Regional Operational Plan No. ROP.CF.1J.2025.08

Operational Plan: Stock Assessment Studies of Chilkoot Lake Sockeye Salmon, 2023–2025

by

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February 2025

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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OPERATIONAL PLAN: STOCK ASSESSMENT STUDIES OF CHILKOOT LAKE SOCKEYE SALMON, 2023–2025

by

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SIGNATURE PAGE

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Approval

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PURPOSE

The Chilkoot Lake sockeye salmon (*Oncorhynchus nerka*) run 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 and harvest, (2) provide information for inseason fishery management, and (3) reconstruct runs and assess stock status. The Chilkoot Lake run is managed for a sustainable escapement goal range of 38,000–86,000 fish, which is enumerated through a standard picket weir located just downstream of the lake outlet. Weir counts of sockeye salmon are compared to weekly escapement targets and an inseason run projection model to determine inseason run strength and run timing. Genetic mixed stock analysis of weekly sockeye salmon harvests in the District 15 commercial drift gillnet fishery provides stock composition estimates that also guide inseason management of the fishery. Biological sampling, along with escapement enumeration and stock-specific harvest data, allows for total run reconstruction required for escapement goal review.

Keywords: Chilkoot Lake, Chilkoot River, commercial harvest, District 15 commercial drift gillnet fishery, escapement, enumeration weir, genetic stock identification, Haines, Lynn Canal, *Oncorhynchus nerka,* sockeye salmon, sustainable escapement goal

BACKGROUND

The Chilkoot and Chilkat River watersheds, located in northern Southeast Alaska near the town of Haines (Figure 1), support two of the largest sockeye salmon (*Oncorhynchus nerka*) runs in Southeast Alaska. Between 1900 and 1920, the annual commercial harvest of sockeye salmon in northern Southeast Alaska averaged 1.5 million fish, the majority of which were believed to originate from the Chilkat and Chilkoot River watersheds (Rich and Ball 1933). Harvests decreased in the early 1920s and remained at relatively low levels thereafter; the average sockeye salmon harvest in northern Southeast Alaska averaged 0.44 million fish between 1980 and 2008, of which an average 89,000 and 93,000 fish originated from Chilkoot and Chilkat Lakes, respectively (Eggers et al. 2009). Total run size (harvest and escapement combined) of Chilkoot Lake sockeye salmon has ranged from 15,000 to 420,000 fish since 1976. Historically, Chilkoot Lake sockeye salmon were harvested in the large fish trap and purse seine fisheries in Icy and northern Chatham Straits as well as in terminal drift gillnet areas of Lynn Canal. Fish traps were eliminated with Alaska statehood in 1959 and Lynn Canal developed into a designated drift gillnet fishing area (District 15) where most of the commercial harvest of Chilkoot Lake sockeye salmon takes place (Figure 1). A smaller portion of the Chilkoot Lake sockeye salmon run is harvested in the commercial purse seine fisheries that target pink salmon (*O. gorbuscha*) in Icy and northern Chatham Straits. Annual contributions to those fisheries are not known and likely vary annually depending on fishing effort and the strength of pink salmon runs. Chilkoot Lake sockeye salmon are also harvested annually in subsistence fisheries in Chilkoot and Lutak Inlets, where reported harvests for the 10-year period 2012–2021 averaged 3,400 fish per year. A small portion of the Chilkoot sockeye salmon run is also harvested by sport fisheries on the Chilkoot River averaging 400 fish annually over this same time period.

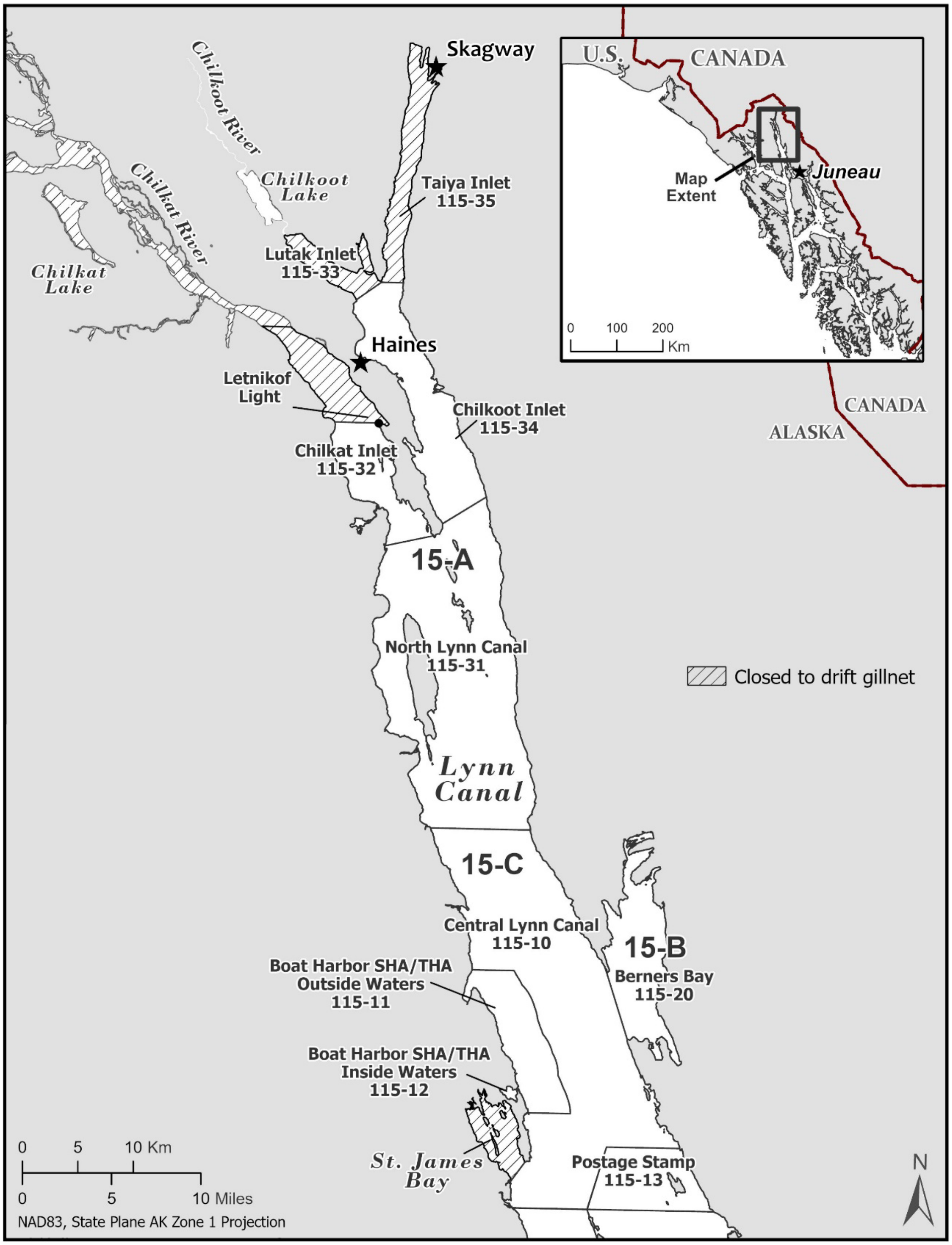

Figure 1.–The Chilkat and Chilkoot River watersheds and District 15 commercial fishing sections and statistical areas in Lynn Canal.

Commercial harvest of Chilkoot Lake sockeye salmon in the District 15 commercial drift gillnet fishery has been estimated from scale pattern analysis and, more recently, genetic stock identification (Bednarski et al. 2017). The Alaska Department of Fish and Game (ADF&G) initiated a scale pattern analysis program in 1980 to estimate contributions of Chilkat and Chilkoot sockeye salmon 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 two methods (Serena Rogers Olive, ADF&G Fisheries Geneticist, personal communication). Since 2017, harvests of sockeye salmon stocks in the District 15 commercial drift gillnet fishery have been estimated solely through genetic stock identification (Bednarski et al. 2017; Zeiser et al. 2020).

Chilkoot Lake sockeye salmon escapements have been counted and sampled annually at an adult salmon counting weir on the Chilkoot River since 1976 (Bachman and Sogge 2006; Bachman et al. 2013 and 2014; Bednarski et al. 2016; Ransbury et al. 2021). Weir counts have ranged from 7,177 (1995) to 140,378 (2019) fish, with an average escapement of nearly 70,000 fish (1976–2022; Table 1). The 2019 weir count was the largest on record. In addition to salmon counts, biological data have been collected annually at the weir to estimate age, size, and sex composition of sockeye salmon escapements. Basic information about lake productivity and rearing sockeye salmon fry populations has also been collected through limnological and hydroacoustic sampling conducted most years since 1987 (Barto 1996; Riffe 2006; Bachman et al. 2014). Those studies have been used in the past to assess potential sockeye salmon production from the lake.

The Chilkoot Lake run has been managed for at least 5 different escapement goals since 1976. Informal goals of 80,000–100,000 fish (1976–1980) and 60,000–80,000 fish (1981–1989; Bergander et al. 1988) were replaced in 1990 with a biological escapement goal of 50,500–91,500 sockeye salmon (McPherson 1990) which was divided into separate goals for early (16,500–31,500 fish) and late runs (34,000–60,000 fish). In 2006, the escapement goal was rounded to 50,000–90,000 sockeye salmon and classified as a sustainable escapement goal due to uncertainty in escapement levels based on weir counts (Geiger et al. 2005). Early- and late-run goals were eliminated and replaced with weekly cumulative escapement targets based on historical run timing (Table 2). The current sustainable escapement goal of 38,000–86,000 sockeye salmon was established in 2009 based on an updated stock-recruit analysis by Eggers et al. (2009). ADF&G recommended maintaining the current sustainable escapement goal and weekly escapement targets following subsequent reviews by Brenner et al. (2018) and Heinl et al. (2021).

The primary purpose of the sockeye salmon stock assessment program is to estimate the escapement and commercial harvest of Chilkoot Lake sockeye salmon. Information provided by this project, in conjunction with stock assessment projects on the adjacent Chilkat River (Figure 1; Zeiser et al. 2020b and 2020c; Ransbury et al. 2021a), is used inseason to manage the District 15 commercial drift gillnet fishery, ensure escapement goals are met, and to maximize and sustain the harvest of sockeye salmon from the two watersheds. Escapement and stock-specific harvest data, along with biological data on age at return, are essential for reconstruction of brood-year returns for use in future escapement goal evaluation.

Table 1.–Chilkoot River weir dates of operation and annual salmon counts by species, 1976–2022.

Year	Dates	Chinook salmon	Sockeye salmon	Coho salmon	Pink salmon	Chum salmon
1976	5/29–11/4	NA	71,291	991	1,250	241
1977	5/28–9/18	NA	97,368	5	5,270	195
1978	6/6–11/8	NA	35,454	1,092	112	382
1979	6/9–11/4	NA	96,122	899	NA	253
1980	6/15–10/4	NA	98,673	628	4,683	719
1981	6/10–10/12	NA	84,047	1,585	34,821	405
1982	6/3–9/14	6	103,038	5	6,665	507
1983	6/4–11/12	0	80,141	1,844	11,237	501
1984	6/3–9/14	0	100,781	321	5,034	732
1985	6/5–10/28	5	69,141	2,202	33,608	1,031
1986	6/4–10/28	6	88,024	1,966	1,249	508
1987	6/4–11/2	3	94,208	576	6,689	431
1988	6/9–11/12	1	81,274	1,476	5,274	450
1989	6/3–10/30	0	54,900	3,998	2,118	223
1990	6/3–10/30	0	76,119	988	10,398	216
1991	6/7–10/8	0	92,375	4,000	2,588	357
1992	6/2–9/26	1	77,601	1,518	7,836	193
1993	6/3–9/30	203	52,080	322	357	240
1994	6/4–9/24	118	37,007	463	22,472	214
1995	6/5–9/10	7	7,177	95	1,243	99
1996	6/6–9/11	19	50,741	86	2,867	305
1997	6/4–9/9	6	44,254	17	26,197	268
1998	6/4–9/13	11	12,335	131	44,001	368
1999	6/2–9/13	29	19,284	11	56,692	713
2000	6/3–9/12	10	43,555	47	23,636	1,050
2001	6/7–9/12	24	76,283	103	32,294	810
2002	6/8–9/11	36	58,361	304	79,639	352
2003	6/6–9/9	12	75,065	15	55,424	498
2004	6/3–9/12	17	77,660	89	107,994	617
2005	6/6–9/12	9	51,178	23	90,486	262
2006	6/5–9/13	1	96,203	158	33,888	257
2007	6/4–9/12	39	72,678	13	61,469	252
2008	6/4–9/12	31	33,117	50	15,105	321
2009	6/3–9/10	12	33,705	11	34,483	171
2010	6/6–9/14	6	71,657	90	30,830	410
2011	6/5–9/5	43	65,915	18	76,244	118
2012	6/3–9/12	47	118,166	139	40,753	494
2013	6/1–9/8	139	46,329	43	8,195	566
2014	5/27–9/9	83	105,713	162	12,457	126
2015	6/2–9/8	22	71,515	11	41,592	185
2016	6/3–9/9	2	86,721	53	8,354	116
2017	6/2–9/6	11	43,098	12	58,664	529
2018	6/3–9/8	31	85,453	95	5,475	225
2019	6/6–9/8	64	140,378	80	17,156	396
2020	6/2–9/8	45	60,218	156	30,954	759
2021	6/6–9/11	20	98,672	221	48,213	1,241
2022	6/7–9/6	6	57,176	3	1,255	246
Average		27	70,048	577	26,244	416

Table 2.–Weekly and cumulative Chilkoot Lake sockeye salmon escapement targets and total sustainable escapement goal of 38,000–86,000 sockeye salmon.

Statistical week[a]	Weekly target		Cumulative weekly target	
	Lower	Upper	Lower	Upper
23	378	856	378	856
24	1,546	3,498	1,924	4,354
25	2,670	6,042	4,594	10,396
26	2,259	5,113	6,853	15,509
27	1,480	3,350	8,333	18,859
28	1,770	4,006	10,103	22,865
29	3,183	7,204	13,286	30,069
30	4,403	9,963	17,689	40,032
31	5,547	12,555	23,236	52,587
32	5,031	11,386	28,267	63,973
33	3,298	7,464	31,565	71,437
34	2,806	6,350	34,371	77,787
35	1,904	4,310	36,275	82,097
36	1,249	2,826	37,524	84,923
37	476	1,077	38,000	86,000
Total	38,000	86,000	38,000	86,000

Source: Eggers et al. 2009.

[a] Statistical weeks begin on Sunday at 0001 and end the following Saturday at midnight. Statistical weeks are numbered sequentially starting from the beginning of the calendar year (Appendix A).

STUDY SITE

Chilkoot Lake (ADF&G Anadromous Waters Catalogue No. 115-33-10200-0010; 59°21′16” N, 135°35′42” W) is located approximately 16 km northeast of the city of Haines, Alaska (Figures 1 and 2). It is glacially turbid, has a surface area of 7.2 km^2 (1,734 acres), a mean depth of 55 m, a maximum depth of 89 m, and a total volume of 382.4 × 106 m^3. The Chilkoot River originates from glaciers east of the Takshanuk Mountains and west of the Ferebee Glacier. The glacial river flows approximately 26 km southeast into Chilkoot Lake, then flows approximately 2 km into Lutak Inlet. Early-run sockeye salmon spawn in lake and river tributaries and late-run fish spawn in the main channel of the Chilkoot River and along lake beaches where upwelling water occurs (McPherson 1990). Chilkoot Lake is located within the northern temperate rainforest that dominates the Pacific Northwest coast of North America. Although the climate is characterized by cold winters and cool, wet summers, the lake is set in a transitional zone with warmer and drier summers and cooler winters than the rest of Southeast Alaska. Average precipitation in the study area is approximately 165 cm/year (Bugliosi 1988). Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and Sitka alder (*Alnus viridis*) dominate the forested watershed.

Drift gillnet fisheries in Lynn Canal occur in the waters of District 15 encompassing Section 15-A (Northern Lynn Canal), Section 15-C (Central Lynn Canal), and Section 15-B (Berners Bay) (Figure 1). Historically, the sockeye salmon was the primary species targeted from late June through September in Section 15-A (McPherson 1990). Since the early 2000s, fishing effort has shifted to Section 15-C to harvest substantial hatchery summer chum salmon (*O. keta*) runs to

Douglas Island Pink and Chum, Inc. (DIPAC) release sites at the Boat Harbor terminal harvest area and Amalga Harbor special harvest area, which have attracted record-level effort (Bednarski et al. 2016; Gray et al. 2017). The fall fishery is directed at harvesting wild fall-run chum and coho (*O. kisutch*) salmon runs to the Chilkat River. Fall-run chum and coho salmon have similar run timing, and management of these species is based on fishery performance and inriver abundance based on Chilkat River fish wheel catches. Following a sharp decline in Chilkat River fall-run chum salmon runs in the early 1990s, management of the fall fishery shifted abruptly from an emphasis on harvesting chum salmon to exploiting abundant coho salmon runs (Shaul et al. 2017).

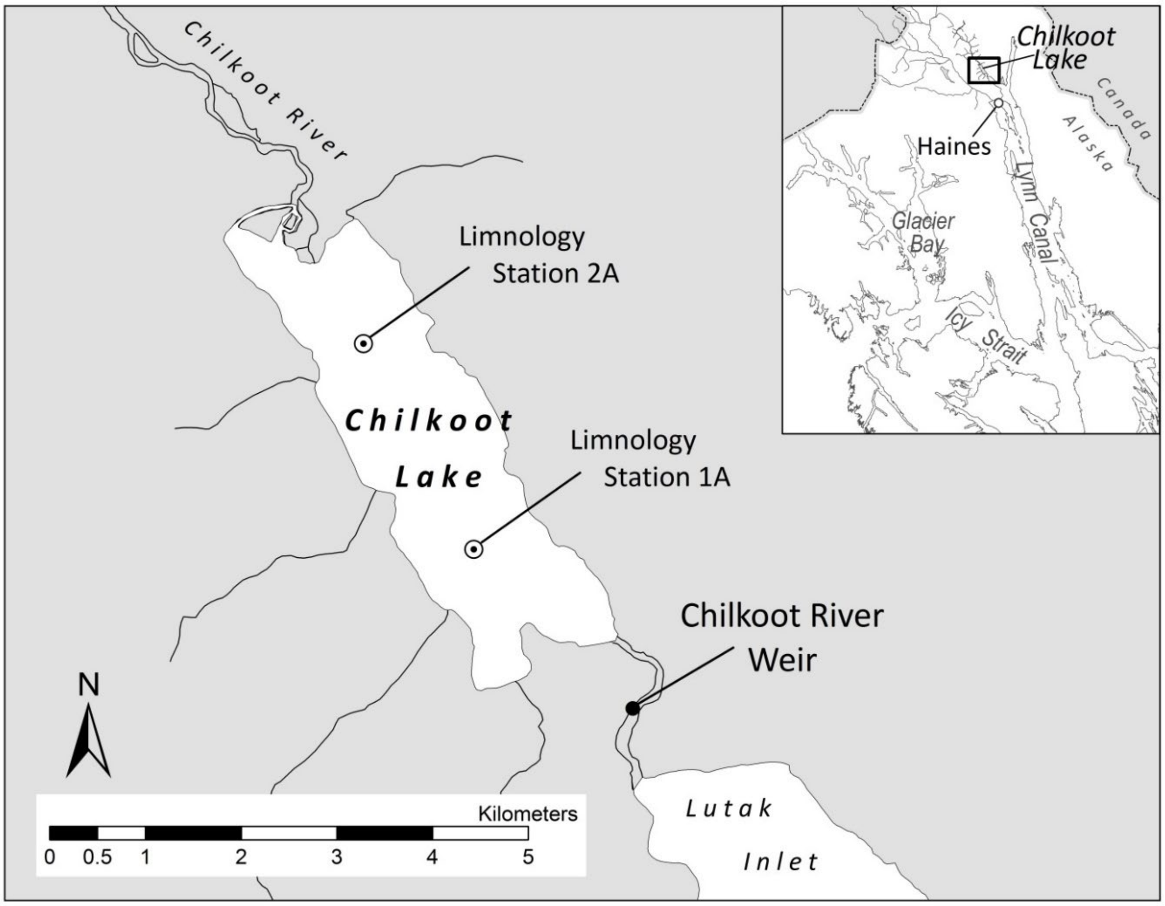

Figure 2.–Map showing Lutak Inlet, Chilkoot Lake, location of the salmon counting weir, and locations of limnology stations within Chilkoot Lake.

OBJECTIVES

Primary Objectives

1. Enumerate adult salmon by species through the Chilkoot River weir from approximately 1 June to 4 September.
2. Estimate the age, sex, and length composition of the Chilkoot Lake sockeye salmon escapement such that the estimated proportions are within 5% of the true value with at least 95% probability.

3. Estimate the weekly stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery for each of the first 10 statistical weeks of the season such that the estimates are within 7% of the true value with at least 90% probability.
4. Estimate the seasonal age-specific stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery for major age classes (i.e., those contributing >0.5%; ages 0.3, 1.2, 1.3, 2.2, 2.3) and “other” age classes combined (e.g., minor age classes such as ages 1.4, 2.4, 3.3).

Secondary Objectives

1. Estimate the abundance and density of sockeye salmon fry and other pelagic fish species in Chilkoot Lake such that the coefficient of variation is no greater than 15% of the point estimate.
2. Measure water column temperature, record light penetration profiles, and estimate zooplankton species composition, size, density, and biomass in Chilkoot Lake on a monthly basis during the middle of the month, May–September.

METHODS

ADULT SALMON WEIR ENUMERATION

The Chilkoot River adult salmon counting weir will be installed annually during the first week of June and operated to at least 4 September (see Project End Date—1% Weir Escapement Rule section below). The weir is located 1 km downstream from Chilkoot Lake (Figures 2 and 3). The weir is supported by a 110 m long permanent steel structure anchored with 20 cm steel pilings driven approximately 7 m into the bottom of the Chilkoot River channel. Pickets of black iron pipe are installed into the support structure to form a fence across the river channel. The pickets are 2 to 3 m long, with a 2.5 cm outside diameter, and spaced 3.8 cm apart. The weir will be regularly inspected, and gaps or small openings will be blocked with sandbags or plastic-coated wire mesh to prevent fish from passing undetected. A fish recovery box, counting station, and sampling station will be installed near the center of the weir structure.

In order to minimize handling, most fish will be passed by temporarily removing up to 4 pickets at a counting station located between two chairs mounted near the center of the weir (Figure 4). Fish will be counted by species as they pass through the opening. To facilitate identification and enumeration of fish, panels of white plywood of varying width will be stacked in front of and below the weir opening to force fish higher in the water column as they pass upstream (Figure 4). Fish will be caught with a dip net from the face of the weir (upstream side) at the counting station then processed for age, sex, and length sampling (Figure 5). Sampled fish will be released into a 2 m × 2 m plywood recovery box on the upstream side of the weir to recover from handling. Once recuperated, fish will exit on their own through a large hole in the side of the recovery box.

Stream height and water temperature will be recorded at approximately 6:30 am each day. Stream height (cm) will be measured on a stadia rod, and water temperature (°C) will be measured with a thermometer near the east end of the weir.

Figure 3.–View of Chilkoot River weir from the downstream side, 2013. (©2013 ADF&G. Photo by Steven C. Heinl.)

Figure 4.–View of Chilkoot River weir from the upstream side, 2022. (©2022 ADF&G.)

Figure 5.–Counting chairs positioned on either side of the counting station at the Chilkoot River weir (left), and opening at the counting station (right) showing where fish are counted as they swim through the weir; white plywood is stacked at the opening to force fish higher in the water column and make them easier to identify and count. (Left © 2019 ADF&G. Right © 2018 ADF&G. photo by Shelby M. Flemming.)

Figure 6.–Fish trap, recovery box, and fish sampling trough set-up at the Chilkoot River weir. (© 2019 ADF&G.)

Figure 7.–An electric “unwelcome matt” to discourage bears from climbing on the walkway, 2022. (© 2022 ADF&G. Photo by Nicole L. Zeiser.)

Project End Date—1% Weir Escapement Rule

Fish will be counted through the Chilkoot weir through at least 4 September 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 2013–2022. This date will be known as the *hard date*, the date to which the weir must be operated through each year. A 3-day 1% rule will 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 will be removed on the following day; otherwise, the project will 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. Two models were used to estimate escapement tails: the Gompertz model and the logistic model. Cumulative escapement (y) is predicted using the Gompertz model,

$$y = pe^{-e^{-k(t-t_0)}}, \tag{1}$$

and the logistic model,

$$y = \frac{p}{1+e^{-k(t-t_0)}}. \tag{2}$$

The model (i.e., Gompertz model or the logistic model) with the least total variance is then used for the analysis. In equations 1 and 2, 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 for the most recent 10 years of weir data (2013–2022).

Based on this analysis, the *hard date* for Chilkoot River weir operations during 2023–2025 will be 4 September (Julian day 247), and the earliest date the weir can be removed is 5 September (Julian day 248; the *end date*). That is, if daily weir counts are <1% of the cumulative escapement for 3 consecutive days up to and including 4 September, the weir will be removed on 5 September; otherwise, the project will continue until daily weir counts are <1% of the cumulative escapement for 3 consecutive days. The projected median weir removal date is 5 September, based on the estimated day the weir project would have ended if a 3-day 1% rule had been in place during the past 10 years, 2013–2022. 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

In some years, brief periods of flooding require removal of pickets to prevent structural damage to the weir, therefore upstream salmon passage must be estimated for days the weir is inoperable. Estimates will be assumed to be zero if passage is likely negligible based on historical or inseason data. 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 weir is not in operation for all of 1 day, an estimate for that day ($\hat{n}_i$) will be calculated as the average of the number of fish counted on the 2 days before (n_b and n_{b-1}) and the 2 days after (n_a and n_{a+1}) the missing day:

$$\hat{n}_i = \left(\frac{(n_b+n_{b-1}+n_a+n_{a+1})}{4}\right). \tag{3}$$

If the weir is not in operation for a period of 2 or more days, passage estimates for the 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 days before and 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 day (i) of the inoperable period, where D is the total number of inoperable days, will be estimated as:

$$\hat{n}_i = \left(\frac{n_b+n_{b-1}}{2}\right) + i\left(\frac{(n_a+n_{a+1})-(n_b+n_{b-1})}{2(D+1)}\right). \tag{4}$$

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 weir is not in operation for 1 day, equation 3 will be used to fill in missing counts. If the weir is not in operation for a period of 2 days, equation 4 will be used to fill in missing counts. If the weir is not in operation for a period of 2 or more days, equation 4 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 K for details) will be used to fill in missing counts.

SOCKEYE SALMON AGE, SEX, AND LENGTH COMPOSITION

The seasonal age composition of the Chilkoot 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 at 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 20% of sampled fish. In addition, 3 scales will be sampled from each fish to increase the proportion of readable scales.

Up to 10 sockeye salmon (70 fish/week) will be sampled for matched scales, sex, and length each day during the morning shift. This weekly sample will be more than sufficient to meet objective criteria, since the total seasonal sample will likely be more than the 635 samples required. This sample will also meet seasonal sex and length composition requirements, as only 385 samples (assuming no data loss) are needed to achieve the precision criteria (within 5% of the true value 95% of the time) for estimating sex composition (Thompson 2002).

Scale samples will be analyzed at the ADF&G 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). Age, length, and sex data will be entered into the Region 1 fisheries database by Douglas staff. The weekly age distribution, the seasonal age distribution weighted by week, and the mean length by age and sex weighted by week will be calculated using standard sampling summary statistics (Cochran 1977).

COMMERCIAL FISHERY AND HARVEST

The District 15 commercial drift gillnet fishery season opens by regulation on the third Sunday of June, and weekly openings begin at 1200 noon each Sunday. Each week typically begins with a

48-hour opening and may be extended, depending on fishery performance and sockeye salmon escapements to Chilkoot and Chilkat Lakes. Commercial harvest data for District 15 will be obtained through the ADF&G OceanAK data system. Harvests will be summarized by statistical weeks, which begin on Sunday at 0001 and end the following Saturday at midnight. Statistical weeks are numbered sequentially starting from the beginning of the calendar year (Appendix A).

Commercial Drift Gillnet Fishery Performance

The Area Management Biologist and a Fish and Wildlife Technician 3 will conduct a vessel survey of the District 15 commercial drift gillnet fleet each Monday of the fishing season to interview permit holders and tender operators to collect information on harvest and effort. This information will be used to estimate the number of vessels participating in the fishery, catch per unit effort (CPUE), and total harvest of all salmon species.

Surveys will start from Portage Cove harbor, in Haines, and will cover areas open to commercial fishing in District 15. A total boat count will be made, and permit holders will be interviewed in each of the open subdistricts. The number of interviews conducted in each subdistrict will be proportional to observed effort, with a goal of interviewing at least 20% of participants each opening. Tender vessels encountered on the fishing grounds will be boarded, and E-ticket tender logs will be printed and retained with a goal of obtaining 3–5 tender logs for the entire district. After 24 hours of fishing, each tender log will typically include the catch of 5–15 boats. The CPUE, defined as the number of fish caught per boat per day (24 hours), will be determined by averaging catch data from tender logs and interviews with permit holders. The CPUE will then be multiplied by the total number of boats to estimate the total harvest during the first day of the opening. The CPUE and estimated total harvest will be reported in advisory announcements distributed each Thursday afternoon. Harvest estimates and cumulative escapement counts at the fish weirs will be compared to historical trends and weekly escapement targets to determine if an extension is warranted for each drift gillnet opening.

Commercial Sockeye Salmon Harvest Estimates

Inseason stock composition of the sockeye salmon harvest in the District 15 commercial drift gillnet fishery will be estimated through genetic stock identification. Sockeye salmon will be identified in 7 reporting groups: Chilkat Lake, Chilkat mainstem, Chilkoot Lake, Juneau Mainland, Snettisham, Taku River/Stikine mainstem, and Other (Appendix J); however, reporting groups will be reduced to Chilkat Lake, Chilkoot Lake, and Other for weekly inseason reporting. Laboratory analysis, including quality control, will be performed by the ADF&G Gene Conservation Laboratory following methods outlined in Dann et al. (2012). Stock composition will be estimated inseason for each statistical week using a Bayesian mixed stock analysis (MSA) approach as implemented in the R package *rubias* (Moran and Anderson 2019; R Development Core Team 2021), which will compare fishery samples against the genetic baseline described in Appendix J (see Rogers Olive et al. (2018) for details). Postseason, samples will be reanalyzed with age composition data from the harvest using an MSA model that incorporates ages from matched scale samples to provide age-specific stock composition estimates for all major contributing age classes (i.e., those contributing > 0.5%; ages 0.3, 1.2, 1.3, 2.2, and 2.3) and “other” age classes combined (e.g. minor age classes such as ages 1.4, 2.4, and 3.3).

Fishery Sampling

Matched sockeye and Chinook salmon (O. *tshawytscha*) scale and genetic tissue samples will be collected from District 15 commercial drift gillnet fishery landings by ADF&G port sampling personnel at fish processing facilities in Haines, Petersburg, and Juneau (Renolds-Manney et al. 2020). Sampling will be stratified by statistical week and sampling effort will span the first 10 weeks of the fishery, as approximately 94% of the sockeye salmon harvest occurs during that period (2013–2022 average). The target sample size for each statistical week is set at a minimum of 200 and a maximum of 300 paired sockeye salmon tissues and scales. According to sample theory, under the worst-case scenario (stocks contributing equal proportions) a sample of this size should provide weekly estimates of relative proportions within 7% of the true value 90% of the time (Thompson 1987).

Starting in 2018, sockeye salmon harvested in the District 15 commercial drift gillnet fishery have been sampled regardless of the harvest type and all samples have been recorded as traditional harvest (harvest code 11). Previously, sockeye salmon harvested in the Boat Harbor terminal harvest area (THA; statistical areas 115-11 and 115-12), were not sampled, including sockeye salmon on tenders with fish mixed from traditional and terminal harvest (harvest code 12) fisheries (Ransbury et al. 2021). The Boat Harbor THA was designated to manage and harvest hatchery chum salmon returning to the Boat Harbor release site as outlined in the *Boat Harbor Terminal Harvest Area Management Plan* (5 AAC 33.386). The THA is located in Section 15-C in central Lynn Canal (Figure 1) through which mixed stocks of sockeye salmon must migrate, and sockeye salmon are harvested incidentally in the terminal fishery. There are no hatchery sockeye salmon released inside Boat Harbor or anywhere else in District 15. Over the 10-year period 2013–2022, an average 21% (range: 13–31%) of sockeye salmon harvested in Section 15-C (statistical areas 115-10, 115-11, 115-12, and 115-13) were harvested in the Boat Harbor THA. Since 2018, all sockeye salmon samples have been identified as harvest code 11. To be consistent, future stock composition analyses will need to include the entire sockeye salmon harvest in Lynn Canal, harvest codes 11 and 12 combined, for years prior to 2018.

Sampling protocols will ensure that weekly samples will be as representative of harvests as possible to account for fluctuations in harvest and effort over the course of a weekly fishery. Samples will be collected from sockeye salmon harvested within a single district but not from landings that consist of harvest from mixed districts unless the fish have been separated in some manner onboard the vessel. When possible, pure samples will be collected from sockeye salmon harvested from only Section 15-A or Section 15-C, which will allow for spatial stratification within the district. No more than 40 samples will be collected from a single vessel delivery, and no more than 200 samples will be collected from a single tender delivery. Samples will be collected without regard to size or sex of fish, and, whenever possible, samples will be systematically collected from the entire hold as it is offloaded to ensure they are representative of the entire delivery.

A 2.5 cm piece of the pelvic fin will be removed from each sampled fish and placed on a Whatman filter paper card for dry preservation. Matched scale, length, and sex data will also be collected from each sampled fish. Metadata for each sample, including matched age information, will be recorded and entered into a mobile computer application. Tissue samples will be shipped on a weekly basis to the Region 1 Scale Aging Laboratory in Douglas, along with matching scale samples and associated data for inventory. Tissue samples will then be shipped to the ADF&G Gene Conservation Laboratory in Anchorage for analysis. Scale samples will be inventoried and prepared for postseason analysis as outlined in the Sockeye Salmon Age, Sex, and Length Composition section.

Laboratory Analysis

Genomic DNA will be extracted from tissue samples using a NucleoSpin® 96 Tissue Kit by Macherey-Nagel (Düren, Germany). A multiplexed preamplification PCR of 48 screened single nucleotide polymorphism (SNP) markers will be used to increase the concentration of template DNA. Samples will be genotyped for 48 screened SNP markers using 2 sets of Fluidigm® 192.24 Dynamic Array™ Integrated Fluidic Circuits, which systematically combine up to 24 assays and 192 samples into 4,608 parallel reactions (https://www.fluidigm.com). The Dynamic Arrays will be read on a Fluidigm® EP1™ System after amplification and scored using Fluidigm® SNP Genotyping Analysis software. If necessary, SNPs may be rescreened on a QuantStudio™ 12K Flex Real-Time PCR System (Life Technologies) as a backup method for assaying genotypes. Genotypes will be imported and archived in the Gene Conservation Laboratory Oracle database, LOKI.

A quality control analysis (QC) will be conducted postseason to identify laboratory errors and to measure the background discrepancy rate of the genotyping process. The QC analyses will be performed by staff not involved in the original genotyping, and the methods are described in detail in Dann et al. (2012). Briefly, the method will consist of re-extracting 8% of project fish and genotyping them for the same SNPs assayed in the original genotyping process. Discrepancy rates will be calculated as the number of conflicting genotypes, divided by the total number of genotypes compared. These rates will describe the difference between original project data and QC data for all SNPs and can identify extraction, assay plate, and genotyping errors. Assuming that discrepancies among analyses are due equally to errors during the original genotyping and during QC, error rates in the original genotyping will be estimated as half the rate of discrepancies. If there are many discrepancies, a duplicate check will be performed to determine if the QC fish are a better match to any other project fish. A QC fish matching other project fish would indicate that fish were swapped during the extraction process. This information will be used to identify which, and how many, fish should be re-extracted.

Statistical Analysis

Genotypes in the LOKI database will be imported into the statistical program R for analysis. Prior to statistical analysis, 3 statistical quality control analyses will be performed to ensure high-quality data: 1) individuals missing >20% of their genotype data (markers) will be identified and removed from analyses as this is indicative of low-quality DNA (80% rule; Dann et al. 2012); 2) duplicate individuals will be identified and removed; and 3) non-sockeye salmon will be identified and removed.

Stock composition for each stratum will be estimated using the R package *rubias*. A single Markov Chain Monte Carlo (MCMC) chain with starting values equal among all populations will form the posterior distribution that describes the stock composition of each stratum. Summary statistics will be tabulated from these distributions to describe stock compositions. Stock composition estimates of commercial harvest will be applied to observed harvest (obtained from fish ticket data) to quantify stock-specific harvests within each week. Postseason, age-specific stock composition for all major contributing age classes will be estimated seasonally through a mark- and age-enhanced genetic mixed-stock analysis (MAGMA) model, which is an extension of the Pella-Masuda genetic stock identification model (Pella and Masuda 2001) that incorporates paired scale-age data. Total season estimates will be provided by age group using MAGMA. This method requires two sets of parameters: 1) a vector of stock compositions summing to 1 weighted by harvest per stratum; and 2) a matrix of age composition, with a row for each stock summing to 1 and a column for each age class. This information will be "completed" iteratively by stochastically assigning each fish to a population, then estimating the stock proportions based on summaries of assignment from each iteration. In this process, all available information (i.e., age and genotype) will be used to assign individuals to stock of origin.

To initialize the algorithm, all wild fish are given a stock assignment stochastically. The initialized algorithm will then proceed in the following steps:

1) Summarize all age data by assigned stock;
2) Estimate the stock proportions and age composition from previous summaries (accounting for sampling error);
3) Stochastically assign each fish with genotypes and ages to a stock of origin based on the product of its genotypic frequency, age frequency, and stock proportion for each population;
4) Stochastically assign each fish without genotypes (only those samples that were aged) to a stock of origin based on the product of its age frequency and stock proportion for each population; and
5) Repeat steps 1–4 while updating and recording the estimates of the stock proportions and age compositions with each iteration.

This algorithm will be run for 40,000 repetitions, and the first 20,000 repetitions will be discarded to eliminate the effect of the initial state. 5 MCMC chains will be run and checked for convergence among chains using the Gelman-Rubin convergence diagnostic. The point estimates and credible intervals for stock-specific age compositions will be summary statistics of the output.

JUVENILE SOCKEYE SALMON ABUNDANCE

Hydroacoustic and mid-water trawl methods will be used to estimate abundance of small pelagic fish in Chilkoot Lake. To control year-to-year variation in estimates, acoustic surveys will be conducted annually along the same 12 transects (2 from each of 6 sampling sections of the lake) that were randomly chosen in 2002 as permanent transects (Riffe 2006). Hydroacoustic surveys will be conducted annually in either late October or early November. Hydroacoustic sampling will be conducted after sunset, and all transects will be sampled on the same night. A Biosonics DT-X™ scientific echosounder (430 kHz, 7.3° split-beam transducer) with Biosonics Visual Acquisition© version 6.0 software will be used to collect data. Ping rate will be set at 5 pings sec^{-1} and pulse width at 0.3 ms. Surveys will be conducted at a constant boat speed of about 2.0 m sec^{-1}. A target strength of -40 dB to -70 dB will be used to represent fish within the size range of juvenile sockeye salmon and other small pelagic fish.

Fish-target density $\hat{M}_{ij}$ (targets/m^2) in section i across transect j will be estimated using Biosonics Visual Analyzer© version 5.0 software, using echo integration methods (MacLennan and Simmonds 1992). Methods for calculating fish population estimates are similar to DeCino (2001) and DeCino and Willette (2014) and adapted from Burczynski and Johnson (1986). The population estimate of each transect j in a section i will be estimated as:

$$\hat{N}_{ij} = a_i \hat{M}_{ij}, \tag{5}$$

where a_i represents the surface area (m^2) of the lake in section i. Using transects as the sampling unit (Burczynski and Johnson 1986), fish abundance ($\hat{N}_i$) across each section will be estimated from the mean abundance of the replicate transects j in section i,

$$\widehat{N}_i = J^{-1} \sum_{j=1}^{J} N_{ij}, \tag{6}$$

with variance

$$v(\widehat{N}_i) = \sum_{j=1}^{J} (\widehat{N}_{ij} - \widehat{N}_i)^2 (J-1)^{-1} J^{-1} \tag{7}$$

The sum of the 6 section estimates ($\widehat{N}_i$) will provide an estimate of total targets for the entire lake ($\widehat{N}$). Note that target density will be expressed as average targets per unit of lake surface area a_i, not per unit of volume. Because the estimate of total targets in each section is essentially independent (neglecting any movement of fry from one section to the other during surveys), the sample variance of the estimate of the total targets in the entire lake $v(\widehat{N})$ will be estimated by summing the sample variances $v(\widehat{N}_i)$ across all 6 sections. Sampling error for the estimate of total targets for the entire lake will be measured and reported with the coefficient of variation (Sokal and Rohlf 1981). The CV of population estimates was 15% or less in 14 of 19 years from 2004 to 2022 (Table 3).

Historically, estimates of total targets will be partitioned into species categories based on the proportion of each species captured in mid water trawls. A 2 m × 2 m elongated trawl net will be used to capture pelagic fish and estimate species composition (Riffe 2006). 4 to 6 nighttime trawls will be conducted at various depths, ranging from near surface to 15 m. Trawl depths and duration will be determined from observations of fish densities and distributions throughout the lake during the hydroacoustic survey. Fish will be counted by species and released. Mid-water trawl surveys were not conducted from 2015 to 2018, or in 2022[1] because sockeye salmon fry accounted for the vast majority of fish captured (median = 99%; *n* = 26 years; Table 3; Bednarski et al. 2016).

In addition, species apportionment may be biased if the relative catchability of each species is not the same. Threespine stickleback (*Gasterosteus aculeatus*) are more susceptible to capture than sockeye salmon fry (Enzenhofer and Hume 1989; Bednarski and Heinl 2010) and larger fish (e.g., age-1 sockeye salmon fry) can more easily avoid the trawl net (Hyatt et al. 2005). Although caution is required in interpreting sampling results, mid-water trawling will be conducted at Chilkoot Lake to maintain sampling effort consistent with prior years and to confirm that the vast majority of small pelagic fish in the lake are sockeye salmon fry.

[1] A mid-water trawl was conducted in 2021 but the hydroacoustic equipment malfunctioned and data could not be analyzed.

Table 3.–Number of fish collected in trawl samples by species, percentage of sockeye salmon in trawl samples, and estimated total number of fish (hydroacoustic targets) and sockeye salmon fry in autumn surveys of Chilkoot Lake, 1987–2022.

	Trawl samples					Hydroacoustic estimates		
Year[a]	Total fish	Sockeye	Stickleback	Other	Percent sockeye	Targets	CV	Sockeye
1987	194	141	41	12	73%	1,344,951	ND	977,516
1988	85	83	0	2	98%	3,066,118	ND	2,993,974
1989	209	208	1	0	100%	874,794	ND	870,608
1990	240	238	0	2	99%	607,892	ND	602,826
1991	47	38	9	0	81%	475,404	ND	384,369
1992	ND	ND	ND	ND	ND	ND	ND	ND
1993	ND	ND	ND	ND	ND	ND	ND	ND
1994	ND	ND	ND	ND	ND	ND	ND	ND
1995	775	708	52	15	91%	260,797	ND	238,250
1996	174	173	0	1	99%	418,152	ND	415,749
1997	117	116	0	1	99%	637,628	ND	632,178
1998	526	523	0	3	99%	1,309,711	ND	1,302,241
1999	263	248	11	4	94%	400,307	ND	377,476
2000	15	14	0	1	93%	1,380,950	ND	1,288,887
2001	61	29	23	9	48%	1,351,068	ND	642,311
2002	289	288	1	0	100%	1,389,712	4%	1,384,903
2003	139	138	1	0	99%	1,384,754	NA	1,384,754
2004	199	187	4	8	94%	1,059,963	10%	996,200
2005	25	25	0	0	100%	247,283	22%	247,283
2006	80	80	0	0	100%	356,957	17%	356,957
2007	48	48	0	0	100%	99,781	6%	99,781
2008	534	531	1	2	99%	1,020,388	14%	1,014,655
2009	60	60	0	0	100%	832,991	14%	832,991
2010	379	379	0	0	100%	741,537	5%	741,537
2011	82	82	0	0	100%	651,847	24%	651,847
2012	142	142	0	0	100%	752,212	13%	752,212
2013	131	131	0	0	100%	642,256	6%	642,256
2014	551	546	0	5	99%	1,160,985	8%	1,150,450
2015	ND	ND	ND	ND	ND	1,148,335	7%	1,148,335
2016	ND	ND	ND	ND	ND	1,294,334	4%	1,294,334
2017	ND	ND	ND	ND	ND	491,901	5%	491,901
2018	ND	ND	ND	ND	ND	919,761	11%	919,761
2019	107	107	0	0	100%	719,165	8%	719,165
2020	ND	ND	ND	ND	ND	279,263	27%	279,263
2021[b]	ND	ND	ND	ND	ND	ND	ND	ND
2022	ND	ND	ND	ND	ND	1,008,110	10%	1,008,110

[a] No hydroacoustic surveys were conducted from 1992-1994. No trawl surveys were conducted from 2015-2018 and from 2020-2021.

[b] In 2021, the sonar malfunctioned during the hydroacoustic survey.

LIMNOLOGICAL ASSESSMENT

Basic limnological data, including zooplankton, light, and temperature sampling, will be collected monthly on or around the 15th from May through October. Since 2008, all limnological sampling has been conducted at 2 primary stations marked by anchored buoys in the lake (station 1A at 59° 20.81′ N, 135° 35.79′ W; station 2A at 59° 21.88′ N, 135° 36.64′ W) (Figure 2). The anchored buoys will be deployed and removed each season due to the lake freezing. The stations are marked with GPS coordinates and are located at the beginning of the season using a GPS/InReach® navigational device.

Light and Temperature Profiles

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, recordings of 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 instead 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 I).

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^{-1}. Once the top of the net has cleared the surface, the rest of the net will be pulled slowly out of the water and rinsed from the outside with lake water to wash organisms into the screened sampling container at the cod end of the net. All specimens in the sampling container will be carefully rinsed with clean tap water into a 500 ml sampling bottle and preserved in buffered 10% formalin. Bottle labels will include the lake name, date, name of the samplers, station number, depth, and preservative type.

DATA COLLECTION

CHILKOOT RIVER WEIR ENUMERATION

Weir personnel will record the number of fish passed through the counting opening in the weir on the Chilkoot Weir Daily Counting Form (Appendix B). Each counting period will be approximately 3 hours in length, or until fish have stopped passing through the weir, and the start and stop time for each counting period will be recorded on the form. The first daily counting period (the "morning count") will start immediately after the temperature and water level are recorded at 0630. Counts of each species will be recorded on hand tally counters. At the end of the day, counts for each species and time period will be summarized and the total will be recorded in the "Daily Cumulative" boxes on this form.

As a service to commercial fishermen, as well as the general public, the weir crew will maintain updated daily and cumulative counts of sockeye salmon on a sign posted downriver from the weir. The sign will be visible from the road and posted before the no stopping or standing zone begins. These counts will be updated daily. A summary of the previous day's information will be communicated via cellular phone to the Haines Management office at approximately 0900 each morning. Information communicated during this call will also include the sockeye salmon count from the enumeration period conducted earlier that morning.

SAMPLING FOR AGE, SEX, AND LENGTH

Sockeye salmon will be the only species sampled. **Procedures for sampling and recording data are outlined in detail in Appendices C through I**. All fish sampled for scales will be measured (mm) from mid eye to tail fork (Appendix D), and the sex will be determined from examination of external dimorphic sexual maturation characteristics such as snout and kype development, belly shape, and shape of vent opening (Appendix E). 3 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 F) and placed on a scale card (Appendices F and H). Corresponding data (sex and length) will be recorded on (ASL) optical scan forms (Appendix G).

LIMNOLOGICAL ASSESSMENT

Zooplankton samples and associated forms will be delivered to the Haines ADF&G Commercial Fisheries office for seasonal storage. At the end of the season, all samples will be shipped to the ADF&G Kodiak Limnology Laboratory for analysis (Hopkins 2017). Monthly results will be averaged between the 2 sampling stations, and seasonal estimates will be calculated as the average of the monthly values, mid-May to mid-September.

DATA REDUCTION

WEIR COUNTS

Data collected at the fish weir will be recorded on field forms specific to each activity (Appendices B and G). Data forms will be kept up to date and inspected daily for errors and completeness by each crew members and checked again by the crew leader before turning the forms in to the project leader. Daily counts will be called into the Haines office daily by 0900 and distributed within the department via weekly email by office staff.

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, holes in the weir, % net marked fish, seal bites, pickets removed due to high water), and fish numbers by count type and species.

It is important that a count of 0 be entered for any species 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 sockeye salmon are counted through the weir.** 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. If counts for missing days must be interpolated due to high water events or other problems (see Passage Estimates), those counts will be entered as "Calculated Values," or "CV".

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 (e.g., there should be no counts of "jack" sockeye or pink salmon).

AGE, SEX, LENGTH DATA

Completed ASL forms and scale cards will be delivered to the Haines ADF&G office on a weekly basis and reviewed for accuracy and completeness. Scale samples and ASL forms will be sent to the Douglas office weekly for review, analysis, and archiving.

COMMERCIAL HARVEST DATA

Information collected on the fishing grounds by Haines staff will be reported on field sheets that separate each observation by subdistrict. These data will be entered into an Excel spreadsheet to track opening estimates through the drift gillnet season. Estimated CPUE, total harvest, and effort will be reported by the Haines area manager in weekly advisory announcements.

The ADF&G Gene Conservation Laboratory will provide inseason weekly stock composition estimates to the Haines Office, including a running summary of the current season and stock composition estimates from the 2015–2025 seasons for comparison. There will be a total of 10 inseason reports spanning statistical weeks 25–34. Postseason, age-specific stock composition for all major contributing age classes will be estimated seasonally.

SCHEDULE AND DELIVERABLES

OPERATIONS

Field sampling activities are scheduled as follows:

1. Project training and field camp set up ~May 23 to May 31
2. Chilkoot River weir operations 1 June to 10 September
3. Chilkoot Lake limnology Mid-month, May to September
4. Chilkoot Lake hydroacoustic/mid-water trawl surveys Late October/November

REPORTS

Project results will be presented in the annual fishery management plans for the Lynn Canal drift gillnet fishery (Fishery Management Report) in April of each year and in a biannual stock assessment report (Fishery Data Series Report).

RESPONSIBILITIES

Nicole 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 and technicians; edits, analyzes, and reports data; oversees major repairs; expedites and approves major purchases; reviews and approves crew schedules; resolves personnel or administrative issues; writes the operational plan and project reports; collects limnological data and completes fry production assessments; writes crew performance evaluation reports and serves as lead biologist for the project.

Shelby Flemming, Fishery Biologist 1. Responsible for overseeing fish weir operations and directing the project in the absence of Zeiser. Assists with the supervision of project; edits, analyzes, and reports data; trains the crew in safety and project procedures; creates crew schedules; assists with fieldwork; and serves as project expeditor. Collects limnological data and completes fry production assessments. Assists with reviewing and editing the operational plan and ensures that it is followed appropriately. Assists with resolving personnel or administrative issues related to this project.

Fish and Wildlife Technician 3, Lead Technician. Responsible for the day-to-day safe operation and maintenance of the fish weir, and the training and direction of the crew member in all aspects of the project including fish weir maintenance, fish handling, the collection and recording of data, and adherence to the operational plan and Department policies. Assists with limnological sampling at Chilkoot Lake.

Fish and Wildlife Technician 2. Assist in all aspects of fish weir operations, and adherence to the operational plan and Department policies. Assists with limnological sampling at Chilkoot Lake.

Faith Lorentz, Program Technician. Coordinates communication with Chilkoot weir crew, updates master spreadsheet with daily weir counts, provides administrative assistance, tracks project budgets and reconciles expenditures and payments, and provides other technical support as necessary.

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.

Chase Jalbert, ADF&G Fisheries Geneticist 1, Gene Conservation Laboratory. Runs the inseason genetic stock identification Performs genetic stock identification analyses with *rubias* and the post-season age-specific MAGMA model. Provides weekly commercial harvest stock composition estimates to fishery managers in-season.

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APPENDICES

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

Statistical	2023		2024		2025	
week	Beginning	Ending	Beginning	Ending	Beginning	Ending
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

Note: A new statistical week always begins on Sunday at 1201.

Appendix B.–Chilkoot River Weir Daily Count Form.

Chilkoot River Salmon Weir Daily Counting Form

Sampler: ______________ # of Fish Sampled: ______________

Date: ______________ Cumm. Sampled: ______________

Water Level (cm): ______________ Water Visibility: ______________

Water Temp. (C): ______________ Weather: ______________

Time Period:	SOCKEYE Period Count	SOCKEYE Daily Cum.	CHINOOK Period Count	CHINOOK Daily Cum.	COHO Period Count	COHO Daily Cum.	PINK Period Count	PINK Daily Cum.	CHUM Period Count	CHUM Daily Cum.
Open:										
Closed:										
Open:										
Closed:										
Open:										
Closed:										
Open:										
Closed:										
Open:										
Closed:										
Daily Cumulative:										
Previous Day's Cum:										
Total Cumulative:										

Comments (holes in weir, other species, predation, debris, etc.):

Net Marked:

-continued-

PROCEDURE FOR FILLING OUT A DAILY COUNTING FORM (Appendix B):

- Begin a new counting form each day and record the date.
- A counting/sampling day begins at 0001 and ends at 2359. Record times in military format (e.g., 3:00 p.m. = 1500 hours).
- Copy the season total cumulative for each species over from the previous day's sheet and enter them into the appropriate columns for the "Previous Day's Cum" row at the bottom of the form.
- Record water level and temperature once a day at 0630 and note if the water visibility or level changes significantly throughout the day.
- Each count begins when the fish passing gate is opened. **Record the times when the gate was opened and closed** in the "Time Period" column.
- After each count, add the count from that time period in the corresponding "Closed" row and "Daily Cum" column for each species. If no fish were counted when the gate was opened, note times and indicate 0 fish for each corresponding species column.
- At the end of each day, the last daily cumulative number recorded for each species should be the same number recorded in the "Daily Cumulative" row at the bottom of the sheet. The "Daily Cumulative" is then added to the "Previous Days Cum" to equal the "Total Cumulative" count for the season up to that day.
- In the "comments section," record notes such as predation, holes in the weir, other species, etc.
- **Double-check all calculations before reporting numbers to the Haines ADF&G office staff at the 0900 daily check-in.**
- **Don't forget to count any sockeye salmon that were sampled to the corresponding period count total.**

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,
- 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 H). 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 F). If the preferred scales are missing, reabsorbed, or obviously deformed, try the preferred area on the right side of the fish or sample a different fish. **Do not sample scales outside of the preferred area.**

After plucking scales from the fish, **take time to clean the scales, 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 F).

-continued-

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

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

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, you will 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 (See Appendices F and H). A new scale card will be used for each sampling event, and the sampling goal of 10 fish per day will fill one scale card. The same ASL form will be used each day until it is full. Each sockeye salmon ASL form will have 4 scale cards associated with it if sampling is done for 4 days. 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 H)

Species:

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

-continued-

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., Chilkoot River weir).

Stat. Code:

Write the 3-digit district (115), then the 2-digit subdistrict (33), then the 3-digit stream number (020) (i.e., 115-33-020 for Chilkoot River).

Sampling date:

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

Gear:

Write out completely (e.g., 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 (ASL) 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 Section:

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

Write the description information in the header of the ASL sheet following the examples shown in Appendix G. For the Chilkoot River weir this will be **Sockeye/115-33-020/weir/Chilkoot River Escapement /Week 26**.

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
001	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Scale cards are numbered sequentially throughout the season starting with 001 or continuing where previously left off. A separate numbering sequence will be used for each species, gear, fishery, and harvest code so be sure 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						
10	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

District:

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

-continued-

Sub-District:

SUB-DISTRICT: 33	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Stream:

STREAM:	0	1	2	3	4	5	6	7	8	9
020	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Port: Leave Blank

Statistical Week:

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

STAT. WEEK 29	0	1	2	3	4	5	6	7	8	9
	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: 14	0	1	2	3	4	5	6	7	8	9
	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

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.

-continued-

Sex Column:

Fill in the appropriate M (male) or F (female) block 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 5 mm (Appendix D).** Mark (1) in the "T" column for fish > 999 mm in MEF length.

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

SOME REMINDERS

- It is extremely important to keep the optical scan forms flat, dry, and clean. Fish slime and water curling will cause the optical scanning reader machine to reject the entire optical scan form. If unnecessary pencil marks, dark spots, etc. are visible, they need to be erased or the machine will misinterpret the mark. It is essential to fill in all information and darken the blocks completely.
- Record length by blackening the appropriate column blocks on the optical scan form. Column 3 labeled "T" on the optical scan form is only used for fish over 999 millimeters long. Measure all salmon to the nearest 5 millimeters.
- 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.

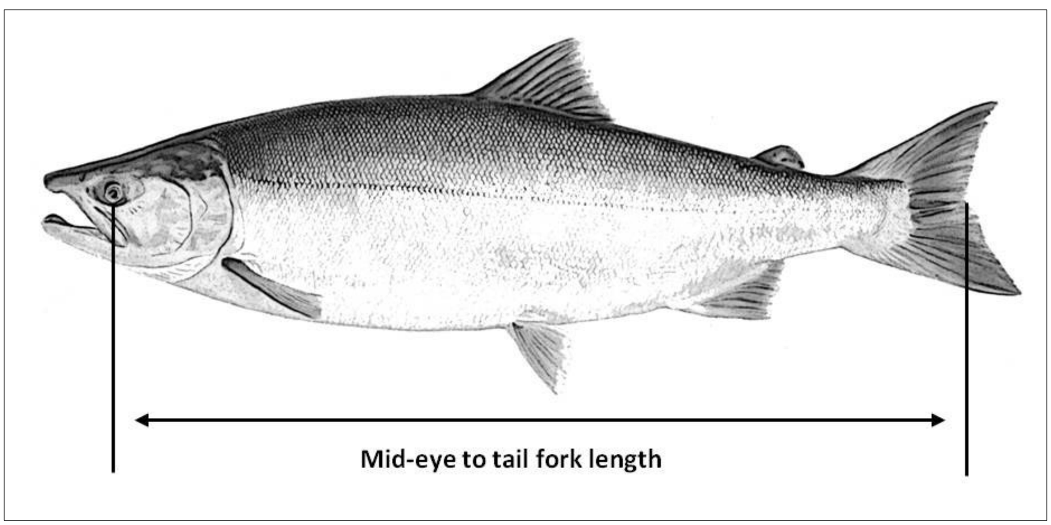
-continued-

- 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 Chilkoot River weir site, and the sampling is done solo. The procedure for measuring mid eye to tail fork length is as follows:

1. Because technicians on the Chilkoot Weir will be sampling alone, it is important to note that they are the wrestler (W), plucker (P), and recorder (R). 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. Handling the salmon will depend on whether you are right- or left-handed to ensure the dominant hand is free to utilize the tweezers. Place the salmon flat and right side down in the measuring trough with the caudle peduncle (tail) in your non-dominant hand. If you are right-handed, orient the salmon with its head on your right, the tail in your left hand, and the salmon's dorsal surface (back) towards you. If you are left-handed, orient the salmon with its head on your left, the tail in your right hand, and the salmon's dorsal surface (back) away from you. This puts the salmon in the correct orientation for the removal of the preferred scales from the fish's left side while handling the tweezers with your dominant hand.



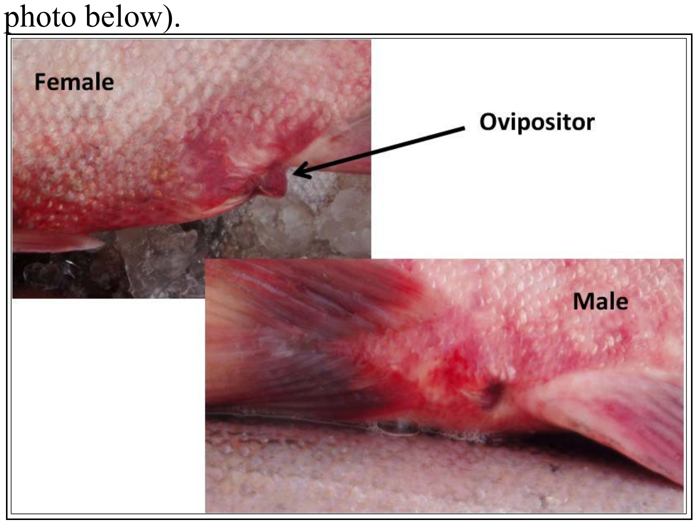
Appendix E.–Determining the sex of salmon.

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

1) Male sockeye 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 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).

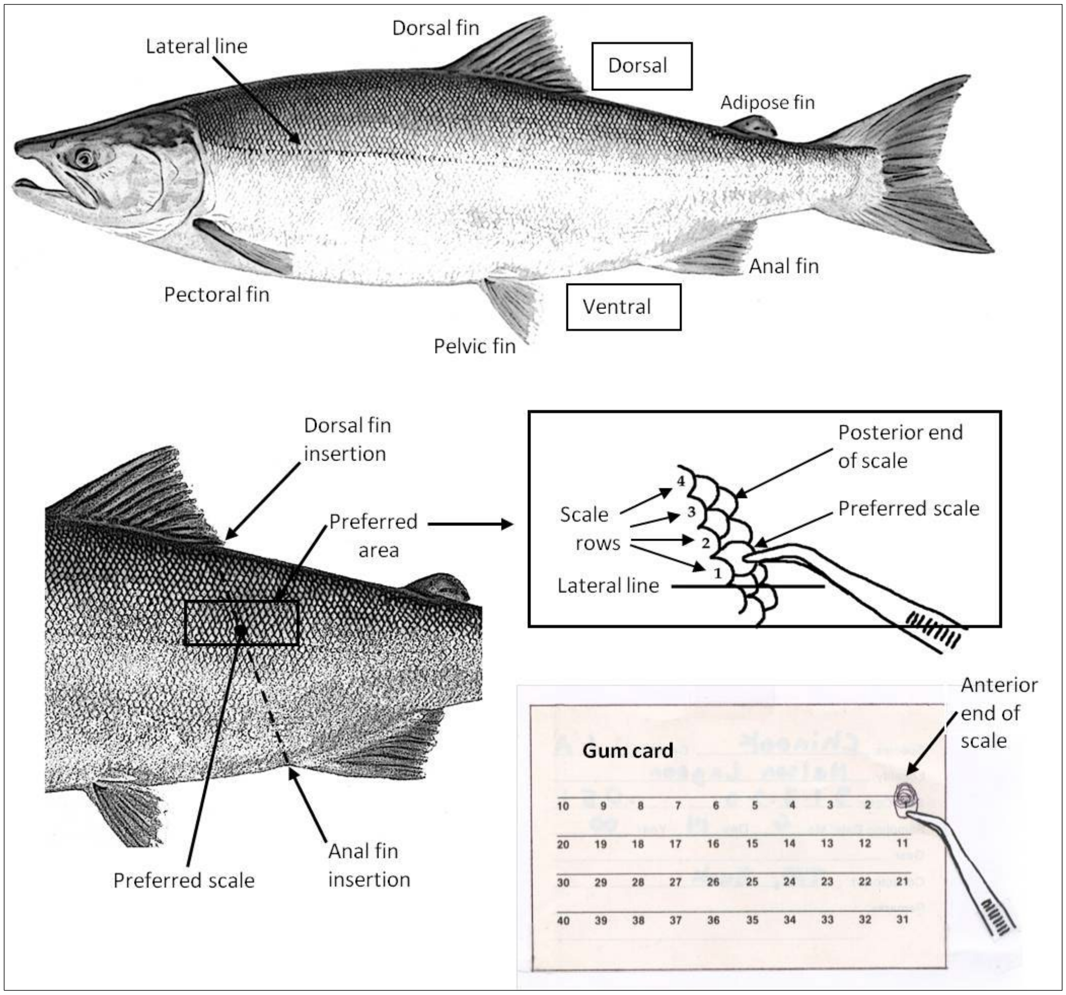
(© 2019 ADF&G.)

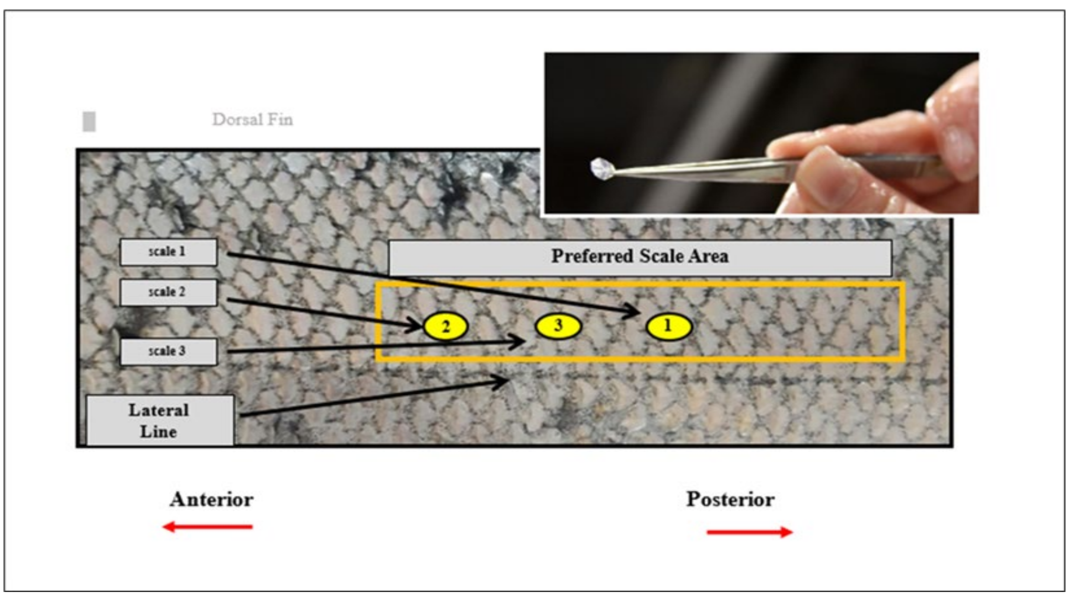
2) Examining the fish's vent is another helpful procedure to determine male or female salmon (shown in the photo below).



(© 2019 ADF&G.)

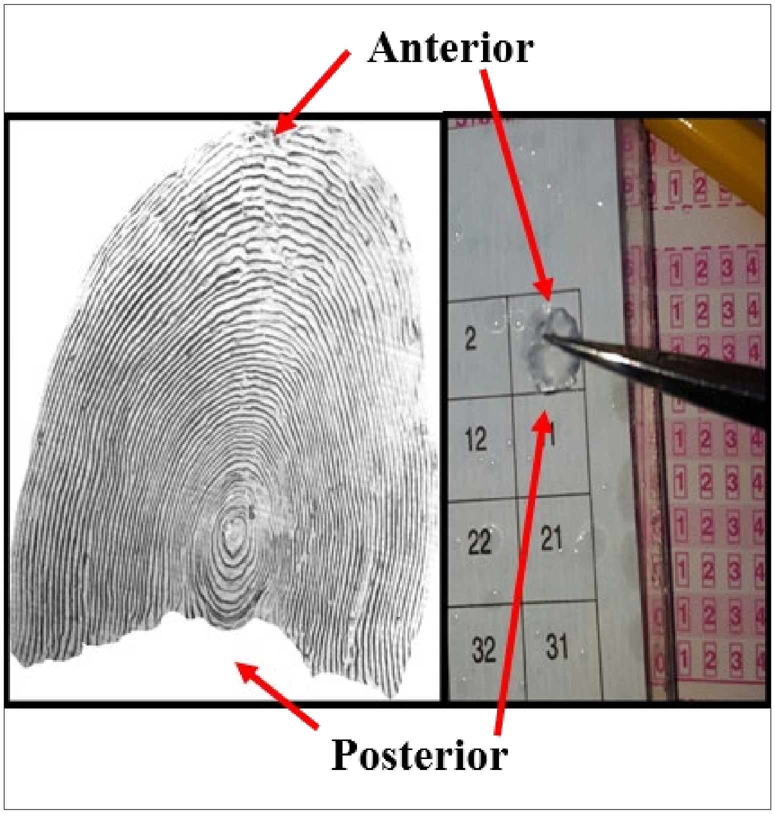
Appendix F.–Preferred scale sampling area on an adult salmon.

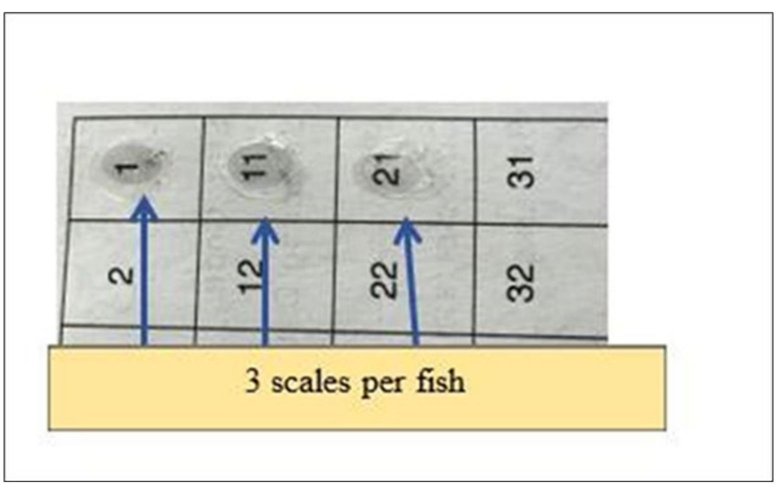




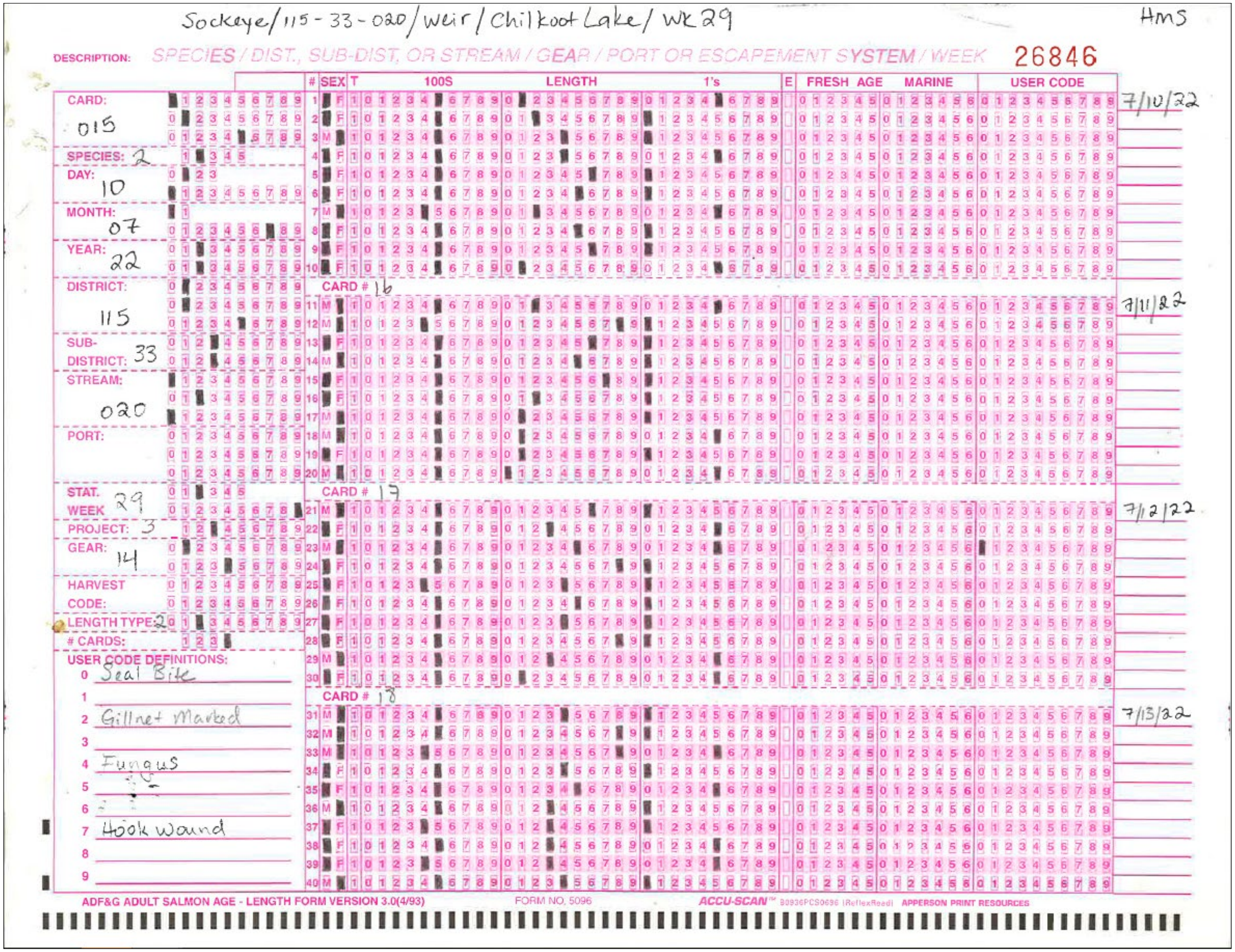
-continued-

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 THE HEAD) POINTING UP, POSTERIOR SIDE (TOWARD THE TAIL) POINTING DOWN, AND SCULPTURED SIDE FACING OUT.**

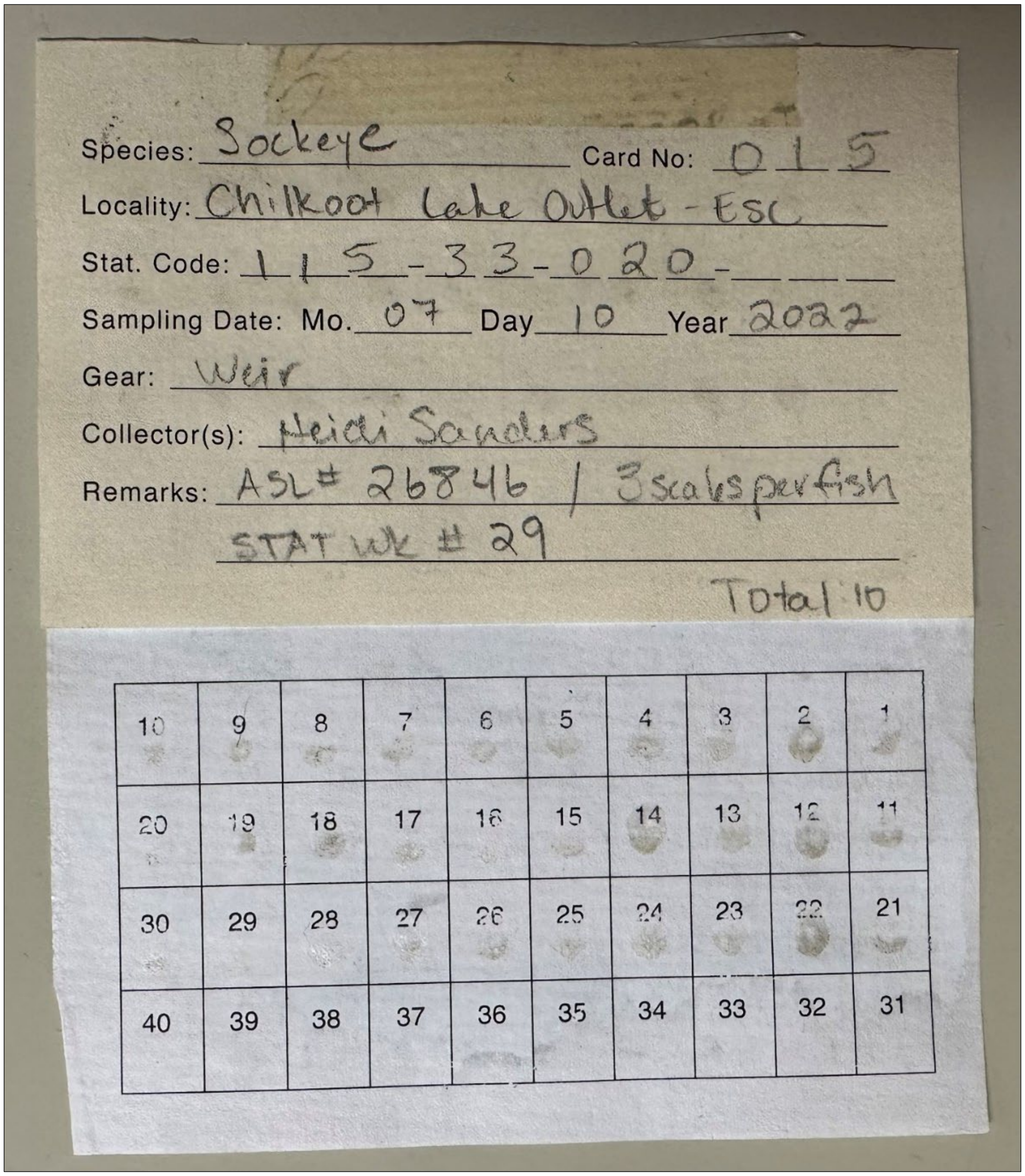




Appendix G.–Example of completed ADF&G adult salmon Age-Length-Sex (ASL) form.



Appendix H.–Example of completed scale cards that correspond to the completed ASL form in Appendix G.



Appendix I.–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.

Appendix J.–ADF&G collection code, location, reporting group, and the number of sockeye salmon used in the genetic baseline for mixed stock analysis in District 15 commercial drift gillnet fishery.

ADF&G collection code	Location	Reporting group	n
SCKAT07E	Chilkat Lake07 Early	Chilkat Lake	95
SCKAT07L	Chilkat Lake07 Late	Chilkat Lake	95
SCKAT13	Chilkat Lake13	Chilkat Lake	189
SBEARFL07	Bear Flats - Chilkat	Chilkat Mainstem	95
SMULE03.SMULE07	Mule Meadows - Chilkat	Chilkat Mainstem	190
SMOSQ07	Mosquito Lake - Chilkat	Chilkat Mainstem	95
SCHIK03	Chilkoot River	Chilkoot	159
SCHILBC07	Chilkoot Lake - Bear Creek	Chilkoot	233
SCHILB07	Chilkoot Lake - beaches	Chilkoot	251
SLACE13	Lace River	Juneau Mainland	63
SBERN03.SBERN13	Berners Bay	Juneau Mainland	165
SANTGILK13	Antler-Gilkey River	Juneau Mainland	53
SWIND03.SWIND07	Windfall Lake	Juneau Mainland	142
SSTEE03	Steep Creek	Juneau Mainland	91
SAUKE13baseline.SLAKECR14	Lake Creek (Auke Creek Weir)	Juneau Mainland	318
SKUTH06	Kuthai Lake	Taku River/Stikine Mainstem	171
SKSLK10.SKSLK11	King Salmon Lake	Taku River/Stikine Mainstem	214
SLTRA90.SLTRA06	Little Trapper Lake	Taku River/Stikine Mainstem	237
SLTAT11	Little Tatsamenie11	Taku River/Stikine Mainstem	59
STATS05.STATS06	Tatsamenie Lake	Taku River/Stikine Mainstem	288
SHACK08	Hackett River	Taku River/Stikine Mainstem	52
SNAHL03.SNAHL07. SNAHL12	Nahlin River	Taku River/Stikine Mainstem	179
STAKU07	Taku River	Taku River/Stikine Mainstem	95
STAKWA09	Taku Mainstem – Takwahoni/Sinwa	Taku River/Stikine Mainstem	67
SSUSTA08.SSHUST09	Shustahini Slough	Taku River/Stikine Mainstem	185
STUCH08.SCHUNK09.STUSK08.SBEARSL09. STUSKS08.STUSKS09	Tuskwa/Chunk Slough	Taku River/Stikine Mainstem	356
SYELLB08.SYELLB10. SYELLB11	Yellow Bluff Slough	Taku River/Stikine Mainstem	81
STULS07.STULS08. STULS09	Tulsequah River	Taku River/Stikine Mainstem	156
SFISHCR09.SFISHCR10	Fish Creek	Taku River/Stikine Mainstem	160
SYEHR07.SYEHR09	Yehring Creek	Taku River/Stikine Mainstem	171
SCHUT08	Chutine River	Taku River/Stikine Mainstem	94
SCHUTL09.SCHUT11	Chutine Lake	Taku River/Stikine Mainstem	224
SFOWL07.SFOWL08.SFOWL09.SANDY07. SANDY09	Andy Smith slough	Taku River/Stikine Mainstem	54
SPORCU07.SPORCU11	Porcupine	Taku River/Stikine Mainstem	74
SDEVIL07.SDEVIL08	Devil's Elbow0708	Taku River/Stikine Mainstem	148

-continued-

ADF&G collection code	Location	Reporting group	n
SDEVIL09	Devil's Elbow09	Taku River/Stikine Mainstem	53
SSCUD07.SSCUD08.SSCUD09	Scud River	Taku River/Stikine Mainstem	192
SISKU85.SISKU86.SISKU02.SISKU06. SISKU08.SISKU09	Iskut River	Taku River/Stikine Mainstem	153
SISKU07	Iskut River (Craigson Slough)	Taku River/Stikine Mainstem	42
SCRAIG06.SCRAIG07.SCRAIG08	Craig River-CAN	Taku River/Stikine Mainstem	38
SBRON08.SBRON09	Bronson Slough	Taku River/Stikine Mainstem	78
SSHAKS06.SSHAKES07.SSHAKS09	Shakes Slough	Taku River/Stikine Mainstem	67
SCHRI11.SCHRI12	Christina Lake	Taku River/Stikine Mainstem	70
SCRES03	Crescent Lake	Snettisham	194
SSPEE03	Speel Lake	Snettisham	95
SSNET06.SSPEE07	Snettisham Hatchery0607	Snettisham	190
SSPEE13	Snettisham Hatchery13	Snettisham	146
SVIVID93	Vivid Lake	Other	48
SSECLK14.SSECLKIN14	Seclusion Lake	Other	117
SNBERG91	North Berg Bay Inlet91	Other	53
SNBERG92	North Berg Bay Inlet92	Other	100
SBART13	Bartlett River	Other	69
SNEVA08	Neva Lake08	Other	94
SNEVA09.SNEVA13	Neva Lake0913	Other	255
SHOKTAI04	Hoktaheen - main inlet	Other	47
SHOKTAO04	Hoktaheen - outlet	Other	49
SHOKTAM14	Hoktaheen - marine waters	Other	47
SKLAG09	Klag Bay Stream	Other	200
SFORD04	Ford Arm Lake	Other	207
SFORD13	Ford Arm Creek	Other	199
SREDOUBT13	Redoubt Lake	Other	200
SSALML07.SSALML08	Salmon Lake	Other	185
SNECKER91.SNECKER93	Benzeman Lake	Other	95
SFALL03.SFALL10	Falls Lake	Other	190
SREDB93	Redfish Lake	Other	94
SKUTL03	Kutlaku03	Other	95
SKUTL12	Kutlaku12	Other	78
SKUTL13	Kutlaku13	Other	50
SPAVLOF12.SPAVLOFR13	Pavlof River	Other	174
SKOOK07.SKOOK10L.SKOOK12L	Kook Lake Late	Other	194
SKOOK12E.SKOOK13	Kook Lake early	Other	148

-continued-

ADF&G collection code	Location	Reporting group	n
SSITK03.SSITK11.SSITK12	Sitkoh Lake	Other	351
SLEVA12	Lake Eva	Other	115
SHASSEL12.SHASSELR13	Hasselborg Lake	Other	209
SKANA07.SKANA10.SKANAL13	Kanalku Lake	Other	319
SBAIN10	Bainbridge Lake	Other	95
SCOGH91.SCOG92HL.SCOG92ES.SCOGH10	Coghill Lake	Other	378
SESHAR08.SESHA91	Eshamy Creek	Other	185
SMAIN91	Main Bay	Other	96
SMINE91.SMINE09	Miners Lake	Other	191
SEYAM07	Eyak Lake - Middle Arm	Other	95
SEYASB07	Eyak Lake - South beaches	Other	87
SEYAK10	Eyak Lake - Hatchery Creek	Other	95
SMEND08.SMEND09	Mendeltna Creek	Other	188
SSWEDE08	Swede Lake	Other	95
SFISHC08	East Fork Gulkana River	Other	95
SGULK08EF	Gulkana River - East Fork	Other	75
SPAXSO09	Paxson Lake	Other	75
SMENT08	Mentasta Lake	Other	95
STANA05	Tanada Creek	Other	94
STANAO09	Tanada Lake - lower outlet	Other	95
STANAS09	Tanada Lake - shore	Other	93
SKLUT08	Klutina River	Other	95
SKLUTI08.SKLUTI09	Klutina Lake	Other	95
SBEARH08	Bear Hole - Klutina	Other	94
SBANA08	Banana Lake - Klutina	Other	80
SSANN05.SSTACR08	St. Anne Creek	Other	186
SMAHL08	Mahlo River	Other	94
STONSL09	Tonsina Lake	Other	94
SLONGLK05	Long Lake	Other	95
STEBA08	Tebay River	Other	93
SSTEAM08	Steamboat Lake - Bremner	Other	95
SSALMC08	Salmon Creek - Bremner	Other	93
SCLEAR07	Clear Creek	Other	87
SMCKI07	McKinley Lake07	Other	95
SMCKI08	McKinley Lake08	Other	95
SMCKI91	McKinley Lake91	Other	95
SMCKSC07	McKinley Lake - Salmon Creek	Other	93
SMART07.SMART08	Martin Lake	Other	187

-continued-

ADF&G collection code	Location	Reporting group	n
SMARTR08	Martin River Slough	Other	95
STOKUN08.STOKUN09	Tokun Lake	Other	189
SBERI91	Bering Lake	Other	95
SKUSH07.SKUSH08	Kushtaka Lake	Other	189
SSITU07	Mountain Stream	Other	159
SSITU13	Situk Lake	Other	190
SOSITU07	Old Situk River	Other	163
SLOST03B	Lost/Tahwah Rivers	Other	93
SAHRN07	Ahrnklin River	Other	90
SDANG09	Dangerous River	Other	95
SAKWE09	Akwe River	Other	95
SEAST03B	East Alsek River	Other	94
SDATLAS12	Datlasaka Creek	Other	95
SGOATC07.SGOATC12	Goat Creek	Other	56
SBORD07.SBORD08	Border Slough0708	Other	71
SBORD09.SBORD11	Border Slough0911	Other	70
STWEED07	Tweedsmuir07	Other	48
STWEED09	Tweedsmuir09	Other	46
SVERNR09.SVERNR10	Vern Ritchie	Other	114
SNESK07	Neskataheen Lake	Other	195
SKLUK06	Klukshu River06	Other	95
SKLUK07	Klukshu River07	Other	94
SKUDW09.SKUDW10.SKUDW11	Kudwat Creek	Other	100
SBRIDGE11.SBRIDGE12	Tatshenshini - Bridge/Silver	Other	105
SSTINKY11	Tatshenshini - Stinky Creek	Other	40
SUTATS03	Upper Tatshenshini	Other	95
SLTATS01.SLTATS03	Little Tatshenshini Lake	Other	65
SKWAT11	Kwatini River	Other	65
SBLAN07	Blanchard River07	Other	89
SBLAN09	Blanchard River09	Other	62
SLTAH90	Tahltan Lake90	Other	95
STAHL06	Tahltan Lake06	Other	196
SPETL04	Petersburg Lake	Other	95
SKAHS03	Kah Sheets Lake	Other	96
SMILLC07E	Mill Creek Weir Early	Other	94
SMILLC07L	Mill Creek Weir Late	Other	95
SKUNK03	Kunk Lake	Other	96
STHOM04.STHOM14	Thoms Lake	Other	93
SREDBL04	Red Bay Lake	Other	95

-continued-

ADF&G collection code	Location	Reporting group	n
SSALM04.SSALM07	Salmon Bay Lake	Other	170
SSHIP03	Shipley Lake	Other	94
SSARK00.SSARF05	Sarkar Lakes	Other	91
SHATC03.SHATC07	Hatchery Creek	Other	142
SLUCK04	Luck Lake	Other	94
SBIGLK10.SBIGLA14	Big Lake	Other	161
SMCDO01.SMCDO03.SMCDO07.SMCDO13	McDonald Lake	Other	369
SKART92.SMCGI03.SMCGI04.SMCGI16	Karta River	Other	472
SGENE07	Unuk River07	Other	95
SGENE08	Unuk River08	Other	69
SHELM05	Helm Lake	Other	94
SHECK04.SHECK07	Heckman Lake	Other	189
SMAHO03.SMAHO07	Mahoney Creek	Other	154
SKEGA04	Kegan Lake	Other	95
SFILLM05	Fillmore Lake	Other	52
STHRE04.STHRE10	Klawock - Three Mile	Other	181
SINCK03.SINCK08.SHALF08	Klawock - Inlet Creek	Other	212
SHETT03.SHETT08.SHETT09L	Hetta Lake	Other	281
SHETT09M	Hetta Creek - middle run	Other	95
SHETT10E	Hetta Creek - early run	Other	95
SEEK04.SEEK07	Eek Creek	Other	50
SKLAK04	Klakas Lake	Other	95
SBAR04	Essowah Lake	Other	95
SHSMI92.SHUGH13	Hugh Smith	Other	155
SHUGH04	HS - Buschmann	Other	151
SCOBB07	HS - Cobb Creek	Other	99
SKWIN01.SKWIN12U	Kwinageese	Other	76
SBOWS01	Bowser Lake	Other	94
SBONN01.SBONN12	Bonney Creek	Other	164
SDAMD01	Damdochax Creek	Other	93
SMERI01.SMEZIB06	Meziadin Lake	Other	186
SHANNA06	Hanna Creek	Other	93
STINT06	Tintina Creek	Other	94
SGING97	Gingit Creek	Other	94
SALAS87.SALAS06	Alastair Lake	Other	118
SLAKEL06	Lakelelse Lake	Other	93
SSUST01	Sustut River	Other	79
SSALIX87.SSALIX88	Salix Bear	Other	94

-continued-

ADF&G collection code	Location	Reporting group	n
SMOTA87	Motase Lake	Other	47
SSLAM06	Slamgeesh River	Other	95
SUBAB06	Babine River	Other	95
SFMILE06	Four Mile Creek	Other	85
SPINK94.SPINK06	Pinkut Creek	Other	187
SGRIZ87	Grizzly Creek	Other	76
SPIER06	Pierre Creek	Other	95
SFULT06	Fulton River	Other	95
SMORR07	Morrison	Other	92
SLTAH94	Lower Tahlo River	Other	78
STAHLO07	Tahlo Creek	Other	95
SMCDON02.SMCDON06	McDonell Lake (Zymoetz River)	Other	131
SKALUM06	Kitsumkalum Lake06	Other	56
SKALUM12	Kitsumkalum Lake12	Other	94
SKITW12	Kitwanga River	Other	92
SSTECR01	Stephens Creek	Other	95
SNANG06	Nangeese River	Other	40
SKISP02	Kispiox River	Other	53
SSWANLK06	Swan Lake	Other	93
SNANI88.SNANI07	Nanika River	Other	114
SKYNO97	Trembleur - Kynock	Other	94
STACH01	Tachie River	Other	94
SSTEL07	Stellako River	Other	94
SFRAS96	Fraser Lake	Other	85
SMITCH01	Mitchell River	Other	94
SLHOR01.SUHOR01.SHORSE07	Horsefly River	Other	274
SNAHAT02	Nahatlatch River	Other	92
SCULT02	Cultus Lake	Other	91
SCHILW04	Chilliwack Lake	Other	90
SCHILK01	Chilko Lake	Other	87
SRAFT01	Raft River	Other	84
SLADA02.SADAM07	Adams River	Other	187
SMSHU02	Middle Shuswap River	Other	91
SSCOT00	Scotch River	Other	91
SGATES09	Gates Creek	Other	90
SBIRK07	Birkenhead River	Other	90
SWEAV01	Weaver Creek	Other	89
SHARR07	Harrison River	Other	95
SNTHOM05	North Thompson	Other	95

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ADF&G collection code	Location	Reporting group	n
SNADE95	Naden River	Other	95
SYAKO93	QCI - Yakoun Lake	Other	70
SKITIM10	Kitimat River	Other	93
SBLOOM05	Bloomfield Lake	Other	94
STANK03	Tankeeah River03	Other	47
STANK05	Tankeeah River05	Other	47
SAMBA04	Central Coast - Amback Creek	Other	91
SKITL06	Kitlope Lake	Other	95
SGCENLK02	Great Central Lake	Other	95
SQUAT03	Vancouver Island - Quatse River	Other	95
SOKAN02	Okanagan River	Other	95
SLAKE97	Lake Pleasant	Other	89
SISSA96	Issaquah Creek	Other	82
SWENA98	Lake Wenatchee	Other	95

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 (Su and Yajima 2015) 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 (Chang et al. 2022) 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

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

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,

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

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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.