Regional Operational Plan CF.1J.14-03

Operational Plan: Stock Assessment Studies of Chilkat River Adult Salmon

by

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and

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June 2014

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

REGIONAL OPERATIONAL PLAN CF.1J.14-03

OPERATIONAL PLAN: STOCK ASSESSMENT STUDIES OF CHILKAT RIVER ADULT SALMON

by

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Division of Commercial Fisheries

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SIGNATURE PAGE

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Approval

Title	Name	Signature	Date
Project leader	Mark M. Sogge and Randall L. Bachman		06/10/2014
Biometrician	Sara Miller		06/10/2014
Research Coordinator	Steven C. Heinl		06/10/2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PURPOSE

The primary purpose of this project is to estimate the abundance of sockeye, Chinook, and fall chum salmon in the Chilkat River drainage, and provide information useful for inseason management of the District 15 (Lynn Canal) commercial salmon drift gillnet fishery. The Alaska Department of Fish and Game operates two fish wheels in the Chilkat River, and a Dual Frequency Identification Sonar (DIDSON) sonar counting system on the outlet of Chilkat Lake. The sonar is operated from mid-June through the first week of October to directly enumerate sockeye salmon into the lake. The fish wheels are operated continuously from early June to mid-October to provide inseason information on relative abundance and timing of all Pacific salmon in the Chilkat River and the opportunity to sample fish for age, sex, and length data. Sockeye and Chinook salmon are marked at the wheels, and the ratio of marked to unmarked fish captured on the spawning grounds forms the basis of total escapement estimates in the Chilkat River. In addition, the fish wheel catch of chum salmon is used as a relative index to estimate the spawning escapement of Chilkat River fall chum salmon. Sockeye salmon scale samples collected by this project provide known-origin samples used in scale pattern analysis to estimate contributions to mixed stock harvests in the District 15 commercial drift gillnet fishery. The proportions of scale samples classified as Chilkat Lake or Chilkat River mainstem fish are applied to the harvest to provide weekly estimates of stock contribution for inseason management of the fishery and postseason estimates of total harvest by stock. This project also supports the collection of basic limnological information at Chilkat Lake. This project is coordinated with the Division of Sport Fish stock assessment studies of Chilkat River Chinook and coho salmon.

BACKGROUND

The Chilkoot and Chilkat river watersheds, located in northern Southeast Alaska near the town of Haines, support two of the largest sockeye salmon (*Oncorhynchus nerka*) runs in Southeast Alaska (Figure 1). Between 1900 and 1920, the annual commercial harvest of sockeye salmon in northern Southeast Alaska averaged 1.5 million fish, the majority of which were believed to originate from Chilkat and Chilkoot river watersheds (Rich and Ball 1933). Over the past two decades, the average sockeye salmon harvest in northern Southeast Alaska was 0.5 million fish, of which an average 96,000 fish originated from Chilkat Lake and 65,000 fish originated from Chilkoot Lake (Eggers et al. 2010). Historically, Chilkat Lake sockeye salmon were harvested in the large fish trap and purse seine fisheries in Icy and northern Chatham straits as well as in terminal drift gillnet areas of Lynn Canal. Fish traps were eliminated with Alaska statehood in 1959 and Lynn Canal developed into a designated drift gillnet fishing area (District 15) where most of the commercial harvest of Chilkat sockeye salmon takes place (Figure 1). A smaller portion of the Chilkat run is harvested in the commercial purse seine fisheries that target pink salmon (*O. gorbuscha*) in Icy and northern Chatham straits. Annual contributions to those fisheries are not known and likely vary annually depending on fishing effort and the strength of pink salmon runs. Chilkat sockeye salmon are also harvested annually in subsistence fisheries in Chilkat Inlet and Chilkat River, with reported harvests for the period 1990–2004 averaging approximately 6,700 fish per year (Eggers et al. 2010).

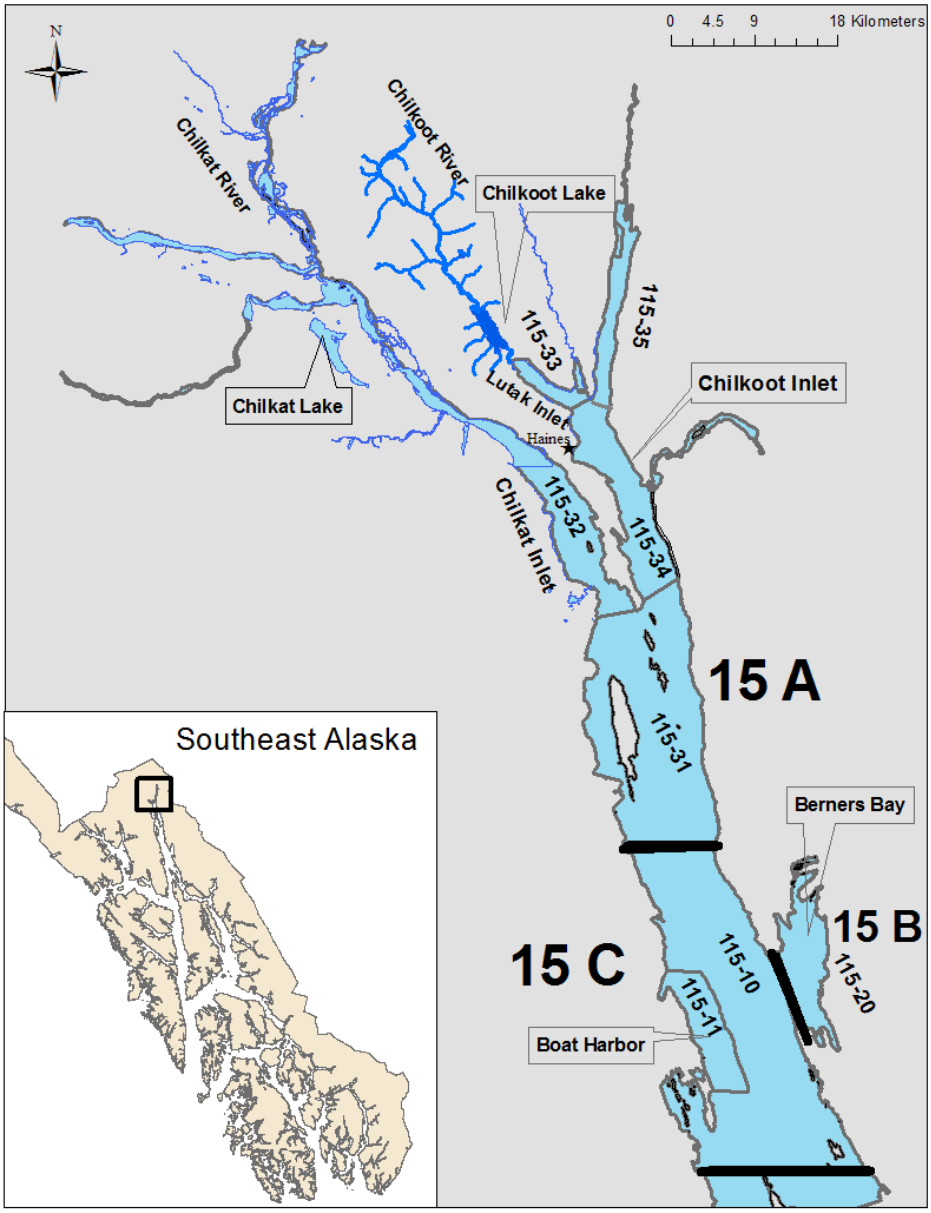

Figure 1.–The Chilkat and Chilkoot River watersheds and the District 15 commercial fishing sub districts in Lynn Canal.

The Alaska Department of Fish and Game (ADF&G) began stock assessment work on Chilkat Lake sockeye salmon following statehood in 1959. The first adult salmon counting weir was established across the outlet of Chilkat Lake in 1967 (Eggers et al. 2010). The weir was operated annually through 1995, but questions concerning the accuracy of the count, as well as funding issues, led to replacement of the weir count with annual mark-recapture studies to estimate escapement. The weir count alone was considered to be an unreliable estimate of escapement due to periodic flow reversals in the outlet stream and increased boat traffic, which required frequent lowering of a boat gate in the center of the weir through which fish could move uncounted (Kelley and Bachman 2000).

Mark-recapture studies to estimate sockeye salmon escapements in the Chilkat drainage have been conducted since 1994 using two fish wheels operated by ADF&G in the lower Chilkat River as a marking platform (Table 1; Appendices A–D). The fish wheel project provides timely information on stock composition and abundance useful for inseason management of the Lynn Canal commercial drift gillnet fishery. The fish wheel program was operated experimentally in 1977, 1978, 1982, 1983, and again in 1990 to assess fall chum (*O. keta*) and coho salmon (*O. kisutch*) escapement (Kelley and Bachman 2000), and Chinook salmon (*O. tshawytscha*) escapements since 1991 (Johnson et al. 1992).

Table 1.–Chilkat River fish wheel dates of operation and catches of Chinook, sockeye, coho, pink, and chum salmon, 1977, 1978, 1982, 1983, 1990, 1991, and 1994 to 2013.

Year	Dates of Operation	Fish Wheel Catch					Number, Type, and Basket Configuration of Fish wheels
		Chinook	Sockeye	Coho	Pink	Chum	
1977	8/21–10/21	0	108	729	0	604	NA
1978	8/14–11/9	0	119	369	14	1,586	NA
1982	10/5–26	0	10	78	0	254	1 wooden 4–basket wheel
1983	8/9–10/3	0	299	190	67	176	1 wooden 4-basket wheel
1990	8/14–10/25	0	2,984	3,686	1,140	3,025	2 wooden 4-basket wheels
1991	6/10–7/20	382	1,385	0	578	8	2 wooden 4-basket wheels
1994	6/18–9/11	214	3,865	140	532	196	2 wooden 4-basket wheels
1995	6/16–9/16	139	3,231	1,353	609	2,288	2 wooden 4-basket wheels
1996	6/22–9/16	68	3,118	546	494	430	2 wooden 4-basket wheels
1997	6/11–10/9	179	5,016	1,057	1,657	1,315	2 aluminum 3-basket wheels
1998	6/8–10/13	138	5,747	1,071	1,738	1,947	2 aluminum 3-basket wheels
1999	6/7–10/8	320	7,735	1,697	15,740	4,250	2 aluminum 3-basket wheels
2000	6/9–10/7	99	3,709	1,495	1,265	4,045	2 aluminum 3-basket wheels
2001	6/6–10/7	172	4,417	2,550	1,971	4,680	2 aluminum 3-basket wheels
2002	6/7–10/19	270	4,219	5,090	1,030	2,898	2 aluminum 3-basket wheels
2003	6/6–10/21	289	4,551	5,306	2,903	3,846	2 aluminum 3-basket wheels
2004	6/7–10/19	185	4,366	1,745	5,821	4,277	2 aluminum 3-basket wheels
2005	6/6–10/11	113	3,692	1,350	6,869	3,125	2 aluminum 3-basket wheels
2006	6/7–10/14	140	3,169	4,889	5,150	10,563	2 aluminum 3-basket wheels
2007	6/11–10/9	122	2,751	1,658	4,202	4,967	2 aluminum 3-basket wheels
2008	6/9–10/10	157	6,412	3,217	4,603	6,770	2 aluminum 3-basket wheels
2009	6/11–10/9	235	9,045	2,029	7,531	5,049	2 aluminum 3-basket wheels
2010	6/7–10/11	140	3,504	1,149	1,967	1,369	2 aluminum 3-basket wheels
2011	6/7–10/7	234	4,940	1,594	12,404	5,517	2 aluminum 3-basket wheels
2012	6/11–10/7	105	4,096	1,005	2,207	4,401	2 aluminum 3-basket wheels
2013	6/5–10/3	197	5,961	1,433	10,569	2,251	2 aluminum 3-basket wheels
Average Catch [a] 1997–2013		182	4,902	2,255	5,155	4,192	

[a] Average catch calculated for the years of similar fish wheel efficiency.

Mark-recapture methods to estimate escapements of Chilkat Lake sockeye salmon varied over time. From 1994 to 1995, sockeye salmon were marked at the fish wheels (first event) and the marked-unmarked ratio was determined from sampling at the Chilkat Lake weir and spawning beaches in Chilkat Lake (second event). The weir was not operated from 1996 to 1998, however, and the second-event sampling was conducted only at holding and spawning areas in the lake.

Analysis of these data revealed that fish marked later in the run were missed entirely in recovery samples since they had not moved into spawning areas before the lake iced-up in November (Kelley and Bachman 2000). The Chilkat Lake weir project was restarted in 1999 and continued in operation until 2007. However, the weir was not used to directly count escapement into Chilkat Lake but was used as a platform to sample sockeye salmon for marks applied at the fish wheels and to determine age, sex, and length composition of the stock. Since the start of the 2008 season, a DIDSON sonar has been used at the weir site to count adult sockeye salmon escapement into Chilkat Lake.

A scale pattern analysis program was initiated in 1980 to estimate contributions of Chilkat and Chilkoot Lake sockeye salmon to the District 15 commercial drift gillnet fishery, based on distinct differences in their freshwater scale patterns (Stockley 1950, Bergander 1974). Scale pattern analysis was refined (Marshall et al. 1982, McPherson and Marshall 1986) and expanded to include a third stock group, a combination of Chilkat River mainstem and Berners Bay stocks that also contribute to early-season harvests in Lynn Canal (McPherson 1987b). Studies conducted to verify accuracy showed that classifications based on visual analysis were highly accurate and the difference between initial and corrected estimates varied by only 2% or less (McPherson and Marshall 1986; McPherson 1987a, 1987b; McPherson and Jones 1987; McPherson 1989; McPherson et al. 1992; McPherson and Olsen 1992).

The Chilkat Lake sockeye salmon run has been managed for at least five different escapement goals since 1976. Informal goals of 60,000–70,000 (1976–1980) and 70,000–90,000 (1981–1989) (Bergander et al. 1988) were replaced in 1990 with a *biological* escapement goal of 52,000–106,000 sockeye salmon based on extensive stock-recruit analysis by McPherson (1990). Efforts to update the escapement goal were hindered by lake stocking in the 1990s and concerns regarding accuracy of weir counts (Geiger et al. 2005). Geiger et al. converted the weir-based goal to mark-recapture units and revised the goal to a *sustainable* escapement goal of 80,000–200,000 sockeye salmon. In 2009, the escapement goal was revised again to a *biological* escapement goal of 70,000–150,000 sockeye salmon (Eggers et al. 2008, 2010).

Mainstem sockeye salmon escapements have been estimated through mark-recapture studies since 1999. Based on mark-recapture studies, catch statistics from the gillnet fishery, and fish wheel scale pattern analysis data, it is estimated that 80–90% of the sockeye salmon produced in the Chilkat River drainage originate from Chilkat Lake, and the remainder are produced in the Chilkat River mainstem and its tributaries (Kelley and Bachman 2000; Bachman 2005, 2010). For management purposes, sockeye salmon that spawn in the Chilkat River mainstem or its tributaries are considered a single stock. Important mainstem sockeye salmon spawning locations include Mule meadows, Mosquito Lake, Little Salmon River, and Bear flats. Formal escapement goals have not been established for Chilkat mainstem spawners, since scale pattern analysis cannot be used to differentiate between Chilkat River mainstem sockeye salmon and Berners Bay sockeye salmon harvested in District 15. Thus it is not possible to estimate the number of Chilkat River mainstem sockeye salmon harvested. Without these data, the spawner-recruit relationship for Chilkat River mainstem sockeye salmon remains uncertain.

In addition to the sockeye salmon stocks, the Chilkat River drainage supports the largest fall chum salmon run in the region (Halupka et al. 2000). Chilkat River fall chum salmon populations originate from the Klehini River (early run) and the Chilkat River, mainly along the Tsirku River delta near the village of Klukwan (late run). Chilkat River fall chum salmon harvests occur primarily after statistical week 33 (mid-August) in the District 15 drift gillnet

fishery. The chum salmon escapement to the Chilkat River drainage was historically monitored via aerial surveys; however, ADF&G considers historic aerial surveys of the drainage to be unreliable primarily due to the highly glacial nature of the system causing the water to be opaque. Mark-recapture studies were conducted in conjunction with the fish wheel project in 1990 and 2002–2005 (Bachman 2005, Bachman 2010). These studies were designed to estimate the spawning population of chum salmon and relate those estimates to the fish wheel catches and aerial surveys of the primary spawning areas. During those five years, the total spawning population estimates ranged from 166,000 to 310,000 chum salmon and the cumulative fish wheel catch averaged 1.55% of the total escapement. This percentage is now used to expand the fish wheel catch and estimate the total chum salmon escapement for the drainage.

The current escapement goal for Chilkat River fall chum salmon is 75,000–170,000 chum salmon, based on a stock recruit analysis and the range of escapements estimated to provide 90% of maximum sustained yield (Eggers and Heinl 2008). The recommended goal is considered a *sustainable* escapement goal rather than a *biological* escapement goal, because only nine brood years were used in the analysis (1994–2002). This goal is currently under review.

The commercial drift gillnet fleet in District 15 (Figure 1) is the primary harvester of Chilkat River salmon stocks, and the management of this fishery is the central focus of the ADF&G Commercial Fisheries office in Haines. This project provides management with escapement assessments of sockeye and fall chum salmon to the Chilkat River drainage and allows for timely strategy adjustments to the District 15 (Lynn Canal) commercial drift gillnet fishery based on inseason comparison of weekly fish wheel counts with historic counts and other criteria. Data collected by this project, in conjunction with data contributed from the Lynn Canal salmon marine stock composition program, are used to assess the health, productivity, and pattern of exploitation of Chilkat River salmon stocks, to monitor trends and changes in stock abundances, and to evaluate established escapement goals.

Other activities associated with this project include collection of basic limnological data at Chilkat Lake, encompassing water temperature and light penetration profiles as well as zooplankton sampling to estimate species composition and abundance. Coho and Chinook salmon are sampled at the wheels and examined for coded wire tags, and Chinook salmon are tagged as part of the mark-recapture program conducted by the ADF&G Division of Sport Fish (Chapell and Elliott 2013a, 2013b).

STUDY SITE

The Chilkat River drains a large watershed stretching from British Columbia, Canada to the northern end of Lynn Canal, near Haines, Alaska (Figure 2). The watershed encompasses approximately 1,600 km^2, and the main river and tributaries comprise approximately 350 km of river channels. Principle tributaries include the Tahkin, Tsirku, Klehini, Kelsall, and Tahini rivers. The Chilkat River discharge rates range from 80 to 20,400 ft^3/s (Bugliosi 1988). The Chilkat supports large runs of sockeye, coho, chum, Chinook, and pink salmon. The Chilkat River receives input from several different glaciers, and heavy silt loads in the main river impairs visual salmon stock assessment methods.

Chilkat Lake (59°19’34” N, 135°53’33” W) is a relatively large clear water lake with a surface area of 9.8 x 106 m^2 (2,432 acres), mean depth of 32.5 m, a maximum depth of 57 m, and a volume of 319 x 10^6 m^3. The lake drains into the Chilkat River by way of the Tsirku River. Chilkat Lake is located approximately 27 river miles upstream from the town of Haines. Average

precipitation for this area is approximately 165 cm/yr. (Bugliosi 1988). Resident fish include sockeye salmon, coho salmon, Dolly Varden (*Salvelinus malma*), cutthroat trout (*Salmo clarki*), threespine stickleback (*Gasterosteus aculeatus*), sculpin (*Cottus sp*.) and whitefish (*Prosopium cylindraceum*) (Johnson and Daigneault 2013). Since the weir installation ADF&G has observed small numbers of adult pink and chum salmon moving through the Chilkat Lake weir, but it is not known if these fish enter the lake.

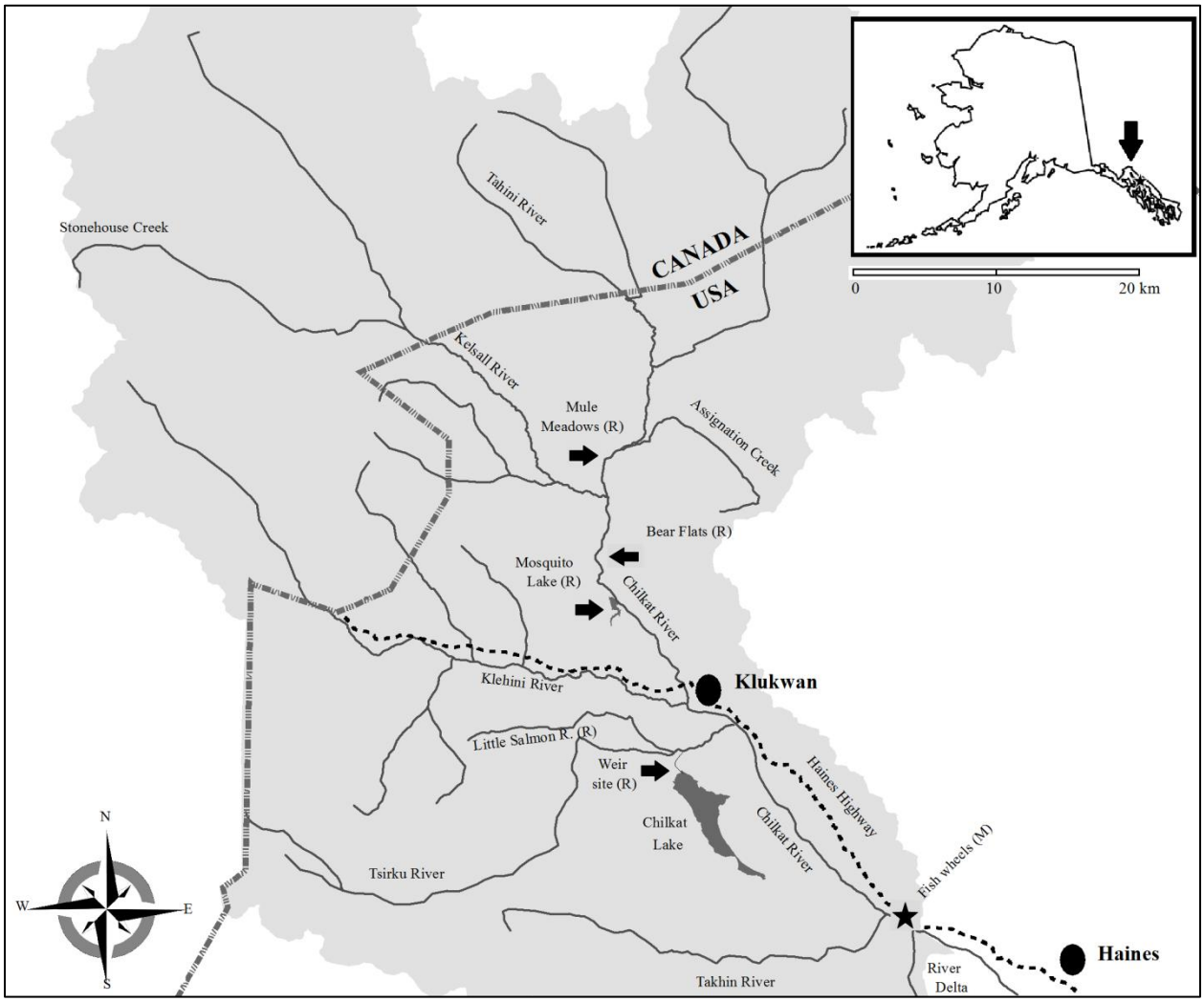

Figure 2.–Chilkat River drainage, with fish wheel locations (marking locations-M), mainstem sockeye salmon recovery sites (R), and Chilkat Lake weir location.

OBJECTIVES

PRIMARY OBJECTIVES

The primary objectives of this project are to:

1. Estimate the annual escapement of sockeye salmon into the Chilkat River mainstem, such that the estimated coefficient of variation is no greater than 15% of the point estimate.
2. Enumerate the annual escapement of adult sockeye salmon into Chilkat Lake.

3. Estimate the age, sex and length composition of sockeye salmon escapements to Chilkat Lake and Chilkat River mainstem so that the estimated proportion of each major age class is within 5% of the true value with at least 95% probability.
4. Estimate Chilkat River fall chum salmon escapement based on an expanded fish wheel count.
5. Estimate the annual commercial harvest of Chilkoot Lake sockeye salmon in the Lynn Canal drift gillnet fishery.

SECONDARY OBJECTIVES

The secondary research objectives of this project are to:

1. Sample all adult Chinook and coho salmon captured at the fish wheels for adipose fin clips and for coded wire tags (CWT).
2. Mark all adult Chinook salmon in conjunction with the Chilkat River Chinook Salmon Escapement Study conducted by ADF&G Division of Sport Fish.
3. Sample Chinook and coho salmon captured at the fish wheels for age, sex, and length determination.
4. Estimate the age, sex and length composition of the fall chum salmon escapement to the Chilkat River.
5. Sample pink salmon captured at the fish wheels for sex and length determination.
6. Measure water column temperature and record light profiles, and estimate zooplankton species composition, size, density, and biomass in Chilkat Lake on a monthly basis from April to October.

METHODS

The escapement of Chilkat River mainstem (non-Chilkat Lake) sockeye salmon will be estimated using a 2-sample mark-recapture experiment for a closed population (Seber 1982). Adult sockeye salmon will be captured in the Chilkat River fish wheels and marked in event 1 between the first week of June and mid-October. Adult sockeye salmon will be captured on the spawning grounds and inspected for marks in event 2 from mid-June through mid-September. Event 2 sampling will be conducted in the primary spawning areas in the Chilkat drainage, including Mule Meadows, Bear Flats, Mosquito Lake, Tahini River, Little Salmon River, and the Kelsall River (Figure 2). All sampled sockeye salmon will be measured during each event. The length information will provide a way of testing assumptions of the mark-recapture estimates by comparing the lengths of fish captured in the marking event (fish wheels) to those collected on the spawning grounds or recovery event.

The escapement of Chilkat Lake sockeye salmon will be estimated by the direct counting of salmon as they pass through the weir in the outlet stream of Chilkat Lake. A DIDSON sonar will be used to enumerate the escapement of adult Chilkat Lake sockeye salmon. The weir serves as a means to temporarily prevent the passage of salmon, allowing for the species composition and age, sex, and length composition sampling of the run. Additionally, sockeye salmon will be examined for marks applied at the fish wheels, and these data will be used to estimate the duration of the sockeye salmon in-river migration.

CHILKAT RIVER FISH WHEEL OPERATION

Two three-basket configured fish wheels will be operated in the lower Chilkat River located near mileposts 8 and 9.5 along the Haines highway. Alternate fishing areas may become necessary if conditions warrant. Fish wheels will be deployed in the first week of June and operated continuously (i.e., 24 hours each day) through mid-October (statistical weeks 23 to 42; see Appendix E for statistical week calendars). The crew will consist of five ADF&G, Division of Commercial Fisheries staff: a Fishery Biologist II assistant field project leader, a Fish & Wildlife Technician III crew leader, and three Fish and Wildlife Technician II crew members. When the crew is at the fish wheel, there will be at least three crew members present at all times.

Each fish wheel will have an aluminum live box attached to the outside of each pontoon of the structure. Fish caught in the seine mesh lined baskets are guided through troughs and enclosed chutes into the live boxes and held until they are sampled. The live boxes sit in the flowing river and are perforated to allow the fresh river water to flow through at all times. The fishing depth of each fish wheel is adjustable by means of a tower and chain hoist system. The wheels will be fished as deeply as possible, and fishing depth will be adjusted in response to varying water levels and river depths.

Captured fish will be sampled a minimum of twice each day. Since the majority of the fish are caught overnight, the live boxes will be inspected, data recorded, and fish marked or tagged first thing each morning. Live boxes will be examined and fish processed again in the afternoon. Additional sampling may be required during periods of peak fish movement. All sampling, marking, and measurement of fish will take place in padded troughs filled with fresh river water that will be changed often. The fish will be handled with care.

MAINSTEM SOCKEYE SALMON ESCAPEMENT ESTIMATE

Event 1, Chilkat River Fish Wheels

Each healthy, uninjured sockeye salmon will be measured from mid eye to tail fork (MEF) and marked with an adipose and secondary fin clip. Fish less than or equal to 360 mm MEF (jacks) have historically been excluded from the mark-recapture study, because they can swim through the Chilkat Lake weir uncounted. Thus, historical escapement estimates, both for Chilkat Lake and the mainstem Chilkat River, have not included jack sockeye salmon. Beginning this year, all sockeye salmon will be marked at the fish wheels, and recovery data will be recorded separately for jack sockeye salmon and non-jack sockeye salmon. A review of the historical length and age data for the Chilkat River has resulted in the redefinition of jack sockeye salmon to include those fish $\leq$ 400 mm in length (MEF).

The adipose clip will be used as the primary mark to identify all sockeye salmon that were captured at the fish wheels and marked with a secondary fin clip. Secondary fin clips will be applied over 10 marking strata on the bi-weekly schedule in Table 2, which will allow determination of the period in which the fish was initially marked at the fish wheels. This will help to pool strata when marked fractions are similar. Criteria used to select marks for this program are that all marks are relatively easy to apply, all marks are permanent, and marks are harmless and easily detected in recovery events.

Table 2.–Secondary fin clip schedule for Chilkat River sockeye salmon.

Dates (varies annually)	Statistical Weeks	Mark (adipose clip+)
Start–15 June	Start–24	Adipose fin clip only
16 June–29 June	25–26	Right axillary appendage clip
30 June–13 July	27–28	Left axillary appendage clip
14 July14–27 July	29–30	Right ventral fin clip
28 July–10 August	31–32	Left ventral fin clip
11 August–24 August	33–34	Right pectoral fin clip
25 August–7 September	35–36	Left pectoral fin clip
8 September–21 September	37–38	Clip last 4 rays of dorsal fin
22 September–5 October	39–40	Right axillary appendage clip
6 October–End	41–End	Left axillary appendage clip

Every sockeye salmon captured in the fish wheels will be measured to the nearest 5 mm MEF length, examined externally to determine the sex, and sampled for scales as described in the Data Collection section. Scale samples will be taken from the first 40 fish sampled from the live boxes and will be sent to Juneau for aging and stock composition determination. Jack sockeye salmon (≤ 400 mm MEF) will be measured and, if they fall within the first 40 fish of the day, sampled for scales.

Event 2, Recovery on Spawning Grounds

Department personnel will be responsible for sampling sockeye salmon at Chilkat River mainstem spawning locations. Project crews will sample spawning fish with beach seines in sloughs and small tributaries to the mainstem Chilkat River and its major tributaries when water levels permit. Sampling locations include Mule Meadows, Bear Flats, Mosquito Lake, Tahini River, Little Salmon River, and the Kelsall River (Figure 2). Sampling of mainstem spawners will commence approximately mid-July and continue into mid-September. ADF&G recovery crews will consist of three persons: two to operate the beach seine and handle fish, and the third to operate the skiff and record data. This procedure entails finding spawning sockeye salmon on spawning grounds, quickly deploying a seine around groups of fish, and sampling the catch. Additional samples will be obtained by examining carcasses of spawn-outs if stream surveys are conducted.

All captured sockeye salmon must be examined individually for marks as they are removed from the beach seine. Other species of fish captured by the seine will be removed and released without measurement or counting. ADF&G staff will use the following procedure when examining sockeye salmon for marks:

1. Sockeye salmon will be examined for a lower left operculum punch. If a punch is present the fish will be tallied as a previously examined fish and released.
2. Sockeye salmon with no operculum punch will then be checked for the presence of an adipose fin.
3. If the adipose fin is absent the technician will determine and record the type of secondary fin clip present.
4. The fish will then be measured and sexed, and this information recorded.
5. A scale will be taken as described within the Data Collection section.

6. Prior to release, the fish will be marked with a punch on the lower 1/3 of the left operculum. The operculum punch will identify all sockeye salmon that have previously been sampled on the spawning grounds to prevent double-sampling of the same fish.

The goal each week is to collect a minimum of approximately 100 scales, with matching length and sex data, from sockeye salmon captured during recovery events at mainstem spawning locations for Primary Objective 3. The scale samples collected from sockeye salmon on the spawning grounds will be aged and used as standards for identifying mainstem stocks sampled in the fish wheels and commercial fisheries. Scale samples and associated data sheets will be sent to Juneau each Monday morning for analysis (see Data Collection section). Recovery sampling trips in a given area may be limited to once every 3–5 days to allow for replacement of spawning fish and to minimize repeated handling of fish on spawning grounds.

Sample Size

Primary Objective 1 is to estimate the annual escapement of sockeye salmon into the Chilkat River mainstem, such that the estimated coefficient of variation is no greater than 15% of the point estimate. To maximize the precision of the escapement estimate the strategy of capturing and marking as many fish as possible has been adopted (Eames et al. 1983). The precision criterion has been met in all years that a coefficient of variation has been calculated (Table 3). Similar to prior years, we will make every effort to meet or exceed the 15% coefficient of variation.

Table 3.–Annual fish wheel catch of Chilkat River sockeye salmon, total number of mainstem sockeye salmon marked, captured, and recaptured, and mainstem sockeye salmon abundance estimate and preferred model, 1999–2013.

Year	Total Fish wheel Catch	Total Sockeye Marked	Mainstem Sockeye Marked (*M*)	Mainstem Sockeye Captured (*C*)	Mainstem Sockeye Recaptured (*R*)	Mainstem Escapement Estimate	Estimator	Coefficient of Variation
1999	7,735	7,461	709	512	26	24,355	Darroch	NA[a]
2000	3,709	3,516	1,028	2,184	76	54,266	Darroch	NA
2001	4,417	4,202	1,066	1,458	70	21,925	Darroch	NA
2002	4,219	4,076	953	610	29	39,086	Darroch	NA
2003	4,551	4,012	967	1,415	68	36,119	Darroch	NA
2004	4,366	4,011	1,104	1,647	49	44,849	Petersen	NA
2005	3,692	3,519	1,296	1,971	70	39,186	Darroch	NA
2006	3,169	2,765	682	1,336	41	28,344	Darroch	NA
2007	2,751	2,371	591	1,627	38	19,693	Darroch	NA
2008	6,412	6,087	1,748	2,082	93	35,665	Petersen	9.7%
2009	9,052	8,729	1,109	1,169	43	27,840	Petersen	14.3%
2010	3,504	3,331	1,296	1,844	69	34,158	Petersen	11.3%
2011	4,940	4,626	1,369	2,194	79	37,479	Petersen	10.6%
2012	4,096	3,953	1,349	2,065	56	47,009	Petersen	12.7%
2013	5,961	5,681	775	1,539	58	19,921	Petersen	12.0%
Average	4,838	4,556	1,069	1,577	58	33,993		

[a] Coefficient of variation not available for estimates 1999–2007 since the mainstem estimate was derived from a total drainage wide estimate using scale pattern analysis to apportion the stock composition.

Sockeye salmon will be marked throughout the entire run and it is expected that the study populations will be stratified. The marking of fish will start by the first week of June and will continue throughout the run until low water and/or icing conditions prevent safe use of the fish wheels (approximately mid-October). Every sockeye salmon captured will be marked at the fish wheels. The condition of all captured salmon will be assessed. Fish with open wounds where fresh flesh is visible, extremely lethargic fish, fish with fungus, or fish observed to be bleeding, particularly around the gill area, will not be marked and will be released immediately to the river. For a summary of sampling and marking goals refer to Appendix F.

CHILKAT LAKE SOCKEYE SALMON ESCAPEMENT ESTIMATE

The Chilkat Lake weir will be installed across the outlet stream of the lake. In addition to temporarily holding back migrating salmon, the weir also concentrates the movement of migrating sockeye salmon through a narrow opening. A DIDSON sonar, placed just upstream of the weir, will be used between mid-June to mid-October to count the fish as they swim toward the lake. Sockeye salmon will be seined below the weir and sampled for age, length, and sex data, as well as examined for marks applied at the fish wheels for Primary Objectives 2 and 3.

Chilkat Lake Weir Installation

The Chilkat Lake weir is a semi-removable steel bipod structure approximately 23 meters wide. The weir is installed approximately 0.4 km downstream of the outlet of Chilkat Lake. The weir framework consists of 2-inch steel pipe bipods driven into the bed of the river and connected together with perforated steel stringers of varying lengths. Iron pipe pickets, 2.5 cm outside diameter, spaced 3.8 cm apart, will be placed in the evenly spaced holes of the stringers to form a fence across the lake outlet. The maximum possible space between each picket is 4.1 cm. Each spring, divers and crew will install two removable bipods that support a 3-meter wide boat gate that is used to guide fish and boats through an opening in the center of the weir. The boat gate is operated remotely via an electric hoist. Sandbags and fencing will be used along the upstream edge of the weir to keep fish from passing uncounted. The integrity of the weir will be verified throughout the season by underwater inspections and placement of additional sand bags and fencing if needed. Three fishery technicians will operate and monitor equipment at the weir site while rotating through shifts (two people per shift).

DIDSON Installation and Settings

One DIDSON unit will be deployed at the Chilkat Lake weir site on the left bank of the river directly upstream of the weir and approximately 3–5 meters from the bank. The DIDSON transducer will be attached to an aluminum pod and oriented perpendicular to the current. The wide axis of the beam will be oriented horizontally and positioned close to the river bottom to maximize residence time of targets in the beam. Daily visual inspections will be conducted to confirm proper placement and orientation of the transducer to accommodate varying water levels.

The DIDSON is controlled by a laptop computer running the latest version of the DIDSON software. A 30 m cable will connect the DIDSON to the “topside box” in the camp cabin next to the weir. This cable transmits power and data between the “topside box” and the DIDSON unit in the water. An Ethernet cable will be used to route data to a laptop computer. Data will be stored on a two terabyte portable external hard drive, which has sufficient capacity to allow for

the storage of an entire season's data. A small gasoline powered generator will provide power for all equipment.

The DIDSON is a high frequency, multi-beam sonar with a unique acoustic lens system designed to focus the beam to create high resolution images. Sound pulses are generated by the sonar at center frequencies of 1.2 or 1.8 MHz. The DIDSON simultaneously transmits and then receives from a set of 12 sonar beams. Images or frames are built in sequences of these sets of pings. The DIDSON will be set on high resolution at frequencies of 1.8 MHz. At this setting, 96 beams (8 sets of 12) are used to form the image. Sampling will occur at a range of approximately 5 meters to 10 meters from the face of the transducer with the sample rate set at 6 frames per second. Fish will be counted as they pass through the boat gate opening in the center of the weir, well within the 30 m effective range for a DIDSON set at the high frequency.

Enumeration and Sampling Procedures

Sonar project activities will commence approximately mid-June and end mid-October. Acoustic sampling will begin at 0600 each morning and will terminate each evening by 2200 when the weir will be closed for the night to prevent upstream migration of sockeye salmon. Fish will be allowed to swim through unimpeded during that 16 hour time period and the DIDSON will be operated continuously during that time. The DIDSON will be set to record data onto the hard drive in one-hour blocks of time, creating a separate date and time stamped file for each recording period. In the rare event that a boat requires passage through the weir between 2200 and 0600, the policy is to keep the period of time the gate is down as limited as possible and not count any fish. The assumption on which this policy is based is that the boat activity will scatter the fish and few, if any, will pass during the short period of time that the gate is open.

Technicians will identify and tally fish traces from the play back of recorded files. This can be completed at the same time new files are being recorded. All fish determined to be salmon will be counted. Technicians will familiarize themselves with behaviors typical of various fish species through intensive observation. Fish which display feeding or milling behavior known to be associated with cutthroat trout or whitefish will not be counted. Fish exhibiting the behavior identified with sockeye salmon of directional migration with no milling will be assumed to be sockeye salmon. Counting will be done manually using tally counters.

Length, sex, and scale data from all adult sockeye salmon (including jack sockeye salmon) will be collected each morning from fish that have built up behind the weir each night. If fish are present at 0600, beach seine gear will be used to capture, sample and release fish back into the lake outlet slough. The daily sampling goal is 40 scale samples with associated length and sex information. Sampling procedures will be the same as those listed above, under the section entitled: Event 2, Recovery on Spawning Grounds. All the steps listed, including examination of fish for marks applied at the fish wheels and marking of each examined fish with an operculum punch, will be followed.

The scale samples collected from sockeye salmon at the Chilkat Lake weir will be used as standards for identifying Chilkat Lake fish sampled in the fish wheels and in commercial fisheries harvests. It will be important that the scales collected in the first few weeks of the season be brought to the Haines ADF&G office as soon as possible and sent to Juneau for analysis (see Data Collection section). Sockeye salmon management of the commercial fisheries depends upon the inseason stock separation analysis made possible by the collection of these

known site scales. Scales collected later in the season will be brought into the Haines office and sent to Juneau in the regular Monday morning shipment.

Coho salmon are expected to enter Chilkat Lake beginning in late August or early September. Coho salmon will be counted in beach seine sets and will be used to apportion the daily DIDSON estimates by species. Coho salmon captured at the weir will not be sampled for age, sex, and length data. Historically, a small number of pink and chum salmon have sometimes been counted through the weir. The number of these fish is expected to be insignificant, but they will be counted if present in the seine catches.

CHUM SALMON ESCAPEMENT

A rough estimate of the fall chum salmon escapement will be made from a simple expansion of the total fish wheel catch of this species for Primary Objective 4 (Table 4). Chilkat River chum salmon escapements were estimated from mark-recapture studies conducted during the years 1990 and 2002–2005; total fish wheel catches in those years averaged approximately 1.55% of estimated escapements (Bachman 2005; Eggers and Heinl 2008).

Table 4.–Peak aerial survey counts, fish wheel catch, mark-recapture estimates, and expanded escapement estimates of Chilkat River fall chum salmon, 1990 and 2002–2013.

Year	Drainage-wide Peak Aerial Survey Count	Total Fish Wheel Catch	Drainage-wide Mark-Recapture Estimate	SE	Ratio Fish Wheel Catch To Escapement Estimate[a]	Expanded Escapement Estimate
1990	29,350	3,025	275,000	NA	0.0110	195,000

2002	63,300	2,898	206,000	22,000	0.0141	187,000
2003	46,600	3,846	166,000	17,000	0.0232	248,000
2004	58,700	4,277	310,000	25,000	0.0138	276,000
2005	56,800	3,125	202,000	23,000	0.0155	202,000
2006	56,900	10,563	NA	NA	NA	681,000
2007	50,250	4,967	NA	NA	NA	320,000
2008	28,150	6,770	NA	NA	NA	437,000
2009	31,500	5,049	NA	NA	NA	326,000
2010	8,000	1,369	NA	NA	NA	88,000
2011	39,800	5,517	NA	NA	NA	356,000
2012	34,400	4,401	NA	NA	NA	284,000
2013	39,500	2,551	NA	NA	NA	170,000
Average	41,800	4,489	231,800		0.0155	290,000

[a] Ratio of the fish wheel catch to the mark-recapture escapement estimate.

COMMERCIAL HARVEST ESTIMATE

Visual scale pattern analysis will be used to determine stock composition of sockeye salmon harvested in the Lynn Canal (District 15) commercial drift gillnet fishery (McPherson 1990). Escapement scale samples from three stocks of known origin, Chilkoot Lake, Chilkat Lake, and "other" (Chilkat River mainstem and tributaries, Berners Bay stocks), will be aged at the ADF&G salmon-aging laboratory and compared to scale samples from the commercial fisheries.

In a separate project, scale samples from District 15 commercial drift gillnet landings of sockeye salmon will be collected weekly through the season by ADF&G personnel at fish processing facilities at Excursion Inlet and Juneau. The sampling goal of 520 fish per week has been

determined to be sufficient to describe the estimated sockeye salmon age composition with a precision of ± 5% and a probability of 0.10 (Thompson 1987). Sampling protocols will ensure that samples will be as representative of catches as possible: deliveries with catches mixed from more than one gear type or fishing district will not be sampled, no more than 40 samples will be taken from a single delivery, and, whenever possible, samples will be systematically taken from the entire hold as it is being offloaded to ensure they are representative of the entire delivery. Sampled fish will be identified to sex and one scale per fish will be taken from the preferred area (INPFC 1963). Samples will be processed and aged at the ADF&G salmon-aging laboratory following procedures described below in the Data Collection section.

Known-origin scale samples will be processed inseason on a weekly basis, after which the commercial fishery samples will be analyzed and assigned to one of three stocks: Chilkoot Lake, Chilkat Lake, and "other" based on scale characteristics. The size of the freshwater annulus and the number of circuli in the freshwater growth zones will be the principle scale characteristics used to distinguish between runs; however, the total size of the freshwater growth zone, size of the freshwater-plus growth zone, and completeness of circuli and spacing between circuli in the freshwater growth zone will also be considered. Differences in age composition between stocks and migratory timing by age will also be accounted for inseason. The weekly proportions of classified scale samples will be applied to the District 15 commercial harvest to provide weekly estimates of stock contribution for inseason management and postseason estimates of total harvest by stock, weighted by statistical week for Primary Objective 5.

SECONDARY OBJECTIVES

Chinook Salmon

This topic is covered in detail in the ADF&G Division of Sport Fish operational plan for Chilkat River Chinook salmon escapement (Chapell and Elliot 2013a). The fish wheel crew will follow these procedures carefully. Each Chinook salmon will be examined for the presence or absence of an adipose fin. All Chinook salmon <660 mm MEF missing an adipose fin will be sacrificed for CWT recovery. Each Chinook salmon will be sampled for age, sex, and length and tagged with a numbered tag, and data will be recorded on the appropriate data forms.

Coho Salmon

This topic is covered in detail in the ADF&G Division of Sport Fish operational plan for Chilkat River coho salmon escapement (Chapell and Elliot 2013b). As with Chinook salmon sampling, the fish wheel crew will be very familiar with the sampling and data recording procedures in the operational plan. Every coho salmon captured in the wheels will be examined for the presence or absence of an adipose fin, and those fish missing the adipose will be sacrificed for CWT recovery, with the pertinent age, sex, and length sampling completed. The coho salmon operational plan has specific sampling instructions for the rate at which scale samples will be taken and the convention for numbering scale cards and associated forms. Prior to release, all coho salmon will be given an operculum punch that will be recognized upon recapture.

Chum Salmon

Every fifth chum salmon captured at the fish wheels will be measured to the nearest 5 mm MEF length, examined externally to determine the sex, and sampled for scales as described in the Data Collection section to estimate age. In times of intense chum salmon catch (approximately late

August–September) this sampling rate may be reduced to every tenth fish. The total number of chum salmon captured by each fish wheel will be recorded daily.

Pink Salmon

Each day, the first 40 pink salmon will be sampled for sex and length. The rest of the pink salmon will be sexed, counted, and released

Other Fish Captured

The number of other fish captured in the wheels will be tallied each day, organized by species, fish wheel, and time of capture (a.m. or p.m.).

Limnological Assessment

Basic limnological data, including zooplankton, light, and temperature sampling, will be collected monthly between April and October. Sampling will be conducted at two stations marked by anchored buoys in the lake.

Light and Temperature Profiles

Light and temperature profiles will be collected at each station. Underwater light intensity will be recorded at 0.5 m intervals, from just below the surface to the depth at which ambient light level equals 1% of the light level just below the surface, using an electronic light meter (Protomatic). The meter must be switched to uplooking. Temperature (ºC) will be measured with a Yellow Springs Instruments (YSI) Model 57 m. Measurements will be made at 1 m intervals from the surface to a depth of 20 meters, and then continued in 5 m increments to a depth of 50 meters.

Measurements of underwater light intensity will be used to determine vertical light extinction coefficients and algal compensation depths. The natural log (ln) of the ratio of light intensity just below the surface to light intensity at depth z, I_0/I_z, will be calculated for each depth. The vertical light extinction coefficient (K_d) will be estimated as the slope of $\ln(I_0/I_z)$ versus depth. The euphotic zone depth (EZD) is defined as the depth at which light (photosynthetically available radiation at 400–700 nm) is attenuated to 1 percent of the intensity just below the lake surface (Schindler 1971) and will be calculated with the equation EZD = $4.6502/K_d$ (Kirk 1994). Temperature readings will be plotted against depth and analyzed for seasonal and annual variation.

Secondary Production

Zooplankton samples will be collected at each station using a 0.5 m diameter, 153 μm mesh conical net. Vertical zooplankton tows will be pulled from a depth of 50 meters to the surface at a constant speed of 0.5 meters sec^{-1}. Once the top of the net has cleared the surface, the rest of the net is pulled slowly out of the water and rinsed from the outside with lake water to wash organisms into the screened sampling container at the cod end of the net. All specimens in the sampling container will be carefully rinsed into a sampling bottle and preserved in a buffered, 10% formalin solution. Sampling bottles will be topped off with clean lake water. Zooplankton samples will be analyzed at the ADF&G Kodiak Limnology Lab, using methods detailed in the ADF&G Limnology Field and Laboratory Manual (Koenings et al. 1987). Results will be averaged between the two stations.

DATA COLLECTION

CHILKAT RIVER FISH WHEELS

Fish wheel sampling data will be recorded on the **ADF&G Adult Salmon Age–Length (ASAL) Form Version 3.0** (Appendix G). This data form allows for sequential recording of length and sex data for each individual fish sampled. Information for each species will be recorded on separate forms. The comment section of the form will be used to note which fish wheel (FW1 or FW2) the fish is sampled from, as well as the sampling period. See the Biological Sampling for Age, Sex, and Length section below for detailed instructions for the completion of this form and the collection of scale samples.

Each day, information recorded on ASAL forms will be checked and summarized. These data include the daily catch and number of species of salmon marked or tagged. These data will be recorded on the **Chilkat River Fish Wheel Sampling Period Form** (Appendix H). The catch for each fish wheel and each wheel check will be totaled separately, as well as summed for the entire day.

Water level, temperature, and weather data will be collected daily at approximately 0830 hours and recorded in the **Fish Wheel Log Book** (Appendix I). Water level (mm) will be measured at an established staff gauge located near milepost 8.5 on the Haines highway. Water temperature (°C) will be measured at the fish wheels. Weather information will include the direction and estimated velocity of wind, type of cloud cover, and presence or absence of rain. Fish wheel rotation speed will be measured at the start of each sampling period and recorded in the log book.

Fish wheel effort information will be collected so that catch data can be adjusted by the hours fished. Fish wheel catch per unit effort is a better indicator of fish passage in the river than catch alone. If a fish wheel is stopped for any reason, the duration of the time it is shut down will be recorded in decimal hour format. If a fish wheel is found to be stopped due to a natural event such as a jammed log or a sudden drop in river level, the stop time for the day will be estimated by the crew leader and recorded as an estimate. Additional comments may be recorded in the comment column in the log book. Comments may include, but are not limited to, fish wheel maintenance, unusual fish or wildlife observations, or public comments and interactions.

At the end of each day the crew will update an EXCEL spreadsheet (**Chilkat River Fish Wheel Summary Form**; Appendix J) that summarizes daily catch, cumulative catch, fish wheel effort, environmental data, and any other relevant comments. This spread sheet will be stored on the ADF&G Commercial Fisheries server in the Haines office and will be available to the fishery manager to assist in the formation of management decisions.

This summary information will also be recorded by hand on the **Chilkat River Fish Wheel Office Form** (Appendix K). Each morning the data from this form will be entered by staff into a weekly escapement file that will be sent to fisheries managers throughout Southeast Alaska. The specific forms used for Chinook and coho salmon sampling are outlined in the relevant operational plans for those species.

MAINSTEM SOCKEYE SALMON ESCAPEMENT ESTIMATE

Event 1, Chilkat River Fish Wheels

Fish will be marked according to the Secondary Fin Clip Schedule (Table 2). The total number of fish marked will be recorded on the **Chilkat River Fish Wheel Sampling Period Form** (Appendix H) as noted above.

Event 2, Recovery on Spawning Grounds

Field data will be recorded in Rite-in-Rain© data log books and age, length, and sex data will be recorded on ASAL (Appendix G) forms. For each mainstem spawning ground recovery trip, field crews will record the date, the catch location, recovery gear, number of marked and unmarked fish, and the number of previously sampled fish (marked with a lower operculum punch). Physical data such as weather, wildlife encounters, and general observations will be recorded. The specific type of fin clip observed on each marked fish will also be recorded on the ASAL forms. See the Biological Sampling for Age, Sex, and Length section below for detailed instructions for the completion of this form and the collection of scale samples.

Data from the recovery events will be recorded on one of two versions of the **Chilkat Sockeye Recovery Form** when the trip is complete. Jack sockeye salmon (≤ 400 mm MEF) will be recorded on a form specific to fish of that size. Sockeye salmon >400 mm MEF will be recorded on a form specific to fish of that larger size (Appendix L). These data sheets will be kept on file in the Haines ADF&G office, and data will be entered into spreadsheets for analysis.

CHILKAT LAKE SOCKEYE SALMON ESCAPEMENT ESTIMATE

The DIDSON sonar will be set to automatically record data directly to a portable hard drive in files representing one hour blocks of time. Each file is created with a separate date and time stamp for each recording period. The number of salmon enumerated will be summed for each one hour data file and totals recorded into a log book. At the end of each day that day's hourly counts will be summed, and the total will be entered into a spreadsheet (**Chilkat Lake Fish Weir Summary Form**; Appendix M**)** and checked for errors by the crew leader. Fish counts will be relayed to the Haines area office each morning by 0900. All sonar data will be saved on the hard drive and will be archived in the Haines ADF&G office at the end of the season.

Water level (mm), river temperature (°C), and general weather information will be recorded each day in a logbook and on the spreadsheet. Water level and temperature will be taken at the established staff gauge and thermometer located near the weir. Weather information will include the direction and estimated velocity of wind, type of cloud cover, and precipitation. These observations will be recorded each day at approximately 0830 and will be relayed to the Haines ADF&G each morning.

Sockeye salmon captured in the seining operation downstream of the weir and sampled for biological data will also be examined for fin clips applied at the Chilkat River fish wheels. Field data will be recorded in Rite-in-Rain© data log books and age, length, and sex data will be recorded on ASAL forms (Appendix G). For each seining event, field crews will record the date, the catch location, recovery gear, number of marked and unmarked fish, and the number of previously sampled fish (marked with a lower operculum punch). The specific type of fin clip observed on each marked fish will also be recorded on the ASAL forms. See the Biological

Sampling for Age, Sex, and Length section below for detailed instructions for the completion of this form and the collection of scale samples.

Data collected during sockeye salmon seining will be recorded on one of two versions of the **Chilkat Sockeye Recovery Form** when the seining is complete. Jack sockeye salmon (≤ 400 mm MEF) will be recorded on a form specific to fish of that size. Sockeye salmon >400 mm MEF will be recorded on a form specific to fish of that larger size (Appendix L). These data sheets will be kept on file in the Haines ADF&G office, and data will be entered into spreadsheets for analysis.

When coho salmon are captured in the seining event, the crew will use the **Chilkat Lake Weir DIDSON/Seine Apportionment Form** (Appendix N) to apportion the daily DIDSON estimates by species. Coho salmon captured at the weir will only be counted. They will not be sampled for age, sex, and length data.

BIOLOGICAL SAMPLING FOR AGE, SEX, AND LENGTH

Salmon scales will be collected using sampling procedures presented in ADF&G Regional Information Report No. 1J94-06 (ADF&G 1994). Scale samples will be collected from the "preferred area" of each sampled fish (INPFC 1963). The preferred area is on the left side of the fish, in the second scale row above the lateral line, on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (ADF&G 1994). Scales will be mounted on gum cards by the Haines field crews.

For sockeye and chum salmon, one scale will be collected from each fish and placed over the scale card number that corresponds to the fish number on the **ADF&G Adult Salmon Age–Length Form Version 3.0** (Appendix G). For Chinook and coho salmon, five scales will be collected from each fish and placed on gum cards at the rate of one fish per column over spaces 1, 11, 21, 31, and below space 31 on the gum card. Scales need to be carefully cleaned, and placed on the gum card upright (integument down) with the rough (convex) side out. Obvious regenerated scales will be discarded and a new scale selected. Scale cards should be kept as dry as possible to prevent gum from running and obscuring the scale ridges, and should be completely labeled, including the last names of each sampler. Species, card number, locality and, statistical area code should be noted in the appropriate section of each scale card. The statistical area code to use on the Chilkat River fish wheel project is 115-32-025. Fish lengths will be measured (mm) from mid eye to tail fork by laying the fish in a foam-lined measuring/sampling trough. The sampling troughs will be partially filled with water to minimize handling stress. Scale sampling will occur while the fish are in the troughs. Sex will be determined by examining external dimorphic sexual maturation characteristics, such as kype development, belly shape, and trunk depth. Once biological information is collected, each fish will be gently released back into the river.

ASAL forms will be used to record length and sex data for sockeye, Chinook, coho, pink, and chum salmon. One ASAL form per species per day will be used; if there are more than 40 fish of any species caught in a day, then additional ASAL forms will be needed. Additional ASAL forms that do not have associated scale samples will be numbered with the same number used for the last scale card for that day, and sequentially labeled with a letter. For example, if the last scale card used for scale samples was 069 then the rest of the ASAL forms sampled for that day without scale samples should be numbered 069A, 069B, etc.

The ASAL form allows the user to designate user codes for common observations regarding fish appearance, etc. The user codes we will use are presented in Table 5.

Table 5.–Definition of user codes on ADF&G Adult Salmon Age–Length (ASAL) Form Version 3.0 , to be used for the fish wheel project.

User code[a]	Comment
0	Seal bite
1	(leave blank)
2	Gillnet marked
3	(leave blank)
4	Fungus
5	Escaped but scale sample was taken
6	Mainstem fish (to be used by age lab); based on recapture location
7	Hook wound
8	Marked fish (adipose fin clip or operculum punched)
9	Adipose fin absent (Chinook or coho salmon CWT)

[a] On ASAL forms we will use the E (error) column for a missing, injured, or escaped (not scale sampled) fish.

The E column will be marked if a fish escapes before a scale could be taken under any condition, even if its length and sex were recorded. Use of the E column in this way will maintain number sequencing of each fish sampled. If no scale sample was taken, then the appropriate space on the scale card will be left blank and the next scale sample will be attached to the appropriate number. The word "escaped" will be written in the right hand column of the ASAL for each escaped fish.

LIMNOLOGICAL ASSESSMENT

All limnological sampling data will be recorded directly on the **Limnology Sampling Form** (Appendix O). Temperature readings will be recorded in the "Meter" column. The recording of the light intensity will include the initial value for the meter multiplier and the value each time it is changed.

Zooplankton samples will be rinsed into clearly labeled 500 ml plastic bottles. The labeling will include the lake name, date, sampler's names, station, depth, and net diameter. The samples and associated forms will be delivered to the Haines office of ADF&G Commercial Fisheries for seasonal storage and eventual shipping to the ADF&G Kodiak Limnology Laboratory for analysis.

DATA REDUCTION

Data collected at the fish wheels, the Chilkat Lake weir, and during mark-recovery sampling events will be recorded on field forms specific to each activity (See appendices for forms). ADF&G personnel will enter data into EXCEL computer spreadsheets at the Haines office. These data records will be updated daily, or weekly in the case of the mark-recovery information. Age, sex, and length information pertaining to sockeye, pink, and chum salmon will be entered onto ASAL forms and sent with the associated scale samples to the Douglas office each Monday morning for scanning, data analysis, and archiving. The ASAL forms and associated data sheets for Chinook and coho salmon captured at the fish wheels will be provided

to the ADF&G Sport Fish personnel in the Haines office. Data will be inspected daily for errors and completeness.

DATA ANALYSIS

MAINSTEM SOCKEYE SALMON ESCAPEMENT ESTIMATE

A two-sample mark-recapture model will be used to estimate the escapement of sockeye salmon into the Chilkat River mainstem. Fish marked at the fish wheels will be identified by scale pattern analysis as Chilkat mainstem or Chilkat Lake fish. Radio telemetry studies conducted in 2003–2004 showed that sockeye salmon radio-tagged and sampled for scales at the fish wheels were identified as "lake" or "river" spawners with 96% accuracy based on scale pattern analysis (Brian Elliot, ADFG, personal communication, unpublished data). The mark-recapture estimate will be based on the estimated number of marked mainstem fish released. Marking and recapture data will be organized in a matrix by strata, with stratum corresponding to two consecutive statistical weeks for marking and by sampling date for recovery strata. Ten temporal periods will be used to define strata and fish will be uniquely marked by these temporal periods (Table 2). All statistical tests will be performed using the program "Stratified Population Analysis System (SPAS)" (Arnason et al. 1996) or Program R (R Core Team 2014).

The first step in the estimation of the escapement of the mainstem sockeye stock is to determine if the assumptions (Seber 1982) of an unbiased estimate of abundance using mark-recapture data in a closed population are met:

1. all adults have an equal probability of being marked;
2. all adults have an equal probability of being sampled for marks;
3. there is no recruitment, death, or emigration to the population between the fish wheels and the sampling sites upstream (i.e., the population is closed);
4. there is no trap induced behavior; and
5. there is no tag loss due to shedding, misidentification, or non-reporting.

An additional assumption based on a stratified estimate is that,

6. all adults released in an initial stratum have the same probability distribution of movement to the final recapture strata.

The first five assumptions can be easily generalized to a stratified estimate. The closed population assumption is true for the Chilkat sockeye salmon populations; each sampling day is a snapshot of the sockeye salmon population as the fish move past the fish wheels. The population's location in time functions as if it were a location in space; a salmon population passing the fish wheels in a time stratum could be considered a closed population (Schwarz and Taylor 1998). There should be no trap-induced behavior in this study because different sampling gears are used in different sampling events (fish wheels for marking and beach seining for recapture). Fish will be identified as marked fish by their clipped adipose fin and secondary fin clips, therefore there will be insignificant tag loss and tag non-reporting (Table 2). To reduce tagging-induced mortality, fish will be handled as carefully and as little as possible.

If all assumptions are adequately met based on the sampling design, the next step is to use chi-square tests to evaluate the adequacy of using a Pooled-Petersen estimator versus a stratified estimate such as the Maximum Likelihood (ML) Darroch estimate, the Schaefer estimate, or the Least Squares estimate (Schaefer 1951; Darroch 1961, Seber 1982; Plante 1990) (Table 3).

One of two conditions must be satisfied in order for the pooled-Petersen estimate to be unbiased and the preferred model. The first condition, 'complete mixing,' states that the recovery probabilities are constant across strata. The second condition, 'equal probability,' states that the expected ratio of marked and unmarked individuals is constant across all recovery strata due to similar migration patterns. If either of these conditions are satisfied ($P > 0.05$), the pooled-Petersen estimator (N*) is considered to be the appropriate model (Arnason et al. 1996). Let M denote the number of fish marked in the lower Chilkat River fish wheels. Let C denote the number of fish examined for marks at a different time period, and let R denote the number of fish in the second sample that are marked,

$$N^* = \frac{(M+1)(C+1)}{(R+1)} - 1, \tag{1}$$

with variance,

$$v^* = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \tag{2}$$

The approximate 95% confidence intervals for N^* based on normal theory, is

$$N^* \pm 1.96\sqrt{v^*}, \tag{3}$$

and the coefficient of variation (CV) is,

$$\mathrm{C}\quad(N^*) = \frac{\sqrt{v^*}}{N^*}(100\%). \tag{4}$$

If neither of the conditions of the chi square tests is met, partial pooling of the recovery strata will be guided by the estimated proportions of marked fish in each stratum, physical proximity of the strata, environmental conditions, goodness of fit (GOF) tests, the Kolmogorov-Smirnov (K-S) two-sample test (Conover 1999), additional chi-square tests, and admissible ML estimates of abundance. If a recovery stratum has few or zero counts it may be an indication that little movement occurred to this particular stratum (e.g., fish in this stratum died before reaching the recovery spawning grounds), the recovery effort was small, or the stratification interval (time period) was too small. In this case, it would be appropriate to temporally pool two or more recovery strata. The ten period strata (Table 2) will change based on the size of the strata and environmental conditions during marking events on the river (river stage height and rainfall). Experience has shown that probabilities of capture of sockeye salmon change as their annual migration progresses. Water levels fluctuate on the lower river, which alters the effectiveness of fish wheels (Bachman 2010).

The GOF tests will be used to assess the adequacy of the stratified model for lack of fit. The K-S two-sample test will be used to detect if fish of different sizes were captured with equal probability. The K-S two-sample test compares the cumulative size distributions of marked fish in the first event (marking) with those examined for marks in the second event (recovery), and those examined during the second event that contain marks (recaptured). The test hypothesis (H_o) is that there are no differences in the length of fish between the data sets being tested. If size selective sampling is detected, the abundance estimate will be stratified by size (Appendix P). Contingency tables using chi-square tests will be used to compare the sex distributions and gear selectivity of marked fish in the first event (marking) with those examined for marks in the second event (recovery), and those examined during the second event that contain marks

(recaptured) (Appendix P). We assume that sex determination of each fish during event 2 will be more accurate because secondary characteristics are more developed on the spawning grounds than in the main river. Inadmissible estimates of abundance can include failure of the ML algorithm to converge, or convergence to unrealistic estimators such as negative capture probabilities or negative stratum abundances.

ESCAPEMENT AGE, SEX, AND LENGTH COMPOSITION

Scale samples will be analyzed at the ADF&G salmon-aging laboratory in Douglas, Alaska. Scale impressions will be made in cellulose acetate and prepared for analysis as described by Clutter and Whitesel (1956). Scales will be examined under moderate (70×) magnification to determine age. Age classes will be designated by the European aging system where freshwater and saltwater years are separated by a period (e.g., 1.3 denotes a fish with one freshwater and three ocean years) (Koo 1962). Assuming no size or sex selectivity, weekly age-sex distributions, seasonal age-sex distributions weighted by week, and mean lengths by age and sex weighted by week will be calculated using standard methods (Cochran 1977) (Appendix Q).

SCHEDULE AND DELIVERABLES

OPERATIONS

Field sampling activities are scheduled as follows:

1. Lower Chilkat River fish wheels	5 June–15 October
2. Chilkat River mainstem sockeye salmon recovery	15 July–15 September
3. Chilkat Lake weir and DIDSON sonar	15 June–15 October
4. Chilkat Lake limnology	monthly, April–October

REPORTS

Results of this study will be presented in the annual fishery management plan for the Lynn Canal drift gillnet fishery (Fishery Management Report) in April of each year and the biannual report summarizing the results of this project (Fishery Data Series Report), which will be completed in March of 2016 and in March of each following even year.

RESPONSIBILITIES

Randy Bachman, Fishery Biologist III, Principal Investigator. Sets up all major aspects of project, including planning, budget, sample design, permits, equipment, personnel, and training. Supervises overall project; edits, analyzes, and reports data; oversees major repairs; and expedites major purchases. Reviews schedules and operational plan, and serves as lead biologist for the project.

Mark Sogge, Fishery Biologist II. Responsible for overseeing fish wheel operations and directing the projects in the absence of Bachman. Assists with the supervision of overall project; edits, analyzes, and reports data; trains the crew in safety and project procedures; creates the crew schedule; assists with fieldwork; arranges logistics with field crew; and serves as project expeditor. Writes the operational plan and assures that it is followed or modified appropriately with consultation with the Sport Fish Division biologists. Resolves personnel or administrative issues related to this project, and writes crew evaluations.

David Folletti, Fish and Wildlife Technician III. Responsible for the day to day safe operation and maintenance of the fish wheels, and the training and direction of crew members in all aspects of the project including fish wheel maintenance, fish handling, fish marking and tagging, boat operation, the collection and recording of data, and adherence to Department policies. Acts as the lead technician for recovery portion of the project. Responsible for the weekly compilation of data, the organization of project data records, and for providing data to the Juneau office for entry and analysis.

Theodore Hart, Tammy Fisher-Hotch, and Emily Frederick, Fish and Wildlife Technicians II. These positions assist in all aspects of field operations, including safe operation of the fish wheels, riverboats and all other equipment; assist with the daily preparation of forms for data entry, the marking, tagging, and sampling of fish on the wheels, any required fish wheel or boat maintenance, completion of data forms, and all aspects of the salmon recovery portion of this project.

Tim Brush, Fish and Wildlife Technician III. Crew leader responsible for the day to day safe operation and maintenance of the Chilkat fish weir and all related projects.

Eric Johnson and unfilled position, Fish and Wildlife Technicians II. Assist in all aspects of the operation and maintenance of the Chilkat fish weir. Assist in the limnological sampling.

Faith Lorentz, Program Technician. Coordinates communication with Chilkat weir crew, updates master spreadsheet with daily weir and fish wheel counts, provides administrative assistance, tracks project budgets, and provides other assistance as necessary.

Steven C. Heinl, Regional Research Coordinator. Assists with project operational planning and review of project report.

Sara Miller, Biometrician II. Assists with sampling design, project operational planning, and data analysis.

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APPENDICES

Appendix A.–Weekly catches of sockeye salmon in the Chilkat River fish wheels 1994–2013.

Stat																					Avg.	Avg.
Week	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	1994-2013	2004-13
23					0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	9	1	1
24		1		10	11	8	2	8	18	6	4	4	0	1	3	23	8	15	25	17	9	10
25	0	39	0	39	80	35	81	16	157	71	26	42	7	3	54	522	77	142	78	91	78	104
26	38	93	32	76	219	183	330	175	270	172	110	130	46	8	249	784	64	93	220	477	188	218
27	87	148	130	247	407	422	371	232	334	295	264	146	112	36	248	854	303	290	446	477	292	318
28	207	169	386	125	317	962	359	274	325	210	395	194	124	110	436	505	281	420	513	268	329	325
29	129	164	334	120	368	567	441	450	288	226	396	252	99	118	620	296	399	335	278	272	308	307
30	202	328	333	277	325	766	317	804	317	159	305	304	152	270	454	364	233	347	291	236	339	296
31	206	300	315	337	351	518	306	447	405	177	352	250	385	134	343	494	285	369	250	456	334	332
32	236	314	498	465	430	617	292	632	420	414	588	344	400	164	394	890	277	553	167	276	419	405
33	858	263	263	237	445	680	255	348	375	527	481	258	278	235	454	806	385	461	320	415	417	409
34	442	448	209	202	409	654	246	280	276	491	448	258	477	163	576	552	474	367	363	539	394	422
35	412	367	257	305	495	602	148	238	257	498	337	216	311	247	710	610	279	289	391	318	364	371
36	487	234	164	379	315	295	199	253	337	490	352	350	208	395	708	604	90	430	343	630	363	411
37	460	356	166	578	474	302	110	91	176	368	81	260	223	313	424	696	162	164	163	420	299	291
38	101		5	899	313	413	135	75	58	175	74	423	149	190	326	435	100	344	122	534	256	270
39				199	443	308	60	67	33	130	53	158	43	225	232	465	45	198	73	340	181	183
40				448	258	317	36	27	22	80	55	81	108	118	77	129	26	104	47	186	125	93
41				73	77	86	11	0	7	42	30	15	47	21	104	23	10	19	6	0	34	28
42					10	0	0	0	0	18	12	7	0	0	0	0	6	0	0	0	3	3
43										2	3		0	0	0	0	0	0	0		1	0
	3,865	3,224	3,092	5,016	5,747	7,735	3,699	4,417	4,076	4,551	4,366	3,692	3,169	2,751	6,412	9,052	3,504	4,940	4,096	5,961	4,668	4,794

Appendix B.–Weekly catches of Chinook salmon in the Chilkat River fish wheels 1994–2013.

Stat																					Avg.	Avg.
Week	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	1994-2013	2004-13
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	2	0	0	1	3	1	4	1	0	2	0	0	4	1	1	1	1	1
25	1	1	0	6	13	3	2	8	22	17	2	5	5	1	1	7	13	25	0	24	8	8
26	27	29	3	7	31	54	20	52	51	64	19	13	24	5	11	48	12	35	16	73	30	26
27	74	20	17	118	48	43	18	42	58	112	34	25	43	21	38	57	48	45	23	56	47	39
28	67	44	24	18	23	117	24	43	102	46	74	29	49	28	61	81	33	46	24	19	48	44
29	31	37	10	18	14	79	14	20	19	41	32	30	9	56	19	36	14	48	30	18	29	29
30	11	6	9	6	4	19	19	6	10	5	11	7	4	7	13	5	12	21	5	4	9	9
31	1	1	4	1	1	3	1	0	4	1	5	3	4	2	9	0	3	8	3	1	3	4
32	1	0	0	3	1	1	1	0	1	2	3	0	2	0	5	1	1	2	2	1	1	2
33	1	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
34	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
35	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	214	139	68	179	137	320	99	172	270	289	185	113	140	122	157	235	140	234	105	197	176	163

Appendix C.–Weekly catches of coho salmon in the Chilkat River fish wheels 1994–2013.

Stat																					Avg.	Avg.
Week	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	1994-2013	2004-13
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
31	2	4	2	0	0	1	0	0	4	1	0	0	4	0	1	0	0	0	0	0	1	1
32	7	15	11	0	0	5	3	7	14	11	15	1	11	2	1	1	3	1	0	4	6	4
33	59	35	8	1	10	26	7	28	69	45	23	4	27	7	5	8	8	5	9	4	19	10
34	121	89	45	10	13	41	16	72	123	118	99	7	108	32	56	20	16	7	14	20	51	38
35	278	225	108	29	33	37	45	150	264	247	111	35	290	88	131	65	70	35	38	33	116	90
36	377	375	212	33	27	85	87	380	854	801	389	145	822	148	173	142	49	93	86	132	271	218
37	469	610	58	169	119	165	228	274	1,032	1,117	170	287	683	480	352	332	186	268	86	372	373	322
38	128			228	193	213	316	725	995	465	173	340	475	249	708	463	301	408	165	319	381	360
39				135	192	599	307	701	754	564	175	323	715	430	752	638	199	481	431	361	456	451
40				408	283	239	223	196	553	800	242	128	1,183	193	303	280	84	255	164	188	337	302
41				43	143	286	191	17	140	939	144	37	571	29	735	80	204	40	11	0	212	185
42				0	58	0	0	0	288	134	166	43	0	0	0	0	29	0	0	0	42	24
43										57	38	0	0	0	0	0	0	0	0	0	9	4
	1,441	1,353	444	1,056	1,071	1,697	1,423	2,550	5,090	5,299	1,745	1,350	4,889	1,658	3,217	2,029	1,149	1,594	1,005	1,433	2,075	2,007

Appendix D.–Weekly catches of chum salmon in the Chilkat River fish wheels 1994–2013.

Stat																					Avg.	Avg.
Week	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	1994-2013	2004-13
28									3	0	2	0	2	0	2	0	0	1	0	2	1	1
29					2	0	2	1	4	5	14	0	6	6	5	4	1	0	1	6	4	4
30	21	9	16	1	3	3	45	73	12	11	20	3	7	8	7	10	2	2	1	13	13	7
31	22	15	17	13	6	21	76	78	42	11	36	3	26	4	42	15	10	15	21	25	25	20
32	19	112	25	22	13	16	115	115	50	51	94	20	32	9	56	96	25	37	27	42	49	44
33	26	102	47	11	54	76	236	300	112	106	164	38	114	55	180	176	96	52	163	85	110	112
34	26	171	29	45	37	116	265	506	147	304	373	60	310	128	735	207	115	81	291	158	205	246
35	30	45	92	66	132	153	339	639	157	339	648	65	419	363	693	401	251	237	860	148	304	409
36	26	6	133	75	66	285	417	757	291	478	856	246	635	501	587	648	92	365	698	222	369	485
37	19	0	61	356	163	496	300	360	379	665	418	400	812	1585	621	1059	149	550	487	366	462	645
38				320	182	635	521	828	323	291	264	861	683	1086	733	852	142	1670	520	411	607	722
39				83	481	605	549	920	276	270	287	727	892	738	989	1033	84	1164	616	809	619	734
40				303	569	981	598	88	199	472	564	386	4618	401	521	408	85	1250	671	263	728	917
41				16	171	862	291	15	222	697	326	102	2007	83	1599	140	232	93	45	0	406	463
42					66	0	0	0	681	123	201	214	0	0	0	0	85	0	0	0	86	50
43										23	10	0	0	0	0	0	0	0	0	0	3	1
	189	461	420	1,311	1,945	4,249	3,754	4,680	2,898	3,846	4,277	3,125	10,563	4,967	6,770	5,049	1,369	5,517	4,401	2,550	3,617	4,859

Appendix E.–ADF&G Statistical Weeks, 2014–2016.

Statistical week	2014		2015		2016	
	Beginning	Ending	Beginning	Ending	Beginning	Ending
23	1-Jun	7-Jun	1-Jun	6-Jun	29-May	4-Jun
24	8-Jun	14-Jun	7-Jun	13-Jun	5-Jun	11-Jun
25	15-Jun	21-Jun	14-Jun	20-Jun	12-Jun	18-Jun
26	22-Jun	28-Jun	21-Jun	27-Jun	19-Jun	25-Jun
27	29-Jun	5-Jul	28-Jun	4-Jul	26-Jun	2-Jul
28	6-Jul	12-Jul	5-Jul	11-Jul	3-Jul	9-Jul
29	13-Jul	19-Jul	12-Jul	18-Jul	10-Jul	16-Jul
30	20-Jul	26-Jul	19-Jul	25-Jul	17-Jul	23-Jul
31	27-Jul	2-Aug	26-Jul	1-Aug	24-Jul	30-Jul
32	3-Aug	9-Aug	2-Aug	8-Aug	31-Jul	6-Aug
33	10-Aug	16-Aug	9-Aug	15-Aug	7-Aug	13-Aug
34	17-Aug	23-Aug	16-Aug	22-Aug	14-Aug	20-Aug
35	24-Aug	30-Aug	23-Aug	29-Aug	21-Aug	27-Aug
36	31-Aug	6-Sep	30-Aug	5-Sep	28-Aug	3-Sep
37	7-Sep	13-Sep	6-Sep	12-Sep	4-Sep	10-Sep
38	14-Sep	20-Sep	13-Sep	19-Sep	11-Sep	17-Sep
39	21-Sep	27-Sep	20-Sep	26-Sep	18-Sep	24-Sep
40	28-Sep	4-Oct	27-Sep	3-Oct	25-Sep	1-Oct
41	5-Oct	11-Oct	4-Oct	10-Oct	2-Oct	8-Oct
42	12-Oct	18-Oct	11-Oct	17-Oct	9-Oct	15-Oct

Appendix F.–Chilkat River Fish Wheel Sampling Goals Summary.

Sockeye Salmon:

1. Adipose clip and apply secondary fin clips in accordance with the schedule to all uninjured salmon captured in the fish wheels.
2. Length and sex determination of all fish at both fish wheels.
3. Scales (matched with length and sex) from 40 fish/day between both fish wheels.

Sockeye Salmon Mark Recovery:

1. Starting in June, at the Chilkat Lake weir site, use seines downstream of the weir to sample sockeye salmon two or three times each week or until the weekly sampling goal of 280 fish is reached. A daily sampling goal of 40 fish/day is ideal.
2. Starting in July, on the mainstem Chilkat River, sample a minimum of 100 sockeye salmon per week for age (scales), sex, size. Measure as many fish as possible, included all fish wheel marked fish and as many unmarked fish as possible.

Coho Salmon:

1. Determine the sex and measure the length of all fish captured at both fish wheels.
2. Collect scale (age) samples from the first 13 of each set of 40 fish each day.
3. Examine all coho salmon for an adipose fin. Fish missing an adipose fin will be sacrificed so the tag can be read. Heads will receive a numbered plastic cinch strap, and the strap number will be recorded on the CWT recovery form.

Chinook Salmon:

1. Sex, length, and scales (matched with length and sex) from every Chinook salmon captured in the fish wheels.
2. Tag all Chinook salmon in good health and not sacrificed for CWT sampling.
3. Sacrifice all adipose-clipped Chinook salmon <660 mm MEF for CWT sampling. Tag and release adipose-clipped fish ≥660 mm MEF that test positive for head CWT presence. Adipose-clipped fish ≥660 mm MEF that test negative for a head CWT will be sacrificed to verify tag loss.

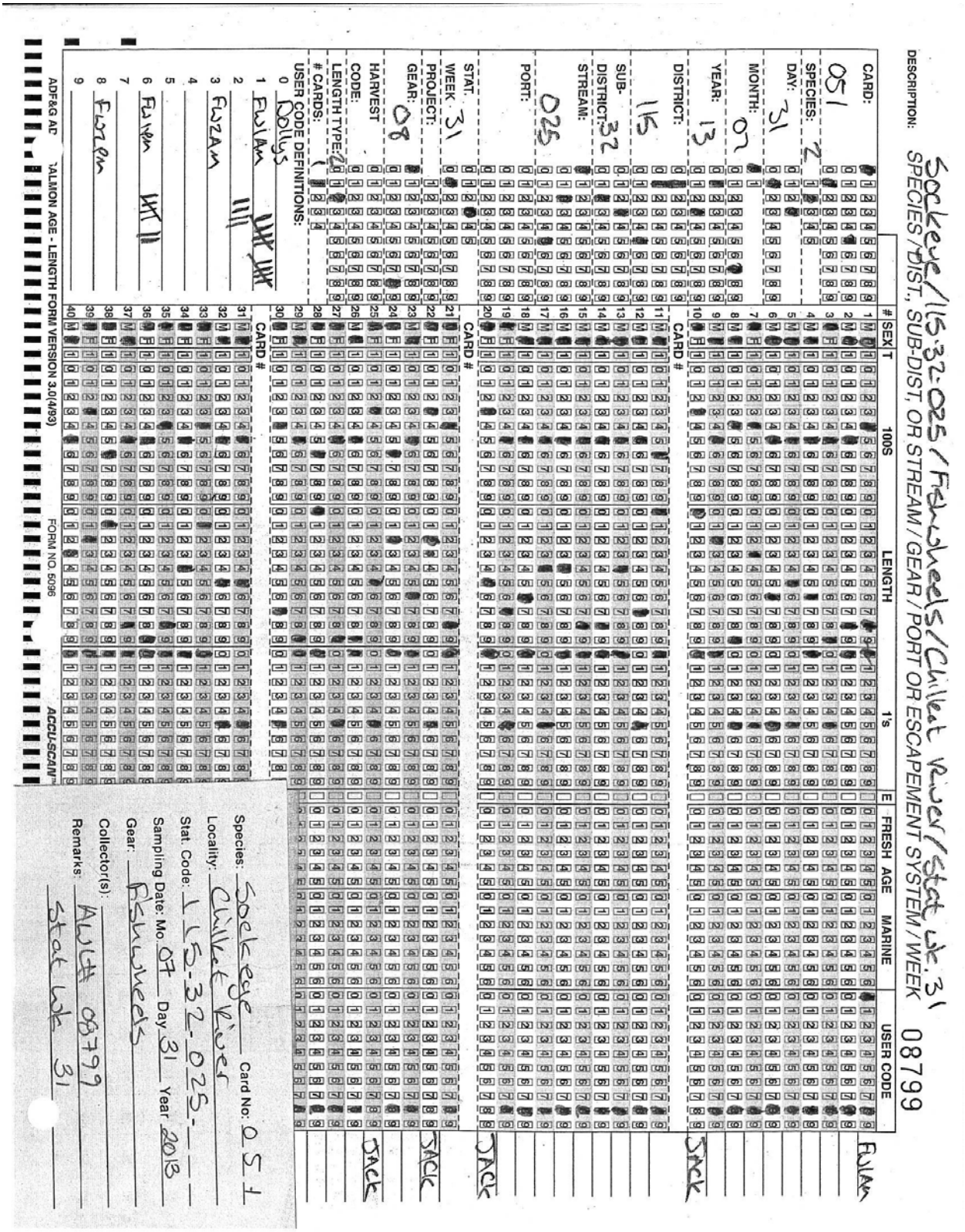
Chum Salmon:

1. Sex, length, scales (matched with length and sex) from every fifth chum salmon captured in the fish wheels, up to a total of 40 fish per day.
2. Count all chum salmon captured by fish wheel each day.

Pink Salmon:

1. Each day sample the first 40 pink salmon for sex and length determination. The rest of the pink salmon will be sexed, counted, and released. The number of each sex will be tallied on the ASAL forms, separately for each wheel and wheel check.

Appendix G.–ADF&G Adult Salmon Age–Length Form Version 3.0 (ASAL).



Appendix H.–Chilkat River Fish Wheel Sampling Period Form.

2013			Chinook		Sockeye		Coho	Pink		Chum	DV	Other
Date	Time		Caught	Tagged	Caught	Marked	Caught	Caught	Sampled	Caught	Caught	Caught
	AM	FW1										
		FW2										
		Subtotal										
	PM	FW1										
		FW2										
		Subtotal										
Daily Total		FW1										
Daily Total		FW2										
		Total										
Number of Escapes												
Number of Jacks												
Morts												
Number of AD-Clips												
Cinch Tag Numbers												

Appendix I.–Chilkat River Fish Wheel Log Book.

Appendix J.–Chilkat River Fish Wheel Summary Form.

Stat. Week	Date	Chinook				Sockeye					Coho		Pink		Chum		Dolly Varden		Wheel 1 Total Catch all species	Wheel 2 Total Catch all species	Water Level	Water Temp.	Fish Wheel #1		Fish Wheel #2		Comments
		Daily	Cum.	# Tag	Cum.	Daily	Cum.	# Mark	Cum.	Mark Type	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.					RPM	Effort	RPM	Effort	

Appendix K.–Chilkat River Fish Wheel Office Form.

Stat.		Chinook		Tag		Sockeye					Coho		Pink		Chum		Dolly		Water		Effort		Comments
Wk	Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Marked	Cum.	Mark Type	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Level	Temp	FW1	FW2	FW notes, weather etc.
23	3-Jun																						
	4-Jun																						
	5-Jun																						
	6-Jun																						
	7-Jun																						
	8-Jun																						
	9-Jun																						
24	10-Jun																						
	11-Jun																						
	12-Jun																						
	13-Jun																						
	14-Jun																						
	15-Jun																						
	16-Jun																						
25	17-Jun																						
	18-Jun																						
	19-Jun																						
	20-Jun																						
	21-Jun																						
	22-Jun																						
	23-Jun																						
26	24-Jun																						
	25-Jun																						
	26-Jun																						
	27-Jun																						
	28-Jun																						
	29-Jun																						
	30-Jun																						
27	1-Jul																						
	2-Jul																						
	3-Jul																						
	4-Jul																						
	5-Jul																						
	6-Jul																						
	7-Jul																						

Appendix L.–Chilkat Sockeye Recovery Form.

MARK RECOVERY DATA FORM							**SOCKEYE > 400mm IN LENGTH**											Page ___ of ___		
Year: **2014**			Chilkat River Sockeye				**(Do Not Include Jack Sockeye)**													
			BS=Beach Seine				Remember to Mark These Fish with a Lower Left Opercule Punch:													
			CC=Carcass count					Number w/ Adipose Clip plus strata clips:												
Date (MM/DD)	Hour	Location	Capture Method	Set #	Sampler's Initials	Number Previously Sampled Fish	Number New Fish Sampled (includes clipped fish)	Adipose Clip Only	Right Axillary Clip	Left Axillary Clip	Right Ventral Clip	Left Ventral Clip	Right Pectoral Clip	Left Pectoral Clip	Dorsal Fin Clip	Right Axillary Clii	Left Axillary Clip	AWL Card Number	AWL Sample Number(s)	Comments
				Totals																

Total fish recovered		(all fish combined)
Total fish recaptured		(fish with lower operculum punches, previously seined fish)
% Recaptured		= this divided by this
Total new fish viewed		(all fish not previously looked at)(with or without strata clips)
Total fish marked		(fish with strata clips)
% Marked		= this divided by this

Appendix M.–Chilkat Lake Fish Weir Summary Form.

Stat.		**Sockeye DIDSON**		**Sockeye visual**		**Sockeye sampled**		**Sockeye Total Esc.**		**Coho**		**Others**		**Water**			Boat	**Comments**
Wk	Date	Daily	Cum	Daily	Cum	Daily	Cum	**Total**	**Cum**	Daily	Cum.	Daily	Cum.	Level	Temp	Vis	Gate Drops	FW notes, weather etc.

Appendix N.–Chilkat Lake Weir DIDSON/Seine Apportionment Form.

Seine set											Visual counts	
Number	sockeye	coho	other	total				sonar counts			Sockeye	Coho
1				0			A			A		
2				0			B			B		
3				0			C			**C**		
4				0			D			D		
5				0			E			E		
6				0			F			Total	0	0
Total	0	0	0	0			G					
prop.	#DIV/0!	#DIV/0!	#DIV/0!				H					
							I					
							Total	0				
					Sockeye	**Daily**	**Escap.**	**Total**				
					Coho	**Daily**	**Escap.**	**Total**				
Seine set											Visual counts	
Number	sockeye	coho	other	total				sonar counts			Sockeye	Coho
1				0			A			A		
2				0			B			B		
3				0			C			**C**		
4				0			D			D		
5				0			E			E		
6				0			Total	0		Total	0	0
Total	0	0	0	0								
prop.	#DIV/0!	#DIV/0!	#DIV/0!									
					Sockeye	**Daily**	**Escap.**	**Total**				
					Coho	**Daily**	**Escap.**	**Total**				

Appendix O.–Limnology Sampling Form.

LAKE SURVEY - Field Form

Lake ID _____ Date: _____

Sampling Station: _____ Sampling Depth (m): _____ Lake Elev (m): _____

Weather / Surface Conditions: _____

Observers: _____

Physical and Chemical Parameters

Parameter profile: _____ to _____ Hrs DO/temp meter used: _____

Light intensity profile: _____ to _____ Hrs Light meter used: _____

	Dissolved Oxygen (mg/L)				Temperature (C)			Light Intensity	
Depth	meter	% O2 saturation	Winkler titration		Meter	Therm.		Foot Candles (Up looking)	Multiplier
Above Surface							Above Surface		
5 cm							5 cm		
0.5 m							0.5 m		
1.0 m							1.0 m		
1.5 m							1.5 m		
2.0 m							2.0 m		
2.5 m							2.5 m		
3.0 m							3.0 m		
3.5 m							3.5 m		
4.0 m							4.0 m		
4.5 m							4.5 m		
5.0 m							5.0 m		
5.5 m							5.5 m		
6.0 m							6.0 m		
6.5 m							6.5 m		
7.0 m							7.0 m		
7.5 m							7.5 m		
8.0 m							8.0 m		
8.5 m							8.5 m		
9.0 m							9.0 m		
9.5 m							9.5 m		
10.0 m							10.0 m		
10.5 m							10.5 m		
11.0 m							11.0 m		
11.5 m							11.5 m		
12.0 m							12.0 m		
12.5 m							12.5 m		
13.0 m							13.0 m		
13.5 m							13.5 m		
14.0 m							14.0 m		
14.5 m							14.5 m		
15.0 m							15.0 m		

Lake ID _____ Date: _____

Sampling Station: _____ Sampling Depth (m): _____

Depth	Dissolved Oxygen (mg/L)			Temperature (C)		Depth	Light Intensity	
	meter	% O2 saturation	Winkler titration	Meter	Therm.		Foot Candles (Up looking)	Multiplier
16.0 m						16.0 m		
17.0 m						17.0 m		
18.0 m						18.0 m		
19.0 m						19.0 m		
20.0 m						20.0 m		
25.0 m						25.0 m		
30.0 m						30.0 m		
35.0 m						35.0 m		
40.0 m						40.0 m		
45.0 m						45.0 m		
50.0 m						50.0 m		

Secchi Disk

Depth disc disappears / reappears, DOWN / UP _____ _____ meters

Time: _____ hrs Lake surface conditions _____

Water Samples Collected for Lab Analysis

Depth	Date	Time (hrs)	Sample Bottle #

Biological Parameters

Zooplankton

Station			**Station**		
Time of Sample End:	:		Time of Sample End:	:	
Time of Sample Start:	:		Time of Sample Start:	:	
Elapsed time (min:sec)	:		Elapsed time (min:sec)	:	
Tow depth:		m	Tow depth:		m
Station			**Station**		
Time of Sample End:	:		Time of Sample End:	:	
Time of Sample Start:	:		Time of Sample Start:	:	
Elapsed time (min:sec)	:		Elapsed time (min:sec)	:	
Tow depth:		m	Tow depth:		m

Phytoplankton - Phaeophytin - Chlorophyll samples

Date	Depth (m)	Time set (hrs)	Chl a	Date and time filtered

Appendix P.–Detection of size and/or sex selective sampling during a two-sample mark-recapture experiment using the Kolmogorov-Smirnov two sample test or contingency table analysis (chi-square test) and recommended procedures for estimating population size and population composition.

Size selective sampling: The Kolmogorov-Smirnov two sample test (Conover 1999) is used to detect significant evidence that size selective sampling occurred during the first and/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*) by 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 that compares *M* and *C* is then 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-square test) is generally used to detect significant evidence that sex selective sampling occurred during the first and/or second sampling events. The counts of observed males to females are compared between *M* and *R*, *C* and *R*, and *M* and *C* using the null hypothesis that the probability that a sampled fish is male or female is independent of sample. If the proportions by gender are estimated for a sample (usually *C*), rather observed for all fish in the sample, contingency table analysis is not appropriate and the proportions of females (or males) are then compared between samples using a two sample test (e.g. Student's t-test).

M **vs.** *R*	*C* **vs.** *R*	*M* **vs.** *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	Either result possible

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

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

C. If a) sample sizes for *C* vs. *R* are small, b) the *C* vs. *R* p-value is not large (~0.20 or less), and c) the *M* vs. *R* sample sizes are not small and/or the *M* vs. *R* *P*-value is fairly large (~0.30 or more), the rejection of the null in the *M* vs. *C* test was likely the result of size/sex selectivity during the first event which the *C* vs. *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* vs. *R* and *M* vs. *R* are both small, and b) both the *C* vs. *R* and *M* vs. *R* *P*-values are not large (~0.20 or less), the rejection of the null in the *M* vs. *C* test may be the result of size/sex selectivity during both events which the *C* vs. *R* and *M* vs. *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* vs. *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* vs. *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 prior to estimating composition parameters, then overall composition parameters (p_k) is estimated by combining within stratum composition estimates using:

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

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

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; and,

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

Appendix Q.–Escapement sampling data analysis.

The weekly sockeye salmon age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week, were calculated using equations from Cochran (1977).

Let

h = index of the stratum (week),

j = index of the age class,

p_{hj} = proportion of the sample taken during stratum h that is age class j,

n_h = number of fish sampled in week h, and

n_{hj} = number observed in class j, week h.

Then the age distribution was estimated for each week of the escapement in the usual manner,

$$\hat{p}_{hj} = n_{hj}/n_h \ . \tag{1}$$

If N_h equals the number of fish in the escapement in week h. Standard errors of the weekly age class proportions are calculated in the usual manner (Cochran 1977, page 52, equation 3.8),

$$SE\left(\hat{p}_{hj}\right) = \sqrt{\left[\frac{\left(\hat{p}_{hj}\right)\left(1-\hat{p}_{hj}\right)}{n_h - 1}\right]\left[1 - n_h/N_h\right]}. \tag{2}$$

The age distributions for the total escapement were estimated as a weighted sum (by stratum size) of the weekly proportions. That is,

$$\hat{p}_j = \sum_h p_{hj}\left(N_h/N\right), \tag{3}$$

such that N equals the total escapement. The standard error of a seasonal proportion is the square root of the weighted sum of the weekly variances (Cochran 1977, pages 107–108),

$$SE\left(\hat{p}_j\right) = \sqrt{\sum_j^h \left[SE\left(\hat{p}_{hj}\right)\right]^2 \left(N_h/N\right)^2} \ . \tag{4}$$

The mean length, by sex and age class (weighted by week of escapement), and the variance of the weighted mean length, were calculated using the following equations from Cochran (1977, pages 142–144) for estimating means over subpopulations. That is, let i equal the index of the individual fish in the age-sex class j, and y_{hij} equal the length of the ith fish in class j, week h, so that,

$$\hat{\bar{Y}}_j = \frac{\sum_h \left(N_h/n_h\right)\sum_i y_{hij}}{\sum_h \left(N_h/n_h\right) n_{hj}} \text{, and} \tag{5}$$

$$\hat{V}\left(\hat{\bar{Y}}_j\right) = \frac{1}{\hat{N}_j^2}\sum_h \frac{N_h^2\left(1-n_h/N_h\right)}{n_h\left(n_h-1\right)}\left[\sum_i \left(y_{hij} - \bar{y}_{hj}\right)^2 + n_{hj}\left(1 - \frac{n_{hj}}{n_h}\right)\left(\bar{y}_{hj} - \hat{\bar{Y}}_j\right)^2\right].$$