Regional Operational Plan No. ROP.CF.1J.2025.17

Operational Plan: Chilkat Lake Salmon Weir Enumeration and Sampling Procedures, 2023–2024

by

Nicole L. Zeiser

Shelby M. Flemming

Steven C. Heinl

and

Sara E. Miller

April 2025

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 figures 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 NO. ROP.CF.1J.2025.17

OPERATIONAL PLAN: CHILKAT LAKE SALMON WEIR ENUMERATION AND SAMPLING PROCEDURES, 2023–2024

by

Nicole L. Zeiser and Shelby M. Flemming
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
802 3rd Street, Douglas, AK 99824-5412

April 2025

Nicole L. Zeiser and Shelby M. Flemming
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 follows:
Zeiser, N. L., S. M. Flemming, S. C. Heinl, and S. E. Miller. 2025. Operational plan: Chilkat Lake salmon weir enumeration and sampling procedures, 2023–2024. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan No. ROP.CF.1J.2025.17, Douglas.

SIGNATURE PAGE

Project Title:	*Operational Plan: Chilkat Lake Salmon Weir Enumeration and Sampling Procedures, 2023–2024*
Project Manager:	*Nicole L. Zeiser*
Project Leader:	*Shelby M. Flemming*
Division, Region, and Area	*Commercial Fisheries, Region 1, Haines*
Project Nomenclature:	*FM-163 GF Chilkat Weir-DIDSON*
Period Covered	*2023–2024*
Field Dates:	*1 June–15 October*
Plan Type:	*Category II*

Approval

Title	Name	Signature	Date
Project Manager	Nicole L. Zeiser		2-10-2023
Project Leader	Shelby M. Flemming		3-6-2023
Research Coordinator	Steven C. Heinl		2-10-2023
Biometrician	Sara E. Miller		2-14-2023

TABLE OF CONTENTS

Page

LIST OF FIGURES ... iii

LIST OF APPENDICES ... iii

PURPOSE ... 1

BACKGROUND ... 1

STUDY SITE ... 3

OBJECTIVES ... 6

METHODS ... 6

Chilkat Lake Escapement Enumeration ... 6

- Chilkat Lake Weir ... 6
- Sockeye Salmon Age, Sex, and Length Composition ... 9
- DIDSON Installation and Settings ... 10
- DIDSON Operation ... 11
- Observer Training ... 11
- Project End Date–1% Weir Escapement Rule ... 13
- Weir Passage Estimates ... 14
  - Inseason ... 14
  - Postseason ... 15
- Species Apportionment ... 15

Limnological Assessment ... 16

- Light and Temperature Sampling ... 16
- Zooplankton Sampling ... 17

DATA REDUCTION ... 17

DIDSON Weir Counts ... 17

Sockeye Salmon Age, Sex, and Length Composition ... 17

SCHEDULE AND DELIVERABLES ... 18

Field Operations ... 18

Reporting ... 18

RESPONSIBILITIES ... 18

REFERENCES CITED ... 19

APPENDICES ... 22

LIST OF FIGURES

Figure **Page**

1. Map showing Chilkat and Chilkoot River watersheds, and the District 15 commercial fishing sections and statistical areas in Lynn Canal. 2
2. Map of the Chilkat River drainage and locations of Chilkat Lake and limnology sampling stations, the weir site, and fish wheel site. 5
3. Downstream view of the new Chilkat Lake weir without pickets. 7
4. View of the Chilkat River weir from the upstream side of Clear Creek. 8
5. The installation of the gate frame by weir crew, and the view of the weir board walk with pickets installed. 8
6. Fencing and sandbags installed river right of weir to ensure no fish passage during high water events. 9

LIST OF APPENDICES

Appendix **Page**

A. ADF&G statistical weeks 23–42 and corresponding calendar dates, 2023–2025. 23
B. Procedures for sampling adult sockeye salmon for age, sex, and length. 24
C. Measuring adult salmon for length. 31
D. Determining the sex of salmon. 32
E. Preferred scale sampling area on an adult salmon. 33
F. Example of a completed scale card showing 3 scales per fish, proper orientation of scale samples, and the initials of the people who recorded data, plucked the scales, and wrestled and measured the fish. 35
G. Example of a completed Optical Scan form for sampling sockeye salmon at the Chilkat Lake weir. 36
H. Chilkat Lake daily beach seine form. 37
I. Chilkat Lake Hourly and Daily Counts spreadsheet data recording pages. 38
J. Chilkat Lake weir daily office reporting form. 39
K. Limnology sampling form. 40
L. Escapement sampling data analysis. 41
M. Missing escapement estimates. 42

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: biological escapement goal, Chilkat Lake, Chilkat River, DIDSON, sockeye salmon, *Oncorhynchus nerka*, coho salmon, *O. kisutch,* sonar, limnology, weir

BACKGROUND

The Chilkat and Chilkoot River watersheds, located in northern Southeast Alaska, near the town of Haines (Figure 1), support 2 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's 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 unknown 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 2012–2021 averaged 4,400 fish per year. A very small portion of the Chilkat sockeye salmon run is also harvested by sport fisheries, averaging 380 fish annually over the same period.

The commercial harvest of Chilkat Lake sockeye salmon in the District 15 commercial drift gillnet fishery has been estimated using 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 harvest estimates using the 2 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. 2020a).

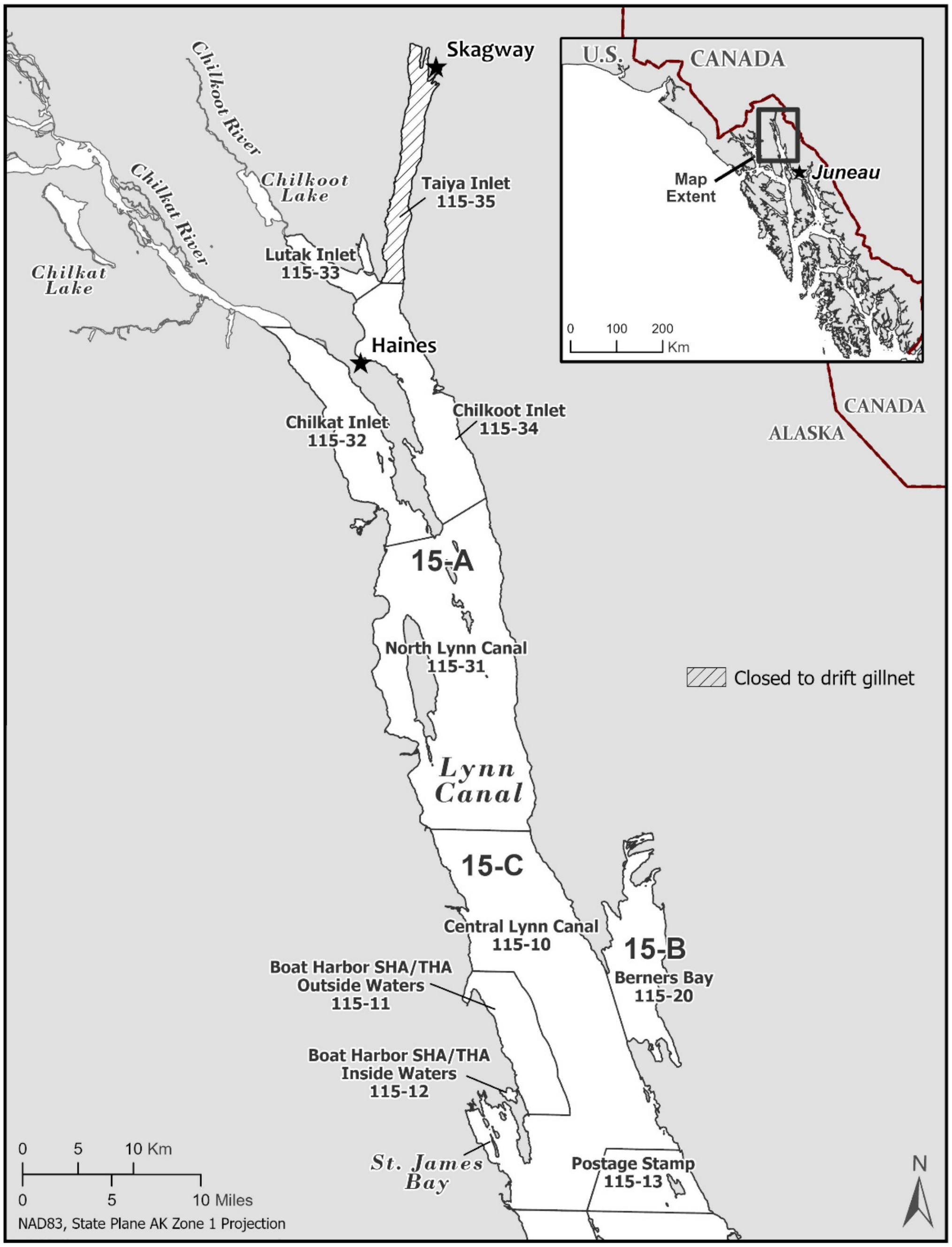


Figure 1.–Map showing Chilkat and Chilkoot River watersheds, and District 15 commercial fishing sections and statistical areas in Lynn Canal.

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), Dual-Frequency Identification Sonar (DIDSON) counts with mark–recapture estimates (2008–2016), and DIDSON estimates only (2017-present)

(Eggers et al. 2010; Sogge and Bachman 2014; Bednarski et al. 2017; Zeiser 2020b). Biological data have been collected annually at the lake to estimate 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). Concerns regarding the reliability of mark–recapture methods to measure abundance of salmon for this system lead to suspension of that program after 2016 (Bednarski et al. 2017). Since 2017, Chilkat Lake salmon escapements have been estimated using the DIDSON in conjunction with a picket weir (Bednarski et al. 2017).

The Chilkat Lake sockeye salmon run has been managed for at least 5 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.

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 (Zeiser 2020c; Elliott 2022; Elliott and Peterson 2022) and Chilkoot Lake (including genetic stock identification of sockeye salmon harvested in the District 15 commercial drift gillnet fishery; Zeiser et al. 2020a), 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 2 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 in the summer and by snowmobiles in the winter.

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 (Figure 2). Chilkat River discharge rates range from 80 to 20,400 ft^3/s (Bugliosi 1988). The Chilkat River supports large runs of sockeye, coho, chum, Chinook (*O. tshawytscha*), and pink salmon.

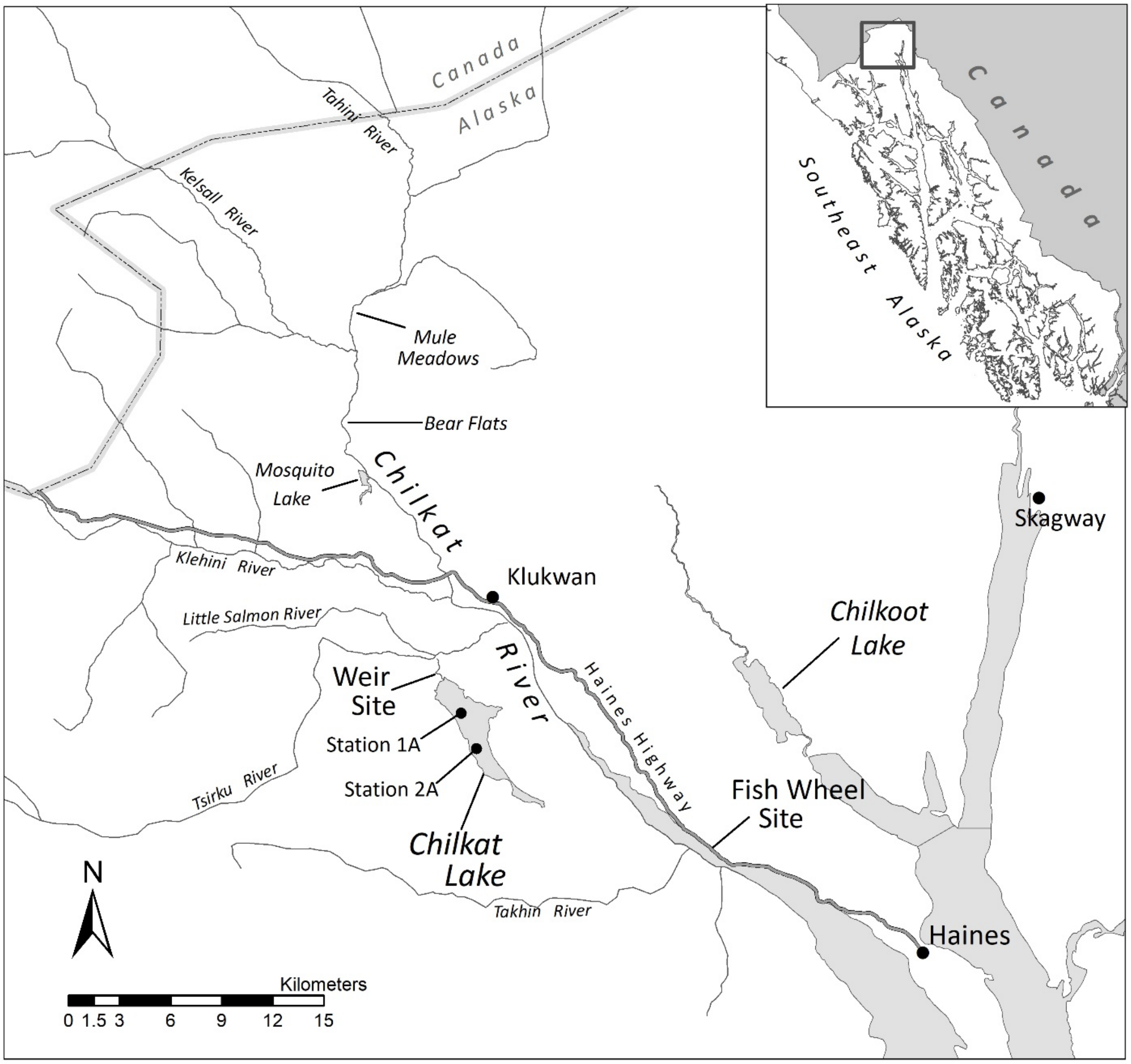


Figure 2.–Map of the Chilkat River drainage and locations of Chilkat Lake and limnology sampling stations, the weir site, and fish wheel site.

OBJECTIVES

Primary objectives

1. Enumerate the sockeye salmon escapement into Chilkat Lake starting no later than 20 June and ending no earlier than 12 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 experienced and less experienced observers of more than 10% 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 at the beginning of each month from June through October.

METHODS

CHILKAT LAKE ESCAPEMENT ENUMERATION

A DIDSON (manufactured by Sound Metrics Corporation) 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 installed annually during the second week of June and operated through at least 11 October (see Project End Date–1% Weir Escapement Rule section below. The weir will be installed in Clear Creek, approximately 0.4 km downstream of Chilkat Lake (Figure 2). The weir is currently a semi-removable aluminum and steel bipod structure approximately 33 m wide. In 2020, a new weir was built out of aluminum approximately 20 m down river of the original structure (Figure 3). The boat gate frame was modified to allow easier installation (e.g., installation no longer requires scuba divers to assist), and the width of the gate was increased to allow for easier passage by jet boats. Since its installation, some aluminum hardware has been replaced by steel to strengthen the structure to withstand the dynamic hydrology of clear creek. The maximum water depth at the weir site is approximately 3 m. The weir framework consists of a combination of 13, 5 cm steel and aluminum pipe bipods spaced 2.4–2.7 m apart and driven into the bed of the river. Bipods are connected with perforated aluminum stringers of varying lengths. Iron and aluminum 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 (Figure 4). The maximum possible space between each picket is 4.1 cm. The boat gate will be installed in the 4.3 m gap between bipods at the center of the weir. The boat gate will have 2 electric hoists/winches, one on each side with remotes for each to open and close the gate. The crew will don dry suits to conduct underwater inspections, and placement of sandbags if needed throughout the season to monitor the integrity of the weir (Figure 5). The DIDSON will also be operated overnight (i.e., 24 hours) once a week with the gate shut to check for gaps in the weir, particularly gaps in the gate frame. Both sides of the weir will be extended with fencing to ensure that no fish may pass during high water events (Figure 6).

Stream height, water temperature, and water clarity (e.g., clear, fair, poor) will be recorded at approximately 0630 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. During flow reversals, the DIDSON will be operated continuously (24 hours per day) until the flow reversal ends. If the boat gate was closed during a flow reversal, water pressure could force the gate to overextend backwards (upstream), which would form gaps that would allow fish to pass through. Flow reversals could last from a few hours to several days. After a reversal has ended, the DIDSON will be operated over night with the gate closed to ensure no holes have formed in the weir. The weir crew will need to don dry suits to check for gaps where the pickets meet the riverbed after every flow reversal event.

Figure 3.–Downstream view of the new Chilkat Lake weir without pickets. (© 2022 ADF&G. Photo by Shelby M. Flemming.)

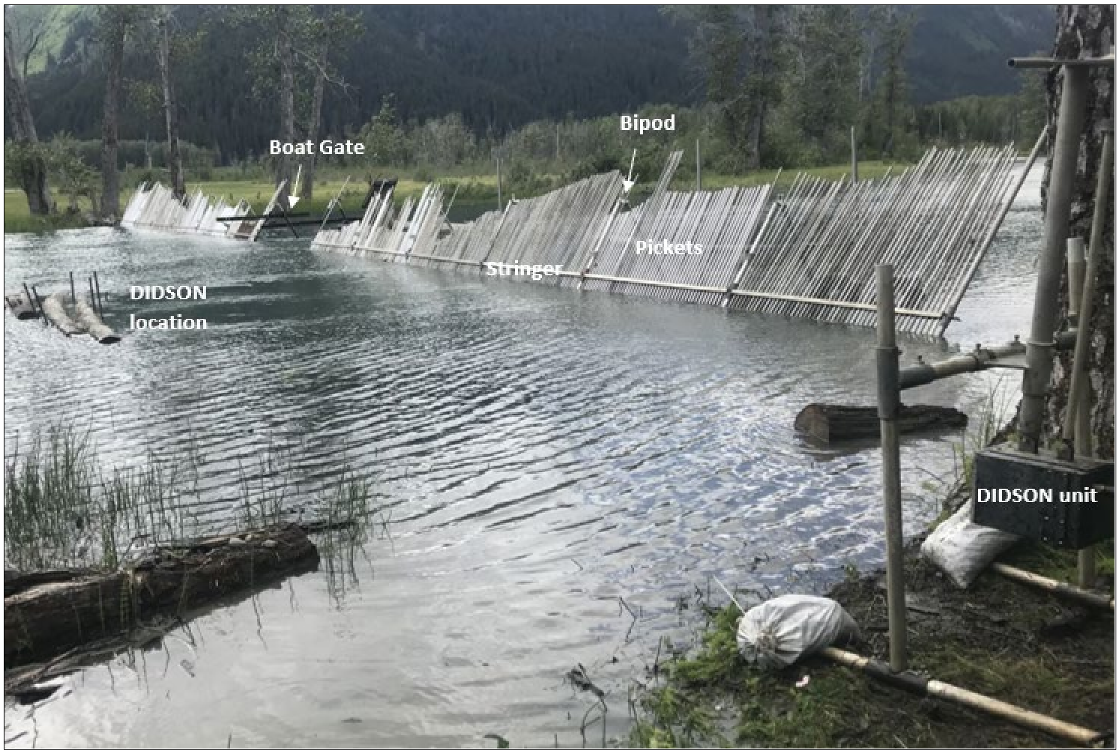


Figure 4.–View of the Chilkat River weir from the upstream side of Clear Creek showing the lowered boat gate, the DIDSON unit, the location of the DIDSON unit when placed in the river, and the weir stringers, bipods, and pickets. (©2022 ADF&G. Photo by Shelby M. Flemming.)

Figure 5.–The installation of the gate frame by weir crew (left), and the view of the weir board walk with pickets installed (right). (© 2022 ADF&G. Photos by Shelby M. Flemming.)

Figure 6.–Fencing and sandbags installed river right of weir to ensure no fish passage during high water events. (© 2022 ADF&G. Photo by Shelby M. Flemming.)

Sockeye Salmon Age, Sex, and Length Composition

The seasonal age composition of the Chilkat Lake sockeye salmon escapement (including jack sockeye salmon; i.e., fish <350 mm mid eye to tail fork length) will be determined from a minimum sample of 635 fish captured on the downstream side of the weir. This sample size was based on work by Thompson (2002) to estimate proportions of 4 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 635 fish to ensure the sampling goal will be met, even if age cannot be determined from the scales of 20% of the sampled fish. In addition, 3 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)**, over the entire field season, approximately statistical weeks 24–41. Beach seine gear will be used to capture fish below the weir each morning at 0600. This weekly sample size will be more than sufficient to meet objective criteria since the total seasonal sample will be more than the 635 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 the 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, 2 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 1 freshwater and 3 ocean years; Koo 1962). The weekly age distribution, the seasonal age distribution and SE weighted by statistical week, will be calculated postseason using standard equations from Cochran (1977; Appendix L). ADF&G statistical weeks begin on Sunday at 0001 and end the following Saturday at midnight and are numbered sequentially, starting from the first week of the calendar year (Appendix A).

DIDSON Installation and Settings

The DIDSON will be deployed upstream of the weir, approximately 3–5 m from the right bank (cabin side) of the river (Figure 4). The transducer will be attached to an aluminum rod and oriented perpendicularly to the current. The lens will be pointing in the direction of the boat gate to capture fish passage when the gate is open. 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 6 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 no later than 20 June. The DIDSON will be operated 24 hours a day for the first 5 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 5 days if fish continue to be observed passing through the weir when the gate is closed. The DIDSON will then be powered on each morning around 0600 and continue until 2200, when the boat gate will be closed for the night. Closing the gate at 2200 will allow fish to build up behind the weir for morning beach seining and sampling events. In the rare event that a boat requires passage through the weir between 2200 and 0600, the gate will be opened briefly, and some fish may pass without being counted. If the boat gate remains open after 2200 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 for 24 hours every Sunday to ensure the weir is fish tight, as well as after each reversal event. 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 remainder of the 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 while viewing 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.). The crew 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 observation 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/Preseason

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 4 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, a raw 60-minute file representing the peak count for the previous month will be reviewed and enumerated for sockeye salmon by an 'experienced' observer. This raw file should incorporate abundances greater than 100 fish/file when possible. The 'experienced' observer will enumerate sockeye salmon for the 60-minute file, repeatedly, until the fish count has a CV of less than 10% between repetitions of the same file. Three counts (that are within a CV of 10% between repetitions) of the 'experienced' observer will be averaged to serve as the baseline enumerated count ($\bar{x}$). Each less experienced observer will then review and enumerate the raw file 3 times. For a single observer, the average across the 3 abundance estimates will serve as the individual count for the less experienced observer ($\bar{x}_i$). Mean absolute percent error (MAPE) will be calculated for each less experienced observer to yield a measure of observer performance with over- and under-estimates treated equally (e.g., Ryall 1998),

$$\text{MAPE} = \left| -\frac{(\bar{x}-\bar{x}_i)}{\bar{x}} \right| * 100. \tag{1}$$

Disagreement of more than 10% (MAPE > 10%) between the average of the inexperienced observer's individual counts ($\bar{x}_i$) and the more experienced observer's baseline count ($\bar{x}$) should be flagged for a detailed review (and additional training if deemed necessary).

Project End Date–1% Weir Escapement Rule

Fish will be counted through the Chilkat weir through at least 11 October each year. This date was determined through several steps to analyze run timing and quantify the date to which a specified proportion of the run would be counted with 95% probability (as outlined below) using data from 2012–2021. The date was then adjusted based on budgetary and personnel constraints. The first step was to estimate the date when X% of the escapement would be counted with 95% probability. This date will be known as the *hard date*, the date on which the weir must be operated each year. A 3-day 1% rule could then be implemented to determine the project *end date*, whereby, if daily weir counts are <1% of the cumulative escapement for 3 consecutive days up to and including the *hard date*, the weir would be removed on the following day; otherwise, the project would continue until daily weir counts are <1% of the cumulative escapement for 3 consecutive days.

Estimating the *hard date* requires reconstructing past escapements by modeling the tails of past escapements that were not counted with the weir. Three models were used to estimate escapement tails: the Gompertz model, the logistic model, and the Expectation-Maximization (EM) algorithm. Cumulative escapement (y) is predicted using the Gompertz model,

$$y = pe^{-e^{-k(t-t_0)}}, \tag{2}$$

and the logistic model,

$$y = \frac{p}{1+e^{-k(t-t_0)}}. \tag{3}$$

In equations 2 and 3, p represents the asymptote of the cumulative escapement, k is the steepness of the curve, t is the Julian day, and t_0 is the inflection point of the curve. Next, cumulative escapement is converted into the number of estimated fish that passed through the weir on a given day. Third, a reconstructed escapement is then estimated using observed daily weir counts and filling in any data gaps with estimated daily escapement numbers. This reconstructed escapement is then used to compute a cumulative sum of escapement. Finally, the *hard date* that the weir should remain in place (the date that captures 95% of the escapement with 95% probability) is calculated using the reconstructed cumulative sums of annual escapements.

The third method, the EM algorithm (McLachlan and Krishnan 1997; McLachlan et al. 2004), was used to fill gaps in observed historical data using an iterative procedure. Missing values of the escapement were filled in under the assumption that the expected count is determined by a given year and Julian day in a multiplicative way. The estimated counts for a given Julian day in a given year are interpolated by assuming the expected count for a given Julian day and year is equal to the sum of all counts for the particular Julian day times the sum of all counts for the year divided by the sum of all counts over all Julian days and years. For example, if the count for year 2019, Julian day 10 is missing, then this missing value would be imputed by summing the counts on Julian day 10 (across all years) and then multiplying this by the sum of all counts in year 2019. This value would then be divided the sum of counts across all years and all Julian days to fill in the missing count. If there is more than one missing value, an iterative procedure (as described in

Brown 1974) is used since the sums change as missing values are filled in at each step. Reconstructed escapement is then used to compute a cumulative sum of escapement (Figure 4). The date that a weir should remain in place to capture 95% of the escapement with 95% probability is calculated using the reconstructed cumulative sums.

For Chilkat Lake sockeye salmon escapements, the best performing model was the EM algorithm because the Gompertz and logistic models overestimated escapement tails and projected hard dates using those models were much later than appear reasonable for the Chilkat Lake sockeye salmon run (e.g., 17 November). Based on the EM algorithm analysis, a *hard date* of 15 October (Julian day 288) would capture 95% of the escapement with 95% probability. After considering project budgets and staff time, a *hard date* of 11 October (Julian day 284) was chosen, which will capture 91% of the run with 95% probability. Thus, for Chilkat River weir operations during 2023–2025, fish will be counted through 11 October (Julian day 284), and the earliest date the weir can be removed is 12 October. If budgets allow, a 1% rule could be used to operate the weir later into the season: if daily weir counts are <1% of the cumulative escapement for 3 consecutive days up to and including 11 October, the weir will be removed on 12 October; otherwise, the project will continue until daily weir counts are <1% of the cumulative escapement for 3 consecutive days. Periodically, this analysis should be updated to see if there are recent changes in run timing that affect the *hard date*. All associated files, data, and code are located at https://github.com/commfish/weiRends. This work is based upon efforts originally developed by Scott Raborn (former ADF&G biometrician). The code was originally written by Ben Williams (former ADF&G biometrician) and adapted by Sara Miller.

Weir Passage Estimates

Inseason

Frequent occurrences of flow reversals (which cause turbidity), brief periods of flooding that require removal of weir pickets, and DIDSON malfunctions result in the need to occasionally estimate salmon passage for hours or days when recorded files are unreadable or missing. Estimates will be assumed to be 0 if passage is likely negligible based on historical or inseason data, or if the gate of the weir is closed. Otherwise, estimates for missed passage will be calculated following methods used at the Kogrukluk River weir in western Alaska (Hansen and Blain 2013). If the DIDSON is not in operation for all of 1 hour (or 1 day), an estimate for that hour (or day) ($\hat{n}_i$) will be calculated as the average of the number of fish counted on the 2 hours (or 2 days) before (n_b and n_{b-1}) and the 2 hours (or 2 days) after (n_a and n_{a+1}) the missing hour (or day):

$$\hat{n}_i = \left(\frac{(n_b+n_{b-1}+n_a+n_{a+1})}{4}\right). \tag{4}$$

If the DIDSON is not in operation for a period of 2 or more hours, or for a period of 2 or more days, passage estimates for the missing hours (or missing days) will be calculated using linear interpolation. This method is appropriate for short periods of inoperability when fish passage is reasonably assumed to have a linear relationship with time. Average fish counts from the 2 hours (or 2 days) before and 2 hours (or 2 days) after the inoperable period will be used to estimate the counts during the period of missed passage. The estimated fish count ($\hat{n}$) on the hour (or day) (i) of the inoperable period, where D is the total number of inoperable hours (or days), will be estimated as:

$$\hat{n}_i = \left(\frac{n_b+n_{b-1}}{2}\right) + i\left(\frac{(n_a+n_{a+1})-(n_b+n_{b-1})}{2(D+1)}\right). \tag{5}$$

If the DIDSON malfunctions during the hour(s) when the boat gate is first opened for the day, an interpolation for the entire day will be calculated. This is due to the larger push of fish that often occurs when the boat gate is first opened (after fish have been held behind the weir overnight) compared to movement of fish during other hours of the day. If an interpolation for an entire day needs to be made, and 1 or more of the 4 surrounding days is already an interpolated value, then all days must be interpolated until 2 days before and 2 days after the period in question consist of valid raw counts. A day with hourly interpolations may be used if the rest of the day is considered representative of the run. Estimated counts will be entered into the electronic data files and entered into the Zander weir data entry application as "Calculated Values".

Postseason

Postseason, if the DIDSON is not in operation for all of 1 hour, or 1 day, equation 4 will be used to fill in missing counts. If the DIDSON is not in operation for a period of 2 or more hours, or 2 days, equation 5 will be used to fill in missing counts. If the DIDSON is not in operation for a period of 2 or more days, equation 5 or a hierarchical Bayesian estimation technique (Adkison and Su 2001) based on historical run timing fitted to a log-normal distribution (e.g., Hansen et al. 2016; Matter and Tyers 2020; see Appendix M for details) will be used to fill in missing counts.

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 (approximately statistical weeks 37–42) 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 (Thompson 2002), with the assumption that the proportion sampled in morning beach seine events is representative of the proportion of coho and sockeye salmon present throughout the day. The number of fish captured by species for each beach seine set conducted will be recorded on the "Chilkat Lake Beach Seine Recovery Form" (Appendix H). If fewer than 68 fish are captured in the first set, additional beach seine sets will be conducted until adequate effort has shown that pooling with previous days is the logical approach. 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, but these species will not be sampled. **The proportions of coho and sockeye salmon captured during morning sampling events will be applied to that day's DIDSON counts. If on day X fewer than 68 fish are captured (after several attempts), 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 then be applied to the DIDSON counts on day X.

ADF&G personnel will enter the beach seine recovery data from field forms into the “Chilkat Weir Hourly + Daily Counts” Excel computer spreadsheets at the field camp (Appendix I). Hourly DIDSON counts will be recorded on the “Hourly” tab in this spreadsheet, and data from the “Chilkat Lake Beach Seine Recovery Form” will be entered into the “Daily Counts” tab. The DIDSON count totals and apportionment calculations will then auto-populate and can be relayed to the Haines ADF&G office via email or cell phone.

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 to the first day of each month as possible. Since 2008, all limnological sampling has been conducted at two primary stations marked by anchored buoys in the lake (station 1A at 59° 34.20′ N. lat., 135° 91.31′ W. long.; station 2A at 59° 32.63′ N. lat., 135° 89.61′ W. lat.; Figure 2). These anchored buoys will be deployed and removed each season due to the lake freezing. All sampling data will be recorded directly onto Limnology Sampling Forms (Appendix K). At the end of the season, all samples will be shipped to the ADF&G Kodiak Limnology Laboratory for analysis. 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 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 $\ln(I_0/I_z)$ versus depth, and euphotic zone depth 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 euphotic zone depth.

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 column 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 m, and at 5 m intervals from 20 m to a depth of 50 m. 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 sampling station using a 0.5 m diameter, 153 µm mesh conical net. Vertical zooplankton tows will be pulled from a depth of 50 m 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

DIDSON Weir Counts

Data collected at the fish weir will be recorded on field forms and in electronic data files specific to each activity (Appendices H–J). Data forms will be kept up to date and inspected daily for errors and completeness by all crew members and checked again by the crew leader. Daily counts will be emailed or called into the Haines office daily by 1100. The Haines Program Technician will enter fish counts into Excel computer files at the Haines office that will then be distributed within the department via email.

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 (cm), brief comments (e.g., water clarity, flow reversals), and fish numbers by count type, 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 checked again by the project leader to ensure they are accurate and complete. Electronic data files will be archived on the Region 1 shared drive and field forms will be filed in a project binder and housed in the ADF&G office in Haines.

Sockeye Salmon Age, Sex, and Length Composition

All ASL forms and scale cards (Appendices B–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 weekly for review, analysis, and archiving.

SCHEDULE AND DELIVERABLES

FIELD OPERATIONS

Field sampling activities are scheduled as follows:

1.	Project training and field camp set up	~May 23 to June 15
2.	Chilkat Lake weir/DIDSON operations	(no later than) 20 June to 11 October
3.	Chilkat Lake limnology	1st of the month, June to October

REPORTING

The results of this study will be presented in the annual fishery management plan for the Lynn Canal drift gillnet fishery (ADF&G Fishery Management Report) in April of each year. A biannual report summarizing the results of this project in the ADF&G Fishery Data Series will be completed in March of each following even year.

RESPONSIBILITIES

Nicole L. Zeiser, Fishery Biologist 3, 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 and approves major purchases. Reviews schedules and writes the operational plan and project reports; and serves as lead biologist for the project.

Shelby Flemming, Fishery Biologist 1: 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. Assists project manager with resolving personnel or administrative issues related to this project and writes crew evaluations.

Fish and Wildlife Technician 3: Lead technician. Responsible for the day-to-day safe operation and maintenance of the fish weir and DIDSON sonar, and the training and direction of the crew member in all aspects of the project including fish handling and data collection and data entry. Trains the crew in safety, jet-boat operation, maintenance of weir, and project procedures. Conducts quality control on data and data files.

Two Fish and Wildlife Technician 2: These positions assist in all aspects of the operation and maintenance of the Chilkat Lake weir and DIDSON and assist in the limnological sampling at Chilkat Lake.

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 approves sampling design; reviews and assists with data analysis and final project report.

Sara Miller, Biometrician 3: Assists with sampling design, project operational planning, and data analysis.

REFERENCES CITED

Adkison, M., and Z. Su. 2001. A comparison of salmon escapement estimates using a hierarchical Bayesian approach versus separate maximum likelihood estimation of each year's return. Canadian Journal of Fisheries and Aquatic Sciences 58:1663-1671.

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 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.

Brown, M. B. 1974. Identification of the sources of significance in two-way contingency tables. Applied Statistics 23:405–413.

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

Clutter, R. I., and L. E. Whitsel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9.

Cochran, W. 1977. Sampling techniques. 3rd edition. John Wiley & 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. 2022. Operational Plan: Chilkat River Chinook salmon escapement studies in 2021. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan No. ROP.SF.1J.2022.21, Anchorage.

Elliott, B. W., and R. L. Peterson. 2022. Production and harvest of Chilkat River Chinook and coho salmon, 2021–2022. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan No. ROP.SF.1J.2022.18, 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*] J. A. Der Hovanisian, 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.

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.

Hamazaki, T. 2023. Missing passage estimation analyses (source: https://shiny.rstudio.com/). Available from https://hamachan.shinyapps.io/Missed_Run/ (Accessed February 2023).

Hansen, T. R., and B. J. Blain. 2013. Kogrukluk River salmon studies, 2011. Alaska Department of Fish and Game, Fishery Data Series No. 13-13, Anchorage.

Hansen, T. R., B. J. Blain, D. V. Taylor, and Z. W. Liller. 2016. Salmon escapement monitoring in the Kuskokwim Area, 2014. Alaska Department of Fish and Game, Fishery Data Series No. 16-03, 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 No. ROP.CF.4K.2017.14, Kodiak.

Ingledue, D. 1989. Hawk Inlet shoreline 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, B.C.

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, Cambridge.

Koo, T. S. Y. 1962. Age designation in salmon. Pages 37–48 [*In*] T. S. Y. Koo, editor. 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.

Matter, A. N., and M. Tyers. 2020. Chinook salmon escapement in the Chena and Salcha Rivers and coho salmon escapement in the Delta Clearwater River, 2017. Alaska Department of Fish and Game, Fishery Data Series No. 20-01, Anchorage.

REFERENCES CITED (Continued)

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.

McLachlan, G. J., and T. Krishnan. 1997. The EM algorithm and extensions. John Wiley & Sons, Inc., New York.

McLachlan, G. J., T. Krishnan, and S. K. Ng. 2004. The EM algorithm, Papers, No. 2004, 24, Humboldt-Universität zu Berlin, Center for Applied Statistics and Economics (CASE), Berlin.

McPherson, S. A. 1990. An in-season 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 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. 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.

R Development Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

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. North Pacific Anadromous Fish Commission Bulletin 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 No. ROP.CF.1J.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 edition. John Wiley and Sons, Inc., New York.

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 C. S. Jalbert, 2020a. Operational plan: stock assessment studies of Chilkoot Lake sockeye salmon, 2020–2022. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan No. ROP.CF.1J.2020.01, Douglas.

Zeiser, N. L., S. R. Ransbury, S. C. Heinl, and S. E. Miller. 2020b. Operational plan: Chilkat Lake salmon weir enumeration and sampling procedures, 2020–2022. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan No. ROP.CF.1J.2020.02, Douglas.

Zeiser, N. L., S. R. Ransbury, S. C. Heinl, and S. E. Miller. 2020c. Operational plan: Chilkat River fish wheels salmon enumeration and sampling procedures, 2020–2022. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan No. ROP.CF.1J.2020.05, Douglas.

APPENDICES

Appendix A.–ADF&G statistical weeks 23–42 (sampling periods) and corresponding calendar dates, 2023–2025.

	2023		2024		2025	
Statistical week[a]	Beginning date	Ending date	Beginning date	Ending date	Beginning date	Ending date
23	4-Jun	10-Jun	2-Jun	8-Jun	1-Jun	7-Jun
24	11-Jun	17-Jun	9-Jun	15-Jun	8-Jun	14-Jun
25	18-Jun	24-Jun	16-Jun	22-Jun	15-Jun	21-Jun
26	25-Jun	1-Jul	23-Jun	29-Jun	22-Jun	28-Jun
27	2-Jul	8-Jul	30-Jun	6-Jul	29-Jun	5-Jul
28	9-Jul	15-Jul	7-Jul	13-Jul	6-Jul	12-Jul
29	16-Jul	22-Jul	14-Jul	20-Jul	13-Jul	19-Jul
30	23-Jul	29-Jul	21-Jul	27-Jul	20-Jul	26-Jul
31	30-Jul	5-Aug	28-Jul	3-Aug	27-Jul	2-Aug
32	6-Aug	12-Aug	4-Aug	10-Aug	3-Aug	9-Aug
33	13-Aug	19-Aug	11-Aug	17-Aug	10-Aug	16-Aug
34	20-Aug	26-Aug	18-Aug	24-Aug	17-Aug	23-Aug
35	27-Aug	2-Sep	25-Aug	31-Aug	24-Aug	30-Aug
36	3-Sep	9-Sep	1-Sep	7-Sep	31-Aug	6-Sep
37	10-Sep	16-Sep	8-Sep	14-Sep	7-Sep	13-Sep
38	17-Sep	23-Sep	15-Sep	21-Sep	14-Sep	20-Sep
39	24-Sep	30-Sep	22-Sep	28-Sep	21-Sep	27-Sep
40	1-Oct	7-Oct	29-Sep	5-Oct	28-Sep	4-Oct
41	8-Oct	14-Oct	6-Oct	12-Oct	5-Oct	11-Oct
42	15-Oct	21-Oct	13-Oct	19-Oct	12-Oct	18-Oct

[a] Statistical weeks begin on Sunday at 0001 and end the following Saturday at midnight and are numbered sequentially starting from the first week of the calendar year.

ESCAPEMENT SAMPLING FOR SCALES

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

For sampling one will need:

- Clipboard with ADF&G Adult Salmon Age-Sex-Length Form (ASL) forms,
- Pencils (No. 2),
- Pre-labeled scale cards,
- Wax paper inserts,
- Forceps (tweezers),
- Plastic scale card holders (optional),
- Measuring trough,
- Beach Seine and seine skiff
- Dip net, and
- Gloves.

SCALE CARDS

A scale card (also called a gum card) is a gum-backed sheet for mounting individual scales collected from a fish (Appendix F). Each card has 40 positions, numbered 1 through 40. Scale samples are placed on the cards in sequential order with the top row, and additional scales from each individual fish are placed in the corresponding column.

It is important to keep scale cards as dry as possible. If a scale card gets too wet the scales will fall off and prevent a readable impression from being taken, and the scales will need to be remounted to a new scale card. If the scales are remounted onto a new scale card, 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, 2 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.**

-continued-

After plucking scales from the fish, **take time to clean the scale and make sure they 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 and render it 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.

It is important to orient the scale correctly 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 important that all scales be uniformly oriented when mounted on the scale card. 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, take 3 SCALES from each fish. For the first sockeye salmon sampled, mount the 3 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 (Appendices E and F). A new scale card will be used for each sampling event, and the sampling goal of 10 fish per day will fill 1 scale card. The same ASL form will be used each day until it is full. Each sockeye salmon ASL form can have up to 4 scale cards associated with it if sampling is done for 4 or more days within the same statistical week. On the ASL form, write the new sampling date in the right margin of the corresponding scale card number (Appendix G). It is important that scale card number and labeling match the information entered on the corresponding ASL form. **Remember to always start a new scale card and corresponding ASL form at the beginning of each statistical week** (Appendix A).

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

-continued-

Species:

Write name of species out completely, as shown on the reverse side of the ASL form (e.g., 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 sampling crew 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 blocks as shown in Appendix G. It is imperative that you darken the block completely and neatly. Make every effort to darken the entire block because the optical scanner that reads and records the data from the optical scan forms often misses partially filled or lightly filled blocks. 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.

-continued-

ASL Header:

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

Write the description information in the header of the ASL form following the example shown in Appendix G. For sampling sockeye salmon on the Chilkat Lake weir this will be **Sockeye/115-32-032/weir/Chilkat Lake Escapement/Week 30**).

Appendix B.–Page 4 of 7.

Continue filling out the entries along the left side of the ASL form (Appendix G) as described below:

Card:

CARD:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
021	**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 to use the correct scale card number. The first scale card of the sequence for each ASL form should be recorded in the top left corner of the form with appropriate blocks filled in. Other associated scale card numbers should be written after "CARD #" between each 10-row section.

Species:

Refer to the reverse side of the ASL form to see codes. The species code for sockeye salmon is 2.

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

Day, Month, Year:

Use appropriate blocks for the date the fish were sampled. This date should match the first scale card correlated with this ASL form, and the date of each scale card after will be listed in the margins on the right side of the corresponding Card #.

DAY:	**0**	**1**	**2**	**3**						
18	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
MONTH:	**0**	**1**								
07	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
YEAR:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
22	**0**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

-continued-

District: Haines area District is 115.

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: The subdistrict code for Chilkat Lake is 32.

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

Stream: The stream code for Chilkat Lake is 032.

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 sampling is conducted. Refer to the statistical week calendar found in Appendix A for this number.

STAT.	0	1	2	3	4	5	6	7	8	9
WEEK 30	0	1	2	3	4	5	6	7	8	9

Project:

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

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

Gear:

Refer to the reverse side of the ASL form to see codes. The gear code for a weir is 14.

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

Length Type:

Refer to the reverse side of the ASL form to see codes. The length type code for this project is mid-eye to tail fork, or 2.

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

-continued-

Number of Cards:

Mark 1, 2, 3, or 4 as appropriate for number of scale cards used when sampling sockeye salmon within the given statistical week.

# CARDS: 4	1	2	3	4	

User Code Definitions: Leave blank.

Sex Column:

Fill in the appropriate sex code block, M (male) or F (female), for each sockeye salmon sampled.

#	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. The example below shows measurements for three different fish. The top row is a fish measured at 640 mm, the second row is a fish measured at 320 mm, and the last row is a fish measured at 1,175 mm.

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 blocks completely.
- Record length by blackening the appropriate column blocks on the optical scan form. The column labeled "T" on the optical scan form is used for fish over 999 millimeters long. It is unlikely you will see sockeye salmon over 999 millimeters long. Measure all salmon to the nearest 5 millimeters.

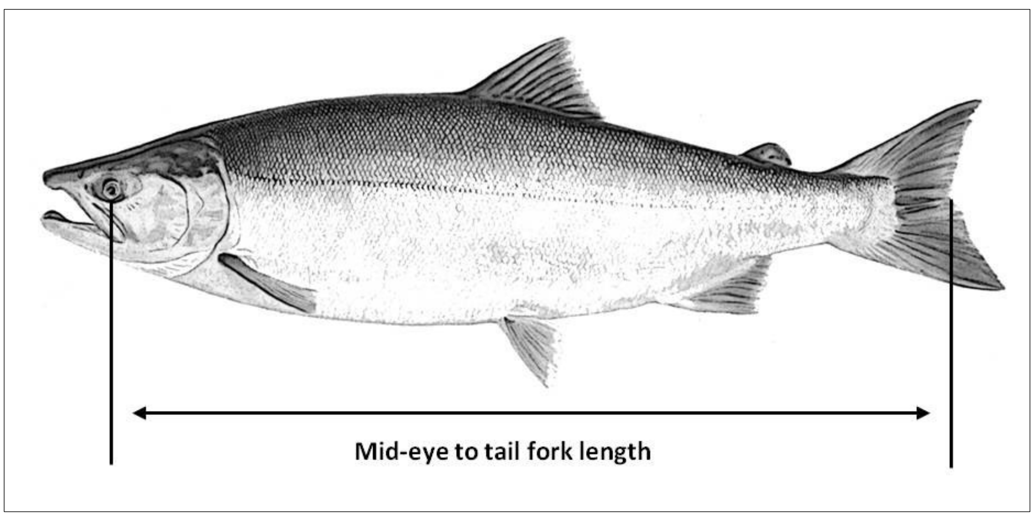
-continued-

- ASL 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 and make sure all information is filled in. Card numbers should not be repeated. Crew leaders should take time to ensure that the blocks are being filled in and blackened correctly; if the blocks are not darkened properly or are sloppily marked the optical scanner will record the information incorrectly or miss it entirely. Keep marks within each block and completely fill them. Do not mark outside the blocks.
- Transfer important comments from and about 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 margin to the right of the corresponding scale card data, 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 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 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.

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 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 Chilkat Lake weir site. Two technicians sample together. One person will be the wrestler (W), and the other crew member will collect scales and record data. This is the plucker (P), and recorder (R). The procedures for measuring mid-eye to fork of tail length and collecting scales are as follows:

1. It is ideal to measure the fish prior to sampling scales to reduce the chance of losing the scale samples when trying to handle the fish. Once the salmon is in the sampling trough, place it flat and right side down with the caudle peduncle (tail) in your right hand. Line the eye of the salmon up with the end of the measuring tape, holding the salmon's head with your left hand.
2. Hold the caudle peduncle against the measuring tape with your right hand to allow the fork of tail, or caudle fin, to rest on the tape. Read the mid eye to fork of tail length to the nearest 5 millimeters and record the length on the ASL form.
3. The wrestler (W) can perform the above handling technique to correctly orient the salmon for scale sampling, while the plucker, recorder (P, R) extracts scales from the preferred area on the left side of the fish.

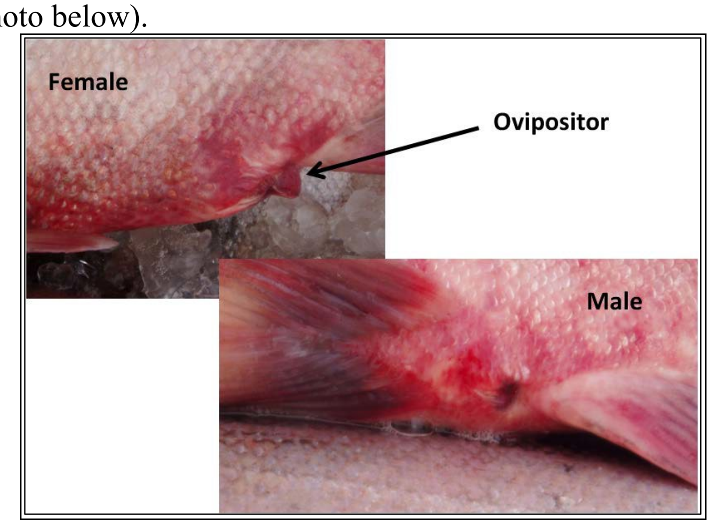


External sexing of salmon can be difficult, depending on the species and sexual maturity of the fish, and requires practice and attention to detail in order to be accurate. Sex determination requires examination of a combination of characteristics: 1) the head of the fish for the development of a long 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 salmon may have a longer snout than females and develop more of a hooked top jaw/nose and hooked kype (lower jaw) as they mature (shown in the photo below by the fish on the right). Female salmon tend to have a rounder, shorter nose/face and lack the hooked top jaw (shown in the photo below by the fish on the left).

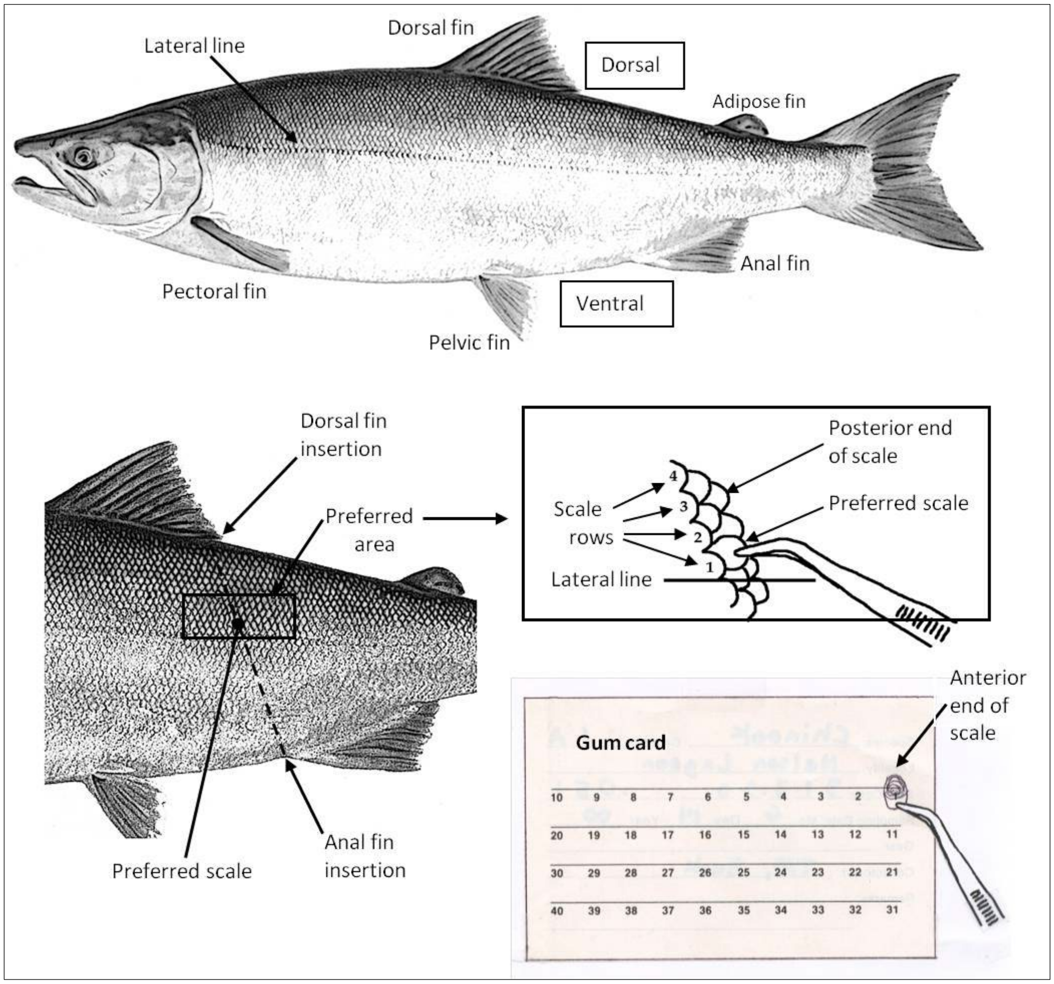
(© 2019 ADF&G.)

2) Examining the fish's vent is another helpful procedure to determine male or female salmon (shown in photo below).



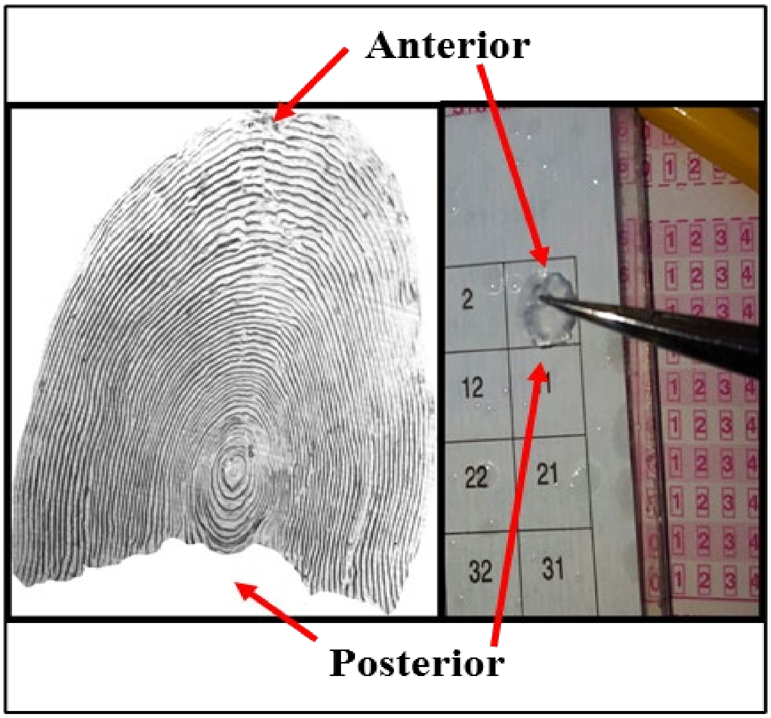
(© 2019 ADF&G.)

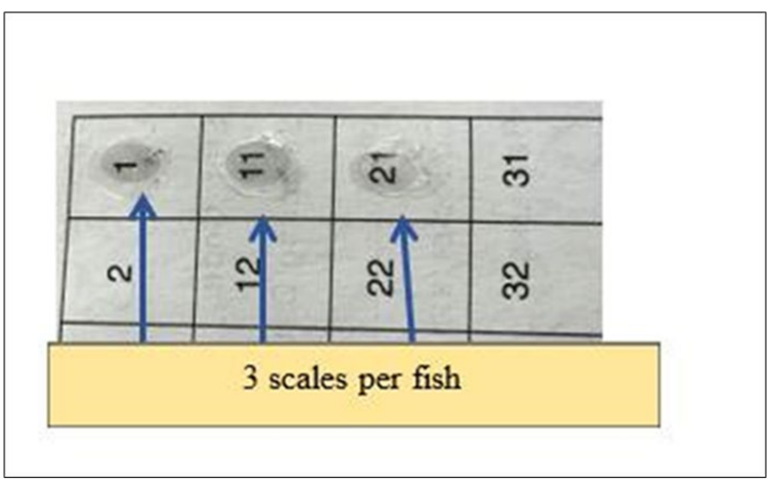
Appendix E.–Preferred scale sampling area on an adult salmon.



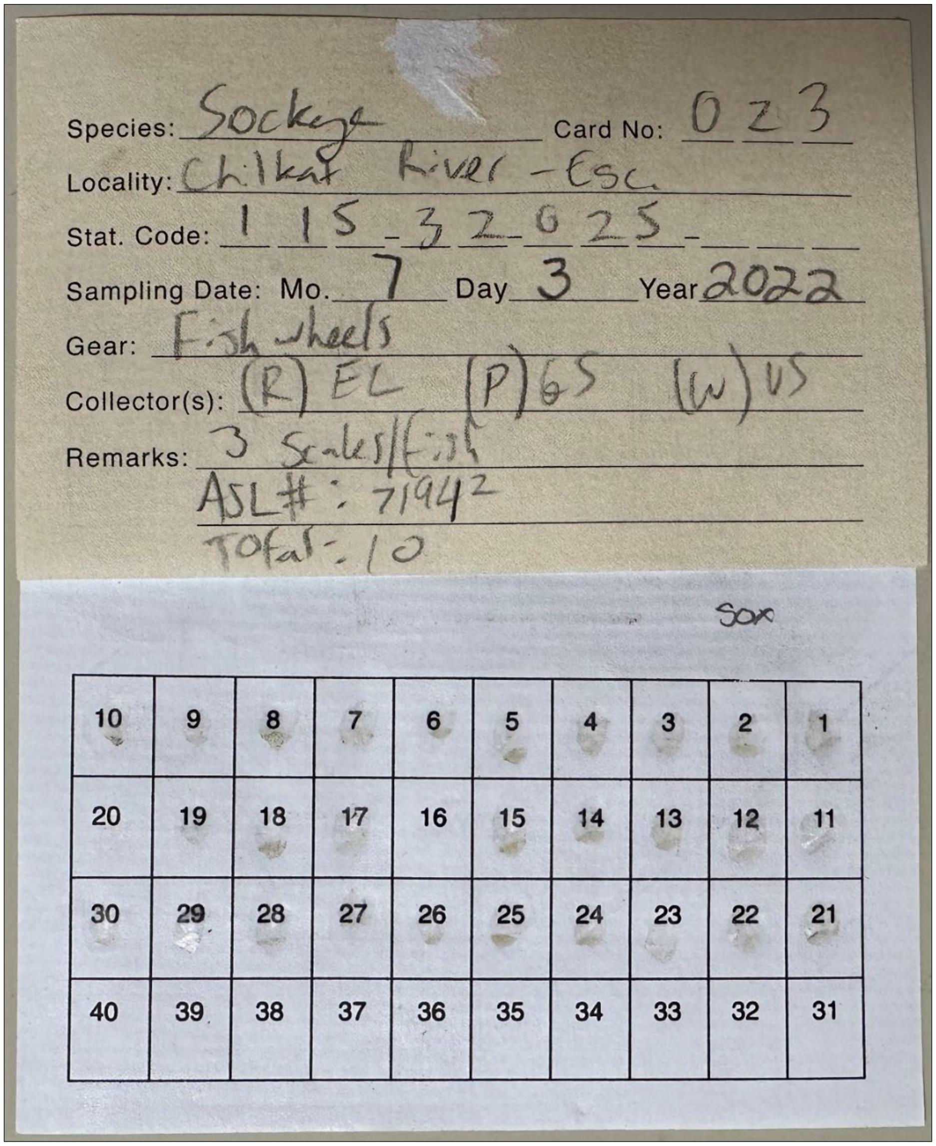
-continued-

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 (towards head) POINTING UP, POSTERIOR SIDE (towards head) POINTING DOWN, AND SCULPTURED SIDE FACING OUT.**

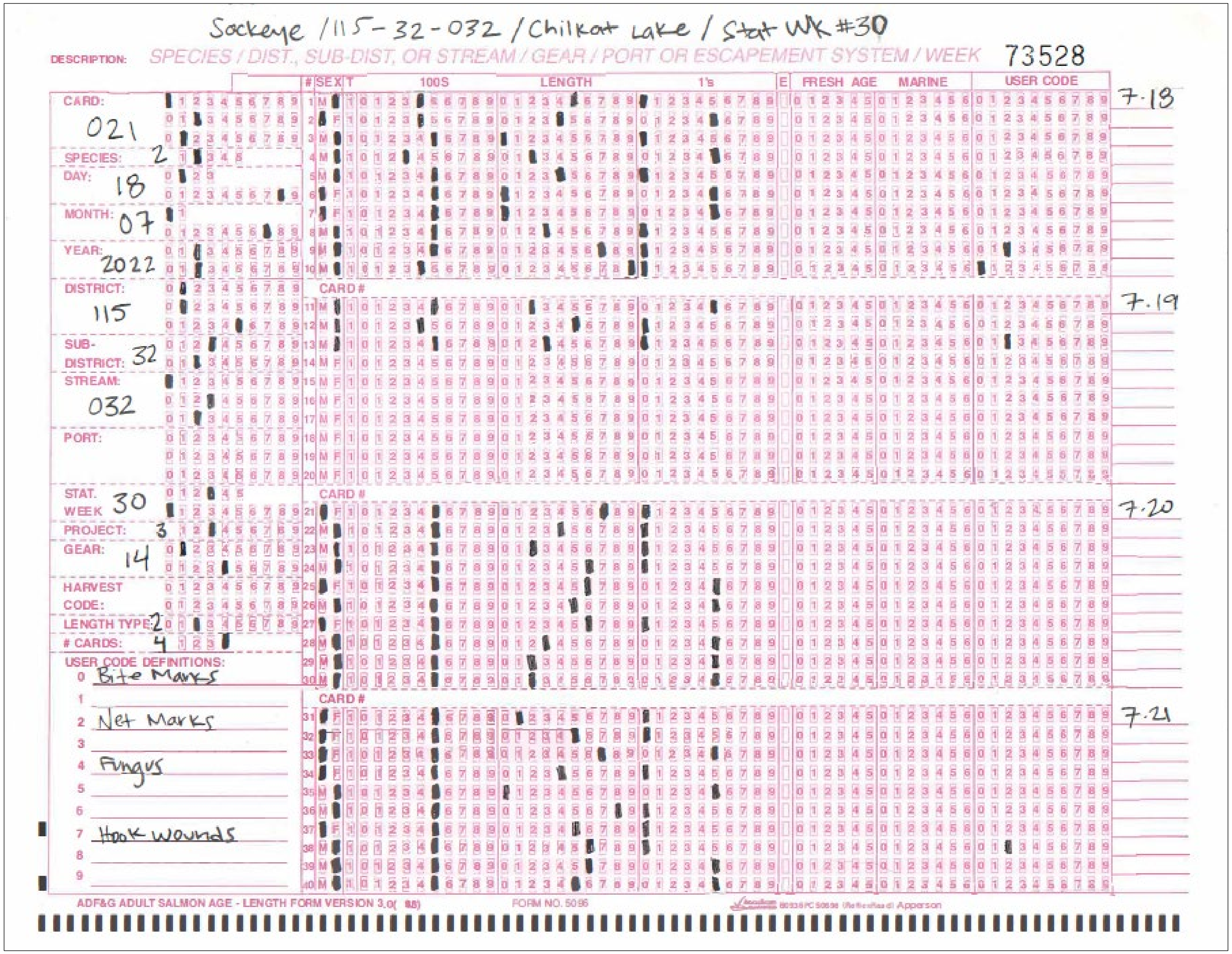




Appendix F.–Example of a completed scale card showing 3 scales per fish, proper orientation of scale samples, and the initials of the people who recorded data (R), plucked the scales (P), and wrestled and measured the fish (W).



Appendix G.–Example of a completed Optical Scan (ASL) form for sampling sockeye salmon at the Chilkat Lake weir.


Sockeye / 115-32-032 / Chilkat Lake / Stat Wk #30

DESCRIPTION: SPECIES / DIST., SUB-DIST. OR STREAM / GEAR / PORT OR ESCAPEMENT SYSTEM / WEEK 73528

CARD: 021

SPECIES: 2

DAY: 18

MONTH: 07

YEAR: 2022

DISTRICT: 115

SUB-DISTRICT: 32

STREAM: 032

PORT:

STAT. WEEK 30

PROJECT: 3

GEAR: 14

HARVEST CODE:

LENGTH TYPE: 2

CARDS: 4

USER CODE DEFINITIONS:

0 Bite Marks

1

2 Net Marks

3

4 Fungus

5

6

7 Hook wounds

8

9

SEX T 100S LENGTH 1's E FRESH AGE MARINE USER CODE

CARD #

7.18

7.19

7.20

7.21

ADF&G ADULT SALMON AGE - LENGTH FORM VERSION 3.0 FORM NO. 5096 Apperson

Appendix H.–Chilkat Lake daily beach seine form.

Chilkat Lake Weir Beach Seine

Stat Week 27

	7/2		7/3		7/4		7/5		7/6		7/7		7/8	
Seine Sets	# Sockeye	# Coho	# Sockeye	# Coho	# Sockeye	# Coho	# Sockeye	# Coho	# Sockeye	# Coho	# Sockeye	# Coho	# Sockeye	# Coho
1														
2														
3														
4														
5														

	7/2	7/3	7/4	7/5	7/6	7/7	7/8
Seine:	Start ____	Start ____	Start ____	Start ____	Start ____	Start ____	Start ____
	Stop ____	Stop ____	Stop ____	Stop ____	Stop ____	Stop ____	Stop ____
	Crew ____	Crew ____	Crew ____	Crew ____	Crew ____	Crew ____	Crew ____
Water:	Temp (^oC) ____	Temp (^oC) ____	Temp (^oC) ____	Temp (^oC) ____	Temp (^oC) ____	Temp (^oC) ____	Temp (^oC) ____
	Level (cm) ____	Level (cm) ____	Level (cm) ____	Level (cm) ____	Level (cm) ____	Level (cm) ____	Level (cm) ____
	Visibility ____ (Poor,Fair,Clear)	Visibility ____	Visibility ____	Visibility ____	Visibility ____	Visibility ____	Visibility ____
Samples:	# Sockeye ____	# Sockeye ____	# Sockeye ____	# Sockeye ____	# Sockeye ____	# Sockeye ____	# Sockeye ____
	# Coho ____	# Coho ____	# Coho ____	# Coho ____	# Coho ____	# Coho ____	# Coho ____
Notes:							

* Sockeye Samples - 70 per week [10 per day, 3 scales per fish]

Appendix I.–Chilkat Lake Hourly (top) and Daily Counts (bottom) spreadsheet data recording pages.

DIDSON Hourly Counts

		0:00				1:00				2:00				3:00				4:00				5:00				6:00				7:00				8:00			
Stat. Week	Date	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate	Up	Down	# Fish	Gate
24	6/11			0				0				0				0				0				0				0				0				0	
24	6/12			0				0				0				0				0				0				0				0				0	
24	6/13			0				0				0				0				0				0				0				0				0	
24	6/14			0				0				0				0				0				0				0				0				0	
24	6/15			0				0				0				0				0				0				0				0				0	
24	6/16			0				0				0				0				0				0				0				0				0	
24	6/17			0				0				0				0				0				0				0				0				0	
25	6/18			0				0				0				0				0				0				0				0				0	
25	6/19			0				0				0				0				0				0				0				0				0	
25	6/20			0				0				0				0				0				0				0				0				0	
25	6/21			0				0				0				0				0				0				0				0				0	
25	6/22			0				0				0				0				0				0				0				0				0	
25	6/23			0				0				0				0				0				0				0				0				0	
25	6/24			0				0				0				0				0				0				0				0				0	
26	6/25			0				0				0				0				0				0				0				0				0	
26	6/26			0				0				0				0				0				0				0				0				0	
26	6/27			0				0				0				0				0				0				0				0				0	
26	6/28			0				0				0				0				0				0				0				0				0	
26	6/29			0				0				0				0				0				0				0				0				0	
26	6/30			0				0				0				0				0				0				0				0				0	
26	7/1			0				0				0				0				0				0				0				0				0	

Date		DIDSON	Apportionment											Water			Comments
			Seine Sampling			Daily Count											
Stat. Week	Date	Daily Total	Sockeye	Coho	Total Seined (Goal 68/day)	Sockeye	Cumulative Sockeye	Scales Collected	Scale Cumulative (70/wk)	Coho	Cumulative Coho	Coho Samples	Sample Cumulative (200 total)	Temp. (ºC)	Level (cm)	Visibility (Poor, Fair, Clear)	ie: Reversals, DIDSOI
24	6/11	0			0	0	0		0	0	0		0				
24	6/12	0			0	0	0		0	0	0		0				
24	6/13	0			0	0	0		0	0	0		0				
24	6/14	0			0	0	0		0	0	0		0				
24	6/15	0			0	0	0		0	0	0		0				
24	6/16	0			0	0	0		0	0	0		0				
24	6/17	0			0	0	0		0	0	0		0				
25	6/18	0			0	0	0		0	0	0		0				
25	6/19	0			0	0	0		0	0	0		0				
25	6/20	0			0	0	0		0	0	0		0				
25	6/21	0			0	0	0		0	0	0		0				
25	6/22	0			0	0	0		0	0	0		0				
25	6/23	0			0	0	0		0	0	0		0				
25	6/24	0			0	0	0		0	0	0		0				
26	6/25	0			0	0	0		0	0	0		0				
26	6/26	0			0	0	0		0	0	0		0				
26	6/27	0			0	0	0		0	0	0		0				
26	6/28	0			0	0	0		0	0	0		0				
26	6/29	0			0	0	0		0	0	0		0				
26	6/30	0			0	0	0		0	0	0		0				
26	7/1	0			0	0	0		0	0	0		0				

Appendix J.–Chilkat Lake weir daily office reporting form.

CHILKAT LAKE WEIR 2023

Take Detailed notes

		DIDSON		Seine		Apportionment				Samples				Water			Comments
Stat Week	Date	Daily	Cum.	Sockeye	Coho	Sockeye	Cum.	Coho	Cum.	Sockeye Scales	Cum.	Coho Samples	Cum.	Temp (°C)	Level (cm)	Visibility	Ie. Reversals, DIDSON mishaps, fish leaks, other species seined, etc
30	23-Jul																
	24-Jul																
	25-Jul																
	26-Jul																
	27-Jul																
	28-Jul																
	29-Jul																
31	30-Jul																
	31-Jul																
	1-Aug																
	2-Aug																
	3-Aug																
	4-Aug																
	5-Aug																

Chilkat Weir Office Form

Appendix K.–Limnology sampling form.

LAKE SURVEY - Field Form

Lake ID ______________________ Date: ______________________

Observers: ______________________ Time: ______________________

Weather / Surface Conditions: ______________________

Sampling Station: ______________ Sampling Depth (m) : ______________

DO/temp meter used: ______________ Light meter used: ______________

Temperature (C)	
Depth	Meter
Above Surface	
5 cm	
1 m	
2 m	
3 m	
4 m	
5 m	
6 m	
7 m	
8 m	
9 m	
10 m	
11 m	
12 m	
13 m	
14 m	
15 m	
16 m	
17 m	
18 m	
19 m	
20 m	
25 m	
30 m	
35 m	
40 m	
45 m	
50 m	

Light Intensity (Stop at 1% of the 5cm value)			
Depth	Foot Candles (Up looking)	Multiplier	
Above Surface			
5 cm			100%
0.5 m			
1.0 m			
1.5 m			
2.0 m			
2.5 m			
3.0 m			
3.5 m			
4.0 m			
4.5 m			
5.0 m			
5.5 m			
6.0 m			
6.5 m			
7.0 m			
7.5 m			
8.0 m			
8.5 m			
9.0 m			
9.5 m			
10.0 m			
10.5 m			
11.0 m			
11.5 m			
12.0 m			
12.5 m			
13.0 m			
13.5 m			
14.0 m			
14.5 m			
15.0 m			

Depth	Foot Candles (Up Looking)	Multiplier
16.0 m		
17.0 m		
18.0 m		
19.0 m		
20.0 m		
25.0 m		
30.0 m		
35.0 m		
40.0 m		
45.0 m		
50.0 m		

Secchi Disk (if used)	
Depth Disappears (m)	
DOWN	UP

Zooplankton Vertical Tow	
Time Length of Tow*	Tow Depth (m)

* Try to retrieve net in 100 seconds.

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,

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

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),

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

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

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

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),

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

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,

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

$$\hat{V}\left(\hat{\bar{Y}}_j\right) = \frac{1}{\hat{N}_j^2}\sum_h \frac{N_h^2(1-n_h/N_h)}{n_h(n_h-1)}\left[\sum_i \left(y_{hij} - \bar{y}_{hj}\right)^2 + n_{hj}\left(1 - \frac{n_{hj}}{n_h}\right)\left(\bar{y}_{hj} - \hat{\bar{Y}}_j\right)^2\right]. \tag{6}$$

An interactive online application will be used postseason to fill in missing passage counts using a hierarchical Bayesian model (Hamazaki 2023; hereafter referred to as the *Hamazaki App*). Within the *Hamazaki App*, Markov-chain Monte Carlo (MCMC) methods are used to generate the joint posterior probability distribution of all unknowns in the model. The *R2jags* package[1] provides the interface between the R (R Development Core Team 2021) software environment and the Bayesian data analysis software JAGS (JAGS - Just Another Gibbs Sampler (sourceforge.io)), while the *Shiny* package[2] creates the interactive interface of the application. Within the *Hamazaki App*, the simulation length, burn-in length, thinning, number of chains, error structure, and sigma can be chosen. The *Hamazaki App* will be used for model fitting, diagnostics, and calculation of missing passage.

Bayesian Missing Passage Estimation Method

The missing passage model used by the *Hamazaki App* fits a model to historic observed daily passage data. Missing passages are estimated from the model.

The model utilizes a hierarchical model structure in which each year's run timing parameters are not independent, but derived from a common distribution (i.e., hyperparameter). This means each year's peak passage date and duration of the run are similar among years (e.g., normal, early, or late run timing). The hierarchical model draws strength from all years combined. Total weir passage is then the observed passage plus the sum of the estimated missed passage, and the lower and upper credible interval range is the observed count ± 90% Bayes posterior of the missed passage. The model assumes passage follows a log-normal distribution. The passage count, $C_{d,y}$, on the *d*-th day in *y*-th year is normally distributed with mean $\theta_{d,y}$ and sigma σ_d,

$$C_{d,y} \sim N\left(\theta_{d,y}, {\sigma_d}^2\right). \tag{1}$$

The mean passage $\theta_{d,y}$ follows a simplified, modified log-normal curve,

$$\theta_{d,y} = e^{a_y} e^{-\frac{1}{2}\left(\frac{ln(d)-ln(m_y)}{b_y}\right)^2} + \epsilon_d \ , \tag{2}$$

where

$$a_y \sim N(a_0, {\sigma_a}^2)T(min_a,) \tag{3}$$

and a_y is the natural log of the peak passage for each year, a_0 and ${\sigma_a}^2$ are hyperpriors, and $T(min_a,)$ denotes a truncated distribution with lower bound min_a. The peak passage date from the first day m_y is

$$m_y \sim N(m_0, {\sigma_m}^2)T(min_m,), \tag{4}$$

-continued-

[1] Su, Y-S., and M. Yajima. 2015. R2jags: Using R to run 'JAGS'. R package version 0.5-7. https://cran.r-project.org/web/packages/R2jags/index.html (Accessed 1 January 2023.)

[2] Chang, W., J. Cheng, J. Allaire, C. Sievert, B. Schloerke, Y. Xie, J. Allen, J. McPherson, A. Dipert, and B. Borges. 2022. Shiny: web application framework for R. R package version 1.7.4. https://CRAN.R-project.org/package (accessed April 11, 2025).

where m_0 and ${\sigma_m}^2$ are hyperpriors, and $T(min_m,)$ denotes a truncated distribution with lower bound min_m. The duration of the run, b_y, is the standard deviation of the log-normal distribution curve,

$$b_y \sim N(b_0, {\sigma_b}^2)T(min_b,), \tag{5}$$

where b_0 and ${\sigma_b}^2$ are hyperpriors, and $T(min_b,)$ denotes a truncated distribution with lower bound min_b, and

$$\epsilon_d \sim N(0, \sigma_d^2)T(0,), \tag{6}$$

where $T(0,)$ denotes a truncated distribution with lower bound 0. The model estimates the following parameters:

Parameter	Prior
a_0	$a_0 \sim N(a0, \sigma_{a0}^2)$
m_0	$m_0 \sim N(m0, \sigma_{m0}^2)$
b_0	$b_0 \sim N(b0, \sigma_{b0}^2)$
σ_a	$\sigma_a \sim U(0,2)$
σ_m	$\sigma_m \sim U(0,10)$
σ_b	$\sigma_b \sim U(0,2)$
σ_d	$\sigma_d \sim U(0, s_d)$

The prior for $a0$ is defined by the data and is calculated as the median of the natural logarithm of the peak passage of all years. The prior for $m0$ is defined by the data and is the median of the peak passage date of all years. The prior for $b0$ is defined by the data and is the median passage coefficient of variation (CV) of all years, and prior for s_d is defined by the data as a user-specified CV multiplied by the median passage of all years.