Fishery Data Series No. 13-14

Production, Harvest, and Escapement of Chilkat River Coho Salmon, 2009–2010

by

Brian W. Elliott

April 2013

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 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)

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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by
Brian W. Elliott
Division of Sport Fish, Haines

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

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Brian W. Elliott[a]
Alaska Department of Fish and Game, Division of Sport Fish,
P. O. Box 330, Haines, AK 99827-0330, USA

[a]*Author to whom all correspondence should be addressed: brian.elliott1@alaska.gov*

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ABSTRACT

This study conducted a full stock assessment of Chilkat River coho salmon *Oncorhynchus kisutch*. Coho salmon smolt were captured in the Chilkat River during spring 2009, marked with an adipose fin clip and a coded wire tag (CWT), and sampled for age, weight, and length. In 2010, adult coho salmon were sampled for CWTs in sport and commercial fishery harvests throughout Southeast Alaska and in the Chilkat River to estimate the marked fraction. The 2010 escapement to the Chilkat River was estimated by expanding peak survey counts.

An estimated 872,829 (SE = 151,981) coho salmon smolt emigrated from the Chilkat River in 2009. Most (79.1%, SE = 2.0%) of the smolt emigrating were age-1. In 2010, the total (nonjack) return of Chilkat River coho salmon was estimated at 154,157 (SE = 17,171), of which 68,385 (SE = 5,165) were harvested in marine fisheries, 706 (SE = 138) were harvested inriver, and 85,066 (SE = 16,375) escaped into the Chilkat River. Most (54.0%) of the harvest occurred in the District 115 drift gillnet fishery (37,322, SE = 4,096). The majority of the escapement was age-1.1 (2007 brood year, 73.5%, SE = 1.8%), and male (52.0%, SE = 1.5%). The marine survival (smolt-to-adult) and exploitation rates were estimated at 17.7% (SE = 3.7%) and 44.4% (SE = 5.1%), respectively.

Key words: abundance, escapement, coded wire tag, harvest, contribution, subsistence fishery, recreational fishery, troll fishery, drift gillnet fishery, seine fishery, age composition, size composition, sex composition, length-at-age, marine survival, exploitation rate, coho salmon, *Oncorhynchus kisutch*, Chilkat River, Haines, Southeast Alaska

INTRODUCTION

The purpose of this study was to conduct a full stock assessment of Chilkat River coho salmon *Oncorhynchus kisutch*. The long-term goal of this study is to gather information needed to manage harvests in accordance with sustained yield principles.

The Chilkat River produces annual adult returns of 65,000 to 300,000 coho salmon and is the second largest coho salmon stock in Southeast Alaska after the Taku River (Shaul et al. 2008). Research conducted during the 1980s on coho salmon stocks in Lynn Canal (including the Chilkat River) concluded that these stocks have, at times, been subjected to very high (over 85%) exploitation rates (Elliott and Kuntz 1988; Shaul et al. 1991).

The Chilkat River is a large glacial system that originates in British Columbia, Canada, flows through rugged dissected mountainous terrain, and terminates in Chilkat Inlet near Haines, Alaska (Figure 1). The mainstem and major tributaries comprise approximately 350 km of river channel in a watershed covering about 2,600 km^2 (Bugliosi 1988).

Sport fishing for all species comprises a significant share of the overall economy for both Southeast Alaska and the Haines/Skagway management area, as indicated by recent studies. Overall in 2007, anglers spent $274 million in Southeast Alaska, including $175 million by nonresident anglers. Nonresident anglers fishing in Southeast Alaska spent an average of $403.94 per day on sport fishing activities (all types combined) in 2007, while residents spent an average of $102.54 per day of fishing (Southwick Associates Inc. et al. 2008). Specifically the freshwater coho salmon fishery in Haines provides a small but important component of the local economy and sport fishery in Southeast Alaska. In 1988, anglers fishing in Haines and Skagway for coho salmon spent an estimated $181,000 (Jones and Stokes Associates 1991). This fishery operates late in the year when other fisheries have finished and is popular with local and non-local anglers. In 2007, 79.5% of anglers who fished in freshwater areas of Haines were nonresidents (Jennings et al. 2010a), and while they may spend less than the average for Southeast Alaska, their economic impact in Haines is significant.

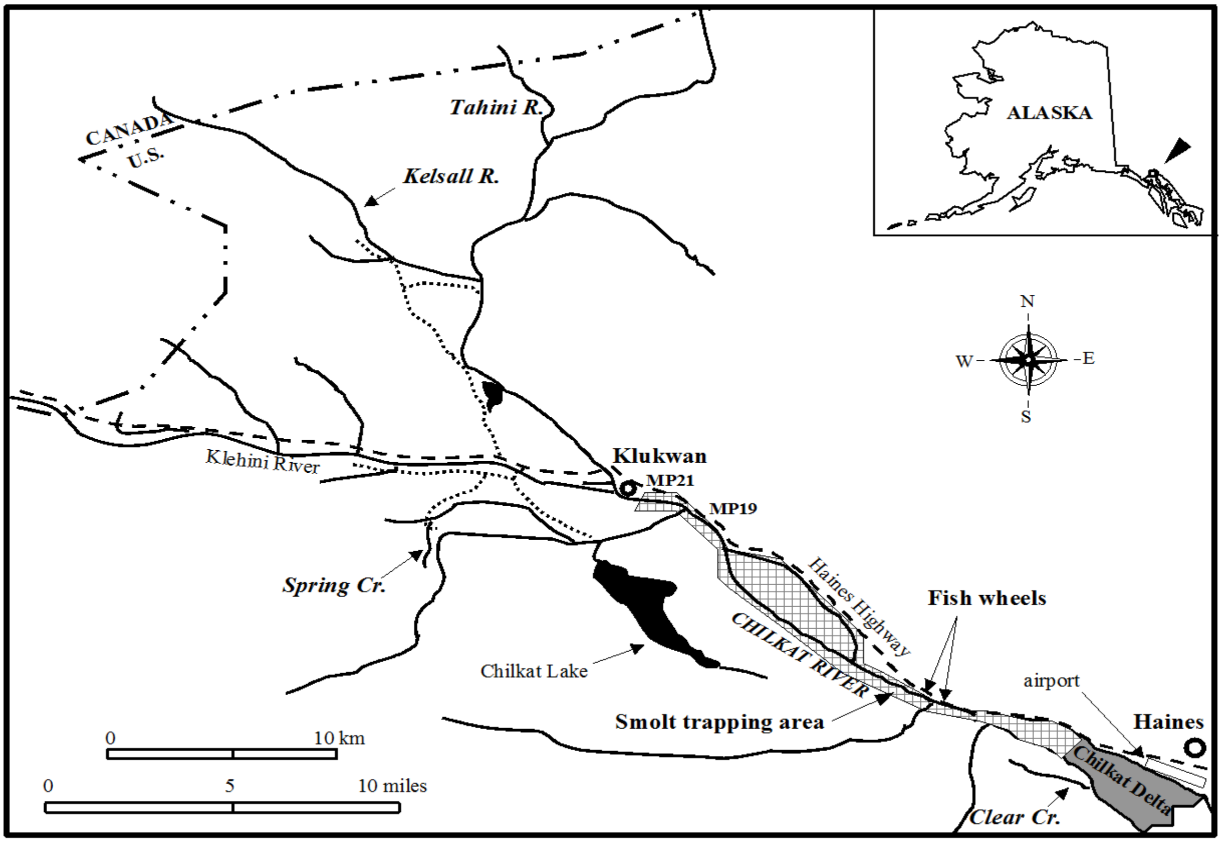

Figure 1.–The Chilkat River drainage, showing location of sampling sites.

The Chilkat River produces most of the coho salmon harvested in the Haines management area and supports one of the largest freshwater coho fisheries in Southeast Alaska; annual harvests averaged 2,060 coho salmon from 2000 to 2009 (Howe et al. 2001; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, 2009a-b, 2010a-b, 2011). This stock also contributes a significant number (more than 60,000 per year) of fish to the commercial troll, gillnet, and seine fisheries in northern Southeast Alaska (Elliott and Kuntz 1988; Shaul et al. 1991; Ericksen 2001–2003; Ericksen and Chapell 2005; Elliott 2009, 2010, 2012a-b).

The current management program for Chilkat River coho salmon relies on escapement monitoring on four index streams: Clear Creek, Spring Creek, Tahini River, and Kelsall River (Figure 1). Alaska Department of Fish and Game (ADF&G) personnel survey the index streams by foot or boat on a weekly basis in October during peak spawning, and count all observed coho salmon. The peak number counted for each stream is used as the index count for that year. Peak survey count estimation has been performed consistently since 1987.

The escapement of coho salmon to the Chilkat River drainage has also been estimated by mark-recapture experiments in five years (1990, 1998, 2002, 2003, and 2005), and ranged from 38,589 (SE = 4,625) in 2005 to 205,429 (SE = 31,165) in 2002. (Table 1; Ericksen 2006).

This was the eleventh consecutive year in this study designed to monitor the cycle of smolt production and subsequent adult return of Chilkat River coho salmon. Between 1999 and 2009, 700,000–3,000,000 smolt emigrated from the Chilkat River and contributed 12,000–131,000 adults to commercial, sport, and subsistence fisheries (Ericksen 2001, 2003, 2006; Ericksen and Chapell 2005; Elliott 2009, 2010, 2012a-b).

OBJECTIVES

Research objectives for this study were to:

1. estimate the number of coho salmon smolt leaving the Chilkat River in 2009;
2. estimate the escapement of coho salmon to the Chilkat River in 2010;
3. estimate the age, sex, and length composition of adult (ocean age-1) coho salmon entering the Chilkat River in 2010; and
4. estimate the marine harvest of Chilkat River coho salmon in 2010.

METHODS

During spring 2009, coho salmon smolt were captured in main channels of the Chilkat River and marked with an adipose fin clip and a coded wire tag (CWT). In 2010, adult coho salmon were sampled for CWTs in sport and commercial fisheries harvests throughout Southeast Alaska and in the Chilkat River to estimate the adipose-finclipped mark fraction (θ_{smolt}, or θ_s) used to estimate abundance of the 2009 coho smolt emigration. The fraction of adipose-finclipped adult coho salmon sampled in the Chilkat River containing valid decoded CWTs (θ_{marine}, or θ_m) was used to estimate marine harvest of adult coho salmon in sampled fisheries in 2010.

SMOLT CAPTURE, SAMPLING, AND MARKING

During spring 2009, smolt were captured in the main channels of the Chilkat River from the Haines airport (Haines Highway milepost [MP] 4) upstream to approximately MP 21 (Figure 1). Two two-person crews fished approximately 100 G-40 minnow traps per day between April 11 and May 29. Traps were baited with disinfected salmon roe and checked at least once per day.

Crew members immediately released coho salmon obviously less than 75 mm FL and nontarget species at the capture site. Remaining fish were transported to holding pens for processing at the tagging site, located on the bank of the Chilkat River adjacent to MP 19. Water depth (cm) and temperature (°C) were recorded each morning near the tagging site. The weekly peak catch, as measured by coho smolt per minnow trap (CPUE), was determined.

Preceding tagging, coho salmon smolt were sorted into three size classes: small (75–84 mm FL), medium (85–99 mm FL), and large (≥100 mm FL). All healthy coho salmon smolt ≥75 mm FL were marked with an adipose fin clip and given a CWT following the methods in Koerner (1977). Fish were first tranquilized in a solution of tricaine-methane sulfonate (MS 222) buffered with sodium bicarbonate.

Spring 2009 was the fourth year when Chilkat River juvenile coho salmon were differentially marked by size class. During April 11–May 29, small fish were marked with tag code 04-15-08, and represented fish in the small (75–84 mm FL) category. Medium and large fish (≥85 mm) were marked with tag code 04-15-09 from April 11 to May 14, and tag code 04-15-46 from May 15 to May 29. In an experimental analysis, statistical methods outlined in Weller et al. (2005) and discussed in Appendix B1, were used to test for size-based differences.

Table 1.–Peak survey counts and estimated escapement of coho salmon to the Chilkat River, 1987–2010. Escapement estimates in bold were estimated directly through mark-recapture studies (inriver abundance minus inriver harvest). All others were expanded from the combined peak surveys.

	Peak surveys							
	Spring Creek	Kelsall River	Tahini River	Clear Creek	Combined (C_t)	Estimated escapement ($\hat{N}$)	SE ($\hat{N}$)	Estimation method
1987	99	197	792	25	1,113	37,432	7,202	expanded survey
1988	87	160	590	40	877	29,495	5,675	expanded survey
1989	57	190	1,064	141	1,452	48,833	9,395	expanded survey
1990	88	379	2,766	150	3,383	**79,807**	**9,980**	**mark-recapture**
1991	176	417	1,785	135	2,513	84,517	16,260	expanded survey
1992	183	281	1,143	700	2,307	77,588	14,927	expanded survey
1993	101	129	1,041	460	1,731	58,217	11,200	expanded survey
1994	451	440	4,482	408	5,781	194,425	37,405	expanded survey
1995	268	197	1,033	189	1,687	56,737	10,916	expanded survey
1996	204	179	412	315	1,110	37,331	7,182	expanded survey
1997	227	133	684	250	1,294	43,519	8,373	expanded survey
1998	271	265	649	275	1,460	**50,758**	**10,698**	**mark-recapture**
1999	335	207	962	195	1,699	57,140	10,993	expanded survey
2000	305	571	1,324	435	2,635	88,620	17,050	expanded survey
2001	450	225	1,272	1,285	3,232	108,698	20,912	expanded survey
2002	1,328	440	2,582	1,310	5,660	**205,429**	**31,165**	**mark-recapture**
2003	500	356	1,419	1,675	3,950	**134,340**	**15,070**	**mark-recapture**
2004	564	170	827	445	2,006	67,465	12,980	expanded survey
2005	221	42	219	495	977	**38,589**	**4,625**	**mark-recapture**
2006	503	220	761	915	2,399	80,683	15,523	expanded survey
2007	55	51	415	237	758	25,493	4,905	expanded survey
2008	337	64	779	526	1,706	57,376	11,039	expanded survey
2009	183	159	429	682	1,453	48,867	9,402	expanded survey
2010	439	58	1,122	1,031	2,650	89,124	17,147	expanded survey
Mean	304	238	1,193	491	2,225	74,407	14,399	
					Expansion factor (π)	33.6		
					SE(π)	6.5		

All marked coho salmon smolt were held overnight to check for 24-hour tag retention and handling-induced mortality. The following morning, 100 fish from the previous day's marking effort were checked for the retention of CWTs. If tag retention was 98% or greater, mortalities were counted and all live fish from that batch were released. If tag retention was less than 98%, then every smolt presumed to contain a CWT was checked for tag retention and those that tested negative were retagged. The number of fish tagged, number of tagging-related mortalities, and number of fish that had shed their tags were compiled and submitted to the ADF&G Division of Commercial Fisheries (CF) Mark, Tag, and Age Laboratory in Juneau at the completion of the field season.

Every 60th coho salmon smolt tagged was measured to the nearest mm FL, weighed to the nearest gram, and 12 to 15 scales were collected for age analysis using methods outlined by Scarnecchia (1979). Scales were mounted individually between two 25 mm × 75 mm glass slides and viewed through a microfiche reader at 70× magnification. Age was estimated once for each fish and reported in European notation.

LOWER RIVER ADULT SAMPLING

Returning coho salmon were captured in fish wheels operating adjacent to MP 9 (Figure 1) during 2010. CF personnel installed two three-basket aluminum fish wheels in early June to estimate escapement of coho, sockeye *O. nerka*, Chinook *O. tshawytscha*, and chum salmon *O. keta*, to the Chilkat River. One fish wheel was operated adjacent to MP 9, and the other about 300-m downstream of the first. The fish wheels were operated continuously from June 7 through October 11, except for maintenance. The wheels were located along the east bank of the river where the main flow was constrained primarily to one side of the floodplain. Water depth (cm) and temperature (°C) were recorded each morning near MP 8.

Every captured coho salmon was inspected for missing adipose fins and sampled for sex determination and length, measured to the nearest 5 mm MEF. Coho salmon ≥350 mm MEF were assumed to be 1-ocean adults, based on past data, for preliminary estimates of the marked fraction (θ_s). Every third coho salmon was systematically sampled for scales. Five scales were removed from the left side of the fish, along a line 2 to 4 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. Ages were estimated according to methods in Mosher (1968).

Fish wheel personnel retained heads from all coho salmon with missing adipose fins, and a plastic cinch strap with a unique number was inserted through the jaw of the head. Fish with missing adipose fins were also sampled for scales to determine freshwater age composition of returning coded wire tagged fish. Heads and CWT recovery data were sent to the CF Mark, Tag, and Age Laboratory in Juneau where any tags present were removed and decoded; corresponding information was entered into the tag lab database.

SMOLT ABUNDANCE

A two-event mark-recapture experiment was used to estimate the abundance of coho salmon smolt ($\hat{N}_s$) emigrating from Chilkat River in 2009. The number of smolt marked during spring 2009 (n_1) defined the first sampling event. Sampling returning adults for missing adipose fins during fall 2010 (n_2) defined the second sampling event.

The number of emigrating coho salmon smolt was estimated using the Chapman's modified Petersen estimator for a closed population (Seber 1982):

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

$$\text{var}[\hat{N}_s] = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \quad (1b)$$

where n_1 is the number of smolt marked in the spring of 2009, n_2 is the number of age-1.1 and -2.1 coho salmon captured in the Chilkat River fish wheels in 2010, and m_2 is the subset of n_2 that had been marked with an adipose fin clip as coho smolt in 2009. The marked fraction θ_s was calculated as m_2/n_2. Standard error for θ_s was calculated using standard methods for variance of proportions, because n_1 and m_2 are known with certainty, and the amount of error contained in n_2 is considered negligible. A small amount of process error occurs because n_2, which represents 1-ocean coho salmon in the escapement, is estimated from a proportion of aged fish. However, because the proportion of 1-ocean fish in the population has averaged 0.97, and almost half of the captured fish are aged, the error from n_2 is considered insignificant.

$$\text{var}[\theta_S] = \frac{\theta_S(1-\theta_S)}{(n_2 - 1)}. \tag{1c}$$

The validity of the Petersen mark-recapture experiment rests on several assumptions: (a) that every fish has an equal probability of being marked during event 1, that every fish has an equal probability of being captured in event 2, or that marked fish mix completely with unmarked fish; (b) that "death" (emigration) occurs proportionately among marked and unmarked fish between sampling events; (c) that marking does not affect the ability to capture fish, or the probability of mortality; (d) that fish do not lose marks between sample events; (e) that all recovered marks are reported; and (f) that double sampling does not occur (Seber 1982).

Tagging smolt groups according to size allows for testing of assumption (a), which is violated by either different marking probabilities during event 1 or different capture probabilities in event 2. If significant differences in event 1 or 2 capture probability by size class are detected, an unbiased size-stratified smolt abundance estimator, based on Chapman's modification of the Peterson estimator (Appendix B1; Seber 1982; Weller et al. 2005) can be used.

ADULT HARVEST

In 2010, harvest of coho salmon originating from the Chilkat River was estimated by randomly sampling for CWTs in commercial and recreational marine fisheries, and in the Chilkat River recreational fishery. To account for tag loss, the marked fraction relevant to the marine environment was calculated as θ_m = number of CWTs successfully decoded/n_2. The parameter θ_m is a subset of the ratio of adipose-clipped fish observed (θ_s), and variance was calculated similarly to equation (1c). As with the estimation of smolt abundance, there is a small amount of error contained in the term n_2 because it is estimated from escapement sampling and represents 1-ocean coho salmon inspected at the Chilkat River fishwheels. Because there is a high proportion of 1-ocean fish in the escapement (0.97) and a high sampling rate, the error contained in n_2 is insignificant and does not result in a biased estimate of θ_m.

The CF port sampling program randomly sampled landings from commercial drift gillnet, set gillnet, purse seine, and troll fisheries throughout Southeast Alaska and Yakutat. During summer and early fall, samplers were stationed at processors in Ketchikan, Craig, Wrangell, Petersburg, Sitka, Pelican, Port Alexander, Elfin Cove, Excursion Inlet, and Juneau. The sample goal was to inspect at least 20% of the total catch of Chinook and coho salmon for missing adipose fins. Heads from fish missing their adipose fin were sent to the CF Mark, Tag, and Age Laboratory in Juneau on a weekly basis where CWTs were removed and decoded, and the resulting information compiled. The annual CF port sampling manual (unpublished Alaska Department of Fish and Game document, Division of Commercial Fisheries) provides a detailed explanation of commercial catch sampling procedures and logistics.

Methods used by ADF&G Division of Sport Fish (SF) creel surveys to sample recreational fisheries in Southeast Alaska are described in Hubartt et al. (1997). Chilkat River coho salmon

CWTs recovered from sport fisheries in 2010 depended on creel survey sampling data for harvest estimation.

Because there was no consistent sampling in the Haines area, the estimated harvests of Chilkat River coho salmon in the Haines marine and Chilkat River sport fisheries came from the SF-produced Statewide Harvest Survey (SWHS). SWHS estimates in all streams and tributaries within the Chilkat River drainage were summed to estimate the total inriver coho salmon harvest. Haines area marine sport fishery estimates were restricted to SWHS locations near the terminus of the Chilkat River, and all coho salmon harvested within these locations were assumed to be of Chilkat River origin.

Because several fisheries exploit coho salmon over several months, the 2010 harvest was estimated over several strata, each a combination of time, area, and type of fishery. Sampling data from the commercial troll fishery were stratified by statistical week and quadrant. Statistics from drift gillnet fisheries were stratified by week and district.

Data from the port sampling program were used to estimate the commercial harvest of coho salmon bound for the Chilkat River $\hat{r}_i$ and its variance (by stratum) using the procedures in Bernard and Clark (1996). Heads recovered from select sampling, such as freezer boats in the NW troll fishery, are not considered as representing harvest because these catches are not randomly sampled. Estimates of harvest were summed across strata and across fisheries to obtain an estimate of the total $\hat{T}$:

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

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

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

The mean date of harvest for a commercial fishery was estimated as (Mundy 1982):

$$\hat{\bar{d}} = \sum_{d=1}^{n} d\hat{P}_d \ , \tag{3}$$

where $\hat{P}_d$ is the estimated proportion of harvest on day d:

$$\hat{P}_d = \frac{\hat{H}_d}{\sum_d H_d}$$
$$v\left(\hat{P}_d\right) = \frac{\hat{P}_d(1-\hat{P}_d)}{n-1}, \tag{4}$$

where $\hat{H}_d$ is the estimated number of Chilkat River coho salmon harvested on day d, and n is the number of days sampled.

ADULT ESCAPEMENT

The 2010 coho salmon escapement to the Chilkat River was estimated by expanding the combined peak survey counts on four index spawning tributaries. The surveys were repeated weekly during the peak spawning period of October 1 to October 31. Five mark-recapture studies were compared to corresponding index counts to calculate a mean expansion factor (33.6, SE = 6.5), and validated that the peak survey counts are a good relative measure of coho escapement to the Chilkat River with the former surveyor (Ericksen 2006). While the current surveyor has not had a mark-recapture experiment to validate the accuracy of spawning grounds peak counts, methods are identical to the previous surveyor and it is assumed that counts are relative to abundance.

Expansion for Peak Survey Counts

The ratio ($\hat{\pi}_i$) of abundance to peak survey counts for spawning Chilkat coho salmon in year *i* was:

$$\hat{\pi}_i = \hat{N}_i / C_i \tag{5a}$$

$$\mathrm{v}(\hat{\pi}_i) = \mathrm{v}(\hat{N}_i) / C_i^2 , \tag{5b}$$

where $\hat{N}_i$ was the mark-recapture escapement estimate of coho salmon (inriver abundance minus inriver harvest) and C_i was the total of peak survey counts for that year.

The mean ratio $(\overline{\pi})$ from the five years with mark-recapture estimates was used to expand peak survey counts in years *t* without such estimates:

$$\hat{N}_t = \overline{\pi}\ C_t \tag{6a}$$

$$\mathrm{v}(\hat{N}_t) = C_t^2\ \mathrm{v}(\pi) , \tag{6b}$$

where

$$\overline{\pi} = \frac{\sum_{y=1}^{k} \hat{\pi}_y}{k} \tag{7a}$$

Note that the variance of year *t*, $v(\pi)$, instead of average mark-recapture variance, $v(\overline{\pi})$, was used in equation 6b to capture the expected year-to-year variability in the expansion factor, while simultaneously accounting for measurement error from the mark-recapture experiments.

Estimating variance of the expansion of index counts also needs to reflect these two sources of variability for the prediction of π, represented by (π_p). The variance expression has two components, which reflect an estimate of process error and measurement error:

$$v\hat{a}r(\pi_p) = v\hat{a}r(\pi) + v\hat{a}r(\overline{\pi}) . \tag{7b}$$

The term $\mathrm{v\hat{a}r}(\pi)$ represents process error, i.e., error that is present through environmental variability or the population dynamics process. The term $\mathrm{v\hat{a}r}(\overline{\pi})$ represents the interannual uncertainty in predicting $\hat{\pi}$, or measurement error, which declines with every subsequent mark-recapture estimate of $\hat{\pi}$.

Expanding these two terms into variance terms that can be estimated yields the expressions:

$$v\hat{a}r(\hat{\pi}) = \frac{\sum_{y=1}^{k} (\hat{\pi}_y - \overline{\pi})^2}{k-1} , \tag{7c}$$

and

$$v\hat{a}r(\overline{\pi}) = \frac{\sum_{y=1}^{k}(\hat{\pi}_y - \overline{\pi})^2}{k(k-1)}. \quad (7d)$$

Estimates of $var(\hat{\pi})$ and $var(\overline{\pi})$ were performed through a parametric bootstrap technique with 1,000,000 iterations as described in Efron and Tibshirani (1993). A bootstrap sample of size k is drawn from the k values of the individual estimates of $\hat{\pi}_y$ to produce a set of values represented by $\hat{\pi}_{y(b)}$.The bootstrap mean, $\overline{\pi}_{(b)}$, of these values is used to estimate $var(\hat{\pi})$ using these relationships:

$$v\hat{a}r_B(\hat{\pi}) = \frac{\sum_{b=1}^{B}(\hat{\pi}_{(b)} - \overline{\hat{\pi}_{(b)}})^2}{B-1}, \quad (7e)$$

where

$$\overline{\hat{\pi}_{(b)}} = \frac{\sum_{b=1}^{B}\hat{\pi}_{(b)}}{B}. \quad (7f)$$

Calculating $var_B(\overline{\pi})$ uses equations 7e and 7f by substituting appropriate terms. The overall variance of expansion factor prediction combined the bootstrap estimates, with the average of estimated variance of the individual expansion terms $\hat{\pi}_y$, to yield the result:

$$v\hat{a}r(\pi_p) = v\hat{a}r_B(\hat{\pi}) - \frac{\sum_{y=1}^{k}\mathrm{v\hat{a}r}(\hat{\pi}_y)}{k} + v\hat{a}r_B(\overline{\pi}). \quad (7g)$$

AGE AND SEX, AND SIZE COMPOSITIONS

Age composition of coho salmon smolt in 2009 and age and sex compositions of adults in 2010 were estimated from systematically drawn samples as described above. Standard sample summary statistics were used to calculate estimates of mean length- and mean weight-at-age and their variances (Cochran 1977). Proportions in the age (or sex) compositions and their variances were estimated as:

$$\hat{p}_a = \frac{n_a}{n} \quad (8a)$$

$$\mathrm{v}[\hat{p}_a] = \frac{\hat{p}_a\ (1-\hat{p}_a)}{n-1}, \quad (8b)$$

where n is the number of successfully aged (or sexed) fish and n_a is the subset of n determined to be age (or sex) a.

The abundance of sex x coho salmon in the escapement was estimated as:

$$\hat{N}_x = \hat{N}_e\ \hat{p}_x \quad (9a)$$

$$\mathrm{v}[\hat{N}_x] = \mathrm{v}[\hat{p}_x]\hat{N}_e^{\,2} + \mathrm{v}[\hat{N}_e]\hat{p}_x^{\,2} - \mathrm{v}[\hat{p}_x]\mathrm{v}[\hat{N}_e], \quad (9b)$$

where $\hat{N}_e$ is the estimated escapement of coho salmon in 2010. The abundance of age *a* coho salmon by sex in the escapement $\hat{N}_{x,a}$ was estimated by substituting $\hat{N}_x$ and $\hat{p}_{x,a}$ for $\hat{N}_e$ and $\hat{p}_x$ in equations 9a and 9b.

RUN SIZE, EXPLOITATION RATE, AND MARINE SURVIVAL

In 2010, the Chilkat River coho salmon return (harvest plus escapement) was estimated as:

$$\hat{N}_R = \hat{T} + \hat{N}_e \tag{10a}$$

$$\mathrm{v}\left[\hat{N}_R\right] = \mathrm{v}\left[\hat{T}\right] + \mathrm{v}\left[\hat{N}_e\right]. \tag{10b}$$

The fraction of the run harvested (the exploitation rate) was calculated as:

$$\hat{E} = \frac{\hat{T}}{\hat{N}_R} \tag{11a}$$

$$\mathrm{v}[\hat{E}] \approx \frac{\mathrm{v}[\hat{T}]\hat{N}_e^2}{\hat{N}_R^4} + \frac{\mathrm{v}[\hat{N}_e]\hat{T}^2}{\hat{N}_R^4}, \tag{11b}$$

where the variance is an approximation from the delta method (Seber 1982).

The estimated marine survival rate (smolt-to-adult) and the delta method approximation of its variance were calculated as:

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

$$\mathrm{v}[\hat{S}] \approx \hat{S}^2\left[\frac{\mathrm{v}[\hat{N}_R]}{\hat{N}_R^2} + \frac{\mathrm{v}[\hat{N}_s]}{\hat{N}_s^2}\right]. \tag{12b}$$

RESULTS

2009 SMOLT TAGGING, AGE AND SIZE

During spring 2009, 25,020 coho salmon smolt ≥75 mm FL were marked with an adipose fin clip and a CWT (Table 2). Eighty three of these died within 24 hours of tagging, leaving a total marked population of 24,937. In a concurrent study, 3,911 Chinook salmon smolt were released with adipose fin clips and CWTs (Table 3).

Table 2.–Summary of coded wire tagging data in the Chilkat River drainage during spring 2009.

Tag code	Species	Last date	Tagged	24 h mortalities	Marked	Shed tags	Valid CWTs
041508	coho	5/30/2009	7,785	25	7,760	0	7,760
041509	coho	5/15/2009	11,273	7	11,266	0	11,266
041546	coho	5/30/2009	5,962	51	5,911	0	5,911
Subtotal			25,020	83	24,937	0	24,937

Table 3.–Number of traps checked and smolt caught, tagged, and released in the Chilkat River by time period, April 11 through May 29, 2009.

	Chilkat River				
		Number tagged		CPUE[a]	
Dates	Traps checked	Coho	Chinook	Coho	Chinook
4/11–4/17	407	2,075	365	5.1	0.9
4/18–4/24	507	2,589	590	5.1	1.2
4/25–5/1	650	3,705	945	5.7	1.5
5/2–5/8	706	4,636	460	6.6	0.7
5/9–5/15	708	3,979	780	5.6	1.1
5/16–5/22	704	4,141	572	5.9	0.8
5/23–5/29	708	3,812	199	5.4	0.3
Total	4,390	24,937	3,911	5.7	0.9

[a] Catch of smolt per trap day.

April 2009 started out with typical low water levels and water temperatures between 1 and 2 °C; however abnormally warm temperatures during the last week in April caused a sharp increase in water level and temperature (Figure 2). As a result, the peak catch occurred on May 5, approximately a week earlier than the average (May 13). After this unusually warm weather things returned to normal and the Chilkat River water level actually decreased from May 7 until May 18. During this time catches remained stable and once water levels increased again, there was a second peak catch on May 22 (818 coho salmon, third highest day in 2009). Overall CPUE was above average (5.7; Table 3). The maximum average weekly CPUE coincided with the first substantial rise in water level and temperature and peaked May 2–8 at 6.6 fish per trap (Table 3).

During spring 2009, 409 coho salmon smolt ≥75 mm were sampled from the Chilkat River for age, weight and length (Table 4). Of the 407 Chilkat River scale samples that were successfully aged, age-1.0 fish comprised the majority of the smolt emigration (79.1%, SE = 2.0%). Overall, coho salmon smolt weighed 8.5 g (SE = 3.3 g) and averaged 94.1 mm FL (SE = 12.3 mm; Table 4).

2009 Lower River Adult Sampling

From August 3 through October 11, 2010; a total of 1,143 adult coho salmon were captured in the fish wheels (Figure 3), of which 1,136 were examined for missing adipose fins; 1,082 were 350 mm FL or greater and were assumed to be ocean-age-1 fish. Of those successfully sampled, 30 fish were missing an adipose fin, and their heads were examined for CWTs (Table 5). Twenty eight heads contained decodable tags that were released in the Chilkat River in 2009. Two fish with missing adipose fins did not contain tags.

Scale samples were collected from 658 coho salmon and 593 were successfully aged. Of these, 95.4% were age-1.1 or -2.1 (ocean age-1; Table 6). Applying the ocean age-1 proportion to all sampled fish, an estimated 1,084 adults sampled for missing adipose fins in 2010 emigrated as smolt during 2009.

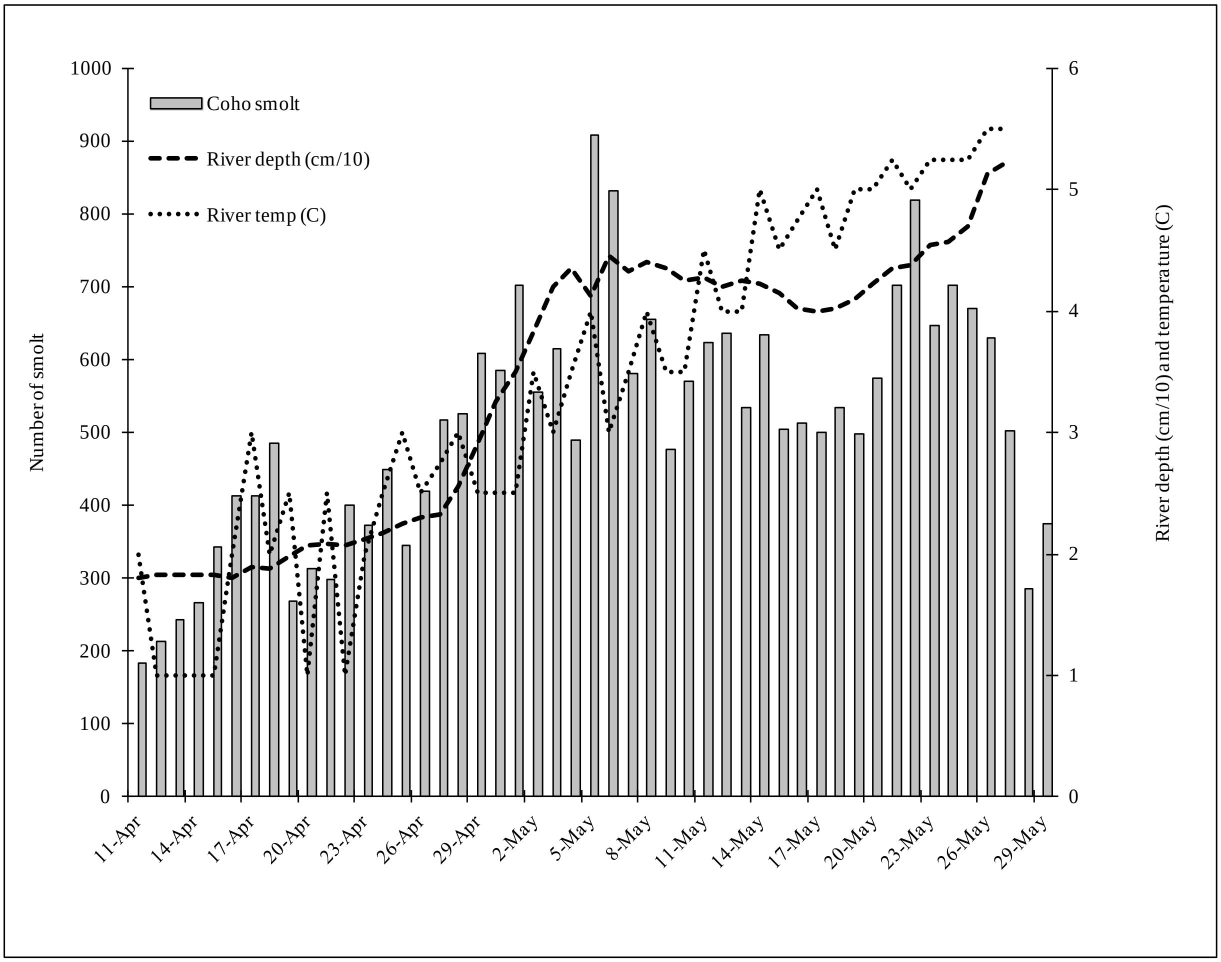

Figure 2.–Catches of coho salmon smolt ≥75 mm, daily water temperature (^oC), and depth (cm/10), in the Chilkat River, April 11 through May 29, 2009.

Table 4.–Estimated age composition and average size of coho salmon smolt ≥75 mm FL marked in the Chilkat River, 2009.

	Age-1	Age-2	Total aged	Total sampled
sample size	322	85	407	409
percent (SE)	79.1 (2.0)	20.9 (2.0)		
mean length (SE)	90.0 (9.4)	109.4 (9.6)		94.1 (12.3)
mean weight (SE)	7.4 (2.3)	12.6 (3.4)		8.5 (3.3)

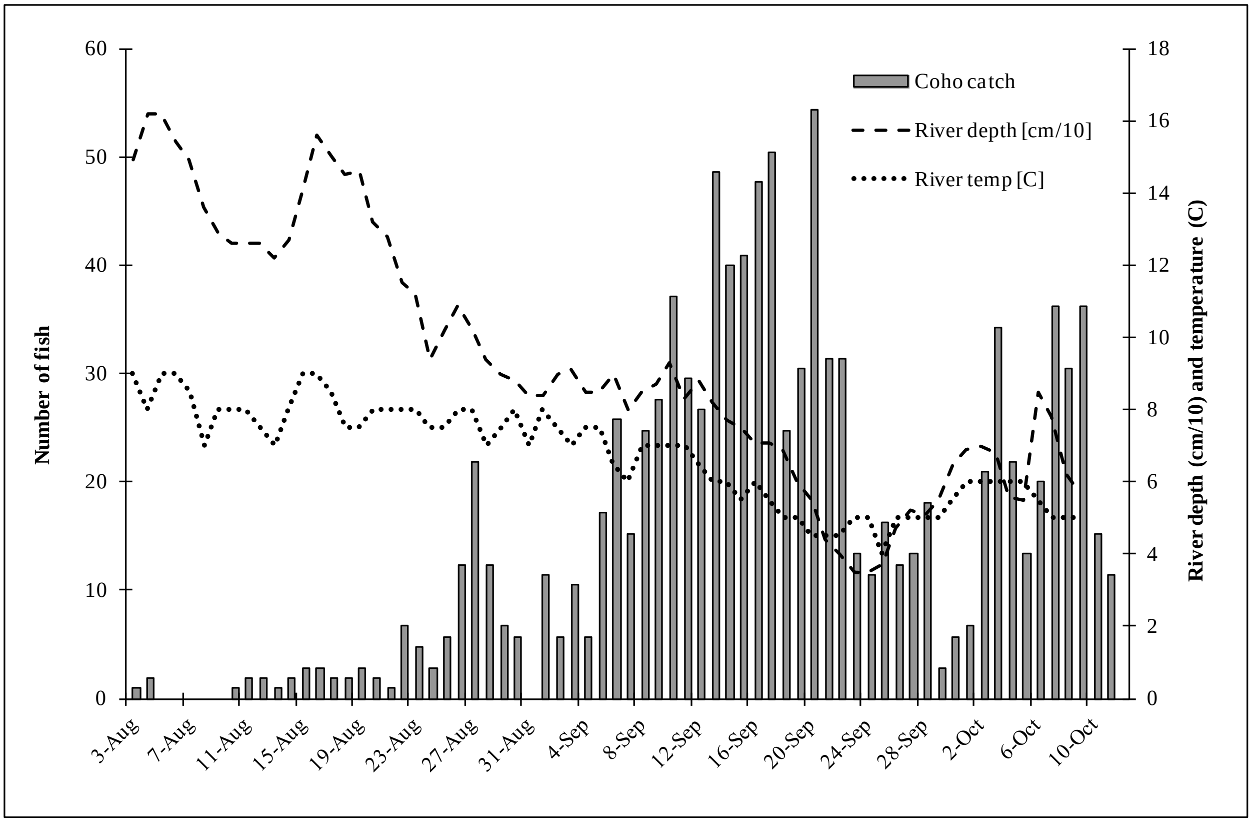

Figure 3.–Fish wheel catch of adult coho salmon, daily water temperature (°C), and depth (cm/10) in the lower Chilkat River, August 3 through October 11, 2010.

Table 5.–Number of age-.1 adult coho salmon sampled in the lower Chilkat River for missing adipose fins and coded wire tags, 2010.

Statistical week	Number sampled	Tag code 04-15-08	04-15-09	04-15-46	No tag	Total adipose-clips	Proportion marked
32	3					0	0.000
33	8		1			1	0.131
34	15		1			1	0.065
35	67	1	1			2	0.030
36	46	1				1	0.022
37	178	1	2	1	2	6	0.034
38	280	4	5	1		10	0.036
39	189	1		2		3	0.016
40	80					0	0.000
41	193	1	4	1		6	0.031
42	27					0	0.000
Total	1,084	9	14	5	2	30	0.028

Table 6.–Combined first and second half stratified estimates for the sampled age/sex composition and length of coho salmon captured in the fish wheels, and estimated escapement in the Chilkat River, 2010.

	Brood year and age class					
	2008	2007	2007	2006		
	1.0	2.0	1.1	2.1	Total aged	Total sampled[a]
Females						
Sample size			202	72	274	547
Percent			34.1	12.1		48.0
SE			1.9	1.3		1.5
Number			30,558	10,940		41,498
SE			4,621	1,994		6,307
Mean length			635	645		
SD			42	36		
Males						
Sample size	2	25	234	58	319	594
Percent	0.3	4.2	39.5	9.8		52.0
SE		0.8	2.0	1.2		1.5
Number	300	3,742	34,896	8,687		47,626
SE		883	5,154	1,593		6,920
Mean length	305	337	568	603		
SD	7	68	106	89		
All fish[b]						
Sample size	2	25	436	130	593	1,143
Percent	0.3	4.2	73.5[c]	21.9[c]		
SE		0.8	1.8	1.7		
Number	300	3,742	65,454	19,627		89,124
SE		883	6,922	2,552		17,147
Mean length	305	337	599	627		
SD	7	67	89	68		

[a] Includes fish not assigned an age.
[b] Includes fish with no sex information.
[c] Actual proportions are 0.7352 and 0.2192, respectively.

SMOLT ABUNDANCE

Using Chapman's modified Petersen estimator for a closed population (Seber 1982), the 2009 Chilkat River coho salmon smolt abundance estimate is 872,829 (SE = 151,981). This estimate is based on n_1 = 24,937 smolt released in spring 2009, n_2 = 1,084 ocean-age-1 adults sampled from the fish wheels in 2010, and a total of m_2 = 30 valid-marked fish recovered inriver (28 with 2009 Chilkat River tag codes and 2 missing or nonvalid tags). The estimated marked fraction θ_s relevant to calculating smolt abundance was 0.028 (SE = 0.005).

Using chi-square testing, no significant difference was detected in recovery rates between the two distinct tagging groups (Table 7). The first group was smolt 75–84 mm FL and given tag code 04-15-08, while the second group was smolt ≥85 mm FL, which was given tag codes 04-15-09 and 04-15-46. Overall 7,760 coho salmon smolt were released in group 1; 121 CWTs were recovered in fisheries, and 9 CWTs were recovered in lower Chilkat River sampling for a total of 130. In the second group, 17,177 coho salmon smolt were released; 303 were recovered in fisheries, and 19 were recovered in lower river sampling for a total of 322. A 2 x 2 contingency table revealed no significant difference in recovery rates for these two tagging groups (χ^2 = 1.15, df = 1, P =0.28).

The recovery rate (B) for larger coho salmon smolt was only 1.1 times the rate for smaller smolt. The alternate smolt abundance estimator (Appendix B1), used to eliminate bias introduced by significantly different recovery rates, is not necessary due to similar recovery rates.

Table 7.–Comparison of coded wire recoveries for two classes of coho smolt sizes tagged in the Chilkat River in 2009. Tag code 041508 was used for smolt 75-84 mm, and tag codes 041509 and 041546 were used for smolt ≥85 mm; chi-square tests show no significant difference at alpha = 0.10 in recovery rates between the two size groups.

Tag code			Chi-square test of independence		
Tag code 041508 (75-84mm)			2 X 2 contingency table		
number tagged (N1)	7,760		*N1*		*N2*
recovered in fisheries	121		7,760		17,177
recovered in fish wheels	9		130		322
total recoveries	130				
survival rate 1 (S_1)=		0.0168		X^2= 1.15	
				df= 1	
Tag code 041509+041546 (≥85mm)				P= 0.28	
number tagged (N2)	17,177				
recovered in fisheries	303				
recovered in fish wheels	19				
total recoveries	322				
survival rate (S_2)=		0.0187			
survival rate ratio (B)=		1.119			

CODED WIRE TAG RECOVERY

In 2010, 424 CWTs with Chilkat River codes were recovered from coho salmon during the random sampling of commercial marine harvests (Table 8; Appendix A1). Most tags (240) were recovered in the District 111 and 115 drift gillnet fisheries, followed by 175 recoveries in the Northeast and Northwest Quadrant commercial troll fisheries (Table 8). There was one recovery in the inside purse seine fishery and eight recoveries in marine sport fisheries. The 2010 sample also contained three select recoveries from the Sitka area Northwest Quadrant troll fishery (Appendix A1). These heads were retained by freezer boats that are required to turn in heads from adipose-finclipped fish to the local port sampling supervisor. These recoveries are from fish not randomly sampled and therefore are not included in harvest estimates. There were also five voluntary recoveries from the Chilkat River sport fishery bearing a 2009 Chilkat River code (Appendix A1). These recoveries were turned into the Haines ADF&G office by sport anglers during the fall coho salmon fishery. For random CWT samples, coho salmon bearing Chilkat River tag codes were recovered with comparable relative frequencies in the District 115 (Lynn Canal) drift gillnet fishery from August 5 to September 29, and in the Northwest Quadrant troll fishery from July 21 through September 21 (χ^2 = 1.25, df = 2, P = 0.54).

Table 8.–Random marine recoveries of coded wire tags released during the Chilkat River coho salmon smolt emigration by tag code, fishery, and gillnet statistical week or troll period, 2010.

Statistical week	Dates	Tag code 04-15-08	04-15-09	04-15-46	Total
		District 111 Gillnet Fishery			
38	9/12–9/18	1			1
		District 115 gillnet fishery			
32	8/1–8/7		1		1
33	8/8–8/14	1		3	4
34	8/15–8/21	2	3	4	9
35	8/22–8/28	14	15	5	34
36	8/29–9/4	10	26	16	52
37	9/5–9/11	9	19	6	34
38	9/12–9/18	15	22	10	47
39	9/19–9/25	15	22	9	46
40	9/26–10/2	4	7	1	12
	Gillnet subtotal	70	114	54	240
		Northeast purse seine fishery			
32	8/1–8/7	1			1
	Purse seine subtotal	1			1
		Northwest Quadrant troll fishery			
30	7/18–7/24	1	1	1	3
31	7/25–7/31	1	4		5
32	8/1–8/7	1	1	2	4
33	8/8–8/14	6	13	5	24
34	8/15–8/21	2	6	2	10
35	8/22–8/28	4	10	9	23
36	8/29–9/4	9	9	5	23
37	9/5–9/11	8	15	11	34
38	9/12–9/18	13	14	8	35
39	9/19–9/25	1	5	4	10
		Northeast Quadrant troll fishery			
34	8/15–8/21	1			1
35	8/22–8/28		1	1	2
36	8/29–9/4		1		1
	Troll subtotal	47	80	48	175
		Yakutat sport fishery			
34	8/15–8/21			1	1
		Juneau sport fishery			
33	8/8–8/14			2	2
34	8/15–8/21	2	1		3
35	8/22–8/28		1		1
37	9/5–9/11			1	1
	Marine sport subtotal	2	2	4	8
Total recoveries		120	196	106	424
Valid tags released		7,760	11,266	5,911	24,937
Percent gillnet		58	58	51	57
Percent troll		39	41	45	41

HARVEST

The tagged fraction θ_m, used for estimating marine harvest contributions, was 0.026 (SE = 0.005). This estimate is based on 28 Chilkat River CWTs decoded out of the heads collected from 30 adipose-finclipped fish, among the 1,084 1-ocean adult coho salmon inspected for marks in the Chilkat River in 2010.

An estimated 68,290 (SE = 5,169) Chilkat River coho salmon were harvested in sampled marine commercial and recreational fisheries in 2010 (Table 9). An additional 344 coho salmon were harvested in the Chilkat Inlet and Chilkat River subsistence fisheries, an estimated 449 (SE = 138) in Chilkat River recreational fisheries, and an estimated 8 (SE = 6) in Haines marine recreational fisheries, for a total harvest of 69,091 (SE = 5,165, Table 10). Most of the Chilkat River coho salmon harvest (54.0%; 37,322, SE = 4,096) occurred in the District 115 commercial drift gillnet fishery, followed by commercial troll fisheries (41.5%; 28,646, SE = 3,029). The remainder of the harvest occurred in the recreational (3.3%), subsistence (0.5%), District 111 drift gillnet (0.4%), and District 112 purse seine (0.4%) fisheries. Harvests in the troll fisheries occurred earlier in the year (July 21) due to the migration route from Gulf of Alaska feeding grounds to the Chilkat River (Figures 4 and 5), and covered a period of 10 weeks during the migration (Table 8). In contrast, harvest in the drift gillnet fisheries occurred over seven weeks, from mid-August through the end of September. The estimated mean date of harvest in the Northwest Quadrant troll fishery was August 30 compared to September 7 for the Lynn Canal drift gillnet fishery.

ESCAPEMENT

A total of 2,650 coho salmon were counted during peak surveys in the Chilkat River drainage in 2010 (Table 1). Expansion factors for peak survey counts from past years, when mark-recapture was used to estimate inriver abundance, ranged from 23.6 (SE = 2.9) in 1990 to 39.5 (SE = 4.7) in 2005. The mean expansion factor 33.6 (SE = 6.5) was used to estimate that 89,124 (SE = 17,147) coho salmon reached spawning areas in the Chilkat River in 2010 (Table 1).

AGE AND SEX COMPOSITION OF THE ESCAPEMENT

There was a significant difference in sex composition between the first half of the immigration (prior to September 16; the median date of the fish wheel catch) and second half (χ^2 = 34.9, df = 1, P < 0.001). Sex compositions also varied significantly over time for age-1.1 fish (χ^2 = 25.6, df = 1, P < 0.001) and age-2.1 fish (χ^2 = 8.0, df = 1, P =0.005). Because of these differences, the samples were temporally stratified to estimate the age and sex composition of the escapement (Appendices A2 and A3). Age 1.1 males comprised 50.0% (SE=2.9%) of the sample in the first half and 29.2% (SE=2.6%) in the second half. Females showed an opposite shift in proportions, as age-1.1 females comprised 26.4% (SE = 2.6%) in the first half of the sample, and 41.5% (SE = 2.8%) in the second half of the sample. Similarly, age-2.1 females comprised 7.5% (SE=1.6%) in the first half of the sample compared to 16.6% (SE=2.1%) in the second half of the sample. Overall, males comprised 52.0% (SE = 1.5%), and age-1.1 fish comprised 73.5% (SE = 1.8%) of the escapement (Table 6).

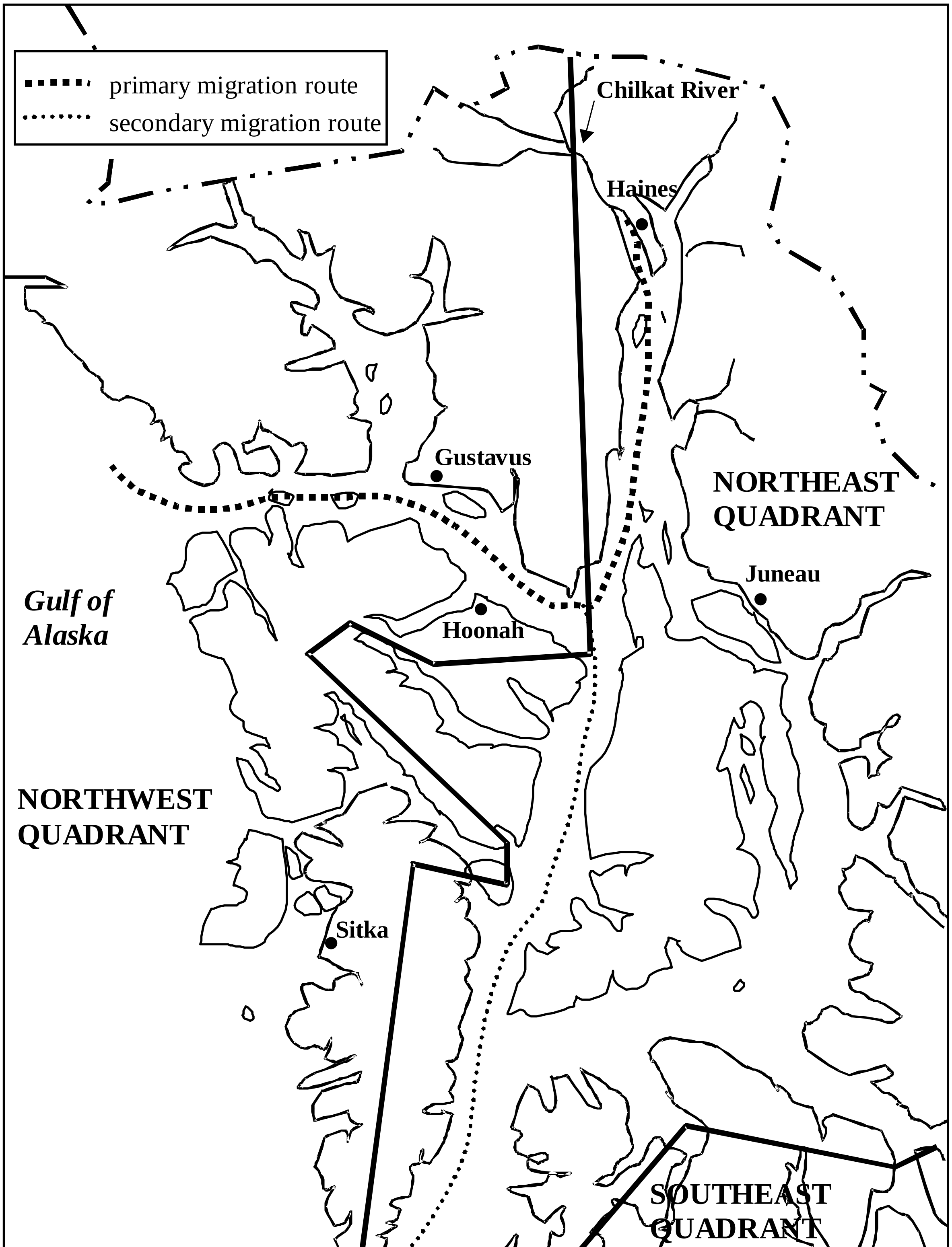

Figure 4.–Commercial troll quadrants and migration routes of Chilkat River coho salmon through northern Southeast Alaska.

Table 9.–Estimated marine harvest in 2010 of adult coho salmon bound for the Chilkat River, by fishery and temporal stratum (sport period or commercial statistical week).

Fishery	District	Statistical week	Harvest	Var[*N*]	*n*	*a*	*a′*	*t*	*t′*	*m*	*r*	SE[*r*]
District 111 gillnet	111	35	10,447		1,524	33	33	26	26	1	265	265
Lynn Canal gillnet	115	32-33	2,410		855	16	16	13	13	5	546	259
Lynn Canal gillnet	115	34	4,434		1,363	25	25	25	25	9	1,133	426
Lynn Canal gillnet	115	35	4,881		1,704	49	49	44	44	34	3,770	946
Lynn Canal gillnet	115	36	9,343		3,646	109	107	95	94	52	5,311	1,225
Lynn Canal gillnet	115	37	12,524		2,295	71	69	66	66	34	7,391	1,856
Lynn Canal gillnet	115	38	14,511		2,059	91	91	86	86	47	12,824	3,015
Lynn Canal gillnet	115	39	9,236		3,391	103	100	94	94	46	4,996	1,178
Lynn Canal gillnet	115	40	6,187		2,129	60	60	55	55	12	1,350	457
		Gillnet subtotal	73,973		18,966	557	550	504	503	240	37,587	4,105
Purse seine	111	32	1,511		237	1	1	1	1	1	247	246
		Seine subtotal	1,511		237	1	1	1	1	1	247	246
District 114 Sport	114	17	79		49	1	1	1	1	1	62	62
Juneau Sport	111-112	17	2,308		589	7	7	7	7	5	759	361
Juneau Sport	111	18-19	1,073		112	4	3	3	3	2	989	711
		Sport subtotal	3,460		750	12	11	11	11	8	1,810	800
NW troll period 3		27-33	377,026		110,248	1,433	1,400	1,017	1,014	36	4,302	879
NW troll period 4		34-37	334,225		70,327	1,347	1,310	1,056	1,052	90	17,810	2,594
NW troll period 5		38-40	94,513		27,663	695	688	553	551	45	6,053	1,267
NE troll period 4		34-37	54,969		17,960	317	314	209	208	4	481	252
	Troll subtotal		860,733		226,198	3,792	3,712	2,835	2,825	175	28,646	3,029
		Total	939,677		246,151	4,362	4,274	3,351	3,340	424	68,290	5,169

Table 10.–Total estimated commercial, sport, and subsistence harvest, Chilkat River harvest of coho salmon in Alaska fisheries, by fishery and area, 2010.

		Coho salmon harvest			Percent of harvest	
Fishery	Area	Total	Chilkat	SE	Fishery	Chilkat
Drift gillnet	District 115	63,526	37,322	4,096	58.8	54.0
	District 111	10,447	265	265	2.5	0.4
	Subtotal	73,973	37,587	4,105	50.8	54.4
Seine fishery	District 112	1,511	247	246	16.3	0.4
	Subtotal	1,511	247	246	16.3	0.4
U.S. troll fishery	NW Quadrant	805,764	28,165	3,018	3.5	40.8
	NE Quadrant	54,969	481	252	0.9	0.7
	Subtotal	860,733	28,646	3,029	3.3	41.5
Recreational	Yakutat sport	79	62	62	79.0	0.1
	Juneau sport	3,381	1,748	797	51.7	2.5
	Haines marine[a]	195	8	6	4.1	0.0
	Chilkat River[a]	449	449	138	100.0	0.6
	Subtotal	4,104	2,267	811	55.2	3.3
Subsistence	Chilkat Inlet[b]	86	87	0	101.2	0.1
	Chilkat River[b]	236	257	0	108.9	0.4
	Subtotal	322	344	0	106.8	0.5
Total		939,132	69,091	5,165	7.4	100.0

[a] Estimates from the Statewide Harvest Survey.
[b] Subsistence harvests as reported on returned permits.

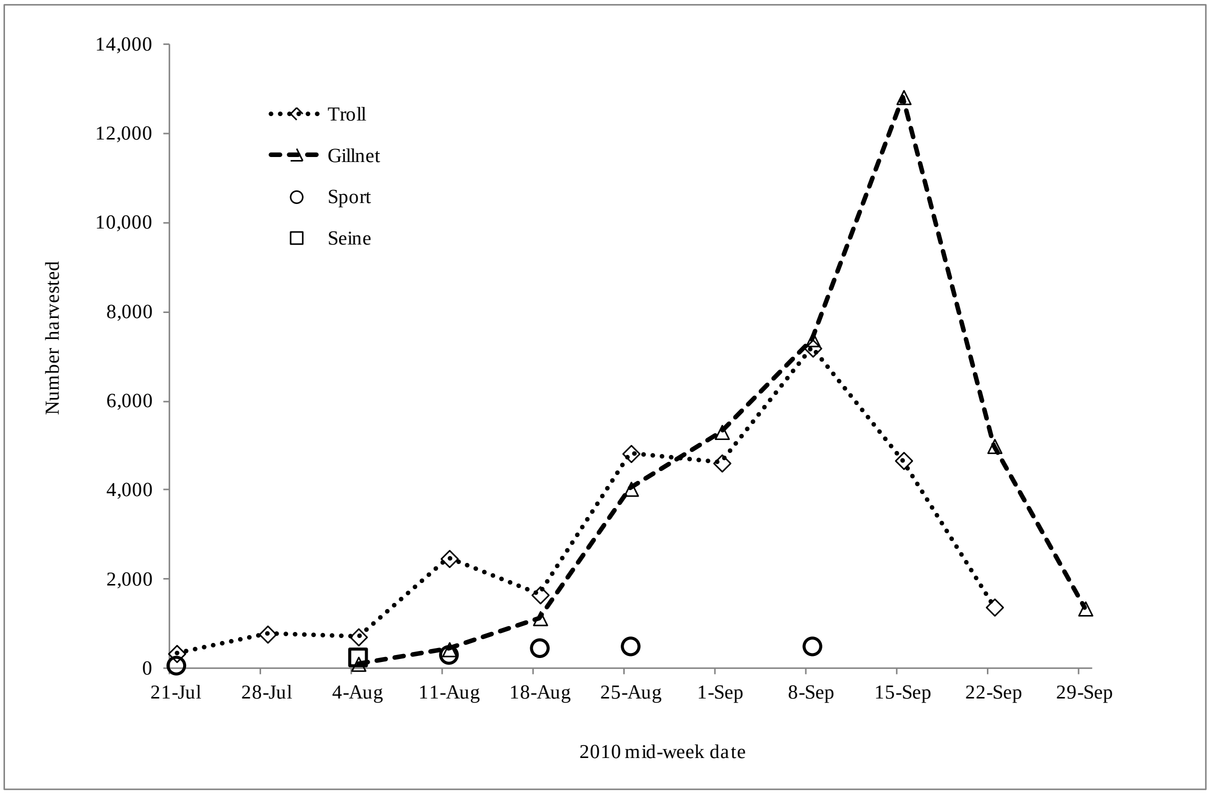

Figure 5.–Estimated marine harvests of coho salmon bound for the Chilkat River, by fishery and mid-week date, 2010. Weekly estimates of harvest in marine sport fisheries (bi-week) are approximated.

MARINE EXPLOITATION AND SURVIVAL

The total ocean-age-.1 component of the estimated escapement was 85,066 fish (SE = 16,375, Table 11). Assuming all 68,385 fish harvested in marine fisheries and 706 fish harvested ininriver fisheries in 2010 (Tables 9 and 10) were age-.1, the total 2010 return of age-.1 Chilkat River coho salmon was 154,157 fish (SE = 17,171). The estimated marine survival rate for 2009 emigrants was 17.7% (SE = 3.7%). The marine exploitation of this stock was estimated at 44.4% (SE = 5.1%).

Data collected during this study (Appendix C1) have been archived in ADF&G offices in Haines, Douglas, and Anchorage.

Table 11.–Estimated stock assessment parameters for coho salmon that emigrated from the Chilkat River in 2009.

Parameter	Estimate	SE
2009 smolt emigration	872,829	151,981
2010 marine harvest	68,385	5,165
2010 inriver harvest[a]	706	138
2010 1ocean-age-.1 escapement[b]	85,066	16,375
Total 2010 run	154,157	17,171
Marine exploitation rate	44.4%	5.1%
Marine survival	17.7%	3.7%

[a] Includes estimate of Haines recreational fishery from the Statewide Harvest Survey and Chilkat Inlet subsistence

[b] Total escapement excluding age-1.0 and -2.0 coho salmon.

DISCUSSION

The estimate of smolt abundance satisfies the several mark-recapture assumptions discussed above. Attempts were made to ensure every smolt had an equal chance of being marked. Although smolt were still being captured when trapping ceased on May 29, catch rates were declining from the peak in early May. Therefore, the majority of the emigration was probably sampled. In addition, sampling effort for adults in the fish wheels (to estimate the marked fraction) was relatively constant over time, tending to equalize probability of capture during the second sampling event. Comparing CWT recovery rates for different coho salmon smolt size categories revealed no significant difference between groups (assumption a).

Although the population in this experiment was not closed to losses from mortality, it was essentially closed to recruitment (assumption b) because salmon return to their natal stream to spawn. There have been rare instances when coho salmon with Berners River tags have been recovered in the Chilkat River (Ericksen 1999; Ericksen and Chapell 2005; Elliott 2010, 2012b), or when juvenile coho salmon containing Chilkat River tags have been captured in other drainages. The most recent example of the former occurred in 2008, when a returning adipose-finclipped adult coho salmon captured in the Chilkat River fish wheels had a Berners River CWT released in 2007. This fish could either have strayed as an adult, or more likely was of Chilkat River origin, and reared for some period of time in the Berners River where it was captured and tagged.

In addition to adult recoveries, a juvenile coho salmon with a Chilkat River tag code was captured in Auke Creek near Juneau (Ericksen and Chapell 2005). This was the first time that a juvenile Chilkat River fish was captured migrating *upstream* into another drainage in the fall. However, smolt with Chilkat River tag codes have been recovered from other drainages. One coho salmon smolt with a 2001 Chilkat River tag code was sampled as it emigrated from Jordan Creek near Juneau in 2002 (Ericksen 2003). Two smolt were recaptured in the Berners River in 2000 with 1999 codes (Ericksen 2001). Although interesting, these irregular events are considered negligible and assumption (b) remains robust.

Because different capture gear was used during the first and second sampling events, it is unlikely that juvenile marking affected the ability to capture adults (assumption c). Other studies have shown that marked coho smolt do not suffer significantly higher mortality than unmarked fish (Elliott and Sterritt 1990; Vincent-Lang 1993). Because all fish had secondary marks (adipose fin clips) that were not lost, assumption (d) was satisfied. Overall, 99.4% of fish captured in the Chilkat River fish wheels were examined (1,136 examined out of 1,143 captured) for missing adipose fins; fish that were not examined either escaped or were overlooked. Once examined, fish were marked to prevent resampling, satisfying assumption (e).

In previous years there has been a disparity between smolt and adult ages. For return year 2010, there was no significant difference ($P = 0.93$) between smolt and adult ages, even though the adult population continued to contain a higher proportion of age-2. fish. Freshwater age-2. fish represented approximately 20.9% of the smolt emigration in 2009, and 26.1% of the adult escapement. Both proportions are above average, and the adult 2-ocean percentage continued to be higher than the smolt proportion. Return year 2010 was also the first year since differential tagging began where CWT recovery and survival rates were similar between the two tagging groups, although the proportion of 2-ocean adults continued to be higher. Reasons for a higher 2-ocean component in adults are two-fold. Weller et al. (2005) concluded that minnow traps were biased toward smaller fish, because the limited diameter of the G-40 minnow trap entrance tunnel excluded the largest coho salmon smolt; this could result in smolt estimates that were biased low by as much as 20%. Another explanation is that coho salmon smolt emigrating from Chilkat Lake were under represented in event 1. Results from smolt sampling by CF at Chilkat Lake indicated that age-2. fish represented 27% of the population in 2006 (Elliott 2010), and 42% in 2008. These age-2. proportions are significantly higher than those of coho salmon smolt captured in the Chilkat River. An explanation for the higher proportion of freshwater age-2 fish in the 2009 smolt emigration could relate to the emigration timing of Chilkat Lake coho salmon smolt. The early warm weather in April 2009 could have triggered an earlier emigration from Chilkat Lake, consequently exposing that component of the Chilkat stock to more trapping effort during May than in most years.

In addition to potential biases in estimated age proportions of emigrating smolt, sex identification of returning adults may also contain measurement error; the sex of ocean-phase fish can be difficult to identify. Ericksen (2006) examined 62 coho salmon that were sampled at the fish wheels then recaptured and sexed on the spawning grounds. Assuming that sex determination is more reliable on the spawning grounds than in the lower river, 13% were incorrectly identified as females, and 10% were incorrectly identified as males at the fish wheels. In mark-recapture years, sex compositions determined in the second sampling event can be used to accurately estimate proportions at age of males and females.

The 2010 total escapement estimate of coho salmon (including jacks) to the Chilkat River (89,124, SE = 17,147) was above average and clearly the result of the highest marine survival estimate (17.7%, SE = 3.7%) since Chilkat River coded wire tagging began in 1999. The above-average marine survival rate compensated for low smolt emigration abundance and the escapement goal (30,000–70,000; Ericksen and Fleischman 2006) was exceeded in 2010. The above average marine survival was not related to the age-2. proportion of the emigrating class, as there is no relationship between freshwater rearing time and marine survival. Other Southeast Alaska coho salmon stocks also survived at higher rates in return year 2010, potentially indicating favorable ocean-rearing conditions (Shaul et al. 2011).

Despite high catch variability, the median date of coho salmon immigration at the Chilkat River fish wheels in 2010 (September 17) was consistent with the 1997–2009 average (September 19, Figure 6). The median date is not representative of the nonnormal distribution of catches, however. The Haines area experienced an unusually dry September when Chilkat River water levels declined 62% from September 10 through September 23, which resulted in the lowest reading at MP8 on the Chilkat River since 2003. Fish wheel catches of coho salmon subsequently declined, with a total catch of 100 fish from September 23 through October 1, when the lowest number of fish caught daily was three on September 29 (Figure 3). After the low point on September 23–24, water levels rose 86% by September 30. Similar to prior years, the increase in the Chilkat River water level triggered another surge in fish wheel catches. Following this sharp increase in water level, from October 2 through October 9, 19% of the yearly fish wheel catch occurred (Figure 3), compared to the 1997–2009 average during this time period of 2%.

Overall, the total fish wheel catch (1,143) of coho salmon in 2010 was only 45% of the 1997–2009 average of 2,545 fish, and was not proportionate to abundance. The 2010 fish wheel coho salmon catch was only 1.3% of the escapement estimate, the lowest since fish wheel operation methodology became consistent in 1997. Additionally, the proportion of escapement captured by the fish wheels has averaged 3.4% (SE 1.7%) and has been highly variable, as evidenced by a 49% CV value (Figure 7). Reasons for this year to year fluctuation include changing river channels and changing water levels, mechanical and debris problems, and resources committed to sampling Chilkat River coho salmon.

The percentage of Chilkat River coho salmon in different fishery harvests increased with closer proximity to the Chilkat River because the numbers of unique stocks present in a particular fishery decreases with proximity to natal streams. For example the estimated harvest of Chilkat River fish was substantial in the Northwest Quadrant troll fishery (28,165, SE = 3,018), but those fish represented only 3.5% of the total harvest. Estimated Chilkat coho salmon troll harvest is small compared to the Lynn Canal drift gillnet fishery (37,322, SE = 4,096), where Chilkat River fish represented 58.8% of the total harvest. This was also the largest Chilkat River coho salmon harvest of all fisheries represented in 2010.

The CWT recovery rate also increased with proximity to the Chilkat River. Despite a higher recovery rate from District 115 gillnet fisheries, however, there was no significant difference in the relative frequency of recoveries between tag codes in the gillnet fishery and the Northwest Quadrant troll fishery ($\chi^2 = 1.2$, df = 2, P = 0.55). This indicates that tagged fish mixed well in the ocean environment. The combined gillnet (56.6%), troll (41.3%), sport (1.9%) and seine (0.2%) fisheries comprised 100% of all Chilkat River coho salmon CWT recoveries from commercial and sport fisheries.

The 2010 harvest estimate of Chilkat River coho salmon represents the minimum total harvest because not all fisheries were sampled, and some were not sampled at rates sufficient to detect small harvests. Some marine sport fishery sites (including Pelican, Prince William Sound, and Cook Inlet) were not sampled for CWTs, so stock contribution to these fisheries cannot be estimated. Furthermore, harvest contributions of Chilkat River coho salmon cannot be determined from tags recovered in mixed district fisheries, as expansions of harvest for Chilkat coho salmon are based on harvests for a particular district (Table 9).

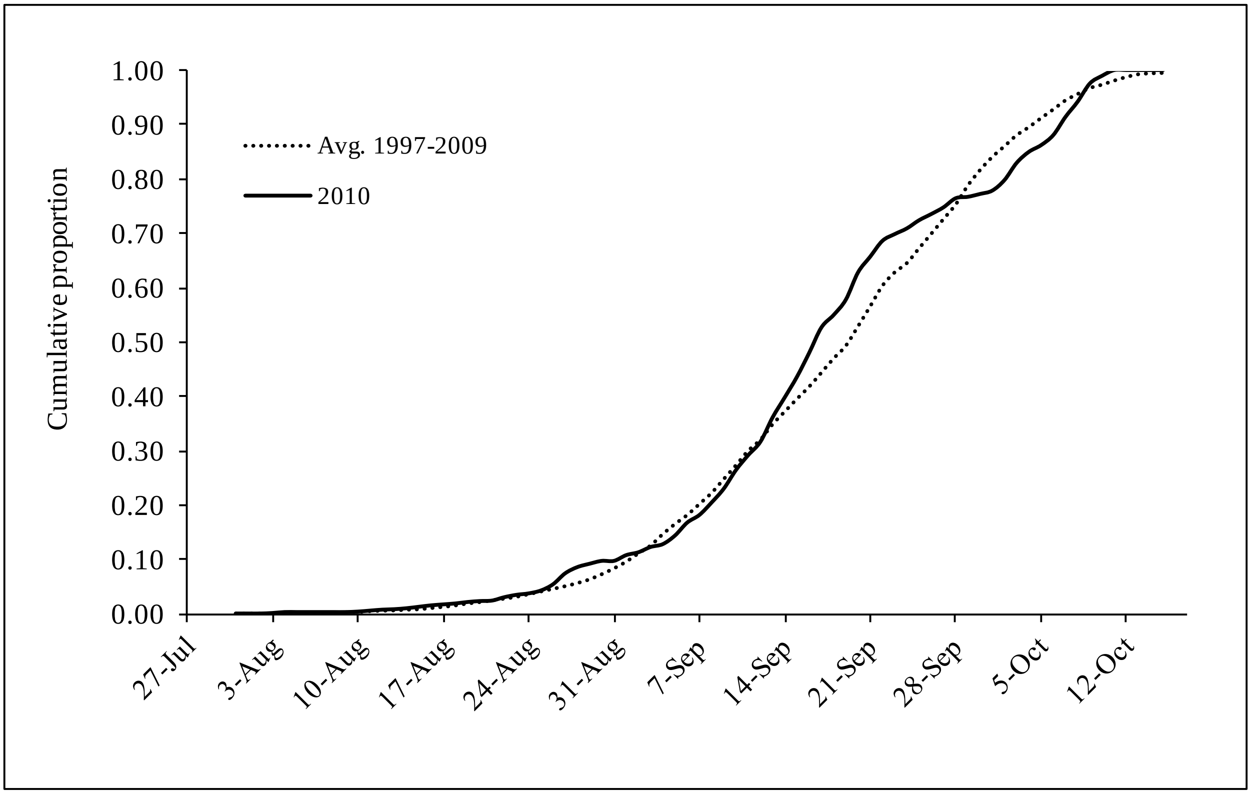

Figure 6.–Cumulative proportion of adult coho salmon captured in the Chilkat River fish wheels during 2010 compared to the mean cumulative proportion of 1997–2009.

The all-age escapement estimate (89,124, SE = 17,147) exceeded the upper range of the escapement goal (Ericksen and Fleischman 2006); with the recent downward trend in freshwater production, however, the escapement goal should be revisited when sufficient additional data are accumulated. The 2009 estimate of emigrating coho salmon smolt was only 62% of the 1999–2008 average and was the fourth consecutive below-average smolt estimate since outmigration year 2006. Estimated marine survival (17.7%) was the highest since Chilkat River smolt tagging began in 1999 and allowed for above-average escapement and total return from a poor emigrating class. This spike in marine survival was also observed on the Berners River stock, which tracks closely with the Chilkat River (Shaul et al. 2011).

Declining freshwater production in the Chilkat River drainage can be best demonstrated by examining the decaying relationship between spring CWT trapping productivity as expressed by CPUE (tagged coho salmon smolt per trap deployed) and resulting smolt population estimates. For outmigration years 1999–2005, CPUE was a very useful predictor of smolt emigration estimates, as evidenced by an R^2 value of 0.98 when performing linear regression between the two data sets. Outmigration years 2006–2009 have sharply increased the error of this model, contributing 55% of the residual sum of squares error when fitting a regression line for all outmigration years (Figure 8).

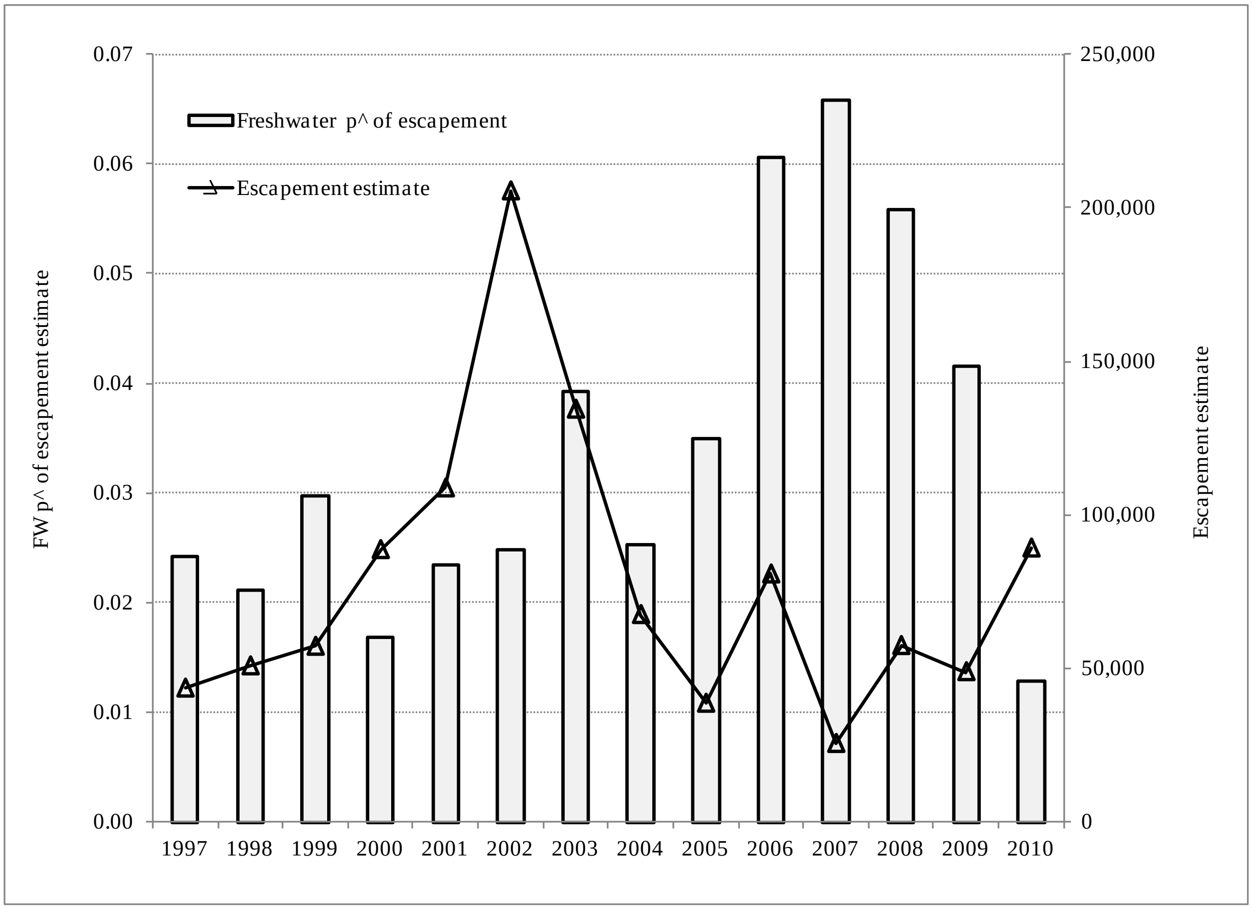

Figure 7.–Adult coho salmon captured in Chilkat River fish wheels as a proportion of the escapement estimate, 1997–2010.

When adding the four most recent CPUE and smolt estimates, the model fit reduces from an R^2 value of 0.98 to 0.64. The data supports the theory that there has been a dramatic shift in freshwater production when solely considering outmigration years 2006–2009. Linear regression results in almost the same model fit ($R^2 = 0.99$) using the four most recent data points. The slope of the regression line for the most recent years is 48% less than 1999–2005, demonstrating that minnow trap CPUE predicts lower abundance in recent years (Figure 9).

Accompanying this shift in model fit are the four highest smolt theta (θ_s) estimates since smolt tagging began in 1999. The last four estimates are 0.023, 0.027, 0.032, and 0.028 for years 2006–2009, respectively, compared to the 1999–2005 average θ_s of 0.016. Methods during the spring CWT project have remained consistent and environmental conditions have also been relatively similar year to year. This sudden jump in the proportion tagged could indicate increased efficiency by the spring CWT crew; however, varying CPUE has resulted in similar smolt estimates. The reasons for lower smolt estimates in the last four years may have more to do with the carrying capacity of the Chilkat River drainage then minnow trap abundance during the CWT project. Causes for this decline in freshwater production should be investigated if this trend continues.

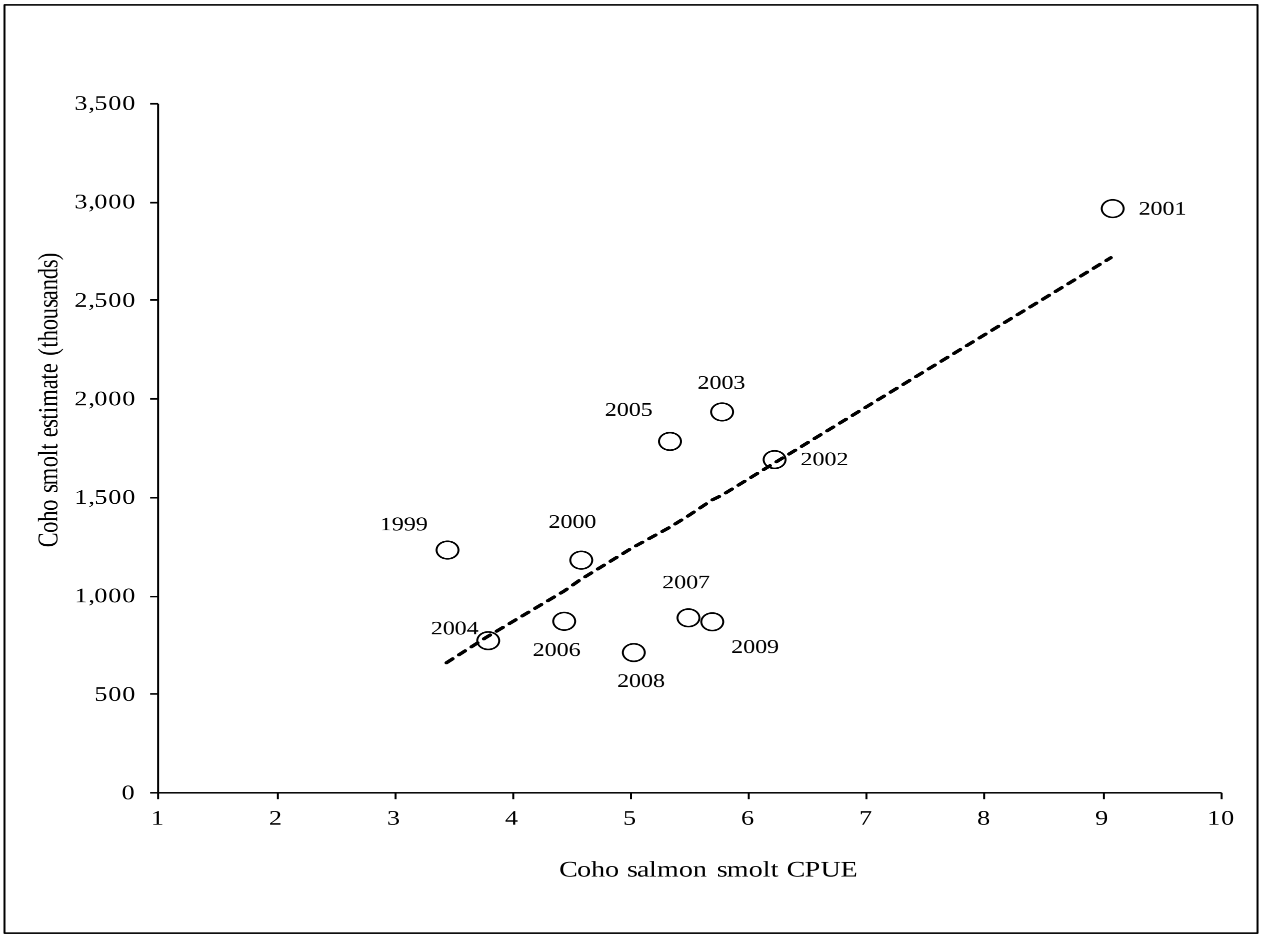

Figure 8.–Chilkat River coho salmon smolt spring CWT minnow trapping CPUE and smolt emigration estimate for years 1999–2009.

The reduced ability of spring minnow trapping CPUE to predict smolt abundance also hinders ability to predict the subsequent year's return. Because total return of Chilkat River coho salmon is largely dependent on the abundance of the previous year's smolt emigration, the ability to forecast the smolt abundance greatly aides predicting total return. In 2002, for example, when marine survival was average (10.7%), the estimated return of 318,798 coho salmon was 118% higher than the 2000–2008 average (Table 12) due to the large smolt emigration (2,970,458 fish) in 2001. In contrast, marine survival was estimated at an above-average 12.4% for return year 2008, but the smolt outmigration in 2007 was below average at 893,032, resulting in a below average total return estimate of 110,349 (Figure 10; Table 12). Linear regression of smolt emigration on total return yields an R^2 value of 0.96 (Figure 11). Return year 2010 is a clear outlier in this data set due to above average marine survival (17.7%) and contributes 33% to the residual sum of squares. Overall, the abundance of the previous year's smolt emigration estimate has reasonable predictive capability on the return of Chilkat River coho salmon.

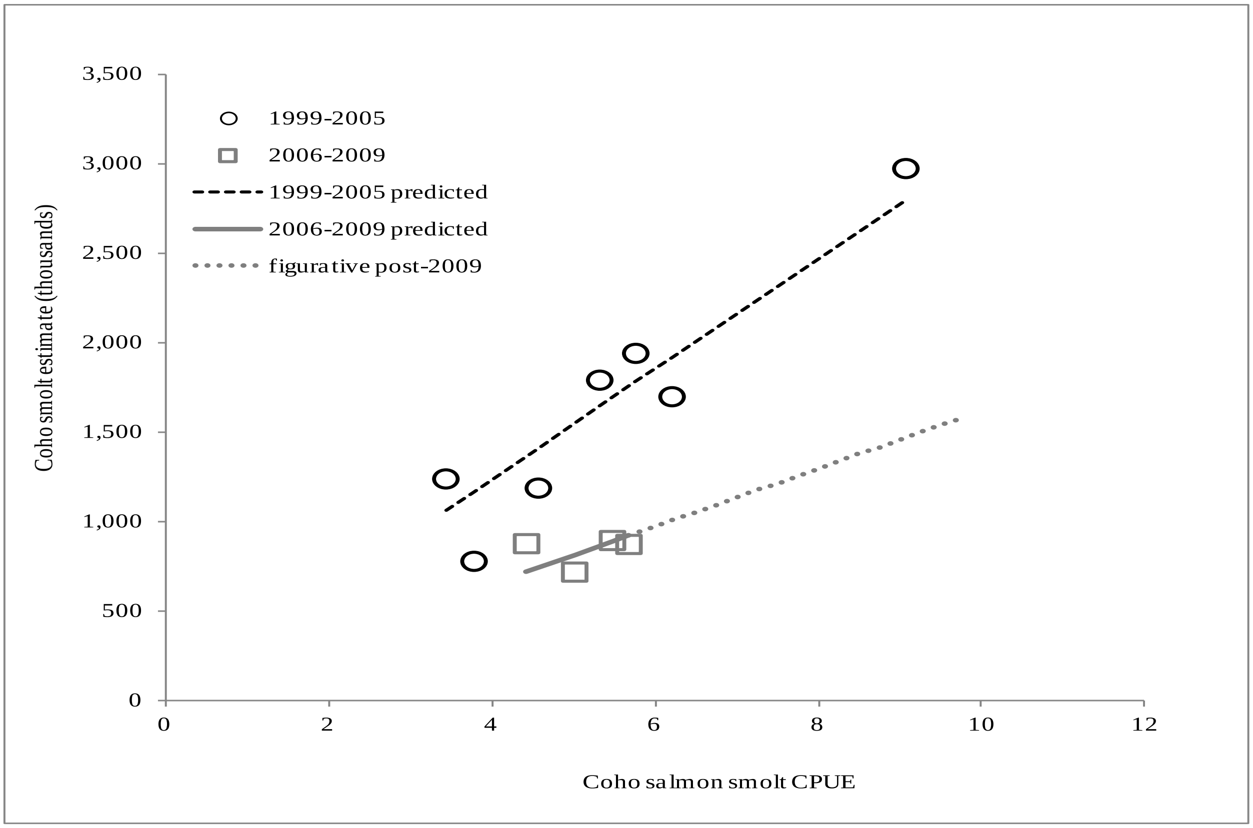

Figure 9.–Chilkat River coho salmon smolt spring CWT minnow trapping CPUE and smolt emigration estimate for years 1999–2005 and 2006–2009, including figurative values post-2009 based on the most recent four-year regression. The relationship between CPUE and resultant smolt estimates changed after emigration year 2005.

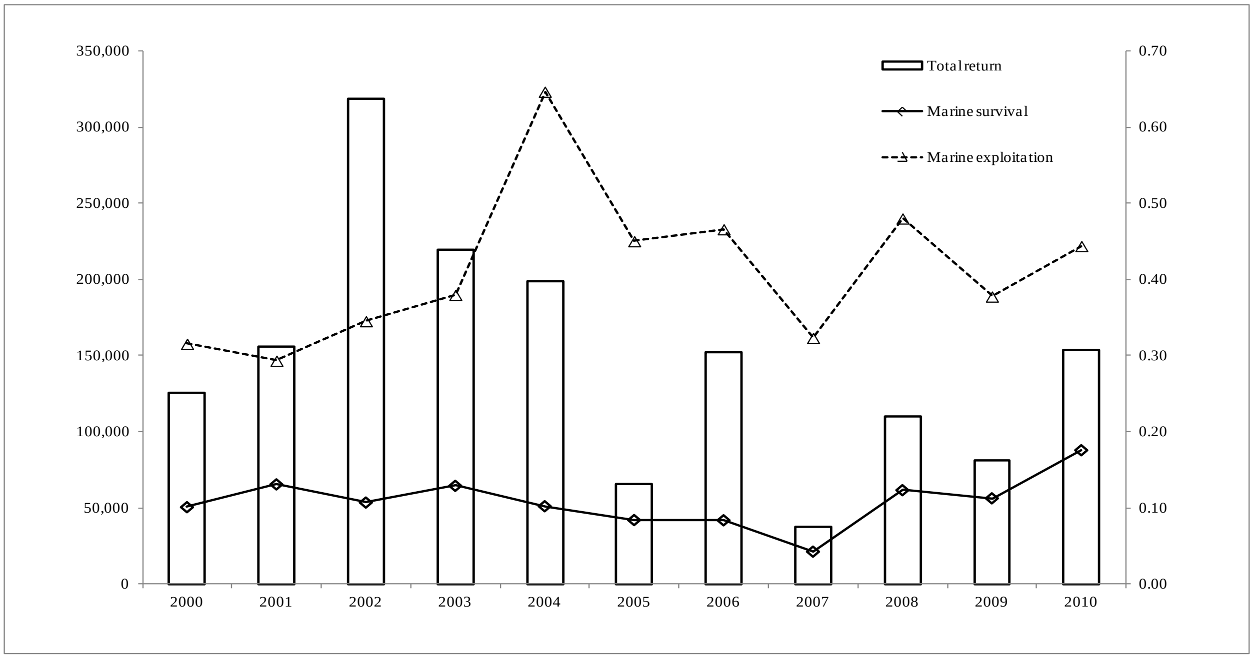

Figure 10.–Estimated total return, marine survival, and marine exploitation rate of Chilkat River coho salmon, 2000–2010.

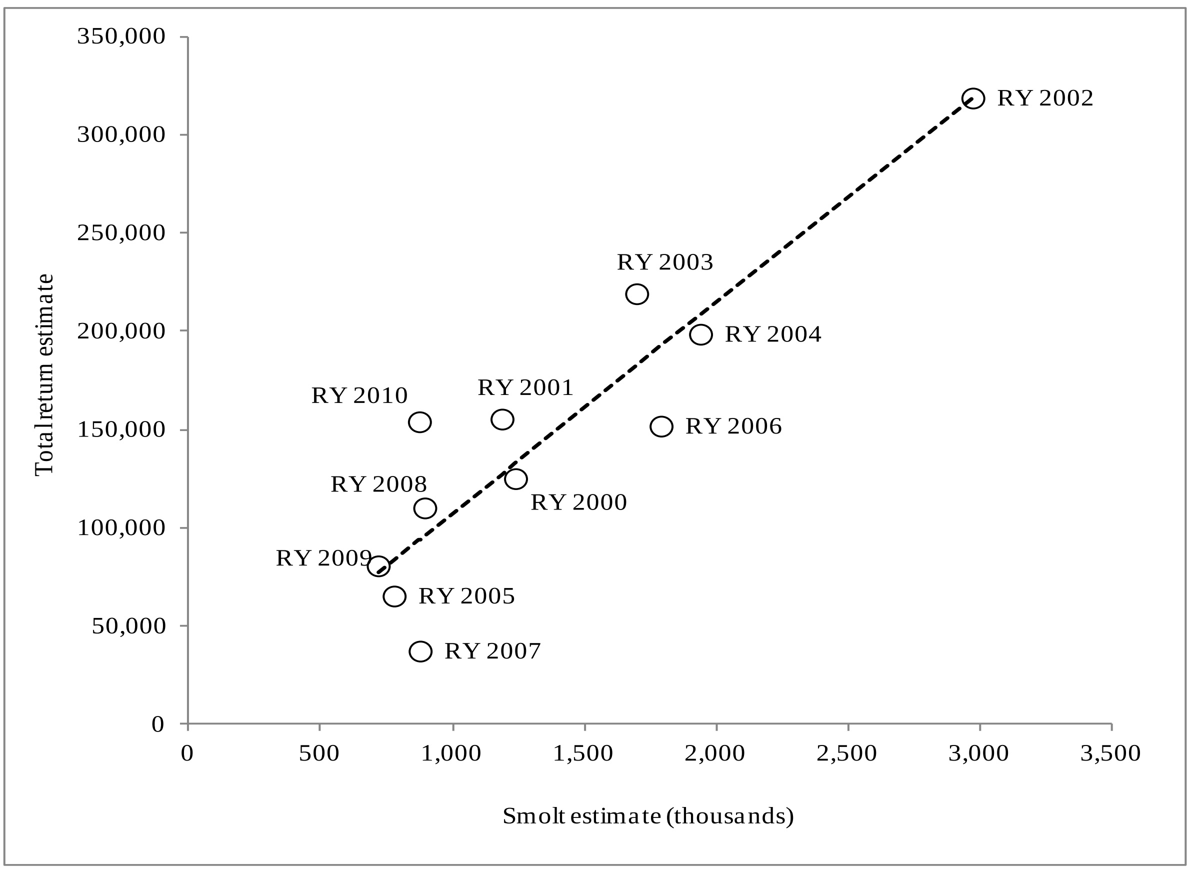

Figure 11.–Estimated smolt emigration and resulting total return of Chilkat River coho salmon, 2000–2010. Linear regression results in an R^2 value of 0.96 and a significant slope with a $P < 0.001$. RY = return year.

Production of Chilkat River coho salmon smolt is limited by the amount of rearing habitat (Ericksen and Fleischman 2006), which would indicate some degree of density dependence. The data does show some density dependence, as liner regression results in an R^2 value of 0.64 with a significant slope of the regression line (P = 0.003); the data are 80% correlated (Figure 12). Emigration years 2001 and 2009 are good examples of how smolt abundance in the Chilkat River drainage affects smolt size as expressed by weight. The smolt estimate for emigration year 2001 (2,970,458) was the highest since smolt tagging began in 1999, and the average weight of these smolt was 6.4 g; conversely the 2009 estimate was below average (872,829) and the average weight of these smolt was 8.5 g, the highest since 1999 (Table 13; Figure 12). This correlation will become clearer in subsequent years as more data points are added to the model. Average smolt weight also has an effect on marine survival, as the two data sets are 98% positively correlated; for average smolt weights above 6.9 grams, marine survival has been an above-average 11% or higher (Figure 13). Smolt size is a direct function of the proportion of 2-freshwater fish; the 2009 emigrating class had the highest estimated age-2 smolt since 1999. Explanations for this include coho salmon smolt not reaching size-at-age thresholds, influencing fish to remain in freshwater an extra year. This phenomenon usually occurs in streams with poor rearing conditions, where the largest individuals will migrate after the first year of freshwater rearing (Bradford et al. 1997).

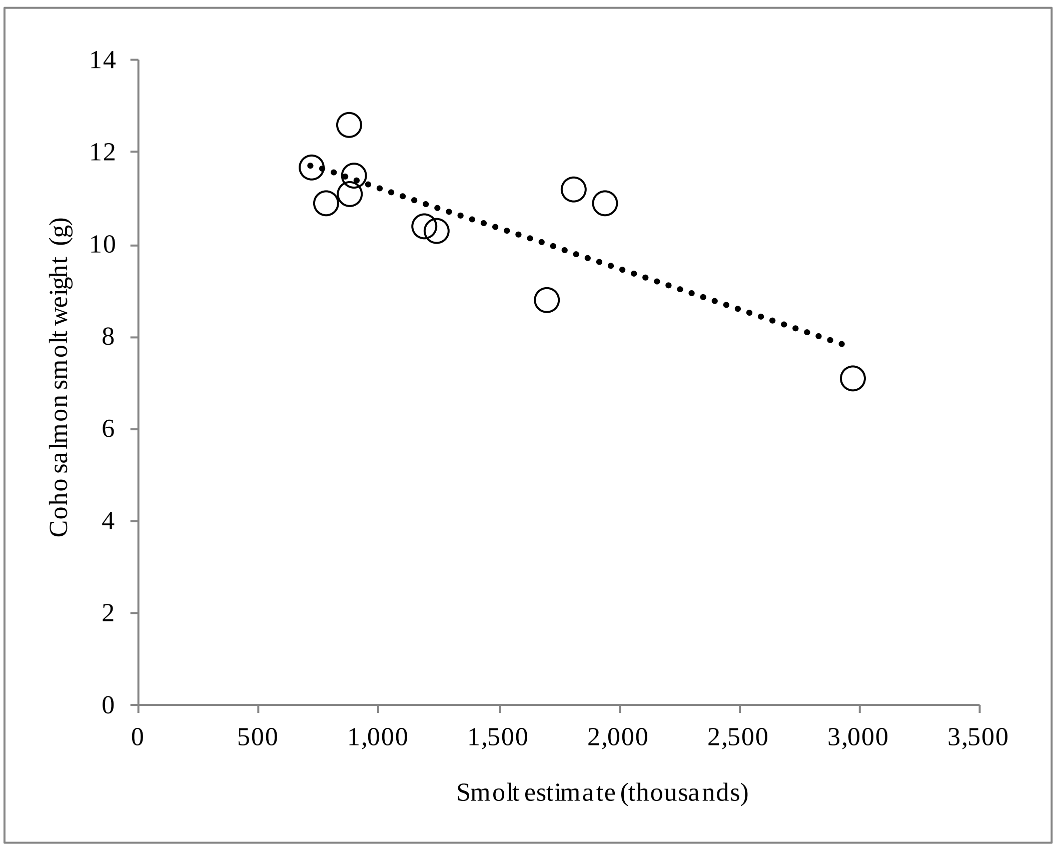

Figure 12.–Estimated coho salmon smolt emigration estimates and average smolt weight, outmigration years 1999–2009. The data are 80% positively correlated and regression results in a significant slope with P = 0.003.

Table 12.–Estimates of Chilkat River coho salmon smolt and adult production, 2000–2010. Esc = escapement, expl = exploitation.

Return year, t	Number CWT smolt (t-1)	Smolt theta (θ_s)	Smolt estimate	SE	Marine theta (θ_m)	Marine harvest	SE	Inriver harvest	SE	Age-x.1 esc	SE	Total return	SE	Marine expl	SE	Marine survival	SE
2000[a]	25,915	0.019	1,237,056	219,715	0.019	39,546	3,745	853	221	84,843	16,330	125,242	16,755	0.316	0.046	0.101	0.023
2001[b]	25,016	0.021	1,185,804	164,121	0.020	45,658	7,194	2,176	451	107,697	20,720	155,531	21,938	0.294	0.051	0.131	0.026
2002[c]	36,114	0.012	2,970,458	377,695	0.012	110,105	10,355	3,888	742	204,787	31,071	318,780	32,759	0.345	0.040	0.107	0.018
2003[d]	25,296	0.015	1,696,212	190,330	0.015	83,302	6,956	2,932	497	133,109	14,926	219,291	16,474	0.380	0.032	0.129	0.017
2004[e]	24,563	0.012	1,938,322	401,419	0.010	128,466	19,882	3,169	661	67,053	12,901	198,688	23,710	0.647	0.054	0.103	0.025
2005[f]	17,276	0.021	776,934	147,738	0.020	29,518	3,483	1,453	293	34,575	4,561	65,546	5,746	0.450	0.042	0.084	0.018
2006[g]	26,342	0.014	1,807,837	217,352	0.013	70,813	7,632	2,082	293	79,050	15,210	151,945	17,020	0.466	0.053	0.084	0.014
2007[h]	22,149	0.025	875,478	134,864	0.023	12,142	1,585	635	149	24,770	4,769	37,547	5,027	0.323	0.050	0.043	0.009
2008[i]	24,104	0.027	893,032	95,380	0.025	52,989	3,518	991	261	56,369	10,846	110,349	11,405	0.480	0.050	0.124	0.018
2009[j]	23,059	0.032	716,689	88,013	0.031	30,558	2,585	2,424	421	47,911	9,219	80,893	9,584	0.378	0.047	0.113	0.019
2010	24,937	0.028	872,829	151,981	0.026	68,385	5,165	706	138	85,066	16,375	154,157	17,171	0.444	0.051	0.177	0.037
Average 00-09	24,983	0.020	1,409,782	203,663	0.019	60,310	6,694	2,060	399	84,016	14,055	146,381	16,042	0.408	0.046	0.102	0.019

[a] From Ericksen (2001b).
[b] From Ericksen (2002b).
[c] From Ericksen (2003).
[d] From Ericksen and Chapell (2005).
[e] From Ericksen and Chapell (2006).
[f] From Ericksen (2006).
[g] From Elliott (2009).
[h] From Elliott (2010).
[i] From Elliott (2012a).
[j] From Elliott (2012b).

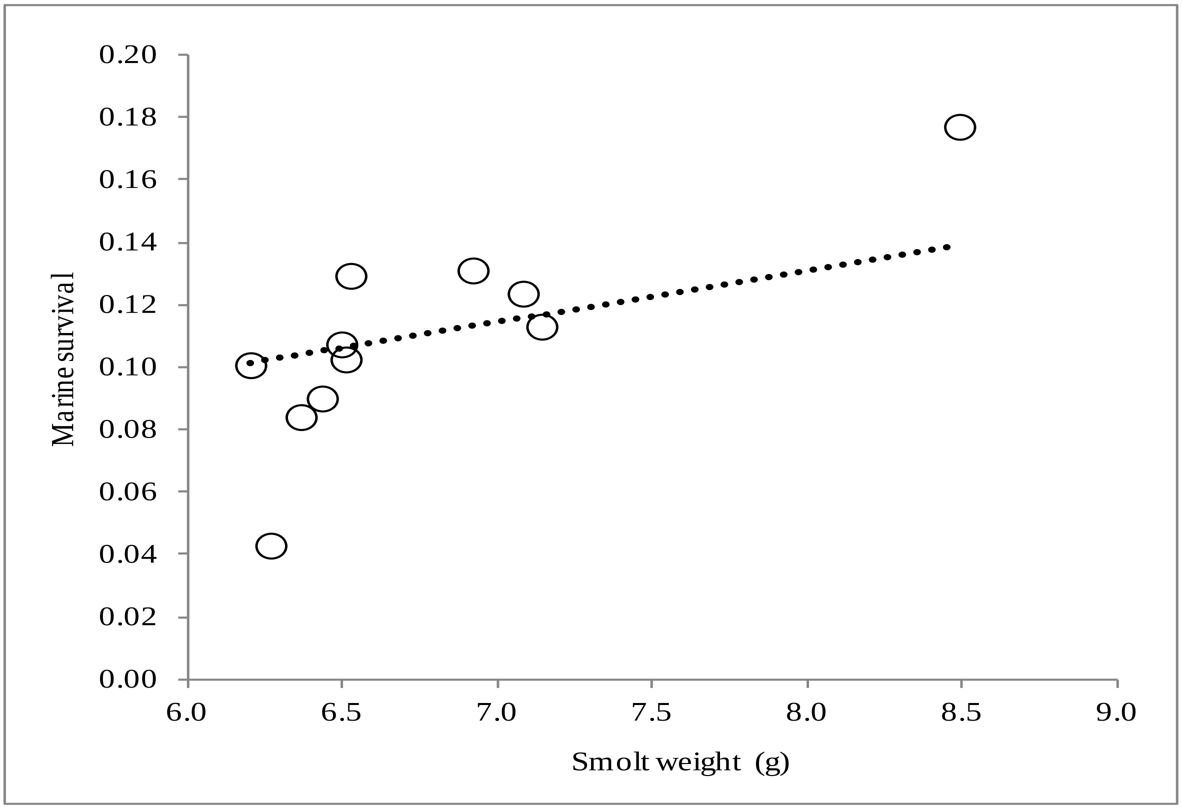

Figure 13.–Average Chilkat River coho salmon smolt weight and resulting marine survival for emigration years 1999–2009. The data are 81% correlated and regression results in a good model fit with a significant predicted slope ($P < 0.01$) an R^2 value of 0.95.

Table 13.–Smolt estimate, average smolt size by age, and marine survival for Chilkat River coho salmon, 1999–2009.

	Smolt	Age 1.			Age 2.			Marine
Smolt year	estimate	n	length	weight	n	length	weight	survival
1999	1,237,056	236	80.0	5.4	46	101.0	10.3	10.1%
2000	1,185,804	184	86.3	6.5	22	102.0	10.4	13.1%
2001	2,970,458	379	85.0	6.4	58	101.0	7.1	10.7%
2002	1,696,212	266	83.0	6.0	61	96.0	8.8	12.9%
2003	1,938,322	315	85.0	6.2	22	104.0	10.9	10.3%
2004	776,934	203	83.5	6.1	15	102.1	10.9	9.0%
2005	1,807,837	398	83.0	5.9	38	105.0	11.2	8.4%
2006	875,478	345	84.0	5.9	26	106.6	11.1	4.3%
2007	893,032	352	85.4	6.4	54	105.3	11.5	12.4%
2008	716,689	337	85.4	6.4	52	105.9	11.7	11.3%
2009	872,829	322	90.0	7.4	85	109.4	12.6	17.7%

Regardless of average fish size, the relationship between smolt abundance and marine survival does not appear to be strong for Chilkat River coho salmon (Figure 14). Regression of survival on smolt abundance produces a line with an insignificant slope ($P = 0.70$) and the data are only 14% correlated. When examining the marine survival to smolt abundance relationship among

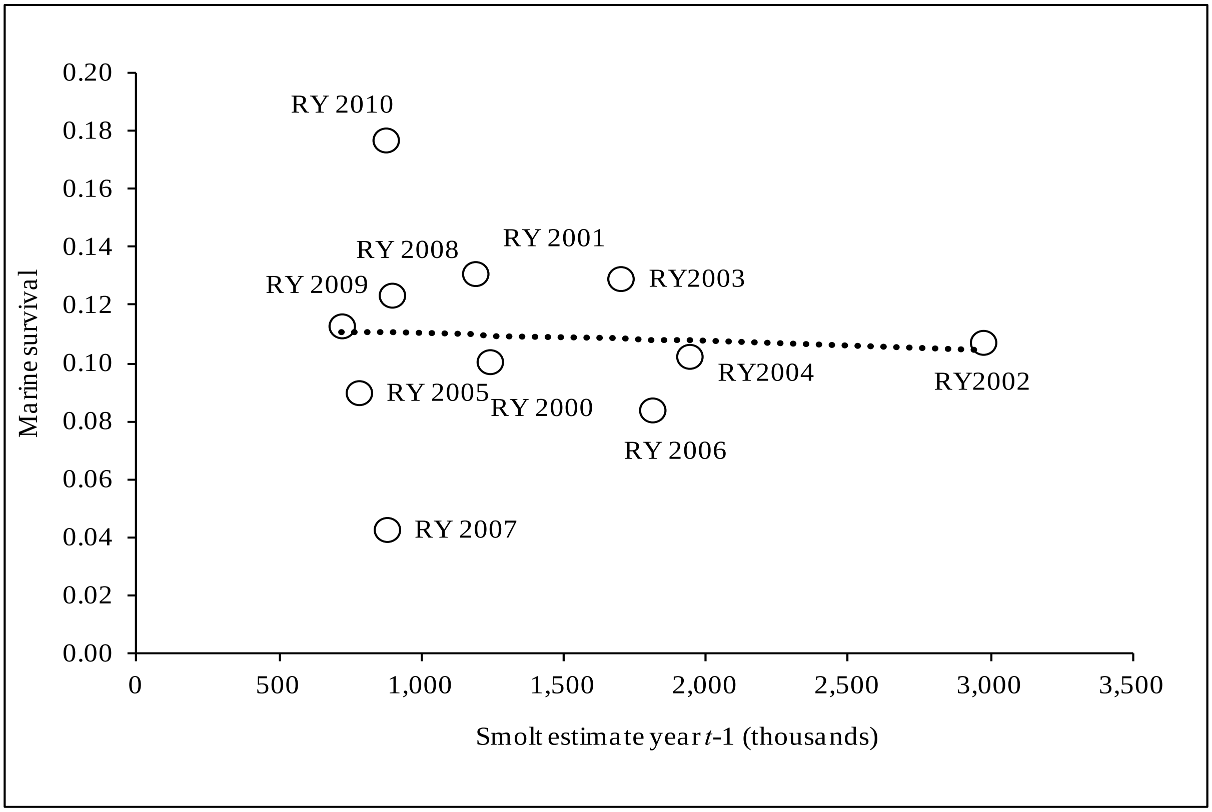

Figure 14.–Observed smolt outmigration estimates and observed and predicted marine survival for Chilkat River coho salmon, return years 2000–2010. There is no relationship between smolt emigration abundance and marine survival as evidenced by an R^2 value of 0.003; predicted marine survival also has an insignificant slope with P value of 0.87, and the data are 5.7% negatively correlated. RY = return year.

all Southeast Alaska coho salmon indicator stocks, including Auke Creek, Berners River, Chilkat River, Taku River, Ford Arm Lake, Hugh Smith Lake, Chuck Creek, and Nakwasina River, the data are 14% correlated (Shaul et al. 2008). This weak relationship for the Chilkat River stock and other Southeast Alaska stocks could indicate that marine survival is more driven by ocean rearing conditions than freshwater abundance of rearing juvenile fish.

A predictor of marine survival that may be useful for making inseason fishery management decisions, such as the Chilkat River sport bag limits for coho salmon, is the CWT recovery rate from commercial troll fisheries (Table 14; Figure 15). Examining recovery rates from 2000 to 2009 for Chilkat River coho salmon reveals that marine recovery and marine survival are 99% positively correlated. Because troll fishery CWT interceptions largely occur before the escapement of Chilkat River coho salmon, and the recovery rate is based on known quantities (smolt released with tags and CWTs recovered), assessing this relationship can help predict marine survival and, after adding the inseason marking fraction θ_m, can be a useful predictor of return strength (Figure 16).

Table 14.–Chilkat River coho salmon marine coded wire tags released and recovered 2000–2010.

Return year	Smolt tagged (t-1)	Marine theta	Marine coded wire tags	Marine recovery rate	Adult return
2000	25,915	0.019	265	1.02%	125,242
2001	25,016	0.020	251	1.00%	155,531
2002	36,114	0.012	329	0.91%	318,780
2003	25,296	0.015	424	1.68%	219,291
2004	24,563	0.010	254	1.03%	198,688
2005	17,276	0.020	142	0.82%	65,546
2006	26,342	0.013	217	0.82%	151,945
2007	22,149	0.023	78	0.35%	37,547
2008	24,104	0.025	370	1.54%	110,349
2009	23,059	0.031	325	1.41%	80,893
2010	24,937	0.026	424	1.71%	154,157
Average	24,979	0.019	280	1.12%	147,074

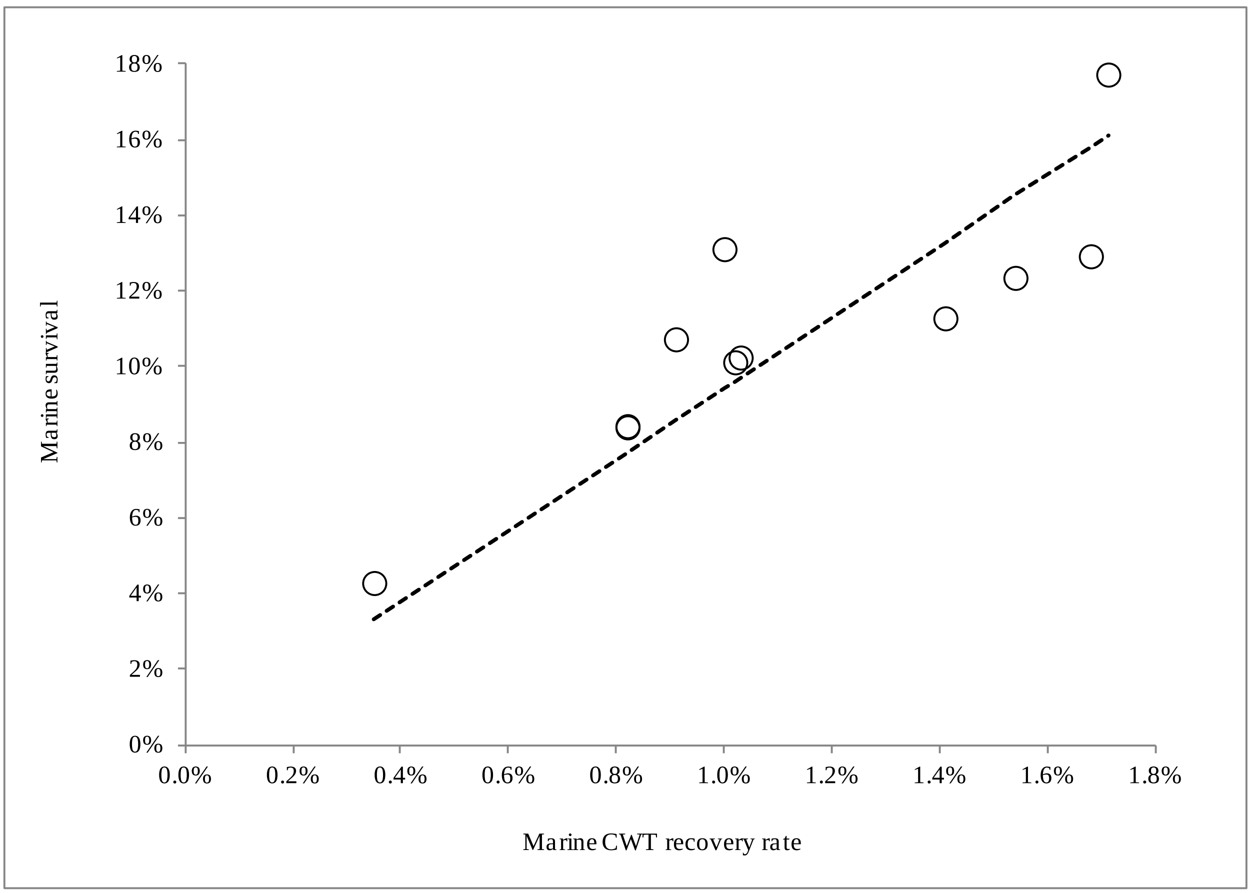

Figure 15.–Marine coded wire tag (CWT) recovery rate and marine survival for Chilkat River coho salmon, 2000–2010. The data are 87% correlated and linear regression results in an $\mathbf{R}^2$ value of 0.97.

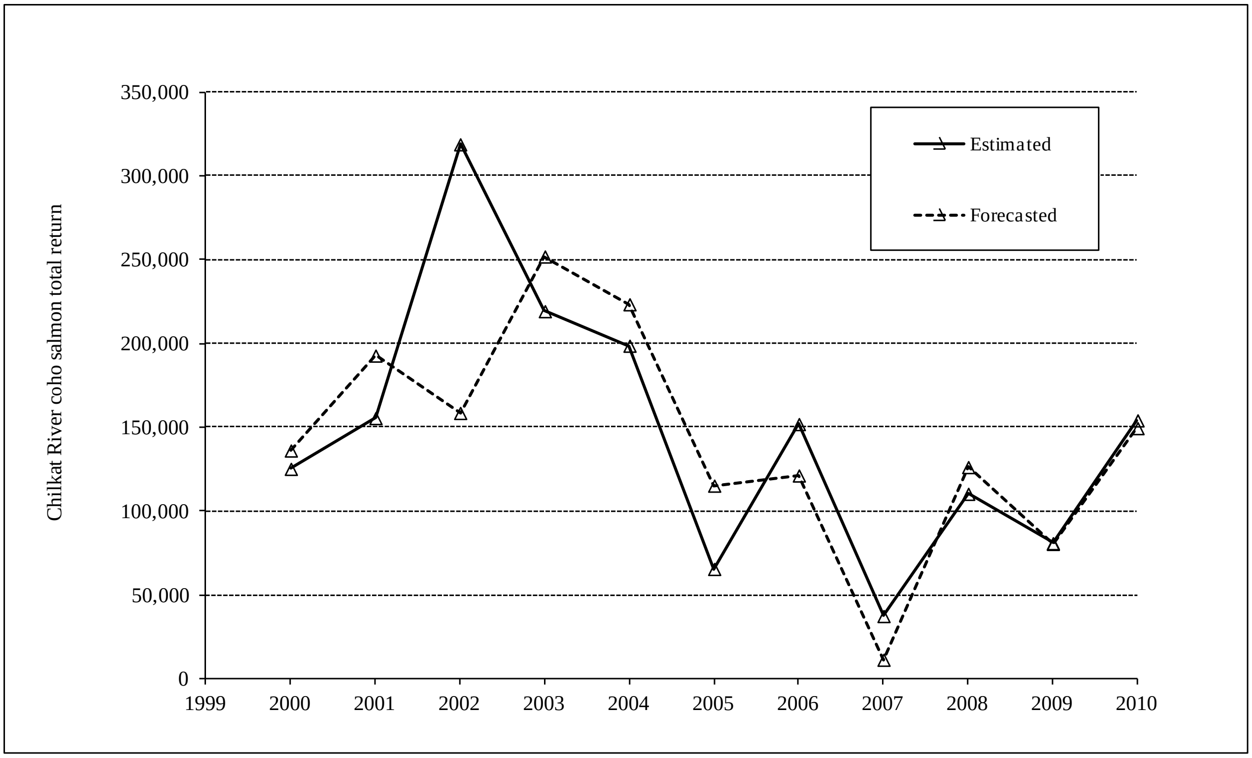

Figure 16.–Inseason forecasted returns and postseason estimated returns of Chilkat River coho salmon, 2001–2010. The number of coded wire tags released in year *t*-1, average marine theta, and the marine coded wire tag recovery rate are used to generate the forecasted total. Return year 2002 accounts for 77% of total forecast error for years 2000–2010.

The forecasting model estimates 2 parameters (ρ and ϕ); the first (ρ) is for the CWT recovery rate from the troll fishery represented by T_{CWT}, and the second (ϕ) is the parameter for marine theta, represented by θ_m (Figure 16). Nonlinear regression using the least squares method produces estimates for ρ and ϕ, including the residual term ε representing additive error from the model:

$$\text{Estimated return} = \rho\left(\mathrm{T_{CWT}}\right) - \phi\left(\theta_m\right) + \varepsilon$$

Most troll fishery interceptions occur by the end of statistical week 38, which coincides with mid September. That time frame is also the median date of the Chilkat River fish wheel catch, when marine theta can be reasonably estimated. Using the total CWTs released in year *t*-1, marine theta, and the marine CWT recovery rate produces inseason forecasted return totals with a forecasting error of less than 25% in 7 of the 10 years examined. Return year 2002 was one anomaly, as the return was the highest recorded and exceeded expectations, and accounts for 77% of the model error, expressed as a proportion of residual sum of squares (Table 12; Figure 16). The model has accurately predicted returns in 2008, 2009, and 2010; forecasting error has been 6.4% in these three most recent return years. Prior forecasts of coho salmon return have used CWTs released with average marine survival and average marine exploitation rates; using inseason marine CWT recovery rates allows for more accurate forecasting while utilizing contemporary data. As more data are collected in subsequent years, this forecasting tool will be developed further and should continue to be studied to predict overall return and escapement of coho salmon to the Chilkat River.

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APPENDIX A

Appendix A1.– Random and select recoveries of coded wire tagged Chilkat River coho salmon in 2009.

Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
RANDOM RECOVERIES									
363209	041509	Sport	Yakutat	7/23/2010	30	NW	181	60	640
245571	041546	Sport	Juneau	8/14/2010	33	NE	111	ND	515
245562	041546	Sport	Juneau	8/14/2010	33	NE	111	ND	630
223238	041508	Sport	Juneau	8/15/2010	34	NE	112	15	580
069504	041508	Sport	Juneau	8/15/2010	34	NE	112	15	ND
245597	041509	Sport	Juneau	8/15/2010	34	NE	111	ND	615
223239	041509	Sport	Juneau	8/22/2010	35	NE	111	50	605
069589	041546	Sport	Juneau	9/05/2010	37	NE	112	15	ND
085829	041509	Drift gillnet	Excursion Inlet	8/05/2010	32	NE	115	32	675
085918	041508	Drift gillnet	Excursion Inlet	8/11/2010	33	NE	115	ND	625
085919	041546	Drift gillnet	Excursion Inlet	8/11/2010	33	NE	115	ND	490
085922	041546	Drift gillnet	Excursion Inlet	8/11/2010	33	NE	115	ND	520
085920	041546	Drift gillnet	Excursion Inlet	8/11/2010	33	NE	115	ND	570
363742	041508	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	550
363759	041508	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	660
363764	041509	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	505
363744	041509	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	565
363754	041509	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	680
363765	041546	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	580
363746	041546	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	585
363743	041546	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	640
363750	041546	Drift gillnet	Excursion Inlet	8/20/2010	34	NE	115	ND	645
363634	041507	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	545
363648	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	505
363654	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	510
363639	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	525
363638	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	540
363650	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	615
363645	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	670
363647	041508	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	680
363642	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	480
363658	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	515
363637	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	520
363652	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	520
363644	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	530
363655	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	540
363653	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	610
363657	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	610
363633	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	645
363656	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	660
363640	041509	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115	ND	685

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
363651	041546	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115		530
363649	041546	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115		590
363659	041546	Drift gillnet	Excursion Inlet	8/25/2010	35	NE	115		670
363680	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115	10	550
363676	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115	10	620
363661	041508	Drift Gillnet	Excursion Inlet	8/26/2010	35	NE	115		525
363666	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		540
363668	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		580
363665	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		585
363667	041508	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		610
363663	041509	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		575
363660	041509	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		630
363670	041509	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		635
363669	041509	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		655
363671	041546	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		660
363664	041546	Drift gillnet	Excursion Inlet	8/26/2010	35	NE	115		675
371381	041373	Drift gillnet	Juneau	9/1/2010	36	NE	115		715
371398	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		530
371392	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		570
371383	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		585
371391	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		600
371362	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		605
371387	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		615
371385	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		635
371388	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		650
371334	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		680
371395	041508	Drift gillnet	Juneau	9/1/2010	36	NE	115		730
371378	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		495
371361	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		525
371372	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		560
371396	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		565
371331	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		570
371386	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		580
371379	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		585
371366	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		600
371498	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		600
371365	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		605
371377	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		605
371323	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		610
371370	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		615
371316	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		620
371337	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		620
371367	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		635
371371	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		650

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
371344	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		650
371399	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		655
371375	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		660
371319	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		670
371376	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		680
371202	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		690
371358	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		695
371393	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		710
371390	041509	Drift gillnet	Juneau	9/1/2010	36	NE	115		715
371400	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		560
371382	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		570
371373	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		595
371201	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		600
371360	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		600
371328	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		610
371345	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		620
371302	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		630
371374	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		635
371308	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		650
371368	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		665
371364	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		670
371369	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		675
371363	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		690
371380	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		695
371343	041546	Drift gillnet	Juneau	9/1/2010	36	NE	115		700
389012	041508	Drift gillnet	Juneau	9/7/2010	37	NE	115		600
389015	041508	Drift gillnet	Juneau	9/7/2010	37	NE	115		625
389005	041508	Drift gillnet	Juneau	9/7/2010	37	NE	115		635
389017	041508	Drift gillnet	Juneau	9/7/2010	37	NE	115		645
389021	041508	Drift gillnet	Juneau	9/7/2010	37	NE	115		650
389019	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		610
389009	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		615
389010	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		635
389007	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		650
389027	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		655
389001	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		660
389004	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		660
389002	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		675
389008	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		675
389022	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		675
389025	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		680
389006	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		685
389024	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		695
389014	041509	Drift gillnet	Juneau	9/7/2010	37	NE	115		700

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
389020	041546	Drift gillnet	Juneau	9/07/2010	37	NE	115	ND	585
389018	041546	Drift gillnet	Juneau	9/07/2010	37	NE	115	ND	630
389003	041546	Drift gillnet	Juneau	9/07/2010	37	NE	115	ND	670
389023	041546	Drift gillnet	Juneau	9/07/2010	37	NE	115	ND	670
389083	041508	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	590
389060	041508	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	620
389054	041508	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	670
389091	041508	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	715
389067	041509	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	670
389070	041509	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	675
389093	041509	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	675
389097	041509	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	680
389088	041509	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	685
389096	041546	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	605
389068	041546	Drift gillnet	Juneau	9/08/2010	37	NE	115	10	675
389415	041508	Drift gillnet	Juneau	9/14/2010	38	NE	111	32	630
389447	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	580
389451	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	600
389457	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	600
371269	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	610
389432	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	610
389444	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	610
371253	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	620
389436	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	620
389431	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	640
389429	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	650
389463	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	650
389446	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	655
371290	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	660
389440	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	670
389455	041508	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	670
389412	041509	Drift gillnet	Juneau	9/14/2010	38	NE	111	32	680
389458	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	595
371251	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	605
389434	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	620
389468	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	625
371275	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	630
389435	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	650
389448	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	650
389467	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	650
389454	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	655
371276	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	660
371281	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	660

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
389464	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	660
389437	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	670
371268	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	675
389441	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	675
371257	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	680
389433	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	680
389469	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	680
389443	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	685
389460	041509	Drift Gillnet	Juneau	9/14/2010	38	NE	115	ND	700
389425	041509	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	705
389449	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	540
389439	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	545
389452	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	565
389453	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	625
371272	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	635
389450	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	635
371291	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	665
389426	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	665
389427	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	685
371286	041546	Drift gillnet	Juneau	9/14/2010	38	NE	115	ND	690
389497	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	570
389211	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	580
389219	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	580
389483	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389202	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389209	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389230	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389382	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	630
389207	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	630
389489	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	640
389374	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	640
389492	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389203	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389236	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389232	041508	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	690
389493	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	590
389385	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	590
389227	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	610
389231	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	610
389370	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389233	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389474	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	630
389216	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	630
389237	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	640

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
389494	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389213	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389242	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389389	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	660
389302	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389495	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389204	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389226	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389229	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389220	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	680
389478	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	690
389372	041509	Drift Gillnet	Juneau	9/21/2010	39	NE	115	ND	690
389473	041509	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	700
389399	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	600
389472	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	620
389487	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	630
389475	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389396	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389206	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	650
389477	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389499	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	670
389208	041546	Drift gillnet	Juneau	9/21/2010	39	NE	115	ND	730
389736	041508	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	620
389738	041508	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	620
389719	041508	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	650
389740	041508	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	680
389193	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	10	620
389197	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	10	630
389723	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	580
389721	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	660
389743	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	670
389742	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	690
389722	041509	Drift gillnet	Juneau	9/29/2010	40	NE	115	ND	710
389192	041546	Drift gillnet	Juneau	9/29/2010	40	NE	115	10	630
085807	041508	Purse seine	Excursion Inlet	8/2/2010	32	NE	111	11	510
380969	041509	Troll	Sitka	7/21/2010	30	NW	113	81	600
085457	041546	Troll	Excursion Inlet	7/22/2010	30	NW	ND	ND	620
379009	041508	Troll	Sitka	7/24/2010	30	NW	113	91	610
371913	041509	Troll	Hoonah	7/27/2010	31	NW	114	21	561
379795	041509	Troll	Sitka	7/29/2010	31	NW	113	91	600
371952	041508	Troll	Hoonah	7/30/2010	31	NW	ND	ND	598
305416	041509	Troll	Pelican	7/30/2010	31	NW	ND	ND	615
379525	041509	Troll	Sitka	7/31/2010	31	NW	113	21	630
378586	041509	Troll	Sitka	8/1/2010	32	NW	113	21	645

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
085838	041508	Troll	Excursion Inlet	8/6/2010	32	NW	ND	ND	600
379264	041546	Troll	Sitka	8/6/2010	32	NW	113	45	645
371959	041546	Troll	Hoonah	8/6/2010	32	NW	114	ND	569
371967	041509	Troll	Hoonah	8/8/2010	33	ND	ND	ND	624
378635	041546	Troll	Sitka	8/8/2010	33	NW	113	ND	610
378432	041546	Troll	Sitka	8/9/2010	33	NW	113	31	550
379354	041508	Troll	Sitka	8/10/2010	33	NW	114	21	645
077262	041508	Troll	Yakutat	8/10/2010	33	NW	181	60	610
085887	041508	Troll	Excursion Inlet	8/10/2010	33	NW	ND	ND	620
305438	041509	Troll	Pelican	8/10/2010	33	NW	113	91	505
379329	041509	Troll	Sitka	8/10/2010	33	NW	114	21	660
378904	041509	Troll	Sitka	8/10/2010	33	NW	116	ND	665
085909	041509	Troll	Excursion Inlet	8/10/2010	33	NW	ND	ND	575
085886	041509	Troll	Excursion Inlet	8/10/2010	33	NW	ND	ND	595
378905	041546	Troll	Sitka	8/10/2010	33	NW	116	ND	470
378486	041508	Troll	Sitka	8/11/2010	33	NW	ND	ND	600
382006	041509	Troll	Sitka	8/11/2010	33	NW	114	21	630
372005	041546	Troll	Hoonah	8/11/2010	33	NW	ND	ND	499
372003	041546	Troll	Hoonah	8/11/2010	33	NW	ND	ND	640
378950	041508	Troll	Sitka	8/12/2010	33	NW	113	91	575
378937	041508	Troll	Sitka	8/12/2010	33	NW	113	91	605
378947	041509	Troll	Sitka	8/12/2010	33	NW	113	91	460
378955	041509	Troll	Sitka	8/12/2010	33	NW	113	91	510
378939	041509	Troll	Sitka	8/12/2010	33	NW	113	91	570
378963	041509	Troll	Sitka	8/12/2010	33	NW	113	91	570
378973	041509	Troll	Sitka	8/12/2010	33	NW	113	91	650
378966	041509	Troll	Sitka	8/12/2010	33	NW	113	91	675
372030	041509	Troll	Hoonah	8/17/2010	34	NW	ND	ND	597
372037	041509	Troll	Hoonah	8/17/2010	34	NW	ND	ND	628
372013	041508	Troll	Hoonah	8/18/2010	34	NW	114	23	630
372040	041509	Troll	Hoonah	8/18/2010	34	NW	114	23	681
085929	041509	Troll	Excursion Inlet	8/18/2010	34	NW	ND	ND	675
372286	041508	Troll	Hoonah	8/20/2010	34	NW	157	ND	704
371190	041508	Troll	Juneau	8/21/2010	34	NE	112	16	470
363783	041509	Troll	Excursion Inlet	8/21/2010	34	NW	ND	ND	620
363785	041509	Troll	Excursion Inlet	8/21/2010	34	NW	ND	ND	650
363776	041546	Troll	Excursion Inlet	8/21/2010	34	NW	ND	ND	600
372414	041546	Troll	Hoonah	8/21/2010	34	NW	ND	ND	633
077452	041509	Troll	Yakutat	8/23/2010	35	NW	ND	ND	675
363612	041546	Troll	Excursion Inlet	8/23/2010	35	NE	112	ND	675
077455	041508	Troll	Yakutat	8/24/2010	35	NW	ND	ND	510
372409	041508	Troll	Hoonah	8/24/2010	35	NW	ND	ND	654
377535	041509	Troll	Petersburg	8/24/2010	35	NE	109	ND	615
363620	041509	Troll	Excursion Inlet	8/24/2010	35	NW	ND	ND	615

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
379945	041546	Troll	Sitka	8/24/2010	35	NW	113	45	590
363627	041546	Troll	Excursion Inlet	8/24/2010	35	NW	ND	ND	635
372441	041509	Troll	Hoonah	8/26/2010	35	NW	ND	ND	673
372447	041509	Troll	Hoonah	8/26/2010	35	NW	ND	ND	673
372442	041546	Troll	Hoonah	8/26/2010	35	NW	ND	ND	623
363696	041508	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	595
363803	041508	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	630
382174	041509	Troll	Sitka	8/27/2010	35	NW	113	91	580
382151	041509	Troll	Sitka	8/27/2010	35	NW	113	91	600
363697	041509	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	540
363694	041509	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	560
363808	041509	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	600
382163	041546	Troll	Sitka	8/27/2010	35	NW	113	91	570
382181	041546	Troll	Sitka	8/27/2010	35	NW	113	91	630
363689	041546	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	600
363691	041546	Troll	Excursion Inlet	8/27/2010	35	NW	ND	ND	670
382185	041509	Troll	Sitka	8/28/2010	35	NW	113	45	620
077290	041546	Troll	Yakutat	8/28/2010	35	NW	ND	ND	550
077294	041546	Troll	Yakutat	8/28/2010	35	NW	ND	ND	625
383397	041508	Troll	Sitka	8/30/2010	36	NW	113	91	630
371413	041508	Troll	Juneau	8/30/2010	36	NW	ND	ND	610
371429	041508	Troll	Juneau	8/30/2010	36	NW	ND	ND	615
371414	041508	Troll	Juneau	8/30/2010	36	NW	ND	ND	650
371410	041508	Troll	Juneau	8/30/2010	36	NW	ND	ND	660
377807	041509	Troll	Petersburg	8/30/2010	36	NE	109	61	690
383392	041509	Troll	Sitka	8/30/2010	36	NW	113	91	620
383396	041509	Troll	Sitka	8/30/2010	36	NW	113	91	620
383380	041509	Troll	Sitka	8/30/2010	36	NW	113	91	665
371433	041509	Troll	Juneau	8/30/2010	36	NW	ND	ND	620
371422	041509	Troll	Juneau	8/30/2010	36	NW	ND	ND	665
383384	041546	Troll	Sitka	8/30/2010	36	NW	113	91	670
371423	041546	Troll	Juneau	8/30/2010	36	NW	ND	ND	625
372503	041509	Troll	Hoonah	8/31/2010	36	NW	ND	ND	569
372491	041509	Troll	Hoonah	8/31/2010	36	NW	ND	ND	570
372460	041509	Troll	Hoonah	8/31/2010	36	NW	ND	ND	601
372488	041509	Troll	Hoonah	8/31/2010	36	NW	ND	ND	669
372476	041546	Troll	Hoonah	8/31/2010	36	NW	ND	ND	628
372584	041373	Troll	Hoonah	9/01/2010	36	NW	ND	ND	734
305474	041508	Troll	Pelican	9/01/2010	36	NW	113	91	490
305476	041508	Troll	Pelican	9/01/2010	36	NW	113	91	650
372575	041508	Troll	Hoonah	9/01/2010	36	NW	ND	ND	596
372546	041508	Troll	Hoonah	9/01/2010	36	NW	ND	ND	650
372569	041546	Troll	Hoonah	9/01/2010	36	NW	ND	ND	660
372567	041546	Troll	Hoonah	9/03/2010	36	NW	114	ND	687

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
077461	041546	Troll	Yakutat	9/05/2010	37	NW	181	60	675
372594	041509	Troll	Hoonah	9/06/2010	37	NW	ND	ND	677
372603	041546	Troll	Hoonah	9/07/2010	37	NW	114	25	661
372607	041508	Troll	Hoonah	9/08/2010	37	NW	ND	ND	674
372632	041509	Troll	Hoonah	9/08/2010	37	NW	ND	ND	613
372630	041509	Troll	Hoonah	9/08/2010	37	NW	ND	ND	640
372625	041509	Troll	Hoonah	9/08/2010	37	NW	ND	ND	669
372627	041509	Troll	Hoonah	9/08/2010	37	NW	ND	ND	685
372629	041546	Troll	Hoonah	9/08/2010	37	NW	ND	ND	557
372622	041546	Troll	Hoonah	9/08/2010	37	NW	ND	ND	617
389137	041373	Troll	Juneau	9/09/2010	37	NW	ND	ND	650
389180	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	570
389113	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	580
389177	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	600
389124	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	620
389101	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	640
389179	041508	Troll	Juneau	9/09/2010	37	NW	ND	ND	650
366350	041509	Troll	Sitka	9/09/2010	37	NW	113	ND	640
389117	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	590
389135	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	630
389148	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	640
389114	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	660
389102	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	670
389128	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	680
389142	041509	Troll	Juneau	9/09/2010	37	NW	ND	ND	700
372633	041546	Troll	Hoonah	9/09/2010	37	NW	114	25	619
389111	041546	Troll	Juneau	9/09/2010	37	NW	ND	ND	620
389154	041546	Troll	Juneau	9/09/2010	37	NW	ND	ND	640
389115	041546	Troll	Juneau	9/09/2010	37	NW	ND	ND	670
389136	041546	Troll	Juneau	9/09/2010	37	NW	ND	ND	670
366486	041509	Troll	Sitka	9/10/2010	37	NW	113	45	640
383696	041546	Troll	Sitka	9/10/2010	37	NW	113	45	670
372654	041546	Troll	Hoonah	9/10/2010	37		ND	ND	662
383866	041508	Troll	Sitka	9/11/2010	37	NW	113	91	640
383864	041509	Troll	Sitka	9/11/2010	37	NW	113	91	590
372681	041508	Troll	Hoonah	9/13/2010	38	NW	ND	ND	689
383882	041509	Troll	Sitka	9/13/2010	38	NW	113	45	635
372690	041509	Troll	Hoonah	9/13/2010	38	NW	ND	ND	683
077471	041546	Troll	Yakutat	9/13/2010	38	NW	181	60	660
372663	041546	Troll	Hoonah	9/13/2010	38	NW	ND	ND	638
371238	041508	Troll	Juneau	9/14/2010	38	NW	ND	ND	620
371234	041508	Troll	Juneau	9/14/2010	38	NW	ND	ND	650
371219	041508	Troll	Juneau	9/14/2010	38	NW	ND	ND	690
372709	041508	Troll	Hoonah	9/14/2010	38	NW	ND	ND	697

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
372659	041509	Troll	Hoonah	9/14/2010	38	NW	113	91	629
371230	041509	Troll	Juneau	9/14/2010	38	NW	ND	ND	590
371217	041509	Troll	Juneau	9/14/2010	38	NW	ND	ND	640
371228	041509	Troll	Juneau	9/14/2010	38	NW	ND	ND	685
372728	041508	Troll	Hoonah	9/15/2010	38	NW	114	21	701
372733	041508	Troll	Hoonah	9/15/2010	38	NW	114	25	712
372730	041509	Troll	Hoonah	9/15/2010	38	NW	114	21	671
372758	041509	Troll	Hoonah	9/15/2010	38	NW	181	60	685
372723	041546	Troll	Hoonah	9/15/2010	38	NW	114	21	689
372726	041546	Troll	Hoonah	9/15/2010	38	NW	114	21	699
372759	041546	Troll	Hoonah	9/15/2010	38	NW	181	60	629
372804	041508	Troll	Hoonah	9/16/2010	38	NW	ND	ND	715
383901	041509	Troll	Sitka	9/16/2010	38	NW	113	45	665
372818	041509	Troll	Hoonah	9/16/2010	38	NW	ND	ND	690
372806	041546	Troll	Hoonah	9/16/2010	38	NW	ND	ND	637
372792	041546	Troll	Hoonah	9/16/2010	38	NW	ND	ND	704
372823	041508	Troll	Hoonah	9/17/2010	38	NW	114	25	650
383912	041509	Troll	Sitka	9/17/2010	38	NW	113	91	635
383928	041509	Troll	Sitka	9/17/2010	38	NW	113	91	655
383927	041546	Troll	Sitka	9/17/2010	38	NW	113	91	665
378732	041508	Troll	Sitka	9/18/2010	38	NW	113	41	685
372854	041508	Troll	Hoonah	9/18/2010	38	NW	ND	ND	645
372853	041508	Troll	Hoonah	9/18/2010	38	NW	ND	ND	664
372826	041508	Troll	Hoonah	9/18/2010	38	NW	ND	ND	667
372844	041509	Troll	Hoonah	9/18/2010	38	NW	ND	ND	670
372847	041509	Troll	Hoonah	9/18/2010	38	NW	ND	ND	690
389321	041509	Troll	Juneau	9/20/2010	39	NW	ND	ND	610
389323	041509	Troll	Juneau	9/20/2010	39	NW	ND	ND	650
372843	041546	Troll	Hoonah	9/20/2010	39	NW	114	25	671
389329	041546	Troll	Juneau	9/20/2010	39	NW	ND	ND	640
372883	041508	Troll	Hoonah	9/21/2010	39	NW	ND	ND	645
372865	041509	Troll	Hoonah	9/21/2010	39	NW	ND	ND	589
372866	041509	Troll	Hoonah	9/21/2010	39	NW	ND	ND	671
372870	041509	Troll	Hoonah	9/21/2010	39	NW	ND	ND	675
372880	041546	Troll	Hoonah	9/21/2010	39	NW	ND	ND	589
372877	041546	Troll	Hoonah	9/21/2010	39	NW	ND	ND	688
088667	041509	Fish wheels	Chilkat River	8/10/2010	33	NE	115	32	480
088668	041509	Fish wheels	Chilkat River	8/21/2010	34	NE	115	32	490
088669	041509	Fish wheels	Chilkat River	8/22/2010	35	NE	115	32	440
088670	041508	Fish wheels	Chilkat River	8/23/2010	35	NE	115	32	435
088671	041508	Fish wheels	Chilkat River	9/03/2010	36	NE	115	32	440
088672	041546	Fish wheels	Chilkat River	9/05/2010	37	NE	115	32	620
088674	041509	Fish wheels	Chilkat River	9/09/2010	37	NE	115	32	605
088676	041508	Fish wheels	Chilkat River	9/11/2010	37	NE	115	32	660

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Head number	Tag code	Gear	Port	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
088677	041509	Fish wheels	Chilkat River	9/11/2010	37	NE	115	32	600
088680	041508	Fish wheels	Chilkat River	9/12/2010	38	NE	115	32	615
088679	041508	Fish wheels	Chilkat River	9/12/2010	38	NE	115	32	625
088678	041508	Fish wheels	Chilkat River	9/12/2010	38	NE	115	32	670
088681	041509	Fish wheels	Chilkat River	9/13/2010	38	NE	115	32	435
088682	041509	Fish wheels	Chilkat River	9/14/2010	38	NE	115	32	630
088683	041509	Fish wheels	Chilkat River	9/15/2010	38	NE	115	32	575
088685	041509	Fish wheels	Chilkat River	9/16/2010	38	NE	115	32	600
088684	041509	Fish wheels	Chilkat River	9/16/2010	38	NE	115	32	685
088687	041508	Fish wheels	Chilkat River	9/17/2010	38	NE	115	32	620
088686	041546	Fish wheels	Chilkat River	9/17/2010	38	NE	115	32	680
088688	041508	Fish wheels	Chilkat River	9/21/2010	39	NE	115	32	615
088689	041546	Fish wheels	Chilkat River	9/23/2010	39	NE	115	32	685
088690	041546	Fish wheels	Chilkat River	9/25/2010	39	NE	115	32	615
088691	041509	Fish wheels	Chilkat River	10/03/2010	41	NE	115	32	670
088692	041508	Fish wheels	Chilkat River	10/07/2010	41	NE	115	32	630
088693	041509	Fish wheels	Chilkat River	10/08/2010	41	NE	115	32	605
088694	041509	Fish wheels	Chilkat River	10/08/2010	41	NE	115	32	620
088695	041546	Fish wheels	Chilkat River	10/08/2010	41	NE	115	32	730
088696	041509	Fish wheels	Chilkat River	10/11/2010	42	NE	115	32	675
SELECT RECOVERIES									
901068	041508	Troll	Sitka	9/08/2010	37	NW	181	60	ND
901028	041508	Troll	Sitka	9/11/2010	37	NW	113	91	ND
901049	041546	Troll	Sitka	9/11/2010	37	NW	113	91	ND
VOLUNTARY RECOVERIES									
088705	041546	Sport	Haines	10/16/2010	42	NE	115	32	665
088706	041508	Sport	Haines	10/22/2010	43	NE	115	32	710
088708	041509	Sport	Haines	10/24/2010	44	NE	115	32	660
088707	041546	Sport	Haines	10/24/2010	44	NE	115	32	655
088709	041509	Sport	Haines	10/28/2010	44	NE	115	32	570

Appendix A2.– Age, sex, and length composition of coho salmon sampled at the Chilkat River fish wheels, and estimated escapement in the first of two time strata, August 3–September 16, 2010.

	Brood year and age class					
	2008	2007	2007	2006		
	1.0	2.0	1.1	2.1	Total aged	Total sampled[a]
Females						
Sample size	ND	ND	77	22	99	200
Percent	ND	ND	26.4	7.5	ND	36.6
SE	ND	ND	2.6	1.6	ND	2.1
Number	ND	ND	11,227	3,208	ND	14,434
SE	ND	ND	2,415	894	ND	3,413
Mean length	ND	ND	637	645	ND	ND
SD	ND	ND	42	25	ND	ND
Males						
Sample size	1	14	146	32	193	346
Percent	0.3	4.8	50.0	11.0	ND	63.4
SE	0.0	1.2	2.9	1.8	ND	2.1
Number	146	2,041	21,287	4,666	ND	28,139
SE	146	654	4,275	1,179	ND	5,753
Mean length	300	339	533	564	ND	ND
SD	0	90	108	99	ND	ND
All fish[b]						
Sample size	1	14	223	54	292	546
Percent	0.3	4.8	76.4	18.5	ND	47.8
SE	0.0	1.3	2.5	2.3	ND	1.5
Number	146	2,041	32,513	7,873	ND	42,574
SE	146	654	4,909	1,480	ND	8,191
Mean length	300	339	569	597	ND	ND
SD	ND	90	103	87	ND	ND

[a] Includes fish not assigned an age.

[b] Includes fish with no sex information.

Appendix A3.– Age, sex, and length composition of coho salmon sampled at the Chilkat River fish wheels and estimated escapement in the second of two time strata, September 17-October 11, 2010.

	Brood year and age class					
	2008	2007	2007	2006		
	1.0	2.0	1.1	2.1	Total aged	Total sampled[a]
Females						
Sample size	ND	ND	125	50	175	347
Percent	ND	ND	41.5	16.6	ND	58.3
SE	ND	ND	2.8	2.1	ND	2.0
Number	ND	ND	19,332	7,733	ND	27,064
SE	ND	ND	3,940	1,782	ND	5,304
Mean length	ND	ND	633	646	ND	ND
SD	ND	ND	42	40	ND	ND
Males						
Sample size	1	11	88	26	126	248
Percent	0.3	3.7	29.2	8.6	ND	41.7
SE	0.3	1.1	2.6	1.6	ND	2.0
Number	155	1,701	13,609	4,021	ND	19,486
SE	155	593	2,880	1,071	ND	3,845
Mean length	310	335	625	652	ND	ND
SD	0	23	73	37	ND	ND
All fish[b]						
Sample size	1	11	213	76	301	597
Percent	0.3	3.7	70.8	25.2	ND	52.2
SE	0.3	1.1	2.6	2.5	ND	1.5
Number	155	1,701	32,941	11,754	ND	46,550
SE	155	593	4,880	2,079	ND	8,956
Mean length	310	335	630	648	ND	ND
SD	ND	22	57	39	ND	ND

[a] Includes fish not assigned an age.

[b] Includes fish with no sex information.

APPENDIX B

Coded wire tagging coho salmon smolt in different size groups allows for testing of mark-recapture assumption [a], i.e., that every fish has an equal probability of being marked during event 1, that every fish has an equal probability of being captured in event 2, or that marked fish mix completely with unmarked fish. In the event that chi-square tests indicate unequal probabilities of tagging in event 1 or capture in event 2, an alternate Peterson mark-recapture model will be used for a 2-group population.

A population divided into 2 groups labeled (1) and (2), Peterson's mark-recapture model can be expanded into:

$$N_1 + N_2 = \left(N_1\alpha_1 + N_2\alpha_2\right)\frac{N_1\alpha_1 S_1 B_1 + N_2\alpha_2 S_2 B_2 + N_1\left(1-\alpha_1\right)S_1 B_1 + N_2\left(1-\alpha_2\right)S_2 B_2}{N_1\alpha_1 S_1 B_1 + N_2\alpha_2 S_2 B_2}. \qquad \text{(B.1)}$$

In the above equation, N is abundance, α_i is the capture probability in event 1 for each group, S_i the survival rate for each group, and β_i the capture probability for each group.

If one or both capture probability parameters, α_i or β_i, are equal, then the above equation reduces to a more simplified version. Consider the case when $\beta_1 = \beta_2$, the abundance estimator reduces to:

$$N_1 + N_2 = \left(N_1\alpha_1 + N_2\alpha_2\right)\frac{N_1\alpha_1 S_1 + N_2\alpha_2 S_2 + N_1\left(1-\alpha_1\right)S_1 + N_2\left(1-\alpha_2\right)S_2}{N_1\alpha_1 S_1 + N_2\alpha_2 S_2}. \qquad \text{(B.2)}$$

If the relationship between α_i parameters is expressed as A= α_2 / α_1 and the relationship between S_i parameters is expressed as B = S_2 / S_1, equation (B.2) reduces further to:

$$N_1 + N_2 = \frac{\left(N_1 + AN_2\right)\left(N_1 + BN_2\right)}{N_1 + ABN_2}. \qquad \text{(B.3)}$$

It is important to note that equation (B.3) is only true if $A = 1$ (i.e. $\alpha_2 = \alpha_1$) OR if $B = 1$ ($S_2 = S_1$). If both A and B are not equal to 1, the above relationship does not hold and an unbiased estimator of abundance cannot be produced. If it is determined that there are both unequal marking probabilities (event 1) and unequal capture or survival probabilities (event 2), Peterson's model can be adjusted to produced an unbiased estimate of smolt abundance. Consider Chapman's modification of the standard Peterson model with two tagging groups, labeled group 1 and group 2:

$$\hat{N} = \frac{\left(N1_1 + N1_2 + 1\right)\left(N2 + 1\right)}{\left(M2_1 + M2_2 + 1\right)}. \qquad \text{(B.4)}$$

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where $N1_1$ and $N1_2$ are the number marked in groups 1 and 2, $N2$ is the number inspected for marks in the second event, and $M2_1$ and $M2_2$ are the amount of marks recovered from groups 1 and 2. Consider the case where $A > 1$ and $S > 1$, that is, group 2 had both a higher marking probability and capture probability. This would create a negative bias in the estimator and $N > \hat{N}$. Adjusting Chapman's modification for this tagging bias results in a new, unbiased estimator:

$$\hat{N}^* = \frac{(AN1_1 + N1_2 + 1)(N2 + 1)}{\hat{A}M2_1 + M2_2 + 1} - 1. \qquad \text{(B.5)}$$

Using the scaler $\hat{A}$, i.e., the ratio of marking rates of the two groups essentially forces the two groups to have the same marking probability, and therefore the expected value of equation (B.5) equals N as a result.

Retention rates for coded wire tagged fish are rarely 100%; adipose-clipped fish sometime do not contain valid CWTs as tags are shed during freshwater or marine rearing. Also occasionally heads are lost from adipose-clipped fish before they can become decoded. Because of this, a new parameter $\hat{\pi}$ can be used to adjust for adipose-clipped fish with no tag information ($M2_U$), which is the observed ratio of tags recovered from group 1 divided by group 2. Basically the observed recovery rate is extrapolated for fish marked in the first event (as indicated by an adipose fin clip) that contain no tag information:

$$\hat{N}^* = \frac{(\hat{A}N1_1 + N1_2 + 1)(N2 + 1)}{\hat{A}(M2_1 + (\hat{\pi})M2_U) + M2_2 + (1 - \hat{\pi})M2_U + 1} - 1. \qquad \text{(B.6)}$$

In the event that all observed adipose-clipped fish contain valid coded wire tags, the term $M2_U$ is zero and equation (B.6) is identical to equation (B.5).

Variance and relative bias in the modified estimator can be estimated through bootstrapping techniques outlined in Efron and Tibshirani (1993).

APPENDIX C

Appendix C1.– Computer files used in the analysis of data for this report.

File name	Description
2009ChilkatCohoSmolt.xls	Excel workbook containing 2009 Chilkat River coho salmon smolt trapping, CWT release, smolt emigration estimator, and age-weight-length data.
10ChilkatCohoFWanalysis.xls	Excel workbook containing 2010 Chilkat River fish wheel coho salmon catch, marking, and age-length sample data.
10 Chilkat coho CWT analysis.xls	Excel workbook containing CWT recovery data and harvest estimates of Chilkat River coho salmon tagged as smolt during 2009.
DiscussionTablesFigures_2010_ChilkatCoho	Excel workbook containing figures and tables used in the discussion section of the 2009-2010 Chilkat River coho salmon FDS report