Fishery Data Series No. 12-68

Production, Escapement, and Juvenile Tagging of Chilkat River Chinook Salmon in 2008

by

Richard S. Chapell

November 2012

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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November 2012

The report was prepared by Richard Chapell under award NA07NMF4380288 (Alaska Sustainable Salmon Fund project 45831) from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, administered by the Alaska Department of Fish and Game. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration, the U.S. Department of Commerce, or the Alaska Department of Fish and Game.

This investigation was also partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Projects F-10-23 and F-10-24, PSC Northern Fund Grant No. NF-2006-I-14.

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This document should be cited as:
Chapell, R. S. 2012. Production, escapement, and juvenile tagging of Chilkat River Chinook salmon in 2008. Alaska Department of Fish and Game, Fishery Data Series No. 12-68, Anchorage.

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ABSTRACT

The purpose of this study was to estimate the sport harvest and escapement of Chinook salmon *Oncorhynchus tshawytscha* returning to the Chilkat River during 2008. Angler effort and harvest of wild mature Chinook salmon in the spring Haines marine boat sport fishery were estimated using an onsite creel survey. A stratified mark-recapture experiment was used to estimate the inriver abundance of Chinook salmon returning to the Chilkat River. Juvenile abundance and marine harvest of 2001 brood year Chilkat River Chinook salmon were estimated through recoveries of fish marked with coded wire tags as fry in fall 2002 and as smolts in spring 2003.

An estimated 1,132 angler-h (SE = 167) of salmon effort in the Haines marine sport fishery yielded a harvest of 27 (SE = 11) large Chinook salmon (≥28 in TL), of which 5 (SE = 2) were wild, mature fish.

Technicians marked and released 258 Chinook salmon; 143 large (age-1.3 and older), 29 medium (age-1.2), and 76 small (age-1.1) fish in the lower Chilkat River between June 12 and August 9. Technicians examined 443 large, 111 medium, and 37 small Chinook salmon in spawning tributaries. Of the captured fish, 21 large, 4 medium, and 2 small fish were marked. An estimated 2,905 (SE = 544) large Chinook salmon and 2,255 (SE = 753) medium and small fish immigrated into the Chilkat River during 2008.

An estimated 596,410 (SE = 87,540) brood year 2001 fry were rearing in the Chilkat River in fall 2002. Overwinter survival was estimated at 24.9% (SE = 10.1%), and an estimated 148,800 (SE = 49,770) smolts emigrated in 2003. An estimated 902 (SE = 229) 2001 brood year fish were harvested in marine fisheries between 2004 and 2008. In addition, 20,174 fry in fall 2008 and 3,911 smolts in spring 2009, all from brood year 2007, were captured in the Chilkat River and released with coded wire tags.

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). 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).

A marine boat sport fishery occurs each spring in Chilkat Inlet that targets mature Chinook salmon returning to the Chilkat River. A creel survey has been used to estimate harvest in this fishery since 1984. 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, 1990, 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 & Stokes 1991).

Beginning in 1981, the Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (DSF) began a program to provide index counts to monitor escapement trends of Chinook salmon abundance in the Chilkat River (Kissner 1982) using aerial survey counts in Stonehouse and Big Boulder creeks (Figure 1). 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).

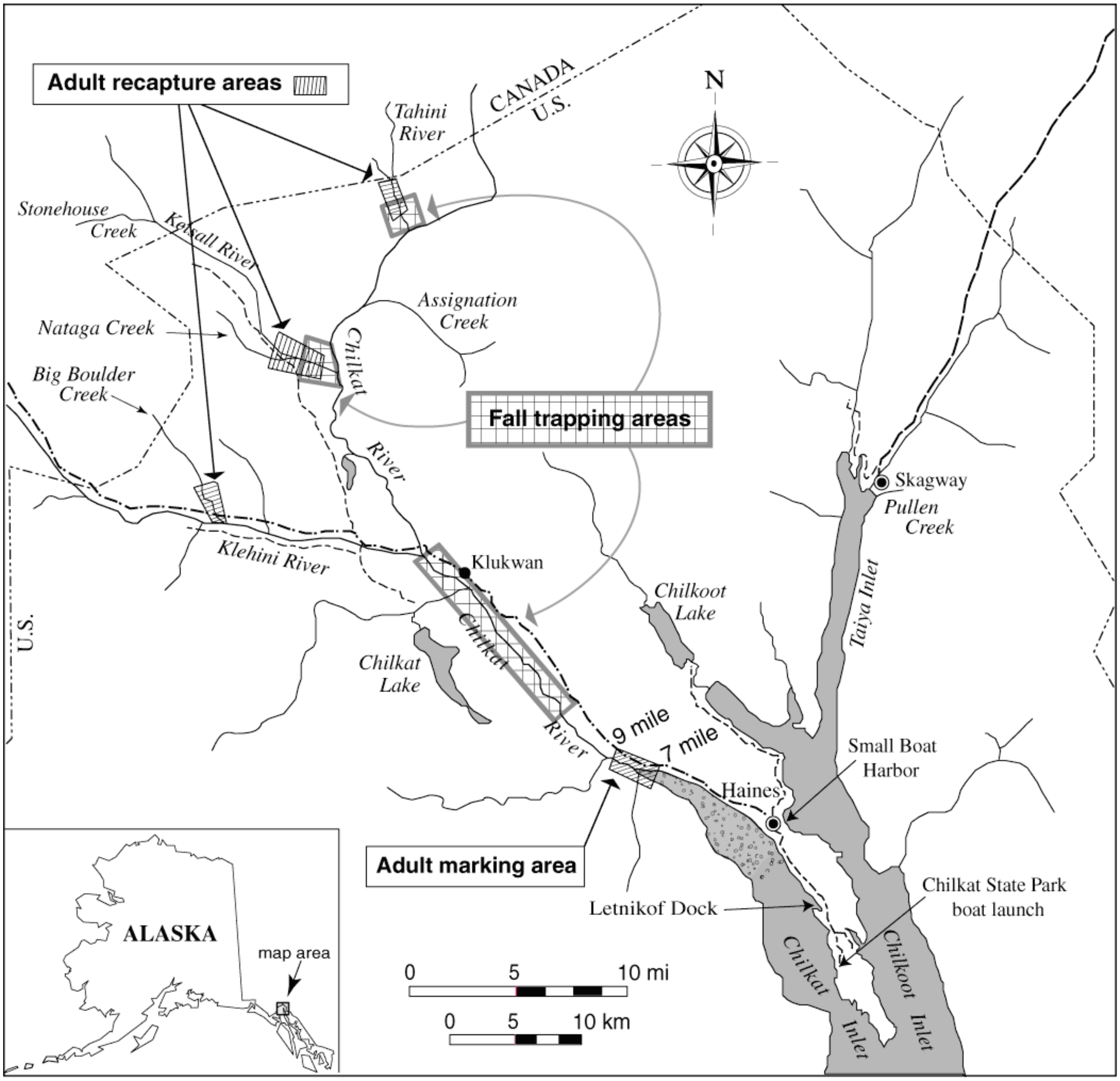

Figure 1.–Location of adult and juvenile Chinook salmon capture, sampling, and release sites near Haines and Skagway in Southeast Alaska, 2008.

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 in the 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 coded wire tagging (CWT) program on wild juvenile Chinook salmon in 1989 and 1990 to identify migratory patterns and to estimate contributions to sport and commercial fisheries (Pahlke et al. 1990; Pahlke 1991). DSF also conducted radiotelemetry and mark-recapture experiments in 1991, 1992, and 2005 to estimate spawning distribution and abundance of large (age-1.3 and older, i.e., fish ≥660 mm MEF) Chinook salmon in the river. Results of this research indicated that most Chinook spawn in 2 major tributaries of the Chilkat River, the Kelsall and Tahini rivers, and that 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, 2010). DSF has continued to conduct mark-recapture experiments and escapements since 1991 (Johnson et al. 1992, 1993; Johnson 1994; Ericksen 1995–2001, 2002a, 2003–2005, Ericksen and Chapell 2006, Chapell 2009, 2010).

In 2000, DSF began to mark Chinook salmon smolts with coded wire tags (CWTs) each spring to estimate the smolt emigration and marine harvest of this stock. During the first year, DSF tagged 1,996 smolts, which was fewer than expected (Ericksen 2002b). To increase the number of CWT'd Chinook salmon outmigrating from the Chilkat River, DSF began tagging juvenile Chinook salmon (fry) 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 impacting spawning production, a nonlethal CWT marking and detection method was used for the first time on this project starting with brood year 2001. For Chinook salmon smolt released in spring 2003, a second CWT was implanted in the muscle tissue beneath the dorsal fin of juvenile fish marked in spring. A handheld wand scanner was used on returning adult fish to detect the second CWT under the dorsal fin. The presence or absence of the second CWT combined with the age determination from scale samples identified adipose-clipped fish as marked in the fall or spring in a certain year.

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.

In 2007, the estimated escapement of large Chilkat River Chinook salmon was 1,438 fish (SE = 227), below the BEG for the first time since the mark-recapture project was started (Chapell 2010). In 2008, conservative sibling survival rates were used to project an inriver run below the low end of the inriver abundance goal range. As prescribed in the Lynn Canal and Chilkat River King Salmon Fishery 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 (July 3, 2008) by Emergency Order (EO) 1-KS-F-08-08. The Haines Sportsman's Association cancelled the 2008 Haines King Salmon Derby.

Because the forecasted Southeast Alaska Chinook salmon abundance index was low (<1.1) in 2008, sport fishing regulations were implemented to reduce Chinook salmon harvest (EO 1-KS-R-09-08, 5AAC 47.055). The bag and possession limit for Alaska residents was 1 fish 710 mm TL (28 in hereafter) or greater. The nonresident bag and possession limit was 1 fish, but the minimum size for nonresident harvest was increased to 1,220 mm TL (48 in) during July 16–September 30. The nonresident annual harvest limit was stepped down from 3 fish through June 30, to 2 fish July 1–15, and to 1 fish after July 16, with all fish kept earlier in the year applying to the later annual limit.

An additional regulation implemented by emergency order that was in effect July 16–31 allowed resident and nonresident anglers fishing in Taiya Inlet to keep 2 Chinook salmon 28 in TL or greater (EO 1-KS-F-22-08). This regulation targeted hatchery-released fish returning to Pullen Creek in Skagway (Figure 1).

The purpose of the studies described in this report was to estimate the sport harvest and escapement of Chinook salmon returning to the Chilkat River during 2008. DSF also tagged juvenile Chilkat River Chinook salmon from brood year (BY) 2007 in fall 2008 and spring 2009. This report describes the methods and results of the adult studies in 2008, the juvenile tagging in fall 2008 and spring 2009, and smolt production and harvest of BY 2001 Chilkat River Chinook salmon. The long-term goal of these studies is to refine maximum harvest guidelines for this stock in accordance with sustained yield management.

OBJECTIVES

Research objectives were to estimate:

1. the inriver run of Chinook salmon into the Chilkat River in 2008;
2. the age, sex, and length compositions of the escapement of large Chinook salmon in the Chilkat River in 2008;
3. the harvest of wild mature Chinook salmon in the Haines spring marine boat sport fishery from May 5 to June 22, 2008;
4. the mean length of juvenile Chinook salmon rearing in the Chilkat River drainage during fall 2008;
5. the number of Chinook salmon smolt that emigrated from the Chilkat River in 2003 (BY 2001); and
6. the marine harvest of Chilkat River Chinook salmon from BY 2001.

METHODS

INRIVER RUN ESTIMATE

A stratified mark-recapture experiment was used to estimate the number of Chinook salmon that immigrated to the Chilkat River in 2008.

Event 1 - Marking

Gillnets 21.3 m long and 3.0 m deep (70 ft × 10 ft) were drifted in the lower Chilkat River June 12 through July 25, 2008. The gillnets consisted of 2 equal-length panels: one of 17.1 cm (6.75 in) and the other of 20.3 cm (8.0 in) stretch measured nylon mesh. Forty-three (43) drifts were completed between 0600 and 1400 hours each day. Fishing was conducted from a 5.5 m (18 ft) boat in 6 adjoining 0.5 km sections, which were marked along a 3 km section of river (Figure 2). This area was about 100 m wide and 2 m to 3 m deep. The 43 drifts took about 6 h to complete when fish were not captured. 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 3-basket aluminum fish wheels were operated by the ADF&G Division of Commercial Fisheries (CF) to tag sockeye *O. nerka*, coho *O. kisutch*, and chum salmon *O. keta* from June 10 to October 10; incidentally captured Chinook salmon were also marked. One fish wheel operated adjacent to 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.

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

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 straps and sent to the CF Mark, Tag, and Age Laboratory in Juneau (CF 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. Unhealthy fish (e.g. lethargic or bleeding from the gills) were released untagged.

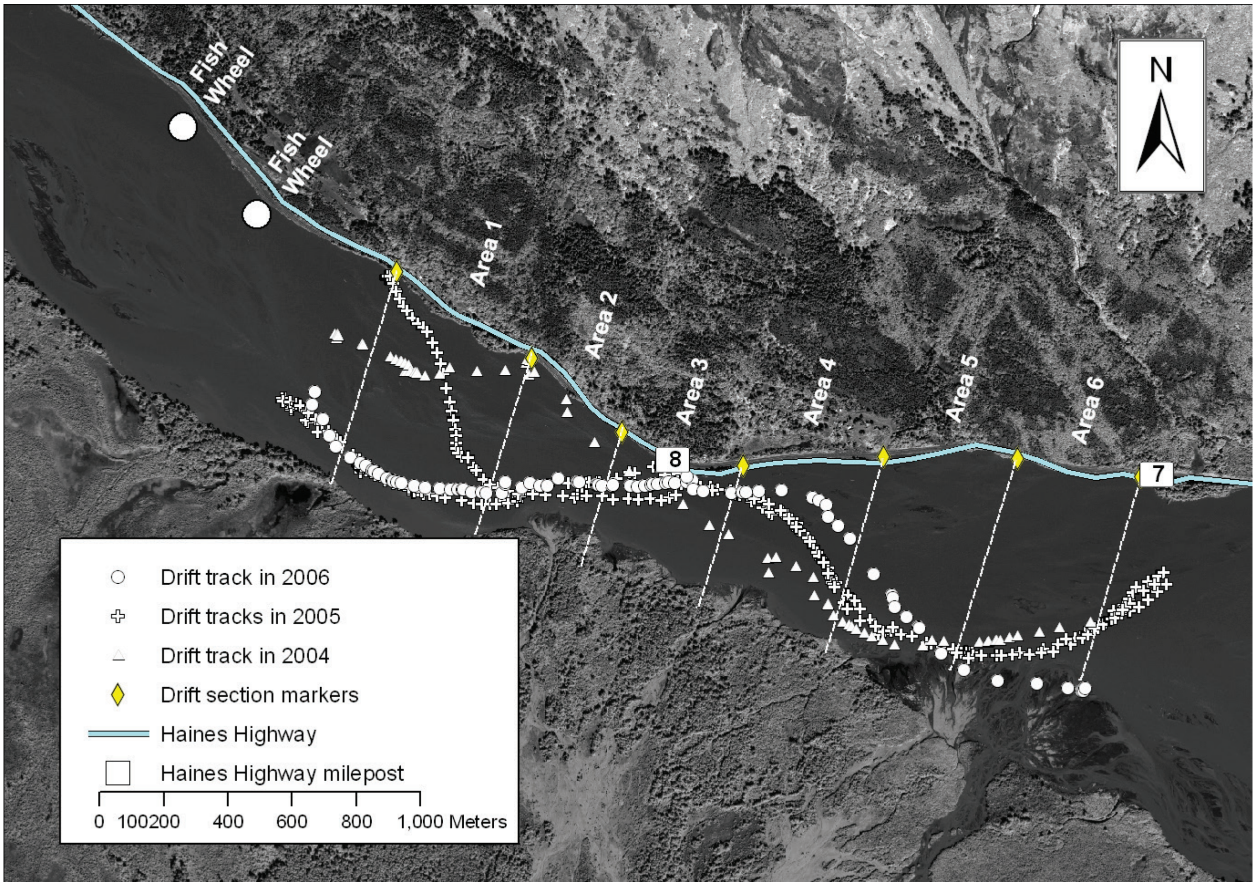

Figure 2.–Section marker locations and gillnet drift paths in the lower Chilkat River, 2004–2006. Area markers remained the same and similar paths were followed in 2008.

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 the 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.

The scale sampling procedure was to remove 5 scales from the left side of each sampled fish (right side if left side scales were missing or regenerated as determined by visual inspection) along a line 2 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 10,240 kg/cm^2, or 3,500 lb/in^2, at a temperature of 97°C) was used to determine age 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

Chinook salmon on the Kelsall and Tahini Rivers spawning grounds (Figure 1) were sampled by two 2-person crews. Kelsall River (including Nataga Creek) sampling occurred 7 days/wk from August 4 to September 3, and Tahini River sampling occurred Monday through Friday from August 5 to September 4. Chinook salmon were also sampled about every 5 days in 3 clearwater tributaries of the Klehini River: Big Boulder Creek, Little Boulder Creek, and 37-Mile Creek. Fish were captured using gillnets, dip nets, snagging gear, by hand, or by spear. All captured fish were inspected for marks, missing adipose fins, sex, measured to the nearest 5 mm MEF, and were sampled for scales as described in the 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 only from large fish in postspawning condition. Collected heads were marked with individually numbered straps and sent to the DCF Tag Laboratory in Juneau for CWT recovery and decoding.

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

(a) every fish has an equal probability of being marked during event 1, or every fish has an equal probability of being captured in event 2, or marked fish mix completely with unmarked fish;
(b) recruitment and "death" (emigration) do not occur between sampling events;
(c) marking does not affect catchability (or mortality) of the fish;
(d) fish do not lose marks between sample events;
(e) all marks in event 2 are identified and 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 immigration (e.g., early vs. late) were recaptured at the same rate.

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

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

Mid season discussion with event 1 staff revealed that the secondary mark had not been applied to medium and small fish captured in the fish wheels. Several cases of primary tag loss were observed in event 2. To minimize the possibility that marked fish were not recognized, violating assumptions (d) and (e), only fish that were successfully sampled for both scales and length were considered in event 2 analyses. The scale and length sampling procedures gave event 2 staff ample opportunity to observe wear behind and below the dorsal fin that a primary tag would cause even if it were lost later. Event 2 samples of severely decayed carcasses and "head only" samples were not considered.

To limit potential bias, the mark-recapture estimate was stratified into large fish (≥age-1.3, or ≥660 mm MEF if scales could not be aged) and medium/small fish (≤age-1.2, or <660 mm MEF if scales were not ageable) categories, as was done for annual Chilkat Chinook salmon inriver run estimates in 1991–2005. The inriver run for each category was calculated using a Chapman's modified Petersen estimator for a closed population (Seber 1982):

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

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

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

Assumption (f) is considered in the "Discussion."

Results of K-S tests of length distributions within the large and medium/small strata were evaluated using the protocol in Appendix A. The results of these tests, presented later, indicated that in both the large and the medium/small strata, event 1 was not size selective, but event 2 was size selective, so Case II applied, and the abundance estimate was not stratified within each stratum (large and medium/small).

Age and Sex 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). 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).

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 (Cochran 1977) 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.

As noted above, the protocols in Appendix A recommended that, for each size stratum (large and medium/small), pooled event 1 data (fish wheel and drift gillnet) be used to estimate inriver age composition. These proportions were estimated for each stratum by:

$$\hat{p}_a = \frac{n_a}{n} \quad (3)$$

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

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:

$$\hat{N}_a = \hat{N}\ \hat{p}_a \quad (5)$$

$$var[\hat{N}_a] = var[\hat{p}_a]\hat{N}^2 + var[\hat{N}]\hat{p}_a^{\ 2} - var[\hat{p}_a]var[\hat{N}] \quad (6)$$

Contingency table analysis (χ^2 test) was used to detect sex-selective sampling within each size stratum (large and medium/small) in the event 1 and 2 samples, using the null hypothesis that the probability that a sampled fish is male or female is independent of the sample. Similar to the length distribution comparisons, sex compositions were compared in 3 ways as directed in the Appendix A protocols:

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

Evaluation of the sex χ^2-test results, presented later, indicated that for the large fish stratum, the conservative approach was to use event 1 data to estimate the large sex composition. Therefore, the combined gear, event 1, large fish samples were used to estimate proportions by sex within each large fish age class by:

$$\hat{p}_s = \frac{n_s}{n} \quad (7)$$

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

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.

For the medium/small stratum, the sex χ^2-test results indicated that sex composition could be estimated using pooled event 1 and 2 data. However, the sex χ^2-test results showed the event 1 data was unbiased, and it was more practical to use only the event 1 data because those samples were being used to estimate age composition. Therefore, the combined gear, event 1, medium/small fish samples were used to estimate proportions by sex within each age class using equations (7) and (8).

The abundance of sex *s* Chinook salmon for each age class in the escapement was estimated as:

$$\hat{N}_s = \hat{N}\,\hat{p}_s \tag{9}$$

$$var[\hat{N}_{a,s}] = var[\hat{p}_s]\hat{N}_a^{\,2} + var[\hat{N}_a]\hat{p}_s^{\,2} - var[\hat{p}_s]var[\hat{N}_a] \tag{10}$$

TERMINAL HARVEST

2008 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 harbor. Temporal stratification included 7-day (weekly) periods at one high-use site, and 14-day (biweekly) periods at 2 low-use sites. A separate temporal stratum was created for the two weekends of the Haines King Salmon Derby, scheduled for May 24–26, May 31, and June 1 at both the high- and low-use sites. Each fishing day was defined as starting at 0800 hours and ending at civil twilight, which ranged from 2205 to 2351 hours. Midday was defined as the time mid way between 0800 hours and civil twilight. Sampling at each location had days as primary sampling units and boat-parties as secondary units.

The three access locations were Letnikof Dock, Chilkat State Park boat launch, and Haines Small Boat Harbor (Figure 1). Prior surveys indicated that, with the exception of 2000, anglers landing their catch at Letnikof Dock accounted for 51–93% of the harvest of Chinook salmon, so Letnikof Dock has always been the high-use site, and Chilkat State Park boat launch and Small Boat Harbor have been low-use sites. However, because Chilkat Inlet was closed to Chinook salmon retention by emergency order starting May 5, 2008 for the duration of the creel survey, it was anticipated that most sport fishing effort would shift from Letnikof Dock to the Small Boat Harbor. To accommodate the effort shift, Letnikof Dock and Chilkat State Park were treated as low-use sites, and the Small Boat harbor was treated as the high-use site in 2008. The Haines King Salmon Derby was cancelled after the start of the creel survey. The sample design was not changed mid season, so the derby sampling stratum was retained.

Sampling at the Small Boat harbor occurred from May 5 to June 22, 2008, and contained morning and evening stratification, and weekend and 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 3 evening strata were sampled each week, except as noted below. During the peak of the fishery (May 5–June 8) the evening strata at Small Boat Harbor were further divided into weekday and weekend strata. During this time, 2 morning, 2 weekday evening, and 2 weekend/holiday evening periods were sampled each week. In total, 17 unique strata were sampled at the Small Boat Harbor in 2008.

Sampling at the Letnikof Dock started on May 5 and continued through June 22. Sampling at the Chilkat State Park boat launch started on May 12, and ended on June 22. There was no type-of-day stratification at the low-use sites. At the low-use harbors, each biweekly period was divided into 14 morning and 14 evening periods of equal length, except during the Haines King Salmon Derby, when the biweek was divided into one 9-day (non-derby) period and one 5-day (derby) with no time-of-day stratification. Because of the very low use levels at Chilkat State Park boat launch, the initial 7-day stratum and final 7-day stratum had no time-of-day stratification. Random selections determined primary units to sample within each morning and evening stratum. To accommodate the impossibility of sampling the three sites simultaneously with only 2 technicians, 11 changes (period moves) were made to the randomly selected sample periods at low-use sites. Sixteen (16) unique strata were sampled at the low-use sites during 2008.

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, hours fished targeting species other than salmon, type of trip (charter or noncharter), target species (Chinook salmon, Pacific halibut *Hippoglossus stenolepis*), and number of fish caught/kept by species. Boat-party interviews also included sampling all harvests of Chinook salmon for maturity and missing adipose fins. Maturity was determined (Appendix A in Ericksen 1994) in order to estimate the harvest of wild mature fish, 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 for 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 (Cochran 1977):

$$\hat{H}_h = D_h \overline{H}_h \quad (11)$$

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h} \quad (12)$$

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \quad (13)$$

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:

$$var\left[\hat{H}_h\right] = (1-f_{1h}) D_h^2 \frac{\sum_{i=1}^{d_h} (\hat{H}_{hi} - \overline{H}_h)^2}{d_h(d_h - 1)} + D_h \sum_{i=1}^{d_h} M_{hi}^2 (1-f_{2hi}) \frac{\sum_{j=1}^{m_{hi}} (h_{hij} - \overline{h}_{hi})^2}{d_h m_{hi}(m_{hi} - 1)} \quad (14)$$

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 (11) through (14). Total harvests for the season are the sums 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 (11) through (14). Angler effort targeting salmon using trolling gear was calculated in salmon-h, and effort targeting all fish species and all rod & reel gear, including salmon trolling, was calculated in angler-h.

Chinook salmon sampled in the angler harvest were measured to the nearest 5 mm FL, and sampled for age by collecting scale samples as described above in the 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:

$$\hat{p}_a = \frac{\sum_h \hat{H}_h \hat{p}_{a,h}}{\sum_h \hat{H}_h} \quad (15)$$

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

$$\text{var}(\hat{p}_a) \cong \hat{H}^{-2} \sum_h \hat{H}_h^2 \,\text{var}\left(\hat{p}_{a,h}\right) + \hat{H}^{-2} \sum_h \text{var}\left(\hat{H}_h\right)\left(\hat{p}_{a,h} - \hat{p}_a\right)^2 \quad (16)$$

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 Mood et al. 1974, p. 181).

Contribution of Coded Wire Tagged Stocks to the 2008 Haines Marine Sport Fishery

Technicians retained heads from Chinook salmon in the marine sport fishery with missing adipose fins, and a plastic strap with a unique number was inserted through the jaw of the head. Heads and CWT recovery data were sent to the DCF Tag Lab where heads were dissected for the presence of coded wire. CWTs were subsequently decoded and all corresponding information was then entered into the DCF Tag Lab database.

The contribution of all CWT'd stocks to the 2008 Haines marine boat sport fishery was estimated:

$$\hat{r}_{ij} = \hat{H}_i \left(\frac{m_{ij}}{\lambda_i n_i} \right) \hat{\theta}_j^{-1} \qquad (17)$$

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

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

JUVENILE TAGGING

Juvenile Chinook salmon from BY 2007 were captured in primary rearing areas of the Chilkat River drainage during the fall of 2008 (fry) and in the mainstem of the Chilkat River during the spring of 2009 (smolt) and marked with an adipose fin clip and a CWT. In addition, smolt tagged in the spring 2009 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. Chinook salmon fry were captured in G-40 minnow traps at 3 locations in the Chilkat River drainage during fall 2008 (Figure 1). Trapping began in upriver locations and moved downstream as the season progressed. The Tahini River was trapped from September 20 to 25, the Kelsall River from October 5 to 14, and the lower Chilkat River from Haines Highway MP 13–MP 24 from October 22 to 30. In spring 2009, the lower Chilkat River (MP 5–21) was trapped from April 13 to May 30.

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

Following the methods in Koerner (1977), all healthy Chinook juveniles ≥50 mm FL were injected with a CWT and externally marked by excision of the adipose fin. Prior to marking, fish were first tranquilized in a solution of tricaine methanesulfonate (MS 222) buffered with sodium bicarbonate. In fall 2008, every 100th fish tagged with a CWT was additionally measured to the nearest mm FL. In spring 2009, every 20th fish 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-h tag retention and handling-induced mortality. The following morning 100 fish in the previous day's catch were randomly selected and checked for the retention of CWTs and mortality. If tag retention was 98% or greater, mortalities were counted and all live fish from that batch were released. If tag retention was less than 98%, the entire batch was checked for tag retention and those that tested negative were retagged. The number of fish tagged, number of tagging-related mortalities, and number of fish that had shed their tags were compiled and submitted to the DCF Tag Lab at the completion of the field season.

BROOD YEAR 2001 SMOLT ABUNDANCE

Between September 19 and October 27, 2002, 31,390 Chinook salmon fry from BY 2001 were captured, marked with adipose fin clips and

CWTs, and released into the Tahini, Kelsall, and Chilkat Rivers (Ericksen 2002a). In April and May 2003, an additional 2,797 smolts (also BY 2001) were marked and released into the Chilkat River (Ericksen and Chapell 2006).

Between 2004 and 2008, the DCF sampled landings from commercial drift gillnet, set gillnet, purse seine, and troll fisheries throughout Southeast Alaska and Yakutat for 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, and Juneau. The sample goal was to inspect at least 20% of the total catch of Chinook salmon for missing adipose fins. Heads from fish missing their adipose fin were sent to the DCF Tag Lab on a weekly basis where CWTs were removed and decoded. The annual DCF port sampling manual (ADF&G Unpublished, available from Director of DCF Tag Lab, Juneau) provides a detailed explanation of commercial catch sampling procedures and logistics.

The number of BY 2001 Chilkat River Chinook salmon CWTs recovered 2004–2008 in all commercial, sport, and subsistence fisheries, and the number recovered from Chilkat River escapement sampling events, was tallied by release period, whether fall 2002 or spring 2003, as determined by the tag code.

In the Chilkat River, large (≥660 mm FL) adipose-clipped fish in prespawning condition were not sacrificed for CWT recovery. All adipose-clipped fish in the Chilkat River were examined with a handheld wand CWT detector to determine presence or absence of the second CWT under the dorsal fin and the CWT in the head, as described above in juvenile tagging methods. For BY 2001 fish whose heads were taken, the results of CWT recovery and decoding by the DCF Tag Lab were paired with the results of handheld wand CWT scanning in the field. The agreement or disagreement of paired results were tallied. Agreement was defined as the CWT scan results correctly identifying the presence or absence of head and dorsal CWTs that would be expected given the tag code read at the lab. A scan result of CWT absence in the head would agree with a “NO TAG” result from the lab.

A form of the Petersen estimator (Seber 1982) was used to obtain estimates of the number of BY 2001 fry rearing in the Chilkat River in fall 2002 (N_{FRY}) and the number of smolts emigrating in 2003 (N_{SMOLT}):

$$\hat{N}_{FRY} = (M_{FRY} * C) / \hat{R}_{FRY} \tag{18}$$

and

$$\hat{N}_{SMOLT} = (M_{SMOLT} * C) / \hat{R}_{SMOLT} \tag{19}$$

where:

- M_{FRY} = number of CWTs applied to Chinook salmon fry marked during fall 2002,
- M_{SMOLT} = number of CWTs applied to Chinook salmon smolts marked during spring 2003,
- $C = R_1 + R_2 + R_3 + R_4$ = the total number of BY 2001 Chinook salmon examined for adipose fin clips in the Chilkat River in 2004–2008,
- R_1 = the number of fall 2002 CWTs decoded from adipose-clipped fish in the Chilkat River,
- R_2 = the number of spring 2003 CWTs decoded from adipose-clipped fish in the Chilkat River,
- R_3 = the number of adipose-clipped fish in the Chilkat River whose CWTs were not decoded because the head was not taken, the head was lost, or the tag was lost, and
- R_4 = the number of fish without adipose fin clips in the Chilkat River.

In order to estimate $\hat{R}_{FRY}$ and $\hat{R}_{SMOLT}$, the proportion ρ of all adipose-clipped fish in the BY 2001 population with decoded CWTs needed to be estimated using:

$$\hat{\rho} = R_{VTOT} / (R_1 + R_2 + R_3) \tag{20}$$

where:

$$R_{VTOT} = R_1 + R_2. \tag{21}$$

The number of fall 2002-marked adipose-clipped fish in C was then estimated using:

$$\hat{R}_{FRY} = R_{VTOT} * \left[\frac{(R_1 + m_{FALL})}{(R_{VTOT} + m)} \right] \Big/ \hat{\rho} \tag{22}$$

where:

- m = number of BY 2001 Chilkat Chinook CWTs recovered in marine fisheries, and

m_{FALL} = the CWTs from m that were fall 2002 CWTs.

The number of spring 2003-marked adipose-clipped fish in C was estimated using:

$$\hat{R}_{SMOLT} = R_{VTOT} * \left\{ 1 - \left[\frac{(R_1 + m_{FALL})}{(R_{VTOT} + m)} \right] \right\} \Big/ \hat{\rho} . \quad (23)$$

The survival probability ϕ_1 of BY 2001 Chinook salmon from fall 2002 to spring 2003 was estimated as:

$$\hat{\phi}_1 = \hat{N}_{SMOLT} \big/ \hat{N}_{FRY} . \quad (24)$$

The proportion of the fall 2002 fry population marked with CWTs was estimated using:

$$\hat{q}_{FALL} = \hat{R}_{FRY} / C \quad (25)$$

and the estimated proportion of the spring 2003 smolt population marked with CWTs was:

$$\hat{q}_{SPRING} = \hat{R}_{SPRING} / C. \quad (26)$$

A statistical model was fit to the BY 2001 data to estimate the error associated with the estimated parameters N_{FRY}, ϕ_1, and N_{SMOLT}. The number of valid CWTs from fall and spring marking events recovered from Chinook salmon sampled in the Chilkat River from 2004 to 2008 was modeled as having a multinomial distribution with parameters π_1, π_2, π_3, π_4, and C, where:

$\pi_1 = q_{FALL}\ \rho$,
$\pi_2 = q_{SPRING}\ \rho$,
$\pi_3 = (q_{FALL} + q_{SPRING})\ (1\text{-}\rho)$,
$\pi_4 = 1 - \pi_2 - \pi_3$, $q_{FALL} = M_{FRY} / N_{FRY}$, and
$q_{SPRING} = M_{SMOLT} / N_{SMOLT}$

The relative proportion of fall and spring CWTs recovered elsewhere (fisheries outside of the Chilkat River) also contains information about the survival probability ϕ_1. Therefore the number of valid CWTs from the fall 2002 marking event recovered from Chinook salmon sampled elsewhere from 2004 to 2008 was modeled as having a binomial distribution with parameters:

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

Bayesian statistical methods, which are well-suited for analyzing unconventional data[1], were used to estimate the error associated with parameters of the model. 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_{FRY}, essentially equivalent to a uniform distribution. A beta (0.1, 0.1) prior was used for ϕ_1 and ρ. All priors were noninformative, chosen to have a negligible effect on the posterior.

Markov-Chain Monte Carlo simulation, implemented with the Bayesian software WinBUGS (Gilks et al. 1994), was used to draw samples from the joint posterior probability distribution of all unknowns in the model. 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. WinBUGS model code, data, initial values, and results are in Appendix E.

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

BROOD YEAR 2001 ADULT HARVEST

Harvest of BY 2001 Chilkat River Chinook salmon was estimated from fish sampled for CWTs in marine commercial and recreational fisheries harvests, and in the Chilkat River escapement to determine the fraction θ_h of BY 2001 fish carrying a CWT.

Because several fisheries exploited Chinook salmon over several months and years, harvest was estimated over several strata, each a combination of time, area, and type of fishery. Statistics from the commercial troll fishery were stratified by troll fishing period and quadrant. Statistics from drift gillnet fisheries were stratified by statistical week and district. Statistics from the Haines area marine subsistence gillnet fishery were stratified by year. In recreational fisheries where creel survey programs estimate harvest, statistics were stratified by fortnight (biweek). In recreational 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 recreational fisheries in Southeast Alaska.

Data from the port sampling and creel survey programs were used to estimate the commercial and recreational harvest of Chinook salmon bound for the Chilkat River following equation 17[2]. The variance of the individual harvest contribution estimates $\{r_i\}$ (by stratum) followed Bernard and Clark (1996, their Table 2, situations 3 and 4) for a wild stock harvested in commercial and recreational fisheries.

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

$$\hat{T} = \sum_i \hat{r}_i \qquad (27)$$

$$\mathrm{v}[\hat{T}] = \sum_i \mathrm{v}[\hat{r}_i] \qquad (28)$$

$$SE[\hat{T}] = \sqrt{var[\hat{T}]} \qquad (29)$$

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 Chinook salmon returning to the Chilkat River from the BY 2001 was estimated as:

$$\hat{R} = \hat{T} + \hat{S} \qquad (30)$$

$$var[\hat{R}] = var[\hat{T}] + var[\hat{S}] \qquad (31)$$

$$SE[\hat{R}] = \sqrt{var[\hat{R}]} \qquad (32)$$

where $\hat{S}$ is the total escapement of age-1.2 and older BY 2001 fish estimated between 2005 and 2008.

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

$$\hat{\mu} = \frac{\hat{T}}{\hat{R}} = \frac{\hat{T}}{\hat{S} + \hat{T}} \qquad (33)$$

$$var[\hat{\mu}] \approx \frac{var[\hat{T}]\hat{S}^2}{\hat{R}^4} + \frac{var[\hat{S}]\hat{T}^2}{\hat{R}^4} \qquad (34)$$

$$SE[\hat{\mu}] = \sqrt{var[\hat{\mu}]} \qquad (35)$$

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

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

$$\hat{\phi}_2 = \frac{\hat{R}}{\hat{N}_{SMOLT}} \qquad (36)$$

$$var[\hat{\phi}_2] \approx \hat{\phi}_2^2 \left[\frac{var[\hat{R}]}{\hat{R}^2} + \frac{var[\hat{N}_{SMOLT}]}{\hat{N}_{SMOLT}^2} \right] \qquad (37)$$

$$SE[\hat{\phi}_2] = \sqrt{var[\hat{\phi}_2]} \qquad (38)$$

RESULTS

INRIVER RUN ESTIMATE

In event 1, 144 large (age-1.3 and older) 31 medium (age-1.2), and 83 small (age-1.1) Chinook salmon were captured in the lower Chilkat River with drift gillnets and fish wheels

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

between June 12 and August 9, 2008 (Table 1, Figure 3). Of those captured, 143 large, 29 medium, and 76 small fish were given a uniquely numbered external tag. The remaining captured fish that were not tagged were: 2 medium and 6 small fish with adipose fin clips that were sacrificed to recover CWTs, and 1 large and 1 small fish mortalities.

Application of the secondary mark (ULOP) was inconsistent. Contrary to the operational plan, the fish wheel staff did not to apply the ULOP to 32 of 34 small fish tagged from the season start through July 7. Event 2 inspections turned up an additional 2 large and 2 medium spaghetti-tagged fish without discernible ULOPs. These fish had been tagged June 27 (1 medium), July 8 (1 large), and July 11 (1 large, 1 medium) at the fish wheel capture site.

The capture rate of large Chinook salmon peaked on July 2 (Figure 3). The mean of the immigration timing density of both large fish and all fish combined was July 8 (Figures 3 and 4; Mundy 1984).

In event 2, we captured 443 large, 111 medium, and 37 small Chinook salmon on the spawning grounds, of which 21 large, 4 medium, and 2 small fish were marked (Table 2). The count of large fish examined does not include 6 large fish, all partial carcasses, whose tagged status could not be determined with certainty. Among the large fish examined, there were 5 detected cases of primary tag loss. LAA examination indicated that 2 had been captured in event 1 by drift gillnet, and 3 by fish wheel.

Recapture rates of marked fish were not significantly different for fish marked in the first half of event 1 (127 fish marked from June 12 to July 7) versus the second half (121 fish marked from July 12 to August 9) ($\chi^2 = 0.86$, df = 1, P = 0.35), so the Petersen-type model used to estimate the inriver run was not stratified by time. The marked fractions of large Chinook salmon sampled at the three tributaries (Kelsall 5.4%, Tahini 4.3%, Klehini tributaries 4.5%) were not different ($\chi^2 = 0.246$, df = 2, P = 0.884), so the large fish abundance estimate was not stratified by area. The marked fractions of medium and small Chinook salmon sampled at the three tributaries (Kelsall 5.4%, Tahini 3.6%, Klehini tributaries 3.6%) were not different ($\chi^2 = 0.232$, df = 2, P = 0.891), so the medium/small fish abundance estimate was not stratified by area.

The comparison of the length distributions of large Chinook salmon marked in event 1 (combined fish wheel and drift gillnet gear types) and recaptured large fish in event 2 showed no difference at α = 0.1 (K-S test, D = 0.265, P = 0.112, Figure 5). The comparison of the length distributions of all large fish captured in event 2 with large fish recaptured in event 2 showed no difference (K-S test, D = 0.207, P = 0.338, Figure 5). The comparison of the length distributions of all large fish marked in event 1 with all large fish captured in event 2 showed a significant difference (K-S test, D = 0.146, P = 0.017, Figure 5). These results required further evaluation.

Considering that the recaptured large fish sample size (21 fish) was small, that the event 1 marked vs. recaptured K-S test P-value (P = 0.112) was not large, and that the captured vs. recaptured K-S test P-value was large (P = 0.338), the rejection of the null hypothesis in the marked vs. captured test was likely the result of size/sex selectivity during the second event, which the marked vs. recaptured test was not powerful enough to detect (Figure 5). The protocol in Appendix A suggested that a *Case I* situation could be considered, but that *Case II* was the more conservative interpretation. The suggested *Case II* analysis was an unstratified Petersen-type population estimator, with age composition estimated using event1 data. The outcomes of a series of χ^2 tests, as outlined in Appendix A, of sex composition of large Chinook salmon in events 1 and 2 dictated that further evaluation was required (Table 3). Because the recaptured sample size was small (21 fish) and the captured vs. recaptured χ^2 test P-value was large (P = 0.888), the closest matching situation was B, which indicated that there was sex selectivity in the second event, but the marked vs. recaptured χ^2 test was not powerful enough to detect the selectivity. As was the case with the length-selectivity analysis, the conservative procedure recommended in Appendix A was to not stratify the large fish population estimate by sex, and to use event 1 data to estimate the sex proportions.

Table 1.–Number of Chinook salmon caught in the lower Chilkat River by time period, gear type and size, June 12–August 10, 2008.[a]

Time	Drift gillnet			Fish wheels			Combined			
period	L	M	S	L	M	S	L	M	S	Total
6/12–6/16	2	0	0	0	0	0	2	0	0	2
6/17–6/21	8	1	0	0	1	0	8	2	0	10
6/22–6/26	5	0	0	2	1	3 [b]	7	1	3	11
6/27 7/01	11	0	0	3	3 [c]	13	14	3	13	30
7/02–7/06	32	4	0	10	4	12 [d]	42	8	12	62
7/07–7/11	12	1	0	9	3 [e]	34 [f]	21	4	34	59
7/12–7/16	17	2	0	8	5	11	25	7	11	43
7/17–7/21	6	1	0	3	1	5	9	2	5	16
7/22–7/26	4	0	0	5	1	1	9	1	1	11
7/27–7/31				4 [g]	1	2 [h]	4	1	2	7
8/01–8/05				1	2	0	1	2	0	3
8/06–8/10				2	0	2 [i]	2	0	2	4
	97	9	0	47	22	83	144	31	83	258

[a] L = age-1.3 and older fish, M = age-1.2 fish, S = age-1.1 fish.
[b] 1 S not tagged.
[c] 1 M not tagged.
[d] 1 S not tagged.
[e] 1 M not tagged.
[f] 3 S not tagged.
[g] 1 L not tagged.
[h] 1 S not tagged.
[i] 1 S not tagged.

Table 2.–Number of Chinook salmon inspected for marks and number of marked fish recaptured during tag recovery surveys in the Chilkat River drainage by location, size and sex in 2008.

		Inspected								Marked						
		Large			Medium			Small		Large			Medium		Small	
	Dates	M	F	Total	M	F	Total	M	Total	M	F	Total	M	Total	M	Total
Kelsall River	8/04–9/03	81	66	147	25	2	27	10	10	3	5	8	1	1	1	1
Tahini River	8/05–9/04	109	99	208	60	1	61	22	22	5	4	9	3	3	0	0
Big Boulder	8/05–8/29	31	19	50	15	0	15	3	3	2	0	2	0	0	1	1
Little Boulder	8/15–8/25	18	19	37	8	0	8	2	2	1	1	2	0	0	0	0
37-Mile Cr	8/15–8/25	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Total		239	204	443	108	3	111	37	37	11	10	21	4	4	2	2

[a] M = male, F = female

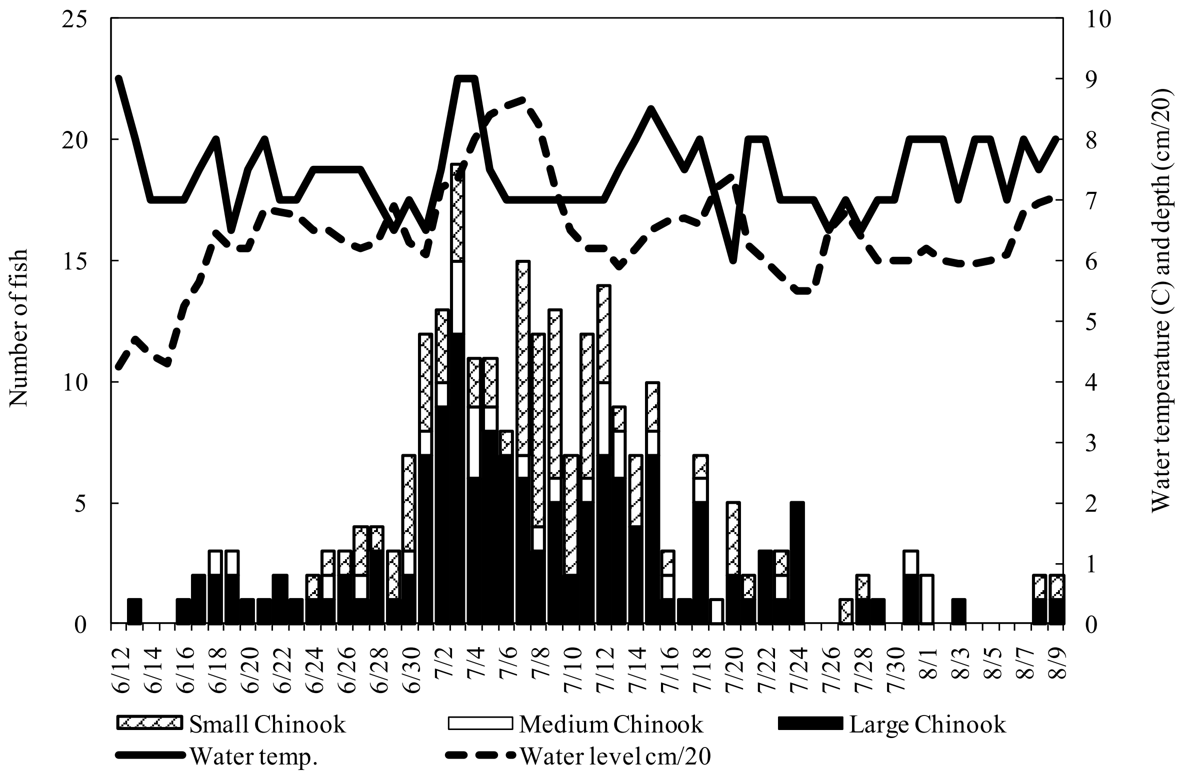

Figure 3.–Daily water depth (cm/20), temperature (°C), and catches of small (age-1.1), medium (age-1.2), and large (≥ age-1.3) Chinook salmon in drift gillnets and fish wheels operating in the lower Chilkat River, June 12–August 9, 2008.

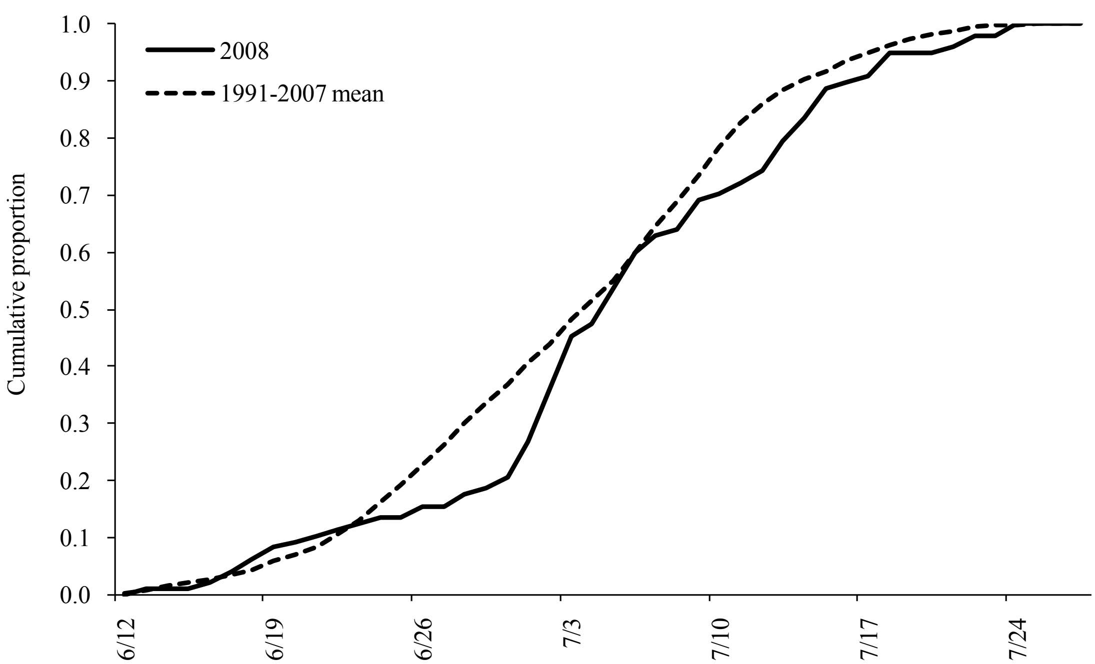

Figure 4.–Cumulative proportion of large (≥ age-1.3) Chinook salmon captured with drift gillnets in the lower Chilkat River June 12–July 25, 2008 compared to the mean cumulative proportion, 1991–2007.

Sex identification during event 1 has historically been unreliable for this project (Table 4). The 2008 results were remarkable in that the sex determination agreed between events 1 and 2 for 22 of 22 Chinook salmon of all sizes recaptured with numbered spaghetti tags. The length distributions of medium/small (≤age-1.2) Chinook salmon marked in event 1 (combined fish wheel and drift gillnet gear types) and recaptured in event 2 were different at $\alpha = 0.1$ (K-S test, $D = 0.533$, $P = 0.070$, Figure 6). The comparison of length distributions of medium/small fish captured vs. recaptured in event 2 showed no difference (K-S test, $D = 0.297$, $P = 0.678$, Figure 5). The comparison of length distributions of event 1 marked fish vs. event 2 captured fish showed a significant difference (K-S test, $D = 0.518$, $P < 0.001$, Figure 6). These results indicate *Case II*, where event 1 was not size selective, but event 2 was, so the medium/small fish was not further stratified for the population estimate, and event 1 data was used for estimating age composition (Appendix A).

Chi-square tests comparing sex compositions of medium/small (≤age-1.2) Chinook salmon in events 1 and 2 detected no sex selectivity in either event 1 or event 2 (Table 3). Appendix A protocols indicate that stratification by sex was not required and that combined data from events 1 and 2 could be used to estimate sex composition. However, for the simplicity of working with a unified set of age, length, and sex data, only event 1 data was used to estimate sex proportions.

Table 3.–Contingency table tests for evaluation of sex selectivity in large (≥age-1.3) and medium/small (≤age-1.2) categories of Chinook salmon in mark-recapture events 1 and 2.

Large (≥age-1.3) Chinook salmon				Medium/small (≤age-1.2) Chinook salmon			
	Number of fish				Number of fish		
	Male	Female			Male	Female	
Marked (event 1)	57	87		Marked (event 1)	99	6	
Captured (event 2)	239	204		Captured (event 2)	145	3	
Recaptured (event 2)	11	10		Recaptured (event 2)	6	0	
Comparison	χ^2	df	P	Comparison	χ^2	df	P
Marked vs. recaptured	1.239	1	0.226	Marked vs. recaptured	0.362	1	0.547
Captured vs. recaptured	0.020	1	0.888	Captured vs. recaptured	0.124	1	0.725
Marked vs. captured	8.973	1	0.003	Marked vs. captured	2.434	1	0.119

Table 4.–Sex determination error rates in recaptured fish, Chilkat River Chinook salmon mark–recapture studies, 1991–2008.

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 2002aa)
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	
Average	32	4	0.13	

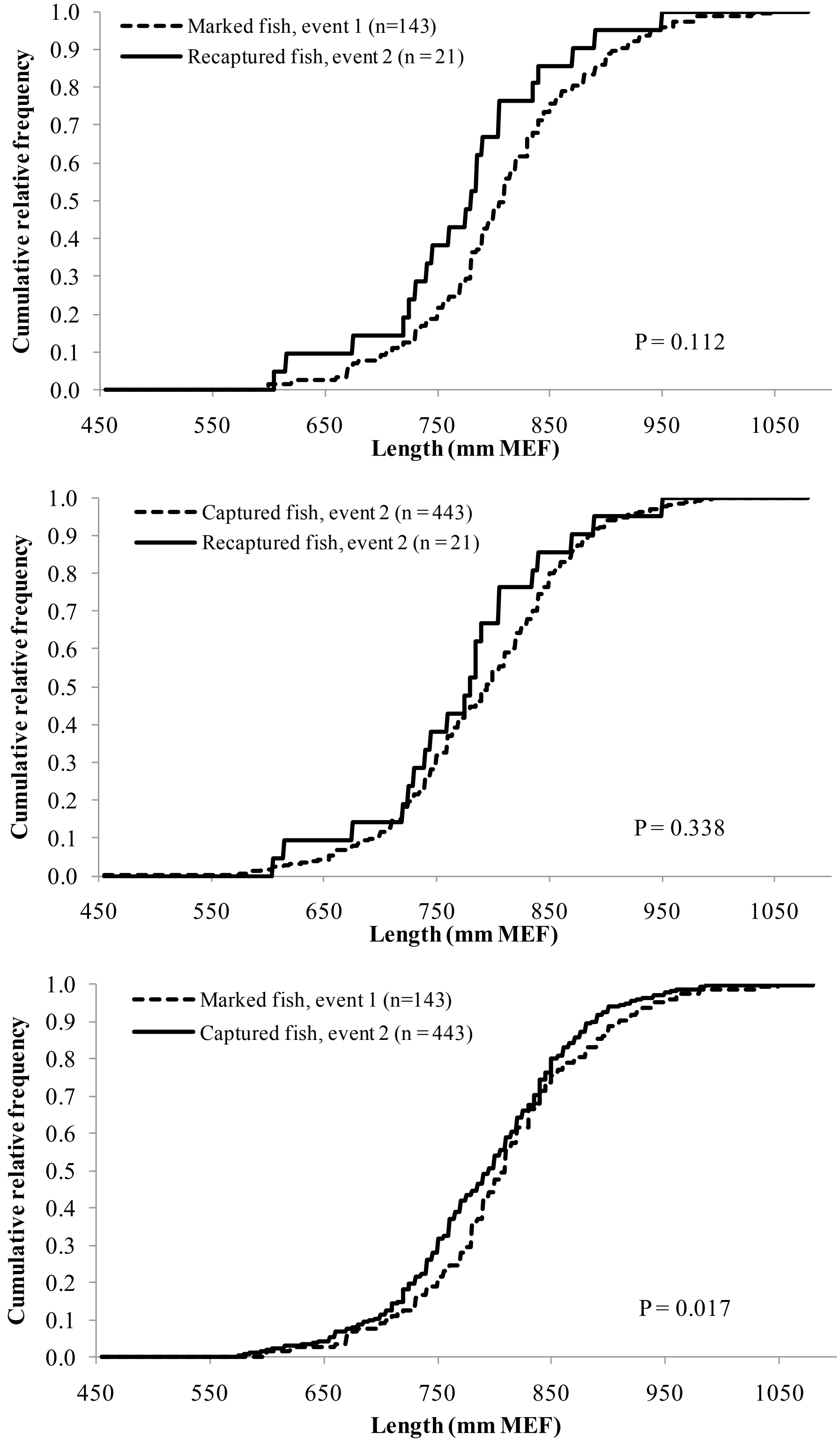

Figure 5.–Empirical cumulative distribution function of MEF lengths of large (≥age-1.3) Chilkat River Chinook salmon marked vs. recaptured (top), captured vs. recaptured (middle), and marked vs. captured (bottom), in 2008.

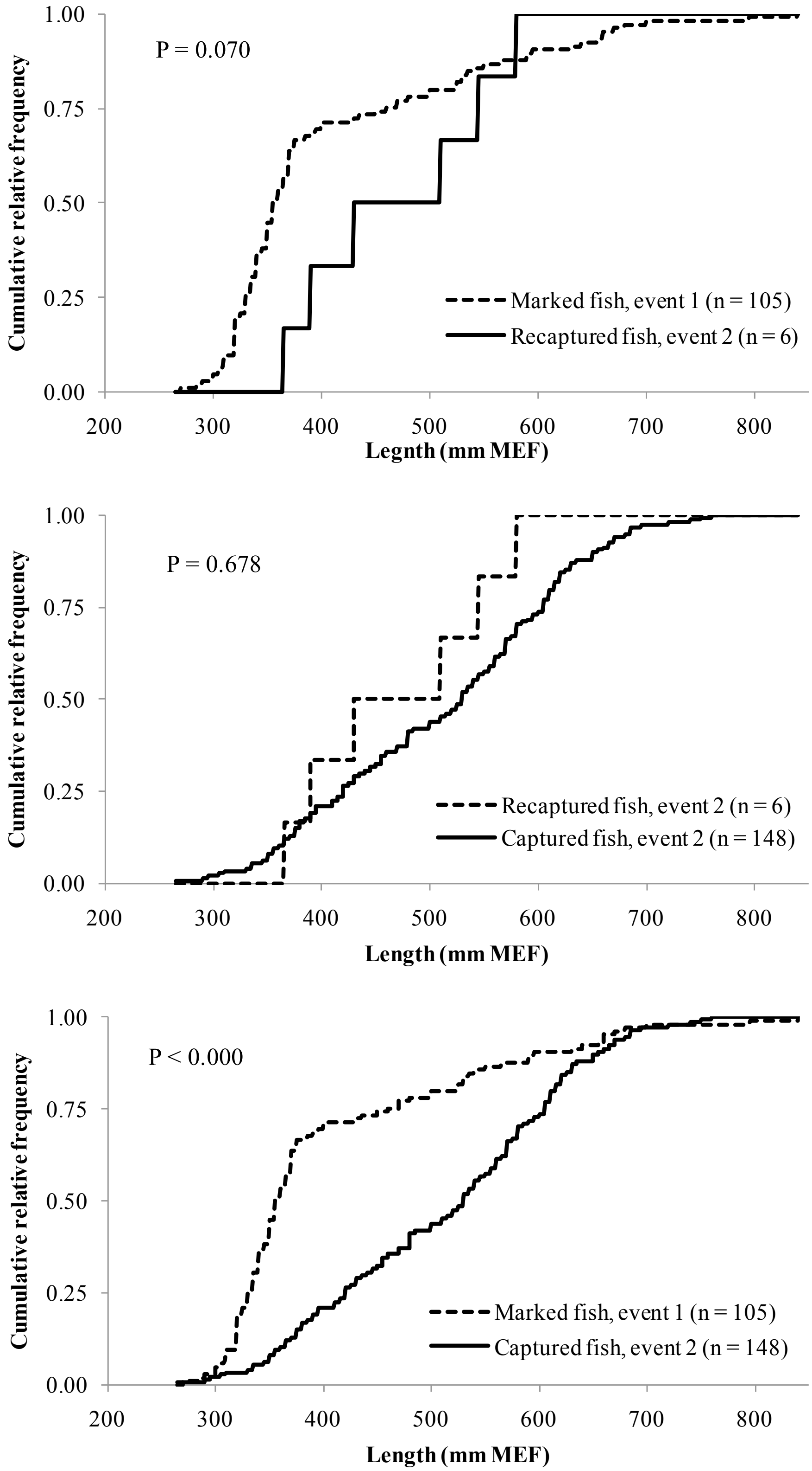

Figure 6.–Empirical cumulative distribution function of MEF lengths of small/medium (≤age-1.2) Chilkat River Chinook salmon marked vs. recaptured (top), captured vs. recaptured (middle), and marked vs. captured (bottom), in 2008.

An estimated 2,905 (SE = 544) large (≥age-1.3) and an estimated 2,255 (SE = 753) medium/small (≤age-1.2) Chinook salmon immigrated into the Chilkat River in 2008 (Table 5).

Table 5.–Abundance estimates and sampling statistics of Chilkat River Chinook salmon by age stratum in 2008.

	Marked	Examined	Recaptures	Abundance	
Stratum	n_1	n_2	m_2	$\hat{N}_a$	$SE(\hat{N}_a)$
age-1.1+1.2	105	148	6	2,255	753
age-1.3+	143	443	21	2,905	544
Total	248	591	27	5,160	928

These estimates are germane to the time of marking at the event 1 sites (Figure 1). The annual Chinook salmon escapement to the spawning grounds may be estimated by subtracting reported Chilkat River subsistence fishery removals, which occur primarily upstream of the marking site.

Age and Sex Composition of the Inriver Run

Chinook salmon captured in gillnets were predominantly age-1.3 (68.3%) or age-1.4 (27.3%) and classified as female (63.2%, Table 6). Fish captured in the fish wheels were classified mostly as males (82.9%) and were most commonly age-1.1 (52.9%) or age-1.3 (22.9%). Almost 75% (78 out of 106) of the fish in the drift gillnets were captured in the large mesh (20.3 cm) panel. The overall age composition of fish captured in the combined lower Chilkat River gear types was 30.3% age-1.1, 12.3% age-1.2, 42.2% age-1.3, and 14.8% age-1.4, and 0.4% age-1.5 (Table 6).

Following the Case II protocol in Appendix A, the event-1 age proportions (Table 6) were used to estimate the inriver run age and sex composition for both the large and medium/small strata. The estimated inriver run age composition was 1,591 (SE = 540) age-1.1, 665 age-1.2 (SE = 243), 2,153 (SE = 417) age-1.3, 732 (SE = 173) age-1.4, and 21 (SE = 21) (Table 7).

Chinook salmon were sampled from the spawning grounds for age and sex (n=591). Of those sampled, 574 were successfully aged (Table 8). The composition of small (age-1.1), medium (age-1.2), and large (≥age-1.3) age classes was not significantly different between the Tahini, Kelsall, and Klehini river sampling areas (χ^2 = 2.21, df = 2, P = 0.33). Male fish outnumbered female fish at all three sampling locations.

Terminal Harvest

2008 Haines Marine Sport Fishery Harvest

The 2008 Haines marine boat creel survey estimates are based on interviews with 71 boat parties who fished 734 angler-h (658 salmon-h) (Table 9). The survey estimated that anglers spent a total of 1,211 (SE = 177) angler-h of effort, of which 1,132 angler-h targeted salmon, in the sport fishery from May 5 to June 22, 2008. This estimated effort was only 14% of the average estimated Haines area salmon effort in May/June of 1993–2007 (Ericksen 1994–2001, 2002a, 2003–2005, Ericksen and Chapell 2006, Chapell 2009, 2010). The estimated total harvest was 27 (SE = 11) large Chinook salmon, which is 10% of the 1993–2007 average annual harvest (ibid.). An estimated 5 (SE = 2) of the Chinook salmon harvested in this fishery were wild mature fish assumed to be returning to the Chilkat River. Anglers caught an estimated 127 (SE = 56) small (<28 in TL) Chinook salmon, but no harvest of sublegal size (<28 in TL) Chinook salmon was encountered by the creel survey. Charter boat anglers were encountered only at the Haines small boat harbor in 2008. Charter anglers accounted for 19% of the salmon effort (211 salmon-h, SE = 56), and 26% of the large Chinook salmon harvest (7 fish, SE = 3).

Only 5% of the estimated salmon effort was based at Letnikof dock in Chilkat Inlet, with the remainder based at the Haines small boat harbor, on Chilkoot Inlet (Figure 1, Appendices B1–B3). In contrast, an average of 84% of salmon effort was based at Letnikof dock in 2001–2007 (Ericksen 2002a, 2003–2005, Ericksen and Chapell 2006, Chapell 2009, 2010). All of the estimated Chinook salmon harvest was by parties landing at the Haines small boat harbor.

Age and Length of Harvest

Creel surveyors sampled a total of 10 Chinook salmon for age, sex, and length in the sport harvest at the Haines small boat harbor, and 0 fish at other harbors (Table 10). Most (9 of 10) of the fish sampled were age-1.3. The samples were evenly split by sex.

Table 6.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 1 marking on the Chilkat River by gear type, 2008.

		Brood year and age class						
		2005	2004	2003	2002	2001	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
FISH WHEELS								
Males	Sample size	74	21	16	4	0	115	126
	Percent	64.3	18.3	13.9	3.5	0.0		82.9
	SE (%)	4.5	3.6	3.2	1.7			3.1
	Mean length	345	536	740	943			
	SD	30	72	103	61			
Females	Sample size	0	0	16	9	0	25	26
	Percent	0.0	0.0	64.0	36.0	0.0		17.1
	SE (%)			9.6	9.6			3.1
	Mean length			783	871			
	SD			37	90			
All fish	Sample size	74	21	32	13	0	140	152
	Percent	52.9	15.0	22.9	9.3	0.0		
	SE (%)	4.2	3.0	3.5	2.5			
	Mean length	345	536	762	893			
	SD	30	72	79	87			
DRIFT GILLNET								
Males	Sample size	0	3	29	5	1	38	39
	Percent	0.0	7.9	76.3	13.2	2.6		36.8
	SE (%)		4.4	6.9	5.5	2.6		4.7
	Mean length		608	788	881	1,050		
	SD		28	62	67			
Females	Sample size	0	6	42	18	0	66	67
	Percent	0.0	9.1	63.6	27.3	0.0		63.2
	SE (%)		3.5	5.9	5.5			4.7
	Mean length		710	795	885			
	SD		86	53	56			
All fish	Sample size	0	9	71	23	1	104	106
	Percent	0.0	8.7	68.3	22.1	1.0		
	SE (%)		2.8	4.6	4.1	1.0		
	Mean length		676	792	884	1,050		
	SD		86	56	57			
COMBINED LOWER RIVER GEAR								
Males	Sample size	74	24	45	9	1	153	165
	Percent	48.4	15.7	29.4	5.9	0.7		64.0
	SE (%)	4.0	2.9	3.7	1.9	0.7		3.0
	Mean length	345	545	771	908	1,050		
	SD	30	72	81	69			
Females	Sample size	0	6	58	27	0	91	93
	Percent	0.0	6.6	63.7	29.7	0.0		36.0
	SE (%)		2.6	5.0	4.8			3.0
	Mean length		710	792	880			
	SD		86	49	68			
All fish	Sample size	74	30	103	36	1	244	258
	Percent	30.3	12.3	42.2	14.8	0.4		
	SE (%)	2.9	2.1	3.2	2.3	0.4		
	Mean length	345	578	783	887	1,050		
	SD	30	100	65	68			

[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, 2008.

	Brood year and age class					
	2005	2004	2003	2002	2001	
	1.1	1.2	1.3	1.4	1.5	Total
Male	1,591	522	941	167	21	3,241
SE	540	197	210	65	21	214
Female	0	143	1,212	565	0	1,919
SE		71	257	143		214
All fish	1,591	665	2,153	732	21	5,160
SE	540	243	417	173	21	928

Table 8.–Age composition and mean length-at-age (mm MEF) of Chinook salmon sampled during event 2 surveys in the Chilkat River drainage by spawning tributary, 2008.

		Brood year and age class						
		2005	2004	2003	2002	2001	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
				KELSALL RIVER				
Males	Sample size	9	25	53	27	0	114	116
	Percent	7.9	21.9	46.5	23.7	0.0		63.0
	SE(%)	2.5	3.9	4.7	4.0			3.6
	Mean length	363	571	772	900			
	SD	53	88	70	74			
Females	Sample size	0	2	28	36	1	67	68
	Percent	0.0	3.0	41.8	53.7	1.5		37.0
	SE(%)		2.1	6.1	6.1	1.5		3.6
	Mean length		640	776	850	845		
	SD		14	56	53			
All fish	Sample size	9	27	81	63	1	181	184
	Percent	5.0	14.9	44.8	34.8	0.6		
	SE(%)	1.6	2.7	3.7	3.6	0.6		
	Mean length	363	576	773	871	845		
	SD	53	87	65	67			
				TAHINI RIVER				
Males	Sample size	20	58	98	9	0	185	191
	Percent	10.8	31.4	53.0	4.9	0.0		65.6
	SE(%)	2.3	3.4	3.7	1.6			2.8
	Mean length	370	551	757	898			
	SD	32	77	78	61			
Females	Sample size	0	1	71	24	0	96	100
	Percent	0.0	1.0	74.0	25.0	0.0		34.4
	SE(%)		1.0	4.5	4.4			2.8
	Mean length		515	788	853			
	SD			48	43			
All fish	Sample size	20	59	169	33	0	281	291
	Percent	7.1	21.0	60.1	11.7	0.0		
	SE(%)	1.5	2.4	2.9	1.9			
	Mean length	370	551	770	865			
	SD	32	77	68	52			

-continued-

Table 8.–Page 2 of 2.

KLEHINI RIVER								
Males	Sample size	5	22	40	7	0	74	77
	Percent	6.8	29.7	54.1	9.5	0.0		66.4
	SE(%)	2.9	5.3	5.8	3.4			4.4
	Mean length	338	584	713	846			
	SD	43	80	80	86			
Females	Sample size	0	0	26	12	0	38	39
	Percent	0.0	0.0	68.4	31.6	0.0		33.6
	SE(%)			7.6	7.6			4.4
	Mean length			772	853			
	SD			40	43			
All fish	Sample size	5	22	66	19	0	112	116
	Percent	4.5	19.6	58.9	17.0	0.0		
	SE(%)	2.0	3.8	4.7	3.6			
	Mean length	338	584	736	850			
	SD	43	80	73	60			
		Brood year and age class						
		2005	2004	2003	2002	2001	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
COMBINED SPAWNING GROUNDS								
Males	Sample size	34	105	191	43	0	373	384
	Percent	9.1	28.2	51.2	11.5	0.0		65.0
	SE(%)	1.5	2.3	2.6	1.7			2.0
	Mean length	364	563	752	891			
	SD	40	81	78	75			
Females	Sample size	0	3	125	72	1	201	207
	Percent	0.0	1.5	62.2	35.8	0.5		35.0
	SE(%)		0.9	3.4	3.4	0.5		2.0
	Mean length		598	782	851	845		
	SD		73	48	47			
All fish	Sample size	34	108	316	115	1	574	591
	Percent	5.9	18.8	55.1	20.0	0.2		
	SE(%)	1.0	1.6	2.1	1.7	0.2		
	Mean length	364	564	764	866	845		
	SD	40	81	70	62			
Combined spawning grounds sex proportion by age class								
Males	Percent	100.0	97.2	60.4	37.4	0.0	65.0	65.0
	SE(%)		1.6	2.8	4.5		2.0	2.0
Females	Percent	0.0	2.8	39.6	62.6	100.0	35.0	35.0
	SE(%)		1.6	2.8	4.5		2.0	2.0

[a] Includes fish that were not assigned a valid age. Excludes 6 large (≥660 mm MEF) fish examined for marks but not sampled for scales because carcass was decayed.

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 5–June 22, 2008. Retention of Chinook salmon was not allowed in Chilkat Inlet 2008. Retention of small Chinook salmon was not allowed in the Haines/Skagway area in 2008. The Haines King Salmon Derby was cancelled in 2008, but the derby and non-derby strata were retained in the sampling plan.

	May 5–May 18	May 19–June 1		June 2–June 15	June 16–June 22	Total
		Non-derby	Derby			
Boats counted	19	5	12	24	11	71
Angler-hr. sampled	177	36	86	275	160	734
Salmon-hr. sampled	122	24	79	273	160	658
Chinook sampled	0	1	2	4	3	10
Sampled for adipose clips	0	1	2	4	3	10
Adipose clips	0	1	0	1	0	2
Angler-hours						
Estimate	217	68	171	436	320	1,211
SE	58	36	97	99	87	177
Salmon-hours						
Estimate	185	41	155	431	320	1,132
SE	58	20	84	96	87	167
Large Chinook catch						
Estimate	0	2	5	10	11	27
SE	0	2	4	6	9	11
Large Chinook kept						
Estimate	0	2	5	10	11	27
SE	0	2	4	6	9	11
Wild mature large Chinook kept (excluding hatchery and immature fish)						
Estimate	0	2	0	2	0	5
SE	0	2	0	2	0	2
Small Chinook catch						
Estimate	0	0	8	42	77	127
SE	0	0	6	23	51	56
Small Chinook kept						
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, May 5–June 22, 2008.

		Brood year and age class						
		2005	2004	2003	2002	2001	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
		CHILKAT INLET HARBORS						
No harvest sampled.								
		SMALL BOAT HARBOR						
Males	Sample size	0	1	4	0	0	5	5
	Mean length		650	720				50.0
	SD(length)			102				16.7
Females	Sample size	0	0	5	0	0	5	5
	Mean length			732	0			50.0
	SD(length)			45				16.7
Combined	Sample size	0	1	9	0	0	10	10
	Percent		10.0	90.0				
	SE(%)		10.0	10.0				
	Mean length		650	727				
	SD(length)			71				

[a] All sampled fish were assigned a valid age.

Thirteen (13) Chinook salmon from the Chilkat Inlet subsistence gillnet fishery were sampled for age and length between June 13 and July 14, 2008 (Appendix C1). Subsistence permit reports totaled 28 Chinook salmon harvested in Chilkat Inlet in 2008. The predominant age class was age-1.3 fish (53.8%, SE = 14.4%)

Contribution of Coded Wire Tagged Stocks to the 2008 Haines Marine Sport Fishery

Two (2) of the 10 Chinook salmon sampled at the Haines small boat harbor had clipped adipose fins, and CWTs were recovered from both heads sent to the DCF Tag Lab (Table 11). Brood year 2003 Chilkat River Chinook salmon contributed an estimated 35 (SE = 35) fish to the sport fishery, and brood year 2004 hatchery fish contributed the remaining 6 (SE = 6) fish. The total of CWT stock contribution estimates was 52% higher than the total sport fishery harvest as estimated by the creel survey.

JUVENILE TAGGING

ADF&G trapping crews captured and marked 20,180 Chinook salmon fingerling from brood year 2007 during September and October 2008 (Table 12). Catch rates were lowest in the Tahini River and highest in the Kelsall River. The overall minnow trap CPUE was 10.9 fingerling/trap, which was below the 14.4 fingerling/trap average during 2000–2007 efforts. After tag retention testing, 6 mortalities were discarded, so 20,174 fish were released with valid CWTs and adipose fin clips (Table 13).

During April 10–May 30, 2009, ADF&G trapping crews captured and marked 3,919 Chinook salmon smolt from brood year 2007 in the lower Chilkat River (Table 12). After tag retention testing, 8 mortalities were discarded, so 3,911 fish were released with valid CWTs and adipose fin clips (Table 13).

A total of 449 Chinook salmon fingerlings were sampled for length during fall 2008 (Table 14). The mean length of fingerlings was 72 mm FL (SD = 7 mm FL). In addition, 85 smolts were sampled for length and weight in spring 2009. Smolts averaged 76 mm FL (SD = 7 mm FL) and 4.7 g (SD = 1.5 g).

BROOD YEAR 2001 JUVENILE ABUNDANCE

As stated previously, 31,390 Chinook salmon fry were released with valid CWTs in fall 2002, and 2,797 smolts were released in spring 2003 (Ericksen 2002a, Ericksen and Chapell 2006). Both groups originated from BY 2001. ADF&G personnel sampled 980 adult BY 2001 Chinook salmon in the Chilkat River between 2004 and 2008, of which 70 were missing adipose fins (Table 15).

Table 11.–Contribution estimate (*r*) of coded wire tagged Chinook salmon to the Haines marine sport fishery, May 5–June 22, 2008, and statistics used for computing estimates. Contribution estimates for wild Chilkat River fish are preliminary as marked fraction estimates for a given brood year are not final until data from all return years are complete.

Agency[a]	Release site	Tag code	Brood year	Harvest N	Harvest SE[N]	Sample *n*	Adipose clip *a*	Head *a′*	Detect *t*	Decode *t′*	Tags *m*	Contribution *r*	Contribution SE
CHILKAT INLET RECOVERIES													
No fish sampled.													
SMALL BOAT HARBOR RECOVERIES													
				Fish of all sizes									
ADFG	Chilkat River wild	04-11-36	2003	27	11	10	2	2	2	2	1	35	35
DIPAC	Pullen Cr 115-34	04-10-28	2004								1	6	6
Haines marine creel survey total											2	41	37

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

Table 12.–Results of juvenile Chinook salmon trapping in the Chilkat River drainage in fall 2008 and spring 2009.

Year	Trapping area	Dates	Days fished	Trap sets	No. caught	CPUE[a]
2008	Tahini River	9/19–9/25	6	464	3,947	8.5
2008	Kelsall River	10/04–10/14	10	697	9,870	14.2
2008	Chilkat River	10/21–10/30	10	696	6,363	9.1
	Fall 2008 subtotal		26	1,857	20,180	10.9
2009	Lower Chilkat River	4/10–5/30	49	4,390	3,919	0.9

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

Table 13.–Number of brood year 2007 Chinook salmon coded wire tagged in the Chilkat River drainage by area and tag year.

Tag year	Tag code	Sequence	Location	Last date	Stage	Injected	24h morts	Marked	Shed tags	Valid CWTs released
2008	04-16-87	274–7,166	Tahini River	9/25	Fingerling	3,947	0	3,947	0	3,947
2008	04-16-87	7,322–25,936	Kelsall River	10/14	Fingerling	9,870	4	9,866	0	9,866
2008	04-16-87	26,019–37,245	Lower Chilkat R	10/30	Fingerling	6,363	2	6,361	0	6,361
Fall subtotal						20,180	6	20,174	0	20,174
2009	04-15-10	Batch code	Chilkat River	5/30	Smolt	3,919	8	3,911	0	3,911

Table 14.–Mean length and smolt weight of brood year 2007 Chinook salmon in the Chilkat River drainage by trapping location and year.

Sample year	Trapping location	Sample dates	Length (snout to fork of tail in mm) n	Range	Mean	SD
2008	Tahini River	9/20–9/25	84	58–95	72	7
2008	Kelsall River	10/05–10/14	225	55–100	72	7
2008	Lower Chilkat River	10/22–10/30	140	54–90	71	6
Fall 2008 subtotal			449	54–100	72	7
2009	Lower Chilkat River	4/10–5/30	85	61–95	76	7
			weight (g)	2.3–11.1	4.7	1.5

Table 15.–Number of brood year 2001 Chinook salmon sampled in the Chilkat River drainage for missing adipose fins and coded wire tags by year and by gear type or spawning tributary, 2004–2008.

Year	Gear/ drainage	Sampled for adipose clips	Fish with adipose clips	Marked fraction	Heads collected	Valid CWTs	CWT loss
			Lower river recoveries				
2004	Gillnet	1	0	0.00			
2004	Fish wheels	47	2	0.04	2	1	0.50
2005	Gillnet	8	0	0.00			
2005	Fish wheels	17	1	0.06	1	1	0.00
2006	Gillnet	51	6	0.12	0		
2006	Fish wheels	45	3	0.07	0		
2007	Gillnet	37	1	0.03	0		
2007	Fish wheels	13	1	0.08	0		
2008	Gillnet	1	0	0.00			
2008	Fish wheels	0					
Lower river total		220	14	0.06	3	2	0.33
			Spawning ground recoveries				
2004	Kelsall River	17	3	0.18	3	3	
2004	Tahini River	7	0	0.00			
2004	Klehini River	4	0	0.00			
2005	Kelsall River	43	2	0.05	2	2	
2005	Tahini River	63	8	0.13	8	8	
2005	Klehini River	34	1	0.03	1	1	
2006	Kelsall River	209	15	0.07	12	11	
2006	Tahini River	165	14	0.08	5	5	
2006	Klehini River	103	4	0.04	2	2	
2007	Kelsall River	61	4	0.07	0		
2007	Tahini River	30	3	0.10	1	1	
2007	Klehini River	23	2	0.09	1	1	
2008	Kelsall River	1	0	0.00			
2008	Tahini River	0					
2008	Klehini River	0					
Spawning ground total		760	56	0.07	35	34	0.03
Grand total		980	70	0.07	38	36	0.05

There was not a significant difference between the marked fraction of fish sampled in the lower river and on the spawning grounds ($\chi^2 = 0.260$, df = 1, P = 0.610), so the inriver marked fraction $\theta_{INRIVER}$ for BY 2001 was estimated at 0.0714 (SE = 0.0082) using combined lower and upper river data.

From the 70 fish with adipose fin clips, 38 heads were collected, and 36 CWTs were successfully recovered and decoded by the DCF Tag Lab (Table 15, Appendix D1). Of the 36 decoded CWTs, 27 were tagged in fall 2002 and 9 were tagged in spring 2003 (Table 16). Among the 21 valid Chilkat CWTs collected in marine sampling, 15 were tagged in fall 2002 and 6 in spring 2003 (Table 16). An estimated 596,410 (SE = 87,540) BY 2001 fry were rearing in the Chilkat River in fall 2002, 24.9% (SE = 10.1% survived the winter, and 148,800 (SE = 49,770) smolts emigrated from the Chilkat River in spring 2003 (Appendix E).

Table 16.–Number of random recoveries of brood year 2001 Chilkat River Chinook salmon coded wire tagged in fall 2002 and spring 2003 by year, fishing district, and gear type, 2004–2008.

	District	Purse seine		Drift gillnet		Troll		Sport		Chilkat Inlet subsistence		Chilkat River escapement		Fall	Spring	Grand
Year	or quad	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	sub-total	sub-total	total
2004	112	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
2004	114	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
2004	115	0	0	0	0	0	0	0	0	0	0	3	1	3	1	4
2004 subtotal		1	1	0	0	0	0	0	0	0	0	3	1	4	2	6
2005	114	1	0	0	0	1	0	0	0	0	0	0	0	2	0	2
2005	115	0	0	3	0	0	0	1	0	0	0	9	3	13	3	16
2005 subtotal		1	0	3	0	1	0	1	0	0	0	9	3	15	3	18
2006	113	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
2006	114	0	0	0	0	2	1	1	0	0	0	0	0	13	1	4
2006	115	0	0	0	0	0	0	1	2	1	0	15	3	17	5	22
2006 subtotal		0	0	0	0	3	1	2	2	1	0	15	3	21	6	27
2007	111	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
2007	115	0	0	0	0	0	0	2	0	0	1	0	2	2	3	5
2007 subtotal		0	0	0	0	0	0	2	1	0	1	0	2	2	4	6
2008		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand total		2	1	3	0	4	1	5	3	1	1	27	9	42	15	57

During 2004–2008, 36 adipose-clipped BY 2001 Chinook salmon in the Chilkat escapement were scanned in the field for head and dorsal CWTs before their heads were removed and sent to the DCF Tag Lab for CWT recovery and decoding (Appendix D3). In 4 of 33 fish (12%), the wand scan for the head CWT did not agree with the DCF Tag Lab result. In 2 of 34 fish (6%), the wand scan of the dorsal area did not agree with the DCF Tag Lab result. Because of the high error rates, wand scan results were not used to assign CWT tagging seasons to the 32 adipose clipped BY 2001 fish whose heads were not collected in 2004–2008 (Table 15).

BROOD YEAR 2001 ADULT HARVEST

The estimated tagged fraction θ_{MARINE} germane to estimating marine harvest contributions was 0.0677 (SE = 0.0080). This estimate was calculated from the 70 fish with missing adipose fins out of 980 fish inspected in the Chilkat River, multiplied by the CWT loss fraction; 36 CWTs were decoded out of 38 heads sent to the DCF Tag Lab (Table 15).

Twenty-one (21) Chinook salmon with Chilkat River CWTs from BY 2001 were recovered through random sampling in marine commercial, sport, and subsistence fisheries between 2004 and 2008 (Tables 16 and 17, Appendix D1). An estimated 902 (SE = 229) BY 2001 Chilkat River Chinook salmon were harvested at age-1.1 and older in sampled marine fisheries between 2004 and 2008 (Table 17). Harvest-at-age was highest at age 1.3 (331 fish, SE = 121), followed by 255 (SE = 146) age-1.4 fish, and by 234 (SE = 114) age-1.2 fish. The commercial fishery sector had the largest share (45%) of the total harvest of BY 2001 Chilkat Chinook salmon, followed by the recreational (34%) and the subsistence (21%) fishery sectors (Table 18). The two individual fisheries that harvested the largest share of the BY 2001 harvest were NW quadrant troll (26%) and Chilkat Inlet subsistence (21%) (Figure 7).

BROOD YEAR 2001 MARINE EXPLOITATION AND SURVIVAL

Based upon a total inriver return of 4,561 (SE = 727) age-1.2 and older fish and a total marine harvest of 821 (SE = 222) age-1.2 and older fish, the total BY 2001 age-1.2 and older return was 5,382 (SE = 760) fish (Table 19). The estimated smolt-to-age-1.2 and older marine survival rate was 3.6% (SE = 1.3%). The age-1.2 and older marine exploitation rate of this stock was estimated at 15.3% (SE = 4.1%).

DATA FILES

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

DISCUSSION

Several assumptions, as noted above, underlie the mark-recapture estimate of inriver abundance. Considerable efforts were made to catch and mark fish in proportion to their abundance (assumption a) by sampling uniformly across the escapement. Also, sampling effort for tag recovery on the Kelsall and Tahini rivers (where 85% of spawning occurred in 2005 and >90% occurred in 1991 and 1992; Ericksen and Chapell 2006; Johnson et al. 1992, 1993) was fairly constant across the time when fish were accessible to sampling as spawners or postspawners. 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 only 20% of the spawning ground samples. Using a variety of capture methods (42% gillnet, 18% snagging, 11% dip net, 8% hands, 2% spear) on the spawning grounds reduced the potential bias that may be inherent in any one method. The assumption (b) of no recruitment during the experiment is reasonable because tagging effort was relatively constant and continued until only about 1 fish per day was being caught. 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). Satisfying assumptions (d), that marks were not lost, and (e), that recaptured fish were detected and reported, was unusually difficult in 2008 because of the systematic failure to apply the secondary mark (ULOP) to medium and small fish early in the season. Documented loss of the primary mark was a problem.

Table 17.–Estimated contributions of brood year 2001 Chilkat River Chinook salmon to marine fishery harvests by year and fishery, 2004–2008. Subsistence and commercial fishery harvest reports are from the Integrated Fisheries Database for Southeast Alaska, maintained by ADF&G Commercial Fisheries Division, Region 1, Douglas. Commercial fishery sampling data is from the ADF&G Mark, Tag and Age Laboratory online database at http://146.63.60.42/CWT/reports/.

	Fishery harvest										Contribution	
Fishery	Time SW, BW, TP, or yr.	District, quadrant, or port	$\hat{H}$	SE[$\hat{H}$]	n	a	a'	t	t'	m	$\hat{r}$	SE $[\hat{r}]$
2004 recoveries age-1.1												
Purse seine	SW 33	112	147		55	7	7	5	5	1	39	39
Purse seine	SW 32	114	31		11	3	3	3	3	1	42	41
2004 subtotal										2	81	57
2005 recoveries age-1.2												
Drift gillnet	SW 26-41	115	710		346	66	65	62	62	3	92	53
Purse seine	SW 29	114-27	12		5	0				1	1[b]	0
Troll	TP 4	NW	49,218		13,591	874	847	655	650	1	56	55
Skagway sport[c]	2005	Skagway	758	159	142	40	37	37	37	1	85	85
2005 subtotal										6	234	114
2006 recoveries age-1.3												
Troll	TP 2	NW	15,223		5,579	319	317	288	288	3	122	70
Troll	TP 3	NW	97,564		27,408	1,297	1,248	932	931	1	55	54
Gustavus sport	BW 12	Gustavus	51	51	45	1	1	1	1	1	17	17
Haines sport[e]	BW 10-13	115-32	131	12	86	6	6	6	6	3	68	39
Chilkat Inlet subsistence[e]	SW 24-27	115-32	86		18	3	3	3	3	1	71	70
2006 subtotal										9	331	121
2007 recoveries age-1.4												
Juneau sport	BW 11	Juneau	449	103[d]	94	5	5	5	5	1	71	70
Haines sport[f]	BW 10-13	115-32	253	41	118	7	7	7	7	2	63	45
Chilkat Inlet subsistence[f]		115-32	90		11	1	1	1	1	1	121[g]	120
2007 subtotal										4	255	146
2008 recoveries age-1.5												
No BY 2001 Chilkat Chinook salmon CWTs were recovered in 2008 marine fishery random samples.												
Combined contribution $[\hat{T}]$										21	902	229

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

[b] Contribution was not expanded because commercial fishery sampling data showed zero adipose-clipped fish found.

[c] Data from Jennings et al. (2009).

[d] Sport creel stratum harvest and variance estimates from Mike Jaenicke, project leader for Marine Harvest Study Project, ADF&G Division of Sport Fish, Region 1, Douglas.

[e] Sampling data from Chapell (2009).

[f] Sampling data from Chapell (2010).

[g] Contribution estimate exceeds reported harvest. Possible causes include small sample size and under reported harvest.

Table 18.–Total marine harvest and estimated brood year 2001 Chilkat River Chinook salmon contribution by fishery and area, 2004–2008.

Fishery	Area	Total fishery harvest	Chilkat harvest	SE	Chilkat percent fishery	Percent of Chilkat total
Commercial fishery						
Drift gillnet	District 115	710	92	53	13	10
Troll	NW Quadrant	162,005	232	105	0	26
Purse seine	Districts 112, 114	179	82	57	46	9
	Subtotal	162,894	407	130	0	45
Recreational fishery						
	Gustavus marine	51	17	17	33	2
	Juneau marine	449	71	70	16	8
	Skagway marine	758	85	85	11	9
	Haines marine	384	131	60	34	15
	Subtotal	1,642	304	126	18	34
Subsistence fishery						
	Chilkat Inlet	176	192	139	109[a]	21
	Subtotal	176	192	139	109	21
Grand total		164,712	902	229	1	100

[a] Contribution estimate exceeds reported harvest. Possible causes include small sample size and under reported harvest.

Table 19.–Estimated stock assessment parameters for brood year 2001 Chilkat River Chinook salmon.

Parameter	Estimate	SE
2002 fall fry abundance	596,410	87,540[a]
2002–2003 overwinter survival	0.249	0.101[a]
2003 smolt emigration	148,800	49,770[a]
Marine harvest (age-1.2 and older)	821	222
Inriver return (age-1.2 and older)	4,561	727
Return (age-1.2 and older)	5,382	760
Marine exploitation rate (age-1.2 and older)	0.153	0.041
Smolt survival to age-1.2 and older	0.036	0.013

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

To minimize the possibility of undetected marks in event 2, only samples with intact left opercula were considered, and only event 2 fish on which scale and length sampling had been performed were considered. The length measurement and scale sampling procedures assured that field staff had adequate opportunity to examine the left opercula for upper and lower punches as well as the area around posterior insertion of the dorsal fin for the puncture wound and abrasion wear that a spaghetti tag would have caused.

The 2008 inriver run of 2,905 (SE = 544) large Chinook salmon was within the inriver run goal range (1,850 to 3,600 large Chinook salmon) that is specified in the *Lynn Canal and Chilkat River King Salmon Fishery Management Plan* (Table 20,

Figure 8). After subtracting the estimated large fish component of the inriver subsistence fishery harvest reported on permits, the estimated large fish escapement was 2,882 fish (Table 20). The BEG for Chilkat River Chinook salmon is 1,750 to 3,500 large Chinook salmon. The mean date of capture (July 8, Figure 4) of large Chinook salmon at the lower Chilkat River marking site was later than the July 3 average date for all previous years of this project (1991–2007).

Estimates of both salmon-directed effort and large Chinook salmon harvest in the Haines marine sport fishery were historic lows (1984–2008) for the Haines marine boat creel survey project (Figure 8, Table 21). Angling effort in Chilkat Inlet was certainly discouraged by the emergency closure of Chilkat Inlet to Chinook salmon retention in May and June. Estimated large Chinook salmon CPUE (0.024 fish/salmon-hr) in 2008 was the fifth lowest in the 23 years of the project. The estimated Chilkat River wild component of the Haines area sport harvest of large Chinook salmon was only 19%, far lower than the 2001–2007 average of 66%.

Each fall in 2000–2008, an average of 28,927 Chinook salmon fry have been marked with CWTs (brood years 1999–2007). Using the average overwinter survival rate (27.5%) for brood years 1999–2001, the fall marking effort has contributed an average of 7,955 marked smolts, almost double the average number of smolts (4,139) marked each spring in 2001–2009. Fall CWT marking has increased the precision of estimates of fry and smolt abundance, marine harvest, and smolt-to-adult survival of the Chilkat River stock. The increased 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. In addition, the range of overwinter survival estimates has increased. The fall tagging effort should be continued because high-resolution stock assessment of Chilkat River Chinook salmon is a high priority because of annual releases of 500,000 hatchery-reared Chinook salmon smolts (ADF&G 2008). The 6%–12% error rate of handheld wand CWT detection is higher than the 5% overall CWT loss rate (Table 15, Appendix D3). If the wand error rate had been lower, the sample size for assigning a tagging season to adipose-clipped fish could have been increased from 36 fish to as many as 70 fish without sacrificing females. The larger sample size would have increased the precision of estimates of fall 2002 fry abundance, overwinter survival, and spring 2003 smolt abundance. Field staff training has been improved in recent years to include specific error reduction techniques such as verifying that the fish examination area is free of stray magnetic fields (wrist watches on samplers, screws in the sampling trough, high-iron gravel beneath the fish), and inserting the wand into the mouth of large fish to detect deep tags.

The BY 2001 estimated marine exploitation rate (Table 19, 15.3%, SE = 4.1%) was within the range of estimates from CWT studies on Chilkat River Chinook salmon brood years 1988–1989, 1991, 1998–2000 (7.4%–24.8%, Appendix F). The 19.7% average exploitation rate for the most recent 3 brood years (BY 1999–2001) indicates that the exploitation rates are slightly higher than those assumed by Ericksen and McPherson 2004) to set the biological escapement goal (range 8–19%) for Chilkat River Chinook salmon.

Terminal harvest area sport regulations that allowed retention of Chinook salmon <28 in TL in Taiya Inlet resulted in the harvest of age-1.1 and -1.2 Chilkat River Chinook salmon from brood years 1999 (4.0% of total return, Chapell 2009), 2000 (5.0% of total return, Chapell 2010), and 2001 (1.6% of total return, Tables 18 and 19, Figure 1). Because the Chilkat River Chinook salmon inriver abundance goal was not met in 2007, the harvest of Chinook salmon <28 in TL in Taiya Inlet was not allowed in 2008. The harvest of Chilkat River Chinook salmon in the Taiya Inlet terminal harvest area should continue to be monitored by marine sport creel sampling and CWT recovery at the Skagway small boat harbor.

Table 20.–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, 1991–2008, and estimated marine harvest and total return by age class of fish from coded wire tagged brood years 1988, 1989, 1991, 1998–2001.

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[a]	Large (≥age-1.3) escapement
1991	Inriver run[b]	817	(139)	3,211	(558)	2,563	(445)	123	(18)	6,714	(1,015)	14	5,833
	Marine harvest												
	Total return												
1992	Inriver run[b]	560	(100)	1,689	(304)	3,595	(649)	0	(0)	5,844	(949)	7	5,277
	Marine harvest[c]	459	(166)										
	Total return	1,019	(194)										
1993	Inriver run[b]	551	(104)	2,217	(424)	2,180	(425)	75	(10)	5,023	(857)	8	4,464
	Marine harvest[d]	134	(50)	572	(208)								
	Total return	685	(115)	2,789	(472)								
1994	Inriver run[b]	184	(28)	2,565	(405)	4,148	(657)	82	(10)	6,979	(1,057)	2	6,793
	Marine harvest			415	(123)	605	(302)						
	Total return			2,980	(423)	4,753	(723)						
1995	Inriver run[b]	1,384	(295)	530	(111)	3,074	(660)	186	(37)	5,174	(857)	12	3,778
	Marine harvest[e]	286	(129)			134	(74)	2	(1)				
	Total return	1,670	(322)			3,208	(664)	188	(37)				
1996	Inriver run[b]	398	(60)	4,140	(639)	737	(112)	43	(5)	5,318	(753)	10	4,910
	Marine Harvest			459	(129)			0	0				
	Total Return			4,599	(652)			43	(5)				
1997	Inriver run[b]	160	(48)	1,943	(354)	6,157	(930)	0	0	8,260	(1,194)	5	8,095
	Marine harvest					260	(104)						
	Total return					6,417	(936)						

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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[a]	Large (≥age-1.3) escapement
1998	Inriver run[b]	226	(54)	1,016	(169)	2,440	(381)	219	(48)	3,901	(568)	18	3,657
	Marine harvest							1	0				
	Total return							220	(48)				
1999	Inriver run[b]	427	(94)	534	(109)	1,656	(302)	80	(27)	2,698	(419)	12	2,258
	Marine harvest												
	Total return												
2000	Inriver run[b]	629	(122)	1,350	(227)	653	(118)	32	(14)	2,664	(356)	6	2,029
	Marine harvest												
	Total return												
2001	Inriver run[b]	755	(209)	2,529	(376)	1,988	(617)	0		5,272	(752)	3	4,514
	Marine harvest												
	Total return												
2002	Inriver run[b]	373	(123)	2,353	(312)	1,667	(294)	30	(19)	4,423	(446)	16	4,034
	Marine harvest[f]	0											
	Total return	373	(123)										
2003	Inriver run[b]	1,267	(293)	1,833	(362)	3,783	(582)	41	(29)	6,924	(746)	26	5,631
	Marine harvest[g]	505	(373)	688	(687)								
	Total return	1,772	(474)	2,521	(777)								
2004	Inriver run[h]	1,361	(492)	1,999	(333)	1,379	(303)	44	(17)	4,783	(667)	16	3,406
	Marine harvest[i]	493	(172)	795	(190)	352	(249)						
	Total return	1,854	(519)	2,794	(383)	1,731	(392)						
2005	Inriver run[j]	1,597	(620)	1,857	(433)	1,498	(345)	11	(8)	4,963	(831)	5	3,361
	Marine harvest[k]	234	(114)	383	(105)	244	(75)	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 ≥age-1.2 total	(SE)	Large (≥age-1.3) inriver subsistence harvest[a]	Large (≥age-1.3) escapement
2006	Inriver run[l]	260	(81)	2,084	(333)	955	(185)	0		3,299	(488)	36	3,003
	Marine harvest			331	(121)	114	(63)	28	(334)				
	Total return			2,415	(354)	1,069	(195)	28	(334)				
2007	Inriver run[m]	602	(138)	585	(136)	860	(182)	0		2,047	(266)	7	1,438
	Marine harvest					255	(146)	0					
	Total return					1,115	(233)	0					
2008	Inriver run[n]	665	(243)	2,153	(417)	732	(173)	21	(21)	3,570	(513)	24	2,882
	Marine harvest							0					
	Total return							21	(21)				

[a] Annual Chilkat River subsistence harvest as reported in ADF&G, Division of Commercial Fisheries ALEXANDER statewide electronic fish ticket database; multiplied by the annual large (≥age-1.3) proportion of Chilkat Inlet subsistence gillnet samples in 2000–2008 (Appendix C2). 1991–1999 estimates use the 2000–2008 average large proportion of Chilkat Inlet samples.

[b] Inriver abundance data from Ericksen and McPherson (2004).

[c] Brood year 1988 marine harvest data from Table 11 in Ericksen (1995).

[d] Brood year 1989 marine harvest data from Table 11 in Ericksen (1995).

[e] Brood year 1991 marine harvest data from Table 13 in Ericksen (1999).

[f] Brood year 1998 marine harvest data from Table 21 Ericksen and Chapell (2006).

[g] Brood year 1999 marine harvest data from Table 16 in Chapell (2009).

[h] Inriver abundance data from Ericksen (2005).

[i] Brood year 2000 marine harvest data from Table 17 in Chapell (2010).

[j] Inriver abundance data from Ericksen and Chapell (2006).

[k] Brood year 2001 marine harvest data from Table 17.

[l] Inriver abundance data from Chapell (2009).

[m] Inriver abundance data from Chapell (2010).

[n] Inriver abundance data from Table 7.

Table 21.–Estimated angler effort, and large (≥28 in TL) Chinook salmon catch and harvest in the Haines marine sport fishery for similar sample periods, 1984–2008.

		Effort				Large (≥28 in TL) fish				
Year	Survey dates	Angler-h	SE	Salmon-h	SE	Catch	SE	Harvest	SE	CPUE[a]
1984[b]	5/06–6/30	10,253	[c]	9,855	[c]	1,072	[c]	1,072	[c]	0.109
1985[d]	4/15–7/15	21,598	[c]	20,582	[c]	1,705	[c]	1,696	[c]	0.083
1986[e]	4/14–7/13	33,857	[c]	32,533	[c]	1,659	[c]	1,638	[c]	0.051
1987[f]	4/20–7/12	26,621	2,557	22,848	2,191	1,094	189	1,094	189	0.048
1988[g]	4/1—7/10	36,222	3,553	32,723	3,476	505	103	481	101	0.015
1989[h]	4/24–6/25	10,526	999	9,363	922	237	42	235	42	0.025
1990[i]	4/23–6/21	[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]	4/26–7/18	11,919	1,559	9,069	1,479	349	63	314	55	0.038
1994[k]	5/09–7/03	9,726	723	7,682	597	269	41	220	32	0.035
1995[l]	5/08–7/02	9,457	501	8,606	483	255	42	228	41	0.030
1996[m]	5/06–6/30	10,082	880	9,596	866	367	43	354	41	0.038
1997[n]	5/12–6/29	9,432	861	8,758	697	381	46	381	46	0.044
1998[o]	5/11–6/28	8,200	811	7,546	747	222	60	215	56	0.029
1999[p]	5/10–6/27	6,206	736	6,097	734	184	24	184	24	0.030
2000[q]	5/08–6/25	4,428	607	4,043	532	103	34	49	12	0.025
2001[r]	5/07–6/24	5,299	815	5,107	804	199	26	185	26	0.039
2002[s]	5/06–6/30	7,770	636	7,566	634	343	40	337	40	0.045
2003[t]	5/05–6/29	10,651	596	10,055	578	405	40	404	40	0.040
2004[u]	5/10–6/27	12,761	763	12,518	744	413	46	403	44	0.033
2005[v]	5/09–6/26	12,641	1,239	12,287	1,216	260	31	252	31	0.021
2006[w]	5/08–6/25	8,172	610	7,869	558	176	15	165	13	0.022
2007[x]	5/07–6/24	7,411	725	7,223	690	285	43	285	43	0.039
2008	5/05–6/22	1,211	177	1,132	167	27	11	27	11	0.024
1984–1987 average		23,082		21,455		1,383		1,375		0.073
1988-2007 average		10,641		9,893		289		274		0.032

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 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 (2002b).
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).

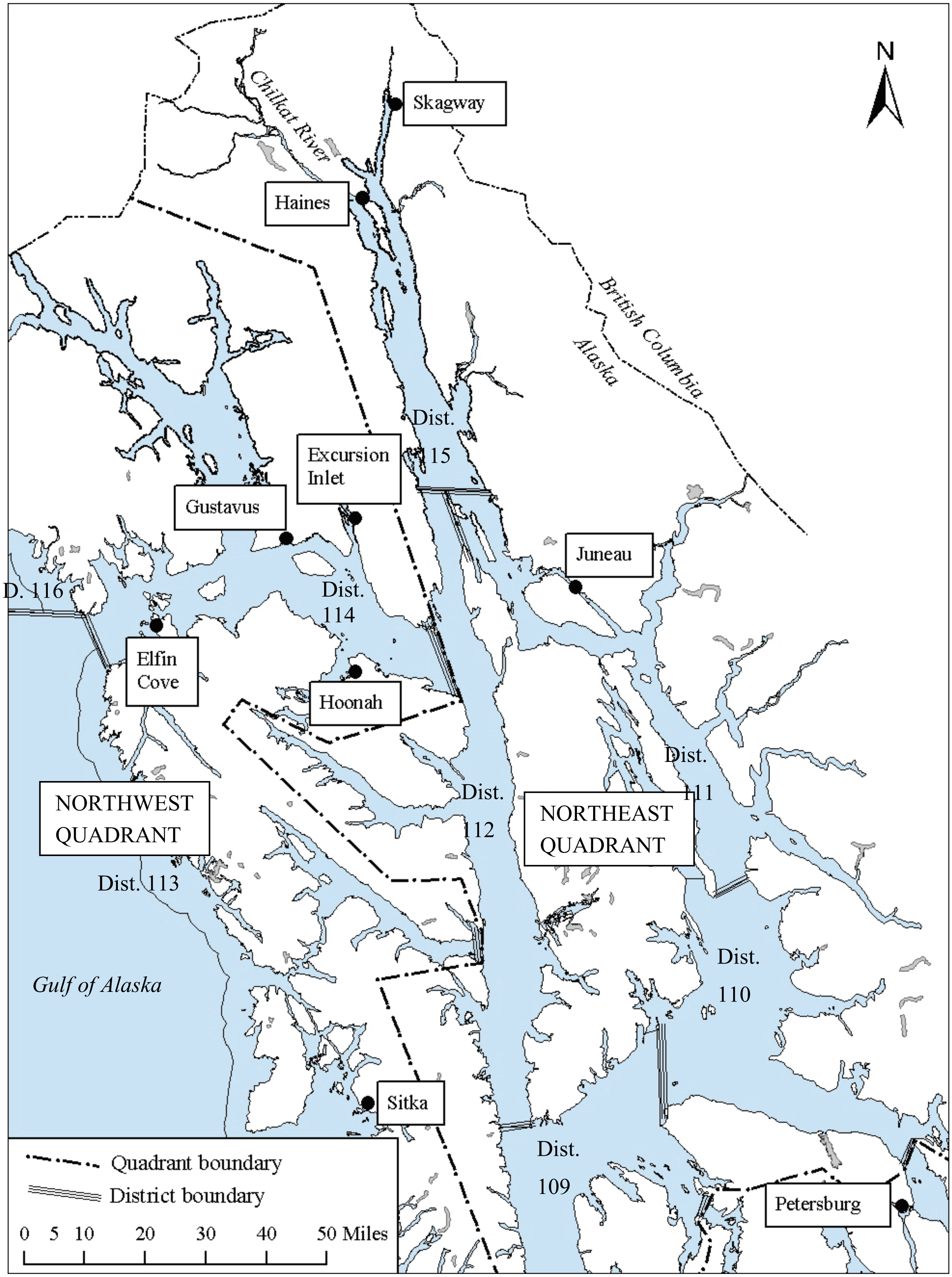

Figure 7.–Fishery quadrants, districts, and sampling ports in northern Southeast Alaska.

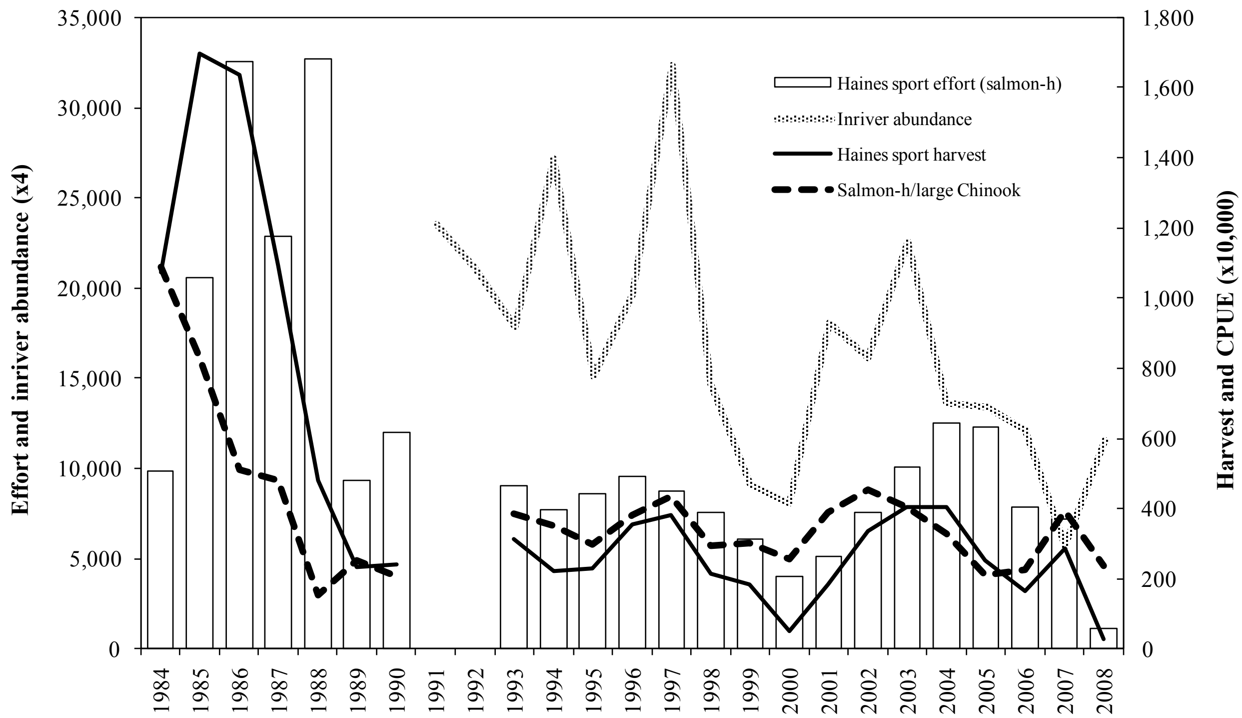

Figure 8.–Estimated angler effort, harvest, and CPUE of large (≥28 inches TL) Chinook salmon in the Haines spring marine boat sport fishery, 1984–2008, and estimated inriver run of large (≥age-1.3) Chinook salmon in the Chilkat River, 1991–2008. The Chilkat Inlet Chinook salmon fishery was closed in 1991, 1992, and 2008. Data taken from Table 21.

ACKNOWLEDGMENTS

I would like to thank the creel survey staff of Rebecca Wilson, Sarah Roark, and Aaron Thomas for their invaluable data collection efforts. Mark Eisenman oversaw the capture and tagging of Chinook salmon at the fish wheels. Brian Elliott supervised the mark-recapture and coded wire tagging field work in 2008 and 2009. Mark Brouwer, Larry Derby, Sarah Hanner, Ted Hart, Jane Pascoe, Scott Ramsey, Aaron Thomas, and Dana Van Burgh III worked in the field to capture, mark, and sample fish to complete this project. Jim Moran of Chilkoot Fish and Caviar Co. and Daymond Hoffman of Dejon Delights donated salmon roe for use as trapping bait. Sue Millard, DSF, Douglas, processed and aged scales from sampled Chinook salmon. Employees at the ADF&G Mark, Tag, and Age Laboratory in Juneau dissected heads from adipose-clipped Chinook salmon to remove and read coded wire tags. Margie Nussbaum of the Research and Technical Services (RTS) Unit, DSF, opscanned forms. Biometricians Bob Marshall and Dan Reed with DSF Research and Technical Services provided biometric support in the study design and data analysis. Biometrician Sarah Power and John Der Hovanisian provided critical review of this report. Stacey Poulson performed final layout of this report for publication.

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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:

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

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

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 5–June 22, 2008. Retention of Chinook salmon was not allowed in Chilkat Inlet during the survey period in 2008. The Haines King Salmon Derby was cancelled in 2008, but the derby and non-derby strata were retained in the sampling plan.

		May 19–June 1				
	May 5–May 18	Non-derby	Derby	June 2–June 18	June 19–June 25	Total
Boats counted	0	1	1	1	2	5
Angler-hr. sampled	0	1	1	4	6	12
Salmon-hr. sampled	0	1	1	4	6	12
Chinook sampled	0	0	0	0	0	0
Sampled for adipose clips	0	0	0	0	0	0
Adipose clips	0	0	0	0	0	0
Angler-hours						
Estimate	0	2	5	28	21	56
Variance	0	4	20	672	315	1,011
Salmon-hours						
Estimate	0	2	5	28	21	56
Variance	0	4	20	672	315	1,011
Large Chinook catch						
Estimate	0	0	0	0	0	0
Variance						
Large Chinook kept						
Estimate	0	0	0	0	0	0
Variance						
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	0	0	0	0	0	0
Variance						
Small Chinook catch						
Estimate	0	0	0	0	0	0
Variance						
Small Chinook kept						
Estimate	0	0	0	0	0	0
Variance						

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 5–June 22, 2008. Retention of Chinook salmon was not allowed in Chilkat Inlet during the survey period in 2008. The Haines King Salmon Derby was cancelled in 2008, but the derby and non-derby strata were retained in the sampling plan.

		May 19–June 1				
	May 5– May 18	Non- derby	Derby	June 2– June 18	June 19– June 25	Total
Boats counted	0	0	0	0	0	0
Angler-hr. sampled	0	0	0	0	0	0
Salmon-hr. sampled	0	0	0	0	0	0
Chinook sampled	0	0	0	0	0	0
Sampled for adipose clips	0	0	0	0	0	0
Adipose clips	0	0	0	0	0	0
Angler-hours						
Estimate	0	0	0	0	0	0
Variance						
Salmon-hours						
Estimate	0	0	0	0	0	0
Variance						
Large Chinook catch						
Estimate	0	0	0	0	0	0
Variance						
Large Chinook kept						
Estimate	0	0	0	0	0	0
Variance						
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	0	0	0	0	0	0
Variance						
Small Chinook catch						
Estimate	0	0	0	0	0	0
Variance						
Small Chinook kept						
Estimate	0	0	0	0	0	0
Variance						

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 5–June 22, 2008. Retention of small Chinook salmon was not allowed in the Haines area in 2008. The Haines King Salmon Derby was cancelled in 2008, but the derby and non-derby strata were retained in the sampling plan.

		May 19–June 1				
	May 5–May 18	Non-derby	Derby	June 2–June 18	June 19–June 25	Total
Boats counted	19	4	11	23	9	66
Angler-hr. sampled	177	35	85	271	154	722
Salmon-hr. sampled	122	23	78	269	154	646
Chinook sampled	0	1	2	4	3	10
Sampled for adipose clips	0	1	2	4	3	10
Adipose clips	0	1	0	1	0	2
Angler-hours						
Estimate	217	65	166	409	300	1,157
Variance	3,398	1,306	9,323	9,094	7,326	30,447
Salmon-hours						
Estimate	185	38	150	404	300	1,077
Variance	3,398	384	7,069	8,627	7,326	26,804
Large Chinook catch						
Estimate	0	2	15	10	11	27
Variance	0	3	15	32	79	128
Large Chinook kept						
Estimate	0	2	15	10	11	27
Variance	0	3	15	32	79	128
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	0	2	0	2	0	5
Variance	0	3	0	3	0	6
Small Chinook catch						
Estimate	0	0	8	43	78	127
Variance	0	0	34	518	2,608	3,159
Small Chinook kept						
Estimate	0	0	0	0	0	0
Variance	0	0	0	0	0	0

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 14–July 13, 2008.

		Brood year and age class					
		2005	2004	2003	2002	Total	Total
		1.1	1.2	1.3	1.4	aged	sampled
Males	Sample size	1	3	5	0	9	9
	Percent	11.1	33.3	55.6			69.2
	SE	11.1	16.7	17.6			13.3
	Mean length	430	603	719			
	SE		18	47			
Females	Sample size	0	0	2	2	4	4
	Percent			50.0	50.0		30.8
	SE			28.9	28.9		13.3
	Mean length			803	790		
	SE			11	28		
Combined	Sample size	1	3	7	2	13	13
	Percent	7.7	23.1	53.8	15.4		
	SE	7.7	12.2	14.4	10.4		
	Mean length	430	603	743	790		
	SE		18	35	28		

Appendix C2.–Estimated age composition of Chinook salmon incidentally harvested in the Chilkat Inlet subsistence gillnet fishery, 2000–2008.

	Number	Percent by age class					
Year	aged	1.1	1.2	1.3	1.4	1.5	Large (≥age-1.3) 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
Average							63.5

[a] Data from Ericksen (2001).
[b] Data from Ericksen (2002–a).
[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 Appendix C1.

APPENDIX D

Appendix D1.–Brood year 2001 Chilkat Chinook salmon coded wire tags recovered from random sampling efforts, 2004–2008.

Year	Head	Tag code	Gear	Survey Site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2004	538265	40453	Purse	Excursion Inlet	8/7/2004	32	NW	114	27	454
2004	534991	40553	Purse	Petersburg	8/10/2004	33	NE	112	ND	418
2004	254003	40453	Escape	Chilkat River	7/4/2004	28	NE	115	32	390
2004	254123	40553	Escape	Chilkat River	8/18/2004	34	NE	115	32	405
2004	254124	40553	Escape	Chilkat River	8/19/2004	34	NE	115	32	340
2004	254125	40553	Escape	Chilkat River	8/19/2004	34	NE	115	32	380
2005	90550	40553	Purse	Excursion Inlet	7/14/2005	29	NW	114	27	627
2005	295698	40553	Troll	Hoonah	8/16/2005	34	NW	114	27	700
2005	14726	40553	Drift	Excursion Inlet	6/29/2005	27	NE	115	ND	611
2005	14729	40553	Drift	Excursion Inlet	6/29/2005	27	NE	115	ND	634
2005	90625	40553	Drift	Excursion Inlet	8/9/2005	33	NE	115	ND	689
2005	254288	40553	Sport	Skagway	7/21/2005	30	NE	115	34	655
2005	254325	40553	Escape	Chilkat River	6/26/2005	27	NE	115	32	580
2005	221457	40553	Escape	Chilkat River	8/4/2005	32	NE	115	32	520
2005	221458	40553	Escape	Chilkat River	8/8/2005	33	NE	115	32	535
2005	254169	40553	Escape	Chilkat River	8/15/2005	34	NE	115	32	590
2005	264067	40553	Escape	Chilkat River	8/16/2005	34	NE	115	32	510
2005	264049	40453	Escape	Chilkat River	8/17/2005	34	NE	115	32	575
2005	264068	40453	Escape	Chilkat River	8/17/2005	34	NE	115	32	620
2005	264070	40553	Escape	Chilkat River	8/18/2005	34	NE	115	32	540
2005	264071	40553	Escape	Chilkat River	8/18/2005	34	NE	115	32	580
2005	264020	40553	Escape	Chilkat River	8/19/2005	34	NE	115	32	470
2005	264079	40453	Escape	Chilkat River	8/26/2005	35	NE	115	32	705
2005	264053	40553	Escape	Chilkat River	8/31/2005	36	NE	115	32	540
2006	27678	40553	Troll	Elfin Cove	6/8/2006	23	NW	113	95	870
2006	27699	40553	Troll	Elfin Cove	6/14/2006	24	NW	114	50	820
2006	299328	40453	Troll	Hoonah	6/14/2006	24	NW	114	25	845
2006	299336	40553	Troll	Hoonah	6/27/2006	26	NW	114	25	663
2006	252653	40553	Sport	Gustavus	6/9/2006	23	NW	114	25	880
2006	254228	40453	Sport	Haines	6/2/2006	22	NE	115	32	690
2006	264054	40453	Sport	Haines	6/4/2006	23	NE	115	32	830
2006	221469	40553	Sport	Haines	6/11/2006	24	NE	115	32	730
2006	254178	40553	Subsist	Haines	7/2/2006	27	NE	115	32	840

-continued-

Appendix D1.–Page 2 of 2.

Year	Head	Tag code	Gear	Survey Site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2006	254181	40553	Escape	Chilkat River	8/9/2006	32	NE	115	32	790
2006	254182	40453	Escape	Chilkat River	8/10/2006	32	NE	115	32	660
2006	254184	40553	Escape	Chilkat River	8/10/2006	32	NE	115	32	795
2006	254238	40453	Escape	Chilkat River	8/18/2006	33	NE	115	32	795
2006	254359	40553	Escape	Chilkat River	8/22/2006	34	NE	115	32	825
2006	254363	40553	Escape	Chilkat River	8/25/2006	34	NE	115	32	745
2006	254362	40553	Escape	Chilkat River	8/25/2006	34	NE	115	32	800
2006	254364	40553	Escape	Chilkat River	8/26/2006	34	NE	115	32	730
2006	254365	40553	Escape	Chilkat River	8/26/2006	34	NE	115	32	770
2006	254240	40553	Escape	Chilkat River	8/27/2006	35	NE	115	32	745
2006	254239	40553	Escape	Chilkat River	8/27/2006	35	NE	115	32	830
2006	254230	40453	Escape	Chilkat River	8/28/2006	35	NE	115	32	795
2006	254243	40553	Escape	Chilkat River	8/28/2006	35	NE	115	32	840
2006	254244	40553	Escape	Chilkat River	8/29/2006	35	NE	115	32	855
2006	254372	40553	Escape	Chilkat River	8/29/2006	35	NE	115	32	850
2006	254233	40553	Escape	Chilkat River	9/1/2006	35	NE	115	32	765
2006	254247	40553	Escape	Chilkat River	9/2/2006	35	NE	115	32	845
2006	254248	40553	Escape	Chilkat River	9/3/2006	36	NE	115	32	775
2007	245713	40453	Sport	Juneau	5/28/2007	22	NE	111	50	870
2007	60882	40553	Sport	Haines	6/2/2007	22	NE	115	32	945
2007	254380	40553	Sport	Haines	6/10/2007	24	NE	115	32	905
2007	264089	40453	Subsist	Haines	6/16/2007	24	NE	115	32	740
2007	56655	40453	Escape	Chilkat River	8/16/2007	33	NE	115	32	890
2007	60894	40453	Escape	Chilkat River	8/17/2007	33	NE	115	32	880

Appendix D2.–Brood year 2001 Chilkat Chinook salmon coded wire tags recovered from nonrandom (select and voluntary) sampling, 2004–2008.

Year	Head	Tag code	Gear	Survey site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2006	252429	40553	Subsist	Haines	7/3/2006	27	NE	115	32	
2006	252430	40553	Subsist	Haines	7/3/2006	27	NE	115	32	
2007	60886	40453	Subsist	Haines	6/18/2007	25	NE	115	32	1,067

Appendix D3.–Comparison of wand detection of head and dorsal coded wire tag presence to tag code data in brood year 2001 Chilkat Chinook salmon escapement samples, 2004–2008.

Year	River	Head number	Length	Tag code	Season tagged	Wand agreement head tag	Wand agreement dorsal tag
2004	Lower Chilkat	254003	390	040453	Spring 2003	Agree	False -
2004	Lower Chilkat	264006	400	NO TAG	NO TAG	False +	Unknown
2004	Kelsall	254123	405	040553	Fall 2002	Not checked	False +
2004	Kelsall	254124	340	040553	Fall 2002	Not checked	Agree
2004	Kelsall	254125	380	040553	Fall 2002	Not checked	Agree
2005	Lower Chilkat	254325	580	040553	Fall 2002	Agree	Agree
2005	Kelsall	264079	700	040453	Spring 2003	Agree	Agree
2005	Kelsall	264020	470	040553	Fall 2002	Agree	Agree
2005	Tahini	221457	520	040553	Fall 2002	Agree	Agree
2005	Tahini	221458	535	040553	Fall 2002	Agree	Agree
2005	Tahini	254169	590	040553	Fall 2002	Agree	Agree
2005	Tahini	264067	510	040553	Fall 2002	Agree	Agree
2005	Tahini	264068	620	040453	Spring 2003	Agree	Agree
2005	Tahini	264070	540	040553	Fall 2002	Agree	Agree
2005	Tahini	264071	580	040553	Fall 2002	Agree	Agree
2005	Tahini	264053	540	040553	Fall 2002	Agree	Agree
2006	Big Boulder	254238	795	040453	Spring 2003	Agree	Agree
2006	Big Boulder	254233	765	040553	Fall 2002	Agree	Agree
2006	Kelsall	254359	825	040553	Fall 2002	False -	Agree
2006	Kelsall	254361	795	NO TAG	NO TAG	Agree	Unknown
2006	Kelsall	254362	800	040553	Fall 2002	Agree	Agree
2006	Kelsall	254363	745	040553	Fall 2002	Agree	Agree
2006	Kelsall	254364	730	040553	Fall 2002	Agree	Agree
2006	Kelsall	254365	770	040553	Fall 2002	Agree	Agree
2006	Kelsall	254239	830	040553	Fall 2002	False -	Agree
2006	Kelsall	254240	745	040553	Fall 2002	Agree	Agree
2006	Kelsall	254243	840	040553	Fall 2002	Agree	Agree
2006	Kelsall	254244	855	040553	Fall 2002	Agree	Agree
2006	Kelsall	254247	845	040553	Fall 2002	Agree	Agree
2006	Kelsall	254248	775	040553	Fall 2002	False -	Agree
2006	Tahini	254181	790	040553	Fall 2002	Agree	Agree
2006	Tahini	254182	660	040453	Spring 2003	Agree	Agree
2006	Tahini	254184	795	040553	Fall 2002	Agree	Agree
2006	Tahini	254230	795	040453	Spring 2003	Agree	Agree
2006	Tahini	254372	850	040553	Fall 2002	Agree	Agree
2007	Tahini	056655	890	040453	Spring 2003	Agree	Agree
Number of erroneous wand results						4 out of 33	2 out of 34
Percent of erroneous wand results (SE)						12% (6%)	6% (4%)

APPENDIX E

Appendix E1.–WinBUGS code and results of Bayesian statistical analysis of brood year (BY) 2001 juvenile Chinook River salmon abundance.

data from other recoveries included, nonvalid tags considered

prior distributions for root nodes underlined

fixed constants in bold

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

likelihood (sampling distribution of data) in italics

BY 2001 constants

adclips <- 70	**# ad clips found in Chilkat escapement sampling**
heads <- 38	**# heads collected in Chilkat (this is actually not relevant here)**
valid.tags <- 36	**# tags decoded by DCF Mark, Tag and Age Lab from Chilkat heads**

Model {

N.fry ~ dnorm(0,1.0E-12)	# abundance of fry in fall
phi.1 ~ dbeta(0.15,0.15)	# proportion of fry surviving until spring
rho ~ dbeta(0.1,0.1)	# proportion of ad clipped fish for which head collected and tag decoded
M.fry <- 31390	**# fry marked**
M.smolt <- 2797	**# smolt marked**
C <- 980	**# fish inspected inriver for ad clips**
m<-21	**# number of Chilkat CWT recoveries elsewhere, fall and spring**
N.smolt <- N.fry * phi.1	# abundance of smolt the following spring
q.fall <- M.fry / N.fry	# fraction marked in fall
q.spring <- M.smolt / N.smolt	# fraction marked in spring
pi[1] <- q.fall * rho	# fraction of returning fish from which could expect a valid fall tag
pi[2] <- q.spring * rho	# fraction of returning fish from which could expect a valid spring tag
pi[3] <- (q.fall + q.spring) * (1 - rho)	# fraction of returning fish with adclip, but no valid tag
pi[4] <- 1 - pi[1] - pi[2] - pi[3]	# fraction with no adclip
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 tags
m.fall ~ dbin(pi.fall,m)	*# number of fall tags among Chilkat tags is binomially distributed*

}

DATA

list(R.tags=c(27,9,34,910),m.fall=15)	# terms in DATA list are: 27 fall tags in Chilkat escapement,
	# 9 spring tags in Chilkat escapement; 34 heads not taken or
	# tags not decoded; 910 fish with intact adipose fins;
	# 15 fall tags recovered in marine random samples.

INITS

list(N.fry =600000, phi.1=0.3, rho=0.5)

RESULTS

Node	Mean	SD	MC error	2.5%	10.0%	Median	90.0%	97.5%	Start	Sample
N.fry	609,300	87,540	438	462,400	504,700	600,900	724,900	804,100	4,001	396,000
N.smolt	165,900	49,770	405	98,460	114,400	157,000	226,300	284,300	4,001	396,000
phi.1	0.2796	0.1011	9.383E-4	0.1453	0.1768	0.2611	0.4000	0.5186	4,001	396,000
pi[1]	0.0270	0.0050	1.989E-5	0.0183	0.0209	0.0267	0.0335	0.0375	4,001	396,000
pi[2]	0.0093	0.0027	9.417E-6	0.0048	0.0061	0.0091	0.0129	0.0153	4,001	396,000
pi[3]	0.0344	0.0058	1.649E-5	0.0240	0.0272	0.0340	0.0419	0.0465	4,001	396,000
pi[4]	0.9293	0.0082	2.984E-5	0.9125	0.9187	0.9296	0.9395	0.9444	4,001	396,000
rho	0.5142	0.0590	9.893E-5	0.3985	0.4382	0.5144	0.5901	0.6292	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 1999–2001.

	Brood year (BY)							
	1988[a]	1989[a]	1991[b]	1998[c]	1999[d]	2000[e]	2001[f]	BY 1999–2001 average
Fall fry abundance					386,400	510,700	596,410	497,837
SE					38,020	74,290	87,450	
Overwinter survival, %					36.4	21.1	24.9	27.5
SE, %					6.5	4.8	10.1	
Smolt emigration				123,680	139,500	105,300	148,800	131,200
SE				30,554	21,920	17,170	49,770	
Marked fraction (inriver)	0.037	0.110	0.048	0.015	0.113	0.102	0.076	0.097
Harvest (≥age-1.1)								
Commercial	910	283	681	191	589	414	407	470
SE	235	74	176	190	108	107	130	
Sport	719	373	374	849	972	353	304	543
SE	327	132	124	706	550	161	126	
Subsistence	9	27	58		252	236	192	227
SE	1	2	2		78	86	139	
Total harvest (≥age-1.2)	1,638	683	1,006	1,040	1,572	990	821	1,128
SE	403	152	210	731	541	211	222	
Inriver return (≥age-1.2)	7,111	6,233	11,900	3,596	4,764	4,173	4,561	4,499
SE	789	781	1,167	488	562	681	727	
Total return (≥age-1.2)	8,749	6,916	12,906	4,636	6,336	5,163	5,382	5,627
SE	885	796	1,186	879	780	713	760	
Exploitation (≥age-1.2), %	18.7	9.9	7.8	22.4	24.8	19.2	15.3	19.7
SE, %				12.5	6.7	4.2	4.1	
Smolt-adult survival, %				3.7	4.5	4.9	3.6	4.4
SE, %				1.2	0.9	1.0	1.3	

[a] Data from Ericksen (1996).
[b] Data from Ericksen (1999).
[c] Data from Ericksen (2006).
[d] Data from Chapell (2009).
[e] Data from Chapell (2010).
[f] Data from Tables 17–19.

APPENDIX G

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

FILE NAME	DESCRIPTION
2008ChilkatFallChinookCWT.xls	Excel workbook containing trapping, length sampling, and sequential tag number data from BY 2007 Chinook salmon CWT project in fall 2008.
2009ChilkatSpringChinookCWT.xls	Excel workbook containing trapping, length and weight sampling data from BY 2007 Chinook salmon CWT project in spring 2009.
2008 Haines creel interview.dta	ASCII file containing edited angler interview data from the Haines marine sport fishery in 2008.
Haines Marine Creel 2008 v3a.sas	SAS program to estimate effort and harvest in the 2008 Haines marine sport fishery using 2008 Haines creel interview.dta.
2008ChilkatChinookTagged.xls	Excel workbook containing raw data from Chinook salmon captured in the lower Chilkat River during 2008.
2008ChilkatChinookSpawn.xls	Excel workbook containing raw data from Chinook salmon sampled on the Chilkat River spawning tributaries during 2008.
2008HainesChinSportSubsAWL.xls	Excel workbook containing raw data from Chinook salmon sampled in Haines marine sport and subsistence fisheries.