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Distribution and Run Timing of Hugh Smith Lake Sockeye Salmon in the District 101 Commercial Net Fisheries of Southern Southeast Alaska, 2004–2006

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)

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 2003, the Alaska Board of Fisheries designated the Hugh Smith Lake sockeye salmon run as a management stock of concern and adopted an action plan that included time and area closures in the District 101 commercial net fisheries in the vicinity of Hugh Smith Lake. These fisheries closures were based on coded-wire tag studies conducted in the 1980s and 1990s. From 2004 to 2006, we sampled commercial harvests in the District 101 net fisheries for stocked, thermal otolith marked Hugh Smith Lake sockeye salmon and estimated the proportion and time and area distribution of stocked Hugh Smith Lake sockeye salmon in weekly harvests using Bayesian modeling. We found the highest proportions of stocked Hugh Smith Lake sockeye salmon in the net fisheries in the vicinity of the fishery closure areas, and we found that peak catches of stocked Hugh Smith Lake sockeye salmon generally coincided with the timing of potential fishery closures during all years of the study. The run-timing of the stocked sockeye salmon was later than the run-timing of wild sockeye salmon in 2004 and 2005, and we inferred that the run-timing of wild fish probably matched the Action Plan better than stocked fish. We did not extrapolate our harvest estimates to include wild fish, because of these differences in run-timing. The exploitation rate on stocked Hugh Smith Lake sockeye salmon remained relatively high in 2004 and 2005, despite a long-term declining trend in fishing effort in the District 101 net fisheries closest to Hugh Smith Lake. The older coded-wire tag studies together with these hatchery otolith sampling results are consistent with the conclusion that the Action Plan is an effective tool for limiting the harvest of wild Hugh Smith Lake sockeye salmon, should the run decline as a result of increased fishing pressure in the future.

Key words: Boca de Quadra, exploitation rate, Hugh Smith Lake, Oncorhynchus nerka, otolith, sockeye salmon, Southeast Alaska, stock of concern, thermal mark, stocking, hatchery supplementation.

INTRODUCTION

In 2003, the Alaska Board of Fisheries formally recognized Hugh Smith Lake sockeye salmon (*Oncorhynchus nerka*) as a *management stock of concern*, based on recommendations by the Alaska Department of Fish and Game (ADF&G; Geiger et al. 2003). Annual escapements of sockeye salmon at Hugh Smith Lake had declined markedly between 1982 and 2002, from an average of 17,500 during the 1980s, to an average of only 5,000 from 1998 to 2002, including several escapements below 2,000 fish (Geiger et al. 2003). This was the first stock of concern designation in Southeast Alaska implemented through the Sustainable Salmon Fisheries Policy (Southeast Alaska and Yakutat Commercial Salmon Fishing Regulations 5 AAC 39.222). The board also adopted an *optimal escapement goal*[1] of 8,000–18,000 sockeye salmon into regulation (5 AAC 33.390) and adopted an action plan to rebuild the sockeye salmon run (Hugh Smith Lake Sockeye Salmon Action Plan, Final Report to the Board of Fish, RC-106, February, 2003). The Action Plan directed 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 by triggering time and area closures in nearby commercial fisheries when runs to Hugh Smith Lake were projected to be below the escapement goal.

The timing and location of these potential fisheries closures were based on 13 years of coded-wire tagging studies of Hugh Smith Lake sockeye salmon conducted by ADF&G (1980–1983, 1986–1988, and 1991–1996; Geiger et al. 2003). Coded-wire tagging studies showed that the total Alaska commercial exploitation rate on Hugh Smith Lake sockeye salmon averaged 60% (range: 28–94%) of the annual run (Geiger et al. 2003). These estimates understate the actual total exploitation rate, as a small portion of these fish were also harvested in Canadian

[1] Recognizing the uncertainty in the stock assessment data used to develop the Hugh Smith Lake sockeye salmon escapement goal, and the contribution of rehabilitation efforts in rebuilding the Hugh Smith Lake sockeye salmon stock, the board adopted an *optimal escapement goal* that included spawning salmon of both wild *and* hatchery origin.

fisheries (Geiger et al. 2003). The largest proportion of the total Alaska harvest occurred in the District 101 net fisheries closest to Hugh Smith Lake (Figure 1), with 39% of the harvest in the drift gillnet fishery and 29% in the purse seine fishery (Geiger et al. 2003). Coded-wire tagging studies showed that, on average, most of the harvest of Hugh Smith Lake sockeye salmon in the District 101 net fisheries occurred between 6 July and 16 August, with peak tag recoveries in late July. The Hugh Smith Lake Action Plan, therefore, identified areas adjacent to Boca de Quadra in District 101 for potential fisheries closures from mid-July to mid-August.

Fishery closures designed to limit harvest of Hugh Smith Lake sockeye salmon would also reduce access to surplus returns of other Boca de Quadra stocks, particularly pink salmon (*O. gorbuscha*). Although the majority of Hugh Smith Lake sockeye salmon are harvested in the District 101 net fisheries, they are not specifically targeted by those fisheries.

Marine tagging studies have shown that sockeye salmon migrating through the waters surrounding Boca de Quadra comprise highly mixed stocks (Hoffman et al. 1983 and 1984), and Hugh Smith Lake sockeye salmon represent a very small percentage of the total salmon harvest in District 101; e.g., Hugh Smith Lake sockeye salmon accounted for only 4% of the total sockeye salmon and 0.5% of the total salmon harvested in the District 101 drift gillnet fishery in years with coded-wire tag returns (Geiger et al. 2003). While the coded-wire tagging studies provided harvest information on a district-wide basis, District 101 encompasses a large area (Figure 1) and coded-wire tagging information was not sufficient to assess the relative abundance of Hugh Smith Lake sockeye salmon in specific areas within the district.

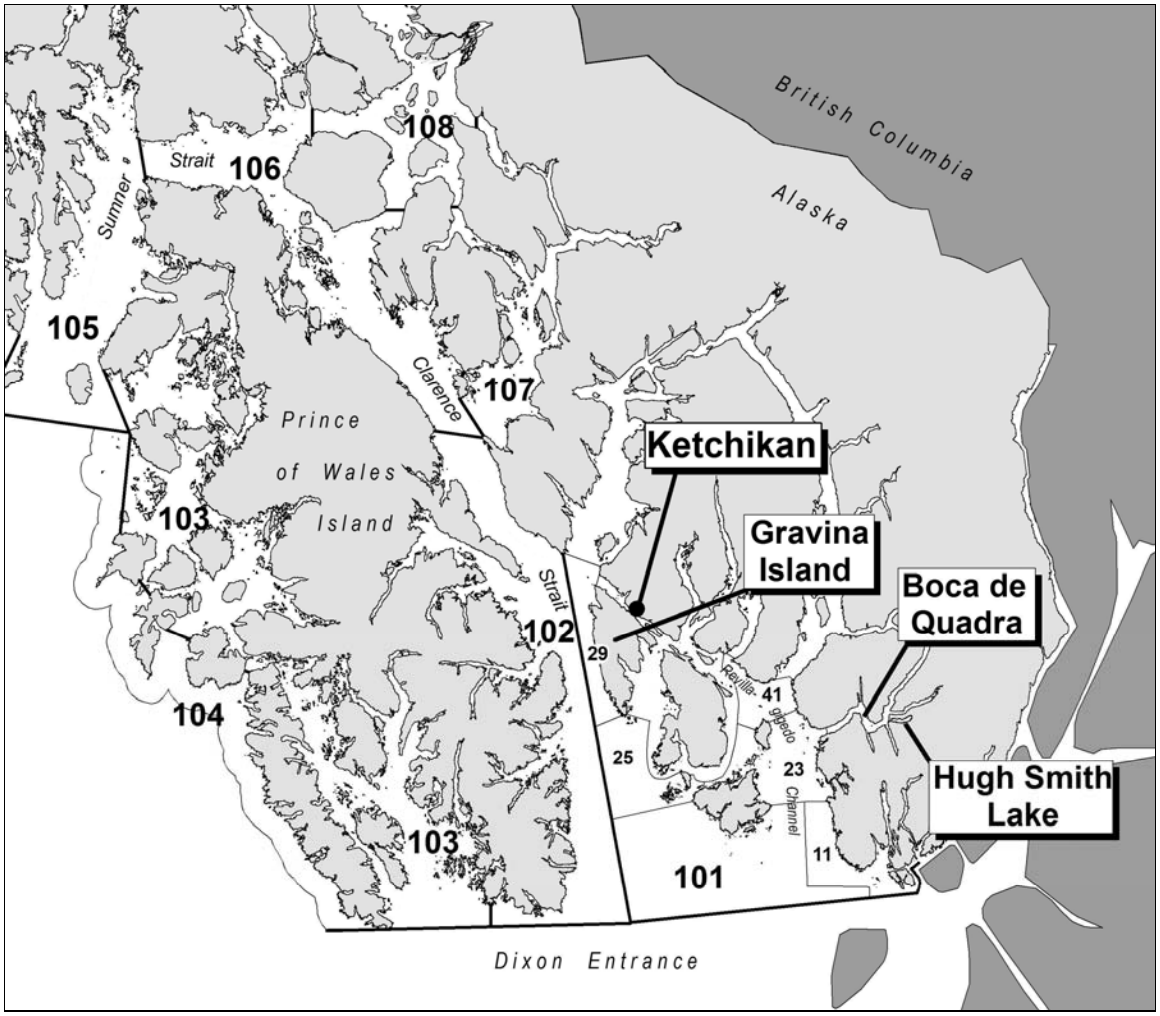

Figure 1.–Southern Southeast Alaska, showing the location of Hugh Smith Lake and Boca de Quadra Inlet, and ADF&G management districts 101–108, and Subdistricts 101-11, 101-23, 101-25, 101-29, and 101-41.

Southeast Regional Aquaculture Association, in conjunction with ADF&G, released sockeye salmon pre-smolt at Hugh Smith Lake from 1999 to 2003 as part of the most recent effort to rehabilitate the sockeye salmon run (Geiger et al. 2003). All of the stocked fry were thermal otolith marked, allowing them to be tracked through the commercial fisheries when they returned as adults. Brothers (1981, 1985), Mosegaard et al. (1987), Volk et al. (1990), and others showed that a series of marks or “coded microstructures” can be induced on the developing otoliths of salmonid yolk-sac fry through careful manipulation of environmental parameters, and these marks would allow a fish to be identified throughout the remainder of its life. Munk et al. (1993) successfully used thermal manipulation to mass-mark salmon on a large scale in an Alaskan hatchery. Thermal marks were subsequently used to assess contributions of hatchery-reared pink salmon to mixed-stock fisheries in Southeast Alaska (Hagen et al. 1995) and Prince William Sound (Joyce and Evans 2000). Thermal marks have also been used to estimate contributions of hatchery-reared transboundary river sockeye salmon stocks in mixed-stock commercial fisheries in Southeast Alaska since the early 1990s (Jensen and Milligan 2001; PSC 2005).

In 2004, 2005, and 2006, we sampled weekly commercial harvests in the District 101 purse seine and drift gillnet fisheries for stocked, otolith-marked Hugh Smith Lake sockeye salmon. We estimated the proportion and time and area distribution of stocked Hugh Smith Lake sockeye salmon in weekly harvests through Bayesian modeling (Geiger 1994; Gelman et al. 1995). Our intent was to relate information about stocked fish to the Hugh Smith Lake sockeye salmon run as a whole, and we assumed that stocked fish would be representative of wild fish; i.e., stocked fish would be harvested in the same places, at the same time, and in the same relative abundance as wild fish. Thus, our intent was that sampling of the commercial fisheries for stocked, otolith-marked fish would provide up-to-date, area-specific information that would augment the district-wide information provided by coded-wire tagging studies in the 1980s and 1990s–information more useful for assessing the effectiveness of potential commercial fisheries closures designed to reduce the harvest and increase the spawning escapement of Hugh Smith Lake sockeye salmon.

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 223 million cubic meters. The lake empties into Boca de Quadra inlet via 50 m-long Sockeye Creek (ADF&G stream number 101-30-10750). Boca de Quadra empties into Revillagigedo Channel. Sockeye salmon otoliths were collected from the net fisheries that take place in District 101 (Figure 1).

DESCRIPTION OF FISHERIES CLOSURES

Closures in the District 101 commercial net fisheries were to be triggered in response to the weekly cumulative count of sockeye salmon through the Hugh Smith Lake weir, based on the average run-timing at the weir over all years of weir operations (Hugh Smith Lake Sockeye Salmon Action Plan, Final Report to the Board of Fish, RC-106, February, 2003). Run-timing was calculated by *statistical week*, a classification used by ADF&G to divide the year into sequentially numbered weeks for management of the salmon fisheries. Each year, Statistical Week 1 begins during the first week of January and ends on the first Saturday of the month; subsequent statistical weeks start on Sunday and end on the following Saturday (see Appendix A for 2004–2006 ADF&G statistical week calendars).

If the cumulative Hugh Smith Lake sockeye salmon weir counts in Statistical Weeks 29 and 30 (mid-July) should fall below the projected cumulative number of sockeye salmon needed to meet the lower end of the escapement goal range, the Action Plan stated that "the department shall close that portion of the District 101 purse seine fishery east of a line from Quadra Point to Slate Island Light to Black Rock Light to a point on the mainland shore at 55°01.40' N. latitude, 131°00.20' W. longitude" (Figure 2A). If the cumulative Hugh smith Lake sockeye salmon weir counts in ADF&G Statistical Weeks 31, 32, and 33 (late July to mid-August) should fall below the projected cumulative number of sockeye salmon needed to meet the lower end of the escapement goal range, "the department shall close that portion of the District 101 purse seine fishery east of a line from Foggy Point Light to Black Rock Light to the southernmost tip of Black Island, and close the upper portion of the Section 1-B (Tree Point) drift gillnet fishery one nautical mile south of the latitude of Foggy Point Light" (Figure 2B). The purse seine closures affected Subdistrict 101-23, and closures in Statistical Weeks 31–33 closed all of the area in Subdistrict 101-23 typically fished by the purse seine fleet.

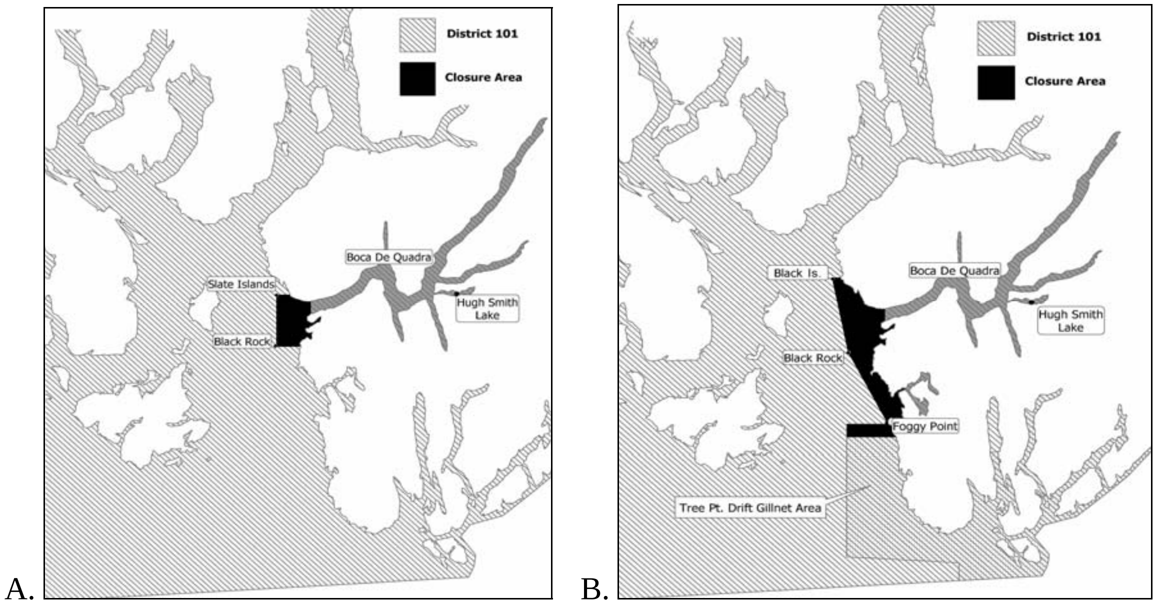

Figure 2.–Commercial fishing areas in District 101 delineated for potential closure in the Hugh Smith Lake Action Plan. (A) In Statistical Weeks 29–30, fisheries closures would affect the Subdistrict 101-23 purse seine area, encompassed by Black Island light on the north, and Foggy Point light on the south (area shaded black). (B) In Statistical Weeks 31–33, the closed area would expand to include all of Subdistrict 101-23, bounded by Black Island light on the north, and Foggy Point light on the south, and would also extend into the north end of the Tree Point drift gillnet Subdistrict 101-11 area to 1 nautical mile south of Foggy Point light (area shaded black). Boca de Quadra is closed to commercial fishing east of Quadra Point (area shaded dark gray).

METHODS

FRY STOCKING PROGRAM

As part of ongoing sockeye salmon rehabilitation efforts at Hugh Smith Lake, Southern Southeast Regional Aquaculture Association collected sockeye salmon eggs annually from 1997 to 2002 at the outlet of Buschmann Creek, the primary spawning stream at Hugh Smith Lake (Geiger et al. 2003). The eggs and fry were reared at Southern Southeast Regional Aquaculture Association's Burnett Inlet hatchery, and mass-marked through thermal otolith marking. The fry were returned to net-pen enclosures at the outlet of the lake in May, where they were fed to pre-smolt size prior to their release in July or early August. Annual releases ranged between 200 thousand and 465 thousand pre-smolt (Table 1). These pre-smolt overwintered in the lake, and emigrated to salt water during the following spring. Adult sockeye salmon from this stocking project returned to Hugh Smith Lake from 2002 to 2007, after spending two or three winters at sea.

Table 1.–Number, size, and adult return years of otolith-marked sockeye salmon fry released in Hugh Smith Lake, 1999–2003.

Brood Year	Release Year	Date Released	Mean Weight (g)	Mean Length (mm)	Total Released	Ocean Age-2 and Age-3 Return Years
1998	1999	19-Jul-99	4.9	80	85,000	2002–2003
1998	1999	27-Jul-99	3.8	71	117,000	2002–2003
1999	2000	21-Jul-00	6.5	83	175,000	2003–2004
1999	2000	28-Jul-00	9.5	91	205,000	2003–2004
2000	2001	18-Jul-01	5.2	75	235,000	2004–2005
2000	2001	1-Aug-01	8.7	88	220,000	2004–2005
2001	2002	19-Jul-02	5.7	NA	216,000	2005–2006
2001	2002	1-Aug-02	8.7	NA	249,000	2005–2006
2002	2003	21-Jul-03	6.3	82	214,000	2006–2007
2002	2003	30-Jul-03	9.2	94	210,000	2006–2007

COMMERCIAL FISHERIES SAMPLING

Our sampling plans for the District 101 drift gillnet and purse seine fleets were somewhat different. Virtually all of the fish harvested in the drift gillnet fishery were landed at two fish processing plants in Ketchikan, making it possible to develop a system for collecting a sample that would very closely approximate a random sample of all the sockeye salmon harvested in a given week. The sampling plan for the purse seine fleet was more complex, and included a two-stage sampling of vessels, where vessels (either purse seine or tenders) were considered the basic sampling units. These basic units were sampled in such way that we could estimate the proportion of marked otoliths within a vessel fishing in the district, and describe the variability among vessels that were grouped into sets of interest. In addition to the samples that we collected, sockeye salmon otolith samples were also collected by other ADF&G personnel from the drift gillnet fisheries in District 106, around the north end of Prince of Wales Island, in Sumner and Clarence straits. The purpose of that sampling program was to estimate proportions of Stikine River sockeye salmon stocks in the District 106 drift gillnet harvest during key weeks of the fishery (PSC 2005); however, a small number of otolith-marked Hugh Smith Lake sockeye salmon were also recovered.

All of our otolith samples were processed and decoded by personnel of the ADF&G Commercial Fisheries Mark Laboratory, Juneau, as outlined by Scott et al. (2001).

Sampling in the Drift Gillnet Fishery

We partitioned the drift gillnet fishery harvest into weekly units, or *sampling domains*, based on ADF&G statistical weeks. The total harvest for each statistical week was obtained from the ADF&G fish ticket system, which is based on a weekly reporting system. We called the weekly harvest “domains” to emphasize that the first estimates of interest are the weekly estimates of the proportion of otolith marks. We assumed that we had resources to decode a total of 2,500 total otoliths for the entire gillnet season. The number of otoliths that were analyzed in each weekly sampling domain was allocated using the dynamic sample size algorithm described by Geiger (1994). We first decoded a batch of 96 otoliths from each domain. Additional otoliths were decoded in batches, so as to produce the steepest decline in the standard deviation of the variance of the overall proportion of otolith marks in all domains. This required collecting more otoliths than would actually be decoded, because the cost of decoding otoliths was greater than the marginal, additional cost of collecting more otoliths than needed. We wanted to ensure that our sample very nearly approximated a random sample, as we used a very small number of otoliths to make an inference about a very large number of fish.

Both of the processing plants that bought gillnet fish deployed two or three tenders each week to the fishing grounds in the District 101 drift gillnet area. Tenders delivered fish to the processors twice per week depending upon the fishing conditions (i.e., about 4 deliveries a week per processor, and up to 8 deliveries total). In addition, one processor consistently deployed a tender to the south end of the gillnet area and another tender to the north end of the gillnet area. This allowed us to obtain some samples each week that were known to be from the southern area of the gillnet fishery and some known to be from the northern area of the gillnet fishery.

We sampled the gillnet fishery from the start of the season in mid-June (beginning dates: 20 June 2004, 19 June 2005, and 18 June 2006) to early or mid-September (ending dates: 4 September 2004, 17 September 2005, and 16 September 2006). Over the five years, 1999 to 2003, 90% of the sockeye salmon harvested in the District 101 drift gillnet fishery were taken by mid-August; the number of sockeye salmon dropped considerably thereafter (Table 2). In 2004, our initial objective, therefore, was to collect up to 600 otoliths per week from mid-June to mid-August (the week ending 14 August), 300 otoliths in the following week, and 100 otoliths a week, if possible, in the last week of August and the first week of September. In 2005–2006, we reduced our weekly gillnet quota from 600 samples per week to 520 samples per week through mid-August. Samples were collected throughout the week, on each day that deliveries were made to the processors, and no more than 120 samples were collected from any one tender delivery.

Otolith samples were collected in such a way as to represent all of the fish that were delivered by the tender. We first estimated the number of sockeye salmon on-board the tender, by dividing the total weight of sockeye salmon (in pounds of fish) by the industry average of 6 pounds for a sockeye salmon. The rate at which we sampled fish was then determined by dividing the estimated number of sockeye salmon by our sampling goal for the boat. Finally, we sampled every i^{th} fish, as determined from this calculation, as fish were unloaded from the tender, or from totes after the fish were unloaded. Information recorded at the time of sampling included the sampler name, processor name, vessel name, the date sampled, and the statistical week the fish were harvested.

We dissected otoliths from whole fish at processing facilities by making a dorsal-ventral cut through the rear of the fish's head, just forward of where the body meat met the cartilage of the head and perpendicular to the axis of the fish's body. This cut allowed us to expose the brain cavity and sagittal wells that hold the otoliths, without completely removing the head from the fish. The left and right sagittal otoliths were removed from each fish and placed into a single cell of a labeled, plastic, 96-cell tray (These trays were 8.5 cm × 12.5 cm, with 96 small cells arranged in 8 rows by 12 columns into which the otoliths were deposited.). Otoliths were cleaned using a treatment described by Hagen et al. (1995): we soaked them in a 0.5% chlorine solution for up to 8 minutes, followed by a rinse in dechlorinating solution, and a rinse in tap water.

Table 2.–Weekly sockeye salmon harvest in the District 101-11 drift gillnet fishery, 1999–2003, and weekly 2004 sockeye salmon otolith sampling goal.

	Year					Average Weekly Harvest	Average Proportion of Total Harvest	Otolith Sampling Goal
Statistical Week	1999	2000	2001	2002	2003			
25			17,533	13,883	7,256			
26	29,645	6,772	10,185	9,954	33,845	18,080	0.16	600
27	21,218	6,644	4,561	42,006	15,981	18,082	0.16	600
28	29,602	13,291	8,513	29,799	10,186	18,278	0.16	600
29	18,013	10,394	4,861	8,620	4,479	9,273	0.08	600
30	22,975	15,466	7,122	7,393	12,478	13,087	0.12	600
31	16,888	10,667	6,383	3,032	5,741	8,542	0.08	600
32	10,039	19,720	16,011	3,507	5,629	10,981	0.10	600
33	5,489	9,724	3,186	1,314	4,076	4,758	0.04	600
34	2,766	1,497	535	577	2,749	1,625	0.01	300
35	1,633	224	772	158	1,757	909	0.01	100
36	1,316	183	264	74	657	499	0.00	100
37	227	26	103	27	355	148	0.00	
38	190	28	12	9	72	62	0.00	
39	25	15		0	2	11	0.00	
40	2					2	0.00	
Total	160,028	94,651	80,041	120,353	105,263	112,067		5,300

Let π_i denote the proportion of otolith marks in one of the sampling domains (e.g., statistical weeks), and suppose there are D total domains (i = 1,2,3, ... D). Let n_i denote the number of sampled otoliths decoded in statistical week i, and let x_i denote the number of otolith marks observed from statistical week i. We assume independent binomial models for the number of otolith marks, x_i:

$$x_i \sim \text{Bin}(n_i, \pi_i),\ i = 1, \ldots D,$$

with the number of sampled otoliths decoded, n_i , known. The parameters π_i are assumed to be independent samples from a beta distribution:

$$\pi_i \sim \text{Beta}(\alpha, \beta),\ i = 1, \ldots D.$$

The beta distribution is a prior distribution for π_i.

To estimate the prior parameters, α and β, we used all the data, $\{\pi_i\} = \{x_i / n_i\}$, from total domains ($i$ = 1 ... D). Since $\pi_i \sim$ beta (α, β), we have:

$$E(\pi_i) = \frac{\alpha}{\alpha + B}, \text{var}(\pi_i) = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)};$$

Then we have:

$$\alpha + \beta = \frac{E(\pi_i)(1 - E(\pi_i))}{\text{var}(\pi_i)} - 1,$$

$$\alpha = (\alpha + \beta)E(\pi_i), \text{ and}$$

$$\beta = (\alpha + \beta)(1 - E(\pi_i)).$$

E(π_i) and *var*(π_i) were estimated as the sample mean, $\bar{\pi} = \frac{1}{D}\sum_{i=1}^{D}\pi_i$, and sample variance, $s^2 = \frac{1}{D-1}\sum_{i=1}^{D}(\pi_i - \bar{\pi})^2$, respectively. The analysis using the data to estimate the prior parameters is called empirical Bayes (Gelman 2004).

The beta distribution is a conjugate prior for binomial likelihood; that is, the posterior distributions are also beta distributions with new parameters, ($\alpha + x_i$) and ($\beta + n_i - x_i$):

$$\pi_i|(x_i \text{ and } n_i) \sim \text{Beta}(\alpha + x_i, \beta + n_i - x_i), i = 1,2,3, \ldots D.$$

The posterior mean of π_i, given x_i and n_i, which can be interpreted as the proportion of otolith marks from the population in statistical week *i*, is now

$$E(\pi_i) = \frac{\alpha + x_i}{\alpha + \beta + n_i}, \tag{1}$$

which always lies between the sample proportion, x_i / n_i, and the prior mean, $\alpha / (\alpha,+\beta)$. The posterior variance is

$$\text{var}(\pi_i) = \frac{(\alpha + x_i)(\beta + n_i - x_i)}{(\alpha + \beta + n_i)^2(\alpha + \beta + n_i + 1)}. \tag{2}$$

Inference about the proportions of otolith-marked sockeye salmon in each domain was calculated through this posterior distribution. We then reported the posterior mean and a measure of precision (credible interval) for each sampling domain.

Sampling in the Purse Seine Fishery

We collected sockeye salmon otolith samples after each purse seine opening at two Ketchikan area fish processing plants. In 2004, we collected up to 50 otoliths from each individual seine boat sampled, and 120 otoliths from each tender; in 2005 and 2006 we reduced our sampling rate to 48 otoliths per individual seine boat, and 96 otoliths per tender. Samples were dissected as described for gillnet samples, and placed into labeled, plastic, 96-well trays specific to each boat that was sampled. The individual otolith samples were collected from each delivery in such a way as to represent all of the fish delivered, as described above for gillnet samples. Individual seine boats frequently delivered fewer than 50 total sockeye salmon, particularly from Subdistricts 101-23 and 101-41. In those instances, we collected otolith samples from every sockeye salmon in the delivery. Information recorded at the time of sampling for each purse seine sample included the sampler name, processor name, vessel name, date sampled, statistical week the fish were harvested, district and subdistrict where fish were harvested, approximate number of fish delivered, and, for tender deliveries, number of boats that delivered to the tender. Much of this information was obtained from ADF&G fish tickets after the fish were bought by the processor or tender.

All of the purse seine samples that we collected in 2004 through 2005 were from Subdistricts 101-23, 101-29, and 101-41. Although we did not obtain samples from other subdistricts with reported sockeye salmon catches (e.g., Subdistricts 101-21, 101-25, 101-45, 101-46, and 101-53), the three subdistricts that we sampled accounted for 92% of the total sockeye salmon catch in the traditional commercial fisheries in 2004 through 2005 (catch data retrieved from ADF&G Integrated Fisheries Database 23 January 2007). In 2006, we also obtained samples from Subdistrict 101-25 (Figure 1). Pure deliveries of District 101 purse seine fish, by subdistrict, were sometimes difficult to obtain at the Ketchikan fish processing plants. Seine boats were often directed to deliver catches to tenders, either on the fishing grounds or at an anchorage in town, rather than directly to the processing plant where ADF&G samplers were stationed. This was particularly true late in the fishing season, when tender deliveries often contained fish caught in multiple districts or multiple subdistricts of District 101. In order to obtain sufficient information about the distribution of Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, we combined our sampling units into two sampling domains: what we call here the "District 101 inside" domain (Subdistricts 101-23 and 41 combined) and the "District 101 outside" domain (Subdistricts 101-25 and 29 combined). Combining harvests and samples in this manner allowed us to compare the estimated proportion of stocked Hugh Smith Lake sockeye salmon in "inside" areas of the District 101 fishery, near the entrance to Boca de Quadra, to the estimated proportion of Hugh Smith Lake fish in "outside" areas of the District 101 fishery, in Clarence Strait (see Figure 1). We sampled purse seine deliveries throughout the season, from the start of the purse seine season in early July (beginning date: 4 July 2004, 3 July 2005, and 2 July 2006) to late August (ending date: 28 August 2004, 27 August 2005, and 26 August 2006).

Again, in the purse seine fishery, individual vessels (seine boats or tenders) were considered the basic sampling units. We collected more otoliths than would actually be decoded, because decoding of the otoliths was more expensive than the marginal, additional cost of collecting more otoliths than needed. In 2004 and 2005, we decoded about 50% of the otoliths that were collected, by decoding every other otolith sample in each first-stage sampling unit. In 2006, we decoded nearly all of the otoliths that were collected. Sampling units were pooled into sampling domains by means of Bayesian hierarchical modeling. Let the set A denote a collection of sampling units that were closely related, so that their mark-rate parameters were all statistically dependent. In the case of the purse seine fishery, the sampling domains can be constructed from any arbitrary grouping of boats. For example, if a set of four specific boats were observed fishing at a particular point on a particular day, those four boats could be grouped into a sampling domain.

We say that i is an element of A if i gives the index of the first-stage sampling unit that is part of the set of interest, and we let A be an index for set A. Let n_i denote the number of sampled otoliths decoded at sampling unit i (i = 1, 2, …, I), and let y_i denote the total number of otolith marks observed from sampling unit i. The data from the sampling units are assumed to follow independent binomial distributions:

$$y_i \sim \text{Bin}(n_i, \pi_i), \tag{3}$$

and the parameters π_i are assumed to be independent samples from a Beta distribution with two hyperprior parameters, α and β:

$$\pi_i \sim \text{Beta}(\alpha, \beta). \tag{4}$$

Next we sought hyperprior distributions for (α, β). We first reparameterized in terms of the mean and sample size. Let r denote the mean, and J denote the sample size so that we have $\alpha = J \cdot r$ and $\beta = J(1-r)$. We assumed r and J to follow Beta and Gamma distribution, respectively. Based on available information, we assumed the otolith-mark ratio was 0.2, if weighted by sample size 30, then r~Beta(6, 24). Parameters in the Gamma distribution were estimated using the mean and variance of sample sizes from all the data.

We then used the posterior distributions for π_i, weighted by sample sizes n_i, to develop the posterior distribution for the overall mean of each statistical domain of interest, such as set A. All of our statistical calculations were performed using WinBugs software.

ESCAPEMENT SAMPLING

We assumed that stocked fish would share similar run-timing to wild fish, and that stocked fish would be harvested in the same places, and at the same time, as wild fish. In order to consider the question of run-timing, we compared the run-timing of stocked fish to wild fish as sockeye salmon entered Hugh Smith Lake through an adult counting weir. We estimated the proportion of stocked, otolith-marked sockeye salmon in the escapement by collecting a systematic otolith sample from every 100th adult sockeye salmon that was passed through the weir over the entire duration of the run. This sample was collected in conjunction with other studies conducted at Hugh Smith Lake (Piston et al. 2006). We assumed that this sampling rate would yield a reasonable, self-weighted estimate of the stocked portion of the run, while at the same time it would have minimal impact on the run should the escapement come in below the lower bound of the escapement goal of 8,000–18,000 adult sockeye salmon.

We used standard sampling theory (Cochran 1977) to estimate the mean proportions (and standard errors) of stocked and wild sockeye salmon. Because the sample was a systematic sample rather than a random sample, the estimate of the variance is not strictly appropriate if the otolith-marked fish had different entry timing than wild fish. However, we expect the square root of the variance to overstate the standard error of the estimate, and we will assume that it is a reasonable approximation. We compared the proportion of stocked to wild fish in the escapement in each third of the run, based on the historical run-timing of sockeye salmon at the weir since 1982.

RESULTS

DISTRICT 101-11 DRIFT GILLNET FISHERY

In 2004, we estimated that stocked Hugh Smith Lake sockeye salmon accounted for 8.9% (95% Credible Interval: 7.9–9.9%) of the total sockeye salmon harvest of 142,000 fish in the District 101-11 drift gillnet fishery in Statistical Weeks 26–36 (20 June–4 September; Appendix B1). This translated to an estimated 12,600 stocked Hugh Smith Lake sockeye salmon (95% Credible Interval: 11,000–14,000). Stocked Hugh Smith Lake sockeye salmon contributed an average 24% of the total sockeye salmon harvested during Statistical Weeks 30–35 (18 July–28 August). About 83% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33, the exact weeks of the Hugh Smith Lake Action Plan (11 July–14 August; Figure 3). The peak of abundance, as shown by the estimated catch-per-boat-day, also occurred in Statistical Weeks 29–33 (Figure 4).

In 2004, the distribution of stocked Hugh Smith Lake sockeye salmon in the drift gillnet fishery was about equally divided between the northern and southern tenders: roughly 9% (SE = 1%) of sockeye salmon harvests in the south end of the gillnet area, and 8% (SE = 1%) of sockeye salmon harvests in the north end. These estimates were based on very small sample sizes (average weekly sample size of 48 otoliths from a north end tender, and 63 otoliths from a south end tender), hence the high degree of imprecision in the estimates. There were also several instances when it was not clear that these tenders bought fish exclusively from boats that fished either the north or south areas of the fishery; some of the catches that we sampled from a "north-end" or "south-end" tender may have included fish from both areas.

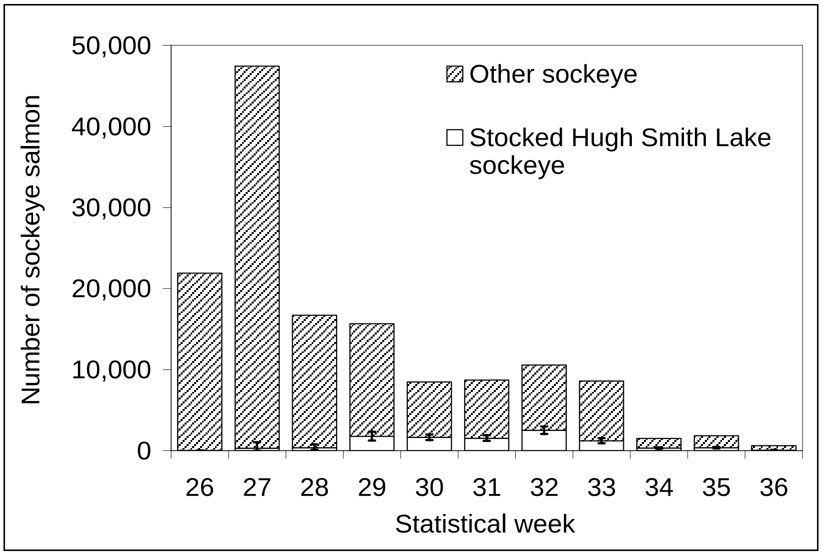

Figure 3.–Total weekly catch of sockeye salmon and estimated weekly catch of stocked Hugh Smith Lake sockeye salmon in the District 101-11 drift gillnet fishery, 2004. Error bars represent the 95% credible intervals.

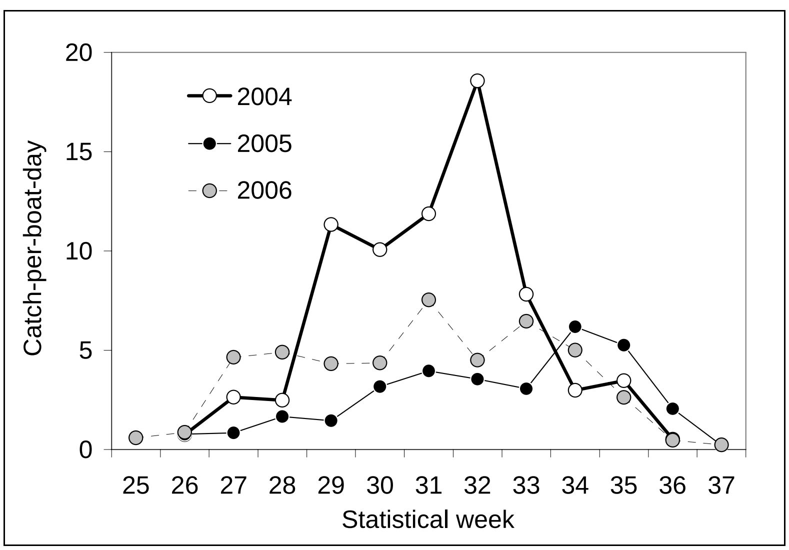

Figure 4.–Estimated weekly catch-per-boat-day of stocked Hugh Smith lake sockeye salmon in the District 101-11 drift gillnet fishery, 2004–2006.

In 2005, we estimated that stocked Hugh Smith Lake sockeye salmon accounted for 6.2% (95% Credible Interval: 5.3–7.1%) of the total sockeye salmon harvest of 79,700 fish in the District 101-11 drift gillnet fishery in Statistical Weeks 26–38 (19 June–17 September; Appendix B1). This translated to an estimated 4,900 stocked Hugh Smith Lake sockeye salmon (95% Credible Interval: 4,200–5,600). About 51% of the harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33 (11 July–14 August), the weeks of the Hugh Smith Lake Action Plan (Figure 5). The peak of abundance, as shown by the estimated catch-per-boat-day, occurred in Statistical Weeks 30–35 (Figure 4). Stocked Hugh Smith Lake sockeye salmon contributed an average 22% of the total sockeye salmon harvested during Statistical Weeks 31–35 (24 July–27 August). Thus, the run-timing of stocked Hugh Smith Lake through the gillnet fishery was later in 2005 than in 2004. In 2005, we did not attempt to estimate the north-south distribution of the proportion of stocked Hugh Smith Lake sockeye salmon in the catch.

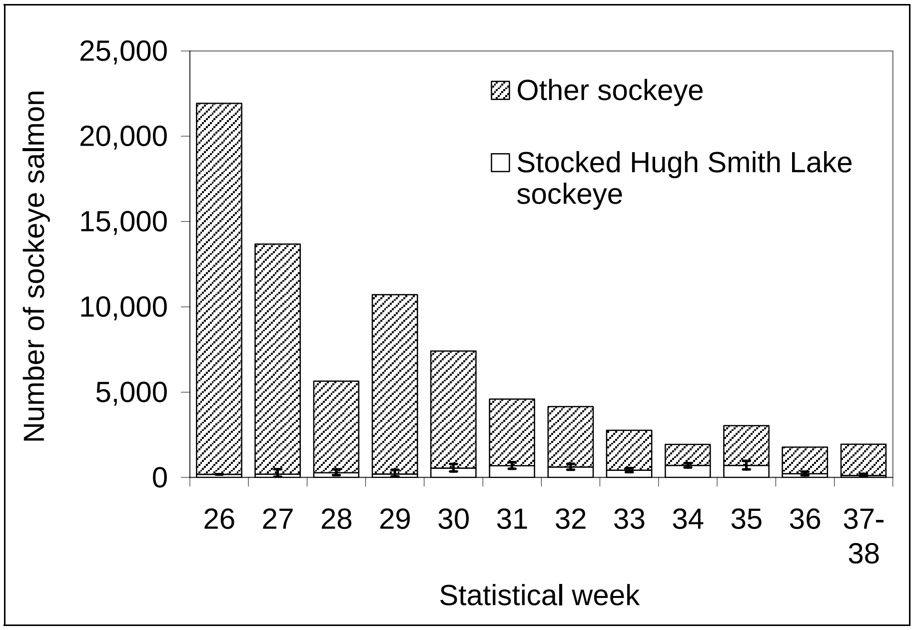

Figure 5.–Total weekly catch of sockeye salmon and estimated weekly catch of stocked Hugh Smith Lake sockeye salmon in the District 101-11 drift gillnet fishery, 2005. Error bars represent the 95% credible intervals.

In 2006, we estimated that stocked Hugh Smith Lake sockeye salmon accounted for 8.4% (95% Credible Interval: 7.4–9.5%) of the total sockeye salmon harvest of 62,800 fish in the District 101-11 drift gillnet fishery in Statistical Weeks 25–37 (18 June–16 September; Appendix B1). This translated to an estimated 5,300 stocked Hugh Smith Lake sockeye salmon (95% Credible Interval: 4,600–5,900). About 61% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33, the weeks of the Hugh Smith Lake Action Plan (16 July–19 August; Figure 6). The peak of abundance, as shown by the estimated catch-per-boat-day, occurred from Statistical Weeks 31 to 34 (30 July–26 August; Figure 4). In 2006, we did not attempt to estimate the north-south distribution of the proportion of stocked Hugh Smith Lake sockeye salmon in the catch.

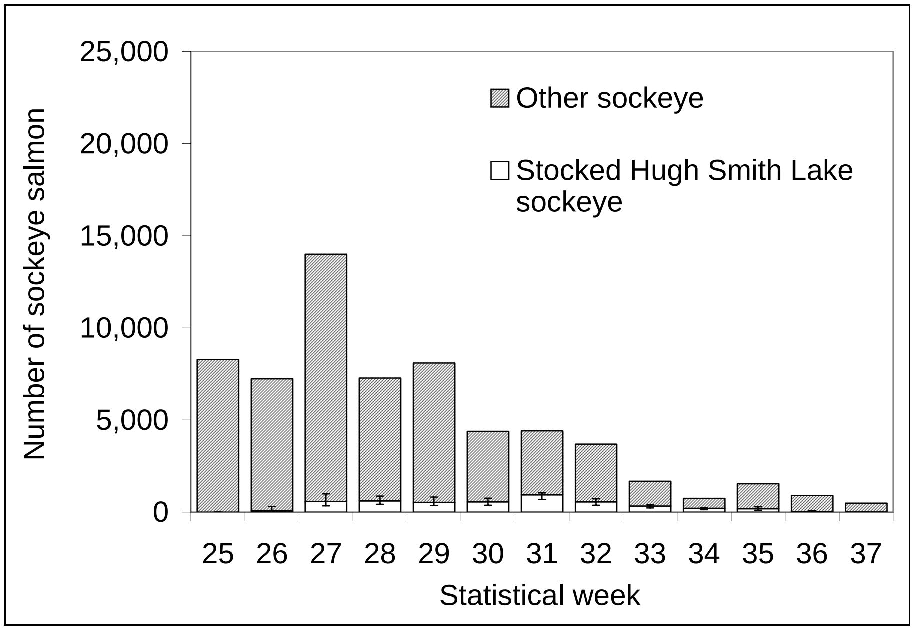

Figure 6.–Total weekly catch of sockeye salmon and estimated weekly catch of stocked Hugh Smith Lake sockeye salmon in the District 101-11 drift gillnet fishery, 2006. Error bars represent the 95% credible intervals.

DISTRICT 101 PURSE SEINE FISHERY

We successfully obtained many weekly samples from individual seine boats early in the fishing season, during Statistical Weeks 28–32 (early July to early August; Appendices C1–C6). In 2004 and 2005, however, Ketchikan fish processors bought most of their fish through tenders once purse seine catches of pink salmon began to peak in early August. As a result, we obtained fewer weekly samples after early August because samples were available primarily from tenders rather than individual seine boats, and because many tenders bought fish that were harvested in multiple districts or subdistricts. Deliveries that contained multiple districts or subdistricts (other than a combination of Subdistricts 101-23 and 101-41) were unsuitable for our sampling purposes.

Fishing effort in Subdistrict 101-23, the area affected by the Hugh Smith Lake Action Plan, was low throughout the season in all three years of the study. For example, the maximum number of boats that landed fish from Subdistrict 101-23 in 2004 was six in Statistical Week 28; only two to four boats per week made landings in Statistical Weeks 29–33, and there was no reported catch in Statistical Weeks 34 and 36. A total of only 69 boat-days were fished in 2004. The fishing effort was lower still in 2005 (41 boat-days) and 2006 (28 boat-days). In 2006, fishing hours were greatly reduced from previous years due to a very poor pink salmon return to the region. Finally, low sockeye escapement at the Hugh Smith Lake weir required the Action Plan to be enacted during Statistical Week 29 in 2005 and Statistical Weeks 29–31 in 2006, and the area at the entrance of Boca de Quadra was closed to fishing (Figure 2A). As a result, we obtained few pure samples from Subdistrict 101-23 after mid-July, because of the lower fishing effort and the use of tenders by the fish processors.

We also determined that seiners sometimes fished both Subdistricts 101-23 and 101-41 during a single opening when openings were longer than 15 hours, particularly in the middle and latter part of the 2004 and 2005 season when these areas were open to fishing for more than 100 hours a week. On several occasions we obtained samples from individual seine boats that we were told had fished in Subdistrict 101-23 (communication from boat crew), only to find out later that Subdistrict 101-41 was listed as the fishing location on the ADF&G fish ticket. On one occasion in 2004, our management biologists observed a boat fishing in Subdistrict 101-23 during an aerial survey, yet no catch was recorded for that opening—that boat likely also fished in both Subdistrict 101-23 and 101-41, but only 101-41 was recorded on the ADF&G fish ticket.

As outlined in the Methods section above, we combined harvests and samples from Subdistricts 101-23 and 101-41 into an "inside" area of the District 101 fishery. This allowed us to compare this "inside" area near the entrance to Boca de Quadra to harvests and samples in the "outside" area in Clarence Strait: Subdistrict 101-29 and, in 2006, Subdistricts 101-25 and 101-29 combined.

2004

In 2004, stocked Hugh Smith Lake sockeye salmon accounted for an average 22% (95% Credible Interval: 18–25%) of the sockeye salmon harvested in the District 101 "inside area" purse seine fishery, Subdistricts 101-23 and 101-41 combined. An estimated 7,200 stocked Hugh Smith Lake sockeye salmon were harvested during the weeks that were sampled (95% Credible Interval: 6,100–8,400). More than 90% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33, the exact weeks of the Hugh Smith Lake Action Plan, with the peak catch occurring in Statistical Week 32 (1–7 August; Figure 7).

Stocked Hugh Smith Lake sockeye salmon accounted for an average 7% (95% Credible Interval: 4–9%) of the sockeye salmon harvested in the District 101 "outside area" (Subdistrict 101-29). An estimated 4,500 stocked Hugh Smith Lake fish were harvested during the weeks that were sampled (95% Credible Interval: 3,100–6,000; Figure 8). The peak catch of stocked Hugh Smith Lake sockeye salmon occurred in Statistical Week 32 (1–7 August). More than 90% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33, the exact weeks of the Hugh Smith Lake Action Plan.

We estimated that the harvest of stocked Hugh Smith Lake sockeye salmon in the traditional District 101 purse seine fishery was about 11,700 for the weeks and areas that we sampled. The abundance of stocked Hugh Smith Lake sockeye salmon, as determined by catch-per-boat-day, was highest in Subdistrict 101-23, followed by Subdistrict 101-41 and Subdistrict 101-29 (Figure 9). The abundance of stocked Hugh Smith Lake fish in Subdistricts 101-41 and 101-29 was similar in Statistical Weeks 30–33 (18 July–14 August).

2005

In 2005, stocked Hugh Smith Lake sockeye salmon accounted for an average 15% (95% Credible Interval: 13–17%) of the sockeye salmon harvested in the District 101 "inside area" purse seine fishery, Subdistricts 101-23 and 101-41 combined. An estimated 2,600 stocked Hugh Smith Lake sockeye salmon were harvested during the weeks that were sampled (95% Credible Interval: 2,300–3,000 (Figure 10). About 90% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33 (11 July–14 August), the exact weeks of the Hugh Smith Lake Action Plan, with the peak catches occurring in Statistical Weeks 29 and 32.

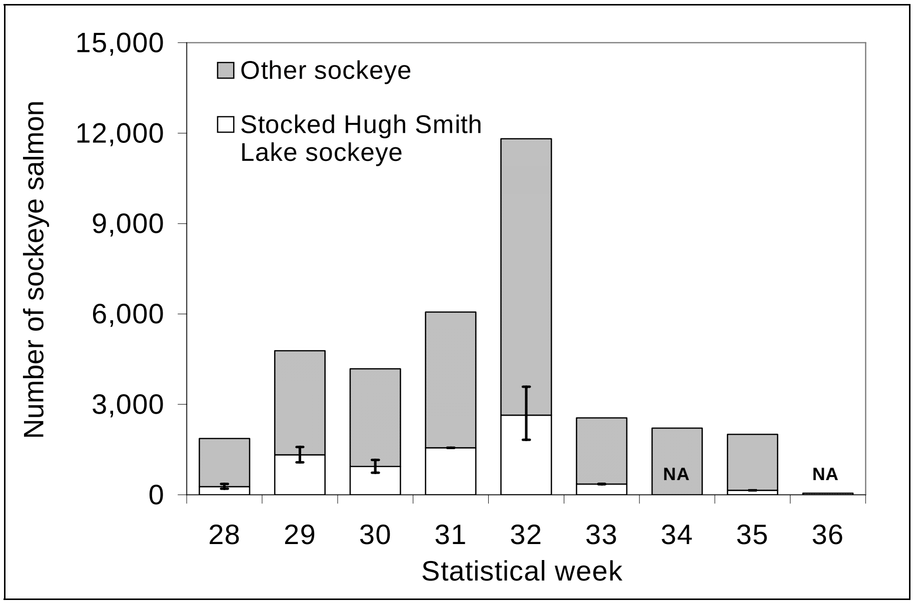

Figure 7.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, Subdistricts 101-23 and 101-41 combined, 2004. Error bars represent the 95% credible intervals for weeks with multiple samples (no samples were obtained in Statistical Weeks 34 and 36).

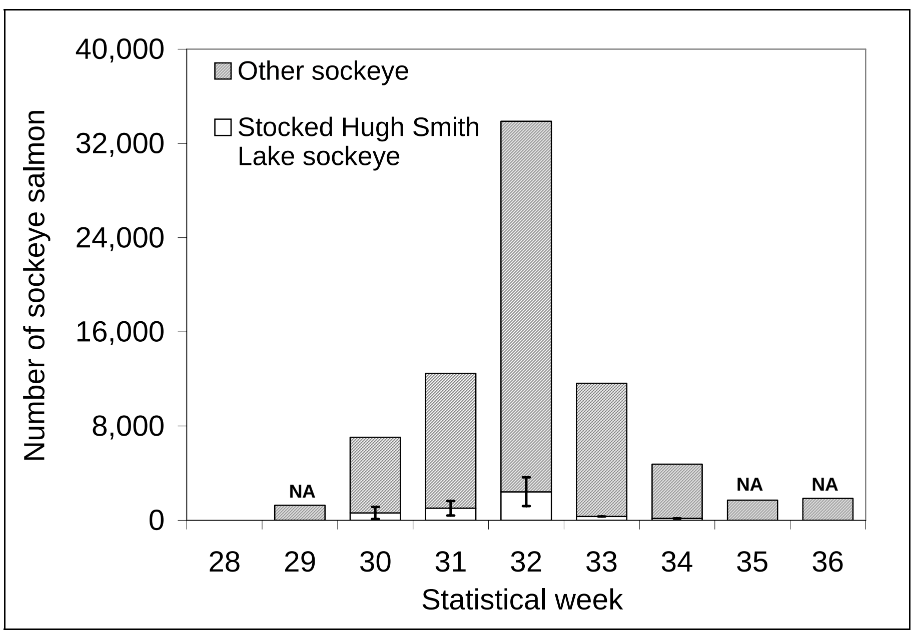

Figure 8.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101-29 purse seine fishery, 2004. Error bars represent the 95% credible interval for weeks with multiple samples (no samples were obtained in Statistical Weeks 29, 35, and 36).

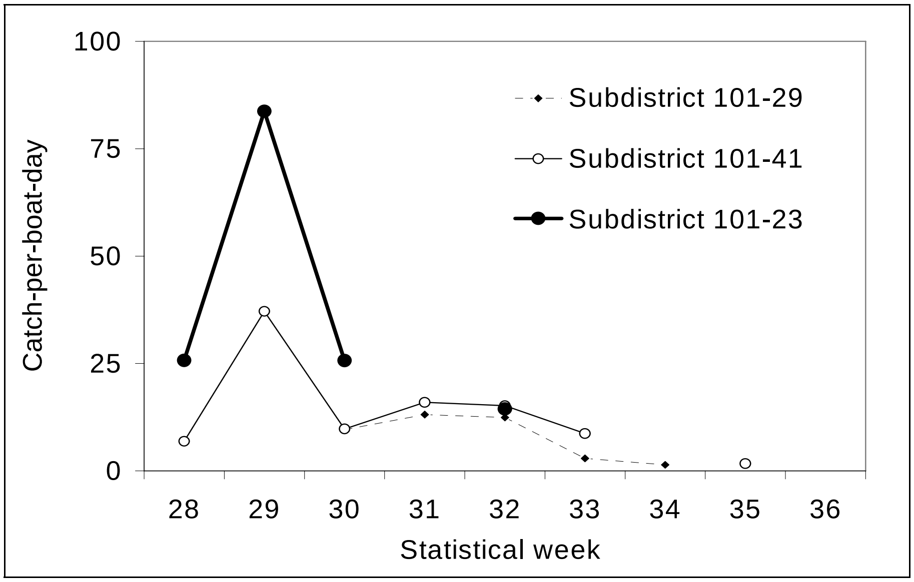

Figure 9.–Estimated weekly catch-per-boat-day of stocked Hugh Smith lake sockeye salmon in the District 101 purse seine fishery, by subdistrict, 2004.

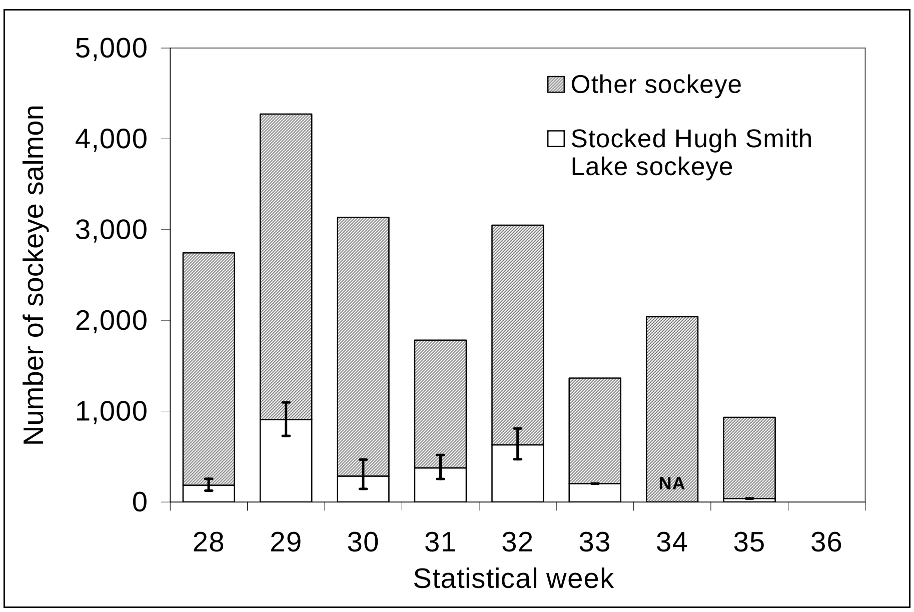

Figure 10.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, Subdistricts 101-23 and 101-41 combined, 2005. Error bars represent the 95% credible intervals for weeks with multiple samples (no sample was obtained in Statistical Week 34).

Stocked Hugh Smith Lake sockeye salmon accounted for an average 4% (95% Credible Interval: 3–5%) of the sockeye salmon harvested in the District 101 “outside area” (Subdistrict 101-29). An estimated 2,300 stocked Hugh Smith Lake fish were harvested during the weeks that were sampled (95% Credible Interval: 1,700–3,000; Figure 11). The peak catch of stocked Hugh Smith Lake sockeye salmon occurred in Statistical Week 32 (31 July–6 August). About 80% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33, the exact weeks of the Hugh Smith Lake Action Plan.

We estimated that the harvest of stocked Hugh Smith Lake sockeye salmon in the traditional District 101 purse seine fishery was about 4,900 for the weeks and areas that we sampled. The abundance of stocked Hugh Smith Lake sockeye salmon, as determined by catch-per-boat-day, was highest in Subdistrict 101-23, followed by Subdistrict 101-41 and Subdistrict 101-29 (Figure 12). The abundance of stocked Hugh Smith Lake fish in Subdistricts 101-41 and 101-29 was similar for all weeks when both subdistricts were sampled.

2006

In 2006, stocked Hugh Smith Lake sockeye salmon accounted for an average 22% (95% Credible Interval: 22–26%) of the sockeye salmon harvested in the District 101 “inside area” purse seine fishery, Subdistricts 101-23 and 101-41 combined. An estimated 2,700 stocked Hugh Smith Lake sockeye salmon were harvested during the weeks that were sampled (95% Credible Interval: 2,400–2,900; Figure 13). About 75% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33 (16 July–19 August), the exact weeks of the Hugh Smith Lake Action Plan, with the peak catch occurring in Statistical Week 29.

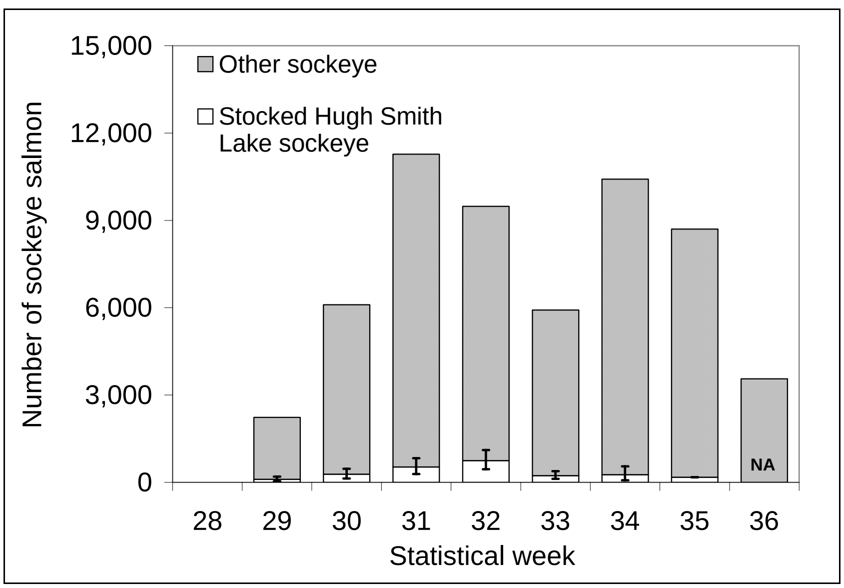

Figure 11.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101-29 purse seine fishery, 2005. Error bars represent the 95% credible intervals for weeks with multiple samples (no sample was obtained in Statistical Week 36).

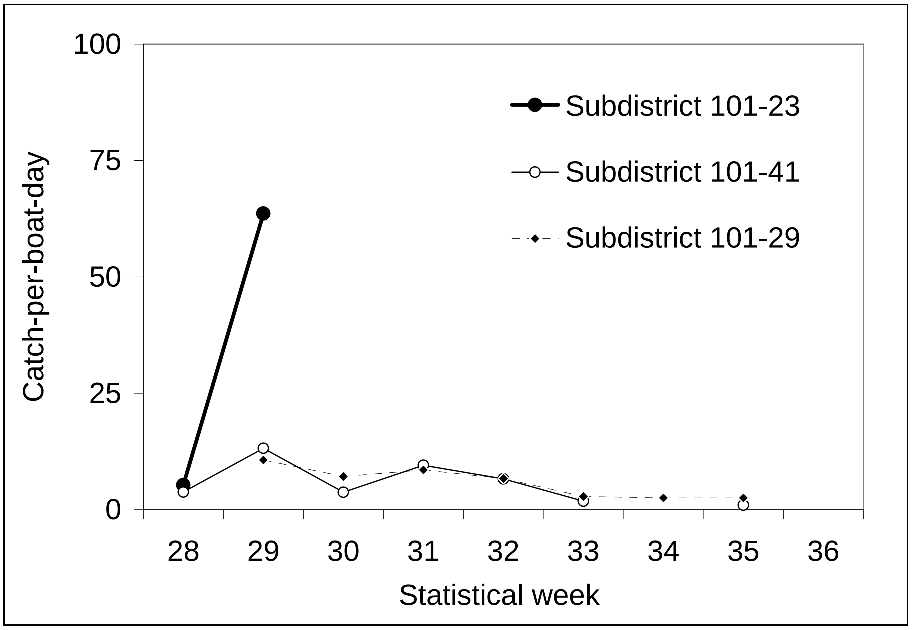

Figure 12.–Estimated weekly catch-per-boat-day of stocked Hugh Smith lake sockeye salmon in the District 101 purse seine fishery, by subdistrict, 2005.

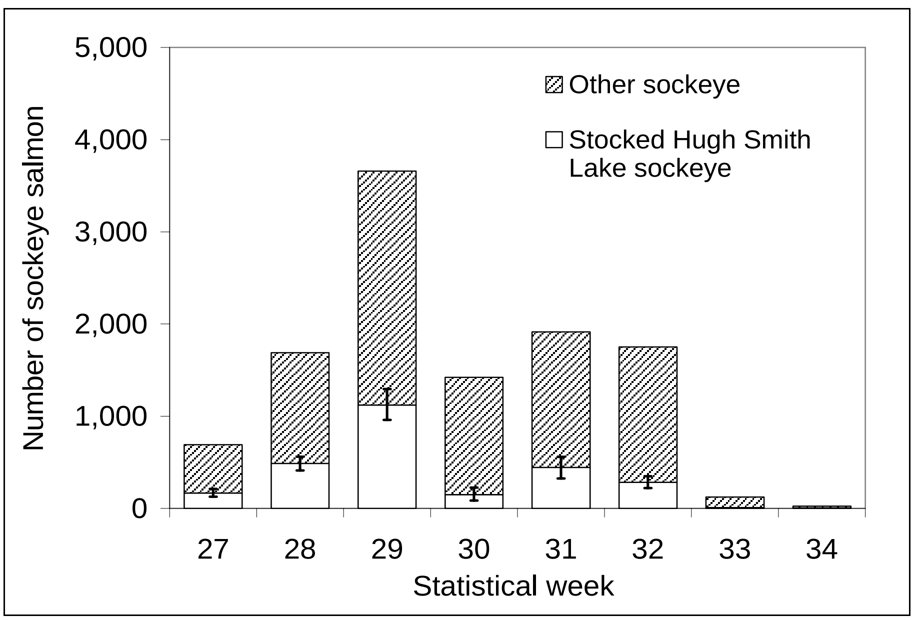

Figure 13.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, Subdistricts 101-23 and 101-41 combined, 2006. Error bars represent the 95% credible intervals for weeks with multiple samples.

Stocked Hugh Smith Lake sockeye salmon accounted for an average 4% (95% Credible Interval: 3–6%) of the sockeye salmon harvested in the District 101 "outside area," Subdistricts 101-25 and 101-29 combined. An estimated 1,300 stocked Hugh Smith Lake fish were harvested during the weeks that were sampled (95% Credible Interval: 900–1,800). The peak catch of stocked Hugh Smith Lake sockeye salmon occurred in weeks 30–31 (31 July–6 August; Figure 14), the only weeks that Subdistrict 101-29 was open to fishing. About 88% of the total harvest of stocked Hugh Smith Lake sockeye salmon took place between Statistical Weeks 29 and 33(16 July–19 August), the exact weeks of the Hugh Smith Lake Action Plan.

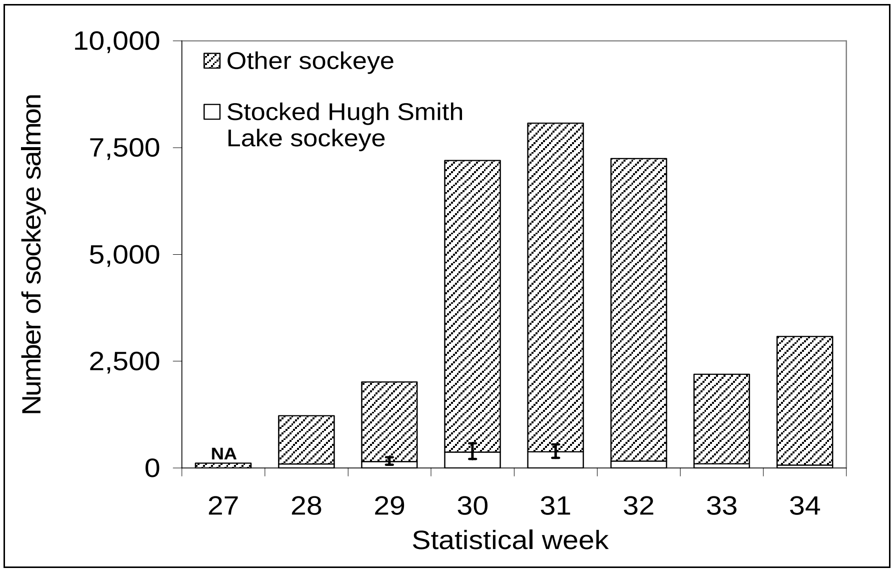

Figure 14.–Total weekly harvest of sockeye salmon and estimated weekly harvest of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, Subdistricts 101-25 and 101-29 combined, 2006. Error bars represent the 95% credible intervals for weeks with multiple samples (no sample was obtained in Statistical Week 27).

We estimated that the harvest of stocked Hugh Smith Lake sockeye salmon in the traditional District 101 purse seine fishery was about 4,000 for the weeks and areas that we sampled. The abundance of stocked Hugh Smith Lake sockeye salmon, as determined by catch-per-boat-day, was fairly similar between all the subdistricts sampled through Statistical Week 31 (30 July–5 August); however, as abundance declined in the "inside" Subdistrict 101-41 fishery, abundance peaked in "outside" Subdistrict 101-25 (Figure 15). Unlike 2004 and 2005, the abundance of stocked Hugh Smith Lake fish in Subdistrict 101-23 was not higher than in other subdistricts.

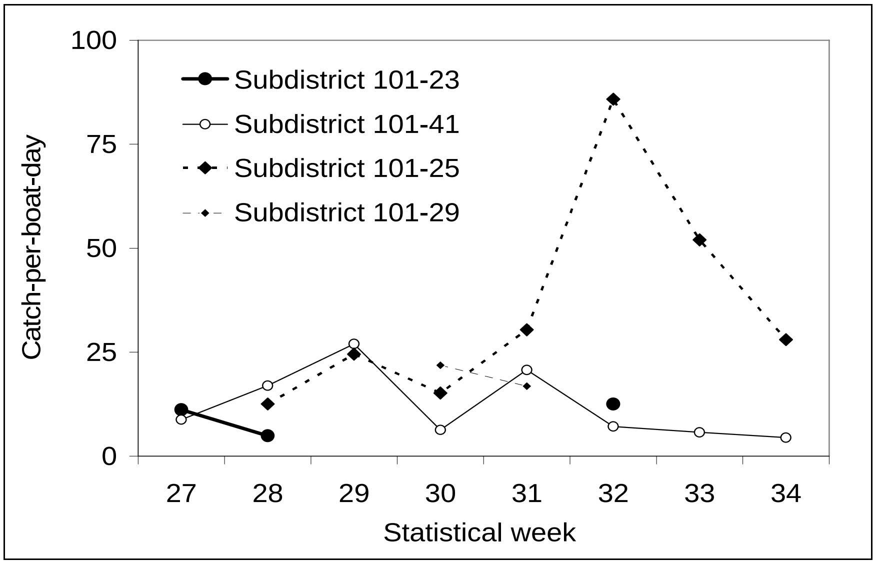

Figure 15.–Estimated weekly catch-per-boat-day of stocked Hugh Smith lake sockeye salmon in the District 101 purse seine fishery, by subdistrict, 2006.

OTHER FISHERIES

Stocked Hugh Smith Lake sockeye salmon were recovered in otolith samples collected in the District 106 drift gillnet fishery in Clarence Strait and Sumner Strait in 2004–2006 (Appendices B2–B3) and in the District 108 drift gillnet fishery near Wrangell in 2005.

In 2004, stocked Hugh Smith Lake sockeye salmon accounted for only 0.3% of the sockeye salmon harvested in Sumner Strait (Subdistrict 106-41; 95% Credible Interval: 0.1–0.5%), or about 300 fish (95% Credible Interval: 100–500). Most (96%) of that harvest occurred in Statistical Weeks 30–33 (18 July–14 August). Sockeye salmon harvests in Clarence Strait (Subdistrict 106-30) were not sampled as intensively, and not sampled at all in the first three weeks of the fishing season. We estimated a minimum harvest of 640 stocked Hugh Smith Lake fish (95% Credible Interval: 320–960) during Statistical Weeks 30–35 (18 July–28 August).

In 2005, stocked Hugh Smith Lake sockeye salmon accounted for only 1.2% of the sockeye salmon harvested in Sumner Strait (Subdistrict 106-41; 95% Credible Interval: 0.9–1.5%), or about 980 fish (95% Credible Interval: 700–1,300). That harvest was distributed over Statistical Weeks 28–37 (3 July–10 September). Sockeye salmon harvests in Clarence Strait (Subdistrict 106-30) were not sampled as intensively, and not at all for the first five weeks of the fishing season. We estimated a minimum harvest of 430 stocked Hugh Smith Lake fish (95% Credible Interval: 230–620) during Statistical Weeks 30–35 (17 July–27 August).

In 2006, stocked Hugh Smith Lake sockeye salmon accounted for only 0.3% of the sockeye salmon harvested in Sumner Strait (Subdistrict 106-41; 95% Credible Interval: 0.2–0.5%), or about 200 fish (95% Credible Interval: 100–300). Most otolith recoveries occurred in Statistical Weeks 30–35 (23 July–2 September). In 2006, sampling of the sockeye salmon harvests in Clarence Strait (Subdistrict 106-30) was greatly improved over the previous two years; we estimated a harvest of 380 stocked Hugh Smith Lake fish (95% Credible Interval: 300–500) during Statistical Weeks 26–35 (25 June–2 September).

Two Hugh Smith Lake sockeye salmon were recovered in the Wrangell drift gillnet fishery in 2005, in Subdistrict 108-40: one from a sample of 56 otoliths in Statistical Week 33 (7–13 August), and one from a sample of only nine otoliths in Statistical Week 37 (4–10 September).

ESCAPEMENT

In 2004, we collected 192 otoliths samples from a total escapement of 19,926 adult sockeye salmon (Appendix D1). Of this sample, seven were unreadable, and 118 were thermally marked; thus, stocked fish comprised about 64% (SE=4%) of the adult escapement, or about 12,700 fish (SE=700). The run-timing of stocked fish in the escapement was clearly different from the run-timing of wild fish; stocked fish peaked in the last two-thirds of the run, whereas wild fish peaked in the first two-thirds of the run (Figure 16).

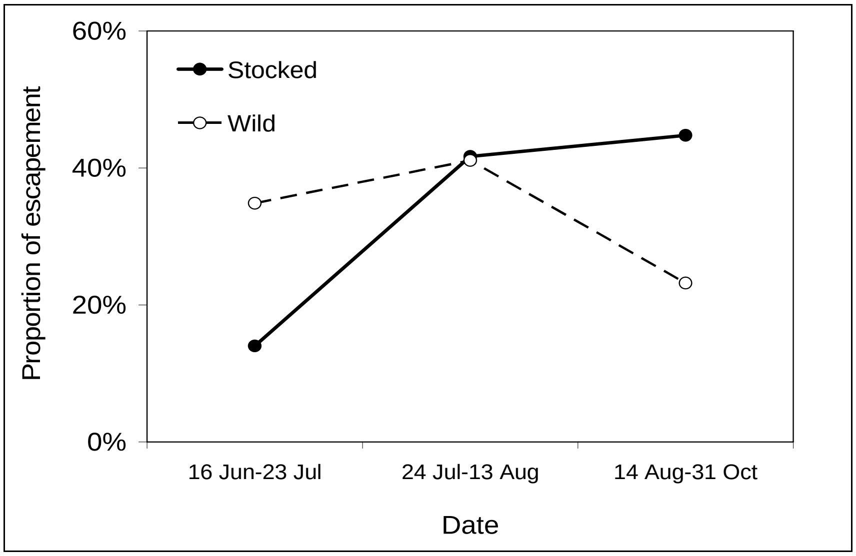

Figure 16.–Run-timing curves for stocked and wild sockeye salmon at the Hugh Smith Lake weir, 2004. Dates represent the historical mean thirds of the run. Each data point represents the proportion of the total escapement of wild or stocked fish recorded in that period, and each curve sums to 100%. For example, 14% of the total escapement of stocked fish occurred in the first third of the run, 42% in the middle third of the run, and 44% in the final third of the run.

In 2005, we collected 236 otoliths samples from a total escapement of 24,108 adult sockeye salmon (Appendix D2). Of this sample, 135 were thermally marked; thus, stocked fish comprised about 57% (SE=3%) of the adult sockeye salmon escapement, or about 13,800 fish (SE=770). Stocked fish exhibited later run-timing than wild fish, with 74% of the stocked fish passing the Hugh Smith Lake weir in the last third of the run, whereas the run-timing of wild fish was more uniform through the season (Figure 17).

In 2006, we collected 418 otoliths samples from a total escapement of 42,530 adult sockeye salmon (Appendix D3). Of this sample, three were unreadable, and 268 were thermally marked; thus, stocked fish comprised about 65% (SE=2%) of the adult sockeye salmon escapement, or about 27,500 fish (SE=990). In 2006, the run-timing of wild fish and stocked fish was very similar, and peaked during the middle third of the run (Figure 18).

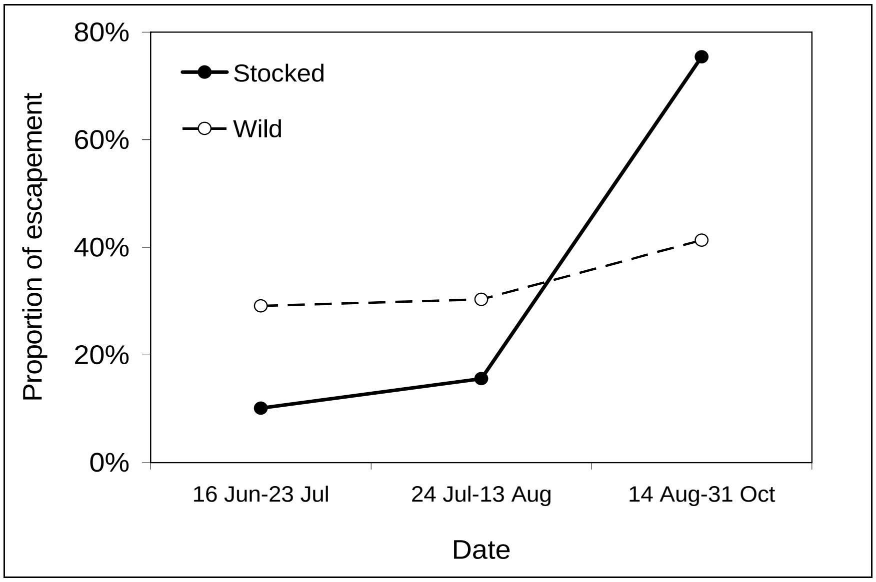

Figure 17.–Run-timing curves for stocked and wild sockeye salmon at the Hugh Smith Lake weir, 2005. Dates represent the historical mean thirds of the run. Each data point represents the proportion of the total escapement of wild or stocked fish recorded in that period, and each curve sums to 100%. For example, 10% of the total escapement of stocked fish occurred in the first third of the run, 16% in the middle third of the run, and 74% in the final third of the run.

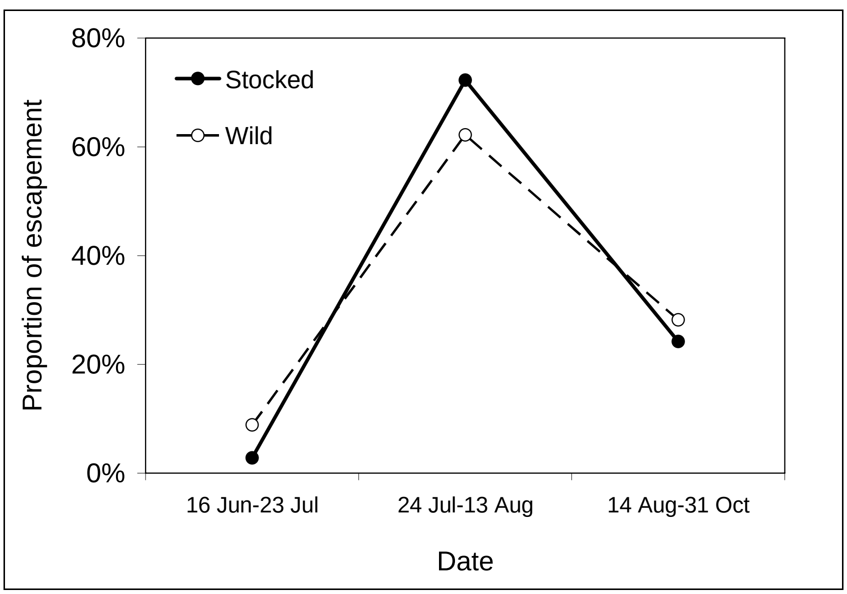

Figure 18.–Run-timing curves for stocked and wild sockeye salmon at the Hugh Smith Lake weir, 2006. Dates represent the historical mean thirds of the run. Each data point represents the proportion of the total escapement of wild or stocked fish recorded in that period, and each curve sums to 100%. For example, 3% of the total escapement of stocked fish occurred in the first third of the run, 72% in the middle third of the run, and 25% in the final third of the run.

EXPLOITATION RATE

We estimated that the minimum exploitation rate on stocked Hugh Smith Lake sockeye salmon in the traditional District 101 fisheries was 66% in 2004, 42% in 2005, and 25% in 2006 (Table 3). In addition, the exploitation rate by the purse seine fishery was generally higher than the exploitation rate by the drift gillnet fishery. Although we sampled the major District 101 fisheries, as already noted, we did not sample all subdistricts in the traditional District 101 purse seine fishery, nor did we obtain samples from every statistical week of the fisheries that we did sample. Thus, our estimates of the exploitation rates in District 101 should be considered minimum values.

Table 3.–Estimated distribution and exploitation rate of stocked Hugh Smith Lake sockeye salmon in the District 101 net fisheries that were sampled in 2004–2006.

Year		District 101 Gillnet Harvest	District 101 "Inside" Seine Harvest[a]	District 101 "Outside" Seine Harvest[b]	Total District 101 Harvest	Escapement
2004	Estimated Harvest	12,600	7,200	4,500	24,300	12,700
	Exploitation Rate	34%	19%	12%	66%	34%
	95% Credible Interval	11,000–14,000	6,100–8,400	3,100–6,000		
2005	Estimated Harvest	4,100	2,600	2,300	9,000	13,800
	Exploitation Rate	18%	11%	10%	42%	58%
	95% Credible Interval	4,200–5,600	2,300–3,000	1,700–3,000		
2006	Estimated Harvest	5,300	2,700	1,300	9,300	27,500
	Exploitation Rate	14%	7%	4%	25%	76%
	95% Credible Interval	4,600–5,900	2,400–2,900	900–1,800		

[a] The District 101 "inside" area includes Subdistricts 101-23 and 101-41 combined.
[b] The District 101 "outside" area includes Subdistrict 101-29, and in 2006, 101-25 and 101-29 combined.

DISCUSSION

Our estimates of the contribution and run-timing of stocked Hugh Smith Lake sockeye salmon in the commercial net fisheries of District 101 largely corroborated what was already known through coded-wire tagging studies conducted in the 1980s and 1990s. Our study also provided much finer area-specific information about the distribution of Hugh Smith Lake sockeye salmon within District 101 than was previously available from earlier coded-wire tagging studies.

The precision of our estimates of the contribution of stocked Hugh Smith Lake sockeye salmon to the District 101 fisheries were generally quite reasonable. In 2004–2005, the approximate coefficient of variation of our estimates averaged 7% for the District 101 drift gillnet fishery, 6% for the District 101 "inside" purse seine area, and 15% for the District 101-29 purse seine area. These results compared favorably to previously reported harvest estimates generated from coded-wire tagging studies conducted by ADF&G. For example, the coefficient of variation of estimates of the *total harvest* (over all fisheries sampled) of coded-wire tagged Fish Creek chum salmon averaged 13% from 1991 to 1995 (range: 6–21%; Heinl et al. 2000), Hugh Smith Lake sockeye salmon averaged 16% from 1989 to 1998 (Geiger et al. 2003), and Unuk River coho salmon averaged 17% from 1998 to 2002 (range: 12–23%; Jones et al. 1999, 2001a, and 2001b; Weller et al. 2002 and 2003). The total harvest of coded wire tagged Unuk River Chinook salmon averaged 23% for the 1982 to 1986 brood years (range: 12–40%; Pahlke 1995), and the total harvest of coded wire tagged Chikamin River Chinook salmon averaged 25% for the 1982 to 1986 brood years (range: 16–41%; Pahlke 1995). If more resources became available, we could further improve the precision of our estimates simply by decoding the remaining archived samples that were collected during our study.

The accuracy of our study depended on being able to relate information about stocked fish to the wild Hugh Smith Lake sockeye salmon run. We had originally intended to expand our total estimates of stocked Hugh Smith Lake fish by the stocked-to-wild ratio at the Hugh Smith Lake weir; however, the run-timing of stocked fish at the Hugh Smith Lake weir was clearly later than the run-timing of wild fish in 2004 and 2005. After considering this fact, we felt that it would be best to present information only for stocked fish that we directly sampled in the fisheries. We can infer that wild Hugh Smith Lake sockeye salmon were probably more prevalent in the fisheries earlier in the season than stocked fish. In 2005, for example, it was highly likely that the timing of wild fish in the District 101 drift gillnet fishery actually corresponded better with the Action Plan weeks than was suggested by the later timing of stocked fish. It should be clear, too, that the proportions of Hugh Smith Lake sockeye salmon in the commercial fisheries would be higher still if we had been able to expand for wild fish.

EFFECTIVENESS OF THE HUGH SMITH LAKE ACTION PLAN

Our primary concern was to determine whether or not fisheries closures directed at conserving Hugh Smith Lake sockeye salmon would have the desired effect. Specifically, were Hugh Smith Lake sockeye salmon more abundant in the closure area dictated by the Action Plan compared to other areas in the District 101 net fisheries. And, did the timing of fishery closures dictated by the Action Plan correspond to peak abundance of Hugh Smith Lake sockeye salmon in the commercial fisheries? The answer to both of these questions was yes, though this "yes" was qualified to some degree, by the differences we found in run-timing between the stocked fish and wild fish.

The abundance of stocked Hugh Smith Lake sockeye salmon was greatest in the purse seine catches in Subdistrict 101-23, the area primarily affected by the potential fisheries closures. In 2004 and 2005, the catch-per-boat-day of Hugh Smith Lake sockeye salmon was higher in the weeks that we sampled Subdistrict 101-23, compared to other subdistricts (Figures 9 and 12). This was not true in 2006, when the catch-per-boat-day was about the same in all purse seine areas that we sampled, suggesting that the entry pattern of Hugh Smith Lake fish through Clarence Strait and Revillagigedo Channel was different than in the previous two years. That difference may have also simply reflected the limited fishing effort and smaller sample sizes in much of the District 101 purse seine fisheries in 2006.

The proportion of stocked Hugh Smith Lake sockeye salmon was greater in sockeye salmon catches sampled from the "inside" waters of Revillagigedo Channel (Subdistricts 101-23 and 101-41), than along the Gravina Island shore in Clarence Strait (Subdistrict 101-25 and 101-29). These results should come as no surprise, because the entire Hugh Smith Lake sockeye salmon run must migrate through Revillagigedo Channel and Subdistrict 101-23 enroute to Boca de Quadra and Hugh Smith Lake. Catches of sockeye salmon in Revillagigedo Channel are generally much lower than catches in Clarence Strait, because there are fewer stocks of sockeye salmon in this area; consequently, the concentration of Hugh Smith Lake sockeye salmon would be higher. Purse seine openings conducted in the entrance of Boca de Quadra function as quasi-terminal fisheries on stocks that spawn in Boca de Quadra, and are quite different from the mixed-stock fisheries that take place along the Gravina Island shore in Clarence Strait or in the

District 101 drift gillnet area. A management action that moves boats out of Boca de Quadra can only improve the sockeye salmon escapement at Hugh Smith Lake.

We had intended to make an inference about the effectiveness of the Action Plan in the District 101 drift gillnet fishery, but we were not able to directly sample catches from the small closure area at the north end of the fishery. Although our results in 2004 showed that the distribution of stocked Hugh Smith Lake sockeye salmon was about equally divided between samples from "north-end" and "south-end" tenders, those estimates were based on very small sample sizes and there was some uncertainty as to whether or not some of the sampled fish were strictly "northern" or "southern." A meaningful comparison of the north-south distribution in the gillnet area would require more intensive sampling, including sampling aboard tenders on the fishing grounds.

The timing of stocked Hugh Smith Lake sockeye salmon through the District 101 purse seine fisheries corresponded well with the timing of the Action Plan closures. From 75% (2006) to 90% (2004 and 2005) of the estimated harvest of stocked Hugh Smith Lake sockeye salmon in the "inside" purse seine areas (Subdistricts 101-23 and 101-41 combined) occurred during the Action Plan weeks. The timing of stocked Hugh Smith Lake sockeye salmon through the District 101 drift gillnet fishery also generally corresponded with the timing of the Action Plan closures, with between 51% (2005) and 83% (2006) of the stocked Hugh Smith Lake sockeye salmon harvested in the drift gillnet fishery taken during the Action Plan weeks. The run was latest in 2005, when the peak of abundance occurred just after the Action Plan weeks, in Statistical Weeks 34–35.

Geiger et al. (2005) concluded that there would be minimal risk of implementing fisheries closures to limit the harvest of Hugh Smith Lake sockeye salmon in years when the escapement goal was reached, and likewise, little risk of not implementing closures when the escapement was below goal. There have been 12 years when the final Hugh Smith Lake sockeye salmon escapement was less than the lower range of the current escapement goal of 8,000 adults, and 13 years when the final escapement exceeded 8,000 adults. In the 11 years when the final escapement was below goal, fisheries closures would have been enacted in 52 of 55 weeks covered by the Action Plan, had it been in effect (Table 4; Geiger et al. 2005). In the 17 years when the final escapement was above goal, fisheries closures would have been enacted unnecessarily in 17 of 65 weeks covered by the Action Plan, and five of those weeks occurred in 1994, when the final escapement of 8,386 just made goal (Table 5).

Table 4.–Effects of the Hugh Smith Lake Action Plan on management of the District 101 commercial fisheries in the years when the final escapement of Hugh Smith Lake sockeye salmon *was below* the lower range of the escapement goal of 8,000–18,000 adults. The "-" signs indicate the weeks when fishery closures would have occurred under the current Action Plan. The "+" signs indicate weeks when closures would not have been implemented and fishing would have been conducted as normal.

Statistical Week	1988	1989	1990	1991	1995	1996	1998	1999	2000	2001	2002
29	-	-	-	-	-	-	-	-	+	-	-
30	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	+	-	-
32	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	+
Final Escapement	5,056	6,513	1,285	5,885	3,422	7,123	1,138	3,174	4,281	3,825	6,166

Table 5.–Effects of the Hugh Smith Lake Action Plan on management of the District 101 commercial fisheries in the years when the final escapement of Hugh Smith Lake sockeye salmon *exceeded* the lower range of the escapement goal of 8,000–18,000 adults. The “-“ signs indicate the weeks when fishery closures would have occurred under the current Action Plan. The “+” signs indicate weeks when closures would not have been implemented and fishing would have been conducted as normal.

Statistical Week	1982	1983	1984	1985	1987	1992	1993	1994	1997	2003	2004	2005	2006
29	+	-	+	+	+	+	+	-	+	-	+	-	-
30	+	+	+	+	+	+	+	-	+	-	+	+	-
31	+	+	+	+	+	+	+	-	+	-	+	+	-
32	+	-	+	+	+	+	+	-	+	-	+	+	+
33	+	-	+	+	+	+	+	-	+	-	+	+	+
Final Escapement	57,219	10,429	16,106	12,245	33,097	65,737	11,312	8,386	12,180	19,568	19,734	23,865	42,112

COMMERCIAL FISHING PATTERNS IN THE ACTION PLAN AREA

Our difficulty in consistently obtaining otolith samples through the entire season in Subdistrict 101-23 was due primarily to low commercial fishing effort. The low fishing effort in Subdistrict 101-23 was the continuation of a long decreasing trend in the catch and effort in that area, a change related to changes in the Southeast Alaska purse seine fishery as a whole and not to a lack of pink salmon, the targeted species in that area. The catch and effort in Subdistrict 101-23 decreased from an average of 1.2 million pink salmon and 430 boat-days in the early 1980s, to an average of 0.5 million pink salmon and 120 boat-days since 2000, while the catch-per-boat-day of pink salmon doubled from 2,000 per boat-day in the early 1980s, to 4,000 per boat-day since 2000 (Figure 19); clearly, the abundance of pink salmon in this area is as high as it has ever been. Similar reductions in the fishing effort have also taken place in the District 101 drift gillnet fishery, where the number of boat days has fallen to about half the historic average since 2000 (Figure 20).

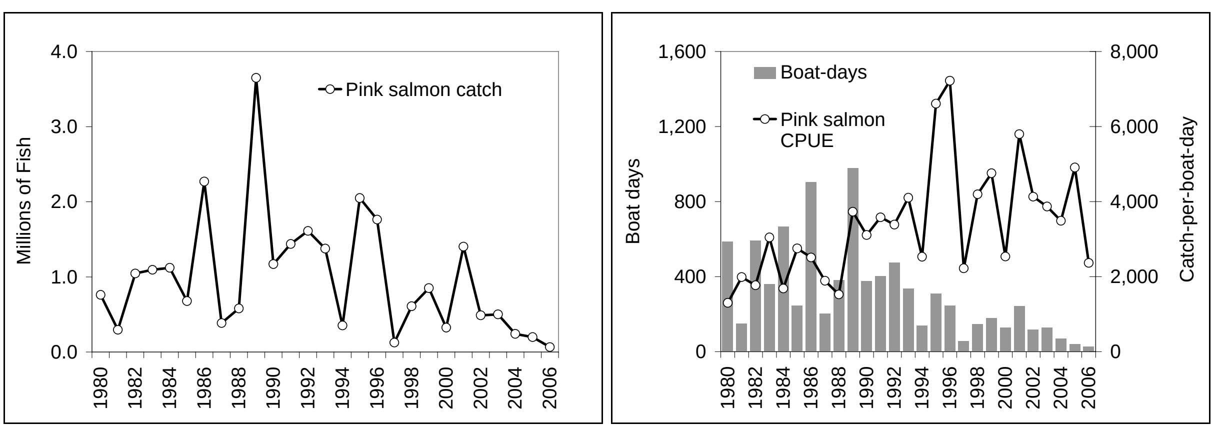

Figure 19.–The annual commercial fishing effort and total harvest of pink salmon in the District 101-23 purse seine fishery, compared to the relative abundance of pink salmon as shown by the catch-per-boat-day (CPUE), 1980–2006.

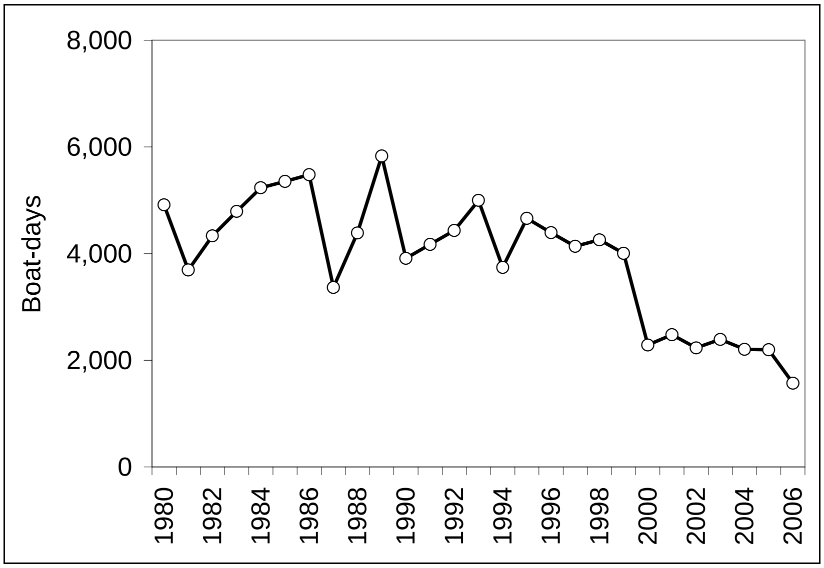

Figure 20.–The annual commercial fishing effort (boat-days) in the District 101-11 drift gillnet fishery, 1980–2006.

The exploitation rate on wild Hugh Smith Lake sockeye salmon in Alaskan fisheries was estimated to average 60% in eight years of coded-wire tag recoveries, from 1989 to 1991 and 1994 to 1998 (Geiger et al. 2003). That estimate was derived from sampling most of the net fisheries in southern Southeast Alaska, not just District 101. Although Hugh Smith Lake sockeye salmon are primarily harvested in the commercial fisheries of District 101, coded-wire tag studies showed that portions of the Hugh Smith Lake sockeye salmon run were also harvested in District 104 and 102 purse seine fisheries, and the Annette Island net fisheries (Metlakatla Indian Community). In this study, we estimated the exploitation rate on stocked Hugh Smith Lake sockeye salmon to be 66% in 2004, 42% in 2005, and 25% in 2006 (Table 3). We did not obtain samples from all weeks in the District 101 purse seine subdistricts of interest and, aside from the District 106 drift gillnet fishery, we did not obtain samples from fisheries in any other Districts in southern Southeast Alaska. These estimates should be considered minimums, therefore, and the total harvest rate on Hugh Smith Lake sockeye salmon was certainly higher to some unmeasured level during all years of this study.

The exploitation rate on Hugh Smith Lake sockeye salmon was relatively high in 2004 and 2005 in light of the substantially lower-than-historical fishing effort in the net fisheries. We can only assume that had the fishing effort been similar to that of the 1980s–1990s, the exploitation rate on Hugh Smith Lake sockeye salmon would have been higher. If the historical trend toward lower commercial fishing effort should reverse, the Action Plan will remain an important and effective tool for limiting the harvest of Hugh Smith Lake sockeye salmon.

ACKNOWLEDGEMENTS

First, this project was made possible because Southern Southeast Regional Aquaculture Association otolith-marked all the Hugh Smith Lake sockeye salmon that were reared and released at Hugh Smith Lake as part of the rehabilitation project. We would like to thank Todd A. Johnson, Kimberly E. Adams, Malika Brunette, Glenn Hollowell, Robert A. Bale, and Leslie L. Wood, for their useful suggestions and significant contributions in collecting sockeye salmon otolith samples. In addition to decoding all of the otolith samples that we collected, Bev Agler, Dion Oxman, and Kray Van Kirk, of the ADF&G Mark Laboratory, provided suggestions that improved our sampling method and analysis. Jan Conitz, Andrew W. Piston, and Todd A. Johnson provided many useful comments on this manuscript.

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APPENDIX A STATISTICAL WEEK CALENDARS

Appendix A1.–ADF&G statistical weeks, 2004.

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

Appendix A2.–ADF&G statistical weeks, 2005.

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

Appendix A3.–ADF&G statistical weeks, 2006.

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

APPENDIX B. HUGH SMITH LAKE DRIFT GILLNET OTOLITH RECOVERIES AND ASSOCIATED STATISTICS

Appendix B1.–Weekly sockeye salmon catch and effort, otolith sampling statistics, and estimated proportion, contribution, and catch-per-boat-day of stocked Hugh Smith Lake sockeye salmon in the District 101-11 drift gillnet fishery, 2004–2006.

Year	District	Statistical Week	Total Catch	Boat-Days	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Estimated Proportion of Total Catch	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2004	101-11	26	21,905	212	191	0	1%	0–2%	159	1
2004	101-11	27	47,441	220	191	1	1%	0–3%	581	3
2004	101-11	28	16,712	184	190	4	3%	1–5%	457	2
2004	101-11	29	15,667	176	285	36	13%	9–17%	1,993	11
2004	101-11	30	8,470	200	287	69	24%	19–29%	2,014	10
2004	101-11	31	8,703	155	286	61	21%	17–26%	1,840	12
2004	101-11	32	10,567	175	288	90	31%	26–36%	3,250	19
2004	101-11	33	8,581	180	286	47	16%	12–21%	1,408	8
2004	101-11	34	1,512	135	191	52	27%	21–33%	403	3
2004	101-11	35	1,837	130	192	48	25%	19–31%	451	3
2004	101-11	36	616	125	79	8	11%	5–18%	66	1
2004	101-11	37-40	346	312	N/A					
2004	Total		142,357				8.9%	7.9–9.9%	12,622	
2005	101-11	26	21,933	240	95	0	1%	0–3%	188	1
2005	101-11	27	13,682	236	191	2	1%	0–4%	198	1
2005	101-11	28	5,641	168	192	9	5%	2–8%	279	2
2005	101-11	29	10,711	144	191	3	2%	1–4%	209	1
2005	101-11	30	7,414	175	285	21	7%	5–11%	554	3
2005	101-11	31	4,601	175	284	43	15%	11–19%	693	4
2005	101-11	32	4,148	175	286	43	15%	11–19%	620	4
2005	101-11	33	2,764	140	282	44	16%	12–20%	428	3
2005	101-11	34	1,937	115	191	72	37%	30–44%	711	6
2005	101-11	35	3,044	135	95	23	23%	16–32%	709	5
2005	101-11	36	1,784	108	96	12	12%	7–19%	222	2
2005	101-11	37-38	1,951	531	95	5	6%	2–11%	112	0
2005	101-11	39-40	115	124	N/A					
2005	Total		79,725				6.2%	5.3–7.1%	4,924	
2006	101-11	25	8,280	144	95	0	1%	0–4%	85	1
2006	101-11	26	7,230	164	96	1	2%	0–5%	142	1
2006	101-11	27	14,002	144	285	13	5%	3–7%	669	5
2006	101-11	28	7,273	140	288	27	9%	6–13%	687	5
2006	101-11	29	8,098	140	286	21	7%	5–11%	605	4
2006	101-11	30	4,382	140	192	27	14%	10–19%	611	4
2006	101-11	31	4,415	136	288	68	23%	19–28%	1,025	8
2006	101-11	32	3,690	136	190	32	17%	12–22%	612	5
2006	101-11	33	1,675	56	190	42	22%	16–28%	362	6
2006	101-11	34	747	44	96	30	29%	21–38%	220	5
2006	101-11	35	1,536	78	96	13	13%	8–20%	205	3
2006	101-11	36	890	81	39	1	4%	1–11%	38	0
2006	101-11	37	482	63	92	2	3%	1–7%	15	0
2006	101-11	38-40	70		N/A					
2006	Total		62,770				8.4%	7.4–9.5%	5,277	

Appendix B2.–Weekly sockeye salmon catch, otolith sampling statistics, and estimated proportion and contribution of stocked Hugh Smith Lake sockeye salmon in the District 106-30 drift gillnet fishery, 2004–2006.

Year	District	Statistical Week	Total Catch	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Estimated Proportion of Total Catch	95% Credible Interval	Estimated Contribution of Stocked Fish
2004	106-30	26	235	N/A				
2004	106-30	27	2,345	N/A				
2004	106-30	28	3,466	N/A				
2004	106-30	29	5,810	40	0	2%	0–5%	96
2004	106-30	30	4,326	39	3	5%	2–11%	232
2004	106-30	31	4,184	190	3	2%	1–4%	79
2004	106-30	32	7,095	151	3	2%	1–5%	160
2004	106-30	33	1,576	48	2	4%	1–8%	59
2004	106-30	34	417	N/A				
2004	106-30	35	406	26	1	3%	1–9%	14
2004	106-30	36-40	470	N/A				
2004	Total		30,330			2.7%	1.4–4.1%	639
2005	106-30	25	12	N/A				
2005	106-30	26	638	N/A				
2005	106-30	27	1,163	N/A				
2005	106-30	28	828	N/A				
2005	106-30	29	3,612	N/A				
2005	106-30	30	3,412	36	1	3%	0–8%	102
2005	106-30	31	1,993	131	3	2%	1–5%	50
2005	106-30	32	2,379	192	2	1%	0–3%	34
2005	106-30	33	4,659	N/A				
2005	106-30	34	5,189	192	8	4%	2–7%	207
2005	106-30	35	1,588	120	1	1%	0–4%	23
2005	106-30	36	517	16	0	2%	0–7%	12
2005	106-30	37-40	462	N/A				
2005	Total		26,452			2.8%	1.5–4.1%	427
2006	106-30	25	243	N/A				
2006	106-30	26	1,178	296	2	1%	0–2%	9
2006	106-30	27	2,893	295	0	0%	0–1%	9
2006	106-30	28	4,387	183	3	1%	0–3%	60
2006	106-30	29	8,481	354	4	1%	0–2%	93
2006	106-30	30	3,284	297	6	2%	1–3%	56
2006	106-30	31	1,977	283	2	1%	0–2%	16
2006	106-30	32	3,068	290	8	2%	1–4%	68
2006	106-30	33	2,455	296	4	1%	0–2%	31
2006	106-30	34	3,730	289	2	1%	0–2%	30
2006	106-30	35	1,450	285	1	1%	0–1%	8
2006	106-30	36	366	225	0	0%	0–1%	1
2006	106-30	37-40	109	N/A				
2006	Total		33,621			1.2%	0.8–1.5%	383

Appendix B3.–Weekly sockeye salmon catch, otolith sampling statistics, and estimated proportion and number of stocked Hugh Smith Lake sockeye salmon in the District 106-41 drift gillnet fishery, 2004–2006.

Year	District	Statistical Week	Total Catch	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Estimated Proportion of Total Catch	95% Credible Interval	Estimated Contribution of Stocked Fish
2004	106-41	25	1,204	158	0	0%	0–1%	2
2004	106-41	26	8,618	285	0	0%	0–1%	8
2004	106-41	27	25,425	288	0	0%	0–1%	24
2004	106-41	28	14,348	286	0	0%	0–1%	14
2004	106-41	29	15,090	288	0	0%	0–1%	14
2004	106-41	30	5,596	287	1	0%	0–1%	23
2004	106-41	31	5,529	288	4	1%	0–3%	73
2004	106-41	32	6,679	288	3	1%	0–2%	68
2004	106-41	33	2,330	256	6	2%	1–4%	50
2004	106-41	34	449	35	0	0%	0–3%	2
2004	106-41	35	176	62	3	3%	1–8%	6
2004	106-41	36	90	17	0	1%	0–4%	1
2004	106-41	37-41	395	N/A				
2004	Total		85,929			0.3%	0.1–0.5%	284
2005	106-41	25	1,044	277	1	1%	0–2%	7
2005	106-41	26	15,914	287	0	0%	0–1%	63
2005	106-41	27	12,047	288	0	0%	0–1%	48
2005	106-41	28	11,387	285	3	1%	0–2%	132
2005	106-41	29	11,318	286	3	1%	0–2%	131
2005	106-41	30	9,566	288	5	2%	1–3%	159
2005	106-41	31	3,171	287	2	1%	0–2%	29
2005	106-41	32	2,674	287	6	2%	1–3%	51
2005	106-41	33	5,095	288	5	2%	1–3%	84
2005	106-41	34	4,130	287	7	2%	1–4%	90
2005	106-41	35	4,366	284	12	3%	2–5%	151
2005	106-41	36	1,932	286	4	2%	1–3%	32
2005	106-41	37	448	175	3	2%	0–3%	7
2005	106-41	38-41	555	N/A				
2005	Total		83,647			1.2%	0.9–1.5%	984
2006	106-41	24	372	288	0	0%	0–1%	0
2006	106-41	25	3,600	288	0	0%	0–1%	4
2006	106-41	26	7,761	287	1	0%	0–1%	31
2006	106-41	27	15,072	284	0	0%	0–1%	17
2006	106-41	28	10,013	288	0	0%	0–1%	11
2006	106-41	29	11,935	286	0	0%	0–1%	13
2006	106-41	30	2,759	286	6	2%	1–3%	51
2006	106-41	31	1,632	38	0	0%	0–2%	6
2006	106-41	32	1,253	192	5	2%	1–4%	26
2006	106-41	33	1,328	286	5	2%	1–3%	21
2006	106-41	34	1,302	68	0	0%	0–2%	4
2006	106-41	35	822	159	3	2%	0–4%	13
2006	106-41	36	248	57	0	0%	0–2%	1
2006	106-41	37	198	17	0	0%	0–3%	1
2006	106-41	38-40	63	N/A				
2006	Total		58,358			0.3%	0.2–0.5%	199

APPENDIX C. HUGH SMITH LAKE PURSE SEINE OTOLITH RECOVERIES AND ASSOCIATED STATISTICS

Appendix C1.–Sockeye salmon otolith samples by boat (sampling unit) in the District 101 purse seine fishery, and estimated mean proportions and 95% credible intervals, 2004.

Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2004	101-23	28	1	20	0	0%	5%	0–16%
2004	101-23	28	1	20	1	5%	8%	1–20%
2004	101-23	28	1	20	1	5%	8%	1–21%
2004	101-23	28	1	20	12	60%	44%	24–66%
2004	101-23	28	1	40	1	3%	5%	1–13%
2004	101-23	29	1	40	9	23%		
2004	101-23	30	1	Confidential				
2004	101-23	30	1	Confidential				
2004	101-23	30	1	Confidential				
2004	101-23	32	1	20	6	30%		
2004	101-41	28	1	20	1	5%	11%	2–24%
2004	101-41	28	1	20	11	55%	37%	21–57%
2004	101-41	28	1	20	2	10%	14%	4–27%
2004	101-41	28	1	20	1	5%	11%	2–24%
2004	101-41	29	1	20	5	25%	27%	15–39%
2004	101-41	29	1	40	13	33%	30%	20–41%
2004	101-41	29	1	20	6	30%	28%	17–41%
2004	101-41	29	1	40	13	33%	30%	20–41%
2004	101-41	29	1	20	4	20%	25%	14–38%
2004	101-41	29	1	20	5	25%	27%	15–40%
2004	101-41	29	1	40	13	33%	30%	20–41%
2004	101-41	30	1	40	9	23%	21%	11–31%
2004	101-41	30	1	40	10	25%	22%	13–33%
2004	101-41	30	1	20	2	10%	15%	5–28%
2004	101-41	30	1	20	1	5%	13%	4–25%
2004	101-41	31	3	70	18	26%		
2004	101-41	32	5	49	11	22%		
2004	101-41	33	3	72	7	10%	12%	6–19%
2004	101-41	33	1	36	7	19%	18%	9–29%
2004	101-41	35	3	24	1	4%		
2004	101-29	30	1	20	1	5%	9%	2–19%
2004	101-29	30	1	20	0	0%	7%	1–17%
2004	101-29	30	1	20	2	10%	11%	3–23%
2004	101-29	31	6	68	1	1%	4%	1–10%
2004	101-29	31	3	20	3	15%	14%	5–26%
2004	101-29	31	1	38	4	11%	13%	5–24%
2004	101-29	32	4	47	3	6%	8%	3–15%
2004	101-29	32	3	49	3	6%	7%	3–14%
2004	101-29	32	3	50	2	4%	6%	2–13%
2004	101-29	32	4	49	2	4%	6%	2–13%
2004	101-29	32	1	20	2	10%	10%	3–20%
2004	101-29	33	3	72	2	3%		
2004	101-29	34	5	120	4	3%		

-continued-

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Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2004	Inside[a]	28	1	20	1	5%	8%	1–21%
2004	Inside	28	1	20	11	55%	43%	24–64%
2004	Inside	28	1	20	2	10%	12%	3–26%
2004	Inside	28	1	20	1	5%	8%	1–21%
2004	Inside	28	1	20	0	0%	5%	0–15%
2004	Inside	28	1	20	1	5%	8%	1–20%
2004	Inside	28	1	20	1	5%	8%	1–20%
2004	Inside	28	1	20	12	60%	46%	28–66%
2004	Inside	28	1	40	1	3%	5%	1–13%
2004	Inside	29	1	40	9	23%	25%	15–35%
2004	Inside	29	1	20	5	25%	26%	15–39%
2004	Inside	29	1	40	13	33%	30%	20–41%
2004	Inside	29	1	20	6	30%	28%	16–41%
2004	Inside	29	1	40	13	33%	30%	20–41%
2004	Inside	30	1	42	11	26%	24%	15–35%
2004	Inside	30	1	20	1	5%	14%	4–26%
2004	Inside	30	1	40	16	40%	32%	21–45%
2004	Inside	30	1	40	9	23%	22%	12–33%
2004	Inside	30	1	40	10	25%	23%	14–35%
2004	Inside	30	1	20	2	10%	16%	6–29%
2004	Inside	30	1	20	1	5%	14%	4–26%
2004	Inside	31	3	70	18	26%		
2004	Inside	32	1	20	6	30%	25%	13–40%
2004	Inside	32	5	28	5	18%	20%	10–32%
2004	Inside	32	5	49	11	22%	22%	14–33%
2004	Inside	33	3	72	7	10%	12%	6–19%
2004	Inside	33	1	36	7	19%	18%	9–29%
2004	Inside	35	3	120	9	8%		

[a] Inside area refers to District 101-23 and District 101-41 combined.

Appendix C2.–Weekly sockeye salmon catch and effort, otolith sampling statistics, and estimated proportion, contribution, and catch-per-boat-day of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, 2004.

Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2004	101-23	28	1,536	8	6	5	120	15	13%	13%	8–18%	193	26
2004	101-23	29	1,861	5	4	1	40	9	23%			419	84
2004	101-23	30	Conf. [a]	7	2	Conf.							
2004	101-23	31	621	10	3	No Sample							
2004	101-23	32	937	20	4	1	20	6	30%			281	14
2004	101-23	33	Conf.	7	2	No Sample							
2004	101-23	34		0									
2004	101-23	35	248	15	3	No Sample							
2004	101-23	36		0									
2004	101-23	Total								21%	15–28%	1,060	
2004	101-41	28	327	9	7	4	80	15	19%	18%	12–26%	60	7
2004	101-41	29	2,919	23	18	7	200	59	30%	29%	23–35%	836	37
2004	101-41	30	3,547	68	21	4	120	22	18%	19%	13–26%	666	10
2004	101-41	31	5,444	88	27	1	70	18	26%			1,400	16
2004	101-41	32	10,875	161	33	1	49	11	22%			2,441	15
2004	101-41	33	2,236	36	11	2	108	14	13%	14%	9–20%	311	9
2004	101-41	34	2,209	93	19	No Sample							
2004	101-41	35	1,760	78	16	1	120	9	8%			132	2
2004	101-41	36	Conf.	4	1	No Sample							
2004	101-41	Total								22%	16–27%	5,846	
2004	101-29	29	1,272	8	6	No Sample							
2004	101-29	30	7,049	65	20	3	60	3	5%	9%	3–16%	623	10
2004	101-29	31	12,473	78	24	3	126	8	6%	8%	4–13%	1,021	13
2004	101-29	32	33,870	195	40	5	215	12	6%	7%	4–11%	2,423	12
2004	101-29	33	11,628	111	34	1	72	2	3%			323	3
2004	101-29	34	4,762	112	23	1	120	4	3%			159	1
2004	101-29	35	1,707	83	17	No Sample							
2004	101-29	36	1,850	25	7	No Sample							
2004	101-29	Total								7%	4–9%	4,549	

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Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2004	Inside[b]	28	1,863	16	13	9	200	30	15%	15%	11–19%	275	17
2004	Inside	29	4,780	28	22	8	240	68	28%	28%	23–33%	1,327	48
2004	Inside	30	4,184	75	23	8	222	50	23%	22%	18–28%	936	13
2004	Inside	31	6,065	98	30	1	70	18	26%			1,560	16
2004	Inside	32	11,812	180	37	3	97	22	23%	22%	15–30%	2,641	15
2004	Inside	33	2,551	42	13	2	108	14	13%	14%	9–20%	355	8
2004	Inside	34	2,209	93	19	No Sample							
2004	Inside	35	2,008	93	19	1	120	9	8%			151	2
2004	Inside	36	Conf.	4	1	No Sample							
2004	Inside	Total								22%	18–25%	7,245	

[a] Catch information is confidential if fewer than three boats report catches in an opening (Conf.).

[b] Inside area refers to District 101-23 and District 101-41 combined.

Appendix C3.–Sockeye salmon otolith samples by boat (sampling unit) in the District 101 purse seine fishery, and estimated mean proportions and 95% credible intervals, 2005.

Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2005	101-23	28	1	29	4	14%	14%	6–24%
2005	101-23	28	1	48	6	13%	13%	6–21%
2005	101-23	28	1	14	1	7%	12%	3–23%
2005	101-23	28	1	12	0	0%	10%	2–21%
2005	101-23	28	1	13	2	15%	14%	5–26%
2005	101-23	28	1	8	1	13%	13%	4–26%
2005	101-23	28	1	23	2	9%	11%	4–21%
2005	101-23	29	1	24	4	17%	N/A	
2005	101-41	28	1	47	1	2%	4%	0–9%
2005	101-41	28	1	48	0	0%	2%	0–7%
2005	101-41	28	1	21	1	5%	6%	1–14%
2005	101-41	28	1	28	2	7%	7%	2–15%
2005	101-41	28	1	9	0	0%	4%	0–14%
2005	101-41	28	1	25	0	0%	3%	0–9%
2005	101-41	28	3	25	1	4%	5%	1–13%
2005	101-41	28	1	24	0	0%	3%	0–10%
2005	101-41	28	1	21	2	10%	8%	2–18%
2005	101-41	29	1	48	7	15%	17%	9–26%
2005	101-41	29	1	48	13	27%	24%	16–35%
2005	101-41	29	1	20	5	25%	23%	12–36%
2005	101-41	29	1	24	7	29%	24%	14–37%
2005	101-41	29	1	24	6	25%	23%	13–35%
2005	101-41	29	1	24	3	13%	18%	8–29%
2005	101-41	29	1	24	3	13%	18%	8–29%
2005	101-41	29	1	24	5	21%	21%	11–33%
2005	101-41	30	1	48	4	8%	10%	4–18%
2005	101-41	30	1	29	1	3%	8%	2–16%
2005	101-41	30	1	26	2	8%	10%	3–20%
2005	101-41	31	1	48	10	21%	20%	12–31%
2005	101-41	31	1	23	8	35%	27%	15–42%
2005	101-41	31	1	9	1	11%	18%	5–33%
2005	101-41	31	1	10	0	0%	14%	3–29%
2005	101-41	32	1	24	7	29%	24%	12–38%
2005	101-41	32	1	21	2	10%	15%	5–27%
2005	101-41	32	1	23	8	35%	26%	14–41%
2005	101-41	32	1	24	1	4%	12%	3–23%
2005	101-41	32	1	24	3	13%	16%	6–28%
2005	101-41	33	3	47	7	15%		
2005	101-41	35	1	24	1	4%		
2005	101-29	29	1	29	0	0%	3%	0–10%
2005	101-29	29	1	24	0	0%	4%	0–11%
2005	101-29	29	1	24	0	0%	4%	0–11%
2005	101-29	29	1	24	1	4%	6%	1–14%
2005	101-29	29	1	24	2	8%	8%	2–18%
2005	101-29	30	5	96	4	4%	5%	2–10%
2005	101-29	30	1	38	0	0%	3%	0–9%
2005	101-29	30	1	29	3	10%	9%	3–19%
2005	101-29	30	5	48	0	0%	2%	0–8%
2005	101-29	31	3	96	4	4%	5%	2–10%
2005	101-29	31	1	48	0	0%	3%	0–8%
2005	101-29	31	1	28	1	4%	5%	1–13%
2005	101-29	31	3	48	2	4%	5%	1–12%
2005	101-29	31	3	48	2	4%	5%	1–12%
2005	101-29	32	3	47	2	4%	7%	2–13%
2005	101-29	32	1	24	3	13%	11%	4–22%
2005	101-29	32	1	24	1	4%	8%	2–16%

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Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2005	101-29	32	3	48	2	4%	7%	2–13%
2005	101-29	32	3	15	2	13%	11%	4–23%
2005	101-29	32	5	48	3	6%	8%	3–15%
2005	101-29	33	NA	48	3	6%	6%	2–13%
2005	101-29	33	5	48	0	0%	2%	0–7%
2005	101-29	33	5	48	1	2%	3%	0–9%
2005	101-29	33	3	48	3	6%	6%	2–13%
2005	101-29	33	3	48	1	2%	4%	0–9%
2005	101-29	33	3	48	0	0%	2%	0–7%
2005	101-29	34	3	48	1	2%	3%	0–9%
2005	101-29	34	3	48	1	2%	3%	0–9%
2005	101-29	34	3	48	0	0%	2%	0–6%
2005	101-29	34	4	48	0	0%	2%	0–6%
2005	101-29	35	4	49	1	2%		
2005	Inside[a]	28	1	29	4	14%	11%	4–21%
2005	Inside	28	1	48	6	13%	11%	5–19%
2005	Inside	28	1	14	1	7%	8%	2–17%
2005	Inside	28	1	12	0	0%	5%	0–15%
2005	Inside	28	1	13	2	15%	10%	3–22%
2005	Inside	28	1	8	1	13%	9%	2–21%
2005	Inside	28	1	47	1	2%	4%	1–10%
2005	Inside	28	1	48	0	0%	3%	0–8%
2005	Inside	28	1	21	1	5%	6%	1–15%
2005	Inside	28	1	28	2	7%	7%	2–16%
2005	Inside	28	1	9	0	0%	6%	1–16%
2005	Inside	28	1	23	2	9%	8%	2–17%
2005	Inside	28	1	25	0	0%	4%	0–11%
2005	Inside	28	3	25	1	4%	6%	1–14%
2005	Inside	28	1	24	0	0%	4%	0–11%
2005	Inside	28	1	21	2	10%	8%	2–18%
2005	Inside	29	1	24	4	17%	20%	10–31%
2005	Inside	29	1	48	7	15%	18%	10–27%
2005	Inside	29	2	48	12	25%	23%	15–33%
2005	Inside	29	1	48	13	27%	24%	16–34%
2005	Inside	29	1	20	5	25%	22%	12–35%
2005	Inside	29	1	24	7	29%	24%	14–37%
2005	Inside	29	1	24	6	25%	23%	13–34%
2005	Inside	29	1	24	3	13%	18%	9–29%
2005	Inside	29	1	24	3	13%	18%	9–29%
2005	Inside	29	1	24	5	21%	21%	11–32%
2005	Inside	30	1	48	4	8%	10%	4–18%
2005	Inside	30	1	29	1	3%	8%	2–16%
2005	Inside	30	1	26	2	8%	10%	3–20%
2005	Inside	31	1	48	10	21%	20%	12–31%
2005	Inside	31	1	23	8	35%	27%	15–42%
2005	Inside	31	1	9	1	11%	18%	5–33%
2005	Inside	31	1	10	0	0%	14%	3–29%
2005	Inside	32	1	24	7	29%	24%	13–39%
2005	Inside	32	1	21	2	10%	15%	6–28%
2005	Inside	32	1	23	8	35%	27%	15–41%
2005	Inside	32	1	24	1	4%	12%	4–24%
2005	Inside	32	1	24	3	13%	16%	7–28%
2005	Inside	32	3	48	13	27%	24%	15–35%
2005	Inside	33	3	47	7	15%		
2005	Inside	35	1	24	1	4%		

[a] Inside area refers to District 101-23 and District 101-41 combined.

Appendix C4.–Weekly sockeye salmon catch and effort, otolith sampling statistics, and estimated proportion, contribution, and catch-per-boat-day of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, 2005.

Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2005	101-23	28	419	10	8	7	147	16	11%	13%	8–18%	53	5
2005	101-23	29	2,385	6	5	1	24	4	17%			398	64
2005	101-23	30	341	13	4	No Sample							
2005	101-23	31	Conf. [a]	3	1	No Sample							
2005	101-23	32	Conf.	5	1	No Sample							
2005	101-23	33	0	0	0								
2005	101-23	34	0	0	0								
2005	101-23	35	Conf.	3	1	No Sample							
2005	101-23	36	0	0	0								
2005	101-23	Total								16%	3–29%	450	
2005	101-41	28	2,325	26	21	9	248	7	3%	4%	2–7%	99	4
2005	101-41	29	1,889	30	24	8	236	49	21%	21%	16–26%	395	13
2005	101-41	30	2,795	68	21	3	103	7	7%	9%	5–15%	254	4
2005	101-41	31	1,616	36	11	4	90	19	21%	21%	14–14%	340	10
2005	101-41	32	2,994	83	17	5	116	21	18%	18%	12–25%	549	7
2005	101-41	33	1,365	112	23	1	47	7	15%			203	2
2005	101-41	34	2,039	89	17	No Sample							
2005	101-41	35	901	39	12	1	24	1	4%			38	1
2005	101-41	36	0	0	0								
2005	101-41	Total								14%	11–16%	1,878	
2005	101-29	29	2,229	10	8	5	125	3	2%	5%	2–9%	106	11
2005	101-29	30	6,103	39	12	4	211	7	3%	5%	2–8%	278	7
2005	101-29	31	11,273	62	19	5	268	9	3%	5%	3–7%	527	9
2005	101-29	32	9,481	112	23	6	206	13	6%	8%	5–12%	748	7
2005	101-29	33	5,923	83	17	6	288	8	3%	4%	2–6%	234	3
2005	101-29	34	10,416	105	20	4	192	2	1%	3%	1–5%	264	3
2005	101-29	35	8,697	72	22	1	49	1	2%			177	2
2005	101-29	36	3,553	15	9	No Sample							
2005	101-29	Total								4%	3–6%	2,334	

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Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2005	Inside[b]	28	2,744	36	29	16	395	23	6%	7%	5–9%	184	5
2005	Inside	29	4,274	36	29	10	308	65	21%	21%	17–26%	907	25
2005	Inside	30	3,136	81	25	3	103	7	7%	9%	5–15%	285	4
2005	Inside	31	1,783	39	12	4	90	19	21%	21%	14–29%	375	10
2005	Inside	32	3,049	88	18	6	164	34	21%	21%	15–27%	629	7
2005	Inside	33	1,365	112	23	1	47	7	15%			203	2
2005	Inside	34	2,039	89	17	No Sample							
2005	Inside	35	933	42	13	1	24	1	4%			39	1
2005	Inside	36	0	0	0								
2005	Inside	Total								15%	13–17%	2,624	

[a] Catch information is confidential if fewer than three boats report catches in an opening (Conf.).
[b] Inside area refers to District 101-23 and District 101-41 combined.

Appendix C5.–Sockeye salmon otolith samples by boat (sampling unit) in the District 101 purse seine fishery, and estimated mean proportions and 95% credible intervals, 2006.

Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2006	101-23	27	1	29	15	52%		
2006	101-23	28	1	48	5	10%		
2006	101-23	32	2	96	6	6%	8%	4–14%
2006	101-23	32	1	84	9	11%	11%	6–17%
2006	101-41	27	1	47	12	26%	23%	14–33%
2006	101-41	27	1	48	7	15%	16%	9–25%
2006	101-41	27	1	19	7	37%	24%	13–38%
2006	101-41	27	1	12	0	0%	14%	4–27%
2006	101-41	28	1	36	11	31%	30%	20–41%
2006	101-41	28	1	48	19	40%	35%	25–46%
2006	101-41	28	1	33	5	15%	23%	13–34%
2006	101-41	28	1	48	22	46%	38%	28–49%
2006	101-41	28	1	48	22	46%	38%	28–49%
2006	101-41	28	1	48	17	35%	33%	23–43%
2006	101-41	28	1	47	11	23%	26%	16–36%
2006	101-41	28	1	27	6	22%	26%	16–37%
2006	101-41	29	1	48	11	23%	25%	16–35%
2006	101-41	29	1	48	20	42%	36%	25–47%
2006	101-41	29	1	38	7	18%	23%	14–34%
2006	101-41	29	1	48	23	48%	39%	28–51%
2006	101-41	29	1	48	24	50%	41%	30–52%
2006	101-41	29	1	48	10	21%	24%	15–34%
2006	101-41	29	1	21	3	14%	23%	12–35%
2006	101-41	29	1	34	10	29%	29%	18–40%
2006	101-41	30	1	29	4	14%	12%	5–22%
2006	101-41	30	1	43	8	19%	15%	8–25%
2006	101-41	30	1	47	0	0%	5%	1–12%
2006	101-41	31	1	48	8	17%	19%	11–29%
2006	101-41	31	1	48	13	27%	24%	15–34%
2006	101-41	31	1	35	12	34%	27%	17–39%
2006	101-41	32	1	40	12	30%	26%	17–37%
2006	101-41	32	2	21	5	24%	24%	14–37%
2006	101-41	32	1	34	5	15%	20%	11–30%
2006	101-41	32	1	33	11	33%	28%	18–40%
2006	101-41	32	1	23	8	35%	28%	17–40%
2006	101-41	33	1	Confidential				
2006	101-41	34	3	Confidential				
2006	101-25	28	1	39	3	8%		
2006	101-25	29	1	47	2	4%	7%	2-14%
2006	101-25	29	1	37	1	3%	6%	2–13%
2006	101-25	29	6	40	4	10%	10%	4–18%
2006	101-25	30	3	42	2	5%		
2006	101-25	31	1	44	1	2%	6%	1–12%
2006	101-25	31	4	41	2	5%	7%	2–14%
2006	101-25	31	3	47	4	9%	9%	3–16%
2006	101-25	32	3	45	1	2%		
2006	101-25	33	4	45	2	4%		
2006	101-25	34	1	44	1	2%		
2006	101-29	30	1	47	0	0%	3%	0–8%
2006	101-29	30	1	48	2	4%	5%	2–11%
2006	101-29	30	1	48	2	4%	5%	1–11%
2006	101-29	30	6	48	3	6%	6%	2–13%
2006	101-29	30	3	48	2	4%	5%	2–11%
2006	101-29	31	1	48	3	6%	6%	2–13%
2006	101-29	31	4	48	3	6%	6%	2–12%
2006	101-29	31	3	48	1	2%	4%	1–9%
2006	101-29	31	3	48	0	0%	3%	0–7%
2006	101-29	31	4	48	0	0%	3%	0–8%

Year	District	Statistical Week	Number of Boats in Sample	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval
2006	Inside[a]	27	1	29	15	52%	35%	24–50%
2006	Inside	27	1	47	12	26%	24%	15–35%
2006	Inside	27	1	48	7	15%	18%	10–27%
2006	Inside	27	1	19	7	37%	28%	16–41%
2006	Inside	27	1	12	0	0%	17%	6–29%
2006	Inside	28	1	48	5	10%	17%	9–27%
2006	Inside	28	1	36	11	31%	29%	18–40%
2006	Inside	28	1	48	19	40%	34%	24–45%
2006	Inside	28	1	33	5	15%	21%	12–32%
2006	Inside	28	1	48	22	46%	38%	27–49%
2006	Inside	28	1	48	22	46%	38%	27–48%
2006	Inside	28	1	48	17	35%	32%	22–42%
2006	Inside	28	1	47	11	23%	25%	15–35%
2006	Inside	28	1	27	6	22%	25%	15–37%
2006	Inside	28	2	17	3	18%	23%	12–37%
2006	Inside	29	1	48	11	23%	25%	16–35%
2006	Inside	29	1	48	20	42%	36%	25–47%
2006	Inside	29	1	38	7	18%	23%	14–34%
2006	Inside	29	1	48	23	48%	39%	28–51%
2006	Inside	29	1	48	24	50%	41%	30–52%
2006	Inside	29	1	48	10	21%	24%	15–34%
2006	Inside	29	1	21	3	14%	23%	12–35%
2006	Inside	29	1	34	10	29%	29%	18–40%
2006	Inside	30	1	29	4	14%	12%	5–22%
2006	Inside	30	1	43	8	19%	15%	8–25%
2006	Inside	30	1	47	0	0%	5%	1–12%
2006	Inside	31	1	48	8	17%	19%	10–29%
2006	Inside	31	1	48	13	27%	25%	16–35%
2006	Inside	31	1	35	12	34%	27%	17–39%
2006	Inside	32	2	96	6	6%	9%	5–15%
2006	Inside	32	1	84	9	11%	13%	8–20%
2006	Inside	32	1	40	12	30%	24%	15–36%
2006	Inside	32	2	21	5	24%	20%	10–33%
2006	Inside	32	1	34	5	15%	17%	8–27%
2006	Inside	32	1	33	11	33%	26%	15–39%
2006	Inside	32	1	23	8	35%	25%	14–38%
2006	Inside	33	1	47	4	9%		
2006	Inside	34	1	Confidential				
2006	Outside[b]	28	1	39	3	8%		
2006	Outside	29	1	47	2	4%	7%	2–14%
2006	Outside	29	1	37	1	3%	6%	2–13%
2006	Outside	29	1	40	4	10%	10%	4–18%
2006	Outside	30	1	42	2	5%	6%	2–11%
2006	Outside	30	1	47	0	0%	3%	0–9%
2006	Outside	30	1	48	2	4%	5%	1–11%
2006	Outside	30	1	48	2	4%	5%	2–11%
2006	Outside	30	1	48	3	6%	6%	2–13%
2006	Outside	30	1	48	2	4%	5%	2–11%
2006	Outside	31	1	44	1	2%	4%	1–9%
2006	Outside	31	1	41	2	5%	5%	1–11%
2006	Outside	31	1	47	4	9%	7%	3–14%
2006	Outside	31	1	48	3	6%	6%	2–12%
2006	Outside	31	2	48	3	6%	6%	2–13%
2006	Outside	31	1	48	1	2%	4%	1–8%
2006	Outside	31	1	48	0	0%	3%	0–7%
2006	Outside	31	1	48	0	0%	3%	0–7%
2006	Outside	32	1	45	1	2%		
2006	Outside	33	1	45	2	4%		
2006	Outside	34	1	44	1	2%		

[a] Inside area refers to District 101-23 and District 101-41 combined.
[b] Outside area refers to District 101-25 and District 101-29 combined.

Appendix C6.–Weekly sockeye salmon catch, associated otolith sampling statistics, and estimated proportion and number of stocked Hugh Smith Lake sockeye salmon in the District 101 purse seine fishery, 2006.

Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2006	101-23	27	81	4	3	1	29	15	52%			42	11
2006	101-23	28	293	6	5	1	48	5	10%			31	5
2006	101-23	29	Conf. [a]	3	2	No Sample							
2006	101-23	30	Conf.	3	2	No Sample							
2006	101-23	31	574	4	3	No Sample							
2006	101-23	32	1,186	9	7	2	180	15	8%	9%	6–14%	110	13
2006	101-23	33	Conf.	1	1	No Sample							
2006	101-23	Total								12%	8–15%	182	
2006	101-41	27	610	14	11	4	126	26	21%	20%	14–26%	120	9
2006	101-41	28	1,396	26	21	8	335	113	34%	32%	28–37%	445	17
2006	101-41	29	3,079	35	28	10	333	108	32%	31%	26–35%	944	27
2006	101-41	30	962	16	13	3	119	12	10%	11%	6–16%	102	6
2006	101-41	31	1,341	15	12	3	131	33	25%	23%	17–30%	311	21
2006	101-41	32	567	20	16	7	151	41	27%	25%	19–32%	142	7
2006	101-41	33	Conf.	1	2	Conf.							
2006	101-41	34	Conf.	1	2	Conf.							
2006	101-41	Total								26%	23–28%	2,077	
2006	101-25	27	Conf.	3	2	No Sample							
2006	101-25	28	1,223	8	6	1	39	3	8%			94	13
2006	101-25	29	2,014	6	5	3	124	7	6%	8%	4–13%	153	24
2006	101-25	30	2,388	8	6	1	42	2	5%			114	15
2006	101-25	31	3,152	8	6	3	132	7	5%	7%	3–11%	228	30
2006	101-25	32	7,241	2	3	1	45	1	2%			161	86
2006	101-25	33	2,194	2	3	1	45	2	4%			98	52
2006	101-25	34	3,080	3	4	1	44	1	2%			70	28
2006	101-25	Total								4%	2–6%	917	
2006	101-29	30	4,809	11	9	6	239	9	4%	5%	3–8%	246	22
2006	101-29	31	4,919	13	10	7	240	7	3%	4%	2–7%	210	17
2006	101-29	Total								5%	3–6%	456	

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Year	District	Statistical Week	Total Catch	Boat-Days	Number of Boats	Number of Boats Sampled	Number Sampled for Otoliths	Number of Hugh Smith Otoliths	Proportion Marked	Posterior Mean Proportion	95% Credible Interval	Estimated Contribution of Stocked Fish	Estimated Catch-per-boat-day of Stocked Fish
2006	Inside[b]	27	691	18	14	5	155	41	26%	24%	18–31%	167	10
2006	Inside	28	1,689	33	26	10	400	121	30%	29%	24–33%	488	15
2006	Inside	29	3,658	38	30	10	333	108	32%	31%	26–35%	1,121	30
2006	Inside	30	1,422	19	15	3	119	12	10%	11%	6–16%	151	8
2006	Inside	31	1,915	19	15	3	131	33	25%	23%	17–29%	444	24
2006	Inside	32	1,753	29	23	9	331	56	17%	16%	13–20%	284	10
2006	Inside	33	124	2	3	1	47	4	9%			11	6
2006	Inside	34	Conf[3].	1	2	Conf.							
2006	Inside	Total								22%	18–25%	2,672	
2006	Outside[c]	27	Conf.	3	2	No Sample							
2006	Outside	28	1,223	8	6	1	39	3	8%			94	13
2006	Outside	29	2,014	6	5	3	124	7	6%	8%	4–13%	153	24
2006	Outside	30	7,197	19	15	7	281	11	4%	5%	3–8%	371	20
2006	Outside	31	8,071	20	16	10	372	14	4%	5%	3–7%	381	19
2006	Outside	32	7,241	2	3	1	45	1	2%			161	86
2006	Outside	33	2,194	2	3	1	45	2	4%			98	52
2006	Outside	34	3,080	3	4	1	44	1	2%			70	28
2006	Outside	Total								4%	3–6%	1,327	

[a] Catch information is confidential if fewer than three boats report catches in an opening (Conf.).
[b] Inside area refers to District 101-23 and District 101-41 combined.
[c] Outside area refers to District 101-25 and District 101-29 combined.

APPENDIX D. HUGH SMITH LAKE WEIR OTOLITH RECOVERIES AND ASSOCIATED STATISTICS

Appendix D1.–Sockeye salmon otolith samples at the Hugh Smith Lake adult escapement weir, and estimated proportion and number of stocked and wild fish in each historical mean third of the run and the total escapement, 2004. The date ranges for the historical mean thirds of the run were determined from the average run-timing at the Hugh Smith Lake weir from 1982 to 2006.

		Escapement	Number of Otoliths Sampled	Number of Otoliths Analyzed	Stocked Fish	Wild Fish
Period 1	16 Jun–23 Jul	4,296	42	41	17	24
	Estimated Proportion				41%	59%
	SE of %				3.6%	3.6%
	Estimated Number				1,781	2,515
	SE of Number				333	333
Period 2	24 Jul–13 Aug	8,264	80	78	50	28
	Estimated Proportion				64%	36%
	SE of %				3.5%	3.5%
	Estimated Number				5,297	2,967
	SE of Number				450	450
Period 3	14 Aug–31 Oct	7,366	70	66	51	15
	Estimated Proportion				77%	23%
	SE of %				3.1%	3.1%
	Estimated Number				5,692	1,674
	SE of Number				381	381
Total	Escapement	19,926	192	185	118	67
	Estimated Proportion				64%	36%
	SE of %				3.5%	3.5%
	Estimated Number				12,710	7,216
	SE of Number				703	703

Appendix D2.–Sockeye salmon otolith samples at the Hugh Smith Lake adult escapement weir, and estimated proportion and number of stocked and wild fish in each historical mean third of the run and the total escapement, 2005. The date ranges for the historical mean thirds of the run were determined from the average run-timing at the Hugh Smith Lake weir from 1982 to 2006.

		Escapement	Number of Otoliths Sampled	Number of Otoliths Analyzed	Stocked Fish	Wild Fish
Period 1	16 Jun–23 Jul	4,401	41	41	13	28
	Estimated Proportion				32%	68%
	SE of %				3.0%	3.0%
	Estimated Number				1,395	3,006
	SE of Number				322	322
Period 2	24 Jul–13 Aug	5,279	54	54	22	32
	Estimated Proportion				41%	59%
	SE of %				3.2%	3.2%
	Estimated Number				2,151	3,128
	SE of Number				354	354
Period 3	14 Aug–31 Oct	14,664	141	141	100	41
	Estimated Proportion				71%	29%
	SE of %				2.9%	2.9%
	Estimated Number				10,400	4,264
	SE of Number				560	560
Total	Escapement	24,108	236	236	135	101
	Estimated Proportion				57%	43%
	SE of %				3.2%	3.2%
	Estimated Number				13,791	10,317
	SE of Number				774	774

Appendix D3.–Sockeye salmon otolith samples at the Hugh Smith Lake adult escapement weir, and estimated proportion and number of stocked and wild fish in each historical mean third of the run and the total escapement, 2006. The date ranges for the historical mean thirds of the run were determined from the average run-timing at the Hugh Smith Lake weir from 1982 to 2006.

		Escapement	Number of Otoliths Sampled	Number of Otoliths Analyzed	Stocked Fish	Wild Fish
Period 1	16 Jun–23 Jul	2,110	19	19	7	12
	Estimated Proportion				37%	63%
	SE of %				2.4%	2.4%
	Estimated Number				777	1,333
	SE of Number				239	239
Period 2	24 Jul–13 Aug	29,225	283	282	192	90
	Estimated Proportion				68%	32%
	SE of %				2.3%	2.3%
	Estimated Number				19,898	9,327
	SE of Number				809	809
Period 3	14 Aug–31 Oct	11,195	116	116	71	45
	Estimated Proportion				61%	39%
	SE of %				2.4%	2.4%
	Estimated Number				6,852	4,343
	SE of Number				506	506
Total	Escapement	42,530	418	417	270	147
	Estimated Proportion				65%	35%
	SE of %				2.3%	2.3%
	Estimated Number				27,537	14,993
	SE of Number				991	991