Fishery Data Series No. 15-47

Hugh Smith Lake Sockeye Salmon Studies, 2014

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

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ABSTRACT

In 2014, we continued long-term sockeye salmon population studies at Hugh Smith Lake designed to evaluate adult sockeye salmon abundance and juvenile production. An estimated 95,000 sockeye salmon smolt were passed through the smolt weir, which was operated at the outlet of the lake from 19 April to 31 May. We estimated 71% of the emigrating sockeye salmon smolt were freshwater age 1 and 29% were freshwater age 2. From 16 June to 9 November we enumerated the adult salmon escapement through a weir, conducted an ancillary mark–recapture estimate to confirm the weir count, and collected biological information to estimate the age, length, and sex composition of the sockeye salmon escapement. The 2014 weir count of 10,397 adult sockeye salmon was the tenth escapement in the past 12 years to meet the optimal escapement goal range of 8,000–18,000 adult sockeye salmon. Age-1.3 adults were the dominant returning age class, representing an estimated 52% of the total spawning population, which was composed of 3-ocean fish (54%) and 2-ocean fish (45%). Peak counts of live fish on the spawning grounds were observed on 23 September in Buschmann Creek (1,133 fish) and 17 September in Cobb Creek (44 fish). The reported subsistence harvest of 457 sockeye salmon was the third largest harvest since 1985.

Key words: escapement, Hugh Smith Lake, mark–recapture, *Oncorhynchus nerka*, optimal escapement goal, sockeye salmon, stock of concern.

INTRODUCTION

Located southeast of Ketchikan, Alaska, in Boca de Quadra Inlet, Hugh Smith Lake 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 2 canneries in Boca de Quadra Inlet and a saltery adjacent to the estuary of Hugh Smith Lake (Rich and Ball 1933; Roppel 1982). A private hatchery was operated at the head of the lake from 1901 to 1903 and also 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 maintained a weir at the outlet of Hugh Smith Lake from 1967 to 1971 and annually since 1980. Beginning in the early 1980s, the lake was the subject of ADF&G enhancement and rehabilitation efforts which included nutrient enrichment from 1981 to 1984, and fry plants from 1986 to 1997 (Geiger et al. 2003). The vast majority of juveniles from these early stocking programs were not marked, so detailed information on the proportion of stocked fish in subsequent escapements is unavailable. Despite rehabilitation efforts, total escapements declined from an average of 17,500 fish in the 1980s, to 12,000 in the 1990s, and 3,500 fish from 1998 to 2002, including the lowest recorded escapement of 1,138 fish in 1998.

In 2003, the Alaska Board of Fisheries (BOF) classified Hugh Smith Lake sockeye salmon 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 BOF 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 it contained measures to reduce commercial harvests of Hugh Smith Lake sockeye salmon when the projected escapement was below the lower end of the escapement goal range. Fishery restrictions, in the form of time and area closures, affected the commercial net fisheries closest to the entrance of Boca de Quadra (Figure 1). The rehabilitation effort included Southern Southeast Regional Aquaculture Association's (SSRAA) existing stocking program for which eggs were collected from Buschmann Creek, then reared and thermal marked at Burnett Inlet Hatchery. Each spring, from 1999 through 2003, thermal-marked fry were returned to Hugh Smith Lake and fed in net pens to pre-smolt size until they were released in summer. ADF&G estimated the contribution, distribution, and run timing of stocked Hugh Smith Lake sockeye salmon in the commercial net fisheries from recoveries of marked fish when these fish returned from 2003 to 2007. Results from this project showed that management restrictions outlined in the action plan were appropriately timed and located to reduce harvests on this stock (Heinl et al. 2007).

Adult escapements have steadily improved from a low of 1,138 in 1998 and surpassed the lower bound of the escapement goal in 9 of 11 years, 2003–2013 (Brunette and Piston 2015). Fish from the SSRAA stocking program made up a significant portion of the escapements from 2003 to 2007 (Piston et al. 2006 and 2007) and Hugh Smith Lake sockeye salmon's stock of concern status was removed in 2006 due to an improvement in escapements (Geiger et al. 2005). Additionally, ADF&G conducted studies to identify factors that might limit juvenile sockeye salmon survival at various stages of their early life history; however, these studies did not identify any factors in the freshwater environment that would increase mortality of juvenile sockeye salmon (Piston et al. 2006 and 2007; Piston 2008).

Population studies at Hugh Smith Lake constitute the longest time series of escapement and age, sex, and length (ASL) information for both sockeye and coho (*O. kisutch*) salmon (Shaul et al. 2009) in southern Southeast Alaska. Thus, these are important indicator stocks that provide useful information for managing local Southeast Alaska fisheries. At Hugh Smith Lake, we estimated sockeye salmon smolt abundance through the smolt weir in the spring and estimated the escapement through an adult counting weir in summer and early fall to determine if the escapement goal was met. We also conducted an ancillary mark–recapture study to provide a secondary escapement estimate if the adult weir failed. ASL data were collected from a subset of sockeye salmon smolt and adults at the weirs, and bi-weekly foot surveys were conducted on both inlet streams to count spawning salmon.

STUDY SITE

Hugh Smith Lake (55° 06' N, 134° 40' W; Orth 1967) 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 $222.7 \cdot 10^6$ m^3 (Figure 2). Hugh Smith Lake empties into Boca de Quadra Inlet via 50-m-long Sockeye Creek (ADF&G Anadromous Waters Catalog number 101-30-10750). Sockeye salmon spawn in 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" 101-30-10750-3003); and Cobb Creek flows north 8 km to the southeast head of the lake (ADF&G Anadromous Waters Catalog number 101-30-10750-2004; Figure 2). Cobb Creek has a barrier to anadromous migration approximately 0.8 km upstream from the lake. Hugh Smith Lake is meromictic and a layer of saltwater located below 60 m does not interact with the upper freshwater layer of the lake.

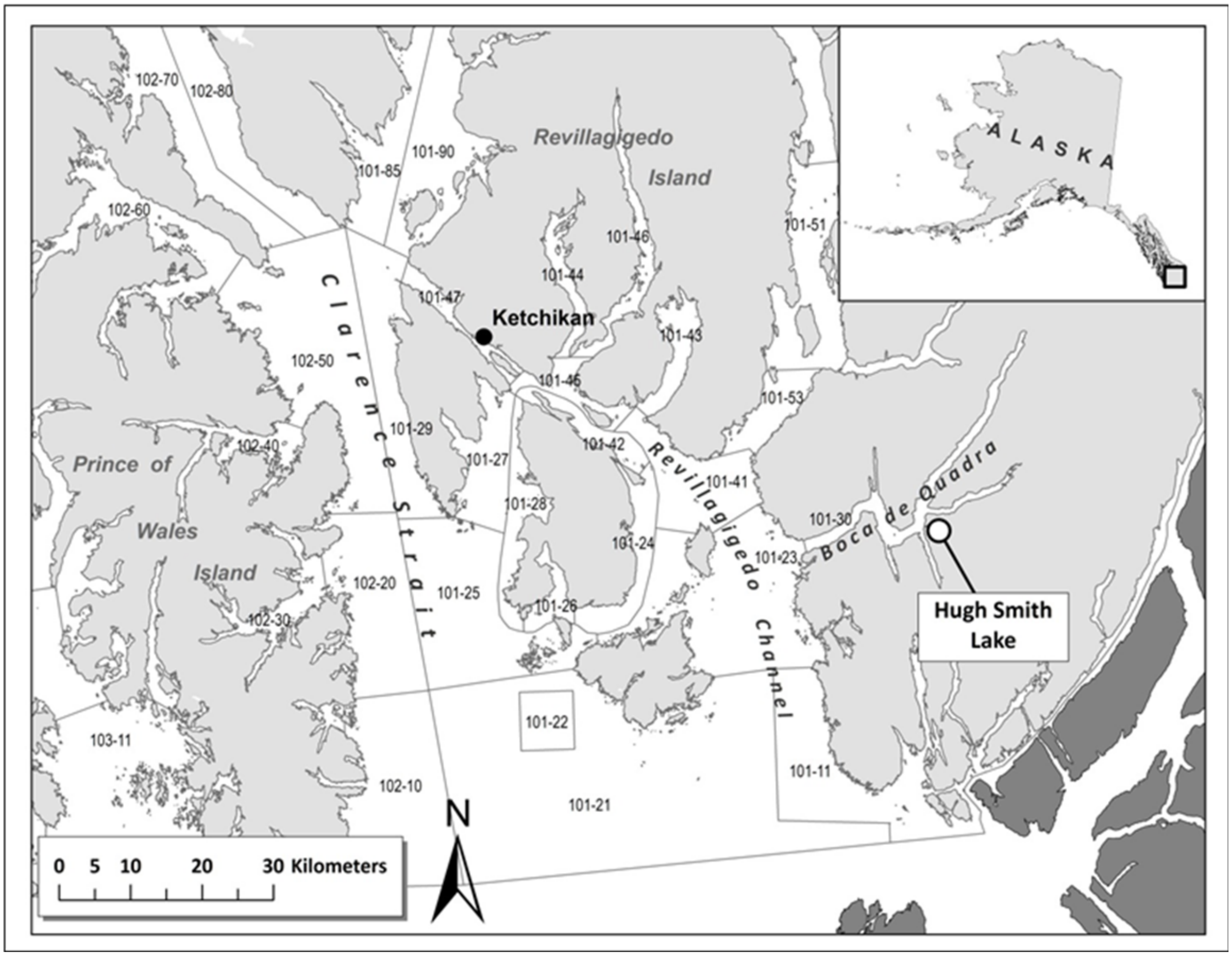

Figure 1.–The location of Hugh Smith Lake in Southeast Alaska.

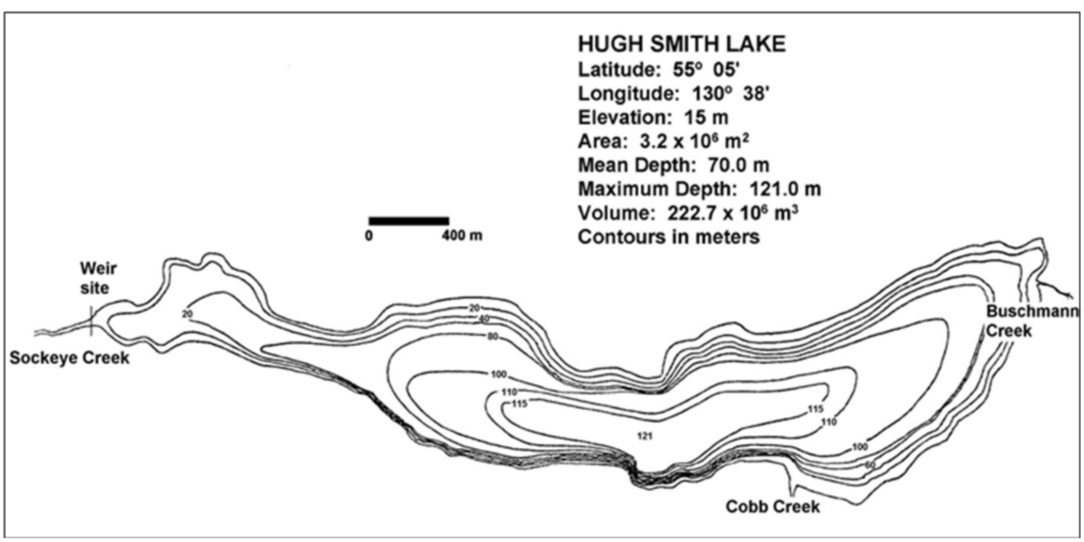

Figure 2.–Bathymetric map of Hugh Smith Lake, Southeast Alaska, showing the location of the weir, the 2 primary inlet streams, and other features of the lake system.

METHODS

SMOLT EMIGRATION

Since 1982, coho and sockeye salmon smolt have been counted and sampled through a smolt weir as they emigrate from Hugh Smith Lake each spring (Shaul et al. 2009 provided a physical description of weir). In 2014, the smolt weir was operated from 19 April to 31 May. Fish were counted through the weir by species and scale samples and length-weight data were collected from sockeye salmon smolt. Sixteen scale samples were collected on days when fewer than 100 fish were captured at the weir and 28 scale samples were collected on days when more than 100 fish were captured. The length (snout-to-fork in mm) and weight (to the nearest 0.1 g) were recorded for each fish sampled. A preferred-area scale smear (Clutter and Whitesel 1956) was collected from each fish and mounted on a 2.5 cm by 7.5 cm glass slide, 4 fish per slide, and scales were aged at the Ketchikan ADF&G office using a video-linked microscope.

Total smolt weir counts have tended to underestimate the true smolt population size due to fish escaping past the weir uncounted and passing before and after the weir was installed. An unknown but presumably small number of smolt also passed through a small, deep opening designed to allow adult steelhead unimpeded passage through the weir. Hugh Smith Lake coho salmon smolt tagging data from 1982 to 2006 showed that capture rate at the smolt weir was highly variable, ranging from 14% to 84%. Improvements made to prevent smolt from passing the weir uncounted increased capture efficiency to an average of 70% for coho salmon smolt from 1996 to 2006 (Shaul et al. 2009).

ADULT ESCAPEMENT

Weir Counts

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. In 2014, the weir was operated from mid-June to early November. A concurrent mark–recapture study and periodic underwater inspections were conducted to verify the integrity of the weir.

The weir was an aluminum bi-pod channel-and-picket design with an upstream trap divided into 2 sections: a smaller section exclusively for enumerating salmon, and a larger section for enumerating and sampling salmon. Guillotine-style drop-closing doors on both trap sections enabled us to pass fish freely into the lake or immediately close the trap door when a fish of interest was identified. Hugh Smith Lake coho salmon are an important indicator stock in Southeast Alaska, so it was imperative that all coho salmon were examined for the presence of coded-wire tags before they entered the lake (Shaul et al. 2005 and 2009). The guillotine doors allowed us to meet the sampling goals of the ongoing coho salmon study while efficiently counting and freely passing 90% of all salmon into the lake.

Fish passage was also monitored with an underwater video camera, and the video recording was reviewed daily to verify the weir count. If a coho salmon passed through the doors unexamined, we were able to determine if its adipose fin was present on the video recording. Additionally, we applied 4–6 mil plastic sheeting to the upstream face of the weir during periods of low water to concentrate the stream flow through the trap. The increase in current prompted fish to move upstream into the trap, thereby reducing their holding time below the weir (Piston and Brunette 2010).

Mark–recapture

Two-sample mark–recapture studies are an essential component of estimating the adult sockeye escapement at Hugh Smith Lake. Mark–recapture estimates are used to verify the weir count if fish passed the weir uncounted during extreme flood events, or if substantial numbers of sockeye salmon entered the lake before the weir was fish tight in mid-June. Ten percent of adult sockeye salmon (fish >400 mm in length) were anesthetized in a clove oil solution at the weir (Woolsey et al. 2004), marked with a readily identifiable fin clip, sampled for scales, and released upstream. Fish that did not appear healthy were not marked. Marking was stratified through time by applying fin clips on the following schedule: right pelvic fin clip from 18 June to 18 July, left pelvic fin clip from 19 July to 15 August, and a partial dorsal fin clip from 16 August to 29 September. We did not conduct a mark–recapture study for jack sockeye salmon (<400 mm) because most swim freely between the weir pickets and relatively few are trapped. In previous years, we have been unable to mark and recover enough fish to obtain a valid population estimate for jack sockeye salmon.

Weekly surveys were conducted at Buschmann and Cobb creeks beginning statistical week 34 (generally the third week of August; Appendix A) to sample spawners for marks. Live fish were captured and examined for marks using a beach seine off the creek mouth or dip nets in the spawning channels. All recovered carcasses found on stream surveys were also examined for marks. Each fish examined was recorded as unmarked (no fin clip) or by its mark type (right pelvic, left pelvic, or dorsal fin clip) and given a secondary mark (a left operculum hole punch) to prevent double sampling on subsequent sampling events. Our goal was to examine at least 600 sockeye salmon over the entire spawning season. A sample size of 600 fish in the second sampling event should yield a population estimate with a coefficient of variation less than 15%, when a population of nearly 5,000 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. SPAS was designed for analysis of 2-sample mark–recapture data where marks and recoveries take place over a number of strata. This program was based on work by Chapman and Junge (1956), Darroch (1961), Seber (1982), and Plante (1990). We used this software to calculate the following: 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. We typically chose full pooling of the data (i.e., the pooled-Petersen estimate) if the result of either of these tests was not significant (P>0.05). Our goal was to estimate the escapement such that the coefficient of variation was no greater than 15% of the point estimate. The manipulation of release and recovery strata in calculating estimates (the method used in SPAS) was presented and discussed at length by Schwarz and Taylor (1998).

The weir count was used as the official escapement estimate if it fell within the 95% confidence interval of the mark–recapture estimate. This was the same criterion used in previous years (Geiger et al. 2003). The escapement goal was met if the weir count fell within the escapement goal range and was within the 95% confidence interval of the mark–recapture estimate. If both the weir count and the mark–recapture estimate were below the lower bound of the escapement goal range, the goal would not have been met. In the case where one or the other estimate fell within the escapement goal range, the weir count would be used as the official escapement estimate, unless the weir count was below the lower bound of the 95% confidence interval of the mark–recapture estimate. We chose to use the mark–recapture “point” estimate for the purpose of judging the escapement objective.

Adult Length, Sex, and Scale Sampling

The age composition of adult sockeye salmon at Hugh Smith Lake was determined from a minimum of 600 scale samples collected from live fish at the weir. This sample size was selected based on work by Thompson (1992) for calculating a sample size to estimate several proportions simultaneously. A sample size of 510 fish was needed to ensure the estimated proportion of each adult sockeye salmon age class would be within 5% of the true value 95% of the time. We increased our sampling goal to 600 scale samples to guarantee the sample goal would be achieved even if 15% of the scales were unreadable. We collected scale samples from 1 out of every 10 fish (10%) at the beginning of the summer and adjusted the sampling rate, if necessary, based on inseason escapement projections. Mideye to tail fork length and sex data were recorded for each fish sampled. Fish shorter than 400 mm were counted as jacks and not included in the adult sockeye salmon age composition sample. Three scales were collected from the preferred area (i.e., the left side of the fish, 2 scale rows above the lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin; INPFC 1963), placed on a gum card, and prepared for analysis as described by Clutter and Whitesel (1956). Scales were analyzed in the fall 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 B).

STREAM COUNTS

Live and dead salmon were counted, by species, during surveys of Buschmann and Cobb creeks. Cobb Creek was surveyed from the mouth to the barrier falls (0.8 km; 55° 05.35 N, 130° 38.673 W). Buschmann Creek was typically surveyed to the top of the Hatchery Channel on the right fork, and to the drained beaver ponds on the left fork (Figure 3). Effort was focused on areas with the highest abundance of spawning fish.

What we have generally called Buschmann Creek actually consists of 2 separate creeks, draining 2 separate valleys, which meet in their lower reaches. The stream flowing from the southeast valley is Buschmann Creek and the tributary flowing out of the northeast valley that meets Buschmann Creek, at what we have called the Main Fork, is referred to as the “Beaver Pond Channel” (Figure 3). The Beaver Pond Channel was named for the beaver dams and ponds along its length.

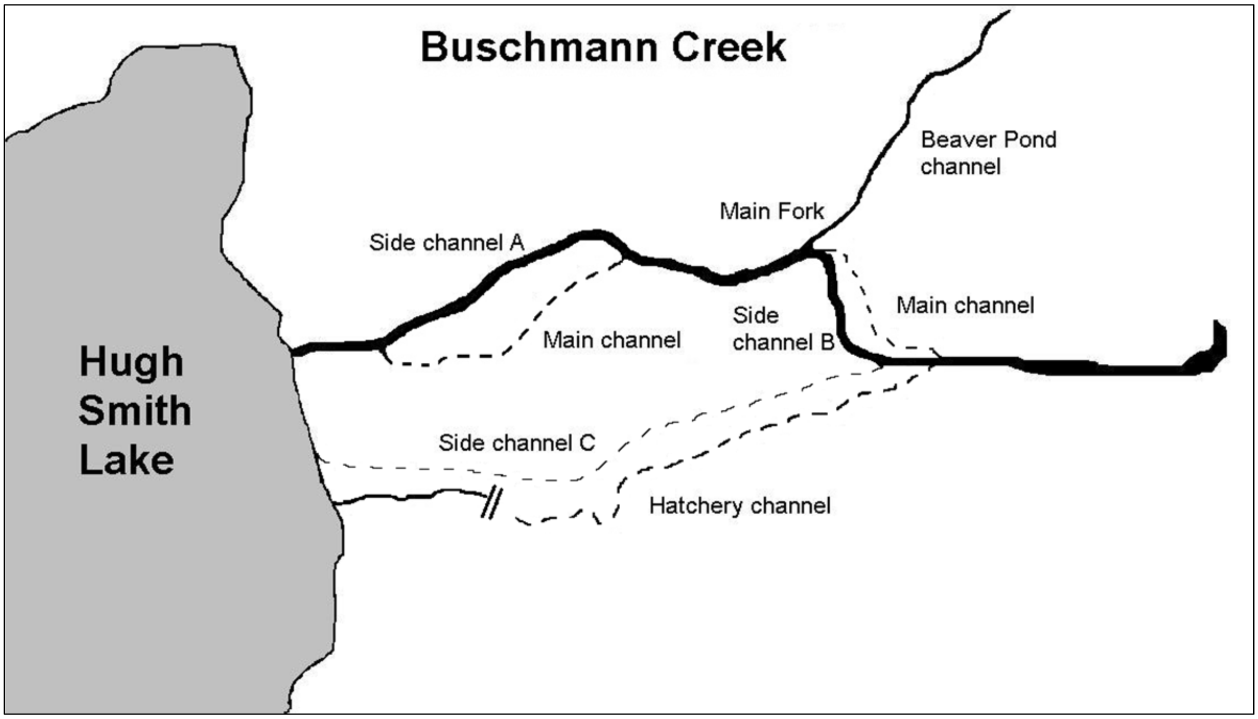

Figure 3.–Schematic diagram of the main flow of lower Buschmann Creek, as of October 2014. Dashed lines indicate channels that did not have adequate water flow to accommodate spawning salmon. Hatchery channel was blocked by a beaver dam in 2014.

SUBSISTENCE HARVEST

The Sockeye Creek subsistence fishery takes place 300 feet below the weir and within 500 feet of the terminus of Sockeye creek at the estuary confluence with Boca de Quadra. In 2014, the fishery was open from 22 June to 31 July and permitted fishers were allowed to retain 12 sockeye salmon daily, with no annual limit. Fishery participants were required to obtain an ADF&G-issued Personal Use and Subsistence Fishing permit prior to fishing, and to return their permit with their detailed harvest record by 10 November 2014 even if they did not fish. ADF&G documented the annual reported subsistence harvest and effort for each subsistence or personal use area fished based exclusively on reporting cooperation from fishery participants. Reported subsistence harvest is likely a minimum harvest estimate due to a proportion of permits and harvest records that are not returned each year (13–25% from 1985 to 2014).

RESULTS

SMOLT EMIGRATION

An estimated 95,000 sockeye salmon smolt were counted through the smolt weir between 24 April and 30 May (Table 1, Figure 4). In the first week of smolt emigration, persistent rainfall caused the lake level to rise and water to flow over a central section of the smolt weir from 7 May to 9 May. Thousands of smolt likely swam over the weir uncounted during this brief period prior to the peak of emigration; therefore, the 2014 smolt weir count underrepresents the true smolt population size. Emigration peaked during the second and third weeks of May, and approximately 27,300 sockeye salmon smolt passed on 16 May. Fish passage declined to low levels during the last week of May when the smolt weir was removed.

We collected 843 scale samples from sockeye salmon smolt and determined the freshwater age composition, weighted by week, to be 71% age-1 and 29% age-2 (Figure 5, Table 1). Mean lengths by age class were 76 mm for age-1 and 89 mm for age-2 smolt. Mean weights by age class were 3.9 g for age-1 and 6.0 g age-2 smolt (Table 2).

Table 1.–Hugh Smith Lake sockeye salmon smolt counts, hatchery releases, and freshwater age composition, 1981–2014. 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			Wild smolt	Stocked smolt	Percent stocked
					Age 1	Age 2	Age 3			
1980	-	-	1981	319,000	71%	29%	0%	319,000	-	-
1981	-	-	1982	90,000	83%	18%	0%	90,000	-	-
1982	-	-	1983	77,000	60%	40%	0%	77,000	-	-
1983	-	-	1984	330,000	92%	8%	0%	330,000	-	-
1984	-	-	1985	40,000	51%	48%	1%	40,000	-	-
1985	-	-	1986	58,000	73%	24%	3%	58,000	-	-
1986	273,000	Unfed Fry	1987	105,000	42%	57%	1%	-------	No data	-------
1987	250,000	Unfed Fry	1988	54,000	65%	35%	0%	-------	No data	-------
1988	1,206,000	Unfed Fry	1989	427,000	83%	17%	0%	-------	No data	-------
1989	532,800	Unfed Fry	1990	137,000	31%	68%	2%	-------	No data	-------
1990	1,480,800	Unfed Fry	1991	75,000	64%	36%	0%	-------	No data	-------
1991	-	-	1992	15,000	42%	57%	1%	-------	No data	-------
1992	477,500	Fed Fry	1993	36,000	63%	36%	2%	-------	No data	-------
1993	-	-	1994	43,000	75%	21%	4%	-------	No data	-------
1994	645,000	Unfed Fry	1995	19,000	38%	62%	0%	-------	No data	-------
1995	418,000	Unfed Fry	1996	16,000	44%	40%	16%	-------	No data	-------
1996	358,000	Unfed Fry/ Pre-Smolt[a]	1997	44,000	52%	40%	8%	26,000	18,000	40%
1997	573,000	Unfed Fry[a]	1998	65,000 [b]	81%	18%	1%	34,000	30,000	47%
1998	-	-	1999	42,000	68%	32%	0%	39,000	3,000	4%
1999	202,000	Pre-smolt[c]	2000	72,000	77%	22%	1%	-------	No data	-------
2000	380,000	Pre-smolt[c]	2001	189,000	91%	8%	1%	44,000	145,000	77%
2001	445,000	Pre-smolt[c]	2002	297,000	88%	12%	0%	134,000	163,000	55%
2002	465,000	Pre-smolt[c]	2003	261,000	86%	14%	0%	76,000	185,000	71%
2003	420,000	Pre-smolt[c]	2004	364,000	88%	12%	0%	194,000	170,000	47%
2004	-	-	2005	77,000	54%	46%	0%	77,000	-	-
2005	-	-	2006	119,000	63%	36%	1%	119,000	-	-
2006	-	-	2007	89,000	71%	27%	2%	89,000	-	-
2007	-	-	2008	59,000	62%	37%	1%	59,000	-	-
2008	-	-	2009	116,000	40%	59%	1%	116,000	-	-
2009	-	-	2010	64,000	19%	79%	2%	64,000	-	-
2010	-	-	2011	244,000	89%	10%	1%	244,000	-	-
2011	-	-	2012	179,000	72%	28%	0%	179,000	-	-
2012	-	-	2013	186,000	74%	26%	0%	186,000	-	-
2013	-	-	2014	95,000	71%	29%	0%	95,000	-	-

[a] In 1996, Southern Southeast Regional Aquaculture Association released 251,123 unfed fry into the lake in May and 106,833 pre-smolt in October. All fish released in 1996 and 1997 were otolith marked.

[b] In 1998, the total smolt count does not equal the sum of wild and stocked smolt due to rounding.

[c] From 1999–2003, fry were pen-reared at the outlet of the lake beginning in late May and released as pre-smolt in late July and early August. All fish from those releases were otolith marked.

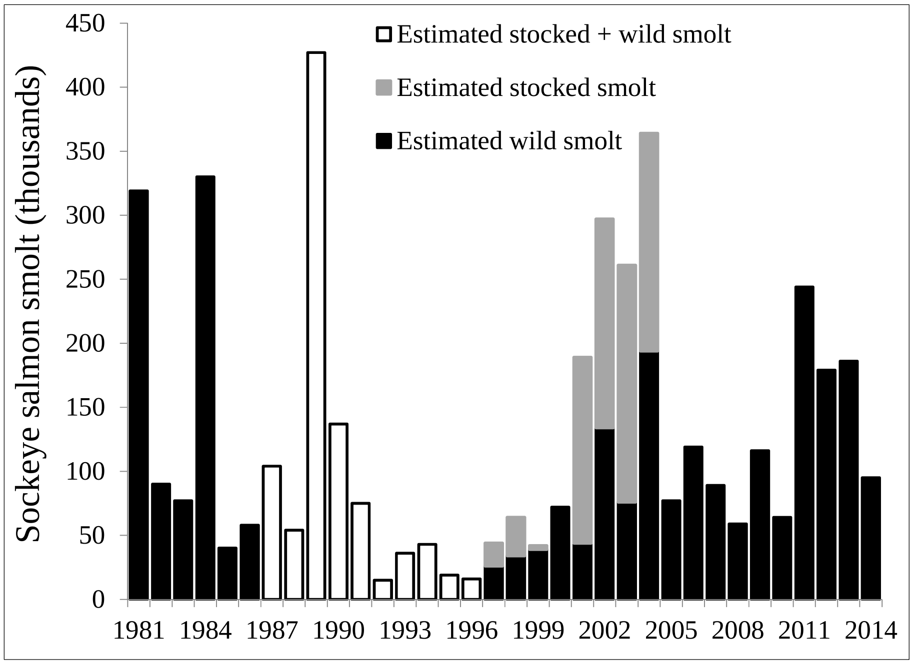

Figure 4.–Annual smolt weir counts at Hugh Smith Lake, 1981–2014. Divided bars show estimates of wild (black) and stocked (grey) smolt for years in which proportions of stocked smolt were estimated from otoliths collected at the weir (1997–1999 and 2001–2004). Stocked fish released prior to 1996 were unmarked.

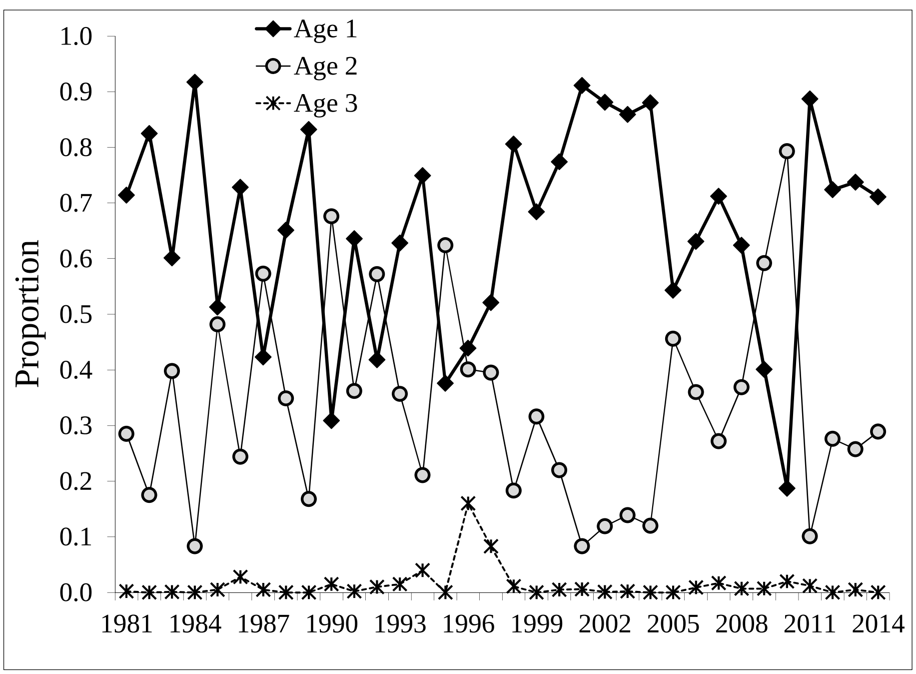

Figure 5.–Age composition of sockeye salmon smolt at Hugh Smith Lake, 1981–2014.

Table 2.–Lengths and weights of sockeye salmon smolt by freshwater age, weighted by week, 2014.

	Smolt age	
	Age-1	Age-2
Number sampled	619	224
Mean length (mm)	76	89
Standard error (mm)	0.5	0.6
Maximum length (mm)	94	154
Minimum length (mm)	58	75
Number sampled	605	221
Mean weight (g)	3.9	6.0
Standard error (g)	0.1	0.1
Maximum weight (g)	7.0	28.7
Minimum weight (g)	1.6	3.6

ADULT ESCAPEMENT

Weir and Stream Counts

The adult weir was operated from 16 June to 9 November, and during that time 10,397 adult sockeye salmon and 350 jacks were counted through the weir into the lake (Appendix C). This was the eighth year the optimal escapement goal range of 8,000–18,000 sockeye salmon was met exclusively with wild fish in the past decade (Figure 6). The midpoint of the run occurred on 28 July, and the 75th percentile occurred 3 days later on 31 July. No handling mortalities were observed at the weir in 2014. Peak counts of live sockeye salmon in the spawning tributaries were observed on 23 September at Buschmann Creek (1,133 fish; Table 3) and on 17 September at Cobb Creek (44 fish; Table 4).

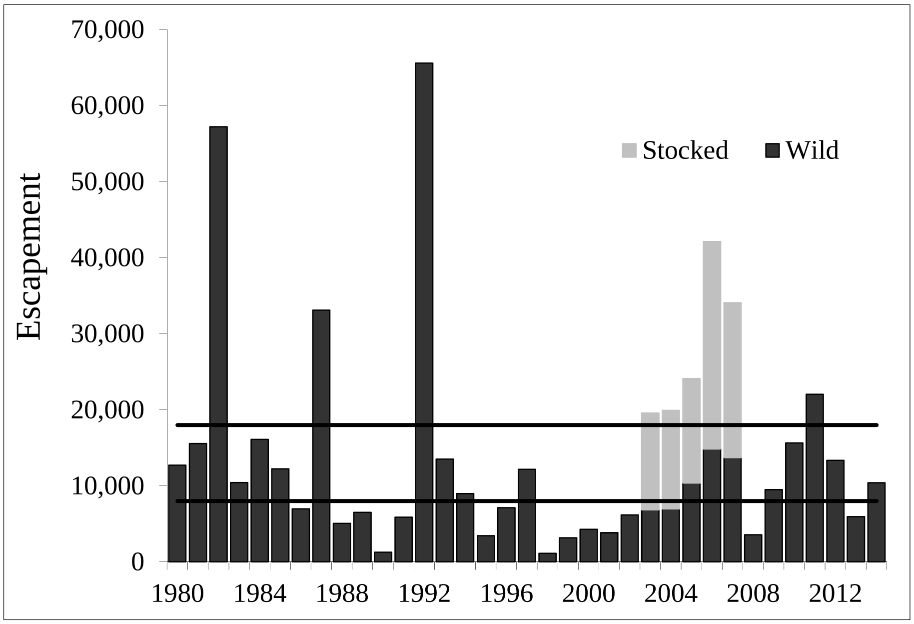

Figure 6.–Annual sockeye salmon escapement at Hugh Smith Lake, 1980–2014. Black horizontal lines indicate the current optimal escapement goal range of 8,000–18,000 adult sockeye salmon, which includes both wild and hatchery stocked fish. From 2003 to 2007, the bars are divided to show our estimate of wild (black) and stocked fish (grey) 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.

Table 3.–Mouth and stream counts of adult sockeye salmon in Buschmann Creek by section, 2014.

Date	Mouth estimate	Main channel	Side channel A	Side channel B	Stream total
21-Aug	265	71	56	NA	127
28-Aug	500	143	223	NA	366
4-Sep	700	272	239	295	806
8-Sep	1,000	183	408	155	746
13-Sep	900	68	128	49	245
17-Sep	700	59	143	28	230
23-Sep	NA	244	358	531	1,133
30-Sep	NA	200	119	223	542

Table 4.–Mouth and stream counts of adult sockeye salmon in Cobb Creek, 2014.

Date	Mouth estimate	Stream total
21-Aug	NA	0
28-Aug	1	0
8-Sep	NA	22
17-Sep	NA	44

Mark–recapture

A total of 1,039 adult sockeye salmon were marked at the weir over 3 marking strata: 233 were marked with a right ventral fin clip (18 June–18 July), 730 were marked with a left ventral fin clip (19 July–15 August), and 76 were marked with a partial dorsal fin clip (16 August–29 September). Recapture sampling was conducted on the spawning grounds from 21 August to 23 October, and all sockeye salmon carcasses that washed up on the weir were also inspected for marks through 9 November. A total of 1,326 fish were sampled for fin clips, of which 134 fish were marked (Table 5). The result of the χ^2 test for complete mixing of marked fish between the marking and recapture events was significant (P=0.01); however, the result of the χ^2 test for equal proportions of marked fish on the spawning grounds was not significant (P>0.05). The pooled-Petersen mark–recapture estimate was 10,222 adult sockeye salmon (SE=775; 95% CI=8,703–11,741 fish; Appendix D), which was within 200 fish of the weir count of 10,397. Since the weir count fell within the 95% confidence interval of the pooled-Peterson estimate, the weir count was the official escapement estimate in accordance with our established methods.

Table 5.–Daily number of fish inspected for marks by release stratum for the adult sockeye salmon mark–recapture study, 2014.

		Marked fish			Unmarked	Total
Date	Sampling area	Right pelvic fin	Left pelvic fin	Dorsal fin	fish	examined
21-Aug	Buschmann Creek	1	1	0	33	35
28-Aug	Buschmann Creek	8	4	0	93	105
4-Sep	Buschmann Creek	8	5	0	147	160
8-Sep	Buschmann Creek	6	13	0	173	192
13-Sep	Buschmann Creek	5	13	0	130	148
17-Sep	Buschmann Creek	5	14	0	135	154
17-Sep	Cobb Creek	0	1	0	23	24
19-Sep	Weir	0	0	0	1	1
23-Sep	Buschmann Creek	4	30	1	322	357
23-Sep	Weir	1	0	0	0	1
26-Sep	Weir	0	0	0	1	1
27-Sep	Weir	0	0	0	2	2
30-Sep	Weir	0	1	0	1	2
30-Sep	Buschmann Creek	0	10	1	96	107
30-Sep	Cobb Creek	0	0	0	2	2
1-Oct	Cobb Creek	0	0	0	1	1
1–2-Oct	Weir	0	0	0	3	3
4-Oct	Weir	0	0	0	1	1
6-Oct	Weir	0	0	0	1	1
6-Oct	Buschmann Creek	0	1	0	9	10
7-Oct	Weir	0	0	0	2	2
8-Oct	Cobb Creek	0	0	0	2	2
9-Oct	Weir	0	1	0	2	3
10-Oct	Cobb Creek	0	0	0	4	4
14–15-Oct	Weir	0	0	0	2	2
21-Oct	Buschmann Creek	0	0	0	4	4
23-Oct	Cobb Creek	0	0	0	1	1
23-Oct	Buschmann Creek	0	0	0	1	1
	Total	38	94	2	1,192	1,326

Adult Length, Sex, and Scale Sampling

Based on scale pattern analysis, 54% of the escapement was composed of 3-ocean fish (an estimated 5,632 sockeye salmon) and 45% was composed of 2-ocean fish (4,683 sockeye salmon; Figures 7 and 8; Appendix E). The 2 most abundant adult age classes were age-1.3 fish (52%), followed by age-1.2 fish (32%; Table 6). Of the 638 readable scale samples collected at the weir, 4 fish were identified as jacks (Table 6). Those 4 jacks were all large enough (>400 mm) to have been classified as adults at the weir.

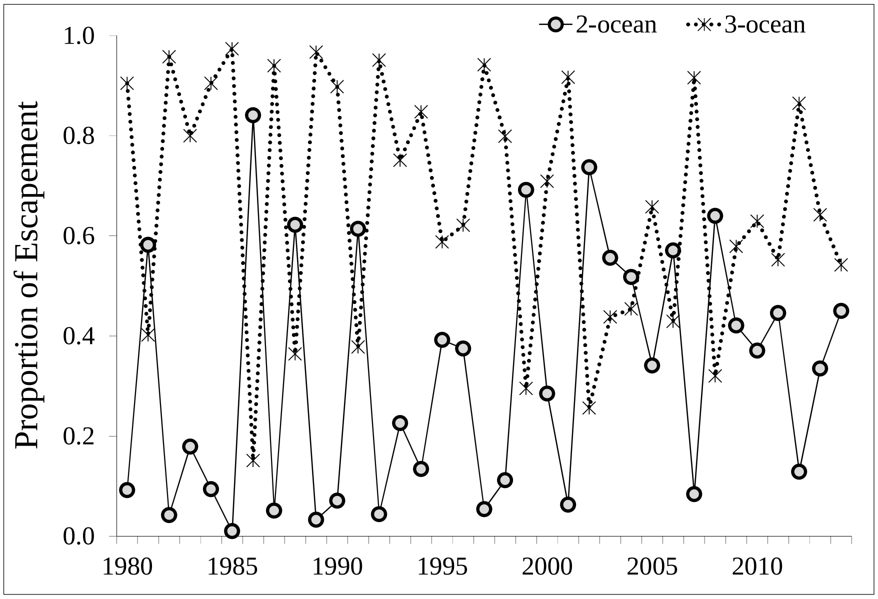

Figure 7.–Annual proportions of 2-ocean and 3-ocean aged sockeye salmon in the Hugh Smith Lake escapement, 1980–2014.

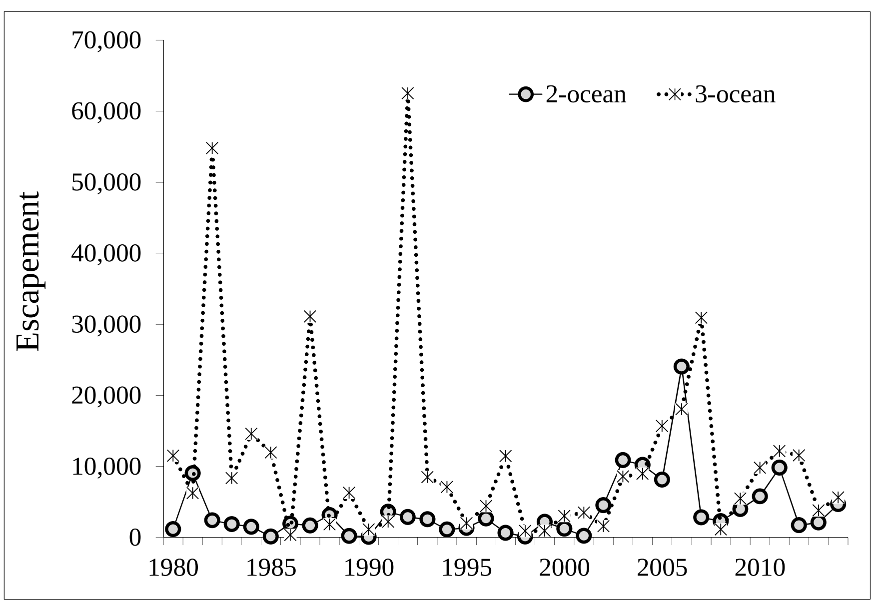

Figure 8.–Annual numbers of 2-ocean and 3-ocean aged sockeye salmon in the Hugh Smith Lake escapement, 1980–2014.

Table 6.–Age composition of the 2014 adult sockeye salmon escapement at Hugh Smith Lake based on scale samples, weighted by statistical week.

		Age class						
		Ocean-age-1		Ocean-age-2		Ocean-age-3		
Statistical week		1.1	2.1	1.2	2.2	1.3	2.3	Total
25–26	724	0	0	11	2	52	4	69
	Proportion	0.0%	0.0%	15.9%	2.9%	75.4%	5.8%	
	Esc. Age Class	0	0	115	21	546	42	
	SE of %	0.0%	0.0%	4.2%	1.9%	5.0%	2.7%	
27	943	0	0	16	2	58	3	79
	Proportion	0.0%	0.0%	20.3%	2.5%	73.4%	3.8%	
	Esc. Age Class	0	0	191	24	692	36	
	SE of %	0.0%	0.0%	4.4%	1.7%	4.8%	2.1%	
28–29	676	0	0	16	3	40	1	60
	Proportion	0.0%	0.0%	26.7%	5.0%	66.7%	1.7%	
	Esc. Age Class	0	0	180	34	451	11	
	SE of %	0.0%	0.0%	5.5%	2.7%	5.9%	1.6%	
30	954	0	0	35	7	41	1	84
	Proportion	0.0%	0.0%	41.7%	8.3%	48.8%	1.2%	
	Esc. Age Class	0	0	398	80	466	11	
	SE of %	0.0%	0.0%	5.2%	2.9%	5.2%	1.1%	
31	5,002	1	1	82	32	132	8	256
	Proportion	0.4%	0.4%	32.0%	12.5%	51.6%	3.1%	
	Esc. Age Class	20	20	1,602	625	2,579	156	
	SE of %	0.4%	0.4%	2.8%	2.0%	3.0%	1.1%	
32	578	0	0	12	2	9	0	23
	Proportion	0.0%	0.0%	52.2%	8.7%	39.1%	0.0%	
	Esc. Age Class	0	0	302	50	226	0	
	SE of %	0.0%	0.0%	10.4%	5.9%	10.2%	0.0%	
33	815	0	1	15	12	10	1	39
	Proportion	0.0%	2.6%	38.5%	30.8%	25.6%	2.6%	
	Esc. Age Class	0	21	313	251	209	21	
	SE of %	0.0%	2.5%	7.7%	7.3%	6.9%	2.5%	
34	333	0	0	6	3	7	0	16
	Proportion	0.0%	0.0%	37.5%	18.8%	43.8%	0.0%	
	Esc. Age Class	0	0	125	62	146	0	
	SE of %	0.0%	0.0%	12.2%	9.8%	12.5%	0.0%	
35–42	372	0	1	3	6	2	0	12
	Proportion	0.0%	8.3%	25.0%	50.0%	16.7%	0.0%	
	Esc. Age Class	0	31	93	186	62	0	
	SE of %	0.0%	8.2%	12.8%	14.8%	11.1%	0.0%	
Total	Escapement 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 %	0.2%	0.4%	1.9%	1.4%	1.9%	0.6%	
	Sample size	1	3	196	69	351	18	638

SUBSISTENCE HARVEST

The 2014 reported Sockeye Creek subsistence harvest was 457 Hugh Smith Lake sockeye salmon, with 24 permits reported having participated in the fishery.

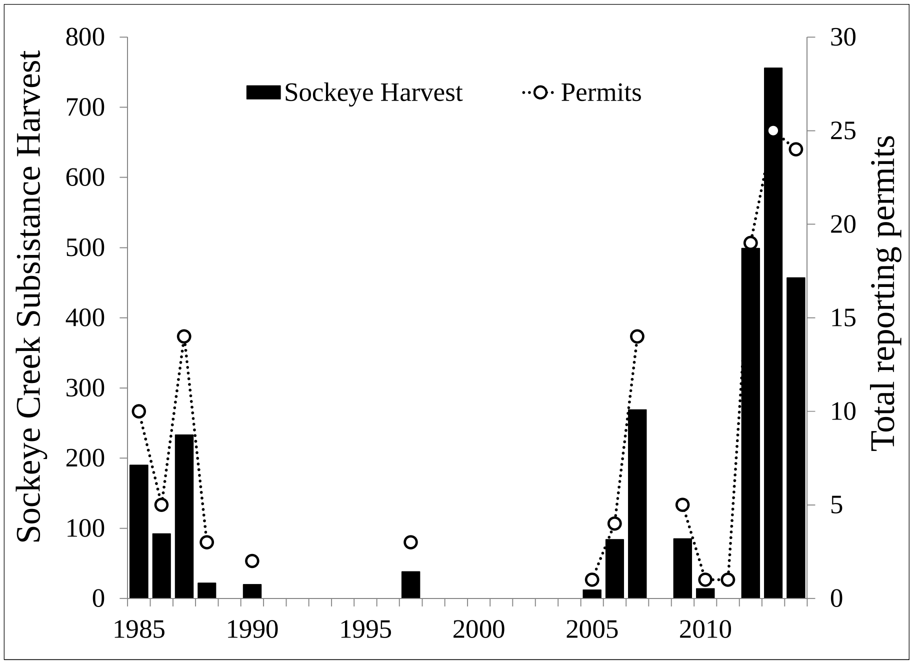

Figure 9.–Reported sockeye salmon subsistence harvest in the Hugh Smith Lake estuary (Sockeye Creek) and number of permits fished annually, 1985–2014.

DISCUSSION

The 2014 weir count of 10,397 adult sockeye salmon was above the lower bound of the Hugh Smith Lake optimal escapement goal range of 8,000–18,000 spawners, and escapements have now met or exceeded the goal ten times in the past 12 years (Figure 6). Run timing at the weir was earlier in 2014 than the historical average (1982–2013). The 75th percentile of the run was reached on the fifth earliest date since 1982 (31 July, Appendix C), and, for the third year in a row, more than 80% of the sockeye salmon escapement had already passed through the weir by the historical average midpoint date (3 August). More than half of the total escapement passed through the weir in the 10-day period of 22 July to 31 July.

Although ADF&G does not produce formal forecasts of Hugh Smith Lake sockeye salmon runs, several indicators suggest runs will be above average in the next 2 years. The 2014 weir count of 350 jack sockeye salmon was the second highest count since we began actively counting jacks in 2001. The 4 jacks identified in our adult scale sample were all large enough to be initially classified as adults at the weir. Both the high abundance and potentially larger size of ocean age-1 jack sockeye salmon observed in 2014 may indicate favorable marine growth conditions for fish that went to sea in 2013. In the years immediately following a weir count of more than 275 jacks, wild sockeye salmon escapements to Hugh Smith Lake averaged 12,000 adults. In addition, the number of 2-ocean fish in this year’s escapement (4,683) was the fourth highest since 1980, excluding years with returns from the 1999–2003 pre-smolt stocking program. The 5 largest escapements of 2-ocean fish since 1980 were all followed by escapements of 3-ocean fish in excess of 8,000. All of these factors bode well for the sockeye salmon escapement at Hugh Smith Lake in 2015.

Participation in the subsistence fishery was high in 2014 and was second only to 2013 as the highest reported effort on record. Recent reported harvests also continue to be higher than what has historically been reported. Prior to 2012, both subsistence harvest and effort was low, averaging 88 fish and 5 permits annually (Figure 9). Since 2012, the subsistence harvest has increased 640% to an average 570 fish, and reported effort has increased 440% to average 22 permits fished annually. In addition, the subsistence harvest proportion of the terminal run size has increased from 1% prior to 2012, to 4% (2012, 2014) and 11% (2013) of the terminal run size. Beginning in 2012, the Sockeye Creek subsistence fishery was extended for 2 additional weeks in an effort to match open periods for other southern Southeast Alaska subsistence fishing locations and provide more harvest opportunity. This 2-week extension appears to have resulted in increased participation and harvest since an average 72% of the subsistence harvest was caught during this formerly closed 2-week period in 2012 and 2013. In 2014, however; 92% of the harvest occurred prior to 15 July due to the earlier timing of the run.

Since an initial inventory of spawning habitat on Buschmann Creek was made in 2004 (Piston et al. 2006), the spawning channels in the lower drainage have gradually shifted. Two secondary channels, side channels A and B (Figure 3), have slowly become the primary channels with the vast majority of stream flow. As would be expected, the distribution of spawning sockeye salmon has also shifted with the stream flow. Counts of spawning sockeye salmon in these relatively new channels have increased and now account for the majority of spawning fish (Table 4). The lower reaches of Buschmann Creek are flat, unstable, and prone to frequent changes, but the changes observed since 2004 do not appear to have had any obvious effects on the overall sockeye salmon population based on recent smolt counts and adult escapements.

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APPENDICES

Appendix A.–2014 statistical week calendar start and end dates.

Week	Start	End
1	1-Jan	4-Jan
2	5-Jan	11-Jan
3	12-Jan	18-Jan
4	19-Jan	25-Jan
5	26-Jan	1-Feb
6	2-Feb	8-Feb
7	9-Feb	15-Feb
8	16-Feb	22-Feb
9	23-Feb	1-Mar
10	2-Mar	8-Mar
11	9-Mar	15-Mar
12	16-Mar	22-Mar
13	23-Mar	29-Mar
14	30-Mar	5-Apr
15	6-Apr	12-Apr
16	13-Apr	19-Apr
17	20-Apr	26-Apr
18	27-Apr	3-May
19	4-May	10-May
20	11-May	17-May
21	18-May	24-May
22	25-May	31-May
23	1-Jun	7-Jun
24	8-Jun	14-Jun
25	15-Jun	21-Jun
26	22-Jun	28-Jun
27	29-Jun	5-Jul

Week	Start	End
28	6-Jul	12-Jul
29	13-Jul	19-Jul
30	20-Jul	26-Jul
31	27-Jul	2-Aug
32	3-Aug	9-Aug
33	10-Aug	16-Aug
34	17-Aug	23-Aug
35	24-Aug	30-Aug
36	31-Aug	6-Sep
37	7-Sep	13-Sep
38	14-Sep	20-Sep
39	21-Sep	27-Sep
40	28-Sep	4-Oct
41	5-Oct	11-Oct
42	12-Oct	18-Oct
43	19-Oct	25-Oct
44	26-Oct	1-Nov
45	2-Nov	8-Nov
46	9-Nov	15-Nov
47	16-Nov	22-Nov
48	23-Nov	29-Nov
49	30-Nov	6-Dec
50	7-Dec	13-Dec
51	14-Dec	20-Dec
52	21-Dec	27-Dec
53	28-Dec	31-Dec

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:

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

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

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

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

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

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

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

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

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

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

Appendix C.–Escapement and run timing for Hugh Smith Lake sockeye salmon, 1967–2014.

Year	1967	1968	1969	1970	1971	1980	1981	1982	1983	1984
Weir Count	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106
Total Escapement [a]	ND [b]	ND	ND	ND	ND	12,714	ND	57,219	10,429	16,106
Wild fish	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106
Stocked fish	0	0	0	0	0	0	0	0	0	0
Weir Mortalities	ND	ND	ND	ND	ND	ND	ND	81	45	134
Adults used for egg takes	0	0	0	0	0	0	0	0	0	439
Spawning Escapement [d]	ND	ND	ND	ND	ND	ND	ND	57,138	10,384	15,533
Jacks (not included in weir count) [e]	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
Ending Date	3-Sep	21-Aug	14-Aug	1-Sep	22-Aug	4-Oct	8-Sep	27-Nov	30-Nov	26-Nov
Days Elapsed	94	69	64	84	63	121	93	176	184	178
Date of First Sockeye	13-Jun	14-Jun	11-Jun	11-Jun	20-Jun	6-Jun	8-Jun	7-Jun	1-Jun	6-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
Days Elapsed for sockeye caught	82	68	64	82	63	120	92	140	146	166
10th Percentile Run Date	22-Jun	2-Jul	26-Jun	26-Jun	1-Jul	4-Jul	28-Jun	20-Jun	11-Jul	14-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
50th Percentile Run Date	7-Jul	15-Aug	20-Jul	27-Jul	20-Jul	6-Aug	27-Jul	9-Jul	11-Aug	8-Aug
75th Percentile Run Date	18-Jul	19-Aug	7-Aug	6-Aug	19-Aug	26-Aug	24-Aug	18-Jul	4-Sep	26-Aug
90th Percentile Run Date	28-Jul	21-Aug	9-Aug	13-Aug	20-Aug	9-Sep	3-Sep	7-Aug	24-Sep	10-Sep

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Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Weir Count	12,245	2,312	33,097	5,056	6,513	1,285	5,885	65,737	11,312	8,386
Total Escapement [a]	12,245	6,968 [c]	33,097	5,056	6,513	1,285	5,885	65,737	13,532	8,992
Wild fish [b]	12,245	6,968	33,097	5,056	ND[c]	ND	ND	ND	ND	ND
Stocked fish [b]	0	0	0	0	ND	ND	ND	ND	ND	ND
Weir Mortalities	201	12	0	28	32	28	33	151	278	42
Adults used for egg takes	798	619	1,902	424	1,547	0	357	178	1,460	763
Spawning Escapement [d]	11,246	6,337	31,195	4,604	4,934	1,257	5,495	65,408	11,794	8,187
Jacks (not included in weir count) [e]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Starting Date	1-Jun	17-Jun	3-Jun	5-Jun	3-Jun	8-Jun	17-Jun	16-Jun	17-Jun	20-Jun
Ending Date	11-Nov	29-Oct	21-Oct	22-Oct	25-Oct	31-Oct	9-Oct	25-Oct	4-Nov	1-Nov
Days Elapsed	163	134	140	139	144	145	114	131	140	134
Date of First Sockeye	5-Jun	18-Jun	8-Jun	12-Jun	11-Jun	13-Jun	19-Jun	16-Jun	20-Jun	20-Jun
Date of Last Sockeye	29-Oct	3-Oct	4-Oct	16-Oct	18-Oct	21-Oct	11-Oct	18-Oct	3-Nov	26-Oct
Days Elapsed for sockeye caught	146	107	118	126	129	130	114	124	136	128
10th Percentile Run Date	12-Jul	11-Jul	18-Jul	19-Jul	30-Jul	8-Jul	22-Jul	12-Jul	2-Jul	20-Jul
25th Percentile Run Date	25-Jul	15-Jul	20-Jul	24-Jul	5-Aug	23-Jul	29-Jul	19-Jul	16-Jul	1-Aug
50th Percentile Run Date	23-Aug	20-Jul	4-Aug	9-Aug	10-Aug	27-Aug	21-Aug	27-Jul	30-Jul	23-Aug
75th Percentile Run Date	2-Sep	28-Jul	30-Aug	25-Aug	14-Aug	7-Sep	12-Sep	29-Jul	14-Aug	26-Aug
90th Percentile Run Date	13-Sep	8-Aug	31-Aug	1-Sep	22-Aug	16-Sep	22-Sep	11-Aug	31-Aug	3-Sep

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Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Weir Count	3,424	7,123	12,182	1,138	3,174	4,281	3,665	6,166	19,588	19,930
Total Escapement [a]	3,452	7,123	12,182	1,138	3,174	4,281	3,825	6,166	19,588	19,930
Wild fish [b]	ND	ND	ND	ND	ND	ND[c]	ND	ND	6,856	6,976
Stocked fish [b]	ND	ND	ND	ND	ND	ND	ND	ND	12,732	12,955
Weir Mortalities	11	57	28	23	20	12	6	0	20	196
Adults used for egg takes	312	513	0	218	276	280	268	286	0	0
Spawning Escapement [b]	3,129	6,553	12,154	897	2,878	3,989	3,551	5,880	19,568	19,734
Jacks (not included in weir count)	ND	ND	ND	ND	ND	ND	ND	167	1,356	147
Starting Date	17-Jun	17-Jun	18-Jun	17-Jun	16-Jun	17-Jun	16-Jun	17-Jun	17-Jun	17-Jun
Ending Date	3-Nov	4-Nov	5-Nov	11-Nov	8-Nov	11-Nov	11-Nov	4-Nov	7-Nov	7-Nov
Days Elapsed	139	140	140	147	145	147	148	140	146	142
Date of First Sockeye	19-Jun	20-Jun	18-Jun	19-Jun	22-Jun	19-Jun	19-Jun	19-Jun	19-Jun	18-Jun
Date of Last Sockeye	1-Nov	20-Oct	1-Nov	12-Oct	4-Oct	27-Oct	6-Oct	17-Oct	2-Nov	31-Oct
Days Elapsed for sockeye caught	135	122	136	115	104	130	109	120	136	135
10th Percentile Run Date	7-Jul	25-Jul	3-Jul	8-Jul	7-Jul	29-Jun	2-Jul	10-Jul	2-Aug	8-Jul
25th Percentile Run Date	17-Jul	11-Aug	16-Jul	21-Jul	15-Jul	7-Jul	18-Jul	4-Aug	17-Aug	4-Aug
50th Percentile Run Date	29-Jul	19-Aug	25-Jul	30-Jul	31-Jul	20-Jul	17-Aug	7-Aug	21-Aug	6-Aug
75th Percentile Run Date	9-Aug	3-Sep	2-Aug	10-Aug	15-Aug	30-Jul	22-Aug	9-Aug	28-Aug	29-Aug
90th Percentile Run Date	21-Aug	13-Sep	15-Aug	18-Aug	22-Aug	6-Aug	23-Aug	12-Aug	2-Sep	2-Sep

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Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Weir Count	24,108	42,529	34,077	3,590	9,483	15,646	22,029	13,353	5,946	10,397
Total Escapement [a]	24,108	42,529	34,077	3,590	9,483	15,646	22,029	13,353	5,946	10,397
Wild fish [b]	10,366	14,993	13,713	3,590	9,483	15,646	22,029	13,353	5,946	10,397
Stocked fish [b]	13,742	27,537	20,364	0	0	0	0	0	0	0
Weir Mortalities	236	417	334	2	0	0	0	0	0	0
Adults used for egg takes	0	0	0	0	0	0	0	0	0	0
Spawning Escapement [b]	23,872	42,112	33,743	3,588	9,483	15,646	22,029	13,353	5,946	10,397
Jacks (not included in weir count)	331	4	236	260	301	158	46	46	275	350
Starting Date	17-Jun	17-Jun	17-Jun	17-Jun	16-Jun	16-Jun	17-Jun	16-Jun	18-Jun	17-Jun
Ending Date	4-Nov	7-Nov	4-Nov	3-Nov	8-Nov	8-Nov	11-Nov	10-Nov	10-Nov	9-Nov
Days Elapsed	143	143	140	139	145	146	147	147	146	146
Date of First Sockeye	19-Jun	19-Jun	18-Jun	19-Jun	18-Jun	18-Jun	19-Jun	18-Jun	19-Jun	18-Jun
Date of Last Sockeye	22-Oct	3-Nov	26-Oct	28-Oct	5-Oct	4-Oct	8-Nov	1-Nov	17-Oct	17-Oct
Days Elapsed for sockeye caught	125	137	130	131	110	110	142	137	121	122
10th Percentile Run Date	17-Jul	1-Aug	19-Jul	16-Jul	4-Jul	5-Jul	11-Jul	1-Jul	17-Jun	2-Jul
25th Percentile Run Date	31-Jul	4-Aug	16-Aug	26-Jul	10-Jul	23-Jul	23-Jul	10-Jul	19-Jul	22-Jul
50th Percentile Run Date	20-Aug	9-Aug	28-Aug	31-Jul	23-Jul	24-Jul	28-Jul	22-Jul	25-Jul	28-Jul
75th Percentile Run Date	26-Aug	15-Aug	1-Sep	14-Aug	11-Aug	29-Jul	16-Aug	1-Aug	27-Jul	31-Jul
90th Percentile Run Date	3-Sep	26-Aug	7-Sep	24-Aug	13-Aug	11-Aug	19-Aug	8-Aug	22-Aug	12-Aug

[a] The total escapement equals the weir count or mark–recapture estimate (2001) plus weir mortalities.

[b] Escapements were not separated into numbers of wild and stocked fish from 2000 to 2002.

[c] ND = no data.

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

[e] Separate counts of jacks were not kept from 1967 to 2002, so those weir counts include an unknown number of jacks.

Appendix D.–Mark–recapture estimates for Hugh Smith Lake sockeye salmon, 1992–2014.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Live Weir Count[a]	**65,586**[b]	11,034	8,344	3,413	**7,066**	**12,154**	**1,115**	**3,154**	**4,269**	3,629	**5,999**[b]	**19,568**
Proportion Marked	36%	99%	97%	100%	99%	67%	67%	67%	67%	50%	50%	10%
Number Marked	23,790	10,973	8,126	3,396	6,995	8,100	745	2,103	2,846	1,807	2,999	1,945
Number Sampled for Marks	1,974	2,377	1,152	1,028	374	934	226	323	443	484	908	2,057
Number of Marks Recovered	814	2,029	1,041	1,006	369	638	157	221	299	230	449	194
Pooled Petersen Estimate[c,d]	57,652	12,854	8,992	3,470	7,090	11,853	1,071	3,070	4,213	**3,789**	6,059	20,537
SE	1,520	99	81	13	41	253	42	109	131	168	187	1,324
+/-95% CI	2,979	194	159	25	80	496	82	214	257	329	367	2,595
CV	3%	1%	1%	0%	1%	2%	4%	4%	3%	4%	3%	6%
ML Darroch Estimate[c]	Failed	**13,254**	Failed	Failed	Failed	12,312	1,015	3,038	4,050	–	Failed	19,147
SE	–[e]	134	–	–	–	849	46	138	145	–	–	1,526
+/-95% CI	–	263	–	–	–	1,664	90	270	284	–	–	2,990
CV	–	1%	–	–	–	7%	5%	5%	4%	–	–	8%
ML Darroch - Pooled Strata[f]	58,712	–	**8,925**	**3,441**	7,090	–	–	–	–	3,641	6,047	–
SE	1,823	–	77	70	42	–	–	–	–	205	194	–
+/-95% CI	3,573	–	151	137	82	–	–	–	–	402	380	–
CV	3%	–	1%	2%	1%	–	–	–	–	6%	3%	–

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Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Live Weir Count[a]	**19,734**	**23,872**	**42,112**	**33,743**	**3,588**	**9,483**	**15,646**	**22,029**	**13,353**	**5,946**	**10,397**
Proportion Marked	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Number Marked	1,979	2,278	4,208	3,414	358	949	1,565	2,202	1,335	595	1,039
Number Sampled for Marks	1,547	1,244	2,187	1,764	659	1,271	3,652	2,490	2,199	1,714	1,326
Number of Marks Recovered	136	115	229	176	50	123	339	242	196	138	134
Pooled Petersen Estimate[c,d]	22,372	24,459	40,039	34,053	4,645	9,744	16,824	22,582	14,919	7,353	10,222
SE	1,754	2,098	2,423	2,357	573	772	768	1,295	934	522	775
+/-95% CI	3,438	4,112	4,749	4,621	1,123	1,513	1,505	2,539	1,831	1,022	1,519
CV	8%	9%	6%	7%	12%	8%	5%	6%	6%	7%	8%
ML Darroch Estimate[c]	21,950	–[e]	–	–	–	–	–	–	–	Failed	–
SE	1,991	–	–	–	–	–	–	–	–	–	–
+/-95% CI	4,000	–	–	–	–	–	–	–	–	–	–
CV	9%	–	–	–	–	–	–	–	–	–	–
ML Darroch - Pooled Strata[f]	–	–	–	–	–	–	–	–	–	6,363	–
SE	–	–	–	–	–	–	–	–	–	623	–
+/-95% CI	–	–	–	–	–	–	–	–	–	1,221	–
CV	–	–	–	–	–	–	–	–	–	10%	–

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

[b] Boldfaced estimates were used as the official escapement estimate for that year.

[c] Pooled Petersen, and ML Darroch estimates and their standard errors were calculated using Stratified Population Analysis Software. Release data were stratified into three release periods and recovery data were stratified by recovery days.

[d] Chi-square tests for goodness of fit and complete mixing in 1993, 1994, and 1995 were highly significant and suggest that the ML Darroch estimates should be used rather than a Pooled Petersen estimate.

[e] Dashes (–) indicate no calculation was made.

[f] When ML Darroch estimates failed to converge, data were pooled until an estimate was obtained.

Appendix E.–Age distribution of the Hugh Smith Lake sockeye salmon escapement, weighted by week, 1980–2014.

Return 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
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	0	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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Return 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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Return 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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		Age Class																
Return 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
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

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Return 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
		Age Class																
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