Fishery Data Series No. 13-12

Production, Escapement, and Juvenile Tagging of Chilkat River Chinook Salmon in 2009

by

Richard S. Chapell

April 2013

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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by

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ABSTRACT

The purposes of this study were to estimate the 2009 sport harvest and inriver run of Chilkat River Chinook salmon *Oncorhynchus tshawytscha*, to estimate the production of brood year 2002 Chilkat River Chinook salmon, and to document the coded wire tagging of brood year 2008 Chilkat River Chinook salmon. Angler effort and harvest of Chinook salmon in the spring 2009 Haines marine boat sport fishery were estimated using an onsite creel survey. A stratified mark–recapture experiment was used to estimate the 2009 inriver run of Chilkat River Chinook salmon. Juvenile abundance and marine harvest of brood year 2002 Chilkat River Chinook salmon were estimated through coded wire tag recoveries.

An estimated 7,267 angler-h (SE = 520) of salmon effort in the 2009 Haines marine sport fishery yielded a harvest of 143 (SE = 12) large Chinook salmon (≥28 in TL), of which 80 (SE = 10) were wild, mature fish.

Between June 10 and August 3, a total of 338 Chinook salmon were marked and released in the lower Chilkat River: 195 large (age-1.3 and older), 59 medium (age-1.2), and 84 small (age-1.1) fish. In spawning tributaries, 609 large, 117 medium, and 8 small Chinook salmon were examined. Of the captured fish, 25 large, 6 medium, and 0 small fish were marked. An estimated 4,429 (SE = 747) large Chinook salmon and 3,357 (SE = 582) medium and small fish immigrated into the Chilkat River during 2009.

In fall 2003, an estimated 509,700 (SE = 81,390) brood year 2002 parr reared in the Chilkat River drainage. Overwinter survival was estimated at 38.8% (SE = 10.6%), and an estimated 194,000 (SE = 47,020) smolts emigrated in 2004. An estimated 380 (SE = 93) brood year 2002 fish were harvested in marine fisheries between 2005 and 2009. From brood year 2008, 15,997 parr in fall 2009 and 996 smolts in spring 2010, 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 km² (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 2009–2012). 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 area 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 (Neimark 1985; Mecum and Suchanek 1986, 1987; Bingham et al. 1988; Suchanek and Bingham 1989–1991; Ericksen 1994–2001, 2002a, 2003–2005). 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 and 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.

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 radio telemetry and mark-recapture experiments in 1991, 1992, and 2005 to estimate spawning distribution and the inriver run of large (age-1.3 and older, i.e., fish ≥660 mm MEF) Chilkat River Chinook salmon.

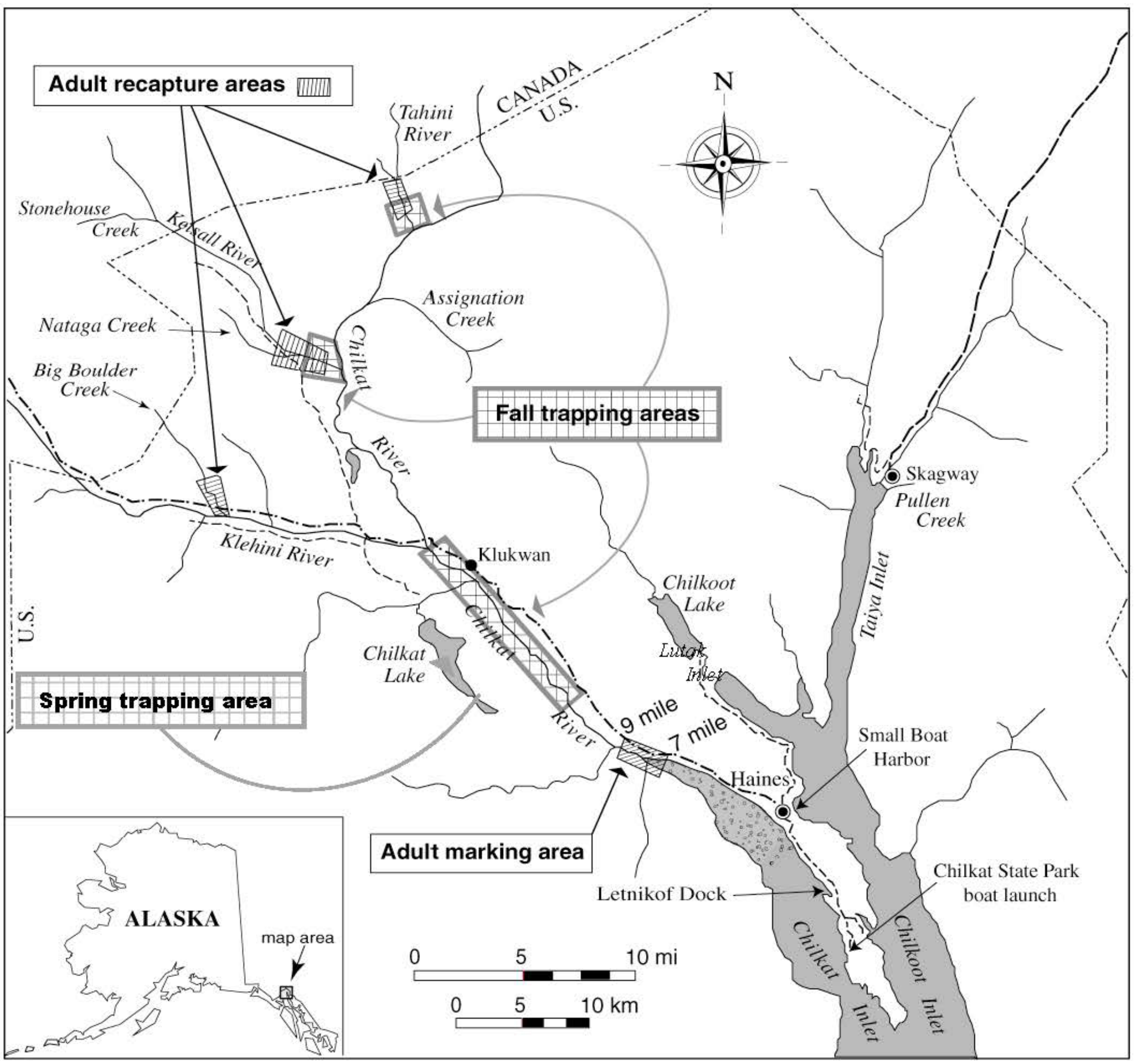


Figure 1.–Location of adult and juvenile Chinook salmon capture, sampling, and release sites near Haines and Skagway in Southeast Alaska, 2009.

Most Chinook salmon spawned in two major tributaries of the Chilkat River, the Kelsall and Tahini Rivers, and immature fish are harvested primarily in the inside waters of Southeast Alaska (Johnson et al. 1992, 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006; Chapell 2009–2012). 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 2009–2012).

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 2002b). To increase the number of CWT-tagged Chilkat River Chinook salmon, DSF began tagging juvenile Chinook salmon (parr) beginning in the fall of 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 in 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 2009–2012).

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.

This report describes the methods and results of the Haines area marine Chinook salmon creel survey in 2009, the inriver adult Chinook salmon mark-recapture study in 2009, the tagging of juvenile Chinook salmon from BY 2008 in fall 2009 and spring 2010, and the smolt production and harvest of BY 2002 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 2009;
2. the age, sex, and length compositions of the inriver run of large Chinook salmon in the Chilkat River in 2009;
3. the harvest of wild mature Chinook salmon in the Haines spring marine boat sport fishery from May 4 to June 21, 2009;
4. the mean length of Chinook salmon parr rearing in the Chilkat River drainage during fall 2009;

5. the mean length and weight of Chinook salmon smolts leaving the Chilkat River drainage in spring 2010;
6. the Chilkat River Chinook salmon smolt abundance in 2004 (BY 2002); and
7. the marine harvest of Chilkat River Chinook salmon from BY 2002.

METHODS

INRIVER RUN ESTIMATE

A stratified mark-recapture experiment was used to estimate the inriver abundance of Chilkat River Chinook salmon in 2009. This estimate was germane to the time of marking at the event 1 site (Figure 1). The 2009 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

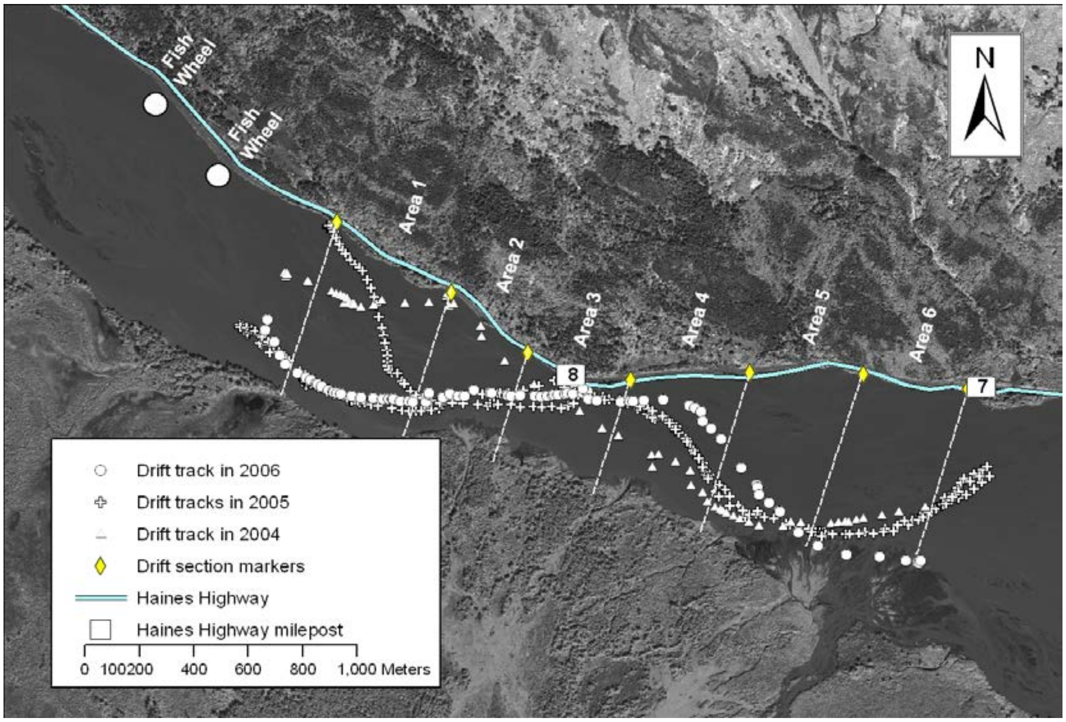
Gillnets 21.3 m long and 3.0 m deep (70 ft × 10 ft) were drifted daily in the lower Chilkat River from June 10 through July 24, 2009. The gillnets consisted of two equal-length panels: one of 17.1 cm (6.75 in) and the other of 20.3 cm (8.0 in) stretch measured nylon mesh. Forty-three (43) drifts were completed between 0600 and 1400 hours each day. Fishing was conducted from a 5.5 m (18 ft) boat in six 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. Fishing continued uninterrupted from area to area when fish were not captured. 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 three-basket aluminum fish wheels were operated by the ADF&G Division of Commercial Fisheries (DCF) to tag sockeye *O. nerka*, coho *O. kisutch*, and chum salmon *O. keta* from June 11 to October 9, 2009; incidentally captured Chinook salmon were also marked. One fish wheel operated adjacent to Haines Highway milepost (MP) 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 MP 8 at 0900 hours each day.

Captured Chinook salmon were placed in a water-filled tagging box (Johnson 1994: Figure 3), 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 and 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 (LAA). This tertiary mark identified the event 1 capture gear (fish wheel or gillnet) in the event of primary tag loss.



Note: Area markers remained the same and similar drift paths were followed in 2009.

Figure 2.–Event 1 fish wheel locations and drift gill net paths in the lower Chilkat River, 2004–2006.

The scale sampling procedure was to remove five 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 two 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 postseason by counting the scale annuli (Olsen 1992). When scale ageing results were available, 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 were classified as small. Any fish whose scales could not be aged was classified by length as described above.

Event 2 – Recapture

During the recapture event, Chinook salmon were captured in spawning tributaries using gillnets, dip nets, snagging gear, by hand, or by spear. The Kelsall River, including Nataga Creek, and the Tahini River were each sampled by a two-person crew 5 d/wk (Monday through Friday) during August 3–September 2, 2009 (Figure 1). Klehini River tributaries Big Boulder Creek, Little Boulder Creek, and 37-Mile Creek were sampled about every five 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 (LLOP) 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 post-spawning condition. Collected heads were marked with individually numbered straps and sent to the Tag Lab 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 disproportionately between marked and unmarked fish 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 versus 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 three ways:

(a) fish marked in event 1 versus marked fish recaptured in event 2 (M versus R);

(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C versus R); and

(c) fish marked in event 1 versus all fish captured in event 2 (M versus 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):

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

and

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

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 1995–2001, 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009–2012). 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 1995–2001, 2002a, 2003–2005).

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:

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

and

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

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:

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

and

$$var[\hat{N}_a] = var[\hat{p}_a]\hat{N}^2 + var[\hat{N}]\hat{p}_a^{\ 2} - var[\hat{p}_a]var[\hat{N}]. \tag{6}$$

The abundance estimate of large fish (age-1.3 and older) 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 sample in three comparisons, similar to comparisons of length distributions:

(a) fish marked in event 1 versus those recaptured in event 2 (M versus R);

(b) all fish captured in event 2 versus marked fish recaptured in event 2 (C versus R); and

(c) fish marked in event 1 versus all fish captured in event 2 (M versus 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 using:

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

and

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

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

2009 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 non-derby, were created for the biweek that included the five days of the Haines King Salmon Derby, May 23–25 and May 30–31. 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 2206 to 2351 hours over the seven weeks of the survey. Midday was defined as the time mid-way 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, anglers landing their catch at the high-use Letnikof Cove dock site accounted for 59%–86% of the total harvest of Chinook salmon, the low-use Small Boat Harbor site 12%–39%, and the rarely used Chilkat State Park boat launch 1%–5%. The rare use trend at the Chilkat State Park site prompted a method change in 2009 from previous years of the Haines marine creel survey (Ericksen 1994–2001, 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009–2012). In 1993–2008, the Chilkat State Park site was sampled as one of two low-use harbors, but with a survey start date delayed in some years by one temporal stratum relative to the Small Boat Harbor. 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.

Sampling at Letnikof Cove dock occurred May 4–June 21 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 morning and two evening strata were sampled each week, except as noted below. During the peak weeks of the fishery (May 4–June 7), the evening strata at Letnikof Cove dock were further divided into weekday and weekend strata. During this time, two morning, two weekday evening, and two weekend/holiday evening periods were sampled each week. During the week of June 8–14, two morning and three evening periods were sampled. The May 18–31 biweek, which included the five Haines King Salmon Derby days, was divided into a nine-day non-derby stratum and a five-day derby stratum. Three of five morning derby and three of five evening derby periods were sampled. Three of nine morning non-derby and three of nine evening non-derby periods were sampled. In total, 17 unique strata were sampled at Letnikof Cove dock in 2009.

Sampling at the low-use Small Boat Harbor site took place May 4–June 21. There was no weekday/weekend stratification. Each biweekly period was divided into 14 morning and 14 evening periods of equal length; three morning and three evening periods were sampled each biweek, except May 18–31. That biweek, which included the five Haines King Salmon Derby days, was divided into a nine-day non-derby stratum and a five-day derby stratum. Two of nine morning non-derby periods and two of nine evening non-derby periods were sampled. The derby stratum was not further stratified by time of day, and two of 10 derby periods were sampled. In total, nine unique strata were sampled at the Small Boat Harbor site in 2009.

The Chilkat State Park boat launch site was sampled during one five-day stratum of Haines King Salmon Derby days, May 23–25 and 30–31. With no time of day stratification, two of 10 periods were sampled.

Random selections determined which primary units to sample within each stratum at all three sites. To accommodate the impossibility of sampling three sites simultaneously with two technicians who could sample one period each per day, eight 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 non-salmon species or using non-trolling 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 all harvested Chinook salmon for maturity and missing adipose fins. Maturity was determined by either observing external secondary characteristics (Ericksen 1994: Appendix A) or observing the 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):

$$\hat{H}_h = D_h \overline{H}_h , \quad (9)$$

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

and

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \quad (11)$$

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:

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

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 ΣH_h and $\Sigma var[H_h]$. 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 sampled 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:

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

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

$$\text{var}(\hat{p}_a) \cong \hat{H}^{-2} \sum_h \hat{H}_h^2 \, \text{var}(\hat{p}_{a,h}) + \hat{H}^{-2} \sum_h \text{var}(\hat{H}_h)(\hat{p}_{a,h} - \hat{p}_a)^2 , \quad (14)$$

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 2009 Haines Marine Sport Fishery

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

The contribution of all CWT-tagged stocks to the 2009 Haines marine boat sport fishery was estimated:

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

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 bi-week.

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

JUVENILE TAGGING

Juvenile Chinook salmon from BY 2008 were captured using minnow traps in the Chilkat River drainage during the fall of 2009 (parr) and in the mainstem of the Chilkat River during the spring of 2010 (smolt). Each juvenile Chinook salmon was marked with an adipose fin clip and a CWT then released close to the capture site. Smolts tagged in the spring 2010 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 2009, trapping began in upriver locations and moved downstream as the season progressed (Figure 1). The Tahini River was trapped September 19–25, the Kelsall River October 1–9, and the Chilkat River from the mouth of the Kelsall River down to Haines Highway MP 13 October 16–29. In spring 2010, the lower Chilkat River (MP 5–21) was trapped April 9–May 26.

A crew consisting of four 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 2009, every 100th fish marked was additionally measured to the nearest mm FL. In spring 2010, 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 Tag Lab at the completion of the field season.

BROOD YEAR 2002 PRODUCTION

Smolt Abundance

Between September 18 and October 30, 2003, 36,640 Chinook salmon parr from BY 2002 were captured, marked with adipose fin clips and CWTs, and released back into the Tahini, Kelsall, and Chilkat rivers (Ericksen 2004). In April and May 2004, an additional 5,707 smolts (also BY 2002) were marked and released into the Chilkat River.

Between 2005 and 2009, 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 Tag Lab on a weekly basis where CWTs were removed and decoded. The annual DCF port sampling manual (*Coded wire tag sampling program detailed sampling instructions, commercial fisheries sampling*, located at Alaska Department of Fish and Game, Division of Commercial Fisheries, 802 3rd Street, Douglas, Alaska) provides a detailed explanation of commercial catch sampling procedures and logistics.

From 2005 to 2009, the number of BY 2002 Chilkat River Chinook salmon CWTs recovered in all marine fisheries (commercial, sport, and subsistence) was tallied by release period, whether fall 2003 or spring 2004, as determined by the tag code read at the Tag Lab.

In Chilkat River escapement sampling during 2005–2009, heads were taken from all Chinook salmon with clipped adipose fins, except large (≥660 mm FL) fish in pre-spawning 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 two 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 and CWTs recovered by the 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 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 2002 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 versus 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 BY 2002 Chilkat River Chinook salmon data to obtain estimates of the number of BY 2002 parr rearing in fall 2003 (N_{PARR}), the overwinter survival to spring 2004 (ϕ_1), the number of smolts outmigrating in 2004 (N_{SMOLT}), 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 2002 Chinook salmon sampled in the Chilkat River from 2005 to 2009 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 2002 Chinook salmon examined for adipose fin clips in the Chilkat River in 2005–2009, 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 that with no wand scan result,

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

$q_{FALL} = M_{PARR} / N_{PARR}$,

$q_{SPRING} = M_{SMOLT} / N_{SMOLT}$,

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 2003,

M_{SMOLT} = number of CWT-tagged smolts released during spring 2004,

falseposDorsal = the number of adult fish known to have been CWT-tagged in the fall that had a positive second CWT scan result in 2005–2011,

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 2005–2011,

falsenegDorsal = the number of adult fish known to have been CWT-tagged in the spring that had a negative second CWT scan result in 2005–2011, and

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 2005–2011.

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 2003 marking event recovered from Chinook salmon sampled elsewhere from 2005 to 2009 was modeled as having a binomial distribution with parameters:

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

and m = number of BY 2002 Chilkat River Chinook salmon fall and spring CWTs recovered in fisheries outside of the Chilkat River from 2005 to 2009.

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 2005 through 2011, 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 (Appendix E1; Gilks et al. 1994), was used to draw samples from the joint posterior probability distribution of all unknowns in the model. 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.

Adult Harvest

Harvest of BY 2002 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 2002 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

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

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.

Data from the port sampling and creel survey programs were used to estimate the commercial and sport harvest of Chinook salmon bound for the Chilkat River following equation 15.[2] The variance of the individual harvest contribution estimates $\{r_i\}$ (by stratum) followed Bernard and Clark (1996: Table 2, situations 3 and 4) for a wild stock harvested in commercial and sport fisheries.

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

$$\hat{T} = \sum_i \hat{r}_i \tag{16}$$

$$\mathrm{v}[\hat{T}] = \sum_i \mathrm{v}[\hat{r}_i] \tag{17}$$

$$SE[\hat{T}] = \sqrt{var[\hat{T}]} \tag{18}$$

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 2002 Chilkat River Chinook salmon was estimated as:

$$\hat{R} = \hat{T} + \hat{S}, \tag{19}$$

$$var[\hat{R}] = var[\hat{T}] + var[\hat{S}], \tag{20}$$

and

$$SE[\hat{R}] = \sqrt{var[\hat{R}]}, \tag{21}$$

[2] Except that, in the case of commercial fisheries, the harvest N is known, not estimated.

where $\hat{S}$ is the total escapement of age-1.2 and older BY 2002 fish estimated between 2006 and 2009.

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

$$\hat{\mu} = \frac{\hat{T}}{\hat{R}} = \frac{\hat{T}}{\hat{S} + \hat{T}}, \tag{22}$$

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

and

$$SE[\hat{\mu}] = \sqrt{var[\hat{\mu}]}, \tag{24}$$

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:

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

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

and

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

RESULTS

INRIVER RUN ESTIMATE

In event 1, 196 large (age-1.3 and older), 65 medium (age-1.2), and 89 small (age-1.1) Chinook salmon were captured in the lower Chilkat River with drift gillnets and fish wheels between June 11 and August 2, 2009 (Table 1, Figure 3). Of those captured, 195 large, 59 medium, and 84 small fish were given a uniquely numbered external tag. The remaining captured fish that were not tagged were: one large mortality, six medium and four small fish with adipose fin clips that were sacrificed to recover CWTs, and one small fish mortality.

The daily number of large Chinook salmon captured peaked on June 26 and on July 10 (Figure 3). The mean of immigration timing was July 5 for large fish and July 6 for all sizes combined (Figures 3 and 4; Mundy 1984).

In event 2, 609 large, 117 medium, and 8 small Chinook salmon were captured on the spawning grounds, of which 25 large, 6 medium, and 0 small fish were marked (Table 2). There was 1 case of primary tag loss, a medium size fish whose intact LAA indicated it had been captured by fish wheel in event 1.

Recapture rates of marked fish were not significantly different (χ^2 = 1.27, df = 1, P = 0.26) for fish marked in the first half of event 1 (165 fish marked June 10–July 4) versus the second half (173 fish marked July 5–July 24), so the Petersen-type model used to estimate the inriver run was not stratified by time. The marked fractions of all sizesof Chinook salmon sampled at the three tributaries (Kelsall 5.0%, Tahini 4.0%, Klehini tributaries 4.7%) were not different (χ^2 = 0.26, df = 2, P = 0.86), so the abundance estimate was not stratified by area.

Size selectivity was evaluated by comparing length distributions using the protocol in Appendix A. The length distribution of Chinook salmon marked in the lower Chilkat River (combined fish wheel and drift gillnet captures) was significantly different (*M* versus *R*, K-S test, D = 0.281, P = 0.018) from that of marked Chinook salmon recaptured on the spawning grounds (Figure 5, top). The length distribution of all fish captured in event 2 was not significantly different (*C* versus *R*, K-S test, D = 0.102, P = 0.918) from that of the marked fish recaptured in event 2 (Figure 5, bottom). 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.

Table 1.–Number of Chinook salmon caught in event 1, lower Chilkat River, by time period, gear type, and age category, June 10–August 3, 2009.

	Drift gillnet			Fish wheels			Combined			
Time period	Large	Med.	Small	Large	Med.	Small	Large	Med.	Small	Total
06/10–06/14	1	2	0	0	0	0	1	2	0	3
06/15–06/19	1	0	0	3	1	0	4	1	0	5
06/20–06/24	19	1	0	10	15[a]	6	29	16	6	51
06/25–06/29	25	4	0	6	8[b]	17	31	12	17	60
06/30–07/04	11	0	0	5	15	22[c]	16	15	22	53
07/05–07/09	17	1	0	19	6	15[d]	36	7	15	58
07/10–07/14	20	2	0	30[e]	6	23[e]	50	8	23	81
07/15–07/19	11	1	0	7	2	5	18	3	5	26
07/20–07/24	7	1	0	4[f]	0	0	11	1	0	12
07/25–07/29	–[g]	–[g]	–[g]	0	0	0	0	0	0	0
07/30–08/03	–[g]	–[g]	–[g]	0	0	1[h]	0	0	1	1
Total	112	12	0	84	53	89	196	65	89	350

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

[a] 3 Med. not tagged.

[b] 3 Med. not tagged.

[c] 1 Small not tagged.

[d] 1 Small not tagged.

[e] 1 Large not tagged, 2 Small not tagged.

[f] 1 Large not tagged.

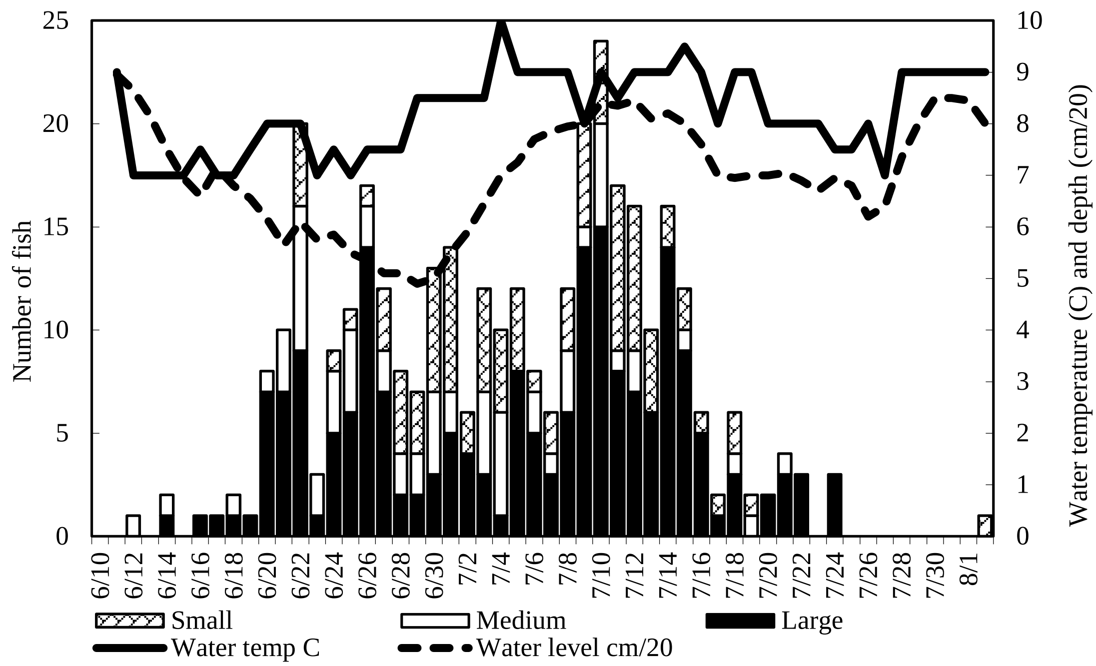
[g] Drift gillnet effort ended July 24,2009

[h] 1 Small not tagged.

Table 2.–Number of Chinook salmon inspected for marks and number of recaptured fish in event 2, by Chilkat River tributary, age category, and sex in 2009.

		Captured									Recaptured					
		Large				Medium			Small		Large			Medium		Small
Tributary	Dates	M	F	U	Total	M	F	Total	M	Total	M	F	Total	M	Total	Total
Kelsall River	08/03–09/01	48	55	0	103	11	0	11	6	6	2	3	5	1	1	0
Tahini River	08/03–09/02	159	269	0	428	90	8	98	2	2	4	12	16	5	5	0
Big Boulder	08/04–09/02	11	23	0	34	4	0	4	0	0	0	2	2	0	0	0
Little Boulder	08/04–09/02	18	24	2	44	4	0	4	0	0	0	2	2	0	0	0
Total		236	371	2	609	109	8	117	8	8	6	19	25	6	6	0

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



Note: Small = (age-1.1), medium = (age-1.2), large = (≥ age-1.3).

Figure 3.–Daily water depth, temperature, and catches of small, medium, and large Chinook salmon in event 1 drift gillnets and fish wheels, June 10–August 2, 2009.

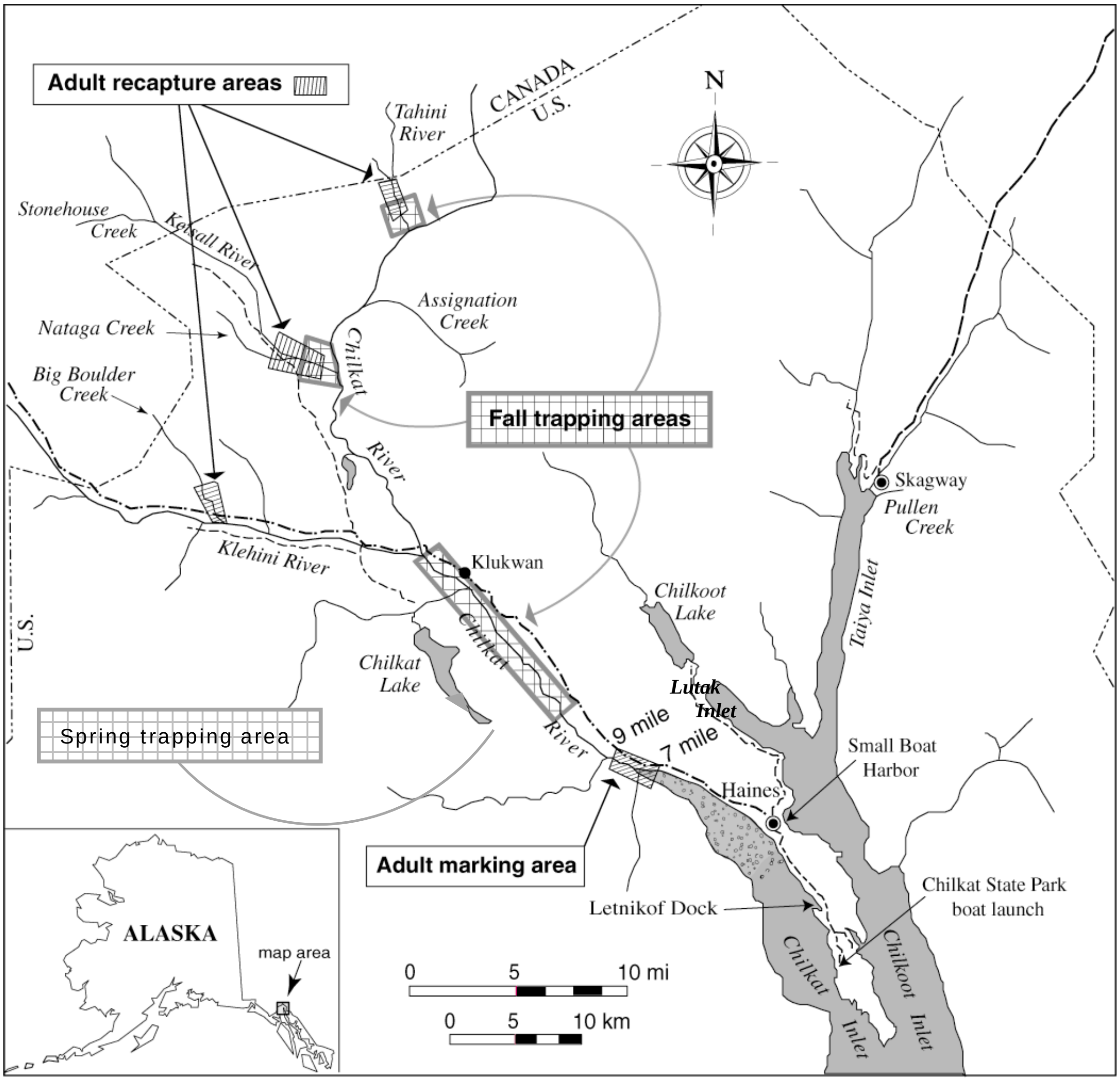


Figure 4.–Location of adult and juvenile Chinook salmon capture, sampling, and release sites near Haines and Skagway in Southeast Alaska, 2009.

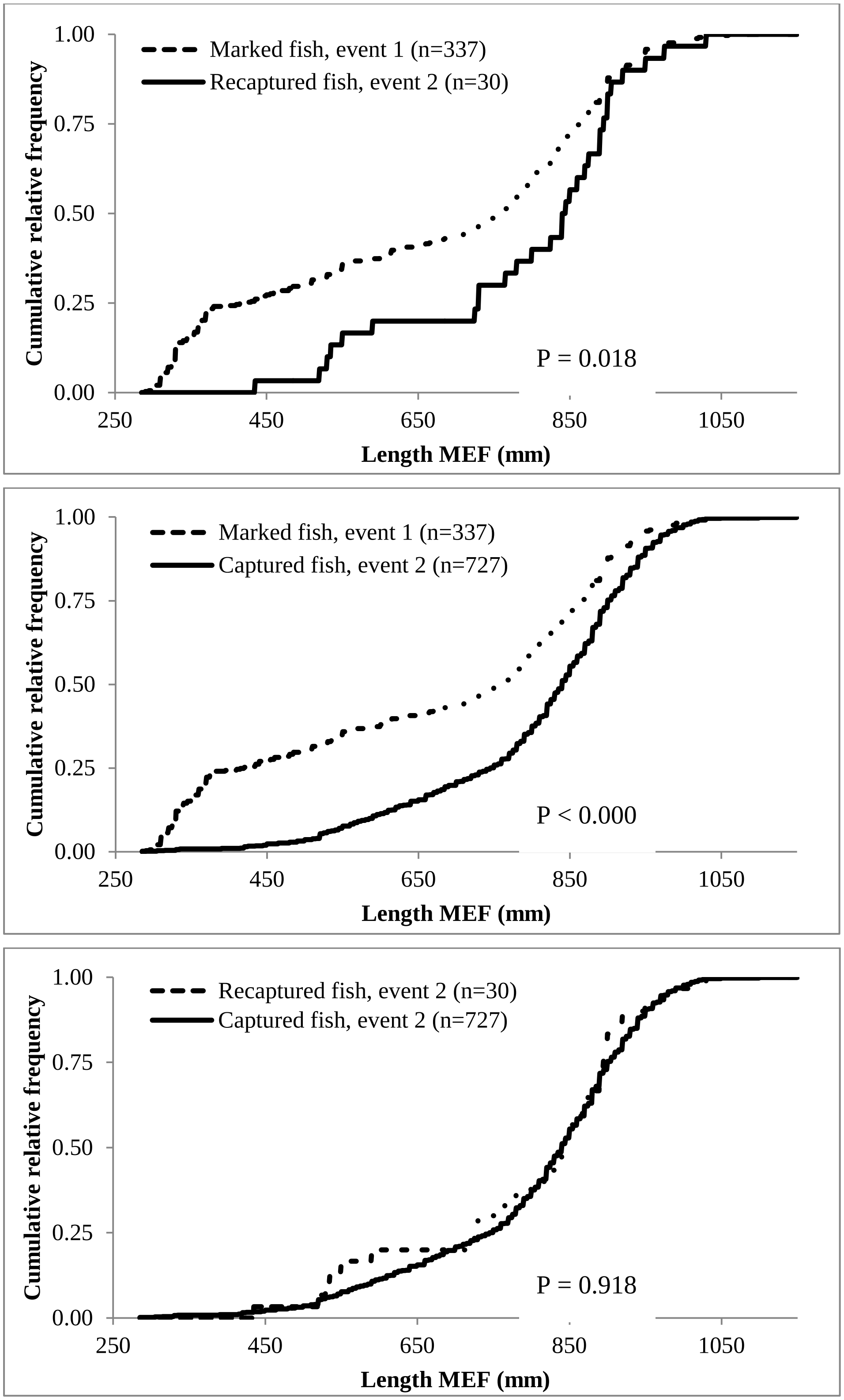


Figure 5.–Empirical cumulative distribution function of MEF lengths of Chilkat River Chinook salmon marked versus recaptured (top), captured versus recaptured (middle), and marked versus captured (bottom), in 2009.

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 3). This fit Case II (Appendix A) in which the abundance estimate should not be stratified by sex, and event 1 data should be used in for sex composition estimates. Sex identification during event 1 has historically been unreliable for this project (Table 4). The 2009 sex identification error rate (10%) was slightly better than historic average rate (13%) for this project.

Table 3.–Contingency table tests for evaluation of sex selectivity in mark-recapture events 1 and 2.

	Number of fish		
	Male	Female	
Marked	209	129	
Captured	353	379	
Recaptured	12	19	
Comparison	χ^2	df	P
Marked versus recaptured	6.32	1	0.01
Captured versus recaptured	1.08	1	0.30
Marked versus captured	17.18	1	<0.01

An estimated 7,785 (SE = 1,261) Chinook salmon of all ages immigrated into the Chilkat River in 2009 (Table 5). This estimate is germane to the time of marking at the event 1 site (Figure 1).

Age, Sex, and Length Composition of the Inriver Run

Chinook salmon captured in event 1 gillnets were predominantly age-1.4 (57.5%) or age-1.3 (33.3%) and classified as female (62.1%, Table 6). Fish captured in the event 1 fish wheels were classified mostly as males (77.0%) and were most frequently age-1.1 (38.3%), age-1.2 (23.8%), or age-1.4 (22.9%). Slightly less than half (60 out of 124) of drift gillnet-caught fish were caught in the large mesh (8 in) panel. The event 1 combined gear age composition was 35.3% age-1.4, 21.6% age-1.3, 18.6% age-1.2, and 24.6% age-1.1.

Following the Case II protocol in Appendix A, the event 1 age and sex proportions were used to estimate the inriver run age composition as 1,911 (SE = 359) age 1.1, 1,445 age 1.2 (SE = 286), 1,678 (SE = 322) age 1.3, 2,751 (SE = 489) age 1.4 (Table 7).

Chinook salmon were sampled from spawning tributaries for age and sex (n = 732). Of those sampled, 693 were successfully aged (Table 8). Age-1.4 female was the most frequent age-sex category in all 3 tributaries. The composition of large, medium, and small fish was different (χ^2 = 18.25, df = 4, P = 0.001) among the three tributaries. The largest difference (χ^2 = 14.15, df = 2, P < 0.001) was between the Tahini and Kelsall rivers, with the proportion of age-1.2 fish on the Tahini River almost double that on the Kelsall River.

TERMINAL HARVEST

2009 Haines Marine Sport Fishery Harvest

The 2009 Haines marine boat creel survey estimates are based on interviews with 369 boat-parties who fished 4,315 angler-h (4,263 salmon-h) (Table 9). The survey estimated that anglers spent a total of 7,405 (SE = 534) angler-h of effort, of which 7,267 (SE = 534) angler-h targeted salmon in the sport fishery during May 4–June 21.The estimated total harvest was 143 (SE = 12) large Chinook salmon, of which 80 (SE = 10) were wild mature fish returning to the Chilkat River. Anglers caught and released an estimated 181 (SE = 31) small (<28 in TL) Chinook salmon, but no harvest of what would have been sublegal fish was encountered by the creel survey. Charter anglers accounted for 4% of the salmon effort (286 salmon-h, SE = 103) and 18% of the large Chinook salmon harvest (33 fish, SE = 8). Most (87%) of the estimated salmon effort was based at Letnikof dock in Chilkat Inlet (Figure 1, Appendix B1–B3).

Creel surveyors sampled 61 Chinook salmon for age, sex, and length in the sport harvest at Letnikof Cove dock and 8 fish at the Haines Small Boat Harbor (Table 10). At Letnikof Cove, 62.4% (SE = 6.1%) of the fish sampled were age-1.4, 36.5% (SE = 6.1%) were age-1.3, and the remainder were age-1.2. At the Haines small boat Harbor, 68.7% (SE = 19.9%) of fish sampled were age-1.3 and the remainder were age-1.2.

Creel survey staff at Letnikof Cove also sampled 11 Chinook salmon harvested in the Chilkat Inlet subsistence gillnet fishery during June 20–July 4. Nearly half (45.5%, SE = 4.1%) of those samples were age-1.2, with the remainder equally split between age-1.3 and age-1.4 (Appendices C1 and C2). Subsistence permit reports totaled 46 Chinook salmon harvested in Chilkat Inlet in 2009 (from a query on DCF Alexander Integrated Fisheries Database November 22, 2011).

Table 4.–Sex determination error rates in recaptured fish, Chilkat River Chinook salmon mark–recapture studies, 1991–2009.

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 (2002a)
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	
1991–2008 average	32	4	0.13	

Table 5.–Unstratified inriver run estimate and sampling statistics of Chilkat River Chinook salmon, 2009.

Marked	Examined	Recaptures	Abundance	
n_1	n_2	m_2	$\hat{N}_a$	SE [$\hat{N}_a$]
338	734	31	7,785	1,261

Table 6.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 1 in the Chilkat River, by gear type, 2009.

		Brood year and age class						
		2006	2005	2004	2003	2002	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
				FISH WHEELS				
Males	Sample size	82	50	18	14	0	164	174
	Percent	50.0	30.5	11.0	8.5			77.0
	SE(%)	3.9	3.6	2.4	2.2			2.8
	Mean length	336	527	787	899			
	SD	26	68	56	64			
Females	Sample size	0	1	14	35	0	50	52
	Percent		2.0	28.0	70.0			23.0
	SE(%)		2.0	6.4	6.5			2.8
	Mean length		650	778	865			
	SD			33	55			
All fish	Sample size	82	51	32	49	0	214	226
	Percent	38.3	23.8	15.0	22.9			
	SE(%)	3.3	2.9	2.4	2.9			
	Mean length	336	529	783	875			
	SD	26	69	47	59			
				DRIFT GILLNET				
Males	Sample size	0	8	20	17	0	45	47
	Percent		17.8	44.4	37.8			37.9
	SE(%)		5.8	7.5	7.3			4.4
	Mean length		593	773	907			
	SD		58	60	89			
Females	Sample size	0	3	20	52	0	75	77
	Percent		4.0	26.7	69.3			62.1
	SE(%)		2.3	5.1	5.4			4.4
	Mean length		613	785	891			
	SD		3	51	52			
All fish	Sample size	0	11	40	69	0	120	124
	Percent		9.2	33.3	57.5			
	SE(%)		2.6	4.3	4.5			
	Mean length		599	779	895			
	SD		49	55	63			
				COMBINED LOWER RIVER GEAR				
Males	Sample size	82	58	38	31	0	209	221
	Percent	39.2	27.8	18.2	14.8			63.1
	SE(%)	3.4	3.1	2.7	2.5			2.6
	Mean length	336	536	780	903			
	SD	26	70	58	78			
Females	Sample size	0	4	34	87	0	125	129
	Percent		3.2	27.2	69.6			36.9
	SE(%)		1.6	4.0	4.1			2.6
	Mean length		623	782	881			
	SD		18	44	55			
All fish	Sample size	82	62	72	118	0	334	350
	Percent	24.6	18.6	21.6	35.3			
	SE(%)	2.4	2.1	2.3	2.6			
	Mean length	336	542	781	887			
	SD	26	71	51	62			

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

Table 7.–Estimated inriver run of Chinook salmon in the Chilkat River, by age and sex, 2009.

	Brood year and age class					
	2006	2005	2004	2003	2002	
	1.1	1.2	1.3	1.4	1.5	Total
Male	1,911	1,352	886	723	0	4,872
SE	359	271	196	169		815
Female	0	93	793	2,028	0	2,914
SE		48	181	377		514
All fish	1,911	1,445	1,678	2,751	0	7,785
SE	359	286	322	489		1,261

Table 8.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 2 in the Chilkat River drainage, by spawning tributary, 2009.

		Brood year and age class						
		2006	2005	2004	2003	2002	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
				KELSALL RIVER				
Males	Sample size	4	11	24	23	0	62	65
	Percent	6.5	17.7	38.7	37.1			54.2
	SE(%)	3.1	4.9	6.2	6.2			4.6
	Mean length	343	513	808	924			
	SD	53	56	68	80			
Females	Sample size	0	0	21	31	1	53	55
	Percent			39.6	58.5	1.9		45.8
	SE(%)			6.8	6.8	1.9		4.6
	Mean length			776	861	920		
	SD			61	46	NA		
All fish	Sample size	4	11	45	54	1	115	120
	Percent	3.5	9.6	39.1	47.0	0.9		
	SE(%)	1.7	2.8	4.6	4.7	0.9		
	Mean length	343	513	793	888	920		
	SD	53	56	66	70	NA		
				TAHINI RIVER				
Males	Sample size	2	86	70	82	0	240	251
	Percent	0.8	35.8	29.2	34.2			47.5
	SE(%)	0.6	3.1	2.9	3.1			2.2
	Mean length	360	585	789	943			
	SD	42	69	86	55			
Females	Sample size	0	8	75	179	1	263	277
	Percent		3.0	28.5	68.1	0.4		52.5
	SE(%)		1.1	2.8	2.9	0.4		2.2
	Mean length		614	804	892	940		
	SD		55	60	52	NA		
All fish	Sample size	2	94	145	261	1	503	528
	Percent	0.4	18.7	28.8	51.9	0.2		
	SE(%)	0.3	1.7	2.0	2.2	0.2		
	Mean length	360	588	797	908	940		
	SD	42	68	74	58	NA		

-continued-

Table 8.–Page 2 of 2.

		Brood year and age class						Total
		2006	2005	2004	2003	2002	Total	sampled[a]
		1.1	1.2	1.3	1.4	1.5	aged	sampled
KLEHINI RIVER								
Males	Sample size	0	8	16	8	0	32	37
	Percent		25.0	50.0	25.0			44.0
	SE(%)		7.8	9.0	7.8			5.4
	Mean length		536	748	859			
	SD		78	78	55			
Females	Sample size	0	0	10	33	0	43	47
	Percent			23.3	76.7			56.0
	SE(%)			6.5	6.5			5.4
	Mean length			769	850			
	SD			41	40			
All fish	Sample size	0	8	26	41	0	75	84
	Percent		10.7	34.7	54.7			
	SE(%)		3.6	5.5	5.8			
	Mean length		536	756	851			
	SD		78	66	43			
COMBINED TRIBUTARIES								
Males	Sample size	6	105	110	113	0	334	353
	Percent	1.8	31.4	32.9	33.8			48.2
	SE(%)	0.7	2.5	2.6	2.6			1.8
	Mean length	348	574	787	933			
	SD	46	72	83	64			
Females	Sample size	0	8	106	243	2	359	379
	Percent		2.2	29.5	67.7	0.6		51.8
	SE(%)		0.8	2.4	2.5	0.4		1.8
	Mean length		614	795	882	930		
	SD		55	60	52	14		
All fish	Sample size	6	113	216	356	2	693	732
	Percent	0.9	16.3	31.2	51.4	0.3		
	SE(%)	0.4	1.4	1.8	1.9	0.2		
	Mean length	348	577	791	899	930		
	SD	46	71	72	61	14		
Sex composition by age class, combined tributaries								
Males	Percent	100	92.9	50.9	31.7		48.2	48.2
	SE(%)		2.4	3.4	2.5		1.9	1.8
Females	Percent		7.1	49.1	68.3	100	51.8	51.8
	SE(%)		2.4	3.4	2.5		1.9	1.8

Note: NA = SD is not applicable.

[a] Total sampled includes 34 large fish that were not assigned a valid age, but excludes 2 large carcasses with undetermined sex.

Table 9.–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 4–June 21, 2009.

	May 4– May 17	May 18–May 31		June 1– June 14	June 15– June 21	Total
		Non-derby	Derby			
Boats counted	50	18	111	165	25	369
Angler-hr. sampled	317	95	2,087	1,583	233	4,315
Salmon-hr. sampled	313	95	2,087	1,535	233	4,263
Chinook sampled	2	0	37	25	5	69
Sampled for adipose clips	2	0	37	25	5	69
Adipose clips	0	0	2	7	2	11
Angler-hours						
Estimate	617	291	3,046	2,908	544	7,405
SE	216	41	282	370	145	534
Salmon-hours						
Estimate	613	291	3,046	2,774	544	7,267
SE	216	41	282	348	145	520
Large Chinook catch						
Estimate	2	0	44	82	17	145
SE	0	0	5	10	5	12
Large Chinook harvest						
Estimate	2	0	44	80	17	143
SE	0	0	5	9	5	12
Wild mature large Chinook harvest (excluding hatchery and immature fish						
Estimate	0	0	25	59	15	80
SE	0	0	5	8	4	10
Small Chinook catch						
Estimate	0	9	33	122	18	181
SE	0	4	8	28	11	31
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Table 10.–Estimated age composition and mean length-at-age (mm MEF) of harvested Chinook salmon in the Haines marine sport fishery by harbor location, May 4–June 21, 2009.

		Brood year and age class						
		2006 1.1	2005 1.2	2004 1.3	2003 1.4	2002 1.5	Total aged	Total sampled[a]
				CHILKAT INLET HARBORS				
Males	Sample size	0	1	10	13	0	24	25
	Mean length		655	748	994			
	SD(length)		NA	49	284			
	Percent male							48.1
	SE(%)							7.0
Females	Sample size	0	0	6	21	0	27	27
	Mean length			771	877			
	SD(length)			75	42			
	Percent female							51.9
	SE(%)							7.0
Unknown	Sample size	0	0	6	2	0	8	9
	Mean length			742	875			
	SD(length)			67	28			
Combined	Sample size	0	1	22	36	0	59	61
	Percent by age		1.1	36.5	62.4			
	SE(%)		1.1	6.1	6.1			
	Mean length		655	753	919			
	SD(length)		NA	60	179			
				SMALL BOAT HARBOR				
Males	Sample size	0	1	3	0	0	4	4
	Mean length		615	723				
	SD(length)		NA	111				
	Percent male							50.0
	SE(%)							18.9
Females	Sample size	0	1	3	0	0	4	4
	Mean length		665	752				
	SD(length)		NA	85				
	Percent female							50.0
	SE(%)							18.9
Combined	Sample size	0	2	6	0	0	8	8
	Percent by age		31.3	68.7				
	SE(%)		19.9	19.9				
	Mean length		64	738				
	SD(length)		35	90				

Note: NA = SD is not applicable.

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

Contribution of Coded Wire Tagged Stocks to the 2009 Haines Marine Sport Fishery

Ten (10) of the 61 Chinook salmon sampled at Letnikof Cove and 1 of 8 fish sampled at Haines Small Boat Harbor had clipped adipose fins, and CWTs were recovered from all 11 heads sent to the Tag Lab (Table 11). Estimated contributions to the Chilkat Inlet sport fishery were 187 (SE = 66) BY 2003 Chilkat River Chinook salmon and 9 (SE = 5) BY 2004 Chinook salmon from the Pullen Creek hatchery smolt release. Estimated contributions to the sport fishery based at the Haines small boat harbor were 39 (SE = 39) BY 2004 Chilkat River Chinook salmon. The total of CWT stock contribution estimates was 64% higher than the total sport fishery harvest as estimated by the creel survey.

The marked fractions of BY 2003 and BY 2004 Chilkat River Chinook salmon used in these estimates are preliminary until those data are published in FDS reports.

JUVENILE TAGGING

During September and October 2009, 15,997 Chinook salmon parr from BY 2008 were captured and marked in the Chilkat River drainage (Table 12). Catch rates were highest in the Tahini River and lowest in the Chilkat River. After tag retention testing, 10 mortalities were discarded, so 15,987 fish were released with valid CWTs and adipose fin clips (Table 13).

During April 8–May 26, 2010, 996 Chinook salmon smolt from BY 2008 were captured and marked in the lower Chilkat River (Table 12). After tag retention testing, 1 mortality was discarded, so 995 fish were released with valid CWTs and adipose fin clips (Table 13).

A total of 228 Chinook salmon parr were sampled for length during fall 2009 (Table 14). The mean length of parr was 68 mm FL (SD = 7 mm FL). In addition, 53 smolt were sampled for length and weight in spring 2010. Smolt averaged 73 mm FL (SD = 7 mm FL) and 4.0 g (SD = 1.1 g).

BROOD YEAR 2002 PRODUCTION

Juvenile Abundance

As stated previously, 36,640 Chinook salmon parr were released with valid CWTs in fall 2003, and 5,707 smolts were released in spring 2004 (Ericksen 2004). Both groups originated from BY 2002. Between 2005 and 2009, 451 adult BY 2002 Chinook salmon were sampled in the Chilkat River, of which 48 were missing adipose fins (Table 15). There was not a significant difference (χ^2 = 0.01, df = 1, P = 0.91) between the marked fraction of fish sampled in the lower river and on the spawning grounds, so the inriver marked fraction $\theta_{INRIVER}$ for BY 2002 was estimated at 0.106 (SE = 0.015) using combined lower and upper river data.

From the 48 adipose fin-clipped BY 2002 Chinook salmon sampled in the Chilkat River escapement, 23 heads were collected, 22 CWTs were successfully recovered and decoded (Table 15). The Tag Lab found no CWT in one head (Appendix D3). Of the 22 decoded CWTs, 17 were tagged in fall 2003 and 5 were tagged in spring 2004 (Table 16). Of the 22 fish with paired CWT and handheld dorsal wand scan results, the tag code matched the scan results in all 22 fish (Appendix D3).

Of the 48 adipose finclipped BY 2002 Chinook salmon sampled in the Chilkat River escapement, 47 were scanned with a handheld wand detector for a second (dorsal) CWT (Table 15, Appendix D3).

The wand scans results were used to assign 36 fish as tagged in fall 2003 and 11 fish as were tagged in spring 2004. In calendar year 2005–2011 Chilkat River Chinook salmon escapement sampling, 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 (Table 17). 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. The false negative rate second CWT wand detection rate in BY 2002 Chilkat River Chinook salmon of all lengths (ω_{f-}) was estimated as 6.4% (SD = 3.1%) and the false positive rate in fish of all lengths (ω_{f+}) was estimated as 6.0% (SD = 1.7%, Appendix E1).

An estimated 509,700 (SD = 81,390) BY 2002 parr were rearing in the Chilkat River in fall 2003, 38.8% (SD = 10.6%) survived the winter, and 194,000 (SD = 47,020) smolts emigrated from the Chilkat River in spring 2004 (Table 18, Appendix E1).

Adult Harvest

The estimated tagged fraction θ_{MARINE} germane to estimating marine harvest contributions was 0.1018 (SE = 0.0145). This estimate was calculated from the 48 fish with missing adipose fins out of 451 fish inspected in the Chilkat River, multiplied by the head CWT loss fraction, 22 CWTs decoded out of 23 heads sent to the DCF Tag Lab (Table 15).

Eighteen (18) Chinook salmon with Chilkat River CWTs from BY 2002 were recovered through random sampling in marine commercial, sport, and subsistence fisheries between 2005 and 2009 (Table 16, Appendix D1). An estimated 380 (SE = 93) BY 2002 Chilkat River Chinook salmon were harvested in sampled marine fisheries between 2005 and 2009 (Table 19). Harvest-at-age was highest at age 1.3 (233 fish, SE = 71), followed by 95 fish (SE = 53) at age-1.2, and by 52 fish (SE = 29) at age-1.4. The commercial fishery sector had the largest share (67%) of the total harvest of BY 2002 Chilkat Chinook salmon, followed by the sport (33%) and the subsistence (<1%) fishery sectors (Table 20). The specific fisheries with the largest share of the Chilkat harvest were combined Southeast Alaska troll quadrants (50%) and Haines sport (25%) fisheries (Figure 6).

Marine Exploitation and Survival

Based upon a total inriver return of 1,577 (SE = 234) age-1.2 and older fish and a total marine harvest of 380 (SE = 93) age-1.2 and older fish, the total BY 2002 age-1.2 and older return was 1,957 (SE = 252) fish (Table 18). The estimated smolt-to-adult marine survival rate was 1.0% (SE = 0.2%). The estimated marine exploitation rate of this stock was 19.4% (SE = 4.5%).

Table 11.–Contribution estimate (*r*) of coded wire tagged Chinook salmon to the Haines marine sport fishery, May 4–June 21, 2009, and statistics used for computing estimates.

			Brood	Harvest		Sample	Adiposeclip	Head	Detect	Decode	Tags	Contribution	
Agency	Release site	Tag code	year	*N*	SE[*N*]	*n*	*a*	*a'*	*t*	*t'*	*m*	*r*	SE
CHILKAT INLET RECOVERIES													
ADFG	Chilkat River wild	04-10-28, 04-09-62, 04-11-36	2003	111	9	61	10	10	10	10	8	187	66
DIPAC[a]	Pullen Cr 115-34	04-12-27	2004								2	9	5
Chilkat Inlet total											10	195	66
SMALL BOAT HARBOR RECOVERIES													
ADFG	Chilkat River wild	04-12-19	2004	33	8	8	1	1	1	1	1	39	39
Haines marine creel survey total											11	235	77

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

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

Table 12.–Results of juvenile Chinook salmon trapping in the Chilkat River drainage in fall 2009 and spring 2010.

Year	Trapping area	Dates	Days fished	Traps set	Number caught	CPUE[a]
2009	Tahini River	Sept. 9–5	5	349	3,048	8.7
2009	Kelsall River	Oct. 1–9	8	589	4,787	8.1
2009	Chilkat River	Oct. 16–30	13	1,198	8,162	6.8
	Fall 2009 subtotal		26	2,136	15,997	7.5
2010	Lower Chilkat River	April 8–May 26	48	4,667	996	0.2

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

Table 13.–Number of brood year 2008 Chinook salmon coded wire tagged (CWT) in the Chilkat River drainage, by trapping location and tag year.

Tag year	Tag code	Sequence range	Location	Last date	Stage	Injected	24h morts	Marked	Shed tags	Valid CWTs released
2009	04-17-89	191–5,590	Tahini River	9/25	Parr	3,048	7	3,041	0	3,041
2009	04-17-89	5,668–13,822	Kelsall River	10/09	Parr	4,787	3	4,784	0	4,784
2009	04-17-89	13,929–28,253	Lower Chilkat R	10/30	Parr	8,162	0	8,162	0	8,162
Fall 2009 subtotal						15,997	10	15,987	0	15,987
2010	04-15-45	Batch code	Chilkat River	5/20	Smolt	996	1	995	0	995

Table 14.–Mean length and smolt weight of brood year 2008 Chinook salmon 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
2009	Tahini River	Sept. 19–25	50	60–85	71	6
2009	Kelsall River	Oct. 1–9	91	58–87	72	6
2009	Lower Chilkat River	Oct. 16–30	87	50–82	63	6
Fall 2009 subtotal			228	50–87	68	7
2010	Lower Chilkat River	April 10–May 26	53	59–89	73	7
			weight (g)	2.2–6.9	4.0	1.1

Table 15.–Number of brood year 2002 Chinook salmon sampled in the Chilkat River drainage for missing adipose fins and coded wire tags (CWT), by year and gear type or spawning drainage, 2005–2009.

					Wand detector results			Tag Lab CWT recovery results		
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 collected	Valid CWTs	Head CWT loss fraction
2005	Gillnet	0								
2005	Fish wheels	37	5	0.14	5	4	1	5	4	0.20
2006	Gillnet	1	0	0.00						
2006	Fish wheels	11	0	0.00						
2007	Gillnet	25	2	0.08	2	2	0			
2007	Fish wheels	9	1	0.11	1	0	1	0		
2008	Gillnet	23	2	0.09	2	2	0			
2008	Fish wheels	13	3	0.23	3	2	1	0		
2009	Gillnet	0								
2009	Fish wheels	0								
Event 1 total		119	13	0.11	13	10	3	5	4	0.20
2005	Kelsall River	12	2	0.17	2	0	2	2	2	0.00
2005	Tahini River	9	3	0.33	3	3	0	3	3	0.00
2005	Klehini River	3	0	0.00						
2006	Kelsall River	16	2	0.13	2	2	0	1	1	0.00
2006	Tahini River	32	3	0.09	3	3	0	3	3	0.00
2006	Klehini River	10	1	0.10	1	0	1	1	1	0.00
2007	Kelsall River	49	8	0.16	8	6	2	3	3	0.00
2007	Tahini River	63	4	0.06	4	3	1	1	1	0.00
2007	Klehini River	23	3	0.13	2	2	0	1	1	0.00
2008	Kelsall River	61	3	0.05	3	3	0	2	2	0.00
2008	Tahini River	33	5	0.15	5	4	1	0		
2008	Klehini River	19	1	0.05	1	0	1	1	1	0.00
2009	Kelsall River	1	0	0.00						
2009	Tahini River	1	0	0.00						
2009	Klehini River	0								
Event 2 total		332	35	0.11	34	26	8	18	18	0.00
Grand total		451	48	0.11	47	36	11	23	22	0.04
Fraction with head CWT (marine theta)				0.10						

Table 16.–Number of brood year 2002 Chilkat River Chinook salmon coded wire tags (CWT) recovered from heads taken in random samples in 2005–2009, by year, area, gear type, and season tagged.

		Purse Seine		Drift gillnet		Troll		Sport		Chilkat Inlet subsistence		Chilkat River escapement				
Year	District or quad	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall subtotal	Spring subtotal	Grand total
2005	115	0	0	0	0	0	0	0	0	0	0	7	2	7	2	9
2006	110	0	0	0	0	1	0	0	0	0	0	ND	ND	1	0	1
2006	111	0	0	0	1	0	0	1	0	0	0	ND	ND	1	1	2
2006	112	0	1	0	0	0	0	0	0	0	0	ND	ND	0	1	1
2006	115	0	0	0	0	0	0	0	0	0	0	4	1	4	1	5
2006 subtotal		0	1	0	1	1	0	1	0	0	0	4	1	6	3	9
2007	109	0	0	0	0	1	1	0	0	0	0	ND	ND	1	1	2
2007	111	0	0	0	0	0	0	2	0	0	0	ND	ND	2	0	2
2007	114	0	0	0	0	0	3	0	0	0	0	ND	ND	0	3	3
2007	115	0	0	0	0	0	0	2	2	0	0	4	1	6	3	9
2007 subtotal		0	0	0	0	1	4	4	2	0	0	4	1	9	7	16
2008	105	0	0	0	0	1	0	0	0	0	0	ND	ND	1	0	1
2008	109	0	0	0	0	1	0	0	0	0	0	ND	ND	1	0	1
2008	114	0	0	0	0	1	0	0	0	0	0	ND	ND	1	0	1
2008	115	0	0	0	0	0	0	0	0	0	0	2	1	2	1	3
2008 subtotal		0	0	0	0	3	0	0	0	0	0	2	1	5	1	6
2009		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand total		0	1	0	1	5	4	5	2	0	0	17	5	27	13	40

Note: Marine CWTs were recovered and decoded by Division of Commercial Fisheries Mark, Tag, and Age Laboratory.

Table 17.–Summary of handheld wand scans for second coded wire tag (CWT) as verified by recovered primary tag codes, in brood year 2001 and later Chilkat River Chinook salmon, 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	135

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	110

Note: A detailed list of recovered CWTs and wand scan results is in Appendix D2

Table 18.–Estimated stock assessment parameters for brood year 2002 Chilkat River Chinook salmon.

Parameter	Estimate	SE
2003 fall parr abundance	509,700	81,390[a]
2003–2004 overwinter survival	0.388	0.106[a]
2004 spring smolt abundance	194,000	47,020[a]
Marine harvest (age-1.2 and older)	380	93
Inriver return (age-1.2 and older)	1,577	234
Return (age-1.2 and older)	1,957	252
Marine exploitation rate (age-1.2 and older)	0.194	0.045
Smolt survival to age-1.2 and older	0.010	0.002

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

Table 19.–Estimated contributions of brood year 2002 Chilkat River Chinook salmon to marine fishery harvests, by year and fishery, 2005–2009.

Fishery	Fishery harvest									Contribution		
	Time period	District, quadrant, or port	$\hat{H}$	SE[$\hat{H}$]	n	a	a'	t	t'	m	$\hat{r}$	SE $[\hat{r}]$
2005 recoveries age-1.1												
No BY 2002 Chilkat Chinook salmon CWTs were recovered in 2005 marine fishery random samples.												
2006 recoveries age-1.2												
Troll	TP 4	Q NE	4,273		1,402	320	319	292	292	1	30	30
Drift gillnet	SW 28	D 111	103		46	6	6	5	5	1	24	22
Purse seine	SW 27	D 112	397		341	45	44	41	41	1	38	37
Juneau sport	BW 16	Juneau	647	56[b]	440	71	70	64	64	1	3	6
2006 subtotal										4	95	53
2007 recoveries age-1.3												
Troll	TP 2	D 109	6,255		3,245	389	388	363	362	2	38	26
Troll	TP 2	D 114	2,957		1,219	70	70	64	64	3	71	41
Drift gillnet	SW 36	D 115	13		9	1	1	1	1	0	1[c]	0
Juneau sport	BW 16	Juneau	547	44[b]	391	30	30	26	26	2	27	19
Haines sport[d]	SW 19-25	Haines	299	45	126	8	8	7	7	4	93	48
Chilkat Inlet subsistence	SW 25,29	D 115-32	90		11	1	1	1	1	0	2[e]	0
2007 subtotal										11	233	71
2008 recoveries age-1.4												
Troll	TP 2	D 105	1,168		673	44	44	40	40	1	17	17
Troll	TP 2	D 109	8,631		5,379	1,097	1,088	1,019	1,015	1	15	14
Troll	TP 2	D 114	2,243		1,196	80	74	65	65	1	20	19
2008 subtotal										3	52	29
2009 recoveries age-1.5												
No BY 2002 Chilkat Chinook salmon CWTs were recovered in 2009 marine fishery random samples.												
Combined contribution $[\hat{T}]$										18	380	93

Source: Commercial and sport fishery sampling data are from the Division of Commercial Fisheries Mark, Tag, and Age Laboratory online database at http://tagtoweb.adfg.state.ak.us. Subsistence fishery permit harvest data are from the 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] 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.

[c] No harvest expansion for 1 select recovery from statistical area 115-34.

[d] Sampling data from Chapell (2010).

[e] No harvest expansion for 2 select recoveries from statistical area 115-32.

Table 20.–Total marine harvest and estimated contribution of brood year 2002 Chilkat River Chinook salmon, by fishery and area, 2005–2009.

Fishery	Area	Total fishery harvest	Chilkat harvest	SE	Chilkat percent of fishery	Percent of Chilkat total
Commercial fishery						
Troll	Quad. NE	19,159	83	42	0.4	21.9
Troll	Quad. NW	5,200	91	45	1.8	24.1
Troll	Quad. SE	1,168	17	17	1.5	4.5
Drift gillnet	Dist. 111	103	24	22	23.3	6.3
Drift gillnet	Dist. 115	13	1[a]	0	7.7	0.3
Purse seine	Dist. 112	1,887	38	37	2.0	9.9
	Subtotal	27,530	254	77	0.9	66.9
Sport fishery						
	Juneau	1,194	30	20	2.6	8.0
	Haines	299	93	48	31.2	24.6
	Subtotal	1,493	124	52	8.3	32.6
Subsistence fishery						
	Chilkat Inlet	90	2[b]	0	2.2	0.5
Grand total		29,113	380	93	1.3	100.0

[a] Harvest not expanded from 1 select recovery in statistical area 115-34.

[b] Harvest not expanded from 2 select recoveries in statistical area 115-32.

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; Johnson et al. 1992, 1993; Ericksen and Chapell 2006) 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 58% of the spawning ground samples. Using other capture methods (17% snagging, 12% gillnet, 7% hands, 6% dipnet) 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 one fish per day was being caught. The 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 LLOP in event 2. Only fish with intact left opercula were considered in events 1 and 2.

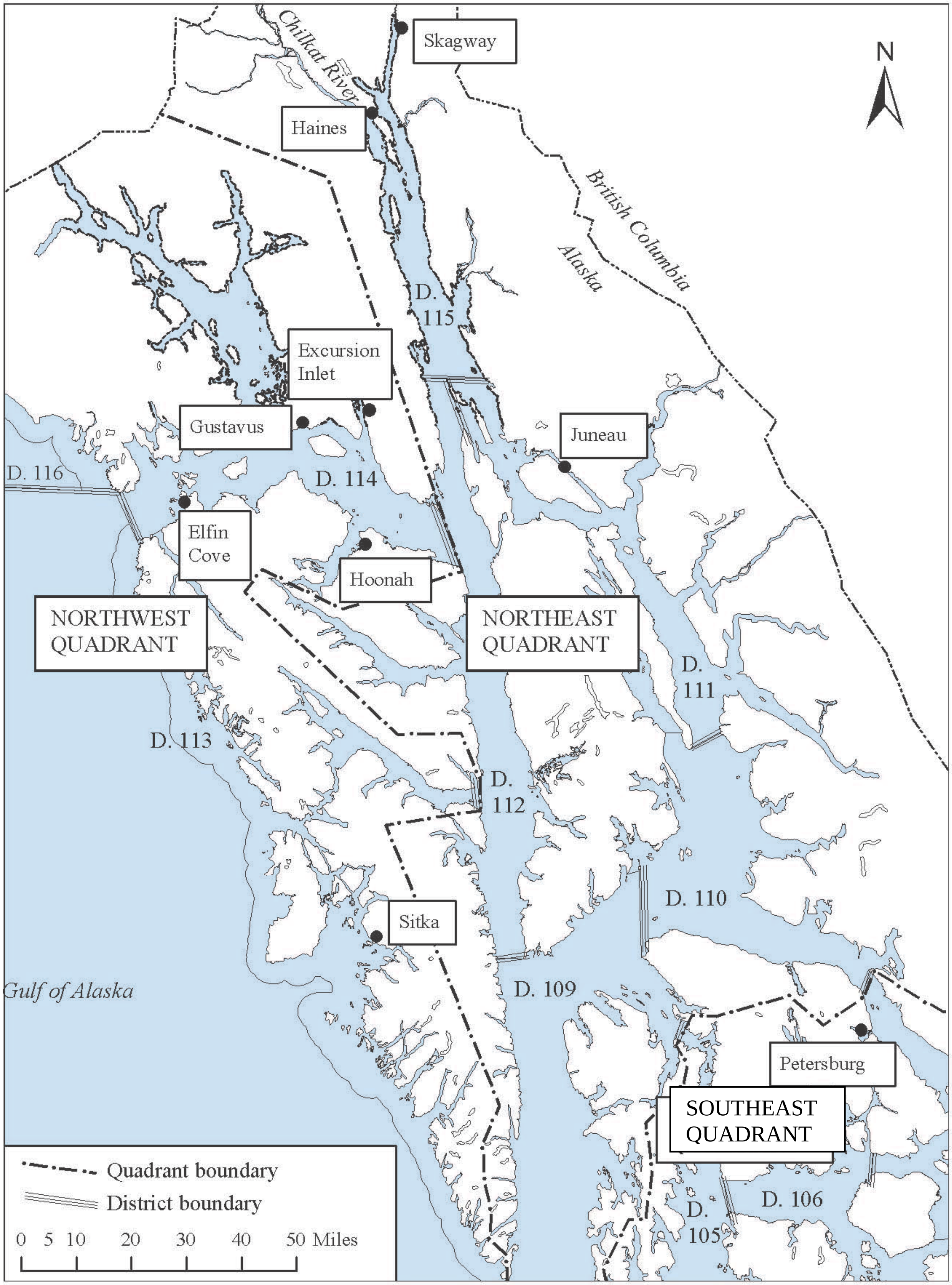


Figure 6.–Fishing quadrants, districts, and sampling ports in northern Southeast Alaska.

The 2009 inriver run of 4,429 (SE = 586) large Chinook salmon exceeded 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 21, Figure 7). After subtracting the estimated large fish component of the inriver subsistence fishery harvest reported on permits, the estimated large fish escapement was 4,406 fish (Table 21). This escapement exceeded the Chilkat River Chinook salmon BEG of 1,750 to 3,500 large Chinook salmon.

In 2009, the Haines marine sport fishery large Chinook salmon CPUE (0.020) was below the 1988–2008 average (0.029, Table 22). As an early indicator of large Chinook salmon abundance, the below-average sport fishery CPUE matched the below-average DSF event 1 gillnet catch (112 large fish, 1991–2008 average = 144 large fish). However, the postseason mark-recapture inriver run estimate (4,429 large fish) was above the 1991–2008 average of 4,202 large fish (Table 21). As has been true in previous years, the Haines area saltwater sport CPUE was not a useful abundance indicator for inseason management.

Haines area marine sport fishing harvest patterns observed during 2009 were similar to years 2001–2007. In 2009, the salmon-targeted effort was 79% of the 2001–2007 average, and most (74%) of the harvest of large (≥28 in TL) Chinook salmon was landed at the Letnikof Cove dock (2001–2007 average = 70%; Ericksen 2002a, 2003–2005; Ericksen and Chapell 2006; Chapell 2009–2012). However, the large Chinook salmon harvest was well below historic levels (Table 22). The creel survey estimated that 56% of the large Chinook salmon harvested were wild and mature, most likely headed for the Chilkat River (Table 9). CWT recoveries indicate the remainder of the harvest was immature and hatchery fish (Table 11).

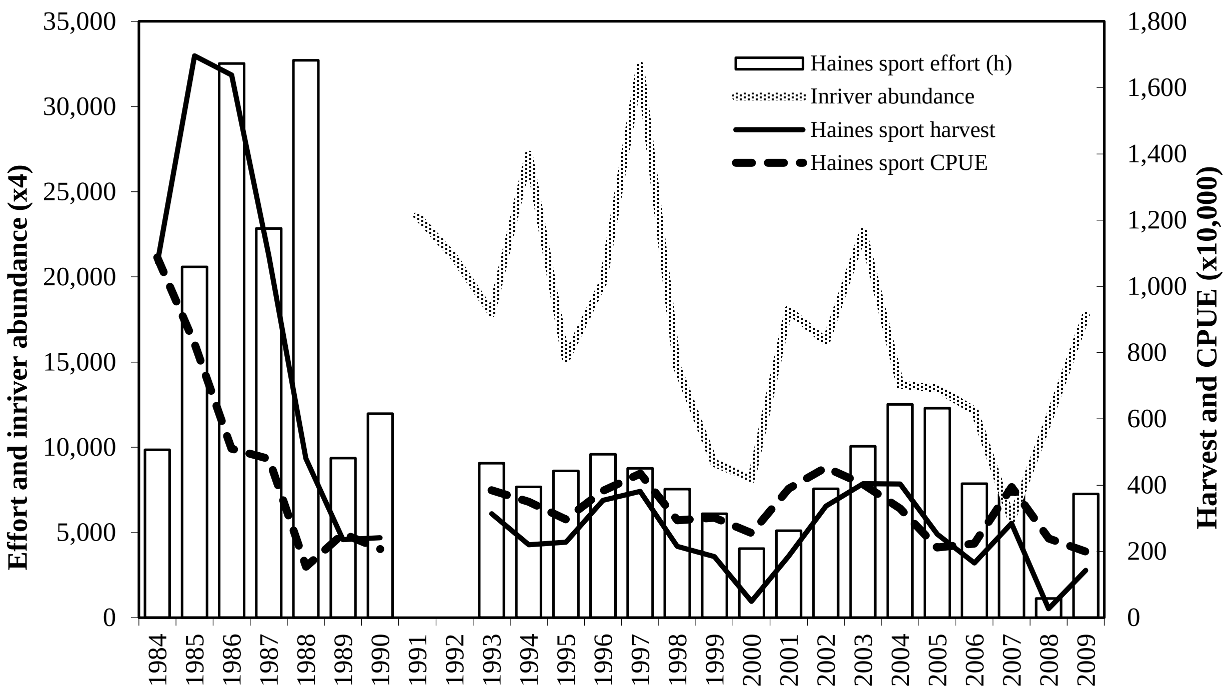


Figure 7.–Estimated angler effort, harvest, and CPUE of large (≥28 inches TL) Chinook salmon in the Haines spring marine boat sport fishery, 1984–2009, and estimated inriver run of large (≥age-1.3) Chinook salmon in the Chilkat River, 1991–2009.

Source: Tables 21 and 22.

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

Table 21.–Estimated annual inriver run by age of medium (age-1.2) and large (≥ age-1.3) immigrating Chilkat River Chinook salmon, annual large escapement estimates, 1991–2009, and estimated marine harvest and total return by age class of fish from coded wire tagged brood years 1988, 1989, 1991, 1998–2002.

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)				

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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
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)				
2007[aa]	Inriver run	602	(138)	585	(136)	860	(182)	0	(0)	2,047	(266)	7[o]	1,438
	Marine harvest	NA	NA	233	(71)	255	(146)	0	(0)				
	Total return	NA	NA	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	NA	NA	52	(29)	0	(0)				
	Total return	NA	NA	NA	NA	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	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 and Chapell (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 Table 7.

Table 22.–Estimated angler effort, and large (≥28 inches TL) Chinook salmon catch and harvest in the Haines marine sport fishery for similar sample periods, 1984–2009.

		Effort				Large (≥28") 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	May 4–June 21	7,405	534	7,267	520	145	12	143	12	0.020
1984–1987 average		23,082		21,455		1,383		1,375		0.064
1988–2008 average		10,117		9,432		275		261		0.029

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. (1988).
g From Suchanek and Bingham (1989).
h From Suchanek and Bingham (1990).
I From Suchanek 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.

Each fall in 2000–2011, an average of 28,458 Chinook salmon parr have been marked with CWTs (brood years 1999–2010). Using the 30% average overwinter survival rate for BY 1999–2002, the fall marking effort has produced an average of 8,600 CWT-tagged smolts each spring (Appendix F). Spring 2001–2011 tagging efforts have produced an average of 3,978 CWT-tagged smolts from BY 1999–2009. The average CWT-marked fraction for BY 1999–2002 has been 9.9%. The high number of marked fish has allowed the harvest of the 1999 and later brood year Chilkat River Chinook salmon to be documented in many more fisheries than for previous brood years. The fall and spring tagging efforts should be continued to monitor harvest of wild Chilkat River Chinook salmon in nearby Lutak Inlet and Taiya Inlet terminal harvest areas where returns from annual releases of up to 500,000 hatchery-reared Chinook salmon smolts will be targeted (Figure 1; ADF&G 2012).

Using the nonlethal wand scan to detect second CWT presence/absence in the escapement allowed the release of 24 large adipose-finclipped pre-spawners from BY 2002, and an average of 31 large pre-spawners released per brood year from BY 2001–2004. Releasing viable spawners provides an important benefit to the relatively small Chilkat Chinook salmon stock in years when escapement falls short of the goal range, such as 2007 and 2012 (Table 21). However, not taking heads from large CWT-tagged fish adds uncertainty to parameter estimates due to the wand's 6% incorrect second CWT detection rate (calendar years 2005–2011, Appendix E1). When only sacrificed fish and decoded CWTs were considered in the BY 2002 CWT analysis, the juvenile abundance estimates were similar, with confidence intervals that overlapped those of the wand detector method, but the CV estimates were higher for the sacrificed fish method (Appendices E1 and 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 are 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 each year 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 (noncommercial survey site = Chilkat, http://tagotoweb.adfg.state.ak.us/CWT/reports/).

The 100% correct rate, 22 of 22 sacrificed BY 2002 fish, for handheld wand detection of second CWT presence/absence is remarkable (Appendix D3). Results for BY 2001 were a 6% error (2 of 34) in second CWT detection, and 12% error (4 of 33) in head CWT detection (Chapell 2012). Continued staff training to avoid magnetized items in proximity to the sampling area and carefully scanning large fish is necessary to minimize handheld wand scan errors.

The number of juvenile Chinook salmon captured in the Chilkat River drainage during fall 2009 and spring 2010 CWT efforts indicates very low abundance for BY 2008 (Table 12). The fall minnow trap CPUE (7.5 fish/trap) was the lowest ever for the fall effort (range 10.0–20.4, average 13.9 fish/trap, calendar years 2001–2008 and 2010–2011). The spring 2010 CPUE (0.2 fish/trap) was also the lowest ever for the project (range 0.5–1.2, average 0.9 fish/trap, calendar years 2001–2009 and 2011). The low fall and spring CPUEs were in spite of experienced staff, favorable water conditions, and similar area trapped to previous years.

The BY 2002 estimated marine exploitation rate (Table 18, 19.4%, SE = 4.5%) was within the range of estimates from CWT studies on Chilkat River Chinook salmon BYs 1988–1989, 1991, and 1998–2002 (7.8%–24.8%, Appendix F). The average exploitation rate for the most recent 4 brood years (19.7%, BY 1999–2002) is higher than rates used by Ericksen and McPherson (2004) to set the BEG (range 8%–19%) for Chilkat River Chinook salmon.

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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.

-continued-

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.

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

$$\hat{p}_k = \sum_{i=1}^{j} \frac{\hat{N}_i}{\hat{N}_\Sigma} \hat{p}_{ik}, \tag{1}$$

and

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

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 4–June 21, 2009.

		May 18–May 31				
	May 4– May 17	Non-derby	Derby	June 1– June 14	June 15– June 21	Total
Boats counted	43	17	109	150	20	339
Angler-hr. sampled	245	91	2,081	1,377	128	3,922
Salmon-hr. sampled	241	91	2,081	1,365	128	3,906
Chinook sampled	2	0	36	19	3	60
Sampled for ad-clips	2	0	36	19	3	60
Ad-clips	0	0	2	6	2	10
<u>Angler-hours</u>						
Estimate	283	273	3,016	2,403	406	6,381
SE	19	37	281	338	114	456
<u>Salmon-hours</u>						
Estimate	279	273	3,016	2,374	406	6,348
SE	19	37	281	321	114	444
<u>Large Chinook catch</u>						
Estimate	2	0	39	52	15	108
SE	0	0	3	6	4	8
<u>Large Chinook harvest</u>						
Estimate	2	0	39	50	15	106
SE	0	0	3	5	4	7
<u>Wild mature Chinook harvest (excluding hatchery and immature fish)</u>						
Estimate	0	0	20	38	15	73
SE	0	0	1	6	4	8
<u>Small Chinook catch</u>						
Estimate	0	9	33	73	4	119
SE	0	4	8	23	3	25
<u>Small Chinook harvest</u>						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Retention of small Chinook salmon was not allowed in the Haines area in 2009.

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 23–25 and May 30–31, 2009.

	May 23–25 and 30–31	
	Derby	Total
Boats counted	1	1
Angler-hr. sampled	2	2
Salmon-hr. sampled	2	2
Chinook sampled	1	1
Sampled for adipose clips	1	1
Adipose clips	0	0
Angler-hours		
Estimate	10	10
SE	9	9
Salmon-hours		
Estimate	10	10
SE	9	9
Large Chinook catch		
Estimate	5	5
SE	4	4
Large Chinook harvest		
Estimate	5	5
SE	4	4
Wild mature Chinook harvest (excluding hatchery and immature fish)		
Estimate	5	5
SE	4	4
Small Chinook catch		
Estimate	0	0
SE	0	0
Small Chinook harvest		
Estimate	0	0
SE	0	0

Note: Retention of small Chinook salmon was not allowed in the Haines area in 2009.

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 4–June 21, 2009.

		May 18–May 31				
	May 4–May 17	Nonderby	Derby	June 1–June 14	June 15–June 21	Total
Boats counted	7	1	1	15	5	29
Angler-hr. sampled	72	4	4	206	105	391
Salmon-hr. sampled	72	4	4	170	105	355
Chinook sampled	0	0	0	6	2	8
Sampled for adipose clips	0	0	0	6	2	8
Adipose clips	0	0	0	1	0	1
Angler-hours						
Estimate	334	18	20	505	138	1,015
SE	215	16	18	149	90	283
Salmon-hours						
Estimate	334	18	20	400	138	910
SE	215	16	18	135	90	270
Large Chinook catch						
Estimate	0	0	0	31	2	33
SE	0	0	0	7	2	8
Large Chinook harvest						
Estimate	0	0	0	31	2	33
SE	0	0	0	7	2	8
Wild mature Chinook harvest (excluding hatchery and immature fish)						
Estimate	0	0	0	22	0	22
SE	0	0	0	5	0	5
Small Chinook catch						
Estimate	0	0	0	50	14	64
SE	0	0	0	16	11	19
Small Chinook harvest						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Note: Retention of small Chinook salmon was not allowed in the Haines area in 2009.

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 20–July 4, 2009.

		Brood year and age class						
		2006	2005	2004	2003	2002	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled
Males	Sample size	0	4	1	1	0	6	6
	Proportion		0.67	0.17	0.17			0.60
	SE		0.21	0.17	0.17			0.16
	Mean length		598	650	970			
	SE		10	NA	NA			
Females	Sample size	0	1	1	2	0	4	4
	Proportion		0.25	0.25	0.50			0.40
	SE		0.25	0.25	0.29			0.16
	Mean length		605	745	858			
	SE		NA	NA	10			
Unknown	Sample size	0	0	1	0	0	1	1
	Proportion			1.00				
	SE			NA				
	Mean length			810				
	SE			NA				
Combined	Sample size	0	5	3	3	0	11	11
	Proportion		0.45	0.27	0.27			
	SE		0.04	0.02	0.02			
	Mean length		599	735	895			
	SE		9	9	10			

Appendix C2.–Estimated age composition of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, 2000–2009.

	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
2000–2009 average	21	2.5	34.9	41.7	20.9	0.0	62.6

[a] Data from Ericksen (2001).
[b] Data from Ericksen (2002a).
[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).
[h] Data from Chapell (2010).
[i] Data from Chapell (2012).
[j] Data from Appendix C1.

APPENDIX D

Appendix D1.–Brood year 2002 Chilkat Chinook salmon coded wire tags recovered from marine fisheries, 2005–2009. No brood year 2002 tags were recovered in 2005 or 2009.

Year	Head	Tag code	Gear	Survey site	Recovery date	Stat week	Quad-rant	Dist.	Sub-dist.	Length (mm MEF)
RANDOM SAMPLING RECOVERIES										
2006	266501	040964	Drift	Juneau	07/12/06	28	NE	111	ND	630
2006	18254	040964	Purse	Petersburg	07/07/06	27	NE	112	22	500
2006	265791	040771	Sport	Juneau	08/06/06	32	NE	111	ND	670
2006	18868	040771	Troll	Petersburg	08/23/06	34	NE	110	21	625
2007	264087	040964	Sport	Haines	05/28/07	22	NE	115	32	760
2007	254367	040771	Sport	Haines	06/03/07	23	NE	115	32	670
2007	254379	040771	Sport	Haines	06/10/07	24	NE	115	32	810
2007	254381	040964	Sport	Haines	06/15/07	24	NE	115	32	890
2007	223311	040771	Sport	Juneau	08/05/07	32	NE	111	ND	740
2007	223322	040771	Sport	Juneau	08/05/07	32	NE	111	ND	790
2007	522525	040964	Troll	Pelican	05/23/07	21	NW	114	50	815
2007	316471	040771	Troll	Sitka	05/31/07	22	NE	109	62	635
2007	306606	040964	Troll	Petersburg	06/01/07	22	NE	109	62	750
2007	522547	040964	Troll	Pelican	06/13/07	24	NW	114	50	790
2007	522566	040964	Troll	Pelican	06/15/07	24	NW	114	50	810
2008	324492	040771	Troll	Ketchikan	05/20/08	21	SE	105	41	820
2008	354013	040812	Troll	Hoonah	05/27/08	22	NW	114	25	911
2008	353446	040771	Troll	Sitka	05/30/08	22	NE	109	62	875
SELECT AND VOLUNTARY RECOVERIES										
2007	254109	040771	Drift	Haines	09/06/07	36	NE	115	34	ND
2007	60883	040771	Sport	Haines	06/12/07	24	NE	115	32	ND
2007	60884	040771	Sport	Haines	06/12/07	24	NE	115	32	ND
2007	60885	040771	Subsist	Haines	06/18/07	25	NE	115	32	787
2007	60887	040771	Subsist	Haines	07/15/07	29	NE	115	32	ND

Appendix D2.–Comparison of season tagged from tag codes to handheld wand detection of dorsal coded wire tag (CWT) presence/absence in 253 adipose finclipped adult Chinook salmon examined in the Chilkat River escapement, calendar years 2005–2011.

Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second (dorsal) 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 (dorsal) 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 (dorsal) 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 (dorsal) 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 (dorsal) 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 (dorsal) 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
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

-continued-

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Calendar year	Brood year	Site	Head number	Length (mm MEF)	Tag code	Season tagged	Second (dorsal) CWT present
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

Note: **Bold** indicates erroneous wand detection results. Agreement of tag codes and wand scan results is summarized in Table 16.

Appendix D3.–Wand scan results from 48 adipose fin-clipped brood year 2002 Chinook salmon sampled in the Chilkat River escapement, 2005–2009.

Year	River	Length (mm MEF)	Head number	Tag code	Head CWT	Dorsal CWT	Season tagged	Comment
2005	Low. Chilkat	385	254,324	040771	Yes	No	Fall	
2005	Low. Chilkat	325	254,327	040771	Yes	No	Fall	
2005	Low. Chilkat	340	254,328	No tag	No	Yes	Spring	Head CWT loss
2005	Low. Chilkat	340	254,329	040771	Yes	No	Fall	
2005	Low. Chilkat	325	254,330	040771	Yes	No	Fall	
2005	Kelsall	405	264,014	040964	Yes	Yes	Spring	
2005	Kelsall	355	264,081	040964	Yes	Yes	Spring	
2005	Tahini	390	221,459	040771	Yes	No	Fall	
2005	Tahini	400	254,170	040771	Yes	No	Fall	
2005	Tahini	400	264,077	040771	Yes	No	Fall	
2006	Big Boulder	545	221,480	040964	Yes	Yes	Spring	
2006	Kelsall	570	Not taken		Yes	No	Fall	
2006	Kelsall	510	254,360	040771	Yes	No	Fall	
2006	Tahini	565	254,185	040771	Yes	No	Fall	
2006	Tahini	535	254,373	040771	Yes	No	Fall	
2006	Tahini	530	254,378	040771	Yes	No	Fall	
2007	Low. Chilkat	745	Not taken		Yes	No	Fall	
2007	Low. Chilkat	725	Not taken		Yes	No	Fall	
2007	Low. Chilkat	770	Not taken		Yes	Yes	Spring	
2007	Big Boulder	810	Not taken		Yes	No	Fall	
2007	Big Boulder	790	Not taken		ND	ND	ND	Fish not scanned
2007	Big Boulder	750	60,895	040771	Yes	No	Fall	
2007	Kelsall	730	Not taken		Yes	No	Fall	
2007	Kelsall	660	Not taken		Yes	No	Fall	
2007	Kelsall	810	Not taken		Yes	Yes	Spring	
2007	Kelsall	790	Not taken		Yes	Yes	Spring	
2007	Kelsall	815	56,678	040812	Yes	No	Fall	
2007	Kelsall	695	Not taken		Yes	No	Fall	
2007	Kelsall	760	254,107		Yes	No	Fall	
2007	Kelsall	810	254,108		Yes	No	Fall	
2007	Tahini	840	Not taken		No	No	Fall	Head CWT loss
2007	Tahini	855	Not taken		Yes	No	Fall	
2007	Tahini	770	Not taken		Yes	No	Fall	
2007	Tahini	720	56,661	040964	Yes	Yes	Spring	

-continued-

Year	River	Length (mm MEF)	Head number	Tag code	Head CWT	Dorsal CWT	Season tagged	Comment
2008	Low. Chilkat	880	Not taken		Yes	No	Fall	
2008	Low. Chilkat	840	Not taken		No	No	Fall	Head CWT loss
2008	Low. Chilkat	840	Not taken		Yes	No	Fall	
2008	Low. Chilkat	920	Not taken		Yes	No	Fall	
2008	Low. Chilkat	900	Not taken		Yes	Yes	Spring	
2008	Kelsall	960	Not taken		Yes	No	Fall	
2008	Kelsall	895	56,737	040812	Yes	No	Fall	
2008	Kelsall	890	56,738	040771	Yes	No	Fall	
2008	Little Boulder	850	60,896	040964	Yes	Yes	Spring	
2008	Tahini	825	Not taken		Yes	No	Fall	
2008	Tahini	950	Not taken		Yes	No	Fall	
2008	Tahini	885	Not taken		Yes	No	Fall	
2008	Tahini	815	Not taken		Yes	Yes	Spring	
2008	Tahini	985	Not taken		Yes	No	Fall	
2009	No brood year 2002 Chinook salmon were examined in 2009.							

Note: CWT = coded wire tag, ND = no data.

Note: The tag code verified the season tagged (17 fall, 5 spring) for the 22 fish whose heads were taken, assigned a head number, and the CWT recovered.

APPENDIX E

Appendix E1.–WinBUGS code and results of Bayesian statistical analysis of brood year (BY) 2002 Chinook salmon juvenile abundance, using results of handheld wand scans for dorsal coded wire tag presence/absence. Historic wand scan error rates from 2005–2011 Chilkat River Chinook salmon escapement sampling were used to adjust proportions of fish coded wire tagged in fall 2003 and spring 2004 events.

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 2002 constants
adclips <- 48 # fish with adipose fin clips found in Chilkat escapement
heads <- 47 # adipose finclipped fish scanned with wand for dorsal CWT
valid.tags <- 47 # tag event assigned by wand/age sampling or decoded CWT

Model {
falseneg ~ dbeta(falsenegDorsal, correct.ID.Dorsal)
false negative dorsal CWT detection rate in spring-tagged fish
falsepos ~ dbeta(falseposDorsal,correct.ID.NoDorsal)
false positive dorsal CWT detection rate in fall-tagged fish
N.fry ~ 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 fall or spring tag event assigned
M.fry <- 36,640 # parr marked
M.smolt <- 5,707 # smolt marked
C <- sum(R.tags[]) # fish inspected in Chilkat escapement for adipose fin clips
m<-18 # number of Chilkat CWTs recovered elsewhere, fall and spring
N.smolt <- N.fry * phi.1 # abundance of smolt in spring
q.fall <- M.fry / N.fry # fraction tagged in fall
q.spring <- M.smolt / N.smolt # fraction tagged in spring
pi[1] <- ((1+falsepos)*q.fall-falseneg*q.spring)*rho # adjusted fraction assigned to fall tag event
pi[2] <- ((1+falseneg)*q.spring-falsepos*q.fall)*rho # adjusted fraction assigned to spring tag event
pi[3] <- (q.fall + q.spring) * (1 - rho) # fraction with tagging event not assigned
pi[4] <- 1 - pi[1] - pi[2] - pi[3] # fraction 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 tags is binomially distributed
}

DATA
list(falsenegDorsal=4,correct.ID.Dorsal=56,falseposDorsal=11,correct.ID.NoDorsal=178,
R.tags=c(36,11,1,403),m.fall=10)
# Data terms are
# a.) Calendar year 2005-20011 Chilkat escapement sampling dorsal CWT wand scan sampling results:
# false negative (4) and correct (56) dorsal CWTs in spring-tagged fish,
# false positive (11) and correct (178) dorsal CWTs in fall-tagged fish;
# b.) BY 2002 Chilkat escapement dorsal CWT wand scan sampling results:
# 36 fish assigned fall, 11 fish assigned spring, 1 fish not assigned, 403 fish with intact adipose fins
# c.) Marine recoveries of BY 2002 Chilkat fall CWTs: 10.

INITS
list(N.fry =510000, phi.1=0.4, rho=0.9, falseneg =0.06, falsepos =0.07)

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RESULTS

Node	Mean	SD	MC error	2.5%	10.0%	Median	90.0%	97.5%	Start	Sample
N.fry	509,700	81,390	357	375,100	412,700	500,800	617,400	692,100	4,001	396,000
N.smolt	194,000	47,020	106	122,900	141,100	187,100	255,000	304,700	4,001	396,000
phi.1	0.3883	0.1061	3.467E-4	0.2278	0.2692	0.3728	0.5241	0.6372	4,001	396,000
pi[1]	0.0744	0.0119	5.101E-5	0.0529	0.0595	0.0738	0.0899	0.0992	4,001	396,000
pi[2]	0.0280	0.0073	1.257E-5	0.0155	0.0191	0.0274	0.0376	0.0438	4,001	396,000
pi[3]	0.0024	0.0023	5.794E-6	8.114E-5	2.982E-4	0.0017	0.0054	0.0084	4,001	396,000
pi[4]	0.8953	0.0143	5.297E-5	0.8658	0.8767	0.8958	0.9132	0.9216	4,001	396,000
rho	0.9772	0.0213	5.364E-5	0.9207	0.9489	0.9834	0.9971	0.9992	4,001	396,000
falseneg	0.0638	0.0307	5.836E-5	0.0178	0.0286	0.0592	0.1053	0.1355	4,001	396,000
falsepos	0.0597	0.0173	3.095E-5	0.0303	0.0386	0.0580	0.0825	0.0976	4,001	396,000

Appendix E2.–Alternate WinBUGS code and results of Bayesian statistical analysis of brood year (BY) 2002 Chinook salmon juvenile abundance. Coded wire tag 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 2002 constants

adclips <- 48	**# fish with adipose fin clips found in Chilkat escapement**
heads <- 23	**# heads collected from adipose finclipped fish**
valid.tags <- 22	**# CWTs decoded by Tag Lab**

Model {

N.fry ~ 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.fry <- 36,640	**# parr marked**
M.smolt <- 5,707	**# smolt marked**
C <- sum(R.tags[])	**# fish inspected in Chilkat escapement for adipose fin clips**
m<-18	**# number of Chilkat CWTs recovered elsewhere, fall and spring**
N.smolt <- N.fry * phi.1	# abundance of smolt in spring
q.fall <- M.fry / N.fry	# 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*

}

DATA
list(R.tags=c(17,5,26,403),m.fall = 10) # Data terms are sampling results: 17 fall tags, 5 spring tags, 26 heads with tags not decoded, and 403 fish with intact adipose fins in the escapement, 10 marine fishery recoveries.
INITS
list(N.fry =510,000, phi.1=0.4, rho=0.5)

RESULTS

Node	Mean	SD	MC error	2.5%	10.0%	Median	90.0%	97.5%	Start	Sample
N.fry	523,000	97,570	501	369,200	411,300	511,600	649,300	741,700	4,001	396,000
N.smolt	192,800	63,430	199	108,500	127,500	179,700	273,800	360,500	4,001	396,000
phi.1	0.3847	0.1581	6.80E-4	0.1786	0.2236	0.3504	0.5853	0.8293	4,001	396,000
pi[1]	0.0332	0.0078	3.06E-5	0.0197	0.0236	0.0325	0.0435	0.0503	4,001	396,000
pi[2]	0.0149	0.0049	1.12E-5	0.0068	0.0090	0.0144	0.0214	0.0259	4,001	396,000
pi[3]	0.0567	0.0108	3.21E-5	0.0374	0.0434	0.0561	0.0709	0.0796	4,001	396,000
pi[4]	0.8953	0.0143	5.34E-5	0.8656	0.8766	0.8958	0.9132	0.9215	4,001	396,000
rho	0.4586	0.0711	1.13E-4	0.3217	0.3672	0.4580	0.5506	0.5989	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 1999–2002.

PARAMETER ESTIMATES												
					Harvest (≥age-1.1)			≥Age-1.2				
Brood year (BY)	Fall parr	Overwinter survival, %	Smolt	Marked fraction, inriver	Commercial	Sport	Subsistence	Total harvest	Inriver return	Total return	Exploitation, %	Smolt–adult 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
BY 1999–2002 average	500,803	30.3	146,900	0.099	416	438	171	941	3,769	4,710	19.7	3.5
STANDARD ERRORS												
					Harvest (≥age-1.1)			≥Age-1.2				
Brood year (BY)	Fall parr	Overwinter survival, %	Smolt	Marked fraction, inriver	Commercial	Sport	Subsistence	Total harvest	Inriver return	Total return	Exploitation, %	Smolt–adult 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

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 Tables 17–20.

APPENDIX G

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

FILE NAME	DESCRIPTION
09FallChinookCWT.xls	Excel workbook containing trapping, length sampling, and sequential tag number data from BY 2008 Chinook salmon CWT project in fall 2009.
10SpringChinookCWT.xls	Excel workbook containing trapping, length and weight sampling data from BY 2008 Chinook salmon CWT project in spring 2010.
2009 Haines creel interview.dta	ASCII file containing edited angler interview data from the Haines marine sport fishery in 2009.
Haines Marine Creel 2009 v3a.sas	SAS program to estimate effort and harvest in the 2009 Haines marine sport fishery using 2009 Haines creel interview.dta.
09KingsTagged.xls	Excel workbook containing raw data from Chinook salmon captured in the lower Chilkat River during 2009.
09KingSpawningSamples.xls	Excel workbook containing raw data from Chinook salmon sampled on the Chilkat River spawning tributaries during 2009.
09KingHainesSportSubsAWL.xls	Excel workbook containing raw data from Chinook salmon sampled in Haines marine sport and subsistence fisheries during 2009.