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A Mark-Recapture Experiment to Estimate the Escapement of Coho Salmon in Steep Creek, 1994

by

Scott A. McPherson,

Brian J. Glynn,

and

Edgar L. Jones III

October 1996

Alaska Department of Fish and Game

Division of Sport Fish

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
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
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
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

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	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
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.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
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
standard length	SL
total length	TL
variance	Var

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Scott A. McPherson,
Brian J. Glynn,
and
Edgar L. Jones III
Division of Sport Fish, Douglas

Alaska Department of Fish and Game
Division of Sport Fish
333 Raspberry Road
Anchorage, AK 99518-1599

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Scott A. McPherson, Brian J. Glynn, and Edgar L. Jones III
Alaska Department of Fish and Game, Division of Sport Fish
P. O. Box 240020, Douglas, AK 99824-0020, USA

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ABSTRACT

A mark-recapture experiment was used to estimate total escapement of coho salmon *Oncorhynchus kisutch* returning to Steep Creek, a tributary of Mendenhall Lake located in the upper Mendenhall River drainage near Juneau, Alaska. Two hundred sixty-two coho salmon were captured in beach seines between 29 September and 21 October. All were marked with uniquely numbered anchor tags and given a secondary mark consisting of an upper opercle punch. Between 7 October and 10 November, 416 fish on the spawning grounds were inspected for marks and 118 (28%) were marked. A Darroch model was used to estimate a total escapement of 952 (SE = 68) coho salmon. As part of regular escapement monitoring activities, five foot surveys were conducted between 23 September and 3 November to count the number of coho salmon observed in a single day at Steep Creek. The peak observer count was 200 (14 October), representing 21% of the total escapement.

Key words: Coho salmon, *Oncorhynchus kisutch,* Steep Creek, Mendenhall Lake, Mendenhall River, mark-recapture, escapement, observer, index expansion.

INTRODUCTION

Streams on the Juneau road system, along with the Taku River and Gastineau hatchery stocks, produce most of the coho salmon *Oncorhynchus kisutch* harvested by recreational fisheries in the Juneau area. In 1993, Juneau anglers spent 140,000 days to harvest an estimated 30,428 coho salmon (Mills 1994). To help manage these fisheries, indices of observer counts of coho salmon escapement have been obtained annually since 1980 in five roadside streams—Montana, Steep, Jordan, Switzer, and Peterson creeks (Figure 1). However, because these indices are not correlated with total escapement (those fish that successfully reach the stream to spawn over the entire season), management of fisheries to attain precise escapement goals has not been possible.

As a first step in developing escapement goals, Clark (1995) applied spawner-recruit models to the index data and estimated index goals for the five streams; he found that a harvestable surplus is available in some. To evaluate these models and provide accurate estimates of total escapement, we developed a program to estimate total escapement of coho salmon in the five roadside streams and compare those values to indices obtained from observer counts.

Past studies indicated that it would be difficult if not impossible to accurately count immigrating coho salmon, as breaches in weirs caused by floods allow uncounted fish to escape upstream. Since these circumstances usually required a mark-recapture experiment to estimate the number of fish lost, it seems appropriate and cost effective to dispense with the weir and use a mark-recapture experiment to estimate the total escapement.

We designed a pilot study that used mark-recapture methods to estimate total escapement of coho salmon and chose Steep Creek, one of the five Juneau roadside streams, for our initial experiment. The stream is small and easily accessible by road and thus an ideal study site.

Our objectives in 1994 were:

1) to estimate the total escapement of coho salmon in Steep Creek;
2) to estimate the largest fraction of total escapement in an observer count; and
3) to estimate the age and length composition of coho salmon spawning in Steep Creek in 1994.

METHODS

ESCAPEMENT ESTIMATE

A mark-recapture experiment was used to estimate the total escapement of coho salmon to Steep Creek in 1994 (Figure 2). A beach seine 60 feet long and 10 feet deep was used to capture fish in location 4, a pool located near the mouth of Steep

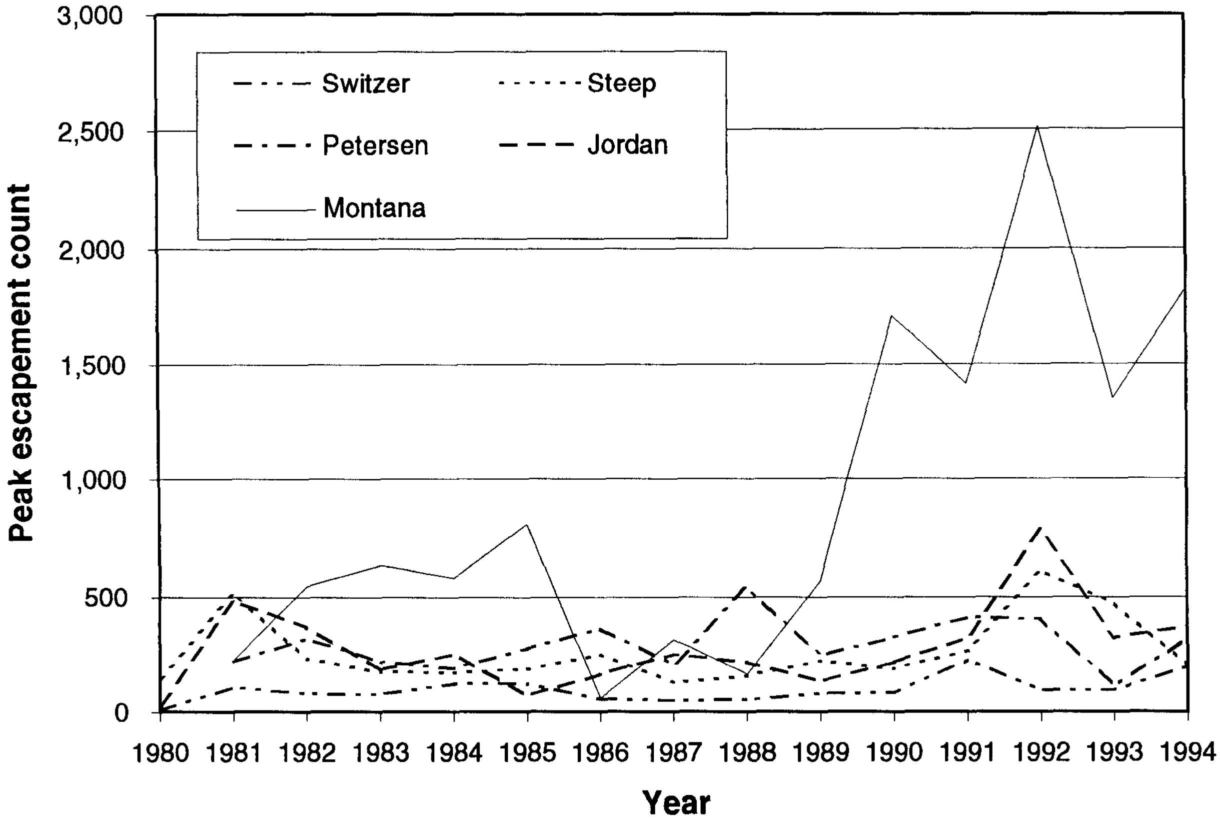

Figure 1.–Peak observer counts of coho salmon in Jordan, Montana, Peterson, Steep, and Switzer creeks from 1980 to 1994.

Creek. Location 4 is at the lowest portion of the stream where little spawning occurs and is primarily a milling site for fish which will eventually spawn further upstream. It is also the downstream end of the escapement survey area.

Fish were marked on four separate occasions spaced one week apart on 29 September and 7, 14, and 21 October. Catch effort consisted of one seine haul and was consistent for each of the weekly marking sessions. Each fish captured was inspected for a previous mark and, if one was found, was released without further sampling. Each fish without a previous mark was given a Floy T-Bar anchor tag just posterior of the dorsal fin and a secondary mark by punching a ¼-inch-diameter hole with a paper punch in the upper third of the left operculum (UOP). The tag number and condition of the fish were recorded before release, except that condition was not noted for individual fish during the first marking event. Definitions for condition were:

1) **bright**, for a fish that was ocean bright or nearly ocean bright;
2) **semi-bright**, for a fish with some color (primarily blush red), but not completely dark;
3) **dark**, for a fish of very dark color (primarily red);
4) **ragged**, for a fish with worn fins or rough texture, but not yet spawned;
5) **spawn**, for a fish spawned out but not yet dead;
6) **dead**, for a carcass; and
7) **mortality**, for a dead, but not spawned fish.

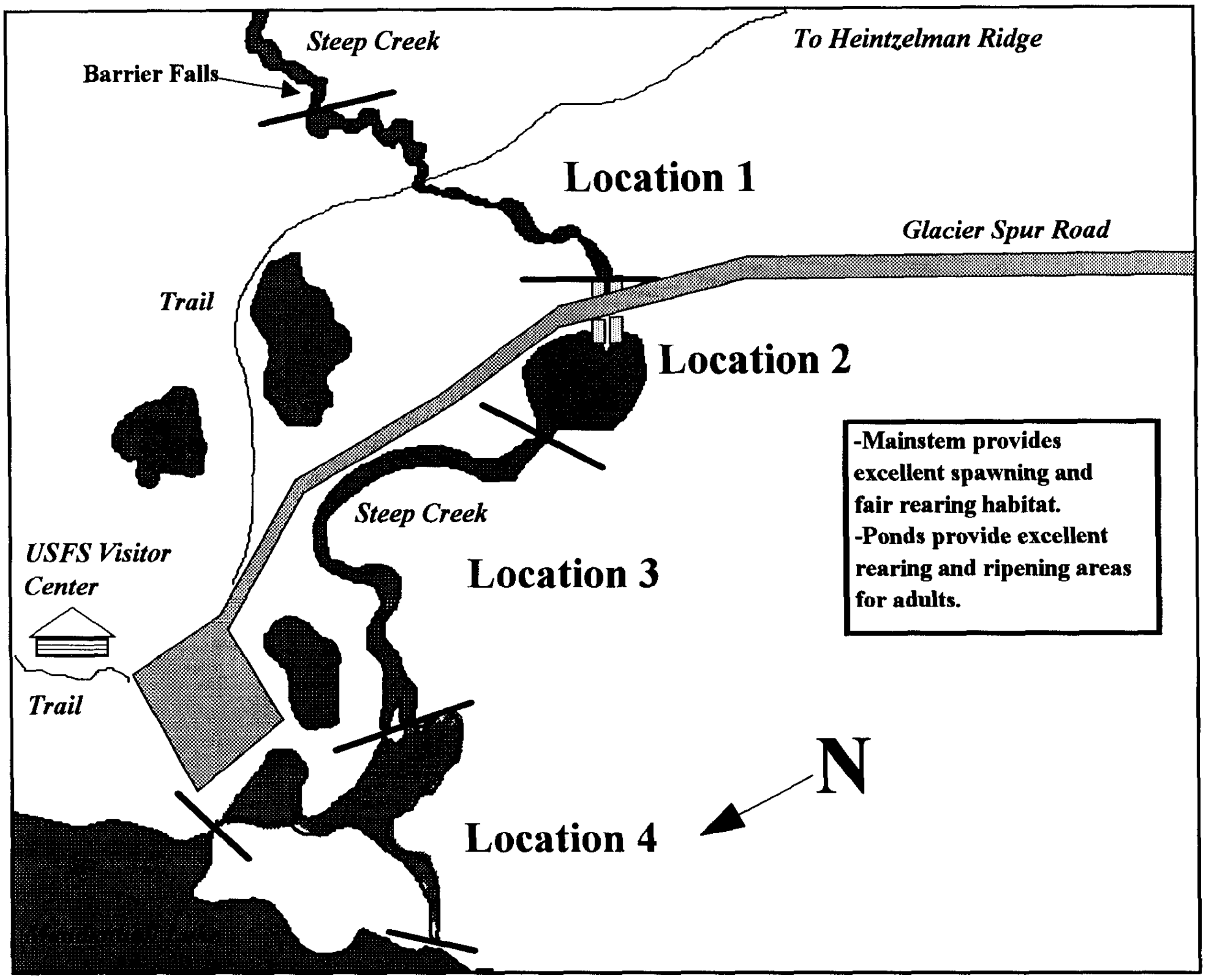

Figure 2.–Drawing of Steep Creek depicting the general stream features and locations 1-4.

Tag recovery began one week after the first marking session and was conducted once each week for six weeks from 7 October to 10 November.

The stream was divided into four areas for recovery sampling: locations 1 through 4 (see Figure 2). Location 1 extended from the barrier falls downstream to a pool just below Glacier Spur Road; this pool was designated as location 2. Location 3 was the stream reach between locations 2 and 4. At locations 1 and 3, fish were captured by dip net. In the deep pools at locations 2 and 4, live fish were captured primarily with the beach seine; while spawners in shallow water areas were captured by dip net. All carcasses that could be retrieved were also inspected for marks. Locations 1, 2 and 3 were sampled in all six weekly periods, and location 4 only during the latter three periods, after marking was finished. To promote proportional sampling, each recovery location was sampled as thoroughly as possible and with consistent effort throughout the six periods—with one exception: it was not possible to use the beach seine at locations 2 and 4 on the last recovery date, because the ponds had iced over.

Each captured fish was inspected for an anchor tag and an opercle punch on the upper third of the left opercle (UOP) and then given a punch on the lower third of the left operculum (LOP) to prevent duplicate sampling at a later date. If an anchor tag was present, the tag number and condition of the fish was recorded. If a UOP was present, but not the anchor tag, the fish was recorded as a valid tag recovery (indicating the anchor tag was shed). If an LOP was present the fish was disregarded as having been previously sampled.

Calculations of abundance were performed using a program written by Mike Wallendorf (ADF&G Sport Fish, Fairbanks, personal communication) which uses the log-likelihood of Darroch's (1961) model given by

$$\hat{N} = \mathbf{n}'\mathbf{M}^{-1}\mathbf{a} \qquad (1)$$

where

- $\hat{N}$ is the population estimate,
- **n** is a vector of the number of salmon examined in each recovery location j,
- **M** is a matrix of m_{ij}, the number of tag recoveries in each recovery location j which were released in marking location i, and
- **a** is a vector of the number of marked salmon released per marking location i.

This model was used as an objective function for a numeric search of the maximum likelihood estimate of abundance. The observed information matrix was used to estimate the covariance, and the delta method (Seber 1982, pp.7–9) was used to approximate the variance of the population size estimate.

AGE, SEX AND SIZE

Fish at locations 1 and 3 that were captured and had already spawned were also sampled for scales, sex, and length. These fish were given a punch on the lower third of the right operculum to prevent sampling at a later date. Five scales were removed from the preferred area—three from 2 or 3 rows above the lateral line and taken 1″ apart, and two from 4 or 5 rows up and ½″ from one of the lower three on the left side (Scarnecchia 1979); all were mounted on gummed cards using methods described in (ADF&G 1993). The sample size was planned by using methodology in Thompson (1987). Sex was determined from secondary maturation characteristics. Length was taken as mid-eye to fork-of-tail to the nearest 5 mm.

Proportions by age or by sex in samples from spawning grounds were estimated by

$$\hat{p}_i = \frac{n_i}{n} \qquad (2)$$

with variance

$$v[\hat{p}_i] = \sqrt{\frac{\hat{p}_i(1-\hat{p}_i}{(n-1)}} \qquad (1)$$

where $\hat{p}_i$ is the proportion in the population in group i; n_i is the number in the sample of group i; and n is the sample size. The mean length of fish sampled was estimated by taking the sum of the lengths obtained and dividing by the total sample size obtained.

RESULTS

Two hundred sixty-two (n_1 = 262) healthy adult coho salmon were captured, marked and released at location 4 between 29 September and 21 October in four weekly marking events (Table 1). Sixty-seven percent (67%) of the marks were applied in the first two marking sessions. In Steep Creek, fish which entered the stream early in the season exhibited the behavior of milling longer in the marking location than those which entered the stream later in the season. As a result, the availability of fish at the marking location decreased with time.

Four hundred sixteen (n_2 = 416) coho salmon were captured and inspected during nine recovery events from 7 October to 11 November (Table 1). Ten percent (10%) of the sample were captured at location 1, 47% at location 2, 18% at location 3, and 25% at location 4. One hundred eighteen (m_2 = 118) marked fish were recovered amongst the four locations. The fractions of marked fish (m_2/n_2) at the upstream locations (1 and 2) were 0.24 and 0.21, respectively, values not significantly different

Table 1.–Marking and recovery data from Steep Creek coho salmon, 1994.

Date--Sampling event		n_1	n_2	m_2	m_2/n_2
9/29/94 Mark period #1	Location 1	-	-	-	-
	Location 2	-	-	-	-
	Location 3	-	-	-	-
	Location 4	92	-	-	-
	TOTAL	92	-	-	-
	Cumulative	92	-	-	-
10/07 + 10/10/94 Mark period #2 Recovery period #1	Location 1	-	15	2	0.13
	Location 2	-	67	*12	0.18
	Location 3	-	7	0	0.00
	Location 4	84	-	-	-
	TOTAL	84	89	14	0.16
	Cumulative	176	89	14	0.16
10/14 + 10/17 Mark period #3 Recovery period #2	Location 1	-	9	*3	0.33
	Location 2	-	53	7	0.13
	Location 3	-	18	10	0.56
	Location 4	66	-	-	-
	TOTAL	66	80	20	0.25
	Cumulative	242	169	34	0.20
10/21 Mark period #4 Recovery period #3	Location 1	-	6	2	0.33
	Location 2	-	28	*11	0.39
	Location 3	-	9	2	0.22
	Location 4	20	-	-	-
	TOTAL	20	43	15	0.35
	Cumulative	262	212	49	0.23
10/28 Recovery period #4	Location 1	-	10	3	0.30
	Location 2	-	16	*3	0.19
	Location 3	-	19	*8	0.42
	Location 4	-	73	*26	0.36
	TOTAL	-	118	40	0.34
	Cumulative	262	330	89	0.27
11/03 + 11/04 Recovery period #5	Location 1	-	1	0	0.00
	Location 2	-	30	7	0.23
	Location 3	-	6	2	0.33
	Location 4	-	29	12	0.41
	TOTAL	-	66	21	0.33
	Cumulative	262	396	110	0.28
11/11 Recovery period #6	Location 1	-	0	0	-
	Location 2	-	3	1	-
	Location 3	-	17	7	0.41
	Location 4	-	-	-	-
	TOTAL	-	20	8	0.40
	Cumulative	262	416	118	0.28

Unique fish handled = $(n_1+n_2-m_2)$ = 560

Totals by location	n_1	n_2	m_2	m_2/n_2
Location 1	0	41	10	0.24
Location 2	0	197	41	0.21
Location 3	0	76	29	0.38
Location 4	262	102	38	0.37
TOTAL	262	416	118	0.28

Location 1 is upstream and primarily spawning fish; location 2 is upstream and primarily prespawn fish; Location 3 is downstream and primarily spawning fish; location 4 is downstream and primarily prespawn fish
* One fish missing primary mark out of total.

(X^2 = 0.13, df = 1, P > 0.70). The fractions of marked fish at downstream locations (3 and 4) were 0.38 and 0.37, respectively, also not significantly different (X^2 = 0.01, df = 1, P > 0.90). However, when data from the upstream locations (1 and 2) were combined and compared to combined data from downstream locations (3 and 4), fractions were significantly different (X^2 = 6.92, df = 1, P < 0.01), indicating a higher probability of encountering a marked fish in the lower locations. The mark-recapture data by individual tag number are summarized in Appendix A1.

The mark-recapture data were stratified by time and location:

Mark time	Recapture period A	B	C	D	a_i
I	23	1	9	4	92
II	15	4	24	4	84
IV	4	2	9	7	66
VI	1	1	4	6	20
U_j	161	26	80	31	

where mark time corresponds to marking periods in location 4. The recapture period A corresponds to the sum of recoveries in locations 1 and 2 for 7–28 October; B relates to locations 1 and 2 for 3–11 November; C relates to locations 3 and 4 for 7–28 October; and D relates to locations 3 and 4 for 3–11 November.

As a first step in the calculation of escapement, the consistency of Chapman's (1951) nearly unbiased modification of the Petersen estimate (N^* = 921, n_1 = 262, n_2 = 416, m_2 = 118) was tested with methodologies described in Seber (1982, p. 438). A goodness-of-fit test of the hypothesis H_o:$\theta_{ij} = \theta_j$ for all I (t_3 = 13.49, p < 0.001) suggests that differences in the probability of movement among locations exist and that use of the pooled Petersen estimate is unsatisfactory. Therefore, using the method described by Mike Wallendorf (ADF&G Sport Fish, Fairbanks, personal communication), the final estimate of the total escapement of coho salmon in Steep Creek in 1994 is 952 (SE = 68), with capture probability estimates of 0.353, 1.000, 1.000, 0.244.

Five observer counts were made in Steep Creek in 1994:

- 37 fish were counted on 23 September,
- 125 fish on 12 October,
- 200 fish on 14 October,
- 152 fish on 20 October, and
- 118 fish on 3 November.

The peak observer count, 200 on 14 October, consisted of 23 fish in location 1, 45 fish in location 2, 17 fish in location 3 and 115 fish in location 4, and represented 21% of the estimated total escapement. This count (200) was midpoint in the escapement index goal range of 100 to 300 fish recently established for Steep Creek (Clark 1995; also see Table 2).

Age and length compositions collected from spawned-out fish in locations 1 and 3 were:

	Age class 1.1	2.1	3.0	3.1	Total
Sample size	52	68	4	6	130
Percent	40.0	52.3	3.1	4.6	
SE	4.3	4.4	1.5	1.8	
Avg. length	623	654	335	635	631
SE	7.3	4.9	4.1	13.1	6.2

One hundred forty (140) fish were sampled for scales, sex and length (AWL sampling) and 130 were aged, equating to an aged fraction of 93% (130/140).

Sex composition from spawned-out fish in locations 1 and 3 suggested that there were many more females (71%) than males. This bias was consistent between marked and unmarked fish in these locations; 35 marked fish were included in the 130 aged fish above, and, of those 35, 66% were females. Sex data, in addition to scale and length data, generally were not collected from prespawn fish in locations 2 and 4, which constituted the majority (72%) of

Table 2.–Peak observer counts of coho salmon in Jordan, Montana, Peterson, Steep, and Switzer creeks from 1980 to 1994.

Year	Jordan Creek	Montana Creek	Peterson Creek	Steep Creek	Switzer Creek	Total
1980	31	-	-	147	7	-
1981	482	227	219	515	109	1,552
1982	368	545	320	232	80	1,545
1983	184	636	219	171	80	1,287
1984	250	581	189	168	123	1,312
1985	72	810	276	186	122	1,466
1986	163	60	397	250	54	887
1987	251	314	204	128	48	945
1988	215	164	542	155	51	1,127
1989	133	566	242	222	78	1,241
1990	216	1,711	324	185	82	2,518
1991	322	1,415	410	267	227	2,641
1992	785	2,512	403	612	93	4,405
1993	322	1,352	112	471	94	2,351
Mean	271	838	297	265	89	1,791
SD	189	715	117	153	50	974
CV	70%	85%	40%	58%	57%	54%
Min	31	60	112	128	7	887
Max	785	2,512	542	612	227	4,405
1994	371	1,829	318	200	198	2,915
Escapement goal [a] range:						
Upper	200	500	350	300	75	
Lower	75	200	100	100	25	

[a] Escapement goals adopted by ADF&G, 9/15/94.

n_2 in the experiment. However, sex data were collected during one seine haul at location 2 on 4 November, and, of the 60 fish examined, 47 (78%) were males. Thus, it appears that the spawned-out fish sampled for AWL in locations 1 and 3 were biased towards females whereas pre-spawn fish at locations 2 and 4 were biased toward males. This indicated that females tended to remain at the spawning sites after spawning (die on redds) while males tended to float downstream out of the spawning areas, a phenomenon also observed for chinook salmon *O. tschawytcha* (Kissner 1985).

DISCUSSION

The current research project on Steep Creek is the start of a program to determine the relationship between peak observer counts and the total escapement of coho salmon in Southeast Alaska streams. In 1994, we estimated that 21% of the total escapement was counted during a peak observer count on 20 October in Steep Creek.

The general assumptions that must hold, if $\hat{N}$ is to be a suitable estimate of escapement, are listed in Seber (1982, p. 431) and McGregor et al. (1991, p. 7). These are usually listed as:

a) all coho salmon have an equal probability of being inspected for marks; and
b) there is no recruitment to the population between events; and
c) there is no mark-induced behavior; and
d) fish do not lose their marks and all marks are recognizable.

We found that only six marked fish, 5% of the 118 marked fish recaptured with a secondary mark, had actually lost their primary mark.

Marking did not appear to affect the behavior or movement of fish, as marked fish were observed spawning with or near unmarked fish throughout the entire project. For assumption *a*, probability of capture varied across locations, but not necessarily within locations—the probability of main concern.

The ratio of m_2/n_2 in the two upper locations (p = 0.22) was lower than the ratio in the two lower locations (p = 0.38). However, this ratio increased in the upper portion as the season progressed. This may be an indication that some fish bound for upper portions of the stream managed to evade marking efforts in the lower portion at location 4 (some had probably migrated past location 4 before marking began).

The number of unique fish inspected in the upper portion decreased as the season progressed, suggesting that fish which spawned early did so in the upper portions of the stream and those which spawned later did so in the lower portions (Figure 3). This is understandable, especially when water levels have a tendency to drop, later in the season, thus promoting spawning in the lower portions.

Similarly, the number of tag recoveries in the upper portion decreased throughout the marking effort; 57% of the marks applied on 29 September were recaptured later in the upper portion versus only 17% of the marks applied on 21 October (Figure 4).

Prior to 29 September, no carcasses were found within the study area indicating that spawning had not yet occurred. Emigration from the study area was considered insignificant. Recruitment into the

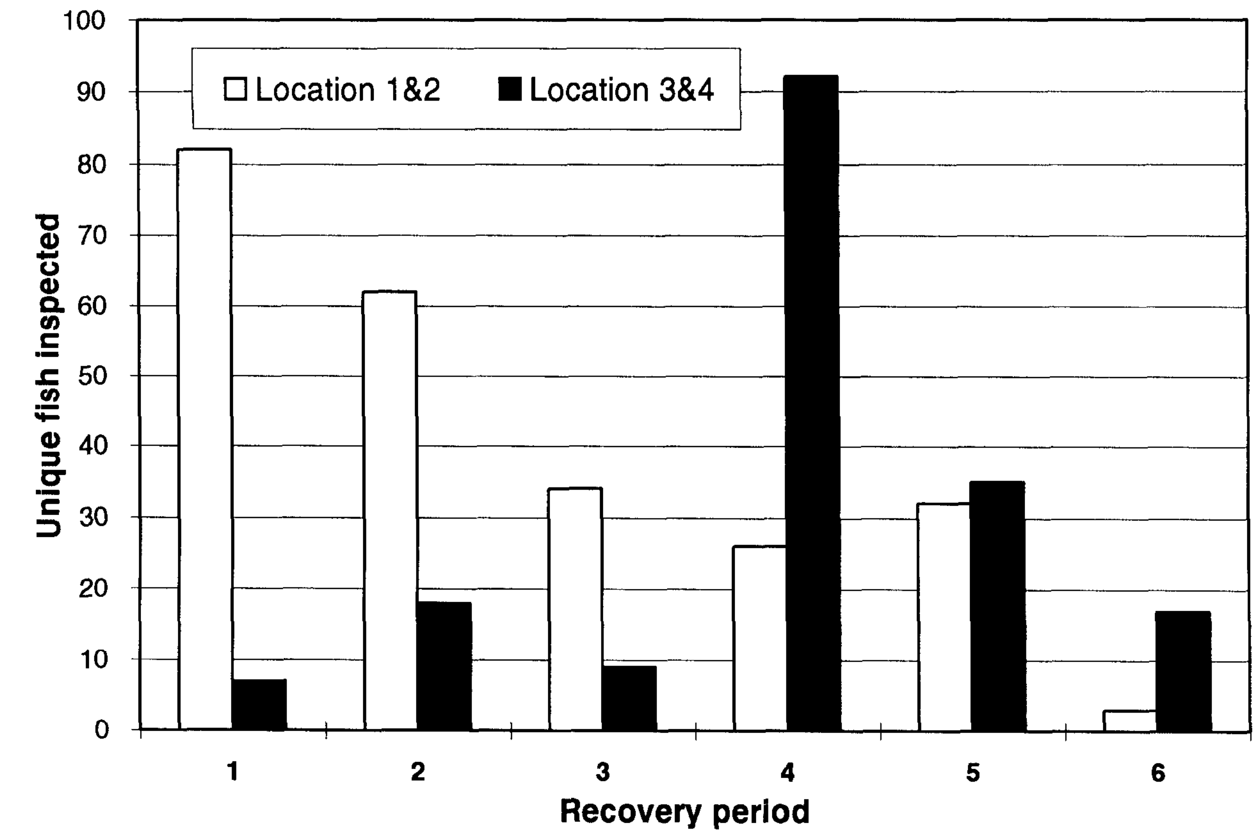

Figure 3.–Number of unique coho salmon sampled in locations 1 and 2 versus locations 3 and 4 in six recovery periods in Steep Creek in 1994.

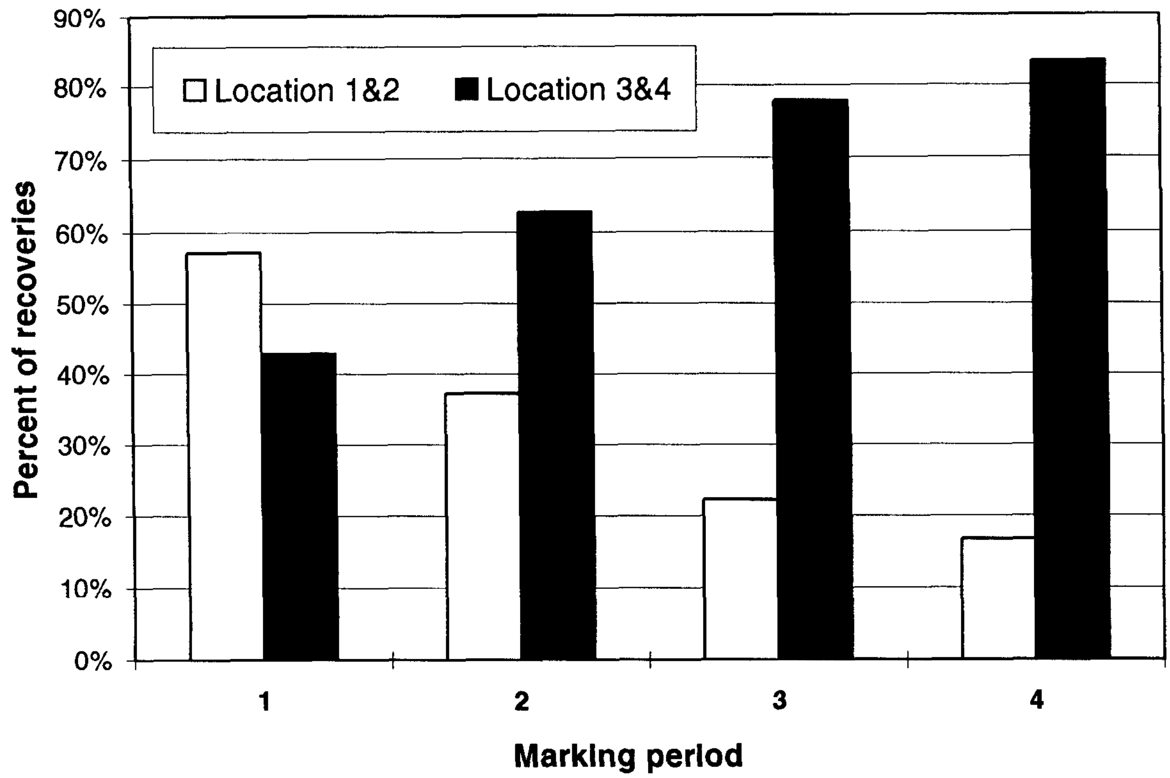

Figure 4.–Percent of recoveries in locations 1 and 2 versus locations 3 and 4 for each of four marking periods in Steep Creek in 1994.

study area occurred throughout the study and ceased by 10 November. We estimated that the average time between marking and recovery of spawned-out live fish was at least 21 days (Figure 5). Thus, the spacing of recovery efforts one week apart ensured that all fish had an equal probability of being captured during recovery (most fish were present in the system over several recovery events).

In the method used to estimate the total escapement of 952 fish, 560 unique fish were handled during marking and recovery, or 59% of the estimate. The 95% relative precision of the estimate (±16%) was better than the 25% level targeted in the operational plan using methods described in Robson and Regier (1964). This study was not performed without skepticism; nevertheless, most of the assumptions were satisfied or appear to have been satisfied, and we are confident in the estimate.

Steep Creek is a relatively small clearwater stream, and the relationship we found in 1994 between the peak observer count and the total escapement may be typical for similar streams salmon in Southeast Alaska which produce coho. Estimates of total escapement based on observer counts may be more or less precise depending on stream types and the perceptual ability of the observer (Bevan 1961).

The visibility of spawning salmon depends on many factors such as weather, water clarity, canopy cover, pool-to-riffle ratio, the density of fish, the amount of undercut banks, and the ecology, behavior, size, and color of salmon (Jones 1995). These factors may increase the likelihood for differences in the relationship between the observer count and the estimate of escapement.

This study has gathered at best a minimum of information necessary for calculation of the

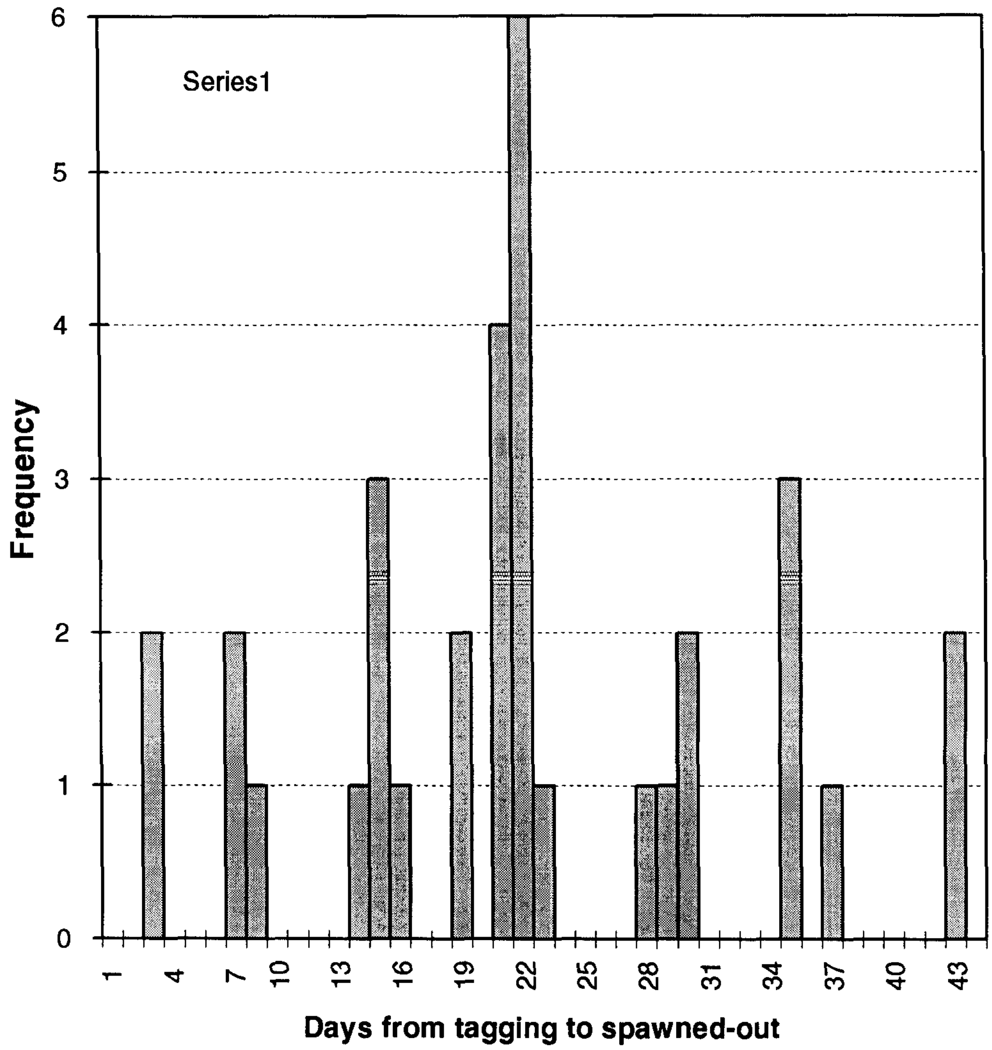

Figure 5.–Number of days from marking to "spawned-out" condition for 33 coho salmon in Steep Creek in 1994.

total escapement using observer counts. Future effort should be made to explore this relationship on a variety of stream types that produce coho salmon and over a variety of observer conditions.

More than 2,000 streams or river systems exist in Southeast Alaska that produce coho salmon. Sixty-six of these are currently monitored annually for escapement: 61 for peak escapement, and 5 (Ford Arm Lake, Berners River, Auke Lake, Taku River, and Hugh Smith Lake) for total escapement. An increased understanding of the relationship between the observer count and the total escapement directly relates to improved management providing for larger, more stable run sizes and increased fishing opportunity.

RECOMMENDATIONS

For future studies, we offer the following recommendations as potential improvements:

1. Conduct the study as a multiple mark-recapture experiment for an open population.
2. Begin marking earlier to ensure that the earliest arriving fish are sampled and not missed.
3. If conditions permit, marking should take place throughout the entire study area.
4. Distinct primary marks should be used again with the addition of secondary marks unique for each tagging location.
5. AWL data should be collected at all times.
6. Recovery efforts should be made on at least a weekly basis.
7. The experiment should be repeated in Steep Creek again with an improved sample design for comparison with the 1994 results.

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APPENDIX A

Appendix A1.–Tagging and recovery of individual tags on coho salmon at Steep Creek, 1994. The shaded cells represent fish counted as recaptures for use in the mark-recapture experiment. Some cells contain numbers which correspond to the location of recapture.

TAG NUMBER	MARKING PERIOD AND RECOVERIES BY DATE AND LOCATION									
	9/29	10/7	10/10	10/14	10/17	10/21	10/28	11/03	11/04	11/10
11701	Tag									
11702	Tag	2		2						
11703	Tag									
11704	Tag									
11705	Tag			2						
11706	Tag	2		2						
11707	Tag									
11708	Tag									
11709	Tag			4		2			4	
11710	Tag	4		4						
11711	Tag									
11712	Tag									
11713	Tag	2		2						
11714	Tag			4					4	
11715	Tag									
11716	Tag									3
11717	Tag									
11718	Tag			4			1			
11719	Tag									
11720	Tag	4				4			2	
11721	Tag									
11722	Tag									
11723	Tag			2						
11724	Tag									
11725	Tag			1						
11726	Tag	2								
11727	Tag									
11728	Tag									
11729	Tag	2								
11730	Tag									
11731	Tag									
11732	Tag			4						
11733	Tag	2		2		2				
11734	Tag									
11735	Tag	1								
11736	Tag	4							4	
11737	Tag									
11738	Tag									
11739	Tag									
11740	Tag			2						
11741	Tag									
11742	Tag									
11743	Tag									
11744		Tag					3			
11745	Tag									
11746	Tag	2		2			1			
11747	Tag									
11748	Tag									
11749	Tag	4				4				
11750		Tag						3		
11751	Tag								4	
11752	Tag									
11753	Tag	4		4			4		2	
11754	Tag	2		4		2			2	
11755	Tag	4					4		2	

- continued-

TAG	MARKING PERIOD AND RECOVERIES BY DATE AND LOCATION									
NUMBER	9/29	10/7	10/10	10/14	10/17	10/21	10/28	11/03	11/04	11/10
11756	Tag	2								
11757	Tag									
11758	Tag									
11759	Tag									
11760	Tag									
11761	Tag									
11762	Tag									
11763	Tag									
11764	Tag									
11765	Tag									
11766	Tag	2		2		2	1(2)			
11767	Tag	4								
11768	Tag									
11769	Tag			2						
11770	Tag						2		2	
11771	Tag									
11772	Tag	4			3			4		
11773	Tag									
11774	Tag				3					
11775	Tag				3					
11776	Tag									
11777		Tag					4			
11778	Tag	2					4			
11779	Tag									
11780	Tag									
11781		Tag				4			4	
11782	Tag									
11783	Tag									
11784	Tag									
11785	Tag						3			
11786	Tag									
11787	Tag	1								
11788	Tag				3					
11789	Tag									
11790	Tag					3				
11791	Tag	4								3
11792	Tag	4								
11793	Tag	4								
11794	Tag									
11795	Tag						3			
11796	Tag									
11797		Tag								
11798		Tag								
11799		Tag								
11800		Tag								
11801		Tag								
11804		Tag								
11805		Tag				2				
11806		Tag			3					
11807		Tag		4			4			
11808		Tag								
11809		Tag							2	
11810		Tag								
11811		Tag								
11812		Tag					4			
11814		Tag								
11815		Tag					4		4	
11817		Tag		4		4				

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Appendix A1.–Page 3 of 5.

TAG NUMBER	MARKING PERIOD AND RECOVERIES BY DATE AND LOCATION									
	9/29	10/7	10/10	10/14	10/17	10/21	10/28	11/03	11/04	11/10
11818		Tag								
11819		Tag								
11820		Tag					4			
11821		Tag								
11823		Tag		4			4			
11824		Tag				4			2	
11825		Tag								
11826		Tag		4			4			
11827		Tag					4			
11829		Tag		4		4	4		4	
11830		Tag			3					
11831		Tag					3			
11833		Tag								
11836		Tag								
11837		Tag								
11838		Tag		4		2	4		2	
11839		Tag				1				
11841		Tag								
11842		Tag								
11843		Tag								
11844		Tag					1			
11846		Tag								
11847		Tag				2				
11848		Tag		2						
11849		Tag								
11850		Tag				2				
11851				Tag						
11852				Tag						
11853				Tag		2	4		2	3
11854				Tag			1			
11856				Tag						
11857				Tag						
11858				Tag						
11859				Tag						
11860				Tag						
11861				Tag				4		
11901		Tag							2	
11902		Tag			3		1			
11903		Tag								
11904		Tag		4			4			
11905		Tag		4						
11906		Tag								
11907		Tag		4		4				
11908		Tag				2	1 (2)		2	
11909		Tag		4		4				2
11910		Tag								
11911		Tag				4	4		2	
11912		Tag								3
11913		Tag				2	4			
11914		Tag		4		4				
11915		Tag		4		4				
11916		Tag		4			3			
11917		Tag					4		2	
11918		Tag		4						
11919		Tag								
11920		Tag		4		2				1
11921		Tag		2			2		2	

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Appendix A1.–Page 4 of 5.

TAG NUMBER	MARKING PERIOD AND RECOVERIES BY DATE AND LOCATION									
	9/29	10/7	10/10	10/14	10/17	10/21	10/28	11/03	11/04	11/10
11922		Tag								
11923		Tag		4						
11924		Tag		1						
11925		Tag				4				
11926		Tag		4			3			
11927		Tag								
11928		Tag		4						
11929		Tag					4			
11930		Tag		2						
11931		Tag					4			
11932		Tag				3				
11933		Tag								
11934		Tag								
11935		Tag								
11936		Tag								
11937		Tag								
11938				Tag						
11939				Tag		1				
11941				Tag						
11942				Tag						
11943				Tag		4			4	
11945				Tag						
11947				Tag		4	4		4	
11948				Tag						
11949				Tag		4				
11950				Tag						
11952				Tag		4				
11953				Tag						
11954				Tag					2	
11955				Tag		4	4		4	
11956				Tag						
11957				Tag						
11958				Tag						
11959				Tag						
11960				Tag						
11961				Tag						
11962				Tag			3			
11963				Tag						
11964				Tag		4			4	
11965				Tag			4			
11966				Tag						
11967				Tag	3					
11968				Tag	3		3			
11969				Tag	3					
11970				Tag						
11971				Tag						
11973				Tag		4			4	
11974				Tag						
11975				Tag		4	4	3		3
11976				Tag						
11977				Tag						
11978				Tag						
11979				Tag		4				
11980				Tag						
11981				Tag						
11982				Tag						
11983				Tag						

- continued-

Appendix A1.–Page 5 of 5.

TAG NUMBER	MARKING PERIOD AND RECOVERIES BY DATE AND LOCATION									
	9/29	10/7	10/10	10/14	10/17	10/21	10/28	11/03	11/04	11/10
11985				Tag						
11986				Tag						
11987				Tag		2				
11988				Tag					4	
11989				Tag		4				
11991				Tag						
11992				Tag						
11993				Tag						
11994				Tag						
11995				Tag		4			2	
11996				Tag				3		
11997				Tag		4				
11998				Tag		4	4			
11999				Tag						
12000				Tag					4	
11101						Tag				
11102						Tag	2	3		
11103						Tag				
11104						Tag	4			
11106						Tag	4			3
11108						Tag	4			
11110						Tag	4			
11111						Tag				
11112						Tag			4	
11113						Tag				3
11114						Tag				
11115						Tag				
11118						Tag				3
11119						Tag			4	
11120						Tag				3
11121						Tag				
11122						Tag			2	
11123						Tag				
11124						Tag				3
11125						Tag				

Appendix A2.–Computer data files concerning data on Steep Creek coho salmon in 1994.

File name	Description
94Steepr.doc	WORD 6.0 (Windows) file of this FDS report. All data from the Steep Creek study performed in 1994 are contained in this file. Abundance estimates were performed using a program written and maintained by Mike Wallendorf (ADF&G, Sportfish, Fairbanks).