Fishery Data Series No. 22-18

Hugh Smith Lake Sockeye Salmon Stock Assessment, 2021

NOTE: Figure 12 was updated on 6/2/2023.

by

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and

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 22-18

HUGH SMITH LAKE SOCKEYE SALMON STOCK ASSESSMENT, 2021

by
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ABSTRACT

In 2021, long-term population studies designed to evaluate adult sockeye salmon (*Oncorhynchus nerka*) abundance and juvenile production at Hugh Smith Lake continued. The smolt weir count of 9,000 sockeye salmon smolt was the lowest count on record. An estimated 75.7% of smolt were freshwater age-1, and 24.3% were freshwater age-2. Escapement was counted through a weir, a mark–recapture study was conducted to confirm the weir count, and biological data were collected to estimate the age, length, and sex composition of adult sockeye salmon returning to Hugh Smith Lake. The 2021 weir count of 3,235 adult sockeye salmon was below the optimal escapement goal range of 8,000–18,000 and was the 7th lowest escapement in the 1980–2021 data series. Age-1.3 fish were the most abundant age class, representing an estimated 73.8% of the total spawning population. Foot surveys of Buschmann and Cobb Creeks were conducted weekly from 19 August through 31 October. Counts of live sockeye salmon in Buschmann Creek (not including mouth estimates) only exceeded 300 fish during 3 of 11 surveys and peaked at 510 live fish on 14 September. Counts of live sockeye salmon in Cobb Creek peaked at only 40 fish on 13 September; most other counts were of 10 or fewer fish. Reported subsistence harvest was 111 fish, which accounted for an estimated 3.3% of the terminal run. The estimated minimum harvest rate in the District 101–108 commercial net fisheries was 79.3% in 2021.

Keywords: commercial fishery, escapement, Hugh Smith Lake, mark–recapture, *Oncorhynchus nerka*, optimal escapement goal, sockeye salmon, stock of concern, Southeast Alaska, harvest rate

INTRODUCTION

Hugh Smith Lake, located southeast of Ketchikan, Alaska, in Boca de Quadra Inlet (Figure 1), has been an important sockeye salmon (*Oncorhynchus nerka*) contributor to southern Southeast Alaska commercial fisheries for over a century. Intense fisheries in the late 1800s and early 1900s supplied a saltery adjacent to the Hugh Smith Lake estuary and 2 canneries in Boca de Quadra Inlet (Rich and Ball 1933; Roppel 1982). A private hatchery was operated by various salmon packing companies at the head of the lake on Buschmann Creek from 1901 to 1903 and from 1908 to 1935, but numbers of adult sockeye salmon returning to the lake were not recorded (Roppel 1982). Egg-take records suggest 3,000–6,000 females were collected annually for broodstock from Buschmann Creek, one of the primary spawning tributaries (Roppel 1982). Moser (1898) concluded that despite overfishing, Hugh Smith Lake should produce annual runs of 50,000 sockeye salmon under average conditions.

The Alaska Department of Fish and Game (ADF&G) has monitored salmon escapements through a weir at the outlet of Hugh Smith Lake from 1967 to 1971 and annually since 1980. Although this report focuses on sockeye salmon, parallel information regarding coho salmon can be found in in Shaul et al. (2009), Shaul and Crabtree (2017), Priest et al. (2021), and annual funding reports to the Pacific Salmon Commission. Beginning in the early 1980s, the lake was the subject of ADF&G sockeye salmon enhancement and rehabilitation efforts that included nutrient enrichment from 1981 to 1984 and fry plants from 1986 to 1997 (Geiger et al. 2003). Most juveniles from these early stocking programs were not marked, so detailed information on the proportion of stocked fish in subsequent escapements is unavailable. Despite lake enrichment and enhancement efforts, sockeye salmon escapements steadily declined from an average of 17,500 fish in the 1980s to 12,000 fish in the 1990s. Escapements averaged only 3,500 fish from 1998 to 2002, including the smallest escapement on record in 1998 (1,138 fish).

In 2003, the Alaska Board of Fisheries designated the Hugh Smith Lake sockeye salmon run a stock of management concern (5 AAC 39.222) due to the long-term decline in escapement (Geiger et al. 2003). Based on escapement goal analyses outlined in Geiger et al. (2003), the Alaska Board of Fisheries set an optimal escapement goal of 8,000–18,000 sockeye salmon (5 AAC 33.390) to include spawning salmon of wild and hatchery origin. They also adopted an action plan that directed ADF&G to review stock assessment and rehabilitation efforts at the lake and implement conservation measures to reduce commercial harvests of Hugh Smith Lake sockeye salmon when projected escapements were below the lower bound of the escapement goal range. Fishery restrictions, in the form of time and area closures, were implemented in the commercial drift gillnet and purse seine fisheries closest to the entrance of Boca de Quadra (Figure 1). At that time, Southern Southeast Regional Aquaculture Association had initiated a 5-year stocking program intended to boost adult returns. Eggs were collected from Buschmann Creek and reared and thermal marked at Burnett Inlet Hatchery. Each spring, from 1999 through 2003, thermal marked fry were fed in net pens at the outlet of Hugh Smith Lake, then released into the lake as presmolt in late July.

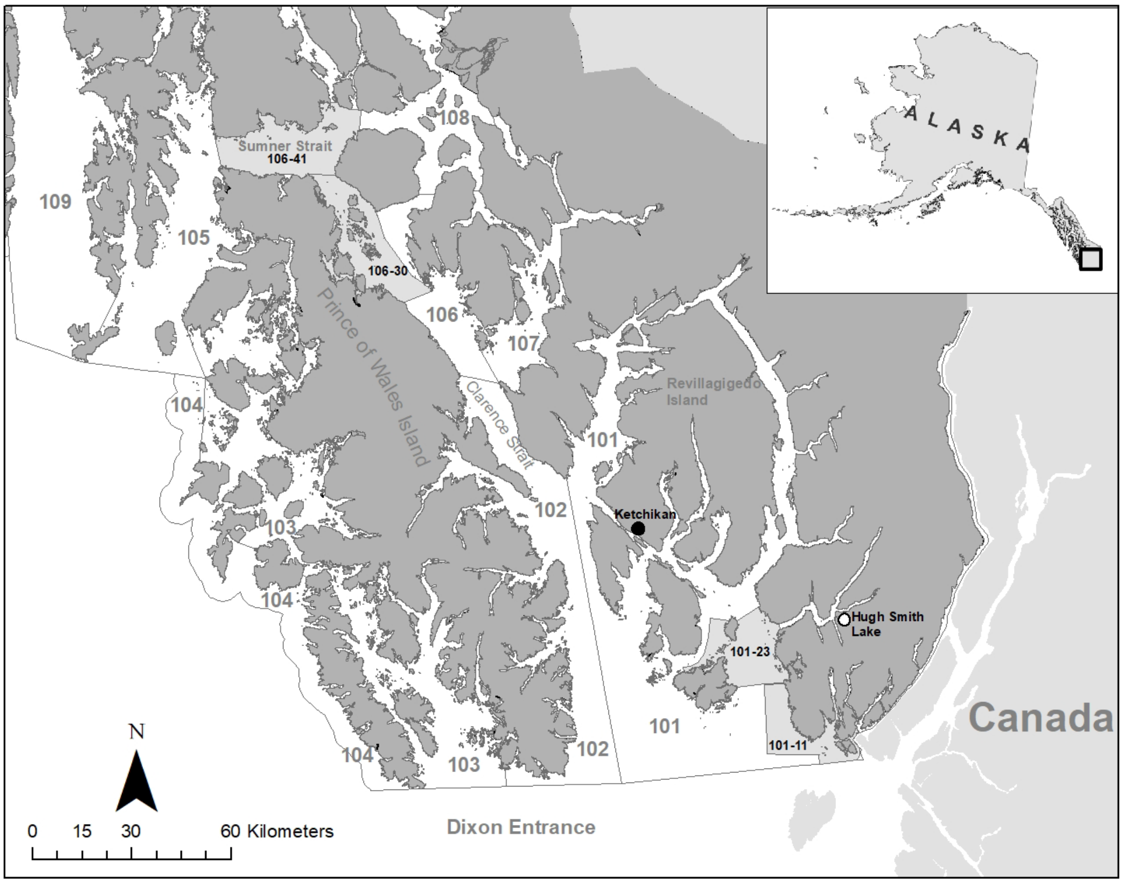

Figure 1.–Location of Hugh Smith Lake in Southeast Alaska. Fishing Districts are labeled in gray and subdistricts specifically mentioned in the text are labeled in black.

ADF&G estimated the contribution, distribution, and run timing of stocked Hugh Smith Lake sockeye salmon from recoveries of marked fish in the District 101 commercial net fisheries from 2003 to 2007. Results from this project showed that fisheries management restrictions outlined in the action plan were appropriately timed and located to reduce harvests on this stock (Heinl et al. 2007). ADF&G also conducted studies to identify factors in the freshwater environment that might limit juvenile sockeye salmon survival; however, none of the factors evaluated indicated increased mortality of juvenile sockeye salmon (Piston et al. 2006 and 2007; Piston 2008). Escapements steadily improved from a low of 1,138 fish in 1998 to a high of 42,529 fish in 2006 (Piston et al. 2007). The stock of concern status was removed in 2006 due to improved escapements (Geiger et al. 2005). However, fish returning from the Southern Southeast Regional Aquaculture Association stocking program made up a significant portion (58–65%) of the 2003–2007 escapements (Heinl et al. 2007; Piston 2008). Sockeye salmon escapements continued to surpass the lower bound of the escapement goal in 9 of the 12 years between 2006 and 2017 but fell short from 2018 to 2020 (Fish and Piston 2022).

Population studies at Hugh Smith Lake provide the longest time series of escapement and age, sex, and length (ASL) information for both sockeye and coho (*O. kisutch*; 1982–2021; Shaul et al. 2009) salmon in southern Southeast Alaska. Thus, these important indicator stocks provide information useful for managing southern Southeast Alaska commercial fisheries. In 2021, ADF&G continued operation of a smolt weir in the spring (operated annually since 1982) to estimate sockeye salmon smolt abundance, and an adult weir from summer through early fall (operated annually since 1980) to enumerate the salmon escapement and determine if the escapement goal was met. In addition, a mark–recapture study was conducted to provide a secondary estimate of escapement should the adult weir fail. Length-at-age data were collected from a subset of outmigrating smolt and returning adults, and foot surveys were conducted on both inlet streams (Buschmann Creek and Cobb Creek) to count spawning salmon. Results from genetic stock identification (GSI) analysis were used to estimate the harvest of Hugh Smith Lake sockeye salmon in southern Southeast Alaska commercial drift gillnet and purse seine fisheries. These estimates were combined with the reported subsistence harvest and annual escapement counts to estimate total run size and annual harvest rates.

STUDY SITE

Hugh Smith Lake is located on mainland Southeast Alaska, 67 km southeast of Ketchikan, in Misty Fjords National Monument (Figure 1). The lake is organically stained and covers a surface area of 320 ha. It has a mean depth of 70 m, a maximum depth of 121 m, and a volume of 222.7×10^6 m^3 (Figure 2). Hugh Smith Lake is meromictic; an upper layer of freshwater sits on and does not exchange with a layer of saltwater located below a depth of 60 m. The lake empties into Boca de Quadra Inlet by way of Sockeye Creek (50 m long, ADF&G Anadromous Waters Catalog[1] number 101-30-10750). Sockeye salmon spawn in the 2 inlet streams: Buschmann Creek flows northwest 4 km to the head of the lake (ADF&G Anadromous Waters Catalog number 101-30-10750-2006, “Beaver Pond Channel” 101-30-10750-2006-3003; Giefer and Blossom 2021); and Cobb Creek flows north 8 km to the southeast head of the lake (ADF&G Anadromous Waters Catalog number 101-30-10750-2004; Giefer and Blossom 2021; Figure 2). Accessible spawning habitat in Cobb Creek is limited by a barrier to anadromous migration approximately 0.8 km upstream from the lake. Beach spawning by sockeye salmon has not been documented in Hugh Smith Lake; the steep-sided rocky shore along the lake perimeter limits potential spawning areas primarily to the 2 inlet streams.

[1] https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=main.home (accessed July 2021).

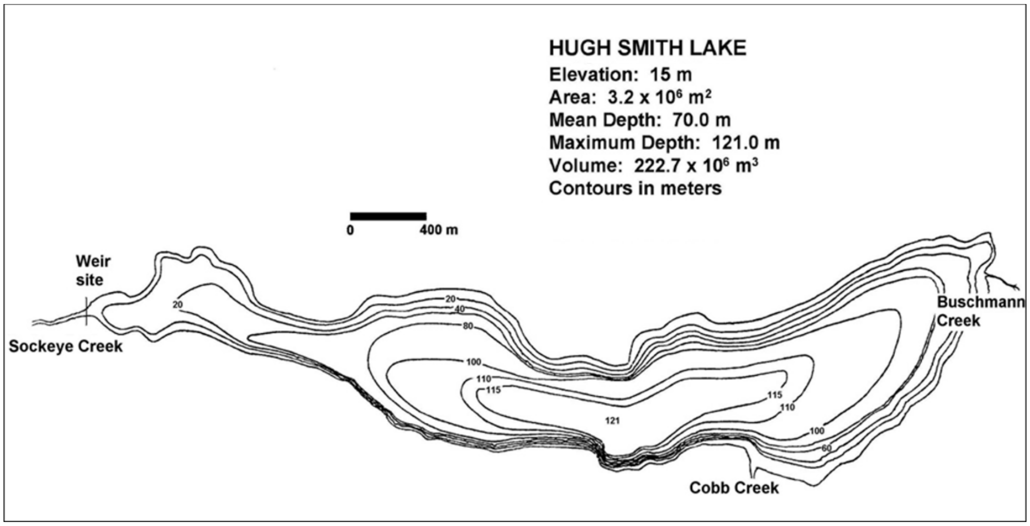

Figure 2.–Bathymetric map of Hugh Smith Lake showing the weir location above the outlet stream, the 2 primary inlet streams, and other features of the lake system.

OBJECTIVES

1. Estimate the abundance, age composition, and size-at-age of sockeye salmon smolt leaving Hugh Smith Lake.
2. Enumerate the adult salmon escapement through the Hugh Smith Lake weir by species.
3. Provide a mark–recapture estimate of the total spawning population of adult sockeye salmon (fish ≥400 mm from mid eye to tail fork [METF]) in Hugh Smith Lake with an estimated CV no greater than 15% of the estimate.
4. Estimate the age, length, and sex composition of adult sockeye salmon into Hugh Smith Lake such that the estimated proportions are within 5% of the true value with at least 95% probability.
5. Estimate the contribution of Hugh Smith Lake sockeye salmon to the commercial purse seine and drift gillnet fisheries such that the estimates are within 10% of the true value with at least 90% probability.

METHODS

SMOLT OUTMIGRATION

Hugh Smith Lake coho and sockeye salmon smolt have been counted and sampled annually since 1982 at a smolt weir (Shaul et al. 2009 provided a physical description of the weir). In 2021 the smolt weir was operated from 23 April to 8 June. Fish were sorted and counted through the weir by species. Scale samples, length, and weight data were collected daily from sockeye salmon smolt, with a seasonal goal of 600 total samples (Table 1). Snout-to-fork length (mm) and total body weight (to the nearest 0.1 g) were recorded, and approximately 10 scales were collected from the preferred area of each fish sampled following protocols described by Clutter and Whitesel (1956). Scale samples were placed on a 2.5 × 7.5 cm glass microscope slide, 4 fish per slide, and aged at the Douglas ADF&G office using a video-linked microscope.

Annual smolt weir counts have underestimated the total smolt population because fish leave the lake before and after the weir is installed, and fish are able to pass through the weir uncounted through holes or during extreme floods (Shaul et al. 2009). An unknown but presumably small number of smolt also passed through a conical opening 1.5 m below the surface designed to provide adult steelhead (*O. mykiss*) free upstream passage through the weir. The capture rate of sockeye salmon smolt is assumed to be similar to coho salmon smolt trapped at the same time. Tagging data from 1982 to 1996 showed that the capture rate of Hugh Smith Lake coho salmon at the smolt weir was highly variable, ranging from 10% to 56%, but improvements made to the weir in the mid-1990s increased the capture efficiency and consistency to 58–75% from 1997 to 2006 (Shaul et al. 2009). From 1997 to present, smolt capture efficiency averaged 61% (Justin Priest, ADF&G Biologist III, Southeast Alaska Coho Salmon Project Leader, personal communication).

Table 1.–Daily sockeye salmon sample goals for length, weight, and scale sample collection.

Date range	Number of samples (*n*)
24 April–6 May	4
7–27 May	24
28 May–7 June	4
Total	600

ADULT ESCAPEMENT

ADF&G operated an adult salmon counting weir at the outlet of the lake, approximately 50 m from saltwater, from 1967 to 1971 and annually since 1980. The weir is an aluminum bi-pod, channel-and-picket design with an upstream trap for counting and sampling salmon. In 2021, the weir was operated from 18 June to 8 November. Regular underwater inspections were conducted to verify the integrity of the weir.

A guillotine gate on the upstream side of the weir trap allowed the crew to visually identify fish to species and count them as they swam unimpeded into the lake. Alternatively, when a fish of interest was identified, it could be netted out of the trap for sampling. Fish passage through the gate was recorded using an underwater video camera and those recordings were reviewed daily to verify the visual weir count. Using this method allowed efficient passage of 90% of all salmon into the lake without introducing handling stress, while also meeting the 100% mark rate of the ongoing coho salmon study. Sampled fish were anesthetized, marked (see Mark–Recapture section), and released upstream in front of the weir. During periods of low water, 6 mm plastic sheeting was applied to the upstream face of the weir to direct the stream flow through the trap and encourage fish to move upstream, thereby reducing fish holding time behind the weir (Piston and Brunette 2010).

Mark–Recapture

Two-sample mark–recapture studies have been conducted annually since 1992 as an essential component of the project to estimate the sockeye salmon escapement at Hugh Smith Lake. Mark–recapture population estimates are used to validate the weir count and may be used instead of the weir count if substantial numbers of fish entered the lake before the weir was installed (in mid-June) or if fish passed the weir uncounted during extreme flood events. In 2021, sockeye salmon (fish ≥400 mm METF length) counted through the weir were marked at a rate of 10%. Visibly healthy fish were anesthetized in a clove oil solution (Woolsey et al. 2004) and marking was stratified on the following schedule:

- right pelvic fin clip from 16 June to 17 July,
- left pelvic fin clip from 18 July to 14 August, and
- partial dorsal fin clip from 15 August to 20 September.

A mark–recapture study was not conducted for jack sockeye salmon (ocean-age-1 fish, identified inseason as fish <400 mm METF length) because most can swim freely between the weir pickets and relatively few are trapped. When attempted in previous years, numbers of jack sockeye salmon marked and recovered were insufficient to obtain a valid population estimate (Piston et al. 2007; Piston 2008).

Weekly surveys were conducted at Buschmann and Cobb Creeks beginning 10 September to examine spawning salmon for marks. Live fish were captured using a beach seine off the mouth of Buschmann Creek and using dip nets in the spawning channels of Buschmann and Cobb Creeks. All carcasses encountered during the weekly surveys were also examined for marks. Each fish examined was recorded as either unmarked, or by the mark type (right or left pelvic, or partial dorsal fin clip), and given a secondary mark (a small hole punch through the left operculum plate) to prevent resampling. Our goal was to examine at least 600 sockeye salmon over the entire spawning season to yield a population estimate with a coefficient of variation less than 15%, assuming a population of approximately 10,000 fish (recent 10-year average wild sockeye salmon escapement is 10,900 fish) is marked at a 10% rate (Robson and Regier 1964).

We used Stratified Population Analysis System (SPAS) software (Arnason et al. 1996) to generate mark–recapture estimates of the total spawning population of sockeye salmon ≥400 mm METF length. Based on work by Chapman and Junge (1956), Darroch (1961), Seber (1982), and Plante (1990), SPAS was designed to analyze two-sample mark–recapture data where marks and recoveries occur over multiple strata. This software was used to calculate: 1) maximum likelihood (ML) Darroch estimates and pooled-Petersen (Chapman's modified) estimates, and their standard errors; 2) χ^2 tests for goodness-of-fit based on the deviation of predicted values (fitted by the ML Darroch estimate) from the observed values; and 3) two χ^2 tests of the validity of using fully pooled data—a test of complete mixing of marked fish between release and recovery strata, and a test of equal proportions of marked fish in the recovery strata. Recovery data were stratified by period, based on the transition of each mark type in recovery samples. If the result of either the χ^2 test of complete mixing or the χ^2 test of equal proportions was not significant ($P > 0.05$), we typically chose to pool data (i.e., the pooled-Petersen estimate). The manipulation of release and recovery strata in calculating estimates (i.e., the method used in SPAS) was presented and discussed at length by Schwarz and Taylor (1998). If the ML Darroch estimates failed to converge, data were pooled until an estimate was obtained.

The weir count was reported as the official escapement estimate if it fell within the transform-based 95% confidence interval (Sprott 1981; Arnason et al. 1991) of the mark–recapture estimate. If the weir count was outside this confidence interval, we would assume the weir count was flawed due to fish passing the weir uncounted, either before or after installation, and the mark–recapture point estimate would then be used as the official escapement estimate. This was the same criterion used in previous years (Geiger et al. 2003). The escapement goal was judged to have been met if the weir count fell within the transform-based 95% confidence interval of the mark–recapture estimate and within the escapement goal range (8,000–18,000 sockeye salmon with METF length ≥400 mm), or if the weir count was outside the transform-based 95% confidence interval of the mark–recapture estimate but the mark–recapture point estimate was within the escapement goal bounds.

Adult Age, Sex, and Length Composition

Based on work by Thompson (1992), scale samples from 510 fish were needed to ensure the estimated proportion of each adult sockeye salmon age class would be within 5% of the true value with at least 95% probability. We increased the sample goal to 600 fish to account for unreadable scales (~15%). In 2021, we systematically collected scale samples from 20% of adult sockeye salmon that passed the weir. Length (METF) and sex data were recorded for each fish sampled. Fish shorter than 400 mm METF length were counted as jacks (ocean-age-1 fish) and were not included in the sockeye salmon age composition sample. Three scales were collected from the preferred area of each sampled fish (INPFC 1963), placed on a gum card, and prepared for analysis as described by Clutter and Whitesel (1956). Scales were analyzed at the ADF&G salmon-aging laboratory in Douglas, Alaska. The weekly age distribution, seasonal age distribution weighted by week, and the mean length by age and sex weighted by week were calculated using equations from Cochran (1977; Appendix A).

STREAM COUNTS

Live and dead salmon were counted, by species, during weekly foot surveys of Buschmann and Cobb Creeks beginning in mid-August. Buschmann Creek was typically surveyed to the top of the Hatchery Channel on the right fork, and to the Beaver Pond channel on the left fork. Cobb Creek was surveyed from the mouth to the barrier falls (0.8 km; 55°05.35′N, 130°38.673′W; Figure 3). Effort was focused on areas with the highest abundance of spawning fish and stream flow.

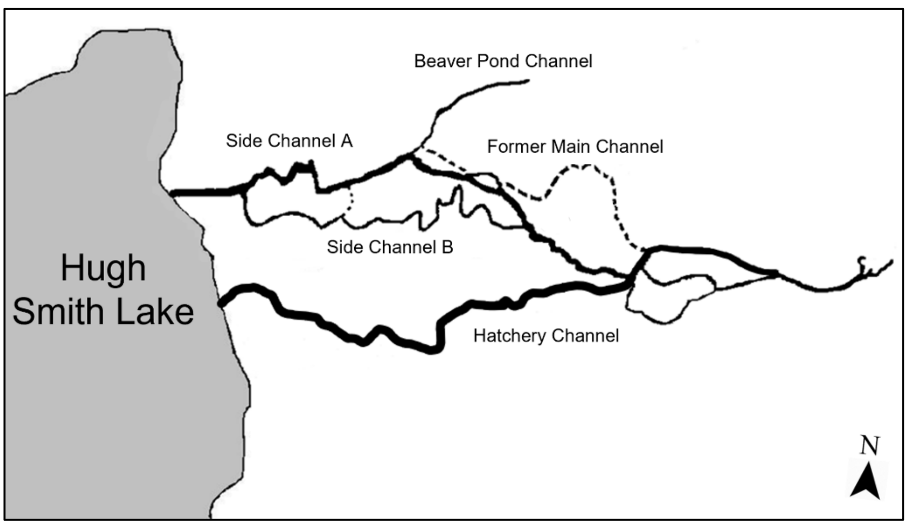

Figure 3.–Schematic diagram of the main flow of lower Buschmann Creek, as of September 2021. Dashed lines represent channels that did not have adequate water flow to accommodate spawning salmon. The Buchmann Creek floodplain contains 2 separate creeks, draining 2 separate valleys, that meet in their lower reaches. The stream flowing from the southeast valley is Buschmann Creek and the stream flowing out of the northeast valley is the Beaver Pond channel.

HARVEST

Commercial Fisheries

The commercial harvest of Hugh Smith Lake sockeye salmon was estimated through GSI methods. Laboratory analysis and quality control was performed by the ADF&G Gene Conservation Laboratory (GCL) in Anchorage, Alaska, following methods outlined in Dann et al. (2012), or by the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service, Alaska Fishery Science Center, Auke Bay Laboratory, Ted Stevens Marine Research Institute using methods outlined in Guthrie et al. (2022). Stock composition estimates for the District 101–103 purse seine fisheries and District 106 and 108 drift gillnet fisheries were computed by the GCL, and estimates for the District 104 purse seine and District 101 drift gillnet fisheries were computed by the NOAA Auke Bay Laboratory. Analyses were conducted using a genetic baseline consisting of 241 populations (Rogers Olive et al. 2018, with minor additions to the Yakutat region), which are representative of the major producing stocks in the study area. A Bayesian mixed stock analysis (MSA) approach, using the R package *rubias*[2] (Moran and Anderson 2019), was used to obtain stock composition estimates for the District 101–104 fisheries. Stock composition estimates for the District 106 and 108 drift gillnet fisheries were computed using a method that incorporates age and hatchery thermal mark information from matched scale and otolith samples to help inform the genetic estimates. This method (Mark- and Age-enhanced Genetic Mixture Analysis) requires 2 sets of parameters: (1) a vector of stock compositions, summing to one, with a proportion for each of the wild and hatchery stocks weighted by harvest per stratum; and (2) a matrix of age composition, with a row for each of the wild and hatchery stocks (summing to one) and a column for each age class. This method utilizes all available information to assign individuals to stock of origin based on age, genotype, and otolith information.

Tissue samples were collected at the major fish processing ports in Southeast Alaska by the ADF&G Port Sampling Program to facilitate management of commercial fisheries and fulfill obligations under the Pacific Salmon Treaty (Buettner et al. 2017). Sample sizes were primarily designed to determine the harvest contribution by country of origin in the boundary area fisheries—specifically, the estimated contribution of Alaska sockeye salmon and British Columbia Nass and Skeena River sockeye salmon. Sockeye salmon bound for Hugh Smith Lake can be accurately identified using MSA (Rogers Olive et al. 2018), as determined by reporting group testing following the methods described in Barclay et al. (2019). To maintain precision and accuracy for single population reporting groups, it has been ADF&G's guideline to report estimates when the expected proportion of fish in a mixture is 5% or more (Kyle Shedd, ADF&G, Fisheries Geneticist, personal communication), and when mixture sample sizes are sufficient that stock composition estimates are within 10% of the estimate, 90% of the time (i.e., $n \geq 100$ samples; Thompson 1987). However, the estimated proportions of Hugh Smith Lake sockeye salmon in weekly harvests were less than 5% in almost all fisheries from 2014 to 2020 making it impossible to follow this guideline and still estimate harvests using GSI. In cases where weekly proportions are less than 5%, weekly strata can be pooled and weighted by the total season harvest to generate estimates following Jasper et al. (2012a, 2012b). This was done to estimate contribution of Hugh Smith Lake sockeye salmon to purse seine fisheries in Districts 102 and 103 and drift gillnet fisheries in Districts 106 and 108. The analysis of District 104 purse seine samples was conducted by NOAA with the primary goal of estimating harvest contributions by country of origin for treaty purposes. As a result, it was not possible for us to pool the weekly stock composition estimates for the District 104 purse seine fishery; estimates were instead provided for each weekly stratum. We report point estimates as well as standard deviations and 90% credible intervals. Harvest estimates for all fisheries over a year were calculated by multiplying the estimated proportion by the

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

respective harvest for each stratum, then summing across all strata. Standard deviations across all strata in a year were computed by calculating the sum of squares to estimate variance then taking the square root of this value. The standard deviation was multiplied by 1.645 to calculate 90% confidence intervals over all fisheries. Commercial harvest rates were calculated by dividing the estimated commercial harvest by the sum of commercial harvest, subsistence harvest, and escapement.

Sockeye salmon harvested in southern Southeast Alaska traditional net fisheries (Districts 101–108) were sampled from statistical weeks 25 through 35 (approximately mid-June to late August; Table 2; Appendix B). On average, this period covered 99% of the total sockeye salmon harvest in southern Southeast Alaska. Established ADF&G Port Sampling Program procedures ensured that weekly samples were as representative of a specific district harvest as possible (Reynolds-Manney et al. 2020). Only harvests originating from a single fishing district and gear type were sampled. No more than 40 tissue samples were collected from each individual boat's harvest, and no more than 200 tissue samples were collected from each tender (Buettner et al. 2017). When individual seine boats caught fewer than 40 total sockeye salmon, tissues were collected from every sockeye salmon on board. When possible, samples were systematically collected from the entire hold as it was offloaded to ensure they were representative of the entire delivery. Additionally, samples were collected from multiple deliveries from each fishing district over the entire statistical week as much as possible. Total weekly harvest was obtained from the ADF&G fish ticket database.

Table 2.–Weekly sockeye salmon tissue sampling goals for southern Southeast Alaska commercial net fisheries, 2021.

Fishery	District	Weekly sample objectives	Statistical weeks	Annual sample objective
Purse seine	101	260	29–35	1,820
	102	260	26–35	2,600
	103	390	28–35	3,120
	104	260	28–35	2,080
Drift gillnet	101	260	26–35	2,600
	106-30	300	25–35	3,300
	106-41	300	25–35	3,300
	108-30 and 108-40	520	25–35	5,720
	108-50 and 108-60	520	25–35	5,720
Grand total		3,070		30,260

Subsistence Fishery

Hugh Smith Lake sockeye salmon are harvested in the Hugh Smith Lake/Sockeye Creek subsistence fishery. The subsistence fishery occurs "in Boca de Quadra, in the waters of Sockeye Creek, and within 500 yards of the terminus of Sockeye Creek, and in Hugh Smith Lake" (5 AAC 01.716(a)(1)(B)(ii)). Because Sockeye Creek is only 50 m long and regulations prohibit fishing within 300 feet (approximately 90 m) of the weir (5 AAC 01.010(e)), the fishery takes place predominantly in saltwater. The fishery was open from 22 June to 31 July and the daily possession limit was 12 sockeye salmon per person with no annual limit. Fishery participants were required to obtain an ADF&G-issued Subsistence and Personal Use Fishing permit prior to fishing, and to return their permit with a detailed daily harvest record by 15 November even if they did not fish. Reported subsistence harvest and effort has been based entirely on the cooperation of fishery participants. However, reported subsistence harvests here and elsewhere in Southeast Alaska probably underrepresent the true harvest (Conitz and Cartwright 2005; Conitz 2008; Walker 2009; Fall et al. 2020) because not all permits are returned, and those that are returned may underreport the actual number of fish harvested. Subsistence fishery harvest rates were calculated by dividing the reported subsistence harvest by the total terminal run (sum of subsistence harvest and escapement).

RESULTS

SMOLT OUTMIGRATION

An estimated 9,000 sockeye salmon smolt were counted through the smolt weir between 23 April and 8 June (Figure 4; Appendix C). This was the fewest sockeye salmon smolt counted in the 40-year record (1982–2021). The peak daily live count occurred on 17 May (890 fish) and declined thereafter, with only 2 days when more than 500 fish were counted before the weir was removed. The observed 51 cm of rainfall was within the historical norms of spring smolt trapping seasons, but 2 separate week-long heavy precipitation events (dropping 20 cm and 25 cm of rain) caused substantial flooding. The smolt weir was overtopped to some degree for 12 of the 47 days of operation, probably spilling many uncounted sockeye salmon smolt in these events.

We collected 588 scale samples from sockeye salmon smolt and determined the freshwater age composition of 584 fish. The age composition, weighted by week, was estimated to be 75.7% age-1 and 24.3% age-2 smolt (Appendix C). Mean lengths by age class were 79.1 mm for age-1 and 111.4 mm for age-2 smolt, and mean weights by age class were 4.5 g for age-1 and 13.0 g for age-2 smolt (Table 3).

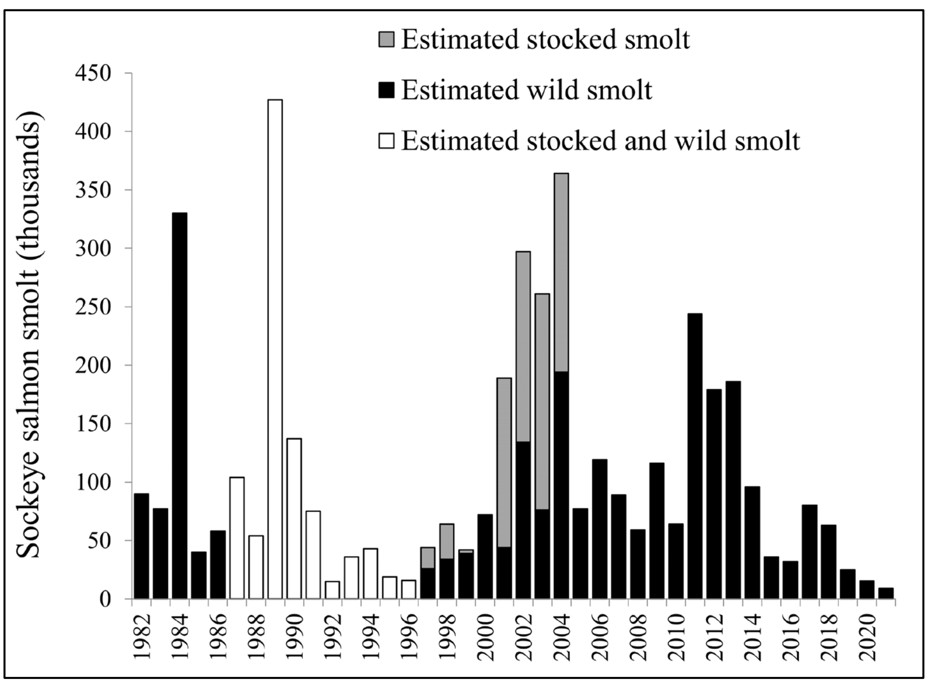

Figure 4.–Annual sockeye salmon smolt weir counts at Hugh Smith Lake, 1981–2021. Divided bars show estimates of wild (black) and stocked (grey) smolt for years when proportions of hatchery stocked smolt were estimated from otolith samples collected at the weir (1997–1999 and 2001–2004). Stocked fish released prior to 1996 (smolt year 1997) were unmarked.

Table 3.–Lengths and weights of sockeye salmon smolt by freshwater age, weighted by week, at Hugh Smith Lake, 2021.

	Smolt freshwater age		
	Age-1	Age-2	Age-3
n	437	146	1
Mean length (mm)	79.1	111.4	206.0
Standard error (mm)	8.1	19.0	–
Maximum length (mm)	114.0	161.0	–
Minimum length (mm)	57.0	75.0	–
Mean weight (g)	4.5	13.0	77.0
Standard error (g)	1.5	6.4	–
Maximum weight (g)	11.9	36.9	–
Minimum weight (g)	1.4	3.8	–

ADULT ESCAPEMENT

Weir and Stream Counts

The adult weir was operated from 18 June to 8 November. A total of 3,235 adult sockeye salmon and 18 jacks were counted between 20 June and 29 September (Appendix D). This was the sixth lowest count on record and the fourth consecutive year the escapement was well below the optimal escapement goal range of 8,000–18,000 sockeye salmon (Figure 5). Run timing was very close to the 10-year average percentile dates. The 25th percentile of the run was reached 20 July, 4 days before the recent 10-year (2011–2020) average; the midpoint of the run occurred 30 July (coinciding with the recent 10-year average), and the 75th percentile of the run occurred 14 August, 2 days after the recent 10-year average.

Foot survey counts were conducted weekly at Buschmann and Cobb Creeks from 19 August through 31 October. Live sockeye salmon counts at Buschmann Creek increased to the peak count of 510 on 14 September and remained over 400 fish through 26 September (Figure 6). Counts decreased to 200 or less until the last survey at the end of October when only 20 live fish were counted. Counts at Cobb Creek were lower, and the peak live count (excluding mouth estimates) was only 40 sockeye salmon on 13 September. Sockeye salmon were only observed on the 3 subsequent surveys, and counts diminished rapidly to zeros.

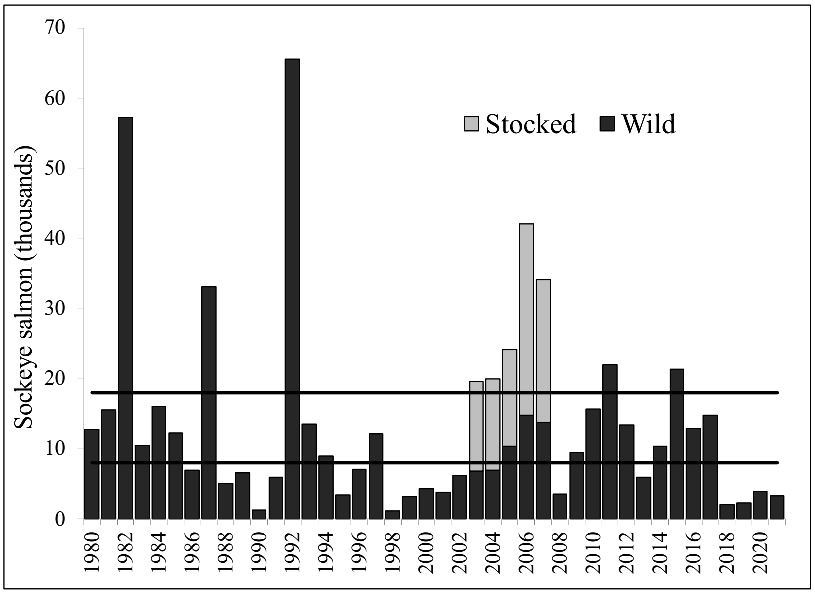

Figure 5.–Annual sockeye salmon escapement at Hugh Smith Lake, 1980–2021. From 2003 to 2007, the bars are divided to show our estimate of wild (black) and stocked fish (gray) in the escapement. Fry stocked from 1986 to 1997 were thought to have experienced very low survival rates with few surviving to emigrate from the lake (Geiger et al. 2003). Contribution estimates of wild and stocked fish are not available for years prior to 2003. Black horizontal lines indicate the current optimal escapement goal range of 8,000–18,000 sockeye salmon, which includes both wild and hatchery stocked fish.

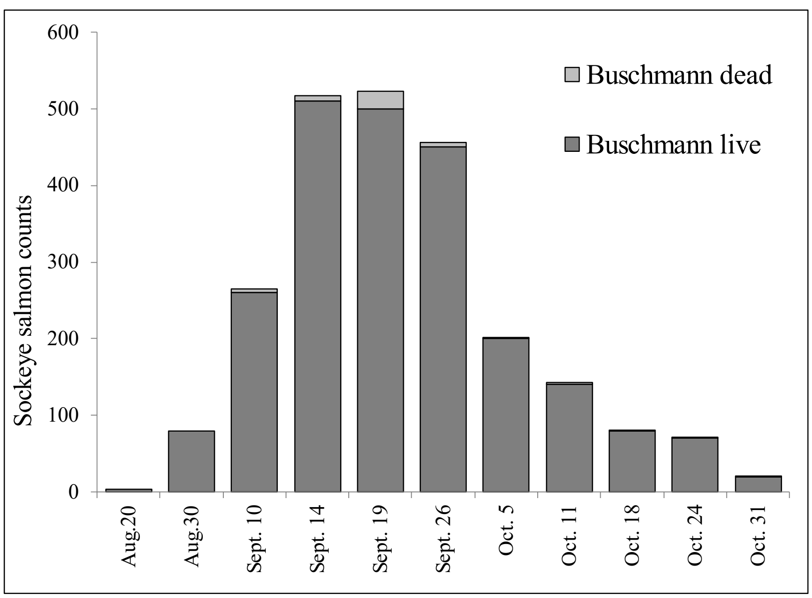

Figure 6.–Sockeye salmon foot survey counts at Buschmann Creek, 2021.

Mark–Recapture

A total of 323 adult sockeye salmon were marked at the weir over 3 marking strata: 43 fish were marked with a right pelvic fin clip (20 June–17 July), 204 fish were marked with a left pelvic fin clip (18 July–14 August), and 76 fish were marked with a partial dorsal fin clip

(15 August–20 September). Recapture sampling was conducted on the spawning grounds from 10 September to 31 October. Out of 476 fish inspected for marks, 47 fish had been marked with a fin clip (Table 4). The result of the χ^2 test for complete mixing of marked fish between the marking and recapture events was significant (P = 0.00); however, the result of the χ^2 test for equal proportions of marked fish on the spawning grounds was not significant (P = 0.76), indicating that a pooled-Petersen estimate is appropriate in this case. The pooled-Petersen mark–recapture estimate was 3,219 sockeye salmon (SE = 403; 95% transform-based CI = 2,543–4,157 fish; Appendix E). The weir count of 3,235 sockeye salmon fell within the 95% transform-based confidence interval of the pooled-Peterson estimate and therefore was used as the official escapement estimate.

Table 4.–Daily number of adult sockeye salmon inspected for the mark–recapture study, 2021.

Sampling (recapture) location	Sampling (recapture) date	Marked fish: Right pelvic fin	Marked fish: Left pelvic fin	Marked fish: Dorsal fin	Unmarked fish	Total fish examined
Buschmann	10-Sep	0	2	1	18	21
	14-Sep	1	2	0	28	31
	19-Sep	1	5	3	89	98
	21-Sep	0	0	0	1	1
	23-Sep	1	6	0	64	71
	26-Sep	0	0	0	8	8
	28-Sep	0	3	3	61	67
	2-Oct	0	0	0	1	1
	3-Oct	0	0	0	1	1
	5-Oct	1	3	4	51	59
	10-Oct	1	0	5	44	50
	11-Oct	0	0	0	7	7
	17-Oct	0	1	1	32	34
	18-Oct	0	0	0	1	1
	21-Oct	0	0	0	3	3
	24-Oct	0	0	0	1	1
	26-Oct	0	0	3	12	15
	31-Oct	0	0	0	2	2
Cobb	13-Sep	0	0	0	1	1
	26-Sep	0	0	0	2	2
	6-Oct	0	0	0	2	2
Total		5	22	20	429	476

Adult Age, Sex, and Length Composition

Based on scale pattern analysis, the escapement consisted primarily of ocean-age-3 fish (87.4%; 2,828 sockeye salmon) and secondarily of ocean-age-2 fish (12.4%; 402 sockeye salmon; Figures 7 and 8; Appendix F). One ocean-age-4 fish was observed and that age class contributed less than 0.5% of the run. The most abundant age classes were age-1.3 fish (73.8%) followed by age-2.3 fish (13.6%) and age-1.2 fish (10.0%; Appendices F and G). Age-1.3 fish (both sexes) were the smallest and age-2.3 fish (both sexes) were the second smallest in the 40-year record (1982–2021; Figure 9). Age-1.3 males were on average 552 mm (95% CI ± 3.9 mm) and age-1.3 females were 536 mm (95% CI ± 2.2 mm). Age-2.3 males were 556 mm (95% CI ± 7.5 mm) and age-2.3 females were 544 mm (95% CI ± 6.2 mm; Table 5). The average size of ocean-age-2 fish was within the historical range for both sexes but at or below the third quartile of observations from 1982 to 2021 (Figure 9; Table 5).

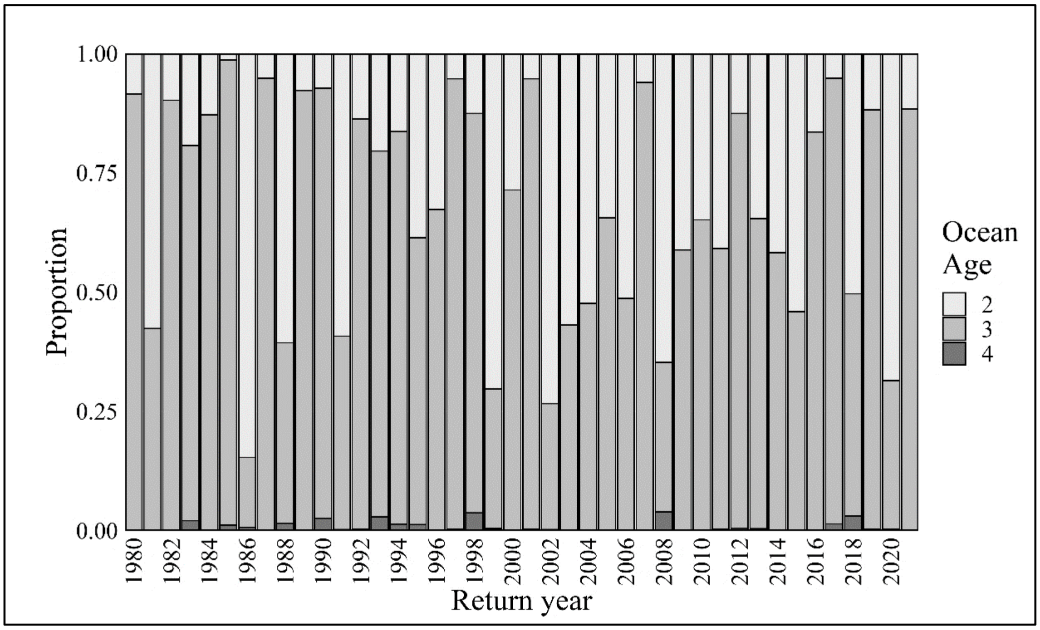

Figure 7.–Annual proportion of ocean-age-2, ocean-age-3, and ocean-age-4 sockeye salmon in the Hugh Smith Lake escapement, 1980–2021.

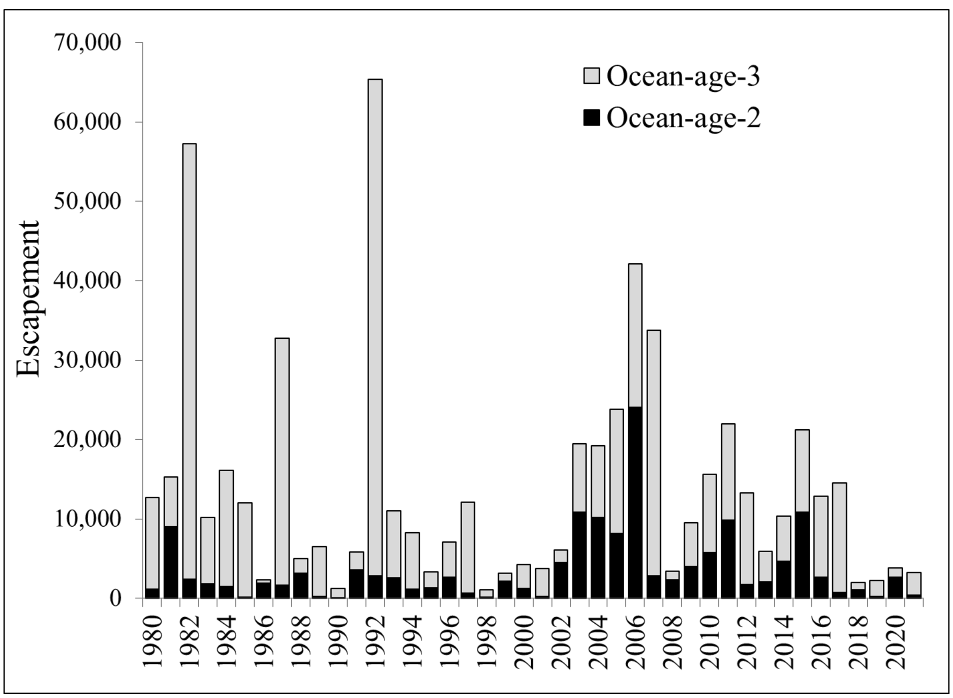

Figure 8.–Annual number of ocean-age-2 and ocean-age-3 sockeye salmon in the Hugh Smith Lake escapement, 1980–2021. Ocean-age-2 and ocean-age-3 sockeye salmon represented nearly all (99.2%) of the Hugh Smith Lake escapements during this period.

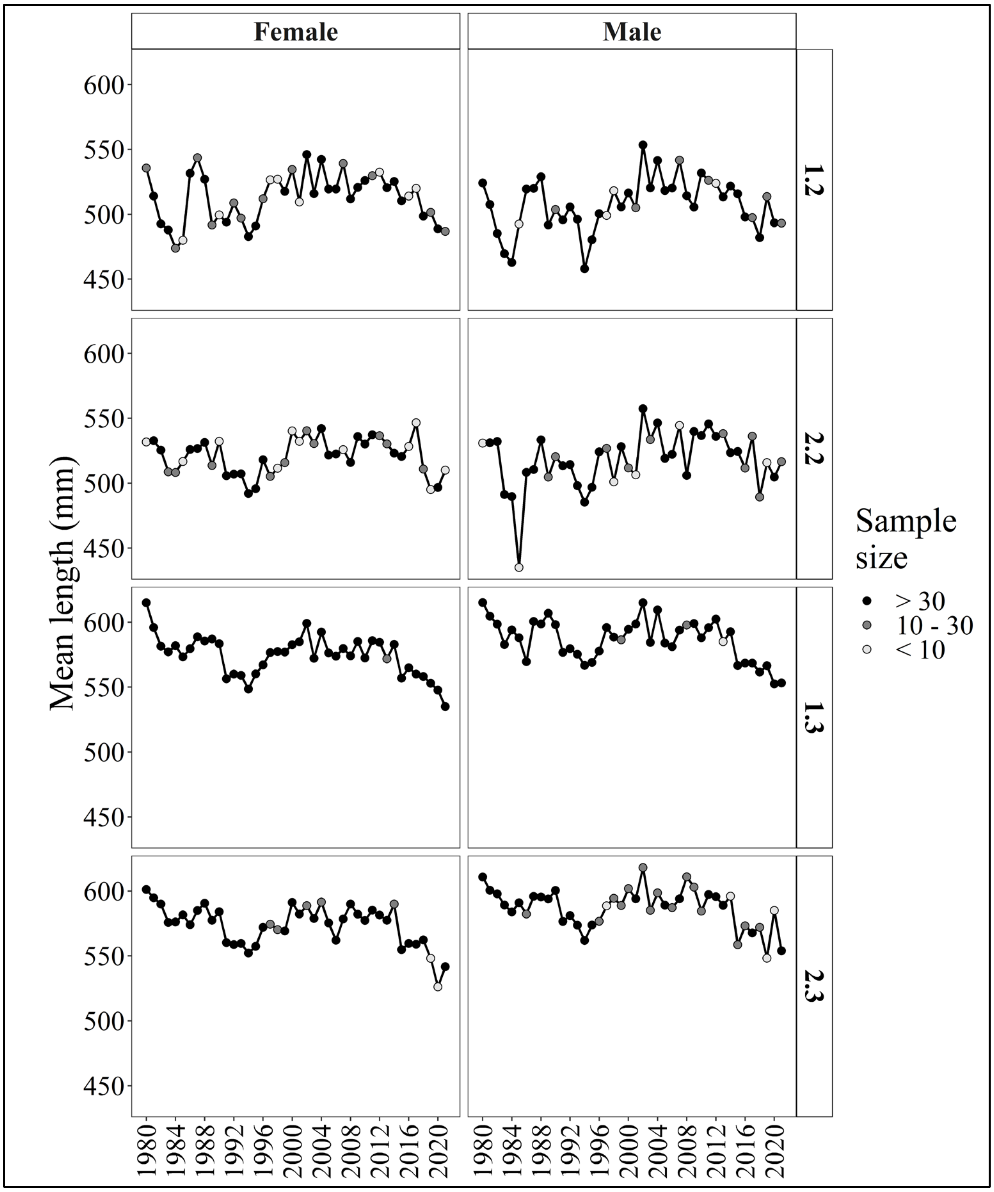

Figure 9.–Mean lengths of age-1.2, age-2.2, age-1.3, and age-2.3 female and male sockeye salmon, 1980–2021. Mean lengths calculated from more than 30 fish are displayed in black, 10 to 30 fish in dark gray, and less than 10 fish in light gray.

Table 5.–Lengths (mean, maximum, minimum, standard error, 95% credible interval), sex, and sample size, by age, of sockeye salmon at Hugh Smith Lake, 2021.

Sex	Female				Male				
Age	1.2	2.2	1.3	2.3	1.2	2.2	1.3	2.3	2.4
n	24	4	261	50	34	11	172	30	1
Mean length (mm)	487	509	536	544	499	521	552	556	550
Maximum length (mm)	530	535	595	590	560	575	635	610	–
Minimum length (mm)	455	480	475	510	425	480	480	525	–
Standard error (mm)	4.0	13.9	1.1	3.1	4.7	9.1	2.0	3.7	–
95% credible interval (+/- mm)	8.3	44.2	2.2	6.2	9.5	20.4	3.9	7.5	–

HARVEST

Subsistence Fishery

The reported subsistence harvest was 111 sockeye salmon from a total 12 permit-days of participation (Figure 10). Based on the estimated terminal run of 3,346 sockeye salmon (sum of subsistence harvest and escapement), the estimated terminal harvest rate was 3.3% (Appendix H).

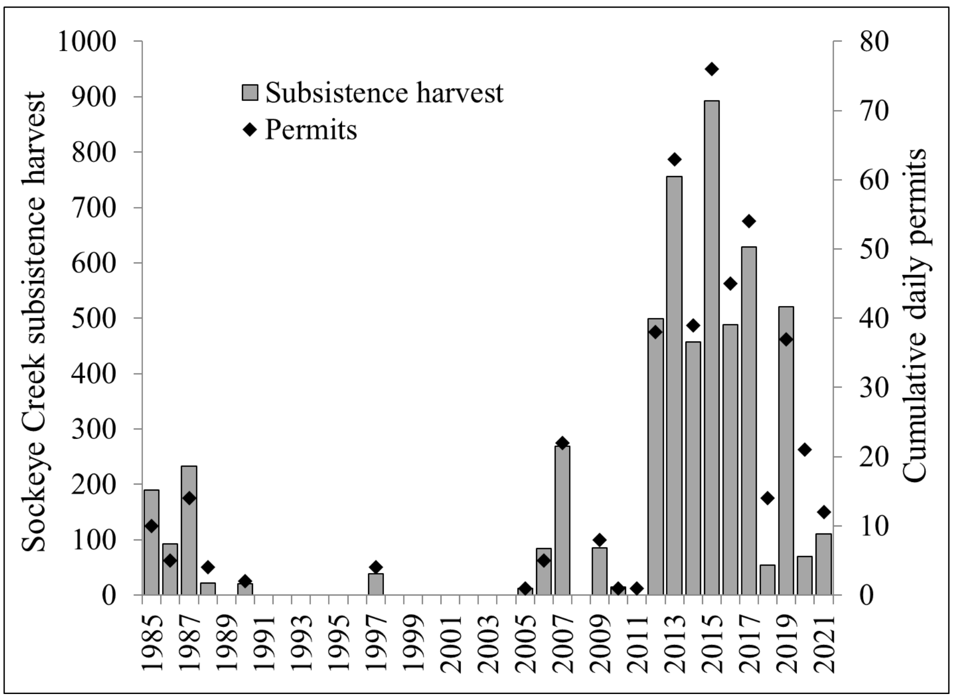

Figure 10.–Reported sockeye salmon subsistence harvests and permit days at Sockeye Creek, in the Hugh Smith Lake estuary, 1985–2021. Years with no known harvest (no permits issued) appear as blanks.

Commercial Fisheries

We used GSI based proportions to estimate approximately 12,809 Hugh Smith Lake sockeye salmon (90% CI = 7,805–17,814; Appendix I) were harvested in the traditional southern Southeast Alaska commercial net fisheries in 2021. We estimated a total commercial harvest rate of 79.3% (90% CI = 70.0–84.2%). The majority of commercially caught Hugh Smith Lake sockeye salmon were harvested in the District 104 purse seine fishery (9,676 fish; 75.5% of all commercially caught Hugh Smith Lake sockeye salmon), the District 101 purse seine fishery (1,210 fish; 9.4%)

and the District 102 purse seine fishery (1,053 fish; 8.2%; Appendix J). The drift gillnet fishery in District 101-11 harvested an estimated 574 Hugh Smith Lake sockeye salmon or just 4.5% of the total, and harvests in all other districts were 2.0% or less of the total.

The timing of peak proportions and estimated number of Hugh Smith Lake sockeye salmon caught varied across fisheries. In the District 104 purse seine fishery, the largest estimated harvest of Hugh Smith Lake sockeye salmon (4,006 fish; 3.4%) occurred in statistical week 31. The highest proportion of Hugh Smith Lake sockeye salmon (3,654 fish; 5.6%,) occurred later in statistical week 35 (Figure 11), when the total sockeye salmon harvest was 65,857 fish (Appendix J). In other weeks, the proportions of Hugh Smith Lake sockeye salmon in the District 104 purse seine fishery harvests were 2.0% or less. In the District 101 purse seine fishery, the estimated proportion of Hugh Smith Lake sockeye salmon peaked at only 3.4% in pooled statistical weeks 28–31 (an estimated 1,186 Hugh Smith Lake sockeye salmon) and proportions were very small in all other periods (0.1% in pooled statistical weeks 32–34 and 0.0% in weeks 35–36). In the District 102 purse seine fishery, the estimated proportion of Hugh Smith Lake sockeye salmon peaked at 4.2% in pooled statistical weeks 32–34 (1,053 Hugh Smith Lake fish) and was less than 0.1% in all other reporting groups (pooled statistical weeks 26–28, 29–31, and 35–36).

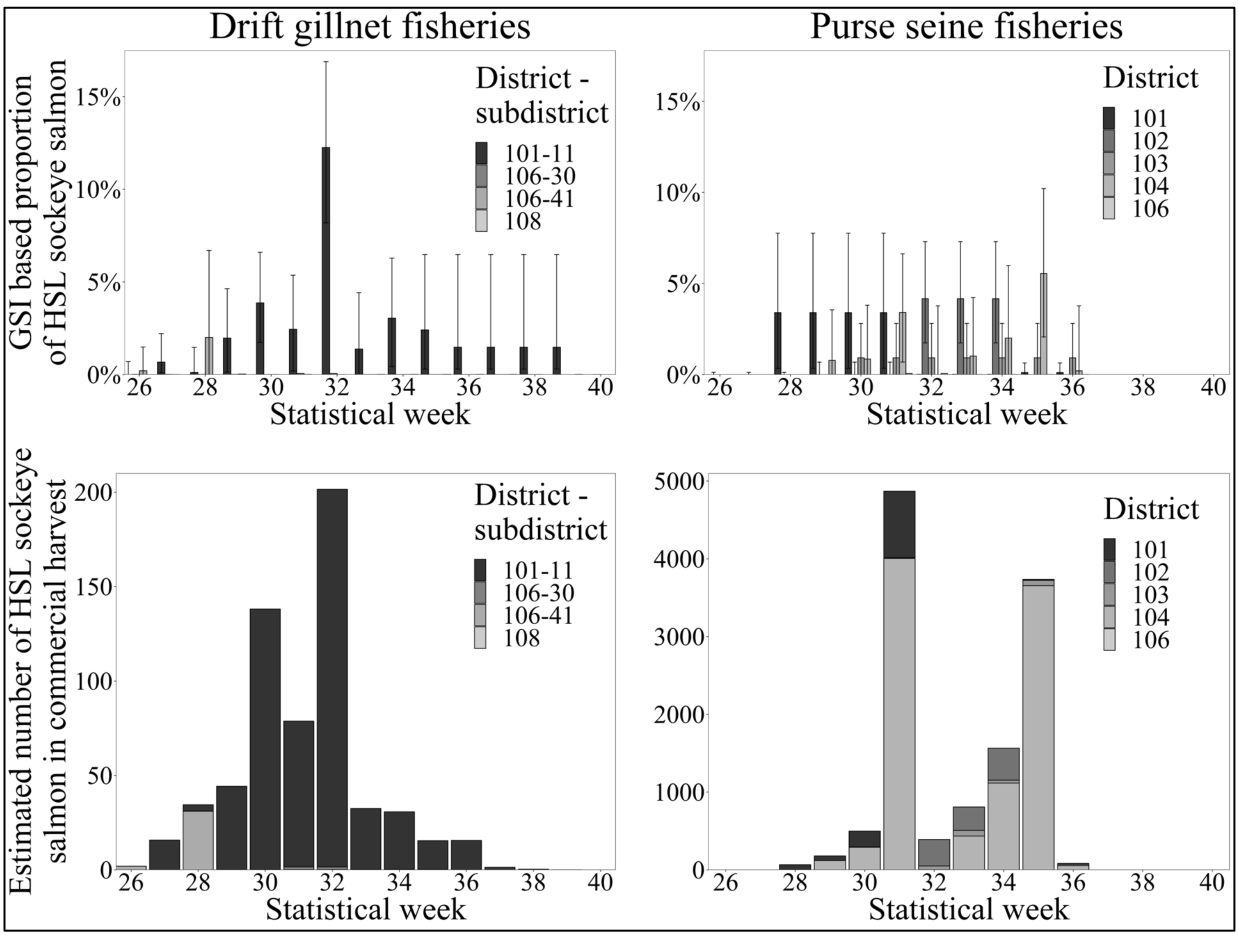

Figure 11.–Genetic stock identification (GSI) based proportions and stacked estimates of Hugh Smith Lake (HSL) sockeye salmon caught in southern Southeast Alaska drift gillnet (left) and purse seine (right) fisheries by statistical week, 2021. District 101, 102, 103 purse seine and 101-11 and 106-30 drift gillnet proportions are pooled across some weeks; see Appendix J for details.

TOTAL RUN

The estimated total run of Hugh Smith Lake sockeye salmon (16,155 fish) is within the observed range (67.1% of average) since GSI results became available in 2014 although the estimated cumulative common property commercial fishery harvest rate (79.3%) is the highest in the 8 years of GSI sampling (Figure 12; Appendix I).

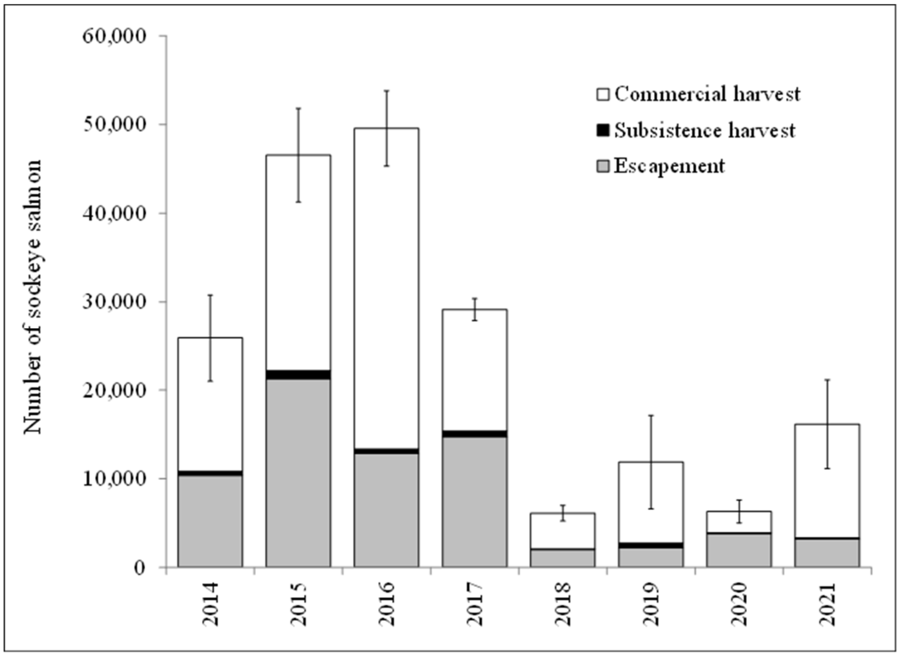

Figure 12.–Estimated total annual run of Hugh Smith Lake sockeye salmon, 2014–2021. Vertical lines represent the 90% CI for commercial harvest estimates.

DISCUSSION

The 2021 estimated smolt count of 9,000 sockeye salmon was the smallest outmigration of the 40-year record and followed poor counts of 25,000 and 16,000 sockeye salmon smolt in 2019 and 2020, respectively. The low number of smolt was probably a result of poor escapements in previous years (only 2,039 and 2,241 adult sockeye salmon in 2018 and 2019 escapements, respectively). Although brief flooding events are regular in the spring, it is possible that the 2 separate week-long heavy precipitation events (dropping 20 cm and 25 cm of rain) allowed for a higher-than-average proportion of the smolt emigration to escape uncounted, because the smolt weir was overtopped to some degree for 12 of the 47 days of operation. Once all the coho salmon that were coded-wire-tagged at the smolt weir return in 2022, we will be able to estimate the smolt weir capture efficiency, discern if it was lower than the recent average, and determine if sockeye salmon smolt abundance in 2021 was higher than indicated by our count.

The total weir count of 3,235 adult sockeye salmon was the seventh-lowest escapement of the 42-year record (1980–2021) and the fourth consecutive year the escapement was below the lower bound of the escapement goal range (Figure 5). Despite enacting fishery restrictions in the District 101 purse seine fishery as outlined in the Hugh Smith Lake sockeye salmon action plan (Heinl et al. 2007; Thynes et al. 2020a; Thynes et al. 2020b), the estimated commercial harvest rate of 79.3% was the highest observed since genetic estimates became available in 2014, primarily due to large estimated harvests of Hugh Smith Lake sockeye salmon outside of District 101. The estimated total run of 16,155 Hugh Smith adult sockeye salmon was large enough to provide an escapement within goal range if the harvest rate had been below 50.0%.

Fisheries restrictions were implemented in District 101 purse seine fisheries for the fourth consecutive year because the escapement to Hugh Smith Lake was projected inseason to be well below the escapement goal. Escapement projections are made based on historical run timing at the weir (Brunette 2019). In statistical week 29, fisheries managers instituted the first management action described in the Hugh Smith Lake action plan and closed the section of District 101-23 south from a line between Quadra Point to Slate Island Light and north of a line from Black Rock Light to a point on the mainland shore (Figure 13). At that time, 188 sockeye salmon had passed the weir, which projected to a total escapement of only 2,067 fish. By statistical week 31, the projected escapement (4,067 fish) was still well below the lower bound of the escapement goal range (8,000 to 18,000 fish). As a result, the purse seine fishery closure area was expanded to include the southernmost tip of Black Island south to Black Rock light and Foggy Point light. Escapement projections continued to be below the escapement goal range into statistical week 32 and 33. Based on the historical average, nearly 80% of the Hugh Smith Lake sockeye salmon run had passed the weir by the end of statistical week 33. Therefore, the closure area was removed on the final day of purse seine fishing in statistical week 33. The estimated harvest (1,210 fish) and proportion (less than 2.0%) of Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery were the lowest in the 8 years of GSI sampling (Fish and Piston 2022; Appendix I). Fishing restrictions were not implemented in the District 101 Tree Point drift gillnet fishery (101-11) in 2021 and the fishery was responsible for less than 5% of the estimated harvest of Hugh Smith Lake sockeye salmon.

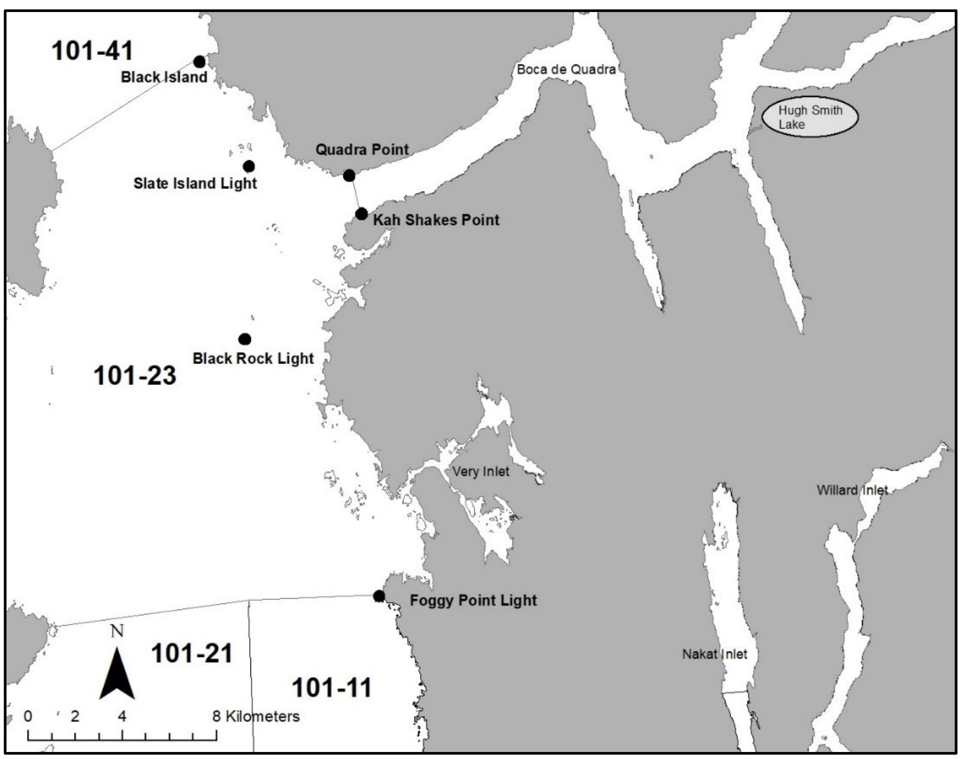

Figure 13.–District 101 subdistricts and points relative to Hugh Smith Lake closures.

The Hugh Smith action plan included management restrictions in the fishing areas closest to Hugh Smith Lake and Boca de Quadra but did not include areas outside of District 101. Most of the total harvest of Hugh Smith Lake sockeye salmon (70.9% average from 2014 to 2020) has occurred within District 101. In 2021, however, 86.1% of the estimated harvest occurred outside of District 101, particularly in the District 102 and 104 purse seine fisheries (Figure 1). An estimated 1,053 Hugh Smith Lake sockeye salmon were harvested in the District 102 purse seine fishery, which was the second-largest harvest in District 102 in 8 years of GSI sampling. The District 104 purse seine fishery accounted for most of the commercially harvested Hugh Smith Lake sockeye salmon (75.5%). The estimated 9,676 Hugh Smith Lake sockeye salmon was the largest harvest in District 104 of the 8 years of GSI sampling. Most of the harvest occurred in statistical weeks 31 and 35 (4,006 and 3,654 fish, respectively). The average proportion of Hugh Smith Lake sockeye salmon in District 104 has historically been small (average of 1.5% per week for all statistical weeks and years) and remained relatively small in 2021 (range 0.0–5.6%) but the magnitude of the commercial catch in the area (second highest since 2014) resulted in a substantial estimate of Hugh Smith Lake sockeye salmon harvest. The peak harvest of Hugh Smith Lake sockeye salmon in the District 104 fishery occurred in week 31, when approximately 4,000 fish were harvested out of a total sockeye salmon harvest of 117,000 fish (Appendix J). Since 2014, peak contribution has occurred in weeks 30 or 31 in all but one year (week 33 in 2015). The estimated harvest of 3,654 Hugh Smith Lake sockeye salmon at the end of August (week 35) was unusually late, and the proportion of the catch represented by the Hugh Smith Lake stock was the highest of the season at 5.6%. Approximately 94.1% of the escapement had passed the weir by the end of August, which suggests either a later segment of the run was harvested at an extremely high rate, or there were problems with the harvest estimate for that week.

It is possible that the anomalously large harvest estimate for the District 104 purse seine fishery in 2021 is related in part to uncertainty in our estimates due to the very small proportion of the harvest comprised of Hugh Smith Lake sockeye salmon. The District 104 sockeye salmon harvest is dominated by large Canadian sockeye salmon stocks such as the Skeena and Nass Rivers and, late in the season, the Fraser River. The Skeena and Nass River stocks alone accounted for an average of 61% of the District 104 sockeye salmon harvest from 1985 to 2017 (Piston 2021). The comparative magnitude of the larger run sizes to these rivers and the diversity of stocks harvested in District 104 means Hugh Smith Lake sockeye salmon are likely to represent a very small proportion of the District 104 purse seine harvest even in years with large Hugh Smith Lake runs. Due to the small proportion of Hugh Smith Lake sockeye salmon in the District 104 harvest, our weekly estimates typically have low precision, and the 90% credible intervals often include zero (Figure 11; Appendix J).

ADF&G genetic guidelines cannot be strictly followed due to the relatively small proportion of Hugh Smith Lake sockeye salmon in the commercial fisheries. To maintain precision and accuracy for single population reporting groups, it has been ADF&G's guideline to only report estimates when the expected proportion of fish in a mixture is 5.0% or more, and when mixture sample sizes are sufficient that stock composition estimates for the reporting group are within 10% of the estimate, 90% of the time. This guideline is based on an initial GSI sampling design to determine harvest contribution at a relatively coarse resolution (e.g., by major stocks or country of origin). In the 8 years of GSI studies, we have collected 316 unique samples representing fishing districts at different time periods. Periods were as short as a single statistical week, but to maintain a robust sample size, weeks were regularly pooled, sometimes for the entirety of the season (up to 10 statistical weeks). Weekly or pooled GSI proportions were then applied to distinct harvest strata, each representing a single statistical week and commercial fishery (defined by gear type and area) to estimate Hugh Smith Lake sockeye salmon harvested commercially.

In the 8 years of GSI studies, we applied GSI proportions to 731 distinct harvest strata, but the estimated proportion of Hugh Smith Lake sockeye salmon in very few strata (123 strata) was greater than or equal to 5.0% (Table 6). The number of strata with proportions of Hugh Smith Lake sockeye salmon estimated to be greater than or equal to 5.0% has ranged from a high of 30.9% in 2016 to a low of 2.3% in 2021.When all strata (even those less than 5.0%) are included in Hugh Smith Lake sockeye salmon harvest estimates, the average harvest rate is greater by 11.3% (range: 2.3–25.8%) than if only strata with proportions greater than or equal to 5.0% were included (Table 7). Although we acknowledge the increase in uncertainty that accompanies incorporating all weeks of GSI estimates, we believe including all the data provides a better representation of the removal of Hugh Smith Lake sockeye salmon from commercial fisheries than would be achieved by omitting most strata (any estimated to be less than 5.0% Hugh Smith Lake sockeye). The weeks with higher proportions of Hugh Smith Lake sockeye salmon and higher precision estimates tend to account for a large proportion of estimated harvests in most years. The estimated harvest rates we have obtained using GSI from 2014 to 2021 are comparable to harvest rate estimates from Hugh Smith Lake sockeye salmon coded wire tagging studies conducted from 1980 to 1996, which showed commercial fishery harvest rates ranging from 40–95% (mean = 62%; Geiger et al. 2003).

Table 6.–Total annual strata (statistical weeks 24–40 of each fishery) in District 101–108 purse seine and drift gillnet fisheries combined, number of strata with estimated Hugh Smith Lake sockeye salmon proportions greater than or equal to 5.0%, and the percent of strata with greater than or equal to 5.0% Hugh Smith Lake sockeye salmon, 2014–2021.

Year	Number of strata	Strata with proportions ≥5.0%	Percent strata with proportions ≥5.0%
2014	95	21	22.1%
2015	99	13	13.1%
2016	97	30	30.9%
2017	95	28	29.5%
2018	89	10	11.2%
2019	90	12	13.3%
2020	78	7	9.0%
2021	88	2	2.3%
Total	731	123	16.8%

The preliminary 2021 subsistence harvest estimate (111 sockeye salmon), the harvest rate on the terminal run (3.3%), and subsistence fishing effort (12 permit days) were less than the recent 10-year average (2011–2020; 437 fish, 5.4% harvest rate, and 39 permit days, respectively; Figure 10; Appendix H). Fish entered the lake in steady low numbers and never held en masse in the estuary, but the CPUE of 9.3 fish/permit day matched the recent 10-year average (9.2 fish/permit day) and was much higher than the low of 3.3 fish/permit day observed in 2020. Most of the 12 permits were filled to the daily bag limit (12 fish/day); the 3 that did not meet the limit were fished early and late in the season. ADF&G will continue to monitor participation and effort to determine if harvest restrictions, such as an annual household limit, are necessary for the Sockeye Creek subsistence fishery.

Table 7.–Comparison of commercial purse seine and drift gillnet fisheries combined harvest estimates when strata with less than 5.0% Hugh Smith Lake proportions are used, including total run and harvest rates, number of fish added, and the increase in harvest rate, 2014–2021.

	Proportions ≥5.0%		All proportions (including those <5.0%)		
Year	Total run	Harvest rate	Additional fish	Harvest rate	Increase in harvest rate
2014	21,417	49.3%	4,467	58.1%	8.7%
2015	37,780	41.3%	8,753	52.3%	11.0%
2016	45,619	70.7%	3,934	73.0%	2.3%
2017	26,534	42.0%	2,608	47.2%	5.2%
2018	4,748	55.9%	1,376	65.8%	9.9%
2019	7,552	63.4%	4,332	76.8%	13.3%
2020	5,126	23.3%	1,191	37.8%	14.5%
2021	7,200	53.5%	8,955	79.3%	25.8%
Average	19,497	49.9%	4,452	61.3%	11.3%

In 2021, we saw a continuation of the pattern of reduced length of ocean-age-3 sockeye salmon at Hugh Smith Lake that has been evident since 2015 (Brunette and Piston 2020). Average lengths of male and female ocean-age-3 sockeye salmon (age-1.3 and -2.3) were the shortest on record (Figure 9). The reduced size was also present in ocean-age-2 sockeye salmon of both sexes but to a lesser extent. Ocean-age-2 females were ranked at or below the third quartile for average lengths and ocean-age-2 males were ranked within the third quartile (at or between the 0.5 and 0.25; Figure 9). Reductions in the size of sockeye salmon, as well as other species of salmon, have been documented throughout Alaska and have been attributed to both shifting age structure (Oke et al. 2020) and declines in size at age (Lewis et al. 2015). At Hugh Smith Lake the reduction in size is not related to changes in the age structure, which remains relatively stable. For example, from 2015 to 2021, the average proportion of ocean-age-3 sockeye salmon in the Hugh Smith Lake escapement was 67%, with a range of 31% to 94%, which is similar to the average of 70% from 1980 to 2003 (range = 15–97%). The average size at age for ocean-age-3 sockeye salmon over the same time periods (1982–2003 and 2015–2021) declined by 3.7% for age-1.3 females, 4.1% for age-2.3 females, 4.4% for age-1.3 males, and 3.7% for age-2.3 males. Hugh Smith Lake ocean-age-2 sockeye salmon were small but within the historic norms, which supports the Lewis et al. (2015) hypothesis that the longer a fish is exposed to marine conditions, the more apparent the decline becomes. Unlike many recent years, the juvenile sockeye salmon heading to sea in 2020 and 2021 did not experience the anomalously warm sea surface temperatures that persisted throughout the Gulf of Alaska from fall 2013 through much of 2016 (Bond et al. 2015; Di Lorenzo and Mantua 2016; Walsh et al. 2018) and in 2018 and 2019[3]. Although the reason for the decline in size at age is not well understood, it may be related to a variety of environmental, geographic, and anthropogenetic factors (Lewis et al. 2015; Cline et al. 2019; Connors et al. 2020; Oke et al. 2020). The returns of ocean-age-3 fish to Hugh Smith Lake starting in 2023 will be of particular interest due to the change in the marine rearing environment they will have experienced compared to most recent brood years.

[3] https://apps-afsc.fisheries.noaa.gov/REFM/REEM/ecoweb/pdf/archive/2019GOAecosys.pdf (Accessed 1 June 2022).

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APPENDICES

The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week, for smolt and adults, were calculated using equations from Cochran (1977; pages 52, 107–108, and 142–144).

Let

h	=	index of the stratum (week),
j	=	index of the age class,
p_{hj}	=	proportion of the sample taken during stratum h that is age j,
n_h	=	number of fish sampled in week h, and
n_{hj}	=	number observed in class j, week h.

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

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

If N_h equals the number of fish in the escapement in week h, standard errors of the weekly age class proportions are calculated in the usual manner (Cochran 1977, page 52, equation 3.12):

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

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

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

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

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

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

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

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

Appendix B.–Statistical weeks and corresponding calendar dates, 2021.

Statistical week	Beginning date	Ending date
16	11-Apr	17-Apr
17	18-Apr	24-Apr
18	25-Apr	1-May
19	2-May	8-May
20	9-May	15-May
21	16-May	22-May
22	23-May	29-May
23	30-May	5-Jun
24	6-Jun	12-Jun
25	13-Jun	19-Jun
26	20-Jun	26-Jun
27	27-Jun	3-Jul
28	4-Jul	10-Jul
29	11-Jul	17-Jul
30	18-Jul	24-Jul
31	25-Jul	31-Jul
32	1-Aug	7-Aug
33	8-Aug	14-Aug
34	15-Aug	21-Aug
35	22-Aug	28-Aug
36	29-Aug	4-Sep
37	5-Sep	11-Sep
38	12-Sep	18-Sep
39	19-Sep	25-Sep
40	26-Sep	2-Oct
41	3-Oct	9-Oct
42	10-Oct	16-Oct
43	17-Oct	23-Oct
44	24-Oct	30-Oct
45	31-Oct	6-Nov

Appendix C.–Sockeye salmon smolt counts, hatchery releases, and freshwater age composition at Hugh Smith Lake, 1982–2021. Proportions of stocked smolt were determined from otolith samples collected at the weir.

Release year	Hatchery release numbers	Release type	Smolt year	Total smolt counted	Freshwater age percent of total[a]			Wild smolt	Stocked smolt	Percent stocked
					Age 1	Age 2	Age 3			
1981	–	–	1982	94,000	82.5%	17.5%	0.0%	94,000	–	–
1982	–	–	1983	77,000	60.1%	39.8%	0.1%	77,000	–	–
1983	–	–	1984	330,000	91.7%	8.3%	0.0%	330,000	–	–
1984	–	–	1985	40,000	51.3%	48.2%	0.5%	40,000	–	–
1985	–	–	1986	58,000	72.8%	24.4%	2.8%	58,000	–	–
1986	273,000	Unfed fry	1987	104,000	42.3%	57.3%	0.5%	ND[b]	ND	ND
1987	250,000	Unfed fry	1988	54,000	65.1%	34.9%	0.0%	ND	ND	ND
1988	1,206,000	Unfed fry	1989	427,000	83.2%	16.8%	0.0%	ND	ND	ND
1989	532,800	Unfed fry	1990	137,000	30.9%	67.6%	1.5%	ND	ND	ND
1990	1,480,800	Unfed fry	1991	75,000	63.6%	36.2%	0.2%	ND	ND	ND
1991	–	–	1992	15,000	41.8%	57.2%	1.0%	ND	ND	ND
1992	477,500	Fed fry	1993	36,000	62.8%	35.7%	1.5%	ND	ND	ND
1993	–	–	1994	43,000	74.9%	21.1%	4.0%	ND	ND	ND
1994	645,000	Unfed fry	1995	19,000	37.6%	62.4%	0.0%	ND	ND	ND
1995	418,000	Unfed fry	1996	16,000	43.9%	40.1%	16.0%	ND	ND	ND
1996	358,000	Unfed fry/ Presmolt[b]	1997	44,000	52.1%	39.5%	8.3%	26,000	18,000	40%
1997	573,000	Unfed fry[b]	1998	64,000	80.6%	18.3%	1.1%	34,000	30,000	47%
1998	–	–	1999	40,000	68.4%	31.6%	0.0%	38,000	2,000	4%
1999	202,000	Presmolt[c]	2000	72,000	77.4%	22.0%	0.5%	ND	ND	ND
2000	380,000	Presmolt[c]	2001	189,000	91.1%	8.3%	0.6%	44,000	145,000	77%
2001	445,000	Presmolt[c]	2002	297,000	88.1%	11.9%	0.1%	134,000	163,000	55%
2002	465,000	Presmolt[c]	2003	261,000	85.9%	13.9%	0.2%	76,000	185,000	71%
2003	420,000	Presmolt[c]	2004	364,000	88.0%	12.0%	0.0%	193,000	171,000	47%
2004	–	–	2005	77,000	54.3%	45.6%	0.0%	77,000	–	–
2005	–	–	2006	119,000	63.1%	36.0%	0.9%	119,000	–	–
2006	–	–	2007	89,000	71.2%	27.2%	1.7%	89,000	–	–
2007	–	–	2008	58,000	62.4%	36.9%	0.7%	58,000	–	–
2008	–	–	2009	116,000	40.1%	59.2%	0.7%	116,000	–	–
2009	–	–	2010	64,000	18.7%	79.3%	2.0%	64,000	–	–
2010	–	–	2011	244,000	88.7%	10.1%	1.2%	244,000	–	–
2011	–	–	2012	179,000	72.4%	27.6%	0.0%	179,000	–	–
2012	–	–	2013	186,000	73.7%	25.8%	0.5%	186,000	–	–
2013	–	–	2014	95,000	71.1%	28.9%	0.0%	95,000	–	–
2014	–	–	2015	36,000	53.0%	46.6%	0.4%	36,000	–	–
2015	–	–	2016	31,000	85.2%	13.8%	1.0%	31,000	–	–
2016	–	–	2017	80,000	88.3%	11.7%	0.0%	80,000	–	–
2017	–	–	2018	63,000	57.4%	42.2%	0.5%	63,000	–	–

-continued-

Release year	Hatchery release numbers	Release type	Smolt year	Total smolt counted	Freshwater age percent of total[a]			Wild smolt	Stocked smolt	Percent stocked
					Age 1	Age 2	Age 3			
2018	–	–	2019	25,000	55.5%	43.3%	1.2%	25,000	–	–
2019	–	–	2020	16,000	47.7%	52.3%	0.0%	16,000	–	–
2020	–	–	2021	9,000	75.7%	24.3%	0.0%	9,000	–	–

Note: En dashes indicate that no hatchery fish were stocked in the lake or available to sample from the smolt population; ND indicates no data.

[a] Due to rounding, the sum of percentages may not equal 100.0.

[b] In release year 1996, Southern Southeast Regional Aquaculture Association released 251,123 unfed fry into the lake in May and 106,833 presmolt in October. The hatchery releases were rounded to 358,000 fish. All fish released in 1996 and 1997 were thermal marked.

[c] From release years 1999 to 2003, fry were pen-reared at the outlet of the lake beginning in late May and released as presmolt in late July and early August. These fish smolted in the year following release (2000–2004). All fish from those releases were thermal marked.

Appendix D.–Escapement and run timing for Hugh Smith Lake sockeye salmon, 1967–1971, and 1980–2021.

Year	1967	1968	1969	1970	1971	1980	1981	1982	1983	1984	1985	1986
Weir count	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106	12,245	2,312
Total escapement[a]	ND	ND	ND	ND	ND	12,714	ND	57,219	10,429	16,106	12,245	6,968[b]
Wild fish[b]	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106	12,245	6,968
Stocked fish	0	0	0	0	0	0	0	0	0	0	0	0
Weir mortalities	ND	ND	ND	ND	ND	ND	ND	81	45	134	201	12
Adults used for egg takes	0	0	0	0	0	0	0	0	0	439	798	619
Spawning escapement[c]	ND	ND	ND	ND	ND	ND	ND	57,138	10,384	15,533	11,246	6,337
Jacks (not included in weir count)[d]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Starting date	1-Jun	13-Jun	11-Jun	9-Jun	20-Jun	5-Jun	7-Jun	4-Jun	30-May	1-Jun	1-Jun	17-Jun
Ending date	3-Sep	21-Aug	14-Aug	1-Sep	22-Aug	4-Oct	8-Sep	27-Nov	30-Nov	26-Nov	11-Nov	29-Oct
Days elapsed	94	69	64	84	63	121	93	176	184	178	163	134
Date of first sockeye	13-Jun	14-Jun	11-Jun	11-Jun	20-Jun	6-Jun	8-Jun	7-Jun	1-Jun	6-Jun	5-Jun	18-Jun
Date of last sockeye	3-Sep	21-Aug	14-Aug	1-Sep	22-Aug	4-Oct	8-Sep	25-Oct	25-Oct	19-Nov	29-Oct	3-Oct
Days elapsed for sockeye caught	82	68	64	82	63	120	92	140	146	166	146	107
10th percentile run date	22-Jun	2-Jul	26-Jun	26-Jun	1-Jul	4-Jul	28-Jun	20-Jun	11-Jul	14-Jul	12-Jul	11-Jul
25th percentile run date	28-Jun	11-Jul	9-Jul	6-Jul	9-Jul	20-Jul	7-Jul	29-Jun	17-Jul	26-Jul	25-Jul	15-Jul
50th percentile run date	7-Jul	15-Aug	20-Jul	27-Jul	20-Jul	6-Aug	27-Jul	9-Jul	11-Aug	8-Aug	23-Aug	20-Jul
75th percentile run date	18-Jul	19-Aug	7-Aug	6-Aug	19-Aug	26-Aug	24-Aug	18-Jul	4-Sep	26-Aug	2-Sep	28-Jul
90th percentile run date	28-Jul	21-Aug	9-Aug	13-Aug	20-Aug	9-Sep	3-Sep	7-Aug	24-Sep	10-Sep	13-Sep	8-Aug

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Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Weir count	33,097	5,056	6,513	1,285	5,885	65,737	11,312	8,386	3,424	7,123	12,182	1,138
Total escapement[a]	33,097	5,056	6,513	1,285	5,885	65,737	13,532	8,992	3,452	7,123	12,182	1,138
Wild fish[b]	33,097	5,056	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[b]	ND[b]
Stocked fish	0	0	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[c]	ND[b]	ND[b]
Weir mortalities	0	28	32	28	33	151	278	42	11	57	28	23
Adults used for egg takes	1,902	424	1,547	0	357	178	1,460	763	312	513	0	218
Spawning escapement[c]	31,195	4,604	4,934	1,257	5,495	65,408	11,794	8,187	3,129	6,553	12,154	897
Jacks (not included in weir count)[d]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND[d]	ND[d]
Starting date	3-Jun	5-Jun	3-Jun	8-Jun	17-Jun	16-Jun	17-Jun	20-Jun	17-Jun	17-Jun	18-Jun	17-Jun
Ending date	21-Oct	22-Oct	25-Oct	31-Oct	9-Oct	25-Oct	4-Nov	1-Nov	3-Nov	4-Nov	5-Nov	11-Nov
Days elapsed	140	139	144	145	114	131	140	134	139	140	140	147
Date of first sockeye	8-Jun	12-Jun	11-Jun	13-Jun	19-Jun	16-Jun	20-Jun	20-Jun	19-Jun	20-Jun	18-Jun	19-Jun
Date of last sockeye	4-Oct	16-Oct	18-Oct	21-Oct	11-Oct	18-Oct	3-Nov	26-Oct	1-Nov	20-Oct	1-Nov	12-Oct
Days elapsed for sockeye caught	118	126	129	130	114	124	136	128	135	122	136	115
10th percentile run date	18-Jul	19-Jul	30-Jul	8-Jul	22-Jul	12-Jul	2-Jul	20-Jul	7-Jul	25-Jul	3-Jul	8-Jul
25th percentile run date	20-Jul	24-Jul	5-Aug	23-Jul	29-Jul	19-Jul	16-Jul	1-Aug	17-Jul	11-Aug	16-Jul	21-Jul
50th percentile run date	4-Aug	9-Aug	10-Aug	27-Aug	21-Aug	27-Jul	30-Jul	23-Aug	29-Jul	19-Aug	25-Jul	30-Jul
75th percentile run date	30-Aug	25-Aug	14-Aug	7-Sep	12-Sep	29-Jul	14-Aug	26-Aug	9-Aug	3-Sep	2-Aug	10-Aug
90th percentile run date	31-Aug	1-Sep	22-Aug	16-Sep	22-Sep	11-Aug	31-Aug	3-Sep	21-Aug	13-Sep	15-Aug	18-Aug

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Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Weir count	3,174	4,281	3,665	6,166	19,588	19,930	24,108	42,529	34,077	3,590	9,483	15,646
Total escapement[a]	3,174	4,281	3,825	6,166	19,588	19,930	24,108	42,529	34,077	3,590	9,483	15,646
Wild fish[b]	ND[b]	ND[b]	ND[b]	ND[b]	6,856	6,976	10,366	14,993	13,713	3,590	9,483	15,646
Stocked fish	ND[b]	ND[b]	ND[b]	ND[b]	12,732	12,955	13,742	27,537	20,364	0	0	0
Weir mortalities	20	12	6	0	20	196	236	418	334	2	0	0
Adults used for egg takes	276	280	268	286	0	0	0	0	0	0	0	0
Spawning escapement[c]	2,878	3,989	3,551	5,880	19,568	19,734	23,872	42,112	33,743	3,588	9,483	15,646
Jacks (not included in weir count)[d]	ND[d]	ND[d]	ND[d]	167	1,356	147	331	4	236	260	301	158
Starting date	16-Jun	17-Jun	16-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun	16-Jun	16-Jun
Ending date	8-Nov	11-Nov	11-Nov	4-Nov	7-Nov	7-Nov	4-Nov	7-Nov	4-Nov	3-Nov	8-Nov	8-Nov
Days elapsed	145	147	148	140	143	143	140	143	140	139	145	145
Date of first sockeye	22-Jun	19-Jun	19-Jun	19-Jun	19-Jun	18-Jun	19-Jun	19-Jun	18-Jun	19-Jun	18-Jun	18-Jun
Date of last sockeye	4-Oct	27-Oct	6-Oct	17-Oct	2-Nov	31-Oct	22-Oct	3-Nov	26-Oct	28-Oct	5-Oct	4-Oct
Days elapsed for sockeye caught	104	130	109	120	136	135	125	137	130	131	109	109
10th percentile run date	7-Jul	29-Jun	2-Jul	10-Jul	2-Aug	8-Jul	17-Jul	1-Aug	19-Jul	16-Jul	4-Jul	5-Jul
25th percentile run date	15-Jul	7-Jul	18-Jul	4-Aug	17-Aug	4-Aug	31-Jul	4-Aug	16-Aug	26-Jul	10-Jul	23-Jul
50th percentile run date	31-Jul	20-Jul	17-Aug	7-Aug	21-Aug	6-Aug	20-Aug	9-Aug	28-Aug	31-Jul	23-Jul	24-Jul
75th percentile run date	15-Aug	30-Jul	22-Aug	9-Aug	28-Aug	29-Aug	26-Aug	15-Aug	1-Sep	14-Aug	11-Aug	29-Jul
90th percentile run date	22-Aug	6-Aug	23-Aug	12-Aug	2-Sep	2-Sep	3-Sep	26-Aug	7-Sep	24-Aug	13-Aug	11-Aug

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Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Weir count	22,029	13,353	5,946	10,397	21,298	12,868	14,753	2,039	2,241	3,860	3,235
Total escapement[a]	22,029	13,353	5,946	10,397	21,298	12,868	14,753	2,039	2,241	3,860	3,235
Wild fish[b]	22,029	13,353	5,946	10,397	21,298	12,868	14,753	2,039	2,241	3,860	3,235
Stocked fish	0	0	0	0	0	0	0	0	0	0	0
Weir mortalities	0	0	0	0	2	3	5	0	1	0	0
Adults used for egg takes	0	0	0	0	0	0	0	0	0	0	0
Spawning escapement[c]	22,029	13,353	5,946	10,397	21,296	12,865	14,748	2,039	2,240	3,860	3,235
Jacks (not included in weir count)[d]	46	46	275	350	125	93	195	90	145	37	18
Starting date	17-Jun	16-Jun	18-Jun	17-Jun	18-Jun	16-Jun	18-Jun	18-Jun	19-Jun	18-Jun	18-Jun
Ending date	11-Nov	10-Nov	10-Nov	9-Nov	5-Nov	13-Nov	4-Nov	7-Nov	5-Nov	6-Nov	8-Nov
Days elapsed	147	147	145	145	140	149	139	142	139	142	144
Date of first sockeye	19-Jun	18-Jun	19-Jun	18-Jun	20-Jun	20-Jun	18-Jun	20-Jun	21-Jun	18-Jun	20-Jun
Date of last sockeye	8-Nov	1-Nov	17-Oct	17-Oct	26-Oct	3-Nov	12-Oct	15-Sep	21-Sep	5-Oct	29-Sep
Days elapsed for sockeye caught	142	136	120	121	128	136	116	87	92	110	102
10th percentile run date	11-Jul	1-Jul	17-Jun	2-Jul	25-Jul	24-Jul	20-Jul	8-Jul	21-Jul	16-Jul	13-Jul
25th percentile run date	23-Jul	10-Jul	19-Jul	22-Jul	27-Jul	24-Jul	28-Jul	14-Jul	29-Jul	24-Jul	20-Jul
50th percentile run date	28-Jul	22-Jul	25-Jul	28-Jul	5-Aug	27-Jul	3-Aug	10-Aug	7-Aug	4-Aug	30-Jul
75th percentile run date	16-Aug	1-Aug	27-Jul	31-Jul	16-Aug	13-Aug	16-Aug	12-Aug	18-Aug	21-Aug	14-Aug
90th percentile run date	19-Aug	8-Aug	22-Aug	12-Aug	27-Aug	22-Aug	28-Aug	17-Aug	25-Aug	26-Aug	27-Aug

Note: ND = no data.

[a] The total escapement equals the weir count or mark–recapture estimate (1986, 1993, 1994, 1995, 2001), including mortalities. The 1967–1971 and 1981 escapements were underestimated due to early weir removal.

[b] Escapements were not separated into estimates of wild and stocked fish from 1989 to 2002.

[c] The spawning escapement equals the total estimated escapement minus weir mortalities, fish killed for samples (coded wire tag or otolith samples), and fish killed for egg takes.

[d] Separate counts of jacks (fish <400 mm METF length) were not kept from 1967 to 2001, so those weir counts include an unknown number of jacks.

Appendix E.–Mark–recapture estimates for Hugh Smith Lake sockeye salmon, 1992–2021.

Year	Live weir count[a]	Proportion marked	Fish marked	Fish sampled for marks	Marked fish recovered	Method[b]	Estimate	SE	+/-95% CI[c]	CV
1992	**65,586**	36%	23,790	1,974	814	PPE	57,652	1,520	2,979	3%
1993	11,034	99%	10,973	2,377	2,029	Darroch	**13,254**	134	263	1%
1994	8,344	97%	8,126	1,152	1,041	Darroch	**8,925**	77	151	1%
1995	3,413	100%	3,396	1,028	1,006	Darroch	**3,441**	70	137	2%
1996	**7,066**	99%	6,995	374	369	PPE	7,090	41	80	1%
1997	**12,154**	67%	8,100	934	638	PPE	11,853	253	496	2%
1998	**1,115**	67%	745	226	157	PPE	1,071	42	82	4%
1999	**3,154**	67%	2,103	323	221	PPE	3,070	109	214	4%
2000	**4,269**	67%	2,846	443	299	PPE	4,213	131	257	3%
2001	**3,629**	50%	1,807	484	230	PPE	3,789	168	329	4%
2002	**5,999**	50%	2,999	908	449	PPE	6,059	187	367	3%
2003	**19,568**	10%	1,945	2,057	194	PPE	20,537	1,324	2,595	6%
2004	**19,734**	10%	1,979	1,547	136	Darroch	21,950	1,991	4,000	9%
2005	**23,872**	10%	2,278	1,244	115	PPE	24,459	2,098	4,112	9%
2006	**42,112**	10%	4,208	2,187	229	PPE	40,039	2,423	4,749	6%
2007	**33,743**	10%	3,414	1,764	176	PPE	34,053	2,357	4,621	7%
2008	**3,588**	10%	358	659	50	PPE	4,645	573	1,123	12%
2009	**9,483**	10%	949	1,271	123	PPE	9,744	772	1,513	8%
2010	**15,646**	10%	1,565	3,652	339	PPE	16,824	768	1,505	5%
2011	**22,029**	10%	2,202	2,490	242	PPE	22,582	1,295	2,539	6%
2012	**13,353**	10%	1,335	2,199	196	PPE	14,919	934	1,831	6%
2013	**5,946**	10%	595	1,714	138	Darroch	6,363	623	1,221	10%
2014	**10,397**	10%	1,039	1,326	134	PPE	10,222	775	1,519[c]	8%
2015	**21,296**	12%	2,515	1,590	161	PPE	24,709	1,774	21,534–8,540	7%
2016	**12,865**	10%	1,297	1,008	94	PPE	13,785	1,289	11,538–16,655	9%
2017	**14,748**	10%	1,478	687	66	PPE	15,186	1,710	12,274–19,098	11%
2018	**2,039**	30%	621	9	4	ND	ND	ND	ND	ND
2019	**2,241**	17%	378	5	1	ND	ND	ND	ND	ND
2020	**3,860**	10%	387	463	42	PPE	4,186	567	3,075–5,297	14%
2021	**3,235**	10%	323	476	47	PPE	3,219	403	2,543–4157	13%

Notes: Bold estimates were used as the official escapement estimate for each year. PPE = Pooled Peterson estimate. Data used to calculate 1986 estimate are no longer available.

[a] The weir count used to compare to mark–recapture estimates was the number of live fish passed through the weir (weir count minus weir mortalities).

[b] Pooled Petersen and Darroch estimates and their standard errors were calculated using Stratified Population Analysis Software. Release data were stratified into 3 release periods and recovery data were stratified by recovery days. Chi-square tests for goodness of fit and complete mixing in 1993, 1994, 1995, 2004, and 2013 were highly significant and suggested that Darroch estimates should be used rather than Pooled Petersen estimates in those years.

[c] Normal distribution 95% confidence intervals are presented for 1992–2014. Transform-based 95% confidence intervals are presented for 2015 to present.

Appendix F.–Age composition of the sockeye salmon (fish ≥ 400 mm METF length) escapement at Hugh Smith Lake based on scale pattern analysis, weighted by statistical week, 2021. Due to rounding, the sum of percentages may not equal 100.0.

Stat.		Ocean-age-2		Ocean-age-3		Ocean-age-4	
week		1.2	2.2	1.3	2.3	2.4	Total
26–27	*n*	2	0	7	5	0	14
	Proportion	14.3%	0.0%	50.0%	35.7%	0.0%	100%
	SE of %	8.8%	0.0%	12.5%	12.0%	0.0%	
	Number in esc.	11	0	38	27	0	
28	*n*	2	0	14	4	0	20
	Proportion	10.0%	0.0%	70.0%	20.0%	0.0%	100%
	SE of %	6.2%	0.0%	9.5%	8.3%	0.0%	
	Number in esc.	11	0	78	22	0	
29	*n*	5	1	35	5	0	46
	Proportion	10.9%	2.2%	76.1%	10.9%	0.0%	100%
	SE of %	4.2%	2.0%	5.7%	4.2%	0.0%	
	Number in esc.	26	5	184	26	0	
30	*n*	10	3	93	14	1	121
	Proportion	8.3%	2.5%	76.9%	11.6%	0.8%	100%
	SE of %	2.3%	1.3%	3.5%	2.6%	0.7%	
	Number in esc.	53	16	496	75	5	
31	*n*	6	4	98	7	0	115
	Proportion	5.2%	3.5%	85.2%	6.1%	0.0%	100%
	SE of %	1.9%	1.6%	3.0%	2.0%	0.0%	
	Number in esc.	33	22	536	38	0	
32	*n*	5	4	56	9	0	74
	Proportion	6.8%	5.4%	75.7%	12.2%	0.0%	100%
	SE of %	2.6%	2.3%	4.4%	3.3%	0.0%	
	Number in esc.	21	17	234	38	0	
33	*n*	7	1	46	13	0	67
	Proportion	10.4%	1.5%	68.7%	19.4%	0.0%	100%
	SE of %	3.4%	1.4%	5.2%	4.5%	0.0%	
	Number in esc.	44	6	286	81	0	
34	*n*	4	0	18	5	0	27
	Proportion	14.8%	0.0%	66.7%	18.5%	0.0%	100%
	SE of %	6.3%	0.0%	8.4%	6.9%	0.0%	
	Number in esc.	23	0	105	29	0	
35	*n*	5	0	47	11	0	63
	Proportion	7.9%	0.0%	74.6%	17.5%	0.0%	100%
	SE of %	3.1%	0.0%	5.0%	4.4%	0.0%	
	Number in esc.	28	0	265	62	0	
36	*n*	7	0	14	1	0	22
	Proportion	31.8%	0.0%	63.6%	4.5%	0.0%	100%
	SE of %	9.3%	0.0%	9.6%	4.2%	0.0%	
	Number in esc.	44	0	88	6	0	
37–40	*n*	5	2	13	6	0	26
	Proportion	19.2%	7.7%	50.0%	23.1%	0.0%	100%
	SE of %	7.2%	4.9%	9.1%	7.7%	0.0%	
	Number in esc.	29	12	77	35	0	
Total	*n*	58	15	441	80	1	595
	Proportion	10.0%	2.4%	73.8%	13.6%	0.2%	
	SE of %	5.8%	2.8%	8.5%	6.7%	0.8%	
	Number in esc.	324	78	2,388	440	5	3,235
	SE of number	36	18	53	41	5	

Appendix G.–Age distribution of the Hugh Smith Lake sockeye salmon escapement, weighted by statistical week, 1980–2021.

		Age class																
Year		0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	Total
1980	Number by age class	–	37	–	–	–	1,055	113	–	–	9,380	2,129	–	–	–	–	–	12,714
	SE of number	–	21	–	–	–	139	33	–	–	200	156	–	–	–	–	–	–
	Proportion by age class	–	0.3%	–	–	–	8.3%	0.9%	–	–	73.8%	16.7%	–	–	–	–	–	–
	SE of proportion	–	0.2%	–	–	–	1.1%	0.3%	–	–	1.6%	1.2%	–	–	–	–	–	–
	Sample size	–	3	–	–	–	72	12	–	–	719	175	–	–	–	–	–	981
1981	Number by age class	–	250	–	–	–	7,216	1,826	–	–	4,598	1,655	–	–	–	–	–	15,545
	SE of number	–	55	–	–	–	208	126	–	–	204	119	–	–	–	–	–	–
	Proportion by age class	–	1.6%	–	–	–	46.4%	11.7%	–	–	29.6%	10.6%	–	–	–	–	–	–
	SE of proportion	–	0.4%	–	–	–	1.3%	0.8%	–	–	1.3%	0.8%	–	–	–	–	–	–
	Sample size	–	19	–	–	–	502	149	–	–	338	137	–	–	–	–	–	1,145
1982	Number by age class	–	–	–	–	–	1,613	805	–	12	52,124	2,665	–	–	–	–	–	57,219
	SE of number	–	–	–	–	–	155	115	–	11	205	118	–	–	–	–	–	–
	Proportion by age class	–	–	–	–	–	2.8%	1.4%	–	0.0%	91.1%	4.7%	–	–	–	–	–	–
	SE of proportion	–	–	–	–	–	0.3%	0.2%	–	0.0%	0.4%	0.2%	–	–	–	–	–	–
	Sample size	–	–	–	–	–	174	122	–	1	2,305	407	–	–	–	–	–	3,009
1983	Number by age class	–	14	8	–	–	1,375	495	–	12	5,501	2,843	–	182	–	–	–	10,429
	SE of number	–	14	7	–	–	98	62	–	8	169	157	–	38	–	–	–	–
	Proportion by age class	–	0.1%	0.1%	–	–	13.2%	4.7%	–	0.1%	52.7%	27.3%	–	1.7%	–	–	–	–
	SE of proportion	–	0.1%	0.1%	–	–	0.9%	0.6%	–	0.1%	1.6%	1.5%	–	0.4%	–	–	–	–
	Sample size	–	1	1	–	–	157	57	–	2	565	301	–	23	–	–	–	1,107
1984	Number by age class	–	9	–	–	–	966	551	–	–	10,436	4,144	–	–	–	–	–	16,106
	SE of number	–	9	–	–	–	77	70	–	–	153	137	–	–	–	–	–	–
	Proportion by age class	–	0.1%	–	–	–	6.0%	3.4%	–	–	64.8%	25.7%	–	–	–	–	–	–
	SE of proportion	–	0.1%	–	–	–	0.5%	0.4%	–	–	0.9%	0.9%	–	–	–	–	–	–
	Sample size	–	1	–	–	–	149	56	–	–	1,007	378	–	–	–	–	–	1,591
1985	Number by age class	–	–	15	–	–	76	43	–	–	8,935	2,997	13	74	70	–	23	12,245
	SE of number	–	–	14	–	–	23	17	–	–	151	147	9	31	28	–	13	–
	Proportion by age class	–	–	0.1%	–	–	0.6%	0.3%	–	–	73.0%	24.5%	0.1%	0.6%	0.6%	–	0.2%	–
	SE of proportion	–	–	0.1%	–	–	0.2%	0.1%	–	–	1.2%	1.2%	0.1%	0.3%	0.2%	–	0.1%	–
	Sample size	–	–	1	–	–	10	6	–	–	856	279	2	6	7	–	3	1,170
1986	Number by age class	–	5	–	–	4	5,076	780	–	–	745	305	–	49	–	5	–	6,968
	SE of number	–	3	–	–	1	28	25	–	–	25	18	–	6	–	3	–	–
	Proportion by age class	–	0.1%	–	–	0.1%	72.8%	11.2%	–	–	10.7%	4.4%	–	0.7%	–	0.1%	–	–
	SE of proportion	–	0.0%	–	–	0.0%	0.4%	0.4%	–	–	0.4%	0.3%	–	0.1%	–	0.0%	–	–
	Sample size	–	1	–	–	1	1,389	191	–	–	195	77	–	13	–	1	–	1,868

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Year		Age class																
		0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	Total
1987	Number by age class	–	147	130	–	–	626	1,030	24	–	29,329	1,733	61	17	–	–	–	33,097
	SE of number	–	68	49	–	–	112	133	11	–	257	187	45	17	–	–	–	–
	Proportion by age class	–	0.4%	0.4%	–	–	1.9%	3.1%	0.1%	–	88.6%	5.2%	0.2%	0.1%	–	–	–	–
	SE of proportion	–	0.2%	0.1%	–	–	0.3%	0.4%	0.0%	–	0.8%	0.6%	0.1%	0.1%	–	–	–	–
	Sample size	–	9	18	–	–	66	132	4	–	3,374	278	6	1	–	–	–	3,888
1988	Number by age class	–	5	3	–	–	1,907	1,237	–	–	1,054	782	2	67	–	–	–	5,056
	SE of number	–	2	1	–	–	31	27	–	–	26	21	2	6	–	–	–	–
	Proportion by age class	–	0.1%	0.1%	–	–	37.7%	24.5%	–	–	20.8%	15.5%	0.0%	1.3%	–	–	–	–
	SE of proportion	–	0.0%	0.0%	–	–	0.6%	0.5%	–	–	0.5%	0.4%	0.0%	0.1%	–	–	–	–
	Sample size	–	3	2	–	–	1,076	727	–	–	624	499	1	46	–	–	–	2,978
1989	Number by age class	–	–	–	–	–	163	52	1	–	5,808	486	1	–	2	–	–	6,513
	SE of number	–	–	–	–	–	11	11	0	–	37	35	0	–	2	–	–	–
	Proportion by age class	–	–	–	–	–	2.5%	0.8%	0.0%	–	89.2%	7.5%	0.0%	–	0.0%	–	–	–
	SE of proportion	–	–	–	–	–	0.2%	0.2%	0.0%	–	0.6%	0.5%	0.0%	–	0.0%	–	–	–
	Sample size	–	–	–	–	–	116	24	1	–	1,489	184	1	–	1	–	–	1,816
1990	Number by age class	–	12	1	–	–	52	38	–	–	658	495	1	27	–	–	–	1,285
	SE of number	–	3	1	–	–	6	4	–	–	14	14	0	2	–	–	–	–
	Proportion by age class	–	0.9%	0.1%	–	–	4.1%	3.0%	–	–	51.2%	38.5%	0.1%	2.1%	–	–	–	–
	SE of proportion	–	0.2%	0.0%	–	–	0.4%	0.3%	–	–	1.1%	1.1%	0.0%	0.1%	–	–	–	–
	Sample size	–	8	1	–	–	39	29	–	–	537	294	1	24	–	–	–	933
1991	Number by age class	–	2	26	4	–	1,588	2,028	2	–	781	1,442	–	–	13	–	–	5,885
	SE of number	–	0	8	3	–	16	31	1	–	15	30	–	–	4	–	–	–
	Proportion by age class	–	0.0%	0.4%	0.1%	–	27.0%	34.5%	0.0%	–	13.3%	24.5%	–	–	0.2%	–	–	–
	SE of proportion	–	0.0%	0.1%	0.1%	–	0.3%	0.5%	0.0%	–	0.3%	0.5%	–	–	0.1%	–	–	–
	Sample size	–	2	11	1	–	1,274	1,103	1	–	629	998	–	–	8	–	–	4,027
1992	Number by age class	–	3	3	–	–	1,587	1,262	15	–	60,690	1,824	–	336	15	–	–	65,737
	SE of number	–	3	3	–	–	436	156	15	–	628	360	–	286	13	–	–	–
	Proportion by age class	–	0.0%	0.0%	–	–	2.4%	1.9%	0.0%	–	92.3%	2.8%	–	0.5%	0.0%	–	–	–
	SE of proportion	–	0.0%	0.0%	–	–	0.7%	0.2%	0.0%	–	1.0%	0.5%	–	0.4%	0.0%	–	–	–
	Sample size	–	1	1	–	–	63	105	1	–	914	135	–	2	2	–	–	1,224
1993	Number by age class	–	–	13	–	–	1,137	1,916	10	–	3,055	7,038	66	285	13	–	–	13,532
	SE of number	–	–	7	–	–	142	159	8	–	167	215	44	48	10	–	–	–
	Proportion by age class	–	–	0.1%	–	–	8.4%	14.2%	0.1%	–	22.6%	52.0%	0.5%	2.1%	0.1%	–	–	–
	SE of proportion	–	–	0.1%	–	–	1.3%	1.4%	0.1%	–	1.5%	1.9%	0.4%	0.4%	0.1%	–	–	–
	Sample size	–	–	2	–	–	62	163	1	–	279	564	2	31	1	–	–	1,105

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Year		Age class																
		0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	Total
1994	Number by age class	–	51	41	–	–	572	625	6	–	6,546	1,079	–	66	5	2	–	8,992
	SE of number	–	23	14	–	–	73	88	4	–	139	95	–	18	3	1	–	–
	Proportion by age class	–	0.6%	0.5%	–	–	6.4%	7.0%	0.1%	–	72.8%	12.0%	–	0.7%	0.1%	0.0%	–	–
	SE of proportion	–	0.3%	0.2%	–	–	0.8%	1.0%	0.0%	–	1.5%	1.1%	–	0.2%	0.0%	0.0%	–	–
	Sample size	–	12	13	–	–	148	91	2	–	966	243	–	18	2	1	–	1,496
1995	Number by age class	–	–	25	–	–	902	451	–	–	802	1,226	–	44	1	–	–	3,452
	SE of number	–	–	6	–	–	47	38	–	–	44	49	–	14	0	–	–	–
	Proportion by age class	–	–	0.7%	–	–	26.1%	13.1%	–	–	23.2%	35.5%	–	1.3%	0.0%	–	–	–
	SE of proportion	–	–	0.2%	–	–	1.4%	1.1%	–	–	1.3%	1.4%	–	0.4%	0.0%	–	–	–
	Sample size	–	–	16	–	–	299	133	–	–	263	408	–	13	1	–	–	1,133
1996	Number by age class	–	12	–	–	–	1,012	1,654	6	–	3,519	904	–	–	16	–	–	7,123
	SE of number	–	8	–	–	–	125	176	5	–	175	139	–	–	16	–	–	–
	Proportion by age class	–	0.2%	–	–	–	14.2%	23.2%	0.1%	–	49.4%	12.7%	–	–	0.2%	–	–	–
	SE of proportion	–	0.1%	–	–	–	1.8%	2.5%	0.1%	–	2.5%	1.9%	–	–	0.2%	–	–	–
	Sample size	–	2	–	–	–	97	76	1	–	287	70	–	–	1	–	–	534
1997	Number by age class	–	18	–	–	–	249	404	–	–	10,793	664	20	35	–	–	–	12,182
	SE of number	–	18	–	–	–	68	83	–	–	144	101	19	24	–	–	–	–
	Proportion by age class	–	0.1%	–	–	–	2.0%	3.3%	–	–	88.6%	5.5%	0.2%	0.3%	–	–	–	–
	SE of proportion	–	0.1%	–	–	–	0.6%	0.7%	–	–	1.2%	0.8%	0.2%	0.2%	–	–	–	–
	Sample size	–	1	–	–	–	13	22	–	–	580	37	1	2	–	–	–	656
1998	Number by age class	–	27	9	–	3	75	49	–	–	576	332	–	66	–	–	–	1,138
	SE of number	–	18	3	–	2	26	19	–	–	54	50	–	30	–	–	–	–
	Proportion by age class	–	2.4%	0.8%	–	0.3%	6.6%	4.3%	–	–	50.6%	29.2%	–	5.8%	–	–	–	–
	SE of proportion	–	1.5%	0.3%	–	0.2%	2.3%	1.6%	–	–	4.7%	4.4%	–	2.7%	–	–	–	–
	Sample size	–	2	3	–	1	9	7	–	–	81	32	–	5	–	–	–	140
1999	Number by age class	–	–	29	–	–	1,658	538	–	–	573	363	–	6	7	–	–	3,174
	SE of number	–	–	14	–	–	67	52	–	–	53	43	–	5	6	–	–	–
	Proportion by age class	–	–	0.9%	–	–	52.2%	17.0%	–	–	18.1%	11.4%	–	0.2%	0.2%	–	–	–
	SE of proportion	–	–	0.4%	–	–	2.1%	1.6%	–	–	1.7%	1.4%	–	0.2%	0.2%	–	–	–
	Sample size	–	–	4	–	–	245	77	–	–	81	53	–	1	1	–	–	462
2000	Number by age class	–	14	–	13	–	918	302	–	–	2,251	769	14	–	–	–	–	4,281
	SE of number	–	13	–	12	–	86	52	–	–	103	82	13	–	–	–	–	–
	Proportion by age class	–	0.3%	–	0.3%	–	21.4%	7.1%	–	–	52.6%	18.0%	0.3%	–	–	–	–	–
	SE of proportion	–	0.3%	–	0.3%	–	2.0%	1.2%	–	–	2.4%	1.9%	0.3%	–	–	–	–	–
	Sample size	–	1	–	1	–	94	33	–	–	257	70	1	–	–	–	–	457

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Year		Age class 0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	Total
2001	Number by age class	7	60	–	–	6	162	71	–	–	2,908	598	–	7	6	–	–	3,825
	SE of number	6	18	–	–	6	34	18	–	–	60	49	–	6	6	–	–	–
	Proportion by age class	0.2%	1.6%	–	–	0.2%	4.2%	1.9%	–	–	76.0%	15.6%	–	0.2%	0.2%	–	–	–
	SE of proportion	0.2%	0.5%	–	–	0.1%	0.9%	0.5%	–	–	1.6%	1.3%	–	0.2%	0.1%	–	–	–
	Sample size	1	9	–	–	1	25	14	–	–	591	120	–	1	1	–	–	763
2002	Number by age class	–	6	21	–	–	3,981	564	–	–	1,318	263	–	13	–	–	–	6,166
	SE of number	–	6	11	–	–	89	58	–	–	76	41	–	9	–	–	–	–
	Proportion by age class	–	0.1%	0.3%	–	–	64.6%	9.2%	–	–	21.4%	4.3%	–	0.2%	–	–	–	–
	SE of proportion	–	0.1%	0.2%	–	–	1.4%	0.9%	–	–	1.2%	0.7%	–	0.1%	–	–	–	–
	Sample size	–	1	3	–	–	582	77	–	–	197	36	–	2	–	–	–	898
2003	Number by age class	–	42	67	–	14	10,028	840	18	136	7,385	1,059	–	–	–	–	–	19,588
	SE of number	–	23	28	–	13	287	121	17	44	276	129	–	–	–	–	–	–
	Proportion by age class	–	0.2%	0.3%	–	0.1%	51.2%	4.3%	0.1%	0.7%	37.7%	5.4%	–	–	–	–	–	–
	SE of proportion	–	0.1%	0.1%	–	0.1%	1.5%	0.6%	0.1%	0.2%	1.4%	0.7%	–	–	–	–	–	–
	Sample size	–	3	5	–	1	622	50	1	9	437	65	–	–	–	–	–	1,193
2004	Number by age class	–	523	36	–	–	8,623	1,695	–	–	8,362	690	–	–	–	–	–	19,930
	SE of number	–	102	25	–	–	339	196	–	–	341	113	–	–	–	–	–	–
	Proportion by age class	–	2.6%	0.2%	–	–	43.3%	8.5%	–	–	42.0%	3.5%	–	–	–	–	–	–
	SE of proportion	–	0.5%	0.1%	–	–	1.7%	1.0%	–	–	1.7%	0.6%	–	–	–	–	–	–
	Sample size	–	25	2	–	–	385	84	–	–	387	39	–	–	–	–	–	922
2005	Number by age class	–	–	26	–	–	6,696	1,566	–	18	14,264	1,537	–	–	–	–	–	24,108
	SE of number	–	–	18	–	–	267	152	–	18	296	150	–	–	–	–	–	–
	Proportion by age class	–	–	0.1%	–	–	27.8%	6.5%	–	0.1%	59.2%	6.4%	–	–	–	–	–	–
	SE of proportion	–	–	0.1%	–	–	1.1%	0.6%	–	0.1%	1.2%	0.6%	–	–	–	–	–	–
	Sample size	–	–	2	–	–	440	98	–	1	900	97	–	–	–	–	–	1,538
2006	Number by age class	–	–	–	–	–	20,815	3,467	–	–	16,642	1,604	–	–	–	–	–	42,529
	SE of number	–	–	–	–	–	1,029	488	–	–	1,000	303	–	–	–	–	–	–
	Proportion by age class	–	–	–	–	–	48.9%	8.2%	–	–	39.1%	3.8%	–	–	–	–	–	–
	SE of proportion	–	–	–	–	–	2.4%	1.1%	–	–	2.4%	0.7%	–	–	–	–	–	–
	Sample size	–	–	–	–	–	314	102	–	–	357	46	–	–	–	–	–	819
2007	Number by age class	–	–	–	–	–	2,266	592	–	–	25,915	5,304	–	–	–	–	–	34,077
	SE of number	–	–	–	–	–	383	188	–	–	655	555	–	–	–	–	–	–
	Proportion by age class	–	–	–	–	–	6.6%	1.7%	–	–	76.0%	15.6%	–	–	–	–	–	–
	SE of proportion	–	–	–	–	–	1.1%	0.6%	–	–	1.9%	1.6%	–	–	–	–	–	–
	Sample size	–	–	–	–	–	34	11	–	–	494	96	–	–	–	–	–	635

-continued-

Year		Age class																Total
		0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	
2008	Number by age class	–	–	–	–	–	1,437	855	–	–	708	445	–	129	16	–	–	3,590
	SE of number	–	–	–	–	–	90	77	–	–	77	60	–	35	16	–	–	–
	Proportion by age class	–	–	–	–	–	40.0%	23.8%	–	–	19.7%	12.4%	–	3.6%	0.4%	–	–	–
	SE of proportion	–	–	–	–	–	2.5%	2.1%	–	–	2.1%	1.7%	–	1.0%	0.4%	–	–	–
	Sample size	–	–	–	–	–	140	90	–	–	67	44	–	13	1	–	–	355
2009	Number by age class	–	–	–	–	–	2,407	1,588	–	–	4,397	1,091	–	–	–	–	–	9,483
	SE of number	–	–	–	–	–	151	135	–	–	174	118	–	–	–	–	–	–
	Proportion by age class	–	–	–	–	–	25.4%	16.7%	–	–	46.4%	11.5%	–	–	–	–	–	–
	SE of proportion	–	–	–	–	–	1.6%	1.4%	–	–	1.8%	1.2%	–	–	–	–	–	–
	Sample size	–	–	–	–	–	186	106	–	–	342	75	–	–	–	–	–	709
2010	Number by age class	–	–	–	–	–	3,020	2,762	17	–	7,987	1,728	120	12	–	–	–	15,646
	SE of number	–	–	–	–	–	199	188	17	–	247	158	48	11	–	–	–	–
	Proportion by age class	–	–	–	–	–	19.3%	17.7%	0.1%	–	51.0%	11.0%	0.8%	0.1%	–	–	–	–
	SE of proportion	–	–	–	–	–	1.3%	1.2%	0.1%	–	1.6%	1.0%	0.3%	0.1%	–	–	–	–
	Sample size	–	–	–	–	–	184	144	1	–	499	107	6	1	–	–	–	942
2011	Number by age class	–	–	–	–	–	796	9,019	11	–	7,898	4,261	–	43	–	–	–	22,029
	SE of number	–	–	–	–	–	118	313	11	–	285	261	–	26	–	–	–	–
	Proportion by age class	–	–	–	–	–	3.6%	40.9%	0.1%	–	35.9%	19.3%	–	0.2%	–	–	–	–
	SE of proportion	–	–	–	–	–	0.5%	1.4%	0.0%	–	1.3%	1.2%	–	0.1%	–	–	–	–
	Sample size	–	–	–	–	–	47	447	1	–	496	215	–	3	–	–	–	1,209
2012	Number by age class	–	–	–	–	–	313	1,370	43	–	3,927	7,629	–	50	22	–	–	13,353
	SE of number	–	–	–	–	–	84	163	30	–	241	266	–	34	0	–	–	–
	Proportion by age class	–	–	–	–	–	2.3%	10.3%	0.3%	–	29.4%	57.1%	–	0.4%	0.2%	–	–	–
	SE of proportion	–	–	–	–	–	0.6%	1.2%	0.2%	–	1.8%	2.0%	–	0.3%	–	–	–	–
	Sample size	–	–	–	–	–	13	59	2	–	175	335	–	2	1	–	–	587
2013	Number by age class	–	–	–	–	–	1,689	406	14	–	300	3,485	33	21	–	–	–	5,946
	SE of number	–	–	–	–	–	119	63	14	–	56	130	18	14	–	–	–	–
	Proportion by age class	–	–	–	–	–	28.4%	6.8%	0.2%	–	5.0%	58.6%	0.6%	0.3%	–	–	–	–
	SE of proportion	–	–	–	–	–	2.0%	1.1%	0.2%	–	0.9%	2.2%	0.3%	0.2%	–	–	–	–
	Sample size	–	–	–	–	–	135	38	1	–	26	297	3	2	–	–	–	502
2014	Number by age class	–	20	71	–	–	3,319	1,333	–	–	5,376	278	–	–	–	–	–	10,397
	SE of number	–	19	41	–	–	195	143	–	–	202	65	–	–	–	–	–	–
	Proportion by age class	–	0.2%	0.7%	–	–	31.9%	12.8%	–	–	51.7%	2.7%	–	–	–	–	–	–
	SE of proportion	–	0.2%	0.4%	–	–	1.9%	1.4%	–	–	1.9%	0.6%	–	–	–	–	–	–
	Sample size	–	1	3	–	–	196	69	–	–	351	18	–	–	–	–	–	638

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Year		Age class																Total
		0.1	1.1	2.1	3.1	0.2	1.2	2.2	3.2	0.3	1.3	2.3	3.3	1.4	2.4	1.5	2.5	
2015	Number by age class	–	–	12	–	–	6,010	4,815	24	–	8,835	1,559	–	41	–	–	–	21,298
	SE of number	–	–	12	–	–	323	291	16	–	369	201	–	41	–	–	–	–
	Proportion by age class	–	–	0.1%	–	–	28.2%	22.6%	0.1%	–	41.5%	7.3%	–	0.2%	–	–	–	–
	SE of proportion	–	–	0.1%	–	–	1.5%	1.4%	0.1%	–	1.7%	0.9%	–	0.2%	–	–	–	–
	Sample size	–	–	1	–	–	261	253	2	–	380	66	–	1	–	–	–	964
2016	Number by age class	–	–	–	–	–	1,645	1,029	–	–	8,577	1,603	–	15	–	–	–	12,868
	SE of number	–	–	–	–	–	193	189	–	–	261	218	–	15	–	–	–	–
	Proportion by age class	–	–	–	–	–	12.8%	8.0%	–	–	66.7%	12.5%	–	0.1%	–	–	–	–
	SE of proportion	–	–	–	–	–	1.5%	1.5%	–	–	2.0%	1.7%	–	0.1%	–	–	–	–
	Sample size	–	–	–	–	–	75	27	–	–	455	61	–	1	–	–	–	619
2017	Number by age class	–	–	–	–	–	274	425	24	–	11,432	2,401	–	157	–	–	–	14,753
	SE of number	–	–	–	–	–	56	76	16	–	195	176	–	45	–	–	–	–
	Proportion by age class	–	–	–	–	–	1.9%	2.9%	0.2%	–	77.5%	16.3%	–	1.1%	–	–	–	–
	SE of proportion	–	–	–	–	–	0.4%	0.5%	0.1%	–	1.3%	1.2%	–	0.3%	–	–	–	–
	Sample size	–	–	–	–	–	21	30	2	–	827	154	–	12	–	–	–	1,049
2018	Number by age class	–	–	–	–	11	976	97	–	–	578	323	–	53	–	–	–	2,039
	SE of number	–	–	–	–	10	52	14	–	–	46	38	–	14	–	–	–	–
	Proportion by age class	–	–	–	–	0.5%	47.9%	4.8%	–	–	28.4%	15.9%	–	2.6%	–	–	–	–
	SE of proportion	–	–	–	–	0.5%	2.6%	0.7%	–	–	2.2%	1.9%	–	0.7%	–	–	–	–
	Sample size	–	–	–	–	1	215	32	–	–	150	79	–	15	–	–	–	492
2019	Number by age class	–	25	10	–	–	215	43	–	–	1,829	115	–	3	–	–	–	2,241
	SE of number	–	17	9	–	–	44	18	–	–	55	32	–	3	–	–	–	–
	Proportion by age class	–	1.1%	0.4%	–	–	9.6%	1.9%	–	–	81.6%	5.2%	–	0.2%	–	–	–	–
	SE of proportion	–	0.8%	0.4%	–	–	2.0%	0.8%	–	–	2.5%	1.4%	–	0.1%	–	–	–	–
	Sample size	–	2	1	–	–	28	7	–	–	246	14	–	1	–	–	–	299
2020	Number by age class	–	–	–	–	–	1,110	1,544	–	–	1,103	91	–	12	–	–	–	3,860
	SE of number	–	–	–	–	–	146	147	–	–	87	30	–	11	–	–	–	–
	Proportion by age class	–	–	–	–	–	28.8%	40.0%	–	–	28.6%	2.4%	–	0.3%	–	–	–	–
	SE of proportion	–	–	–	–	–	27.8%	27.9%	–	–	26.3%	9.1%	–	3.4%	–	–	–	–
	Sample size	–	–	–	–	–	95	132	–	–	95	8	–	1	–	–	–	331
2021	Number by age class	–	–	–	–	–	324	78	–	–	2,388	440	–	–	5	–	–	3,235
	SE of number	–	–	–	–	–	36	18	–	–	53	41	–	–	5	–	–	–
	Proportion by age class	–	–	–	–	–	10.0%	2.4%	–	–	73.8%	13.6%	–	–	0.2%	–	–	–
	SE of proportion	–	–	–	–	–	5.8%	2.8%	–	–	8.5%	6.7%	–	–	0.8%	–	–	–
	Sample size	–	–	–	–	–	58	15	–	–	441	80	–	–	1	–	–	595

Note: Due to rounding, the sum of percentages may not equal 100.0.

Appendix H.–Reported subsistence harvest, subsistence harvest rate of the terminal run of Hugh Smith Lake sockeye salmon, and CPUE, 1985–2021.

Year	Sockeye salmon harvested	Permit days	CPUE	Escapement	Subsistence harvest and escapement	Subsistence harvest rate
1985	190	10	19.0	11,246	11,436	1.7%
1986	92	5	18.4	6,337	6,429	1.4%
1987	233	14	16.6	31,195	31,428	0.7%
1988	22	4	5.5	4,604	4,626	0.5%
1989	–	–	–	4,934	4,934	–
1990	20	2	10.0	1,257	1,277	1.6%
1991	–	–	–	5,495	5,495	–
1992	–	–	–	65,408	65,408	–
1993	–	–	–	11,794	11,794	–
1994	–	–	–	8,187	8,187	–
1995	–	–	–	3,129	3,129	–
1996	–	–	–	6,553	6,553	–
1997	38	4	9.5	12,154	12,192	0.3%
1998	–	–	–	897	897	–
1999	–	–	–	2,878	2,878	–
2000	–	–	–	3,989	3,989	–
2001	–	–	–	3,551	3,551	–
2002	–	–	–	5,880	5,880	–
2003	–	–	–	19,568	19,568	–
2004	–	–	–	19,734	19,734	–
2005	12	1	12.0	23,872	23,884	0.1%
2006	84	5	16.8	42,112	42,196	0.2%
2007	269	22	12.2	33,743	34,012	0.8%
2008	–	–	–	3,588	3,588	–
2009	85	8	10.6	9,483	9,568	0.9%
2010	14	1	14.0	15,646	15,660	0.1%
2011	0	1	0.0	22,029	22,029	0.0%
2012	499	38	13.1	13,353	13,852	3.6%
2013	756	63	12.0	5,946	6,702	11.3%
2014	457	39	11.7	10,397	10,854	4.2%
2015	892	76	11.7	21,298	22,190	4.0%
2016	488	45	10.8	12,868	13,356	3.7%
2017	629	54	11.6	14,748	15,377	4.1%
2018	54	14	3.9	2,039	2,093	2.6%
2019	521	37	14.1	2,241	2,762	18.9%
2020	70	21	3.3	3,860	3,930	1.8%
2021	111	12	9.3	3,235	3,346	3.3%

Note: Dashes indicate years in which no subsistence harvest effort was reported for Sockeye Creek.

Appendix I.–Genetic stock identification (GSI) based harvest estimates of Hugh Smith Lake sockeye salmon including upper and lower 90% confidence intervals (CI), weir counts, subsistence harvest, total run, and rates of harvest, 2014–2021.

	GSI based estimates						Harvest rates			
	Common	90% CI						90% CI		Common
Year	property harvest	Lower	Upper	Escapement (weir count)	Subsistence harvest	Total run	Common property	Lower	Upper	property and subsistence
2014	15,030	10,145	25,175	10,397	457	25,884	58.1%	48.3%	69.9%	59.8%
2015	24,343	19,064	43,408	21,298	892	46,533	52.3%	46.2%	66.2%	54.2%
2016	36,198	31,946	40,450	12,868	488	49,554	73.0%	70.5%	75.2%	74.0%
2017	13,760	12,526	14,994	14,753	629	29,142	47.2%	44.9%	49.4%	49.4%
2018	4,031	3,163	4,899	2,039	54	6,124	65.8%	60.2%	70.1%	66.7%
2019	9,122	3,858	14,387	2,241	521	11,884	76.8%	58.3%	83.9%	81.1%
2020	2,386	1,101	3,672	3,860	70	6,1316	37.8%	21.9%	48.3%	38.9%
2021	12,809	7,805	17,814	3,235	111	16,155	79.3%	70.0%	84.2%	80.0%
Average	14,850	11,330	20,752	8,836	403	24,090	61.3%	52.5%	68.4%	63.0%

Appendix J.–Proportional stock composition estimates, standard deviation (SD), 90% credible intervals, and total harvest estimates of Hugh Smith Lake sockeye salmon based on genetic mixed stock analysis, 2021.

					Hugh Smith Lake sockeye salmon harvest contribution					
							90% credible intervals			
Gear	District-sub district	Statistical week	Harvest	MSA sample size	Estimated proportion	SD	Lower	Upper	Point estimate	Harvest SD
Purse seine	101	28–31	34,860	182	0.034	0.03	0.00	0.08	1,185.5	884.2
		32–34	38,169	184	0.000	0.00	0.00	0.00	0.0	66.0
		35–36	21,562	188	0.001	0.01	0.00	0.01	24.1	112.7
	102	26–28	1,332	187	0.000	0.00	0.00	0.00	0.0	5.7
		29–31	15,959	183	0.000	0.01	0.00	0.01	0.0	85.1
		32–34	25,294	178	0.042	0.02	0.02	0.07	1,053.0	429.1
		35–36	26,876	187	0.000	0.00	0.00	0.00	0.0	33.3
	103	30–36	28,229	550	0.009	0.01	0.00	0.03	259.2	262.9
	104	29	15,249	298	0.008	0.01	0.00	0.04	119.1	161.3
		30	34,055	305	0.009	0.01	0.00	0.04	290.6	386.9
		31	117,498	344	0.034	0.02	0.01	0.07	4,005.9	1,776.6
		32	138,502	265	0.000	0.01	0.00	0.04	0.0	1,511.6
		33	42,828	263	0.010	0.01	0.00	0.04	435.4	543.5
		34	55,722	130	0.020	0.02	0.00	0.06	1,116.1	910.3
		35	65,857	130	0.056	0.02	0.02	0.10	3,654.3	1,378.2
		36	26,693	130	0.002	0.01	0.00	0.04	54.3	286.6
	106[a]	31	53	–	0.001	0.00	0.00	0.00	0.0	0.2
		32	897	–	0.001	0.00	0.00	0.00	0.5	4.2
		33	13,069	–	0.000	0.00	0.00	0.00	0.2	4.1
		34	6,826	–	0.000	0.00	0.00	0.00	0.1	2.0
		35	5,975	–	0.000	0.00	0.00	0.00	0.2	2.8
		36	1,817	–	0.000	0.00	0.00	0.00	0.0	0.7
Purse seine subtotal[b]	All	All	717,322	3,704					12,198	

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Gear	District-sub district	Statistical week	Harvest	MSA sample size	Hugh Smith Lake sockeye salmon harvest contribution: Estimated proportion	SD	90% credible interval: Lower	Upper	Point estimate	Harvest SD
Drift gillnet	101-11 [b]	26	487	220	0.000	0.00	0.00	0.01	0.0	1.1
		27	2,348	247	0.007	0.01	0.00	0.02	15.7	14.4
		28	2,984	294	0.001	0.00	0.00	0.01	3.4	12.6
		29	2,240	260	0.020	0.01	0.00	0.05	44.1	26.2
		30	3,567	296	0.039	0.01	0.02	0.07	138.0	44.4
		31	3,158	255	0.024	0.01	0.00	0.05	77.2	43.4
		32	1,632	255	0.123	0.02	0.08	0.17	200.0	36.3
		33	2,354	258	0.014	0.01	0.00	0.04	32.3	29.7
		34	1,003	256	0.030	0.01	0.00	0.06	30.5	14.7
		35	633	235	0.024	0.02	0.00	0.06	15.2	11.5
		36	1,052	224	0.015	0.02	0.00	0.06	15.5	19.0
		37–39	119	ND	0.015	0.02	0.00	0.06	1.8	2.2
	106-30 [b]	26–27	27	ND	0.000	0.00	0.00	0.00	0.0	0.0
		28	353	100	0.000	0.00	0.00	0.00	0.0	0.4
		29	516	87	0.000	0.00	0.00	0.00	0.0	0.9
		30	1,608	100	0.000	0.00	0.00	0.00	0.1	1.8
		31	2,595	143	0.001	0.00	0.00	0.00	1.4	9.7
		32	2,684	128	0.001	0.00	0.00	0.00	1.4	12.5
		33	1,359	102	0.000	0.00	0.00	0.00	0.0	0.4
		34	6,379	182	0.000	0.00	0.00	0.00	0.1	1.8
		35	2,078	87	0.000	0.00	0.00	0.00	0.1	1.0
		36–40	1,274	105	0.000	0.00	0.00	0.00	0.0	0.5
	106-41	26	955	101	0.002	0.01	0.00	0.01	2.0	5.9
		27	873	104	0.000	0.00	0.00	0.00	0.0	0.3
		28	1,552	100	0.020	0.02	0.00	0.07	29.1	35.4
		29	430	104	0.000	0.00	0.00	0.00	0.1	1.3
		30	1,476	98	0.000	0.00	0.00	0.00	0.0	0.5
		31	1,607	99	0.000	0.00	0.00	0.00	0.1	2.4
		32	4,562	174	0.000	0.00	0.00	0.00	0.1	1.8
		33	6,461	185	0.000	0.00	0.00	0.00	0.1	2.1
		34	7,949	173	0.000	0.00	0.00	0.00	0.1	1.9
		35	6,255	171	0.000	0.00	0.00	0.00	0.2	2.4
		36–38	783	104	0.000	0.00	0.00	0.00	0.0	0.4
	108	33–39	815	100	0.000	0.00	0.00	0.00	0.1	0.0
Drift gillnet subtotal	All	All	74,168	5,347					611	
All gear types	All districts	All weeks	791,490	9,051					12,809	

[a] Genetic proportions from drift gillnet 106-30 fishery are applied to purse seine 106.

[b] Totals and subtotals are rounded to the nearest whole fish.

[c] ND = no data; adjacent proportions are applied to harvest not sampled in a given time period