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A STUDY OF COHO SALMON IN SOUTHEAST
ALASKA, 1989: SALMON LAKE, EAGLE RIVER,
ST. JOHN AND SINITSIN CREEKS¹

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ABSTRACT

Investigations of coho salmon *Oncorhynchus kisutch* at Salmon Lake, Eagle River, Sinitsin Creek, and St. John Creek continued through 1989. The escapement of adult salmon to Salmon Lake was 210 fish. Commercial harvest of this stock by the troll fishery was 72 percent of the adult production. Smolt to adult survival rate was an estimated 5.6 percent during 1988 to 1989. The coho presmolt population at Salmon Lake was an estimated 11,700 fish. Escapement of coho salmon to Eagle River was 131 fish, while the troll fishery harvested an estimated 50.2 percent of adult production. Smolt to adult survival rate during 1988-1989 was 2.3 percent for adults returning to Eagle River. Estimates of age-1. juvenile coho salmon in Sinitsin Creek (655) and St. John Creek (518) were at low levels due to limited escapement during 1987. The number of age-1. juvenile coho salmon per parent was 20.5 in Sinitsin Creek and 56.9 in St. John Creek.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, escapement, production, return, smolt, age-weight-length composition, harvest rate, fishery contribution, troll fishery, sport fishery, Southeast Alaska, Sitka, Baranof Island, Kruzof Island.

INTRODUCTION

The purpose of the stock assessment program for coho salmon *Oncorhynchus kisutch* in southeast Alaska is to improve the management of coho salmon stocks that are important to the region's sport fisheries. Improving management involves optimizing the harvest of returning adults and providing for adequate levels of escapement. Data collected on key coho salmon stocks address three goals:

1. Estimate desired escapement goals for indicator stocks for spawner-return and/or spawner-recruit production models.
2. Estimate time and area of harvest and harvest rate from the recovery of adults that were coded-wire tagged as smolt.
3. Develop models to forecast the run-strength of indicator stocks based on the expected ocean survival rates of smolt and/or the catch of adults returning from indicator streams in the first few weeks of the fishery.

In 1989, data were collected on four coho salmon stocks near Sitka that represent the stocks from the northern outside quadrant of southeast Alaska (Figure 1). Stocks rearing and returning to:

1. Salmon Lake represent lacustrine stocks in the outer coastal area. Research at this site has been ongoing since 1983 (Schmidt 1984, 1985, 1986, 1987, 1988; Elliott, Schmidt, and Sterritt 1989).
2. Eagle River represent riverine stocks in the Sitka area. Studies of smolt at this location show stream-produced smolts are of different ages and sizes than lake-produced smolts (Elliott, Schmidt, and Sterritt 1989).
3. Sinitsin and St. John Creeks represent stocks from small streams around Sitka Sound (Schmidt 1988; Elliott, Schmidt, and Sterritt 1989). The escapement in these streams has varied from less than 10 to over 100 adults during the last 5 years. Possible correlations between adult escapement and subsequent juvenile production is being investigated. Desired escapement goals will be derived from this relationship.

Objectives for the program in 1989 were:

1. Count the escapement of age-.1 adult coho salmon to Salmon Lake from 15 August to 15 October and to Eagle River from 15 August to 1 November;
2. Estimate the age and sex composition of adult coho salmon at Eagle River and Salmon Lake;
3. Estimate the mean length of adults at Eagle River and Salmon Lake;
4. Estimate the 1990 harvest of coho salmon bound for Eagle River and Salmon Lake in all fisheries;
5. Estimate the number of coho salmon smolt leaving between 15 April and 15 June 1989 from Eagle River and Salmon Lake;

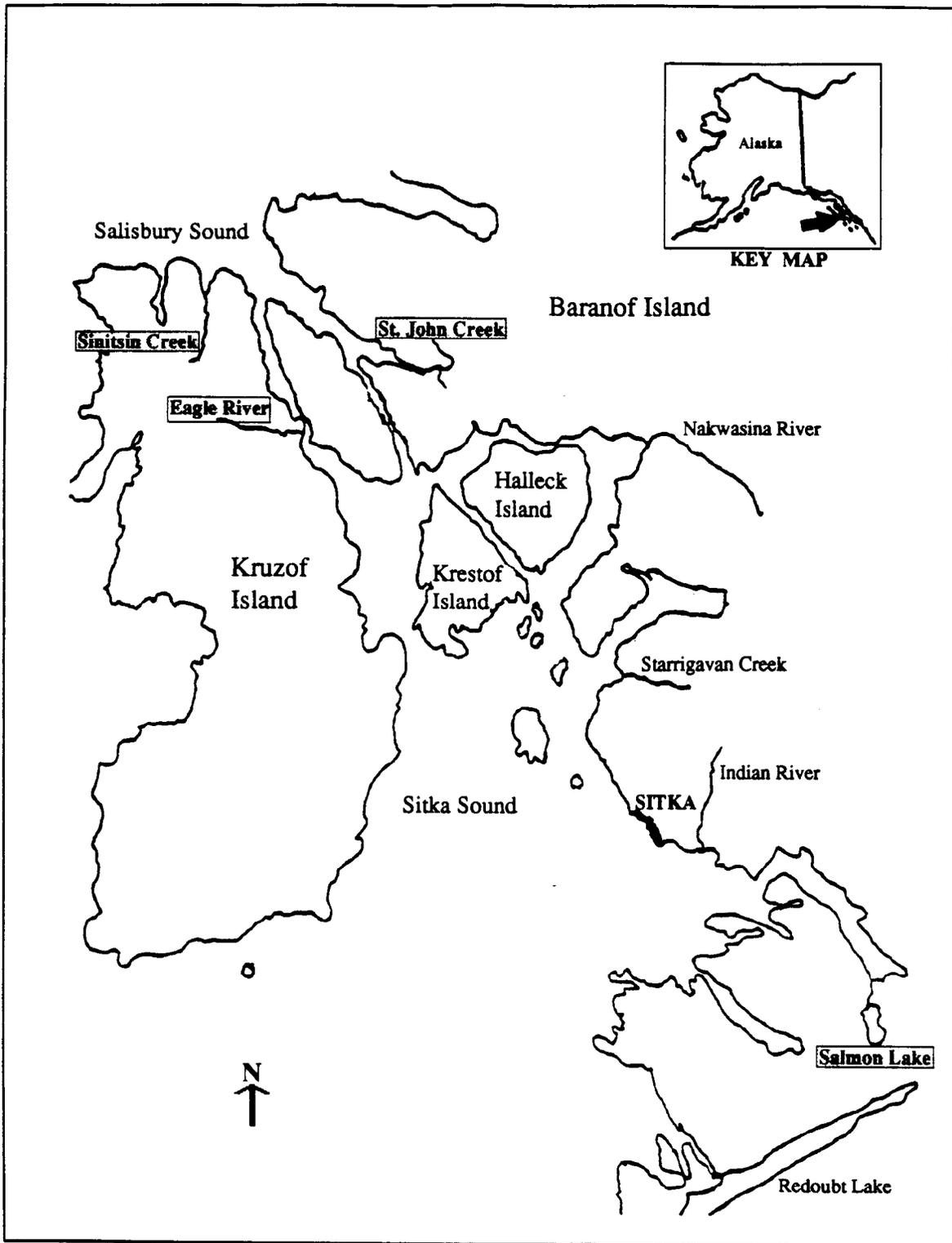


Figure 1. Coho salmon research sites near Sitka in 1989.

6. Estimate the number of coho salmon presmolt in early April 1989 in Salmon Lake;
7. Estimate the mean length of smolt emigrating from Eagle River and Salmon Lake in 1989;
8. Estimate the age composition of coho salmon smolt emigrating from Eagle River and Salmon Lake;
9. Estimate the number of coho salmon juveniles ≥ 65 mm (aged 1. and older) in St. John and Sinitzin Creeks during July;
10. Estimate the age composition of coho salmon juveniles aged 1. and older in St. John and Sinitzin Creeks during July; and
11. Estimate the mean length at age for coho salmon juveniles aged 1. and 2. in St. John and Sinitzin Creeks during July.

METHODS

Estimates of Smolt and Presmolt Abundance

Smolt were captured at Eagle River and Salmon Lake using stream-type fyke nets with a live box. Fyke nets were fished just above tidewater at Eagle River and just below the lake outlet at Salmon Lake. Fyke nets were 1 x 1 m and about 3 m long; the cod end was attached to a 10 cm (4 in) plastic flex pipe that led to a floating live box. Two nets were fished at each site. Leads constructed of 1.27 cm (0.5 in) rebar frames hung with 0.63 cm (0.25 in) vexar were constructed at about a 45° angle upstream such that most of the stream was fished. At Salmon Lake panels were separated to allow upstream migration of adult steelhead *O. mykiss*. Water depth (nearest cm) and water temperature (nearest 0.1°C) were taken at 9-10 a.m. daily. Smolts were captured from 25 April to 25 May at Salmon Lake and from 22 April to 29 May at Eagle River. They were counted, tranquilized with tricain methane sulfonate (MS 222), marked by complete removal of their adipose fin, and tagged with a coded-wire tag (CWT) following instructions of Koerner (1977). Elliott and Kuntz (1988) and Schmidt (1988) showed that the smallest smolt that should be tagged was 70 mm at Eagle River and 85 mm at Salmon Lake.

A systematic sample of smolt was taken at each site for age-length analysis. Every 33rd smolt was sampled at Salmon Lake, and every 10th smolt was sampled at Eagle River. Each sampled fish was measured to the nearest 1 mm fork length. Scales were removed from the preferred area of each fish (Anas 1963), applied to a microscope slide, covered with a second slide, and secured at both ends with "scotch tape." Up to four sets of scales could be applied to a slide. The scales were read on a microfiche projector with a 10 mm objective.

An in-season estimate of "smolt" abundance was obtained at Salmon Lake using a mark-recapture experiment. Presmolt were captured in the lake prior to any significant emigration (the first sampling event) using funnel traps baited with fresh salmon roe. Before release, the caudal fin of each presmolt was shallowly clipped as a temporary mark. Marked and unmarked fish were subsequently recaptured in fyke nets located downstream (the second sampling event). The

abundance of coho salmon smolt was estimated with Chapman's modification of Petersen's method (Seber 1982):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 \quad (1)$$

$$V[\hat{N}] = \frac{N(M-R)(C-R)}{(R+1)(R+2)} \quad (2)$$

where:

- N = estimated abundance;
- M = number of marked fish released alive into the population during the first sampling event;
- C = number of fish caught in the second sampling event; and
- R = number of fish marked in the first event and recaptured during the second event.

Since adults returning to Salmon Lake with CWT's were tagged either as juveniles in the fall of 1987 or as smolts in 1988, the abundance of smolts in spring 1988 was estimated by adjusting the fraction of marked adults at the weir by the fraction of the two tag codes in the harvest. Adjustment to the Petersen method in the mark-recapture experiment was as follows:

$$\hat{N} = \frac{(M_o+1)(C+1)}{(R_o+1)} - 1 = \frac{(M_o+1)(C+1)}{(R+1)} \frac{1}{\hat{\theta}} = \frac{\hat{N}_o}{\hat{\theta}} \quad (3)$$

where:

- M_o = Number of smolts released alive with CWT's and clipped adipose fins during the spring 1988;
- R = Number of adults with missing adipose fins passing through the weir in 1989;
- N_o = Estimated abundance of presmolts without adjustment;
- θ = Fraction of the marked fish inspected in all fisheries combined with the code of the tags used to mark smolts during spring 1988; and
- C = Number of adults inspected for missing adipose fins at Salmon Lake in 1989.

From Goodman (1960), the variance of the estimated abundance is:

$$N[\hat{V}] = V[\hat{N}_o] \hat{\theta}^{-2} + \hat{N}_o^2 V\left[\frac{1}{\hat{\theta}}\right] - V[\hat{N}_o] V\left[\frac{1}{\hat{\theta}}\right] \quad (4)$$

where:

$$v\left[\frac{1}{\hat{\theta}}\right] \approx \frac{v[\hat{\theta}]}{\hat{\theta}^4} \quad (5)$$

from the delta method (see Seber 1982, p. 8); and,

$$\hat{\theta} = \frac{n_t}{n} \quad (6)$$

$$v[\hat{\theta}] = \frac{\hat{\theta}(1-\hat{\theta})}{n-1} \quad (7)$$

where:

n_t = the number in the sample with the tag with the correct code; and
 n = the number of tags found from all fisheries combined.

Variances for proportions of estimated age-sex or age length groups were calculated using:

$$\hat{p}_i = \frac{y_i}{n} \quad (8)$$

$$v[p_i] = \left(\frac{\hat{p}_i(1-\hat{p}_i)}{(n-1)} \right) \left(1 - \frac{n}{N} \right) \quad (9)$$

where:

p_i = the proportion of fish from group i in the sample;
 y_i = the number of fish in group i
 n = the number of fish sampled; and
 N = the number of fish in the population.

Adult Escapement

Weirs constructed at the outlet of Salmon Lake and Eagle River were of standard tripod and picket design with 1.9 cm (0.75 in) diameter pickets spaced on 5.4 cm (2.125 in) centers. The weirs were operated continuously from about 15 August to 5 October 1989. Water depth (nearest cm) and water temperature (nearest 0.1°C) were taken at 9-10 a.m. daily. Adult coho salmon were captured in a 2.4 x 2.4 m (8 x 8 ft) upstream migrant trap with a "V" or slot entrance, tranquilized with a 12 volt DC electric shocking basket (Gunstrom and Bethers 1985; Orsi and Short 1987), checked for the absence of an adipose fin (indicating the presence of a CWT), measured to the nearest 1 mm (mid-eye to fork of tail), sexed by examination of external characters, examined for hook wounds, and

released alive on the upstream side of the weir.

At each weir, a systematic sample of adults was taken throughout the season to collect data on age, sex, and length. The sample schedule at Salmon Lake was every third fish; at Eagle River, three of every five fish were sampled. Four scales were removed from the preferred area (Anas 1963), mounted on gum cards, pressed on acetate cards, and projected with a microfiche reader having an objective diameter of 10 mm. Statistics for mean length, and age-sex composition were obtained with procedures listed in the section on smolt.

Estimated Harvest

The procedures listed in Clark and Bernard (1987) were used to estimate harvests in commercial fisheries of stocks tagged with CWT's. The estimates were based on the following information:

- 1) number of coho salmon harvested;
- 2) fraction of the harvest inspected for missing adipose fins;
- 3) number of coho salmon in the sample with missing adipose fins;
- 4) number of fish heads that reached FRED Division;
- 5) number of these heads that contained CWT's;
- 6) number of these CWT's that were decodable;
- 7) number of decodable tags of the appropriate code(s); and
- 8) fraction of returning adults with tags.

The Alaska Department of Fish and Game, Commercial Fisheries Division inspected the harvest in troll and seine fisheries for coho salmon with coded-wire tags (missing adipose fins) and collected the heads. Heads were sent to the Head Lab, Fisheries Rehabilitation Enhancement and Development Division (F.R.E.D.), Alaska Department of Fish and Game for dissection. Fractions of adults with tags returning to Eagle River and Salmon Lake were estimated by this project. The Head Lab collected and provided all of the necessary information except that on fraction of returning adults with tags.

Each calculation was stratified by fishing quadrant and by fishing period. Since information from F.R.E.D. Division by fishing district are tallies from landings of fishermen that fished exclusively in that district, data from fishermen that fished several districts are excluded from the tallies. Since almost no fishermen fish in more than one of the larger quadrants during an opening, data stratified by quadrants are more comprehensive than data from fishing districts. Estimates were stratified by fishing period because of the delay between the inspection and the reporting of the catch. Inspection for missing adipose fins often occurs on tenders that deliver and record their catch 7-10 days later (Ben Van Alan, Alaska Department of Fish and Game, Juneau, personal communication). Under these circumstances, stratifications finer than 2 weeks would often bias the estimates. Since the samples drawn during each stratum will be independent samples, the estimate of total harvest will be the sum of all the stratified estimates. The variance of the total harvest will likewise be the sum of the stratified variances. Harvest rates were calculated as the estimated harvest of a stock (H) divided by the total estimated return of that stock (r). The variance of the harvest rate was approximated through the delta method:

$$V[E] = \frac{V[H]S^2}{r^4} \quad (10)$$

where: E = the exploitation rate;
 H = the estimated harvest;
 S = the escapement; and
 r = the return (H+S).

Juvenile Population Estimates

Abundance of juvenile coho salmon at Sinitzin and St. John creeks was estimated with Zippin's removal estimator (Seber 1982, p. 59-60, 309-314):

$$\hat{N} = \frac{\sum_1^s U_j}{1-q^s} \quad (11)$$

where:

U_j = the number of unmarked fish captured during day j ;
 s = the total number of sampling days in July; and
 q = the complement to the probability of capture.

The estimate of q is the solution of the following relationship:

$$\frac{q}{1-q} - \frac{sq^s}{1-q^s} = \frac{\sum_1^s (j-1)U_j}{\sum_1^s U_j} \quad (12)$$

The variance was calculated as:

$$V[\hat{N}] = \frac{\hat{N}(1-q^2)q^2}{(1-q^2)^2 - (1-q)^2s^2q^{s-1}} \quad (13)$$

Fish were captured, marked, and released during the first 2 weeks in July 1989 in both streams. Minnow traps baited with frozen salmon roe were spaced evenly throughout 1 km sections of Sinitzin Creek and St. John Creek immediately upstream of the estuary. In both streams, each trap was checked daily and reset in the same location. All captured fish ≥ 65 mm fork length were marked and then released away from their site of capture. Those fish caught in the upstream half of the study section in St. John Creek were marked by shallowly clipping the dorsal lobe of the caudal fin. The ventral lobe of the caudal fin was clipped on those fish caught in the downstream half of the study section. The same procedure was followed on those fish caught in Sinitzin Creek, but the order of clipping was reversed. Every fifth unmarked fish was measured to the nearest mm fork length and a sample of scales was removed for analysis.

After a 1 week pause in trapping, the minnow traps were redeployed throughout each study section. The locations of all recaptured fish were noted. Each unmarked fish was marked by shallowly clipping the anal fin.

RESULTS

Salmon Lake

Based on data collected in 1988 and 1989 an estimated 13,304 (SE=905) smolt emigrated from Salmon Lake in 1988. There were 2,174 juveniles released in fall 1987 with code 4/28/44 and 5,978 smolt released in spring 1988 with code 4/28/60. Eighty-nine tags from Salmon Lake were recovered in the 1989 coho salmon troll fishery. Seventy carried the code 4/28/60 and 19 carried code 4/28/44. At the weir on Salmon Lake, 171 adult coho salmon were inspected for adipose clips and 97 marked fish were observed.

The escapement of coho salmon to Salmon Lake was an estimated 210 adults. This estimate is the sum of: 1) 171 fish examined and counted through the weir (Appendix A1); 2) one adult that jumped out of the trap box on 20 September; 3) a minimum of 36 fish that swam over the weir during the 22 September flood event; and 4) two adults which were seen swimming over the weir during the high water event on 2 October. Some adult salmon may have passed over the weir unobserved during flood events. Since no fish were observed in the outlet stream before 3 September and since large numbers of coho salmon have not passed through the Salmon Lake weir in early September in prior years, it is unlikely that many fish passed over the weir unobserved during the flood on 3-4 September. During a survey of the stream section below the weir conducted the day before the 6-7 October high water event no fish were observed; it is again unlikely that many fish swam over the weir undetected during this flood episode. A foot survey on 9 October and a dive survey on 10 October detected no fish in the stream section below the weir. The weir was taken out on 10 October.

The estimated harvest of coho salmon bound for Salmon Lake included 536 (SE=86) fish caught in the commercial troll fishery (Table 1). No creel census was conducted in Sitka during the coho salmon season, but sport fishermen turned in two coho heads that had tags. Total production is the sum of troll harvest (536), escapement (210), and sport harvest (2), or 748 coho salmon. The harvest rate by the commercial troll fishery was 536/748, or 71.6% (SE=3.2%). The estimated smolt to adult survival rate was 5.6% (SE≈0.75% using the delta method).

Age-3.1 coho salmon adults were the most abundant (51%) with age-2.1 nearly as abundant (44.9%). Age-4.1 coho salmon comprised only 4.1% of the sample.

Relative occurrence of males (55.1%) was higher than females (44.9%). Table 2 presents the mean length, age, and sex composition of adult coho salmon at Salmon Lake in 1989.

An estimated 11,720 (SE=867) presmolts were extant in Salmon Lake in spring 1989. Between 22 April and 29 April 1989, 718 presmolts <85 mm fork length were marked in the lake. During the spring emigration, 409 of these marked presmolts were captured as part of the total catch of 6,683 smolts (Appendix A2).

The total number of smolt tagged with CWTs during spring 1989 was 6,485. There were also 119 pre-tagging mortalities, 48 post-tagging mortalities, and 31 previously coded-wire tagged fish that had tags from earlier years.

Table 1. The estimated harvest of Salmon Lake coho salmon by the troll fishery by fishing period. There were 210 fish in the escapement of which 171 were examined for adipose fin clips; 97 (56.7%) were missing these fins.

Date	Quad	Period	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	Est. Catch	SE
06/18-06/24	NW	4	1,345	103	1	1	1	1	1	23	-
07/02-07/15	NW	6	47,321	8,939	2	68	68	85	84	19	13
07/02-07/15	SW	6	45,882	16,301	2	149	149	189	184	10	6
07/16-08/19	NW	7	499,563	150,898	58	1,425	1,425	1,863	1,795	351	42
08/20-09/30	NW	8	352,711	113,679	24	1,827	1,825	2,176	2,155	133	25
Totals			946,822	289,920	87	3,470	3,468	4,314	4,219	536	86

Table 2. Mean length (mm mid-eye to fork of tail), age, and sex composition of nonjack adult coho salmon sampled at Salmon Lake weir, 23 August to 10 October 1989.

		<u>Parent Year</u>			
		1985	1984	1983	Total
		Age 2.1	Age 3.1	Age 4.1	
Male	N	12	13	2	27
	Mean Length	590	502	568	545
	SD	95	122	156	116
	SE	27	34	110	22
	Percent Composition	24.5	26.5	4.1	55.1
	SE (%)	11.3	10.9	19.4	6.5
Female	N	10	12	-	22
	Mean Length	639	642	-	640
	SD	34	43	-	38
	SE	11	12	-	8
	Percent Composition	20.4	24.5	-	44.9
	SE (%)	12.0	11.3	-	8.1
Total	N	22	25	2	49
	Mean Length	612	569	568	588
	SD	76	115	156	101
	SE	16	23	110	14
	Percent Composition	44.9	51.0	4.1	100
	SE (%)	8.1	7.1	19.4	-

A total of 2,226 tagged smolt were held for a 24 hours and 2,184 (98.1%) retained their tags. Retention rates were calculated daily, and their application was weighted by the number of fish tagged the previous day. There were 6,401 fish released with the valid tag code 4/28/27, and 84 adipose clipped smolt that did not retain tags.

Most smolts were aged 2. (51.5%), with lesser numbers of age-3. (37.1%), age-4. (9.9%), age-1. (0.9%), and age-5. (0.6%). Average length of age-2. smolt was 100-mm fork length, while age-3. smolt averaged 120-mm and age-4. smolt averaged 134 mm. The age composition and length-at-age of the smolt population are presented in Table 3.

Eagle River

The escapement of adult coho salmon to Eagle River was an estimated 131 fish. This estimate is the sum of: 1) 102 adults examined and counted through the weir (Appendix A3); 2) 26 bright coho salmon observed above the weir during the 25 September stream survey; and 3) three bright fish seen above the weir during a dive survey conducted on 3 October. The bright coho salmon observed above the weir during the 25 September and 3 October surveys passed over the weir during the flood events on 22 September and 2 October, and were either fish in excess of numbers previously counted at the weir or fish that were obviously fresh. No coho salmon were seen in the stream section below the weir during a survey conducted on 30 September. The weir washed out on 2 October and was not reinstalled.

The estimated harvest of coho salmon bound for Eagle River was 132 fish (SE=60) caught in the troll fishery (Table 4). No creel census was conducted, and sport fishermen did not turn in any tagged heads from Eagle River. Total estimated coho salmon production is the sum of troll harvest (132) plus known escapement (131). The harvest rate by the commercial troll fishery was 132/263, or 50.2% (SE=11.4%).

Of the 2,621 smolt released with tags in 1988, 23 were recaptured as adults at the weir in 1989 among the 102 that were inspected. This produces an estimate of abundance for coho salmon smolt from Eagle River in 1988 of 11,251 (SE=1,965) fish. The smolt to adult survival rate for these fish is 2.3% (263/11,251) (SE≈0.7% using the delta method).

Table 5 presents the mean length, age, and sex composition of adult coho salmon at Eagle River in 1989. Age-2.1 coho salmon adults were predominant (92.9%), with a few age-3.1 (7.8%) present. Males were slightly more abundant (51%) than females (49%).

From 22 April through 29 May 1989, 3,259 smolt were captured (Appendix A4). Fourteen of these had been tagged during the spring of 1988. Eighty-seven (87) smolt died before tagging, and another died after tagging. During the 24 hours that 1,121 tagged smolt were held, only eight lost their tags. Retention rates were calculated daily, and their application was weighted by the number of fish tagged the previous day.

The total number of smolt tagged during spring 1989 was 3,074. There were 3,031 fish released with the valid tag code 4/28/38, and 43 adipose clipped fish which did not retain tags.

Table 3. Mean fork length (mm) and age composition of coho salmon smolts sampled at Salmon Lake weir, 25 April to 25 May 1989.

	Parent Year					Total
	<u>1987</u> Age 1.	<u>1986</u> Age 2.	<u>1985</u> Age 3.	<u>1984</u> Age 4.	<u>1983</u> Age 5.	
N	3	172	124	33	2	334
Mean Length	95	100	121	134	146	111
SD	5	9	13	16	12	17
SE	3	1	1	3	8	1
Percent Comp.	0.9	51.5	37.1	9.9	0.6	100.0
SE (%)	6.6	2.7	3.4	5.0	7.7	

Table 4. The estimated harvest of Eagle River coho salmon by the troll fishery by fishing period. There were 131 fish in the escapement of which 102 were examined for adipose fin clips; 23 (22.5%) were missing these fins.

Date	Quad.	Period	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	Est. Catch	SE
07/16-08/19	NW	7	499,563	150,898	5	1,425	1,425	1,863	1,795	76	33
08/20-09/30	NW	8	352,711	113,679	4	1,827	1,825	2,176	2,155	56	27
Totals			852,274	264,577	9	3,252	3,250	4,039	3,950	132	60

Table 5. Mean length (mm mid-eye to fork of tail), age, and sex composition of nonjack adult coho salmon sampled at Eagle River weir, 16 August to 3 October 1989.

		<u>Parent Year</u>		
		1985	1984	Total
		Age 2.1	Age 3.1	
Male	N	24	1	25
	Mean Length	559	580	560
	SD	79	-	77
	SE	16	-	15
	Percent Composition	47.0	-	49.0
	SE (%)	7.6	-	7.3
Female	N	23	3	26
	Mean Length	590	608	592
	SD	50	28	48
	SE	10	16	9
	Percent Composition	45.1	5.9	51.0
	SE (%)	7.9	16.1	7.0
Total	N	47	4	51
	Mean Length	574	601	576
	SD	67	27	65
	SE	10	13	9
	Percent Composition	92.9	7.8	100
	SE (%)	1.1	14.9	0

The age composition and length-at-age of the smolt population are presented in Table 6. Coho salmon smolt were mostly age-2. (88.7%), with a few age-3. (8.5%) and age-1. (2.8%). Age 2. smolt averaged 82 mm fork length, while age-3. smolts were 92 mm fork length.

Juvenile Population Estimates

An estimated 775 (SE=31) juvenile coho were extant in Sinitsin Creek in July 1989, and 538 (SE=8) were present in St. John Creek (Table 7). Juvenile coho salmon sampled at Sinitsin Creek were primarily aged 1. (84.5%), with less age-2. (15.5%) fish. Juvenile coho salmon at St. John Creek were nearly all aged 1. (96.2%), with few age-2. (3.8%) fish present. Daily catches of juvenile coho salmon in both Sinitsin and St. John creeks remained quite constant while the number of unmarked fish usually decreased daily (Table 8).

The estimated number of juvenile coho salmon by age class, and the age-1.+ juvenile per spawner production ratios for the 1985-87 brood years are presented in Table 9. The number of age-1. juvenile coho salmon per parent was 20.5 in Sinitsin Creek and 56.9 in St. John Creek during 1989.

Movement of juvenile coho salmon was not random during the experiment as those fish marked in the upper or lower sections of each creek were usually recovered in the same section. The only area where significant mixing occurred was at the juncture of the upper and lower sections of each stream. Movement was primarily upstream. Forty-four of the 142 fish marked in the lower section of Sinitsin Creek were recaptured in the upper section, while only nine of the 271 fish marked in the upper section were recaptured in the lower section. The same pattern existed in St. John Creek where 23 of the 192 fish marked in the lower section were recaptured in the upper section, while only eight of the 212 fish marked in the upper section were recaptured in the lower section.

Estimates of juvenile coho salmon population size are being used as indicators of potential adult return to the area. Juvenile per spawner ratios have varied considerably by system and year, but were lowest from the high escapement of 1985 (Sinitsin = 6.4, St. John = 9.4). The winter of 1985-86 was an exceptionally cold and snow-free period, and excessive mortality of embryos may have occurred before fry emergence. Although recent juvenile per spawner ratios are higher than those observed from the 1985 escapement, the parent escapement was extremely low so recruitment was limited. The potential adult coho salmon production from streams in Salisbury Sound in 1990 and 1991 is considerably reduced because of the low adult escapements in 1986 and 1987.

LITERATURE CITED

- Anas, R. E. 1963. Red salmon scale studies, p. 114-116 in: Annual Report of the International North Pacific Fisheries Commission, 1961, Vancouver, British Columbia, Canada.
- Clark, J. E. and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. Alaska Department of Fish and Game. Informational Leaflet No. 261. Juneau, Alaska, USA.

Table 6. Mean fork length (mm) and age composition of coho salmon smolts sampled at Eagle River, 22 April to 29 May 1989.

	Parent Year			Total
	<u>1987</u> Age 1.	<u>1986</u> Age 2.	<u>1985</u> Age 3.	
N	10	313	30	353
Mean Length	76	83	92	83
SD	4	9	11	9
SE	1	1	2	1
Percent Comp.	2.8	88.7	8.5	100.0
SE (%)	5.4	0.6	5.0	

Table 7. Population estimates and age composition of juvenile coho salmon ≥ 65 mm fork length at Sinitstin and St. John Creeks, July 1989.

Sinitstin Creek		St. John Creek	
N	775	N	538
Variance of N	991	Variance of N	71
SE	31	SE	8
No. of Age 1.+	655	No. of Age 1.+	518
% Composition	84.5	% Composition	96.2
SE (%)	1.7	SE (%)	0.4
No. of Age 2.+	120	No. of Age 2.+	20
% Composition	15.5	% Composition	3.8
SE (%)	9.6	SE (%)	13.2

Table 8. Daily total catch and number of unmarked juvenile coho salmon ≥ 65 mm length, by day, Sinitsin and St. John Creeks, July 1989.

Sinitsin Creek (24 traps/sample)			St. John Creek (22 traps/sample)		
Date	Number Caught		Date	Number Caught	
	Total	Unmarked		Total	Unmarked
11 July	39	39	06 July	170	170
12 July	205	188	07 July	176	101
14 July	285	180	08 July	227	95
17 July	210	55	09 July	132	38
24 July	220	59	18 July	173	36
25 July	182	45	19 July	151	17
26 July	127	31	20 July	170	22
27 July	112	26	21 July	159	28

Table 9. Summary of available juvenile per spawner production ratios for coho salmon from Sinitsin and St. John Creeks, 1985 to 1989.

Escapement Index (Yr)	Juvenile Population Estimate at (Yr) + 2			Adult Return at (Yr) + 4	No. Age 1. Juvenile/ Parent Escapement
	Age 1.+	Age 2.+	Total		
<u>Sinitsin Creek</u>					
144 (85) ^a	921	19	940	76	6.4
4 (86)	76	57	133	-	19.0
32 (87)	655	120	775	-	20.5
56 (88)	-	-	-	-	-
76 (89)	-	-	-	-	-
<u>St. John Creek</u>					
109 (85) ^a	1,027	66	1,093	89	9.4
9 (86)	546	164	710	-	60.6
9 (87)	512	26	538	-	56.9
71 (88)	-	-	-	-	-
89 (89)	-	-	-	-	-

^a Very cold winter with no snow cover may have frozen embryos.

- Elliott, S. T. and K. J. Kuntz. 1988. A study of coho salmon in southeast Alaska: Chilkat Lake, Chilkoot Lake, Yehring Creek, and Vallenar Creek. Alaska Department of Fish and Game. Fisheries Data Series No. 62. 55 pp.
- _____, A. E. Schmidt, and D. A. Sterritt. 1989. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Fisheries Data Series No. 113. 82 pp.
- Goodman, L. A. 1960. On the exact variance of products. J. American Statistical Association 55:708-13.
- Gunstrom, G. K. and M. Bethers. 1985. Electrical anesthesia for handling large salmonids. Progressive Fish-Culturist 47:67-69.
- Koerner, J. F. 1977. The use of the coded-wire tag injector under remote field conditions. Alaska Department of Fish and Game, Informational Leaflet No. 172, Juneau, Alaska, USA.
- Orsi, J. A. and J. W. Short. 1987. Modifications in electrical anesthesia for salmonids. Progressive Fish-Culturist, Technical Note: Volume 49.
- Schmidt, A. E. 1984. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1983-1984, Project AFS51-1, Vol. 25. 23 pp.
- _____. 1985. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1984-1985, Project G-II-D, Vol. 26. 21 pp.
- _____. 1986. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1985-1986, Project S1-4, Vol. 27. 25 pp.
- _____. 1987. Coho salmon in southeast Alaska. Alaska Department of Fish and Game. Fisheries Data Series 18. 38 pp.
- _____. 1988. Coho salmon in southeast Alaska. Alaska Department of Fish and Game. Fisheries Data Series No. 45. 29 pp.
- Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, 2nd ed. Charles Griffin and Sons, Ltd., London. 654 pp.
- Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:122-132.

APPENDIX A

Appendix A1. Daily counts of coho salmon, water temperature, and stream depth at the Salmon Lake weir, 1989.

Date	Average Water Temperature (°C)	Average Stream Depth (m)	Number Adult Coho	Number Jack Coho
23 Aug	14.5	0.18	0	0
24 Aug	14.5	0.17	0	0
25 Aug	14.8	0.17	0	0
26 Aug	15.3	0.17	0	0
27 Aug	15.0	0.16	0	0
28 Aug	15.0	1.45	0	0
29 Aug	14.8	1.45	0	0
30 Aug	14.2	1.45	0	0
31 Aug	14.2	0.14	0	0
01 Sept	14.5	0.13	0	0
02 Sept	14.8	0.17	0	0
03 Sept	12.3	1.30 ^{a,b}	18	0
04 Sept	11.3	1.30 ^{a,b}	0	0
05 Sept	12.0	0.47	0	0
06 Sept	12.0	0.32	0	0
07 Sept	12.0	0.27	0	0
08 Sept	13.3	0.24	1	2
09 Sept	13.7	0.22	0	0
10 Sept	13.2	0.20	0	0
11 Sept	13.2	0.18	0	1
12 Sept	13.3	0.17	0	0
13 Sept	13.0	0.16	0	0
14 Sept	12.7	0.16	0	0
15 Sept	13.0	0.25	3	0
16 Sept	12.5	0.24	0	0
17 Sept	11.2	0.22	1	0
18 Sept	10.5	0.57	1	0
19 Sept	11.0	0.70	79	11
20 Sept	10.8	0.78	37 ^c	2
21 Sept	11.2	0.42	2	1
22 Sept	11.2	1.18 ^b	39 ^d	2 ^e
23 Sept	11.2	0.70	2	3
24 Sept	11.2	0.54	0	0
25 Sept	11.2	0.35	0	1
26 Sept	11.2	0.71	8	1
27 Sept	11.2	0.45	4	0
28 Sept	11.2	0.40	2	1
29 Sept	10.3	0.61	4	2
30 Sept	10.7	0.44	5	0

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Date	Average Water Temperature (°C)	Average Stream Depth (m)	Number Adult Coho	Number Jack Coho
01 Oct	10.5	0.35	0	0
02 Oct	11.0	1.30 ^b	3 ^f	0
03 Oct	10.5	0.98	0	0
04 Oct	10.5	0.68	1	0
05 Oct	10.5	0.51	0	0
06 Oct	9.7	1.00 ^b	0	0
07 Oct	9.0	0.98	0	0
08 Oct	9.2	0.65	0	0
09 Oct	7.8	1.15 ^b	0	0
10 Oct	7.3	0.80	<u>0</u>	<u>0</u>
			210	27

- ^a Exceeded measuring device.
- ^b Weir overtopped.
- ^c Includes one trap escapee.
- ^d Includes 36 adults counted over top of weir.
- ^e Two jacks counted over top of weir.
- ^f Two adults counted over top of weir.

Appendix A2. Daily catches of fish and measurements of rainfall, water temperature, and maximum stream depth at the site of the fyke net on the outlet stream from Salmon Lake, 1989.

Date	Previous 24-Hour Rainfall (inches)	Mean Water Temp. (°C)	Maximum Stream Depth (cm)	Dolly Varden	Smolts		
					SS ^a	SH ^b	RS ^c
25 Apr	0.00	2.3	41	59	18	0	0
26 Apr	0.00	2.2	50	153	36	0	0
27 Apr	0.00	2.7	53	92	60	1	0
28 Apr	0.00	2.7	49	213	46	2	0
29 Apr	0.00	3.2	52	347	148	1	0
30 Apr	0.00	3.2	63	162	187	3	0
01 May	0.00	3.2	64	118	161	3	0
02 May	0.00	3.5	56	103	171	3	0
03 May	0.00	3.8	49	159	133	1	0
04 May	0.00	4.2	51	436	284	22	0
05 May	0.00	4.3	44	498	264	8	0
06 May	0.00	4.7	47	861	288	14	0
07 May	0.20	4.8	64	243	220	2	0
08 May	0.45	5.5	64	468	363	5	0
09 May	0.70	5.7	63	312	474	3	0
10 May	0.20	5.5	47	116	612	4	0
11 May	0.10	5.5	43	69	217	7	0
12 May	0.40	5.2	41	114	106	9	1
13 May	0.30	5.5	46	125	177	4	0
14 May	0.20	5.5	47	25	230	7	3
15 May	0.20	5.5	53	53	418	6	6
16 May	0.45	5.3	61	23	186	6	4
17 May	0.70	5.8	50	21	354	2	12
18 May	0.00	5.7	42	31	338	2	5
19 May	trace	5.8	38	8	210	6	25
20 May	trace	6.2	40	9	215	0	30
21 May	0.00	6.2	43	5	206	3	63
22 May	trace	7.3	45	23	185	5	96
23 May	0.20	7.3	40	14	194	3	154
24 May	0.10	7.2	37	8	86	11	74
25 May	0.00	7.3	35	5	96	2	205
Totals				4,873	6,683	145	678

- ^a coho salmon
- ^b steelhead
- ^c sockeye salmon

Appendix A3. Daily counts of coho salmon, water temperature, and stream depth at the Eagle River weir, 1989.

Date	Average Water Temperature (°C)	Average Stream Depth (m)	Number Adult Coho	Number Jack Coho
16 Aug	12.0	0.14	0	0
17 Aug	12.0	0.14	0	0
18 Aug	12.0	0.15	0	0
19 Aug	12.0	0.18	0	0
20 Aug	12.0	0.18	0	0
21 Aug	12.0	0.15	0	0
22 Aug	12.0	0.16	0	0
23 Aug	12.0	0.16	0	0
24 Aug	12.0	0.16	0	0
25 Aug	12.0	0.15	0	0
26 Aug	12.0	0.13	0	0
27 Aug	13.0	0.10	0	0
28 Aug	13.0	0.08	0	0
29 Aug	13.0	0.11	0	0
30 Aug	12.0	0.13	0	0
31 Aug	12.0	0.12	0	0
01 Sept	10.0	0.12	0	0
02 Sept	0.0	0.48	4	0
03 Sept	12.0	1.10	14	0
04 Sept	11.0	1.15	18	1
05 Sept	11.0	0.25	6	0
06 Sept	11.0	0.25	0	0
07 Sept	11.5	0.25	0	0
08 Sept	11.0	0.26	0	0
09 Sept	11.0	0.20	0	0
10 Sept	10.0	0.19	0	0
11 Sept	12.0	0.19	0	0
12 Sept	11.0	0.17	0	0
13 Sept	11.0	0.18	0	0
14 Sept	10.0	0.18	1	0
15 Sept	10.0	0.29	8	0
16 Sept	9.0	0.24	0	0
17 Sept	8.5	0.22	0	0
18 Sept	9.5	0.48	5	0
19 Sept	10.0	0.37	0	0
20 Sept	11.0	1.15	36	1
21 Sept	10.5	0.38	1	0
22 Sept	11.0	1.50 ^a	26 ^b	3 ^c

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Date	Average Water Temperature (°C)	Average Stream Depth (m)	Number Adult Coho	Number Jack Coho
23 Sept	11.0	0.44	0	0
24 Sept	10.5	0.30	0	0
25 Sept	10.0	0.30	0	0
26 Sept	10.0	0.43	0	0
27 Sept	9.5	0.25	0	0
28 Sept	10.0	0.45	9	0
29 Sept	10.0	0.53	0	0
30 Sept	9.5	0.27	0	0
01 Oct	10.0	0.30	0	0
02 Oct	10.0	1.50 ^a	0	0
03 Oct	^d	^d	<u>3^e</u>	<u>0</u>
			131	5

^a Exceeded measuring device. Weir overtopped.

^b 26 new adults observed during stream survey on 25 September.

^c Three new jacks observed during stream survey on 25 September.

^d Physical data not available.

^e Three new adults observed during stream survey on 3 October.

Appendix A4. Daily catches of fish and measurements of rainfall, water temperature, and maximum stream depth at the site of the fyke net on Eagle River, 1989.

Date	Previous 24-Hour Rainfall (inches)	Mean Water Temp. (°C)	Maximum Stream Depth (cm)	Dolly Varden	Smolts	
					SS ^a	SH ^b
22 Apr	0.00	2.0	23	19	20	0
23 Apr	0.00	2.5	21	14	10	0
24 Apr	0.00	2.5	21	22	25	0
25 Apr	0.00	4.0	21	44	20	1
26 Apr	0.00	3.0	28	58	68	2
27 Apr	0.00	3.0	24	80	56	0
28 Apr	0.00	3.0	23	106	57	2
29 Apr	0.00	3.0	29	107	59	1
30 Apr	0.00	4.0	28	104	91	0
01 May	0.00	5.0	32	141	103	0
02 May	0.00	6.0	30	109	93	0
03 May	0.00	5.0	20	204	128	0
04 May	0.00	6.0	16	107	109	1
05 May	0.00	5.0	29	72	117	1
06 May	0.30	6.0	30	20	38	0
07 May	2.70	5.0	73	91	177	2
08 May	2.80	5.0	45	34	323	2
09 May	1.70	5.0	40	67	201	3
10 May	0.40	5.0	36	62	180	4
11 May	0.10	5.0	23	38	81	1
12 May	1.40	5.5	22	31	104	2
13 May	1.20	5.5	23	16	109	0
14 May	4.20	5.5	75	21	390	4
15 May	1.20	6.0	60	13	104	4
16 May	2.80	5.0	90	16	135	3
17 May	3.00	4.0	37	c	c	c
18 May	0.00	5.0	21	7	16	0
19 May	0.20	5.5	19	5	15	0
20 May	0.10	5.0	16	8	20	0
21 May	0.00	6.0	15	9	35	2
22 May	0.00	7.5	15	11	47	2
23 May	0.50	6.0	15	7	21	1
24 May	0.20	6.5	13	4	33	1
25 May	0.00	6.5	13	6	72	3
26 May	0.00	7.0	12	6	63	7
27 May	0.00	7.5	12	10	62	3

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Date	Previous 24-Hour Rainfall (inches)	Mean Water Temp. (°C)	Maximum Stream Depth (cm)	Dolly Varden	Smolts	
					SS ^a	SH ^b
28 May	0.00	7.5	12	14	50	4
29 May	0.30	8.0	13	8	27	3
Totals				1,691	3,259	59

^a coho salmon

^b steelhead

^c fyke net washed out for 24 hours.

