Fishery Data Series No. 13-25

Production, Escapement, and Juvenile Tagging of Chilkat River Chinook Salmon in 2010

by

Richard S. Chapell

May 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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ABSTRACT

In 2010, angler effort and harvest of Chilkat River Chinook salmon Oncorhynchus tshawytscha in the spring Haines marine boat sport fishery were estimated using an onsite creel survey. An estimated 7,901 angler-h (SE = 510) of salmon effort in the Haines marine sport fishery yielded a harvest of 222 (SE = 25) large Chinook salmon (≥28 in TL), of which 121 (SE = 19) were wild, mature fish.

The 2010 Chinook salmon inriver run was estimated with a stratified mark–recapture experiment. Between June 8 and August 2, a total of 246 Chinook salmon were marked and released in the lower Chilkat River: 143 large (age 1.3 and older), 37 medium (age 1.2), and 66 small (age 1.1). In spawning tributaries, 361 large, 78 medium, and 29 small Chinook salmon were examined. Of the captured fish, 30 large, 3 medium, and 2 small fish were marked. An estimated 3,100 (SE = 451) Chinook salmon, of which 1,815 (SE = 226) were large, immigrated into the Chilkat River.

Chinook salmon brood year 2003 juvenile abundance and marine harvest were estimated through coded wire tag recoveries. In fall 2004, an estimated 668,000 (SE = 75,490) brood year 2003 parr reared in the Chilkat River drainage. Overwinter survival was estimated at 43.0% (SE = 8.3%), and an estimated 284,800 (SE = 49,870) smolts emigrated in 2005. An estimated 1,156 (SE = 227) brood year 2003 fish were harvested in marine fisheries between 2006 and 2010.

Chinook salmon juveniles from brood year 2009, 38,790 parr in fall 2010 and 5,514 smolts in spring 2011, were captured in the Chilkat River drainage and released with coded wire tags and adipose fin clips.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Chilkat River, age stratified, mark-recapture, escapement, angler effort, creel survey, harvest, angler-h, salmon-h, Haines marine sport fishery, coded wire tags, marine survival, total return, length-at-age

INTRODUCTION

The Chilkat River drainage produces the third or fourth largest run of Chinook salmon *Oncorhynchus tshawytscha* in Southeast Alaska (McPherson et al. 2003). This large glacial system has its headwaters 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) of which 867.6 km^2 are considered accessible to anadromous fish (Ericksen and McPherson 2004). Past coded wire tag (CWT) studies have shown that Chilkat River Chinook salmon rear primarily in the inside waters of northern Southeast Alaska, and less so in the Gulf of Alaska, Prince William Sound, and Kachemak Bay (Pahlke 1991; Johnson et al. 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013). Most marine harvest of Chilkat River Chinook salmon occurs in commercial troll and gillnet fisheries in northern Southeast Alaska, in the sport fishery near Haines, and in the Chilkat Inlet subsistence fishery. In the Chilkat River, some Chinook salmon are harvested in the subsistence fishery, but sport and commercial fishing are not allowed.

A creel survey has been used to estimate Chinook salmon harvest in the Haines marine boat sport fishery since 1984. Fishery access points are Letnikof Cove, Haines Small Boat Harbor, and Chilkat State Park (Figure 1). The harvest in this fishery peaked at over 1,600 Chinook salmon in 1985 and 1986 (Table 1). The fishery in Haines contributes significantly to the local economy, supports a salmon derby, and is popular with both Haines residents and anglers from other areas (Bethers 1986; Jones & Stokes 1991).

Beginning in 1981, the Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (DSF) began monitoring Chilkat River Chinook salmon escapement trends using aerial index survey counts in Stonehouse and Big Boulder creeks (Figure 1; Kissner 1982). These creeks were selected as index areas because they were the only clearwater spawning areas that could provide standardized, consistent survey counts. These index areas were used in a regionwide program to monitor Chinook salmon escapements in Southeast Alaska (Pahlke 1992).

Concern about the Chilkat River Chinook salmon population developed when aerial survey counts declined in 1985 and 1986. This decline coincided with increasing marine harvests of Chinook salmon in commercial troll, commercial drift gillnet, and sport fisheries in the area. In 1987, ADF&G began to restrict fisheries in upper Lynn Canal, and the spring sport Chinook salmon fishery near Haines was closed entirely in 1991 and 1992. The Haines King Salmon Derby did not occur from 1988 through 1994.

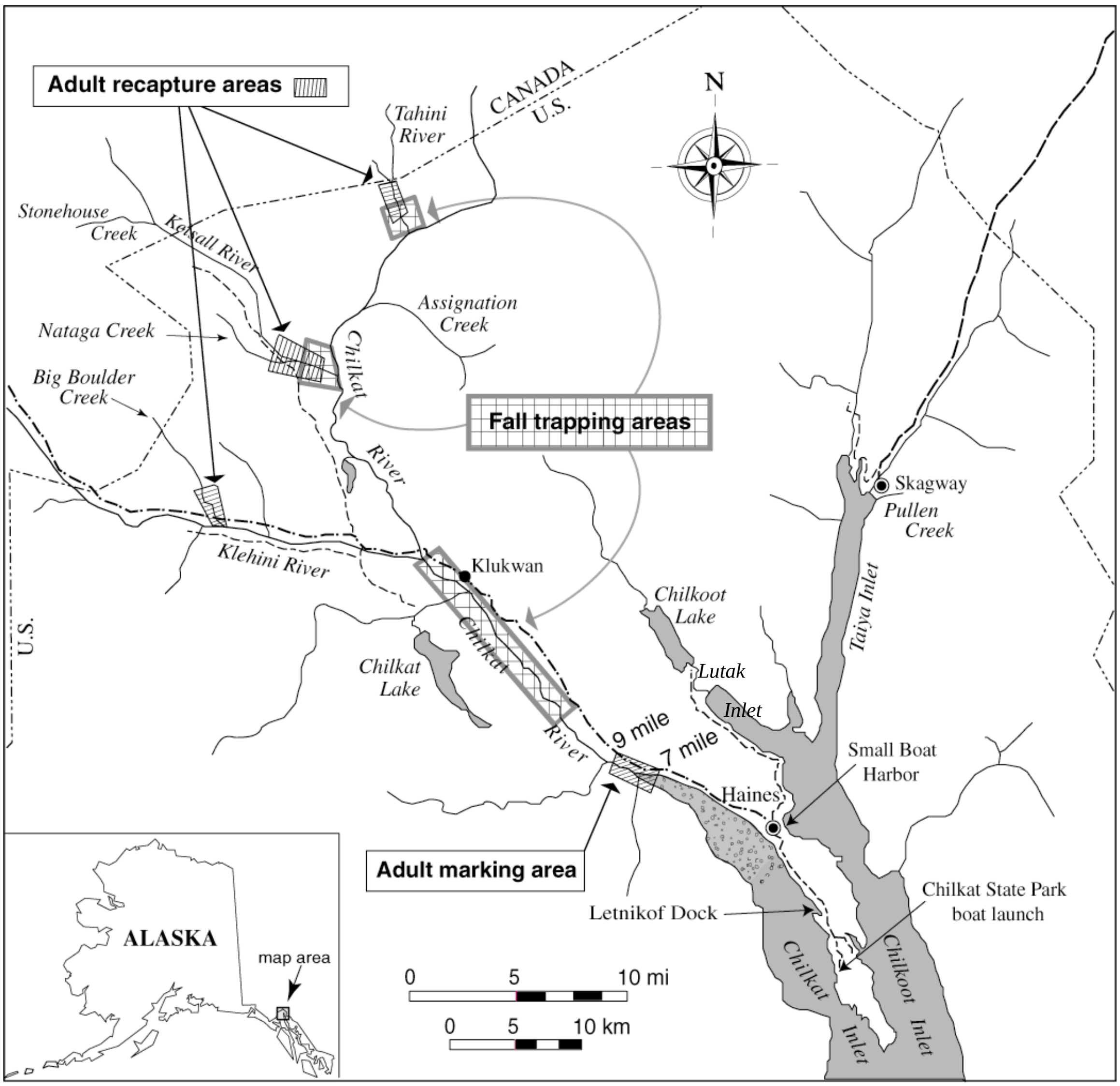

Figure 1.–Location of adult and juvenile Chinook salmon capture, sampling, and release sites near Haines and Skagway in Southeast Alaska, 2010.

Because of these concerns, DSF conducted a CWT-tagging program on wild juvenile Chinook salmon in 1989 and 1990 to identify migratory patterns and to estimate contributions to sport and commercial fisheries (Pahlke et al. 1990; Pahlke 1991). DSF also conducted radiotelemetry and mark-recapture experiments in 1991, 1992, and 2005 to estimate spawning distribution and the inriver run of large (age-1.3 and older fish, i.e., ≥660 mm mid eye to tail fork [MEF]) Chilkat River Chinook salmon. Most Chinook salmon spawned in 2 major tributaries of the Chilkat River, the Kelsall and Tahini rivers, and immature fish were primarily harvested in the inside waters of Southeast Alaska (Johnson et al. 1992, 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013). DSF has continued annual mark-recapture experiments to estimate the inriver run since 1991 (Johnson et al. 1992, 1993; Johnson 1994; Ericksen 1995–2001, 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013).

In 2000, DSF began to mark Chilkat River Chinook salmon smolts with CWTs and adipose fin clips each spring to estimate smolt abundance and marine harvest. During the first year, DSF tagged 1,996 smolts, which was fewer than expected (Ericksen 2002a). To increase the number of CWT-tagged Chilkat River Chinook salmon, DSF began tagging juvenile Chinook salmon (parr) beginning in fall 2000 (Ericksen 2002a).

To increase the sample size of CWT detections in the Chilkat River by brood year (BY) and by fall or spring marking event without sacrificing female fish, a nonlethal CWT marking and detection method was used for the first time on this project starting with BY 2001. In spring 2003, Chinook salmon smolts were released with a second CWT implanted in the muscle tissue beneath the dorsal fin. A handheld wand scanner was used on returning adult fish to detect the second CWT under the dorsal fin. In nonlethal sampling, the presence or absence of the second CWT, combined with the age as determined from scale samples, identified adipose-clipped fish as marked in the fall or spring of a certain year. An added benefit of marking juveniles both as parr and smolts was that freshwater overwinter survival could be estimated.

ADF&G adopted a Chilkat River biological escapement goal (BEG) of 1,750 to 3,500 large Chinook salmon in January 2003 (Ericksen and McPherson 2004). This BEG formed the basis of the Lynn Canal and Chilkat River King Salmon Fishery Management Plan (5AAC 33.384) that was adopted by the Alaska Board of Fisheries in February 2003. The management plan specifies an inriver run goal range of 1,850 to 3,600 large Chinook salmon, as estimated at the adult marking area by the department's annual mark-recapture study (Figure 1). The difference between the management plan inriver run goal range and the BEG range allows for subsistence harvest of 100 large fish between the adult marking area and the spawning grounds. Since the adoption of the BEG and the management plan, inriver run estimates have ranged from 1,438 to 5,631 large Chinook salmon (Ericksen 2004, 2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013).

In 2008, sibling survival rates were used to project an inriver run below the lower end of the management plan goal range. As prescribed in the management plan, retention of Chinook salmon by sport anglers was prohibited in Chilkat Inlet through June 30, and commercial gillnets were prohibited in Chilkat Inlet through statistical week 27 (Figure 1). The Haines Sportsman's Association cancelled the 2008 Haines King Salmon Derby.

Table 1.–Estimated angler effort, and large (≥28 inch TL) Chinook salmon catch and harvest in the Haines marine sport fishery for similar sample periods, 1984–2010.

		Effort				Large (≥28 inch TL) fish				
Year	Survey dates	Angler-h	SE	Salmon-h	SE	Catch	SE	Harvest	SE	CPUE[a]
1984[b]	May 6–June 30	10,253	[c]	9,855	[c]	1,072	[c]	1,072	[c]	0.109
1985[d]	April 15–July 15	21,598	[c]	20,582	[c]	1,705	[c]	1,696	[c]	0.083
1986[e]	April 14–July 13	33,857	[c]	32,533	[c]	1,659	[c]	1,638	[c]	0.051
1987[f]	April 20–July 12	26,621	2,557	22,848	2,191	1,094	189	1,094	189	0.048
1988[g]	April 11–July 10	36,222	3,553	32,723	3,476	505	103	481	101	0.015
1989[h]	April 24–June 25	10,526	999	9,363	922	237	42	235	42	0.025
1990[i]	April 23–June 21	[i]	[i]	11,972	1,169	248	60	241	57	0.021
1991		Chinook salmon sport fishery was closed.								
1992		Chinook salmon sport fishery was closed.								
1993[j]	April 26–July 18	11,919	1,559	9,069	1,479	349	63	314	55	0.038
1994[k]	May 9–July 3	9,726	723	7,682	597	269	41	220	32	0.035
1995[l]	May 8–July 2	9,457	501	8,606	483	255	42	228	41	0.030
1996[m]	May 6–June 30	10,082	880	9,596	866	367	43	354	41	0.038
1997[n]	May 12–June 29	9,432	861	8,758	697	381	46	381	46	0.044
1998[o]	May 11–June 28	8,200	811	7,546	747	222	60	215	56	0.029
1999[p]	May 10–June 27	6,206	736	6,097	734	184	24	184	24	0.030
2000[q]	May 8–June 25	4,428	607	4,043	532	103	34	49	12	0.025
2001[r]	May 7–June 24	5,299	815	5,107	804	199	26	185	26	0.039
2002[s]	May 6–June 30	7,770	636	7,566	634	343	40	337	40	0.045
2003[t]	May 5–June 29	10,651	596	10,055	578	405	40	404	40	0.040
2004[u]	May 10–June 27	12,761	763	12,518	744	413	46	403	44	0.033
2005[v]	May 9–June 26	12,641	1,239	12,287	1,216	260	31	252	31	0.021
2006[w]	May 8–June 25	8,172	610	7,869	558	176	15	165	13	0.022
2007[x]	May 7–June 24	7,411	725	7,223	690	285	43	285	43	0.039
2008[y,z]	May 5–June 22	1,211	177	1,132	167	27	11	27	11	0.024
2009[aa]	May 4–June 21	7,405	534	7,267	520	145	12	143	12	0.020
2010	May 10–June 27	7,983	523	7,901	510	222	25	219	25	0.028
1984–1987 average		23,180		21,317		1,045		1,036		0.061
1988–2009 average		9,975		9,324		269		255		0.027

[a] Catch of large Chinook salmon per salmon-h of effort.
[b] From Neimark (1985).
[c] Estimates of variance were not provided until 1987.
[d] From Mecum and Suchanek (1986).
[e] From Mecum and Suchanek (1987).
[f] From Bingham et al. (Bingham et al. 1988).
[g] From Suchanek and Bingham (1989).
[h] From Suchanek and Bingham (1990).
[i] From Suchanek and Bingham and Bingham (1991); no estimate of the total angler effort and harvest was provided.
[j] From Ericksen (1994).
[k] From Ericksen (1995).
[l] From Ericksen (1996).
[m] From Ericksen (1997).
[n] From Ericksen (1998).
[o] From Ericksen (1999).
[p] From Ericksen (2000).
[q] From Ericksen (2001).
[r] From Ericksen (2002a).
[s] From Ericksen (2003).
[t] From Ericksen (2004).
[u] From Ericksen (2005).
[v] From Ericksen and Chapell (2006).
[w] From Chapell (2009).
[x] From Chapell (2010).
[y] From Chapell (2012).
[z] Chilkat Inlet was closed to Chinook salmon retention and the Haines King Salmon Derby was cancelled.
[aa] From Chapell (2013).

This report describes the methods and results of the Haines area marine Chinook salmon creel survey in 2010, the inriver adult Chinook salmon mark-recapture study in 2010, the tagging of juvenile Chinook salmon from BY 2009 in fall 2010 and spring 2011, and the smolt production and harvest of BY 2003 Chinook salmon. The long-term goal of these studies is to refine maximum harvest guidelines for Chilkat River Chinook salmon in accordance with sustained yield management.

OBJECTIVES

Research objectives were to estimate:

1. the inriver run of Chinook salmon into the Chilkat River in 2010;
2. the age, sex, and length compositions of the inriver run of large Chinook salmon in the Chilkat River in 2010;
3. the harvest of wild mature Chinook salmon in the Haines spring marine boat sport fishery from May 10 to June 27, 2010;
4. the mean length of Chinook salmon parr rearing in the Chilkat River drainage during fall 2010;
5. the mean length of Chinook salmon smolts rearing in the Chilkat River drainage during spring 2011;
6. the Chilkat River Chinook salmon smolt abundance in 2005 (BY 2003); and
7. the marine harvest of Chilkat River Chinook salmon from BY 2003.

METHODS

INRIVER RUN ESTIMATE

A stratified mark-recapture experiment was used to estimate the inriver abundance of Chilkat River Chinook salmon in 2010. This estimate was germane to the time of marking at the event 1 site (Figure 1). The 2010 Chinook salmon escapement to the spawning grounds was estimated by subtracting reported Chilkat River subsistence fishery removals, which occurred primarily upstream of the marking site.

Event 1–Marking

Gillnets 21.3 m long and 3.0 m deep (70 ft × 10 ft) were drifted daily in the lower Chilkat River from June 10 through July 25, 2010. The gillnets consisted of 2 equal-length panels: one of 17.1 cm (6.75 in) and the other of 20.3 cm (8.0 in) stretch measured nylon mesh. Forty-three (43) drifts were completed between 0600 and 1400 hours each day. Fishing was conducted from a 5.5 m (18 ft) boat in 6 adjoining 0.5 km sections, which were marked along a 3 km section of river (Figure 2). This area was about 100 m wide and 2 m to 3 m deep. The 43 drifts took about 6 h to complete when fish were not captured, and continued uninterrupted from area to area. If a (0.5 km) drift was prematurely terminated because a fish was caught, or if the net became entangled or drifted into shallow water, the terminated drift was resumed and completed before a new drift was started.

Two 3-basket aluminum fish wheels were operated by the ADF&G Division of Commercial Fisheries (DCF) to monitor escapement of sockeye *O. nerka*, coho *O. kisutch*, and chum salmon

O. keta from June 7 to October 11, 2010; incidentally captured Chinook salmon were also marked. One fish wheel was operated adjacent to Haines Highway milepost 9, and the other about 300 m downstream (Figure 2). The fish wheels were located along the east bank of the river where the main flow was constrained primarily to one side of the floodplain. Fish wheels operated continuously except for maintenance. The amount of time each fish wheel was stopped for maintenance was recorded each day. Water depth and temperature were recorded at a fixed gauge near milepost 8 at 0900 hours each day.

Captured Chinook salmon were placed in a water-filled tagging box (see Figure 3 in Johnson 1994), measured to the nearest 5 mm MEF, sampled for scales, and visually "sexed." Fish ≥660 mm MEF were designated as large, fish >440 and <660 mm MEF as medium, and fish <440 mm MEF as small. All Chinook salmon were inspected for missing adipose fins.

All fish with missing adipose fins were scanned with a handheld wand CWT detector in the head area for a CWT, and in the area at the base of the dorsal fin for a second CWT. Heads were removed from all medium and small fish with missing adipose fins. Heads were removed from large fish with missing adipose fins only if no head CWT was detected, to verify tag loss. Collected heads were marked with individually numbered cinch straps and sent to the DCF Mark, Tag, and Age Laboratory in Juneau (Tag Lab) for CWT recovery and decoding.

All healthy medium and large Chinook salmon (≥440 mm MEF) not sacrificed for CWT recovery were marked with a uniquely numbered spaghetti tag threaded over a solid plastic core, which was sewn through the bones near the base of the dorsal fin. Healthy small fish (<440 mm MEF) not sacrificed for CWT recovery were marked with a uniquely numbered T-bar anchor tag instead of a spaghetti tag. To minimize bias due to handling effects, unhealthy fish (e.g., lethargic or bleeding from the gills) were released untagged.

All tagged fish were given a 6 mm (¼ in) hole punch in the upper edge of the left operculum (ULOP) as a secondary mark. Fish captured and tagged in gillnets were also marked by removing the left axillary appendage. This tertiary mark identified the event 1 capture gear (fish wheel or gillnet) in the event of primary tag loss.

The scale sampling procedure was to remove 5 scales from the left side of each sampled fish (right side if left side scales were missing or regenerated as determined by visual inspection) along a line 2 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 10,240 kg/cm^2, or 3,500 lb/in^2, at a temperature of 97°C) was used to determine age by counting the scale annuli (Olsen 1992). When scale ageing results were available postseason, each fish was reclassified as large, medium, or small using ocean age, rather than length, as criteria: fish with 3 or more ocean years of residence were classified as large, those with 2 ocean years as medium, and those with 1 ocean year as small. Any fish whose scales could not be aged was classified by length as described above.

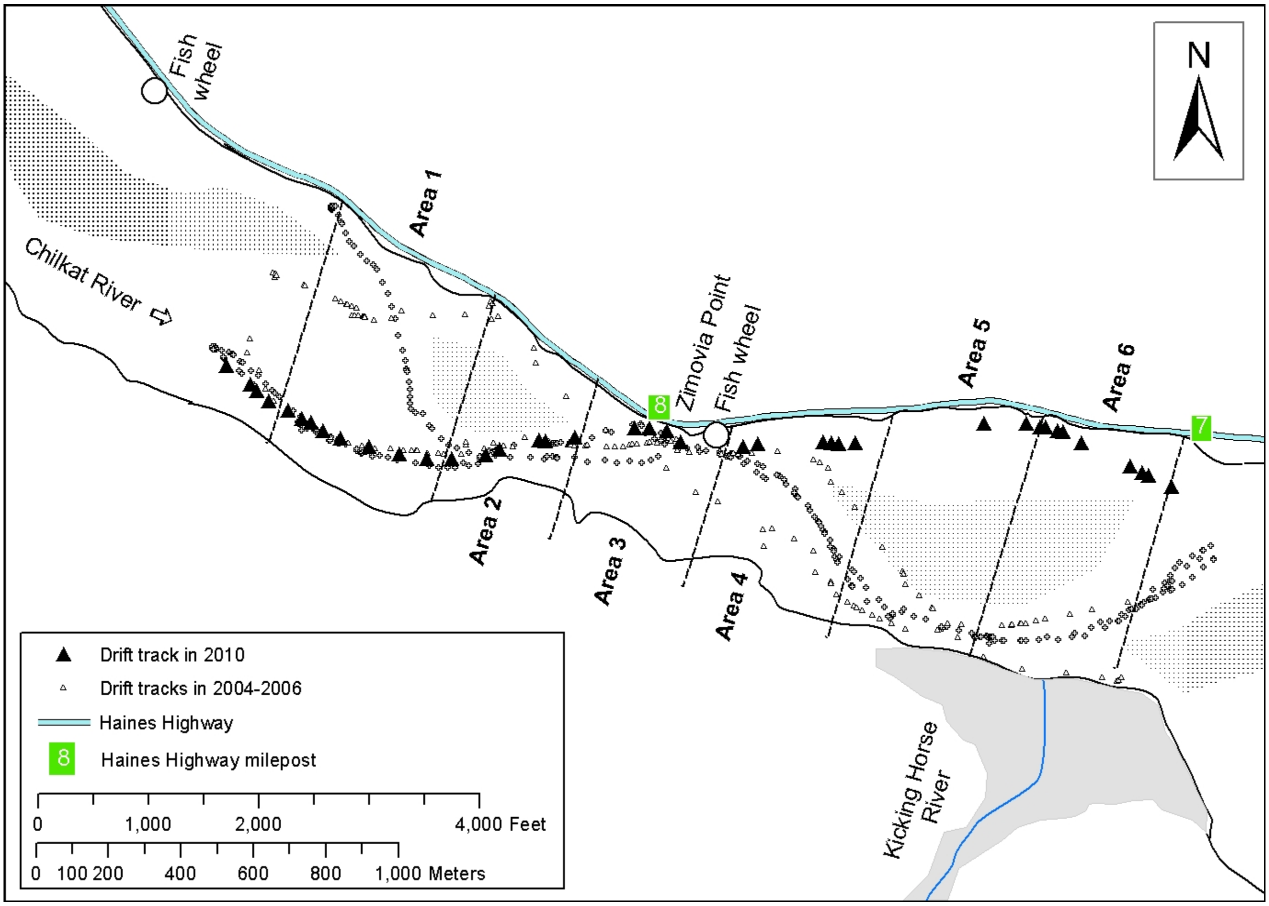

Figure 2–Event 1 fish wheel locations and drift gill net paths in the lower Chilkat River, 2004–2010.

Event 2–Recapture

During the recapture event, Chinook salmon were captured in spawning tributaries using gillnets, dip nets, snagging gear, hands, or spears. The Kelsall River, including Nataga Creek, and the Tahini River were each sampled by a 2-person crew 5 d/wk (Monday through Friday) during August 3–September 2, 2010 (Figure 1). Klehini River tributaries—Big Boulder Creek, Little Boulder Creek, and 37-Mile Creek—were also sampled about every 5 days during the same period.

All captured Chinook salmon were inspected for marks and missing adipose fins, classified by sex, measured to the nearest 5 mm MEF, and sampled for scales as described in event 1 methods. Duplicate sampling was prevented by punching a hole in the lower edge of the left operculum of all captured fish.

As in event 1, all fish with missing adipose fins were scanned with a handheld wand CWT detector. Heads were removed from all medium and small fish with missing adipose fins. Heads were removed from large fish with missing adipose fins only in postspawning condition. Collected heads were marked with individually numbered cinch straps and sent to the DCF Tag Laboratory in Juneau for CWT recovery and decoding.

The validity of the mark-recapture experiment rests on several assumptions (Seber 1982):

(a) every fish has an equal probability of being marked during event 1, or every fish has an equal probability of being captured in event 2, or marked fish mix completely with unmarked fish;

(b) recruitment and "death" (emigration) do not occur between sampling events;

(c) marking does not affect catchability (or mortality) of the fish;

(d) fish do not lose marks between sample events;

(e) all recovered marks are reported; and

(f) duplicate sampling does not occur.

The validity of assumption (a) was tested through a series of hypothesis tests (all at $\alpha = 0.1$). First, a contingency table (χ^2 statistic) was used to test the hypothesis that fish sampled at different spawning tributaries were marked at the same rate. Also, a contingency table was used to test the hypothesis that fish marked at different times in the run (e.g., early vs. late) were recaptured at the same rate.

The possibility of size-selective sampling was investigated because assumption (a) could be violated if the sampling rate varied by size of the fish. The null hypothesis that fish of different sizes were captured with equal probability during the first and second sampling events was tested using Kolmogorov-Smirnov (K-S) two-sample tests (Conover 1980) to compare size distributions in 3 ways:

(a) fish marked in event 1 versus marked fish recaptured in event 2 (M vs. R),
(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C vs. R), and
(c) fish marked in event 1 versus all fish captured in event 2 (M vs. C).

K-S test results were evaluated using the protocol in Appendix A, which indicated a Case II, where event 1 (combined fish wheel and drift gillnet captures) was not size selective but event 2 (spawning ground captures) was selective. The inriver run was therefore calculated using an unstratified Chapman's modified Petersen estimator for a closed population (Seber 1982):

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

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

where n_1 is the number of Chinook salmon marked in the lower river, n_2 is the number examined on the spawning grounds, and m_2 is the subset of n_2 that had been marked in the lower river.

The remaining assumptions are considered in the "Discussion."

Age, Sex, and Length Composition of the Inriver Run

Age and sex composition estimates can be biased due to sampling methods. Fish wheels are usually selective for smaller fish and males, while the gillnet mesh sizes used in this project are selective for larger fish (Ericksen 1995–2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013). Carcass surveys are known to be sex selective in some situations (Pahlke et al. 1996; McPherson et al. 1997; Zhou 2002; Miyakoshi et al. 2003). In addition, significant variation in age compositions between spawning areas can bias composition estimates for the entire drainage when sampling is not proportional to abundance. Sex determination is more difficult early in the season while marking fish in the lower river (Ericksen 1995–2005).

Due to the biases stated above, age compositions were tabulated separately for fish caught in the lower river by gillnet and fish wheels (event 1), and in each sampled tributary (event 2). Standard sample summary statistics (Thompson 2002) were used to calculate age and sex composition, mean length-at-age, and their variances by event 1 gear type and by event 2 tributary.

Because the K-S tests of size distributions indicated that capture probability was not biased by fish size in event 1, pooled event 1 data were used to estimate the age composition of the inriver run by:

$$\hat{p}_a = \frac{n_a}{n} \ , \tag{3}$$

$$var[\hat{p}_a] = \frac{\hat{p}_a \ (1 - \hat{p}_a)}{n-1} , \tag{4}$$

where p_a is the proportion of age class a fish, n_a is the number of age class a fish in the sample, and n is the number of fish in the sample. The inriver abundance of age a fish was estimated by:

$$\hat{N}_a = \hat{N} \ \hat{p}_a , \tag{5}$$

$$\begin{aligned} var[\hat{N}_a] = {} & var[\hat{p}_a]\hat{N}^2 + \\ & var[\hat{N}]\hat{p}_a^{\,2} - var[\hat{p}_a]var[\hat{N}] \end{aligned} . \tag{6}$$

The abundance estimate of large fish (age-1.3 and older fish) was calculated in the same way using equations 3 through 6 with the proportion $\hat{p}_a$ being that of age-1.3 and older fish.

Contingency table analysis (χ^2 test) was used to detect sex-selective sampling in the first and second sampling events, using the null hypothesis that the probability that a sampled fish is male or female is independent of sampling in 3 comparisons, similar to comparisons of length distributions:

(a) fish marked in event 1 versus those recaptured in event 2 (M vs. R),

(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C vs. R),

(c) and fish marked in event 1 versus all fish captured in event 2 (M vs. C).

Evaluation of the sex composition χ^2 test results, presented later, using protocols in Appendix A, indicated that event 1 was not sex selective but event 2 was selective, so event 1 data were used to estimate sex composition by age:

$$\hat{p}_s = \frac{n_s}{n} \ , \tag{7}$$

$$var[\hat{p}_s] = \frac{\hat{p}_s \ (1-\hat{p}_s)}{n-1}, \tag{8}$$

where p_s is the proportion of fish of sex *s*, n_s is the number of fish in the sample of sex *s*, and *n* is the number of sex *s* fish in the sample.

TERMINAL HARVEST

2010 Haines Marine Sport Fishery Harvest

A stratified two-stage direct expansion creel survey was used to estimate the harvest of Chinook salmon in the Haines marine boat sport fishery. Spatial stratification was by sample site. Temporal stratification included 7-day (weekly) periods at a high-use site, and 14-day (biweekly) periods at a low-use site. Separate temporal strata, derby and nonderby, were created for the biweek that included the five days of the Haines King Salmon Derby, May 29–31 and June 5–6. A third rarely used site was sampled only during a stratum of the five derby days. Each fishing day was defined as starting at 0800 hours and ending at civil twilight, which ranged from 2236 to 2351 hours over the 7 weeks of the survey. Midday was defined as the time midway between 0800 hours and civil twilight. Sampling at each site had days as primary sampling units and boat-parties as secondary units.

The three sample sites were Letnikof Dock, Haines Small Boat Harbor, and Chilkat State Park boat launch (Figure 1). Prior surveys indicated that during 2001–2007 and 2009, anglers landing their catch at the high-use Letnikof Dock site accounted for 59–86% of the total harvest of Chinook salmon, the low-use Small Boat Harbor site 12–39%, the Chilkat State Park boat launch 1–5%. The rare use trend at the Chilkat State Park site prompted that site to be surveyed less frequently after 2008. In 1993–2008, the Chilkat State Park site was sampled as 1 of 2 low-use harbors, but often with a delayed start date relative to the Small Boat Harbor (Ericksen 1994–2005, Ericksen and Chapell 2006, Chapell 2009, 2010, 2012, 2013). Starting in 2009, Chilkat State Park was sampled only during the five derby days, when it may have received overflow angler traffic from the more congested Letnikof Cove site (Chapell 2013).

Sampling at Letnikof Dock occurred May 10–June 27 and contained morning/evening stratification and weekend/weekday stratification of evening strata during the peak of the season. Morning sampling strata lasted from 0800 hours until 2 h before midday, and evening sampling strata lasted from 2 h before midday until civil twilight. Thus, evening strata were 4 h longer in duration than morning strata. This stratification scheme was designed to increase the precision of estimates by maximizing sampling during hours when most anglers exit the fishery. Random selections determined primary units to sample in each stratum. Two (2) morning and 2 evening strata were sampled each week, except as noted below. During the peak weeks of the fishery (May 10–June 13), the evening strata at Letnikof Dock were further divided into weekday and weekend strata. During this time, 2 morning, 2 weekday evening, and 2 weekend/holiday evening periods were sampled each week. During the week of June 14–20, 2 morning and 3 evening periods were sampled. The May 24–June 6 biweek, which included the five Haines King Salmon Derby days, was divided into a 9-day nonderby stratum and a 5-day derby stratum. Three (3) of 5 morning derby and 3 of 5 evening derby periods were sampled. Three (3) of 9 morning nonderby and 3 of 9 evening nonderby periods were sampled. In total, 17 unique strata were sampled at Letnikof Dock.

Sampling at the low-use Small Boat Harbor site took place May 10–June 27. There was no weekday/weekend stratification. Each biweekly period was divided into 14 morning and 14 evening periods of equal length; 3 morning and 3 evening periods were sampled each biweek, except May 24–June 6. That biweek, which included the five Haines King Salmon Derby days, was divided into a 9-day nonderby stratum and a 5-day derby stratum. Two (2) of 9 morning nonderby periods and 2 of 9 evening nonderby periods were sampled. The derby stratum was not further stratified by time of day, and 2 of 10 derby periods were sampled. In total, 9 unique strata were sampled at the Small Boat harbor.

The Chilkat State Park boat launch site was sampled during one 5-day stratum of Haines King Salmon Derby days, May 29–31 and June 5–6. With no time of day stratification, 2 of 10 periods were sampled.

Random selections determined which primary units to sample within each stratum at all 3 sites. To accommodate the impossibility of sampling 3 sites simultaneously with 2 technicians who could sample one period each per day, 4 changes (period moves) were made to randomly selected sample periods at low-use sites.

During each sample period, all sport fishing boats returning to the harbor were counted. Boat parties returning to the dock were interviewed to determine: the number of rods fished, hours fished targeting salmon using trolling gear, hours fished targeting nonsalmon species or using nontrolling rod and reel gear, type of trip (charter or noncharter), target species (Chinook salmon, Pacific halibut *Hippoglossus stenolepis*, or other), and number of fish caught/kept by species. Boat-party interviews also included sampling harvested Chinook salmon for maturity and missing adipose fins. Maturity was determined by either observing external secondary characteristics (Appendix A in Ericksen 1994) or by observing gonads in order to estimate the harvest of wild mature fish, which were assumed to be returning to the Chilkat River. In rare cases some parties were not interviewed or maturity status could not be determined. When one or more boat parties could not be interviewed, total effort and catch for the stratum were estimated by expanding by the total number of parties returning to the dock during that period. Similarly, when a boat party had fish of undetermined maturity status, interview information for that boat party was ignored and expansions (by sample period) were made from harvests by remaining boat parties and the total number of boat parties counted.

The harvest in each stratum ($\hat{H}_h$) was estimated (Thompson 2002):

$$\hat{H}_h = D_h \overline{H}_h, \tag{9}$$

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h}, \tag{10}$$

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}}, \tag{11}$$

where h_{hij} is the harvest on boat j in sampling days (periods) i in stratum h, m_{hi} is the number of boat parties interviewed in day i, M_{hi} is the number of boat-parties counted in day i, d_h is the number of days (morning or evening periods) sampled in stratum h, and D_h is the number of days in stratum h. The variance of the harvest by stratum was estimated:

$$\begin{aligned} var\left[\hat{H}_h\right] &= (1-f_{1h})D_h^{\,2}\frac{\sum_{i=1}^{d_h}(\hat{H}_{hi}-\overline{H}_h)^2}{d_h(d_h\text{ -}1)} \\ &+ D_h\sum_{i=1}^{d_h} M_{hi}^{\,2}(1-f_{2hi})\frac{\sum_{j=1}^{m_{hi}}(h_{hij}\text{-}\overline{h}_{hi})^2}{d_h m_{hi}(m_{hi}\text{ -}1)}, \end{aligned} \tag{12}$$

where f_{1h} is the sampling fraction for periods and f_{2hi} is the sampling fraction for boat-parties. Catch and effort was estimated similarly, substituting C and E for H in equations (9) through (11). Total harvest for the season was summed across strata $\mathbf{\Sigma}H_h$ and $\mathbf{\Sigma}var[H_h]$. Similarly, effort and harvest by charter boat anglers were estimated by considering only data collected from chartered anglers in equations (9) through (11). Angler effort targeting salmon using trolling gear was calculated in salmon-h, and effort targeting all fish species and all rod and reel gear, including salmon trolling, was calculated in angler-h.

Chinook salmon were measured to the nearest 5 mm FL and sampled for age by collecting scale samples as described above in event 1 methods. Information recorded for each Chinook salmon sampled included sex, length, maturity, scale sample number, and presence or absence of adipose fins.

For each sampling site, age composition (p_a) was estimated for each stratum by substituting $p_{a,h}$, $n_{a,h}$, and n_h, for p_a, n_a, and n in equations (3) and (4), where h denotes a time, harbor, or time-harbor stratum, and $p_{a,h}$ is the proportion with estimated age a in stratum h, $n_{a,h}$ is the subset of n_h in stratum h having estimated age a, and n_h is the number successfully aged in stratum h. Because sampling was not proportional across strata, the estimate for the whole fishery was estimated as:

$$\hat{p}_a = \frac{\sum_h \hat{H}_h\,\hat{p}_{a,h}}{\sum_h \hat{H}_h}, \tag{13}$$

where the estimated harvests supply appropriate "weights" for the different stratum sizes. Variance was approximated as:

$$\begin{aligned} \mathrm{var}(\hat{p}_a) &\cong \hat{H}^{-2}\sum_h \hat{H}_h^2\,\mathrm{var}\left(\hat{p}_{a,h}\right) \\ &+ \hat{H}^{-2}\sum_h \mathrm{var}\left(\hat{H}_h\right)\left(\hat{p}_{a,h}-\hat{p}_a\right)^2, \end{aligned} \tag{14}$$

where the approximation is from a second order Taylor's series expansion around the expected values of the parameter estimates and substituting estimated values for the expected values (Mood et al. 1974, p. 181).

Contribution of Coded Wire Tagged Stocks to the 2010 Haines Marine Sport Fishery

Each head collected in the marine sport fishery from a Chinook salmon with a missing adipose fin was marked with a uniquely numbered plastic strap cinched around the jaw. Heads and CWT recovery data were sent to the DCF Tag Lab where heads were dissected, CWTs recovered and decoded, and all corresponding information was entered into the DCF Tag Lab database.

The contribution of all CWT-tagged stocks to the 2010 Haines marine boat sport fishery was estimated:

$$\hat{r}_{ij} = \hat{H}_i \left(\frac{m_{ij}}{\lambda_i n_i} \right) \hat{\theta}_j^{-1} , \qquad (15)$$

where $\hat{H}_i$ is the estimated harvest in stratum *i*, $\hat{\theta}_j$ is the fraction of stock *j* marked with CWTs, n_i is the subset of $\hat{H}_i$ examined for missing adipose fins, m_{ij} is the number of decoded CWTs recovered from stock *j*, and λ_i adjusts for imperfect tracking and decoding of CWTs from recovered salmon. See Bernard and Clark (1996) for further details. Statistics were stratified by biweek.

Variance of $\hat{r}_{ij}$ was estimated by means of the appropriate large-sample formulations (Table 2 in Bernard and Clark 1996) for wild or hatchery stocks harvested in the sport fishery. The total contribution of 1 or more cohorts to 1 or more fisheries is the sum of harvests and variances from the individual cohorts and strata.

JUVENILE TAGGING

Juvenile Chinook salmon from BY 2009 were captured using minnow traps in the Chilkat River drainage during fall of 2010 (parr) and in the Chilkat River mainstem during spring of 2011 (smolts). Each juvenile Chinook salmon was marked with an adipose fin clip and a CWT then was released close to the capture site. Smolts tagged in spring 2011 were given a second CWT implanted in the muscle tissue beneath the posterior insertion of the dorsal fin to distinguish spring-tagged from fall-tagged fish.

In fall 2010, trapping began in upriver locations and moved downstream as the season progressed (Figure 1). The Tahini River was trapped September 18–25, the Kelsall River October 2–12, and the Chilkat River from the mouth of the Kelsall River down to Haines Highway MP 13 October 18–27. In spring 2011, the lower Chilkat River (MP 5–21) was trapped April 8–May 28.

A crew consisting of 4 people fished approximately 100 traps per day. Traps were baited with disinfected salmon roe and checked at least once per day. Crew members immediately released nontarget species at the trapping site. Remaining fish were transported to holding boxes for processing at a central tagging location.

Following the methods in Koerner (1977), all healthy Chinook juveniles ≥50 mm FL were injected with a CWT and externally marked by excision of the adipose fin. Prior to marking, fish were first tranquilized in a solution of tricaine methanesulfonate (MS 222) buffered with sodium bicarbonate. In fall 2010, every 100^{th} fish marked with a CWT was additionally measured to the nearest mm FL. In spring 2011, every 20th fish marked was measured to the nearest mm FL and weighed to the nearest 0.1 g.

All marked fish were held overnight to check for 24 hr CWT retention and handling-induced mortality. The following morning 100 fish in the previous day's catch were randomly selected and checked for the retention of CWTs and mortality. 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%, the entire batch 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 DCF Tag Lab at the completion of the field season.

BROOD YEAR 2003 PRODUCTION

Juvenile Abundance

Between September 18 and October 30, 2004, 37,245 Chinook salmon parr from BY 2003 were captured, marked with adipose fin clips and CWTs, and released back into the Tahini, Kelsall, and Chilkat Rivers (Ericksen 2002). In April and May 2005, an additional 5,825 smolts (also BY 2003) were marked and released into the Chilkat River.

Between 2006 and 2010, the DCF sampled landings from commercial drift gillnet, set gillnet, purse seine, and troll fisheries throughout Southeast Alaska and Yakutat for adipose fin clips and CWTs. During summer and early fall, samplers were stationed at processors in Ketchikan, Craig, Wrangell, Petersburg, Sitka, Pelican, Port Alexander, Elfin Cove, Excursion Inlet, Juneau, and Yakutat. The sample goal was to inspect at least 20% of the total catch of Chinook salmon for missing adipose fins. Heads from fish missing their adipose fin were sent to the DCF Tag Lab on a weekly basis where CWTs were removed and decoded. The annual DCF port sampling manual (unpublished, available from the DCF Tag Lab, ADF&G, Juneau) provides a detailed explanation of commercial catch sampling procedures and logistics.

During 2006–2010, the number of BY 2003 Chilkat River Chinook salmon CWTs recovered in all marine fisheries (commercial, sport, and subsistence) was tallied by release period, whether fall 2004 or spring 2005, as determined by the tag code read at the DCF Tag Lab.

In Chilkat River escapement sampling during 2006–2010, heads were taken from all Chinook salmon with clipped adipose fins, except large (≥660 mm FL) fish in prespawning condition. The brood year of adipose-finclipped fish whose heads were not taken was determined from scale samples. As described in event 1 methods, all adipose-finclipped fish were examined with a handheld wand CWT detector to determine presence/absence of 2 CWTs: the first in the head, and the second in the musculature at the base of the dorsal fin. To avoid false positive wand scan results, field staff was trained to avoid magnetized items in the sampling area, such as high-iron gravel, screws in the sampling trough, tools in pockets, zippers, etc. To avoid false negative wand scan results, field staff was trained to insert the wand inside the mouths of large fish (Vander Haegen et al. 2002).

For fish whose heads were taken that contained CWTs recovered by the DCF Tag Lab, the wand determination of second CWT presence/absence was compared with the season tagged from the decoded CWT. A correct determination of season tagged by the wand method was defined as either detecting the presence of the second CWT in spring-tagged fish, or the absence of the second CWT in fall-tagged fish.

To assess the accuracy of the wand scan method, wand scan results from sampling calendar years 2005–2011 were tallied by correct, false positive, and false negative second CWT identifications (Appendix D2). The rate of false positive (ω_{f+}) and false negative (ω_{f-}) identifications was used to adjust the error associated with estimates of spring-tagged and fall-tagged fish in the BY 2003 return. To assess sampling bias by body size, the second CWT false detection rates for large (≥660 mm MEF) and medium/small (<660 mm MEF) were compared using χ^2 tests on fish tagged in the fall vs. fish tagged in the spring. If a cell value in the contingency table was <5, then a Yates (1934) correction was used.

A statistical model was fit to the Chilkat River Chinook salmon BY 2003 data to estimate the number of BY 2003 parr rearing in fall 2004 (N_{PARR}), the overwinter survival to spring 2005 (ϕ_1), the number of smolts outmigrating in 2005 (N_{SMOLT}), and the false negative (ω_{f-}) and the false positive (ω_{f+}) error rates. The number of fish assigned to fall and spring marking events among all BY 2003 Chinook salmon sampled in the Chilkat River from 2006 to 2010 was modeled as having a multinomial distribution with parameters π_1, π_2, π_3, π_4, and C, where

$\pi_1 = ((1 + \omega_{f+})*q_{FALL} - \omega_{f-}*q_{SPRING})*\rho$,
$\pi_2 = ((1 + \omega_{f-})*q_{SPRING} - \omega_{f+}*q_{FALL})*\rho$,
$\pi_3 = (q_{FALL} + q_{SPRING})\ (1 - \rho)$,
$\pi_4 = 1 - \pi_1 - \pi_2 - \pi_3$,
$q_{FALL} = M_{PARR} / N_{PARR}$,
$q_{SPRING} = M_{SMOLT} / N_{SMOLT}$, and
$C = R_1 + R_2 + R_3 + R_4$ = the total number of adult BY 2003 Chinook salmon examined for adipose fin clips in the Chilkat River in 2006–2010, where

R_1 = the number of adipose-finclipped adult fish with wand scan result second CWT absent, implying a fall-tagged fish

R_2 = the number of adipose-finclipped adult fish with wand scan result second CWT present, implying a spring-tagged fish

R_3 = the number of adipose-finclipped adult fish with no wand scan result

R_4 = the number of adult fish without adipose fin clips,

ρ = the proportion of adipose-clipped adult fish that were wand scanned and assigned a fall or spring tagging event,

M_{PARR} = number of CWT-tagged parr released during fall 2004,

M_{SMOLT} = number of CWT-tagged smolts released during spring 2005, and

falseposDorsal = the number of adult fish known to have been CWT-tagged in the fall that had a positive second CWT scan result in 2005–2010,

correct.ID.NoDorsal = the number of adult fish known to have been CWT-tagged in the fall that had a negative second CWT scan result in 2006–2010,

falsenegDorsal = the number of adult fish known to have been CWT-tagged in the spring that had a negative second CWT scan result in 2006–2010,

correct.ID.Dorsal = the number of adult fish known to have been CWT-tagged in the spring that had a positive second CWT scan result in 2006–2010.

The relative proportion of fall and spring CWTs recovered elsewhere (fisheries outside of the Chilkat River) also contains information about the survival probability ϕ_I. Therefore the number of valid CWTs from the fall 2004 marking event recovered from Chinook salmon sampled elsewhere from 2006 to 2010 was modeled as having a binomial distribution with parameters:

$$\pi_{FALL} = q_{FALL} / (q_{FALL} + q_{SPRING}),$$

and m = number of BY 2003 Chilkat River Chinook salmon fall and spring CWTs recovered in fisheries outside of the Chilkat River from 2006 to 2010.

Bayesian statistical methods, which are well suited for analyzing unconventional data,[1] were used to estimate the error associated with model parameters. Bayesian methods use probability distributions to express uncertainty about model parameters. The user supplies the "prior" probability distribution, which expresses knowledge about the parameters outside the frame of the experiment itself. The output of a Bayesian analysis is the "posterior" distribution, which describes the new, updated knowledge about the parameters after consideration of the experimental data. Percentiles of the posterior distribution can be used to construct one-sided probability statements or two-sided intervals about the parameters. Point estimates are de-emphasized in Bayesian statistics; however, the mean, median, or mode of the posterior can be used to describe the central tendency of a parameter. The standard deviation of the posterior distribution can be used as an analogue of the standard error of a point estimate in classical statistics.

Bayesian analyses require that prior probability distributions be specified for all unknowns in the model. A normal prior distribution with very large variance was specified for N_{PARR}, essentially equivalent to a uniform distribution. A beta (0.3, 0.3) prior was used for ϕ_I and a beta (0.1, 0.1) prior was used for ρ. These priors were noninformative, chosen to have a negligible effect on the posterior. Informative priors for ω_{f-} and ω_{f+} were based on the known wand results from 2006 through 2010, the most recent year of data. For ω_{f-}, a beta (4, 56) prior was used where the 4 is equal to the number of false negative wand results for the dorsal CWT, and the 56 is the number of correctly identified dorsal CWTs. For ω_{f+}, a beta (11, 178) prior was used where the 11 is equal to the number of false positive wand results for the dorsal CWT, and 178 is the number of correctly identified fish without a dorsal CWT.

Markov-Chain Monte Carlo simulation, implemented with the Bayesian software WinBUGS (Gilks et al. 1994), was used to draw samples from the joint posterior probability distribution of all unknowns in the model (Appendix E1). Three Markov chains were initiated, a 4,000-sample burn-in period discarded, and 100,000+ updates generated to estimate the marginal posterior means, standard deviations, and percentiles. The diagnostic tools of WinBUGS were used to assess mixing and convergence. Interval estimates were obtained from percentiles of the posterior distribution.

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[1] The juvenile abundance data would be difficult to analyze correctly using standard statistical methods.

Adult Harvest

Harvest of BY 2003 Chilkat River Chinook salmon was estimated from fish sampled for CWTs in marine commercial, sport, and subsistence fishery harvests, and in the Chilkat River escapement to determine the fraction θ_h of BY 2003 fish carrying a CWT.

Because several fisheries exploited Chinook salmon over several months and years, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by troll fishing period and quadrant. Statistics from drift gillnet fisheries were stratified by statistical week and district. Statistics from the Haines area marine subsistence gillnet fishery were stratified by year. In sport fisheries where creel survey programs estimate harvest, statistics were stratified by fortnight (biweek). In sport fisheries with no biweekly harvest estimates from creel surveys, annual Statewide Harvest Survey data were used and statistics were stratified by year. Hubartt et al. (1997) describe methods of sampling sport fisheries in Southeast Alaska.

Estimates of harvest were summed across strata and across fisheries to obtain an estimate of the total harvest, $\hat{T}$:

$$\hat{T} = \sum_i \hat{r}_i \ , \qquad (16)$$

$$\mathrm{v}[\hat{T}] = \sum_i \mathrm{v}[\hat{r}_i], \qquad (17)$$

$$SE[\hat{T}] = \sqrt{var[\hat{T}]}\,. \qquad (18)$$

Variance was estimated as the sum of variances across strata (no covariance terms required) because sampling was independent across strata and fisheries.

Return (harvest plus escapement) of BY 2003 Chilkat River Chinook salmon was estimated as:

$$\hat{R} = \hat{T} + \hat{S}\,, \qquad (19)$$

$$var[\hat{R}] = var[\hat{T}] + var[\hat{S}], \qquad (20)$$

$$SE[\hat{R}] = \sqrt{var[\hat{R}]}\,, \qquad (21)$$

where $\hat{S}$ is the total escapement of age-1.2 and older BY 2003 fish estimated between 2007 and 2010.

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

$$\hat{\mu} = \frac{\hat{T}}{\hat{R}} = \frac{\hat{T}}{\hat{S} + \hat{T}}\,, \qquad (22)$$

$$var[\hat{\mu}] \approx \frac{var[\hat{T}]\hat{S}^2}{\hat{R}^4} + \frac{var[\hat{S}]\hat{T}^2}{\hat{R}^4}\,, \qquad (23)$$

$$SE[\hat{\mu}] = \sqrt{var[\hat{\mu}]}\,, \qquad (24)$$

where the approximate variance was derived by the delta method (Seber 1982).

The estimated marine survival rate (smolt-to-age-1.2 and older) and the delta-method approximation of its variance were calculated as:

$$\hat{\phi}_2 = \frac{\hat{R}}{\hat{N}_{SMOLT}}, \tag{25}$$

$$var[\hat{\phi}_2] \approx \hat{\phi}_2^2 \left[\frac{var[\hat{R}]}{\hat{R}^2} + \frac{var[\hat{N}_{SMOLT}]}{\hat{N}_{SMOLT}^2} \right], \tag{26}$$

$$SE[\hat{\phi}_2] = \sqrt{var[\hat{\phi}_2]}. \tag{27}$$

RESULTS

INRIVER RUN ESTIMATE

In event 1, 145 large (age-1.3 and older) 38 medium (age-1.2), and 72 small (age-1.1) Chinook salmon were captured in the lower Chilkat River with drift gillnets and fish wheels between June 8 and August 2, 2010. Of those captured, 143 large, 37 medium, and 66 small fish were given a uniquely numbered external tag. The remaining captured fish that were not tagged were: 2 large mortalities, and 1 medium and 6 small fish with adipose fin clips that were sacrificed to recover CWTs (Table 2; Figure 3).

Table 2.–Number of Chinook salmon tagged and released in event 1, lower Chilkat River, by time period, gear type, and age category, June 8–August 2, 2010.

	Drift gillnet			Fish wheels			Combined			
Time period	Large	Med	Small	Large	Med	Small	Large	Med	Small	Total
June 8–12	1	0	0	4	0	0	5	0	0	5
June 13–17	4	1	0	3	2	4	7	3	4	14
June 18–22	5	0	0	4[a]	3	5[b]	9	3	5	17
June 23–27	6	1	0	2	1	3	8	2	3	13
June 28–July 2	41	2	1[c]	19	8[d]	16[e]	60	10	17	87
July 3–7	19	3	0	2	6	17[f]	21	9	17	47
July 8–12	7	1	0	2	2	8	9	3	8	20
July 13–17	7	2	0	3	1	6	10	3	6	19
July 18–22	6	0	0	4	2	3[g]	10	2	3	15
July 23–27	2	0	0	1[h]	2	2[i]	3	2	2	7
July 28–August 2	–[j]	–[j]	–[j]	1	0	1	1	0	1	2
Total	98	10	1	45	27	65	143	37	66	246

Note: Large = age-1.3 and older, Med = age-1.2, and Small = age-1.1.

[a] 1 large not tagged.
[b] 1 small not tagged.
[c] 1 small not tagged.
[d] 1 med not tagged.
[e] 1 small not tagged.
[f] 1 small not tagged.
[g] 1 small not tagged.
[h] 1 large not tagged.
[i] 1 small not tagged.
[j] Drift gillnet effort ended July 27, 2010.

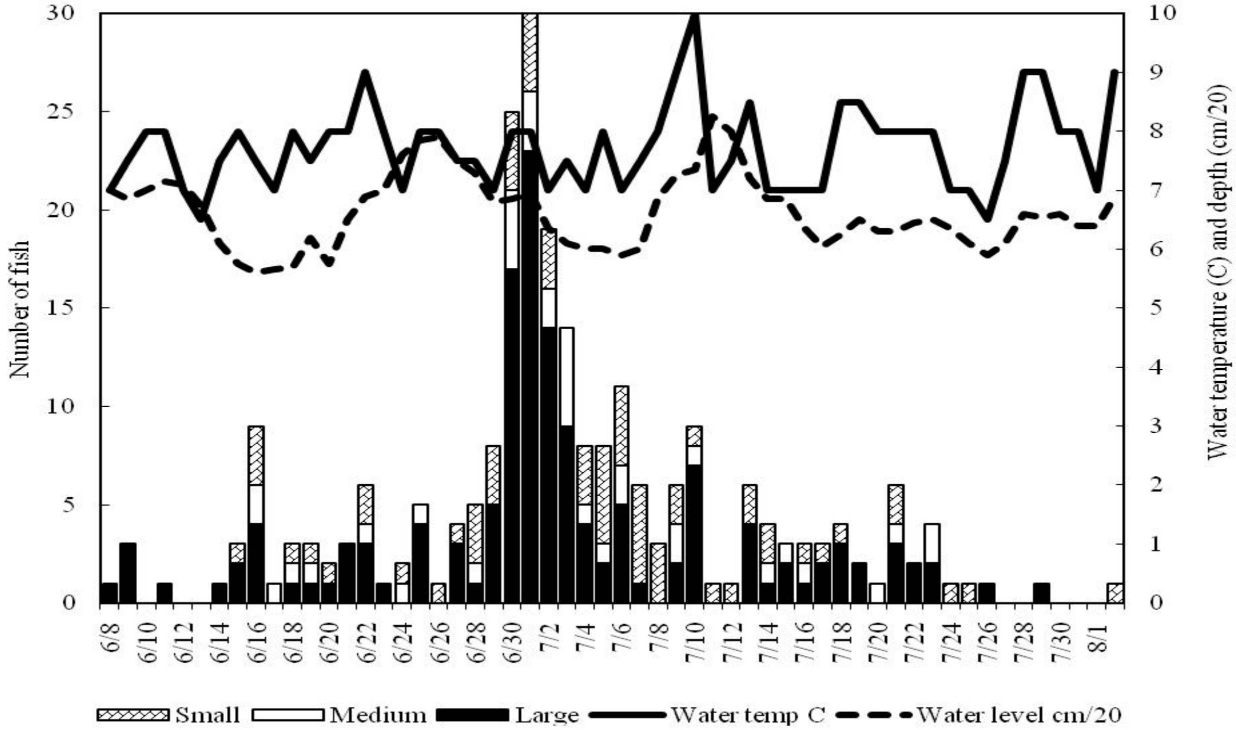

Figure 3–Daily water depth, temperature, and catches of small, medium, and large Chinook salmon in event 1 drift gillnets and fish wheels, June 8–August 2, 2010.

Note: Small = age-1.1, medium = age-1.2, large = age-1.3 and older fish.

The daily number of large Chinook salmon captured peaked on July 1–4 (Figure 3). The mean of the immigration timing density was July 3 for both large fish and all sizes combined (Figures 3 and 4; Mundy 1984).

In event 2, 361 large, 78 medium, and 29 small Chinook salmon were captured on the spawning grounds, of which 30 large, 3 medium, and 2 small fish were marked (Table 3). There were 2 cases of primary tag loss, both large fish whose left axillary appendage clips indicated they had been captured by drift gillnets in event 1.

Table 3.– Number of Chinook salmon inspected for marks and number of recaptured fish in event 2, by Chilkat River tributary, age category, and sex, in 2010.

		Captured										Recaptured									
		Large				Medium				Small		Large				Medium			Small	
Tributary	Dates	M	F	U	Total	M	F	U	Total	M	Total	M	F	U	Total	M	U	Total	M	Total
Kelsall River	8/03–9/02	13	27	3	43	22	1	2	25	15	15	1	3	1	5	0	2	2	2	2
Tahini River	8/03–9/01	113	166	0	279	31	0	0	31	5	5	8	15	0	23	1	0	1	0	0
37-Mile Cr	8/13–8/27	1	3	0	4	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0
Big Boulder	8/04–8/27	10	16	0	26	16	0	0	16	6	6	0	0	0	0	0	0	0	0	0
Little Boulder	8/04–8/27	4	5	0	9	5	0	0	5	3	3	0	0	1	1	0	0	0	0	0
Total		141	217	3	361	75	1	2	78	29	29	9	19	2	30	1	2	3	2	2

Note: Large = age-1.3 and older, Medium = age-1.2, and Small = age-1.1, M = male, F = female, U = unknown.

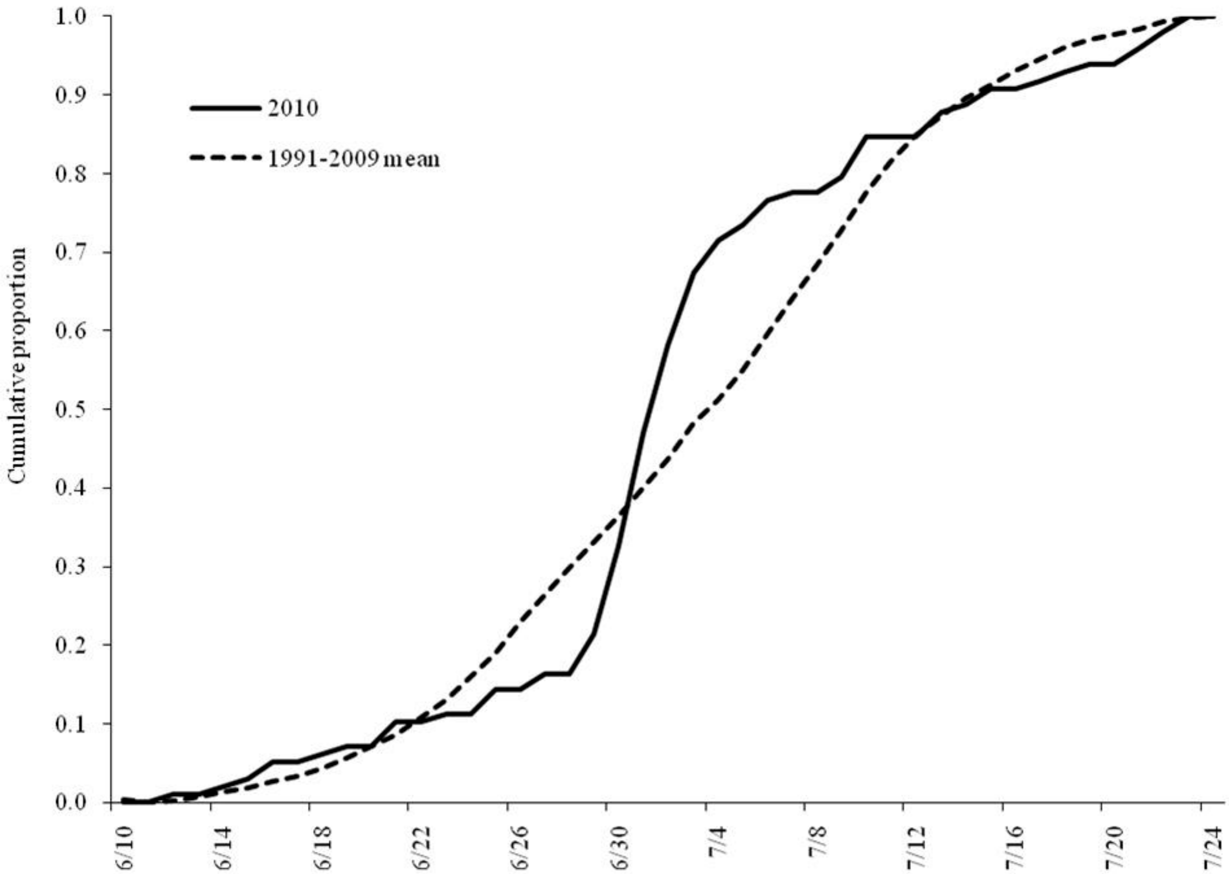

Figure 4.–Cumulative proportion of large (≥age-1.3) Chinook salmon captured in event 1 with drift gillnets in the lower Chilkat River June 10–July 25, 2010 compared to the mean cumulative proportion, 1991–2009.

Recapture rates of marked fish were not significantly different (χ^2 = 1.53, df = 1, P = 0.22) for fish marked in the first half of event 1 (11 fish recaptured of 112 fish marked June 8–July 1) versus the second half (20 fish recaptured of 125 fish marked July 2–August 2), so the Petersen-type model used to estimate the inriver run was not stratified by time. The marked fractions of all sizes of Chinook salmon sampled at the three tributaries (Kelsall River 10.8%, Tahini River 7.6%, Klehini tributaries 2.9%) were not different (χ^2 = 3.53, df = 2, P = 0.17), so the abundance estimate was not stratified by area.

The length distribution of Chinook salmon marked in the lower Chilkat River (combined fish wheel and drift gillnet captures) was significantly different (*M* vs. *R*, K-S test, D = 0.282, P = 0.013) from that of marked Chinook salmon recaptured on the spawning grounds (Figure 5). The length distribution of all fish captured in event 2 was not significantly different (*C* vs. *R*, K-S test, D = 0.129, P = 0.672) from that of the marked fish recaptured in event 2 (Figure 5). These results indicated size-selective sampling during the second event but not the first (Case II in Appendix A), so the abundance estimate was not stratified by size, and event 1 data was used to estimate the size/age composition of the run.

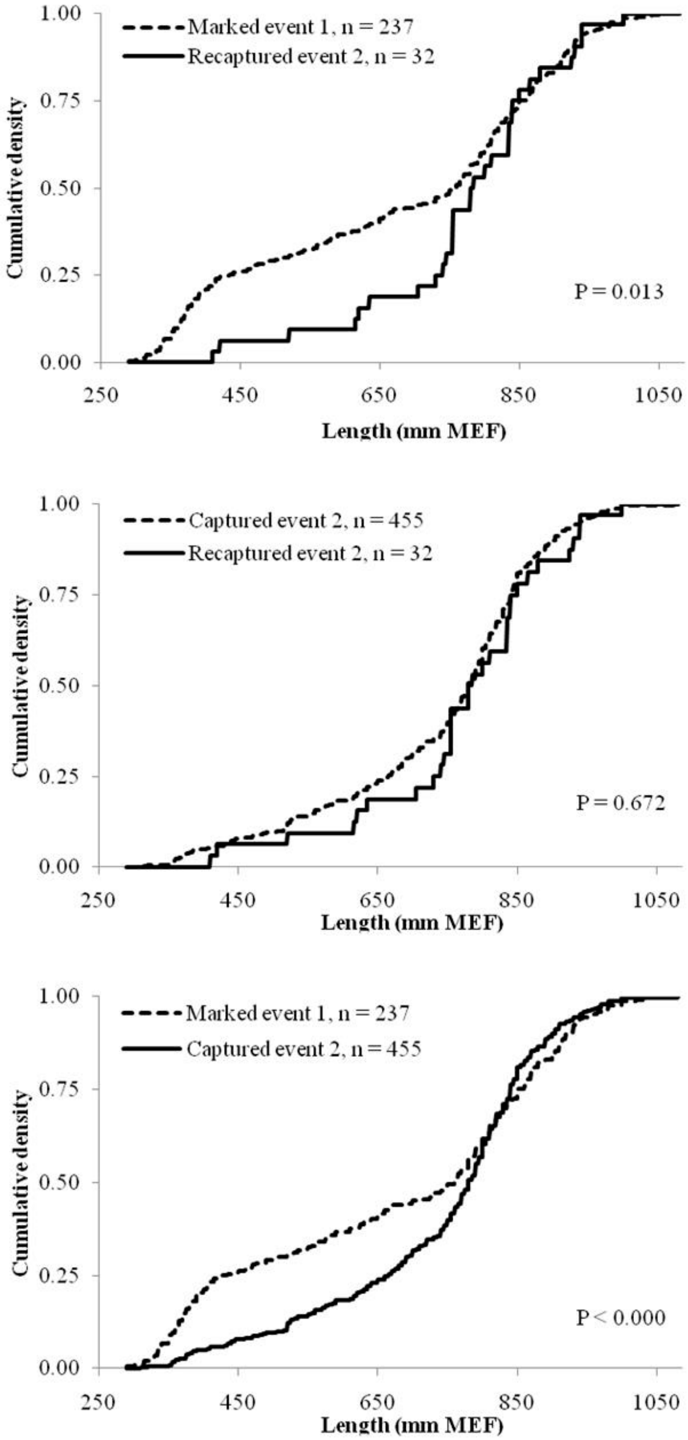

Figure 5.–Empirical cumulative distribution function of MEF lengths of Chilkat River Chinook salmon marked vs. recaptured (top), captured vs. recaptured (middle), and marked vs. captured (bottom), in 2010.

Similar comparisons of the sex composition of Chinook salmon in events 1 and 2 using χ^2 tests indicated there was no size selectivity in event 1, but there was in event 2 (Table 4). This fit Case II in Appendix A, so the abundance estimate was not stratified by sex, and event 1 data was used to estimate sex composition. Sex identification during event 1 has historically been unreliable for this project (Table 5). Based on 29 recaptured fish, the 2010 sex identification error rate (3%) was lower than the historic average (12%).

Table 4.–Contingency table tests for evaluation of sex selectivity in Chilkat River Chinook salmon mark-recapture events 1 and 2.

	Number of fish		
	Male	Female	
Marked	145	92	
Captured	245	218	
Recaptured	13	19	
Comparison	χ^2	df	P
Marked vs. recaptured	4.92	1	0.03
Captured vs. recaptured	1.81	1	0.18
Marked vs. captured	3.09	1	0.08

Table 5.–Sex determination error rates in recaptured fish, Chilkat River Chinook salmon mark–recapture studies, 1991–2010.

Year	Number of recaptures examined	Number incorrectly sexed	Error rate	Data source
1991	24	3	0.13	Ericksen (1995)
1992	24	4	0.17	Ericksen (1995)
1993	21	2	0.10	Ericksen (1995)
1994	32	3	0.09	Ericksen (1995)
1995	17	4	0.24	Ericksen (1996)
1996	31	5	0.16	Ericksen (1997)
1997	29	5	0.17	Ericksen (1998)
1998	28	2	0.07	Ericksen (1999)
1999	32	7	0.22	Ericksen (2000)
2000	37	5	0.14	Ericksen (2001)
2001	46	11	0.24	Ericksen (2002)
2002	54	4	0.07	Ericksen (2003)
2003	59	9	0.15	Ericksen (2004)
2004	43	1	0.02	Ericksen (2005)
2005	28	5	0.18	Ericksen and Chapell (2006)
2006	32	1	0.03	Chapell (2009)
2007	25	3	0.12	Chapell (2010)
2008	22	0	0.00	Chapell (2012)
2009	29	3	0.10	Chapell (2013)
2010	29	1	0.03	
1991–2009 average	32	4	0.12	

An estimated 3,100 (SE = 451) Chinook salmon of all ages immigrated into the Chilkat River in 2010 (Tables 6–8). This estimate is germane to the time of marking at the event 1 site (Figure 1). Of the 463 Chinook salmon sampled for age and sex in spawning tributaries, 437 were successfully aged (Table 9). Age-1.3-female was the most frequent age-sex category in the Kelsall and Tahini rivers, and age-1.4-female was the most frequent age-sex category in the Klehini River. The composition of large, medium, and small fish was different (χ^2 = 78.9, df = 4, P < 0.001) among the three tributaries. The large-medium-small composition was not different (χ^2 = 1.4, df = 2, P = 0.50) between the Kelsall and Klehini rivers, but it was different (χ^2 = 68.0, df = 2, P < 0.001) in the Tahini-Kelsall comparison and different (χ^2 = 44.7, df = 2, P < 0.001) in the Tahini-Klehini comparison.

Table 6.– Unstratified inriver run estimate and sampling statistics of Chilkat River Chinook salmon, 2010.

Marked	Examined	Recaptures	Abundance	
n_1	n_2	m_2	$\hat{N}_a$	SE [$\hat{N}_a$]
237	468	35	3,100	451

Table 7.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 1, in the Chilkat River, by gear type, 2010.

		Brood year and age class						
		2007 1.1	2006 1.2	2005 1.3	2004 1.4	2003 1.5	Total aged	Total sampled[a]
				FISH WHEELS				
Males	Sample size	60	25	10	2	0	97	104
	Percent	61.9	25.8	10.3	2.1	0.0		75.9
	SE(%)	4.8	4.3	3.0	1.4			3.7
	Mean length	366	526	711	890			
	SD	34	63	77	127			
Females	Sample size	0	1	17	14	1	33	33
	Percent	0.0	3.0	51.5	42.4	3.0		24.1
	SE(%)		3.0	8.7	8.6	3.0		3.7
	Mean length		640	773	867	940		
	SD			52	58			
All fish	Sample size	60	26	27	16	1	130	137
	Percent	46.2	20.0	20.8	12.3	0.8		
	SE(%)	3.2	2.6	2.6	2.1	0.6		
	Mean length	366	530	750	870	940		
	SD	34	66	68	64			
				DRIFT GILLNET				
Males	Sample size	1	10	17	20	0	48	48
	Percent	2.1	20.8	35.4	41.7	0.0		44.0
	SE(%)	2.1	5.9	6.9	7.1			4.8
	Mean length	435	606	782	941			
	SD		41	88	58			
Females	Sample size	0	0	22	34	0	56	61
	Percent	0.0	0.0	39.3	60.7	0.0		56.0
	SE(%)			6.3	6.3			4.8
	Mean length			793	875			
	SD			63	58			

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		Brood year and age class						
		2007	2006	2005	2004	2003	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
				DRIFT GILLNET				
All fish	Sample size	1	10	39	54	0	104	109
	Percent	1.0	9.6	37.5	51.9	0.0		
	SE(%)	1.0	2.9	4.7	4.9%			
	Mean length	435	606	788	899			
	SD		41	74	66			
Males	Sample size	61	35	27	22	0	145	152
	Percent	42.1	24.1	18.6	15.2	0.0		61.8
	SE(%)	4.1	3.6	3.2	3.0	0.0		3.1
	Mean length	367	549	756	936			
	SD	34	68	90	64			
Females	Sample size	0	1	39	48	1	89	94
	Percent	0.0	1.1	43.8	53.9	1.1		38.2
	SE(%)	0.0	1.1	5.3	5.3	1.1		3.1
	Mean length		640	784	872	940		
	SD			59	57			
All fish	Sample size	61	36	66	70	1	234	246
	Percent	26.1	15.4	28.2	29.9	0.4		
	SE(%)	2.9	2.4	2.9	3.0	0.4		
	Mean length	367	551	773	892	940		
	SD	34	69	74	66			

[a] Includes fish that were not assigned an age.

Table 8.–Estimated inriver run of Chinook salmon in the Chilkat River, by age and sex, 2010.

	Brood year and age class					
	2007	2006	2005	2004	2003	
	1.1	1.2	1.3	1.4	1.5	Total
Male	808	464	358	291	0	1,921
SE	147	98	83	72		296
Female	0	13	517	636	13	1,179
SE		13	106	123	13	197
All fish	808	477	874	927	13	3,100
SE	147	100	156	163	13	451

Table 9.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 2 in the Chilkat River drainage, by spawning tributary, 2010.

		Brood year and age class						
		2007	2006	2005	2004	2003	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
KELSALL RIVER								
Males	Sample size	15	21	10	3	0	49	50
	Percent	30.6	42.9	20.4	6.1	0.0		64.1
	SE(%)	6.7	7.1	5.8	3.5			5.5
	Mean length	385	570	771	885			
	SD	29	74	112	40			
Females	Sample size	0	1	14	7	1	23	28
	Percent	0.0	4.3	60.9	30.4	4.3		35.9
	SE(%)		4.3	10.4	9.8	4.3		5.5
	Mean length		665	771	832	795		
	SD			40	38			
All fish	Sample size	15	22	24	10	1	72	78
	Percent	20.8	30.6	33.3	13.9	1.4		
	SE(%)	4.8	5.5	5.6	4.1	1.4		
	Mean length	385	574	771	848	795		
	SD	29	75	78	44			
TAHINI RIVER								
Males	Sample size	5	30	77	32	2	146	149
	Percent	3.4	20.5	52.7	21.9	1.4		47.3
	SE(%)	1.5	3.4	4.1	3.4	1.0		2.8
	Mean length	365	537	746	895	1,023		
	SD	18	58	79	88	81		
Females	Sample size	0	0	85	64	3	152	166
	Percent	0.0	0.0	55.9	42.1	2.0		52.7
	SE(%)			4.0	4.0	1.1		2.8
	Mean length			789	867	882		
	SD			43	51	88		
All fish	Sample size	5	30	162	96	5	298	315
	Percent	1.7	10.1	54.4	32.2	1.7		
	SE(%)	0.7	1.7	2.9	2.7	0.7		
	Mean length	365	537	768	876	938		
	SD	18	58	66	67	107		
KLEHINI RIVER								
Males	Sample size	9	21	8	7	0	45	46
	Percent	20.0	46.7	17.8	15.6	0.0		65.7
	SE(%)	6.0	7.5	5.8	5.5			5.7
	Mean length	372	571	753	834			
	SD	41	81	82	63			
Females	Sample size	0	0	6	16	0	22	24
	Percent	0.0	0.0	27.3	72.7	0.0		34.3
	SE(%)			9.7	9.7			5.7
	Mean length			763	829			
	SD			37	47			
All fish	Sample size	9	21	14	23	0	67	70
	Percent	13.4	31.3	20.9	34.3	0.0		
	SE(%)	4.2	5.7	5.0	5.8			
	Mean length	372	571	757	831			
	SD	41	81	65	51			

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		Brood year and age class						
		2007	2006	2005	2004	2003	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
		COMBINED TRIBUTARIES						
Males	Sample size	29	72	95	42	2	240	245
	Percent	12.1	30.0	39.6	17.5	0.8		52.9
	SE(%)	2.1	3.0	3.2	2.5	0.6		2.3
	Mean length	377	556	749	884	1,023		
	SD	32	71	82	84	81		
Females	Sample size	0	1	105	87	4	197	218
	Percent		0.5	53.3	44.2	2.0		47.1
	SE(%)		0.5	3.6	3.5	1.0		2.3
	Mean length		665	785	857	860		
	SD			43	52	84		
All fish	Sample size	29	73	200	129	6	437	463
	Percent	6.6	16.7	45.8	29.5	1.4		
	SE(%)	1.2	1.8	2.4	2.2	0.6		
	Mean length	377	558	768	866	914		
	SD	32	72	67	65	112		
		Sex composition by age class, combined tributaries						
Males	Percent	0.0	1.4	52.5	67.4	66.7	45.1	47.1
	SE(%)	0.0	1.4	3.5	4.1	21.1	2.4	2.3
Females	Percent	100.0	98.6	47.5	32.6	33.3	54.9	52.9
	SE(%)	0.0	1.4	3.5	4.1	21.1	2.4	2.3

[a] Total sampled includes 26 large (≥660 mm MEF) fish that were not assigned a valid age, but excludes 5 large carcasses with undetermined sex.

AGE, SEX, AND LENGTH COMPOSITION OF THE INRIVER RUN

Chinook salmon captured in event 1 gillnets were predominantly age 1.4 (51.9%) or age 1.3 (37.5%) and classified as female (56.0%; Table 7). Fish captured in the event 1 fish wheels were classified mostly as males (75.9%) and were most frequently age age 1.1 (46.2%), age 1.3 (20.8%), or age 1.2 (20.0%). More than half (66 out of 109) of drift gillnet-caught fish were caught in the large mesh (8 in) panel. The event 1 combined gear age composition was 26.1% age 1.1, 15.4% age 1.2, 28.2% age 1.3, and 29.9% age 1.4 (SE = 2.9%, 2.4%, 2.9%, and 3.0%, respectively).

Following the Case II protocol in Appendix A, the event 1 age and sex proportions were used to estimate the inriver abundance-at-age at 808 (SE = 147) age-1.1, 477 (SE = 100) age-1.2, 874 (SE = 156) age-1.3, 927 (SE = 163) age-1.4 fish (Table 8). The large component of the inriver run totaled 1,815 (SE = 226) Chinook salmon age 1.3 and older.

TERMINAL HARVEST

2010 Haines Marine Sport Fishery Harvest

The 2010 Haines marine boat creel survey estimates are based on interviews with 385 boat-parties who fished 5,686 angler-h (5,645 salmon-h) (Table 10). The survey estimated that anglers spent a total of 7,983 (SE = 523) angler-h of effort, of which 7,901 (SE = 510) angler-h targeted salmon during May 10–June 27. The estimated total harvest was 219 (SE = 25) large Chinook salmon, of which 121 (SE = 19) were wild mature fish assumed to be returning to the Chilkat River. Anglers caught and released an estimated 585 (SE = 72) small (<28 in TL) Chinook salmon, but no harvest of what would have been sublegal length fish was encountered by creel surveyors. Charter anglers accounted for 6% of the salmon effort (449 salmon-h, SE = 75) and 13% of the large Chinook salmon harvest (28 fish, SE = 8). Most (77%) of the estimated salmon effort was based at Letnikof dock in Chilkat Inlet (Figure 1, Appendices B1–B3).

Table 10.– Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon in the Haines marine sport fishery, May 10–June 27, 2010.

	May 10– May 23	May 24–June 6 Nonderby	Derby	June 7– June 20	June 21– June 27	Total
Boats counted	83	49	133	97	23	385
Angler-hr. sampled	576	502	3,185	1,141	282	5,686
Salmon-hr. sampled	557	502	3,182	1,122	282	5,645
Chinook sampled	6	9	54	37	6	112
Sampled for adipose clips	6	9	54	37	6	112
Adipose clips	0	0	7	5	0	12
Angler-hours						
Estimate	845	1,112	3,760	1,797	472	7,983
SE	189	333	250	216	133	523
Salmon-hours						
Estimate	805	1,112	3,754	1,760	472	7,901
SE	175	333	249	198	133	510
Large Chinook catch						
Estimate	12	31	63	97	20	222
SE	4	11	5	21	5	25
Large Chinook harvest						
Estimate	11	31	63	97	17	219
SE	4	11	5	21	5	25
Wild mature large Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	15	38	62	6	121
SE	0	6	2	17	3	19
Small Chinook catch						
Estimate	18	62	225	178	102	585
SE	4	18	59	21	31	72
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2010.

Creel surveyors sampled 81 Chinook salmon for age, sex, and length in the sport harvest at Letnikof Cove dock and 30 fish at the Haines Small Boat Harbor (Table 11). At Letnikof Cove, the age composition of the sampled harvest was 0.8% (SE = 0.8%) age 1.2, 59.1% (SE = 6.7%) age 1.3, 39.4% (SE = 6.6%) age 1.4, and 0.8% (SE = 0.8%) age 1.5. At the Haines Small Boat Harbor, the age composition of the sampled harvest was 19.7% (SE = 8.5%) age 1.2, 70.6% (SE = 9.5%) age 1.3, and 9.7% (SE = 5.6%) age 1.4.

Table 11.–Estimated age composition and mean length-at-age (mm MEF) of harvested Chinook salmon in the Haines marine sport fishery by harbor location, May 10–June 27, 2010.

		Brood year and age class						
		2007 1.1	2006 1.2	2005 1.3	2004 1.4	2003 1.5	Total aged	Total sampled[a]
CHILKAT INLET HARBORS								
Males	Sample size	0	1	24	12	0	37	38
	Mean length		665	765	880			
	SD(length)			55	56			
	Percent							53.1
	SE(%)							5.6
Females	Sample size	0	0	24	17	1	42	43
	Mean length			760	861	830		
	SD(length)			56	71			
	Percent							46.9
	SE(%)							5.6
Combined	Sample size	0	1	48	29	1	79	81
	Percent		0.8	59.1	39.4	0.8		
	SE(%)		0.8	6.7	6.6	0.8		
	Mean length		665	762	869	830		
	SD(length)			55	65			
SMALL BOAT HARBOR								
Males	Sample size	0	3	7	0	0	10	11
	Mean length		623	696				
	SD(length)		3	57				
	Percent							37.0
	SE(%)							8.9
Females	Sample size	0	2	13	4	0	19	19
	Mean length		620	752	868			
	SD(length)		0	64	73			
	Percent							63.3
	SE(%)							8.9
Combined	Sample size	0	5	20	4	0	29	30
	Percent		19.7	70.6	9.7			
	SE(%)		8.5	9.5	5.6			
	Mean length		622	732	868			
	SD(length)		3	66	73			

Note: Sample data excludes 1 fish ≥28 in TL sampled for adipose fin status but not for age, sex and length.

[a] Includes 3 fish that were not assigned a valid age.

On June 19–21 and 26, creel survey staff sampled 9 Chinook salmon harvested in the Chilkat Inlet subsistence gillnet fishery. The age composition of the samples was 56% (SE = 18%) age 1.2, 33% (SE = 17%) age 1.3, and 11% (SE = 1%) age 1.4 (Appendices C1 and C2). The total Chinook salmon harvest reported on 2010 subsistence permits was 59 fish in Chilkat Inlet and 40 fish in the Chilkat River (query on DCF Alexander Integrated Fisheries Database, November 14, 2012).

Contribution of Coded Wire Tagged Stocks to the 2010 Haines Marine Sport Fishery

Of the 82 Chinook salmon sampled at Letnikof Cove, 9 had clipped adipose fins. CWTs were recovered from 6 of the heads sent to the Tag Lab, no tags were found in the remaining 3 heads (Table 12). Estimated CWT-tagged stock contributions to the Chilkat Inlet sport fishery were 83

(SE = 37) BY 2004 Chilkat River Chinook salmon and 14 (SE = 13) BY 2005 Chinook salmon from Douglas Island Pink and Chum Inc.'s (DIPAC) hatchery smolt release at Fish Creek in Juneau. Of the 30 Chinook salmon sampled at the Haines Small Boat Harbor, 3 had clipped adipose fins, and the Tag Lab recovered CWTs from all 3 heads. Estimated CWT-tagged stock contributions to the Chilkoot Inlet sport fishery were 25 (SE = 18) BY 2005 and 6 (SE = 6) BY 2004 Chinook salmon from DIPAC's hatchery smolt release at Pullen Creek in Skagway (Figure 1). The estimated contribution of 128 fish (SE = 40) was 57% of the Haines sport harvest estimated by the creel survey. The marked fraction of BY 2004 Chilkat River Chinook salmon used in the contribution estimate is preliminary until the BY 2004 data analysis is published.

Table 12.–Contribution estimate (*r*) of coded-wire tagged Chinook salmon to the Haines marine sport fishery, May 10–June 27, 2010, and statistics used for computing estimates.

Agency	Release site	Tag code	Brood year	Harvest *N*	Harvest SE[*N*]	Sample *n*	Adipose clip *a*	Head *a'*	Detect *t*	Decode *t'*	Tags *m*	Contribution *r*	Contribution SE
CHILKAT INLET RECOVERIES													
ADFG	Chilkat River wild	04-12-19, 04-13-02	2004	145	20	82	9	6	6	6	5	83	37
DIPAC[a]	Fish Cr 111-50	04-14-54	2005								1	14	13
Chilkat Inlet total											6	96	40
SMALL BOAT HARBOR RECOVERIES													
DIPAC[a]	Pullen Cr 115-34	04-14-57	2005	77	15	30	3	3	3	3	2	25	18
DIPAC[a]	Pullen Cr 115-34	04-12-27	2004								1	6	6
Chilkoot Inlet total											3	31	18
Haines marine creel survey total				222	25	112	12	9	9	9	9	128	40

Note: Contribution estimates for wild Chilkat River broods are preliminary until data from all return years are complete and published.

[a] DIPAC = Douglas Island Pink and Chum, Inc.

JUVENILE TAGGING

During September and October 2010, 38,833 Chinook salmon parr from BY 2009 were captured and marked in the Chilkat River drainage (Table 13). CPUE was highest in the lower Chilkat River and lowest in the Tahini River. The overall fall CPUE was 16.1 parr/minnow trap. After being held overnight, 18 mortalities were discarded and 25 fish shed their tags, so 38,790 fish were released with valid CWTs and adipose fin clips (Table 14).

During April 10–May 28, 2011, 5,523 Chinook salmon smolts from brood year 2009 were captured and marked in the lower Chilkat River (Table 13). The 2011 CPUE was 1.2 smolts/minnow trap, After being held overnight, 9 mortalities were discarded and 0 fish shed their tags, so 5,514 fish were released with valid head CWTs, second (dorsal) CWTs, and adipose fin clips (Table 14).

A total of 412 Chinook salmon parr were sampled for length during fall 2010, and their mean length was 68 mm FL (SD = 6 mm, Table 15). In spring 2011, 279 smolts were sampled for length and weight. Smolts averaged 71 mm FL (SD = 6 mm) and 3.7 g (SD = 1.0 g).

Table 13.–Results of juvenile Chinook salmon trapping in the Chilkat River drainage in fall 2010 and spring 2011.

Year	Trapping area	Dates	Days fished	Traps set	Number caught	CPUE[a]
2010	Tahini River	Sept. 18–25	7	649	7,260	11.2
2010	Kelsall River	Oct. 2–10	10	909	15,888	17.5
2010	Chilkat River	Oct. 18–27	9	847	15,685	18.5
	Fall 2010 subtotal		26	2,405	38,833	16.1
2011	Lower Chilkat River	April 10–May 28	57	4,759	5,523	1.2

[a] Catch per unit of effort expressed as the number of juvenile Chinook salmon caught per minnow trap set.

Table 14.–Number of brood year 2009 Chinook salmon coded wire tagged (CWT) in the Chilkat River drainage, by area and tag year.

Tag year	Tag code	Sequence range	Location	Last date	Stage	Injected	24h Morts	Marked	Shed tags	Valid CWTs released
2010	04-19-91	158–12365	Tahini River	9/25	Parr	7,260	6	7,254	0	7,254
2010	04-19-91	12415–38605	Kelsall River	10/12	Parr	15,888	5	15,883	0	15,883
2010	04-19-91	40592–58247	Lower Chilkat R	10/24	Parr	10,600	4	10,596	0	10,596
2010	04-20-88	Non-sequential	Lower Chilkat R	10/27	Parr	5,085	3	5,082	25	5,057
Fall 2010 subtotal						38,833	18	38,815	25	38,790
2011	04-20-89	Non-sequential	Chilkat River	5/28	Smolt	5,523	9	5,514	0	5,514

Table 15.–Mean length and weight of brood year 2009 Chinook salmon juveniles in the Chilkat River drainage by trapping location and year.

				Length (snout to fork of tail in mm)		
Sample year	Trapping location	Sample dates	Sample size	Range	Mean	SD
2010	Tahini River	Sept. 18–25	78	53–95	69	6
2010	Kelsall River	Oct. 2–12	162	52–89	69	6
2010	Chilkat River	Oct. 18–27	172	54–86	66	5
Fall 2010 subtotal			412	52–95	68	6
2011	Lower Chilkat River	April 10–May 28	279	54–90	71	6
			weight (g)	1.7–7.4	3.7	1.0

BROOD YEAR 2003 PRODUCTION

Juvenile Abundance

In fall 2004, 37,245 Chinook salmon parr were released with valid CWTs, and 5,825 smolts were released in spring 2005 (Ericksen 2002). Both groups originated from BY 2003. Between 2006 and 2010, 1,193 adult BY 2003 Chinook salmon were sampled in the Chilkat River, of which 93 were missing adipose fins (Table 16). There was not a significant difference ($\chi^2 = 0.02$, df = 1, P = 0.88) between the fractions of adipose-finclipped fish sampled in the lower river and on the spawning grounds, so the inriver marked fraction ($\theta_{INRIVER}$) for BY 2003 was estimated at 0.078 (SE = 0.008) using pooled lower and upper river data.

Table 16.–Number of brood year 2003 Chinook salmon sampled in the Chilkat River drainage for missing adipose fins and coded wire tags (CWT), by year, and by gear type or spawning drainage, 2006–2010.

					Wand detector results			Tag Lab CWT recoveries		
Year	Event 1 gear or event 2 tributary	Inspected for adipose fin clip	Adipose fin-clipped	Clipped fraction	Scanned	Dorsal CWT not detected (Fall)	Dorsal CWT detected (Spring)	Heads examined	Valid CWTs	Head CWT loss fraction
2006	Gillnet	0								
2006	Fish wheels	56	5	0.09	5	3	2	4	4	0.00
2007	Gillnet	12	0	0.00						
2007	Fish wheels	23	2	0.09	2	2	0	2	2	0.00
2008	Gillnet	71	9	0.13	8	7	1	0		
2008	Fish wheels	32	1	0.03	1	0	1	0		
2009	Gillnet	69	3	0.04	3	1	2	0		
2009	Fish wheels	49	5	0.10	5	3	2	0		
2010	Gillnet	0								
2010	Fish wheels	1	0	0.00						
Event 1 total		313	25	0.08	24	16	8	6	6	0.00
2006	Kelsall River	10	2	0.20	2	2	0	1	1	0.00
2006	Tahini River	26	6	0.23	6	5	1	6	6	0.00
2006	Klehini River	8	1	0.13	1	0	1	1	1	0.00
2007	Kelsall River	30	0	0.00						
2007	Tahini River	94	9	0.10	9	8	1	8	8	0.00
2007	Klehini River	35	3	0.09	3	0	3	3	3	0.00
2008	Kelsall River	81	3	0.04	3	3	0	2	2	0.00
2008	Tahini River	169	14	0.08	14	13	1	6	6	0.00
2008	Klehini River	66	4	0.06	4	2	2	0		
2009	Kelsall River	54	1	0.02	1	1	0	1	1	0.00
2009	Tahini River	261	20	0.08	20	17	3	17	17	0.00
2009	Klehini River	40	5	0.13	5	1	4	2	2	0.00
2010	Kelsall River	1	0	0.00						
2010	Tahini River	5	0	0.00						
2010	Klehini River	0								
Event 2 total		880	68	0.08	68	52	16	47	47	0.00
Grand total		1,193	93	0.08	92	68	24	53	53	0.00
Fraction with head CWT (marine theta)				0.08						

From the 93 adipose-finclipped fish sampled in the escapement, 55 heads were collected, 2 heads were lost in transit, and 53 CWTs were recovered and decoded by the DCF Tag Lab (Appendix D3). Of the 53 decoded CWTs, 40 were tagged in fall 2004 and 13 were tagged in spring 2005 (Table 17).

Table 17.–Number of brood year 2003 Chilkat River Chinook salmon coded wire tags (CWT) recovered from heads taken in random samples in 2006–2010, by year, area, gear type, and season tagged.

		Purse Seine		Drift GN		Troll		Sport		Chilkat Inlet subsistence		Chilkat River escapement		Fall	Spring	Grand
Year	District	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	subtotal	subtotal	total
2006	112	1	1	0	0	0	0	0	0	0	0	8	0	9	1	10
2007	110	0	0	0	0	0	1	0	0	–	–	–	–	0	1	1
2007	114	0	0	0	0	1	0	0	0	–	–	–	–	1	0	1
2007	115	0	0	5	1	0	0	1	0	0	0	9	4	15	5	20
2007 subtotal		0	0	5	1	1	1	1	0	0	0	9	4	16	6	22
2008	108	0	0	1	0	0	0	0	0	–	–	–	–	1	0	1
2008	111	0	0	0	0	0	0	1	0	–	–	–	–	1	0	1
2008	114	0	0	0	0	3	0	0	0	–	–	–	–	3	0	3
2008	115	0	0	1	0	0	0	0	1	1	0	8	4	10	5	15
2008 subtotal		0	0	2	0	3	0	1	1	1	0	8	4	15	5	20
2009	113	0	0	0	0	3	0	0	0	–	–	–	–	3	0	3
2009	114	0	0	0	0	2	2	1	0	–	–	–	–	3	2	5
2009	115	0	0	0	0	0	0	5	3	1	0	15	5	21	8	29
2009 subtotal		0	0	0	0	5	2	6	3	1	0	15	5	27	10	37
2010		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand total		1	1	7	1	9	3	8	4	2	0	40	13	67	22	89

Note: Marine CWTs were recovered and decoded by Division of Commercial Fisheries Mark, Tag, and Age Laboratory. Chilkat River escapement data based on handheld wand CWT scans and scale ages.

In calendar year 2004, the first year Chilkat River Chinook salmon were scanned for second CWT presence/absence, the number sampled was small and the error rate was high, so the 2004 wand scan results were excluded from historic averages (Table 18). In calendar years 2005–2011, the rate of false positive second CWT detections in fall-tagged fish was not different (χ^2 = 0.02, df = 1, P = 0.88) for large (5 false positive out of 90 scanned) vs. medium/small (6 false positive out of 99 scanned) fish. The rate of false negative second CWT detections of spring-tagged fish was not different (Yates χ^2 < 0.01, df = 1, P = 0.97) for large (2 false negative out of 22 scanned) vs. medium/small (2 false negative out of 38 scanned) fish.

Table 18.–Summary of handheld wand scans for second (dorsal) coded wire tag (CWT) presence/absence in brood year 2001 and later adult Chilkat River Chinook salmon, as verified by recovered primary CWT codes, by length category and by sampling calendar year, 2004–2011.

MEF length < 660 mm					
	Fall-tagged fish		Spring-tagged fish		
Calendar year	Correct ID second CWT absent	False positive	Correct ID second CWT present	False negative	Total examined
2004	2	1	0	1	4
2005	16	0	3	0	19
2006	12	0	5	0	17
2007	14	2	9	0	25
2008	11	1	8	0	20
2009	15	1	2	0	18
2010	7	1	3	1	12
2011	18	1	6	1	26
2005–2011 total	93	6	36	2	137
MEF length ≥ 660 mm					
	Fall-tagged fish		Spring-tagged fish		
Calendar year	Correct ID second CWT absent	False positive	Correct ID second CWT present	False negative	Total examined
2004	0	0	0	0	0
2005	0	0	1	0	1
2006	15	0	3	0	18
2007	3	0	2	0	5
2008	8	0	1	0	9
2009	24	1	7	1	33
2010	15	2	1	1	19
2011	20	2	5	0	27
2005–2011 total	85	5	20	2	112
All lengths					
2005–2011 total	178	11	56	4	249

Of the 53 BY 2003 Chilkat River Chinook salmon with paired wand scan results and CWTs decoded by the DCF Tag Lab, 40 were fall and 13 were spring tag codes (Table 17). The handheld wand scan results matched the decoded CWT results for 50 of 53 fish: there were 2 cases of false positive and 1 case of false negative wand detection of second CWTs (Appendix D3). For BY 2003 Chilkat River Chinook salmon, the overall false negative rate in fish of all lengths (ω_{f-}) was estimated as 6.8% (SD = 3.2%) and the false positive rate in fish of all lengths (ω_{f+}) was estimated as 5.6% (SD = 1.6%, Appendix E1). Using the tag codes, the false negative and false positive wand results were corrected in further analysis. Of the 92 BY 2003 fish scanned with the handheld wand, 68 were assigned fall-tagged and 24 were assigned spring-tagged status (Table 16).

An estimated 668,000 (SE = 75,490) BY 2003 parr were rearing in the Chilkat River in fall 2004, 43.0% (SE = 8.3%) survived the winter, and 284,800 (SE = 49,870) smolts emigrated from the Chilkat River in spring 2005 (Appendix E1).

Adult Harvest

There were no cases of head CWT loss in 53 BY 2003 heads examined by the DCF Tag Lab, so $\theta_{MARINE,}$ the estimated tagged fraction germane to marine fisheries, = $\theta_{INRIVER}$ = 0.078 (SE = 0.008, Table 16). Thirty-six (36) BY 2003 Chilkat River Chinook salmon were recovered through random sampling in marine commercial, sport, and subsistence fisheries from 2006 to 2010 (Table 17, Appendix D1). An estimated 1,156 (SE = 227) BY 2003 Chilkat River Chinook salmon were harvested in sampled marine fisheries between 2006 and 2010 (Table 19). Harvest-at-age was 31 (SE = 21) age-1.1, 385 (SE = 161) age-1.2, 305 (SE = 114) age-1.3, and 435 (SE = 112) age-1.4 fish. The commercial fishery sector had the largest share (62%) of the total harvest of BY 2003 Chilkat River Chinook salmon, followed by the sport (31%) and the subsistence (7%) fishery sectors (Table 20). The specific fisheries with the largest share of the Chilkat harvest were the Southeast Alaska commercial troll (39%), Haines sport (25%), and Lynn Canal commercial gillnet (18%) fisheries (Figure 6).

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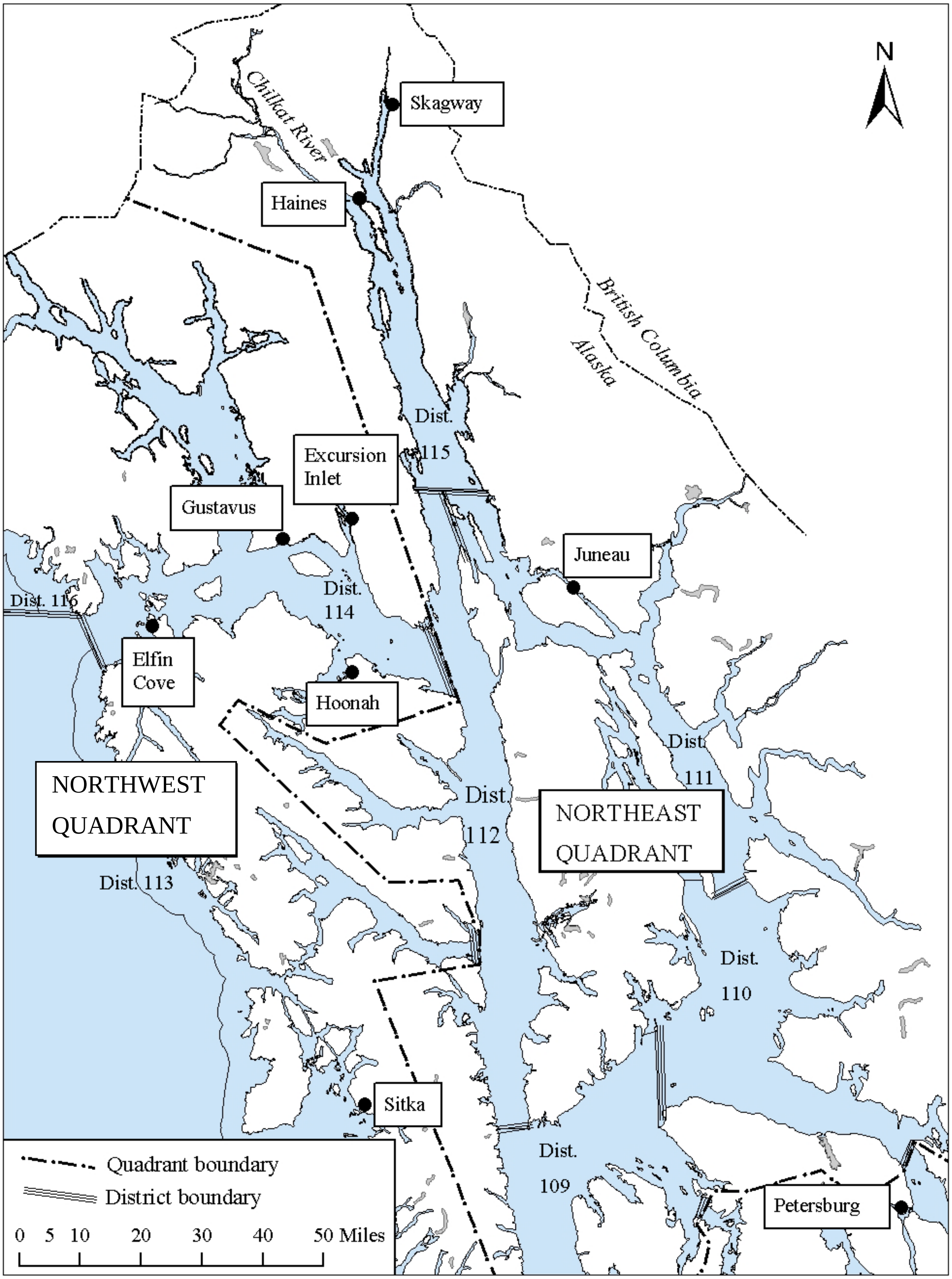

Figure 6.–Fishing quadrants, districts, and sampling ports in northern Southeast Alaska.

Table 19.–Estimated contributions of brood year 2003 Chilkat River Chinook salmon to marine fishery harvests, by year and fishery, 2006–2010.

Fishery	Fishery harvest				Contribution							
	Time[a]	District, quadrant, or port	$\hat{H}$	SE[$\hat{H}$]	n	a	a'	t	t'	m	$\hat{r}$	SE[$\hat{r}$]
2006 recoveries age-1.1												
Purse seine	SA 12	D 112	715	0	600	84	83	76	76	2	31	21
2007 recoveries age-1.2												
Drift gillnet	SW 27–37	D 115	435	0	241	21	21	19	19	6	139	57
Troll	TP 4	NW	306	0	74	8	8	7	7	1	53	53
Troll	TP 5	NE	1,248	0	147	9	8	5	5	1	123	122
Haines sport[b]	BW 10–13	D 115–34	44	15	8	1	1	1	1	1	71	70
2007 subtotal										9	385	161
2008 recoveries age-1.3												
Drift gillnet	SW 24	D 108	1,267	0	655	29	29	29	29	1	25	24
Drift gillnet	SW 25	D 115	177	0	32	6	6	5	5	1	71	70
Troll	TP 2	NW	2,243	0	1,196	80	74	65	65	1	26	26
Troll	TP 3	NW	51,297	0	19,340	1,337	1,302	944	938	2	70	49
Juneau sport	BW 17	Juneau	482	93[c]	123	6	6	6	6	1	50	50
Haines sport[d]	BW 9–12	D 115–34	27	11	10	2	2	2	2	1	35	34
Haines subsistence[d]	BW 12–14	D 115–32	28	0	13	1	1	1	1	1	28	27
2008 subtotal										8	305	114
2009 recoveries age-1.4												
Troll	TP 2	D 113/114	15,888	0	7,910	522	519	373	373	7	181	69
Gustavus sport	2009	Gustavus	384	384[e]	384	30	29	13	13	1	13	13
Haines sport[f]	BW 9–12	D 115–32	111	76	61	10	10	10	10	8	187	68
Haines subsistence[f]	BW 12–13	D 115–32	46	0	11	2	2	2	2	1	54	53
2009 subtotal										17	435	112
2010 recoveries age-1.5												
No BY 2003 Chilkat Chinook salmon CWTs were recovered in 2010 marine fishery random samples.												
Combined contribution [$\hat{T}$]										36	1,156	227

Source: Unless otherwise noted, commercial and sport fishery sampling data are from the ADF&G Mark, Tag and Age Laboratory online database at http://tagtoweb.adfg.state.ak.us.

Source: Subsistence fishery harvests are permit reports in Integrated Fisheries Database for Southeast Alaska, maintained by ADF&G/Division of Commercial Fisheries, Region 1, Douglas.

[a] SW = statistical week, BW = biweek, TP = troll period.

[b] Sampling data from Chapell (2010).

[c] SE estimate from personal communication from Mike Jaenicke, project leader of Northern Southeast AK Creel Survey, ADF&G Division of Sport Fish, Region 1, Douglas.

[d] Sampling data from Chapell (2012).

[e] Harvest and SE not estimated. Assume harvest and SE = total sampled by creel survey.

[f] Sampling data from Chapell (2013).

Table 20.–Total marine harvest and estimated contribution of brood year 2003 Chilkat River Chinook salmon, by fishery and area, 2006–2010.

Fishery	Area	Total fishery harvest	Chilkat harvest	SE	Chilkat percent of fishery	Percent of total Chilkat harvest
Commercial fishery						
Troll	Quad. NE	1,248	123	122	9.8	10.6
Troll	Quad. NW	69,734	331	103	0.5	28.6
Drift gillnet	Dist. 108	1,267	25	24	2.0	2.1
Drift gillnet	Dist. 115	612	210	91	34.3	18.2
Purse seine	Dist. 112	715	31	21	4.3	2.7
	Subtotal	73,576	719	118	1.0	62.2
Sport fishery						
	Juneau, Gustavus	866	64	63	7.3	5.5
	Haines	182	292	173	160.4	25.3
	Subtotal	1,048	355	116	33.9	30.8
Subsistence fishery						
	Chilkat Inlet	74	81	60	109.8	7.0
Grand total		74,698	1,156	60	1.5	100.0

Marine Exploitation and Survival

Based upon a total inriver return of 5,519 (SE = 657) age-1.2 and older BY 2003 Chilkat River Chinook salmon and a total marine harvest of 1,125 (SE = 226) age-1.2 and older fish, the total age-1.2 and older return was 6,644 (SE = 695) fish (Table 21). The estimated smolt-to-age-1.2 and older marine survival rate was 2.3% (SE = 0.5%). The estimated marine exploitation rate of this stock was 16.9% (SE = 3.3%).

Table 21.–Estimated stock assessment parameters for brood year 2003 Chilkat River Chinook salmon.

Parameter	Estimate	SE
2004 fall fry abundance	668,000	75,490[a]
2004–2005 overwinter survival	0.430	0.083[a]
2005 spring smolt abundance	284,800	49,870[a]
Marine harvest (age-1.2 and older)	1,125	226
Inriver return (age-1.2 and older)	5,519	657
Return (age-1.2 and older)	6,644	695
Marine exploitation rate (age-1.2 and older)	0.169	0.033
Smolt survival to age-1.2 and older	0.023	0.005

[a] Standard deviation of the posterior distribution, which is a measure of spread analogous to standard error.

DATA FILES

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

DISCUSSION

Several assumptions, as noted above, underlie the mark-recapture estimate of inriver abundance. Considerable efforts were made to catch and mark fish in proportion to their abundance (assumption a) by sampling uniformly across the escapement. Also, sampling effort for tag recovery on the Kelsall and Tahini rivers (where 85% of spawning occurred in 2005 and >90% occurred in 1991 and 1992; Ericksen and Chapell 2006; Johnson et al. 1992, 1993) was fairly constant across the time when fish were accessible to sampling. Carcass retrievals, which can be sex selective in some situations (Pahlke et al. 1996; McPherson et al. 1997; Zhou 2002; Miyakoshi et al. 2003), comprised 47% of the spawning ground samples. Using other capture methods (21% gillnet, 15% snagging, 13% dipnet, 5% hands,) on the spawning grounds reduced the potential bias that may be inherent in any one method. The assumption (b) of no recruitment during the experiment is reasonable because tagging effort was relatively constant and continued until only about 1 fish per day was being caught. Assumption (c), that marking does not affect catchability of fish was tested in the 2005 radiotelemetry study where 2.3% or less of tagged fish failed to make significant upstream progress after tagging (Ericksen and Chapell 2006). Assumptions (d), that marks were not lost, and (e), that recaptured fish were detected and reported, were satisfied by applying the secondary mark (ULOP). Assumption (f), no duplicate sampling, was satisfied by applying the ULOP in event 1 and left operculum in event 2. Only fish with intact left opercula were considered in events 1 and 2.

The 2010 inriver run of 1,815 (SE = 226) large Chinook salmon fell short of the inriver run goal range (1,850 to 3,600 large Chinook salmon) specified in the Lynn Canal and Chilkat River King Salmon Fishery Management Plan (5 AAC 33.384; Table 22). Since the mark-recapture inriver run estimation project was started in 1991, the inriver run has fallen short of the goal in 3 years: 2007, 2010, and 2012 (Figure 7). After subtracting the estimated 18 large fish removed by the inriver subsistence fishery, the estimated escapement was 1,797 large fish, which is within the Chilkat River Chinook salmon BEG range of 1,750 to 3,500 large fish (Table 22). The inriver subsistence fishery removal was calculated by applying the proportion of large (age-1.3 and older) fish (0.44) in the 2010 Chilkat Inlet subsistence gillnet samples to the total inriver harvest (40 fish) reported on 2010 permits.

The 2009 Haines marine sport fishery large Chinook salmon CPUE (0.028) was near the 1988–2009 average (0.027; Table 1). As an early indicator of large Chinook salmon abundance, the average sport fishery CPUE did not match the below-average gillnet catch (96 large fish, 1991–2009 average = 142 large fish) during event 1 of the mark-recapture experiment, and provided no warning of the weak inriver run. As has been true in previous years, the Haines marine sport fishery CPUE has not been a useful abundance indicator for inseason management.

Haines area marine sport fishing harvest patterns observed during 2010 were similar to years 2001–2007 and 2009. The 2010 salmon-targeted effort was 86% of the average estimated effort in the same May–June period in 2001–2007 and 2009 (Ericksen 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009, 2010, 2012, 2013). In 2010, 66% of the estimated marine harvest of large (≥28 in TL) Chinook salmon was landed at the Letnikof Dock (2001–2007 and 2009 average = 73%, ibid.). The creel survey estimated that 55% of the large Chinook salmon harvested were wild and mature, most likely headed for the Chilkat River (Table 10). CWT recoveries indicate the remainder of the harvest was immature and hatchery-released fish (Table 12).

Each fall in 2000–2011, an average of 28,458 Chilkat River Chinook salmon parr have been marked with CWTs (brood years 1999–2010). Using the 33% average overwinter survival rate for BY 1999–2003, the fall marking effort has produced approximately 9,000 CWT-marked smolts each spring (Appendix F). Spring 2001–2012 tagging efforts have produced an average of 3,911 CWT-tagged smolts from BY 1999–2010. The average CWT-marked fraction for BY 1999–2003 was 9.5%. The high number of marked fish has allowed the harvest of BY 1999 and later Chilkat River Chinook salmon to be tracked with high resolution. The fall and spring tagging efforts should be continued to monitor harvest of the relatively small Chilkat River Chinook salmon stock in nearby hatchery release terminal harvest areas (Lutak Inlet, Taiya Inlet) where up to 500,000 hatchery-reared Chinook salmon smolts will be released (Figure 1; ADF&G 2012).

Using the nonlethal handheld wand scan to detect second CWT presence/absence in the escapement allowed the release of 36 large adipose-finclipped prespawners from BY 2003, and an average of 31 large prespawners released per brood year from BY 2001–2004 (Appendix D4). Releasing viable spawners has provided a significant benefit to the relatively small Chilkat Chinook salmon stock in years when the inriver run fell short of the goal range, such as in 2007, 2010 and 2012, (Table 21). However, not taking heads from large CWT-tagged fish added uncertainty to parameter estimates due to the 6% error rate in detecting the second CWT (calendar years 2005–2011, Table 18). When only sacrificed fish and decoded CWTs were considered in the BY 2003 CWT analysis, the juvenile abundance estimates were similar, with overlapping 95% CI, but the CI was much wider for the sacrificed fish results (Appendix E2). The added uncertainty from nonlethal sampling was outweighed by the larger sample size.

Sacrificing some adipose-finclipped fish in the escapement is necessary to monitor false negative/false positive wand detector error rates, tag loss, and straying. The wand detector method cannot distinguish between second CWT tag loss and a false negative result, so these two errors were treated as the same in the data analysis. False negative and false positive detection rates are factored into the WinBUGS model and will be updated with additional years of tag code-verified wand results when available in an effort to produce bias free estimates. Stray Chinook salmon were not found in the 433 CWTs decoded during Chilkat River escapement sampling in 2001–2012 (non-commercial survey site = Chilkat, http://tagotoweb.adfg.state.ak.us/CWT/reports/).

The 94% correct rate for detecting second CWT presence/absence was average for the wand method in the Chilkat River studies (Table 18; Appendix D3). Continued training of escapement sampling staff is needed to avoid magnetized items in the sample proximity and to carefully scan large fish to minimize handheld wand scan errors.

The BY 2003 smolt production (282,700) was the highest estimated for the Chilkat River Chinook salmon stock (Appendix F). Saltwater survival of this brood, on the other hand, was the second lowest measured. Net production, as measured by total return, was the highest since BY 1999, but only half of the peak total return from BY 1991.

High juvenile CPUE in minnow traps may indicate high abundance of BY 2009 Chilkat River Chinook salmon. The fall 2010 CPUE (16.1 parr/minnow trap) was higher than the 13.4 parr/trap average of 2000–2009 fall efforts, and the total number of parr CWTd was the highest ever for the fall project. The spring 2011 CPUE (1.2 smolt/minnow trap) was also higher than average (0.7 parr/trap in 2001–2010 spring efforts).

Table 22.–Estimated annual inriver run by age of medium (age-1.2) and large (≥ age-1.3) Chilkat River Chinook salmon, annual large escapement estimates, 1991–2010, and estimated marine harvest and total return by age class of fish from coded wire tagged brood years 1988, 1989, 1991, 1998–2003.

Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age-1.3) inriver subsistence harvest	Large (≥ age-1.3) escapement
1991[a]	Inriver run	817	(139)	3,211	(558)	2,563	(445)	123	(18)	6,714	(727)	14[b]	5,883
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
1992[c]	Inriver run	560	(100)	1,689	(304)	3,595	(649)	0	(0)	5,844	(723)	7[b]	5,277
	Marine harvest[d]	459	(166)	ND	ND	ND	ND	ND	ND				
	Total return	1,019	(194)	ND	ND	ND	ND	ND	ND				
1993[e]	Inriver run	551	(104)	2,217	(424)	2,180	(425)	75	(10)	5,023	(582)	8[b]	4,464
	Marine harvest[f]	134	(50)	572	(208)	ND	ND	ND	ND				
	Total return	685	(115)	2,789	(472)	ND	ND	ND	ND				
1994[g]	Inriver run	184	(28)	2,565	(405)	4,148	(657)	82	(10)	6,979	(773)	2[b]	6,793
	Marine harvest	ND	ND	415	(123)	605	(302)	ND	ND				
	Total return	ND	ND	2,980	(423)	4,753	(723)	ND	ND				
1995[h]	Inriver run	1,384	(295)	530	(111)	3,074	(660)	186	(37)	5,174	(733)	12[b]	3,778
	Marine harvest[i]	286	(129)	ND	ND	134	(74)	2	(1)				
	Total return	1,670	(322)	ND	ND	3,208	(664)	188	(37)				
1996[j]	Inriver run	398	(60)	4,140	(639)	737	(112)	43	(5)	5,318	(652)	10[b]	4,910
	Marine Harvest	ND	ND	459	(129)	ND	ND	0	(0)				
	Total Return	ND	ND	4,599	(652)	ND	ND	43	(5)				
1997[k]	Inriver run	160	(48)	1,943	(354)	6,157	(930)	0	(0)	8,260	(997)	5[b]	8,095
	Marine harvest	ND	ND	ND	ND	260	(104)	ND	ND				
	Total return	ND	ND	ND	ND	6,417	(936)	ND	ND				

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Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age-1.3) inriver subsistence harvest	Large (≥ age-1.3) escapement
1998[l]	Inriver run	226	(54)	1,016	(169)	2,440	(381)	219	(48)	3,901	(423)	18[b]	3,657
	Marine harvest	ND	ND	ND	ND	ND	ND	1	0				
	Total return	ND	ND	ND	ND	ND	ND	220	(48)				
1999[m]	Inriver run	427	(94)	534	(109)	1,656	(302)	80	(27)	2,698	(336)	12[b]	2,258
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2000[n]	Inriver run	629	(122)	1,350	(227)	653	(118)	32	(14)	2,664	(283)	6[o]	2,029
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2001[p]	Inriver run	755	(209)	2,529	(376)	1,988	(617)	0	(0)	5,272	(752)	3[o]	4,514
	Marine harvest	ND	ND	ND	ND	ND	ND	ND	ND				
	Total return	ND	ND	ND	ND	ND	ND	ND	ND				
2002[q]	Inriver run	373	(123)	2,353	(312)	1,667	(294)	30	(19)	4,423	(446)	16[o]	4,034
	Marine harvest[r]	0	(0)	ND	ND	ND	ND	ND	ND				
	Total return	373	(123)	ND	ND	ND	ND	ND	ND				
2003[s]	Inriver run	1,267	(293)	1,833	(362)	3,783	(582)	41	(29)	6,924	(746)	26[o]	5,631
	Marine harvest[t]	505	(373)	688	(687)	ND	ND	ND	ND				
	Total return	1,772	(474)	2,521	(777)	ND	ND	ND	ND				
2004[u]	Inriver run	1,361	(492)	1,999	(333)	1,379	(303)	44	(17)	4,783	(667)	16[o]	3,406
	Marine harvest[v]	493	(172)	795	(190)	352	(249)	ND	ND				
	Total Return	1,854	(519)	2,794	(383)	1,731	(392)	ND	ND				
2005[w]	Inriver run	1,597	(620)	1,857	(433)	1,498	(347)	11	(8)	4,963	(831)	5[o]	3,361
	Marine harvest[x]	234	(114)	383	(105)	244	(75)	0	(0)				
	Total return	1,831	(630)	2,240	(446)	1,742	(353)	11	(8)				
2006[y]	Inriver run	260	(81)	2,084	(333)	955	(185)	0	(0)	3,299	(488)	36[o]	3,003
	Marine harvest[z]	95	(53)	331	(121)	114	(63)	28	(334)				
	Total return	355	(97)	2,415	(354)	1,069	(195)	28	(334)				

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Calendar year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver run total	(SE)	Large (≥ age-1.3) inriver subsistence harvest	Large (≥ age-1.3) escapement
2007[aa]	Inriver run	602	(138)	585	(136)	860	(182)	0	(0)	2,047	(266)	7[o]	1,438
	Marine harvest	385	(161)	233	(71)	255	(146)	0	(0)				
	Total return	987	(212)	818	(153)	1,115	(233)	0	(0)				
2008[ab]	Inriver run	665	(243)	2,153	(417)	732	(173)	21	(21)	3,570	(513)	24[o]	2,882
	Marine harvest	NA	NA	305	(114)	52	(29)	0	(0)				
	Total return	NA	NA	2,458	(432)	784	(175)	21	(21)				
2009[ac]	Inriver run	1,445	(286)	1,678	(322)	2,751	(489)	0	(0)	5,874	(652)	23[o]	4,406
	Marine harvest	NA	NA	NA	NA	435	(112)	0	(0)				
	Total return	NA	NA	NA	NA	3,186	(502)	0	(0)				
2010[ad]	Inriver run	477	(100)	874	(156)	927	(163)	13	(13)	2,292	(247)	18[o]	1,797
	Marine harvest	NA	NA	NA	NA	NA	NA	0	(0)				
	Total return	NA	NA	NA	NA	NA	NA	0	(0)				

Note: ND = no data; this brood year not CWT tagged.

Note: NA = data not available at time of publication.

[a] Inriver run data from Johnson et al. (1992).

[b] Annual inriver subsistence harvest as reported in DCF Alexander database, multiplied by the 2000–2008 average of annual large (≥age-1.3) proportions of Chilkat Inlet subsistence gillnet samples (Appendix C2).

[c] Inriver run data from Johnson et al. (1993).

[d] Brood year 1988 marine harvest data from Ericksen (1995).

[e] Inriver run data from Johnson (1994).

[f] Brood year 1989 marine harvest data from Ericksen (1995).

[g] Inriver run data from Ericksen (1995).

[h] Inriver run data from Ericksen (1996).

[i] Brood year 1991 marine harvest data from Ericksen (1999).

[j] Inriver run data from Ericksen (1997).

[k] Inriver run data from Ericksen (1998).

[l] Inriver run data from Ericksen (1999).

[m] Inriver run data from Ericksen (2000).

[n] Inriver run data from Ericksen (2001).

[o] Annual inriver subsistence harvest as reported in DCF Alexander database, multiplied by the annual large (≥age-1.3) proportion of Chilkat Inlet subsistence gillnet samples (Appendix C2).

[p] Inriver run data from Ericksen (2002a).

[q] Inriver run data from Ericksen (2003).

[r] Brood year 1998 marine harvest data from Ericksen (2006).

[s] Inriver run data from Ericksen (2004).

[t] Brood year 1999 marine harvest data from Chapell (2009).

[u] Inriver run data from Ericksen (2005).

[v] Brood year 2000 marine harvest data from Chapell (2010).

[w] Inriver run data from Ericksen and Chapell (2006).

[x] Brood year 2001 marine harvest data from Chapell (2012).

[y] Inriver run data from Chapell (2009).

[z] Brood year 2002 marine harvest data from Table 19.

[aa] Inriver run data from Chapell (2010).

[ab] Inriver run data from Chapell (2012).

[ac] Inriver run data from Chapell (2013).

[ad] Inriver run data from Table 8.

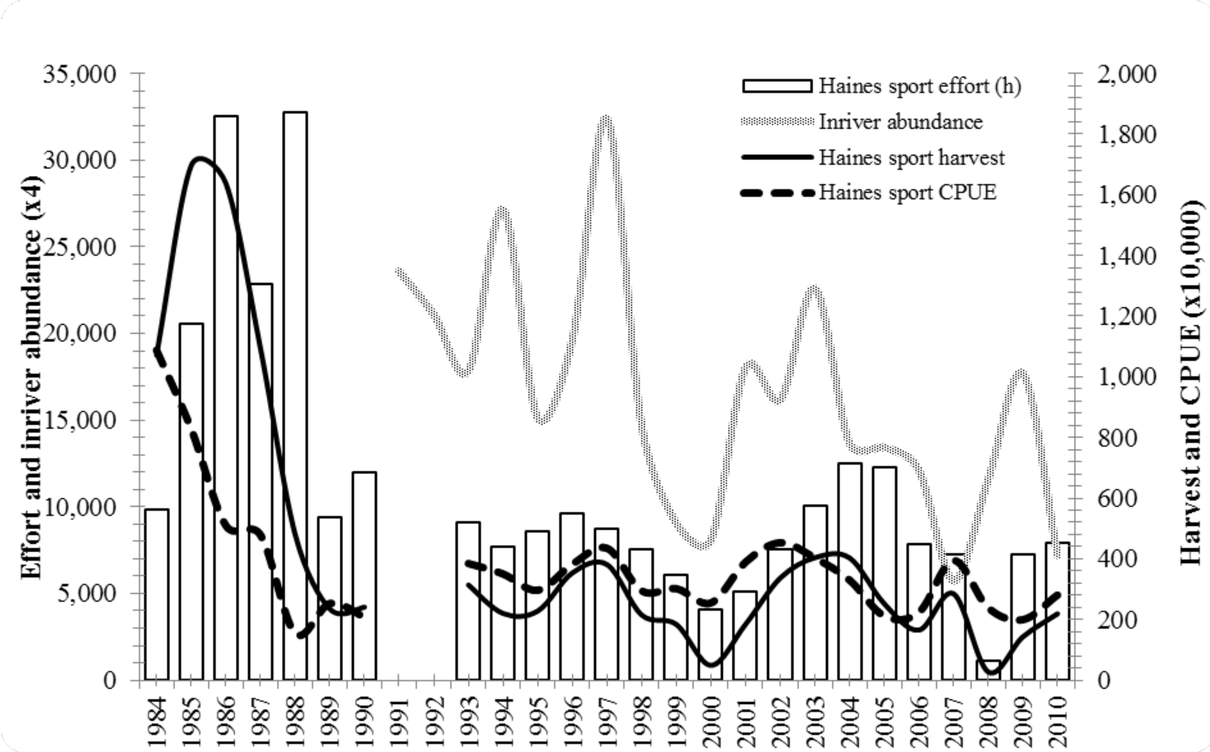

Figure 7.–Estimated angler effort, harvest, and CPUE of large (≥28 inches TL) Chinook salmon in the Haines spring marine boat sport fishery, 1984–2010, and estimated inriver run of large (≥age-1.3) Chinook salmon in the Chilkat River, 1991–2010.

Source: Tables 1 and 22.

Note: The Chilkat Inlet Chinook salmon sport fishery was closed in 1991, 1992, and 2008.

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APPENDIX A

Appendix A1.–Detection of size or sex selective sampling during a 2-sample mark–recapture experiment and recommended procedures for estimating population size and population composition.

Size-selective sampling: The Kolmogorov-Smirnov two sample test (Conover 1980) is used to detect size-selective sampling during the first or second sampling events. The second sampling event is evaluated by comparing the length frequency distribution of all fish marked during the first event (M) with that of marked fish recaptured during the second event (R), using the null test hypothesis of no difference. The first sampling event is evaluated by comparing the length frequency distribution of all fish inspected for marks during the second event (C) with that of R. A third test, comparing M and C, is conducted and used to evaluate the results of the first two tests when sample sizes are small. Guidelines for small sample sizes are <30 for R and <100 for M or C.

Sex selective sampling: Contingency table analysis (Chi^2-test) is used to detect sex-selective sampling during the first or second sampling events. The counts of observed males to females are compared between M&R, C&R, and M&C as described above, using the null hypothesis that the probability that a sampled fish is male or female is independent of sample. When the proportions by gender are estimated for a sample (usually C), rather an observed for all fish in the sample, contingency table analysis is not appropriate and the proportions of females (or males) are compared between samples using a two sample test (e.g., Student's t-test).

M versus. R	**C versus. R**	**M versus. C**
Case I:		
Fail to reject H_o	Fail to reject H_o	Fail to reject H_o

There is no size/sex selectivity detected during either sampling event.

Case II:		
Reject H_o	Fail to reject H_o	Reject H_o

There is no size/sex selectivity detected during the first event but there is during the second event sampling.

Case III:		
Fail to reject H_o	Reject H_o	Reject H_o

There is no size/sex selectivity detected during the second event but there is during the first event sampling.

Case IV:		
Reject H_o	Reject H_o	Reject H_o

There is size/sex selectivity detected during both the first and second sampling events.

Evaluation Required:		
Fail to reject H_o	Fail to reject H_o	Reject H_o

Sample sizes and powers of tests must be considered:

A. If sample sizes for M versus R and C versus R tests are not small and sample sizes for M versus C test are very large, the M versus C test is likely detecting small differences which have little potential to result in bias during estimation. *Case I* is appropriate.

B. If a) sample sizes for M versus R are small, b) the M versus R p-value is not large (~0.20 or less), and c) the C versus R sample sizes are not small and/or the C versus R p-value is fairly large (~0.30 or more), the rejection of the null in the M versus C test was likely the result of size/sex selectivity during the second event which the M versus R test was not powerful enough to detect. *Case I* may be considered but *Case II* is the recommended, conservative interpretation.

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C. If a) sample sizes for C versus R are small, b) the C versus R p-value is not large (~0.20 or less), and c) the M versus R sample sizes are not small and/or the M versus R p-value is fairly large (~0.30 or more), the rejection of the null in the M versus C test was likely the result of size/sex selectivity during the first event which the C versus R test was not powerful enough to detect. *Case I* may be considered but *Case III* is the recommended, conservative interpretation.

D. If a) sample sizes for C versus R and M versus R are both small, and b) both the C versus R and M versus R p-values are not large (~0.20 or less), the rejection of the null in the M versus C test may be the result of size/sex selectivity during both events which the C versus R and M versus R tests were not powerful enough to detect. *Cases I, II, or III* may be considered but *Case IV* is the recommended, conservative interpretation.

Case I. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated after pooling length, sex, and age data from both sampling events.

Case II. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the first sampling event without stratification. If composition is estimated from second event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the M versus R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case III. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the second sampling event without stratification. If composition is estimated from first event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the C versus R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case IV. Data must be stratified to eliminate variability in capture probability within strata for at least one or both sampling events. Abundance is calculated using a Petersen-type model for each stratum, and estimates are summed across strata to estimate overall abundance. Composition parameters may be estimated within the strata as determined above, but only using data from sampling events where stratification has eliminated variability in capture probabilities within strata. If data from both sampling events are to be used, further stratification may be necessary to meet the condition of capture homogeneity within strata for both events. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance.

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If stratification by sex or length is necessary, overall composition is estimated by combining within-stratum composition estimates as follows:

$$\hat{p}_k = \sum_{i=1}^{j} \frac{\hat{N}_i}{\hat{N}_\Sigma} \hat{p}_{ik} \text{, and} \qquad (1)$$

$$\hat{V}[\hat{p}_k] \approx \frac{1}{\hat{N}_\Sigma^2} \left(\sum_{i=1}^{j} \hat{N}_i^2 \hat{V}[\hat{p}_{ik}] + (\hat{p}_{ik} - \hat{p}_k)^2 \hat{V}[\hat{N}_i] \right) \qquad (2)$$

where: j = the number of sex/size strata;

$\hat{p}_{ik}$ = the estimated proportion of fish that were age or size *k* among fish in stratum *i*;

$\hat{N}_i$ = the estimated abundance in stratum *i*;

$\hat{N}_\Sigma$ = sum of the $\hat{N}_i$ across strata.

APPENDIX B

Appendix B1.– Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at Letnikof Cove boat launch, May 10–June 27, 2010.

		May 24–June 6				
	May 10–May 23	Nonderby	Derby	June 7–June 20	June 21–June 27	Total
Boats counted	76	39	118	81	9	323
Angler-hr. sampled	542	314	2,980	741	60	4,637
Salmon-hr. sampled	527	314	2,978	722	60	4,601
Chinook sampled	5	6	41	28	2	82
Sampled for ad-clips	5	6	41	28	2	82
Adipose clips	0	0	5	4	0	9
Angler-hours						
Estimate	686	791	3,227	1,263	172	6,139
Variance	22,238	89,620	50,468	34,144	15,860	212,330
Salmon-hours						
Estimate	665	791	3,224	1,226	172	6,078
Variance	20,678	89,620	49,720	26,674	15,860	202,552
Large Chinook catch						
Estimate	7	18	46	67	8	146
Variance	0	36	7	355	18	416
Large Chinook harvest						
Estimate	6	18	46	67	8	145
Variance	0	36	7	355	18	416
Wild mature Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	15	32	59	4	110
Variance	0	42	6	290	9	347
Small Chinook catch						
Estimate	18	57	142	70	14	301
Variance	17	312	61	74	140	604
Small Chinook harvest						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2010.

Appendix B2.– Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at Chilkat State Park boat launch, May 29–31 and June 5–6, 2010.

	May 29–31 & June 5–6	
	Derby	Total
Boats counted	3	3
Angler-hr. sampled	12	12
Salmon-hr. sampled	11	11
Chinook sampled	0	0
Sampled for adipose clips	0	0
Adipose clips	0	0
Angler-hours		
Estimate	58	58
Variance	2,205	2,205
Salmon-hours		
Estimate	55	55
Variance	2,420	2,420
Large Chinook catch		
Estimate	0	0
Variance	0	0
Large Chinook harvest		
Estimate	0	0
Variance	0	0
Wild mature Chinook harvest (excluding hatchery and immature fish)		
Estimate	0	0
Variance	0	0
Small Chinook catch		
Estimate	0	0
Variance	0	0
Small Chinook harvest		
Estimate	0	0
Variance	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2010.

Appendix B3.– Biweekly sampling statistics and estimated effort, catch, and harvest of large (≥28 in TL) and small (<28 in TL) Chinook salmon at the Haines Small Boat Harbor, May 10–June 27, 2010.

		May 24–June 6				
	May 10–May 23	Nonderby	Derby	June 7–June 20	June 21–June 27	May 10–May 23
Boats counted	7	10	12	16	14	59
Angler-hr. sampled	34	188	193	400	222	1,037
Salmon-hr. sampled	30	188	193	400	222	1,033
Chinook sampled	1	3	13	9	4	30
Sampled for adipose clips	1	3	13	9	4	30
Adipose clips	0	0	2	1	0	3
Angler-hours						
Estimate	159	321	475	534	300	1,789
SE	13,620	21,287	9,680	12,375	1,704	58,666
Salmon-hours						
Estimate	140	321	475	534	300	1,770
SE	10,061	21,287	9,680	12,375	1,704	55,107
Large Chinook catch						
Estimate	5	14	17	32	12	80
SE	17	79	20	102	12	230
Large Chinook harvest						
Estimate	5	14	17	32	9	77
SE	17	79	20	102	12	230
Wild mature Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	0	6	4	2	12
SE	0	0	0	9	3	12
Small Chinook catch						
Estimate	0	5	85	109	89	288
SE	0	16	3,380	371	796	4,563
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Harvest of small Chinook salmon was not allowed in the Haines area in 2010.

APPENDIX C

Appendix C1.–Estimated age composition and mean length-at-age (mm MEF) of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, June 19–June 26, 2010.

		Brood year and age class						
		2007	2006	2005	2004	2003	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled
Males	Sample size	0	5	3	1	0	9	9
	Proportion		0.56	0.33	0.11			1.00
	SE		0.18	0.17	0.11			
	Mean length		517	653	790			
	SE		19	33				
Females	Sample size	0	0	0	0	0	0	0
	Proportion							0.00
	SE							
	Mean length							
	SE							

Appendix C2.–Estimated age composition of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, 2000–2010.

	Number	Percent by age class					Large (≥age-1.3)
Year	aged	1.1	1.2	1.3	1.4	1.5	total
2000[a]	15	0.0	60.0	26.7	13.3	0.0	40.0
2001[b]	20	0.0	35.0	55.0	10.0	0.0	65.0
2002[c]	23	0.0	21.7	52.2	26.1	0.0	78.3
2003[d]	33	3.1	48.5	27.3	21.2	0.0	48.5
2004[e]	38	5.2	31.6	47.4	15.8	0.0	63.2
2005[f]	21	0.0	38.1	33.3	28.6	0.0	62.4
2006[g]	21	0.0	9.5	66.7	23.8	0.0	90.5
2007[h]	11	9.1	36.4	27.3	27.3	0.0	54.6
2008[i]	13	7.7	23.1	53.8	15.4	0.0	69.2
2009[j]	11	0.0	45.5	27.3	27.3	0.0	54.5
2010[k]	9	0.0	55.6	33.3	11.1	0.0	44.4
2000–2007 Average	20	0.2	35.1	42.0	20.8	0.0	62.8

[a] Data from Ericksen (2001).
[b] Data from Ericksen (2002).
[c] Data from Ericksen (2003).
[d] Data from Ericksen (2004).
[e] Data from Ericksen (2005).
[f] Data from Ericksen and Chapell (2006).
[g] Data from Chapell (2009). Data from Chapell (2010).
[h] Data from Chapell (2012).
[i] Data from Chapell (2013).
[j] Data from Appendix C1.

APPENDIX D

Appendix D1.– Brood year 2003 Chilkat Chinook salmon coded wire tags recovered from marine fisheries, 2006–2010.

Year	Head	Tag code	Gear	Survey site	Recovery date	Stat wk.	Quad-rant	Dist.	Sub-dist.	Length
Random sampling recoveries										
2006	16528	041136	Purse seine	Petersburg	7/3/2006	27	NE	112	22	365
2006	46580	041028	Purse seine	Excurs. In.	7/13/2006	28	NE	112		375
2007	351751	041028	Drift	Excurs. In.	7/5/2007	27	NE	115		600
2007	540363	041028	Drift	Excurs. In.	7/18/2007	29	NE	115		615
2007	540429	041028	Drift	Excurs. In.	8/2/2007	31	NE	115		620
2007	540460	041028	Drift	Excurs. In.	8/8/2007	32	NE	115		580
2007	540509	041136	Drift	Excurs. In.	8/14/2007	33	NE	115		590
2007	324109	041028	Drift	Juneau	9/14/2007	37	NE	115		610
2007	96509	041028	Troll	Hoonah	8/17/2007	33	NW	114	27	653
2007	47959	041136	Troll	Petersburg	10/29/2007	44	NE	110	17	635
2007	60890	041028	Sport	Haines	7/10/2007	28	NE	115	34	510
2008	71472	041028	Drift	Wrangell	6/10/2008	24	SE	108	20	810
2008	529660	041028	Drift	Excurs. In.	6/17/2008	25	NE	115	10	790
2008	320753	041028	Troll	Juneau	6/4/2008	23	NW	114	50	838
2008	354059	041028	Troll	Hoonah	7/5/2008	27	NW	114	27	634
2008	354165	041028	Troll	Hoonah	7/6/2008	28	NW			732
2008	254249	041136	Sport	Haines	5/22/2008	21	NE	115	34	630
2008	265561	041028	Sport	Juneau	8/31/2008	36	NE	111	50	920
2008	254251	041028	Subsistence	Haines	6/29/2008	27	NE	115	32	850
2009	324223	041028	Troll	Juneau	5/21/2009	21	NW	113	95	835
2009	64824	041136	Troll	Elf. Cove	5/27/2009	22	NW	114	50	815
2009	64830	041028	Troll	Elf. Cove	5/28/2009	22	NW	113	95	855
2009	64839	041028	Troll	Elf. Cove	6/4/2009	23	NW	113	95	735
2009	64843	041028	Troll	Elf. Cove	6/4/2009	23	NW	114	50	870
2009	64841	041136	Troll	Elf. Cove	6/4/2009	23	NW	114	50	830
2009	64887	041028	Troll	Elf. Cove	6/12/2009	24	NW	114	50	755
2009	83477	041028	Sport	Gustavus	6/10/2009	24	NW	114	25	840
2009	254136	041028	Sport	Haines	5/30/2009	22	NE	115	32	925
2009	343042	041028	Sport	Haines	5/31/2009	23	NE	115	32	835
2009	343043	041136	Sport	Haines	6/2/2009	23	NE	115	32	770
2009	343022	041028	Sport	Haines	6/3/2009	23	NE	115	32	1010
2009	343024	040962	Sport	Haines	6/7/2009	24	NE	115	32	905
2009	343025	041136	Sport	Haines	6/7/2009	24	NE	115	32	960
2009	343045	041028	Sport	Haines	6/16/2009	25	NE	115	32	855
2009	343046	041136	Sport	Haines	6/17/2009	25	NE	115	32	935
2009	254137	041028	Subsistence	Haines	6/20/2009	25	NE	115	32	970
Select and voluntary recoveries										
2007	264088	041028	Sport	Haines	6/18/2007	25	NE	115	34	
2009	355690	041136	Troll	Juneau	4/24/2009	17	NE	111	20	

Note: No brood year 2003 heads were recovered in 2010 sampling efforts.

Appendix D2.–Comparison of handheld wand detection of second (dorsal) coded wire tag (CWT) presence/absence with tag codes in 253 adipose-finclipped adult Chinook salmon examined in the Chilkat River escapement, calendar years 2005–2011. Bold indicates erroneous wand detection results.

Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2004	2001	Lower Chilkat	254,003	390	40453	Spring	**No**
2004	2001	Kelsall	254,123	405	40553	Fall	**Yes**
2004	2001	Kelsall	254,124	340	40553	Fall	No
2004	2001	Kelsall	254,125	380	40553	Fall	No
2005	2002	Lower Chilkat	254,324	385	40771	Fall	No
2005	2001	Lower Chilkat	254,325	580	40553	Fall	No
2005	2002	Lower Chilkat	254,327	325	40771	Fall	No
2005	2002	Lower Chilkat	254,329	340	40771	Fall	No
2005	2002	Lower Chilkat	254,330	325	40771	Fall	No
2005	2002	Kelsall	264,014	405	40964	Spring	Yes
2005	2001	Kelsall	264,020	470	40553	Fall	No
2005	2001	Kelsall	264,079	700	40453	Spring	Yes
2005	2002	Kelsall	264,081	355	40964	Spring	Yes
2005	2001	Tahini	221,457	520	40553	Fall	No
2005	2001	Tahini	221,458	535	40553	Fall	No
2005	2002	Tahini	221,459	390	40771	Fall	No
2005	2001	Tahini	254,169	590	40553	Fall	No
2005	2002	Tahini	254,170	400	40771	Fall	No
2005	2001	Tahini	264,053	540	40553	Fall	No
2005	2001	Tahini	264,067	510	40553	Fall	No
2005	2001	Tahini	264,068	620	40453	Spring	Yes
2005	2001	Tahini	264,070	540	40553	Fall	No
2005	2001	Tahini	264,071	580	40553	Fall	No
2005	2002	Tahini	264,077	400	40771	Fall	No
2006	2003	Lower Chilkat	252,402	360	40962	Fall	No
2006	2003	Lower Chilkat	252,404	390	41136	Spring	Yes
2006	2003	Lower Chilkat	252,406	325	41028	Fall	No
2006	2003	Lower Chilkat	252,408	375	41136	Spring	Yes
2006	2002	Big Boulder	221,480	545	40964	Spring	Yes
2006	2003	Big Boulder	254,231	390	41136	Spring	Yes
2006	2001	Big Boulder	254,233	765	40553	Fall	No
2006	2001	Big Boulder	254,238	795	40453	Spring	Yes

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2006	2001	Kelsall	254,239	830	40553	Fall	No
2006	2001	Kelsall	254,240	745	40553	Fall	No
2006	2001	Kelsall	254,243	840	40553	Fall	No
2006	2001	Kelsall	254,244	855	40553	Fall	No
2006	2003	Kelsall	254,246	405	41028	Fall	No
2006	2001	Kelsall	254,247	845	40553	Fall	No
2006	2001	Kelsall	254,248	775	40553	Fall	No
2006	2001	Kelsall	254,359	825	40553	Fall	No
2006	2002	Kelsall	254,360	510	40771	Fall	No
2006	2001	Kelsall	254,362	800	40553	Fall	No
2006	2001	Kelsall	254,363	745	40553	Fall	No
2006	2001	Kelsall	254,364	730	40553	Fall	No
2006	2001	Kelsall	254,365	770	40553	Fall	No
2006	2001	Tahini	254,181	790	40553	Fall	No
2006	2001	Tahini	254,182	660	40453	Spring	Yes
2006	2001	Tahini	254,184	795	40553	Fall	No
2006	2002	Tahini	254,185	565	40771	Fall	No
2006	2003	Tahini	254,187	400	41136	Spring	Yes
2006	2003	Tahini	254,371	415	40962	Fall	No
2006	2001	Tahini	254,372	850	40553	Fall	No
2006	2002	Tahini	254,373	535	40771	Fall	No
2006	2003	Tahini	254,374	435	40962	Fall	No
2006	2003	Tahini	254,375	435	41028	Fall	No
2006	2003	Tahini	254,376	360	41028	Fall	No
2006	2003	Tahini	254,377	375	41028	Fall	No
2006	2002	Tahini	254,378	530	40771	Fall	No
2006	2001	Tahini	254,230	795	40453	Spring	Yes
2007	2004	Lower Chilkat	252,479	320	41302	Spring	Yes
2007	2004	Lower Chilkat	252,480	410	41219	Fall	**Yes**
2007	2003	Lower Chilkat	252,481	515	41028	Fall	**Yes**
2007	2003	Lower Chilkat	252,482	510	41028	Fall	No
2007	2004	Lower Chilkat	252,483	400	41219	Fall	No
2007	2004	Lower Chilkat	252,484	310	41219	Fall	No
2007	2004	Lower Chilkat	252,485	330	41302	Spring	Yes
2007	2004	Lower Chilkat	252,487	350	41302	Spring	Yes
2007	2004	Lower Chilkat	252,488	320	41219	Fall	No
2007	2004	Lower Chilkat	252,489	300	41219	Fall	No
2007	2004	Lower Chilkat	252,490	285	41219	Fall	No
2007	2004	Lower Chilkat	252,491	365	41219	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2007	2003	Big Boulder	60,891	615	41136	Spring	Yes
2007	2003	Big Boulder	60,892	625	41136	Spring	Yes
2007	2003	Big Boulder	60,893	530	41136	Spring	Yes
2007	2004	Kelsall	56,676	385	41302	Spring	Yes
2007	2004	Kelsall	56,677	360	41302	Spring	Yes
2007	2002	Kelsall	56,678	815	40812	Fall	No
2007	2002	Kelsall	254,107	760	40771	Fall	No
2007	2002	Kelsall	254,108	810	40771	Fall	No
2007	2003	Tahini	56,652	490	41028	Fall	No
2007	2003	Tahini	56,653	595	41028	Fall	No
2007	2003	Tahini	56,654	500	41028	Fall	No
2007	2001	Tahini	56,655	890	40453	Spring	Yes
2007	2003	Tahini	56,656	615	41028	Fall	No
2007	2003	Tahini	56,657	560	41028	Fall	No
2007	2003	Tahini	56,658	595	41136	Spring	Yes
2007	2003	Tahini	56,659	560	41028	Fall	No
2007	2003	Tahini	56,660	590	41028	Fall	No
2007	2002	Tahini	56,661	720	40964	Spring	Yes
2008	2004	Lower Chilkat	321,801	610	41302	Spring	Yes
2008	2005	Lower Chilkat	321,802	315	41398	Fall	No
2008	2004	Lower Chilkat	321,803	550	41302	Spring	Yes
2008	2005	Lower Chilkat	321,804	370	41398	Fall	No
2008	2005	Lower Chilkat	321,806	340	41398	Fall	No
2008	2005	Lower Chilkat	321,807	400	41398	Fall	No
2008	2004	Big Boulder	60,976	450	41302	Spring	Yes
2008	2002	Little Boulder	60,896	850	40964	Spring	Yes
2008	2004	Little Boulder	60,977	610	41302	Spring	Yes
2008	2004	Little Boulder	60,978	535	41302	Spring	Yes
2008	2004	Kelsall	53,735	610	41215	Fall	No
2008	2003	Kelsall	56,734	600	41028	Fall	No
2008	2004	Kelsall	56,736	615	41219	Fall	No
2008	2002	Kelsall	56,737	895	40812	Fall	No
2008	2002	Kelsall	56,738	890	40771	Fall	No
2008	2003	Kelsall	56,739	840	41028	Fall	No
2008	2004	Kelsall	56,740	530	41302	Spring	Yes
2008	2004	Tahini	56,680	630	41302	Spring	Yes
2008	2005	Tahini	56,681	380	41398	Fall	No
2008	2004	Tahini	56,682	540	41302	Spring	Yes
2008	2004	Tahini	56,683	575	41219	Fall	**Yes**
2008	2003	Tahini	56,684	760	41028	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2008	2003	Tahini	56,685	725	41028	Fall	No
2008	2005	Tahini	56,686	295	41398	Fall	No
2008	2003	Tahini	56,687	585	41028	Fall	No
2008	2004	Tahini	56,688	520	41219	Fall	No
2008	2003	Tahini	56,689	740	41028	Fall	No
2008	2003	Tahini	56,690	680	41028	Fall	No
2008	2003	Tahini	56,691	765	41028	Fall	No
2009	2005	Lower Chilkat	343,071	510	41398	Fall	**Yes**
2009	2005	Lower Chilkat	343,072	435	41398	Fall	No
2009	2005	Lower Chilkat	343,073	560	41398	Fall	No
2009	2005	Lower Chilkat	343,074	550	41398	Fall	No
2009	2005	Lower Chilkat	343,075	440	41398	Fall	No
2009	2006	Lower Chilkat	343,077	280	41557	Fall	No
2009	2006	Lower Chilkat	343,078	350	41557	Fall	No
2009	2006	Lower Chilkat	343,079	335	41557	Fall	No
2009	2006	Lower Chilkat	343,080	300	41557	Fall	No
2009	2004	Lower Chilkat	343,081	770	41219	Fall	No
2009	2003	Big Boulder	343,062	830	41136	Spring	Yes
2009	2005	Big Boulder	343,063	420	41398	Fall	No
2009	2005	Big Boulder	343,090	415	41398	Spring	Yes
2009	2004	Little Boulder	343,064	720	41302	Spring	Yes
2009	2003	Little Boulder	343,065	860	41136	Spring	Yes
2009	2005	Kelsall	343,027	480	41398	Fall	No
2009	2003	Kelsall	343,101	890	41028	Fall	No
2009	2005	Kelsall	343,102	560	41398	Fall	No
2009	2005	Tahini	343,028	635	41398	Fall	No
2009	2003	Tahini	343,029	835	41028	Fall	No
2009	2004	Tahini	343,030	815	41219	Fall	No
2009	2003	Tahini	343,031	965	41028	Fall	No
2009	2003	Tahini	343,032	930	41028	Fall	No
2009	2004	Tahini	343,033	790	41219	Fall	No
2009	2003	Tahini	343,034	950	41028	Fall	No
2009	2005	Tahini	343,035	520	41398	Fall	No
2009	2004	Tahini	343,036	770	41219	Fall	No
2009	2005	Tahini	343,037	640	41398	Spring	Yes
2009	2004	Tahini	343,038	820	41302	Spring	Yes
2009	2004	Tahini	343,039	760	41215	Fall	No
2009	2003	Tahini	343,040	880	40962	Fall	**Yes**
2009	2003	Tahini	343,041	920	41028	Fall	No
2009	2005	Tahini	343,047	525	41398	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2009	2004	Tahini	343,048	755	41219	Fall	No
2009	2003	Tahini	343,049	810	41136	Spring	Yes
2009	2003	Tahini	343,050	880	41028	Fall	No
2009	2003	Tahini	343,051	900	41136	Spring	Yes
2009	2004	Tahini	343,052	880	41302	Spring	Yes
2009	2003	Tahini	343,053	920	41028	Fall	No
2009	2004	Tahini	343,054	810	41219	Fall	No
2009	2004	Tahini	343,055	685	41219	Fall	No
2009	2003	Tahini	343,056	885	41028	Fall	No
2009	2004	Tahini	343,057	790	41219	Fall	No
2009	2003	Tahini	343,058	795	41028	Fall	No
2009	2003	Tahini	343,059	980	41028	Fall	No
2009	2005	Tahini	343,060	640	41398	Fall	No
2009	2003	Tahini	343,103	940	41136	Spring	**No**
2009	2003	Tahini	343,104	930	41028	Fall	No
2009	2003	Tahini	343,105	890	41028	Fall	No
2009	2004	Tahini	343,106	865	41219	Fall	No
2009	2003	Tahini	343,107	950	41028	Fall	No
2010	2007	Lower Chilkat	88,651	435	41510	Spring	Yes
2010	2007	Big Boulder	88,751	410	41510	Spring	Yes
2010	2007	Big Boulder	88,754	375	41687	Fall	No
2010	2004	Big Boulder	88,755	940	41219	Fall	**Yes**
2010	2006	Little Boulder	88,753	575	41292	Spring	Yes
2010	2006	Little Boulder	88,756	460	41557	Fall	No
2010	2004	Kelsall	88,701	880	41219	Fall	No
2010	2007	Kelsall	88,702	375	41510	Spring	**No**
2010	2004	Kelsall	88,703	855	41219	Fall	No
2010	2007	Kelsall	88,757	430	41687	Fall	**Yes**
2010	2006	Tahini	88,721	520	41557	Fall	No
2010	2004	Tahini	88,722	900	41302	Spring	**No**
2010	2006	Tahini	88,723	590	41557	Fall	No
2010	2006	Tahini	88,724	520	41557	Fall	No
2010	2004	Tahini	88,725	830	41219	Fall	No
2010	2004	Tahini	88,726	755	41219	Fall	No
2010	2005	Tahini	88,727	745	41398	Fall	No
2010	2005	Tahini	88,728	850	41398	Fall	No
2010	2005	Tahini	88,729	715	41398	Fall	No
2010	2004	Tahini	88,730	945	41219	Fall	No
2010	2006	Tahini	88,731	520	41557	Fall	No
2010	2005	Tahini	88,732	740	41398	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2010	2004	Tahini	88,733	920	41219	Fall	No
2010	2005	Tahini	88,734	760	41398	Fall	No
2010	2005	Tahini	88,735	745	41398	Fall	No
2010	2004	Tahini	88,736	890	41219	Fall	No
2010	2006	Tahini	88,737	480	41557	Fall	No
2010	2005	Tahini	88,738	780	41398	Fall	No
2010	2004	Tahini	88,739	890	41219	Fall	No
2010	2004	Tahini	88,740	910	41302	Spring	Yes
2010	2004	Tahini	88,741	900	41219	Fall	**Yes**
2011	2007	Lower Chilkat	56,783	620	41687	Fall	No
2011	2008	Lower Chilkat	56,784	375	41789	Fall	No
2011	2008	Lower Chilkat	56,785	370	41789	Fall	No
2011	2007	Lower Chilkat	56,786	550	41687	Fall	No
2011	2007	Lower Chilkat	56,787	520	41510	Spring	**No**
2011	2007	Lower Chilkat	56,788	555	41510	Spring	Yes
2011	2006	Lower Chilkat	56,789	680	41292	Spring	Yes
2011	2007	Lower Chilkat	56,790	635	41687	Fall	**Yes**
2011	2007	Lower Chilkat	56,791	565	41510	Spring	Yes
2011	2007	Lower Chilkat	88,697	600	41510	Spring	Yes
2011	2007	Lower Chilkat	88,698	565	41687	Fall	No
2011	2007	Lower Chilkat	88,699	575	41687	Fall	No
2011	2005	Lower Chilkat	88,700	640	41398	Fall	No
2011	2007	Big Boulder	88,786	470	41510	Spring	Yes
2011	2006	Big Boulder	88,787	560	41557	Fall	No
2011	2005	Kelsall	88,798	810	41398	Fall	No
2011	2005	Kelsall	88,799	900	41398	Spring	Yes
2011	2004	Kelsall	88,800	840	41219	Fall	No
2011	2006	Kelsall	88,801	800	41557	Fall	No
2011	2006	Kelsall	88,802	750	41292	Spring	Yes
2011	2005	Kelsall	88,803	910	41398	Fall	No
2011	2006	Kelsall	88,805	810	41557	Fall	No
2011	2006	Kelsall	88,806	805	41557	Fall	No
2011	2005	Kelsall	88,807	585	41398	Fall	No
2011	2006	Kelsall	88,808	780	41557	Fall	No
2011	2005	Kelsall	88,809	920	41398	Fall	No

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second CWT present
2011	2007	Tahini	88,614	590	41687	Fall	No
2011	2007	Tahini	88,615	590	41510	Spring	Yes
2011	2007	Tahini	88,616	465	41687	Fall	No
2011	2007	Tahini	88,617	600	41510	Spring	Yes
2011	2007	Tahini	88,618	600	41687	Fall	No
2011	2007	Tahini	88,619	620	41687	Fall	No
2011	2005	Tahini	88,620	920	41398	Fall	**Yes**
2011	2005	Tahini	88,742	835	41398	Fall	No
2011	2006	Tahini	532,151	815	41557	Fall	No
2011	2007	Tahini	532,152	640	41687	Fall	No
2011	2006	Tahini	532,153	850	41557	Fall	No
2011	2005	Tahini	532,154	860	41398	Fall	No
2011	2007	Tahini	532,155	645	41687	Fall	No
2011	2007	Tahini	532,156	585	41687	Fall	No
2011	2007	Tahini	532,157	575	41687	Fall	No
2011	2005	Tahini	532,158	920	41398	Fall	No
2011	2006	Tahini	532,159	830	41557	Fall	No
2011	2005	Tahini	532,160	865	41398	Fall	No
2011	2005	Tahini	532,161	815	41398	Fall	No
2011	2007	Tahini	532,162	670	41687	Fall	No
2011	2007	Tahini	532,163	605	41687	Fall	No
2011	2005	Tahini	532,164	865	41398	Fall	**Yes**
2011	2006	Tahini	532,165	695	41557	Fall	No
2011	2005	Tahini	532,166	815	41398	Fall	No
2011	2005	Tahini	532,167	855	41398	Spring	Yes
2011	2006	Tahini	532,168	780	41557	Fall	No
2011	2005	Tahini	532,169	910	41398	Spring	Yes

Appendix D3.–Handheld wand scan results from 92 adipose clipped brood year 2003 Chilkat River Chinook salmon escapement samples, 2006–2010.

Year	River	Gear	Fish number	Head number	Head CWT	Dorsal CWT	Season tagged	Comment
2006	Low. Chilkat	FW	8	252,402	Y	N	Fall	
2006	Low. Chilkat	FW	18	252,403	Y	N	Fall	Head lost in the field
2006	Low. Chilkat	FW	35	252,404	Y	Y	Spring	
2006	Low. Chilkat	FW	83	252,406	Y	N	Fall	
2006	Low. Chilkat	FW	108	252,408	Y	Y	Spring	
2006	Tahini	Dip net	219	254,187	Y	Y	Spring	
2006	Tahini	Carcass	271	254,371	Y	N	Fall	
2006	Tahini	Carcass	296	254,374	Y	N	Fall	
2006	Tahini	Snag	302	254,375	Y	N	Fall	
2006	Tahini	Snag	306	254,376	Y	N	Fall	
2006	Tahini	Snag	308	254,377	Y	N	Fall	
2006	Kelsall	GN	28	-	Y	N	Fall	Head not taken
2006	Kelsall	Carcass	303	254,246	Y	N	Fall	
2006	Big Boulder	Snag	68	254,231	Y	Y	Spring	
2007	Low. Chilkat	FW	9	252,481	Y	**Y**	**Fall**	**Wand false +**
2007	Low. Chilkat	FW	17	252,482	Y	N	Fall	
2007	Tahini	Snag	12	55,651	Y	N	Fall	Head lost in the field
2007	Tahini	GN	15	56,652	Y	N	Fall	
2007	Tahini	Snag	61	56,653	Y	N	Fall	
2007	Tahini	GN	69	56,654	Y	N	Fall	
2007	Tahini	Dip net	121	56,656	Y	N	Fall	
2007	Tahini	Hand	151	56,657	Y	N	Fall	
2007	Tahini	GN	176	56,658	Y	Y	Spring	
2007	Tahini	GN	185	56,659	Y	N	Fall	
2007	Tahini	Hand	198	56,660	Y	N	Fall	
2007	Big Boulder	Snag	10	60,891	Y	Y	Spring	
2007	Big Boulder	Snag	12	60,892	Y	Y	Spring	
2007	Big Boulder	Dip net	14	60,893	Y	Y	Spring	

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Year	River	Gear	Fish number	Head number	Head CWT	Dorsal CWT	Season tagged	Comment
2008	Low. Chilkat	FW	142	-	Y	Y	Spring	Head not taken
2008	Low. Chilkat	GN	23	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	27	-	Y	Y	Spring	Head not taken
2008	Low. Chilkat	GN	47	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	57	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	60	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	66	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	93	-	Y	N	Fall	Head not taken
2008	Low. Chilkat	GN	104	-	Y	N	Fall	Head not taken
2008	Tahini	Snag	8	-	Y	Y	Spring	Head not taken
2008	Tahini	GN	21	-	Y	N	Fall	Head not taken
2008	Tahini	GN	31	-	Y	N	Fall	Head not taken
2008	Tahini	GN	54	-	Y	N	Fall	Head not taken
2008	Tahini	GN	120	-	Y	N	Fall	Head not taken
2008	Tahini	GN	122	-	Y	N	Fall	Head not taken
2008	Tahini	Carcass	147	56,684	Y	N	Fall	
2008	Tahini	Carcass	150	56,685	Y	N	Fall	
2008	Tahini	Dip net	173	-	Y	N	Fall	Head not taken
2008	Tahini	GN	190	56,687	Y	N	Fall	
2008	Tahini	GN	205	-	Y	N	Fall	Head not taken
2008	Tahini	Carcass	208	56,689	Y	N	Fall	
2008	Tahini	Carcass	227	56,690	Y	N	Fall	
2008	Tahini	Carcass	247	56,691	Y	N	Fall	
2008	Kelsall	GN	3	56,734	Y	N	Fall	
2008	Kelsall	GN	29	-	**N**	N	Fall	Head not taken **Head CWT loss**
2008	Kelsall	Carcass	182	56,739	Y	N	Fall	
2008	Big Boulder	Snag	10	-	Y	Y	Spring	Head not taken
2008	Lit. Boulder	Snag	45	-	Y	Y	Spring	Head not taken
2008	Lit. Boulder	Snag	78	-	Y	N	Fall	Head not taken
2008	Lit. Boulder	Snag	83	-	Y	N	Fall	Head not taken

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Year	River	Gear	Fish number	Head number	Head CWT	Dorsal CWT	Season tagged	Comment
2009	Low. Chilkat	FW	2	-	Y	Y	Spring	Head not taken
2009	Low. Chilkat	FW	50	-	Y	N	Fall	Head not taken
2009	Low. Chilkat	FW	114	-	Y	Y	Spring	Head not taken
2009	Low. Chilkat	FW	169	-	Y	N	Fall	Head not taken
2009	Low. Chilkat	FW	227	-	Y	N	Fall	Head not taken
2009	Low. Chilkat	GN	11	-	Y	Y	Spring	Head not taken
2009	Low. Chilkat	GN	48	-	Y	N	Fall	Head not taken
2009	Low. Chilkat	GN	95	-	Y	Y	Spring	Head not taken
2009	Tahini	GN	7	-	Y	N	Fall	Head not taken
2009	Tahini	Dip net	110	-	Y	N	Fall	Head not taken
2009	Tahini	Snag	112	-	Y	N	Fall	Head not taken
2009	Tahini	Dip net	154	343,049	Y	Y	Spring	
2009	Tahini	Snag	176	343,050	Y	N	Fall	
2009	Tahini	Carcass	197	343,051	Y	Y	Spring	
2009	Tahini	Carcass	243	343,029	Y	N	Fall	
2009	Tahini	Carcass	253	343,031	Y	N	Fall	
2009	Tahini	Carcass	256	343,032	Y	N	Fall	
2009	Tahini	Carcass	284	343,034	Y	N	Fall	
2009	Tahini	Carcass	369	343,040	Y	**Y**	**Fall**	**Wand false +**
2009	Tahini	Carcass	374	343,041	Y	N	Fall	
2009	Tahini	Carcass	396	343,053	Y	N	Fall	
2009	Tahini	Carcass	423	343,056	Y	N	Fall	
2009	Tahini	Carcass	461	343,058	Y	N	Fall	
2009	Tahini	Carcass	462	343,059	Y	N	Fall	
2009	Tahini	Carcass	499	343,103	Y	**N**	**Spring**	**Wand false –**
2009	Tahini	Carcass	504	343,104	Y	N	Fall	
2009	Tahini	Carcass	517	343,105	Y	N	Fall	
2009	Tahini	Carcass	527	343,107	Y	N	Fall	
2009	Kelsall	Carcass	18	343,101	Y	N	Fall	
2009	Big Boulder	Dip net	1	-	Y	Y	Spring	Head not taken
2009	Big Boulder	Snag	13	343,062	Y	Y	Spring	
2009	Big Boulder	Snag	47	-	Y	N	Fall	Head not taken
2009	Lit. Boulder	Snag	62	-	Y	Y	Spring	Head not taken
2009	Lit. Boulder	Dip net	66	343,065	Y	Y	Spring	
Total fall tag code or dorsal CWT absent (fall tagged fish)							68	
Total spring tag code or dorsal CWT present (spring tagged fish)							24	

Note: The season tagged was verified by the tag code for 53 fish whose heads were taken, assigned a head number, and tags recovered by the CWT Lab.

APPENDIX E

Appendix E1.–WinBUGS code and results of Bayesian statistical analysis of brood year (BY) 2003 Chinook salmon juvenile abundance, using results of handheld wand scans for dorsal CWT presence/absence.

prior distributions for root nodes underlined

fixed constants in bold

deterministic relationships in plain text (these link the priors and the likelihoods, or calculate auxiliary quantities)

likelihood (sampling distribution of data) in italics

BY 2003 constants

adclips <- 93 **# ad clips found in Chilkat escapement**

heads <- 92 **# fish scanned with wand (this is actually not relevant here)**

valid.tags <- 92 **# tag event assigned by wand/age sampling or Tag Lab**

MODEL {

falseneg~ dbeta(falsenegDorsal, correct.ID.Dorsal)# false negative dorsal CWT detection rate in spring fish

falsepos~ dbeta(falseposDorsal, correct.ID.NoDorsal) # false positive dorsal CWT detection rate in fall fish

N.parr ~ dnorm(0,1.0E-12) # abundance of parr in fall 2004

phi.1 ~ dbeta(0.30,0.30) # proportion of parr surviving until spring 2005

rho ~ dbeta(0.1,0.1) # proportion of adipose finclipped fish for which tag event was assigned

M.parr <- 37,245 **# number of parr marked in fall 2004**

M.smolt <- 5,808 **# number of smolts marked in spring 2005**

C <- sum(R.tags[]) **# number of fish inspected in Chilkat escapement for adipose finclips**

m<-36 **# number of all Chilkat CWTs recovered in marine fisheries**

N.smolt <- N.parr * phi.1 # abundance of smolt in spring 2005

q.fall <- M.parr / N.parr # fraction marked in fall 2004

q.spring <- M.smolt / N.smolt # fraction marked in spring 2005

pi[1] <- ((1+falsepos)*q.fall-falseneg*q.spring)*rho # adjusted fraction assigned to fall event

pi[2] <- ((1+falseneg)*q.spring-falsepos*q.fall)*rho # adjusted fraction assigned to spring event

pi[3] <- (q.fall + q.spring) * (1 - rho) # fraction of returning fish with adipose fin clip, but tag event not assigned

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```
pi[4] <- 1 - pi[1] - pi[2] - pi[3]           # fraction of returning fish with no adipose fin clip
R.tags[1:4] ~ dmulti(pi[],C)             # vector of returns by type is multinomially distributed
pi.fall <- q.fall / (q.fall + q.spring) # fraction of fall tags among Chilkat CWTs in marine fisheries
m.fall ~ dbin(pi.fall,m)                    # number of fall tags among Chilkat tags is binomially distributed
}
```

DATA

```
list(falsenegDorsal=4, correct.ID.Dorsal=56,falseposDorsal=11,correct.ID.NoDorsal=178,
R.tags= c(68,24,1,1100), m.fall=27)
# Data terms are:
  # a.) Calendar year 2006-2010 Chilkat escapement sampling results: false negative (4) and correct (56)
  # dorsal CWT present in spring fish, false positive (11) and correct (178) dorsal CWT absent in fall fish;
  # b.) BY 2003 Chilkat escapement sampling results: 68 fish assigned fall, 24 fish assigned spring, 1 fish
  # not assigned, 1100 fish with intact adipose fins;
  # c.) BY 2003 marine recoveries of Chilkat fall CWTs: 27.
```

INITS

```
list(N.parr =645000, phi.1=0.5, rho=0.9, falseneg=0.07, falsepos=0.06)
```

RESULTS

node	mean	sd	MC error	2.5%	10.0%	median	90.0%	97.5%	start	sample
N.parr	668,000	75,490	306	536,000	575,700	662,900	767,400	831,100	4,001	396,000
N.smolt	284,800	49,870	89	203,300	225,900	279,400	350,100	397,300	4,001	396,000
phi.1	0.4304	0.0834	0.00022	0.29380	0.3323	0.4216	0.5396	0.6187	4,001	396,000
pi[1]	0.0575	0.0065	0.00003	0.04549	0.0493	0.0573	0.0660	0.0710	4,001	396,000
pi[2]	0.0190	0.0036	0.00001	0.01259	0.0146	0.0188	0.0238	0.0267	4,001	396,000
pi[3]	0.0009	0.0009	0.00000	0.00003	0.0001	0.0007	0.0020	0.0032	4,001	396,000
pi[4]	0.9225	0.0077	0.00003	0.90670	0.9125	0.9228	0.9322	0.9370	4,001	396,000
rho	0.9882	0.0111	0.00003	0.95870	0.9736	0.9915	0.9985	0.9996	4,001	396,000
falseneg	0.0681	0.0324	0.00006	0.01927	0.0307	0.0634	0.1117	0.1439	4,001	396,000
falsepos	0.0563	0.0164	0.00003	0.02864	0.0364	0.0548	0.0781	0.0925	4,001	396,000

Note: Wand scan error rates from 2005–2011 Chilkat River Chinook salmon escapement sampling were used to adjust proportions of BY 2003 fish CWT tagged in fall 2004 and spring 2005.

Appendix E2.–Alternate WinBUGS code and results of Bayesian statistical analysis of brood year 2003 Chinook salmon juvenile abundance, using coded wire tag (CWT) data restricted to heads taken from sacrificed fish.

prior distributions for root nodes underlined

fixed constants in bold

deterministic relationships in plain text (these link the priors and the likelihoods, or calculate auxiliary quantities)

likelihood (sampling distribution of data) in italics

BY 2003 constants

adclips <- 93	**# fish with adipose fin clips found in Chilkat escapement**
heads <- 53	**# heads collected from adipose finclipped fish**
valid.tags <- 53	**# CWTs decoded by Tag Lab**

Model

{N.parr ~ dnorm(0,1.0E-12)	# abundance of parr in fall 2003
phi.1 ~ dbeta(0.3,0.30)	# proportion of parr surviving until spring 2004
rho ~ dbeta(0.1,0.1)	# proportion of adipose finclipped fish with decoded CWT
M.parr <- 37,245	**# parr marked**
M.smolt <- 5,808	**# smolts marked**
C <- sum(R.tags[])	**# fish inspected in Chilkat escapement for adipose fin clips**
m<-36	**# number of Chilkat CWTs recovered elsewhere, fall and spring**
N.smolt <- N.parr * phi.1	# abundance of smolt in spring
q.fall <- M.parr / N.parr	# fraction tagged in fall
q.spring <- M.smolt / N.smolt	# fraction tagged in spring
pi[1] <- q.fall*rho	# fraction of return from which we expect a valid fall tag
pi[2] <- q.spring*rho	# fraction of return from which we expect a valid spring tag
pi[3] <- (q.fall + q.spring) * (1 - rho)	# fraction of return with adipose fin clip, but tag not decoded
pi[4] <- 1 - pi[1] - pi[2] - pi[3]	# fraction of return with no adipose fin clip
R.tags[1:4] ~ dmulti(pi[],C)	*# vector of returns by type is multinomially distributed*
pi.fall <- q.fall / (q.fall + q.spring)	# fraction of fall tags among all Chilkat CWTs in marine fisheries
m.fall ~ dbin(pi.fall,m)	*# number of fall tags among all Chilkat CWTs is binomially distributed* }

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DATA

list(R.tags=c(40,13,40,1100),m.fall = 27) # Data terms are sampling results: 40 fall tags, 13 spring tags, 40 heads with tags not decoded, and 1,100 fish with intact adipose fins in the escapement, 27 marine fishery recoveries.

INITS

list(N.parr =645,000, phi.1=0.5, rho=0.6)

RESULTS

node	mean	sd	MC error	2.5%	10.0%	median	90.0%	97.5%	start	sample
N.parr	636,000	75,980	350	504,000	543,300	630,500	736,200	802,100	4,001	396,000
N.smolt	340,300	84,460	264	215,200	246,300	325,600	456,300	548,600	4,001	396,000
phi.1	0.5444	0.1574	0.00065	0.31380	0.3702	0.5157	0.7645	0.9664	4,001	396,000
pi[1]	0.0338	0.0050	0.00002	0.02476	0.0276	0.0336	0.0404	0.0444	4,001	396,000
pi[2]	0.0103	0.0026	0.00001	0.00585	0.0071	0.0101	0.0137	0.0159	4,001	396,000
pi[3]	0.0333	0.0052	0.00001	0.02394	0.0269	0.0331	0.0401	0.0442	4,001	396,000
pi[4]	0.9226	0.0077	0.00003	0.90680	0.9125	0.9228	0.9323	0.9370	4,001	396,000
rho	0.5696	0.0510	0.00008	0.46810	0.5037	0.5701	0.6349	0.6681	4,001	396,000

APPENDIX F

Appendix F1.– Summary of Chilkat Chinook salmon stock assessment parameters from coded wire tag studies, brood years 1988–1989, 1991, and 1999–2003.

PARAMETER ESTIMATES												
				Marked	Harvest (≥age-1.1)			≥Age-1.2				
Brood year (BY)	Fall parr	Overwinter survival, %	Smolt	fraction, inriver	Commercial	Sport	Subsistence	Total harvest	Inriver return	Total return	Exploitation, %	Smolt to ≥age-1.2 survival, %
1988[a]	ND	ND	ND	0.037	910	719	9	1,638	7,111	8,749	18.7	ND
1989[a]	ND	ND	ND	0.110	283	373	27	683	6,233	6,916	9.9	ND
1991[b]	ND	ND	ND	0.048	681	374	58	1,006	11,900	12,906	7.8	ND
1998[c]	ND	ND	123,680	0.015	191	849	ND	1,040	3,596	4,636	22.4	3.7
1999[d]	386,400	36.4	139,500	0.113	589	972	252	1,572	4,764	6,336	24.8	4.5
2000[e]	510,700	21.1	105,300	0.102	414	353	236	990	4,173	5,163	19.2	4.9
2001[f]	596,410	24.9	148,800	0.076	407	304	192	821	4,561	5,382	15.3	3.6
2002[g]	509,700	38.8	194,000	0.106	254	124	2	380	1,577	1,957	19.4	1.0
2003[h]	668,000	43.0	284,800	0.078	719	355	81	1,125	5,519	6,644	16.9	2.3
BY 1999–2003 average	534,242	32.9	174,800	0.095	477	422	153	978	4,119	5,096	19.1	3.3

STANDARD ERRORS												
				Marked	Harvest (≥age-1.1)			≥Age-1.2				
Brood year (BY)	Fall parr	Overwinter survival, %	Smolt	fraction, inriver	Commercial	Sport	Subsistence	Total harvest	Inriver return	Total return	Exploitation, %	Smolt to ≥age-1.2 survival, %
1988[a]	ND	ND	ND	0.009	235	327	1	403	789	885	NE	ND
1989[a]	ND	ND	ND	0.019	74	132	2	152	781	796	NE	ND
1991[b]	ND	ND	ND	0.008	176	124	2	210	1,167	1,186	NE	ND
1998[c]	ND	ND	30,554	NE	190	706	ND	731	488	879	12.5	1.2
1999[d]	38,020	6.5	21,920	0.009	108	550	78	541	562	780	6.7	0.9
2000[e]	74,290	4.8	17,170	0.010	107	161	86	211	681	713	4.2	1.0
2001[f]	87,540	10.1	49,770	0.002	130	126	139	222	727	760	4.1	1.3
2002[g]	81,390	10.6	47,020	0.015	77	52	0	93	234	252	4.5	0.2
2003	75,490	8.3	49,870	0.008	118	116	60	226	657	695	3.3	0.5

Note: ND = no data.

Note: NE = not estimated.

[a] Data from Ericksen (1996)

[b] Data from Ericksen (1999)

[c] Data from Ericksen and Chapell (2006)

[d] Data from Chapell (2009)

[e] Data from Chapell (2010)

[f] Data from Chapell (2012)

[g] Data from Chapell (2013).

[h] Data from Tables 16, 19, 21.

APPENDIX G

Appendix G1.–Computer data files used in the analysis of this report.

FILE NAME	DESCRIPTION
10FallChinookCWT.xls	Excel workbook containing trapping, length sampling, and sequential tag number data from BY 2009 Chinook salmon CWT project in fall 2010.
11SpringChinookCWT.xls	Excel workbook containing trapping, length and weight sampling data from BY 2009 Chinook salmon CWT project in spring 2011.
2010 Haines creel interview.dta	ASCII file containing edited angler interview data from the Haines marine sport fishery in 2010.
Haines Marine Creel 2010v3a.sas	SAS program to estimate effort and harvest in the 2010 Haines marine sport fishery using 2010 Haines creel interview.dta.
10KingsTagged.xls	Excel workbook containing raw data from Chinook salmon captured in the lower Chilkat River during 2010.
10KingSpawningSamples.xls	Excel workbook containing raw data from Chinook salmon sampled on the Chilkat River spawning tributaries during 2010.
10KingHainesSportSubsAWL.xls	Excel workbook containing raw data from Chinook salmon sampled in Haines marine sport and subsistence fisheries during 2010.