Regional Operational Plan No. SF.1J.2015.13

Chilkat River Chinook Salmon Escapement Studies in 2015

by

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and

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July 2015

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

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

REGIONAL OPERATIONAL PLAN SF.1J.2015.13

CHILKAT RIVER CHINOOK SALMON ESCAPEMENT STUDIES IN 2015

by

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July 2015

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This document should be cited as:

Elliott, B. W., and S. J. H. Power. 2015. Chilkat River Chinook salmon escapement studies in 2015. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan SF.1J.2015.13, Anchorage.

SIGNATURE/TITLE PAGE

Project Title:	Chilkat River Chinook salmon escapement studies in 2015
Project leader(s):	Brian W. Elliott, Fishery Biologist II
Division, Region, and Area:	Sport Fish, Region 1, Haines/Skagway Management Area
Project Nomenclature:	Project F-10-30 and -31; Study S Job 1-5; Chinook Salmon Research Initiative
Period Covered:	June 10, 2015 – February 28, 2016
Field Dates:	June 10 – September 4, 2015
Plan Type:	Category III

Approval

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Biometrician	Sarah Power		3.27.2015
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Chinook Salmon Research Initiative Approval

Title	Name	Signature	Date
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ABSTRACT

Chilkat River large (age-1.3 and older) Chinook salmon (*Oncorhynchus tshawytscha*) inriver abundance, age-sex-length composition, and escapement will be estimated using a 2-event mark-recapture experiment in 2015. Event 1 marking is conducted in the lower Chilkat River, and the event 2 capture phase is conducted in principal spawning areas within the Chilkat River drainage. Data produced from this project includes spawning abundance of large Chinook salmon, age and sex compositions of the return, and when possible age-1.2 abundance in the Chilkat River drainage.

Chilkat River Chinook salmon is a Pacific Salmon Commission Chinook Technical Committee exploitation rate and escapement indicator stock, and is proposed to be included in the coastwide Chinook model used by the Analytical Work Group of the Chinook Technical Committee. Mark-recapture experiments have been conducted in the Chilkat River drainage since 1991; escapement estimates for 1991–2014 have an average coefficient of variation of 15.4%, which contributes toward precise stock assessment production estimates for the Chilkat Chinook stock.

As part of ongoing Chilkat River Chinook salmon coded wire tag studies, all Chinook salmon encountered in the mark-recapture experiment will be examined for adipose fin clips, and presence of a coded wire tag, which leads to estimates of juvenile production. These data when used in conjunction with inriver abundance creates full production estimates for the Chilkat stock.

Key words: Chinook salmon, *Oncorhynchus tshawytscha,* Chilkat River, age stratified, mark-recapture, escapement, coded wire tags, length-at-age, return-at-age

PURPOSE

The purpose of this study is to estimate Chilkat River Chinook salmon inriver abundance, escapement, and age-sex-length compositions in 2015. The Chilkat River (Figure 1) is considered the third or fourth largest producer of Chinook salmon in Southeast Alaska (McPherson et al. 2003). In 2003, the Alaska Department of Fish and Game (ADF&G) adopted a Chilkat River biological escapement goal (BEG) range of 1,750–3,500 large (age-1.3 and older) Chinook salmon (Ericksen and McPherson 2004). The Lynn Canal and Chilkat River King Salmon Fishery Management Plan (5 AAC 33.384) directs the department to manage fisheries to achieve an inriver run goal of 1,850 to 3,600 large (age-1.3 and older) Chinook salmon upstream of the event 1 capture site at milepost 9 (MP 9) of the Haines Highway. Chilkat River Chinook salmon is a Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC) exploitation rate and escapement indicator stock that contributes to management of the Southeast Alaska sport fishery in accordance with the Pacific Salmon Treaty (PST) and Southeast Alaska King Salmon Management Plan (5 AAC 47.055). Harvest of Chilkat Chinook salmon is part of the Allowable Catch in Aggregate Abundance Based Management (AABM) fisheries in Southeast Alaska as determined by the PST.

A key component of stock assessment is estimating annual abundance and age and sex composition. Accurate stock assessment data will improve run forecasting accuracy and will support sustainable exploitation of the Chilkat River Chinook salmon stock in sport and commercial fisheries in Southeast Alaska.

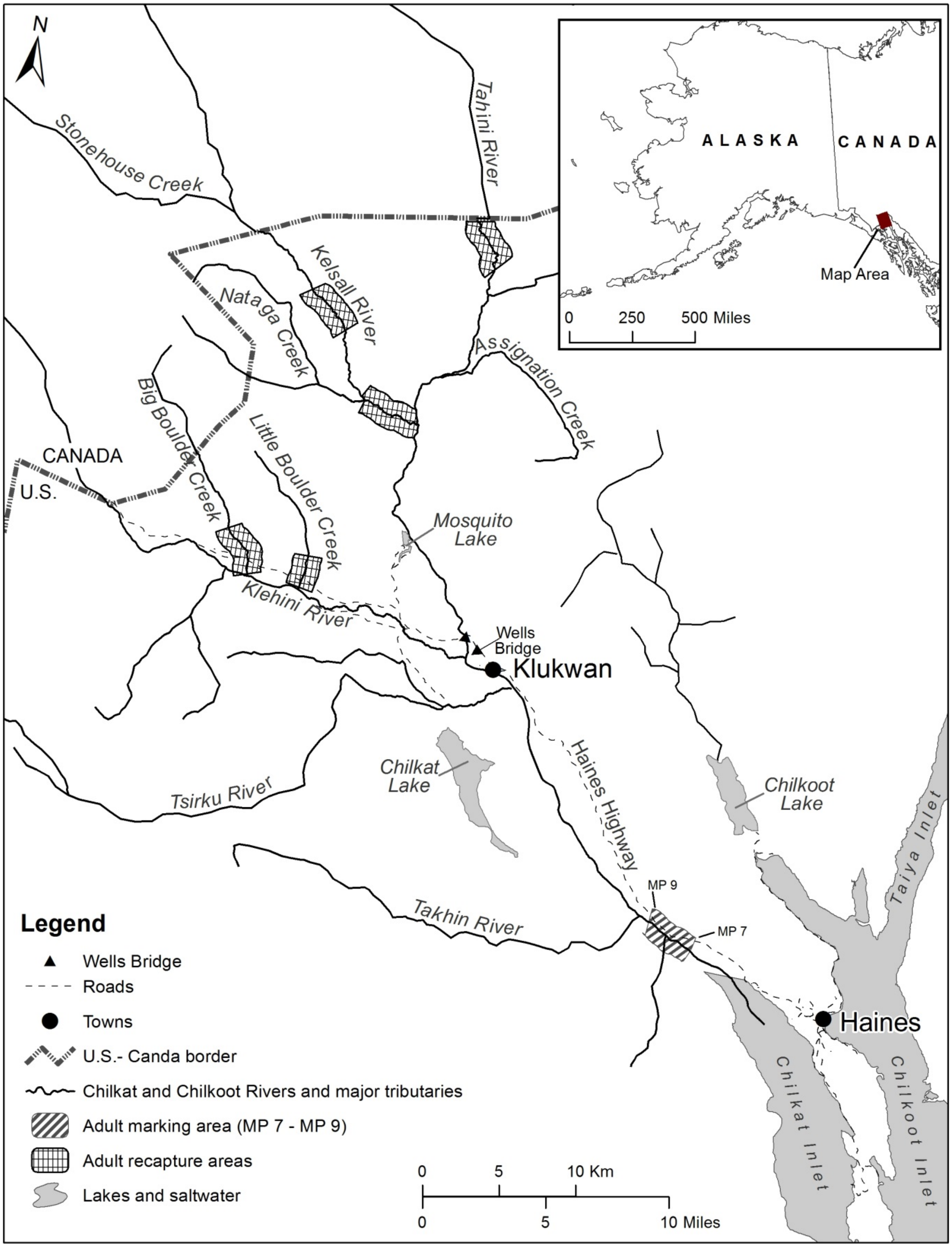

Figure 1.–The Chilkat River drainage in Southeast Alaska, showing the location of sampling sites.

BACKGROUND

The Chilkat River is one of the principal producers of Chinook salmon (*Oncorhynchus tshawytscha*) in Southeast Alaska (SEAK, McPherson et al. 2003), and is an exploitation rate and escapement indicator stock included in the coastwide model used by the CTC to implement and assess provisions of the current PST and to forecast the Abundance Index (AI) of all PSC Chinook salmon stocks subject to management under the PST. The coastwide AI determines the annual AABM all-gear quota for Southeast Alaska, which is allocated as specified in 5 AAC 29.060 (Allocation of Chinook salmon in the Southeastern-Yakutat Alaska Area). There are numerous fisheries that harvest the Chilkat stock, including commercial troll, drift gillnet, and purse seine fisheries, mixed-stock sport fisheries in Southeast Alaska, a Haines area spring sport fishery, and local subsistence fisheries in Chilkat Inlet and the Chilkat River (Table 1).

Table 1.–Estimated harvests of age-1.2+ Chilkat Chinook salmon in Southeast Alaska by fishery, 2004–2014.

Return Year	Winter Troll	Spring Troll	Summer Troll	Drift Gillnet	SEAK Sport	Purse Seine	Haines Sport	Haines Subsistence
2004	0	257	95	333	18	0	269	133
2005	32	107	236	242	87	14	165	84
2006	161	138	15	31	181	94	86	122
2007	177	229	154	201	158	0	177	71
2008	96	189	218	226	18	0	5	73
2009	153	241	84	79	13	0	80	104
2010	93	351	434	358	127	44	120	115
2011	115	822	0	244	84	109	173	142
2012	155	141	319	235	49	43	153	114
2013	0	40	0	200	74	13	74	81
2014	0	117	0	520	26	39	197	78
2004–2014 avg.	89	239	141	243	76	32	136	102
p^ of tot. harvest	0.08	0.23	0.13	0.23	0.07	0.03	0.13	0.10

Overall, drift gillnet and spring troll fisheries account for the highest average harvest of Chilkat Chinook (23% respectively), followed by Haines area marine sport and summer troll (Table 1). Most of the drift gillnet harvest occurs in District 115, and spring troll harvest is concentrated in a few principles areas, mostly in District 114 including Cross Sound and Icy Strait.

From 1975 through 1990, the Chilkat River Chinook salmon escapement was estimated through peak survey counts on clearwater tributaries to the Chilkat River (Big Boulder Creek, Stonehouse Creek) as an index of abundance (Pahlke 1992). A mark-recapture experiment, concurrent with a radio-telemetry project, was initiated in 1991 and continued in 1992, where returning Chinook salmon were captured in the lower river and given an external mark in addition to a radio tag, to determine spawning abundance and distribution within the Chilkat River drainage (Johnson et al. 1993). Survey counts on Big Boulder Creek and Stonehouse Creek were continued in 1991–1992 to assess viability of each estimation method. Comparisons of 1991 and 1992 mark-recapture estimates to expanded Stonehouse Creek and Big Boulder Creek index counts showed that the expanded index counts grossly underestimated total Chilkat River abundance (Johnson et al. 1993).

Starting in 1991, inriver mark-recapture estimation was initiated to more precisely estimate drainage-wide abundance while sampling principal spawning areas in the Chilkat River drainage, including the Tahini, Kelsall, and Klehini rivers (Figure 1). From 1991 through 2014, escapement estimates ranged from 1,435 (SE = 230) to 8,089 (SE = 1,193) large Chinook salmon, and averaged 3,718 (SE = 576), including the last 8 years of declining production where escapements have averaged 2,271 (SE=334) large fish (Table 2).

In 2003, the Department adopted an escapement goal range of 1,750–3,500 (point estimate = 2,200) large Chinook salmon for the Chilkat River drainage, and an inriver run goal range of 1,850–3,600 large Chinook salmon upstream of the adult marking area (5 AAC 33.384, Ericksen and McPherson 2004). The lower bound of the escapement goal range has been reached in 20 of the 24 years that abundance has been estimated by mark-recapture methods.

Harvest of Chilkat Chinook salmon in SEAK mixed stock fisheries is estimated through expansion of recovered coded-wire tags following the methods of Bernard and Clark (1996). A full CWT program was initiated for Chilkat River Chinook salmon in spring of 2000 starting with brood year (BY) 1998, and has been conducted annually since. The ADF&G has an annual goal to sample 20% of harvests in SEAK commercial troll and net fisheries, and in mixed stock sport fisheries in various ports. This sampling rate, combined with adequate marking rates of Chilkat Chinook, produces precise estimates of harvest and contributes toward estimates of total return for the Chilkat stock. Harvest estimates of the Haines spring marine boat fishery are estimated through a creel survey which has been conducted since 1984. Harvest from the Chilkat Inlet and Chilkat River subsistence fishery is gathered from returned subsistence permits (Table 1).

Harvests of Chilkat Chinook salmon in the Haines spring marine boat fishery have fluctuated over the past 30 years. In 1984–1988, an average of 1,196 Chinook salmon was harvested in the Haines area spring marine boat sport fishery. In 1989–2014, excluding the Chilkat Inlet closure years 1991, 1992, and 2008, the Haines sport fishery harvested an average of 243 Chinook salmon. High harvests in 1984–1988 were the result of high levels of salmon effort (average 23,708 hours), largely due to sport closures in Juneau area fisheries, and high catch per unit effort (CPUE, average 0.061). Other factors include above average terminal run sizes of Chilkat Chinook salmon and angling opportunity near the Chilkat River mouth (Table 3). Since 1987, at least the northern portion of Chilkat Inlet has been closed for some period of time to protect immigrating Chinook salmon milling at the mouth of the Chilkat River, as detailed in Ericksen and McPherson (2004).

Table 2.–Mark-recapture data used to estimate the inriver abundance and escapement of large (>age-1.3) Chilkat River Chinook salmon, 1991–2014.

	Event 1		Event 2												
	Drift gillnet	Fish wheels	Kelsall R.		Tahini R.[a]		Klehini R.[b]		Total		Inriver	Inriver			
	M	M	C	R	C	R	C	R	C	R	abundance	harvest	Escapement	SE	RP[c]
1991[d]	80	145	507	15	194	11	30	0	733	27	5,897	15	5,882	1,005	0.28
1992[e]	148	ND	571	18	314	5	20	0	905	23	5,284	7	5,277	949	0.30
1993[f]	159	ND	445	15	133	5	36	1	614	21	4,472	9	4,463	851	0.31
1994[g]	212	84	482	24	250	5	44	4	776	33	6,795	3	6,792	1,057	0.26
1995[h]	121	59	240	11	84	4	59	2	383	17	3,790	22	3,768	805	0.35
1996[i]	188	45	328	13	257	14	129	6	714	33	4,920	18	4,902	751	0.25
1997[j]	189	128	487	21	400	13	80	3	967	37	8,100	11	8,089	1,193	0.24
1998[k]	166	61	385	21	112	8	34	3	531	32	3,675	19	3,656	565	0.25
1999[l]	108	124	121	14	53	7	59	2	233	23	2,271	13	2,258	408	0.30
2000[m]	86	31	216	14	112	6	148	5	476	25	2,035	6	2,029	334	0.27
2001[n]	174	72	366	23	211	11	119	5	695	39	4,517	3	4,514	722	0.26
2002[o]	236	170	325	31	203	19	121	13	649	63	4,050	16	4,034	433	0.18
2003[p]	206	126	264	14	518	33	96	3	878	50	5,657	26	5,631	690	0.20
2004[q]	126	82	307	20	262	14	96	5	665	39	3,422	16	3,406	456	0.22
2005[r]	133	54	210	12	198	9	73	4	496	26	3,366	5	3,361	554	0.27
2006[s]	73	70	333	15	321	14	163	8	820	37	3,039	36	3,003	380	0.21
2007[t]	65	22	119	10	108	6	46	1	276	17	1,442	7	1,435	230	0.26
2008[u]	100	46	150	8	207	7	82	4	439	19	2,905	24	2,881	452	0.26
2009[v]	113	86	103	5	444	16	76	4	623	25	4,429	23	4,406	589	0.22
2010[w]	97	41	43	5	279	23	39	2	361	30	1,815	18	1,797	308	0.28
2011[x]	107	109	198	20	319	19	52	4	569	43	2,688	14	2,674	357	0.22
2012[y]	76	51	146	15	125	8	68	2	339	25	1,744	21	1,723	267	0.25
2013[z]	31	24	191	6	174	5	27	0	392	11	1,730	11	1,719	338	0.32
2014[aa]	37	23	85	4	85	6	20	0	190	10	1,534	5	1,529	307	0.33
1994–2014 Avg	126	72	243	15	225	12	78	4	546	30	3,520	15	3,505	533	0.26

Note: M = number marked, C = number caught and examined, and R = number of marked fish recaptured.

a Sampling at this site was not consistent before 1994.

b Includes Big Boulder, Little Boulder, and 37-Mi creeks.

c Relative precision (90%) = 1.645 x SE / estimate.

d Taken from Johnson et al. (1992).

e Taken from Johnson et al. (1993).

f Taken from Johnson (1994).

g Taken from Ericksen (1995).

h Taken from Ericksen (1996).

i Taken from Ericksen (1997).

j Taken from Ericksen (1998).

k Taken from Ericksen (1999).

l Taken from Ericksen (2000).

m Taken from Ericksen (2001).

n Taken from Ericksen (2002).

o Taken from Ericksen (2003).

p Taken from Ericksen (2004).

q Taken from Ericksen (2005).

r Taken from Ericksen and Chapell (2006).

s Taken from Chapell (2009).

t Taken from Chapell (2010).

u Taken from Chapell (2012).

v Taken from Chapell (2013a).

w Taken from Chapell (2013b).

x Taken from Chapell *(in prep a*).

y Taken from Chapell *(in prep b*).

z Taken from Elliott (*in prep a*)

aa Taken from Elliott (*in prep b*)

Table 3.–Estimated angler effort, catch, harvest, and CPUE of large Chinook salmon in the Haines marine boat sport fishery for comparable sample periods, 1984–2014.

		Effort				Large (>28") chinook salmon				
Year	**Survey dates**	Angler-hr	SE	Salmon-hr	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[w]	5/08-6/25	8,172	610	7,869	558	176	15	165	13	0.022
2007[x]	5/07-6/24	7,411	725	7,223	690	285	43	285	43	0.039
2008[y]	5/05-6/22	1,211	177	1,132	167	27	11	27	11	0.024
2009[z]	5/04-6/21	7,405	534	7,267	520	145	12	143	12	0.020
2010[aa]	5/10-6/27	7,823	534	7,737	520	219	25	216	25	0.028
2011[ab]	5/09-6/26	8,734	478	8,592	471	217	16	217	16	0.025
2012[ac]	5/07-6/24	7,423	498	7,403	496	229	33	217	33	0.031
2013[ad]	5/06-6/23	7,097	599	7,041	596	129	28	123	28	0.018
2014[ae]	5/05-6/22	6,798	363	6,737	360	230	31	228	30	0.034
1984–1988 average		25,710		23,708		1,207		1,196		0.061
1989–1990, 1993–2007, 2009–2014 average		8,635	730	8,267	714	255	37	243	34	0.031

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

Note: Large Chinook in sport fisheries is defined as the legal limit of 28” or greater in length.

--continued--

Table 3.–Page 2 of 2.

a	Catch of large Chinook salmon per salmon hour of effort.	q	From Ericksen (2001).
b	From Neimark (1985).	r	From Ericksen (2002).
c	Estimates of variance were not provided until 1987.	s	From Ericksen (2003).
d	From Mecum and Suchanek (1986).	t	From Ericksen (2004).
e	From Mecum and Suchanek (1987).	u	From Ericksen (2005).
f	From Bingham et al. (1988).	v	From Ericksen and Chapell (2006).
g	From Suchanek and Bingham (1989).	w	From Chapell (2009).
h	From Suchanek and Bingham (1990).	x	From Chapell (2010).
i	From Suchanek and Bingham (1991); no estimate of total angler effort and harvest was provided	y	From Chapell (2012).
j	From Ericksen (1994).	z	From Chapell (2013a).
k	From Ericksen (1995).	aa	From Chapell (2013b).
l	From Ericksen (1996).	ab	From Chapell (*in prep a*).
m	From Ericksen (1997).	ac	From Chapell (*in prep b*).
n	From Ericksen (1998).	ad	From Elliott (*in prep a*).
o	From Ericksen (1999).	ae	From Elliott (*in prep b*).
p	From Ericksen (2000).		

The Chilkat River stock is one of 11 Chinook salmon stocks in Southeast Alaska that are used in coastwide AABM by the Pacific Salmon Commission (PSC 1994). The Chilkat River stock is one of over 40 Chinook salmon escapement indicator stocks included in annual assessments by the CTC of the PSC. The CTC determines stock status and forecasts which are used for calculation of the AI, which sets harvest levels for the U.S. and Canada to comply with the PST. The PST is renewed every 10 years, and was renegotiated in 2008. The agreement calls for continuation of abundance-based management of Chinook salmon coastwide, and for improved stock assessment, escapement goals, and modeling. To that end, the estimation methods for escapement, harvest, and run forecasting for Chilkat Chinook salmon are continually being improved. A CWT program estimates harvest from marine mixed stock fisheries, and also produces smolt abundance estimates, which are important components of production estimation. Preseason forecasts primarily using sibling regression have also been developed. Additionally, the CTC is in the process of improving the PSC Chinook Model to include inriver abundance and age data for Chilkat River Chinook salmon. Chilkat River production estimates will directly contribute to the AI, which in turn will determine harvest levels in Southeast Alaska under the PST. Data from the Chilkat River escapement estimation project is important for management of this stock and Southeast Alaska stocks.

OBJECTIVES

PRIMARY OBJECTIVES

The primary research objectives for 2015 are to:

1) Estimate the inriver abundance of large (age-1.3 and older) Chinook salmon in the Chilkat River upstream of the department's tagging site at Haines Highway MP 9, so that the estimate is within 30% of the true value 90% of the time.

2) Estimate the age and sex compositions of the inriver run of large Chinook salmon in the Chilkat River, so that the estimates are within 10% of the true values 90% of the time.

SECONDARY OBJECTIVES

The secondary research objectives for 2015 are to:

1) Sample all adult Chinook salmon captured during this experiment for adipose fin clips and CWTs placed on juvenile Chinook salmon from brood years 2008–2012;

2) Estimate abundance of age-1.2 Chinook salmon immigrating to the Chilkat River. The precision of this estimate will depend on the number of age-1.2 fish sampled and present in the drainage;

3) Collect length information from sampled Chinook salmon.

METHODS

The abundance of large (age-1.3 and older) as well as age-1.2 Chinook salmon entering the Chilkat River in 2015 will be estimated using a 2-sample mark-recapture experiment for a closed population (Seber 1982). Adult Chinook salmon will be captured and marked in event 1 in the lower Chilkat River between June 10 and July 24. Adult Chinook salmon will be captured and inspected for marks in event 2 from August 1 through approximately September 4 in the three principal spawning areas in the Chilkat drainage: Kelsall River, Tahini River, and Klehini River tributaries (Big Boulder Creek, Little Boulder Creek, and 37-mile Creek, Primary Objective 1). Age and sex compositions (Primary Objective 2) and length distributions (Secondary Objective 1) will be estimated from the event 1 and event 2 samples.

ABUNDANCE ESTIMATE

Event 1, Lower Chilkat River

A drift gillnet 70 ft (21.3 m) long and 10 ft (3.0 m) deep will be used to capture adult Chinook salmon immigrating to the Chilkat River from June 10 to July 24, 2015. Ninety-eight percent of Chinook salmon captured in 1991–2014 were from June 12 to July 21 (Figure 2). The net will consist of 2 panels of equal length: one with 6¾ in (171 mm) mesh, and the other with 8 in (203 mm) mesh. The crew will perform minor net repairs as required. In the event of a major tear, another net of the same dimensions will be deployed, and the damaged net will be taken to a professional net mender for repair at the end of the day. There will be a minimum of 3 nets on hand for fishing. The Division of Commercial Fisheries (ADF&G-CF) will also operate two 3-basket fish wheels in the lower river during this same time period. The two types of event 1 capture gear will be fished in a consistent manner throughout the migration in an attempt to tag salmon in proportion to their abundance as they enter the lower Chilkat River.

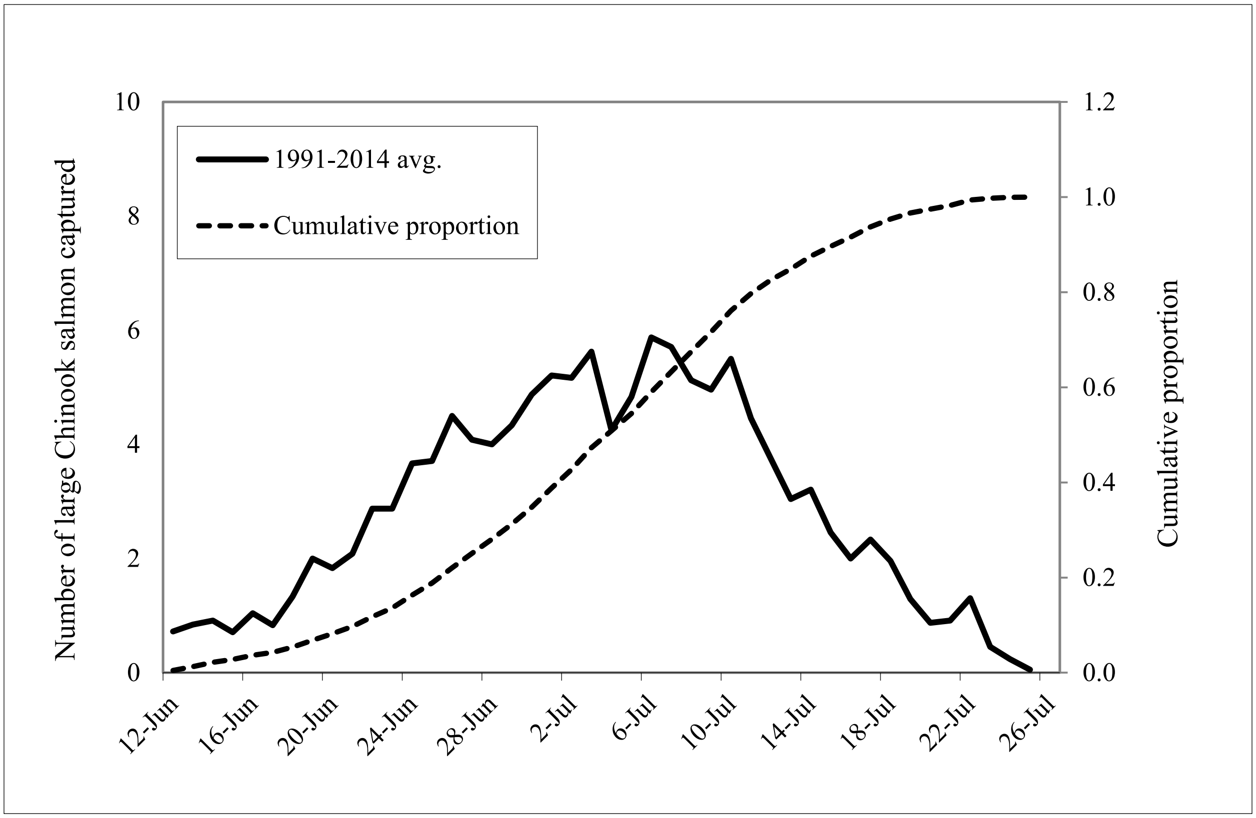

Figure 2.–Average daily catches and cumulative proportion of large Chinook salmon captured in the drift gillnet by day, Chilkat River between MP 7 and MP 9 on the Haines Highway, 1991–2014.

A crew of at least two people will operate a skiff during drift gillnet capture and tagging. Six 0.25 mi (400 m) long areas of the Chilkat River between Haines Highway MP 7 and MP 9 will be fished in 2015 (Figure 3). Each one of these 0.25 mile sections is defined as a "drift area". The CPUE of Chinook salmon in the drift gillnet is higher earlier in the day (Figure 4), so the equivalent of 43 drift areas, or six hours, whichever is greater, will be fished earlier each day starting at approximately 6:30 am. When a drift is interrupted to bring captured fish aboard, the proportion of each incomplete drift will be recorded, and additional drifts will be made to complete the equivalent of 43 drift areas each day. If 43 drift areas cannot be completed in a day, the remainder will be added to the goal for the next day. If 43 drift areas are completed in less than six hours, additional drift areas will be fished to achieve six hours with the net deployed. The tagging crew will be responsible for keeping the number of drifts completed in each of the six areas as even as possible each day.

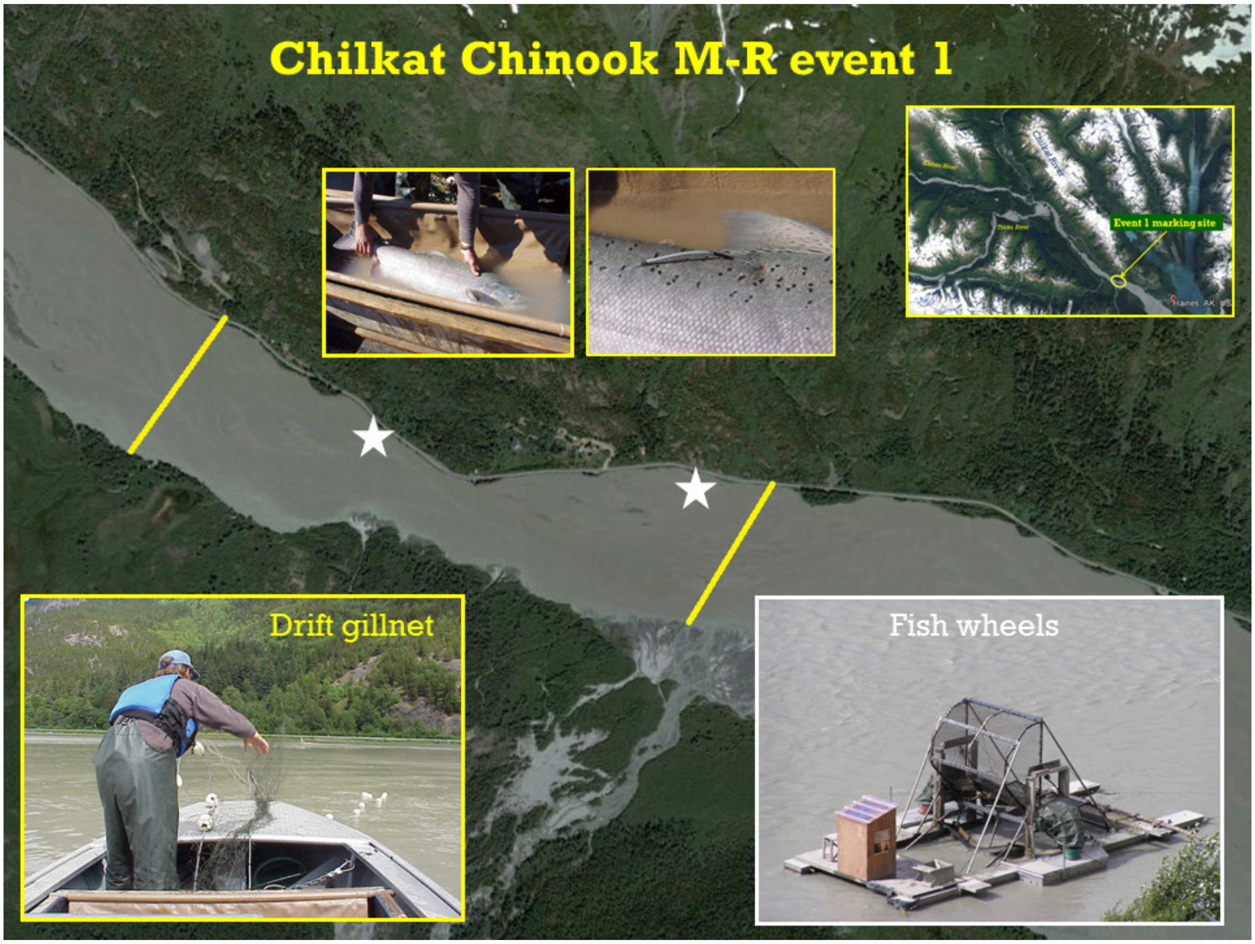

Figure 3.–Drift gillnet areas and fish wheel locations in the lower Chilkat River, Southeast Alaska. Fish wheel locations are denoted by the star icon.

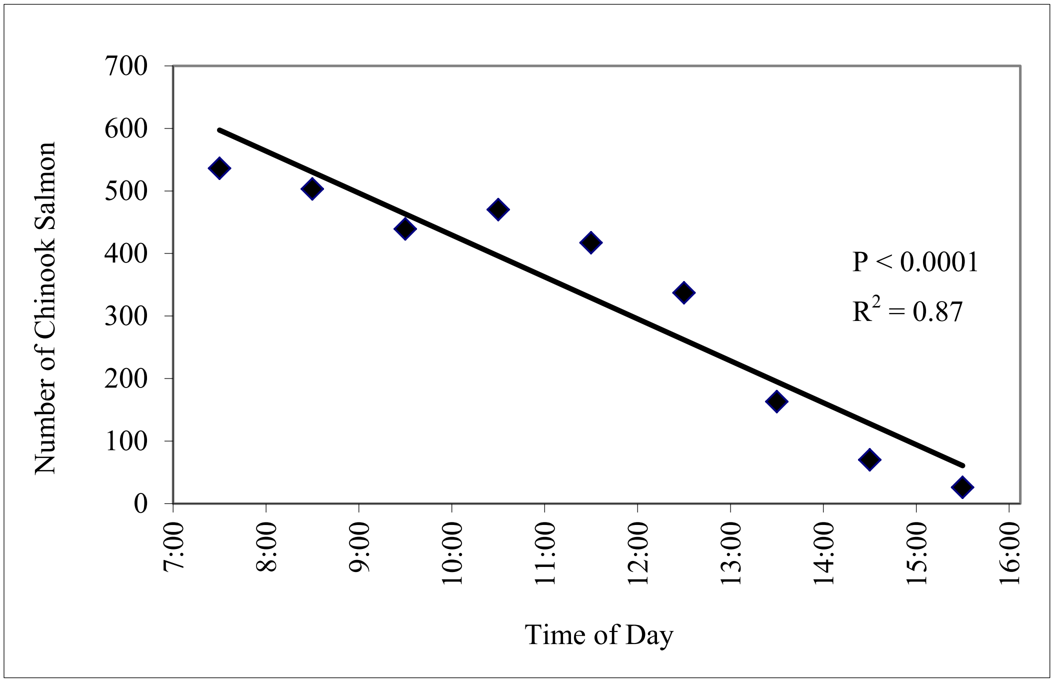

Figure 4.–Total catch of Chinook salmon in the lower Chilkat River drift gillnets by hour of day, 1992–2014, denoted by military (24-hour) time.

Care will be taken not to injure Chinook salmon during capture. Fish will be retrieved immediately after capture in the net by lifting the webbing, while supporting the weight of the fish, into an onboard tagging tank that contains fresh river water. The fish will then be immediately and carefully untangled or cut from the net.

The amount lower river effort during event 1 has remained consistent since mark-recapture estimation began in 1991. Event 1 large Chinook capture totals are 73% correlated with drainage-wide abundance estimates from 1991–2014; in the unlikely event of poor event 2 sampling, the event 1 marking totals could be used as an index to estimate spawning abundance.

The Chilkat River fish wheels are operated and maintained by ADF&G-CF. Twice daily, usually around 9 am and 3 pm, the fish wheel holding pens are emptied, and captured Chinook salmon are sampled identically to the drift gillnet protocol.

Every Chinook salmon captured by fish wheel or gillnet will be measured to the nearest 5 mm mid-eye to fork (MEF) length, examined externally to estimate sex, sampled for scales as described in the Data Collection section, and inspected for adipose fin status (present or absent). All Chinook salmon in good health and not sacrificed for CWT head collection (see criteria below) will receive a uniquely numbered external tag and a ¼ in (7 mm) diameter hole punched along the upper (dorsal) edge of the left operculum (ULOP). External tags will be a solid-core spaghetti tag for fish ≥440 mm MEF, and a t-bar anchor tag for fish <440 mm MEF. All external tags will be gray to reduce visibility in occluded glacial water. Lower visibility will reduce the potential for spawning ground samplers to target tagged fish. Chinook salmon tagged by the drift gillnet crew will be given a tertiary mark by clipping off a portion of the left axillary process (LAP), which is located at the base of the left pelvic fin. This tertiary mark will allow us to detect differences in tag loss between gillnets and fish wheels. Fish with deep scars or lesions, damaged gill filaments, or in lethargic condition will be sampled for length, sex, scales, and adipose fin status, given a lower left operculum punch (LLOP) to prevent double sampling, then released without other marks.

A portable wand CWT detector will be used at the tagging sites to check all adipose fin-clipped Chinook salmon for a CWT in the snout. All adipose fin-clipped Chinook salmon <660 mm MEF will be sacrificed for CWT recovery. The length threshold of 660 mm MEF is used because historical length at age data indicates this length typically defines the break between 2-ocean and 3-ocean fish, and female Chinook salmon are typically ocean age-3 and older. Additionally, because Chilkat River spawning abundance is germane to all fish 3-ocean and older, productive spawners are not sacrificed until they are in post-spawning condition. Adipose fin-clipped fish ≥660 mm MEF that test positive for CWT presence in the head will be tagged and released. Adipose fin-clipped fish ≥660 mm MEF that test negative for a head CWT will be sacrificed to verify tag loss. Note that an estimate of the fraction of the run, by age, that possess CWTs is an important component (contributes to estimation of a parameter commonly expressed as 'theta') in the expansion of CWTs recovered from mixed stock commercial fisheries. A numbered cinch strap will be attached around the jaw of the head of all sacrificed fish. Heads will be stored in a designated freezer and shipped to the Mark, Age and Tag Laboratory in Juneau for CWT recovery and decoding.

Event 2, Spawning Grounds

The event 2 spawning grounds phase of the M-R project strives to accomplish several objectives simultaneously. This includes examining captured Chinook salmon as possible for the primary and secondary marks applied in the lower Chilkat River during event 1 (Primary Objective 1); sampling Chinook salmon as possible for age, sex, (Primary Objective 2), and length (Secondary Objective 3); and examining Chinook salmon for missing adipose fins, and collecting heads from fish with missing adipose fins with the same criteria as described in event 1 (Secondary Objective 1). Field teams will strive to capture and examine as many Chinook salmon as possible while leaving fish unharmed.

Snagging gear, dip nets, short tangle nets, and beach seines will be used to collect live adults, and carcass retrieval will be by hand or a spear. Attempts will be made to capture all fish encountered equally; samplers do not select fish based on size, sex, or tag status. Spaghetti tags will not be removed from live fish to avoid ambiguity upon potential recapture. Spaghetti tags will be removed from carcasses, however, and the side of the carcass will be slashed after sampling so sampled carcasses will be identifiable at a distance.

A crew of 2 people will sample fish for marks on the Tahini River spawning grounds, where 33%, 20%, and 33% of Chinook salmon spawning occurred in radio-telemetry study years 1991, 1992, and 2005, respectively (Johnson et al. 1992, 1993; Ericksen and Chapell 2006). On average during 1994–2014, 97% of Chinook salmon samples were collected between July 30 and August 31 (Figure 5). Areas of Chinook salmon abundance will be accessed primarily on foot and by boat. Sampling on the Tahini River spawning grounds may be discontinued earlier if the number of fish sampled indicates that die-off is complete (i.e., 1 to 2 fish sampled per day for several days).

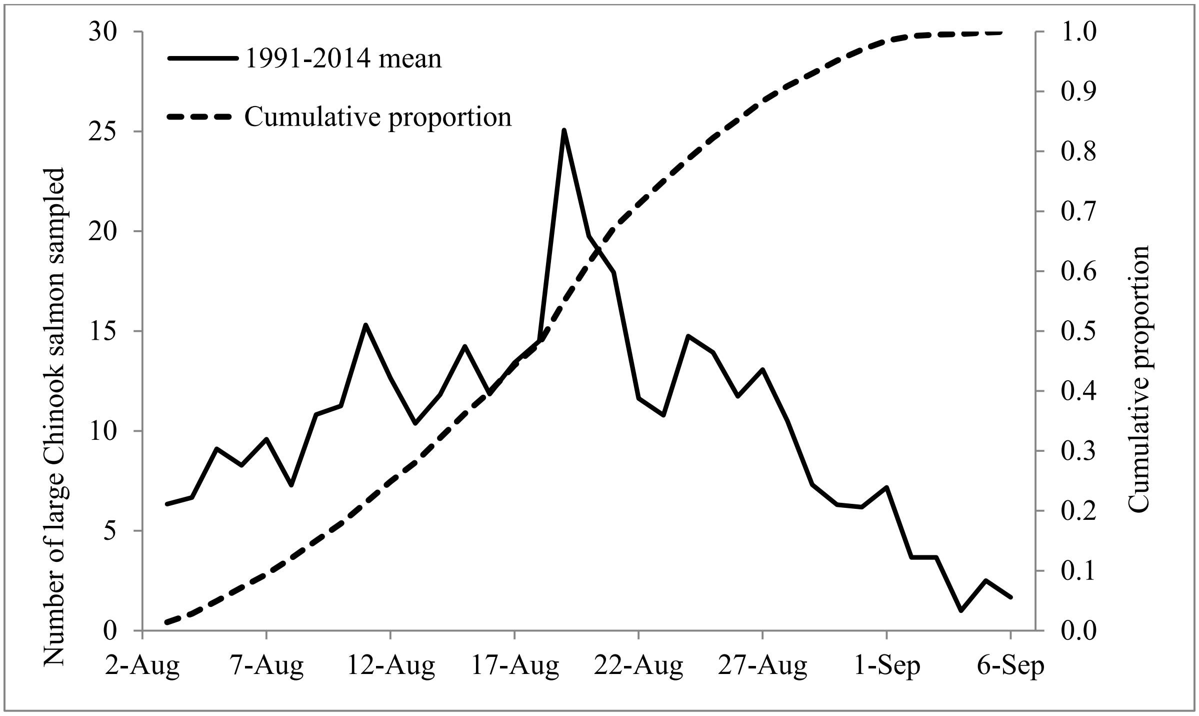

Figure 5.–Mean number sampled and cumulative proportion of large Chinook salmon captured per day in the Tahini River drainage, 1994–2014.

A crew of two people will sample fish for marks in the Kelsall River drainage, where 54%, 73%, and 53% of Chinook salmon spawning occurred in 1991, 1992, and 2005, respectively (Johnson et al. 1992, 1993; Ericksen and Chapell 2006). On average between August 1 and September 2, 97% of Chinook salmon were sampled in 1994–2013 (Figure 6). The 2005 radio-tagging study found that the 62 radio-tagged fish that spawned in the Kelsall drainage were distributed as follows: 23% below the Kelsall River bridge, 29% upstream of the bridge but downstream of the upper canyon, 39% in the upper canyon, and 10% in Stonehouse Creek. Many radio-tagged fish returned downstream after spawning, some as carcasses, so by August 22 the majority (61%) of all Kelsall spawners were downstream of the bridge and in sampling areas A, B and C (Appendix A1). Most (71%) of the upper canyon spawners did not wash down below the Kelsall River bridge (Ericksen and Chapell 2006). The upper Kelsall canyon area, designated as area D, will be sampled frequently to access the large spawning component and the post-spawners that do not wash down to the lower Kelsall areas. Areas of Chinook salmon abundance will be accessed on foot.

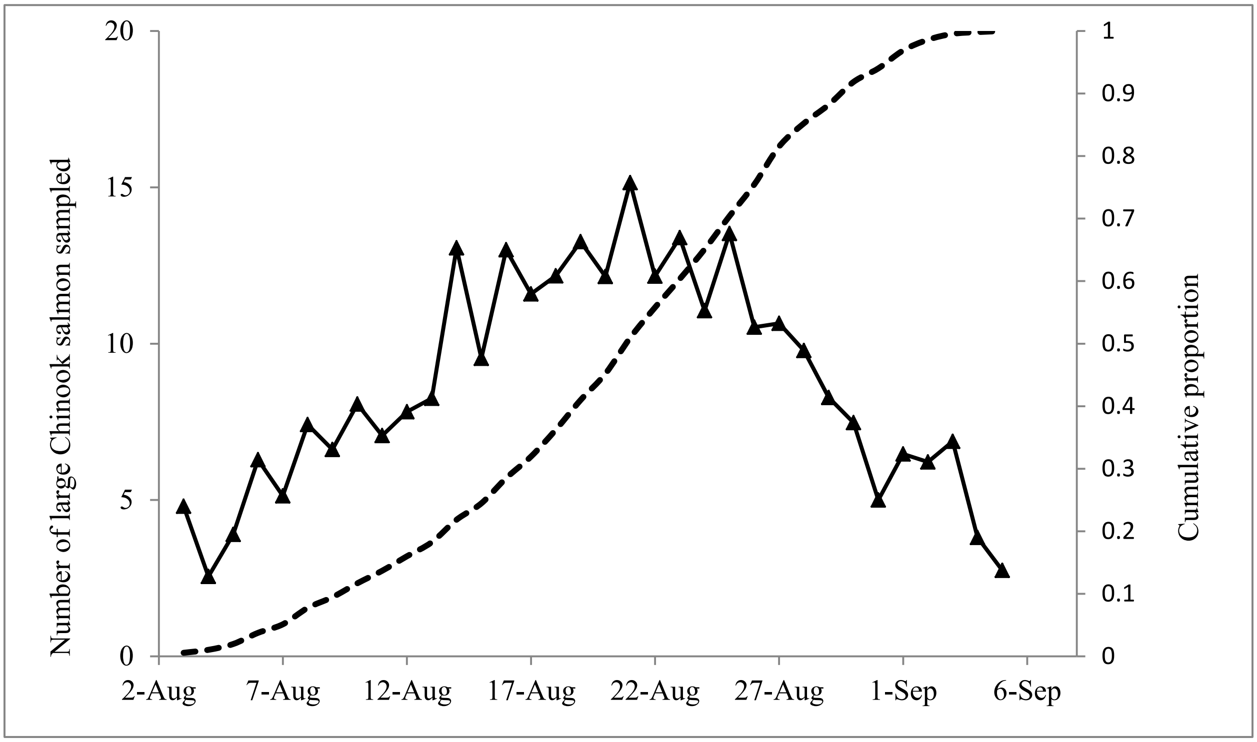

Figure 6.–Mean number sampled and cumulative proportion of large Chinook salmon captured per day in the Kelsall River drainage, Southeast Alaska, 1994–2014.

A crew of 2 people will sample fish for marks in Klehini River tributaries every 4–5 days in August, where 4%, 5%, and 15% of Chinook salmon spawning occurred in 1991, 1992, and 2005, respectively (Johnson et al. 1992, 1993; Ericksen and Chapell 2006). Big Boulder Creek has historically been the primary Klehini River spawning tributary, but in recent years Little Boulder Creek has contained as many or more spawners. Sampling at the confluence of 37-mile Creek and the Klehini River will also occur during the peak of spawning. Areas of Chinook salmon abundance will be accessed on foot.

Chinook salmon captured on the spawning grounds will immediately be removed from the sampling gear. If a fish has not been previously sampled on the spawning grounds, as indicated by the presence of a LLOP, it will be examined for spaghetti or T-bar anchor tags, presence/absence of an adipose fin, and an ULOP. In addition, it will be sampled for sex, length (MEF), and scales as described in the Data Collection section whenever possible. After sampling, all fish, including carcasses, will be given a ¼ in (7 mm) diameter LLOP. If a fish is marked with a ULOP but no spaghetti tag is present, the fish will be examined for a LAP clip to identify where tag loss is occurring in the lower river gear. When sampling in the Kelsall River drainage, the sampling area as listed in Appendix A will be recorded.

Spawning ground sampling crews will use a portable wand CWT detector to scan all adipose-finclipped fish for the presence of a CWT. Heads will be collected from all adipose-finclipped fish <660 mm MEF and all spawned-out and dead adipose-finclipped fish regardless of length, in addition to fish ≥660 mm that test negative for presence of a CWT. Heads are not collected from large fish in pre-spawning condition, except for negative wand tests for presence of a CWT. Collected heads will be marked with a numbered cinch strap around the jaw. Heads collected will be preserved in field camp and frozen when delivered to the ADF&G office in Haines. The heads will then be shipped to the Mark, Age and Tag Laboratory in Juneau for tag reading.

Results of annual experiments to estimate abundance on the Chilkat River (1994–2000) and a meta-analysis using those data (Ericksen 2001) were unable to detect significant ($\alpha = 0.1$) differences in the fractions of fish captured in the Tahini and Kelsall rivers that were marked in the lower Chilkat River. However, we continue to sample Chinook salmon at 3 locations (Kelsall River, Tahini River and Klehini River tributaries) to increase our sample sizes, minimize bias that would result from any small annual differences in the marked fractions by recovery area, and to allow testing of the assumption of equal marked:unmarked ratios among recovery strata.

Abundance Estimate - Sample Size (Primary Objective 1)

The total return forecast for 2015 is based on 2014 returns of younger fish from the same brood year. For example, the abundance of age-1.2 and 1.3 fish from brood year 2009 is used to forecast the number of age-1.4 fish in 2015, as the returns from a given brood year, at younger ages, could be an indicator of overall strength of the age class and early life-stage survival. Because BY2010 only has one year of sibling data, the abundance of age-1.2 fish from BY2010 is used to forecast the number of age-1.3 fish in 2015. The 2015 total return forecast is for 2,143 large Chilkat Chinook salmon, comprised of 1,393 age-1.3 fish from BY2010 and 750 age-1.4 fish from BY2009. Applying recent exploitation rates by age, the inriver abundance forecast is for 1,713 large Chinook salmon, comprised of 1,084 age-1.3 fish from BY2009 and 629 age-1.4 fish from BY2009. Expected numbers of fish captured in event 1 utilize historical data including catchability-at-age and by gear (Table 4).

Table 4.–Predicted 2014 inriver run and event 1 catch of large Chinook salmon in the lower Chilkat River sampling gear by age and gear type in Southeast Alaska.

Brood year	2010	2009	
Age	1.3	1.4	**Total**
Inriver run[a]	1,084	629	1,713
Drift gillnet			
q_{age}[b]	0.035	0.036	
Catch	38	23	60
Fish wheels			
q_{age}[c]	0.025	0.020	
Catch	27	13	40

[a] Predicted total return and inriver run of Chilkat River Chinook is based upon a regression of sibling returns (e.g., the return of age-1.4 fish in year *t* is forecasted from the return of age-1.3 fish in year *t*-1and the return of age-1.2 fish in year *t*-2; the return of age-1.3 fish is forecasted from the return of age-1.2 fish in year *t*-1).

[b] Average catchability-at-age in the lower river drift gillnet from 1991 to 2014 data.

[c] Average catchability-at-age in the fish wheels from 1991 to 2014 data.

Assuming average catchability-at-age (q_{age}), we expect to capture 60 large Chinook salmon in the lower river gillnet and 40 in the fish wheels, for a total (n_1) of 100 marked fish. Based on historical sampling data, we expect to sample 132 large Chinook salmon for marks in the Kelsall River drainage, 148 on the Tahini River, and 52 in Klehini River tributaries including Big Boulder Creek, for a total (n_2) of 332 large Chinook salmon inspected (Table 5). Applying the 1994–2014 average drainage wide marked fraction of 0.058, we expect (m_2) 19 marks will be recovered (Table 6). The expected mark-recapture parameters would produce an abundance estimate of 1,681 large Chinook salmon with a standard error of 319, and a 90% relative precision (RP) of ±0.31, which falls short of the statistical target of 0.30 (Primary Objective 1), despite handling an estimated 19.4% of the population (2000–2014 average). Despite having projections that our precision goal will not be met by a relatively slim margin, we decided to keep the precision goal as oppose to relaxing our goals, with the understanding that we may not reach the desired precision. In order to reach the precision in 2015, if we inspect 31additional fish than the projected (n_2) of 332, the precision goal will be met. Alternately if we mark 27 more fish more than the projected (n_1) of 100, the precision goal will be met. Both scenarios results in a 90% relative precision that meet the objective of 30%.

Table 5. –Predicted 2015 captures of large Chinook salmon by age and spawning area in three Chilkat River tributaries, Southeast Alaska.

Brood year	2010	2009	
Age	1.3	1.4	**Total**
Inriver run	1,084	629	1,713
Kelsall R.			
q_{large}[a]			0.077
Catch	83	48	132
Tahini R.			
q_{large}[a]			0.087
Catch	94	54	148
Klehini R.			
q_{large}[a]			0.030
Catch	33	19	52

[a] Average proportion of large Chinook salmon escapement sampled by spawning area, from 2000–2014 data.

Table 6.–Predicted 2015 mark-recapture parameters and Petersen abundance estimate of large Chinook salmon escaping to the Chilkat River drainage, Southeast Alaska.

Peterson estimator	
n_1[a]	100
n_2[b]	332
m_2[c]	19
N^ =	1,681
V(N^) =	101,512
SE(N^) =	319
CV =	19%
RP =	0.312

[a] Estimate of number of tags (n_1) from average catchability-at-age of lower river drift gillnet and fish wheels, 1991–2014.

[b] Estimate of spawning ground captures (n_2) from average sampling rate of large Chinook salmon, 1994–2014. Spawning ground sampling was not consistent prior to 1994.

[c] Estimate of number of recoveries (m_2) based on 1994–2014 average marked fraction $\theta = 0.058$.

[d] Relative precision (90%) = 1.645 x SE /estimate.

Note: The estimate of m_2 is based on average marked fraction on the spawning grounds.

The event 1 and event 2 effort and sampling design has been consistent for most of the 24-year span (1991–2014) of this project. Variations in event 1 effort include fish wheels not operating in 1992 and 1993 (Table 2). Variations in event 2 effort include gillnets used at the Tahini River mouth in 1991–1993, and Kelsall River sampling effort was reduced from 7d/week in 1991–2008 to 5d/week in 2009–2014. The Kelsall River effort was scaled back to reduce the stress of multiple live captures of the few Chinook salmon present in low abundance years. Kelsall River sampling effort will remain at 5d/week until the number of unique fish encountered returns to historic levels, e.g., ≥300 fish per season.

The relative 90% precision criteria of ±0.30 has been met in 19 of 24 (79%) previous experiments and has ranged from ±0.12 to ±0.38 (Table 2). Primary Objective 1 was not met three times in the last 19 years (2008, 2013, and 2014). In 2008, the number of marks recovered was very low. In 2013, the tagging fraction (0.028) was the lowest since 1992. Despite sampling a high proportion (24%) of the estimated escapement in event 2, the low tagging fraction resulted in the lowest number (11) of marks recovered during event 2 for this project. During event 1 and event 2 in 2014, the Haines area experienced abnormally large precipitation and flood conditions persisted in July and August, severely reducing capture and sampling efforts. Meeting precision goals relies on more than the sampling design. The precision goals are sensitive to low abundance (reducing the number of recovered marks) and poor sampling conditions (reducing the ability to capture fish). Similar to prior years, we will make every effort to meet or exceed the projected 332 large Chinook salmon inspections in event 2.

Age and Sex Compositions of the Inriver Run - Sample Size (Primary Objective 2)

All Chinook salmon caught in the lower river and all live and dead fish encountered on the spawning grounds will be sampled for age, length, and sex. Age compositions in the lower river gillnet and fish wheel sampling and in each escapement sampling location (tributary) will be tabulated separately. Assuming no sex or size selectivity (see Data Analysis), 126 large fish must be collected to meet objective criteria according to the theory of Thompson (1987), based on an inriver run of 1,713 large Chinook salmon and being unable to read 20% of scales. Because we expect to collect scales from 100 large fish in the lower river and 332 large fish on the spawning grounds, the sample size required to meet statistical criteria in Primary Objective 2 should be met. If size-selective sampling is detected, stratification of estimates for abundance, age and sex composition will be required per protocols in Appendix C1.

SECONDARY OBJECTIVES

Coded Wire Tag Study (Secondary Objective 1)

As described in Methods for the inriver abundance estimate mark-recapture study, all adult Chinook salmon encountered in events 1 and 2 will be examined for missing adipose fins and scale sampled for age determination, and all adipose fin-clipped fish will be scanned for presence of a CWT. Heads will be collected from adipose fin-clipped fish that are <660 mm MEF length and from fish ≥660 mm MEF that are in post-spawning condition, in addition to fish ≥660 mm that test negative for presence of a CWT. For each brood year, the number of fish examined, the number with missing adipose fins, the CWT wand scan results, the number of heads taken, and the number of CWTs recovered will be compiled.

During the combined 2011–2014 seasons, 79 brood year 2008 (6 missing adipose fins), and 119 brood year 2009 (7 missing adipose fins) Chinook salmon were sampled during event 1, so the lower river adipose fin clip fractions ($\Omega_{\text{broodyear}}$) to date are $\Omega_{\text{BY2008}} = 0.076$ and $\Omega_{\text{BY2009}} = 0.059$ (Table 7). In 2013 and 2014, 176 brood year 2010 Chinook salmon (14 missing adipose fins) were sampled during event 1, so the current lower river tagging fraction for BY2010 fish is $\Omega_{\text{BY2010}} = 0.080$. In 2015, we expect 2 (= 0.059 x 36) age-1.4 (BY2009) and 5 (= 0.080 x 65) age-1.3 (BY2010) Chinook salmon with CWTs to be sampled in the lower river (see Table 3 for anticipated numbers by age in the lower river). Adipose fin clip data during event 1 is collected for each brood year as fish return to the Chilkat River, starting with age-1.1 fish. Sampling data from each successive age class (e.g., age-1.2, age-1.3, and age-1.4) from the same brood year is added to the previous data for a complete adipose fin clip estimate. In addition, we will sample fish on the spawning grounds during event 2 for adipose fin clips and presence of CWTs. For each brood year, if coded wire tagged fractions are not significantly different between events 1 and 2, we will pool the samples to increase sample sizes. See the Regional Operational Plan titled "*Production and harvest of Chilkat River Chinook and Coho Salmon*" for further details.

Table 7.–Number of brood year 2008–2010 Chinook salmon sampled for adipose fin clips and the number of clips observed in the lower Chilkat River, Southeast Alaska in 2011–2014, with 2008–2010 brood year projections for 2015.

		2008 BY		**2009 BY**		**2010 BY**	
Year	Gear	Examined	Ad-clips	Examined	Ad-clips	Examined	Ad-clips
2011[a]	Gillnet	0	0				
2011[a]	Fish wheels	30	2				
2012[b]	Gillnet	3	0	0	0		
2012[b]	Fish wheels	9	1	38	4		
2013[c]	Gillnet	14	2	4	0	0	0
2013[c]	Fish wheels	7	0	34	1	136	12
2014[d]	Gillnet	13	0	24	0	8	1
2014[d]	Fish wheels	3	1	19	2	32	1
Total to date		79	6	119	7	176	14
2015 Projections[e]							
	Gillnet	0	0	23	1	38	3
	Fish wheels	0	0	13	1	27	2
Total (2015 projected)		0	0	36	2	65	5
Grand total through 2015		79	6	155	9	241	19

Note: BY = brood year.

[a] Data taken from Chapell (2013b).

[b] Data taken from Chapell (*in prep a*).

[c] Data taken from Elliott (*in prep a*).

[d] Data taken from Elliott (*in prep b*).

[e] Gillnet and fish wheel projections based on predicted inriver abundance of 1,084 age-1.3 and 629 age-1.4, and 0 age-1.5 fish (Table 4). Catchabilities-at-age by gear are from Table 4. Marked fractions are Ω_{BY2008}=0.076, Ω_{BY2009}=0.059, and Ω_{BY2010}=0.080, calculated from samples collected through 2014.

Abundance of Age-1.2 Fish (Secondary Objective 2)

Methods for abundance of age-1.2 fish will follow the same methods and analysis of age-1.3 fish and older.

Lengths (Secondary Objective 3)

Lengths will be collected as described above in methods for event 1 and 2 of the abundance estimate.

DATA COLLECTION

ABUNDANCE ESTIMATE

Event 1, Lower Chilkat River

Data for each unique Chinook salmon captured in the lower river will be recorded on either a Fish Wheel Capture Form or Drift Gillnet Capture Form (Appendices B2 and B3). Data to be recorded for each sampled fish are the date, time of day, adipose fin clip status (N = not clipped, Y = clipped), results of CWT wand scans (Y = CWT present, N = CWT absent), sex (based on external characteristics), length to the nearest 5 mm MEF, scale sample card and column number, presence of sea lice, and comments about fish condition or sampling irregularities. For all fish that are tagged and released, the type of tag applied and the tag number will also be recorded on the data form. For all fish that are sacrificed for a CWT, the head cinch strap number will be recorded in the comments column.

For gillnet sampling, the date, crew member initials, first drift start time, and last drift end time will be recorded each day on a Gillnet Drift Effort Form (Appendix B4). Water temperature (nearest 1°C), and river depth (nearest 1 cm) will be measured and recorded twice daily, at approximately 0630 and 1300 hours, at a staff gage and thermometer on a piling near MP 8. For each drift, the number of Chinook salmon captured, and relevant comments will be recorded on 1 row.

Data unique to drift gillnet capture that will be recorded on the Drift Gillnet Capture Form (Appendix B3) are fish number (consecutively numbered through the season beginning with 1), gillnet mesh panel (L = 8 in, S = 6¾ in), drift area (1 through 6), channel fished when 2 main channels are used (R = right, L = left, as seen looking downstream), and percent of the area fished when a drift was interrupted. Previously sampled fish that are recaptured may be noted on this form, but will not be assigned a fish number.

Data that are unique to fish wheel capture that will be recorded on the Fish Wheel Capture Form (Appendix B2) are fish number (consecutively numbered through the season beginning with 1) and fish wheel site (1 = upstream, 2 = downstream). In the past there have been cases at the fish wheels when fish have escaped before sampling was completed. To avoid ambiguity about the marked status of each fish, the upper left operculum punch status of each fish will be recorded (Y = ULOP punched, N = not punched), and "NE" will be recorded in each data column if the fish was not examined.

Event 2, Spawning Grounds

For each Chinook salmon sampled, the following data will be recorded on the Spawning Ground Sampling Form (Appendix B5): date, sampling gear used, fish number (consecutively numbered at each spawning tributary through the season beginning with 1, sex (based on external characteristics), adipose fin clip status (Y = clipped, N = not clipped), results of handheld wand CWT scan (Y = CWT present, N = CWT not present), and length to the nearest 5 mm MEF. If the carcass is not intact, estimated MEF length category (≥660 mm, <660 mm and ≥440 mm, or <440 mm) based on head size will be recorded in the length column. Other data recorded include scale card and column number, condition of the fish (bright/turning, spawning, spawned-out, carcass), presence of an ULOP, tag number if present, and LAP status if there is an ULOP and no spaghetti tag. Comments about the fish include other marks, injuries, and cinch strap number if the head was taken. In addition, if an adipose fin-clipped carcass is scanned for CWTs, the flesh condition (e.g. "firm" or "soft") will be recorded to assess potential recent CWT loss due to decomposition.

Field crews will also maintain a set of field notes that describes the areas sampled by river mile, the river conditions including visibility and water level, comments on the ability to sample fish each day, and any other relevant information.

AGE AND SEX COMPOSITIONS OF THE INRIVER RUN

Scales will be collected from Chinook salmon according to a standard procedure, which is to remove 5 scales from the *left* side of each sampled fish (right side if left-side scales are regenerated), along a line 2 to 4 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin (ADF&G 1990). The first scale removed is from the center of this area (preferred scale), the second scale is 1 in to the left of the preferred scale, the third is 1 in to the right. The fourth and fifth scales are selected 2 rows above the preferred scale row, ½ in to the left and ½ in to the right of the preferred scale. All regenerated scales are discarded and new scales are selected in their place. Scales are carefully cleaned and placed on the gum cards with all the scales from one Chinook salmon in 1 column (i.e., scales from fish #1 will be placed over 1, 11, 21, 31, and below 31 on the gum card). All scales are moistened and mounted upright (posterior side down) with the rough (outer side of the scale) side out. Scales are then pressed down with a finger or pencil so that they stick to the scale card. Room is left at the top middle portion of the card to accommodate a label. Scale cards are kept as dry as possible to prevent gum from running and obscuring the scale ridges. The gum card label is filled out completely, including the last names of each sampler. A triacetate impression of the scales (30 seconds at 3,500 lb/in^2, at a temperature of 97°C) is used for age determination. Scales will be read for age using procedures in Olsen (1992).

Sex data will be collected as described in the Data Collection/Abundance Estimate section.

SECONDARY OBJECTIVES

Coded Wire Tag Study (Secondary Objective 1)

A Coded Wire Tag Sampling Form (Appendix B1) will be completed for each day that Chinook salmon are sampled in events 1 and 2 of the adult abundance estimation mark-recapture study. Daily totals of Chinook salmon examined and adipose fin-clipped fish found will be summarized by event and by fish length category; either "CHIN" (≥618 mm MEF, species code 410) or "JACK" (<618 mm MEF, species code 411). The 618 mm threshold corresponds with 28" sport length (measured from tip of nose to edge of tail) used by the Mark, Age, and Tag Lab. Data that will be recorded on the daily CWT sampling form for each adipose fin-clipped fish will be head cinch strap number, species code, length to the nearest 5 mm MEF, clip status, and sex. For adipose fin-clipped fish whose heads are not taken for CWT recovery (fish ≥660mm pre-spawn and testing positive for CWT), a dummy head number 902XXX will be assigned. Heads taken from adipose fin-clipped fish will be frozen as soon as possible and will be shipped weekly to the Mark, Age, and Tag Lab in Juneau for dissection and CWT recovery.

Abundance of Age-1.2 Fish (Secondary Objective 2)

Data collection for estimating abundance of age-1.2 fish will follow the same methods as described for age-1.3 and older fish.

Lengths (Secondary Objective 3)

Length data will be collected as described in the Data Collection/Abundance Estimate section above.

DATA ANALYSIS

ABUNDANCE ESTIMATE

In event 1, the number of fish tagged by age, sex, size category, time period and gear type will be tabulated. Size categories are: small = age-1.1 (or length <440 mm MEF if age is not obtained), medium = age-1.2 (or length ≥440 mm MEF and <660 mm MEF with no age), and large = age-1.3 or older (or length ≥660 mm MEF with no age). In event 2, the number of fish captured and the number recaptured will be tabulated by age, sex, size category and tributary.

Assuming the experiment does not need to be stratified by spatiotemporal strata, Petersen estimators (Seber 1982) will be used to estimate abundance:

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

$$Var\left[\hat{N}\right] = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)} \quad (2)$$

where $\hat{N}$ = estimated number of large Chinook salmon, n_1 = number of large marked Chinook salmon, n_2 = number of large adults inspected for marks on spawning grounds, and m_2 = number of marked large adults recaptured on spawning grounds. Note that the same estimator will be used for medium-sized fish as well. Further description of analyses will implicitly represent calculations and tests for both large and for medium-sized fish. If time or area stratification is necessary, a Darroch estimator (Seber 1982, Chapter 11) will be used to estimate abundance.

Assumptions of the Petersen model are:

a) all Chinook salmon have an equal probability of being marked in the lower Chilkat River or all Chinook salmon have an equal probability of being inspected for marks, or marked fish mix completely with unmarked fish in the population between events;

b) recruitment of untagged fish does not occur between the tagging and sampling events;

c) tagging does not affect the fate (behavior or mortality) of a fish;

d) tagged fish do not lose their tags and tags are recognizable and detected; and

e) double sampling does not occur.

Tagging will occur in proportion to abundance during immigration (assumption ‘a’) if fishing effort and catchability are constant as each size of fish and "stock" (fish spawning in the same area) immigrates to the river. Each stock can be characterized by its age-size composition and immigration timing. Fishing effort will be constant over time, and catchability (q) is a function of age-size composition and run timing of the stocks, along with environmental variability.

Size-selectivity sampling will be evaluated (α = 0.1) using Kolmogorov-Smirnov (K-S) tests on the lengths of fish marked, captured, and recaptured (Appendix C1). Similarly, sex composition in each sampling event will be compared to investigate the possibility of sex-selective sampling and the need for stratification of the data by sex (Appendix C1). Additionally, the sex estimation of recaptured fish will be compared between events 1 and 2 to assess the accuracy of the event 1 estimation. We assume that the event 2 sex estimation for each fish will be more accurate because secondary sex characteristics are more developed on the spawning grounds than in the lower river.

Chi-squared tests will be used to test for differences in proportion tagged between the Kelsall and Tahini rivers as outlined in Appendix C2. Klehini River tributary sampling data is not included in this test due to low sample sizes and inconsistent abundance relative to the other rivers (Ericksen 2001). If the proportions of tagged fish at the two spawning areas in 2015 are found to be unequal (assumption ‘a’), contributing causes will be investigated. As such we will use the chi-squared tests outlined in Appendix C2 to determine whether a simple Petersen estimator (described above) or a partially stratified estimator (e.g. Darroch 1961, Schwarz and Taylor 1998) should be used.

Contingency table analysis (or a K-S test) can also be used to see if the age (age1.3 compared to age1.4) or size composition of large fish captured in Kelsall and Tahini rivers are statistically different for fish captured during event 1. Results of the test dictate the type of estimator used for the abundance estimate (Appendix C1). Field personnel will not target tagged fish because all encountered fish are pursued and sampled (assumption ‘a’).

Recruitment of untagged fish into the population after tagging seems highly unlikely (assumption ‘b’), because lower river tagging continues until few or no fish are captured, and also because a "late" run of fish is not documented in the Chilkat River.

We assume tagged and untagged fish experience the same (perhaps significant) mortality (assumption ‘c’) due to natural causes and subsistence fishing. In the 2005 telemetry study, 88% of radio-tagged fish reached probable spawning areas, 6% were taken in fisheries, and 6% failed to reach spawning areas for unknown reasons; possibilities were tag regurgitation, handling effects, natural mortality, or unreported harvest (Ericksen and Chapell 2006). Included in the 6% with unknown fates were 2 fish (weighted 1% of the sample) that failed to resume upriver movement after being tagged.

Despite sport, subsistence, and commercial fisheries operating in Chilkat Inlet off the mouth of the Chilkat River, only 2 tagged Chinook salmon have ever been recovered downstream of the tagging site. The first was a radio-tagged fish recovered in the commercial drift gillnet fishery in 1992

(Johnson et al. 1993), and the second was a spaghetti tag recovered in a subsistence net in Chilkat Inlet in 2003. Thus, "backing out" of tagged fish does not appear to be a significant problem in this study, which is consistent with assumption ‘c’.

To account for tag loss, each fish will receive a numbered tag and an ULOP. To examine where tag loss may be occurring during event 1, gillnet-captured fish will also be marked with a left axillary process clip (LAP). Recovery crews will check each captured fish for an ULOP to assess primary tag loss (assumption ‘d’). If tags are lost, the observation will be recorded on the sampling form comment section, and a fish with an ULOP but without a primary tag will be counted as a recovery. If primary tags are lost, samplers will also look for the tertiary LAP mark. Double sampling (assumption ‘e’) will be controlled by using numbered tags and adding a punch mark to the lower (ventral) edge of the left operculum (LLOP).

AGE AND SEX COMPOSITIONS OF THE INRIVER RUN

As described in the abundance estimate data analysis section, size-selective sampling will be investigated within each of large and medium fish, using K-S tests (see Appendix C1 for details). If selectivity is detected, the methods described in Appendix C1 will be used to reduce the bias.

Assuming no size or sex selectivity within medium or within large fish, the fraction $p_{a,i}$ of the fish in age or sex group *a* and length stratum *i* (medium or large fish) will be estimated:

$$\hat{p}_{a,i}=\frac{n_{a,i}}{n_i} \tag{3}$$

$$\text{var}\left[\hat{p}_{a,i}\right] = \frac{\hat{p}_{a,i}(1-\hat{p}_{a,i})}{n_i - 1} \tag{4}$$

where n_i is the number of fish in length stratum *i*, and $n_{a,i}$ is the number from this sample that belong to age or sex group *a*.

The estimated abundance of age or sex group *a* in the population ($\hat{N}_a$) is:

$$\hat{N}_a=\sum_i \hat{p}_{a,i}\hat{N}_i \tag{5}$$

$$\text{var}[\hat{N}_a] = \sum_i \left(\text{var}(\hat{p}_{a,i})\hat{N}_i^2+\text{var}(\hat{N}_i)\hat{p}_{a,i}^2-\text{var}(\hat{p}_{a,i})\,\text{var}(\hat{N}_i)\right) \tag{6}$$

where $\hat{N}_i$ is the estimated abundance in length stratum *i* of the mark-recapture experiment and variance is estimated using the relationship in Goodman (1960).

The estimated fraction of the population that belongs to age or sex group *a* ($\hat{p}_a$) is:

$$\hat{p}_a = \frac{\hat{N}_a}{\sum_i \hat{N}_i} \tag{7}$$

$$\mathrm{var}(\hat{p}_a) \cong \hat{N}^{-2} \sum_i \hat{N}^2{}_i \, \mathrm{var}\left(\hat{p}_{a,i}\right) + \hat{N}^{-2} \sum_i \mathrm{var}\left(\hat{N}_i\right)\left(\hat{p}_{a,i} - \hat{p}_a\right)^2 \tag{8}$$

where the variance is an approximation based on the delta method (Seber 1982) and $\hat{N} = \sum_i \hat{N}_i$

Estimates of mean length at age and its variance will be calculated with standard sample summary statistics (Thompson 2002, Section 2.2).

SECONDARY OBJECTIVES

Coded Wire Tag Study (Secondary Objective 1)

The project operational plan titled "Production and harvest of Chilkat River Chinook and Coho Salmon" describes in detail how adipose fin clip and CWT detection data from the escapement study will be analyzed to generate estimates of juvenile abundance, overwinter survival, marine survival, harvest by fishery, and total return for a given brood year of Chilkat River Chinook salmon.

Abundance of Age-1.2 Fish (Secondary Objective 2)

Data analysis for abundance of age-1.2 fish will follow the same methods described for age-1.3 fish and older.

Lengths (Secondary Objective 3)

Lengths will be collected and canonical mean and variance reported.

SCHEDULE AND DELIVERABLES

It is the responsibility of the field crew leaders to ensure accurate data are collected on a daily basis. The field crew leader will also ensure data collections (such as samplers' initials, environmental data, fish sex and condition, etc.) are complete, and sampling methods (such as length measurements, sex and scale collection procedures, etc.) are correctly implemented. Daily inspections for recording errors will include identification of incorrect dates or transposed numbers, such as fish lengths or tag numbers. Data forms will be kept up to date at all times. Scale cards will be visually inspected to ensure that scales are clean, mounted correctly, and correctly labeled. Data will be sent to the project biologist weekly, where it will be re-inspected for accuracy and compliance with sampling procedures. At later dates, data will be transferred from field forms to Excel™[1] spreadsheet files. Scales will be pressed and ages estimated in the scale-aging lab in Juneau. Scale ages will be entered into the spreadsheet files. When all input is complete, data lists

[1] This and subsequent product names are included for a complete description of the process and do not constitute product endorsement.

will be obtained and checked against the original field data. All entry and editing will be completed by January 31, 2016. Data files will be archived in 2 locations: on the Haines area office network hard drive at “Haines DSF S:\Data archive\Chilkat Chinook escapement\2015” and on the Douglas regional network hard drive at “Region1Shared-DSF R:\Divisions\SF\Offices\Haines\Data archive\Chilkat Chinook escapement\2015”.

The ADF&G-CF maintains the clearinghouse for all information on CWTs. Completed CWT tagging summary and release information will be sent to the Mark, Tag and Age Laboratory in Juneau, after first being given to the project leader and error checked using computer software. All CWT data (sampled fish, adipose-finclipped fish, decoded tags, location, data type, samplers, etc.) are archived and accessible on a permanent Alaska Department of Fish and Game (ADF&G) statewide database (http://tagotoweb.adfg.state.ak.us/CWT/reports/) and once per year are provided to the permanent coastwide database at the Pacific States Marine Fisheries Commission.

A final, edited copy of the data, along with a data map, will be sent to Division of Sport Fish, Research and Technical Services (RTS) in Anchorage electronically for archiving when the Fishery Data Series report is submitted for publication. The data map will include a description of all electronic files contained in the data archive, all data fields and details of where hard copies of any associated data are to be archived, if not in RTS. For this project, all tagging and recovery data are recorded by hand on specialized fields forms, transcribed into Excel™ workbooks and analyzed in Excel™ and other commercial and custom software. All age-sex-length and associated CWT and mark data for individual fish will be reformatted and archived in the Integrated Fisheries Database in the Douglas Region 1 office with the ADF&G-CF. All electronic data sent to RTS and not archived elsewhere, will include the Excel™ workbooks (presently in Office 2007). The original hard copies of all tagging and recovery forms, scale gum cards and acetates, will be logged and stored in the Region I age-sex-length data archives, located in file cabinets in the Douglas regional office.

The research coordinators and project leaders, in consultation with RTS staff, will develop an archive tree to keep track of all data archived with RTS and on Docushare in Region I, to facilitate accuracy of data archiving and retrieval, and then deposit data archives in the appropriate location.

Field sampling activities during 2015 are scheduled as follows:

1. Lower Chilkat River drift gillnet	June 10–July 24
2. Tahini River spawning grounds surveys	July 31–September 3
3. Kelsall River spawning grounds surveys	July 31–September 3

Data editing and analysis will be initiated before the end of the season. A memorandum summarizing observations including successes/difficulties for sampling each area, with recommendations for future project modification, will be prepared by field crews and presented to the project leader prior to leaving the project. The project leader will complete a draft Fisheries Data Series report by June 30, 2016.

Information from the project will also be summarized in reports to the Alaska Board of Fisheries and to the Chinook Technical Committee and the Transboundary Technical Committee of the Pacific Salmon Commission.

RESPONSIBILITIES

Brian W. Elliott, Fishery Biologist II, Lead Biologist. Writes operational plan, supervises overall project; edits, analyzes, and reports data. Supervises field operations to ensure the study design is implemented properly. He is also responsible for writing personnel evaluations for crew members.

Sarah Power, Biometrician II. Writes and reviews biometric portions of the operational plan, computes and reviews portions of the data analysis and final report.

Richard Chapell, Fishery Biologist III, Area Management Biologist. This position provides estimates of Haines marine sport harvest from the Haines marine creel program, collaborates with the Lead Biologist on data collection and analysis.

Jeff Nichols, Regional Research Coordinator. This position reviews the operational plan and the annual technical report and assists in obtaining funding for Chilkat River Chinook salmon projects.

Reed Barber, Fishery Technician III. This position is responsible for supervising 3 technicians during event 1 drift gillnet Chinook capture and tagging on the lower Chilkat River, and for the Kelsall River spawning grounds sampling portion of the project. He is to ensure that the technicians are trained in the proper operation of all aspects of the program including boat safety, fish handling, conduct in the public's view, and adherence to department policies. In addition, he is to inform the field supervisor of any maintenance or repairs that the crew is not capable of performing in a timely manner. He will be responsible for assisting preparation of, and adhering to the schedules, ensuring equipment is operated properly, and submitting data in a timely and accurate manner. With the field supervisor, he will attempt to resolve as many personnel and administrative problems as possible. This position will be responsible for a brief postseason report describing the conduct of the lower Chilkat River drift gillnet portion of the project, including any recommendations for improvement.

Liam Cassidy, Fishery Technician II. During lower river event 1, this position is responsible for deploying and retrieving the net, measuring fish, collecting the biological samples and tagging the fish. Further duties require assisting in the maintenance and repair of equipment. This position will operate the gillnetting boat. This position is also responsible for conducting spawning ground sampling on the Kelsall and Tahini rivers. He will assist the crew leader in capturing fish on the spawning grounds, and will collect age-sex-length information while inspecting fish for missing adipose fins.

Dana Van Burgh, Fishery Technician III. This position is responsible for the Tahini River spawning grounds sampling portion of the project. He ensures that crewmembers are trained in the proper operation of all aspects of the program including boat safety, fish handling, conduct in the public's view, and adherence to department policies. In addition, he is to inform the field supervisor of any maintenance or repairs that the crews are not capable of performing in a timely manner. Position will be responsible for assisting preparation of, and adhering to the schedules, insuring equipment is operated properly, and submitting data in an accurate and timely manner. With the field supervisor, he will attempt to resolve as many personnel and administrative problems as possible. This position will be responsible for a brief postseason report describing the details of the spawning grounds sampling, including any recommendations for improvement.

Mark Brouwer, Fishery Technician II. During lower river event 1, this position is responsible for deploying and retrieving the net, measuring fish, collecting the biological samples and tagging the fish. Further duties require assisting in the maintenance and repair of equipment. This position will operate the gillnetting boat. This position is also responsible for conducting spawning ground (carcass) surveys on the Kelsall River and Tahini River. This position will assist the crew leader in capturing fish on the spawning grounds, and will collect age-sex-length information while inspecting fish for missing adipose fins.

Mark Sogge, Fishery Biologist I. This position is responsible for supervising the Division of Commercial Fisheries fish wheel tagging operations on the lower Chilkat River. He ensures that crewmembers are trained in the proper operation of all aspects of the program including boat safety, fish handling, fish sampling, conduct in the public's view, and adherence to department policies. In addition, he is to inform his supervisor of any maintenance or repairs that the crews are not capable of performing in a timely manner. Position will be responsible for assisting preparation of and adhering to the schedules, insuring equipment is operated properly, and submitting data in an accurate and timely manner. With his supervisor, he will attempt to resolve as many personnel and administrative problems as possible. This position will be responsible for proofreading all Chinook salmon data collected at the fish wheels, including any recommendations for improvement.

David Folletti, Fishery Technician III. This position will assist in the installation, operation, and maintenance of the fish wheels. In addition, he and the crew will sample and mark Chinook salmon captured in the fish wheels while collecting biological data.

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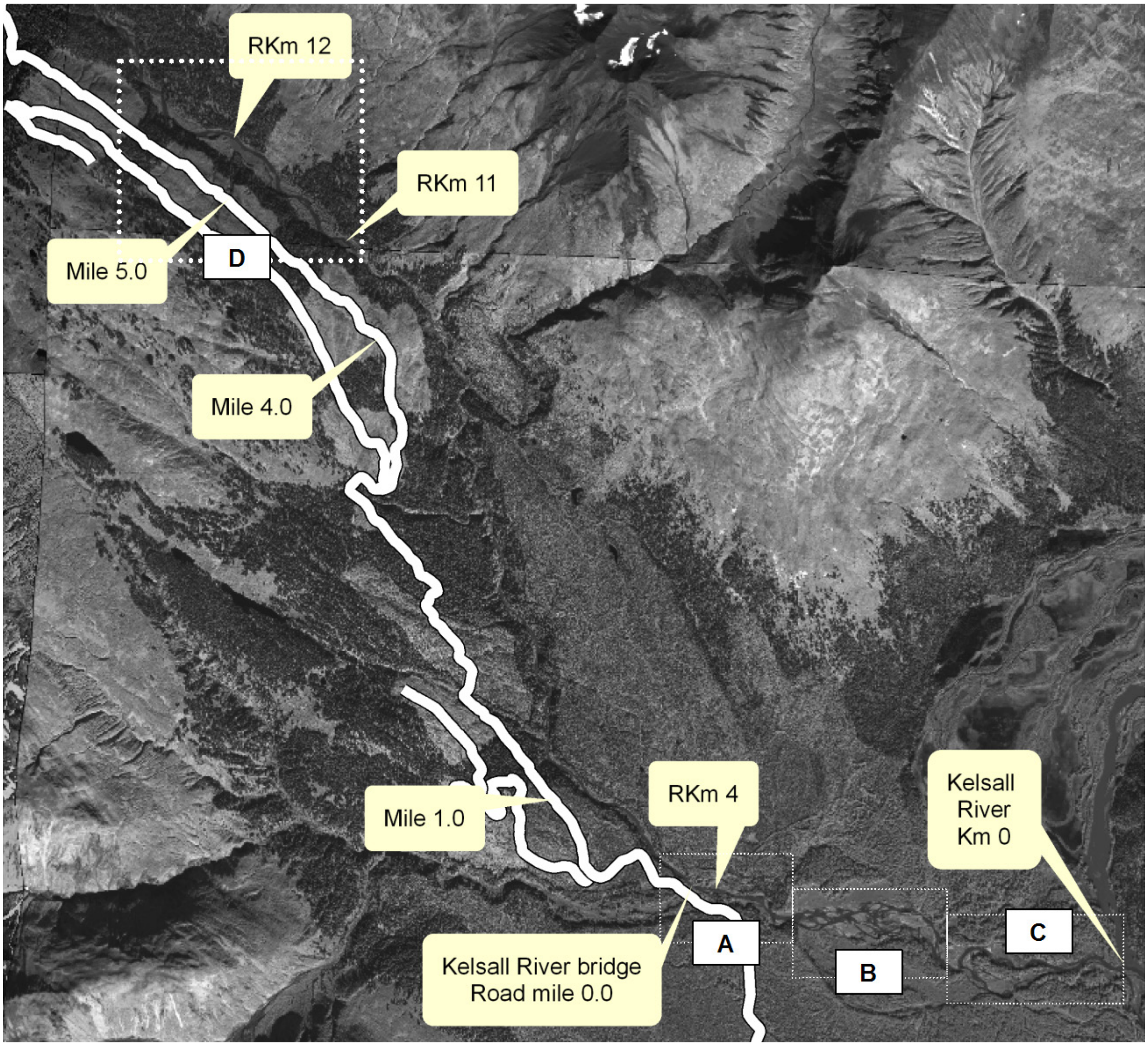
APPENDIX A: KELSALL RIVER DRAINAGE SAMPLING AREAS

Appendix A1.—Satellite photo of the Kelsall River showing the delta (area B), upper canyon (area D) and other sampling areas.



APPENDIX B: DATA COLLECTION FORMS

Appendix B1. –Coded wire tag sampling form.

Alaska Department of Fish and Game

FIGURE 2

Coded Wire Tag Sampling Form

Rack Return and Escapement Survey

Southeast Region

Page Info for this Sample Number only! See Instructions

PAGE [ ] OF [ ] PAGES

SAMPLE NUMBER: 1 ← LEAVE BLANK

SOURCE: (circle one) rack return / **escapement survey** (circled)

SURVEY SITE: CHILKAT RIVER

SAMPLE TYPE: **random** (circled) / select

SAMPLER: SAMPLER NAME

DATE SAMPLED: __ __ - __ __ - 1 __

SAMPLING INFORMATION

This Box to be completed for RANDOM Samples Only

SPECIES (CODE)	TOTAL # FISH CHECKED FOR AD-CLIPS	# AD-CLIPS SEEN	WERE ALL CHECKED?
(410)CHIN	9	1	**y** (circled) n
(411)JACK CHINOOK-ONLY	2	1	**y** (circled) n
(420)SOCK			y n
(430)COHO			y n
(440)PINK	Not in S.E.		y n
(450)CHUM			y n
(540)STHD			y n

AREA INFORMATION (DISTRICT - SUBDISTRICT)

101-	106-	111-	116-	157-	191-
102-	107-	112-	150-	181-	192-
103-	108-	113-	152-	182-	OTHER DISTRICTS
104-	109-	114-	154-	183-	______
105-	110-	115- 32	156-	189-	______

NAME of PLACE SURVEYED: (HATCHERY OR STREAM) CHILKAT RIVER

WATER TYPE: saltwater / **freshwater** (circled)

ANADROMOUS STREAM# (FRESHWATER-ONLY) 115-32-10250 %

HEAD RECOVERY INFORMATION

✓	HEAD NUMBER	SPECIES CODE	LENGTH (mid-eye to fork in mm)	CLIP	SEX
	532197	410	885	1	F
	532198	411	580	1	M

Anadromous Stream Codes:

Chilkat River:
115-32-10250
Kelsall River:
115-32-10250-2143
Tahini River:
115-32-10250-2175
Big Boulder Creek:
115-32-10250-2077-3098
Little Boulder Creek:
115-32-10250-2077-3078
37 Mile Creek:
115-32-10250-2077-3136

Species Code by Length:

410 – CHIN >618mm MEF
411 – JACK <618mm MEF

Adipose fin clip status:

1 – Good
2 - Questionable

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Appendix B2. –Chilkat River fish wheel capture form.

Description: Chilkat River Fish Wheels **Be sure to give tagged fish an upper left operculum punch**.															
Species: 41 (Chinook)					Stream Code: 115-32-10250							Year: 2015			
Gear: 08 (fish wheel)					Length Type: 02 (MEF)							Project: F-15-29			
Date	**Time**	**FW Site**	**Fish Num**	**Ad-clip**	*** CWT Head**	**** CWT Back**	**Sex**	**Length**	**Scale card num**	**Scale col. num**	**Lice**	***** Tag type**	**Tag num.**	**Upper left operc punch**	**Comments/ CWT cinch strap number**
6/11	850	2	1	n			F	1010	001	1	N	S	0001	y	Seal bite
6/12	1602	2	2	n			M	860	001	2	N	S	0002	y	bright
6/13	1630	2	3	n			M	960	001	3	N	S	0003	y	
6/14	930	2	4	n			M	880	001	4	N	S	0004	y	
6/15	850	2	5	y	y	n	M	650	001	5	N	-	-	n	CWT 265012
	850	2	6	n			M	690	001	6	N	S	0005	y	
	850	2	7	n			M	880	001	7	N	S	0006	Y	Turning
	950	1	8	n			M	810	001	8	N	S	0007	Y	
6/16	845	2	9	n			F	870	001	9	N	S	0008	y	
	845	2	10	n			M	780	001	10	N	S	0009	y	
	945	1	11	y	y	n	M	830	002	1	N	S	0010	y	
	1530	2	12	n			M	800	002	2	N	S	0011	y	Turning
6/17	851	2	13	n			F	960	002	3	Y	S	0012	y	
6/18	835	2	14	n			M	450	002	4	N	S	0013	y	
6/19	858	2	15	n			M	640	002	5	N	S	0014	y	
6/20	843	2	16	y	y	y	M	300	002	6	N	-	-	n	CWT 265013
6/21	1427	2	17	n			M	585	002	7	N	S	0015	y	
6/22	900	1	18	y	y	n	M	340	002	8	N	-	-	n	CWT 265014
	930	2	19	n			F	900	002	9	Y	S	0016	y	
	1500	2	20	n			M	780	002	10	N	S	0017	y	
	1500	2	21	n			M	420	003	1	N	T	1068	y	
	1500	2	22	n			F	685	003	2	N	S	1069	y	
6/23	850	1	23	n			F	780	003	3	Y	S	1070	y	

* For ad-clipped Chinook salmon:

Large (≥660 mm MEF): check for a CWT in the head before tagging. If no CWT, retain the head.

Small and medium (<660 mm MEF): retain all heads.

** Check all ad-clipped Chinook salmon for a CWT at the base of the dorsal fin.

*** S = spaghetti tag (≥440 mm MEF), T = t-bar anchor tag (<440 mm MEF),

Appendix B3. –Chilkat River drift gillnet capture form.

DATE	TIME	FISH #	PANEL	ADCLIP	* CWT Head	** CWT Back	SEX	LENGTH	CARD #	SCALE #	LICE	*** TAG TYPE	TAG #	COMMENTS CWT Cinch Strap #
6/13	0725	1	L	N			F	900	001	1	N	S	00301	Bright
6/17	0715	2	L	N			M	870	001	2	N	S	00302	Bright
6/19	1145	3	L	N			M	585	001	3	N	S	00303	Bright
6/22	1100	4	L	N			M	870	001	4	N	S	00304	Bright, seal bite
6/23	0800	5	S	N			F	825	001	5	N	S	00305	Bright
	0825	6	L	N			F	750	001	6	N	S	00306	Bright
	1015	7	L	N			M	745	001	7	N	-	-	Bleeding-not tagged
6/24	0925	8	L	N			F	880	001	8	N	S	00307	Bright
6/25	0740	9	L	N			M	980	001	9	N	S	00308	Steely grey
	0840	10	L	N			M	535	001	10	N	S	00309	Bright
6/26	1025	11	L	N			M	830	002	1	N	S	00310	Bright, gash dorsal
	1105	12	L	Y	Y	N	F	915	002	2	N	S	00311	Bright
6/27	0845	13	L	N			F	820	002	3	N	S	00312	Reddish
	0855	14	L	N			M	920	002	4	N	S	00313	Bright
	1125	15	L	N			M	570	002	5	N	S	00314	Bright
6/28	0700	16	S	Y	Y	Y	M	435	002	6	N	-	-	CWT 264123; back Y
	0715	17	S	N			F	810	002	7	N	S	00315	Bright
	1000	18	S	N			F	870	002	8	N	S	00316	Bright 4 scales
6/29	0725	19	L	N			M	760	002	9	N	S	00317	Bright
	0950	20	L	Y	Y	N	M	355	002	10	N	-	-	CWT 264124; back N
7/1	0705	21	S	N			F	680	003	1	Y	S	00318	Bright
	0812	22	S	N			F	920	003	2	Y	S	00319	Reddish
	0905	23	S	N			F	825	003	3	N	S	00320	Pink
	1130	24	L	N			F	930	003	4	N	S	00321	Chromer
7/2	1150	25	S	N			M	395	003	5	N	T	01003	Bright

* For ad-clipped Chinook salmon:
Large (≥660 mm MEF): check for a CWT in the head before tagging. If no CWT, retain the head.
Small and medium (<660 mm MEF): retain all heads.
** Check all ad-clipped Chinook salmon for a CWT at the base of the dorsal fin.
***S = spaghetti tag (≥440 mm MEF), T = t-bar anchor tag (<440 mm MEF)

Appendix B4. –Chilkat River drift gillnet effort form.

Start Time 0647 (first drift)

Date 6-18-15 Crew LD / RB

End Time 1145 (last drift)

Water Temp. 7.1º at 0645 Hrs.

Water Depth 161 at 0645 Hrs.

Water Temp. 8.1º at 1305 Hrs.

Water Depth 160 at 1305 Hrs.

Weather Comments PtlyCldy/Wind S5k

Water Comments High, flat, muddy

Drift Num.	Done	Num. kings	Area	Channel	% incomplete	Comments
1	X		1	R		
2	X		2	R		
3	X		3			
4	X		4			
5	X		5	R		
6	X	1	6	R	50%	M 710 tag #4590 Caught near shore
7	X		1	L		
8	X		2	L		Large king got away
9	X		3			
10	X		4			
11	X		5	R		
12	X		6	R		
13	X		1	R		
14	X		2	R		
15	X	1	3		55%	M 920 tag #4591
16	X		4			
17	X		5	R		
18	X		6	R		
19	X		1	L		
20	X		2	L		
21	X		3			
22	X		4			
23	X		5	R		
24	X		6	R		
25	X		1	R		
26	X		2	R		
27	X		3			
28	X		4			
29	X		5	R		
30	X		6	R		
Sum	XXXX	2	XXXX	XXX	105%	Add these sums to page 2 totals.

Turn over to continue

Appendix B4. –Page 2 of 2.

Drift Num.	Done	# Fish	Area	Channel	% Incomplete	Comments
31	X		1	L		
32	X		2	L		
33	X		3			
34	X		4			
35	X		5	R		
36	X		6	R		
37	X		1	R		
38	X		2	R		
39	X		3			
40	X		4			
41	X		5	R		
42	X		6	R		
43	X		3			
Sum	XXXX	2	XXXX	XXX	**(A)** 105%	Totals including sums from page 1
44	X		4			
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
Sum	XXXX	2	XXXX	XXX	Should be <1	Totals from all drifts

Calculate (**A**/100) = Number of drifts (largest whole number) to achieve 43 complete drifts. Repeat this procedure until less than one drift remains to achieve the equivalent of 43 complete drifts.

Appendix B5. –Chilkat River spawning ground sampling form.

Location: **Kelsall River** **Crew:** MZ, DVB

DATE	* GEAR	FISH num	SEX	Ad-CLIP	CWT HEAD	CWT BACK	Length MEF	SCALE CARD	SCALE COL.	** COND	OP. PUNCH Lower given	OP. PUNCH Upper present	*** Kels. area	TAG Num or LAP	COMMENTS/ Cinch strap number
8/8	S	1	F	N			780	1	1	S	Y	Y	B		Tag missing, No LAP
8/11	S	2	M	N			875	1	2	S	Y	Y	A	4001	Good s-tag placement
	S	3	M	N			880	1	3	S	Y	Y	B	4257	Left spag tag in fish
8/12	S	4	M	N			1150	1	4	C	Y	N	A		
	C	5	M	N			825	1	5	C	Y	N	A		
8/13	S	6	F	N			900	1	6	S	Y	N	A		
8/15	S	7	F	N			635	1	7	S	Y	N	B		
	S	8	F	N			780	1	8	S	Y	N	B		
	C	9	F	N			785	1	9	C	Y	Y	B	4002	Good s-tag placement
8/16	S	10	F	N			795	1	10	SO	Y	N	A		
	S	11	F	N			820	2	1	SO	Y	N	A		
	S	12	F	N			825	2	2	S	Y	N	A		
	S	13	M	N			940	2	3	SO	Y	N	A		
	C	14	F	Y	Y	N	730	2	4	C	N	N	A		CWT #626456, firm
	S	15	M	Y	Y	N	535	2	5	S	N	N	A		CWT #626457
	S	16	M	N			910	2	6	SO	Y	N	A		
	C	17	M	N			>660	2	7	C	Y	N	A		Estimated length group
	C	18	F	N			790	2	8	C	Y	N	A		
	S	19	M	N			920	2	9	S	Y	N	B		
	S	20	M	N			680	2	10	S	Y	N	B		
8/17	C	21	M	N			1010	3	1	C	Y	N	A		
	C	22	F	N			800	3	2	SO	Y	N	B		
	C	23	M	N			435	3	3	C	Y	Y	A	605	Good T-tag placement
8/18	S	24	F	N			855	3	4	S	Y	N	A		
	S	25	M	N			520	3	5	S	Y	Y	A	4210	Hole from tag wear
	S	26	F	N			750	3	6	S	Y	N	A		

* **S** = Snagging, **GN** = Gillnet, **DN** = Dipnet, **E** = Seine, **C** = Carcass pickup.

** **B** = Bright/Turning, **S** = Spawning, **SO** = Spawned out, **C** = Carcass.

*** Kelsall/Nataga areas: **A** = above delta, **B** = delta, **C** = below delta, D = upper canyon.

APPENDIX C: SIZE AND SEX SELECTIVITY DETECTION PROCEDURES FOR MARK-RECAPTURE EXPERIMENTS

Appendix C1.–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 C 2.-Tests of consistency for the Peterson estimator (from Seber 1982, page 438).

Tests of consistency for Petersen estimator

Of the following conditions, at least one must be fulfilled to meet assumptions of a Petersen estimator:

1. Marked fish mix completely with unmarked fish between events;
2. Every fish has an equal probability of being captured and marked during event 1; or,
3. Every fish has an equal probability of being captured and examined during event 2.

To evaluate these three assumptions, the chi-square statistic will be used to examine the following contingency tables as recommended by Seber (1982). At least one null hypothesis needs to be accepted for assumptions of the Petersen model (Bailey 1951, 1952; Chapman 1951) to be valid. If all three tests are rejected, a temporally or geographically stratified estimator (Darroch 1961) should be used to estimate abundance.

I.-Mixing Test[a]

Area/time	Time/area where recaptured				Not recaptured
where marked	1	2	…	t	(n_1-m_2)
1					
2					
…					
s					

II.-Equal Proportions Test (SPAS terminology)[b]

	Area/time where examined			
	1	2	…	t
Marked (m_2)				
Unmarked (n_2-m_2)				

III.-Complete Mixing Test (SPAS terminology) [c]

	Area/time where marked			
	1	2	…	s
Recaptured (m_2)				
Not recaptured (n_1-m_2)				

[a] This tests the hypothesis that movement probabilities (θ) from time or area i (i = 1, 2, s) to section j (j = 1, 2, t) are the same among sections: H_0: $\theta_{ij} = \theta_j$.

[b] This tests the hypothesis of homogeneity on the columns of the 2-by-t contingency table with respect to the marked to unmarked ratio among time or area designations: H_0: $\Sigma_i a_i\theta_{ij} = kU_j$, where k = total marks released/total unmarked in the population, U_j = total unmarked fish in stratum j at the time of sampling, and a_i = number of marked fish released in stratum i. Note that failure to reject H_0 means the Pooled Petersen estimator can be considered consistent only if the degree of closure among tagging strata is constant ($\Sigma_j\theta_{ij} = \lambda$,) (Schwarz and Taylor 1998). One way this may be achieved is to sample all or the large majority of spawning areas.

[c] This tests the hypothesis of homogeneity on the columns of this 2-by-s contingency table with respect to recapture probabilities among time or area designations: H_0: $\Sigma_j\theta_{ij}p_j = d$, where p_j is the probability of capturing a fish in section j during the second event, and d is a constant.