9.7	17.2	11.4
SE Mean weight	0.2	0.8	0.3

Surviving fish from the 2005 smolt emigration returned to Chuck Creek in both 2005 (as jacks) and in 2006 (as adults), and returning fish were examined for a missing adipose fin to determine the marked fraction (θ). In the 2005 escapement, 295 of 361 jacks examined (θ =0.817) were missing adipose fins. In the 2006 escapement, 285 of 409 adults examined (θ =0.697) were missing their adipose fin. These two marked fractions were significantly different (χ^2 = 14.9, df = 1, P = 0.0001). Pooling both escapement samples (580 in 770 marked) yields an estimate of θ =0.753 for the fraction of the 2005 smolt emigration marked. An estimated 10,306 (SE = 204) coho salmon smolt emigrated from Chuck Creek in 2005 (n_1 = 7,766, n_2 = 770, m_2 = 580).

ESCAPEMENT ENUMERATION AND SAMPLING

2005 Jack Escapement

A total of 367 jack coho salmon were counted through the weir between August 15 and October 14, 2005 (McCurdy 2006b). Of the total jack escapement, 6 fish were passed upstream before they could be examined for the presence or absence of an adipose fin; of the remaining 361 fish, 295 were missing their adipose fin (θ =0.817). Systematically sacrificing every 4th adipose-clipped jack encountered at the weir in 2005 yielded a sample of 76 fish where the sequential CWT was successfully decoded (Appendix A4). One additional jack was sampled in the escapement as a non-random sample (a carcass recovered upstream of the weir) in 2005 (Appendix A4). The average number of days between tagging and recapture of the 76 jacks was 131 days (SD= 9.9), with 107 days the minimum time spent in the marine environment and 166 days the maximum. A simple linear regression model analyzing the relationship of jack immigration date (date of capture at the adult weir) as a function of smolt emigration date (date of capture at the smolt weir) of the 76 jacks yielded an R^2 value of 0.0711 (P=0.02; Figure 4). McCurdy (2006b) provides further details on the 2005 escapement of coho salmon to Chuck Creek.

2006 Escapement

A total of 409 adult and 572 jack coho salmon were counted past the weir on Chuck Creek between August 15 and October 15, 2006 (Appendix A5). Life history type (adult, jack) was assumed to be accurately determined on all mature fish in the 2006 escapement, as no overlap in length between jacks and adults was detected by aging a random sample of 326 fish (Figure 5). In addition, all fish that measured between 380 and 450 mm MEF were sampled for age verification (n = 6, two random samples and four non-random samples), with the largest jack measuring 395 mm and the smallest adult measuring 415 mm MEF. In the previous 5 years of monitoring the escapement of coho salmon at Chuck Creek, there has also been no overlap in fork length detected between jacks and adults, as the largest jack has been 395 mm in MEF and the smallest adult has been 400 mm in MEF (McCurdy 2006b). The temporal pattern of immigration of the escapement was similar to previous years. Timing of the coho salmon escapement was also 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). A small number of mature coho salmon probably entered Chuck Creek after the weir was dismantled on October 15, however this number is likely a very small percentage of the total return as past weir operations have shown few fish return after this date (McCurdy 2005).

A little over 25% of the adult escapement that was passed through the weir was successfully sampled for age (Table 2). The sample size was larger for length and sex determination than age determination, as length and sex was measured and estimated, respectively, on all fish sampled,

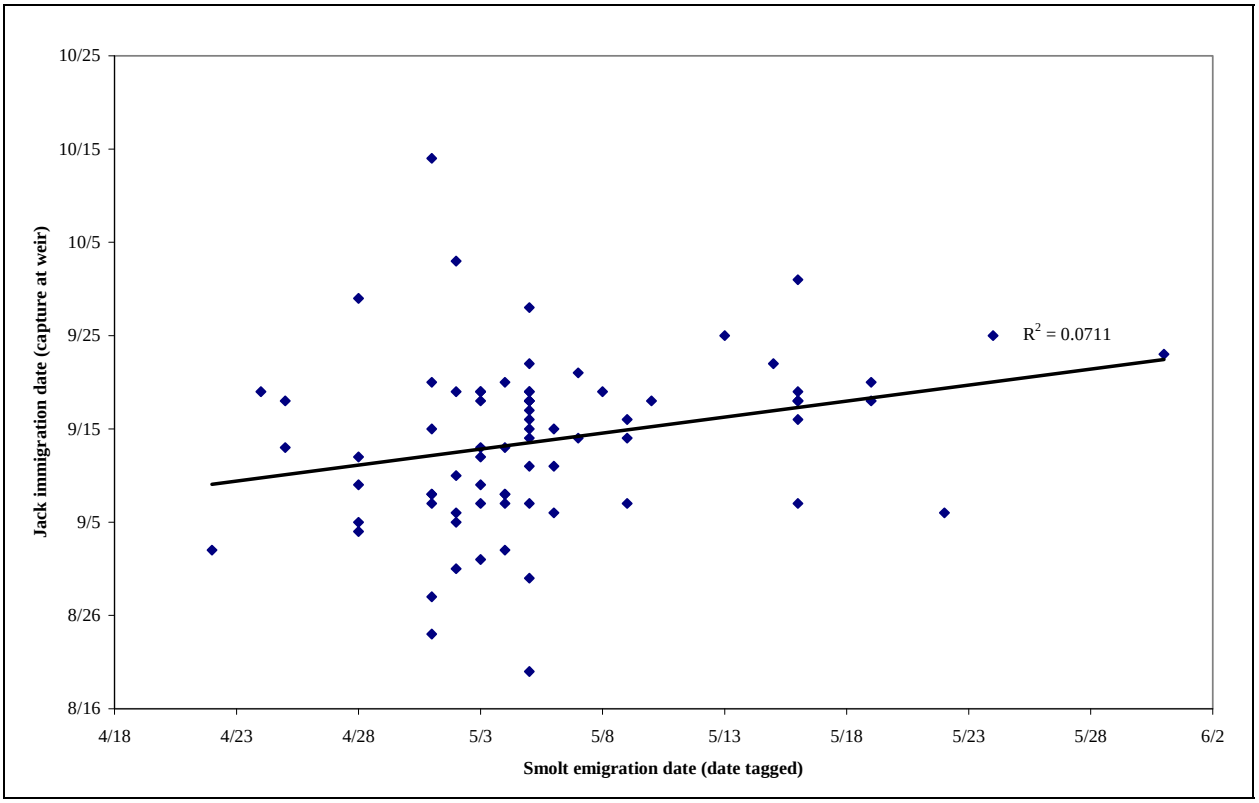

Figure 4.–Date of smolt emigration (capture at weir) plotted by immigration date (capture at weir) of 76 age x.0 jack coho salmon from the 2005 Chuck Creek smolt emigration.

Table 2.–Estimated freshwater age composition, and mean length at age and sex of the 2006 Chuck Creek coho salmon escapement (weir count).

	Age 1.0	Age 2.0	All Jacks [a]	Age 1.1	Age 2.1	All Adults [a]
Females						
Sample size	0	0	0	60	7	84
Percent				89.6%	10.4%	
SE Percent				3.3%	3.3%	
Mean Length				608	621	609
SE Mean Length				4	10	3
Males						
Sample size	150	16	196	35	3	46
Percent	90.4%	9.6%		92.1%	7.9%	
SE Percent	1.9%	1.9%		3.8%	3.8%	
Mean Length	309	345	313	600	622	597
SE Mean Length	2	6	2	9	19	8
Both sexes combined						
Sample size	150	16	196	95	10	130
Percent	90.4%	9.6%		90.5%	9.5%	
SE Percent	1.9%	1.9%		2.5%	2.5%	
Mean Length	309	345	313	605	622	604
SE Mean Length	2	6	2	4	8	3

[a] Includes fish that were sampled for sex and length, but not successfully aged. A total of 409 adults and 572 jacks were counted through the weir in 2006.

but not all scale samples were readable due to some regenerated scales. An estimated 35.4% (SE = 3.5%) of the 409 adult coho salmon counted in the escapement were male. The freshwater age of both jacks and adults was predominately age 1.x (1-year old smolt).

A total of 2,147 adult sockeye salmon, 7 jack sockeye salmon (males < 400 mm MEF), 99 chum salmon, 44,600 pink salmon, 7 Dolly Varden, 3 cutthroat trout, and 6 steelhead trout were also counted through the weir between August 15 and October 15, 2006 (Appendix A6). Escapements were larger than weir counts for all salmon species as an unknown number of sockeye and pink salmon passed upstream of the weir site before weir installation on August 15, and a number of pink and chum salmon spawned downstream of the weir site (personal observations). The crew observed numerous Dolly Varden fitting between the pickets on the weir and it is likely that the weir captured only a small percentage of immigrating Dolly Varden. The six steelhead captured were all less than 400 mm FL, appeared to have recently entered the stream from the marine environment (bright silver coloration), and showed no external characteristics that allowed for sex determination (i.e. appeared to be immature).

RECOVERY OF CWTS AND ESTIMATES OF ADULT HARVEST, RETURN, EXPLOITATION RATE, AND MARINE SURVIVAL

In a random sample of adult coho salmon captured at the weir in the 2006 escapement, all adults found to be missing an adipose fin (n = 89) also tested positive for the presence of a CWT in their snout. Thus, the tagged fraction (θ_{cwt}) used to estimate marine harvest was the fraction of the adult escapement missing adipose fins (θ =0.697), as all adults missing an adipose fin were assumed to have retained their CWT.

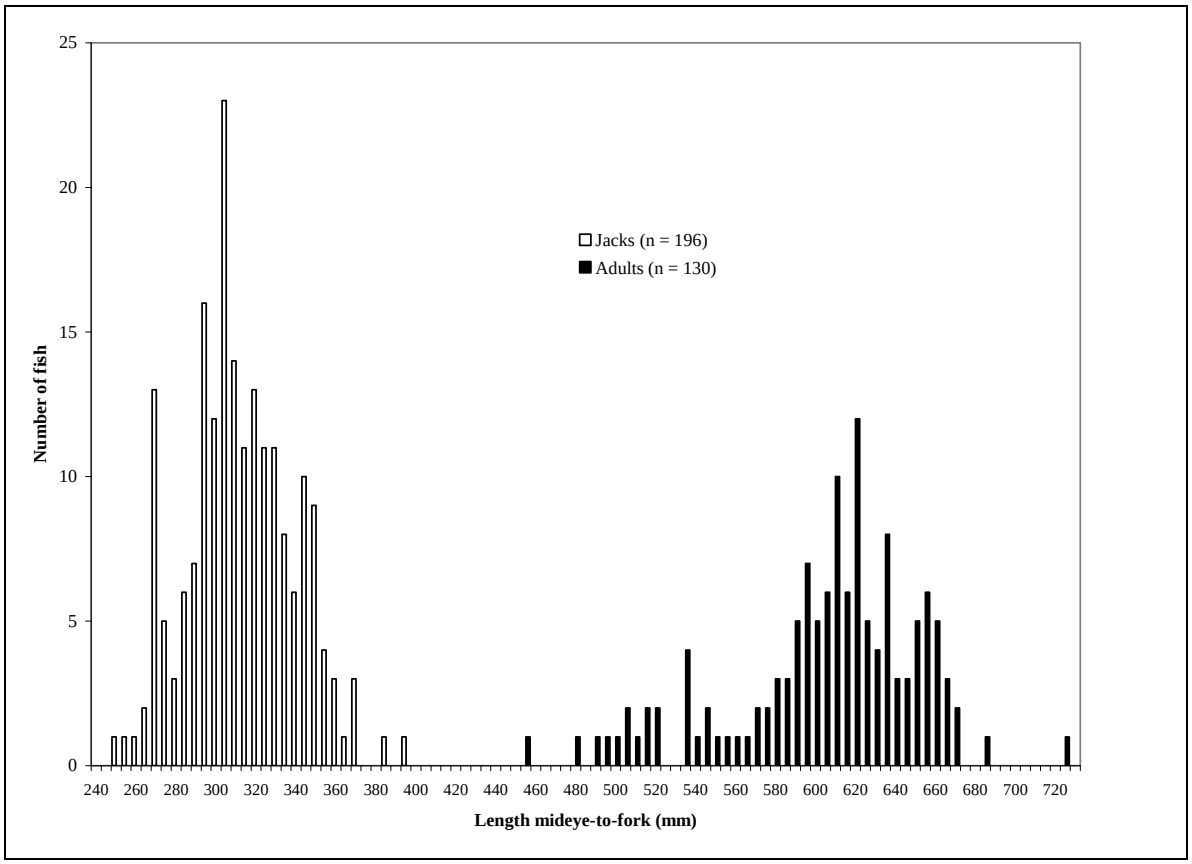

Figure 5.–Length frequency of the coho salmon escapement sampled at the Chuck Creek weir in 2006, by ocean age.

A total of 90 adult coho salmon tagged as smolt emigrating from Chuck Creek in 2005 were recovered in creel and port sampling programs that sampled marine fisheries in Alaska and British Columbia in 2006 (Appendix A7). Of the 90 recoveries, 89 were from SE Alaska, and one was from Northern British Columbia. The unique sequential CWT numbers of all the recoveries were reported in ADF&G and/or PSMFC databases with the exception of the one recovery in British Columbia (Appendix A7). Of this total, 84 recoveries were random samples that were useful for estimating marine harvest in various fisheries (Table 3). The greatest number (76) of the random CWT recoveries of Chuck Creek coho was in U.S and Canadian troll fisheries and the remainder was in the seine fishery (4) and the sport fishery (4). There were also four random recoveries in marine fisheries where the fishing area was not designated and two non-random recoveries (Appendix A7). Of the random troll recoveries, 35 were recovered in the SW quadrant, 17 in the NW quadrant, 12 in the NE quadrant,11 in the SE quadrant, and 1 in Northern British Columbia. Seine recoveries were in fishing Districts 101, 102 and 104. Sport fish recoveries were from the ports of Sitka and Craig/Klawock.

An estimated 448 (SE=46) coho salmon originating from Chuck Creek were harvested in marine commercial and sport fisheries in 2006 (Table 3). The commercial troll fisheries harvested an estimated 408 fish (an estimated 401 fish in Alaskan waters and 7 in Canada) or 91% of the total harvest. The purse seine fishery harvested an estimated 32 fish, or 7% of the total harvest, and the sport fishery harvested an estimated 8 fish, or 2% of the total (Table 4). Harvested fish were sampled from early July through mid-September (Figure 6, Appendix A7).

The total return of Chuck Creek adult coho salmon was estimated at 857 fish (SE = 46) in 2006. Marine survival to adult of the 2005 smolt emigration was estimated at 8.3% (SE = 0.5%) and the exploitation rate in marine fisheries was estimated at 52.3% (SE = 2.6%). An additional 367 fish, or 3.6% (SE =0.07%) of the estimated 10,306 smolt that emigrated in 2005 survived to return as jacks in the same year as their emigration.

DISCUSSION

MARINE SURVIVAL AND POTENTIAL BIAS IN SMOLT ABUNDANCE ESTIMATE

The smolt weir appeared to be operational prior to significant emigration in 2005 (Appendix A3, Figure 2), and it appeared to be virtually 100% effective at capturing coho salmon smolt while it was operating. However, an estimated 24.7% of the escapement from the 2005 smolt emigration was unmarked. It is likely that the majority of these unmarked fish emigrated after the smolt weir was removed on June 4, 2005. 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 the smolt abundance estimate if the marked and unmarked fish survived at different rates. Survival to maturity of coho salmon has been shown to be a function of smolt emigration timing and/or smolt size (Bilton et al. 1982; Lum 2003). Differences in survival rates between marked and unmarked smolt in this study cannot be tested for, although survival among fish tagged with CWTs can be examined (see below) based on recoveries of CWTs in marine fisheries and the escapement.

All smolt captured in 2005 were tagged with a CWT that contained code 041158 plus a unique sequential number that identified their date of emigration (i.e., date of capture; Appendix A2). A total of 94 adult coho salmon containing code 041158 were subsequently sampled in 2006 (89 in marine fisheries and five in the escapement), and had their date of emigration identified (Appendices A4 and A7. note that the unique sequential CWT number of the fish recovered in British Columbia was not reported in PSMFC databases). An additional 77 jacks containing code 041158 were sampled in the 2005 escapement and had their date of emigration identified (Appendix A4). No trends in survival to maturity (adults and jacks combined) as a function of emigration date is apparent based on these recoveries (Appendix A2, Figure 7). Dividing the smolt emigration into two equal time periods (i.e. early and late); with the early period running from April 20 through May 11 (smolt tagged = 5,166;

Table 3.–Estimated marine harvest (r_i) of adult coho salmon bound for Chuck Creek in 2006. See text for key to notation.

SE ALASKA 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]
26-32	6/25-8/12 (3)	NW	469,803	0	134,965	1,476	1,413	1,033	1,033	15	78	19	47%
33-40	8/13-10/7 (4)	NW	405,754	0	96,590	1,568	1,519	1,270	1,269	2	12	8	127%
26-32	6/25-8/12 (3)	NE	103,856	0	28,143	312	308	205	205	10	54	16	57%
33-40	8/13-10/7 (4)	NE	106,264	0	27,849	333	327	244	244	2	11	7	126%
26-32	6/25-8/12 (3)	SE	74,432	0	24,050	211	202	124	124	9	42	13	59%
33-40	8/13-10/7 (4)	SE	42,191	0	7,970	111	109	82	82	2	15	10	130%
26-32	6/25-8/12 (3)	SW	118,505	0	29,450	308	300	178	178	25	148	29	38%
33-40	8/13-10/7 (4)	SW	35,454	0	12,702	179	179	123	123	10	40	11	55%
SE Troll subtotal			1,356,259	0	361,719	4,498	4,357	3,259	3,258	75	401	44	22%
NORTHERN BRITISH COLUMBIA TROLL FISHERY													
Week	Dates		Harvest	Var(H)	n_i	a_i	a_i'	t_i	t_i'	m_i	r_i	SE(r_i)	RP[r_i]
31	7/31-8/6		36,004	0	18,051	213	90	27	27	1	7	6	181%
SE ALASKA 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	7/30-8/5	101	3,108	0	583	9	9	4	4	1	8	7	183%
wk 32	8/6-8/12	102	1,099	0	349	5	5	3	3	1	5	4	173%
wk 31	7/30-8/5	104	4,924	0	801	4	4	3	3	1	9	8	185%
wk 33	8/13-8/19	104	1,499	0	193	3	3	2	2	1	11	11	187%
Purse Seine subtotal			10,630	0	1,926	21	21	12	12	4	32	16	96%
SE ALASKA SPORT FISHERY													
Biweek	Dates	Area	Harvest	Var(H)[a]	n_i	a_i	a_i'	t_i	t_i'	m_i	r_i	SE(r_i)	RP[r_i]
bw 17	8/14-8/27	Sitka	11,529	6,026,488	4,621	44	44	38	38	1	4	3	168%
bw 17	8/14-8/27	Craig	1,295		1,280	13	12	9	9	2	3	1	84%
bw 18	8/28-9/10	Craig	116		100	2	2	1	1	1	1	1	108%
Sport subtotal			12,940		6,017	59	58	48	48	4	8	3	77%
Total all fisheries			1,415,833		387,713	4,791	4,526	3,346	3,345	84	448	46	20%

[a] Variance not estimated in the Craig sport fishery.

subsequent recoveries = 124; Appendix A2), and the late period running from May 12 through June 2 (smolt tagged = 2,596; recoveries = 47; Appendix A2), the recovery rate of the tagged smolt as mature fish (adults and jacks combined) from the two periods was not significantly different (χ^2 = 2.8, df = 1, P = 0.095). The recovery rate of tagged smolt as adults only from the two time periods was also not significantly different (χ^2 = 0.12, df = 1, P = 0.73). However, the recovery rate of tagged smolts as jacks between the two time periods was significantly different (χ^2 = 8.1, df = 1, P = 0.004); smolt from the early period were recovered as jacks at a rate of 1.2% versus later emigrants at a rate of 0.5%.

Koseki and Fleming (2006) found that freshwater processes, rather than marine processes, were the dominant forces affecting the frequency of jacks in a study of nine coho salmon populations over 20 years on the Oregon coast. They concluded that at the time of smolt emigration, the life history type (jack or adult) of most coho salmon was already predetermined. At Chuck Creek, it seems reasonable to assume that the difference in recovery rates of CWTs in the jack population can be attributed to smolt from the earlier emigration period containing a higher portion of "predetermined" jacks than later migrating smolt (as opposed to differential survival). The fact that smolt from the two time periods survived at the same rate to age x.1 adults (based on recoveries of CWTs) supports this assumption. The apparent propensity for earlier emigrating marked smolt to return as jacks at a higher rate than subsequent marked emigrants in this study would also be consistent with other coho salmon studies (Bilton et al. 1982; Lum 2003) and would explain the significant difference in the marked fraction between jacks (θ =0.817) and adults (θ =0.697) noted here; as it is likely that most untagged fish

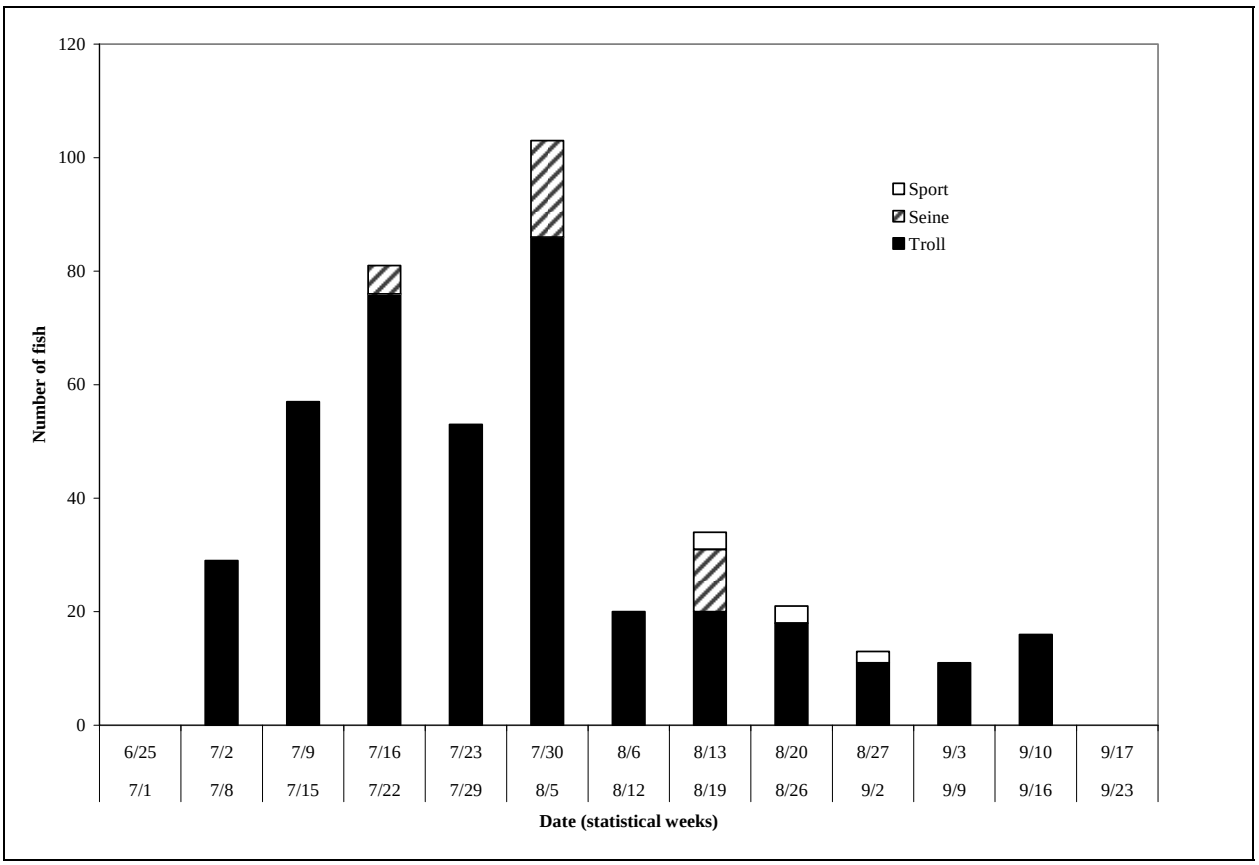

Figure 6.–Estimated marine harvest of coho salmon bound for Chuck Creek by statistical week and fishery in 2006.

Table 4.–Estimated harvest, exploitation rate, and total return of Chuck Creek coho salmon in 2006.

Fishery	Area	Estimated Harvest	SE	Percent of Marine Harvest	Percent of Total Run
Troll	NW Quadrant	91	20	20.3%	10.6%
	NE Quadrant	65	17	14.5%	7.6%
	SW Quadrant	188	30	42.0%	22.0%
	SE Quadrant	57	16	12.8%	6.7%
	North B.C.	7	6	1.5%	0.8%
	subtotal	408	43	91.0%	47.6%
Seine	District 101	8	7	1.7%	0.9%
	District 102	5	4	1.0%	0.5%
	District 104	20	13	4.5%	2.3%
	subtotal	32	3	7.2%	3.8%
Sport	Sitka	3	3	0.7%	0.4%
	Craig/Klawock	5	2	1.1%	0.6%
	subtotal	8	3	1.8%	0.9%
Total harvest		448	46	100.0%	52.3%
Escapement		409	0		47.7%
Total Return		857	46		100.0%

emigrated after the smolt weir was removed; it seems reasonable to assume that the group of marked smolt contained a higher percentage of fish "predetermined" to return as jacks than the group of unmarked smolt.

Survival to maturity of coho salmon smolt is positively correlated to smolt size (Bilton et al. 1982; Holtby et al. 1990; Lum 2003). In this study, there was a small difference in fork length between the two groups of marked emigrants. Marked smolt that migrated prior to May 12 averaged 106.3 mm FL (SE= 1.1) and those that migrated from May 12 on averaged 103.4 mm FL (SE = 1.4). This was not a statistically significant difference (t = 1.6, assuming unequal variance, df = 166, P = 0.1). It seems reasonable to speculate that smolt size was not a factor that significantly influenced survival in this experiment.

Although emigration date (and size) appeared to have had no significant effect on survival to maturity of marked coho salmon smolt in this study, past studies at Chuck Creek have shown that survival to maturity of marked smolt was a function of emigration date in years 2003 and 2004, suggesting that in those years, marked and unmarked fish experienced different survival rates due to different emigration dates (McCurdy 2006a, 2006b). However, a model used to estimate potential bias in smolt abundance estimates in those years demonstrated it would take a very large difference in the survival rate between marked and unmarked fish to bias the smolt abundance estimates to any functionally significant extent.

By applying the same model (Appendix A8) to the 2005 smolt emigration, potential bias in the abundance estimate can be estimated by conducting simulations where *unmarked* fish survive to maturity (to either jack or adult) at a rate different than the 11.6% survival rate of *marked* fish estimated in this study. If *unmarked* fish survive at 14.4% (a rate 25% higher than the rate of 11.6% for marked fish) then the smolt abundance estimate in this report (10,306) would be biased by 2.7% (and the actual abundance would be 10,030). Similarly, if the actual survival rate for unmarked fish was 8.7% (25% lower than for marked fish) the smolt abundance estimate would be biased by -10.7% (and actual abundance would be 11,540). These simulations suggest it would require a large difference in survival rates between marked and unmarked fish to greatly bias the smolt abundance estimate.

TIMING OF JACK RETURN AS A FUNCTION OF EMIGRATION DATE

Although there was a significant relationship between jack immigration date and smolt emigration date, the relationship was functionally mild, as only 7.1% of the variation in return date can be explained by the emigration date. The definition of "return date" in this study is the date

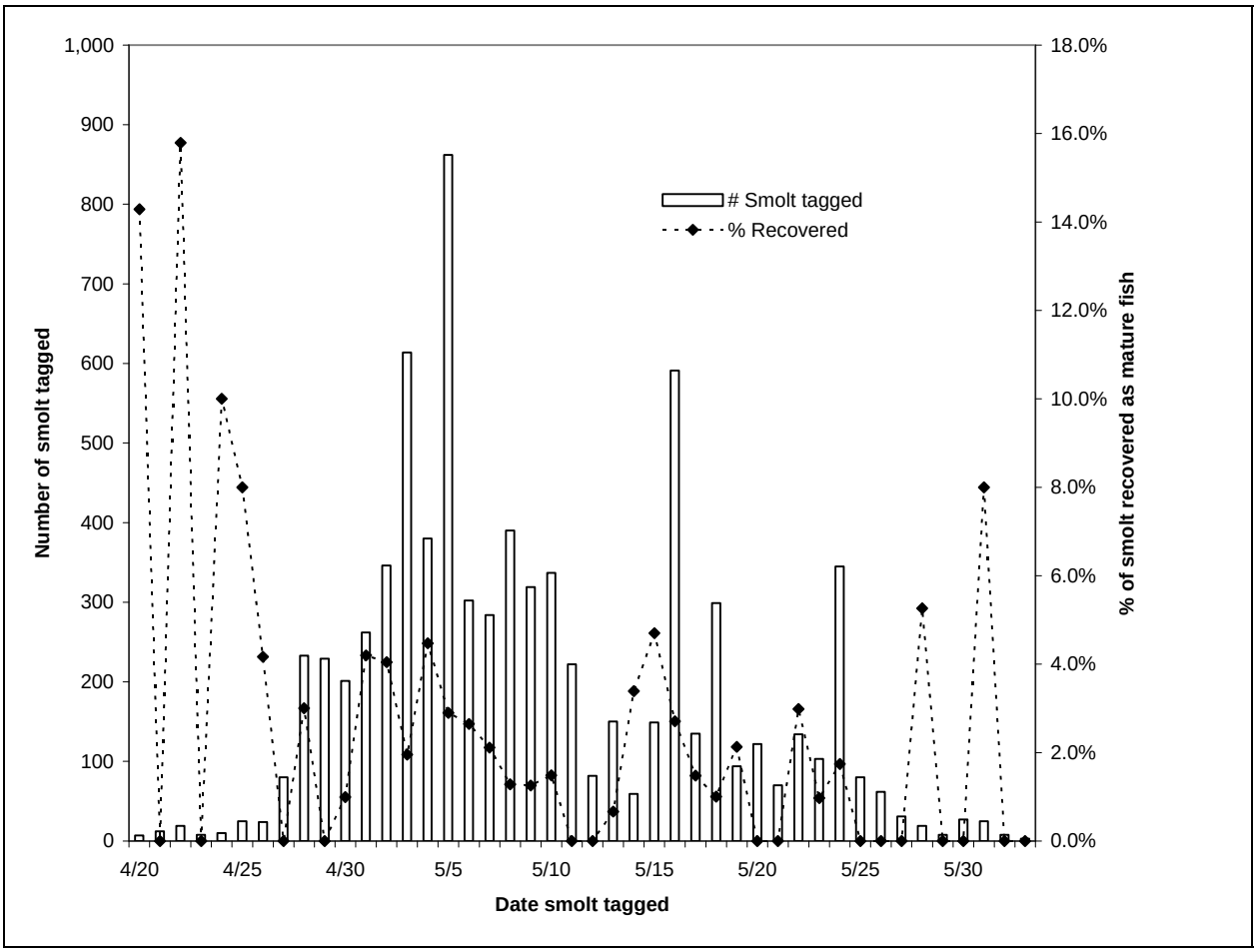

Figure 7.–Number of smolt tagged from the 2005 Chuck Creek coho salmon smolt emigration and the percentage of these smolt subsequently recovered as mature fish (jacks and adults) in sampled marine fisheries and escapement sampling.

that the fish is captured at the weir, requiring the fish to enter the stream, migrate approximately 500 meters upstream, and enter the weir cage. Personal observations of the author and field crews since the project began in 2001 have shown that the vast majority of coho, upon entering the stream, arrive at the weir within a few hours and enter the cage in under an hour upon arriving at the weir (usually within minutes). So it appears that capture at the weir is an excellent indicator of entry date into the stream. However entry into the stream by anadromous salmonids can be influenced by environmental factors such as water temperature and stream discharge (Holtby et al. 1984; Groot and Margolis 1991). Holtby et al. (1984) noted that the immigration of mature coho salmon at Carnation Creek on the west coast of Vancouver Island, Canada, was pulsed in years with few freshets and that fish would enter the stream during these events. Sandercock (Groot and Margolis 1991) noted that coho salmon will hold off stream mouths for several weeks or more before entering if stream conditions are unsuitable. At Chuck Creek in 2005, 70% of the jack escapement entered the stream in a 15–day period in September (McCurdy 2006b), but within that time frame the immigration was pulsed with peak catches occurring during high water events caused by freshets (Figure 8). It appears that stream discharge did affect return date in this experiment to some small unknown degree. If "return date" had been defined as return to the vicinity of the stream mouth, then environmental factors in the stream that influence entry could be controlled for this experiment. However there was no practical way to capture fish when they arrived

at the stream mouth. Any environmental influences in the marine environment that may influence migration and return date could also not be controlled for this experiment.

MARINE HARVEST

Harvest distribution patterns in 2006 were similar to past years (McCurdy 2005, 2006a, 2006b; Shaul et al. 1991), with almost all harvest occurring in districts along the outside coast (Appendices A1 and A7). The estimated marine harvest of 448 Chuck Creek coho salmon and the estimated total return of 857 fish were the smallest to date (for years when this stock has been monitored), and about half the average harvest and total return for the last three years (Table 5). The small total return was due to the smallest smolt emigration to date coupled with slightly below average marine survival. The marine exploitation rate of 52.3 % in 2006 was down slightly from previous years (Table 5). A relatively weak pink salmon run in southern Southeast Alaska in 2006, resulting in the lowest harvest of pink salmon in Southeast Alaska since 1987 (Eggers 2007), required fishery managers to restrict seine fishing effort in the region in order to ensure adequate pink salmon escapements. This reduced effort likely resulted in the low harvest rate of Chuck Creek coho salmon in 2006 by the seine fleet.

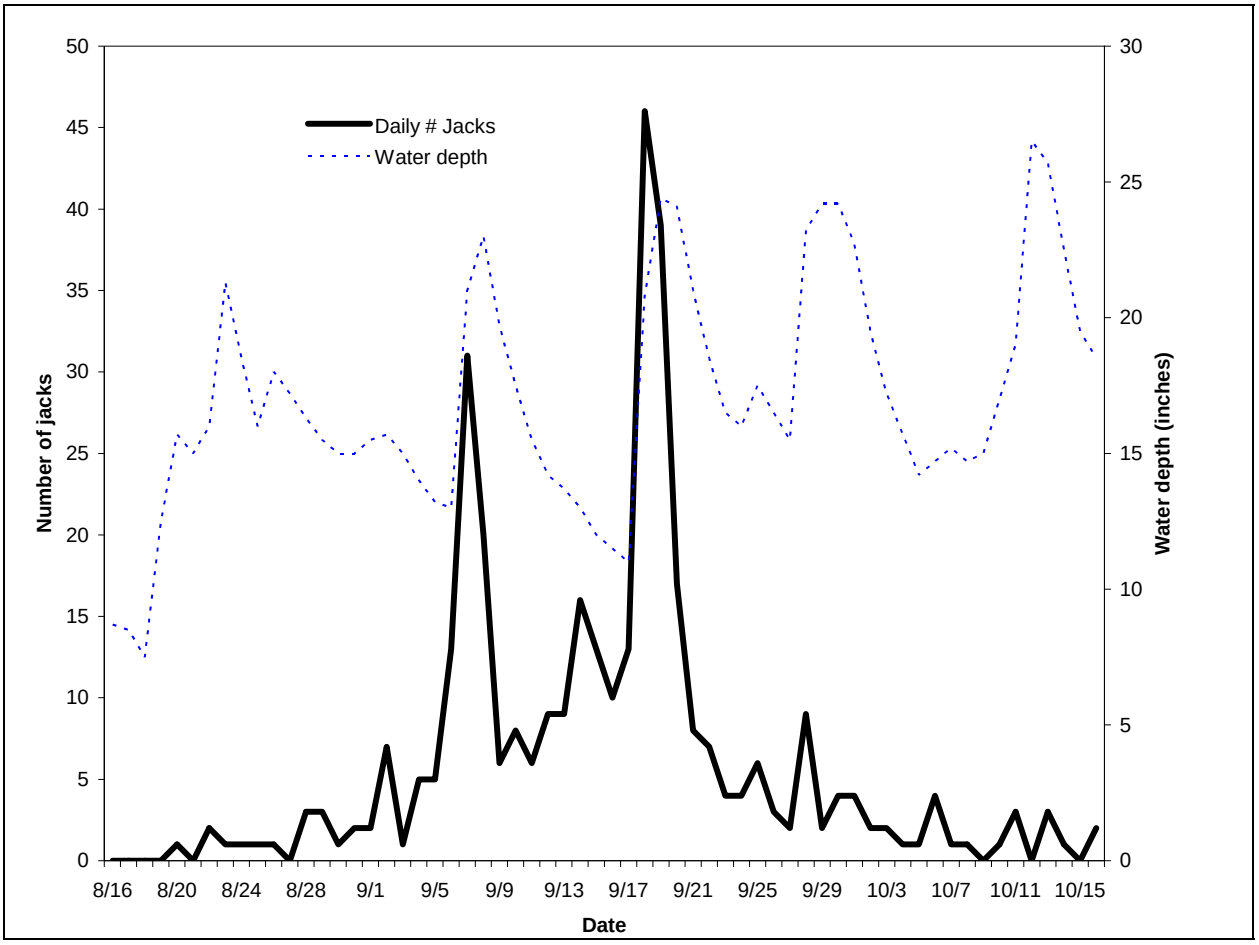

Figure 8.–Daily weir counts of jack coho salmon and stream water depth at Chuck Creek in 2005.

Table 5.–Estimated harvest, escapement, total return, and exploitation rate of adult coho salmon from Chuck creek in years with returning coded wire tagged fish.

Return Year	Harvest	Escapement	Total Return	Exploitation Rate
1982[a]	1,738	1,017	2,755	63.1%
1983[a]	1,169	1,238	2,407	48.6%
1985[a]	2,881	956	3,837	75.1%
2003[b]	874	614	1,488	58.7%
2004[c]	980	606	1,586	61.8%
2005[d]	1,004	646	1,650	60.8%
2006	448	409	857	52.3%

[a] Estimates from Shaul et al. 1991.
[b] Estimates from McCurdy 2005.
[c] Estimates from McCurdy 2006a.
[d] Estimates from McCurdy 2006b.

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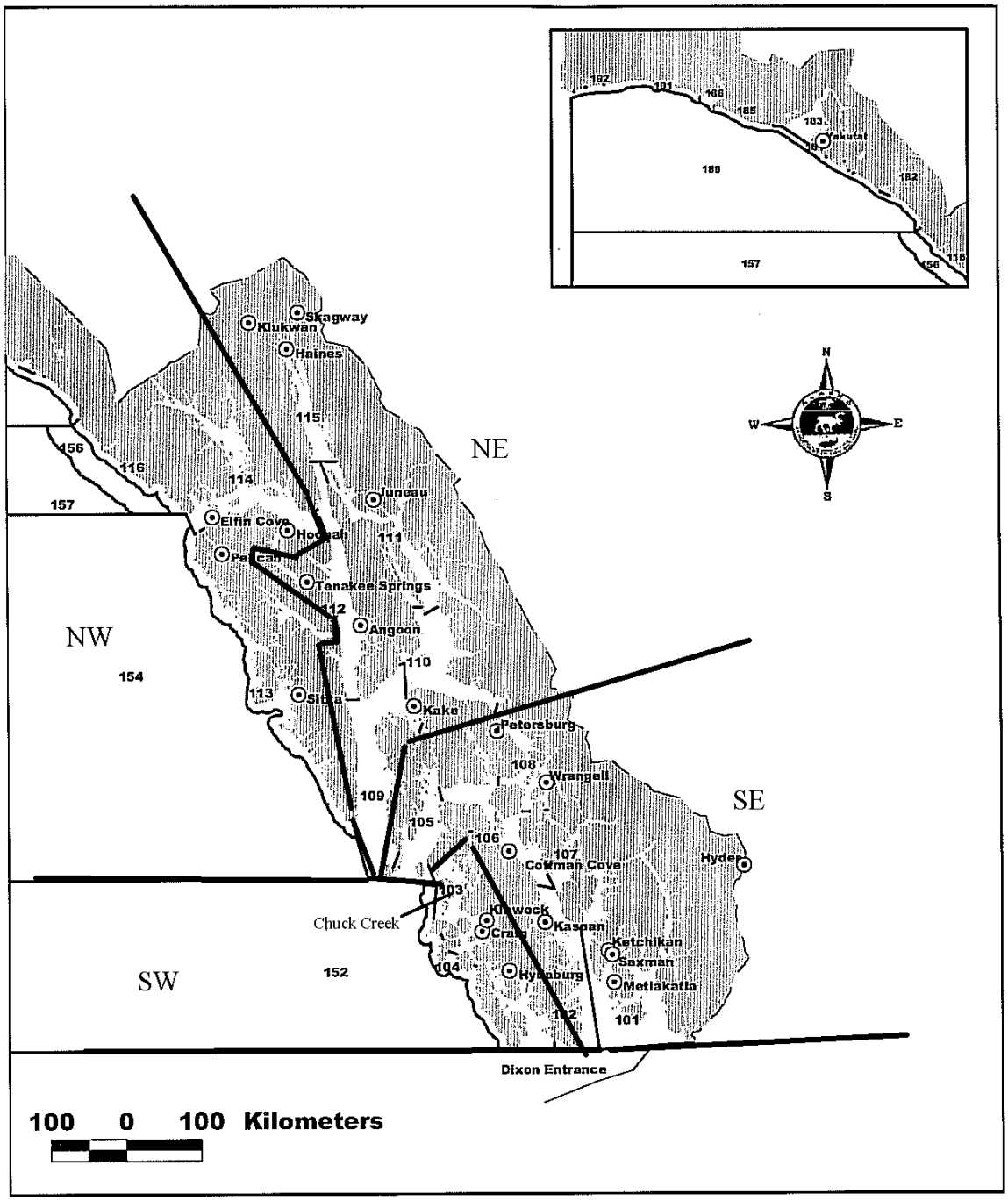
APPENDIX A

Appendix A1.–Map of Southeast Alaska commercial fishing districts and troll quadrants.



Appendix A2.–Summary of coho salmon smolt tagged with coded wire tags, held overnight, and released following sampling for tag retention at Chuck Creek in 2005; and subsequent recoveries of mature fish in marine fisheries and escapement sampling.

				Number Released With:		Sequential CWT Number		Number Recovered	
Date	Tag Code	Total Tagged	Overnight Mortality	Valid Tags	Shed Tags	Beginning	Ending	Adults	Jacks
4/20	041158	7	0	7	0	277	294	1	0
4/21	041158	12	0	12	0	410	435	0	0
4/22	041158	19	0	19	0	448	482	2	1
4/23	041158	8	0	8	0	543	551	0	0
4/24	041158	10	0	10	0	572	589	0	1
4/25	041158	25	0	25	0	605	648	0	2
4/26	041158	24	0	24	0	660	701	1	0
4/27	041158	80	0	80	0	715	846	0	0
4/28	041158	233	0	233	0	1,032	1,417	2	5
4/29	041158	229	0	229	0	1,483	1,863	0	0
4/30	041158	202	0	201	1	1,898	2,230	2	0
5/1	041158	262	0	262	0	2,246	2,689	3	8
5/2	041158	346	0	346	0	2,705	3,270	8	6
5/3	041158	614	0	614	0	3,283	4,289	4	8
5/4	041158	380	0	380	0	4,305	4,924	10	7
5/5	041158	862	0	862	0	4,961	6,368	10	15
5/6	041158	302	0	302	0	6,495	6,986	5	3
5/7	041158	284	0	284	0	7,028	7,492	4	2
5/8	041158	393	0	390	3	7,529	8,174	4	1
5/9	041158	319	0	319	0	8,215	8,734	1	3
5/10	041158	338	1	337	0	8,768	9,321	4	1
5/11	041158	223	1	222	0	9,361	9,726	0	0
5/12	041158	82	0	82	0	9,765	9,901	0	0
5/13	041158	150	0	150	0	9,934	10,180	0	1
5/14	041158	59	0	59	0	10,315	10,413	2	0
5/15	041158	149	0	149	0	10,448	10,692	6	1
5/16	041158	591	0	591	0	10,734	11,696	9	7
5/17	041158	135	0	135	0	11,720	11,951	2	0
5/18	041158	299	0	299	0	11,988	12,476	3	0

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				Number Released With:		Sequential CWT Number		Number Recovered	
Date	Tag Code	Total Tagged	Overnight Mortality	Valid Tags	Shed Tags	Beginning	Ending	Adults	Jacks
5/19	041158	94	0	94	0	12,502	12,657	0	2
5/20	041158	122	0	122	0	12,696	12,896	0	0
5/21	041158	70	0	70	0	12,928	13,043	0	0
5/22	041158	134	0	134	0	13,071	13,291	3	1
5/23	041158	103	0	103	0	13,315	13,484	1	0
5/24	041158	345	0	345	0	13,511	14,075	5	1
5/25	041158	80	0	80	0	14,097	14,229	0	0
5/26	041158	62	0	62	0	14,260	14,363	0	0
5/27	041158	31	0	31	0	14,399	14,450	0	0
5/28	041158	19	0	19	0	14,490	14,523	1	0
5/29	041158	8	0	8	0	14,658	14,678	0	0
5/30	041158	27	0	27	0	14,682	14,727	0	0
5/31	041158	25	0	25	0	14,733	14,777	1	1
6/1	041158	8	0	8	0	14,781	14,795	0	0
6/2	041158	3	0	3	0	14,795	14,802	0	0
Totals		7,768	2	7,762	4			94	77

Appendix A3.–Daily estimates of coho salmon smolt and counts of other downstream migrating fish captured at the Chuck Creek weir, 2005.

Date	Coho Smolt	Sockeye Smolt	Dolly Varden Adults[a]	Dolly Varden Juveniles[b]	Steelhead Juveniles[c]	Cutthroat Adults[a]	Cutthroat Juveniles[b]	Sculpin
4/19	0	0	0	0	0	0	0	0
4/20	7	0	17	0	0	0	1	31
4/21	12	3	13	0	0	0	0	40
4/22	19	22	22	0	0	0	0	74
4/23	8	16	34	1	0	0	0	127
4/24	10	53	22	0	0	0	0	147
4/25	25	57	14	1	0	1	0	155
4/26	24	62	61	0	0	0	0	219
4/27	80	80	109	0	0	0	0	188
4/28	233	243	7	1	0	0	0	135
4/29	229	215	23	4	2	0	0	199
4/30	202	136	21	3	0	0	1	157
5/1	262	172	31	7	0	0	0	181
5/2	346	302	41	13	0	0	0	139
5/3	614	170	33	17	0	0	0	152
5/4	380	695	13	5	0	0	0	103
5/5	862	1,785	9	4	0	0	0	93
5/6	302	875	14	6	0	0	0	96
5/7	284	454	8	1	0	0	0	101
5/8	393	748	6	5	0	0	0	75
5/9	319	1,496	25	8	0	0	1	118
5/10	338	823	4	2	0	0	0	123
5/11	223	598	1	2	0	0	0	122
5/12	82	163	2	14	0	0	0	153
5/13	150	196	7	9	1	0	0	93
5/14	59	166	7	6	1	0	0	135
5/15	149	990	20	14	0	0	0	78
5/16	591	3,813	12	24	1	0	0	63
5/17	135	493	15	31	0	0	0	70
5/18	299	1,350	13	27	0	0	0	47
5/19	94	1,070	17	16	0	0	0	76
5/20	122	563	8	7	0	0	0	58
5/21	70	584	16	29	0	0	0	43
5/22	134	801	9	37	0	0	2	33
5/23	103	522	4	13	1	0	0	39
5/24	345	329	4	22	0	2	0	20
5/25	80	104	2	18	0	0	0	35
5/26	62	186	0	1	1	0	0	15
5/27	31	21	1	0	0	0	0	19
5/28	19	40	0	1	0	0	0	20
5/29	8	68	6	7	0	0	0	27
5/30	27	13	0	0	0	0	0	11
5/31	25	9	0	0	0	0	0	23
6/1	8	5	0	0	0	0	0	16

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Date	Coho Smolt	Sockeye Smolt	Dolly Varden Adults[a]	Dolly Varden Juveniles[b]	Steelhead Juveniles[c]	Cutthroat Adults[a]	Cutthroat Juveniles[b]	Sculpin
6/2	3	3	1	1	0	0	0	7
6/3	0	1	0	0	0	0	0	17
6/4	0	0	0	0	0	0	0	1
Totals	7,768	20,495	672	357	7	3	5	3,874

[a] Fish ≥ 175 mm FL.

[b] Fish < 175 mm FL.

[c] All fish sexually immature. Includes both fish that appear to be smolt and non-smolt.

Appendix A4.–Recoveries of coho salmon that were coded–wire–tagged in the 2005 Chuck Creek smolt emigration and recovered in escapement sampling.

Head #	CWT Tag Code	Sequential CWT #	Date Tagged	Recovery Date[a]	Sex	Age[b]	Length[c] (mm)
RANDOM ESCAPEMENT RECOVERIES							
294018	041158	472	4/22/05	9/2/05	m	2.0	340
294073	041158	583	4/24/05	9/19/05	m	2.0	355
294045	041158	638	4/25/05	9/13/05	m	1.0	320
294058	041158	612	4/25/05	9/18/05	m	2.0	345
294021	041158	1,181	4/28/05	9/5/05	m	1.0	285
294089	041158	1,383	4/28/05	9/29/05	m	1.0	325
294020	041158	1,219	4/28/05	9/4/05	m	2.0	320
294038	041158	1,411	4/28/05	9/9/05	m	2.0	335
294043	041158	1,222	4/28/05	9/12/05	m	2.0	340
294030	041158	2,470	5/1/05	9/7/05	m	1.0	295
294034	041158	2,374	5/1/05	9/8/05	m	1.0	300
294050	041158	2,449	5/1/05	9/15/05	m	1.0	340
294097	041158	2,286	5/1/05	10/14/05	m	1.0	345
294014	041158	2,524	5/1/05	8/28/05	m	2.0	325
294035	041158	2,442	5/1/05	9/8/05	m	2.0	350
294077	041158	2,685	5/1/05	9/20/05	m	2.0	360
294013	041158	2,532	5/1/05	8/24/05	m	R	330
294022	041158	2,719	5/2/05	9/5/05	m	1.0	315
294075	041158	2,796	5/2/05	9/19/05	m	1.0	305
294023	041158	3,222	5/2/05	9/6/05	m	2.0	345
294092	041158	3,159	5/2/05	10/3/05	m	2.0	325
294016	041158	2,974	5/2/05	8/31/05	m	R	320
294039	041158	2,975	5/2/05	9/10/05	m	R	355
294017	041158	3,556	5/3/05	9/1/05	m	1.0	310
294027	041158	3,488	5/3/05	9/7/05	m	1.0	290
294036	041158	3,548	5/3/05	9/9/05	m	1.0	315
294042	041158	3,472	5/3/05	9/12/05	m	1.0	325
294071	041158	3,768	5/3/05	9/19/05	m	1.0	280
294044	041158	3,823	5/3/05	9/13/05	m	2.0	345
294074	041158	3,706	5/3/05	9/19/05	m	2.0	330
294067	041158	3,737	5/3/05	9/18/05	m	R	310
294032	041158	4,382	5/4/05	9/8/05	m	1.0	335
294033	041158	4,533	5/4/05	9/8/05	m	1.0	305
294046	041158	4,375	5/4/05	9/13/05	m	1.0	310
294078	041158	4,824	5/4/05	9/20/05	m	2.0	335
294019	041158	4,888	5/4/05	9/2/05	m	R	315
294029	041158	4,391	5/4/05	9/7/05	m	R	290
294015	041158	5,793	5/5/05	8/30/05	m	1.0	290
294031	041158	5,516	5/5/05	9/7/05	m	1.0	325
294040	041158	5,723	5/5/05	9/11/05	m	1.0	320
294048	041158	5,754	5/5/05	9/14/05	m	1.0	335
294062	041158	6,061	5/5/05	9/18/05	m	1.0	385
294080	041158	5,171	5/5/05	9/22/05	m	1.0	335
294087	041158	5,405	5/5/05	9/28/05	m	1.0	300
294052	041158	5,710	5/5/05	9/15/05	m	2.0	350
294063	041158	5,720	5/5/05	9/18/05	m	2.0	360

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Head #	CWT Tag Code	Sequential CWT #	Date Tagged	Recovery Date[a]	Sex	Age[b]	Length[c] (mm)
RANDOM ESCAPEMENT RECOVERIES							
294012	041158	6,332	5/5/05	8/20/05	m	2.0	320
294055	041158	5,671	5/5/05	9/16/05	m	R	345
294056	041158	5,842	5/5/05	9/17/05	m	R	360
294066	041158	5,095	5/5/05	9/18/05	m	R	330
294069	041158	5,116	5/5/05	9/19/05	m	R	295
294070	041158	5,604	5/5/05	9/19/05	m	R	365
294041	041158	6,886	5/6/05	9/11/05	m	1.0	325
294051	041158	6,501	5/6/05	9/15/05	m	1.0	320
294025	041158	6,944	5/6/05	9/6/05	m	2.0	335
294047	041158	7,150	5/7/05	9/14/05	m	1.0	345
294079	041158	7,477	5/7/05	9/21/05	m	1.0	325
294068	041158	7,978	5/8/05	9/19/05	m	1.0	330
294028	041158	8,628	5/9/05	9/7/05	m	1.0	290
294049	041158	8,592	5/9/05	9/14/05	m	1.0	290
294053	041158	8,348	5/9/05	9/16/05	m	1.0	310
294064	041158	9,047	5/10/05	9/18/05	m	1.0	300
294085	041158	10,077	5/13/05	9/25/05	m	1.0	300
294081	041158	10,646	5/15/05	9/22/05	m	1.0	310
294026	041158	10,760	5/16/05	9/7/05	m	1.0	305
294061	041158	10,992	5/16/05	9/18/05	m	1.0	320
294065	041158	11,082	5/16/05	9/18/05	m	1.0	300
294072	041158	11,644	5/16/05	9/19/05	m	1.0	310
294054	041158	11,627	5/16/05	9/16/05	m	2.0	315
294090	041158	11,593	5/16/05	10/1/05	m	2.0	325
294059	041158	11,645	5/16/05	9/18/05	m	R	285
294060	041158	12,645	5/19/05	9/18/05	m	2.0	315
294076	041158	12,542	5/19/05	9/20/05	m	2.0	320
294024	041158	13,128	5/22/05	9/6/05	m	R	280
294086	041158	14,063	5/24/05	9/25/05	m	R	310
294083	041158	14,772	5/31/05	9/23/05	m	R	310
NON-RANDOM ESCAPEMENT RECOVERIES							
294037	041158	4,651	5/4/05	9/9/05	m	1.0	320
320803	041158	6,840	5/6/05	9/18/06	f	1.1	635
320804	041158	4,354	5/4/05	9/19/06	f	2.1	585
320819	041158	11,626	5/16/05	9/23/06	f	1.1	660
320825	041158	8,968	5/10/05	9/25/06	f	1.1	590
320830	041158	12,451	5/18/05	10/12/06	f	R	580

[a] Date of recovery for random samples was the date of capture at the weir (every 4th jack captured, missing an adipose fin was sampled). All non-random samples were from carcasses found in the watershed upstream of the weir and the date of recovery was the date the carcass was found.

[b] "R" denotes fish where the age was undetermined due to regenerated scales.

[c] All lengths are mid-eye-fork.

Appendix A5.–Daily escapement counts of mature coho salmon passed through the weir on Chuck Creek by life history type and marked statues (adipose fin removed), 2006.

	Adults (age x.1)			Jacks (age x.0)			
Date	Marked	Unmarked	Total	Marked	Unmarked	Unknown[a]	Total
8/15	0	0	0	0	0	0	0
8/16	2	0	2	0	0	0	0
8/17	0	0	0	0	0	0	0
8/18	0	0	0	0	0	0	0
8/19	1	0	1	0	0	0	0
8/20	0	1	1	0	0	0	0
8/21	0	2	2	1	0	0	1
8/22	0	0	0	0	0	0	0
8/23	2	0	2	0	0	0	0
8/24	1	0	1	0	0	0	0
8/25	5	1	6	0	0	0	0
8/26	0	0	0	1	0	0	1
8/27	3	0	3	2	0	0	2
8/28	10	4	14	7	0	0	7
8/29	7	0	7	6	1	0	7
8/30	1	2	3	2	0	2	4
8/31	10	0	10	3	0	0	3
9/1	30	6	36	17	2	0	19
9/2	24	3	27	24	1	2	27
9/3	8	7	15	17	1	0	18
9/4	20	4	24	31	5	0	36
9/5	20	5	25	19	0	1	20
9/6	2	3	5	12	1	0	13
9/7	9	0	9	10	1	0	11
9/8	20	4	24	40	1	3	44
9/9	9	6	15	29	2	0	31
9/10	24	10	34	47	5	0	52
9/11	18	11	29	60	6	0	66
9/12	9	8	17	23	2	0	25
9/13	1	3	4	22	5	0	27
9/14	4	4	8	11	3	0	14
9/15	3	3	6	7	2	0	9
9/16	2	2	4	4	0	0	4
9/17	1	0	1	5	2	0	7
9/18	0	0	0	0	0	0	0
9/19	0	0	0	1	0	0	1
9/20	5	1	6	19	1	1	21
9/21	0	1	1	10	5	0	15
9/22	12	4	16	16	3	0	19
9/23	5	2	7	19	9	0	28
9/24	3	3	6	4	6	2	12
9/25	2	4	6	3	0	0	3
9/26	4	3	7	5	1	0	6
9/27	4	3	7	2	1	0	3
9/28	1	4	5	2	1	0	3
9/29	0	0	0	0	0	0	0
9/30	0	2	2	3	0	0	3

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	Adults (age x.1)			Jacks (age x.0)			
Date	Marked	Unmarked	Total	Marked	Unmarked	Unknown[a]	Total
10/1	2	3	5	2	2	0	4
10/2	0	0	0	1	1	0	2
10/3	0	0	0	0	1	0	1
10/4	0	1	1	0	0	0	0
10/5	0	0	0	0	1	0	1
10/6	1	1	2	0	1	0	1
10/7	0	0	0	0	0	0	0
10/8	0	0	0	0	0	0	0
10/9	0	0	0	0	0	0	0
10/10	0	0	0	0	0	0	0
10/11	0	1	1	0	0	0	0
10/12	0	0	0	0	0	0	0
10/13	0	1	1	0	0	0	0
10/14	0	0	0	0	0	0	0
10/15	0	1	1	0	1	0	1
Totals	285	124	409	487	74	11	572

[a] Fish passed upstream before it was examined for the presence of an adipose fin.

Appendix A6.–Daily escapement counts of sockeye, pink, and chum salmon; Dolly Varden; and cutthroat and steelhead trout passed through the weir at Chuck Creek, 2006.

Date	Sockeye Adults	Sockeye Jacks	Pinks	Chum	Dolly Varden	Cutthroat	Steelhead
8/15	14	0	55	0	0	0	0
8/16	138	1	569	0	0	0	0
8/17	66	0	640	0	0	0	0
8/18	234	0	1,584	0	0	0	0
8/19	98	0	1,232	0	0	0	0
8/20	125	0	1,115	0	0	0	0
8/21	108	0	992	0	0	0	2
8/22	68	0	848	0	0	0	0
8/23	103	1	965	0	0	0	0
8/24	54	0	835	0	0	0	0
8/25	124	0	808	0	0	0	0
8/26	100	0	1,239	0	0	0	0
8/27	174	0	1,953	0	0	0	0
8/28	130	0	1,949	1	0	0	0
8/29	98	0	1,720	1	0	1	0
8/30	43	1	1,432	2	0	0	0
8/31	42	0	2,781	3	0	0	0
9/1	68	1	3,293	5	0	0	0
9/2	51	2	1,544	4	0	0	0
9/3	34	0	678	4	0	0	0
9/4	43	1	691	4	0	0	0
9/5	50	0	1,078	2	0	0	0
9/6	42	0	1,235	1	0	0	0
9/7	23	0	2,382	4	0	0	0
9/8	14	0	1,987	4	0	0	0
9/9	18	0	1,335	9	0	0	0
9/10	14	0	967	7	0	0	0
9/11	13	0	946	8	0	1	0
9/12	6	0	439	5	0	0	0
9/13	7	0	420	3	0	0	1
9/14	5	0	163	0	0	0	0
9/15	7	0	166	0	0	0	1
9/16	1	0	246	0	0	0	0
9/17	0	0	821	0	0	0	0
9/18	1	0	1,717	1	0	0	0
9/19	0	0	404	0	0	0	0
9/20	2	0	306	0	0	0	0
9/21	1	0	136	2	1	0	0
9/22	7	0	469	1	3	0	1
9/23	7	0	340	1	0	1	0
9/24	10	0	967	12	3	0	0
9/25	2	0	347	5	0	0	1
9/26	0	0	213	4	0	0	0
9/27	1	0	54	2	0	0	0
9/28	0	0	73	0	0	0	0
9/29	0	0	0	0	0	0	0
9/30	0	0	95	0	0	0	0

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Date	Sockeye Adults	Sockeye Jacks	Pinks	Chum	Dolly Varden	Cutthroat	Steelhead
10/1	1	0	63	1	0	0	0
10/2	0	0	38	2	0	0	0
10/3	0	0	29	1	0	0	0
10/4	0	0	27	0	0	0	0
10/5	0	0	37	0	0	0	0
10/6	0	0	30	0	0	0	0
10/7	0	0	30	0	0	0	0
10/8	0	0	19	0	0	0	0
10/9	0	0	9	0	0	0	0
10/10	0	0	9	0	0	0	0
10/11	0	0	9	0	0	0	0
10/12	0	0	22	0	0	0	0
10/13	0	0	18	0	0	0	0
10/14	0	0	30	0	0	0	0
10/15	0	0	1	0	0	0	0
Totals	2,147	7	44,600	99	7	3	6

[a] Fish < 400 mm FL.

Appendix A7.–Recoveries of coho salmon that were coded–wire–tagged in the 2005 Chuck Creek smolt emigration and recovered in marine commercial and sport fisheries sampling programs.

Head Number	Sampling Port	Gear	Recovery Date	Stat Wk	Quad	District	Sub-District	Length[a] (mm)	Sequential CWT #	Date Smolt Tagged
RANDOM FISHERIES RECOVERIES										
308006	Ketchikan	Seine	7/17/2006	29	SE	102	10	605	10,509	5/15/2005
311328	Ketchikan	Seine	8/3/2006	31	SE	101	41	560	5,609	5/5/2005
311333	Ketchikan	Seine	8/3/2006	31	SW	104	40	540	11,420	5/16/2005
18491	Petersburg	Seine	8/18/2006	33	SW	104	40	640	10,916	5/16/2005
268785	Craig	Sport	8/14/2006	33	SE	105	50	550	11,814	5/17/2005
318295	Sitka	Sport	8/19/2006	33	NW	113	41	650	2,954	5/2/2005
268793	Craig	Sport	8/23/2006	34	SE	105	50	560	10,517	5/15/2005
268585	Craig	Sport	8/28/2006	35	SE	105	50	670	6,315	5/5/2005
313626	Sitka	Troll	7/4/2006	27	NW			560	3,040	5/2/2005
313098	Sitka	Troll	7/4/2006	27	NW	113		495	7,216	5/7/2005
300482	Sitka	Troll	7/6/2006	27	NW	113		550	2,921	5/2/2005
313520	Sitka	Troll	7/6/2006	27	NW	113		605	6,804	5/6/2005
300491	Sitka	Troll	7/6/2006	27	NW	113	91	530	10,506	5/15/2005
529536	Juneau	Troll	7/9/2006	28	NW			560	14,769	5/31/2005
311601	Ketchikan	Troll	7/9/2006	28	SW	103		535	5,653	5/5/2005
313403	Sitka	Troll	7/10/2006	28	NW			580	9,292	5/10/2005
145912	Port Alexander	Troll	7/11/2006	28	NE	109	61	520	1,271	4/28/2005
313815	Sitka	Troll	7/12/2006	28	NW	113		550	11,428	5/16/2005
311532	Ketchikan	Troll	7/13/2006	28	SW			575	13,996	5/24/2005
313824	Sitka	Troll	7/13/2006	28	NW	113	45	550	10,396	5/14/2005
314106	Sitka	Troll	7/13/2006	28	NW	113	81	555	10,564	5/15/2005
292953	Craig	Troll	7/17/2006	29	SW	152		600	11,064	5/16/2005
314199	Sitka	Troll	7/18/2006	29	NW	113		570	666	4/26/2005
292976	Craig	Troll	7/19/2006	29	SW	152		590	4,664	5/4/2005
292981	Craig	Troll	7/19/2006	29	SW	103	50	555	7,660	5/8/2005
292972	Craig	Troll	7/19/2006	29	SW	152		585	12,223	5/18/2005
292997	Craig	Troll	7/19/2006	29	SW	152		555	13,354	5/23/2005
314411	Sitka	Troll	7/19/2006	29	NE	109	61	500	13,150	5/22/2005
291917	Craig	Troll	7/20/2006	29	NE	109	10	585	1,976	4/30/2005
291923	Craig	Troll	7/20/2006	29	NE	109	10	555	2,908	5/2/2005
291927	Craig	Troll	7/20/2006	29	NE	109	10	640	3,133	5/2/2005
291909	Craig	Troll	7/20/2006	29	SE	105	10	585	5,150	5/5/2005
291938	Craig	Troll	7/21/2006	29	SE	105	10	610	478	4/22/2005

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Head Number	Sampling Port	Gear	Sampling Date	Stat Wk	Quad	District	Sub-District	Length (mm)	Sequential CWT #	Date smolt tagged
RANDOM FISHERIES RECOVERIES										
291934	Craig	Troll	7/21/2006	29	SE	105	10	570	2,499	5/1/2005
291950	Craig	Troll	7/21/2006	29	SE	105	50	575	7,943	5/8/2005
166550	Port Alexander	Troll	7/22/2006	29	NW	113	21	570	11,390	5/16/2005
314460	Sitka	Troll	7/22/2006	29	NW	113	21	590	286	4/20/2005
166582	Port Alexander	Troll	7/24/2006	30				595	3,627	5/3/2005
166580	Port Alexander	Troll	7/24/2006	30				555	14,003	5/24/2005
313967	Sitka	Troll	7/25/2006	30	NW	113		585	3,579	5/3/2005
314465	Sitka	Troll	7/26/2006	30				595	9,151	5/10/2005
292866	Craig	Troll	7/27/2006	30	SW	152		590	452	4/22/2005
292873	Craig	Troll	7/27/2006	30	SW	152		530	1,372	4/28/2005
292858	Craig	Troll	7/27/2006	30	SW	152		580	2,067	4/30/2005
291978	Craig	Troll	7/27/2006	30	SW	103	50	580	3,073	5/2/2005
291983	Craig	Troll	7/27/2006	30	NE	109	61	545	4,335	5/4/2005
292865	Craig	Troll	7/27/2006	30	SW	152		600	5,008	5/5/2005
292871	Craig	Troll	7/27/2006	30	SW	152		565	13,149	5/22/2005
166590	Port Alexander	Troll	7/27/2006	30	NE	109	61	640	4,462	5/4/2005
292885	Craig	Troll	7/28/2006	30	SE	105	50	500	6,838	5/6/2005
308153	Ketchikan	Troll	7/28/2006	30	SW	103		550	4,747	5/4/2005
309012	Craig	Troll	7/31/2006	31	SW	103	60	610	2,433	5/1/2005
309008	Craig	Troll	7/31/2006	31	SW	103	60	570	10,333	5/14/2005
314034	Sitka	Troll	7/31/2006	31	NE	109	61	575	4,686	5/4/2005
314032	Sitka	Troll	7/31/2006	31	NW	113	21	565	5,364	5/5/2005
309035	Craig	Troll	8/1/2006	31	SE	105	50	515	4,823	5/4/2005
309036	Craig	Troll	8/1/2006	31	SE	105	50	585	8,444	5/9/2005
309048	Craig	Troll	8/2/2006	31	NE	109	10	590	8,048	5/8/2005
309052	Craig	Troll	8/3/2006	31	SW	103	70	610	7,050	5/7/2005
309060	Craig	Troll	8/3/2006	31	SW	103	60	600	8,131	5/8/2005
309062	Craig	Troll	8/4/2006	31	SE	105	10	485	6,697	5/6/2005
309121	Craig	Troll	8/4/2006	31	SW	103	60	440	7,115	5/7/2005
309122	Craig	Troll	8/4/2006	31	SW	103	60	550	13,776	5/24/2005
308183	Ketchikan	Troll	8/4/2006	31	SW	103		600	5,134	5/5/2005

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Head Number	Sampling Port	Gear	Sampling Date	Stat Wk	Quad	District	Sub-District	Length (mm)	Sequential CWT #	Date smolt tagged
RANDOM FISHERIES RECOVERIES										
308178	Ketchikan	Troll	8/4/2006	31	SW	103		595	10,807	5/16/2005
308190	Ketchikan	Troll	8/4/2006	31	SW	103		570	13,098	5/22/2005
308179	Ketchikan	Troll	8/4/2006	31	SW	103		560	13,564	5/24/2005
314073	Sitka	Troll	8/8/2006	32	SE	105	50	590	11,585	5/16/2005
309099	Craig	Troll	8/9/2006	32	NE	109	10	620	3,383	5/3/2005
309130	Craig	Troll	8/9/2006	32	SW	103	80	560	8,896	5/10/2005
311376	Ketchikan	Troll	8/16/2006	33	SW			620	2,721	5/2/2005
309169	Craig	Troll	8/17/2006	33	SW			640	3,379	5/3/2005
309174	Craig	Troll	8/17/2006	33	SW	103	90	580	5,701	5/5/2005
309237	Craig	Troll	8/18/2006	33	SW	104		575	2,465	5/1/2005
314638	Sitka	Troll	8/22/2006	34	NW	113		650	4,523	5/4/2005
309376	Craig	Troll	8/23/2006	34	SW	104	40	605	11,098	5/16/2005
311257	Ketchikan	Troll	8/23/2006	34	SW			615	13527	5/24/2005
18947	Petersburg	Troll	8/24/2006	34	NE	109	10	620	10,582	5/15/2005
308237	Ketchikan	Troll	8/29/2006	35				615	2,895	5/2/2005
309615	Craig	Troll	8/31/2006	35	SW	104	40	565	4,526	5/4/2005
309516	Craig	Troll	8/31/2006	35	SW	104	40	615	6,037	5/5/2005
309395	Craig	Troll	8/31/2006	35	SW	104	40	575	14,501	5/28/2005
309632	Craig	Troll	9/1/2006	35	NE	109	10	575	7,076	5/7/2005
309639	Craig	Troll	9/5/2006	36	SW	104	50	635	6,741	5/6/2005
315604	Sitka	Troll	9/6/2006	36	NW	113	45	585	11,881	5/17/2005
309655	Craig	Troll	9/14/2006	37	SE	105		595	10,608	5/15/2005
309667	Craig	Troll	9/14/2006	37	SE	105		680	12,072	5/18/2005
62131	Northern B.C.	Troll		31						
NON-RANDOM FISHERIES RECOVERIES										
268783	Craig	Sport	8/9/2006	32	SW				5,356	5/5/2005
900274	Sitka	Troll	8/9/2006	32					4,336	5/4/2005

[a] All lengths are fork length.

Appendix A8.–Model used to estimate potential bias in smolt abundance estimate of 2005 Chuck Creek coho salmon smolt emigration if unmarked fish survived at a different rate than marked fish.

In this study, overall survival (to either jack or adult) of *marked* fish can be estimated to be 11.6% (= [$300_{cwt\ jacks}$ + $285_{cwt\ adult\ esc}$ + $312_{cwt\ harvest}$] / $7{,}766_{cwt\ smolt}$), with the *CWT harvest* estimated by expanding the number of recoveries in sampled fisheries for the fraction of the harvest not examined; and *CWT jacks* estimated by expanding the number of recoveries in the sampled jack escapement for the fraction of the jack escapement not examined (300 = 367 * 295/361). All other variables are known from weir counts. Thus, smolt abundance at survival rates other than the assumed rate of 11.6% is:

$$\hat{N} = n_{marked} + \left(m_{unmarked} / S_{unmarked}\right)$$

where $\hat{N}$ is the mark–recapture estimate of smolt abundance, n_{marked} is the number of smolt that were marked (7,766), $m_{unmarked}$ is the number of unmarked mature fish (estimated at 327 in this study), and S is the fraction of unmarked smolt that survive to maturity (unknown in this study). The number of unmarked mature fish was estimated by summing the weir counts in the escapement ($67_{jacks\ unmarked}$ + $124_{adults\ unmarked}$) and the estimated number in the harvest (= 136, assuming the harvest rate for unmarked fish is the same for marked fish).

Appendix A9.–Computer files used in the analysis of data in this report.

File Name	Description
06Chuck adult weir.xls	Excel workbook containing 2006 Chuck Creek adult escapement data.
05Chuck smolt data.xls	Excel workbook containing 2005 Chuck Creek smolt and coded wire tagging data.
06Chuck Harvest.xls	Excel workbook containing 2006 marine harvest estimations and cwt recoveries.