Fishery Data Series No. 09-78

Production, Escapement, and Juvenile Tagging of Chilkat River Chinook Salmon in 2006

by

Richard S. Chapell

December 2009

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

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

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

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

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

Measures (fisheries)	
fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

FISHERY DATA SERIES NO. 09–78

PRODUCTION, ESCAPEMENT, AND JUVENILE TAGGING OF CHILKAT RIVER CHINOOK SALMON IN 2006

by
Richard S. Chapell
Alaska Department of Fish and Game, Division of Sport Fish, Haines

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

December 2009

The report was prepared by Richard Chapell under award NA04NMF4380162 (Alaska Sustainable Salmon Fund project 45621) 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-10-16, F-10-21 and F-10-22, PSC Northern Fund Grant No. COOP-07-2002, and NOAA Grant No. 17FF2457 (U. S. Chinook Letter of Agreement).

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Richard S. Chapell[a]
Alaska Department of Fish and Game, Division of Sport Fish
P. O. Box 330, Haines, AK 99827-0330, USA

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

This document should be cited as:
Chapell, R. S. 2009. Production, escapement, and juvenile tagging of Chilkat River Chinook salmon in 2006. Alaska Department of Fish and Game, Fishery Data Series No. 09-78, Anchorage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The purpose of this study was to estimate the sport harvest, escapement, and production of Chinook salmon *Oncorhynchus tshawytscha* returning to the Chilkat River during 2006. Angler effort and spring harvest of wild mature Chinook salmon in the Haines marine boat sport fishery were estimated using an onsite creel survey. We used an unstratified mark–recapture experiment to estimate spawning abundance of Chinook salmon returning to the Chilkat River in 2006. Juvenile abundance and marine harvest of 1999 brood year Chilkat River Chinook were estimated through recoveries of fish marked with coded wire tags as fry in fall 2000 and as smolts in spring 2001.

An estimated 8,172 angler-h (SE = 610) of effort (7,869 salmon-h, SE = 558) were expended in the 2006 spring Haines marine sport fishery for a harvest of 165 (SE = 13) Chinook salmon (≥28 inches), of which 86 (SE = 9) were wild, mature fish.

We captured 216 Chinook salmon with drift gillnets and fish wheels; 208 of these were marked and released in the lower Chilkat River between June 13 and August 11, 2006. Technicians examined 820 Chinook salmon in spawning tributaries of the Chilkat River, and 37 of these were marked. An estimated 4,515 (SE = 639) Chinook salmon immigrated into the Chilkat River during 2006. Using the lower river captures to estimate age composition, an estimated 1,216 (SE = 218) were small (age-1.1), 260 (SE = 81) were medium (age-1.2), and 3,039 (SE = 454) were large (age-1.3 and older) fish.

We estimated that 386,400 (SE = 38,020) fry were rearing in the Chilkat River in fall 2000 (1999 brood year). Overwinter survival from fall 2000 to 2001 was estimated as 36.4% (SE = 6.5%), and an estimated 139,500 (SE = 21,290) smolts emigrated in 2001. An estimated 1,814 (SE = 566) Chilkat River Chinook salmon from this brood year were harvested in marine fisheries between 2002 and 2006. In addition, 18,318 fry captured in the fall of 2006 and 2,239 smolts in the spring of 2007 were coded-wire-tagged. They averaged 74 mm (SD = 6.4) fork length in the fall and 79 mm (SD = 6.5) in the spring. Future recoveries of these fish will allow us to estimate juvenile abundance and marine harvest for the 2005 brood year.

Key words: Chinook salmon, *Oncorhynchus tshawytscha,* mark–recapture, escapement, angler effort, creel survey, harvest, Haines marine sport fishery, coded wire tags, 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 868 km^2 are considered accessible to anadromous fish (Ericksen and McPherson 2004). After spending one winter in fresh water, most Chilkat River Chinook salmon emigrate as smolt and rear for 1–5 years 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 1989-91; Ericksen 1994-2005; Ericksen and Chapell 2006). The fishery in Haines contributes significantly to the local economy, supports a salmon derby, and is popular both with local and non-local anglers (Bethers 1986; Stokes 1991).

Beginning in 1981, the Alaska Department of Fish and Game (ADF&G), Division of Sport Fish 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 areas were selected because they were the only clearwater spawning areas that could provide standardized, consistent survey counts. The indices were used in a regionwide program to monitor Chinook salmon escapements in Southeast Alaska (Pahlke 1992).

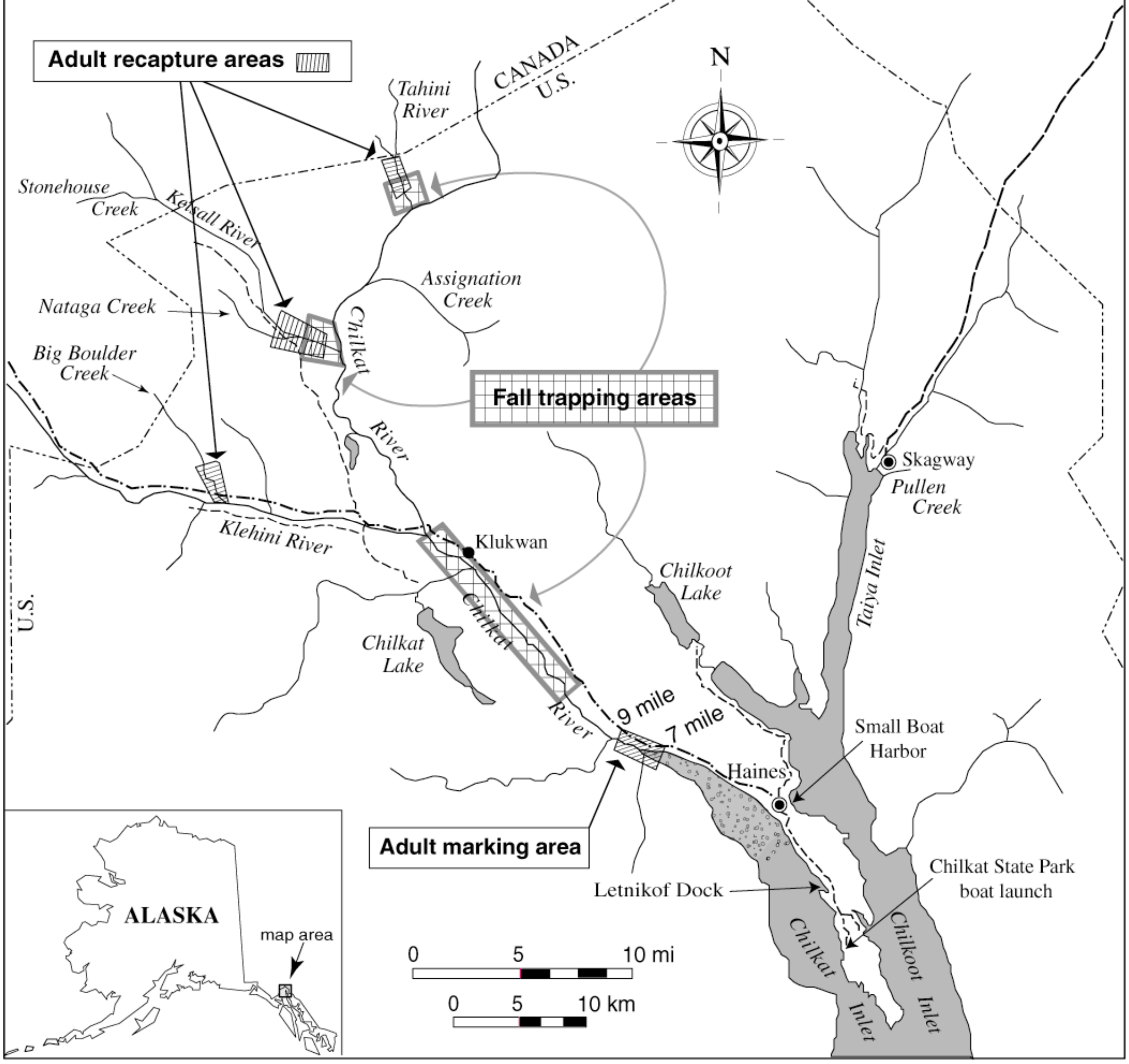


Figure 1.–Location of sampling sites and release sites of coded wire tagged Chinook salmon near Haines and Skagway in Southeast Alaska, 2006.

Concern about Chilkat River Chinook salmon 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, the Department began to restrict fisheries in upper Lynn Canal, and the spring recreational Chinook fisheries near Haines were closed entirely in 1991 and 1992. The Haines King Salmon Derby was closed between 1988 and 1994.

Because of these concerns, the Division of Sport Fish 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). Also, annual mark–recapture experiments were initiated in 1991 to estimate the escapement of large (age-1.3 and older) Chinook salmon, and radiotelemetry experiments were conducted in 1991, 1992, and 2005 to estimate spawning distribution. Results of this research indicated that immature fish are harvested primarily in the inside waters of Southeast Alaska (Johnson et al. 1993; Ericksen 1996, 1999; Ericksen and Chapell 2006) and that most Chinook salmon spawn in two major tributaries of the Chilkat River, the Kelsall and Tahini rivers. Escapement estimates have ranged from 2,035 (SE = 334) in 2000 to 8,100 (SE = 1,193) in 1997 (Johnson et al. 1992, 1993; Ericksen 1995-2005; Johnson 1994; Ericksen and Chapell 2006).

In 2000, we began to CWT Chinook salmon smolts each spring to estimate the smolt emigration and marine harvest of this stock. During the first year, we tagged very few smolts (1,996 in 2000; Ericksen 2002b). To increase the numbers of Chinook salmon outmigrating from the Chilkat River with CWTs, we also started tagging juvenile Chinook salmon (fry) beginning in fall of 2000 (Ericksen 2002a).

ADF&G adopted a biological escapement goal (BEG) of 1,750 to 3,500 large Chinook in January 2003 (Ericksen and McPherson 2004). This BEG forms the basis of the Lynn Canal and Chilkat River king salmon fishery management plan that was adopted by the Alaska Board of Fisheries in February 2003 (5AAC 33.384; Ericksen and McPherson 2004).

By regulation, sport fishing for Chinook salmon was prohibited near the mouth of the Chilkat River April 15–July 15, 2006 (5 AAC 47.021 (c), Figure 1). Regionwide regulations allowed resident anglers to keep three Chinook salmon 28 inches or greater in length per day and in possession. Nonresident anglers were allowed to keep two Chinook salmon 28 inches or greater in length per day and in possession with an annual limit of four Chinook salmon. In addition, effective June 5–July 31, 2006, the daily bag and possession limit was three Chinook salmon any size with no annual limit for all anglers fishing in Taiya Inlet. This regulation was implemented by emergency order to allow anglers to harvest hatchery fish returning to Pullen Creek in the Skagway area, where they had been released as smolts. The Lynn Canal and Chilkat River King Salmon Management Plan (5AAC 33.384) specified commercial fishing regulations that were structured to reduce incidental harvests of mature Chinook salmon in the Lynn Canal gillnet fishery.

The purpose of this study was to estimate the sport harvest, escapement, and production of Chinook salmon returning to the Chilkat River during 2006. We also tagged juvenile Chinook salmon to estimate production and future marine harvest of this stock. This report describes the methods and results of the study during 2006, and the juvenile abundance and harvest of 1999 brood year Chilkat River Chinook Salmon. The long-term goal of this study is to refine maximum harvest guidelines for this stock in accordance with sustained yield management.

Research objectives were to estimate:

1. the inriver abundance of large Chinook salmon in the Chilkat River in 2006;
2. the age, sex, and length compositions of the escapement of large Chinook salmon in the Chilkat River in 2006;
3. the harvest of wild mature Chinook salmon in the Haines spring marine boat sport fishery from May 8 to June 25, 2006;
4. the number of Chinook salmon fry rearing in the Chilkat River drainage in fall 2000 and the number of smolts emigrating from the Chilkat River in spring 2001 (1999 brood year);
5. the mean length of Chinook salmon fry rearing in the Chilkat River drainage during fall 2006, and the mean length and weight of smolts emigrating from the Chilkat River in spring 2007 (2005 brood year);
6. the marine harvest of Chilkat River Chinook salmon from the 1999 brood year.

METHODS

ESCAPEMENT

An unstratified mark–recapture experiment was used to estimate the number of Chinook salmon immigrating to the Chilkat River in 2006. Age composition of the 2006 immigration was estimated in order to reconstruct brood year returns needed for stock-recruit analysis.

Lower River Marking

Gillnets 21.3 m long and 3.0 m deep (70 ft × 10 ft) were drifted in the lower Chilkat River June 10 through July 22, 2006. The gillnets consisted of two equal-length panels, one of 17.1-cm (6 ¾ inch) and the other of 20.3-cm (8 inch) stretch measured nylon mesh. We completed 43 drifts between 0600 and 1400 hours each day. Fishing was conducted from a 5.5-m boat in six adjoining

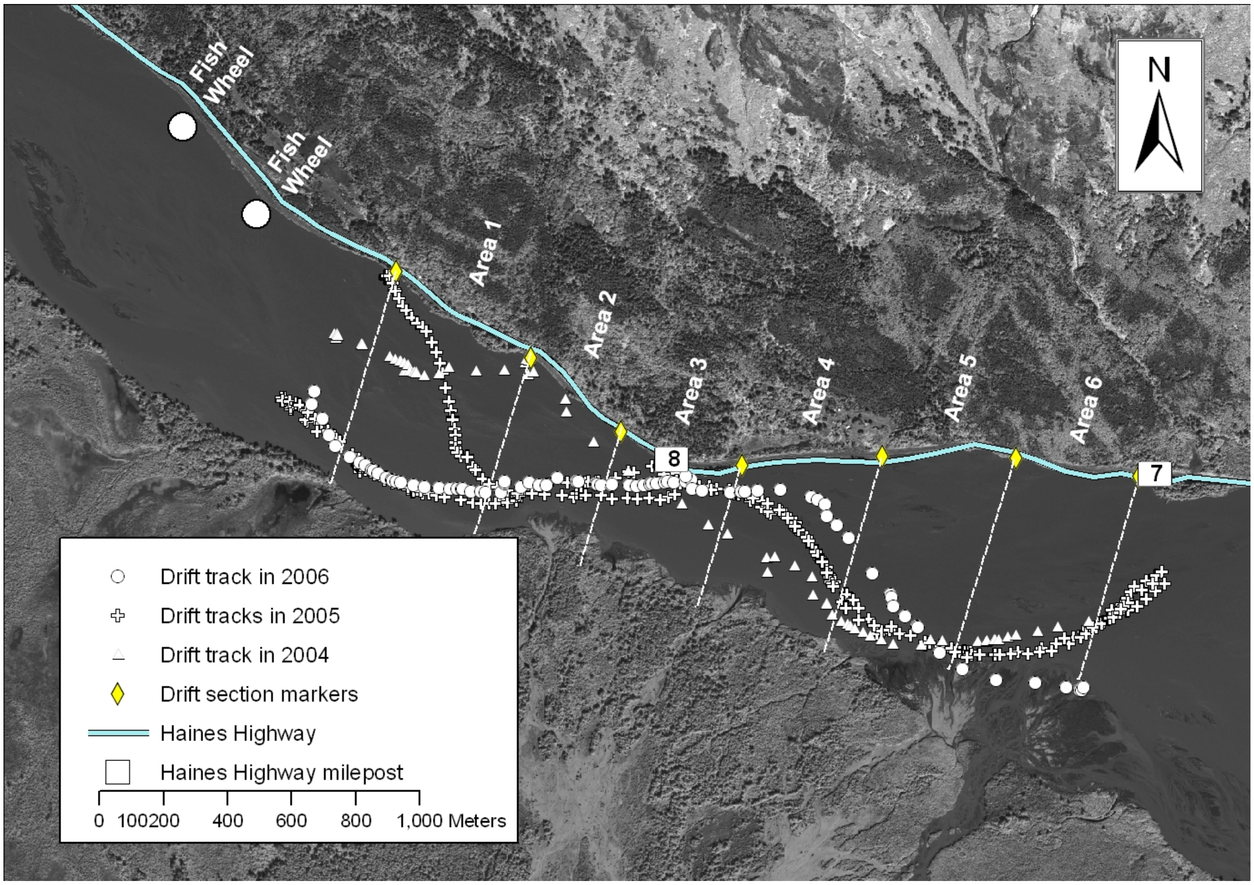


Figure 2.–Section marker locations and gill net drift paths in the lower Chilkat River, 2004–2006.

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 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 Commercial Fisheries Division to tag sockeye O. nerka, coho O. kisutch, and chum salmon O. keta from June 4 to October 14; 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 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), inspected for missing adipose fins, and measured to the nearest 5 mm MEF. Fish were initially classified as 'large,' 'medium,' or 'small,' depending on their length: fish ≥660 mm MEF were designated as large, fish ≥440 and <660 mm MEF as medium, and fish <440 mm MEF as small. To maximize the number of decoded CWTs for Objective 4 without significantly reducing overall production in 2006, small and medium fish bearing CWTs were sacrificed to recover their tags. Of 1,740 Chinook salmon <660 mm MEF sampled for sex and length in Chilkat River spawning areas by this project in 1991–2005, only 24 (1.4%, SE = 0.3%) were identified as female. Heads were removed from all fish <660 mm MEF with missing adipose fins, marked with an individually numbered strap, and sent to the

ADF&G Mark, Tag and Age Laboratory in Juneau for analysis. The heads of all adipose-clipped fish 660 mm or greater (MEF) were tested with a hand-held wand CWT detector for the presence of a CWT. If no CWT was detected, the fish was sacrificed and the head was processed as above. All healthy medium and large Chinook salmon (≥400 mm MEF) not sacrificed for CWTs were sampled for scales, visually 'sexed,' 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, and given a 6-mm hole punch in the upper edge of the left operculum (ULOP) as a secondary mark. Technicians operating the gillnet also marked fish by clipping (removing) the left axillary appendage. This helped to identify where the fish was marked (whether in the fish wheel or gillnet) in the event of tag loss. Healthy small fish (<440 mm MEF) not sacrificed for CWTs were sampled and marked as above except they were given a uniquely numbered T-bar anchor tag instead of a spaghetti tag. The scale sampling procedure was to remove five scales from the left side of each sampled fish (right side if left side scales were missing or regenerated as determined by visual inspection), along a line two scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 3,500 lb/in² at a temperature of 97°C) was used to determine age postseason by counting the scale annuli (Olsen 1992). Each fish was then 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 one ocean year were classified as small. Any fish whose scales could not be aged was classified by length as described above.

Spawning Ground Recovery

Escapements in the Kelsall and Tahini Rivers (Figure 1) were inspected for the presence of marks by two 2-person crews. Spawning grounds in the Kelsall River (including Nataga Creek) and in the Tahini River were sampled from August 4 to September 3. Chinook salmon were also sampled in Big Boulder Creek from August 3 through September 1, and in Little Boulder Creek on August 24. Chinook salmon were captured using gillnets, dip nets, snagging gear, and even bare hands. All captured fish were sampled for scales as described above, inspected for spaghetti tags and missing adipose fins, and measured to the nearest 5 mm MEF. Duplicate sampling was prevented by punching a hole in the lower edge of the left operculum of all captured fish.

Abundance

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

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

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

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

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

(e) all recovered marks are reported; and

(f) duplicate sampling does not occur.

The validity of assumption (a) was tested through a series of hypothesis tests (all at $\alpha = 0.1$). First, a contingency table (chi-square 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 three ways (Appendix A):

(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).

We also conducted contingency table tests for sex selectivity (Appendix A).

Abundance was calculated using an unstratified Chapman's modified Petersen estimator for a closed population (Seber 1982):

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

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

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

The remaining assumptions are considered in the "Discussion."

Age and Sex Composition of the Escapement

Age and sex composition estimates can be biased due to sampling methods. The fish wheels are usually selective for smaller fish (Ericksen 1995) and for males (Ericksen 1995-2005, Ericksen and Chapell 2006), and the gillnets are selective for larger fish. 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 composition between spawning areas can bias composition estimates for the entire drainage when sampling is not proportional to abundance.

Age composition was tabulated separately for fish caught in the lower river by gillnet and fish wheels (event 1), and in each escapement sampling 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.

Based on the results of the K-S tests described above, pooled event 1 data were used to estimate the age proportions of the escapement by:

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

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

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

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

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

Terminal Harvest

2006 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 two low-use sites. A separate temporal stratum existed during the two weekends of the Haines King Salmon Derby (May 27–29, June 3 and 4) at both high- and low-use sites. Each fishing day was defined as starting at 0800 hours and ending at civil twilight, which ranged from 2227 to 2352 hours. Midday was defined as the time mid way between 0800 hours and civil twilight.

The three access locations were the Letnikof Dock (the high-use site), the Chilkat State Park boat launch, and the Small Boat harbor (Figure 1). Prior surveys indicate that with the exception of 2000, anglers landing their catch at the Letnikof

Dock account for 51–93% of the harvest of Chinook salmon. Sampling at each location had days as primary sampling units and boat-parties as secondary units.

Sampling at Letnikof Dock occurred from May 8 to June 25, 2006, and contained morning/evening stratification and weekend/weekday stratification of evening strata during the peak of the season. Morning sampling strata lasted from 0800 hours until 2 h before midday, and evening sampling strata lasted from 2 h before midday until civil twilight. Thus, evening strata were 4 h longer in duration than morning strata. This stratification scheme was designed to increase the precision of estimates by maximizing sampling during hours when most anglers exit the fishery. Random selections determined primary units to sample in each stratum. Two morning and three evening strata were sampled each week, except as noted below.

During the peak of the fishery (May 8–June 11) the evening strata at Letnikof Dock were further divided into weekday and weekend stratification. During this time, two morning, two weekday evening, and two weekend/holiday evening periods were sampled each week. In total, 17 unique strata were sampled at Letnikof Dock in 2006.

Sampling at the Small Boat Harbor was initiated on May 8 and continued through June 25. Sampling at the Chilkat State Park boat launch was initiated on May 15, and ended on June 25. There was no type of day stratification at the low-use sites. Each biweekly period was divided into 14 morning and 14 evening periods of equal length at the Small Boat Harbor, except during the Haines King Salmon Derby, when the biweek was divided into one 5-day (derby) with no time-of-day stratification and one 9-day (non-derby) period, and during the final 7-day period when there was no time-of-day stratification. Because of the short sampling schedule at Chilkat State Park boat launch, there was an initial 7-day stratum with no time-of-day stratification, and during the final 7-day period there was no time-of-day stratification. Random selections determined primary units to sample in each morning and evening stratum. To accommodate the impossibility of sampling three sites simultaneously with only two technicians, five changes (period moves) were made to the randomized sampling schedule at low-use sites. Thirteen (15) unique strata were sampled at the low-use harbors during 2006.

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, type of trip (charter or non-charter), 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 was estimated by expanding by the total number of parties returning to the dock during that period. Similarly, when a boat party had fish of undetermined maturity status, interview information for that boat-party was ignored and expansions (by sample period) were made from harvests by remaining boat parties and the total number of boat parties counted.

The harvest in each stratum ($\hat{H}_h$) was estimated (Cochran 1977):

$$\hat{H}_h = D_h \overline{H}_h \tag{7}$$

$$\overline{H}_h = \frac{\sum_{i=1}^{d_h} \hat{H}_{hi}}{d_h} \tag{8}$$

$$\hat{H}_{hi} = M_{hi} \frac{\sum_{j=1}^{m_{hi}} h_{hij}}{m_{hi}} \tag{9}$$

where h_{hij} is the harvest on boat j in sampling days (periods) i 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:

$$var\left[\hat{H}_h\right] = (1 - f_{1h})D_h^{\ 2}\frac{\sum_{i=1}^{d_h}(\hat{H}_{hi} - \overline{H}_h)^2}{d_h(d_h\text{ -}1)} + D_h\sum_{i=1}^{d_h}M_{hi}^{\ 2}(1 - f_{2hi})\frac{\sum_{j=1}^{m_{hi}}(h_{hij}\text{-}\overline{h}_{hi})^2}{d_h m_{hi}(m_{hi}\text{ -}1)} \tag{10}$$

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 (7) through (10). Total harvests for the season are the sums across strata ΣH_h and $\Sigma var[H_h]$. Similarly, effort and harvest by charterboat anglers were estimated by considering only data collected from chartered anglers in equations (7) through (10).

Chinook salmon sampled in the angler harvest were measured to the nearest 5 mm FL. Five scales were removed from the left side of each sampled fish (right side if left side scales were missing or regenerated as determined by visual inspection), along a line two scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. A triacetate impression of the scales (30 s at 3,500 lb/in² at a temperature of 97°C) was later used to determine age (Olsen 1992). Information recorded for each Chinook salmon sampled included sex, length, maturity, and presence or absence of adipose fins.

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

$$\hat{p}_a = \frac{\sum_h \hat{H}_h\,\hat{p}_{a,h}}{\sum_h \hat{H}_h} \tag{11}$$

where h denotes a (time, harbor, or time-harbor) stratum and the estimated harvests supply appropriate 'weights' for the different stratum sizes. Variance was approximated as:

$$\text{var}(\hat{p}_a) \cong \hat{H}^{-2}\sum_h \hat{H}_h^2\,\text{var}\left(\hat{p}_{a,h}\right) + \hat{H}^{-2}\sum_h \text{var}\left(\hat{H}_h\right)\left(\hat{p}_{a,h} - \hat{p}_a\right)^2 \tag{12}$$

where $p_{a,h}$ is the proportion age a fish sampled in stratum h, and the approximation is from a second order Taylor's series expansion around the expected values of the parameter estimates and substituting estimated values for the expected values (Mood et al. 1974, p. 181).

Contribution of Coded Wire Tagged Stocks to the 2006 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 ADF&G Mark, Tag and Age Laboratory in Juneau where heads were dissected for the presence of coded wire. Coded wire tags were subsequently decoded and all corresponding information was then entered into the ADF&G Mark, Tag, and Age Laboratory database.

The contribution of all tagged stocks to the 2006 Haines marine boat sport fishery was estimated:

$$\hat{r}_{ij} = \hat{H}_i\left(\frac{m_{ij}}{\lambda_i n_i}\right)\hat{\theta}_j^{\ -1} \tag{13}$$

where $\hat{H}_i$ is the estimated harvest in stratum i, $\hat{\theta}_j$ is the fraction of stock j marked with CWTs[1], 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. Statistics were stratified by bi-week.

Variance of $\hat{r}_{ij}$ was estimated by means of the appropriate large-sample formulations in Bernard

[1] In the case of hatchery stocks, θ is known, not estimated.

and Clark (1996, their Table 2, situations 2 and 4) for wild or hatchery stocks harvested in a recreational fishery. The total contribution of one or more cohorts to one or more fisheries is the sum of harvests and variances from the individual cohorts and strata.

JUVENILE TAGGING

Juvenile Chinook salmon (brood year 2005) were captured in primary rearing areas of the Chilkat River drainage during the fall of 2006 (fry) and in the mainstem of the Chilkat River during the spring of 2007 (smolt) and marked with a clipped adipose fin and a CWT. In addition, smolts tagged in the spring were given a second CWT inserted in the back just posterior of the dorsal fin. Adult fish will be sampled from the escapement between 2008 and 2012 to estimate the marked fraction. A hand-held CWT wand detector will be used to identify adults in the escapement that were tagged as smolts without sacrificing the fish. This information will allow us to estimate fall rearing abundance in 2006, overwinter survival, and smolt emigration in 2007. In addition, random recoveries of CWTs in sampled marine fisheries will allow us to estimate total marine harvest of this stock.

Chinook salmon fry were captured in G-40 minnow traps at three locations in the Chilkat River drainage during fall 2006. Trapping began in upriver locations and moved downstream as the season progressed. The Tahini River was trapped September 17–23, the Kelsall River from September 29 to October 15, and the lower Chilkat River near MP 19 November 1–3. In spring 2007, the lower Chilkat River (below MP 21) was trapped from April 12 to June 1.

A crew consisting of four people fished approximately 80 traps per day. Traps were baited with disinfected salmon roe and checked at least once per day. Crew members immediately released non-target 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 ≥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. Every 100th fish tagged with a CWT was additionally measured to the nearest mm FL.

All marked fish were held overnight to check for 24-hour 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 98/100 or greater, mortalities were counted and all live fish from that batch were released. If tag retention was less than 98/100, 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 ADF&G Mark, Tag, and Age Lab in Juneau at the completion of the field season.

1999 BROOD YEAR JUVENILE ABUNDANCE

On September 19 and October 29, 2000, 30,104 Chinook salmon fry from the 1999 brood year (BY-1999) were captured, marked with adipose finclips and CWTs, and released into the Tahini, Kelsall, and Chilkat Rivers (Ericksen 2002a). Between April and June 2001, an additional 4,506 smolts (also BY-1999) were marked and released into the Chilkat River (Ericksen 2002b).

Between 2002 and 2006, the Division of Commercial Fisheries sampled landings from commercial drift gillnet, set gillnet, purse seine, and troll fisheries throughout Southeast Alaska and Yakutat for finclips 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 ADF&G Mark, Tag, and Age Laboratory in Juneau on a weekly basis where CWTs were removed and decoded. The annual Division of Commercial Fisheries port sampling manual (ADF&G *Unpublished*) provides a detailed explanation of commercial catch sampling procedures and logistics.

The number of 1999 brood year Chilkat River Chinook salmon CWTs recovered 2002–2006 in all commercial, sport, and subsistence fisheries and the number recovered from Chilkat River escapement sampling events was tallied by release period, whether fall 2000 or spring 2001.

A statistical model was fit to the 1999 brood year data to obtain estimates of the number of BY-1999 fry rearing in the Chilkat River in fall 2000 ($\mathbf{N_{FRY}}$), the overwinter survival to spring 2001 (ϕ_1), and the number of smolts outmigrating in 2001 ($\mathbf{N_{SMOLT}}$).

The number of valid CWTs from fall and spring marking events recovered from Chinook salmon sampled in the Chilkat River from 2002 to 2006 was modeled as having a multinomial distribution with parameters π_1, π_2, π_3, π_4, and C, where

$\pi_1 = q_{FALL}\,\rho$,

$\pi_2 = q_{SPRING}\,\rho$,

$\pi_3 = (q_{FALL} + q_{SPRING})\,(1\text{-}\rho)$,

$\pi_4 = 1 - \pi_2 - \pi_3$, and

C = number of Chinook salmon captured in the Chilkat River and inspected for adipose clips in 2002–2006,

$q_{FALL} = M_{FRY} / N_{FRY}$

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

ρ = the proportion of adipose-clipped fish for which the head was collected and a CWT was successfully decoded,

M_{FRY} = number of CWTs applied to Chinook salmon fry marked during fall 2000,

M_{SMOLT} = number of CWTs applied to Chinook salmon smolts marked during spring 2001,

N_{FRY} = abundance of Chinook salmon fry during the fall 2000 marking event, and

N_{SMOLT} = abundance of Chinook salmon smolts during spring 2001 marking event, equal to the product of N_{FRY} and

ϕ_1 = the survival probability from fall 2000 to spring 2001.

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 2000 marking event recovered from Chinook salmon sampled elsewhere from 2002 to 2006 was modeled as having a binomial distribution with parameters,

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

m = number of Chilkat fall and spring CWTs recovered in fisheries outside of the Chilkat River from 2002 to 2006.

Bayesian statistical methods, which are well-suited for analyzing unconventional data[2], were used to estimate the 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 non-informative, 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

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

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 E1.

1999 BROOD YEAR ADULT HARVEST

Harvest of brood year 1999 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 1999 brood year 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 fishing period and quadrant. Statistics from drift gillnet fisheries were stratified by 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 18[3]. 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.

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

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

$$\hat{T} = \sum_i \hat{r}_i \tag{14}$$

$$\text{v}[\hat{T}] = \sum_i \text{v}[\hat{r}_i] \tag{15}$$

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 1999 brood year was estimated as:

$$\hat{R} = \hat{T} + \hat{S} \tag{16}$$

$$\text{var}\left[\hat{R}\right] = \text{var}\left[\hat{T}\right] + \text{var}\left[\hat{S}\right] \tag{17}$$

where $\hat{S}$ is the total escapement of age-1.2 and older 1999 brood year fish estimated between 2003 and 2006.

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

$$\hat{\mu} = \frac{\hat{T}}{\hat{R}} = \frac{\hat{T}}{\hat{S} + \hat{T}} \tag{18}$$

$$\text{var}[\hat{\mu}] \approx \frac{\text{var}[\hat{T}]\hat{S}^2}{\hat{R}^4} + \frac{\text{var}[\hat{S}]\hat{T}^2}{\hat{R}^4} \tag{19}$$

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:

$$\hat{\phi}_2 = \frac{\hat{R}}{\hat{N}_{SMOLT}} \tag{20}$$

$$\text{var}[\hat{\phi}_2] \approx \hat{\phi}_2^2 \left[\frac{\text{var}[\hat{R}]}{\hat{R}^2} + \frac{\text{var}[\hat{N}_{SMOLT}]}{\hat{N}_{SMOLT}^2} \right] \tag{21}$$

RESULTS

ESCAPEMENT

We captured 145 large, 14 medium, and 57 small Chinook salmon in the lower Chilkat River with drift gillnets and fish wheels between June 13 and August 11, 2006 (Table 1, Figure 3). Of those captured, 144 large, 13 medium, and 50 small fish were given a uniquely numbered external tag and an ULOP. One small fish was given an ULOP but escaped before it could be given a numbered tag. This fish was included in the analysis as a marked fish. One large and one medium fish captured in the drift gillnets were bleeding from the gills and were released unmarked. Five small fish caught in the fish wheels were missing adipose fins and were sacrificed to recover CWTs. Capture rates of large Chinook salmon peaked on July 10. The mean date of migratory timing (Mundy 1984) in the lower river was July 7 for large fish captured in drift gillnets (Figure 4).

We examined 709 large, 64 medium, and 47 small Chinook salmon on the spawning grounds for marks: 33 large, 1 medium, and 3 small fish possessed marks from the tagging event (Table 2). Four large fish marked with an ULOP were recovered missing their spaghetti tags; two of these had LAA clips and had lost their spaghetti tags, and two were partial carcasses that could not be evaluated for tag loss. One large fish marked with an ULOP was recovered with a spaghetti tag attached, but the tag number recorded in field data was nonsensical.

Recapture rates of marked fish were not different ($\chi^2 = 1.298$, df = 1, P = 0.255) for the first half of the fish marked (12%, June 13–July 8) versus the second half (19%, July 9–August 11). Further, the marked fractions of Chinook salmon sampled at the three spawning tributaries (Kelsall 4.5%, Tahini 4.4%, Klehini tributaries 4.8%) were not different ($\chi^2 = 0.053$, df = 2, P = 0.974). Therefore the abundance estimate was not stratified by time/area.

Size selectivity was evaluated by comparing length distributions, using the protocol in Appendix A. The length distribution of Chinook salmon marked in the lower Chilkat River (combined fish wheel and drift gillnet captures) was significantly different from that of marked Chinook salmon recaptured on the spawning grounds (K-S test, D = 0.216, P = 0.075, Figure 5, top). The length distribution of fish captured on the spawning grounds was not significantly different from that of marked fish recaptured on the spawning grounds (K-S test, D = 0.175, P = 0.224, Figure 5, bottom). Therefore, size-selective sampling was detected during the second event but not the first (Case II in Appendix A) and the abundance estimate was not stratified by size.

Table 1.–Numbers of Chinook salmon caught in the lower Chilkat River by time period, gear type and size, June 13–August 11, 2006.[a]

	Drift gillnet			Fish wheels			Combined			
Time period	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small	Total
6/13–6/17	1	0	0	0	0	0	1	0	0	1
6/18–6/22	0	0	0	0	0	3	0	0	3	3
6/23–6/27	5	0	0	3	0	5	8	0	5	13
6/28–7/02	8	1	0	11	2	11	19	3	11	33
7/03–7/07	23	0	0	17	4	9	40	4	9	53
7/08–7/12	27	1	0	29	3	14	56	4	14	74
7/13–7/17	7	0	0	5	2	7	12	2	7	21
7/18–7/22	3	0	0	0	0	5	3	0	5	8
7/23–7/27				1	0	2	1	0	2	3
7/28–8/01				3	1	0	3	1	0	4
8/02–8/06				1	0	0	1	0	0	1
8/07–8/11				1	0	1	1	0	1	2
	74	2	0	71	12	57	145	14	57	216

[a] L = age-1.3 and older fish, M = age-1.2 fish, S = age-1.1 fish.

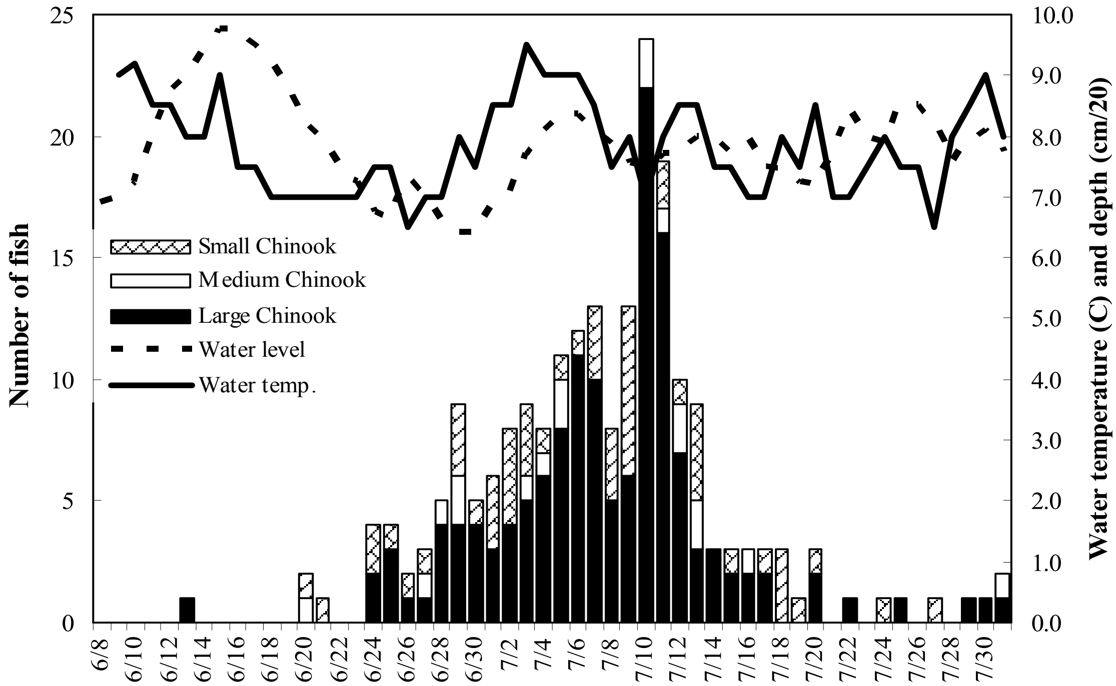


Figure 3.–Daily water depth (cm/20), temperature (°C), and catches of small (age-1.1), medium (age-1.2), and large (≥ age-1.3) Chinook salmon in drift gillnets and fish wheels operating in the lower Chilkat River, June 8–July 31, 2006.

Similar tests conducted for sex selectivity (Appendix A) concluded that sex composition differed ($\alpha = 0.1$) between marked and recaptured, captured and recaptured, and marked and captured fish (Table 3), indicating that both events were sex-selective. The recommended Case IV protocol in Appendix A calls for stratifying the abundance estimate by sex. This was not done[4] because sex identification during event 1 has historically been unreliable for this project (Table 4)[5].

An estimated 4,515 (SE = 639) Chinook salmon of all ages immigrated into the Chilkat River in 2006 (Table 5). This estimate is germane to the time of marking at lower river capture sites because an unknown number of Chinook salmon were removed due to predation between the marking and recovery events.

[4] Sex stratification was not carried out for previous years' abundance estimates for the same reason.

[5] Sex determinations actually agreed well between events in 2006, but this was an exception.

Age and Sex Composition of the Inriver Return

More than half (56%) of the fish in the drift gillnet were captured in the large mesh (20.3 cm) panel. Fish captured in gillnets were predominantly age-1.3 (71.8%) and classified as female (59.2%, Table 6). Those captured in the fish wheels were most commonly age-1.1 (40.9%) or age-1.3 (32.8%), and were classified mostly as males (67.1%). The overall age composition of fish captured in the combined lower Chilkat River gear types was 26.9% age-1.1, 5.8% age-1.2, 46.2% age-1.3, and 21.2% age-1.4 (Table 6).

Following the Case II protocol in Appendix A, the event-1 age proportions (Table 6) were used to estimate the inriver age composition as 1,216 age-1.1, (SE = 218), 260 age-1.2 (SE = 81), 2,084 age-1.3 (SE = 332), and 955 age-1.4 (SE = 184). The estimated abundance of large fish (age-1.3 and older) was 3,039 (SE = 454).

We sampled 812 Chinook salmon on the spawning grounds for age and sex. Of those

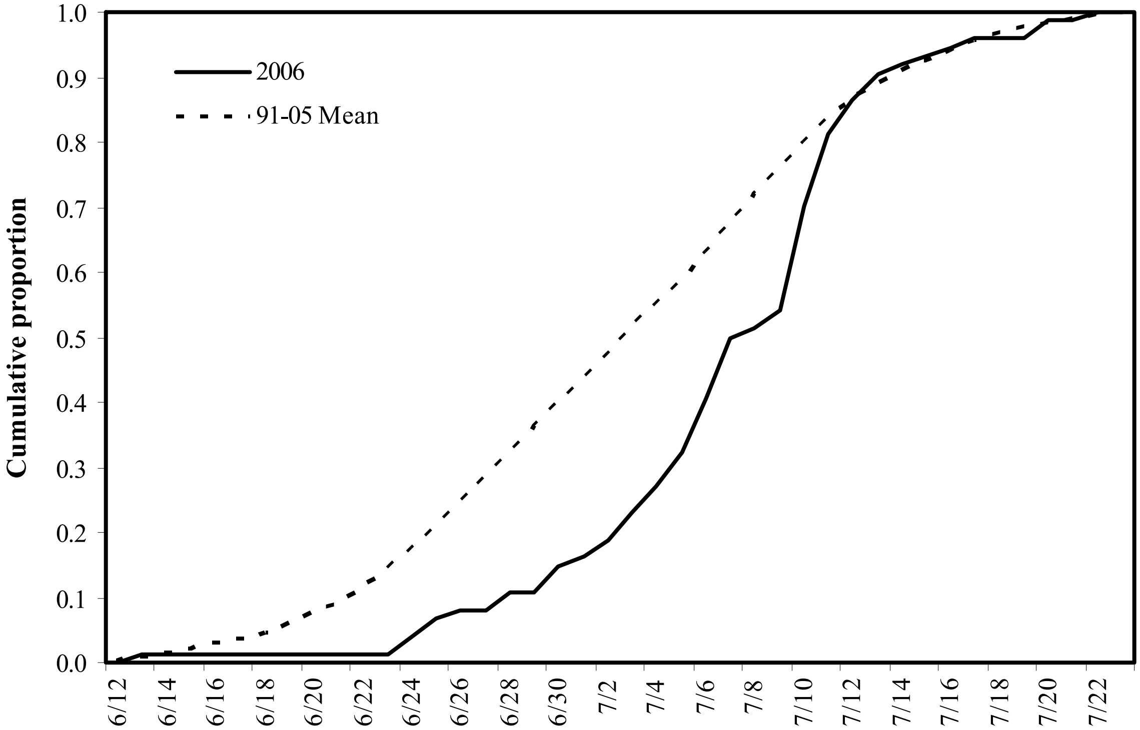


Figure 4.–Cumulative proportion of large (≥age-1.3) Chinook salmon captured with drift gillnets in the lower Chilkat River in 2006 compared to the mean cumulative proportion, 1991–2005.

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 2006.

		Inspected[a]								Marked[a]							
		Large				Medium		Small		Large				Medium		Small	
	Dates	M	F	U	Total	M	Total	M	Total	M	F	U	Total	M	Total	M	Total
Big Boulder	8/04–9/01	55	90	0	145	10	10	8	8	0	7	0	7	0	0	1	1
Kelsall River	8/04–9/03	119	184	1	304	18	18	11	11	4	10	0	14	0	0	1	1
Little Boulder	8/24	2	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Tahini River	8/03–9/01	106	144	7	257	36	36	28	28	0	0	1	12	1	1	1	1
Total		282	419	8	709	64	64	47	47	17	22	1	33	1	1	3	3

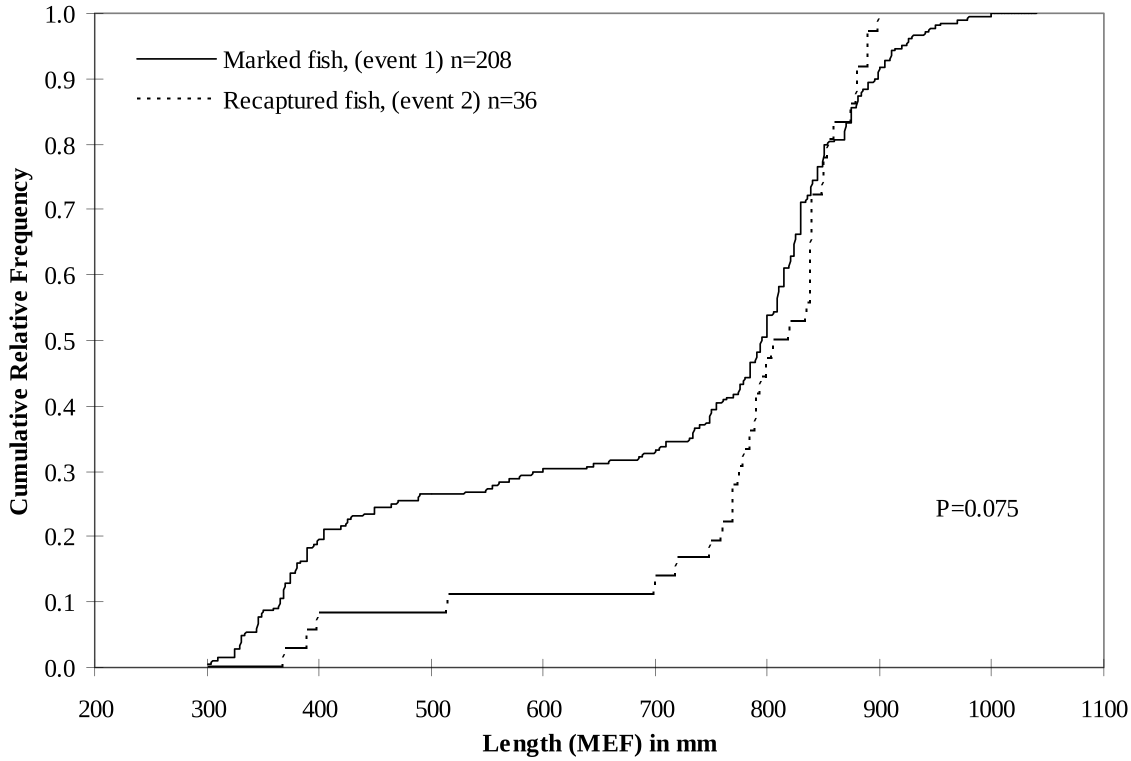
[a] M = male, F = female, U = not sexed.

Table 3.–Contingency table tests for evaluation of sex selectivity in sampling events 1 and 2 (see Appendix A).

	Number of fish		
	Male	Female	
Marked	118	90	
Captured	393	419	
Recaptured	11	25	
Comparison	χ^2	df	P
Marked vs. recaptured	8.438	1	0.004
Captured vs. recaptured	4.400	1	0.036
Marked vs. captured	4.598	1	0.032

sampled, 783 were successfully aged (Table 7). The predominant age class in each spawning area was age 1.3, followed by age 1.4, 1.2, and 1.1. Proportions of the four age classes (age 1.1, 1.2, 1.3, and 1.4) did not differ significantly among the three spawning areas (χ^2 = 0.059, df = 6, P > 0.999).

As mentioned previously, tests for sex selectivity (Appendix A) concluded that both events were sex selective. Because sex determination is more difficult during event 1 and the results have often



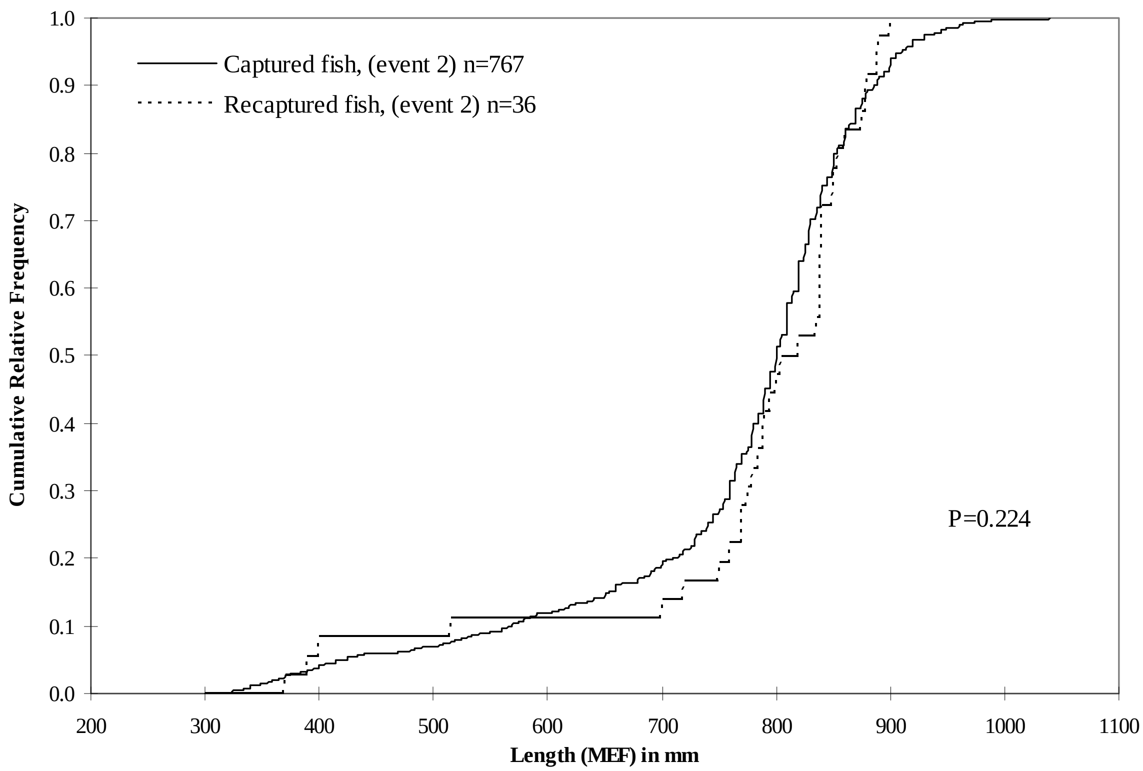


Figure 5.–Empirical cumulative distribution function (ECDF) of MEF lengths of all marked Chinook salmon recaptured on the spawning grounds versus all fish marked in the lower Chilkat River (top) and versus all fish captured on the spawning grounds (bottom), 2006.

Table 4.–Sex determination error rates in Chilkat River Chinook salmon mark–recapture studies, 1991–2006.

Year	Number of recaptures examined	Number incorrectly sexed	Error rate	Data source
1991	24	3	0.13	Ericksen 1995
1992	24	4	0.17	Ericksen 1995
1993	21	2	0.10	Ericksen 1995
1994	32	3	0.09	Ericksen 1995
1995	17	4	0.24	Ericksen 1996
1996	31	5	0.16	Ericksen 1997
1997	29	5	0.17	Ericksen 1998
1998	28	2	0.07	Ericksen 1999
1999	32	7	0.22	Ericksen 2000
2000	37	5	0.14	Ericksen 2001
2001	46	11	0.24	Ericksen 2002a
2002	54	4	0.07	Ericksen 2003
2003	59	9	0.15	Ericksen 2004
2004	43	1	0.02	Ericksen 2005
2005	28	5	0.18	Ericksen and Chapell 2006
2006	32	1	0.03	
Total	24	3	0.13	

Table 5.–Unstratified abundance estimate and sampling statistics of Chilkat River Chinook salmon, 2006.

Marked	Examined	Recaptures	Abundance	
n_1	n_2	m_2	$\hat{N}$	$SE(\hat{N})$
208	820	37	4,515	639

conflicted with event-2 determinations (Table 4), event 2 data have historically been used to estimate proportions by sex. Should event 2-based sex composition estimates be required for historical comparisons, they can be derived from the information in Table 7. However it should be noted that, because event 2 was sex selective, such estimates are probably biased.

TERMINAL HARVEST

2006 Haines Marine Sport Fishery Harvest

An estimated total 8,172 (SE = 610) angler-hours of effort were expended in the Haines marine boat fishery between May 8 and June 25, 2006, to catch 176 (SE = 15) and harvest 165 (SE = 13) large Chinook salmon (Table 8). This estimate is based on a sample of 336 boat-parties who fished 3,891 angler-hours (3,796 salmon-hours). An estimated 86 (SE = 9) of the Chinook salmon harvested in this fishery were wild mature fish assumed to be returning to the Chilkat River. About 96% (7,869 salmon-hours, SE = 558) of angler effort targeted Chinook salmon, and the remainder was directed toward other species, primarily Pacific halibut. Anglers caught an estimated 606 (SE = 120) small (<28 inches TL) Chinook salmon, of which 83 (SE = 25) were kept. Eighty-three percent (83%) of the estimated salmon effort occurred between May 22 and June 18 (Table 9). Angling pressure for Chinook salmon was relatively light during the first and last week, so our coverage of the fishery for mature Chinook salmon was essentially complete. Charter boat anglers accounted for about 8% of the salmon effort (665 salmon-hours, SE = 234), 6% of the large Chinook salmon harvest (11, SE = 9), and 70% of the small Chinook salmon harvest (60, SE = 42) in this fishery. Charter boat effort was encountered only at the Small Boat Harbor in 2006.

Estimates by site are presented in Appendices B1 through B3. Anglers returning to Letnikof Dock (the high-use site) were responsible for 71% of the estimated salmon effort (5,616 salmon-hours, SE = 395) and 75% of the estimated harvest (124, SE = 10) of large Chinook salmon (Appendix B1). Anglers returning to the Chilkat State Park boat launch accounted for an estimated 213 (SE = 108) salmon-hours of effort and harvested 7 (SE = 6) large Chinook salmon (Appendix B2). Those returning to the Small Boat Harbor expended 2,040 (SE = 378) salmon-hours and harvested 34 (SE = 6) large Chinook salmon (Appendix B3).

Table 6.–Mean length (MEF) by sex and age, age composition, and inriver abundance by age of Chinook salmon sampled during tagging operations (event 1) on the Chilkat River by gear type, 2006. Event 1 was found to be sex-selective so sex composition of the sample is not representative of the population.

		Brood year and age class					
		2003	2002	2001	2000		
		1.1	1.2	1.3	1.4	Total aged	Total sampled[a]
DRIFT GILLNET							
Males	Sample size	0	1	22	4	27	31
	Mean length		640	805	893		
	SD			61.8	28.7		
Females	Sample size	0	0	29	15	44	45
	Mean length			825	871		
	SD			32.5	52.7		
All fish	Sample size	0	1	51	19	71	76
	Percent		1.4	71.8	26.8		
	SE(%)		1.4	5.2	5.1		
	Mean length		640	816	876		
	SD			47.9	48.7		
FISH WHEELS							
Males	Sample size	55	8	20	9	92	94
	Mean length	369	545	793	865		
	SD	34.7	46.0	76.2	96.7		
Females	Sample size	1	3	25	16	45	46
	Mean length	450	503	792	873		
	SD		46.5	37.0	54.7		
All fish	Sample size	56	11	45	25	137	140
	Percent	40.9	8.0	32.8	18.2		
	SE(%)	4.2	2.3	4.0	3.3		
	Mean length	370	534	792	870		
	SD	36.1	47.9	57.0	70.7		
COMBINED LOWER RIVER GEAR							
Males	Sample size	55	9	42	13	89	91
	Mean length	369	556	799	873		
	SD	34.7	53.4	68.4	81.3		
Females	Sample size	1	3	54	31	119	125
	Mean length	450	503	810	872		
	SD		46.5	38.2	52.8		
All fish	Sample size	56	12	96	44	208	216
	Percent	26.9	5.8	46.2	21.2		
	SE(%)	3.0	1.6	3.4	2.8		
	Mean length	370	543	805	872		
	SD	36.1	55.0	53.5	61.6		
INRIVER ABUNDANCE BY AGE							
Age		1.1	1.2	1.3	1.4	Total	
All fish	Point Estimate	1,216	260	2,084	955	4,515	
	SE	218	81	332	184	639	

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

Table 7.–Mean length (MEF) by sex and age of Chinook salmon sampled during recovery (event 2) surveys on the Chilkat River drainage by spawning tributary in 2006. Overall, event 2 was found to be size- and sex-selective so size and age composition of the sample are not representative of the population.

		Brood year and age class					
		2003	2002	2001	2000	Total	Total
		1.1	1.2	1.3	1.4	aged	sampled[a]
				Tahini River			
Males	Sample size	26	32	82	20	160	170
	Mean length	373	556	785	875		
	SD	33.9	65.7	72.5	78.7		
Females	Sample size	0	0	85	55	140	144
	Mean length			813	855		
	SD			39.2	48.2		
All Fish	Sample size	26	32	167	75	300	314
	Mean length	373	556	799	861		
	SD	33.9	65.7	59.4	58.0		
				Klehini River			
Males	Sample size	8	10	50	7	75	75
	Mean length	388	574	755	792		
	SD	22.5	41.2	69.7	65.1		
Females	Sample size	0	0	53	35	88	91
	Mean length			782	837		
	SD			44.0	55.5		
All Fish	Sample size	8	10	103	42	163	166
	Mean length	388	574	769	830		
	SD	22.5	41.2	59.1	57.5		
				Kelsall River			
Males	Sample size	11	16	92	21	140	148
	Mean length	390	561	801	884		
	SD	32.6	51.5	68.4	60.1		
Females	Sample size	0	0	117	63	180	184
	Mean length			801	852		
	SD			40.1	55.5		
All Fish	Sample size	11	16	209	84	320	332
	Mean length	390	561	801	860		
	SD	32.6	51.5	54.3	58.0		
				Combined spawning grounds			
Males	Sample size	45	58	224	48	375	393
	Mean length	380	560	785	867		
	SD	32.2	57.9	72.1	74.7		
Females	Sample size	0	0	255	153	408	419
	Mean length			801	850		
	SD			42.0	52.7		
All Fish	Sample size	45	58	479	201	783	812
	Percent	5.7	7.4	61.2	25.7		
	SE (%)	0.8	0.9	1.7	1.6		
	Mean length	380	560	794	854		

[a] Includes fish that were not assigned a valid age. Not all fish examined for marks were sampled for scales (e.g., carcass decayed, part of body missing, etc.).

Table 8.–Biweekly sampling statistics and estimated effort, catch, and harvest of Chinook salmon in the Haines marine sport fishery, May 8–June 25, 2006.

	May 8– May 21	May 22–June 4		June 5– June 18	June 19– June 25	Total
		Non-Derby	Derby			
Boats counted	66	65	84	105	16	336
Angler-hours sampled	431	374	1,575	1,218	293	3,891
Salmon-hours sampled	424	361	1,575	1,181	255	3,796
Chinook sampled	6	4	61	30	9	110
Sampled for adipose-clips	5	4	61	28	9	107
Adipose-clips	1	2	3	2	1	9
Angler-hours						
Estimate	886	1,127	3,237	2,335	588	8,172
SE	337	163	333	298	183	610
Salmon-hours						
Estimate	833	1,082	3,237	2,206	511	7,869
SE	290	155	333	256	164	558
Large Chinook catch						
Estimate	15	14	74	58	14	176
SE	7	5	6	10	5	15
Large Chinook kept						
Estimate	8	14	71	58	14	165
SE	2	5	6	10	5	13
Wild mature large Chinook kept (excluding hatchery and immature fish)						
Estimate	3	6	46	27	4	86
SE	0	3	4	7	3	9
Small Chinook catch						
Estimate	91	51	135	269	60	606
SE	78	12	55	69	18	120
Small Chinook kept						
Estimate	0	0	3	63	18	83
SE	0	0	2	19	15	25

Age and Length of Harvest

Creel technicians sampled a total of 106 Chinook salmon for age, sex, and length in the angler harvest; 100 were assigned an age (Table 9). The age composition (combined age-1.1 and -1.2 fish vs. age 1.3 and 1.4) of fish landed at the Small Boat Harbor was significantly different from that of fish landed at the Chilkat Inlet harbors (χ^2 = 53.8, df = 1, P < 0.001). The difference in age composition at the Small Boat Harbor is likely the result of anglers targeting hatchery produced Chinook salmon returning to the Skagway area. Thus, these samples were analyzed separately.

A total of 86 Chinook salmon were sampled for age, sex and length at the Chilkat Inlet harbors (Letnikof Dock and Chilkat State Park boat launch), and 83 of these were assigned an age (Table 9). Most (54.7%, SE = 5.4%) of the fish harvested were female. The predominant age class was age-1.3 (60.6%, SE = 6.1%).

Creel technicians sampled 20 Chinook salmon for age, sex and length at the Small Boat Harbor and 17 of these were assigned an age. Most (70.0%, SE = 10.5%) of the fish harvested were male. The predominant age class was age-1.2 (53.7%, SE = 1.6%).

Twenty-one (21) Chinook salmon from the Chilkat Inlet subsistence fishery were also sampled for age and length between June 17 and July 2, 2006. Subsistence fishers reported harvesting 86 Chinook salmon in this fishery in 2006. These fish were most commonly age-1.2 (66.7%, SE = 10.5%, Appendix C1).

Table 9.–Estimated age composition and mean length-at-age (snout to fork of tail in mm) of harvested Chinook salmon in the Haines marine sport fishery by harbor location, May 8–June 25, 2006.

		Brood year and age class						
		2003	2002	2001	2000	1999	Total	Total
		1.1	1.2	1.3	1.4	1.5	aged	sampled[a]
CHILKAT INLET HARBORS								
Males	Sample size	0	4	24	9	0	37	39
	Mean length		628	776	898			45.3%
	SD(length)		22	70	72			5.4%
Females	Sample size	0	4	26	16	0	46	47
	Mean length		651	800	868			54.7%
	SD(length)		45	66	48			5.4%
Combined	Sample size	0	8	50	25	0	83	86
	Harvest-weighted percent		11.4	60.6	28.0			
	SE(%)		4.4	6.1	5.5			
	Mean length		639	789	879			
	SD(length)		35	68	58			
SMALL BOAT HARBOR								
Males	Sample size	4	8	0	0	0	12	14
	Mean length	430	621					70.0%
	SD(length)	27	47					10.5%
Females	Sample size	2	1	2	0	0	5	6
	Mean length	435	560	790				30.0%
	SD(length)	7		21				10.5%
Combined	Sample size	6	9	2	0	0	17	20
	Harvest-weighted percent	41.4	53.7	4.8				
	SE(%)	1.5	1.6	0.3				
	Mean length	432	614	790				
	SD(length)	21	48	21				

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

Contribution of Coded Wire Tagged Stocks to the 2006 Haines Marine Sport Fishery

The 2006 Haines marine creel survey recovered coded wire tags from Chinook salmon released by two enhancement projects: fish incubated and reared by Douglas Island Pink and Chum, Inc. (DIPAC) at the Macaulay hatchery facility and released in Pullen Creek (Skagway), and fish produced by the National Marine Fisheries Service (NMFS) Little Port Walter facility (Table 10). In addition, wild Chilkat River Chinook salmon (brood year 2001) with CWTs were recovered in this fishery. Fish landed at the Small Boat Harbor were more likely to be from hatchery releases, so these samples were analyzed separately. Nine (9) of the 93 large and none of the one small (illegal) Chinook salmon sampled at the Chilkat Inlet harbors (Letnikof Dock and Chilkat State Park boat launch) were missing their adipose fins. Fourteen (14; SE = 7) of the estimated 131 large Chinook salmon landed at the Chilkat Inlet harbors were of hatchery origin (Table 10, Appendix B1 and B2). Two (2) of the seven large and one of the 14 small Chinook salmon sampled at the Small Boat Harbor (small fish were harvested in the Taiya Inlet terminal hatchery area) were missing their adipose fins. Twenty-five (25; SE = 20) of the estimated 34 large Chinook salmon harvested and 45 (SE = 45) of the estimated 81 small Chinook salmon harvested at the Small Boat Harbor were of hatchery origin (Table 10, Appendix B3).

JUVENILE TAGGING

The trapping crews captured 18,322 Chinook salmon fry during fall 2006 (Table 11). Trapping operations in the lower Chilkat River were scheduled for the first 10 days of November, later than in past years, but early freezing weather caused the suspension of the November effort. Catch rates were highest in the Kelsall

Table 10.–Contribution estimate (r) of coded wire tagged Chinook salmon to the Haines marine sport fishery, May 8–June 25, 2006, along with statistics used for computing estimates. Contribution estimates for wild Chilkat River fish are preliminary as marked fractions will not be estimated until returns from all brood years are complete.

Agency[a]	Release site	Tag code	Brood year	Marked fraction $\hat{\theta}$	Harvest N	Harvest SE[N]	Sample n	Ad-clip a	Head a'	Detect t	De-code t'	Tags m	Contribution r	Contribution SE
CHILKAT INLET RECOVERIES														
Large Fish														
ADF&G	Chilkat River	04-04-53, 04-05-53	2001	0.0714	131	11	52	6	6	6	6	3	106	61
DIPAC	Pullen Creek	04-03-94	2001	0.5235	131	11	52	6	6	6	6	3	14	7
Subtotal													120	61
SMALL BOAT HARBOR RECOVERIES														
Large Fish														
DIPAC	Pullen Cr	04-09-34	2002	0.2431	34	6	7	2	2	2	2	1	20	19
NMFS	Little Port Walter	03-62-53	2001	0.9821	34	6	7	2	2	2	2	1	5	4
Subtotal													25	20
Small Fish														
DIPAC	Pullen Creek	04-11-17	2003	0.1285	81	24	14	1	1	1	1	1	45	45
Total large													145	65
Total small													45	45

[a] ADF&G = Alaska Department of Fish and Game; DIPAC = Douglas Island Pink and Chum, Inc.; NMFS = National Marine Fisheries Service.

River and lowest in the mainstem of the Chilkat River. Of those captured, 18,318 were released with a valid CWT and adipose finclip (Table 12). In addition, we released 2,239 smolts during spring 2007 with valid CWTs and an adipose finclip (Table 12).

A total of 183 Chinook salmon fry were sampled for length during fall 2006 (Table 13). The mean length of fry was 74 mm FL (SD = 6.4 mm FL). In addition, 193 smolts were sampled for length and weight during the spring of 2007 (Table 13). Smolts averaged 79 mm FL (SD = 6.5 mm FL) and 5.3 g (SD = 1.4 g).

1999 Brood Year Juvenile Abundance

As stated previously, 30,104 Chinook salmon fry were released with valid CWTs in fall 2000, and 4,506 smolts were released in spring 2001. Both groups originated from the 1999 brood year. ADF&G personnel sampled 1,147 adult 1999 brood year Chinook salmon from Chilkat River escapements between 2002 and 2006, of which 129 were missing adipose fins (Table 14)[6]. From these fish, 91 heads were collected, and 89 (Appendix D1) of these resulted in successfully decoded CWTs (Table 14). Sixty-three of these were tagged in fall 2000 and 26 were tagged in spring 2001 (Table 15). Among 72 valid Chilkat CWTs collected in other locations, 50 were tagged in fall 2000 and 22 in spring 2001 (Table 15, by subtraction).

By fitting a statistical capture/recapture model that considered all these data simultaneously (Appendix E1) we estimate[7] that 386,400 (SE = 38,020) BY-1999 fry were rearing in the Chilkat River in fall 2000, that 36.4% (SE = 6.5% survived the winter, and that 139,500 (SE = 21,290) BY-1999 smolts emigrated from the Chilkat River in spring 2001.

[6] The marked fraction did not differ between the lower river fish wheel sample and the spawning ground recoveries ($\chi^2 = 0.85$, df = 1, P = 0.36).

[7] Point estimates reported in this paragraph are means of the Bayesian posterior distribution and standard errors are posterior standard deviations.

1999 Brood Year Adult Harvest

As stated previously, heads from 91 of the 129 brood year 1999 Chinook salmon with missing adipose fins in the Chilkat River escapement were collected and sent to the ADF&G Mark, Tag, and Age laboratory in Juneau for decoding. Eighty-nine (89) of the 91 had valid tags (Appendix D1, Table 14). The estimated tagged fraction θ_h germane to estimating harvest contributions was 0.0110 (SE = 0.0092). This estimate is based on the 129 fish with missing adipose fins, multiplied by the tag loss fraction (89/91) in the 1,147 Chinook salmon inspected for marks in the escapement.

Seventy-two (72) Chinook salmon with Chilkat River coded wire tags from the 1999 brood year were recovered through random sampling in marine commercial, sport, and subsistence fisheries between 2002 and 2006 (Appendix D1, Table 16). An estimated 1,814 (SE = 566) 1999 brood year Chilkat River Chinook salmon were harvested in sampled marine fisheries between 2002 and 2006 (Table 16). The largest harvest-at-age of 1999 brood year fish was 795 age-1.3 fish in 2004 (SE = 190), followed by 505 age-1.2 fish (SE = 373), in 2003. By fishery sector, the recreational fishery harvest comprised more than half (53.6%) of the total (Table 17). The single largest fishery (27.6%) was the Skagway-based recreational fishery in Taiya Inlet which took a combined total of 501 (SE = 203) age-1.1 and -1.2 fish.

1999 Brood Year Marine Exploitation and Marine Survival

Based upon a total inriver return of 4,765 (SE = 562) age-1.2 and older BY-1999 fish (Table 18) and a total marine harvest of 1,814 (SE = 566) fish (Table 16), the total age-1.2 and older BY-1999 return was 6,579 (SE = 798) fish, and the estimated marine survival rate was 4.7% (SE = 0.6%, Table 19). The marine exploitation rate of this stock was estimated at 27.6% (SE = 6.7%).

Data Files

Data collected during this study (Appendix F1) have been archived in ADF&G offices in Haines, Douglas, and Anchorage.

Table 11.–Results of juvenile Chinook salmon trapping in the Chilkat River drainage in fall 2006 and spring 2007.

Year	Trapping area	Dates	Days fished	Trap sets	No. caught	CPUE[a]
2006	Tahini River	09/18–09/22	5	417	2,833	6.8
2006	Kelsall River	09/30–10/14	15	964	15,208	15.8
2006	Chilkat River	11/02	1	75	281	3.7
Fall 2006 subtotal			21	1,456	18,322	12.6
2007	Chilkat River	04/13–05/31	49	4,399	2,241	0.5

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

Table 12.–Number of 2005 brood year juvenile Chinook salmon coded wire tagged in the Chilkat River drainage by area and tag year.

Tag year	Tag code	Sequence	Location	Last date	Stage	Tagged	24h Morts	Marked	Shed tags	Valid CWTs
2006	041398	265-5,330	Tahini River	09/22/06	Fingerling	2,833	1	2,832	0	2,832
2006	041398	5,583-32,308	Kelsall River	10/14/06	Fingerling	15,208	3	15,205	0	15,205
2006	041398	32,561-33,132	Chilkat River	11/02/06	Fingerling	281	0	281	0	281
Fall subtotal						18,322	4	18,318	0	18,318
2007	041398	33,179-37,769	Chilkat River	06/01/07	Smolt	2,241	2	2,239	0	2,239
2005 brood year total						20,563	6	20,557	0	20,557

Table 13.–Mean length and weight of 2005 brood year juvenile Chinook salmon in the Chilkat River drainage by trapping location and year.

			Length (snout to fork of tail in mm)			
Sample year	Trapping location	Sample dates	n	Range	Mean	SD
Fall 2006	Tahini River	09/19–09/22	28	63-82	72	5.6
Fall 2006	Kelsall River	10/01–10/14	152	61-94	74	6.1
Fall 2006	Chilkat River	11/02	3	59-96	74	19.3
Fall 2006 subtotal			183	59-96	74	6.4
Spring 2007	Chilkat River	04/15–06/01	193	59-99	79	6.5
			Weight (g)			
			n	Range	Mean	SD
Spring 2007	Chilkat River	04/15–06/01	193	2.1-10.0	5.3	1.4

DISCUSSION

Several assumptions, as noted above, underlie the estimate of 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 post-spawners. Although carcass surveys can be sex selective in some situations (Pahlke et al. 1996; McPherson et al. 1997; Zhou 2002; Miyakoshi et al. 2003), carcass retrievals comprised only 34% of the spawning ground samples. Use of a variety of capture methods (42% snagging, 12% gill net, 5% hands, 3% dip net, 3% spear) on the spawning grounds reduced the potential bias that may be inherent in any one method. The assumption of no recruitment during the experiment is reasonable because tagging effort was relatively constant and continued until only about one fish per day was being caught. The assumption that marking does not affect catchability of fish has been tested in the 2005

Table 14.–Number of 1999 brood year Chinook salmon sampled in the Chilkat River drainage for missing adipose fins and CWTs, by year and gear type or spawning drainage, 2002–2006.

Year	Gear/drainage	Sampled for adipose-clips	Fish with adipose-clips	Marked fraction	Heads collected	Valid CWTs	CWT loss
			LOWER RIVER RECOVERIES				
2002	Gillnet	0					
2002	Fish wheels	67	8	0.12	8	8	0.00
2003	Gillnet	26	2	0.08	2	2	0.00
2003	Fish wheels	57	9	0.16	9	8	0.11
2004	Gillnet	79	10	0.13	4	4	0.00
2004	Fish wheels	54	10	0.19	0		
2005	Gillnet	66	5	0.08	1	1	0.00
2005	Fish wheels	19	2	0.11	0		
2006	Gillnet	0					
2006	Fish wheels	0					
Lower river total		368	46	0.13	24	23	0.04
			SPAWNING GROUND RECOVERIES				
2002	Kelsall River	5	2	0.40	2	2	0.00
2002	Tahini River	5	0	0.00			
2002	Klehini River	5	0	0.00			
2003	Kelsall River	77	4	0.05	4	4	0.00
2003	Tahini River	55	5	0.09	5	5	0.00
2003	Klehini River	18	4	0.22	4	4	0.00
2004	Kelsall River	186	19	0.10	16	16	0.00
2004	Tahini River	137	16	0.12	13	13	0.00
2004	Klehini River	71	3	0.04	3	2	0.33
2005	Kelsall River	113	14	0.12	12	12	0.00
2005	Tahini River	83	13	0.16	8	8	0.00
2005	Klehini River	24	3	0.13	0		
2006	Kelsall River	0					
2006	Tahini River	0					
2006	Klehini River	0					
Spawning ground total		779	83	0.11	67	66	0.01
Total		1,147	129	0.11	91	89	0.02

radiotelemetry study where 2.3% or less of tagged fish failed to make significant upstream progress after tagging (Ericksen and Chapell 2006). The assumption (d) that marks were not lost was satisfied because all fish were given an ULOP as a secondary mark. Fish whose upper left operculum could not be examined were not included in the experiment. Personnel sampling the spawning tributaries carefully examined each fish for marks; therefore failure of assumption (e) was unlikely.

Tagging ratios of Chinook salmon found on the Tahini (0.044) and Kelsall (0.045) rivers and Big Boulder Creek (0.480) in 2006 were remarkably similar. The hypothesis that fish sampled on the different spawning grounds were marked at the same rate was not rejected. This is consistent with the results of a meta-analysis of past data (Ericksen 2001).

The 2006 immigration of 3,039 (SE = 454) large Chinook salmon was below the 1991–2005 average and was comprised mainly of age-1.3 fish from the 2001 brood year (Table 18).

The immigration timing of large Chinook salmon through the lower Chilkat River was later than in all previous years 1991–2005. By June 27, less than 10% of the large Chinook salmon had been captured, compared to the average of over 28% in previous years (Figure 4). The mean date of migratory timing, July 7 (Mundy 1984) was later than the mean date of July 3 for 1991–2005.migratory timing, July 7 (Mundy 1984) was later than the mean date of July 3 for 1991–2005.

Table 15.–Number of random recoveries of 1999 brood year Chilkat River Chinook salmon coded wire tagged in fall 2000 and spring 2001, by year, fishing district, and gear type, 2002–2006.

		Purse		Drift		Troll		Sport		Haines subsistence		Chilkat River escapement		Fall	Spring	Grand
Year	District	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	sub-total	sub-total	total
2002	112	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
2002	115	0	0	0	0	0	0	2	0	0	0	5	5	7	5	12
2002 subtotal		1	0	0	0	0	0	2	0	0	0	5	5	8	5	13
2003	Juneau	0	0	0	0	0	0	1	1	0	0	0	0	1	1	2
2003	111	0	0	0	0	1	0	2	0	0	0	0	0	3	0	3
2003	114	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
2003	115	0	0	0	1	0	0	7	1	1	1	16	7	24	10	34
2003 subtotal		1	0	0	1	1	0	10	2	1	1	16	7	29	11	40
2004	Juneau	0	0	0	0	0	0	2	0	0	0	0	0	2	0	2
2004	114	0	0	0	0	3	4	0	0	0	0	0	0	3	4	7
2004	115	0	0	11	4	0	0	6	4	4	1	27	8	48	17	65
2004	116	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
2004 subtotal		0	0	11	4	4	4	8	4	4	1	27	8	54	21	75
2005	114	0	0	0	0	1	1	0	0	0	0	0	0	1	1	2
2005	115	0	0	0	2	0	0	1	1	4	0	0	6	5	9	14
2005	181	0	0	0	0	0	0	0	1	0	0	15	0	15	1	16
2005 subtotal		0	0	0	2	1	1	1	2	4	0	15	6	21	11	32
2006	111	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
Grand total		2	0	11	7	6	5	22	8	9	2	63	26	113	48	161

Table 16.–Estimated contributions of 1999 brood year Chilkat River Chinook salmon to marine fishery harvests by year, fishery and area, 2002–2006.

	Fishery harvest									Contribution		
Fishery	Time SW, BW, TP or year	District, quadrant, or site	$\hat{H}$	SE[$\hat{H}$]	n	a	a'	t	t'	m	$\hat{r}$	SE[$\hat{r}$]
2002 recoveries age-1.1												
Purse seine	SW 30	112-16	99	[a]	99	10	10	8	8	1	9	9
Skagway sport	2002	115	410	85[b]	32	5	5	5	5	2	233	168
2002 subtotal											242	168
2003 recoveries age-1.2												
Purse seine	SW 30-32	114	60		27	3	3	2	2	1	20	20
Troll	TP 5	NE	2,130		1,367	158	158	137	137	1	14	14
Drift gillnet	SW 32	115	15		11	3	3	3	3	1	12	12
Juneau marine sport	BW 9	Juneau	498	18,679[c]	76	2	2	2	2	1	60	59
Juneau marine sport	BW 17	Juneau	628	3,973[c]	485	51	51	37	37	3	35	20
Skagway Sport	2003	115	1,211	128[d]	251	61	60	56	56	6	268	113
Haines marine sport	BW 10-13	115-32	1	1[e]	1	1	1	1	1	1	9[f]	9
Haines marine sport	BW 10-13	115-34	119	65[e]	17	4	4	4	4	1	64	63
Chilkat Inlet subsist.	2003	115-32	46		37	3	3	3	3	2	23	15
2003 subtotal											505	373
2004 recoveries age-1.3												
Troll	TP 2	NW	32,586		13,579	766	757	650	650	7	153	58
Troll	TP 3	NW	140,186		34,885	2,027	1,990	1,532	1,517	1	37	37
Drift gillnet	SW 27	115	150		89	10	10	9	9	5	77	34
Drift gillnet	SW 28	115	198		79	6	6	5	5	4	91	45
Drift gillnet	SW 29	115	149		91	10	10	9	9	6	89	36
Juneau marine sport	BW 17	Juneau	583	4,295[c]	411	41	41	35	35	2	26	18
Haines marine sport	BW 11-13	115-32	302	32	159	15	14	13	13	8	148	54
Haines marine sport	BW 11-13	115-34	101	31[g]	32	4	4	4	4	2	57	42
Chilkat Inlet subsist.	SW 25-27	115-32	146		57	9	9	9	9	5	116	52
2004 subtotal											795	190
2005 recoveries age-1.4												
Troll	TP 2	NW	26,483		11,781	699	666	573	573	2	41	28
Drift gillnet	SW 27	115	229		92	21	21	21	21	2	45	31
Yakutat marine sport	2005	NW	499	164[h]	254	11	11	8	8	1	18	17
Haines marine sport	BW 10-13	115-32	153	24[i]	105	6	6	6	6	2	26	18
Chilkat Inlet subsist.	SW 25-29	115-32	78		25	5	5	5	5	4	113[j]	56
2005 subtotal											244	75

-continued-

Table 16.–Page 2 of 2.

	Fishery harvest									Contribution		
Fishery	Time SW, BW, TP or year	District, quadrant, or site	$\hat{H}$	SE[$\hat{H}$]	n	a	a'	t	t'	m	$\hat{r}$	SE$[\hat{r}]$
2006 recoveries age-1.5												
Juneau marine sport	BW 7-19	Juneau	1,170	73,200[c]	1,332	147	139	127	127	1	28	334
Combined contribution $[\hat{T}]$											1,814	566

[a] Assumed $\hat{H} = n$. Port sampling data showed ($\hat{H} < n$). Jack Chinook salmon harvest tallies are often inaccurate in pink salmon seine fisheries (Cathy Robinson, ADF&G/CF Mark, Age and Tag Laboratory, Juneau, personal communication).

[b] Data from Statewide Harvest Survey 2002.

[c] Sampling and harvest data from M. Jaenicke, ADF&G Division of Sport Fish Northern Southeast Creel Survey project leader, personal communication.

[d] Data from Statewide Harvest Survey 2003.

[e] Data from Ericksen 2004.

[f] The BY-1999 contribution estimate shown here is greater than the Haines marine creel survey harvest estimate. The 2003 creel survey did not estimate an expanded harvest based on one illegally harvested Chinook salmon less than 28 inches encountered in Chilkat Inlet.

[g] Data from Ericksen 2005.

[h] Data from B. Johnson, ADF&G, personal communication, 2007.

[i] Data from Ericksen and Chapell 2006.

[j] The BY-1999 contribution estimate shown here is greater than the total reported catch in this fishery.

Table 17.–Total marine harvest and estimated 1999 brood year Chilkat River Chinook salmon harvest in selected fisheries, by fishery and area, 2002–2006.

Fishery	Area	Total fishery harvest	Chilkat harvest	SE	Chilkat percent of fishery	Percent of Chilkat total
Drift gillnet	District 115	741	315	75	42.5%	17.4%
	Subtotal	741	315	75	42.5%	17.4%
U.S. troll fishery	NW Quadrant	199,255	231	201	0.1%	12.7%
	NE Quadrant	2,130	14	14	0.7%	0.8%
	Subtotal	201,385	245	201	0.1%	13.5%
Seine fishery	District 112	99	9	9	9.2%	0.5%
	District 114	60	20	20	33.7%	1.1%
	Subtotal	159	29	21	18.4%	1.6%
Recreational	Skagway marine	1,621	501	203	30.9%	27.6%
	Juneau marine	6,235	149	376	2.4%	8.2%
	Haines marine	676	305	96	45.1%	16.8%
	Yakutat marine	499	18	17	3.6%	1.0%
	Subtotal	9,031	972	438	10.8%	53.6%
Subsistence	Chilkat Inlet	270	252	123	93.5%	13.9%
	Subtotal	270	252	123	93.5%	13.9%
Grand total		211,586	1,814	566	0.9%	100.0%

Sport fishing harvest patterns observed during 2006 were similar to recent years. During 2006, 75% of the estimated harvest of Chinook salmon was landed at the Letnikof Dock. In comparison, 70% of the average total harvest in 2001–2005 was landed at this harbor. Estimates of sport fishing effort, harvest of large Chinook salmon, and CPUE were all below recent 5-year averages (Figure 6, Table 20).

Each fall since 2000 (brood years 1999–2005), an average of 30,217 Chinook salmon fry have been marked with CWTs. Assuming the fall 1999 to spring 2001 overwinter survival rate has been constant for following years, the fall effort has contributed an average of 10,999 marked Chinook salmon juveniles, more than double the average number of smolts (4,406) marked each spring from 2001 to 2007.

Because of the fall 2000 tagging effort, the 1999 brood year estimates of fry abundance and adult harvest were much more precise and the harvest of these fish was documented in many more fisheries than for brood year 1998. In addition we obtained an estimate of overwinter survival for the first time. The fall tagging effort should be continued because high-resolution stock assessment of Chilkat River Chinook salmon will become a higher priority with planned increases in the number of hatchery-raised Chinook salmon smolts released in northern Lynn Canal (ADF&G 2008).

The estimated marine exploitation rate (Table 19, 27.6%, SE = 6.7%) was close to the estimate for brood year 1998, (22.4%, Ericksen and Chapell 2006), but higher than the historical estimates used to set the biological escapement goal for Chilkat River Chinook salmon (range 8-19%, Ericksen and McPherson 2004).

The 1999 brood year smolt to adult marine survival estimate (Table 19, 4.7%, SE = 0.06%) is higher than the Chilkat River 1998 brood year survival estimate (3.7%, Ericksen and Chapell 2006), and less than the 1999 brood year preliminary estimate for the Taku River (5.7%, Ed Jones, Alaska Department of Fish and Game, Douglas, personal communication), which is the closest Chinook salmon stock available for comparison. The difference in survival rates between Chilkat River and Taku River stocks may be due to different marine rearing strategies; Taku

Table 18.–Estimated annual inriver abundance by age of medium and large (≥ age-1.2) immigrating Chilkat River Chinook salmon and total annual escapement estimates, 1991–2006, and estimated marine harvest and total return by age class of fish from coded wire tagged brood years 1988, 1989, 1991, 1998, and 1999.

Return year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver abundance total	(SE)	Inriver subsistence harvest[a]	Escapement
1991[b]	Inriver return	817	(139)	3,211	(558)	2,563	(445)	123	(18)	6,714	(727)	24	6,690
	Marine harvest												
	Total return												
1992[c]	Inriver return	560	(100)	1,689	(304)	3,595	(649)	0	(0)	5,844	(723)	11	5,833
	Marine harvest[d]	459	(163)										
	Total return	1,019	(191)										
1993[e]	Inriver return	551	(104)	2,217	(424)	2,005	(384)	120	(22)	4,894	(582)	14	4,880
	Marine harvest[f]	149	(51)	578	(208)								
	Total return	700	(116)	2,795	(472)								
1994[g]	Inriver return	184	(28)	2,565	(405)	4,148	(657)	82	(10)	6,979	(773)	3	6,976
	Marine harvest			402	(122)	607	(302)						
	Total return			2,967	(423)	4,755	(723)						
1995[h]	Inriver return	1,384	(295)	530	(111)	3,074	(660)	186	(37)	5,174	(733)	20	5,154
	Marine harvest[i]	278	(129)			147	(74)	3	(1)				
	Total return	1,662	(322)			3,221	(664)	189	(37)				
1996[j]	Inriver return	398	(60)	4,140	(639)	737	(112)	43	(5)	5,318	(652)	17	5,301
	Marine harvest			425	(129)			0	0				
	Total return			4,565	(652)			43	(5)				
1997[k]	Inriver return	160	(48)	1,943	(354)	6,157	(930)	0	0	8,260	(997)	9	8,251
	Marine harvest					246	(104)						
	Total return					6,403	(936)						

-continued-

Table 18.–Page 2 of 3.

Return year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver abundance total	(SE)	Inriver subsistence harvest[a]	Escapement
1998[l]	Inriver return	226	(54)	1,016	(169)	2,440	(381)	219	(48)	3,901	(423)	30	3,871
	Marine harvest							1	0				
	Total return							220	(48)				
1999[m]	Inriver return	427	(94)	534	(109)	1,656	(302)	80	(27)	2,698	(336)	20	2,678
	Marine harvest												
	Total return												
2000[n]	Inriver return	629	(122)	1,350	(227)	653	(118)	32	(14)	2,664	(283)	14	2,650
	Marine harvest												
	Total return												
2001[o]	Inriver return	755	(209)	2,529	(376)	1,988	(617)	0		5,272	(752)	5	5,267
	Marine harvest												
	Total return												
2002[p]	Inriver return	373	(123)	2,353	(312)	1,667	(294)	30	(19)	4,423	(446)	21	4,402
	Marine harvest[q]	0											
	Total return	373	(123)										
2003[r]	Inriver return	1,267	(293)	1,833	(362)	3,783	(582)	41	(29)	6,924	(746)	54	6,870
	Marine harvest[s]	505	(373)	688	(687)								
	Total return	1,772	(474)	2,521	(777)								
2004[t]	Inriver return	1,361	(492)	1,999	(333)	1,379	(303)	44	(17)	4,783	(667)	26	4,757
	Marine harvest			795	(190)	352	(249)						
	Total return			2,794	(383)	1,731	(392)						
2005[u]	Inriver return	1,597	(620)	1,857	(433)	1,498	(345)	11	(8)	4,963	(831)	8	4,955
	Marine harvest					244	(75)	0					
	Total return					1,742	(353)	11	(8)				

-continued-

Table 18.–Page 3 of 3.

Return year		1.2	(SE)	1.3	(SE)	1.4	(SE)	1.5	(SE)	Inriver abundance total	(SE)	Inriver subsistence harvest[a]	Escapement
2006	Inriver return	260	(81)	2,084	(333)	955	(185)	0		3,299	(488)	40	3,259
	Marine harvest							28	(334)				
	Total return							28	(334)				

[a] Subsistence permit harvest reports from CF ALEXANDER database.

[b] Inriver abundance data from Johnson et al. (1992).

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

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

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

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

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

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

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

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

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

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

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

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

[o] Inriver abundance data from Ericksen (2002a).

[p] Inriver abundance data from Ericksen (2003).

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

[r] Inriver abundance data from Ericksen (2004).

[s] Brood year 1999 marine harvest data from this report.

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

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

Table 19.–Estimated stock assessment parameters for 1999 brood year Chilkat River Chinook salmon.

Parameter	Estimate	SE
2000 fall fry abundance	386,400	38,020[a]
2000–2001 overwinter survival	0.364	0.065
2001 smolt emigration	139,500	21,290[a]
Marine harvest	1,814	566
Escapement (age-1.2 and older)	4,765	562
Return (age-1.2 and older)	6,579	798
Marine exploitation rate	0.276	0.067
Smolt to adult (marine) survival	0.047	0.006

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

River Chinook salmon rear in outer coastal waters while Chilkat River fish rear primarily in inside waters of northern Southeast Alaska.

The large harvest of age-1.1 and -1.2 Chilkat River Chinook salmon by Skagway-based recreational anglers is the result of liberal bag limits that were implemented in Taiya Inlet (3 Chinook salmon per day of any size, exempt from non-resident annual limit) to facilitate the exploitation of the return of Chinook salmon that had been raised at Macaulay Hatchery and released as smolts in Pullen Creek (Figure 1). Because the Chilkat River Chinook salmon escapement goal was not met in 2007, it may be necessary to reduce harvest of this stock in future years (Chapell *In prep*). The harvest of Chilkat River Chinook salmon in the Skagway recreational fishery can be closely monitored in season through recovery of CWTs by the Skagway creel survey. If Chilkat fish are being harvested at a high rate, then the bag limit in Taiya Inlet should be modified.

Marine harvest and total return data by age class from coded wire tagging studies of Chilkat Chinook salmon brood years 1988, 1999, 1991, 1998, and 1999 are shown in Table 18 to facilitate future brood year analysis of the escapement goal range.

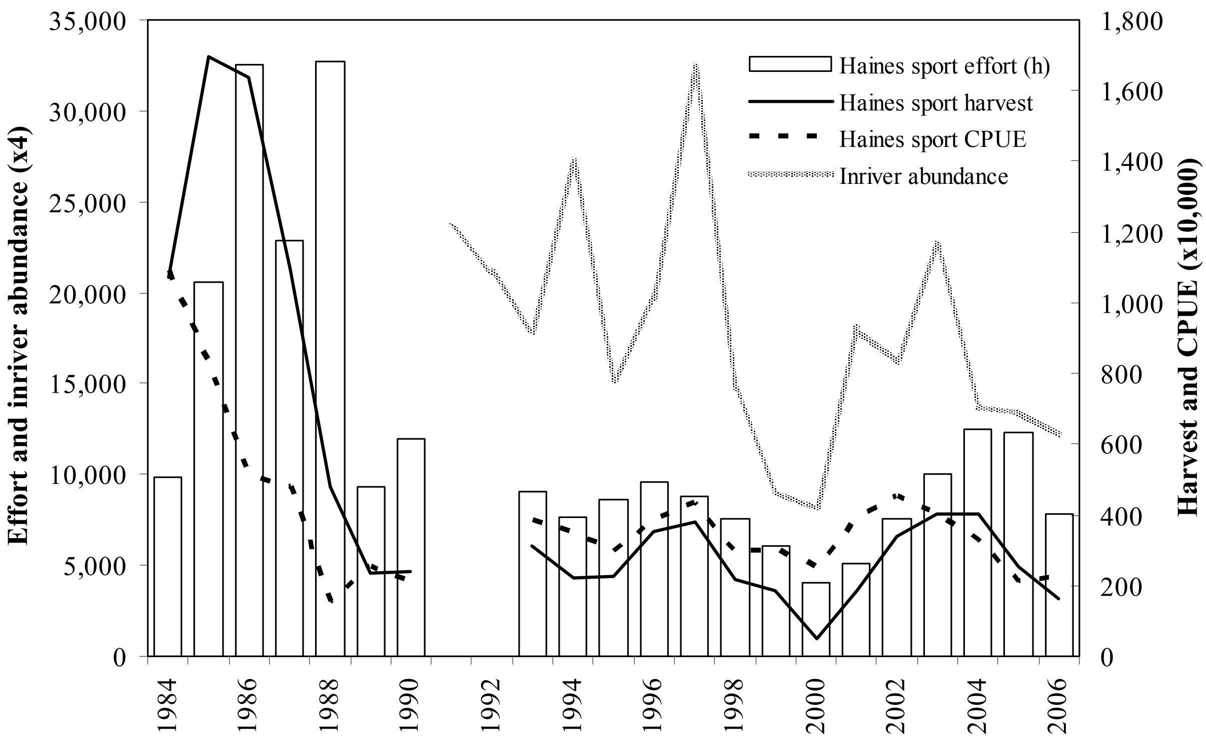


Figure 6.–Estimated angler effort, harvest, and CPUE of large Chinook salmon in the Haines spring marine boat sport fishery, 1984–2006, and estimated inriver abundance of large Chinook salmon in the Chilkat River, 1991–2006. Data taken from Tables 18 and 20 (fishery closed in 1991 and 1992).

Table 20.–Estimated angler effort, and large (≥28 inch) Chinook salmon catch and harvest in the Haines marine sport fishery for similar sample periods, 1984–2006.

		Effort				Large (≥28") fish				
Year	Survey dates	Angler-hs	SE	Salmon-hs	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]	4/11–7/10	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
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	5/08–6/25	8,172	610	7,869	558	176	15	165	13	0.022
1984–1986 average		21,903		20,990		1,479		1,469		0.081
1987–1990 average		24,456		19,227		521		513		0.027
1993–2005 average		9,121		8,379		288		271		0.035
2002–2005 average		9,824		9,507		324		316		0.036

[a] Catch of large Chinook salmon per salmon h of effort.
[b] From Neimark (1985).
[c] Estimates of variance were not provided until 1987.
[d] From Mecum and Suchanek (1986).
[e] From Mecum and Suchanek (1987).
[f] From Bingham et al. (1988).
[g] From Suchanek and Bingham (1989).
[h] From Suchanek and Bingham (1990).
[i] From Suchanek and Bingham (1991), no estimate of the total angler effort and harvest was provided.
[j] From Ericksen (1994).
[k] From Ericksen (1995).
[l] From Ericksen (1996).
[m] From Ericksen (1997).
[n] From Ericksen (1998).
[o] From Ericksen (1999).
[p] From Ericksen (2000).
[q] From Ericksen (2001).
[r] From Ericksen (2002a).
[s] From Ericksen (2003).
[t] From Ericksen (2004).
[u] From Ericksen (2005).
[v] From Ericksen and Chapell (2006).

ACKNOWLEDGMENTS

I would like to thank the creel survey staff of Jane Pascoe, Rebecca Wilson, and Aaron Thomas for their invaluable data collection efforts. Mark Eisenman and Will Prisciandaro oversaw the capture and tagging of Chinook salmon at the fish wheels. Larry Derby, Renee Hebert, Dana Van Burgh III, Ted Lambert, Mark Brouwer, Jarbo Crete, Becky Wilson, Jane Pascoe, and Randy Ericksen worked in the field to capture, mark, and sample fish to complete this project. The Chilkat Indian Village and family of Victor Hotch allowed us to use their land for juvenile tagging operations. Jim Moran of Chilkoot Fish and Caviar Co. and Daymond Hoffman of Dejon Delights donated salmon roe for use as trapping bait. Sue Millard, Division of Sport Fish, 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-finclipped Chinook salmon to remove and read coded wire tags. Margie Nussbaum of the Research and Technical Services (RTS) Unit, Division of Sport Fish, opscanned forms. Steve Fleischman with Research and Technical Services in Anchorage provided biometric support in the study design and data analysis. John Der Hovanisian and Steve Fleischman provided critical review of this report. Judy Shuler performed final layout of this report for publication.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 2008. Statewide stocking plan for recreational fisheries 2008-2012, January 2008 update. Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, Anchorage.

ADF&G (Alaska Department of Fish and Game). *Unpublished*. Coded wire tag sampling program detailed sampling instructions, commercial fisheries sampling., Located at Alaska Department of Fish and Game, Division of Commercial Fisheries, 802 3rd Street, Douglas, Alaska.

Bernard, D. R., and J. E. Clark. 1996. Estimating salmon harvest based on return of coded-wire tags. Canadian Journal of Fisheries and Aquatic Sciences 53:2323-2332.

Bethers, M. 1986. Annual sport fish management report for northern Southeast Alaska. Unpublished report. Alaska Department of Fish and Game, Sport Fish Division, Juneau.

Bingham, A. E., P. N. Suchanek, S. Sonnichsen, and R. D. Mecum. 1988. Harvest estimates for selected sport fisheries in southeast Alaska in 1987. Alaska Department of Fish and Game, Fishery Data Series No. 72, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-072.pdf

Bugliosi, E. F. 1988. Hydrologic reconnaissance of the Chilkat River Basin, Southeast Alaska. U. S. Geological Survey Water Resources Investigation Report 88-4021, Anchorage, Alaska.

Chapell, R. S. *In prep*. Production, escapement, and juvenile tagging of Chilkat River Chinook salmon in 2007. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Cochran, W. G. 1977. Sampling techniques, 3rd edition. John Wiley and Sons, New York.

Conover, W. J. 1980. Practical nonparametric statistics, 2nd edition. John Wiley and Sons, New York.

Ericksen, R. P. 1994. Effort, catch, and harvest of Chinook salmon in the spring marine boat sport fishery near Haines, Alaska, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-30, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-30.pdf

Ericksen, R. P. 1995. Sport fishing effort, catch, and harvest and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska, in 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-42, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds95-42.pdf

Ericksen, R. P. 1996. Sport fishing effort, catch, and harvest, fishery contributions, and inriver abundance of Chilkat River Chinook salmon, in 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-48, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-48.pdf

Ericksen, R. P. 1997. Sport fishing effort, catch, and harvest and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska, in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-27, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-27.pdf

REFERENCES CITED, (Continued)

Ericksen, R. P. 1998. Sport fishing effort, catch, and harvest and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska, in 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-31, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-31.pdf

Ericksen, R. P. 1999. Sport fishing effort, catch, and harvest, fishery contributions, and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska, in 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-19, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-19.pdf

Ericksen, R. P. 2000. Sport fishing effort, catch, and harvest, and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska in 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-28, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-28.pdf

Ericksen, R. P. 2001. Sport fishing effort, catch, and harvest, and inriver abundance of Chilkat River Chinook salmon near Haines, Alaska in 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-12, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-12.pdf

Ericksen, R. P. 2002a. Escapement, terminal harvest, and fall fry tagging of Chilkat River Chinook salmon in 2001. Alaska Department of Fish and Game, Fishery Data Series No. 02-23, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds02-23.pdf

Ericksen, R. P. 2002b. Smolt production and harvest of coho salmon from the Chilkat River, 2000-2001. Alaska Department of Fish and Game, Fishery Data Series 02-18, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds02-18.pdf

Ericksen, R. P. 2003. Escapement, terminal harvest, and fall fry tagging of Chilkat River Chinook salmon in 2002. Alaska Department of Fish and Game, Fishery Data Series No. 03-26, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-26.pdf

Ericksen, R. P. 2004. Escapement, terminal harvest, and fall fry tagging of Chilkat River Chinook salmon in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-20, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-20.pdf

Ericksen, R. P. 2005. Escapement, terminal harvest, and juvenile tagging of Chilkat River Chinook salmon in 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-68, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-68.pdf

Ericksen, R. P. 2006. Production and escapement of coho salmon from the Chilkat River, 2004-2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-77, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-77.pdf

Ericksen, R. P., and R. S. Chapell. 2006. Production and spawning distribution of Chilkat River Chinook salmon in 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-76, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-76.pdf

Ericksen, R. P., and S. A. McPherson. 2004. Optimal production of Chinook salmon from the Chilkat River. Alaska Department of Fish and Game, Fishery Manuscript No. 04-01, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms04-01.pdf

Gilks, W. R., A. Thomas, and D. J. Spiegelhalter. 1994. A language and program for complex Bayesian modeling. The Statistician 43:169-178. http://www.mrc-bsu.cam.ac.uk/bugs Accessed 01/2010.

Hubartt, D. J., A. E. Bingham, and P. M. Suchanek. 1997. Harvest estimates for selected marine sport fisheries in Southeast Alaska during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-16, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-16.pdf

Johnson, R. E. 1994. Chilkat River Chinook salmon studies, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-46, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds94-46.pdf

Johnson, R. E., R. P. Marshall, and S. T. Elliott. 1992. Chilkat River Chinook salmon studies, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-49, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-49.pdf

Johnson, R. E., R. P. Marshall, and S. T. Elliott. 1993. Chilkat River Chinook salmon studies, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-50, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds93-50.pdf

Kissner, P. D. 1982. Status of important native Chinook salmon stocks in Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (AFS 41-10), Juneau.

Koerner, J. F. 1977. The use of coded wire tag injector under remote field conditions. Alaska Department of fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 172, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/afrbil.172.pdf

McPherson, S., D. Bernard, J. H. Clark, K. Pahlke, E. Jones, J. Der Hovanisian, J. Weller, and R. Ericksen. 2003. Stock status and escapement goals for Chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 03-01, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp03-01.pdf

McPherson, S. A., D. R. Bernard, M. S. Kelley, P. A. Milligan, and P. Timpany. 1997. Spawning abundance of Chinook salmon in the Taku River in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-14.pdf

Mecum, R. D., and P. M. Suchanek. 1986. Harvest estimates of selected Southeast Alaska sport fisheries. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (S-1-1), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-10-1(27)S-1-1.pdf

Mecum, R. D., and P. M. Suchanek. 1987. Harvest estimates for selected sport fisheries in southeast Alaska in 1986. Alaska Department of Fish and Game, Fishery Data Series No. 21, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-021.pdf

Miyakoshi, Y., T. Takami, K. Takeuchi, H. Omori, M. Nagata, and J. R. Irvine. 2003. Sampling of masu salmon on the spawning grounds: is carcass sampling effective as a mark-recovery method? Fisheries Management and Ecology. 10:273-275.

Mood, A. M., F. A. Graybill, and D. C. Boes. 1974. Introduction to the theory of statistics, 3rd edition. McGraw-Hill Book Co., New York.

Mundy, P. R. 1984. Migratory timing of salmon in Alaska with an annotated bibliography on migratory behavior of relevance to fisheries research. Alaska Department of Fish and Game, Informational Leaflet No. 234, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/afrbil.234.pdf

Neimark, L. M. 1985. Harvest estimate of selected fisheries throughout Southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (AFS-41-12[B]), Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/FREDf-9-17(26)AFS-41-12B.pdf

Olsen, M. A. 1992. Abundance, age, sex, and size of Chinook salmon catches and escapements in Southeast Alaska in 1987. Alaska Department of Fish and Game, Technical Data Report No. 92-07, Juneau.

Pahlke, K. A. 1991. Migratory patterns and fishery contributions of Chilkat River Chinook salmon, 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-55, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-55.pdf

Pahlke, K. A. 1992. Escapements of Chinook salmon in Southeast Alaska and transboundary rivers in 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds92-32.pdf

Pahlke, K. A., S. A. McPherson, and R. P. Marshall. 1996. Chinook salmon research on the Unuk River, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 96-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-14.pdf

REFERENCES CITED, (Continued)

Pahlke, K. A., R. D. Mecum, and R. P. Marshall. 1990. Migratory patterns and fishery contributions of Chilkat River Chinook salmon. Alaska Department of Fish and Game, Fishery Data Series No. 90-50, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-50.pdf

Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, 2nd edition. Griffin and Company, Ltd. London.

Stokes, J. 1991. Southeast Alaska sport fishing economic study. Final Research Report. December 1991. (JSA 88-028.) Sacramento, California. Prepared for Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, Anchorage.

Suchanek, P. M., and A. E. Bingham. 1989. Harvest estimates for selected sport fisheries in southeast Alaska in 1988. Alaska Department of Fish and Game, Fishery Data Series No. 114, Juneau. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-114.pdf

Suchanek, P. M., and A. E. Bingham. 1990. Harvest estimates for selected marine boat sport fisheries in southeast Alaska in 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-51, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds90-51.pdf

Suchanek, P. M., and A. E. Bingham. 1991. Harvest estimates for selected marine boat sport fisheries in Southeast Alaska during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-48, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds91-48.pdf

Zhou, S. 2002. Size-dependent recovery of Chinook salmon in carcass surveys. Transactions of the American Fisheries Society 131:1194-1202.

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:

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

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

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

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

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

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

APPENDIX B

Appendix B1.–Biweekly sampling statistics and estimated effort, catch, and harvest of Chinook salmon at the Letnikof boat launch, May 8–June 25, 2006.

	May 8–May 21	May 22–June 4 Non-Derby	May 22–June 4 Derby	June 5–June 18	June 19–June 25	Total
Boats counted	56	47	72	90	4	269
Angler-hours sampled	350	297	1,511	1,052	30	3,240
Salmon-hours sampled	350	288	1,511	1,027	30	3,206
Chinook sampled	6	3	60	18	0	87
Sampled for adipose-clips	5	3	60	17	0	85
Adipose-clips	1	1	3	1	0	6
Angler-hours						
Estimate	446	809	2,918	1,411	105	5,688
SE	66	157	329	38	10	400
Salmon-hours						
Estimate	446	782	2,918	1,366	105	5,616
SE	66	149	54	37	10	395
Large Chinook catch						
Estimate	8	9	73	37	0	128
SE	2	3	6	7	0	10
Large Chinook kept						
Estimate	8	9	70	37	0	124
SE	2	12	3	7	0	10
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	3	6	45	27	0	81
SE	0	3	4	7	0	9
Small Chinook catch						
Estimate	7	24	135	151	0	317
SE	0	11	55	23	0	60
Small Chinook kept						
Estimate	0	0	3	0	0	3
SE	0	0	2	0	0	2

Appendix B2.–Biweekly sampling statistics and estimated effort, catch, and harvest of Chinook salmon at the Chilkat State Park boat launch, May 15–June 25, 2006.

		May 22–June 4				
	May 15–May 21	Non-Derby	Derby	June 5–June 18	June 19–June 25	Total
Boats counted	0	3	0	3	2	8
Angler-hours sampled	0	13	0	14	12	39
Salmon-hours sampled	0	13	0	14	8	35
Chinook sampled	0	0	0	1	0	1
Sampled for adipose-clips	0	0	0	1	0	1
Adipose-clips	0	0	0	0	0	0
Angler-hours						
Estimate	0	59	0	98	84	241
SE	0	27	0	91	26	98
Salmon-hours						
Estimate	0	59	0	98	56	213
SE	0	27	0	91	52	108
Large Chinook catch						
Estimate	0	0	0	7	0	7
SE	0	0	0	6	0	6
Large Chinook kept						
Estimate	0	0	0	7	0	7
SE	0	0	0	6	0	6
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0
Small Chinook catch						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0
Small Chinook kept						
Estimate	0	0	0	0	0	0
SE	0	0	0	0	0	0

Appendix B3.–Biweekly sampling statistics and estimated effort, catch, and harvest of Chinook salmon at the Small Boat Harbor, May 8–June 25, 2006.

	May 8–May 21	May 22–June 04		June 5–June 18	June 19–June 25	Total
		Non-derby	Derby			
Boats counted	10	15	12	12	10	59
Angler-hours sampled	81	64	64	152	251	612
Salmon-hours sampled	74	60	64	140	217	555
Chinook sampled	0	1	1	11	9	22
Sampled for adipose-clips	0	1	1	10	9	21
Adipose-clips	0	1	0	1	1	3
Angler-hours						
Estimate	441	259	319	826	399	2,243
SE	331	41	50	247	169	451
Salmon-hours						
Estimate	389	241	319	742	350	2,040
SE	282	32	50	64	141	378
Large Chinook catch						
Estimate	7	5	1	14	14	41
SE	6	4	0	5	5	9
Large Chinook kept						
Estimate	0	5	1	14	14	34
SE	0	4	0	5	5	6
Wild mature Chinook kept (excluding hatchery and immature fish)						
Estimate	0	0	1	0	4	5
SE	0	0	0	0	3	3
Small Chinook catch						
Estimate	84	28	0	119	60	291
SE	78	6	0	65	18	103
Small Chinook kept						
Estimate	0	0	0	63	18	81
SE	0	0	0	19	15	24

APPENDIX C

Appendix C1.–Estimated age composition and mean length-at-age (snout to fork of tail in mm) of harvested Chinook salmon in the Chilkat Inlet subsistence gillnet fishery, June 17–July 2, 2006.

		Brood year and age class					
		2001	2000	1999	1998		
		1.1	1.2	1.3	1.4	Total aged	Total sampled
Males	Sample size	0	2	9	1	12	12
	Percent		16.7	75.0	8.3		57.1
	SE		11.2	13.1	8.3		11.1
	Mean length		635	779	840		
	SE		14.9	21.1			
Females	Sample size	0	0	5	4	9	9
	Percent			55.6	44.4		42.9
	SE			17.6	17.6		11.1
	Mean length			816	816		
	SE			15.3	24.9		
Combined	Sample size	0	2	14	5	21	21
	Percent		9.5	66.7	23.8		
	SE		6.6	10.5	9.5		
	Mean length		635	792	821		
	SE		11.1	14.0	13.8		

APPENDIX D

Appendix D1.–Brood year 1999 Chilkat Chinook salmon coded wire tags recovered from random sampling efforts, 2002–2006.

Year	Head	Tag Code	Gear or project	Sampling port or site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2002	189448	40167	Escape	Chilkat River	6/30/2002	27	NE	115	32	380
2002	189476	40167	Escape	Chilkat River	7/8/2002	28	NE	115	32	390
2002	189477	40167	Escape	Chilkat River	7/14/2002	29	NE	115	32	305
2002	189478	40167	Escape	Chilkat River	7/17/2002	29	NE	115	32	370
2002	189450	40365	Escape	Chilkat River	7/5/2002	27	NE	115	32	380
2002	189451	40366	Escape	Chilkat River	7/7/2002	28	NE	115	32	340
2002	189479	40366	Escape	Chilkat River	7/20/2002	29	NE	115	32	430
2002	189449	40364	Escape	Chilkat River	6/30/2002	27	NE	115	32	385
2002	149914	40167	Escape	Chilkat River	8/20/2002	34	NE	115	32	380
2002	149915	40366	Escape	Chilkat River	8/27/2002	35	NE	115	32	435
2002	506048	40364	Seine	Petersburg	7/23/2002	30	NE	112	16	422
2002	189461	40166	Sport	Skagway	8/22/2002	34	NE	115	34	470
2002	189460	40366	Sport	Skagway	8/22/2002	34	NE	115	34	450
2003	519513	40167	Drift	Excursion Inlet	8/7/2003	32	NE	115		668
2003	231980	40167	Escape	Chilkat River	6/22/2003	26	NE	115	32	525
2003	055912	40166	Escape	Chilkat River	7/5/2003	27	NE	115	32	555
2003	055903	40166	Escape	Chilkat River	7/22/2003	30	NE	115	32	705
2003	231981	40366	Escape	Chilkat River	6/23/2003	26	NE	115	32	540
2003	231983	40366	Escape	Chilkat River	6/25/2003	26	NE	115	32	500
2003	055917	40366	Escape	Chilkat River	7/16/2003	29	NE	115	32	570
2003	231982	40364	Escape	Chilkat River	6/23/2003	26	NE	115	32	620
2003	231988	40364	Escape	Chilkat River	6/27/2003	26	NE	115	32	620
2003	055911	40364	Escape	Chilkat River	7/4/2003	27	NE	115	32	620
2003	055902	40364	Escape	Chilkat River	7/15/2003	29	NE	115	32	600
2003	055997	40167	Escape	Chilkat River	8/14/2003	33	NE	115	32	540
2003	055996	40167	Escape	Chilkat River	8/14/2003	33	NE	115	32	610
2003	222736	40365	Escape	Chilkat River	8/19/2003	34	NE	115	32	620
2003	222740	40167	Escape	Chilkat River	8/25/2003	35	NE	115	32	565
2003	055905	40167	Escape	Chilkat River	8/13/2003	33	NE	115	32	520
2003	055904	40365	Escape	Chilkat River	8/11/2003	33	NE	115	32	540
2003	055906	40365	Escape	Chilkat River	8/24/2003	35	NE	115	32	520
2003	055907	40366	Escape	Chilkat River	8/18/2003	34	NE	115	32	530
2003	055971	40167	Escape	Chilkat River	8/8/2003	32	NE	115	32	595
2003	055976	40167	Escape	Chilkat River	8/29/2003	35	NE	115	32	660
2003	055974	40166	Escape	Chilkat River	8/18/2003	34	NE	115	32	640
2003	222738	40366	Escape	Chilkat River	8/21/2003	34	NE	115	32	640
2003	055973	40364	Escape	Chilkat River	8/12/2003	33	NE	115	32	615
2003	519059	40365	Purse	Excursion Inlet	7/31/2003	31	NW	114	27	629
2003	189499	40366	Sport	Haines	6/8/2003	24	NE	115	32	660
2003	231963	40364	Sport	Haines	6/22/2003	26	NE	115	34	670
2003	234922	40167	Sport	Juneau	8/25/2003	35	NE	JNU		630
2003	193924	40166	Sport	Juneau	5/11/2003	20	NE	111	50	720
2003	234716	40166	Sport	Juneau	8/30/2003	35	NE	111	40	690
2003	253734	40366	Sport	Juneau	8/23/2003	34	NE	JNU		760
2003	222705	40167	Sport	Skagway	8/22/2003	34	NE	115	34	730
2003	231996	40365	Sport	Skagway	8/5/2003	32	NE	115	34	675
2003	055948	40166	Sport	Skagway	7/30/2003	31	NE	115	34	590
2003	055931	40366	Sport	Skagway	7/16/2003	29	NE	115	34	730

-continued-

Year	Head	Tag Code	Gear or project	Sampling port or site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2003	055949	40366	Sport	Skagway	7/30/2003	31	NE	115	34	640
2003	055939	40364	Sport	Skagway	7/23/2003	30	NE	115	34	680
2003	231957	40167	Subsist	Haines	6/24/2003	26	NE	115	32	555
2003	231958	40366	Subsist	Haines	6/24/2003	26	NE	115	32	590
2003	207965	40364	Troll	Juneau	10/24/2003	43	NE	111	14	775
2004	538015	40167	Drift	Excursion Inlet	6/30/2004	27	NE	115		702
2004	538016	40167	Drift	Excursion Inlet	6/30/2004	27	NE	115		894
2004	538110	40167	Drift	Excursion Inlet	7/7/2004	28	NE	115		880
2004	538220	40167	Drift	Excursion Inlet	7/15/2004	29	NE	115		815
2004	538013	40365	Drift	Excursion Inlet	6/30/2004	27	NE	115		832
2004	538014	40365	Drift	Excursion Inlet	6/30/2004	27	NE	115		945
2004	538108	40365	Drift	Excursion Inlet	7/7/2004	28	NE	115		855
2004	538158	40365	Drift	Excursion Inlet	7/12/2004	29	NE	115		832
2004	538218	40365	Drift	Excursion Inlet	7/15/2004	29	NE	115		870
2004	538012	40166	Drift	Excursion Inlet	6/30/2004	27	NE	115		867
2004	538107	40366	Drift	Excursion Inlet	7/7/2004	28	NE	115		862
2004	538111	40366	Drift	Excursion Inlet	7/7/2004	28	NE	115		900
2004	538160	40366	Drift	Excursion Inlet	7/12/2004	29	NE	115		935
2004	538157	40364	Drift	Excursion Inlet	7/12/2004	29	NE	115		837
2004	254106	40365	Drift	Haines	7/15/2004	29	NE	115	32	785
2004	264008	40365	Escape	Chilkat River	6/30/2004	27	NE	115	32	800
2004	264009	40166	Escape	Chilkat River	7/22/2004	30	NE	115	32	845
2004	254002	40366	Escape	Chilkat River	7/4/2004	28	NE	115	32	840
2004	264005	40366	Escape	Chilkat River	7/7/2004	28	NE	115	32	710
2004	254225	40167	Escape	Chilkat River	8/31/2004	36	NE	115	32	800
2004	221443	40167	Escape	Chilkat River	8/11/2004	33	NE	115	32	770
2004	221446	40167	Escape	Chilkat River	8/28/2004	35	NE	115	32	820
2004	221447	40167	Escape	Chilkat River	9/1/2004	36	NE	115	32	760
2004	254111	40364	Escape	Chilkat River	8/9/2004	33	NE	115	32	780
2004	254112	40366	Escape	Chilkat River	8/11/2004	33	NE	115	32	880
2004	254113	40366	Escape	Chilkat River	8/13/2004	33	NE	115	32	715
2004	254114	40166	Escape	Chilkat River	8/13/2004	33	NE	115	32	790
2004	254117	40167	Escape	Chilkat River	8/17/2004	34	NE	115	32	795
2004	254118	40166	Escape	Chilkat River	8/18/2004	34	NE	115	32	770
2004	254119	40365	Escape	Chilkat River	8/18/2004	34	NE	115	32	800
2004	254120	40167	Escape	Chilkat River	8/18/2004	34	NE	115	32	800
2004	254122	40166	Escape	Chilkat River	8/18/2004	34	NE	115	32	840
2004	254126	40167	Escape	Chilkat River	8/19/2004	34	NE	115	32	870
2004	254127	40365	Escape	Chilkat River	8/19/2004	34	NE	115	32	770
2004	254128	40167	Escape	Chilkat River	8/21/2004	34	NE	115	32	805
2004	254129	40166	Escape	Chilkat River	8/21/2004	34	NE	115	32	780
2004	254130	40365	Escape	Chilkat River	8/22/2004	35	NE	115	32	780
2004	254201	40365	Escape	Chilkat River	8/10/2004	33	NE	115	32	760
2004	254202	40365	Escape	Chilkat River	8/12/2004	33	NE	115	32	785
2004	254209	40365	Escape	Chilkat River	8/24/2004	35	NE	115	32	800
2004	254215	40365	Escape	Chilkat River	9/1/2004	36	NE	115	32	830
2004	254208	40166	Escape	Chilkat River	8/18/2004	34	NE	115	32	860
2004	254210	40166	Escape	Chilkat River	8/24/2004	35	NE	115	32	830
2004	254204	40366	Escape	Chilkat River	8/17/2004	34	NE	115	32	845
2004	254211	40366	Escape	Chilkat River	8/24/2004	35	NE	115	32	820

-continued-

Year	Head	Tag Code	Gear or project	Sampling port or site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2004	254214	40366	Escape	Chilkat River	8/30/2004	36	NE	115	32	600
2004	254203	40364	Escape	Chilkat River	8/13/2004	33	NE	115	32	780
2004	254206	40364	Escape	Chilkat River	8/18/2004	34	NE	115	32	810
2004	254207	40364	Escape	Chilkat River	8/18/2004	34	NE	115	32	900
2004	254212	40364	Escape	Chilkat River	8/24/2004	35	NE	115	32	695
2004	256751	40167	Sport	Haines	5/30/2004	23	NE	115	34	790
2004	256747	40167	Sport	Haines	5/31/2004	23	NE	115	32	875
2004	256748	40167	Sport	Haines	5/31/2004	23	NE	115	32	925
2004	254133	40167	Sport	Haines	6/20/2004	26	NE	115	32	1,025
2004	055993	40166	Sport	Haines	5/29/2004	22	NE	115	34	785
2004	256738	40166	Sport	Haines	5/31/2004	23	NE	115	32	820
2004	256740	40166	Sport	Haines	6/16/2004	25	NE	115	32	965
2004	254132	40166	Sport	Haines	6/20/2004	26	NE	115	32	835
2004	256741	40366	Sport	Haines	6/5/2004	23	NE	115	32	850
2004	256743	40364	Sport	Haines	5/29/2004	22	NE	115	32	845
2004	294211	40166	Sport	Juneau	8/21/2004	34	NE	JNU		780
2004	294292	40166	Sport	Juneau	8/23/2004	35	NE	JNU		810
2004	254103	40167	Subsist	Haines	6/26/2004	26	NE	115	32	870
2004	254134	40365	Subsist	Haines	6/26/2004	26	NE	115	32	880
2004	254102	40166	Subsist	Haines	6/19/2004	25	NE	115	32	875
2004	256756	40166	Subsist	Haines	7/3/2004	27	NE	115	32	880
2004	254101	40364	Subsist	Haines	6/19/2004	25	NE	115	32	790
2004	510213	40167	Troll	Gustavus	6/16/2004	25	NW	114	50	890
2004	273051	40167	Troll	Hoonah	5/25/2004	22	NW	114	25	720
2004	273119	40167	Troll	Hoonah	6/11/2004	24	NW	114	25	840
2004	273155	40167	Troll	Hoonah	6/16/2004	25	NW	114	25	825
2004	273125	40365	Troll	Hoonah	6/14/2004	25	NW	114	25	970
2004	273117	40366	Troll	Hoonah	6/11/2004	24	NW	114	25	820
2004	273105	40364	Troll	Hoonah	6/10/2004	24	NW	114	25	840
2004	266226	40366	Troll	Pelican	7/12/2004	29	NW	116		792
2005	014731	40167	Drift	Excursion Inlet	6/29/2005	27	NE	115		805
2005	014733	40167	Drift	Excursion Inlet	6/29/2005	27	NE	115		925
2005	264012	40365	Escape	Chilkat River	7/10/2005	29	NE	115	32	910
2005	264022	40167	Escape	Chilkat River	8/20/2005	34	NE	115	32	855
2005	264021	40167	Escape	Chilkat River	8/20/2005	34	NE	115	32	940
2005	264024	40167	Escape	Chilkat River	8/21/2005	35	NE	115	32	780
2005	264028	40167	Escape	Chilkat River	8/24/2005	35	NE	115	32	825
2005	264030	40167	Escape	Chilkat River	8/25/2005	35	NE	115	32	860
2005	264032	40167	Escape	Chilkat River	8/26/2005	35	NE	115	32	800
2005	264018	40365	Escape	Chilkat River	8/16/2005	34	NE	115	32	820
2005	264031	40365	Escape	Chilkat River	8/25/2005	35	NE	115	32	850
2005	264082	40365	Escape	Chilkat River	8/30/2005	36	NE	115	32	865
2005	264016	40166	Escape	Chilkat River	8/14/2005	34	NE	115	32	840
2005	264015	40366	Escape	Chilkat River	8/13/2005	33	NE	115	32	885
2005	264017	40366	Escape	Chilkat River	8/16/2005	34	NE	115	32	880
2005	264069	40365	Escape	Chilkat River	8/17/2005	34	NE	115	32	875
2005	264065	40166	Escape	Chilkat River	8/16/2005	34	NE	115	32	850
2005	264066	40166	Escape	Chilkat River	8/16/2005	34	NE	115	32	850
2005	264064	40366	Escape	Chilkat River	8/15/2005	34	NE	115	32	830
2005	221460	40364	Escape	Chilkat River	8/9/2005	33	NE	115	32	855

-continued-

Appendix D1.–Page 4 of 4.

Year	Head	Tag Code	Gear or project	Sampling port or site	Recovery date	Stat. week	Quad-rant	Dist.	Sub-dist.	Length
2005	254166	40364	Escape	Chilkat River	8/12/2005	33	NE	115	32	845
2005	254167	40364	Escape	Chilkat River	8/13/2005	33	NE	115	32	905
2005	264072	40364	Escape	Chilkat River	8/19/2005	34	NE	115	32	860
2005	221432	40167	Sport	Haines	6/4/2005	23	NE	115	32	935
2005	221429	40166	Sport	Haines	5/29/2005	23	NE	115	32	1,065
2005	530727	40167	Sport	Yakutat	5/15/2005	21	NW	181	60	1,030
2005	221455	40365	Subsist	Haines	6/26/2005	27	NE	115	32	910
2005	254226	40365	Subsist	Haines	7/10/2005	29	NE	115	32	950
2005	221456	40166	Subsist	Haines	6/26/2005	27	NE	115	32	1,035
2005	221454	40166	Subsist	Haines	6/26/2005	27	NE	115	32	1,055
2005	027302	40167	Troll	Elfin Cove	5/17/2005	21	NW	114	50	925
2005	295060	40364	Troll	Hoonah	6/23/2005	26	NW	114	25	954
2006	265643	40364	Sport	Juneau	5/29/2006	22	NE	111	50	900

APPENDIX E

Appendix E1.–WinBUGS code for Bayesian statistical analysis of BY-1999 juvenile abundance.

Prior distributions for root nodes are italicized.

Fixed constants are in bold font.

Deterministic relationships are in normal font (these link the priors and the likelihoods, or calculate auxiliary quantities).

Likelihood (sampling distribution of data) is underlined.

```
model {
  N.fry ~ dnorm(0,1.0E-12)        # abundance of fry in fall
  phi.1 ~ dbeta(0.1,0.1           # proportion of fry surviving until spring
  rho ~ dbeta(0.1,0.1)            # proportion of adipose-clipped fish for which head collected and tag decoded

  M.fry <- 30104                  # fry marked
  M.smolt <- 4506                 # smolts marked
  C <- 1147                       # fish inspected inriver for adipose clips
  m<-72                           # number of Chilkat CWT recoveries elsewhere, fall and spring

  N.smolt <- N.fry * phi.1                 # abundance of smolts 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 spr 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(63,26,40,1018), m.fall=50)

INITS

list(N.fry =400000, phi.1=0.3, rho=0.7)

-continued-

RESULTS

node	**mean**	**sd**	**2.5%**	**10.0%**	**median**	**90.0%**	**97.5%**	**start**	**sample**
N.fry	3.86E+5	38130.0	317700.0	339500.0	383500.0	4.36E+5	467500.0	4001	96000
N.smolt	139600.0	21400.0	103900.0	114100.0	137400.0	167600.0	187600.0	4001	96000
phi.1	0.3648	0.06545	0.2557	0.2871	0.3583	0.4513	0.5109	4001	96000
pi[1]	0.0543	0.006202	0.04284	0.04652	0.05404	0.06241	0.06713	4001	96000
pi[2]	0.02278	0.003669	0.01618	0.01821	0.02258	0.02756	0.03054	4001	96000
pi[3]	0.03469	0.005385	0.02492	0.028	0.03443	0.04174	0.04599	4001	96000
pi[4]	0.8882	0.0093	0.8693	0.8762	0.8884	0.9	0.9057	4001	96000
rho	0.6896	0.04053	0.6074	0.6366	0.6907	0.7412	0.7658	4001	96000

APPENDIX F

Appendix F1.–Computer data files used in the analysis of this report.

FILE NAME	DESCRIPTION
06FallChinookCWT.xls	Excel workbook containing trapping, length sampling, and sequential tag number data from BY 2005 Chinook CWT project in fall 2006.
07SpringChinookCWT.xls	Excel workbook containing trapping, length and weight sampling data from BY 2005 Chinook CWT project in spring 2007.
c06hnm rich27Sept2007.dta	ASCII file containing edited angler interview data from the Haines marine sport fishery in 2006.
HainesMarineCreel2006v3a.sas	SAS program to estimate effort and harvest in the 2006 Haines marine sport fishery using co6hnm rich27Sept2007.dta
06KingsTagged.xls	Excel workbook containing raw data from Chinook captured in the lower Chilkat River during 2006.
06KingSpawningSamples.xls	Excel workbook containing raw data from Chinook sampled on the Chilkat River spawning tributaries during 2006.