Regional Operational Plan CF.1J.2020.02

Operational Plan: Chilkat Lake Salmon Weir Enumeration and Sampling Procedures, 2020–2022

by

Nicole L. Zeiser

Shane R. Ransbury

Steven C. Heinl

and

Sara E. Miller

April 2020

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

REGIONAL OPERATIONAL PLAN CF.1J.2020.02

OPERATIONAL PLAN: CHILKAT LAKE SALMON WEIR ENUMERATION AND SAMPLING PROCEDURES, 2020–2022

by

Nicole Zeiser and Shane R. Ransbury
Alaska Department of Fish and Game, Division of Commercial Fisheries, Haines

Steven C. Heinl
Alaska Department of Fish and Game, Division of Commercial Fisheries, Ketchikan

and

Sara E. Miller
Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau

Alaska Department of Fish and Game
Division of Commercial Fisheries

April 2020

The Regional Operational Plan Series was established in 2012 to archive and provide public access to operational plans for fisheries projects of the Divisions of Commercial Fisheries and Sport Fish, as per joint-divisional Operational Planning Policy. Documents in this series are planning documents that may contain raw data, preliminary data analyses and results, and describe operational aspects of fisheries projects that may not actually be implemented. All documents in this series are subject to a technical review process and receive varying degrees of regional, divisional, and biometric approval, but do not generally receive editorial review. Results from the implementation of the operational plan described in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author if you have any questions regarding the information provided in this plan. Regional Operational Plans are available on the Internet at: http://www.adfg.alaska.gov/sf/publications/

Nicole L. Zeiser and Shane R. Ransbury
Alaska Department of Fish and Game, Division of Commercial Fisheries
P.O. Box 330, Haines, AK 99827

Steven C. Heinl
Alaska Department of Fish and Game, Division of Commercial Fisheries
2030 Sea Level Drive, Suite 205, Ketchikan, AK 99901

Sara E. Miller
Alaska Department of Fish and Game, Division of Commercial Fisheries
1255 W. 8th Street, Juneau, AK 99801

This document should be cited as:
Zeiser, N. L., S. R. Ransbury, S. C. Heinl, and S. E. Miller. 2020. Operational plan: Chilkat Lake salmon weir enumeration and sampling procedures, 2020–2022. Alaska Department of Fish and Game, Regional Operational Plan ROP.CF.1J.2020.02, Douglas.

SIGNATURE PAGE

Project Title:	*Operational Plan: Chilkat Lake Salmon Weir Enumeration and Sampling Procedures, 2020–2022*
Project leader(s):	*Nicole Zeiser and Shane Ransbury*
Division, Region, and Area	*Commercial Fisheries, Region 1, Haines*
Project Nomenclature:	*FM-163 GF Chilkat Weir-DIDSON*
Period Covered	2020–2022
Field Dates:	1 June–15 October
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project Manager	Nicole Zeiser		
Project Leader	Shane R. Ransbury		
Biometrician	Sara E. Miller		
Research Coordinator	Steven C. Heinl		

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

PURPOSE

The Chilkat Lake sockeye salmon (Oncorhynchus nerka) run, which spawns near Haines, is one of the largest in Southeast Alaska and contributes substantially to harvests in the District 15 commercial drift gillnet fishery in Lynn Canal. This operational plan outlines objectives, methods, and timelines for conducting sockeye salmon stock assessment designed to (1) estimate annual escapement, (2) provide information for inseason fishery management, and (3) reconstruct runs and assess stock status. The Chilkat Lake sockeye salmon run is managed for a biological escapement goal of 70,000–150,000 fish, which is enumerated with a Dual-Frequency Identification Sonar (DIDSON) system operated in conjunction with a standard picket weir located just downstream of the lake outlet. Genetic mixed stock analysis of weekly sockeye salmon harvests in the District 15 commercial drift gillnet fishery provides stock composition estimates that guide inseason management of the fishery (detailed in a separate Chilkoot Lake sockeye salmon operational plan). Biological sampling, along with escapement enumeration and stock-specific harvest data, allows for total run reconstruction required for escapement goal review. This project also supports the collection of basic limnology information at Chilkat Lake.

Keywords: Chilkat Lake, Chilkat River, DIDSON, escapement, Oncorhynchus nerka, sockeye salmon, limnology, weir

BACKGROUND

The Chilkat and Chilkoot river watersheds, located in northern Southeast Alaska, near the town of Haines (Figure 1), support two of the largest sockeye salmon (*Oncorhynchus nerka*) runs in Southeast Alaska. 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 the Chilkat and Chilkoot river watersheds (Rich and Ball 1933). Harvests decreased in the early 1920s and remained at relatively low levels thereafter; the average sockeye salmon harvest in northern Southeast Alaska averaged 0.44 million fish between 1980 and 2008, of which an average 93,000 and 89,000 fish originated from Chilkat and Chilkoot lakes, respectively (Eggers et al. 2010). Historically, Chilkat 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 after Alaska statehood in 1959 and Lynn Canal was 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 (Ingledue 1989; Gilk-Baumer et al. 2015). 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 the Chilkat River, where reported harvests for the period 2009–2018 averaged 5,300 fish per year.

Commercial harvest of Chilkat Lake sockeye salmon in the District 15 commercial drift gillnet fishery has been estimated from scale pattern analysis and, more recently, genetic stock identification (Bednarski et al. 2017). The Alaska Department of Fish and Game (ADF&G) initiated a scale pattern analysis program in 1980 to estimate contributions of Chilkat and Chilkoot sockeye salmon stocks based on consistent differences in freshwater scale patterns (Stockley 1950; Bergander 1974; McPherson 1990; McPherson et al. 1992). From 2015 to 2016, scale pattern analysis and genetic stock identification were conducted concurrently to compare estimates using the two methods (Serena Rogers Olive, ADF&G Fisheries Geneticist, personal communication). Since 2017, harvests of sockeye salmon stocks in the District 15 commercial drift gillnet fishery have been estimated solely through genetic stock identification (Bednarski et al. 2017; Zeiser et al. 2019).

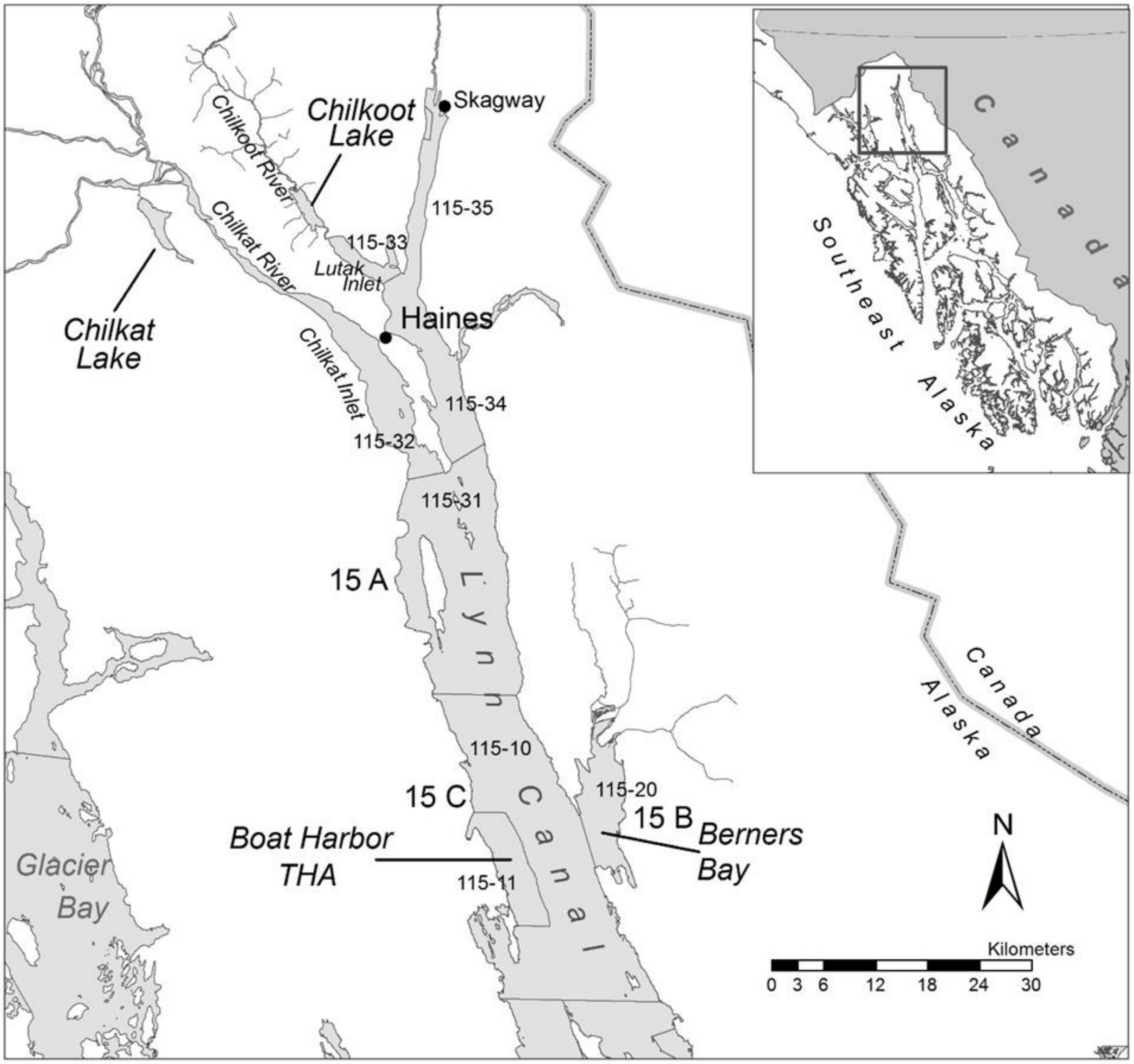


Figure 1.–Map showing Chilkat Lake and its proximity to Haines, the Chilkat and Chilkoot river watersheds, and the District 15 commercial fishing areas in Lynn Canal.

Chilkat Lake sockeye salmon escapements have been variously estimated through weir counts (1967–1993), weir counts with concurrent mark–recapture estimates (1994 and 1995, 1999–2007), mark–recapture estimates only (1996–1998), and Dual-Frequency Identification Sonar (DIDSON) counts with mark–recapture estimates (2008–2016) (Eggers et al. 2010; Sogge and Bachman 2014; Bednarski et al. 2017). Biological data have been collected annually at the lake to estimate the age, size, and sex composition of the escapement. Two-event mark–recapture studies in conjunction with operation of fish wheels in the lower Chilkat River were initiated in 1994 because weir counts at Chilkat Lake were thought to underestimate escapement (Kelley and Bachman 2000; Eggers et al. 2010). Periodic flooding of the silty Tsirku River into Chilkat Lake (Bergander et al. 1988) required opening the weir, sometimes for extended periods, and increased boat traffic in and out of the lake required frequent lowering of a boat gate in the center of the weir through which fish could pass uncounted (Kelley and Bachman 2000). Sockeye salmon were marked at the fish wheels and sampled for marks at the Chilkat Lake weir and various Chilkat River mainstem and tributary spawning locations; drainage wide mark–recapture estimates were then generated and divided into Chilkat Lake and Chilkat River mainstem estimates (Kelley and Bachman 2000; Bachman and McGregor 2001; Bachman 2005, 2010). In 2008, a DIDSON was installed at the Chilkat Lake weir to improve counts (Eggers et al. 2010). Finally, concerns regarding mark–recapture as a reliable measure of abundance lead to suspension of mark–recapture studies after 2016 and recommendations to improve DIDSON operations to estimate escapement into Chilkat Lake (Bednarski et al. 2017).

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 fish in 1976 and 70,000–90,000 fish in 1981 (Bergander et al. 1988) were replaced with a biological escapement goal (BEG) of 52,000–106,000 sockeye salmon in 1990 (McPherson 1990), a sustainable escapement goal (SEG) of 80,000–200,000 sockeye salmon in 2006 (Geiger et al. 2005), and a BEG of 70,000–150,000 sockeye salmon in 2009 (Eggers et al. 2008, 2010). The escapement goal was reviewed in 2018 using updated information and an age-structured state-space spawner-recruit model to account for uncertainty in escapement estimates (Miller and Heinl 2018). Based on model results, however, maximum sustainable yield would be achieved with escapements within the current escapement goal range, so no changes were recommended to the goal (Miller and Heinl 2018).

This operational plan outlines objectives, methods, and timelines for ADF&G stock assessment of the Chilkat Lake sockeye salmon run. Information provided by this project, in conjunction with stock assessment projects on the Chilkat River (Elliott 2018; Elliott and Peterson 2018; Rhea-Fournier 2018) and Chilkoot Lake (Zeiser et al. 2019), is used inseason to manage the District 15 commercial drift gillnet fishery to ensure escapement goals are met and to maximize and sustain the harvest of sockeye salmon from the two watersheds. Escapement and stock-specific harvest data, along with biological data on age at return, are essential for reconstruction of brood year returns for use in future escapement goal evaluation. Bednarski et al. (2017) provided a comprehensive review of historical sockeye salmon stock assessment studies in the Chilkat River drainage and recommendations for future improvements that are reflected in this plan.

STUDY SITE

Chilkat Lake (ADF&G Anadromous Waters Catalogue No. 115-32-10250-2067-3001-0010; 59.32577° N, 135.89436° W) is located approximately 27 river miles upstream from the city of Haines, Alaska (Figures 1 and 2). It is a relatively large clear lake with a surface area of 9.8 × 106 m^2 (2,432 acres), a mean depth of 32.5 m, a maximum depth of 57 m, and a volume of 319 × 106 m^3. The lake outlet, Clear Creek, flows 0.5 km to the Tsirku River, which then drains into the Chilkat River. Resident fish include sockeye salmon, coho salmon (*O. kisutch*), Dolly Varden (*Salvelinus malma*), cutthroat trout (*Salmo clarki*), threespine stickleback (*Gasterosteus aculeatus*), sculpin (*Cottus* spp.) and whitefish (*Prosopium cylindraceum*) (Johnson and Daigneault 2013). Very small numbers of adult pink and chum salmon (*O. keta*) have been observed at the Chilkat Lake weir, but the spawning location of these fish is not known. Chilkat Lake is a remote lake with moderate to heavy boat traffic. There are numerous private cabins on the lake (50 to 100 cabins), which are only accessible by jet boat and floatplane.

The Chilkat River (ADF&G Anadromous Waters Catalogue No. 115-32-10250) drains a large watershed stretching from British Columbia, Canada to the northern end of Lynn Canal, near Haines, Alaska (Figure 2). It is characterized by rugged, highly dissected mountains with steep-gradient streams, and braided rivers that flow through glaciated valleys. 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. Chilkat River discharge rates range from 80 to 20,400 ft^3/s (Bugliosi 1988). The river supports large runs of sockeye, coho, chum, Chinook (*O. tshawytscha*), and pink salmon.

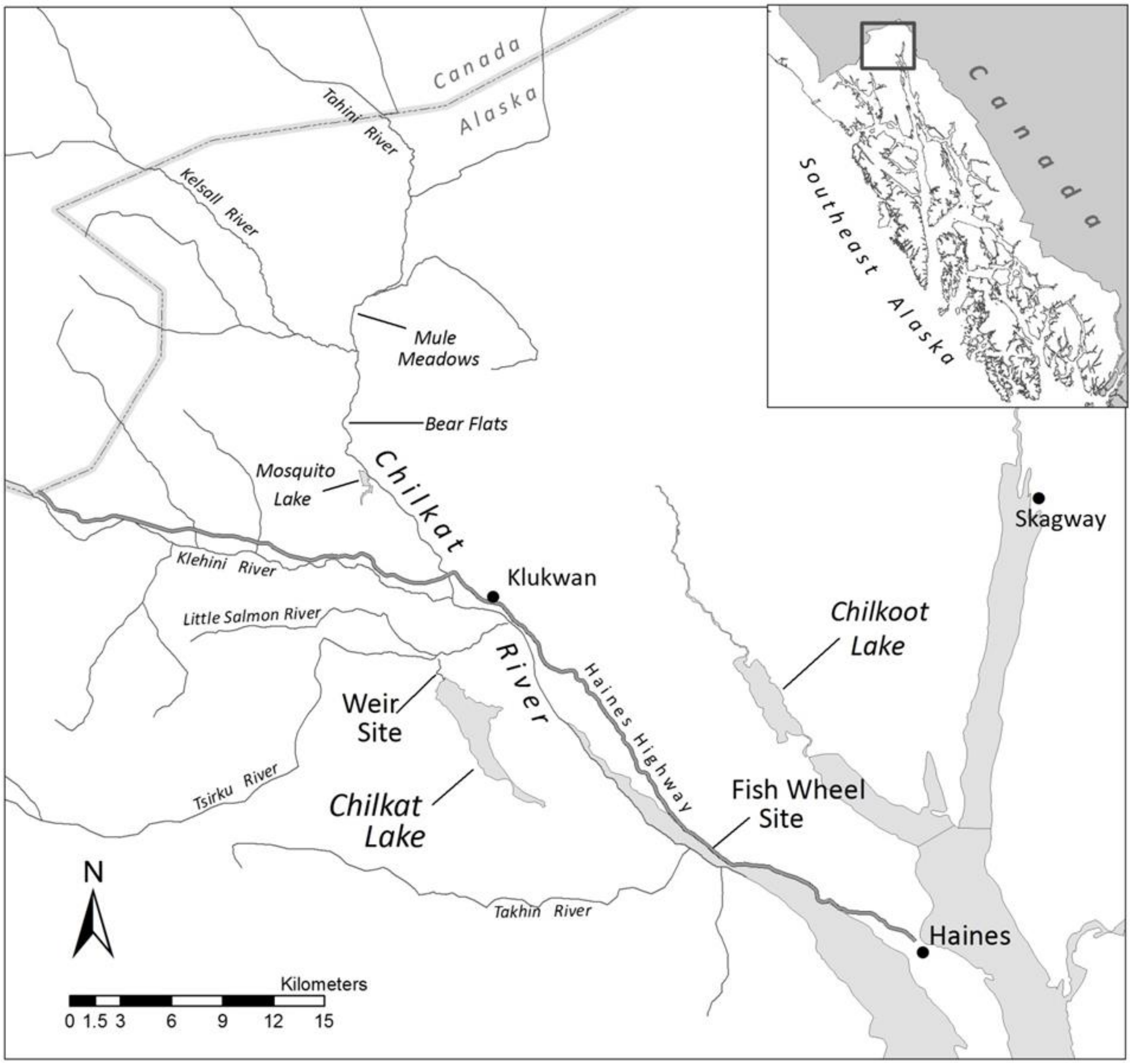


Figure 2.–Map of the Chilkat River drainage, showing locations of the Chilkat River fish wheels, Chilkat Lake, and the Chilkat Lake weir site.

OBJECTIVES

Primary objectives

1. Enumerate the sockeye salmon escapement into Chilkat Lake from 20 June to 10 October.
2. Estimate the seasonal age, sex, and length composition of the Chilkat Lake sockeye salmon escapement, such that the estimated proportions are within 5% of the true value with at least 95% probability.

Secondary objectives

1. Maintain a standardized beach seine sampling schedule during August–October to ensure accurate species apportionment of DIDSON counts between coho and sockeye salmon.
2. Perform periodic, systematic observer comparison of DIDSON counts to increase precision of the DIDSON count. Inseason disagreement between observers of more than 5% should be flagged for a detailed review.
3. Measure water column temperature, record light penetration profiles, and estimate zooplankton species composition, size, density, and biomass in Chilkat Lake on a monthly basis at the beginning of the month, June–October.

METHODS

CHILKAT LAKE ESCAPEMENT ENUMERATION

A DIDSON (manufactured by Sound Metrics Corporation[1]) sonar will be used in conjunction with a picket weir to enumerate the Chilkat Lake sockeye salmon escapement. The escapement count will be used to determine if the escapement goal is met. Data collected at the weir will provide inseason and postseason information on run timing, run strength, and age composition.

Chilkat Lake Weir

The Chilkat Lake adult salmon counting weir will be operated from approximately 20 June to 10 October (Appendix A). The weir will be installed in Clear Creek, approximately 0.4 km downstream of Chilkat Lake (Figure 2). The weir is a semi-removable steel bipod structure approximately 33 m wide. The maximum water depth at the weir site is approximately 3 m. The weir framework consists of 11 5-cm steel pipe bipods spaced between 2.4–2.7 m apart and driven into the bed of the river. Bipods are connected 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 (Figures 3 and 4). The maximum possible space between each picket is 4.1 cm. Each spring, two divers and crew will install two removable bipods in the center of the weir to support a 3.6-m wide boat gate that will allow boat traffic to access the lake. The boat gate will be operated remotely via an electric hoist/winch. Sandbags and fencing will be placed along the upstream side of the weir to prevent fish from passing uncounted. The integrity of the weir will be verified throughout the season by regular underwater inspections and placement of additional sandbags and fencing as needed. Operating

[1] Product names used in this publication are included for completeness but do not constitute product endorsement.

the DIDSON overnight with the gate shut is another method that will be used to check for leaks in the weir.

Stream height, water temperature, and water clarity (e.g., excellent, fair, poor) will be recorded at approximately 6:30 a.m. each day. Stream height (cm) will be measured on a stadia rod, and water temperature (°C) will be measured with a thermometer installed near the middle of the weir.

Periodic flow reversals, caused when glacial water from the flooding Tsirku River backs into Clear Creek and into Chilkat Lake, will require keeping the boat gate open to prevent damage to the gate until the reversal subsides. Flow reversals could last from a few hours to several days.

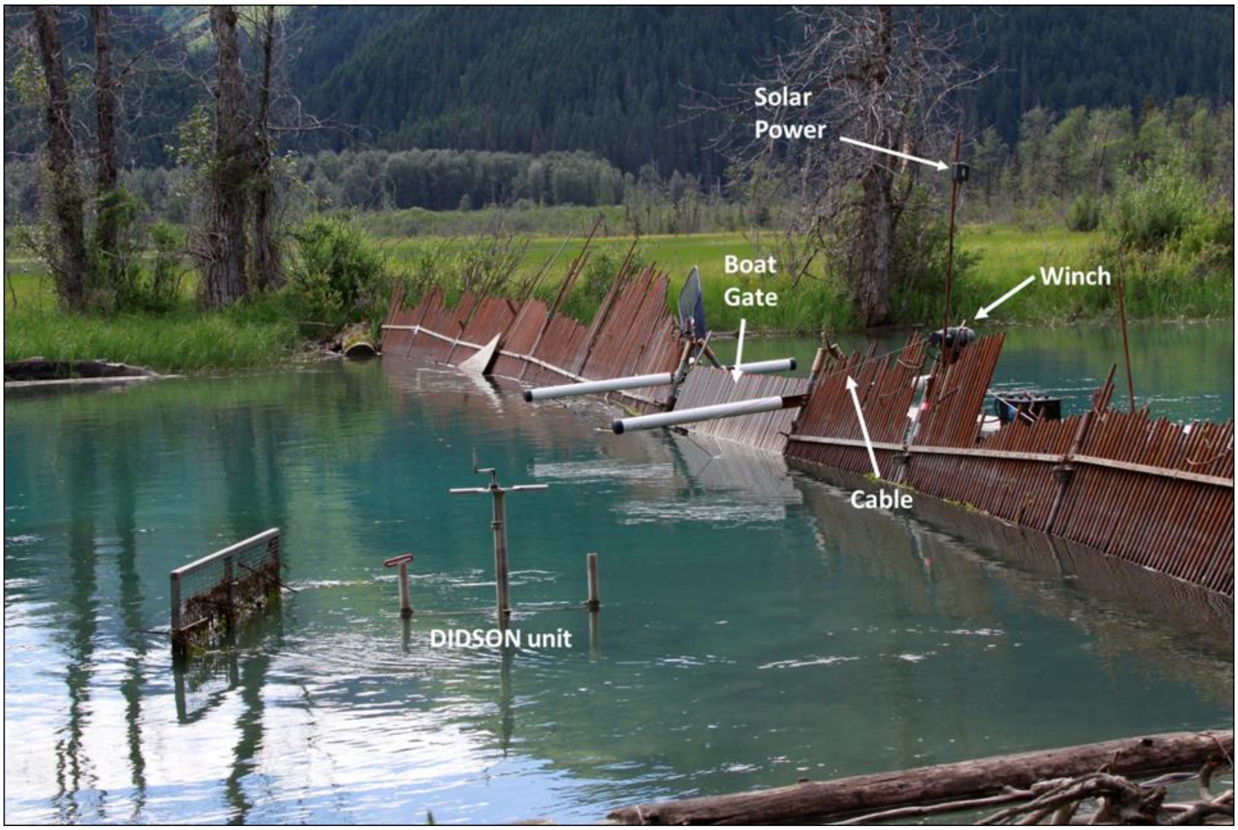


Figure 3–View of the Chilkat River weir from the upstream side, 23 July 2013, showing the boat gate, the boat gate winch and cable, the boat gate solar power panel, and the location of the DIDSON unit. (© ADF&G/photo by Steven C. Heinl.)

Figure 4.–Two views (from the cabin side of the creek) of the Chilkat Lake weir without pickets (left) and with pickets installed (right), 2019. (© 2019 ADF&G/photos by Nicole L. Zeiser.)

Sockeye Salmon Age, Sex, and Length Composition

The seasonal age composition of the Chilkat Lake sockeye salmon escapement (including jack sockeye salmon) will be determined from a minimum sample of 665 fish captured on the downstream side of the weir. This sample size was based on work by Thompson (2002) to estimate proportions of four or more major age classes. A sample of 510 fish is needed to ensure the estimated proportion of each major age class will be within 5% of the true value with at least 95% probability. The sample size was increased to 665 fish to ensure the sampling goal will be met, even if age cannot be determined from the scales of 30% of the sampled fish. In addition, three scales will be sampled from each fish to increase the proportion of readable scales. Up to 10 sockeye salmon will be sampled each day for matched scales, sex, and length (70 fish/week). If fish are present at 6:00 a.m., beach seine gear will be used to capture fish below the weir. This weekly sample will be more than sufficient to meet objective criteria, since the total seasonal sample will be more than the 665 samples required. This sample will also meet seasonal requirements for estimating sex composition, as only 385 samples (assuming no data loss) are needed to achieve the precision criteria (within 5% of the true value with 95% probability) (Thompson 2002).

Procedures for age, sex, and length sampling and recording data are outlined in detail in Appendices B–G. Sockeye salmon will be the only species sampled. All fish sampled for scales will be measured (mm) from mid eye to tail fork (Appendix C), and the sex will be determined from examination of external dimorphic sexual maturation characteristics such as snout and kype development, belly shape, and shape of vent opening (Appendix D). Three scales will be collected from the "preferred area" of each sampled fish (i.e., the left side of the fish, two scale rows above the lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin; INPFC 1963; Appendix E) and placed on a scale card (Appendices E and F). Corresponding data (sex and length) will be recorded on (ASL) optical scan forms (Appendix G).

Scale samples will be analyzed at the Region 1 Scale 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). The weekly age distribution, the seasonal age distribution and SE weighted by statistical week, and SE of sex composition weighted by statistical week will be calculated postseason using standard equations from Cochran (1977) (Appendix L).

DIDSON Installation and Settings

The DIDSON will be deployed just upstream of the weir approximately 3–5 m from the left bank of the river (Figure 3). The transducer will be attached to an aluminum rod and oriented perpendicularly 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 transducer placement and orientation and to make adjustments to accommodate varying water levels. The DIDSON will be operated at 1.8 MHz (high frequency 96 beams) with a viewing angle of 29° × 14°. A 30 m cable will be used to transmit power and data between the DIDSON and a "topside box" located inside the camp cabin, and an Ethernet cable will be used to route data to a laptop computer. Playback of files to enumerate fish will be controlled on the laptop computer with the latest version of DIDSON software inside the camp cabin.

Fish will be recorded as they move upstream through the boat gate opening at a range of approximately 5 m to 10 m from the face of the transducer, well within the 30-m effective range for a DIDSON set at high frequency. The sample rate will be set at 6 frames per second. Data will be recorded continuously in 60-minute increments and saved on a 3-terabyte portable external hard drive.

A gasoline powered generator or solar panel array and inverter will provide power for all equipment. In the event that the generator or array does not produce enough power to operate the DIDSON, power will automatically switch to an onsite battery bank. When sufficient power is being supplied by the generator or array, the battery bank will be charged at a float voltage of 13.7 V, equalization voltage of 14.7-15 V, and absorption voltage of 14.7 V due to the use of four 6 V Rolls S6-275 AGM batteries wired both in series and in parallel. Both the solar controller and the inverter/charger wired to the gasoline generator will be explicitly set to these voltages. Any deviation in the composition of the battery bank will require calling the manufacturer to set new float, equalization, and absorption voltages. The inverter/charger will be monitored via a controller inside the camp cabin.

The solar panel array will consist of six SYP130S-M 130W Instapark Photovoltaic Modules wired in series to breakers on a Big Baby Midnite Classic solar controller. As direct current (DC) power from the photovoltaic (PV) panels is routed through the solar controller and into the battery bank, a Magnum Energy MagnaSine charger/inverter will invert the DC from the battery bank into alternating current (AC) to supply power to most of the camp, including the DIDSON. Power from the battery bank is also known as constant current (CC). When the solar panel array is not in use, a gasoline powered generator will provide AC to the camp and the MagnaSine charger/inverter, which will automatically stop inverting and begin charging the batteries (a diagram of this set-up will be located in the camp cabin). The switch between inverting and charging will be fast enough that the DIDSON will continue to record data between power-source transfers.

DIDSON Operation

DIDSON operation will begin by statistical week 24 (Appendix A). The DIDSON will be operated 24 hours a day for the first five days with the boat gate closed at night. If any fish are observed passing through the weir at night while the gate is closed, the opening will be found and patched as soon as possible. This process will be extended past the first five days if fish continue to be observed passing through the weir when the gate is closed. Acoustic sampling will then begin each morning around 6:00 a.m. and continue until 10:00 p.m., when the boat gate will be closed for the night. Closing the gate at 10:00 p.m. will allow fish to build up behind the weir, where they can be easily sampled in the morning. In the rare event that a boat requires passage through the weir between 10:00 p.m. and 6:00 a.m., the period of time the gate is down will be limited as much as possible, but some fish may pass without being counted. If the boat gate remains open after 10:00 p.m. due to a flow reversal or a mechanical issue with the gate, the DIDSON will be operated 24 hours a day until the boat gate can be closed. In addition, the DIDSON will be operated 24 hours a day every Sunday to ensure the weir is fish tight. If fish are recorded moving though the weir uncounted, the weir will be inspected to rectify the problem. If the problem continues, operating the DIDSON 24 hours a day for the entire season will be considered.

The DIDSON will be set to record data onto the hard drive in 60-minute increments, creating a separate date- and time-stamped file for each recording period. The weir crew will identify and tally fish traces from the playback of recorded files. All fish determined to be salmon will be counted. This can be completed at the same time new files are being recorded, however, during normal operation the files will be viewed sometime after the initial recording, often the next day. Viewing a file later allows for the recording to be sped up, increasing efficiency. Files will not be viewed at speeds in excess of 60 frames per second. Playback of DIDSON files in excess of 60 frames per second causes the computer to drop frames during review, increasing the likelihood of missing fish. Files can be initially screened with the playback speed set at 60 frames per second to facilitate quicker viewing when there are long periods without any observed fish passage. When a moving object is observed, the recording can be stopped then replayed forwards and backwards at a lower speed to evaluate the nature of the object (relative size, swimming pattern, etc.). 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 that exhibit behavior identified with sockeye salmon (directional migration, no milling) will be assumed to be sockeye salmon and will be counted manually with tally counters.

Observer Training

The use of the DIDSON to count fish has limitations that need to be accounted for during operations or addressed preseason, including species apportionment (see below), shadowing effects, and observer bias from species nondetection or misclassification (cutthroat trout and whitefish identification versus salmon species) (Keefer et al. 2017). Observer fatigue or interruptions in viewing can also bias observations between operators (Cronkite et al. 2006). Acoustic shadowing effects can be a problem when fish are present in high densities—fish nearer to the DIDSON mask or "shadow" fish passing farther away—which leads to undercounting. In studies conducted elsewhere, problems associated with shadowing occurred when fish densities were greater than 1,000 fish an hour (Holmes et al. 2006; Maxwell and Gove 2007; Westerman and Willette 2012). Hourly fish counts at Chilkat Lake have usually been well below 1,000 fish. In the rare event that large schools of fish (estimated at >1,000 fish) are present immediately below the weir, fish passage will be restricted by closing the boat gate and pulling a few pickets to create a smaller opening for fish to move through, which should help reduce the occurrence of acoustic shadowing. Event nondetection bias or perception bias occurs in field observations studies when animals are visible but not observed, and typically result in underestimates of abundance (Nichols et al. 2000). Misclassification biases occur when species are misidentified, also inducing bias in abundance estimates (Conn et al. 2013). These biases can be reduced by training observers in the preseason and by routinely conducting inseason observer comparisons to maintain quality control and ensure accuracy.

Early Season

Accurate DIDSON counts rely on an observer's expertise to detect individual fish (Petreman et al. 2014; Martignac et al. 2015). To standardize sockeye salmon identification and enumeration, along with training observers during the preseason, an 'experienced' observer will independently view, enumerate, and process a set of 4 raw 60-minute training files from prior seasons of DIDSON deployment. The 'experienced' observer will enumerate sockeye salmon for each 60-minute file, repeatedly, until the fish count has a CV of less than 10% between repetitions of the same file. The training files will include a variety of fish densities, along with upstream and downstream movement of fish, to ensure that observers are subjected to a full spectrum of fish densities, movement patterns, and behaviors. The training files will be used to develop a sockeye salmon identification criterion, to standardize enumeration scoring, and to increase agreement among different observers about event identification.

Observers in training will independently view and enumerate sockeye salmon detection events from the four raw 60-minute training files. For consistency across observers, software setting, monitor size, and playback speed will be held constant, but observers will be allowed to rewatch clips and adjust some settings such as brightness. Observers in training will rewatch and re-enumerate each training file until they achieve a final fish count ± 15% from the benchmark interpretation set by the 'experienced' observer for each file. The 'experienced' observer will review files, as necessary, with each observer in training.

Inseason

Periodic, systematic observer comparisons of DIDSON counts will be conducted inseason to ensure accuracy of escapement counts. Every four weeks, four raw 60-minute files, representing the peak count for the four previous weeks, will be independently reviewed and enumerated for sockeye salmon abundance one time by each observer. These files should incorporate abundances greater than 100 fish/file when possible. An average of all individual counts ($\bar{x}$) will be used as a baseline to compare against the averages of each observer ($\bar{x}_i$) (Westerman and Willette 2011):

$$\bar{x} = \frac{\sum f}{n} \text{ and } \bar{x}_i = \frac{\sum f_i}{n_i}, \quad (1)$$

where:

$\sum f$ = sum of all fish counts of all observers,

$\sum f_i$= sum of fish counts of an individual observer,

n = number of files counted by all observers, and

n_i = number of files counted by an individual observer.

The difference (d) from the average will be measured for each observer, then compared to the average of all individual subsample counts,

$$d = \bar{x}_i - \bar{x}. \tag{2}$$

If an individual observer's count is higher than the average, the difference will be expressed as a plus (+), and if below the average, a minus (-). Mean absolute percent error (MAPE) will be calculated as the mean of the absolute values of the percent errors. MAPE yields a measure of observer performance with over- and under-estimates treated equally (e.g., Ryall 1998),

$$\text{MAPE} = \left| -\frac{(\bar{x}-\bar{x}_i)}{\bar{x}} \right| * 100. \tag{3}$$

Disagreement of more than MAPE = 5% between the average all the individual counts of the observers and an individual observer's average should be flagged for a detailed review.

Species Apportionment

The DIDSON cannot be used to identify salmon to species when two or more species of similar size and shape are present (Martignac et al. 2015). Although on some river systems apportionment of sonar counts by species requires separate, intensive net or fish wheel sampling programs (Bromaghin 2005; Lozori and McIntosh 2014), species identification at the Chilkat Lake weir involves only two species (coho and sockeye salmon) and it is not an issue until coho salmon start arriving in late August or early September. Pink and chum salmon numbers are expected to be very low since few were historically counted through the weir (the 1981–2007 average annual weir count was 10 chum salmon and 1 pink salmon); therefore it is assumed that these species will have a negligible presence at the weir. Species apportionment of Chilkat Lake DIDSON counts will start on the first day a coho salmon is observed at the weir or captured in morning beach seine sampling events in conjunction with sockeye salmon scale sampling.

The daily proportions of coho and sockeye salmon will be determined from a sample of *at least* 68 fish (combination of coho and sockeye salmon) captured in beach seine sets each morning. This sample will be sufficient to estimate the proportion of each species within 10% of the true value with 90% probability, with the assumption that the proportion sampled in morning beach seine sets is representative of the proportion of coho and sockeye salmon present throughout the day. The number of fish captured by species will be recorded for each beach seine set conducted. To avoid duplicate counting, all captured fish will be marked with a hole punch on the upper left operculum. Coho salmon will simply be marked and enumerated (they will not be sampled for age, sex, and length). Pink and chum salmon will also be counted if any are captured during beach seine sampling events. **The proportions of coho and sockeye salmon captured during morning sampling events will be applied to that day's DIDSON counts. If, however, fewer than 68 fish are captured and counted on day *X*, the total sample on that day will be added to samples from previous days until the combined total equals *at least* 68 fish. The combined total will be then be applied to the DIDSON counts on day *X*.**

ADF&G personnel will enter the beach seine recovery data from field forms into Excel computer spreadsheets at the field camp. Hourly DIDSON counts will be recorded on a paper data sheet during enumeration and recorded into Excel computer spreadsheets at the field camp. The summarized hourly counts will be entered directly into a daily counts Excel spreadsheet with proper apportionment when multiple species are caught in beach seine sampling events.

LIMNOLOGICAL ASSESSMENT

Basic limnological data, including zooplankton, light, and temperature sampling, will be collected monthly at Chilkat Lake from June to October. Sampling will be conducted as close as possible to the first day of each month. Since 2008, all limnological sampling has been conducted at stations 1A (59.3420° N, 135.9131° W) and 2A (59.3263° N, 135.8961° W), which are marked by anchored buoys in the lake. All sampling data will be recorded directly onto Limnology Sampling Forms (Appendix K). Monthly results will be averaged between the two stations, and seasonal estimates will be calculated as the average of the monthly values, June–October.

Light and Temperature Sampling

Light penetration measurements will be used to estimate the euphotic zone depth (EZD) of the lake, which is defined as the depth at which light (photosynthetically available radiation at 400–700 nm) is attenuated to 1% of the intensity just below the lake surface (Schindler 1971). Photometric illuminance will be recorded as lumens per square meter (lm/m^2) at 0.5-m intervals, from just below the lake surface to the depth at which ambient light level equals 1% of the subsurface recording. The natural log of the ratio of light intensity I just below the surface (I_0) to light intensity at depth Z, or $\ln(I_0/I_Z)$, will be calculated for each depth. The vertical light extinction coefficient (K_d), the rate (m^{-1}) at which light dims with increasing depth, will be estimated as the slope of the regression of $\ln(I_0/Iz)$ versus depth, and EZD will be calculated as $4.6502/K_d$ (Kirk 1994; Edmundson et al. 2000). Only the measurements recorded from 5 cm below the surface to just below 1% of the subsurface light level will be used in the calculations, as use of data at depths below 1% of the initial subsurface measurement will skew the estimate of EZD.

Light profiles will be collected at each station using an ILT 1400 International Light Technologies Photometer. A Protomatic light meter that measures illumination in foot candles or a secchi disk may be used as a backup. If the Protomatic light meter is used, the recording of the light intensity will include the value of the meter multiplier (e.g., 10,000x; 1,000x; 100x). If the ILT 1400 is used, this area of the Limnology Sampling Form should be used to record whether each reading is in lumens per square meter (lm/m^2) or kilolumens per square meter (klm/m^2).

Temperature (ºC) will be measured with a Yellow Springs Instruments Model 58 meter. Temperature will be recorded at 1-m intervals from the lake surface to a depth of 20 meters, and at 5-m intervals from 20 meters to a depth of 50 meters. Temperature readings will be recorded in the "Meter" column of the Limnology Sampling Form (Appendix K).

Zooplankton Sampling

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 m/sec. Once the top of the net clears the water surface, the rest of the net will be pulled slowly from 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 with tap water into a labeled 500 ml sampling bottle and preserved in a buffered 10% formalin or 10% EtOH solution. Sampling bottles will be topped off with tap water. The lake name, date, sampler's name, sampling station, and preservative type will be recorded on the bottle label. The start and stop times and time elapsed for each zooplankton tow will be recorded on the Limnology Field Sampling Form (Appendix K). Zooplankton samples will be analyzed at the ADF&G Kodiak Limnology Laboratory (Hopkins 2017).

DATA REDUCTION

WEIR COUNTS

Data collected at the fish weir will be recorded on field forms specific to each activity (Appendices H through J). Data forms will be kept up to date at all times and will be inspected daily for errors and completeness by all crew members and double-checked again by the crew leader. Daily counts will be called into the Haines office daily via cell phone by 9:00 a.m. and distributed within the department via weekly email by office staff.

DIDSON weir counts will be entered daily (or as timely as possible) into the ADF&G database at the Haines ADF&G office using the Zander data entry application on the ADF&G OceanAK website. Data to be entered include the water temperature (°C), stream height (mm), brief comments (e.g., water clarity, flow reversals), and fish numbers by count type, maturity, and species. It is important that a count of 0 be entered for any species/maturity type that might reasonably be expected to be present if none are counted on a given day. Sockeye salmon, for example, should be expected on any given day the weir is operated; thus, enter 0 for all days when no fish are counted through the weir when the gate is open. Conversely, there is no need to enter a count of 0 coho salmon until at least 1 coho salmon has been counted at the weir, after which counts of 0 should be entered for all days when none are counted. To ensure accuracy, entered data should be checked against the raw data each time they are entered into the database. Once the project is completed, daily weir counts for the entire season should be downloaded from OceanAK and double-checked again to ensure they are accurate and complete.

SOCKEYE SALMON AGE, SEX, AND LENGTH COMPOSITION

All ASL forms and scale cards (Appendices E through G) will be checked weekly to ensure that scales are clean and mounted correctly, labeled correctly, and match up with the corresponding ASL data form. Scales will be remounted when necessary. All data associated with sockeye salmon scale samples will be sent to the Region 1 Scale Aging Laboratory in Douglas **each Monday morning** for review, analysis, and archiving.

LIMNOLOGICAL ASSESSMENT

Limnological data forms (Appendix K) will be kept up to date at all times and will be inspected monthly for errors and completeness. Light and temperature data will be entered into specific Excel spreadsheets at the Haines office and stored on the ADF&G regional shared network drive.

Zooplankton samples and associated forms (Appendix K) will be delivered to the Haines ADF&G Commercial Fisheries office for seasonal storage. At the end of the season, all samples will be shipped to the ADF&G Kodiak Limnology Laboratory for analysis.

SCHEDULE AND DELIVERABLES

FIELD OPERATIONS

Field sampling activities are scheduled as follows:

1. Chilkat Lake weir and DIDSON sonar	about 20 June–10 October
2. Chilkat Lake limnology	monthly, June–October

REPORTING

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 December of 2020 and in March of each following odd year.

RESPONSIBILITIES

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

Shane Ransbury, Fishery Biologist I: Responsible for overseeing Chilkat Lake weir operations and directing the projects in the absence of Zeiser. Assists with the supervision of the overall project; edits, analyzes, and reports data; conducts quality control on data and data files and prepares them for shipping; trains the crew in safety and project procedures; creates crew schedules; assists with fieldwork; arranges logistics with the field crew; and serves as project expeditor. Assists with writing and reviewing operational plans and ensures the plan is followed or modified appropriately. Resolves personnel or administrative issues related to this project and writes crew evaluations.

David Besh, Fish and Wildlife Technician III: Crew leader on the Chilkat Lake weir and DIDSON project; responsible for employee training and data quality control.

Taylor Cowan and Zach McKeown, Fish and Wildlife Technicians II: These positions assist in all aspects of the operation and maintenance of the Chilkat Lake weir and DIDSON and assist in the limnological sampling.

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

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

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

REFERENCES CITED

Bachman, R. L. 2005. Stock assessment studies of Chilkat River adult sockeye and chum salmon stocks in 2002. Alaska Department of Fish and Game, Fishery Data Series No. 05-36, Anchorage.

Bachman, R. L. 2010. Stock assessment studies of Chilkat River adult sockeye and chum salmon stocks in 2003 and 2004. Alaska Department of Fish and Game, Fishery Data Series No. 10-23, Anchorage.

Bachman, R. L., and A. J. McGregor. 2001. Stock assessment studies of Chilkat River adult salmon stocks in 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J01-36, Juneau.

Bednarski, J. A., M. M. Sogge, S. E. Miller, and S. C. Heinl. 2017. A comprehensive review of Chilkat Lake and River sockeye salmon stock assessment studies. Alaska Department of Fish and Game, Fishery Manuscript Series No. 17-06, Anchorage.

Bergander, F. 1974. Southeastern Alaska sockeye salmon optimum escapement studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anadromous Fish Conservation Act, Completion Report for period July 1, 1971 to June 30, 1974, AFC-40, Juneau.

Bergander, F. E., S. A. McPherson, and J. P. Koenings. 1988. Southeast Alaska sockeye salmon studies, 1987–88; technical report for the period July1, 1987 to June 30, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J88-44, Juneau.

Bromaghin, J. 2005. A versatile net selectivity model, with application to Pacific salmon and freshwater species of the Yukon River, Alaska. Fisheries Research 74:157– 168.

Bugliosi, E. F. 1988. Hydrologic reconnaissance of the Chilkat River basin. U.S. Geological Survey, Water-Resources Investigations Report 88-4023, Anchorage.

Clutter, R., and L. Whitsel. 1956. Collection and interpretation of sockeye salmon scales. Bull. Int. Pac. Salmon Fish. Comm., No. 9.

Cochran, W. 1977. Sampling techniques. 3rd ed. John Wiley and Sons, Inc., New York.

Conn, P. B., B. T. McClintock, M. F. Cameron, D. S. Johnson, E. E. Moreland, and P. L. Boveng. 2013. Accommodating species identification errors in transect surveys. Ecology 94:2607-2618.

Cronkite, G. M. W., H. Enzenhofer, T. Ridley, J. Holmes, J. Lilja, and K. Benner. 2006. Use of high-frequency imaging sonar to estimate adult sockeye salmon escapement in the Horsefly River, British Columbia. Canadian Technical Report of Fisheries and Aquatic Sciences 2647.

Edmundson, J. A., V. P. Litchfield, G. L. Todd, J. M. Edmundson, and L. Brannian. 2000. Central Region limnology 2000 annual report of progress. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 2A00-27, Anchorage.

Eggers, D. M., J. H. Clark, R. L. Bachman, and S. C. Heinl. 2008. Sockeye salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-17, Anchorage.

Eggers, D. M., R. L. Bachman, and J. Stahl. 2010. Stock status and escapement goals for Chilkat Lake sockeye salmon in Southeast Alaska. Alaska Department of Fish and Game, Fishery Manuscript No. 10-05, Anchorage.

Elliott, B. W. 2018. Chilkat River Chinook salmon escapement studies in 2018. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan No. ROP.SF.1J.2018.07, Anchorage.

Elliott, B. W., and R. Peterson. 2018. Production and harvest of Chilkat River Chinook and coho salmon, 2018–2019. Alaska Department of Fish and Game, Regional Operational Plan No. SF.1J.2018.10, Anchorage.

Geiger, H. J., R. L. Bachman, S. C. Heinl, K. Jensen, T. A. Johnson, A. Piston, and R. Riffe. 2005. Sockeye salmon stock status and escapement goals in Southeast Alaska [*in*] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22, Anchorage.

REFERENCES CITED (Continued)

Gilk-Baumer, S. E., S. D. Rogers Olive, D. K. Harris, S. C. Heinl, E. K. C. Fox, and W. D. Templin. 2015. Genetic mixed stock analysis of sockeye salmon harvests in selected northern Chatham Strait commercial fisheries, Southeast Alaska, 2012–2014. Alaska Department of Fish and Game, Fishery Data Series No. 15-03, Anchorage.

Holmes, J. A., G. M. W. Cronkite, H. J. Enzenhofer, and T. J. Mulligan. 2006. Accuracy and precision of fish-count data from a ‘‘dual-frequency identification sonar’’ (DIDSON) imaging system. ICES Journal of Marine Science 63:543–555.

Hopkins, A. M. 2017. Kodiak Island Limnology Laboratory analysis operational plan, 2017–2019. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan ROP.CF.4K.2017.14, Kodiak.

Ingledue, D. 1989. Hawk Inlet shore purse seine fishery, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J89-31, Juneau.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report 1961. Vancouver, British Columbia.

Johnson, J., and M. Daigneault. 2013. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southeastern Region, Effective July 1, 2013. Alaska Department of Fish and Game, Special Publication No. 13-09, Anchorage.

Keefer, M. L., C. C. Caudill, E. L. Johnson, T. S. Clabough, C. T. Boggs, P. N. Johnson, and W. T. Nagy. 2017. Inter-observer bias in fish classification and enumeration using Dual-frequency Identification Sonar (DIDSON): a Pacific Lamprey case study. Northwest Science 91:41–53.

Kelley, M. S., and R. L. Bachman. 2000. Stock assessment studies of the Chilkat River adult salmon stocks in 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J00-29, Juneau.

Kirk, J. T. O. 1994. Light and Photosynthesis in Aquatic Ecosystems. Cambridge University Press, England

Koo, T. S. Y. 1962. Age designation in salmon [*In*] Studies of Alaska red salmon. University of Washington Press, Seattle.

Lozori, J. D., and B. C. McIntosh. 2014. Sonar estimation of salmon passage in the Yukon River near Pilot Station, 2012. Alaska Department of Fish and Game, Fishery Data Series No. 14-22, Anchorage.

Martignac, F., A. Daroux, J. L. Bagliniere, D. Ombredane, and J. Guillard. 2015. The use of acoustic cameras in shallow waters: new hydroacoustic tools for monitoring migratory fish population. A review of DIDSON technology. Fish and Fisheries 16:486–510.

Maxwell, S. L., and N. E. Gove. 2007. Assessing a dual-frequency identification sonars' fish-counting accuracy, precision, and turbid river range capability. Journal of the Acoustical Society of America 122:3364–3377.

McPherson, S. A. 1990. An inseason management system for sockeye salmon returns to Lynn Canal, southeast Alaska. M. S. Thesis, University of Alaska, Fairbanks.

McPherson, S. A., F. E. Bergander, M. A. Olsen, and R. R. Riffe. 1992. Contribution, exploitation, and migratory timing of Lynn Canal sockeye salmon runs in 1988 based on analysis of scale patterns. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report No. 92-21, Juneau.

Miller, S. E., and S. C. Heinl. 2018. Chilkat Lake sockeye salmon escapement goal review. Alaska Department of Fish and Game, Fishery Manuscript Series No. 18-05, Anchorage.

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, J. E. Fallon, and P. T. Heglund. 2000. A double-observer approach for estimating detection probability and abundance from point counts. The Auk 117:393–408.

Petreman, I. C., N. E. Jones, and S. W. Milne. 2014. Observer bias and subsampling efficiencies for estimating the number of migrating fish in rivers using Dual-frequency IDentification SONar (DIDSON). Fisheries Research 155:160-167.

REFERENCES CITED (Continued)

Rhea-Fournier, W. J., S. C. Heinl, S. E. Miller, J. A. Bednarski, and K. R. Shedd. 2018. Operational plan: stock assessment studies of Chilkat River adult salmon, 2018. Alaska Department of Fish and Game, Regional Operational Plan ROP.CF.1J.2018.06, Douglas.

Rich, W. H., and E. M. Ball. 1933. Statistical review of the Alaska salmon fisheries. Part IV: Southeastern Alaska. Bulletin of the Bureau of Fisheries, Vol. XLVII (47), No. 13: 437–673.

Ryall, P. 1998. Evaluation of the reliability of in-season run size estimation techniques used for Southern British Columbia chum salmon (*Oncorhynchus keta*) runs. N. Pac. Anadr. Fish Comm. Bull. No.1: 380-387

Schindler, D. W. 1971. Light, temperature, and oxygen regimes of selected lakes in the experimental lakes area, northwestern Ontario. Journal of the Fisheries Research Board of Canada 28: 157–169.

Sogge, M. M., and R. L. Bachman. 2014. Operational Plan: Stock assessment studies of Chilkat River adult salmon. Alaska Department of Fish and Game, Regional Operational Plan ROP.CF1J.14-03, Douglas.

Stockley, C. 1950. The sockeye salmon of Chilkat and Chilkoot inlets. Fisheries Research Institute Paper No 286, University of Washington, Seattle.

Thompson, S. K. 2002. Sampling, 2nd ed. John Wiley and Sons, Inc., New York.

Westerman, D. L., T. M. Willette. 2011. Upper Cook Inlet salmon escapement studies, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 11-66, Anchorage.

Westerman, D. L., and T. M. Willette. 2012. Upper Cook Inlet salmon escapement studies, 2011. Alaska Department of Fish and Game, Fishery Data Series No. 12-83, Anchorage.

Zeiser, N. L., S. C. Heinl, S. E. Miller, and K. R. Shedd. 2019. Operational Plan: Stock assessment studies of Chilkoot Lake sockeye salmon, 2019. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan ROP.CF.1J.2019.07, Douglas.

APPENDICES

Appendix A.–ADF&G statistical weeks 23–42 and corresponding calendar dates, 2020–2022.

	2020		2021		2022	
Statistical Week[a]	Beginning Date	Ending Date	Beginning Date	Ending Date	Beginning Date	Ending Date
23	31-May	6-Jun	30-May	5-Jun	29-May	4-Jun
24	7-Jun	13-Jun	6-Jun	12-Jun	5-Jun	11-Jun
25	14-Jun	20-Jun	13-Jun	19-Jun	12-Jun	18-Jun
26	21-Jun	27-Jun	20-Jun	26-Jun	19-Jun	25-Jun
27	28-Jun	4-Jul	27-Jun	3-Jul	26-Jun	2-Jul
28	5-Jul	11-Jul	4-Jul	10-Jul	3-Jul	9-Jul
29	12-Jul	18-Jul	11-Jul	17-Jul	10-Jul	16-Jul
30	19-Jul	25-Jul	18-Jul	24-Jul	17-Jul	23-Jul
31	26-Jul	1-Aug	25-Jul	31-Jul	24-Jul	30-Jul
32	2-Aug	8-Aug	1-Aug	7-Aug	31-Jul	6-Aug
33	9-Aug	15-Aug	8-Aug	14-Aug	7-Aug	13-Aug
34	16-Aug	22-Aug	15-Aug	21-Aug	14-Aug	20-Aug
35	23-Aug	29-Aug	22-Aug	28-Aug	21-Aug	27-Aug
36	30-Aug	5-Sep	29-Aug	4-Sep	28-Aug	3-Sep
37	6-Sep	12-Sep	5-Sep	11-Sep	4-Sep	10-Sep
38	13-Sep	19-Sep	12-Sep	18-Sep	11-Sep	17-Sep
39	20-Sep	26-Sep	19-Sep	25-Sep	18-Sep	24-Sep
40	27-Sep	3-Oct	26-Sep	2-Oct	25-Sep	1-Oct
41	4-Oct	10-Oct	3-Oct	9-Oct	2-Oct	8-Oct
42	11-Oct	17-Oct	10-Oct	16-Oct	9-Oct	15-Oct

[a] Statistical weeks begin on Sunday at 12:01 a.m. and end the following Saturday at midnight and are numbered sequentially starting from the first week of the calendar year.

Appendix B.–Procedures for sampling adult sockeye salmon for age, sex, and length (ASL).

ESCAPEMENT SAMPLING FOR SCALES

The following is a detailed explanation on how to collect salmon scale samples. If you have any questions, ask your co-worker or supervisor for clarification. Scales must be readable and properly organized to be useful, so follow proper technique when sampling.

For sampling you will need:

- Clipboard with ADF&G Salmon Age-Sex-Length (ASL) forms
- Pencils (No. 2)
- Pre-labeled scale cards
- Wax paper inserts
- Forceps (tweezers)
- Plastic scale card holders (optional)
- Measuring tape/measuring board or measuring trough
- Dip net
- Gloves

SCALE CARDS

A scale card (also called a gum card) is a gum-backed sheet for mounting individual scales collected from a fish. Each card has 40 positions, numbered 1 through 40. Scale samples are placed on the cards in sequential order but working down in columns instead of rows because you will take more than one scale from each fish.

It is important to keep scale cards dry at all times. A wet scale card is useless, as the scales will fall off and prevent a readable impression from being taken. If the scale card does get wet (really wet), the scales should be remounted onto a new scale card and great care should be taken to keep each scale in its original position. The completed scale card should be allowed to dry completely before storing. All scale cards should be stored with a sheet of wax paper placed between them to keep the cards from sticking to each other, and the cards should be kept in a moisture-proof container or pressed between paper towels while drying.

SCALE SAMPLING PROCEDURES

Pluck the scale from the "preferred area" of the fish using forceps (tweezers). The preferred scales are located on the left side of the fish, two scale rows above the lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior origin of the anal fin (Appendix E). If the preferred scales are missing, reabsorbed, or obviously deformed, try the preferred area on the right side of the fish or sample a different fish. **Do not sample scales outside of the preferred area.**

After plucking scales from the fish, **take time to clean the scale and make sure the scales are mounted correctly on the scale card.** Remove all slime, grit, and as much skin (silver color) as possible from them by wiping the under surface (the side adhering to the fish) on the back of your hand or between fingers. Moisten cleaned scales and mount them on the appropriate number on the scale card. Mount scales with the anterior end (the end of the scale pointing toward the fish’s head when plucked) pointed toward the top of the scale card (Appendix E).

Avoid collecting scales that are regenerated, torn, or misshapen. Patches of regenerated scales are often visible on the fish as a scar or patch of irregularly shaped scales. Regenerated scales have irregular patterns and often have a clear or blank area visible in the middle of the scale, all of which makes them useless for determining the fish's age.

It is essential that scales be cleaned before they are mounted on the scale card. If all the silver-colored skin, slime, and dirt are not removed, the scale will not adhere well to the card. In addition, slime and dirt on the scales or on the gum card will obscure the scale and render it useless for determining the fish's age (which is the purpose of the entire sampling process).

It is very important to not turn the scale over when mounting it on the gum card. The ridged or sculptured side of the scale should always face up, as it does on the outer surface of the fish. The age of the fish is determined from the pattern of these ridges on the outer surface of the scale. The underside of the scale, the side facing the fish's body, is perfectly smooth and thus not useful for determining age. Scales that are accidentally placed upside down (inverted) on the scale card can often be spotted later, because the edges of the scale will start to pull away from the card as they dry. The ridges can easily be detected by lightly scratching the surface of the scale with a fingernail or tweezers.

It is very important that all scales be mounted on the scale card pointed in exactly the same direction. The anterior portion of the scale (the end of the scale that points toward the fish's head) should be oriented toward the top of the card. Uniform orientation makes it much easier to view and age the scales at the ADF&G aging laboratory. If the scales are pointing in different directions, they will have to be remounted at the lab, so it is essential to mount them correctly at the time they are collected.

SOCKEYE SALMON SCALE SAMPLING

When sampling sockeye salmon, you will take THREE SCALES from each fish. For the first sockeye salmon sampled, mount the three scales over scale-card boxes 1, 11, and 21 (working down in a column instead of across rows). Scales from the second fish sampled will be placed on scale-card boxes 2, 12, and 22. Repeat for the remainder of the fish sampled (Appendix E). You will sample 10 fish every day so the scale card will be filled up daily and you will use a new scale card for each new sampling event. **The same ASL form will be used each day until it is full.** Sockeye salmon ASL forms will have 4 scale cards associated with them if 40 fish are sampled during the statistical week. On the ASL form, simply write the new sampling date on the line in the right margin of the form that corresponds to the fish number (Appendix G). It is important that scale card number and information match the information entered on the corresponding optical scan (ASL) form. **Remember to always start a new scale card and new corresponding ASL form at the beginning of each statistical week** (Appendix A).

FILLING OUT A SCALE CARD (example shown in Appendix F)

Species:

Write name of species out completely, as shown on the reverse side of the ASL form (i.e., sockeye). Do not abbreviate.

Card No:

Scale cards are numbered sequentially beginning with "001" and continue through the entire season. Each species will have its own card numbering series. Do not repeat or omit scale card numbers.

Locality:

Write out the name of the system being sampled (i.e., Chilkat Lake).

Stat. Code:

Write the 3-digit district (115), then the 2-digit subdistrict (32), then the 3-digit stream number (032) **(i.e., 115-32-032 for Chilkat Lake).**

Sampling date:

Record the date when fish were sampled. This should match the date on the corresponding ASL form.

Gear:

Write out completely (i.e., weir). Do not abbreviate.

Collector(s):

Record the last name of the persons sampling and their respective jobs. The fish wrestler (W), the data recorder (R), and the scale plucker (P); e.g., Heinl (W), Zeiser (P, R).

Remarks:

Record any pertinent information (i.e., for sockeye salmon you would record: 3 scales/fish, # of fish sampled, and corresponding ASL #).

COMPLETING THE OPTICAL SCAN FORMS (example shown in Appendix G)

Salmon from many systems throughout the state are sampled for age, sex, and length annually by field crews. To be useful, data must be recorded neatly and accurately on the optical scan forms. Complete each section on the left side of the optical scan form using a No. 2 pencil and darken the corresponding ovals as shown in the figures. It is imperative that you darken the oval completely and neatly. Make every effort to darken the entire oval because the optical scanner that reads and records the data from the optical scan forms often misses partially filled or lightly filled ovals but avoid pressing so hard as to indent the paper. Do not stack forms when filling them out and label only one form at a time to avoid "the carbon paper effect" and resulting stray marks. It is essential that the forms are reviewed at the end of each day to ensure that all data are filled in and appropriately marked.

ASL Header Section:

Description: ***SPECIES/ DIST., SUB-DIST, OR STREAM/ GEAR/ PORT OR ESCAPEMENT SYSTEM/ WEEK.***

Write the description information in the header of the ASL above the appropriate sections, following the examples shown in Appendix G; for the Chilkat Lake weir this will be **Sockeye/ Dist. 115-32-032/weir/Chilkat Lake Escapement/Week 26**).

Continue filling out the entries along the left side of the **optical scan (ASL) form** as described below:

Description:

Write out the name of the species, District, sub-district system and the type of sampling being done, and statistical week

Card:

CARD:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
001	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Scale cards are numbered sequentially throughout the season starting with 001 or continuing where previously left off. A separate numbering sequence will be used for each species, gear, fishery, and harvest code so be sure you are using the correct scale card number. Since three scales per fish are sampled for sockeye salmon, each gum card will have scales from 10 fish, and each ASL can have up to four scale cards. The first scale card of the sequence for each ASL form should be recorded and appropriate blocks filled in, while the other associated scale cards should be written in where the ASL form states "CARD #" between each 10-row section.

Species:

The code numbers for each species are listed on the reverse side of the ASL form.

SPECIES: 2	**1**	**2**	**3**	**4**	**5**	

Sockeye = 2

Day, Month, Year:

An ASL form will show the date of the first sampling event of the week marked in the boxes on the left side of the form, and subsequent sampling dates throughout the statistical week will be written on the line in the right-hand margin of the form (Appendix G). Use appropriate blocks for the date the fish were sampled.

DAY:	**0**	**1**	**2**	**3**						
24	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
MONTH:	**0**	**1**								
06	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
YEAR:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
18	**0**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

District:

DISTRICT:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
115	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

Sub-District:

SUB-DISTRICT: 32	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Stream:

STREAM:	0	1	2	3	4	5	6	7	8	9
032	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Port: Leave Blank

Statistical Week:

List the statistical week in which you are sampling. Refer to the statistical week calendar found in Appendix A for this number.

STAT. WEEK 26	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Project:

The project code for escapement sampling at a weir site is 3. Refer to the reverse side of the ASL form to see codes.

PROJECT: 3	1	2	3	4	5	6	7	8	9

Gear:

The gear code is 14 = Weir. Refer to the reverse side of the ASL form to see codes.

GEAR: 14	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Length Type:

Use length type 2 (mid eye to fork of tail).

LENGTH TYPE: 2	0	1	2	3	4	5	6	7	8	9

Number of Cards:

Mark 1, 2, 3, or 4 as appropriate, for number of scale cards associated with that ASL form.

# CARDS: 4	1	2	3	4	

User Code Definitions: Leave blank.

Sex Column:

Fill in the appropriate M (male) or F (female) block for each sockeye salmon sampled. Do the same for sampling Chinook salmon.

#	SEX	
1	M	F
2	M	F
3	M	F

Length Columns:

Measure fish from **mid eye to fork of tail (MEF) to the nearest 5mm (Appendix C).** Mark (1) in the "T" column for fish > 999 mm in MEF length.

T	100S										LENGTH										1's									
1	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

SOME REMINDERS

- It is extremely important to keep the optical scan forms flat, dry, and clean. Fish slime and water curling will cause the optical scanning reader machine to reject the entire optical scan form. If unnecessary pencil marks, dark spots, etc. are visible, they need to be erased or the machine will misinterpret the mark. It is essential to fill in all information and darken the circles completely.
- Record length by blackening the appropriate column circles on the optical scan form. Column 3 on the optical scan form is used for fish over 999 millimeters long. Measure all salmon to the nearest 5 millimeters.
- Optical scan forms should be carefully reviewed and edited before submitting to the immediate supervisor. This is extremely important and cannot be emphasized enough. Re-check header information on optical scan forms and make sure all available information is filled in. Card numbers should not be repeated. Crew leaders should take time to ensure that the circles are being blackened correctly; if the circles are not darkened properly or are sloppily marked the optical scanner will record the information incorrectly or miss it entirely. Keep marks within each circle and completely fill them. Do not mark outside the circles.
- Transfer important comments from scale cards to optical scan forms. After pressing scales, the cards are seldom referred to again, and important remarks can be lost. Write any necessary comments in the top margin (not on the left side) or on the reverse side of the optical scan form. If no room is available on the optical scan form to completely explain the remarks, use a separate piece of paper.
- If the optical scan forms get terribly wrinkled or blotched, they should be copied to a new form before submitting to the area office. The optical scanning machine is extremely sensitive to wrinkles and blotches and will misread or reject the sheets.

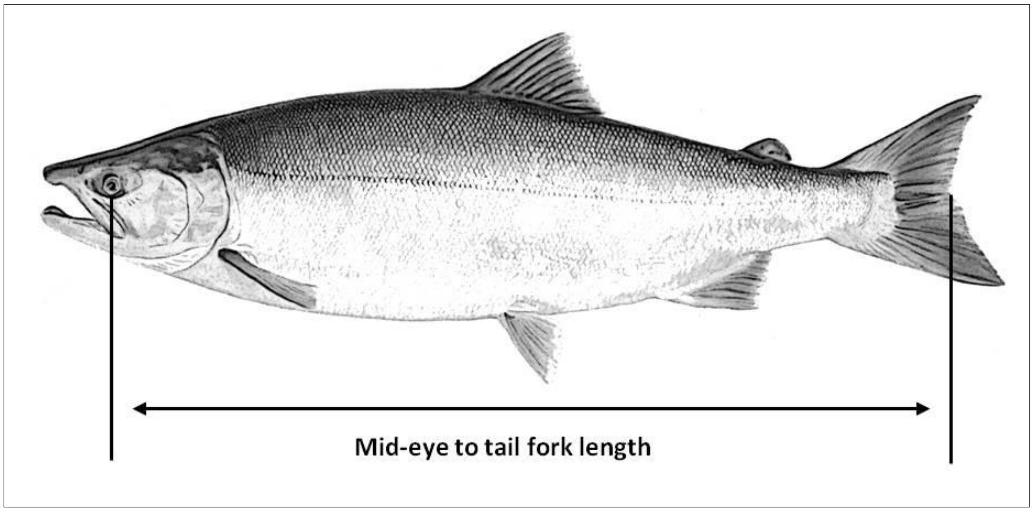
- Look down the form from 2 angles after the data have been recorded to pick up any glaring mistakes. A common error, for instance, is placing both the 1 and 9 of a 419 mm fish in the 10's column with nothing in the 1's column.
- It is important for post-season editing that all information is provided on every ASL form and scale card. Include such information as who wrestled the fish, plucked the scale, and filled out the forms. It is the responsibility of the crew leader to make sure all information is entered correctly. The project leader will also double-check the forms before sending the data to Juneau.

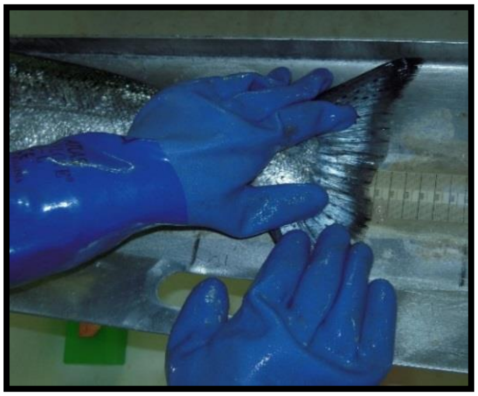
Appendix C.–Measuring adult salmon for length.

The snout of a salmon changes as the fish approaches sexual maturity, therefore changing the length of the fish. As a result, length measurements are made from the middle of the eye to the fork of the tail. **The length is always rounded and recorded to the <u>nearest 5 millimeters (mm).</u>** Examples of rounded lengths are: 561–562 mm rounded to 560 mm, 563–567 mm rounded to 565 mm, and 568–569 mm rounded to 570 mm.

A fish measuring trough is used at the Chilkoot River weir site. The procedure for measuring mid-eye to fork of tail length is as follows:

1. Place the salmon flat, right side down, in the measuring trough. If you are the one wrestling the salmon, orient the salmon with its head on your right, the tail in your left hand, and the salmon's dorsal surface (back) towards you. This puts the salmon in the correct orientation for the plucker (P) and recorder (R) to remove the preferred scale from the fish's left side if the plucker is standing on the other side of the measuring trough.
2. Line the eye of the salmon up with the end of the measuring tape, then hold the salmon's head with your right hand. Gently sliding your thumb into the salmon's mouth and grasping the lower jaw works well for larger fish.
3. Flatten and spread the tail against the board with your left hand. Read the mid eye to fork of tail length to the nearest 5 millimeters and record the length on the ASL form.





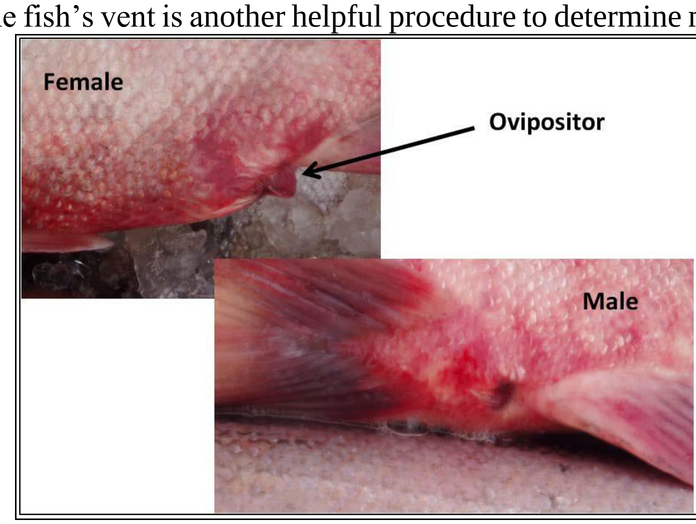
Appendix D.–Determining the sex of salmon.

External sexing of salmon can be difficult, depending on the species and sexual maturity of the fish, and requires practice and attention to detail in order to be accurate. Sex determination requires examination of a combination of characteristics: 1) the head of the fish, for the development of a long snout and kype in males (shown in the photo below); 2) the vent, on the underside of the fish, for the presence of an ovipositor in females; and 3) the belly, which becomes rounder and fuller in females as their eggs develop.

1) Male sockeye and Chinook salmon may have longer snout than females and develop more of a hooked top jaw/nose and hooked kype (lower jaw) as they mature, as illustrated by the fish on the right. Female salmon tend to have a rounder, shorter nose/face and lack the hooked top jaw, as illustrated by the fish on the left.

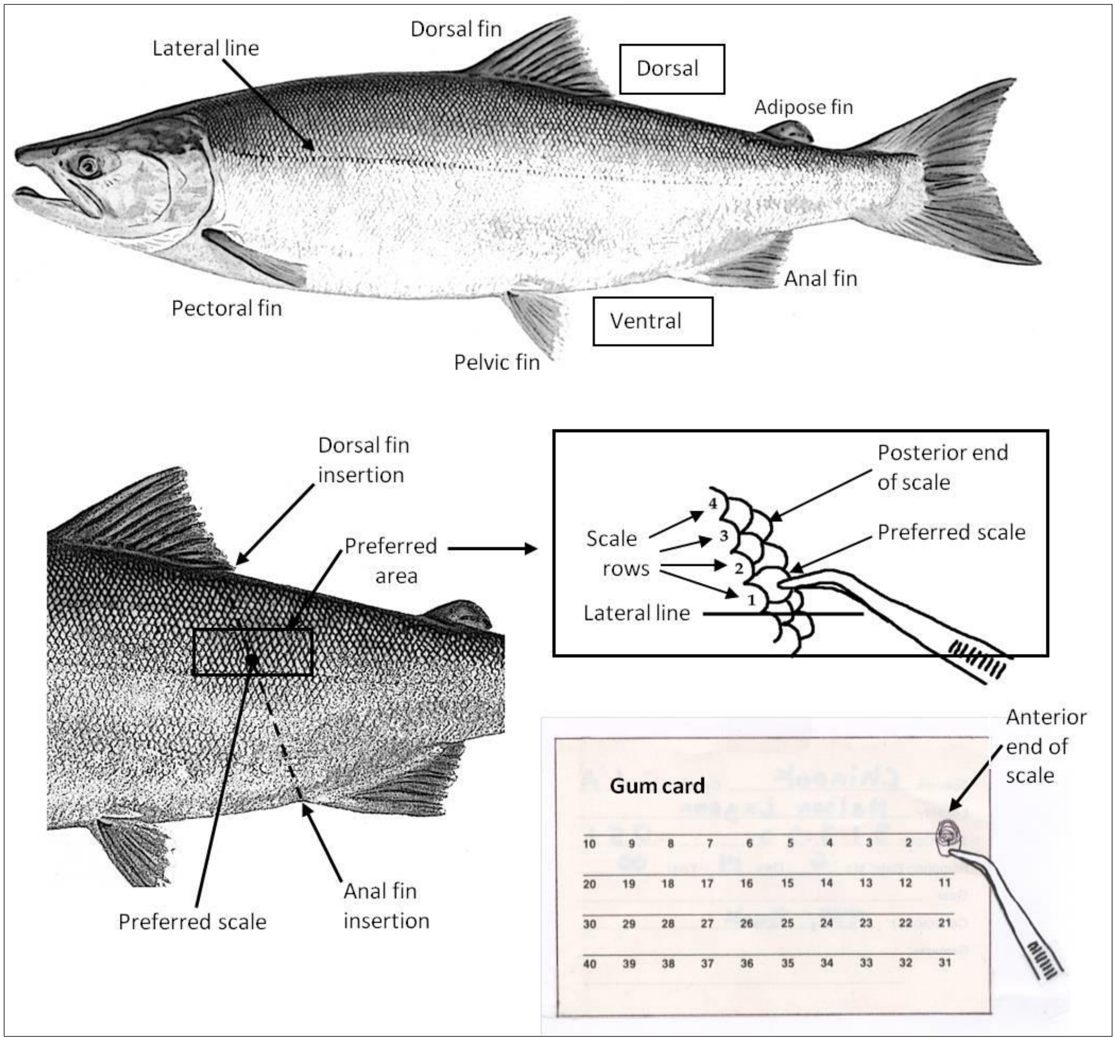
(© 2019 ADF&G)

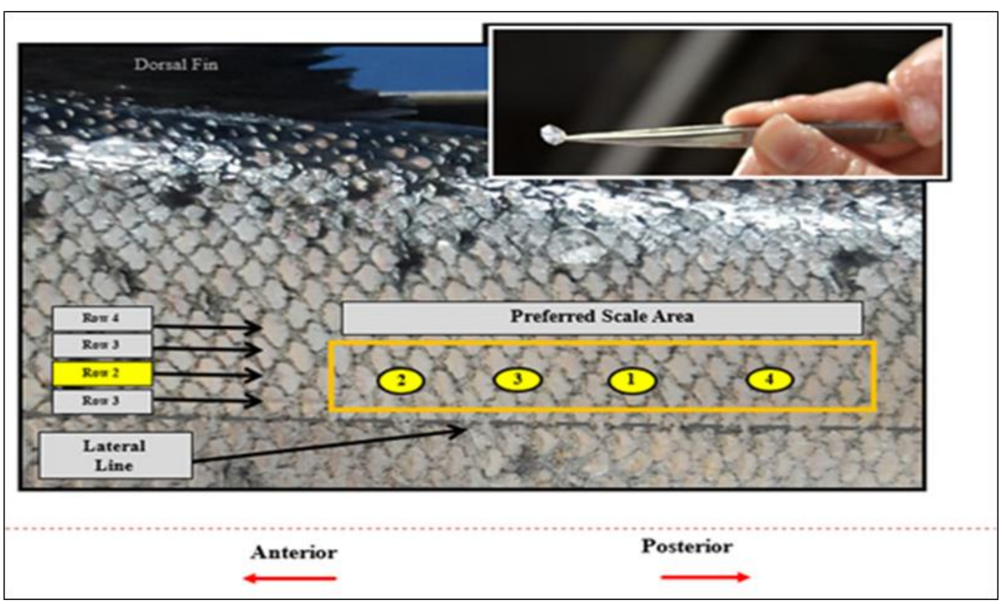
2) Examining the fish's vent is another helpful procedure to determine male or female salmon.



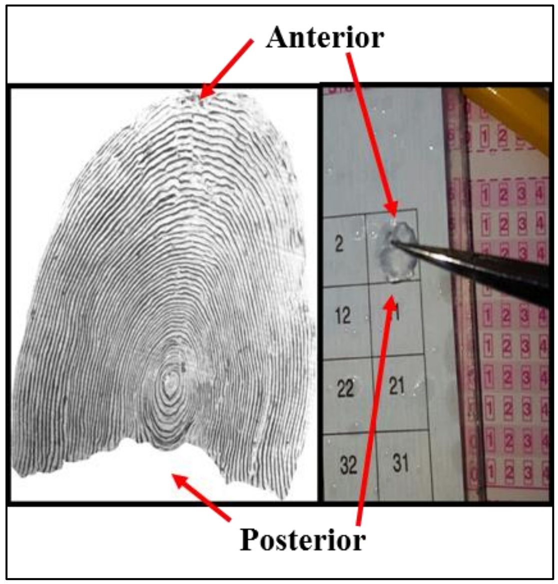
(© 2019 ADF&G)

Appendix E.–Preferred scale sampling area on an adult salmon.

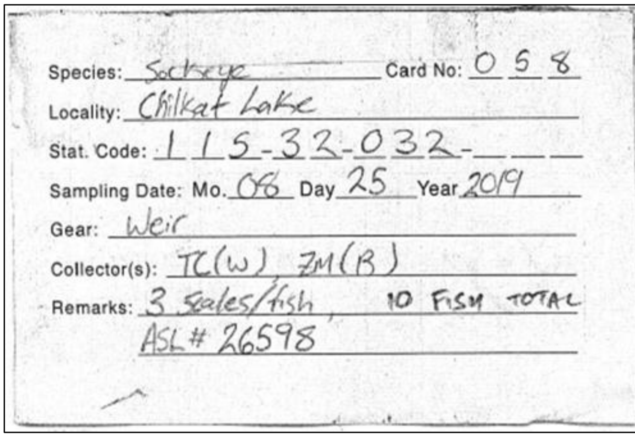


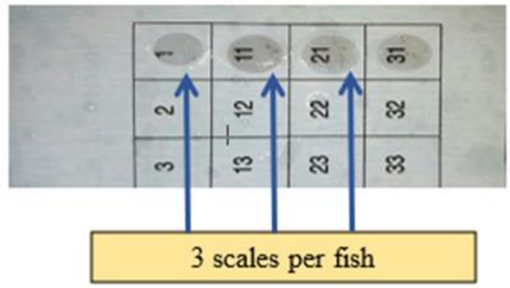


Clean, moisten and mount scale on the scale card directly over the appropriate scale number. The side of the scale facing up on the scale card is the same as the side facing up when it is attached to the fish. This outward facing side is referred to as the "sculptured" side of the scale. The ridges on this sculptured side can be felt with fingernail or forceps. When placing the scale on the scale card, place in one uniform direction. **ANTERIOR SIDE POINTING UP, SCULPTURED SIDE FACING OUT.**

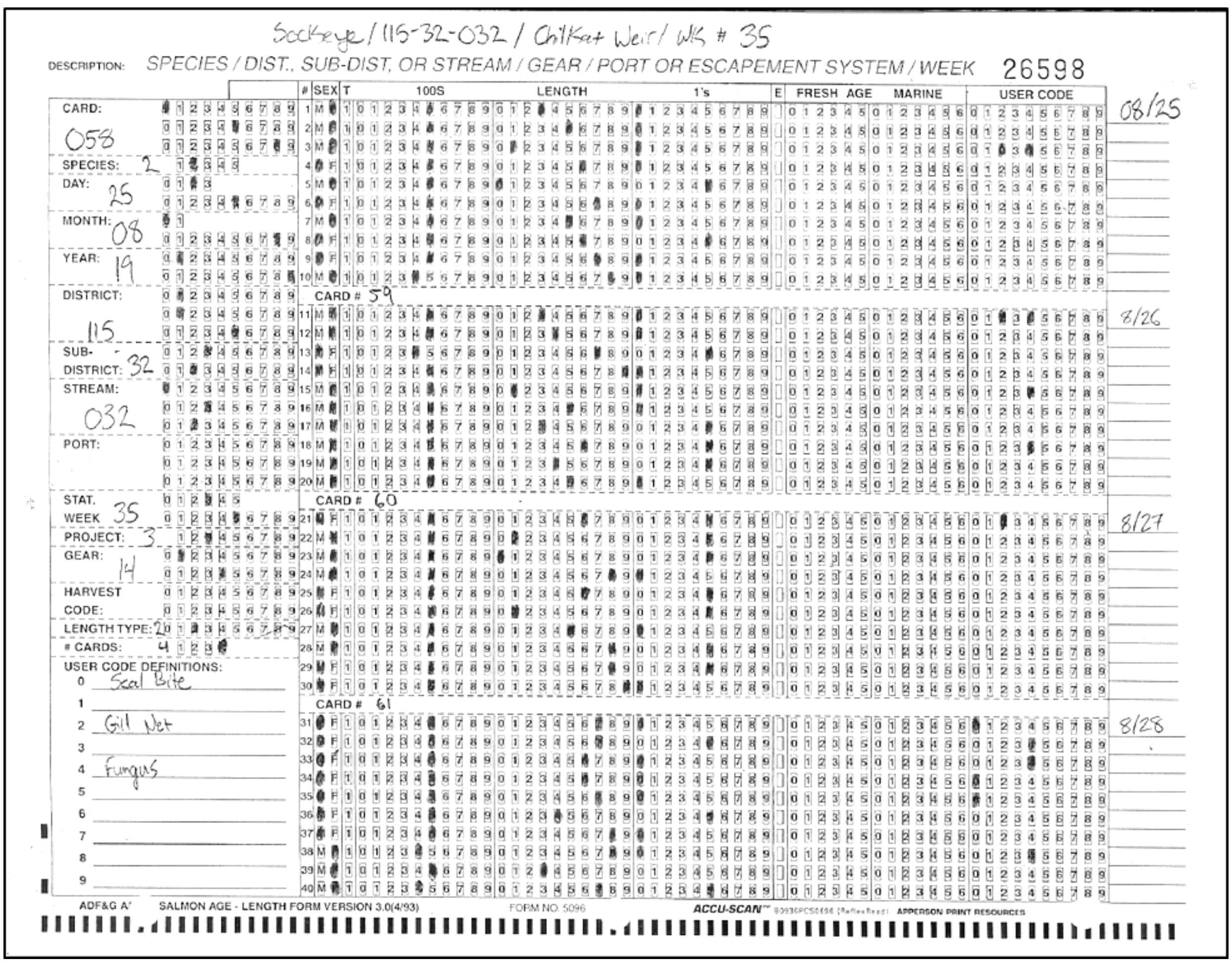


Appendix F.–Example of a completed scale card that corresponds to the completed ASL form in Appendix G.





Appendix G.–Example of ADF&G Adult Salmon Age, Sex, Length (ASL) form filled out for sockeye salmon samples collected at the Chilkat Lake weir.



Appendix H.–Chilkat Lake Hourly Fish Counts Form.

Chilkat Lake 2018
DIDSON Hourly Counts
Stat Week 24

Record hourly counts of fish passage from DIDSON files.
Record gate opening and closure times.
Enter data into "Hourly counts" spreadsheet
Transfer daily totals to "Daily Counts" spreadsheet
Starting week 35 (or when coho present) transfer
daily totals to "Sonar Apportionment"

Data entry by_______________
QC/QA by__________________
Check transcription to "Hourly Counts"
Check daily totals in "Daily Counts"
When coho present,
check "Sonar Apportionment"

	6/10		6/11		6/12		6/13		6/14		6/15		6/16	
	# Fish	Gate	# Fish	Gate	# Fish	Gate	# Fish	Gate	# Fish	Gate	# Fish	Gate	# Fish	Gate
0:00														
1:00														
2:00														
3:00														
4:00														
5:00														
6:00														
7:00														
8:00														
9:00														
10:00														
11:00														
12:00														
13:00														
14:00														
15:00														
16:00														
17:00														
18:00														
19:00														
20:00														
21:00														
22:00														
23:00														
Notes:														
Daily Total	0		0		0		0		0		0		0	

Transfer Daily Totals into "Daily Counts" spreadsheet

Starting week 35 (or when Coho present) transfer daily totals to "Sonar Apportionment" spreadsheet

Appendix I.–Chilkat Lake Seine Recovery Form.

Chilkat Lake 2018
Seine Recovery
Stat Week 24
CREW NAMES
____

Close gate at night and seine in the AM. Daily, collect 10 sockeye salmon for scales, sex and length. 3 scales/fish.
Use one scale gum card per day. Scale data collected within the stat week recorded on one AWL
Punch operculum all sockeye and coho salmon. Count pink and chum if present in seine.
When coho are present, continue to seine until at least 68 fish are caught
Enter data in "Recovery" spreadsheet, transfer #scales daily total to "Daily Counts" spreadsheet
Starting week 35 (or when coho present) transfer #sockeye and #coho daily totals to "Sonar Apportionment"

Data entry by____________
QC/QA by____________
Check this field sheet with AWL and scale cards
Check transcription to "Recovery"
Check data transfer to "Daily Counts"
When coho present, check "Sonar Apportionment"

	6/10			6/11			6/12			6/13			6/14			6/15			6/16		
	Start ____ Stop ____			Start ____ Stop ____			Start ____ Stop ____			Start ____ Stop ____			Start ____ Stop ____			Start ____ Stop ____			Start ____ Stop ____		
set	#sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho
1																					
2																					
3																					
4																					
5																					

6/10	6/11	6/12	6/13	6/14	6/15	6/16
AWL Card Number ______	AWL Card Number ______	AWL Card Number ______	AWL Card Number ______	AWL Card Number ______	AWL Card Number ______	AWL Card Number ______
AWL Sample Number(s) ______	AWL Sample Number(s) ______	AWL Sample Number(s) ______	AWL Sample Number(s) ______	AWL Sample Number(s) ______	AWL Sample Number(s) ______	AWL Sample Number(s) ______
Comments:	Comments:	Comments:	Comments:	Comments:	Comments:	Comments:
#pink ____	#pink ____	#pink ____	#pink ____	#pink ____	#pink ____	#pink ____
#chum ____	#chum ____	#chum ____	#chum ____	#chum ____	#chum ____	#chum ____

	6/10			6/11			6/12			6/13			6/14			6/15			6/16		
	#sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho	# sock	#scales	#coho
Daily Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

transfer #scales daily total to "Daily Counts" spreadsheet
Starting week 35 (or when Coho present) transfer
#sock and #coho daily totals to "Sonar Apportionment" spreadsheet

Appendix J.–Chilkat Lake Daily Counts Spreadsheet.

Date		DIDSON	Apportionment											Water		
			Seine Sampling					Daily Count								
						Sockeye	Coho									
Stat. Week	Date	Daily Total	Actual Sampled Sockeye: Coho	68 Total Sampled (Y/N)	Date of Ratio Used if N	(Most recent ratio of 68 sampled)		Sockeye	Cumulative Sockeye	Scales Collected	Cumulative Collected	Coho	Cumulative Coho	Temp.	Level	Visibility
23	5/31															
23	6/1															
23	6/2															
23	6/3															
23	6/4															
23	6/5															
23	6/6															
24	6/7															
24	6/8															
24	6/9															
24	6/10															
24	6/11															
24	6/12															
24	6/13															
25	6/14															
25	6/15															
25	6/16															
25	6/17															
25	6/18															
25	6/19															
25	6/20															
26	6/21															
26	6/22															
26	6/23															
26	6/24															
26	6/25															
26	6/26															
26	6/27															
27	6/28															
27	6/29															
27	6/30															
27	7/1															

Appendix K.–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: ______________

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

Appendix K.–continued (Page 2 of 2).

Lake ID ______________________________ Date: ______________

Sampling Station: ________ Sampling Depth (m): ________

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

Station ________

Time of Sample End: ______:______

Time of Sample Start: ______:______

Elapsed time (min:sec) ______:______

Tow depth: ________ m

Station ________

Time of Sample End: ______:______

Time of Sample Start: ______:______

Elapsed time (min:sec) ______:______

Tow depth: ________ m

Zooplankton

Station ________

Time of Sample End: ______:______

Time of Sample Start: ______:______

Elapsed time (min:sec) ______:______

Tow depth: ________ m

Station ________

Time of Sample End: ______:______

Time of Sample Start: ______:______

Elapsed time (min:sec) ______:______

Tow depth: ________ m

Phytoplankton - Phaeophytin - Chlorophyll samples

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

Appendix L.–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, will be 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.

The age distribution will then be estimated for each week of the escapement in the usual manner,

$$\hat{p}_{hj} = n_{hj} / n_h \ . \qquad (1)$$

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

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

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

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

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),

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

The mean length, by sex and age class (weighted by week of escapement), and the variance of the weighted mean length, will be 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,

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

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