Fishery Data Series No. 09-61

Hugh Smith Lake Sockeye Salmon Adult and Juvenile Studies, 2008

by

Andrew W. Piston

November 2009

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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 2006, Hugh Smith Lake sockeye salmon were de-listed as a *stock of management concern* by the Alaska Board of Fisheries. This decision was based primarily on the fact that escapements into the lake were above the upper end of the escapement goal range, from 2003 to 2005. In 2008, we continued adult weir operations at the lake that included a backup mark-recapture estimate, and the collection of age, sex, and length information from the adult sockeye salmon population. An estimate of sockeye salmon smolt abundance, as well as age and size information from the smolt, was collected during the spring smolt weir project. The 2008 sockeye salmon escapement at Hugh Smith Lake was composed entirely of naturally spawned fish for the first time in two decades. The escapement of 3,590 adult sockeye salmon was below the lower end of the escapement goal range of 8,000–18,000 sockeye salmon for the first time since 2002. The number of 3-ocean fish, typically the dominant age-class at Hugh Smith Lake, was particularly low (1,153 fish) in 2008, and, in general, sockeye salmon runs were extremely poor throughout Southeast Alaska in 2008. Although no longer a *stock of concern*, management of nearby fisheries proceeded in a manner consistent with the Hugh Smith Lake Action Plan, and in 2008, fisheries closures were implemented in both the seine and gillnet fisheries in District 1 due to low sockeye numbers at the Hugh Smith Lake weir. The estimate of 59,000 sockeye salmon smolt in 2008 was likely biased low due to a flood event in mid-May which overtopped the weir for several days. Even with a generous expansion of smolt numbers to account for the flood, it appears that smolt production in the lake remained low despite high brood year escapements.

Key words: Hugh Smith Lake, sockeye salmon, *Oncorhynchus nerka*, stock of concern, lake stocking, escapement, escapement goal, zooplankton, mark-recapture.

INTRODUCTION

In 2003, the Alaska Board of Fisheries adopted Hugh Smith Lake sockeye salmon as a *stock of management concern*, due to a long-term decline in escapement (Geiger et al. 2003). Escapements averaged 17,500 during the 1980s, 12,000 during the 1990s, and only 5,000 from 1998 to 2002. The Board of Fisheries adopted an action plan to rebuild the sockeye salmon run to levels that would meet the escapement goal range of 8,000–18,000 adult sockeye salmon (Hugh Smith Lake Sockeye Salmon Action Plan, Final Report to the Board of Fish, RC-106, February 2003). The action plan directed the Alaska Department of Fish and Game (ADF&G) to review stock assessment and rehabilitation efforts at the lake and contained measures to reduce commercial harvests of Hugh Smith Lake sockeye salmon when returns were projected to be below the lower end of the escapement goal range. The rehabilitation effort included a hatchery stocking program in which the fry were fed to pre-smolt size from late May through July while rearing in net-pens in the lake. Eggs for this program were collected at the mouth of Buschmann Creek, which is one of the primary spawning tributaries for sockeye salmon in Hugh Smith Lake. This stocking of pen-reared fry occurred from 1999 to 2003, and all released fry had thermal otolith marks. The final returns of adult fish from this stocking program returned to the lake as 3-ocean fish in 2007.

Escapements of adult sockeye salmon at Hugh Smith Lake have improved steadily since reaching a low of 1,100 in 1998, and from 2003 to 2007, escapements surpassed the upper end of the escapement goal range of 8,000 to 18,000 adult sockeye salmon (Piston 2008). Although large numbers of fish were passed through the counting weir in these recent years, the behavior and distribution of the stocked portion of the run within the system indicated that many of these fish did not fully contribute to juvenile production (Geiger et al. 2005, Piston et al. 2007). From 2002 to 2007, stocked fish made up a significant portion of the escapement at the two primary tributaries of Hugh Smith Lake; an average of 22% at Buschmann Creek and 68% at Cobb Creek, with an additional large, but unknown number of stocked sockeye salmon attempting to spawn in unsuitable habitat at the outlet of the lake (Piston et al. 2007). Spring smolt counts from 2005 to 2007 showed no sign of increase over the preceding three years despite a dramatic increase in brood year escapements beginning in 2003 (Piston et al. 2007). Estimates for the wild portion of the spawning escapement have also shown improvement in recent years. In 2005 and 2006, escapements of wild sockeye salmon reached the escapement goal for the first time since 1997 (Piston et al. 2007). Because of the positive trends in escapement through 2005, the Hugh Smith Lake sockeye salmon stock was de-listed as a *stock of management concern* at the 2006 Board of Fisheries meeting.

From 2004 to 2007, studies designed to identify factors limiting the productivity of sockeye salmon at various stages of their life history within Hugh Smith Lake were conducted. Total juvenile sockeye salmon production, mid-summer-to-spring survival rates of sockeye fry, fry emigration timing from Buschmann and Cobb creeks, habitat changes within Buschmann Creek, and zooplankton production within the lake were examined (Piston et al. 2006 and 2007). In addition, a Dolly Varden predation study was conducted at the spring smolt weir in 2007 (Piston 2008). These studies did not identify any factors in the freshwater environment that would result in reduced juvenile sockeye salmon survival rates.

In 2008, we continued operating the adult salmon counting weir at Hugh Smith Lake. Along with counting fish by species through the weir, we conducted a backup mark-recapture estimate on sockeye salmon to ensure we obtained a reliable escapement estimate in case the weir failed during the season. This backup estimate is critical for ensuring we can determine if the formal escapement goal for this system of 8,000–18,000 adult sockeye salmon was reached. Age, sex, and length information was collected from a sub-set of the sockeye salmon passed through the weir and live counts of spawning salmon were conducted on the two primary inlet streams in conjunction with mark-recapture efforts. Smolt numbers were estimated at the spring smolt weir, which is operated by a separate coded-wire tagging coho project, and age, sex, and length information was collected from a sub-set of the sockeye salmon smolt. Zooplankton samples were not collected in 2008, but analysis of the 2007 samples is included in this report.

STUDY SITE

Hugh Smith Lake (55° 06' N, 134° 40' W; Orth 1967) is located 97 km southeast of Ketchikan, on mainland Southeast Alaska, in Misty Fjords National Monument (Figure 1). The lake is organically stained, with a surface area of 320 ha, mean depth of 70 m, maximum depth of 121 m, and volume of $222.7 \cdot 10^6$ m^3 (Figure 2). The lake empties into Boca de Quadra inlet via 50-m long Sockeye Creek (ADF&G stream number 101-30-10750). Sockeye salmon spawn in two inlet streams: Buschmann Creek flows northwest 4 km to the head of the lake (ADF&G stream 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 stream 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.

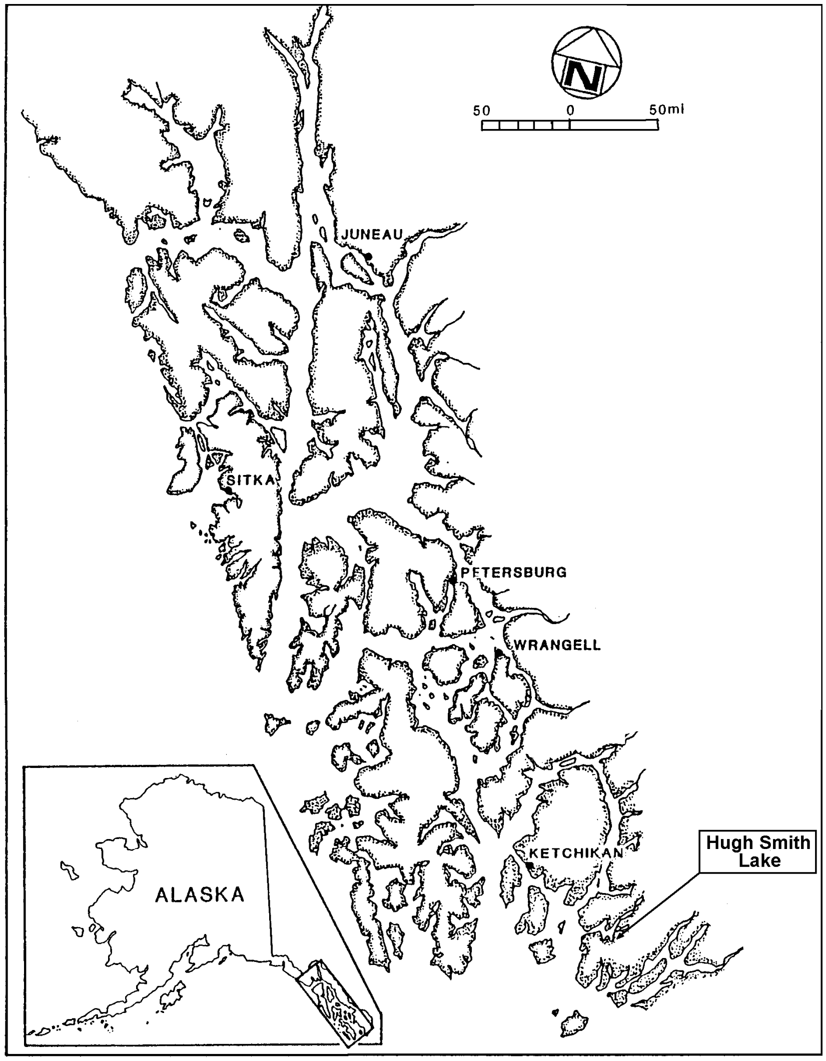

Figure 1.–The location of Hugh Smith Lake in Southeast Alaska.

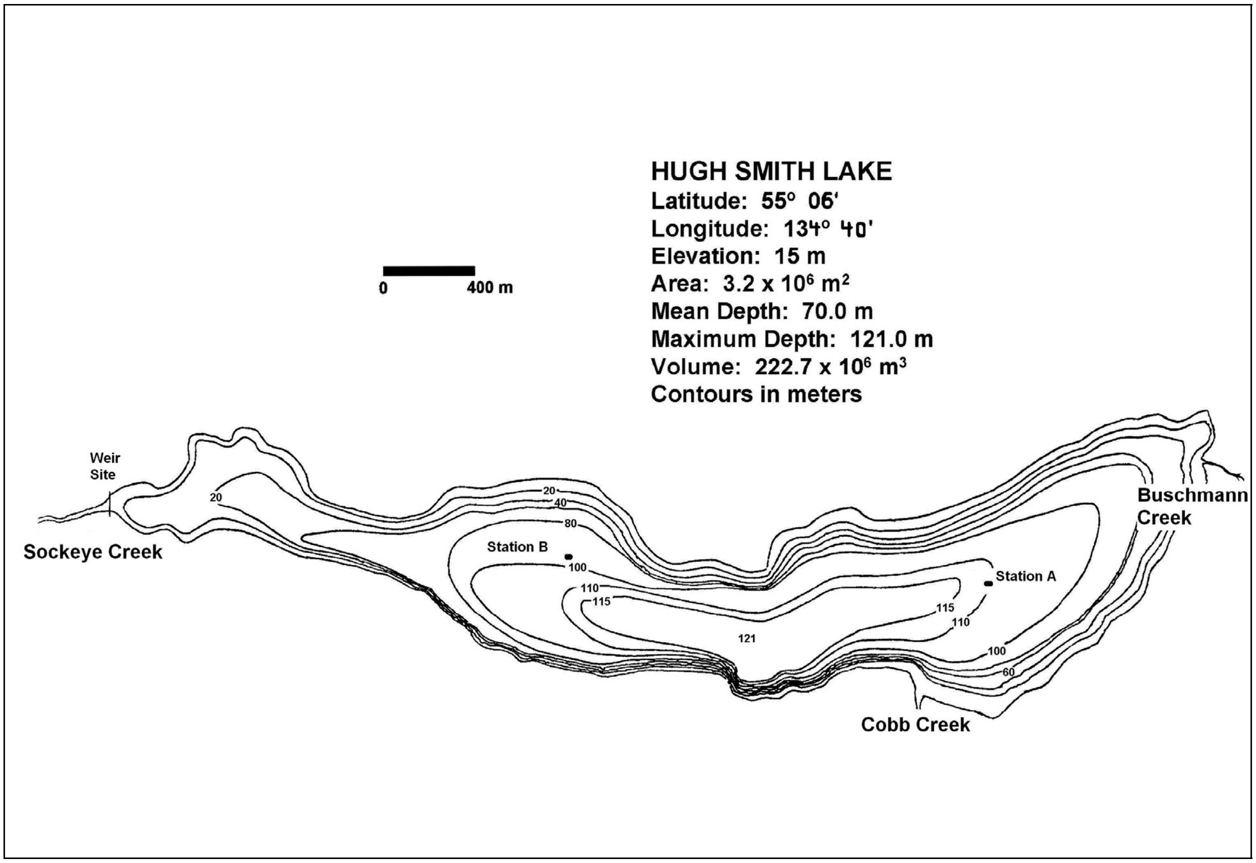

Figure 2.–Bathymetric map of Hugh Smith Lake, Southeast Alaska, showing the location of the weir site, stations A and B, the primary inlet streams, and other features of the lake system.

METHODS

ZOOPLANKTON SAMPLING

From 2004 to 2007, we assessed the biomass and density of the zooplankton population, as well as trends in size of the various zooplankton species, in order to determine whether secondary production in the lake was a limiting factor for sockeye salmon production. (Note; we did not collect zooplankton samples in 2008.) In 2007, zooplankton samples were collected bi-monthly from April through October at two sampling stations, station A and B, located at opposite ends of the lake, using a 0.5 m diameter, 153 μm mesh conical net. Vertical zooplankton tows were pulled from a depth of 50 m to the surface at a constant speed of 0.5 m · sec^{-1}. The net was rinsed prior to removing the organisms, and all specimens were preserved in buffered 10% formalin. Samples were analyzed at the ADF&G Kodiak Limnology Lab, using methods detailed in the Alaska Department of Fish and Game Limnology Field and Laboratory Manual (Koenings et al. 1987) and summarized in Edmundson et al. (1991). Density and biomass of taxa were averaged between station A and B, for each date of sampling. The density estimates have a relative error of 20–25% of the true value (unpublished memorandum from John Edmundson, ADF&G, 21 May 2002).

SMOLT PRODUCTION

A smolt weir was used from 1981 to 2008 to sample and count coho and sockeye salmon smolt emigrating from Hugh Smith Lake (see Geiger et al. 2003 for a physical description of weir). Since 1997, the smolt weir has been operated for the sole purpose of coded-wire-tagging coho salmon smolts. The smolt weir was operated from 21 April to 3 June in 2008. Fish were counted through the weir by species and scale samples and length-weight data were collected from sockeye smolt. Scale samples were collected at a rate of 16 fish per day when fewer than 100 fish were captured at the weir on a daily basis, and 28 fish per day when more than 100 fish were captured per day. The length (snout-to-fork in mm) and weight (to the nearest 0.1 g) was recorded for each fish sampled. A preferred-area scale smear (Clutter and Whitesel 1956) was taken from each fish and mounted on a 2.5 cm × 7.5 cm glass slide, four fish per slide. A video-linked microscope was used to age sockeye smolt scales at the Ketchikan office.

The smolt weir provides us with a minimum estimate of sockeye salmon smolt abundance. In many years, high water events allow fish to pass through the weir uncounted and often sockeye smolt are still leaving the system after the weir is removed in early June. In addition, an unknown, but presumably small number of smolt pass through a small opening designed to allow free upstream passage of adult steelhead. Each season, 100% of the coho salmon smolt that are captured in the smolt weir trap are coded-wire-tagged, which allows us to estimate the smolt weir capture efficiency. Hugh Smith Lake smolt tagging data from 1983–1990 (Shaul 1994) showed that capture rate was highly variable and averaged approximately 41% for coho salmon smolt. The smolt weir capture efficiency has improved more recently, and from 1996 to 2005 the capture rate averaged about 70% for coho salmon smolt (Leon Shaul, ADF&G, personal communication).

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 again from 1981 to 2008. The weir is an aluminum bipod, channel-and-picket design, with an upstream trap for enumerating and sampling salmon. The integrity of the weir was verified by periodic underwater inspections and through a secondary mark-recapture study (see below). The weir was operated from mid-June to early November in 2008 and fish were counted through the weir in a way that minimized handling as much as possible. Adjacent to the primary upstream trap, we built a secondary trap/counting station designed to allow for free passage of fish into the lake, while also allowing us to quickly close the trap when a coho salmon or other fish of interest entered. It was very important that all coho salmon were examined for missing adipose fins, which indicated the presence of coded-wire tags. Hugh Smith Lake coho salmon are an important indicator stock in southeast Alaska (Shaul et al. 2005). The modified trap allowed us to continue passing a portion of the sockeye salmon freely through the pickets throughout the season, while continuing to meet the goals of the ongoing coho salmon study at the lake. We placed a white board on the bottom of the streambed at the secondary trap/counting station to aid in fish identification and fish passage was monitored with a video camera so that in the event we failed to stop a coho salmon we were still able to identify it as adipose-clipped or unclipped.

Mark Recapture

As in past years, we conducted a two-sample mark-recapture population study, in conjunction with weir operations, to estimate the total spawning population of sockeye and coho salmon at Hugh Smith Lake during the 2008 season. These studies helped to determine if fish passed by the weir uncounted, or if sockeye salmon entered the lake before the weir was fish tight in mid-June. Adult sockeye salmon were marked at a rate of 10% with a readily identifiable fin clip at the weir. Fish that were to be marked were dip netted from the trap, anesthetized in a clove oil solution (Woolsey et al. 2004), fin-clipped, scale-sampled, and released upstream next to the trap to recover. Fish that did not appear healthy were not marked with a fin-clip. The population of fish passing through the weir was stratified through time on the following schedule: right ventral fin clip, 16 June–18 July; left ventral fin clip, 19 July–15 August; and partial dorsal fin clip, 16 August–November. We did not conduct a mark-recapture study for jack sockeye salmon because most of them pass freely through the weir pickets. All sockeye salmon <400 mm long are considered to be jacks. In the past, we have not been able to mark and recover enough fish to obtain a valid population estimate for jacks.

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 two-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: 1) maximum likelihood (ML) Darroch estimates and pooled Petersen (Chapman's modified) estimates, and their standard errors; 2) X^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 X^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 chose full pooling of the data (i.e., the pooled-Petersen estimate) if either of these tests was not significant ($p>0.05$). We wished 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).

We deemed the weir count to be "verified" if it fell within the 95% confidence interval of the mark-recapture estimate of adult sockeye salmon, in which case the weir count was entered as the official escapement estimate. This was the same criterion as used in previous years (Geiger et al. 2003). The escapement goal range for this system is 8,000–18,000 spawners. The escapement goal was judged to have been met if the weir count was within 8,000 to 18,000 adult sockeye salmon and the weir count was within the 95% confidence interval of the mark-recapture estimate for adult sockeye salmon. The escapement goal would be deemed to have not been met if the weir count and the mark-recapture estimates were both outside of the escapement goal range. In the case where one or the other estimate fell within the escapement goal range, the weir count would be used, unless the weir count was below the lower end of the 95% confidence interval of the mark-recapture estimate. Prior to the study we agreed to use the mark-recapture "point" estimate, and not one or the other end of a confidence interval, 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. We began the season by taking scale samples at a rate of 1 in 10 (10%). The sex and length (mideye-to-fork to the nearest mm) was recorded for each fish sampled. One scale was taken from the preferred area (INPFC 1963), mounted on a gum card, and prepared for analysis as described by Clutter and Whitesel (1956). The weekly age-sex distribution, the seasonal age-sex distribution weighted by week, and the mean length by age and sex weighted by week were calculated using equations from Cochran (1977; Appendix A).

Escapement Counts

The number of live and dead salmon in the creek was estimated, by species, during each survey of Buschmann and Cobb Creeks. Cobb Creek was surveyed from the mouth to the barrier falls (0.42 miles; 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 beaver ponds on the left fork (Figure 3). We attempted to survey all of Buschmann Creek's stream channels at least twice near the peak of the run.

What we have generally referred to as Buschmann Creek actually consists of two separate creeks, draining two separate valleys, which come together in their lower reaches. The stream flowing in from the valley to the southeast is Buschmann Creek (ADF&G stream number 101-30-10750-2006), and the tributary flowing out of the northeast valley that meets Buschmann Creek at what we call the Main Fork is referred to as the Beaver Pond Channel (ADF&G stream number 101-30-10750-3003, Figure 3). The Beaver Pond Channel is so named because there have consistently been one or more beaver dams and ponds along its length.

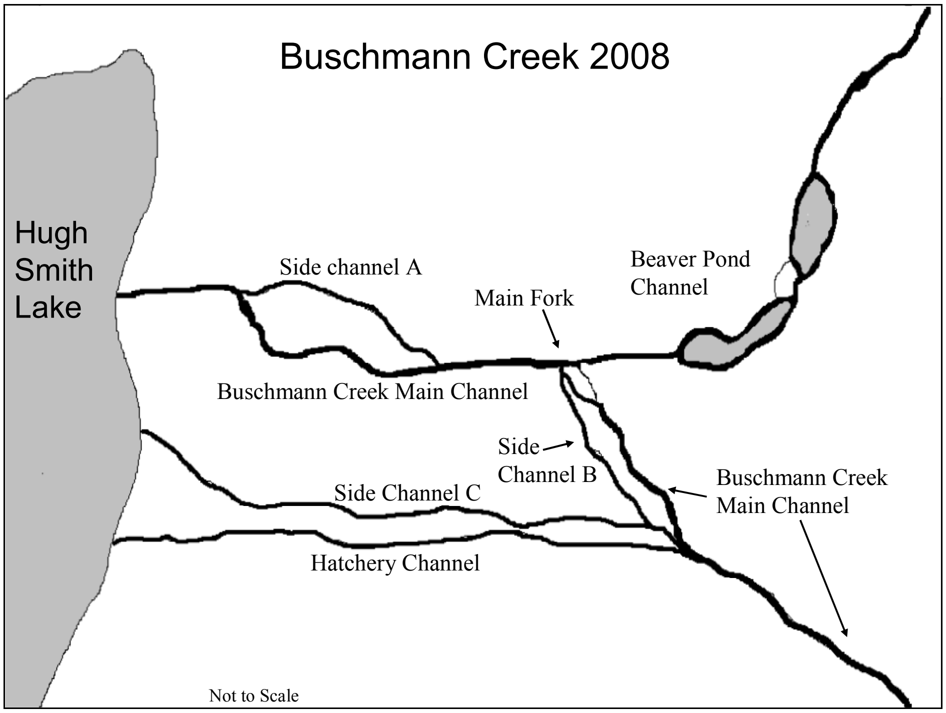

Figure 3.–Schematic diagram of the main channels of lower Buschmann Creek, as of November 2008.

RESULTS

ZOOPLANKTON SAMPLING

The following results are from zooplankton sampling conducted in 2007. (No zooplankton samples were collected at Hugh Smith Lake in 2008).

In 2007, the seasonal mean density of zooplankton was 302,000 per m^2, which is approximately equal to the 1981–2007 average of 305,000 per m^2. The seasonal mean biomass of zooplankton was 517 mg/m^2, which is below the 1981–2007 average of 597 mg/m^2. The seasonal mean density of copepods at 188,000 per m^2 was near the long-term average of 184,000 per m^2 (Figure 4), while the seasonal mean density of cladocerans at 115,000 per m^2 was slightly below the long-term average of 121,000 per m^2. The seasonal mean density of *Bosmina*, the numerically dominant cladoceran in Hugh Smith Lake, was 74,000 per m^2, which represents a decrease from 2006 and is slightly below the long term average of 79,000 per m^2, from 1981–2007 (Figure 5). The seasonal mean density of *Cyclops*, the numerically dominant copepod in Hugh Smith Lake, was 178,000 per m^2, which is approximately equal to the long-term average, from 1981–2007 (Figure 5). The seasonal mean density of *Daphnia* was well below the long-term average of 24,000 per m^2 (Figure 5). The mean weighted lengths of *Cyclops* and *Bosmina* in 2007 were unchanged from the 2006 season, and were slightly below the long-term average, from 1981–2007 (Figure 6). The mean weighted length of *Daphnia l.* showed a slight increases from 2006 (Figure 6), but was below the long-term average of 0.80 mm.

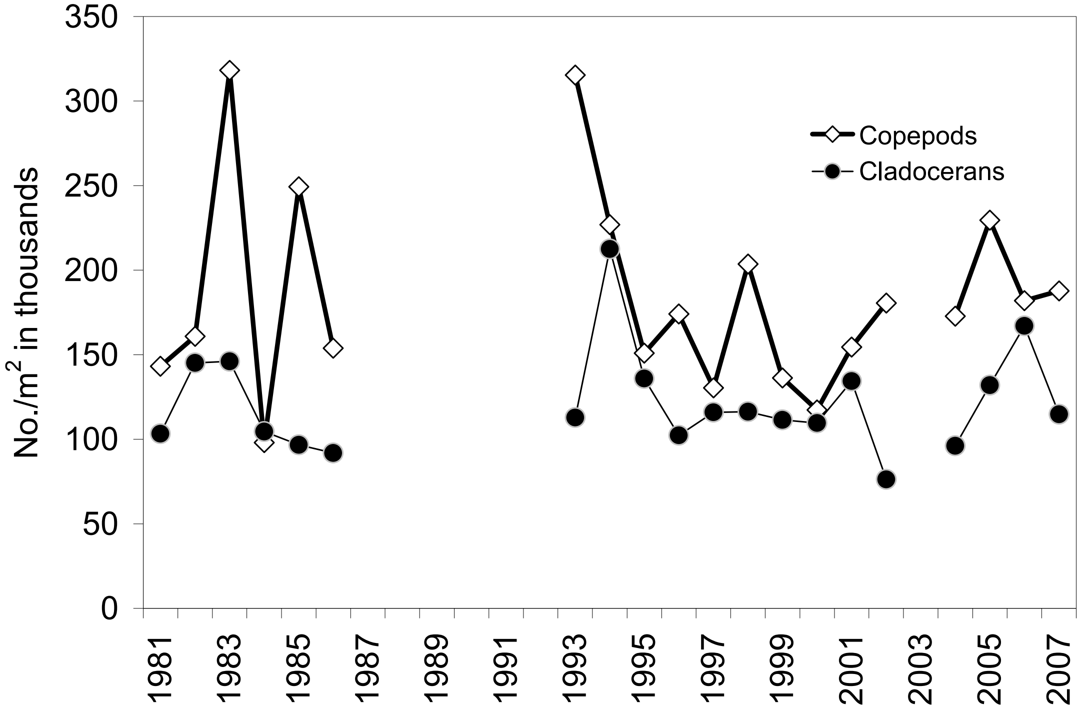

Figure 4.–Seasonal mean density of copepods and cladocerans in Hugh Smith Lake, from 1981–2007.

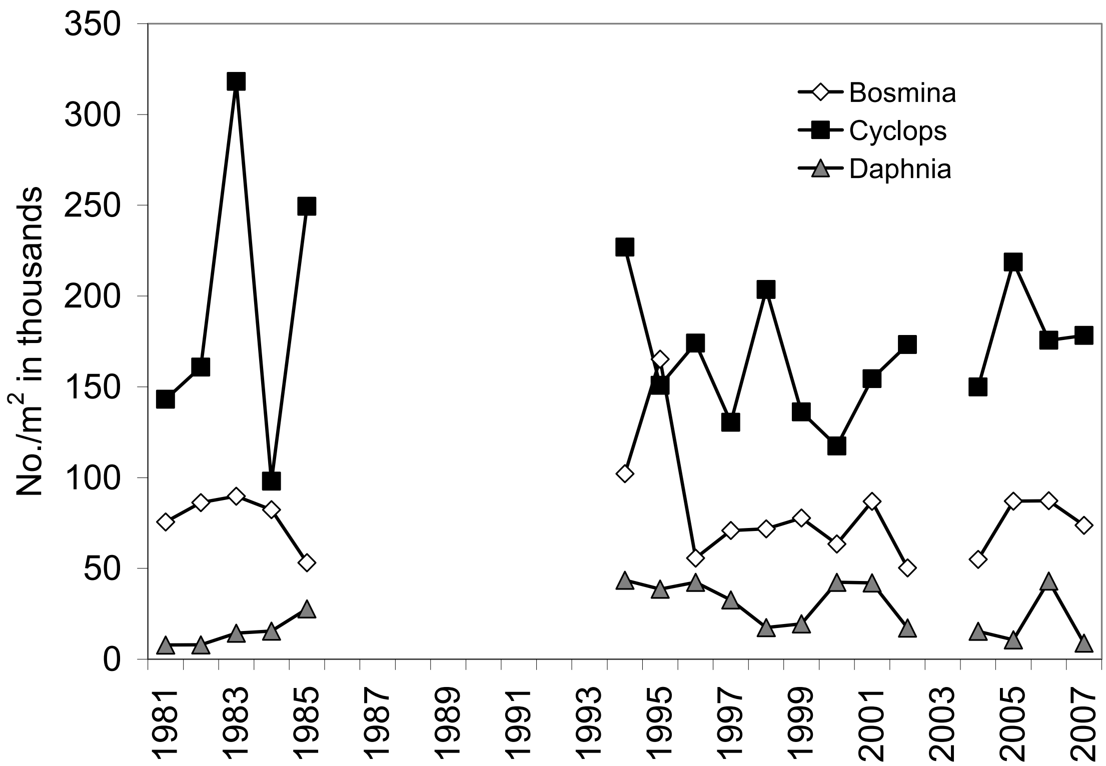

Figure 5.–Seasonal mean density of Bosmina, Cyclops, and Daphnia at Hugh Smith Lake, 1981–2007.

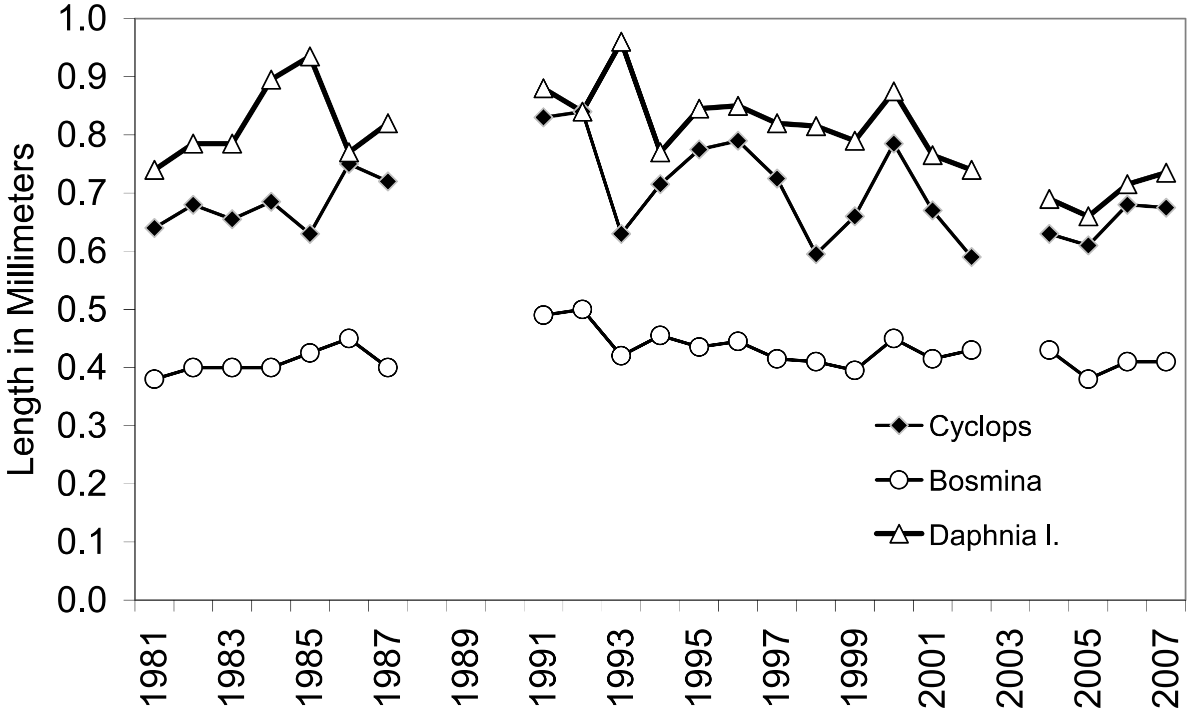

Figure 6.–Seasonal mean weighted length of three primary macrozooplankton species at Hugh Smith Lake, 1981–2007.

SMOLT PRODUCTION

A total of 59,000 sockeye smolt were counted through the smolt weir between 21 April and 3 June (Table 1). A flood in mid-May left the smolt weir partially submerged from midnight on 14 May to approximately noon on 18 May, and it is likely that a substantial number of sockeye salmon smolt escaped past the weir uncounted during this time. The flood coincided with the peak of smolt emigration and over 7,000 sockeye salmon smolt were passed on 13 May and 18 May. We sampled 1,084 sockeye smolt for scales and determined that the age composition, weighted by week, was 62% age 1, 37% age 2, and 1% age 3 (Figure 7, Table 1).

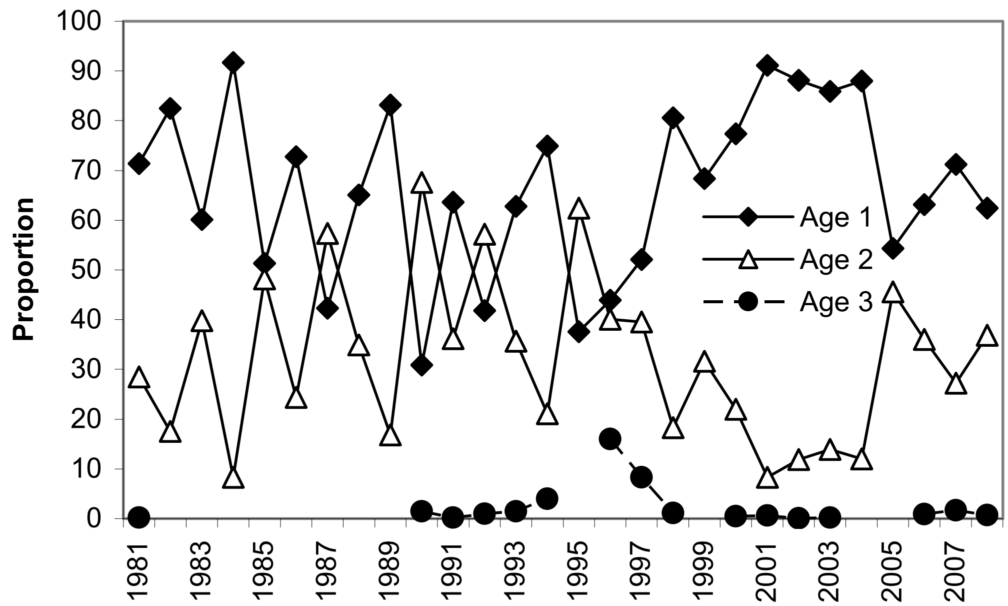

Figure 7.–Age composition of sockeye salmon smolt at Hugh Smith Lake, 1981–2008.

Table 1.–Hugh Smith Lake weir counts of sockeye smolt by smolt year, and stocked fry and pre-smolt releases by year of release, 1981–2008. Proportions of stocked and wild smolt were determined from otolith samples.

Release Year	Hatchery Release Numbers	Release Type	Smolt Year	Total Smolt Counted	Freshwater Age Percent of Total			Stocked Smolt Counted	Wild Smolt Counted	Percent Stocked Smolt
					Age 1	Age 2	Age 3			
			1981	319,000	71%	29%	0%			
			1982	90,000	83%	18%	0%			
			1983	77,000	60%	40%	0%			
			1984	330,000	92%	8%	0%			
			1985	40,000	51%	48%	1%			
			1986	**58,000**[c]	73%	24%	3%			
1986	273,000	Unfed Fry	1987	104,000	42%	57%	1%			
1987	250,000	Unfed Fry	1988	54,000	65%	35%	0%			
1988	1,206,000	Unfed Fry	1989	427,000	83%	17%	0%			
1989	532,800	Unfed Fry	1990	137,000	31%	68%	2%			
1990	1,480,800	Unfed Fry	1991	75,000	64%	36%	0%			
1991			1992	15,000	42%	57%	1%			
1992	477,500	Fed Fry	1993	36,000	63%	36%	2%			
1993			1994	43,000	75%	21%	4%			
1994	645,000	Unfed Fry	1995	19,000	38%	62%	0%			
1995	418,000	Unfed Fry	1996	16,000	44%	40%	16%			
1996	358,000	Unfed Fry/ Pre-Smolt[a]	1997	44,000	52%	40%	8%			
1997	573,000	Unfed Fry	1998	65,000	81%	18%	1%	30,000	34,000	47%
1998	0		1999	42,000	68%	32%	0%	3,000	39,000	4%
1999	202,000	Pre-smolt[b]	2000	72,000	77%	22%	1%	---No data---		
2000	380,000	Pre-smolt[b]	2001	190,000	91%	8%	1%	145,000	44,000	77%
2001	445,000	Pre-smolt[b]	2002	297,000	88%	12%	0%	163,000	134,000	55%
2002	465,000	Pre-smolt[b]	2003	261,000	86%	14%	0%	185,000	76,000	71%
2003	420,000	Pre-smolt[b]	2004	364,000	88%	12%	0%	170,000	194,000	47%
2004	0		2005	77,000	54%	46%	0%		77,000	
2005	0		2006	119,000	63%	36%	1%		119,000	
2006	0		2007	89,000	71%	27%	2%		89,000	
2007	0		2008	59,000	62%	37%	1%		59,000	

[a] In 1996, SSRAA released 251,123 unfed fry into the lake in May and 106,833 pre-smolt in October. All fish from those releases were otolith marked.

[b] 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.

[c] The smolt weir count for 1986 that was reported in Geiger et al. (2003), Piston et al. (2006), and Piston et al. (2007) was actually an estimate based on a hydroacoustic survey. A section of the smolt weir was removed from 27–31 May, and researchers at the time probably assumed the hydroacoustic estimate of 373,000 was a better estimate. I judged that this estimate should not be compared directly to other smolt weir estimates and included the smolt weir count for 1986 in this report.

ADULT ESCAPEMENT

The adult weir was fish-tight from 17 June to 3 November, and we passed 3,588 adult sockeye salmon and 260 jacks into the lake. The total adult sockeye salmon escapement, including handling mortalities was 3,590. The adult escapement was below the lower end of the escapement goal range of 8,000–18,000 sockeye salmon for the first time since 2002 (Figure 8, Appendix B). The mid-point of the run occurred on 31 July, which is slightly earlier then average over the past 26 years (mean=6 August) and the 75th percentile of the run occurred on 14 August (mean=23 August). Counts of adult sockeye salmon on the spawning grounds at Buschmann and Cobb creeks were very low in 2008, with peak estimates of 634 live fish in Buschmann Creek (21 September; Table 2) and 107 live fish in Cobb Creek (12 September; Table 3).

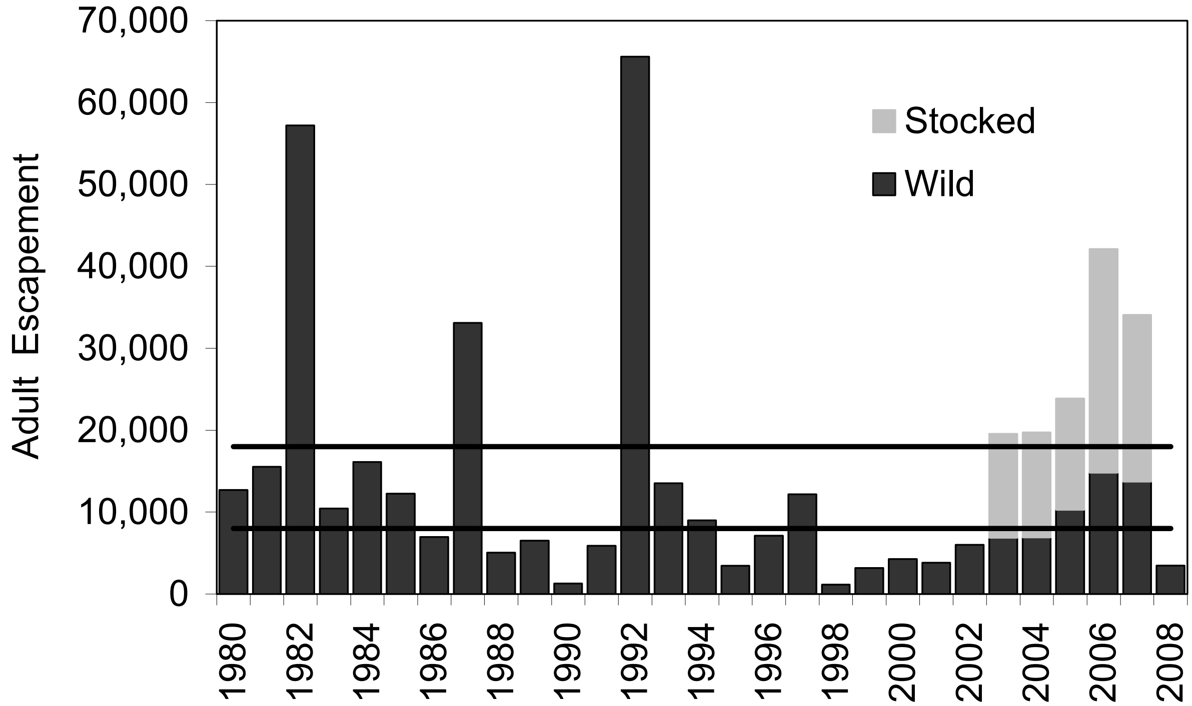

Figure 8.–Annual sockeye salmon escapement at Hugh Smith Lake, 1982–2008. The black horizontal lines show the escapement goal range of 8,000 to 18,000 adult sockeye salmon. This escapement goal range includes both wild and hatchery stocked fish. From 2003 to 2007, the bars are divided to show our estimate of wild (black) and stocked fish (gray). 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).

Table 2.–Counts of adult sockeye salmon in Buschmann Creek by stream section, 2008. Blank cells indicate that the section was not surveyed on the corresponding date. Surveys conducted in the "Beaver Pond Channel" and "Above Hatchery Channel" sections were of varying length and should not be directly compared between dates.

Date	21-Aug	21-Aug	31-Aug	31-Aug	4-Sep	4-Sep	8-Sep	8-Sep	12-Sep	12-Sep	21-Sep	21-Sep	30-Sep	30-Sep
Condition	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
Mouth Estimate	200	0	125	0	300	0	0	0	111	0	25	0	110	0
Main Channel	28	0	88	0	148	0	114	3	242	1	380	25	247	1
Side Channel A			0	1	1	0	3	0						
Side Channel B	8	0			30	0			13	0				
Beaver Pond Channel	0	0	0	0			9	0			41	2	11	0
Fork to Hatchery Channel	0	0					41	0	179	0	161	4	28	0
Above Hatchery Channel											19	0	0	0
Hatchery Channel	1	0			18	2			107	0	33	8	35	0
Stream Total	37	0	88	1	197	2	167	3	541	1	634	39	321	1

Table 3.–Counts of adult sockeye salmon in Cobb Creek, 2008. Each survey was conducted from the mouth to the barrier falls and covered all available spawning habitat within the creek.

Date	31-Aug	31-Aug	8-Sep	8-Sep	12-Sep	12-Sep	20-Sep	20-Sep	29-Sep	29-Sep	7-Oct	7-Oct
Condition	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead
Count	9	0	57	1	107	2	69	14	28	7	7	0

In 2008, a total of 358 adults were marked with different fin clips over three marking strata. Between 19 June and 18 July, 72 adult sockeye salmon were marked with a right ventral fin clip. From 19 July to 15 August, 216 adult sockeye salmon were marked with a left ventral fin clip, and from 16 August to 3 November, 70 adult sockeye salmon were marked with a partial dorsal fin clip. Recapture sampling on the spawning grounds was conducted over the course of the entire spawning season, from 21 August to 30 October (Table 4). We also sampled all dead fish that washed up on the weir through 16 October (Table 4). A total of 659 fish were sampled for fin clips, of which 50 were marked (Table 4). The result of a X^2 test of complete mixing of marked fish between the marking and recovery events was not significant (p=0.67) and a test for equal proportions of marked fish on the spawning grounds was also not significant (p=0.61), therefore we used the pooled-Petersen estimate. Our final estimate was 4,600 (SE=570; 95% CI=3,500 to 5,800) adult Sockeye salmon (Appendix C). The weir count of 3,588 fell within the 95% confidence interval of the mark-recapture estimate, and we deemed the weir count to be verified by the mark-recapture estimate. A coefficient of variation of 12% met our objective of a coefficient of variation of no greater than 15%. Again, we did not conduct a mark-recapture study on sockeye jacks in 2008 because in past years we have been unable to mark and recover enough fish to obtain a reliable population estimate.

Table 4.–Daily number of marked fish recovered by release strata and total number of carcasses sampled for marks for the adult sockeye salmon mark-recapture study, 2008.

		Number of Marked Fish			Number	Total Number
Date	Sampling Area	Left Ventral	Right Ventral	Dorsal	Unmarked	Sampled
21-Aug	Buschmann Creek	0	0	0	5	5
31-Aug	Buschmann Creek	0	1	0	16	17
31-Aug	Cobb Creek	0	0	0	1	1
4-Sep	Buschmann Creek	4	4	0	53	61
8-Sep	Buschmann Creek	4	1	0	46	51
8-Sep	Cobb Creek	0	1	0	0	1
12-Sep	Cobb Creek	0	0	0	18	18
13-Sep	Buschmann Creek	3	0	0	65	68
14-Sep	Buschmann Creek	9	3	1	178	191
15-Sep	Cobb Creek	4	0	0	35	39
20-Sep	Cobb Creek	1	0	0	13	14
21-Sep	Buschmann Creek	0	1	0	18	19
29-Sep	Cobb Creek	0	0	0	5	5
30-Sep	Buschmann Creek	1	0	0	0	1
3-Oct	Buschmann Creek	1	0	0	27	28
4-Oct	Buschmann Creek	2	1	1	61	65
5-Oct	Buschmann Creek	1	0	1	14	16
5-Oct	Cobb Creek	0	0	0	4	4
6-Oct	Buschmann Creek	0	0	4	27	31
7-Oct	Cobb Creek	0	0	0	3	3
10-Oct	Buschmann Creek	0	0	1	12	13
16-Oct	Weir	0	0	0	1	1
30-Oct	Buschmann Creek	0	0	0	7	7
	Total	30	12	8	609	659

The age composition of the adult sockeye salmon, based on scale data, was 63.8% 2-ocean, 32.1% 3-ocean, and 4% 4-ocean fish, with age-1.2 fish being the dominant age class (Table 5, Appendix D). Two-ocean fish accounted for 64% of the adult escapement in 2008 (Table 5, Figure 9). The estimated number of 2-ocean fish in the escapement (2,292), was typical of numbers observed prior to the pen-reared pre-smolt stocking program (Figure 10). The return of 3-ocean fish was very weak in 2008 (1,153 fish) and marks the first time we have seen the escapement of 3-ocean fish come in lower than the return of 2-ocean fish the preceding year (2,829 2-ocean fish in 2007). Typically, few 4-ocean fish are detected at Hugh Smith Lake, but in 2008 they accounted for an estimated 4% of the escapement (145 fish).

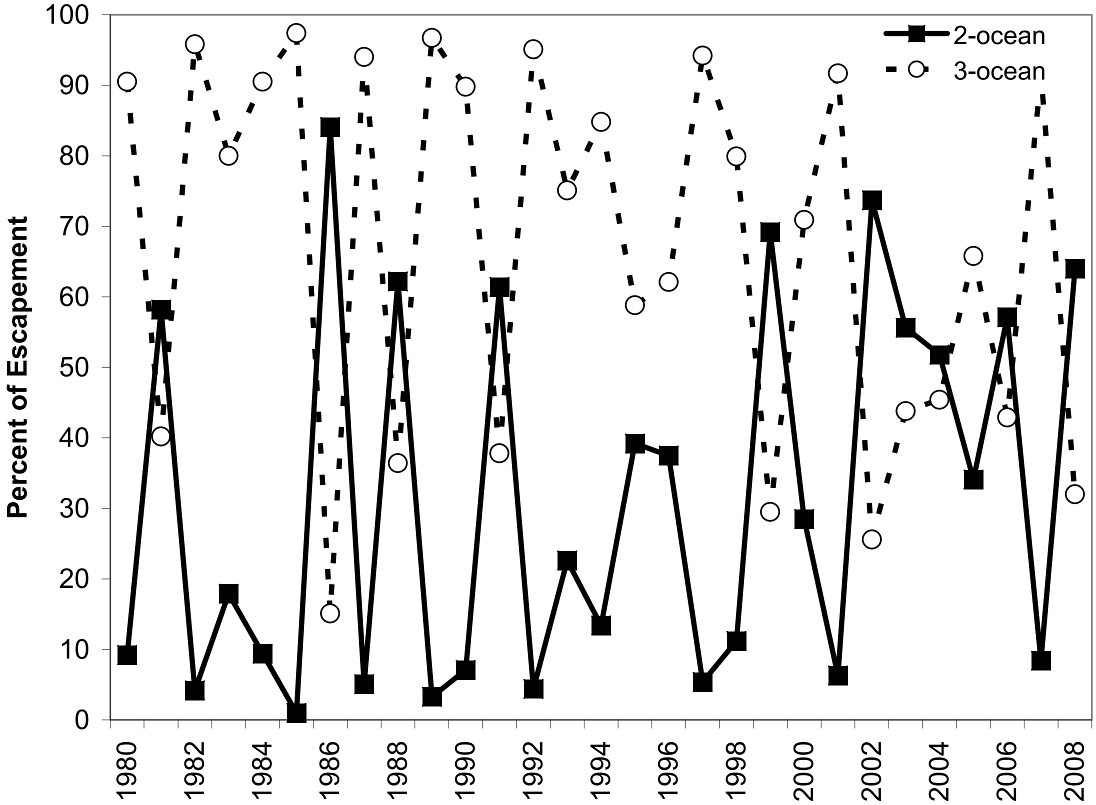

Figure 9.–Annual proportions of 2-ocean and 3-ocean aged sockeye salmon in the Hugh Smith Lake escapement, 1982–2008.

Table 5.–Age composition of the 2008 adult sockeye salmon escapement at Hugh Smith Lake based on scale samples, weighted by statistical week.

		Age Class						
Stat Week		1.2	2.2	1.3	2.3	1.4	2.4	Total
25-27	Sample Size	4						4
	Esc. Age Class	35						35
	Proportion	100%						
	SE of %	0%						
28	Sample Size	1		1				2
	Esc. Age Class	22		22				44
	Proportion	50%		50%				
	SE of %	49%		49%				
29	Sample Size	25	8	10	4	1		48
	Esc. Age Class	342	110	137	55	14		658
	Proportion	52%	17%	21%	8%	2%		
	SE of %	7%	5%	6%	4%	2%		
30	Sample Size	3	1	3	1	1	1	10
	Esc. Age Class	48	16	48	16	16	16	160
	Proportion	30%	10%	30%	10%	10%	10%	
	SE of %	15%	10%	15%	10%	10%	10%	
31	Sample Size	57	33	19	15	3		127
	Esc. Age Class	585	339	195	154	31		1,304
	Proportion	50%	26%	15%	12%	2%		
	SE of %	4%	4%	3%	3%	1%		
32	Sample Size	8	5	1		2		16
	Esc. Age Class	72	45	9		18		144
	Proportion	50%	31%	6%		13%		
	SE of %	12%	11%	6%		8%		
33	Sample Size	32	28	11	6	3		80
	Esc. Age Class	226	198	78	42	21		565
	Proportion	40%	35%	14%	8%	4%		
	SE of %	5%	5%	7%	3%	2%		
34	Sample Size	7	5	9	5	1		27
	Esc. Age Class	75	53	96	53	11		288
	Proportion	26%	19%	33%	19%	4%		
	SE of %	8%	7%	9%	7%	4%		
35	Sample Size	2	4	5	3	1		15
	Esc. Age Class	22	44	55	33	11		165
	Proportion	13%	27%	33%	20%	7%		
	SE of %	9%	11%	12%	10%	6%		
36	Sample Size		4	5	4	1		14
	Esc. Age Class		31	38	31	8		108
	Proportion		29%	36%	29%	7%		
	SE of %		12%	12%	12%	7%		
37-45	Sample Size	1	2	3	6			12
	Esc. Age Class	10	20	30	61			121
	Proportion	8%	17%	25%	50%			
	SE of %	8%	11%	12%	14%			
Total	Escapement by Age Class	1,437	855	708	445	129	16	3,590
	SE of Number	40	19	21	12	2	2	
	Proportion by Age Class	40%	24%	20%	12%	4%	0%	
	SE of %	1%	1%	1%	0%	0%	0%	
	Sample Size	140	90	67	44	13	1	355

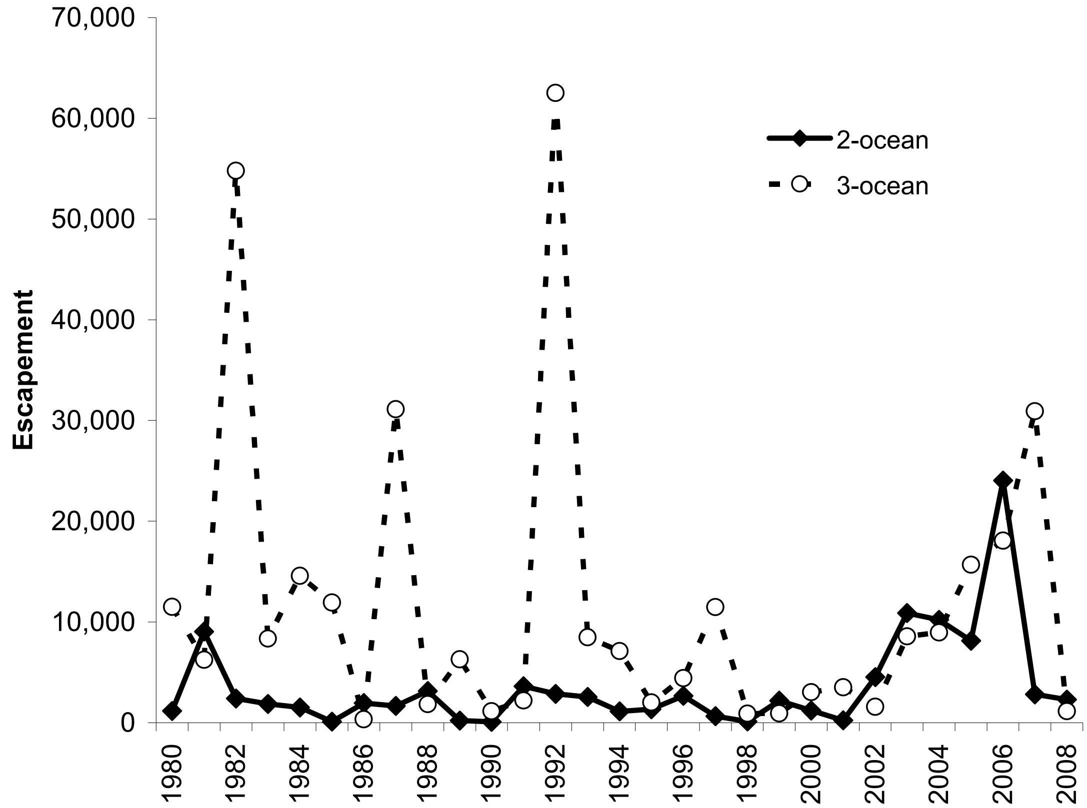

Figure 10.–Annual numbers of 2-ocean and 3-ocean aged sockeye salmon in the Hugh Smith Lake escapement, 1980–2008.

DISCUSSION

Estimated escapements of wild sockeye salmon at Hugh Smith Lake had been trending upwards since 1998 and were within the escapement goal range from 2005 to 2007 (Figure 8). In 2008, however, the escapement of 3,588 was less than half of the lower end of the escapement goal range of 8,000–18,000 adults. It appears that marine survival was very poor for fish that entered the marine environment in 2005. The number of 3-ocean fish, typically the dominant age-class at Hugh Smith Lake, was particularly low (1,153 fish) in 2008, and, in general, sockeye salmon runs were extremely poor throughout Southeast Alaska in 2008. The sockeye salmon harvest in 2008 was the second lowest harvest in the region since the 1800s and escapement goals were not met for 11 of 13 systems with formal goals (Eggers et al. 2008). Other salmon species in Southeast Alaska also experienced poor survival after entering the marine environment in 2005; e.g., the 2006 Pink Salmon return was the poorest in two decades (Heinl et al. 2008), as was the southern southeast summer Chum Salmon run in 2008 (Eggers and Heinl 2008).

Coded-wire tagging studies conducted at Hugh Smith Lake during the 1980s and 1990s showed that well over half the Alaska harvest of Hugh Smith Lake sockeye salmon occurs in the District 1 net fisheries near the mouth of Boca de Quadra Inlet (Geiger et al. 2003). Accordingly, the Action Plan (Hugh Smith Lake Sockeye Salmon Action Plan, Final Report to the Board of Fish, RC-106, February 2003) that was implemented when Hugh Smith Lake was listed as a *stock of management concern* in 2003, contained focused time and area closures in the District 1 purse seine and drift gillnet fisheries (Heinl et al. 2007). Since being de-listed as a stock of concern in 2006 ADF&G has continued to manage these fisheries in a manner consistent with the Action Plan, and fisheries closures were implemented in both the seine and gillnet fisheries in District 1 in 2008.

Fishing effort in the seine fishery near the mouth of Boca de Quadra inlet (District 101-23) was almost non-existent in 2008. From mid-July to mid-August, a portion of the area nearest the mouth of Boca de Quadra was closed due to low escapement through the Hugh Smith Lake weir. These area reductions played a role in the reduction of fishing effort, but the low effort throughout this sub-district was primarily a continuation of a long-term pattern that began in the early 1990s (Figure 11). The harvest of sockeye salmon in the District 101-23 seine fishery (152 fish) was also far below the recent average (1980–2007 mean=15,000).

From 2000 to 2008, the effort levels in the nearby District 101-11 drift gillnet fishery were only about 50% of the effort levels in the preceding 20 years (Figure 11). The 2008 harvest of 34,000 sockeye salmon in the drift gillnet fishery was far below the recent average (1980–2007 mean harvest=139,000 fish). For a three-week period from late July to mid-August, one mile of the drift gillnet fishing area nearest Boca de Quadra was closed as outlined in the Hugh Smith Lake Action Plan. This area closure moved effort one mile south within the sub-district and away from Boca de Quadra Inlet, but probably had only a limited effect on the overall effort and harvest in the area as a whole.

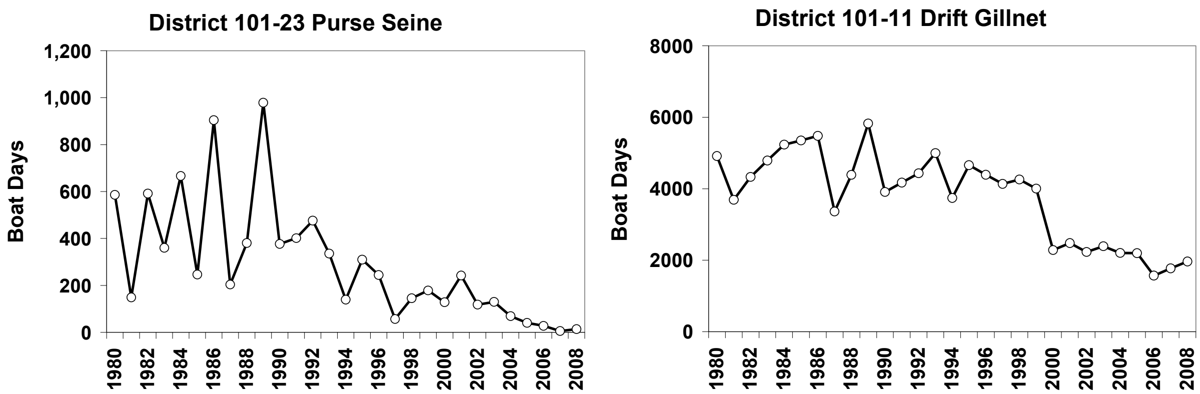

Figure 11.–Fishing effort in boat days for the District 101-23 purse seine fishery and the District 101-11 gillnet fishery, 1980–2008.

The number of sockeye smolt passed through the spring smolt weir in 2008 was disappointing in light of the excellent brood year escapements in 2005 and 2006 (Figure 8). From 2003–2007, large numbers of stocked fish entered the primary spawning tributaries of Hugh Smith Lake (Piston 2008), but this did not result in an increase in juvenile production in the system. For example, although the total escapement nearly quadrupled in 2003, primarily due to a large influx of stocked fish, the wild smolt abundance in 2005 was less than half of the 2004 estimate (Figure 12). In 2006, the adult escapement increased to 42,000 fish, but the smolt weir count in 2008 was only 59,000 fish. As noted earlier, the smolt weir provides only a minimum estimate of smolt abundance, but even if we apply a generous 100% expansion factor to the smolt weir count in 2008, the overall pattern of low wild smolt production in the face of dramatic recent increases in adult escapement would not change (Figure 12).

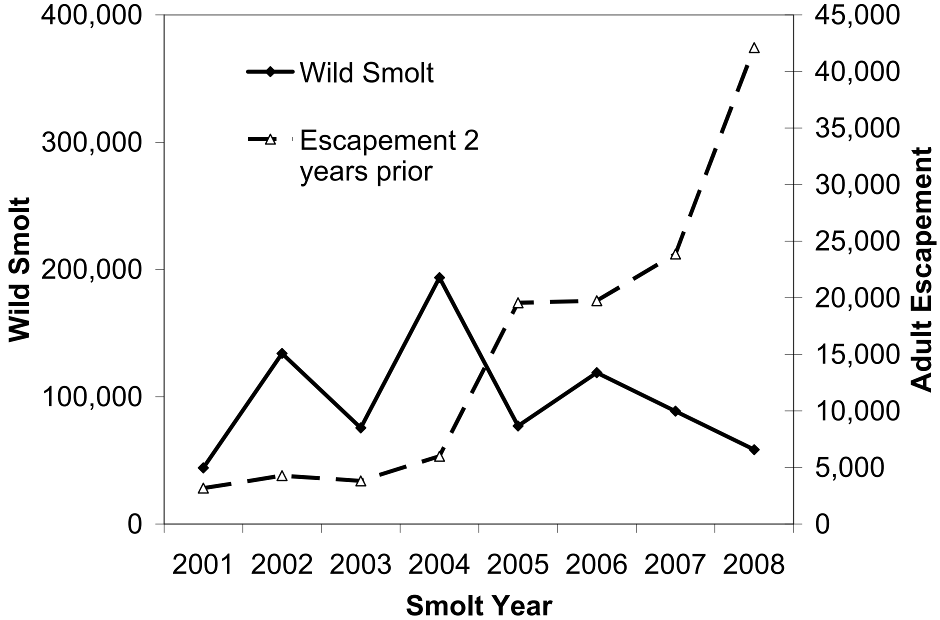

Figure 12.–Smolt weir estimates plotted against adult escapement 2 years prior, 2001–2008.

The 2008 sockeye salmon escapement at Hugh Smith Lake was composed entirely of naturally spawned fish for the first time in two decades. Hugh Smith Lake was stocked in nearly every year between 1986 and 2003 (Table 1), and these stocked fish returned in the adult escapements from 1989–2007. Prior to lake stocking, the lake was fertilized from 1981–1984, so most of the time series of data we have from Hugh Smith Lake covers a period during which the lake was manipulated to some degree. Although the fry stocking that occurred from 1986 to 1997 was thought to be unsuccessful at producing significant numbers of returning adults (Geiger et al. 2003), the pen-reared pre-smolt program that was used from 1999 to 2003 resulted in high survival rates of released fish and strong returns of adult hatchery-reared sockeye salmon to Hugh Smith Lake. Although the available data suggest that these pen-reared fish may not have helped boost natural production as spawners, the methods used to rear these fish were clearly a significant improvement from an aquaculture perspective. In the near future, the Hugh Smith Lake system will be operating in a natural state, without stocking or other lake modifications.

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REFERENCES CITED

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996. Computer analysis of data from stratified mark-recovery experiments for estimation of salmon escapements and other populations. Canadian Technical Report of Fisheries and Aquatic Sciences 2106.

Chapman, D. G., and C. O. Junge. 1956. The estimation of the size of a stratified population. Annals of Mathematical Statistics 27:375–389.

Cochran, W. G. 1977. Sampling techniques, third edition. . John Wiley and Sons, New York.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, New Westminster, British Columbia.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241–260.

Edmundson, J. A., T. P. Zadina, and M. H. Haddix. 1991. The development of a natural sockeye salmon run into Virginia Lake, Southeast Alaska. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement, and Development, Report 113, Juneau.

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

Eggers, D. M., S. C. Heinl. 2008. Chum salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-19, Anchorage.

Geiger, H. J., T. P Zadina, and S. C. Heinl. 2003. Sockeye salmon stock status and escapement goal for Hugh Smith Lake. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-05, Juneau.

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

Heinl, S. C., X. Zhang, and H. J. Geiger. 2007. Distribution and run-timing of Hugh Smith Lake sockeye salmon in the District 101 commercial net fisheries of southern Southeast Alaska, 2004–2006. Alaska Department of Fish and Game, Fishery Manuscript No. 07-03, Anchorage.

Heinl, S. C., D. M. Eggers, and A. W. Piston. 2008. Pink salmon stock status and escapement goals in Southeast Alaska and Yakutat. Alaska Department of Fish and Game, Special Publication No. 08-16, Anchorage.

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

Koenings, J. P., G. B. Kyle, J. A. Edmundson, and J. E. Edmundson. 1987. Limnology Field and Laboratory Manual: Methods for Assessing Aquatic Production. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement, and Development, Report No. 71, Juneau.

Orth, D. J. 1967. Dictionary of Alaska place names. Geological Survey Professional Paper 567. United States Government Printing Office, Washington, 1084 pp.

Piston, A. W., S. C. Heinl, H. J. Geiger, and T. A. Johnson. 2006. Hugh Smith Lake sockeye salmon adult and juvenile studies, 2003 to 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-51, Anchorage.

Piston, A. W., S. C. Heinl, and H. J. Geiger. 2007. Hugh Smith Lake sockeye salmon adult and juvenile studies, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-58, Anchorage.

Piston, A. W. 2008. Hugh Smith Lake sockeye salmon adult and juvenile studies, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 08-43, Anchorage.

Plante, N. 1990. Estimation de la taille d’une population animale a l’aide d’un modele de capture-recapture avec stratification. M.Sc. thesis, Universite Lval, Quebec.

REFERENCES CITED (Continued)

Schwarz, C. J., and C. G. Taylor. 1998. Use of the stratified-Petersen estimator in fisheries management: estimating the number of pink salmon (*Oncorhynchus gorbuscha*) spawners in the Fraser River. Canadian Journal of Fisheries and Aquatic Sciences 55:281–296.

Seber, G. A. F. 1982. The estimation of animal abundance, second edition. Griffin, London.

Shaul, L. D. 1994. A summary of 1982–1991 harvests, escapements, migratory patterns, and marine survival rates of coho salmon stocks in Southeast Alaska. Alaska Fishery Research Bulletin 1:10–34.

Shaul, S., E. Jones, and K. Crabtree. 2005. Coho salmon stock status and escapement goals in Southeast Alaska [*in*] DerHovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22, Anchorage.

Woolsey, J., M. Holcomb, and R. Ingermann. 2004. Effect of temperature on clove oil anesthesia in steelhead fry. North American Journal of Aquaculture 66: 35–41.

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:

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

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):

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

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

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

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

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

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

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

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

Appendix B.–Hugh Smith Lake sockeye salmon escapement and run timing, 1967–2008.

Year	1967	1968	1969	1970	1971	1980	1981	1982	1983	1984	1985
Weir Count	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106	12,245
Total Escapement[a]								57,219	10,429	16,106	12,245
Weir Mortalities	NA	NA	NA	NA	NA	NA	NA	81	45	134	201
Adults used for egg takes	0	0	0	0	0	0	0	0	0	439	798
Spawning Escapement[b]	NA	NA	NA	NA	NA	NA	NA	57,138	10,384	15,533	11,246
Jacks (not included in weir count)											
Starting Date	1-Jun	13-Jun	11-Jun	9-Jun	20-Jun	5-Jun	7-Jun	4-Jun	30-May	1-Jun	1-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
Days Elapsed	94	69	64	84	63	121	93	176	184	178	163
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
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
Days Elapsed for sockeye caught	82	68	64	82	63	120	92	140	146	166	146
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
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
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
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
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

[a] The total escapement equals the weir count, 1967–1985. Separate counts of jacks were not kept from 1967 to 1985, so these weir counts include an unknown number of jacks.

[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded-wire-tagged fish) and fish killed for egg takes.

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Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Weir Count	2,312	33,097	5,056	6,513	1,285	5,885	65,737	11,312	8,386	3,424	7,123	12,182
Total Escapement[a]	6,968	33,097	5,056	6,513	1,285	5,885	65,737	13,532	8,992	3,452	7,123	12,182
Weir Mortalities	12	0	28	32	28	33	151	278	42	11	57	28
Adults used for egg takes	619	1,902	424	1,547	0	357	178	1,460	763	312	513	0
Spawning Escapement[b]	6,337	31,195	4,604	4,934	1,257	5,495	65,408	11,794	8,187	3,129	6,553	12,154
Jacks (not included in weir count)												
Starting Date	17-Jun	3-Jun	5-Jun	3-Jun	8-Jun	17-Jun	16-Jun	17-Jun	20-Jun	17-Jun	17-Jun	18-Jun
Ending Date	29-Oct	21-Oct	22-Oct	25-Oct	31-Oct	9-Oct	25-Oct	4-Nov	1-Nov	3-Nov	4-Nov	5-Nov
Days Elapsed	134	140	139	144	145	114	131	140	134	139	140	140
Date of First Sockeye	18-Jun	8-Jun	12-Jun	11-Jun	13-Jun	19-Jun	16-Jun	20-Jun	20-Jun	19-Jun	20-Jun	18-Jun
Date of Last Sockeye	3-Oct	4-Oct	16-Oct	18-Oct	21-Oct	11-Oct	18-Oct	3-Nov	26-Oct	1-Nov	20-Oct	1-Nov
Days Elapsed for sockeye caught	107	118	126	129	130	114	124	136	128	135	122	136
10th Percentile Run Date	11-Jul	18-Jul	19-Jul	30-Jul	8-Jul	22-Jul	12-Jul	2-Jul	20-Jul	7-Jul	25-Jul	3-Jul
25th Percentile Run Date	15-Jul	20-Jul	24-Jul	5-Aug	23-Jul	29-Jul	19-Jul	16-Jul	1-Aug	17-Jul	11-Aug	16-Jul
50th Percentile Run Date	20-Jul	4-Aug	9-Aug	10-Aug	27-Aug	21-Aug	27-Jul	30-Jul	23-Aug	29-Jul	19-Aug	25-Jul
75th Percentile Run Date	28-Jul	30-Aug	25-Aug	14-Aug	7-Sep	12-Sep	29-Jul	14-Aug	26-Aug	9-Aug	3-Sep	2-Aug
90th Percentile Run Date	8-Aug	31-Aug	1-Sep	22-Aug	16-Sep	22-Sep	11-Aug	31-Aug	3-Sep	21-Aug	13-Sep	15-Aug

[a] The total escapement equals the mark-recapture estimate (1986, 1993, 1994, 1995) plus weir mortalities, or the weir count. (Data used to calculate a Petersen estimate in 1986 are not available). Separate counts of jacks were not kept from 1986 to 1997, so these weir counts include an unknown number of jacks.

[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded-wire-tagged fish) and fish killed for egg takes.

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Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Weir Count	1,138	3,174	4,281	3,665	6,166	19,588	19,930	24,108	42,529	34,077	3,590
Total Escapement[a]	1,138	3,174	4,281	3,825	6,166	19,588	19,930	24,108	42,529	34,077	3,590
Weir Mortalities	23	20	12	6	0	20	196	236	417	334	2
Adults used for egg takes	218	276	280	268	286	0	0	0	0	0	0
Spawning Escapement[b]	897	2,878	3,989	3,551	5,880	19,568	19,734	23,872	42,112	33,743	3,588
Jacks (not included in weir count)					167	1,356	147	331	4	236	260
Starting Date	17-Jun	16-Jun	17-Jun	16-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun	17-Jun
Ending Date	11-Nov	8-Nov	11-Nov	11-Nov	4-Nov	7-Nov	7-Nov	4-Nov	7-Nov	4-Nov	3-Nov
Days Elapsed	147	145	147	148	140	146	142	143	143	140	139
Date of First Sockeye	19-Jun	22-Jun	19-Jun	19-Jun	19-Jun	19-Jun	18-Jun	19-Jun	19-Jun	18-Jun	19-Jun
Date of Last Sockeye	12-Oct	4-Oct	27-Oct	6-Oct	17-Oct	2-Nov	31-Oct	22-Oct	3-Nov	26-Oct	28-Oct
Days Elapsed for sockeye caught	115	104	130	109	120	136	135	125	137	130	131
10th Percentile Run Date	8-Jul	7-Jul	29-Jun	2-Jul	10-Jul	2-Aug	8-Jul	17-Jul	1-Aug	19-Jul	16-Jul
25th Percentile Run Date	21-Jul	15-Jul	7-Jul	18-Jul	4-Aug	17-Aug	4-Aug	31-Jul	4-Aug	16-Aug	26-Jul
50th Percentile Run Date	30-Jul	31-Jul	20-Jul	17-Aug	7-Aug	21-Aug	6-Aug	20-Aug	9-Aug	28-Aug	31-Jul
75th Percentile Run Date	10-Aug	15-Aug	30-Jul	22-Aug	9-Aug	28-Aug	29-Aug	26-Aug	15-Aug	1-Sep	14-Aug
90th Percentile Run Date	18-Aug	22-Aug	6-Aug	23-Aug	12-Aug	2-Sep	2-Sep	3-Sep	26-Aug	7-Sep	24-Aug

[a] The total escapement equals the mark-recapture estimate (2001) plus weir mortalities, or the weir count. Separate counts of jacks were not kept from 1998 to 2000, so these weir counts include an unknown number of jacks.

[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded-wire-tagged fish) and fish killed for egg takes.

Appendix C.–Mark-recapture escapement estimates for Hugh Smith Lake sockeye salmon, 1992–2008. Boldface estimates were used as the official escapement estimate for that year.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Live Weir Count [a]	**65,586**	11,034	8,344	3,413	**7,066**	**12,154**	**1,115**	**3,154**	**4,269**	3,629	**5,999**	**19,568**	**19,734**	**23,872**	**42,112**	**33,743**	**3,588**
Proportion Marked	36%	99%	97%	100%	99%	67%	67%	67%	67%	50%	50%	10%	10%	10%	10%	10%	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	1,979	2,278	4,208	3,414	358
Number Sampled for Marks	1,974	2,377	1,152	1,028	374	934	226	323	443	484	908	2,057	1,547	1,244	2,187	1,764	659
Number of Marks Recovered	814	2,029	1,041	1,006	369	638	157	221	299	230	449	194	136	115	229	176	50
Pooled Petersen Estimate[b,c]	57,652	12,854	8,992	3,470	7,090	11,853	1,071	3,070	4,213	**3,789**	6,059	20,537	22,372	24,459	40,039	34,053	4,645
se	1,520	99	81	13	41	253	42	109	131	168	187	1,324	1,754	2,098	2,423	2,357	573
+/-95% CI	2,979	194	159	25	80	496	82	214	257	329	367	2,595	3,438	4,112	4,749	4,621	1,123
CV	3%	1%	1%	0%	1%	2%	4%	4%	3%	4%	3%	6%	8%	9%	6%	7%	12%
ML Darroch Estimate[b]	Failed	**13,254**	Failed	Failed	Failed	12,312	1,015	3,038	4,050	-	Failed	19,147	21,950				
se		134				849	46	138	145			1,526	1,991				
+/-95% CI		263				1,664	90	270	284			2,990	4,000				
CV		1%				7%	5%	5%	4%			8%	9%				
ML Darroch - Pooled Strata[d]	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%						

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

[b] 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.

[c] 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.

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

Appendix D.–Age distribution of the Hugh Smith Lake sockeye salmon escapement based on scale pattern analysis, weighted by week of escapement, 1980–2008.

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
1980	Number by Age Class		37				1,055	113			9,380	2,129						12,714
	SE of Number		0				16	1			150	39						
	Proportion by Age Class		0.3%				8.3%	0.9%			73.8%	16.7%						
	SE of Proportion		0.0%				0.1%	0.0%			1.2%	0.3%						
	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		1				114	32			65	30						
	Proportion by Age Class		1.6%				46.4%	11.7%			29.6%	10.6%						
	SE of Proportion		0.0%				0.7%	0.2%			0.4%	0.2%						
	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						17	7		0	183	44						
	Proportion by Age Class						2.8%	1.4%		0.0%	91.1%	4.7%						
	SE of Proportion						0.0%	0.0%		0.0%	0.3%	0.1%						
	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		0	0			20	6		0	103	44		2				
	Proportion by Age Class		0.1%	0.1%			13.2%	4.7%		0.1%	52.7%	27.3%		1.7%				
	SE of Proportion		0.0%	0.0%			0.2%	0.1%		0.0%	1.0%	0.4%		0.0%				
	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		0				14	6			95	72						
	Proportion by Age Class		0.1%				6.0%	3.4%			64.8%	25.7%						
	SE of Proportion		0.0%				0.1%	0.0%			0.6%	0.4%						
	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			0			1	0			104	55	0	1	0		0	
	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			0.0%			0.0%	0.0%			0.9%	0.4%	0.0%	0.0%	0.0%		0.0%	
	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			0	20	11			4	3		0		0		
	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%	0.3%	0.2%			0.1%	0.0%		0.0%		0.0%		
	Sample Size		1			1	1,389	191			195	77		13		1		1,868

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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
1987	Number by Age Class		147	130			626	1,030	24		29,329	1,733	61	17				33,097
	SE of Number		1	1			2	6	0		221	27	0	0				
	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		0.0%	0.0%			0.0%	0.0%	0.0%		0.7%	0.1%	0.0%	0.0%				
	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		0	0			13	9			6	4	0	0				
	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%			0.3%	0.2%			0.1%	0.1%	0.0%	0.0%				
	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						1	1	0		32	7	0		0			
	Proportion by Age Class						2.5%	0.8%	0.0%		89.2%	7.5%	0.0%		0.0%			
	SE of Proportion						0.0%	0.0%	0.0%		0.5%	0.1%	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		0	0			0	0			5	9	0	0				
	Proportion by Age Class		0.9%	0.1%			4.1%	3.0%			51.2%	38.5%	0.1%	2.1%				
	SE of Proportion		0.0%	0.0%			0.0%	0.0%			0.4%	0.7%	0.0%	0.0%				
	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	0	0		7	20	0		2	8			0			
	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%	0.0%	0.0%		0.1%	0.3%	0.0%		0.0%	0.1%			0.0%			
	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		0	0			22	31	0		589	34		2	0			
	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%			0.0%	0.0%	0.0%		0.9%	0.1%		0.0%	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			0			25	39	0		50	135	1	5	0			
	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			0.0%			0.2%	0.3%	0.0%		0.4%	1.0%	0.0%	0.0%	0.0%			
	Sample Size			2			62	163	1		279	564	2	31	1			1,105

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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
1994	Number by Age Class		51	41			572	625	6		6,546	1,079		66	5	2		8,992
	SE of Number		0	0			5	7	0		106	11		0	0	0		
	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		0.0%	0.0%			0.1%	0.1%	0.0%		1.2%	0.1%		0.0%	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			0			14	6			13	24		0	0			
	Proportion by Age Class			0.7%			26.1%	13.1%			23.2%	35.5%		1.3%	0.0%			
	SE of Proportion			0.0%			0.4%	0.2%			0.4%	0.7%		0.0%	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		0				30	79	0		93	24			1			
	Proportion by Age Class		0.2%				14.2%	23.2%	0.1%		49.4%	12.7%			0.2%			
	SE of Proportion		0.0%				0.4%	1.1%	0.0%		1.3%	0.3%			0.0%			
	Sample Size		2				97	76	1		287	70			1			534
1997	Number by Age Class		18				249	403			10,791	664	20	35				12,180
	SE of Number		0				5	4			121	20	0	0				
	Proportion by Age Class		0.1%				2.0%	3.3%			88.6%	5.5%	0.2%	0.3%				
	SE of Proportion		0.0%				0.0%	0.0%			1.0%	0.2%	0.0%	0.0%				
	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		4	1		0	4	2			26	21		4				
	Proportion by Age Class		2.4%	0.8%		0.3%	6.6%	4.3%			50.6%	29.2%		5.8%				
	SE of Proportion		0.3%	0.1%		0.0%	0.3%	0.2%			2.3%	1.9%		0.3%				
	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			1			35	11			13	7		0	0			
	Proportion by Age Class			0.9%			52.2%	17.0%			18.1%	11.4%		0.2%	0.2%			
	SE of Proportion			0.0%			1.1%	0.3%			0.4%	0.2%		0.0%	0.0%			
	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		0		0		21	5			52	22	0					
	Proportion by Age Class		0.3%		0.3%		21.4%	7.1%			52.6%	18.0%	0.3%					
	SE of Proportion		0.0%		0.0%		0.5%	0.1%			1.2%	0.5%	0.0%					
	Sample Size		1		1		94	33			257	70	1					457

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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
2001	Number by Age Class	7	60			6	162	71			2,908	598		7	6			3,825
	SE of Number	0	1			0	13	1			43	9		0	0			
	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	0.0%	0.0%			0.0%	0.3%	0.0%			1.1%	0.2%		0.0%	0.0%			
	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		0	1			58	11			21	6		0				
	Proportion by Age Class		0.1%	0.3%			64.6%	9.2%			21.4%	4.3%		0.2%				
	SE of Proportion		0.0%	0.0%			0.9%	0.2%			0.3%	0.1%		0.0%				
	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		2	3		0	144	24	0	0	112	8						
	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		0.0%	0.0%		0.0%	0.7%	0.1%	0.0%	0.0%	0.6%	0.0%						
	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		9	1			154	28			145	6						
	Proportion by Age Class		2.6%	0.2%			43.3%	8.5%			42.0%	3.5%						
	SE of Proportion		0.0%	0.0%			0.8%	0.1%			0.7%	0.0%						
	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			0			86	16		0	176	14						
	Proportion by Age Class			0			27.8%	6.5%		0.1%	59.2%	6.4%						
	SE of Proportion			0			0.3%	0.1%		0.0%	0.7%	0.1%						
	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						572	83			380	45						
	Proportion by Age Class						48.9%	8.2%			39.1%	3.8%						
	SE of Proportion						1.3%	0.2%			0.9%	0.1%						
	Sample Size						314	102			357	46						819
2007	Number by Age Class						2,266	592			25,915	5,304						34,077
	SE of Number						39	9			486	109						
	Proportion by Age Class						6.6%	1.7%			76.0%	15.6%						
	SE of Proportion						0.1%	0.0%			1.4%	0.3%						
	Sample Size						34	11			494	96						635
2008	Number by Age Class						1,437	855			708	445		129	16			3,590
	SE of Number						40	19			21	12		2	2			
	Proportion by Age Class						40.0%	23.8%			19.7%	12.4%		3.6%	0.4%			
	SE of Proportion						1.1%	0.5%			0.6%	0.3%		0.1%	0.0%			
	Sample Size						140	90			67	44		13	1			355