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Coho Salmon Studies in Southeast Alaska, 1990: Auke Lake, Chilkoot Lake, Nahlin River, and Yehring Creek

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ABSTRACT

In 1990, the production of coho salmon *Oncorhynchus kisutch* stocks in northern Southeast Alaska which contribute to important sport fisheries was monitored as part of a continuing program to better manage these fisheries. At Auke Lake, near Juneau, the return was an estimated 1,454 adults (SE = 55), of which 52% (SE = 2%) were harvested by the various fisheries. This return had an ocean survival rate of 21% (SE = 1%). At Chilkoot Lake, near Haines, the coho salmon escapement was an estimated 1,078 (SE = 31) after accounting for recreational harvest above Chilkoot Lake weir. At Nahlin River, British Columbia, 2,007 coho salmon smolt were captured in fyke nets coded wire tagged, and released. At Yehring Creek the return of coho salmon was an estimated 10,047 fish (SE = 1,436) of which 75% (SE = 10%) were harvested by the various fisheries. The return had an ocean survival rate of 13% (SE = 2%), the highest smolt-to-adult survival rate recorded at Yehring Creek.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, escapement, return, smolt, harvest rate, contribution, troll fishery, drift gill net fishery, recreational fishery, forecast model, run-strength.

INTRODUCTION

The purpose of this research program is to measure the productivity of selected coho salmon *Oncorhynchus kisutch* stocks in Southeast Alaska so that important recreational fisheries in the region can be better managed. The program monitors escapements, exploitation rates, and smolt abundance in several watersheds, with the goal of assessing the effects of harvest on stocks and forecasting run-strength. These studies are a continuation of an ongoing program of stock assessment begun in northern Southeast Alaska in 1986 (Elliott 1987; Elliott and Kuntz 1988; Elliott et al. 1989; Elliott and Sterritt 1990). In 1990, data were collected on coho salmon stocks at Chilkoot Lake and Auke Lake, near Juneau (Figure 1), and at Nahlin River and Yehring Creek, in the Taku River drainage (Figure 2).

Auke Lake, near Juneau, Alaska: Harvest and escapement data for this stock are used as an indicator of exploitation rates for coho salmon stocks in the immediate Juneau area. A weir on the outlet of Auke Lake catches all migrating fish and complete counts of coho salmon smolt, jacks, and adults have been obtained since 1980. The weir is operated cooperatively with the National Marine Fisheries Service, Auke Bay Laboratory.

Chilkoot Lake, near Haines, Alaska: Coho salmon returning to Chilkoot Lake support an intense and growing freshwater fishery. This stock is heavily harvested by commercial troll and drift gill net fisheries before they enter Chilkoot River, and exploitation rates over 85% are common. In some years, high exploitation, combined with low production, has resulted in closures of the recreational fishery in order to achieve management escapement goals.

Nahlin River, a tributary of Taku River in British Columbia, Canada: Studies were conducted in spring 1990 in the headwaters of this stream, approximately 58°45′ N, 131°18′30" W. Coho salmon bound for the Nahlin River are the first to return to the Taku River, and they are caught by the Juneau marine recreational fishery in July. The stock is further harvested by the District 111 drift gill net fishery and Canadian set net fishery. Since these commercial fisheries are managed for the harvest of sockeye salmon, there is concern that early-run coho salmon may be overharvested.

Yehring Creek (58°30′00" N, 133°48′10" W), a tributary of Taku River in Alaska: Research has been conducted on coho salmon at this site since 1986. This coho salmon stock is an indicator of exploitation rate for coho salmon stocks on the U.S. portion of the Taku River. Coho salmon bound for these streams may contribute substantially to the Juneau marine recreational fishery. Exploitation rates of Yehring Creek coho salmon are an estimated 70-85% of an return of 5,000 to 10,000 adults.

In 1990, the objectives for research in northern Southeast Alaska were:

1. to estimate the escapement of coho salmon at Chilkoot Lake and Yehring Creek;

2. to estimate the age and sex composition and mean length of adult coho salmon escaping to Yehring Creek;

3. to test the hypothesis that straying of adult coho salmon into Yehring Creek from other streams is negligible;

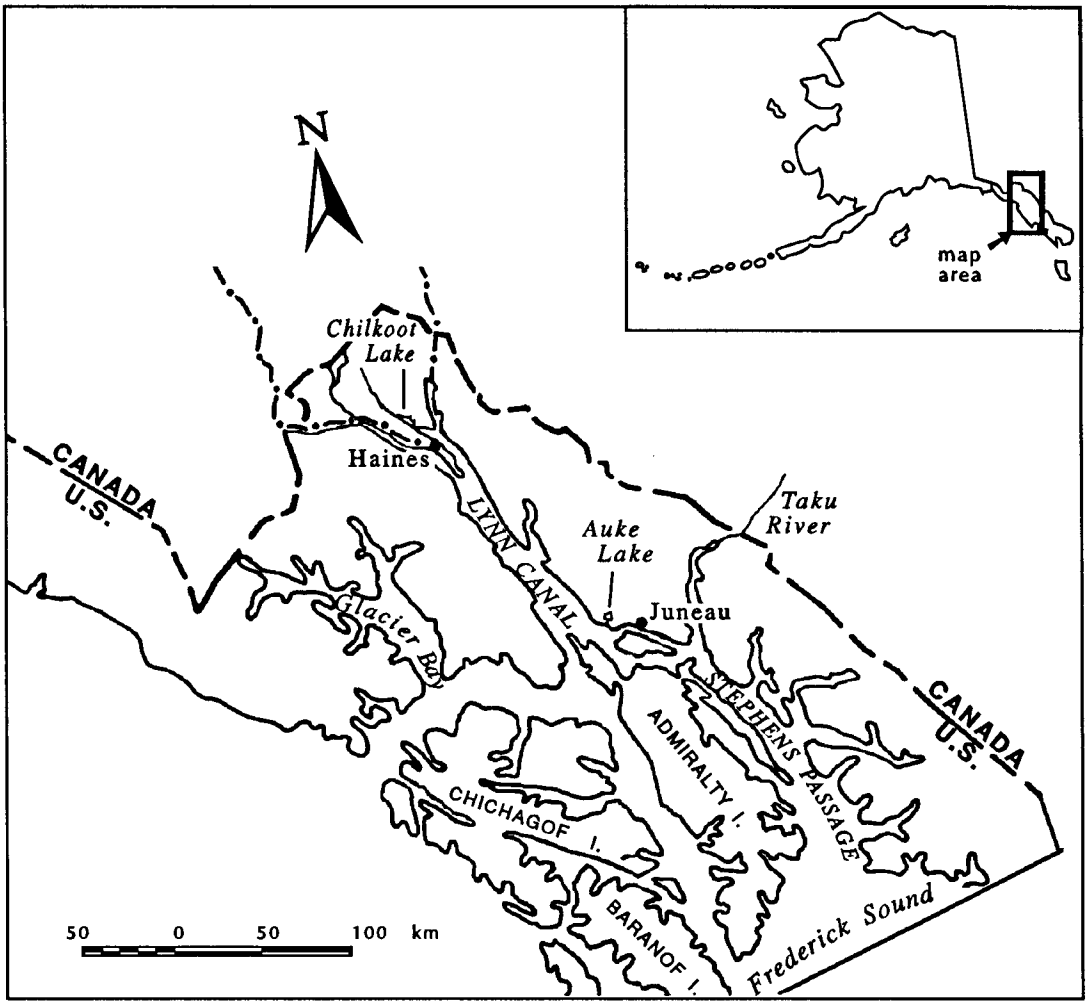

Figure 1. Location of Chilkoot Lake, Taku River, and Auke Lake in northern Southeast Alaska.

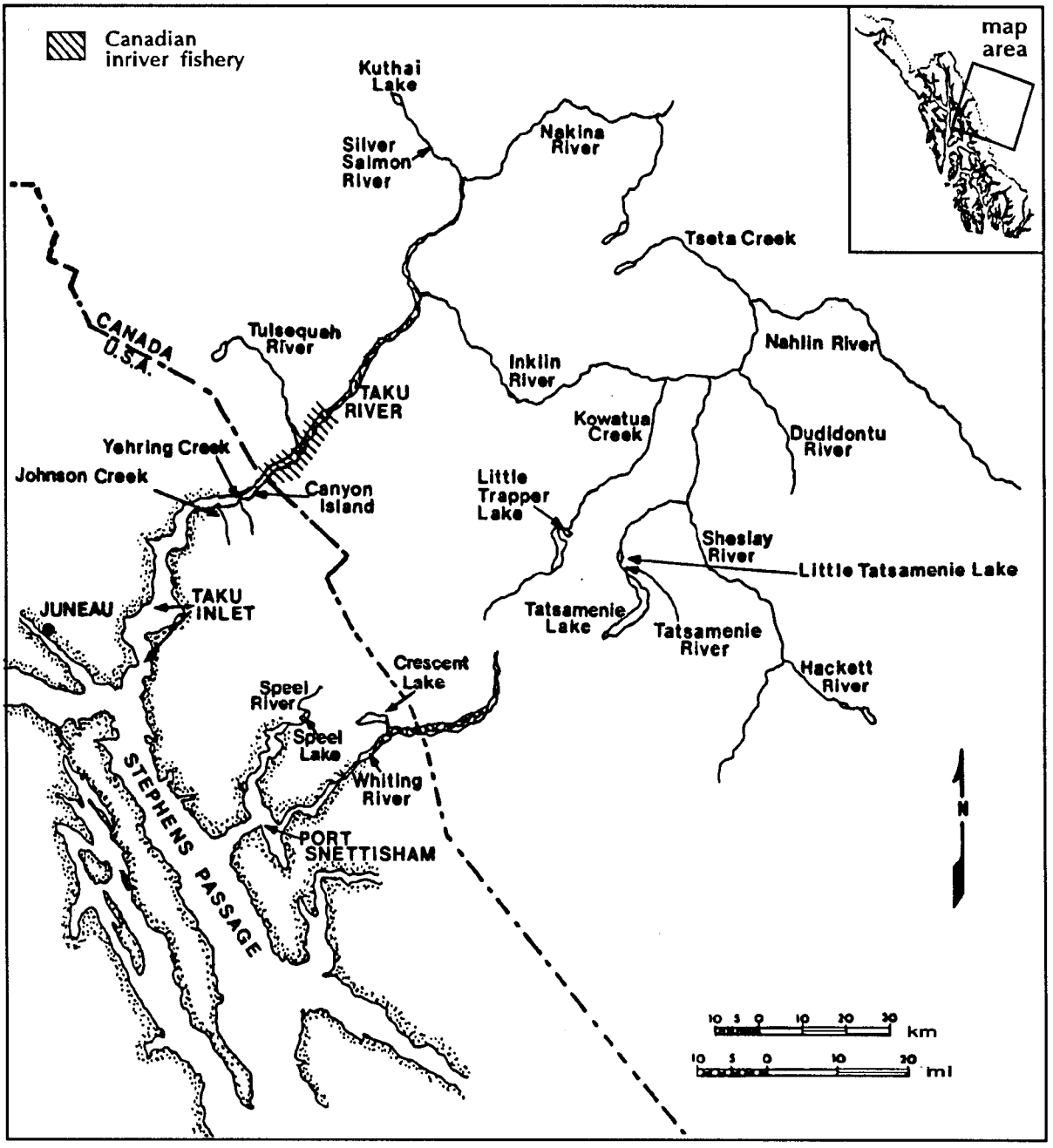

Figure 2. The Taku River drainage, showing location of Nahlin River, northwestern British Columbia, and Yehring Creek in northern Southeast Alaska.

5. to estimate the freshwater harvest of coho salmon at Yehring Creek;

6. to estimate the number of coho salmon smolt leaving Nahlin River and estimate the age composition and mean length of the smolt; and

7. to estimate the 1990 harvest of coho salmon bound for Auke Lake.

METHODS

Smolt Sampling and Coded Wire Tagging: Nahlin River

Stream-type fyke nets (Elliott and Sterritt 1990) were fished on the headwaters of the Nahlin River, British Columbia, from 17 May to 19 June 1990 to capture emigrating coho salmon smolts. The live boxes of the nets were checked daily or round-the-clock, depending on catch rates. All coho salmon <70 mm fork length (FL) were considered to be juveniles and were counted and released. All coho salmon ≥70 mm FL were considered to be smolt; they were counted, transported back to camp, tranquilized with tricain-methane sulfonate (MS 222), marked by removing the their adipose fins, and tagged with coded-wire tags (CWT) following instructions in Koerner (1977). Fish were held in holding boxes overnight and then checked for the presence of CWTs and the number of post tagging mortalities. The number of fish tagged in a tagging session, less the number of post tagging mortalities and multiplied by the tag retention ratio (number of fish with tags after 24 hr/number of live fish after 24 hr), was the valid release for that tagging session.

A random sample for the collection of age-length data was taken by systematically drawing every fifth fish from the catch. Each sampled fish was measured to the nearest 1 mm FL, and scales were removed from the preferred area (Anas 1963) on the side of the fish. Samples from four fish were compressed between two microscope slides. Ages were determined from the samples by microfiche reader equipped with 10 mm objective lens.

Estimate of Yehring Creek Smolt Abundance

In spring 1989, 9,951 coho salmon smolt were captured in trough traps as they left beaver pond wintering areas in the headwaters of Yehring Creek (Elliott and Sterritt 1990). The fish were given CWTs and marked by removal of their adipose fins and released. A sample of these fish was examined for clipped adipose fins at the Yehring Creek weir when the fish returned as adults 18 months later. A mark-recapture experiment based on Chapman's modification of the Petersen method (Seber 1982) was used to estimate the abundance of smolt leaving Yehring Creek in spring, 1989 as follows:

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

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

where $\hat{N}$ = estimated abundance, M = number of smolt with clipped adipose fins released alive in 1989, C = number of adults inspected for missing adipose fins in 1990, and R = number of adults that had missing adipose fins.

Estimated Adult Escapement

A driven pile/picket weir was operated from 1 September to 31 October 1990 on the outlet of Chilkoot Lake, and a tripod/picket weir was operated on Yehring Creek from 25 August to 16 October 1990 approximately 3 km upstream of the Yehring Creek-Taku River confluence. The weirs had 1.9-cm (3/4-in) diameter pickets spaced 5.2 cm (2-1/16 in) on-center in a 43-picket aluminum channel. Adult salmon at Chilkoot Lake weir were counted as they passed through a slot in the weir and over a flashboard; they were not sampled because of concern for handling mortality. At Yehring Creek, fish were captured in a 2.4 X 2.4 m (8 x 8 ft) fish trap, counted and/or sampled, and released alive upstream.

Since the weir was built across Yehring Creek in 1986, a complete count of adults has been achieved only in 1988. In all other years, freshets overtopped, went around the ends of, or undermined the weir. Coho salmon exploited these conditions aggressively and unknown numbers of them passed upstream. Since there was no practical way of improving the performance of the weir, a mark-recapture experiment based on methods in Jolly (1965) and Seber (1965) was used to estimate the number of adults that escaped during freshets.

All coho salmon captured at the weir were tagged with a numbered jaw tag from date of start-up to the date of the first freshet. If it was deemed that the weir would be undermined, overtopped, or would otherwise allow fish to escape upstream, the weir pickets were pulled. When water levels declined to workable levels the pickets were re-installed, any holes were patched, and counting and tagging were resumed. After the weir was reinstalled, an upstream sample of adults was taken after all uncounted fish were judged to have reached the sample sites. Adults were captured with a beach seine, counted, and the numbers from jaw tags on any fish were recorded. All untagged fish were given a jaw tag and released in the area of capture. The next day, a second sample was taken at the same sites, all coho salmon were counted, and the numbers from jaw tags were recorded. The Jolly and Seber method was used to estimate the "recruitment" of adults between the time that the weir was pulled and the time of the first sampling event. "Recruitment," in this case, was an estimate of the number of fish that had passed while the weir was down.

At Yehring Creek there were three hiatuses in weir operation, hence four periods of recruitment (Appendix A1). Recruitment during the first period was estimated by using the Petersen method (Equations 1 and 2), because fish were marked intermittently during the first hiatus. The methods of Jolly and Seber were used to estimate recruitment during the other hiatuses in weir operation:

$$\hat{A}_{i,i+1}=\hat{N}_{i+1}-\hat{N}_i\hat{S}_{i,i+1} \qquad (3)$$

where

$\hat{A}_{i,i+1}$ = the estimated recruitment during period i+1;

$\hat{N}_{i+1}$ = the estimated population size at time i+1;

$\hat{N}_i$ = the estimated population size at time i; and

$\hat{S}_{i,i+1}$ = the estimated survival rate during period i+1.

The Jolly and Seber estimates were calculated using the computer program JOLLY (Pollock et al. 1990) and "Model A," which assumes both death and immigration.

The estimated escapement to Yehring Creek in 1990 was the sum of the recruitment for all periods:

$$\hat{E}=\hat{N}_1+\hat{A}_{1,2}+\hat{A}_{2,3}+\hat{A}_{3,4} \tag{4}$$

The variance of this estimate was approximated using:

$$V[\hat{E}]=V[\hat{N}_1]+\{V[\hat{N}_2]+\hat{S}^2_{1,2}V[\hat{N}_1]+\hat{N}^2_1V[\hat{S}_{1,2}]-V[\hat{S}_{1,2}]V[\hat{N}_1]\}+V[\hat{A}_{2,3}]+V[\hat{A}_{3,4}] \tag{5}$$

At Chilkoot Lake weir the escapement in 1990 was estimated by bootstrapping a set of escapements calculated from escapement timing data from past years. Since the Chilkoot Lake weir became operational, there have been seven years when the weir was not overtopped by freshets and complete counts of the escapement were made: 1976, 1987, 1979, 1983, 1985, 1986, 1989. In 1990, the weir was non-operational from 22 September through 26 September due to flooding which allowed unknown numbers of fish to escape upstream. The first step in making the calculations was to determine the number of fish counted through the weir from 22 September through 26 September in 1976, 1978, 1979, 1983, 1985, 1986, 1989. This number represents the proportion p_e of the escapement in each of those years that was uncounted during a hypothetical hiatus in weir operation, and $1-p_e$ was the proportion of the escapement which was counted. The second step was to divide the incomplete count of 979 fish obtained in 1990 by $1-p_e$ from each of the seven "good" years to obtain seven estimates of total escapement for 1990 (Appendix A4). These values were bootstrapped (Elliott and Kuntz 1988) for 100 iterations, and 100 mean values were obtained. The mean of those means was the estimated total count through the weir; the variance and SE of that mean were obtained by standard methods.

Since this estimate represented the count at the weir, the true escapement was the bootstrapped estimate less the estimated freshwater harvest of coho salmon above the weir, and the variance of the escapement was the sum of the variance of the bootstrapped mean and the variance of the estimate of freshwater harvest. This technique provides a minimal estimate of escapement, with the caveat that the proportion of the escapement passing during a flood event may not be similar to the proportion of the escapement passing on those dates when there is no flood.

Sampling Adults

All coho salmon captured at the Yehring Creek weir were checked for missing adipose fins (indicating the presence of a CWT). Every fourth fish was tranquilized with a 12-volt DC electric shocking basket (Gunstrom and Bethers 1985), measured to the nearest 1 mm fork length (mid-eye to fork of tail), and sexed by examination of external characteristics. To determine age, four scales were removed from the preferred area (Anas 1963) and mounted on gum cards. The scales were pressed on acetate cards and read with a microfiche reader equipped with a 10 mm objective lens.

Estimates of Age and Sex Composition

Proportions by age were estimated for smolts leaving Nahlin River, and by age and sex for adults sampled at the Yehring Creek weir, using

$$\hat{p}_i = \frac{n_i}{n} \tag{6}$$

$$V[\hat{p}_i] = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}\left(1-\frac{n}{N_e}\right) \tag{7}$$

where $\hat{p}_i$ = the proportion in the population in group i, n_i = the number in the sample of group i, n = the sample size, and N_e = the number in the population.

The finite population correction factor was omitted for samples of smolt from the Nahlin River, as the abundance of smolt in the river was not known.

Estimates of Harvest

Coded-wire tags from Auke Lake and Yehring Creek were recovered from troll, purse seine, and gill net fisheries by the ADFG Division of Commercial Fisheries port sampling program and from the recreational fisheries by ADFG Division of Sport Fish marine and freshwater creel programs.

The procedures listed in Clark and Bernard (1987) were used to estimate harvests in commercial and sport fisheries of stocks tagged with CWTs. The estimates were based on the following information supplied by the Fisheries Rehabilitation, Enhancement, and Development (FRED) Division:

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 CWTs;
6) number of these CWTs that were decodable;
7) number of decodable tags of the appropriate code(s); and
8) the tag ratio observed in the adult escapement or in the smolt population.

Each calculation of harvest in the troll fishery was stratified by fishing quadrant and by fishing period. Since information from FRED Division by fishing district was tallies from landings of fishermen who fished exclusively in that district, data from fishermen who fished several districts were excluded from the tallies. Since almost no fishermen fish in more than one of the larger quadrants during an opening, data stratified by quadrants were 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 Alen, Alaska Department of Fish and Game, Juneau). Under those circumstances, stratifications finer than two weeks would often bias the estimates.

In drift gill net and purse seine fisheries, the harvest was stratified by district and statistical week. In weeks when tags were recovered but the

district was not reported, the calculation for harvest for that week was stratified by quadrant.

Since the samples drawn during each stratum were independent samples, the estimate of total harvest was the sum of all the stratified estimates. The variance of the total harvest was likewise the sum of the stratified variances. The harvest from a population of fish that bear a unique coded-wire tag code follows the equation number 10 in Clark and Bernard 1987:

$$\hat{n}_1 = \left(\frac{m_1}{m2}\right)\left(\frac{a_1}{a2}\right)\left(\frac{N_h}{n_2}\right)\frac{\hat{m}_c}{\theta} \tag{8}$$

where

n_1 = number of coho salmon in a return harvested in a sampled stratum h and associated with a tag code;
n_2 = number of coho salmon in sampled stratum h examined for a missing adipose fin;
N_h = total number of coho salmon harvested in sampled stratum h;
m_c = number of tags dissected out of fish heads and decoded as a unique tag code;
θ = proportion of a population which contains a CWT of a unique code;
a_1 = number of fish missing an adipose fin which are counted and marked with a head strap;
m_1 = number of CWT's which are detected in fish heads at the tag lab; and
m_2 = number of CWT's which are removed from fish heads and decoded.

An unbiased estimate of the variance of n_1 (Clark and Bernard 1987) is:

$$V[\hat{n}_1] = \left[\frac{m_2(m_1-1)a_2(a_1-1)n_2(N_h-1)}{(m_2-1)m_1(a_2-1)a_1(n_2-1)N_h}\right] S^2(\hat{n}_1) \tag{9}$$

where

$$S^2(\hat{n}_1) = \left[\hat{m}_c\left(\frac{N_h m_1 a_1}{m_2 a_2 n_2 \theta}\right)^2\right]\left[1-\hat{m}_c+\left(\frac{(m_2-1)(a_2-1)(n_2-1)}{(m_1-1)(a_1-1)(N_h-1)}\right)\left(\frac{m_1 a_1 N_h \hat{m}_c}{m_2 a_2 n_2}\right)-\theta\right] \tag{10}$$

Equation (9) is appropriate for estimating the harvest of a stock tagged at a known rate where the harvest N_h is known. In recreational fisheries, where the harvest is estimated from a creel survey, the variance of $\hat{n}_1$ may be estimated using a different equation (Carlon and Lang 1989):

$$\hat{V}[\hat{n}_1] = \left[\frac{m_1 a_1}{m_2 a_2 n_2 \theta}\right]^2 \left[\hat{N}_h^2 V(\hat{m}_c) + \hat{M}_c^2 V(\hat{N}_h) - V(\hat{m}_c)V(\hat{N}_h)\right] \tag{11}$$

where

$$V[\hat{m}c] = \left[\frac{m_2(m_2-1)a_2(a_2-1)n_2(n_2-1)\hat{n}_1(\hat{n}_1-1)\theta^2}{m_1(m_1-1)a_1(a_1-1)N_h(N_h-1)}\right] \tag{12}$$

$$+\left[\frac{m_2 a_2 n_2 \hat{n}_1 \theta}{m_1 a_1 N_h}\right]-\left[\frac{m_2 a_2 n_2 \hat{n}_1 \theta}{m_1 a_1 N_h}\right]^2$$

is from Clark and Bernard (1989) for N_h being known. When the tagging fraction (θ) is estimated with less than comfortable precision, a bootstrap estimate of confidence intervals is indicated (Geiger 1990), since a closed form estimator for variance is not available. This procedure was not applied to variance estimates for harvests of coho salmon returning to Auke Lake and Yehring Creek, because the SE's of these θ are small.

The exploitation rate was calculated as the estimated harvest of a stock, divided by the total estimated return of the stock, and the variance of the exploitation rate was approximated using the delta method from Seber (1982):

$$\hat{E}=\frac{\hat{H}}{\hat{H}+\hat{J}}=\frac{\hat{H}}{\hat{R}} \tag{13}$$

$$V[\hat{E}]\approx\frac{V[\hat{H}]\hat{J}^2}{\hat{R}^4}+\frac{V[\hat{J}]H^2}{\hat{R}^4} \tag{14}$$

At the Auke Lake weir, the entire escapement of adult coho salmon was counted, and the calculation for the variance of the exploitation rate was approximated by

$$\hat{E}=\frac{\hat{H}}{\hat{H}+J}=\frac{\hat{H}}{\hat{R}} \tag{15}$$

$$V[E]\approx\frac{V[\hat{H}]J^2}{\hat{R}^4} \tag{16}$$

where $\hat{E}$ = the estimated exploitation rate, $\hat{H}$ = the estimated harvest, $\hat{J}$ = the estimated escapement or escapement count, and $\hat{R}$ = the return.

Smolt-to-adult Survival Rates

The smolt-to-adult survival rate (ocean survival rate) was estimated by

$$\hat{S}=\frac{\hat{R}}{\hat{N}_s} \tag{17}$$

and the variance and standard error of the ocean survival rate were approximated using the delta method from Seber (1982):

$$V[\hat{S}]\approx\hat{S}^2\left[\frac{V[\hat{R}]}{\hat{R}^2}+\frac{V[\hat{N}_s]}{\hat{N}_s^2}\right] \tag{18}$$

where $\hat{S}$ = the estimated ocean survival rate, $\hat{R}$ = the return (escapement + harvest) of adults, and $\hat{N}_s$ = the estimated smolt abundance.

RESULTS AND DISCUSSION

Auke Lake

The 1990 return of Auke Lake coho salmon was an estimated 1,454 age-.1 adults (SE = 55) (Table 1), of which 754 were harvested (Appendix A3), for an exploitation rate of 52% (SE = 2%). Of the catch, the troll fishery took 83%,

Table 1. Estimated harvest, return, and exploitation rate of coho salmon bound for Auke Lake, Juneau, Alaska, 1990.

Fishery	Area	Estimated harvest	SE	Percent harvest	Exploitation rate
U.S. troll					
	NE	25	10	3%	2%
	NW	580	46	77%	40%
	SE	8	5	1%	>1%
	SW	13	5	2%	>1%
Canadian troll	NTR	5			
	Subtotal	631	49	83%	43%
Drift gill net					
	111	19	11	2%	1%
	115	34	11	4%	2%
	Subtotal	53	15	7%	4%
Purse seine					
	109	1	1	>1%	>1%
	112	11	5	1%	1%
	Subtotal	12	6	2%	1%
Recreational		61	19	8%	4%
Total harvest		757	55	100.0%	52%
Escapement		697	0		48%
Return		1,454	55		100%

drift gill net and purse seine fisheries took a combined 9%, and the Juneau marine recreational fishery took 8%. In 1989, 6,820 coho salmon smolt were counted and coded-wire tagged at Auke Creek weir. The smolt-to-adult survival rate of this return was 1,454/6,820, or 21% (SE = 1%).

Chilkoot Lake

The escapement to Chilkoot Lake spawning grounds in 1990 was an estimated 1,078 (SE = 31). From 1 September to 31 October, 979 age-.1 coho salmon were counted through the Chilkoot Lake weir (Table 2). Because of floods, pickets were removed from the weir from 22 September through 26 September, and during that time an unknown number of fish escaped upstream. Therefore, a minimal escapement estimate of 1,094 (SE = 30) was obtained by bootstrapping migratory timing data (Elliott and Kuntz 1988) from previous years (Appendix A4). The final estimate was obtained by subtracting the estimated recreational harvest occurring above the weir (16; SE = 8) (Ericksen and Marshall *In press*) from the bootstrap estimate.

Nahlin River

Between 17 May and 19 June 1990, 2,053 coho salmon smolt were captured with stream-type fyke nets in the Nahlin River, British Columbia, and coded-wire tagged with tag code 04-28-46. After accounting for post-tagging mortality and tag loss, the valid release was an estimated 2,007 smolt. Rapidly melting snow produced flood conditions during most of May, and at its peak, the flood water rose 1-2 meters over the stream bank. Few smolt were caught during this period because the nets rapidly plugged with debris (Table 3). All smolt were caught from 9 June to 16 June after runoff had subsided, and since this was near the end of the migration, few fish were caught.

Coho salmon smolt averaged 94 mm FL long (SE = 1); 88% (SE = 2%) of the smolt were aged 1., and 22% (SE = 5%) were aged 2. (Table 4).

Yehring Creek

1990 Escapement:

The escapement to Yehring Creek was an estimated 2,522 (SE = 1,348) age-.1 coho salmon. The weir on Yehring Creek was operated from 25 August to 16 October 1990, and 907 age-.1 fish were counted (Table 5). During this time, the weir was breached three times by floods, and unknown numbers of fish escaped upstream during each hiatus in operation. The periods and recruitment calculations are summarized below.

Period 1 (25 August-18 September). Recruitment was estimated using the Petersen method:

$$\hat{A}_{0,1} = \hat{N}_1 = \frac{(313+1)\ (164+1)}{(42+1)} - 1 = 1,204\ (SE = 145)$$

where

$\hat{N}_1$ = estimated recruitment (abundance) during period 1;

M_1 = 313, the adults marked at the weir before 17 September;

Table 2. Daily counts of coho salmon, water depth, and water temperature at the Chilkoot Lake weir, near Haines, Alaska, 1990.

Date	Coho salmon		Water depth (cm)	Water temp.(°C)
	Number	Cumulative		
26-Aug-90	0	3[a]	17	10.0
27-Aug-90	0	3	13	10.5
28-Aug-90	2	5	15	8.0
29-Aug-90	4	9	22	9.0
30-Aug-90	1	10	15	9.5
31-Aug-90	0	10	11	10.0
01-Sep-90	1	11	7	9.5
02-Sep-90	0	11	4	8.0
03-Sep-90	1	12	2	8.0
04-Sep-90	0	12	5	8.5
05-Sep-90	0	12	14	9.5
06-Sep-90	1	13	10	9.5
07-Sep-90	1	14	10	8.5
08-Sep-90	2	16	6	8.0
09-Sep-90	2	18	3	8.0
10-Sep-90	1	19	2	8.0
11-Sep-90	0	19	4	9.0
12-Sep-90	1	20	4	9.0
13-Sep-90	0	20	6	8.5
14-Sep-90	1	21	10	9.0
15-Sep-90	4	25	27	9.0
16-Sep-90	4	29	24	9.0
17-Sep-90	2	31	12	9.0
18-Sep-90	7	38	10	9.0
19-Sep-90	9	47	6	8.5
20-Sep-90	13	60	8	9.0
21-Sep-90	9	69	27	9.0
22-Sep-90				
23-Sep-90				
24-Sep-90			weir out	
25-Sep-90				
26-Sep-90				
27-Sep-90	0	69	19	8.0
28-Sep-90	4	73	22	8.0
29-Sep-90	10	83	35	7.0
30-Sep-90	25	108	35	7.0

-continued-

Table 2. (Page 2 of 2).

Date	Coho salmon		Water depth (cm)	Water temp.(°C)
	Number	Cumulative		
01-Oct-90	53	161	24	7.0
02-Oct-90	37	198	26	7.0
03-Oct-90	109	307	5	7.0
04-Oct-90	60	367	2	6.0
05-Oct-90	59	426	-2	6.0
06-Oct-90	149	575	-3	7.0
07-Oct-90	111	686	-4	7.0
08-Oct-90	46	732	5	7.0
09-Oct-90	36	768	9	7.0
10-Oct-90	40	808	3	7.0
11-Oct-90	121	929	2	7.0
12-Oct-90	11	940	-1	6.0
13-Oct-90	6	946	-3	
14-Oct-90	30	976	-6	
15-Oct-90	3	979	-7	
16-Oct-90	0	979	-8	
17-Oct-90	0	979	-10	
18-Oct-90	0	979	-12	
19-Oct-90	0	979	-15	6.0
20-Oct-90	0	979	-14	6.0
21-Oct-90	0	979	-7	6.0
22-Oct-90	0	979	-9	6.0
23-Oct-90	0	979	-9	5.0
24-Oct-90	0	979	-4	4.5
25-Oct-90	0	979	-6	5.0
26-Oct-90	0	979	-9	5.0
27-Oct-90	0	979	-10	6.0
28-Oct-90	0	979	-12	6.0
29-Oct-90	0	979	-14	6.0
30-Oct-90	0	979	-16	5.5
31-Oct-90	0	979	-18	6.0

[a] Three coho salmon were counted prior to 26 August.

Table 3. Daily counts of coho salmon smolts, sockeye salmon smolts, and chinook salmon fry in 3 x 5-m fyke nets at Nahlin River, Taku River drainage, British Columbia, 1990.

Date	Water temp(°C)	Water level(cm)	Coho	Chinook	Sockeye	Total
17-May-90	5.5	100.0				
18-May-90	5.0	104.5				
19-May-90	5.5	112.0				
20-May-90	6.0	114.0				
21-May-90	7.0	110.0				
22-May-90	6.0	114.0				
23-May-90	7.0	125.5				
24-May-90	6.0	119.0				
25-May-90	6.0	102.0				
26-May-90	6.0	92.5				
27-May-90	5.5	99.0				
28-May-90	6.0	125.5				
29-May-90	7.0	152.5				
30-May-90						
31-May-90		172.0	42	29	25	96
01-Jun-90	5.0	192.5				
02-Jun-90	7.5	185.5				
03-Jun-90	7.5	173.5				
04-Jun-90		162.0				
05-Jun-90		159.5				
06-Jun-90		152.5	328	153	143	624
07-Jun-90		143.5				
08-Jun-90	7.5	129.5				
09-Jun-90	7.5	100.5	333	399	260	992
10-Jun-90	8.0	90.0	296	313	361	970
11-Jun-90	8.5	78.0	143	356	97	596
12-Jun-90	9.0	87.0	282	475	276	1,033
13-Jun-90	9.0	79.5	182	483	86	751
14-Jun-90	9.5	69.0	292	767	134	1,193
15-Jun-90	9.0	59.0				
16-Jun-90	9.0	49.5	125	417	9	551
17-Jun-90	9.0	42.5	16	45		61
18-Jun-90	9.0	39.5	14	23		37
19-Jun-90	9.0	35.5				
Total			2,053	3,460	1,391	6,904

Table 4. Mean fork length and age composition of coho salmon smolts sampled from catches in fyke nets at Nahlin River, Taku River drainage, British Columbia, 1990.

	Parent year		
	1988	1987	
	Age 1.	Age 2.	Total
No. sampled	272	36	308
Mean length (mm)	91	115	94
SD	14	9	16
SE	1	2	1
Percent composition	88%	22%	100%
SE	2%	5%	

Table 5. Daily counts of adult salmonids at the Yehring Creek weir, Taku River drainage, Alaska, 1990.

Date	Temperature (°C)				Coho salmon							
	H_2O	Min.	Max.	Depth	Clipped	Unclipped	Total	Sockeye	Pink	Chum	Dolly Varden	Comments
25-Aug-90	12.0	6.0	17.0	24.0	0	0	0	0	6	0	1	Weir operational
26-Aug-90	11.5	5.0	20.0	24.0	0	0	0	1	28	0	3	
27-Aug-90	10.5	10.0	13.0	22.5	0	0	0	4	27	0	0	
28-Aug-90	11.0	10.0	14.0	33.0	0	0	0	142	107	0	2	sockeye ST#32541
29-Aug-90	11.0	10.0	19.0	59.0	1	9	10	22	19	2	0	sockeye ST#68210
30-Aug-90	10.0	4.0	16.0	39.5	0	1	1	1	36	0	0	
31-Aug-90	10.0	6.0	21.0	20.5	0	0	0	0	9	1	0	
01-Sep-90	10.0	7.0	17.0	11.0	0	0	0	0	0	0	0	
02-Sep-90	10.0	11.0	16.0	4.0	0	0	0	8	4	0	0	
03-Sep-90	11.0	8.0	12.0	3.0	0	0	0	1	3	0	0	
04-Sep-90	10.0	10.0	12.0	30.0	12	41	53	111	39	7	8	sockeye ST#34518
05-Sep-90	10.0	6.0	12.0	46.0	1	10	11	42	10	1	0	
06-Sep-90	10.0	8.0	12.0	32.0	0	0	0	12	4	0	0	
07-Sep-90	10.0	10.0	14.0	30.0	0	6	6	2	4	0	1	
08-Sep-90	9.0	4.0	17.0	21.0	0	0	0	1	0	0	0	
09-Sep-90	10.5	6.0	14.0	10.0	0	0	0	0	0	0	0	
10-Sep-90	10.0	8.0	13.0	6.5	0	0	0	0	0	0	0	
11-Sep-90	10.0	8.0	12.0	10.0	0	0	0	14	3	0	1	
12-Sep-90	10.0	7.0	14.0	11.5	0	0	0	0	0	1	0	
13-Sep-90	10.0	10.0	15.0	11.5	0	0	0	10	0	0	0	sockeye ST#34671
14-Sep-90	10.0	9.0	12.0	18.0	0	0	0	34	3	0	2	
15-Sep-90	10.0	8.0	12.0	55.0	19	154	173	81	0	0	0	coho ST# 21814 21490,21225
16-Sep-90	9.0	4.0	13.0	43.0	8	50	58	14	0	0	0	
17-Sep-90	8.0	1.0	13.0	21.0	5	26	31	0	1	0	1	
18-Sep-90	8.5	4.0	8.0	15.0	0	5	5	0	0	0	0	
19-Sep-90	8.5	5.0	9.0	14.0	2	15	17	15	0	0	0	
20-Sep-90	9.0	7.0	10.0	14.0	0	4	4	1	0	1	0	

-continued-

Table 5. (Page 2 of 2).

Date	Temperature (°C) H_2O	Min.	Max.	Depth	Coho salmon Clipped	Unclipped	Total	Sockeye	Pink	Chum	Dolly Varden	Comments
21-Sep-90	9.0	8.0	11.0	27.0	14	97	111	21	1	2	2	
22-Sep-90	9.0	10.0	13.0	92.0	42	162	204	21	0	0	1	
23-Sep-90	9.0	11.0	13.0	133.5								Trap closed
24-Sep-90	9.0	7.0	13.0	163.0								Trap closed
25-Sep-90	8.5	8.0	11.0	159.5								Trap closed
26-Sep-90	8.5	2.0	11.0	80.0	2	20	22	1	0	0	0	Trap open
27-Sep-90	6.5	5.0	12.0	55.5	5	66	71	1	0	1	0	
28-Sep-90	8.0	5.0	9.0	73.0	1	39	40	4	0	1	0	
29-Sep-90	8.0	6.0	10.0	102.5								Trap closed
30-Sep-90	9.0	5.0	8.0	77.0	2	37	39	2	0	0	1	Trap open
01-Oct-90	8.0	4.0	10.0	45.0	1	37	38	0	0	2	0	coho ST# 22224
02-Oct-90	7.0	2.0	10.0	26.5	1	9	10	0	0	2	0	
03-Oct-90	6.0	0.0	8.0	19.5	0	0	0	0	0	0	0	
04-Oct-90	6.0	-2.0	8.0	10.0	0	0	0	0	0	0	0	
05-Oct-90	4.0	-5.0	7.0	5.0	0	0	0	0	0	0	0	
06-Oct-90	5.5	0.0	3.0	4.0	0	0	0	0	0	0	0	
07-Oct-90	6.0	1.0	5.0	0.0	0	0	0	0	0	0	0	
08-Oct-90	7.0	4.0	7.0	95.0								Pickets pulled
09-Oct-90	7.0	4.0	10.0	47.0	0	0	0	0	0	0	0	Pickets replaced
10-Oct-90	5.5	-1.0	9.0	28.5	0	0	0	0	0	0	0	
11-Oct-90	6.0	3.0	7.0	15.0	0	0	0	0	0	0	0	
12-Oct-90	5.5	3.0	6.0	14.0	0	0	0	0	0	0	0	
13-Oct-90	5.0	2.0	5.0	11.0	0	0	0	0	0	0	0	
14-Oct-90	5.0	2.0	6.0	6.0	0	0	0	0	0	0	0	
15-Oct-90	5.0	0.0	4.0	5.0	0	0	0	0	0	0	0	
16-Oct-90	4.5	-2.0	3.0	1.5	0	0	0	0	0	0	0	Weir out
Total					116	788	904	566	304	21	23	

C_1 = 164, the number of adults inspected for marks at upstream sample sites on 17 and 18 September; and

R_1 = 42, the number of inspected adults that were marked.

Period 2 (18 September–27 September). Recruitment was estimated by subtracting the estimate of surviving fish from period 1 from a Jolly–Seber estimate of N_2 at the end of period 2:

$$\hat{A}_{1,2} = 747 - [1,204 \times 0.28] = 410 \ (SE \approx 799)$$

where

$\hat{A}_{1,2}$ = the estimated recruitment during period 2;

$\hat{N}_2$ = 747, the estimated abundance of fish above the weir at end of period 2 from Jolly–Seber;

$\hat{N}_1$ = 1,204, the estimated recruitment (abundance) at the end of period 1 from Petersen; and

$\hat{S}_{1,2}$ = 0.28, the estimated survival rate during period 2 from Jolly–Seber.

Period 3 (27 September–3 October): Recruitment ($\hat{A}_{2,3}$) was estimated using Jolly–Seber (Appendix A2): 740 (SE = 997).

Period 4 (4 October–10 October): Recruitment ($\hat{A}_{3,4}$) estimated using Jolly–Seber (Appendix A2): 168 (SE = 405).

Three hundred and eighty coho salmon were sampled at the weir and 304 sets of readable scales were obtained. The sex of 45 fish was incorrectly recorded as jack–i.e., age–.0 precocious male–a judgment made because of their small size. Analysis of their scales showed that all 45 fish were 1–ocean adults. Therefore they could have been either sex, and, consequently, they have been recorded as "unknown" in Table 6. The sex composition was 28% male (SE = 5%), 58% female (SE = 4%), and 15% unknown (SE = 5%). Adults averaged 619 mm long (mid–eye–fork) and ranged from 380 mm to 763 mm long. All were 1–ocean fish: 14% were aged 1.1, 83% were aged 2.1, and 3% were aged 3.1.

Estimated Return, Harvest, and Migratory Timing:

The 1990 return of Yehring Creek coho salmon was an estimated 10,047 fish (SE = 1,436) (Table 7), of which 7,525 were harvested by various fisheries (Appendix A5), an exploitation rate of 75% (SE = 10%). Of the catch, troll fisheries took 59%, drift gill net fisheries took 36%, seine fisheries 2%, and the Juneau marine recreational fishery 2%. A creel census was conducted at the mouth of Yehring Creek from August to mid–October; no anglers were observed. The peak of the catch in all fisheries occurred on 8 September (statistical week 36). During the three weeks ended 8 September, the combined fisheries took about 51% of the total catch and about 38% of the total return of Yehring Creek coho salmon (Figure 3).

Abundance and Survival of 1989 Smolt Cohort:

The number of smolt that left Yehring Creek in 1989 was estimated from the mark ratio of the returning adults one year later:

Table 6. Mean length (mm mid-eye to fork), age, and sex composition of adult coho salmon at Yehring Creek weir, Taku River drainage, Alaska, 1990.

	Parent year			
	1987	1986	1985	
	1.1	2.1	3.1	Total
Males				
No. sampled	14	68	2	84
Mean length (mm)	612	632	673	630
SD	72	72	46	72
SE	19	9	33	8
Percent composition	4.6	22.4	0.7	27.6
SE	5.4	4.7	7.5	4.6
Females				
No. sampled	19	150	6	175
Mean length (mm)	657	658	641	657
SD	36	46	42	45
SE	8	4	17	4
Percent composition	6.3	49.3	2.0	57.6
SE	5.3	3.8	5.8	3.5
Unknown				
No. sampled	8	35	2	45
Mean length (mm)	454	450	487	452
SD	20	30	11	29
SE	7	5	7	4
Percent composition	2.6	11.5	0.7	14.8
SE	5.6	5.1	7.5	5.0
Total				
No. sampled	41	253	10	304
Mean length (mm)	602	622	616	619
SD	90	88	77	88
SE	14	6	25	5
Percent composition	13.5	83.2	3.3	100.0
SE	5.0	2.2	5.5	

Table 7. Estimated harvest, return, and exploitation rate of coho salmon bound for Yehring Creek, Taku River drainage, Alaska, 1990.

Fishery	Area	Estimated harvest	SE	Percent harvest	Exploitation rate
U.S. troll	NE	531	130	7.1%	5.3%
	NW	3,712	353	49.3%	36.9%
	SE	37	36	0.5%	0.4%
	SW	46	32	0.6%	0.5%
Canadian troll	NTR	86	ND	1.1%	0.9%
	Subtotal	4,412	379	58.6%	43.9%
Drift gill net	NE	1,226	176	16.3%	12.2%
	111	1,509	247	20.1%	15.0%
	Subtotal	2,735	303	36.3%	27.2%
Purse seine	104	33	32	0.4%	0.3%
	110	25	17	0.3%	0.2%
	112	116	49	1.5%	1.2%
	Subtotal	174	62	2.3%	1.7%
Estimated commercial harvest		7,321	489	97.8%	72.9%
Estimated sport harvest		204	78	2.2%	2.0%
Total harvest		7,525	495	100.0%	74.9%
Escapement		2,522	1,348		25.1%
Return		10,047	1,436		100.0%

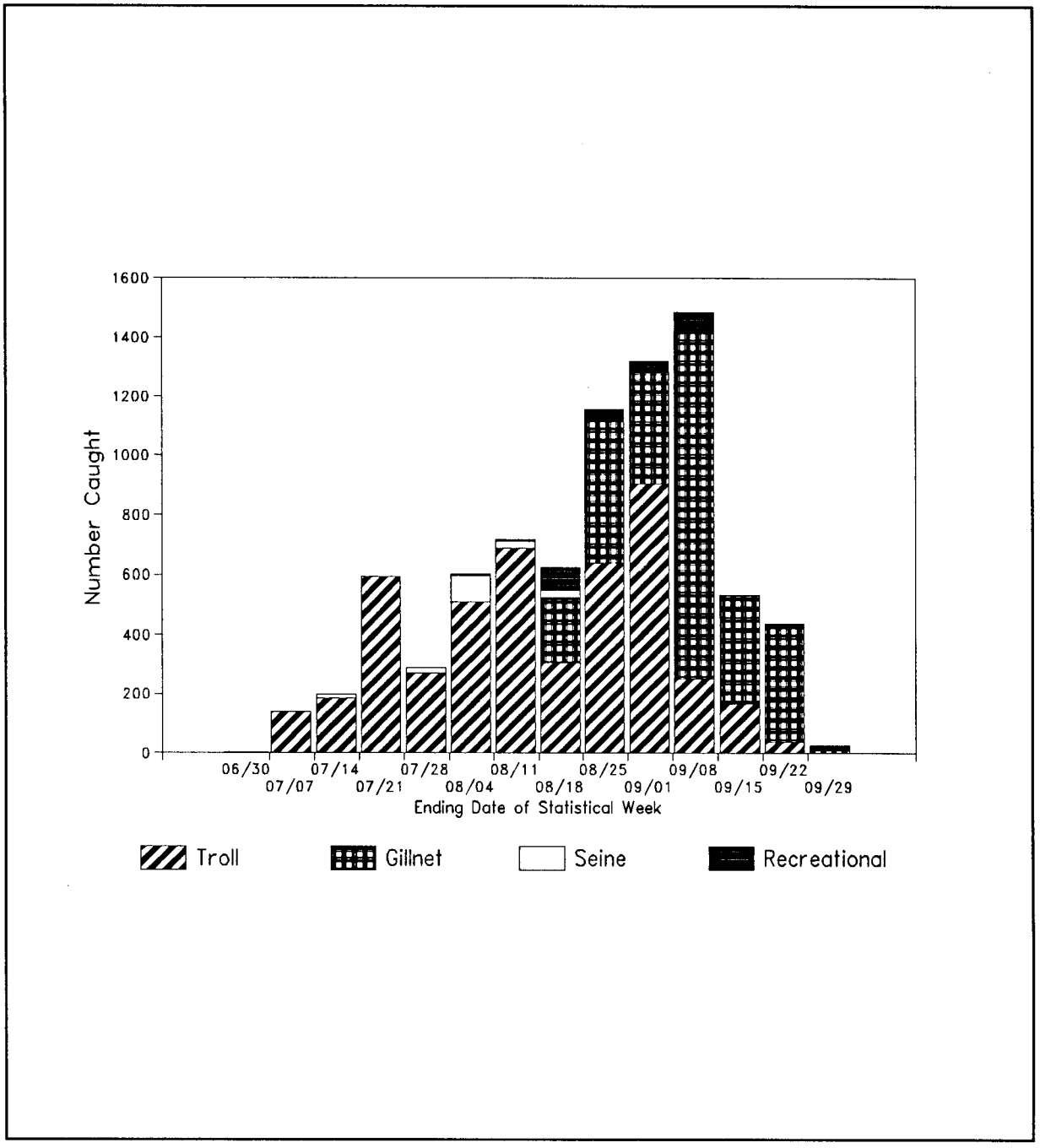

Figure 3. Estimated harvest of coho salmon bound for Yehring Creek, Taku River drainage, Alaska in the troll, drift gill net, purse seine, and recreational fisheries by statistical week, 1990.

$$\hat{N} = \frac{(9,951+1)\ (904+1)}{(116+1)} - 1 = 76,979\ (SE = 6,574)$$

where M = 9,951, the number of smolt adipose fin clipped in 1989; C = 904, the number of adults inspected for marks in 1990; and R = 116, the number of adults that had missing adipose fins.

The ocean survival rate for this cohort is the number of returning adults divided by the number of smolt in the cohort: 10,047/76,979 = 13% (SE = 2%).

Straying of Adults:

The experiment to estimate the amount of straying of adults was to be tested by comparing the CWT tag ratio in samples of fish from the smolt migration and from the adult migration. The test was not conducted, because of a failure of the smolt abundance estimate conducted in spring 1989. The abundance of smolt in 1989 was 76,979 (see above) as estimated from the number of fish with clipped adipose fins observed at the Yehring Creek weir. This estimate is significantly different ($P < 0.05$) from the estimate of smolt abundance (24,577 [SE = 1,276]) conducted in spring 1989 (Elliott and Sterritt 1990). We believe the estimate based on the mark ratio of adult populations to be correct because it is similar to the estimates of 77,761 (SE = 7,850) smolt in 1987 (Elliott et al. 1988) and 79,568 (SE = 4,540) smolt in 1988 (Elliott and Sterritt 1989). We speculate that the spring 1989 mark-recapture experiment failed because (1) a large number of smolt may have wintered below the lower fyke net station and were not included in the mark-recapture experiment, and (2) the mark-recapture experiment was flawed due to non-random distribution of marked fish or marked fish being released in a way that caused high rates of recapture.

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APPENDIX A

Appendix A1. Chronology of the marking and counting of coho salmon at Yehring Creek, Taku River drainage, Alaska, 1990.

Aug 29–Sept 16	Number of fish tagged and released at weir	313
Sept 15–16	Weir breached	
Sept 17	Number of fish tagged and released at weir	31
Sept 17	Begin 1st mark–recapture experiment	
	1st upstream sampling event	
	Unmarked fish caught and given tags	88
	Number of fish captured that were marked at weir 8/29–9/16	26
Sept 18	Number of fish tagged at weir	5
Sept 18	2nd upstream sample event of 1st experiment	
	Number of fish that were unmarked and given tags	34
	R w,2; Number of fish that had been tagged at weir 8/29–9/16	16
	R1,2; Number captured in 1st sample event and recaptured in 2nd	11
Sept 19–Sept 22	Number of fish tagged and released at weir	406
Sept 23–25	Water high, trap closed, weir breached.	
Sept 26	Number of fish tagged and released at weir	22
Sept 27	Second mark–recapture experiment, 1st sample event	
	Number of unmarked fish captured, tagged and released	25
	Number of fish recaptured that were tagged at weir 8/29–9/16	3
	Number of fish recaptured that were tagged at weir 9/17–2/27	6
	Number of fish that were tagged in estimate 9/17–9/18	1
Sept 28	Second experiment, 2nd sampling event	
	Water rises again, experiment abandoned.	
Sept 28–Oct 2	Number of fish tagged and released at weir	127
Oct 3–Oct 16	Number of fish marked at weir	0
	Water low, migration is over.	
Oct 3	Third mark–recapture experiment, 1st sampling event	
	Mi; Number of fish that were unmarked and given a tag	60
	Rw,1; No. fish recaptured that were tagged at weir 8/29–9/16	5
	Rw,1; No. fish recaptured that were tagged at weir 9/17–9/27	20
	Rw,1; No. fish recaptured that were tagged at weir 9/28–10/2	9
	No. fish recaptured that were tagged on 9/17 capture sample	1
	No. fish recaptured that were tagged in 9/18 recapture sample	0
	No. fish recaptured that were tagged in 9/27 capture sample	0
	No. fish recaptured that had lost their tags	2
Oct 4	Third experiment; 2nd sampling event	
	Number of fish that were untagged	38
	Rw,2; No. fish recaptured that were tagged at weir 8/29–9/16	5
	No. fish marked at weir on 9/15, recaptured on 9/27	1
	Rw,2; No. fish recaptured that were tagged at weir 9/17–9/27	16
	Rw,2; No. fish recaptured that were tagged at weir 9/28–10/2	12
	No. fish recaptured that were tagged in 9/17 capture sample	3
	No. fish recaptured that were tagged in 9/27 capture sample	2
	R1,2; No. fish recaptured that were tagged in 10/3 capture sample	7
	R1,2; No. fish tagged on 9/27 capture sample, recaptured on 10/3	1

–continued–

Appendix A1. (Page 2 of 2).

Oct 5-Oct 7	Number marked at weir	0
Oct 8	High water - pickets pulled	
Oct 9	Water drops - pickets re-installed	
Oct 10	4th Jolly Seber est; 1st sample event	
	Number of fish that were unmarked and given a tag	50
	Number of fish recaptured that were marked at weir 8/29-9/16	4
	Number of fish recaptured that were marked at weir 9/17-9/27	10
	Number of fish recaptured that were marked at weir 9/28-10/2	2
	Number of fish recaptured that were marked in the 9/17 capture even	1
	Number of fish recaptured that were marked in 9/27 capture event	2
	Number of fish recaptured that were marked in 10/3 capture event	3
	Number of fish recaptured that were marked in 10/4 recapture event	1
	Multiple recaptures[a]	2
Oct 11	4th Jolly Seber est; 2nd sampling event	
	Number of fish without tags	64
	Number of fish recaptured that were marked at weir 8/29-9/16	1
	Number of fish recaptured that were marked at weir 9/17-9/27	10
	Number of fish recaptured that were marked at weir 9/28-10/2	5
	Number of fish recaptured that were marked in 9/17 capture event	4
	Number of fish recaptured that were marked in 10/3 capture event	1
	Number of fish recaptured that were marked in 10/4 recapture event	2
	Number of fish recaptured that were marked in 10/10 capture event	7
	Multiple recaptures[b]	6

[a] 1. #427 tagged at weir, 9/22; recaptured 10/4 in recapture sample.
2. #553 marked at weir 9/27; recaptured 9/27 capture sample, recaptured in 10/4 recapture sample.

[b] 1. #273 marked at weir, 9/21; recaptured 10/3 in capture sample.
2. #421 marked at weir 9/22; captured in 10/3 capture sample.
3. #427 tagged at weir, 9/22; recaptured 10/4 in recapture sample; recaptured 10/10 in capture sample.
4. #541 marked 9/27 at weir; recaptured 10/3 capture sample.
5. #581 marked 9/27 at weir; recaptured in 10/4 recapture sample.
6. #621 marked at weir 9/28; recaptured in 10/4 recapture sample.

Appendix A2. Mark-recapture data used to estimate recruitment of coho salmon at Yehring Creek weir, Taku River drainage, Alaska, during three breaches of the weir caused by freshets in 1990.

Time of last capture	Time of recapture				
	1	2	3	4	5
1	0	1	4	1	4
2	0	0	5	2	0
3	0	0	0	6	8
4	0	0	0	0	8
5	0	0	0	0	0
Marked	0	1	9	9	20
Unmarked	150	34	165	66	80
Caught	150	35	174	75	100
Released	150	35	174	75	100

Data summary statistics

sample (i)	# captured in time i later recaptured			#captured as marked in i			# captured in i and not recaptured later		
	marked	unmarked	r(i) total	marked in i-1	unmarked in i-1	total	marked	not-marked	total
1	0.	0.	10.	0.	0.	0.	0.	0.	0.
2	0.	0.	7.	0.	0.	1.	0.	0.	0.
3	0.	0.	14.	0.	0.	9.	0.	0.	0.
4	0.	0.	8.	0.	0.	9.	0.	0.	0.
5	0.	0.	0.	0.	0.	20.	0.	0.	0.

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Appendix A2. (Page 2 of 2).

Period	--Survival rate estimates between sampling periods-- PHI	SE(PHI)	SE'(PHI)	95% Conf. interv.	COV(PHI(i,i-1)	Interval length	Survival rate est. PHI	SE(PHI)
1	0.2767	0.1299	0.1246	0.0221-0.5312		237.0000	0.9946	0.0020
2	1.1333	0.5396	0.5413	0.0758-2.1909	-.0349714286	336.0000	1.0004	0.0014
3	0.4227	0.1843	0.1818	0.0615-0.7840	-.0283441719	96.0000	0.9911	0.0045
Mean	0.6109	0.1547	0.1545	0.3077-0.9141			0.9953	0.0015

Period	M	SE'(M)	95# Conf. interval	N	SE(N)
2	41.50	18.69	4.86-78.14	747.00	782.97
3	90.67	37.03	18.08-163.25	1586.67	806.25
4	110.33	44.67	22.78-197.88	838.53	420.05
Mean	80.83	20.32	41.01-120.66	1057.40	400.01

Period	M	SE'(p)	95# Conf. interval	B	SE(B)
2	0.0241	0.0260	-0.0269-0.0751	740.07	997.07
3	0.0993	0.0506	0.0002-0.1983	167.80	405.15
4	0.0816	0.0414	0.0003-0.1628		
Mean	0.0683	0.0017	0.0783-0.0848	453.93	462.25

Appendix A3. Estimated commercial harvest of coho salmon bound for Auke Creek, Juneau, Alaska in 1990 by statistical week and period. The coded wire tag code was 42854. There were 697 adults in the escapement; all were examined for clipped adipose fins and 678 had clips for a tagging fraction of 0.9727 (SE = 0).

Stat. week	Period	Date	Quad.	Dist.	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Est. Catch	SE
Troll fishery by statistical week													
27	5	01 Jul-07 Jul	SE	-	15,821	4,786	1	87	87	102	97	4	3
28	5	08 Jul-14 Jul	NW	-	60,354	11,791	2	149	149	182	181	11	7
28	5	08 Jul-14 Jul	SW	-	55,561	19,550	1	245	244	299	293	3	2
29	5	15 Jul-21 Jul	NW	-	117,145	18,884	4	275	274	328	328	26	12
29	5	15 Jul-21 Jul	SW	-	73,095	26,834	1	309	309	381	369	3	2
30	5	22 Jul-28 Jul	NW	-	96,724	23,834	2	270	270	339	337	8	5
30	5	22 Jul-31 Dec	SW	-	51,021	16,281	1	189	189	223	224	3	3
31	6	29 Jul-04 Aug	NW	-	171,901	41,651	10	593	592	717	711	43	12
32	6	05 Aug-11 Aug	NW	-	128,453	29,571	10	451	451	531	524	45	13
33	6	12 Aug-18 Aug	NW	-	107,494	38,910	9	581	581	678	671	26	7
33	6	12 Aug-18 Aug	SW	-	19,819	9,209	1	163	163	191	190	2	2
34	7	19 Aug-25 Aug	NE	-	13,704	1,213	1	14	14	18	16	13	13
34	7	19 Aug-25 Aug	NW	-	76,153	10,444	8	184	184	214	214	60	20
35	7	26 Aug-01 Sep	NE	-	17,985	3,904	1	62	62	72	72	5	4
35	7	26 Aug-01 Sep	NW	-	137,456	30,252	39	497	496	588	578	186	26
35	7	26 Aug-01 Sep	SE	-	32,395	7,113	1	159	159	191	188	5	4
36	7	02 Sep-08 Sep	NW	-	80,160	14,088	17	175	175	256	204	125	28
37	7	09 Sep-15 Sep	NE	-	6,437	3,027	3	66	66	71	71	7	3
37	7	09 Sep-15 Sep	NW	-	60,537	19,200	22	385	385	461	429	77	14
38	7	16 Sep-22 Sep	NW	-	15,532	11,391	6	197	197	225	222	9	2
Subtotal					1,337,747	341,933	140	5,051	5,047	6,067	5,919	658	53
Troll fishery by period													
27-30	5	01 Jul-28 Jul	NW	-	304,404	58,379	8	751	750	910	907	43	14
27-30	5	01 Jul-28 Jul	SE	-	66,278	23,028	1	394	394	477	465	3	2
27-30	5	01 Jul-28 Jul	SW	-	210,872	73,792	3	843	842	1,045	1,012	9	4
31-33	6	29 Jul-18 Aug	NW	-	407,848	110,132	29	1,625	1,624	1,926	1,906	112	18
31-33	6	29 Jul-18 Aug	SW	-	99,994	27,675	1	404	403	486	480	4	3
34-39	7	19 Aug-29 Sep	NW	-	369,838	85,375	90	1,438	1,437	1,744	1,647	425	40
34-39	7	19 Aug-29 Sep	NE	-	49,782	10,401	5	178	178	205	203	25	10
34-39	7	19 Aug-29 Sep	SE	-	106,265	22,712	1	449	449	538	529	5	4
Subtotal					1,615,281	411,494	138	6,082	6,077	7,331	7,149	626	49

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Appendix A3. (Page 2 of 2).

Stat. week	Period	Date	Quad.	Dist.	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Est. Catch	SE
Drift gill net fishery													
35	-	26 Aug-01 Sep	-	115	12,530	2,976	2	23	23	26	26	9	5
36	-	02 Sep-08 Sep	-	115	15,707	4,921	1	48	48	52	52	3	3
37	-	09 Sep-15 Sep	-	111	7,538	1,441	2	49	49	56	56	11	7
37	-	09 Sep-15 Sep	-	115	18,382	4,579	4	65	65	68	68	17	7
38	-	16 Sep-22 Sep	-	111	8,000	1,084	1	39	39	44	44	8	7
38	-	16 Sep-22 Sep	-	115	9,257	1,825	1	78	78	83	83	5	5
Subtotal					71,414	16,826	11	302	302	329	329	53	15
Purse seine fishery													
31	-	22 Jul-28 Jul	-	112	1,571	545	1	5	4	5	5	4	3
33	-	05 Aug-11 Aug	-	112	5,100	1,462	2	13	13	15	15	7	4
34	-	12 Aug-18 Aug	-	109	900	1,142	1	6	6	10	10	1	1
Subtotal					7,571	3,149	4	24	23	30	30	12	6
Canadian troll			NTR				1					5	
Total commercial harvest					1,694,266	431,469	154	6,408	6,402	7,690	7,508	696	50

Recreational harvest

Date	Bi-wk	Sample stratum	Estimated harvest	SE[N]	Number sampled	mc Tags	SE[mc]	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	Estimated Harvest	Approx. SE[n1]	Approx. V[n1]
7-16 - 7-29-90	15	MBHLH	782	89	201	1	0.864452	3	3	3	3	4	3	12
8-13 - 8-26-90	17	MBHLH	3,806	311	1,212	1	0.893255	18	17	21	20	4	3	10
8-13 - 8-26-90	17	TFHC	10	10	10	2	0.230289	2	2	2	2	2	2	4
8-27 - 9-09-90	18	MBHLH	3,303	482	957	8	2.396272	31	31	39	37	30	10	98
9-10 - 9-23-90	19	MBHEW	441	293	31	1	0.962305	4	4	4	4	15	14	205
9-10 - 9-23-90	19	MBHLH	226	172	39	1	0.905590	3	3	3	3	6	6	33
Total			8,568		2,450	14		61	60	72	69	61	39	362 (SE = 19)

Appendix A4. Data used to bootstrap the 1990 age-.1 coho salmon escapement to Chilkoot Lake, near Haines Alaska.

Year	Number escaping in hiatus	Escapement	Proportion counted	Count/p_e
1976	49	946	0.9482	1,032
1978	147	1,035	0.8580	1,141
1979	136	899	0.8487	1,154
1983	81	1,839	0.9560	1,024
1985	258	2,188	0.8821	1,110
1986	368	1,951	0.8114	1,207
1989	48	3,830	0.9875	991

Appendix A5. Estimated harvest of coho salmon bound for Yehring Creek, Taku River drainage, Alaska by statistical week and period in 1990. The coded wire tag codes were: 42855, 42836, and 4270. There were an estimated 2,522 adults in the escapement; 904 were examined for marks and 116 marks were observed for a tagging fraction of 0.1283 (SE = 0.0086).

Stat. week	Period	Date	Quad	Dist	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Est. Catch	SE
Troll fishery by statistical week													
26	4	24 Jun-30 Jun	NE	-	146	522	1	4	4	5	5	2	2
27	5	22 Jul-28 Jul	NE	-	4,105	1,905	1	19	19	28	27	17	17
27	5	29 Jul-04 Aug	NW	-	30,181	3,870	2	57	57	61	61	122	85
28	5	08 Jul-14 Jul	NW	-	60,354	11,791	4	149	149	182	181	160	79
28	5	08 Jul-14 Jul	SW	-	55,561	19,550	1	245	244	299	293	23	22
29	5	15 Jul-21 Jul	NE	-	17,377	6,514	4	86	85	108	108	84	41
29	5	15 Jul-21 Jul	NW	-	117,145	18,884	10	275	274	328	328	485	152
29	5	15 Jul-21 Jul	SW	-	73,095	26,834	1	309	309	381	369	22	21
30	5	22 Jul-28 Jul	NE	-	19,957	3,521	1	42	42	50	49	45	45
30	5	22 Jul-28 Jul	NW	-	96,724	23,834	7	270	270	339	337	223	83
31	6	29 Jul-04 Aug	NE	-	28,353	5,220	2	76	76	87	87	85	59
31	6	29 Jul-04 Aug	NW	-	171,901	41,651	13	593	592	717	711	422	115
32	6	05 Aug-11 Aug	NE	-	25,763	5,946	1	94	94	106	106	34	33
32	6	05 Aug-11 Aug	NW	-	128,453	29,571	19	451	451	531	524	652	147
33	6	12 Aug-18 Aug	NW	-	107,494	38,910	14	581	581	678	671	305	79
34	7	19 Aug-25 Aug	NE	-	13,704	1,213	3	14	14	18	16	297	169
34	7	19 Aug-25 Aug	NW	-	76,153	10,444	6	184	184	214	214	341	138
35	7	26 Aug-01 Sep	NE	-	17,985	3,904	1	62	62	72	72	36	35
35	7	26 Aug-01 Sep	NW	-	137,456	30,252	24	497	496	588	578	866	174
36	7	02 Sep-08 Sep	NW	-	80,160	14,088	4	175	175	256	204	223	110
36	7	02 Sep-08 Sep	SE	-	22,276	6,510	1	136	136	165	164	27	26
37	7	09 Sep-15 Sep	NE	-	6,437	3,027	2	66	66	71	71	33	23
37	7	09 Sep-15 Sep	NW	-	60,537	19,200	5	385	385	461	429	132	58
38	7	16 Sep-22 Sep	NE	-	2,917	859	1	15	15	18	18	26	26
38	7	16 Sep-22 Sep	NW	-	15,532	11,391	1	197	197	225	222	11	10
Subtotal					1,369,766	339,411	129	4,982	4,977	5,988	5,845	4,673	437

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Appendix A5. (Page 2 of 3).

Stat. week	period	Date	Quad	Dist	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Est. Catch	SE
Troll fishery by period													
25-26	4	17 Jun-30-Jun	NE	-	848	553	1	4	4	5	5	12	11
27-30	5	01 Jul-28-Jul	NW	-	304,404	58,379	23	751	750	910	907	939	193
27-30	5	01 Jul-28-Jul	NE	-	55,265	17,216	6	203	202	259	257	152	61
27-30	5	01 Jul-28-Jul	SW	-	210,872	73,792	2	843	842	1,045	1,012	46	32
31-33	6	29 Jul-18-Aug	NW	-	407,848	110,132	46	1,625	1,624	1,926	1,906	1342	194
31-33	6	29 Jul-18-Aug	NE	-	62,252	14,103	3	226	226	260	260	103	59
34-39	7	19 Aug-29-Sep	NW	-	369,838	85,375	40	1,438	1,437	1,744	1,647	1431	223
34-39	7	19 Aug-29-Sep	NE	-	49,782	10,401	7	178	178	205	203	264	98
34-39	7	19 Aug-29-Sep	SE	-	106,265	22,712	1	449	449	538	529	37	36
Subtotal					1,567,374	392,663	129	5,717	5,712	6,892	6,726	4,326	379
Drift gill net fishery													
33	-	05 Aug-11 Aug	-	111	6,947	2,448	10	34	34	38	38	221	68
34	-	19 Aug-25 Aug	-	111	9,684	1,991	13	37	37	42	42	493	135
35	-	26 Aug-01 Sep	NE	-	22,743	6,824	15	60	60	71	71	390	99
36	-	02 Sep-08 Sep	NE	-	29,553	8,820	32	114	114	140	140	836	146
37	-	09 Sep-15 Sep	-	111	7,538	1,441	9	49	49	56	56	367	121
38	-	16 Sep-22 Sep	-	111	8,000	1,084	7	39	39	44	44	403	151
39	-	23 Sep-29 Sep	-	111	796	493	2	40	40	40	40	25	17
Subtotal					85,261	23,101	88	373	373	431	431	2,735	303

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Appendix A5. (Page 3 of 3).

Stat. week	Period	Date	Quad	Dist	N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Est. Catch	SE
Purse seine fishery													
28	-	08 Jul-14 Jul	-	112	208	115	1	1	1	1	1	14	1
30	-	22 Jul-28 Jul	-	112	999	419	1	4	4	4	4	19	19
31	-	29 Jul-04 Aug	-	112	1,571	545	2	5	4	5	5	56	37
31	-	05 Aug-04 Aug	-	104	45,060	10,795	1	158	158	187	183	33	32
32	-	05 Aug-11 Aug	-	110	400	254	2	3	3	3	3	25	17
33	-	12 Aug-18 Aug	-	112	5,100	1,462	1	13	13	15	15	27	26
Subtotal					53,338	13,590	8	184	183	215	211	174	62
Canadian troll fishery northern troll							2					86	
Total commercial harvest					1,705,973	429,354	227	6,274	6,268	7,538	7,368	7,321	489

Recreational harvest

Date	Bi-wk	Sample stratum	Estimated harvest	SE[N]	Number sampled	mc Tags	SE[mc]	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1 Estimated Harvest	Approx. SE[n1]	Approx. V[n1]
7-30 - 8-12-90	16	DE	1,168	0	1,123	2	1.315420	9	9	12	12	16	11	114
7-30 - 8-12-90	16	MBHLH	3,133	588	782	2	1.376541	12	12	17	14	76	53	2,830
8-13 - 8-26-90	17	MBHLH	3,806	311	1,212	1	0.974537	18	17	21	20	27	27	703
8-27 - 9-09-90	18	MBHLH	3,303	482	957	3	1.695037	31	31	39	37	85	49	2,414
Total			11,410		4,074	8		70	69	89	83	204		6,061 (SE=78)