Fishery Data Series No. 96-16

Escapement and Stock Statistics for Coho Salmon on the Little Susitna River and Selected Matanuska-Susitna Valley, Alaska Streams during 1994

by

Larry D. Bartlett

July 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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by

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Coho salmon returning to the Little Susitna River were censused through a weir at river mile 32.5 on the Little Susitna River. A total of 28,948 coho salmon were censused through the weir in 1994. The contribution of hatchery coho salmon to this census was estimated at 4,162 fish (14.4%, SE = 1.1%). Inspections of boat angler creels at the Burma Landing (river mile 28) produced an estimated hatchery contribution of 26.8% (SE = 2.6%) to the boat angler harvest. A sample of 413 coho salmon taken at the counting weir was found to be predominantly (59.6%, SE = 3.3%) age 2.1. Index coho salmon escapement counts conducted on selected local streams yielded average or better than average counts on most streams. A survey of 2,466 boat anglers exiting the coho salmon sport fishery at Burma Landing found that 85% (SE = 0.7%) of the surveyed boat anglers were Alaska residents with 99% (SE = 0.2%) of these residents being of local origin. Nine percent (SE = 0.6%) of the 2,466 boat anglers surveyed used guided services.

Key words: coho salmon, *Oncorhynchus kisutch*, Little Susitna River, hatchery contribution, weir, run timing, escapement, escapement index, sex and age composition, mean length, coded wire tag, tag loss, tag retention.

INTRODUCTION

The Little Susitna River drainage originates at the Mint Glacier in the Talkeetna Mountains north of Palmer, Alaska and discharges into Cook Inlet approximately 7 miles east of the mouth of the Susitna River and 13 miles west of Anchorage (Figure 1). The river is approximately 110 miles long with about 70 miles open to fishing for salmon, from the mouth to the Parks Highway bridge at the community of Houston. The first 34 miles upstream from the mouth are located within the Susitna Flats State Game Refuge. The Little Susitna River supports runs of chinook salmon *Oncorhynchus tshawytscha*, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, pink salmon *O. gorbuscha*, and chum salmon *O. keta*.

The Little Susitna River supports the second largest freshwater fishery for coho salmon in Alaska, second only to the Kenai River (Howe et al. 1995). Road access to the lower reaches of the Little Susitna River improved with agricultural development in the area during the early 1980s. The harvest of, and corresponding fishing effort for, coho salmon in the lower 40 miles of the Little Susitna River also increased in step with improvements in access. In response to the increases in harvest, the Little Susitna River has been stocked annually with coho salmon since 1982 (Tables 1 and 2).

The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, began an annual creel survey of the sport fishery for coho salmon in the Little Susitna River in 1981 (Bentz 1982). An annual life-history study of coho salmon in the Little Susitna River was begun in 1982 (Bentz 1983). As part of this study, a weir was constructed in the Little Susitna River at river mile 32.5 to estimate the escapements of coho salmon. This weir was initially operated in 1986 and has been operated annually since 1988 (Bartlett 1994).

A coho salmon management plan was adopted in 1990 and implemented in 1991 (5 AAC 61.060). This management plan defines an escapement goal of 7,500 nonhatchery coho salmon for the Little Susitna River upstream of the Parks Highway bridge at about river mile 70. (In this report, nonhatchery coho salmon are coho salmon that can not be identified as part of a specific release of hatchery fish based on marked-to-unmarked ratios or tagging information.)

Data collected during this project are used to refine the management plan for hatchery and nonhatchery stocks of Little Susitna River coho salmon, and insure that the escapement

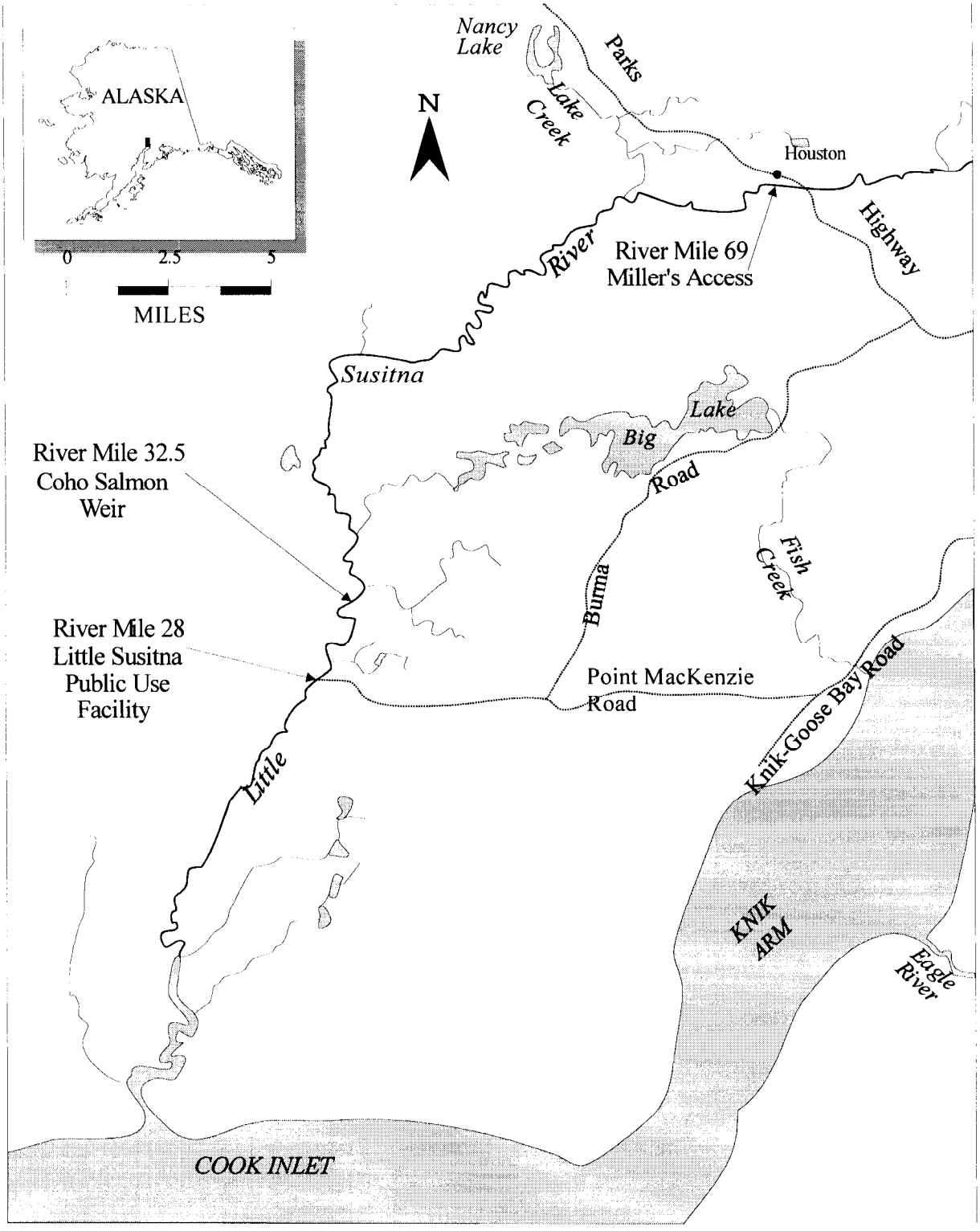

Figure 1.-Little Susitna River study area, 1994.

Table 1.-Summary of coho salmon fry released into the Little Susitna River drainage from eggs taken from the Little Susitna River and incubated at the Big Lake State Fish Hatchery.

Release Location	Date	Size(g)	Number Released	Number Marked	Tag Code
Little Susitna River	6/22/82	0.4		2,950	
Nancy Lake	6/15/83	0.5	23,652	1,880	B4-07-13
	6/16/83	0.5	80,124	4,605	B4-07-13
	6/17/83	0.6	79,251	2,622	B4-07-13
	6/22/83	0.7	67,815	5,278	B4-07-13
	6/23/83	0.7	15,666	6,450	B4-07-13
	Total		266,508	20,835	B4-07-13
Nancy Lake	6/14/84	1.0	171,194	4,026	B4-14-11
	6/15/84	0.9	164,280	5,174	B4-14-11
	6/19/84	0.9	90,742	631	B4-14-11
	Total		436,047	9,831	B4-14-11
Nancy Lake	6/18/85	0.3	127,000	10,000	B4-15-08
	5/31/85	0.3	164,600		
Horseshoe Lake	6/20/85	0.3	140,000		
	6/21/85	0.3	79,000		
	6/05/85	0.3	229,600		
	6/03/85	0.3	85,000		
Crooked Lake	6/12/85	0.3	68,000		
	6/21/85	0.3	164,000		
Butterfly Lake	6/25/85	0.3	119,000		
Delyndia Lake	6/25/85	0.3	49,000		
	Total	Nancy Lake	291,600	10,000	B4-15-08
		All Others	933,600		
Nancy Lake	6/26/86	1.0	211,255	10,300	B3-11-15
	6/27/86	1.0	105,015		
	Total	Nancy Lake			
Horseshoe Lake	5/11/88	16.4	15,725		

-continued-

Table 1.-Page 2 of 2.

Release Location	Date	Size(g)	Number Released	Number Marked	Tag Code
Horseshoe Lake	6/23/88	0.7	450,000		
Crooked Lake	7/01/88	1.0	105,000		
	7/05/88	1.3	151,000		
Nancy Lake	7/05/88	1.3	174,126	3,126	B3-02-02
	7/07/88	0.7-1.3	1,708,939	8,939	B3-02-02
East Papoose L	7/06/88	1.0	172,000		
West Papoose L	7/06/88	1.0	164,000		
Butterfly Lake	7/06/88	1.0	141,000		
Delyndia Lake	7/06/88	1.0	141,000		
Hock Lake	7/06/88	1.0	72,000		
Yohn Lake	7/06/88	1.0	46,000		
My Lake	7/06/88	1.0	58,000		
		Nancy Lake	1,883,065	12,065	B3-02-02
		All Others	1,515,725		
	1988	Total	3,398,790		
Horseshoe Lake	7/28/89	1.4	8,400		
Horseshoe Lake	6/19/90	1.0	344,000		
Crooked Lake	6/20/90	1.0	78,000		
Nancy Lake	6/28/90	1.1	155,619	11,619	13-01-01-04-05
	7/06/90	1.5	65,305	28,305	13-01-01-04-05
	7/13/90	1.7	28,722	10,722	13-01-01-04-06
	7/23/90	2.0	223,681	21,681	13-01-01-04-06
My Lake	6/29/90	1.1	23,000		
Yohn Lake	6/29/90	1.1	26,000		
Butterfly Lake	6/29/90	1.1	90,000		
Hock Lake	6/29/90	1.1	40,000		
Delyndia Lake	6/29/90	1.1	89,000		
		Nancy Lake	220,924	39,924	13-01-01-04-05
		Nancy Lake	252,403	32,403	13-01-01-04-06
		All Others	690,000		
	1990	Total	1,163,327		

Table 2.-Summary of coho salmon smolt released into the Little Susitna River drainage from eggs taken at Nancy Lake and incubated at the Fort Richardson State Fish Hatchery.

Brood Year	Eggs Incubated	Release Site	Year	Size (g)	Number Released	Number Marked	Tag Code	Return Year
1983	56,000	Nancy Lake	1985	17.1	54,394	12,151 [a]	None	1986
1984	564,000	Nancy Lake	1986	17.2	580,065	24,401 [a]	31-17-30	1987
1985	552,000	Houston	1987	19.0	98,156	7,950 [a]	31-17-45	1988
		Nancy Lake	1987	19.2	203,011	16,700 [a]	31-17-45	1988
		Total	1987		301,167	24,650 [a]	31-17-45	1988
1986	495,000	Nancy Lake	1988	20.1	446,016	24,628 [a]	31-17-61	1989
1987	537,877	Houston	1989	18.5	49,349	3,581 [a]	31-18-32	1990
		Nancy Lake	1989	20.8	305,548	22,050 [a]	31-18-32	1990
		Total	1989		354,897	25,631 [a]	31-18-32	1990
1988	462,000	Houston	1990	20.8	106,242	15,679 [a]	31-19-17	1991
		Nancy Lake	1990	20.8	202,114	29,541 [a]	31-16-01	1991
		Total	1990		308,356	45,220 [a]		1991
1989	530,315	Houston	1991	23.4	88,675	16,151 [a]	31-19-36	1992
		Nancy Lake	1991	22.9	189,087	30,207 [a]	31-19-35	1992
		Total	1991		277,762	46,358 [a]		1992
1990	590,015	Houston	1992	24.1	154,466	19,564 [a]	31-20-07	1993
		Nancy Lake	1992	23.4	158,459	19,222 [a]	31-20-06	1993
		Total	1992		312,925	38,786 [a]		1993
1991	833,883	Houston	1993	18.1	148,282	20,312 [a]	31-21-37	1994
		Nancy Lake	1993	20.2	131,591	19,930 [a]	31-21-37	1994
		Total	1993		279,873	40,242 [b]	31-21-37	1994
1992	790,000	Nancy Lake	1994	19.7	126,694	43,818 [b]	31-23-01	1995

[a] Number of smolt marked (tag loss before release was not estimated).

[b] Number of marked smolt released (estimated tag loss before release has been subtracted).

goal of 7,500 nonhatchery coho salmon is attained.

Data collected during this project also aid in assessing the stocking program. The stocking program has contributed up to 75% (an estimated 10,660 fish) of the sport harvest (1989) and has added an inestimable number of angler-days to the sport fishery. Timely harvest, effort, and escapement information has allowed maximum use of returning hatchery stock by the angling public. This program has also enhanced recreational opportunity and social and economic benefits to the citizens.

The 1994 Little Susitna River coho salmon program had the following objectives:

1. Estimate the proportional contribution of stocked coho salmon to the sport fishery of boat anglers exiting at Burma Road from 16 July through 29 August 1994; such that the total seasonal estimated contribution is within ± 5 percentage points of the true proportion 90% of the time.
2. Census the 1994 escapement of coho salmon at river mile 32.5 in Little Susitna River.
3. Estimate the age and sex compositions of the coho salmon escapement past river mile 32.5; such that the estimated proportions by age class are within ± 5 percentage points of the true proportions 90% of the time.
4. Estimate the contribution of stocked coho salmon to the escapement past river mile 32.5 by 7-day periods; such that the total seasonal estimated contribution is within ± 20% of the true contribution 90% of the time and such that each 7-day period estimate is within either ± 300 fish or ± 50% of the true value 90% of the time.
5. Index the coho salmon spawning escapement in 11 selected Northern Cook Inlet (NCI) area streams in 1994.
6. In addition to the objectives listed above, an informal demographic survey of exiting boat anglers was conducted in conjunction with Objective 1. The purpose of the survey was to estimate the proportion of resident and nonresident boat anglers and the proportion of boat anglers who utilized commercial sport fishing services. Data from this task became part of a larger data base designed to assess the economic value of sport fishing services in the fishery.

METHODS

STOCKING AND TAGGING

Two stockings of coho salmon smolt were released in the Little Susitna River drainage in 1993 (Table 2). Approximately 132,000 smolt were released in Nancy Lake (which drains into the Little Susitna River) and approximately 148,000 smolt were released close to river mile 69 near the community of Houston. Approximately 14% of each release were tagged with a coded wire tag (CWT) and had their adipose fin removed. The same tag code (31-21-37) was used for each release.

CENSUS OF ESCAPEMENT AT THE WEIR

A floating weir was used to census the escapement of coho salmon to the Little Susitna River at river mile 32.5. The weir was operated from 20 May through 6 September 1994. Coho were counted through the weir beginning 2 July (Appendix A). This period of operation spanned the majority of the coho salmon migration passing river mile 32.5.

The weir was a floating, resistance-board design constructed of 1 in inside diameter, schedule 40 polyvinyl chloride (PVC) pickets

fabricated in panels 4 ft wide by 20 ft long. Picket spacing on the panels was 1.5 in. An adjustable resistance board was fastened to each panel for current deflection and buoyancy. Panels were attached to a cable which was fastened to a railroad rail placed on the bottom of the river.

One 8 ft by 8 ft by 4 ft partitioned live-trap with a V-shaped entrance was placed on the upstream side of the weir. Spacing between the live trap pickets was also 1.5 in. This spacing allowed for the complete census of all but the smallest 0-ocean (jack) coho salmon.

CONTRIBUTION OF STOCKED FISH TO THE ESCAPEMENT

An escapement goal of 7,500 nonhatchery coho salmon spawners upstream of the Parks Highway is defined in the Little Susitna River Coho Salmon Management Plan. To account for an expected harvest of 500 nonhatchery fish above the weir, an estimated 8,000 nonhatchery coho were required upstream of the weir before the escapement goal was estimated to have been reached. The exact number harvested above the weir is unknown but believed to be small based on the low number of anglers fishing on this reach of the Little Susitna River.

A sample of coho salmon passing the weir was inspected for missing adipose fins. Those missing their fins were killed and their heads collected for recovery of the CWT. Recovery of tags by individual tag code was desirable to more precisely estimate the total contribution of hatchery fish of Little Susitna River origin to the escapement and to the Northern and Central District commercial fisheries. Based on preseason simulations, a total of 127 hatchery fish were expected to be killed. The expected precision calculated from simulated data at the planned inspection rates indicated that both the total seasonal estimate and the within-season estimates would fall within the goal objective criteria.

The following information was collected and recorded daily at the weir: (1) the number of salmon by species, including coho salmon, passing upstream of the weir (the number of salmon by species, including coho salmon, observed to pass back over the weir after release was subtracted from the daily count); (2) the number of coho salmon which pass over the weir during boat passage; (3) the number of coho salmon examined for a missing adipose fin; (4) the number of coho salmon observed to have a missing adipose fin; (5) the number of heads collected; (6) the number of coho salmon sampled for age and sex composition; and (7) any other pertinent factors that could have affected the ability of the weir to accurately census the passing of coho salmon upstream of river mile 32.5

Heads collected at the weir were tagged with a numbered strap tag around the jaw at the time of collection. The number of this tag, the sex, and mid-eye to fork-of-tail (MEF) length of the fish to the nearest 0.5 centimeter were entered on a jaw tag and head record form. Heads collected were kept on ice in coolers and delivered almost daily to Palmer, where they were frozen and ultimately shipped to the decoding lab in Juneau for processing.

We estimated that approximately 30% of the coho salmon passing the weir during each 7-day period until 5 August would be examined for a missing adipose fin. Following 5 August, approximately 15% of the weir escapement was to be inspected for a missing adipose fin. Fish sampled for biological data (age and sex) were included as a portion of the fish examined for tags. The actual number to be examined was estimated daily by the weir crew leader. Factors that figured into the daily estimation included: (1) water (flood)

conditions, (2) the previous day's passage, (3) the immediate safety of working on the weir (flood conditions), and (4) warm water temperature and its potential effects on handling mortality.

Daily summaries of information collected at the weir were forwarded by telephone to the area office each weekday prior to 1000 hours (holidays excluded). Daily escapement data was entered into a computer spreadsheet. A rough estimate of the number of hatchery coho salmon passing the weir, calculated by expanding the proportional number of hatchery fish based on the tag ratio (0.1438), was made each day. The number of nonhatchery fish was estimated daily by subtracting the estimated hatchery contribution from the daily escapement.

The final estimate of the hatchery contribution at the weir was estimated by the procedures outlined in Clark and Bernard (1987; equations [10], [14], and [15]). The procedures of Clark and Bernard (1987) could be followed in this case because the total number of coho salmon through the weir is known, not estimated. Chi-squared contingency table analyses were conducted on the weir data base to determine if contiguous 7-day periods could be combined if necessary (due to insufficient numbers sampled or adipose finclips observed).

Contribution of Stocked Fish to the Sport Fishery Harvest

The lower 70 miles of the Little Susitna River was open to salmon fishing in 1994. Most of the sport fishing effort exited the fishery through one access point, a lower river access site, referred to as the Burma Road (Figure 1). A second site near Houston and third site at the Port of Anchorage were not surveyed.

Selection of the Burma Road site focused the study effort on the majority of anglers (Bartlett and Vincent-Lang 1989; Bartlett and Sonnichsen 1990; Bartlett and Bingham 1991). The inspection of boat angler harvests began on Saturday, 16 July and continued through Monday, 29 August 1994.

To estimate the proportional contribution of these stocked fish to the sport harvest, coho salmon were inspected for a missing adipose fin. Coho salmon inspected were those harvested by boat anglers and checked through the Burma Road boat landing during the scheduled inspection hours. Only the harvest of boat anglers was inspected because it was possible to inspect 100% of their harvest during the sampled periods. A complete inspection of the harvest by shore anglers during the scheduled periods was not possible because most shore anglers did not exit the fishery through the boat launch area. Shore anglers and a portion of the exiting boat anglers fished the same waters. It was therefore assumed that shore and boat anglers harvested hatchery coho salmon at the same rate. The 1994 creel inspection schedule, listed in Appendix B, was based on 1993 harvest and creel inspection results.

All boat anglers exiting the sport fishery through the Burma Road landing during the scheduled inspection periods were contacted; there were no missed anglers. All coho salmon in a contacted angler's creel were examined for a missing adipose fin. Accurate tallies by day of both the numbers of fish examined and the numbers of fish having a missing adipose fin were kept. With the angler's permission, heads were collected from harvested fish with missing adipose fins.

Estimates of the proportional contribution of stocked coho salmon to the sport fishery of boat anglers exiting at Burma Road were obtained by treating all inspected harvested coho salmon as if they were obtained from a simple random sampling procedure. In 1994 the planned schedule called for a systematic

sample of days and periods in the day (Appendix B), and because all exiting boat anglers' creels were inspected, a self-weighting systematic sample was obtained.

Data from the creel surveys conducted in 1991 and 1992 along with projected returns for 1994 were used in conjunction with tagging information from the tag lab to simulate the expected proportional contributions along with their expected precisions. Data from 1993 were not used in these simulations due to unusually high total return and escapement levels observed in 1993 which were not expected to recur in 1994.

These simulations indicated that a total of about 209 adipose-clipped fish would be observed out of approximately 3,661 fish expected to be inspected out of an assumed total harvest of about 10,000 fish (i.e., a sampling fraction of 37%). Of these 209 adipose-clipped fish, 173 heads were expected to be cinch strapped and forwarded to the lab (note many anglers behead their fish prior to inspection by the technicians). About 148 of the heads, from both releases having the same tag code, were expected to contain decodable tags. The resultant estimated proportional contribution of both releases of fish was about 25% of the total harvest. The simulated standard error of this estimate was calculated at about 2.3 percentage points which was within the objective criteria of + 5 percentage points at an alpha level of 0.10.

The proportion of hatchery coho salmon in the 1994 Little Susitna River sport fishery harvest was estimated following the procedure described in Bernard and Clark (*In prep*).

The relative contribution was estimated as:

$$\hat{R} = \hat{p}\theta^{-1} = \left(\frac{m}{\lambda n_2}\right)\theta^{-1} \qquad (1)$$

where:

$\hat{p}$ = an unbiased estimate of the fraction of the catch composed of the subset of a cohort that had been tagged,

θ = the proportion of hatchery released fish which contained a coded wire tag,

m = the number of coded wire tags dissected from salmon heads and decoded as originating from a hatchery release in the Little Susitna ,

n_2 = the number of coho salmon inspected for missing adipose fins from the sampled harvest,

$\lambda = \frac{a_2}{a_1}\frac{m_2}{m_1}$, (2)

a_1 = the number of coho salmon with missing adipose fins which were counted and marked with a head strap,

a_2 = the number of coho salmon heads previously marked with a head strap which arrive at the tag lab,

m_1 = the number of coded wire tags which were detected in the coho salmon heads at the tag lab, and

m_2 = the number of coded wire tags which were removed from the coho salmon heads and decoded.

When θ is known (as in this study):

$$\hat{V}\left[\hat{R}\right] = \hat{V}[\hat{p}]\theta^{-2} \qquad (3)$$

where:

$$\hat{V}[\hat{p}] = \left(\frac{1}{D}\frac{n_2}{(n_2-1)}\right)\left[\left(\frac{1}{\lambda n_2}\right)\hat{p} - \left(1 - D\frac{(n_2-1)}{n_2}\right)\hat{p}^2\right], \qquad (4)$$

and:

$$D = \frac{m_1(m_2 - 1)a_1(a_2 - 1)}{m_2(m_1 - 1)a_2(a_1 - 1)}. \quad (5)$$

AGE AND SEX COMPOSITIONS

When fishing is relatively good, some anglers select the fish they harvest (keep from their catch) based on size, sex, and appearance. The age and sex compositions of returning coho salmon were, therefore, not estimated from the harvest. The age and sex compositions of the coho salmon escapement were, however, estimated by sampling at the weir.

Hatchery fish are predominately age 1.1, while nonhatchery fish may be ages 1.1, 2.1, and even 3.1. Age compositions may change over time, as the contribution of hatchery and nonhatchery fish to the harvest or weir counts change or the age composition of the nonhatchery stock varies. A sample size of 70 fish per 7-day stratum (490 fish total) at the weir was necessary to achieve the objective criteria (Thompson 1987, Cochran 1977)[1]. The sampling of fish for age determination was spread across the 7 days of each stratum, with the objective of meeting the sample goal by the close of the last day.

When sampling at the weir, the sample was obtained by allowing the trap to fill with the approximate number of coho salmon for the sample (10-15 fish per day). The entire contents of the trap was then sampled to eliminate selection or behavior biases inherent in subsampling fish from the trap by dipnetting. Length and sex were determined for each fish sampled.

Coho salmon sampled for age, sex, and length were measured for MEF length to the nearest 5 millimeters (0.5 cm). Where possible, a preferred scale was taken from the left side of the body at a point on a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin and two rows above the lateral line (Scarnecchia 1979). If the preferred scale could not be obtained, another scale was taken from as close to the preferred scale as possible. However, scales were only taken from the area bounded dorsally by the fourth row of scales above the lateral line, ventrally by the lateral line, and between lines drawn vertically from the posterior insertion of the dorsal fin and the anterior insertion of the anal fin. If no scales were available in the preferred area on the left side of the fish, scales were collected from the preferred area on the right side of the fish. The sex of each fish was identified from external sexual characteristics.

Scales were mounted on gum cards and impressions were made in cellulose acetate as described in Clutter and Whitesel (1956). Images of the acetate impressions were enlarged using a microfiche reader. Age was described using the European method.

Estimates of age composition for the sampled coho salmon were calculated for each 7-day stratum. The proportion of coho salmon passing the weir of age u in stratum h ($\hat{p}_{uh}$), and its variance, were estimated as:

$$\hat{p}_{uh} = \frac{n_{uh}}{nh} \quad (6)$$

with variance (corrected for finite population) calculated as:

$$\hat{V}[\hat{p}_{uh}] = \left(1 - \frac{n_h}{N_h}\right) \frac{\hat{p}_{uh}(1 - \hat{p}_{uh})}{n_h - 1}, \quad (7)$$

where n_{uh} is the number of coho salmon classified as age u in stratum h, n_h is the sample size, and N_h is the total number of

[1] The sample size goal of 490 is slightly over the goals of 458 and 463 fish needed for estimating the age composition of the weir population. This sample size goal was obtained by applying a finite correction factor to the sample size goal of 403 given by Thompson (1987), associated with our objective criteria (i.e., α = 0.10 and d = 0.15) and then applying an expansion factor for a scale regeneration rate of approximately 15% as observed in previous surveys.

coho salmon passing the weir during stratum h. Sex composition was estimated similarly.

Estimates of the number of coho salmon passing the weir during stratum h by age and sex ($\hat{N}_{uh}$) were calculated by expanding by the total weir count for stratum h using:

$$\hat{N}_{uh} = N_h \hat{p}_{uh} , \quad (8)$$

with associated variance:

$$\hat{V}\left[\hat{N}_{uh}\right] = N_h^2 \hat{V}\left[\hat{p}_{uh}\right] . \quad (9)$$

The number of fish in the total escapement in each age and sex class ($\hat{N}_u$) was estimated by summing across strata:

$$\hat{N}_u = \sum_{h=1}^{s} \hat{N}_{uh} , \quad (10)$$

where s = the total number of 7-day strata in the season.

The variance of $\hat{N}_u$ was estimated by summing the stratum variances.

Finally, the proportion of each age and sex class across all strata ($\hat{p}_u$) was estimated as:

$$\hat{p}_u = \frac{\hat{N}_u}{N} , \quad (11)$$

with variance:

$$\hat{V}[\hat{p}_u] = \frac{\hat{V}\left[\hat{N}_u\right]}{N^2} , \quad (12)$$

where N = the total weir count across all strata.

ESCAPEMENT INDEX SURVEYS

Index counts of spawning coho salmon were conducted in 11 index streams during the peak spawning period. The 11 streams that were surveyed during 1994 were: Spring (Wasilla), Yellow, McRoberts, Upper Jim, Spring (Flat), Cottonwood, Wasilla, Rabideux, Birch, Question and Answer creeks. The peak spawning period was identified through frequent inspections of coho salmon spawning activity in the streams that were easily accessible. The surveys were conducted by foot or canoe.

The Little Susitna River was index surveyed by helicopter. Criterion for the survey were the same as above.

The following data were recorded during each escapement index survey: (1) the name of the stream and the respective reach or tributary area surveyed, (2) the date and time of the survey, (3) the type of survey, (4) weather conditions during the survey, (5) the stream level or flow, (6) the relative clarity or turbidity of the water (visibility), (7) the total number of live coho salmon observed, and (8) the total number of dead coho salmon observed.

The index survey results together with historical survey data are filed in the Palmer ADF&G office stream files.

ANGLER SURVEY

Burma Road boat anglers were asked the following questions during the demographic survey conducted in conjunction with the creel inspection: (1) resident or nonresident; (2) if resident: local or nonlocal; (3) guided or unguided; (4) if unguided: chartered or private; and (5) outfitted or not outfitted. A short interview ADF&G mark-sense creel survey form was used to record this information.

The following definitions were applied to the questions asked: (1) a resident held a resident sport fishing license; (2) a nonresident held a nonresident sport fishing license; (3) a local was a resident angler who resided in the Matanuska-Susitna or Anchorage boroughs; (4) a nonlocal was a resident angler who resided outside the Matanuska-Susitna or Anchorage boroughs; (5) a guided angler was assisted in the fishing effort by a guide; (6) a

chartered angler was unguided but used some form of commercial business such as transportation to and from a fishing site; and (7) an outfitted angler rented gear such as tackle, clothing or a canoe.

COMPUTER PROGRAMS AND DATA FILES

A list of computer data files and programs used to analyze data collected during the 1994 season is in Appendix C.

RESULTS

WEIR CENSUS

The passage of coho salmon upstream of the Little Susitna River salmon counting weir was censused from 2 July through 6 September (Appendix A). A total of 28,948 coho salmon were censused.

HATCHERY CONTRIBUTIONS

Sport Harvest

Two tag codes were detected in the heads collected from the inspected portion of the 1994 Burma Road boat angler harvest of coho salmon. These codes were 31-21-37 and 31-20-07. A total of 2,769 coho salmon were inspected for missing adipose fins. The heads were collected from those fish having a missing adipose fin. Eighty-four heads collected had tag code 31-21-37 (Table 3). Fish bearing this code were released as smolt in the Little Susitna River at Houston or in Nancy Lake in 1993 (Table 2). (The same tag code was released at both of these 1993 release sites.) The estimated relative contribution of the 1993 release to the 1994 harvest of Little Susitna River coho salmon by boat anglers exiting the Burma Landing sport fishery was 26.4% (SE = 2.6%).

One collected head bore tag code 31-20-07 (Table 3). The fish bearing this code was released with 154,466 smolt at Houston in 1992 (Table 2). The dominant year of return for this release was 1993. This fish most likely held over in the Little Susitna River an additional year and smolted in 1993. Based on the recovery of this one head, the estimated relative contribution of this release to the 1994 harvest was 0.36% (SE = 0.36%). The combined estimated relative contribution from both the 1992 and 1993 releases was 26.8% (SE = 2.6%).

Weir Census

The hatchery contribution to the 28,948 coho salmon censused at the weir was estimated to be 4,162 (SE = 394) fish, or 14.4% (Table 4). A total of 134 coho salmon with a missing adipose fin were observed and 120 heads were collected from 6,077 (21% of the censused coho salmon) coho salmon inspected at the weir (Table 5).

Commercial Fishery

The hatchery contribution by coho salmon of Little Susitna release to selected Cook Inlet commercial fisheries was estimated by Stratton et al. (1996) as 19,960 fish (SE = 1,366, Table 4).

AGE, LENGTH, AND SEX COMPOSITION

A total of 521 coho salmon were sampled at the weir for age and sex composition and mean length estimates. Four hundred and thirteen samples were used for the estimate and 108 (21%) were rejected for scale regeneration and missing values. Based on the proportions in the sample, age 2.1 fish dominated the census of fish through the weir at 59.6% (SE = 3.3%, Table 6).

The mean length by sex and age of the 413 usable fish sample was estimated (Table 7). A significant difference in the mean length of females by age at α = 0.05% was found by comparing lengths with a two-tailed t-test (t = 2.24, df = 192, P = 0.0132). There was no

Table 3.-Little Susitna River sport harvest coho salmon coded wire tag recovery summary by release and 7-day strata in 1994.

Strata	Date	Heads With CWTs	Decodable CWTs[a]	Clips Observed[b]	Heads To CWT Lab	Number Inspected	Tag Code		No Tag[d]	Total	Tagging Proportion[e]
							07[c]	37[c]			
1	7/16-7/22	2	2	2	2	74	0	2	0	2	-07 = 0.12666
2	7/23-7/29	8	8	12	9	96	0	8	1	9	-37 = 0.14379
3	7/30-8/05	15	15	25	18	642	0	15	3	18	
4	8/06-8/12	41	41	54	48	1,126	1	40	7	48	
5	8/13-8/19	12	12	19	15	309	0	12	3	15	
6	8/20-8/26	7	7	12	7	169	0	7	0	7	
7	8/27-8/29	0	0	0	0	53	0	0	0	0	
Totals		85	85	124	99	2,769	1	84	14	99	

[a] Number of heads found to have a decodable coded wire tag.

[b] Number of adipose finclips observed in the inspected sample.

[c] Tag code 31-21-37 released in 1993 at Nancy Lake and in the mainstem river at Houston. Tag code 31-20-07 released in 1992 in the mainstem river at Houston.

[d] Tag not found in head at decoding laboratory.

[e] The tagged fish released/total fish released.

Table 4.-Contributions of hatchery-origin coho salmon to the estimated sport fishery harvest, the census of coho salmon at the Little Susitna River weir and the Cook Inlet commercial fishery.

Year	Total Estimate	SE	Hatchery Estimate	SE	Percent	95 % C.I.
Sport Harvest (total estimates from Burma Road creel survey):						
1986	5,812	--[a]	107	30.5	1.8	
1987	13,202	442.1	3,460	509.7	26.2	± 7.8
1988	12,759	405.0	6,468	571.9	50.7	± 9.3
1989	14,150	746.3	10,660	1,275.2	75.0	± 19.3
1990	8,001	866.8	2,393	478.0	29.9	± 13.3
1991	14,079	1,297.0	6,584	1,205.7	46.8	± 18.8
1992	8,739	674.0	1,482	188.7	17.0	± 4.9
1993	11,051	779.0	3,083	288.8	27.9	± 4.3
1994	--[b]				26.8	± 5.1
Escapement:						
1986 [c]						
1987 [d]						
1988	21,438	--[e]	4,764	1,076.3	22.2	± 9.8
1989	15,855	--[e]	7,191	757.6	45.9	± 9.4
1990	15,511	--[e]	3,791	449.0	24.4	± 5.7
1991	39,241	--[e]	8,375	592.9	21.4	± 3.0
1992	21,182	--[e]	2,468	279.0	11.5	± 2.6
1993	34,822	--[e]	10,211	857.6	29.4	± 4.0
1994	28,948	--[e]	4,162	394.0	14.4	± 2.2
Commercial Harvest:						
1993	--[f]	--[f]	10,852	532.8		
1994	--[f]	--[f]	19,960	1,365.7		

Sources: Bentz 1987, Bartlett and Conrad 1988, Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991, Bartlett 1992, Bartlett and Bingham 1993, and Bartlett 1994 .

[a] Standard error not reported.
[b] No creel survey conducted in 1994.
[c] No tagged fish reported.
[d] No weir in place.
[e] Measured without error.
[f] The total harvest of Little Susitna River coho salmon in the commercial fisheries of Cook Inlet is unknown.

Table 5.-Little Susitna River coho salmon weir coded wire tag recovery summary by release and 7-day strata in 1994.

Strata	Date	Heads With CWTs	Decodable CWTs[a]	Clips Observed[b]	Heads To CWT Lab	Number Inspected	37[c]	No Tag[d]	Total	Tagging Proportion[e]
1	7/02-7/22	1	1	1	1	142	1	0	1	37 = 0.14379
2	7/23-7/29	6	6	7	7	739	6	1	7	
3	7/30-8/05	20	20	22	22	1,497	20	2	22	
4	8/06-8/12	33	33	43	42	1,928	33	9	42	
5	8/13-8/19	10	10	10	10	411	10	0	10	
6	8/20-8/26	7	7	10	9	375	7	2	9	
7	8/27-9/2	25	25	40	28	957	25	3	28	
8	9/3-9/6	1	1	1	1	28	1	0	1	
Totals		103	103	134	120	6,077	103	17	120	

[a] Number of heads found to have a decodable coded wire tag.

[b] Number of adipose finclips observed in the inspected sample.

[c] Tag code 31-21-37 released in 1993 at Nancy Lake and in the mainstem river at Houston.

[d] Tag not found in head at decoding laboratory.

[e] The tagged fish released/total fish released.

Table 6.-Estimated age and sex composition, summed across all strata, of coho salmon censused at the Little Susitna River weir in 1994.

	Age 1.1	Age 2.1	Total
Females:			
Escapement	4,757	7,412	12,169
SE	708	847	1,104
Percent	16.4	25.6	42.0
SE (%)	2.4	2.9	3.8
Males:			
Escapement	6,944	9,835	16,779
SE	848	957	1,278
Percent	24.0	34.0	58.0
SE (%)	2.9	3.3	4.4
Combined:			
Escapement	11,701	17,247	28,948
SE	967	967	0.0
Percent	40.4	59.6	100.0
SE (%)	3.3	3.3	0.0

Table 7.-Estimated mean length (mm) of coho salmon censused at the Little Susitna River weir in 1994.

	Age 1.1	Age 2.1
Females:		
Length (mm)	603	614
SE	4	3
Sample size	79	115
Minimum	520	500
Maximum	675	685
Males:		
Length (mm)	622	630
SE	4	3
Sample size	94	125
Minimum	480	520
Maximum	700	710

significant difference in the length of males by age ($t = 1.63$, $df = 217$, $P = 0.0515$).

Small numbers of age 1.0 and 2.0 coho salmon were present in the sport fishery during 1993 (Bartlett 1994) and probably were present in the 1994 return as well. As mentioned previously, a sample for age, sex and length was not taken from the 1994 sport harvest so no fish from these age groups could be observed. Age 1.0 and 2.0 coho salmon are not sampled at the weir because they can escape through the vertical 1.5 inch spaced pickets in the live trap.

The sex ratio of coho salmon in the 1994 census at the weir was 42% females and 58% males (Table 6).

INDEX SURVEYS

All streams with planned index counts were surveyed in 1994. Survey conditions were generally very good to excellent. Counts were average or better than average on most streams (Tables 8 and 9).

DEMOGRAPHIC SURVEY

A total of 2,466 anglers were interviewed during the demographic survey. Little Susitna River boat anglers were primarily: (1) residents of Alaska (85%), (2) local (Matanuska-Susitna Valley and Anchorage) in origin (99%), and (3) did not use charter (98%) or guiding services (91%) to any significant extent (Table 10).

DISCUSSION

WEIR CENSUS AND ESCAPEMENT GOAL

The 1994 census of coho salmon through the Little Susitna River weir was uneventful and the escapement of nonhatchery stock (24,786) exceeded the escapement goal (Figure 2) by over three fold. Since 1988 the estimate of nonhatchery fish at the weir has never been below the 7,500 fish escapement goal established by the Alaska Board of Fisheries in 1991.

Overall run timing in 1994 was not atypical from other years the weir has been in operation (Figure 3). Coho salmon arrived at the weir when expected but were more abundant during the early days of the 1994 run when compared to the 1988 through 1993 mean. The total 1994 census on 6 September of 28,948 fish was also 21% greater than the 1988 through 1993 mean of 24,025 fish on 6 September.

In most years nonhatchery fish precede hatchery fish in proportional timing and run strength. The 1994 passage through the weir was no exception (Figure 4). The percent of hatchery fish censused lagged slightly behind nonhatchery fish; closing the gap only near the close of the season (Figure 5).

AGE COMPOSITION

In 1994, Little Susitna River nonhatchery coho salmon were predominantly age 2.1 (Table 6). The total census of 28,948, minus the 4,162 hatchery age 1.1 fish, leaves 24,786 nonhatchery fish: 32% (7,964) age 1.1 and 68% (16,822) age 2.1.

HATCHERY CONTRIBUTIONS

The percent 1994 hatchery contributions were within range of those observed during prior years (Table 4). The expected proportional hatchery contribution to the harvest of 25% approximated the actual estimated contribution of 26.8% while the expected contribution to the census 19.8% exceeded the estimated contribution of 14.4%.

The total number of hatchery coho salmon estimated to have returned to the Little Susitna River in 1994 was 8,994. This estimate includes the 4,162 fish estimated at the weir and 4,734 fish harvested from the Little Susitna River by sport anglers (Howe et al. 1995). Added to the estimated commercial

Table 8.-Escapement index counts of coho salmon in Knik Arm index streams 1981-1994.

Year	Little Susitna River[a]			Fish Creek[b]	Cotton-wood Creek	Wasilla Creek	Spring Creek (Wasilla)	Spring Creek (Flat)	Yellow Creek	McRoberts Creek	Upper Jim Creek	Eklutna Tailrace	Grand Total
	Hatchery	Non hatchery	Total										
1981			6,750	2,330	423	238	ns[c]	64	ns[c]	ns[c]	ns[c]	ns[c]	9,805
1982			6,800	5,201	737	171	ns[c]	105	ns[c]	ns[c]	ns[c]	ns[c]	13,014
1983			2,666	2,342	506	4	ns[c]	28	ns[c]	ns[c]	ns[c]	ns[c]	5,546
1984			20,991	4,510	935	876	ns[c]	90	ns[c]	ns[c]	ns[c]	ns[c]	27,402
1985			3,540	5,089	334	16	150	81	65	662	ns[c]	266	10,203
1986			7,511[d]	2,166	121	ns[c]	141	147	20	439	ns[c]	403	10,948
1987			4,865	3,871	360	251	110	42	58	667	ns[c]	1,587	11,811
1988	4,428	16,063	20,491	2,162	293	ns[c]	82	30	110	1,911	ns[c]	1,848	26,927
1989	6,862	8,370	15,232	3,479	147	ns[c]	67	39	226	597	ns[c]	253	20,040
1990	3,370	10,940	14,310	2,673	167	34	38	12	146	599	589	668	19,236
1991	8,322	29,279	38,249	1,297	158	118	16	5	136	484	418	286	41,172
1992	2,690	19,492	21,182	1,705	6	3	11	0	57	11	59	39	23,073
1993	9,189	25,633	34,822	2,078	265	ns[c]	67	69	490	503	535	496	39,325
1994	4,162	24,786	28,948	350[e]	232	282	76	60	172	506	2,119	714	33,459

Note: Aerial or foot surveys unless otherwise noted.

[a] Aerial or foot surveys 1981-1985 and 1987. Weir counts 1986, 1988-1994.

[b] 1982-1991 weir count plus stream survey; 1992, 1993 weir count only; 1994 weir was removed on 15 August before the majority of the coho run.

[c] No survey conducted.

[d] Weir washed out in flood from 21 July-29 July 1986.

[e] Incomplete count; the weir was removed early in the season.

Table 9.-Escapement index counts from aerial or foot surveys of coho salmon in Susitna River index tributaries.

Year	Rabideux Creek	Answer Creek	Question Creek	Birch Creek	Grand Total
1981	ns[a]	ns[a]	ns[a]	ns[a]	ns[a]
1982	ns[a]	ns[a]	ns[a]	ns[a]	ns[a]
1983	ns[a]	ns[a]	ns[a]	ns[a]	ns[a]
1984	480	57	60	236	833
1985	82	9	89	30	210
1986	ns[a]	ns[a]	ns[a]	25	25
1987	50[b]	10	149	46	255
1988	230	160	337	63	790
1989	20	66	31	180	297
1990	20	6	41	36	103
1991	185	51	492	300	1,028
1992	ns[a]	181	227	167	575
1993	ns[a]	34	370	178	582
1994	105	0[c]	339	224	668

[a] No survey conducted.

[b] Poor survey conditions.

[c] Beaver dam downstream of survey area blocked upstream passage of fish.

Table 10.-Demographic survey results from 2,466 Little Susitna River coho salmon boat anglers exiting the sport fishery through Burma Landing and interviewed between 16 July and 29 August 1994.

Type of angler	Number surveyed	Percent of total	SE percent
Nonresident	372	15	0.7
Resident [a]	2,094	85	0.7
Local	2,075	99	0.2
Nonlocal	19	1	0.2
Guided	217	9	0.6
Unguided [b]	2,249	91	0.6
Chartered	37	2	0.3
Nonchartered	2,212	98	0.3
Outfitted	214	9	0.6
Not outfitted	2,252	91	0.6
Total anglers surveyed	2,466	100	

[a] Local and nonlocal anglers are from this group.

[b] Chartered and nonchartered anglers are from this group.

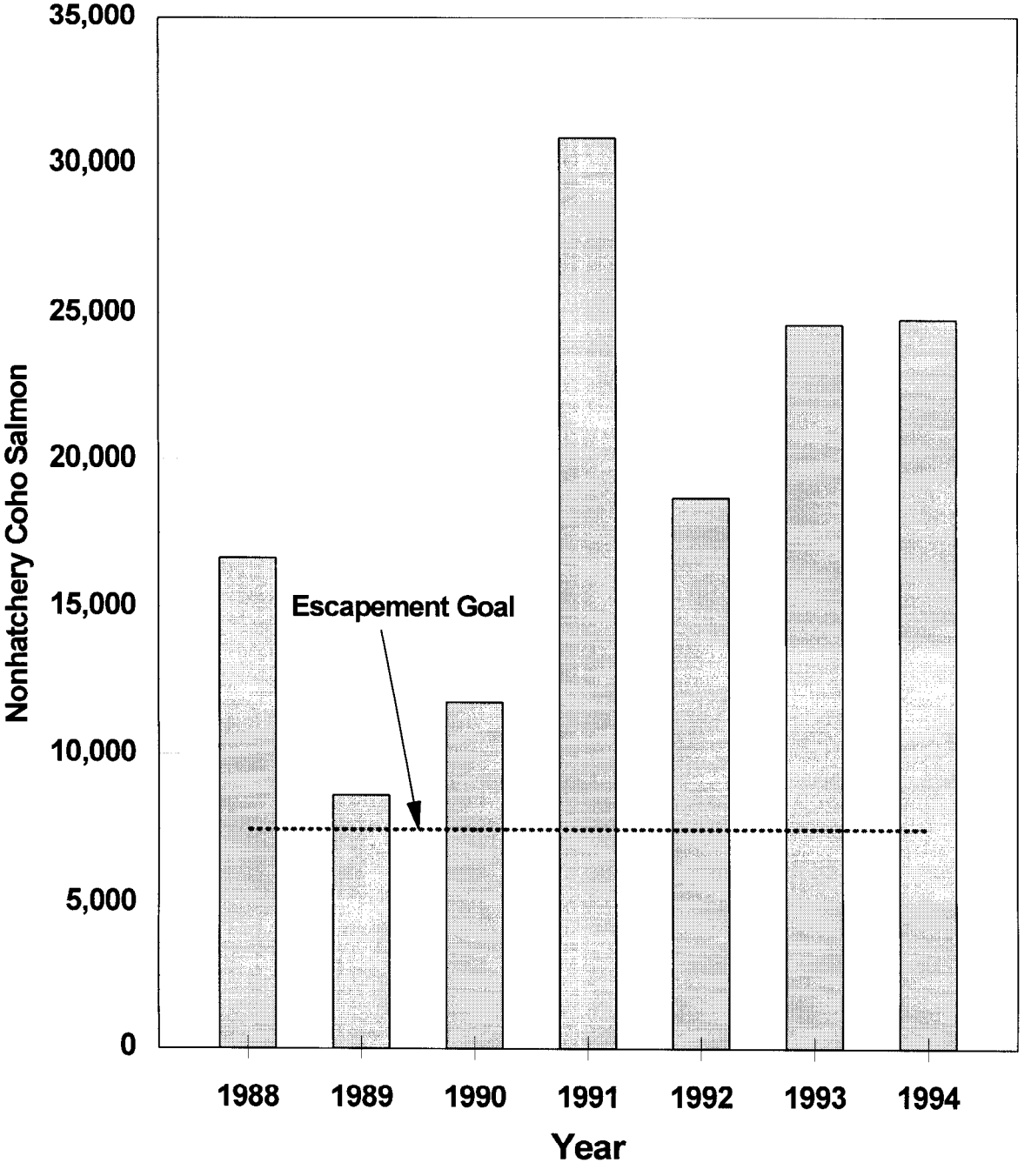

Figure 2.-The number of nonhatchery coho salmon estimated through the Little Susitna River weir from 1988 through 1994.

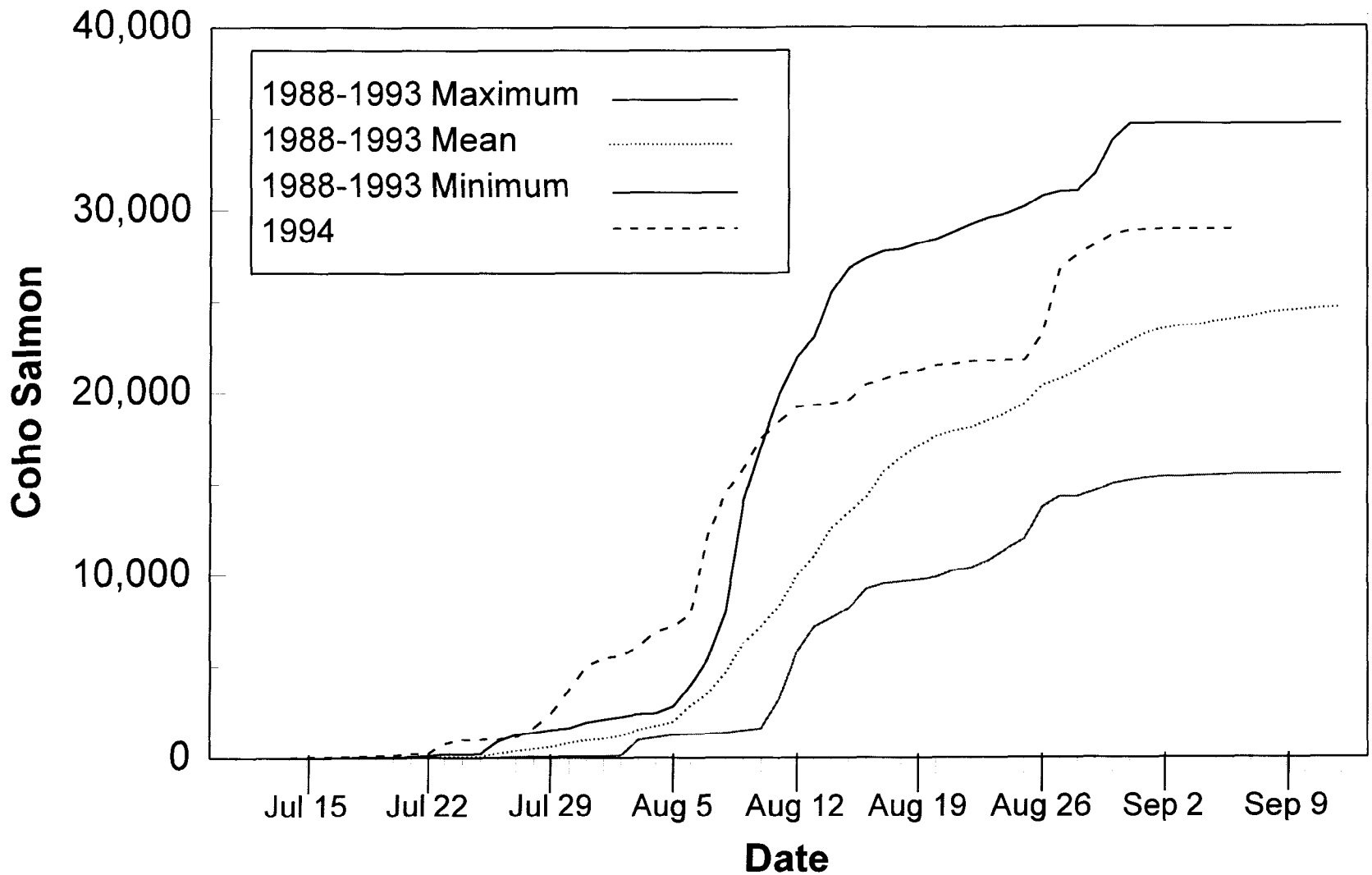

Figure 3.-The run timing of coho salmon censused at the Little Susitna weir in 1994 compared to the 1988 through 1993 minimum, maximum, and mean run timing.

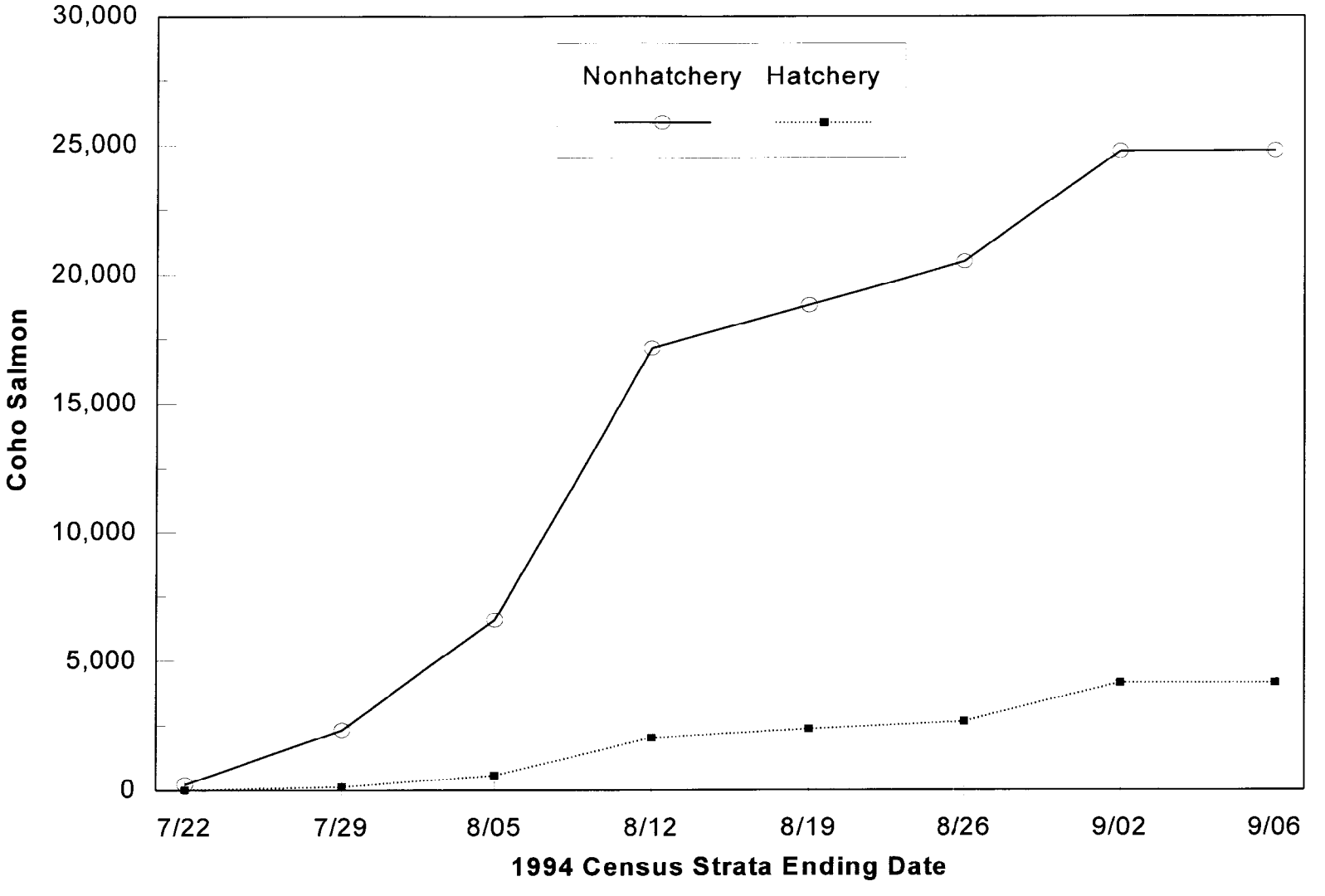

Figure 4.-The cumulative census of hatchery and nonhatchery coho salmon by strata ending date in 1994 at the Little Susitna River weir.

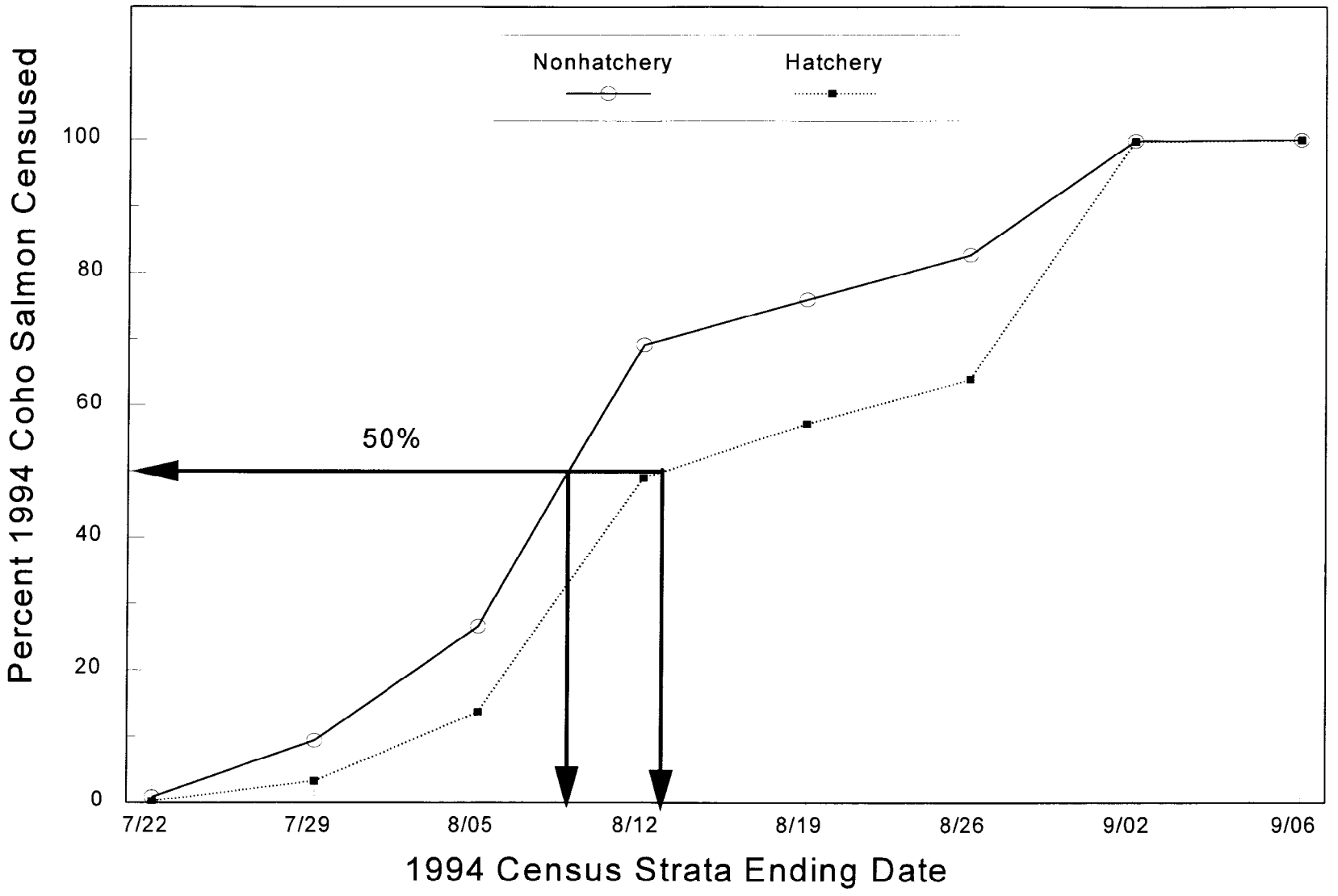

Figure 5.-The cumulative percent census of hatchery and nonhatchery coho salmon by strata ending date in 1994 at the Little Susitna River weir.

contribution of 19,960 fish (Table 4), the total estimated return of Little Susitna River coho salmon in 1994 was 28,854 fish. Of the total, 69.2% of the hatchery fish were taken in commercial fisheries of Cook Inlet, 16.4% in the inriver sport harvest and approximately 14.4% went to the escapement.

These estimates are only approximate because a small but unknown portion of the 4,162 fish estimated at the weir were subsequently harvested in the sport fishery upstream of the weir and considered twice. The small number of fish harvested upstream should, however, not change the percentages appreciably.

The combined estimate of 28,854 hatchery fish came primarily from a smolt stocking of approximately 279,873 smolt in 1993. At this estimated return, an approximate survival from this stocking would be 10%.

It is currently not possible to estimate the total production of coho salmon from the Little Susitna River because the harvest of nonhatchery fish in the mixed-stock Cook Inlet commercial fisheries can not be estimated without a tagging program for nonhatchery juveniles.

Coded Wire Tag Retention

The retention of coded wire tags (conversely, tag loss) in salmon smolt after release has been a point of consideration among hatchery program managers. Tag loss among smolt of a specific tag code has been estimated at the hatchery just prior to release since 1992. In 1993 all smolt released in the Little Susitna River were of one tag code (Table 2). The in-hatchery tag loss of this group of fish just prior to release was estimated to be approximately 5% (Peltz and Hansen 1994). The rate of naturally missing adipose fins in coho salmon is estimated to be approximately 0.06 % in several Puget Sound, Washington streams (Blankenship 1990). The natural rate of missing adipose fins is so small that all coho salmon that were found on this project without an adipose fin were assumed to be a hatchery fish.

Upon recovery in 1994 the observed tag loss within this group of fish was approximately 14% in the Burma Road boat landing harvest and 14% at the weir (Tables 3 and 5).

Data on the number of coho salmon from the Nancy Lake egg take with missing CWT tags has been recorded since 1992 (L. Peltz, ADF&G, Palmer, personal communication). Tag loss in the 1992 egg take was approximately 2%, in the 1993 egg take approximately 10% and in the 1994 egg take approximately 16%.

Stocking

Releases were capped at no more than 150,000 smolt starting in 1994. In 1994 only 126,694 smolt were released in the Little Susitna River drainage (Table 2). This is less than one-half the number of smolt released in many prior years. Fewer hatchery fish could be expected to return in 1995 from this smaller release. Whether or not the 1995 inriver return from this release reaches its fullest potential, however, will ultimately depend on factors such as fresh and saltwater survival and the magnitude of harvest by the 1995 Cook Inlet commercial fisheries.

Escapement Index

Stream discharge estimates from the U.S. Geological Survey for 1994 are not yet available but staff observations are that September and October of 1994 were characterized by low stream flows. These low flows allowed the construction and maintenance of new dams by beavers *Castor canadensis*. Beaver dams inhibited the upstream migration of sockeye and coho salmon on two (and possibly more) coho salmon index streams. Low flows are unable

to breach beaver dams and allow the upstream passage of salmon.

A beaver dam blocked all upstream migration of salmon on the index stream Birch Creek. The blockage left several thousand sockeye and coho salmon in the index area that would normally spawn further upstream than the index area. This dam was breached manually on two occasions several days prior to the index survey to give holding sockeye and coho salmon a chance to move to spawning areas upstream of the index area. This action was an attempt to "normalize" spawning in the index area to get a representative index.

A series of beaver dams also blocked the index stream, Answer Creek. Two accessible dams, which blocked the passage of approximately 300 coho salmon, were breached manually but additional upstream dams blocked access to the index area. Answer Creek was surveyed twice in late September 1994, but no coho salmon were found in the index area. It is not known if coho salmon were able to reach the index area after the final survey on 23 September 1994.

It is unlikely that coho salmon spawned in Answer Creek during 1994 due to low flow conditions that persisted until freeze up. There is no known spawning habitat downstream of the index area in Answer Creek.

Coho salmon returns are generally composed of freshwater age 1 and 2 fish, and the loss of one year class is not considered injurious to the long-term health of returns to a specific spawning stream. An inability of returning salmon to reach the spawning areas for several consecutive years would, however, impact future returns to a specific index stream. This event is unlikely as beaver dams are normally breached by higher fall stream flows.

NORTHERN PIKE

Northern pike are widespread in the Susitna River drainage and in lakes as far south as Anchorage (D. Rutz, ADF&G, Palmer, personal communication). Northern pike are not indigenous to waters of the Matanuska-Susitna Valley. Rumors of northern pike being present in the Little Susitna River drainage near Houston and in Nancy Lake (Figure 1) persist but no northern pike were observed to pass through the weir or in the boat angler sport harvest in 1994. It is possible a small population of northern pike exists in Nancy Lake but are not of sufficient abundance to be using the Little Susitna River as a migratory corridor to new habitat.

RECOMMENDATIONS

The following points relative to this study are suggested:

1. Suspend enhancement of the Little Susitna River with hatchery fish until it is demonstrated that the nonhatchery stock can not sustain the sport fishery (and use the freed hatchery space to establish a coho salmon fishery in Moose Creek, a tributary to the Matanuska River, or in the Knik River ponds). If recent levels of nonhatchery escapement continue, the inriver return from a release of 126,000 smolt will not provide enough fish to the sport fishery to make a noticeable difference.
2. Develop escapement goals for index streams tributary to the Susitna River that are relatively stable on an annual basis and that can be surveyed with consistency. Birch, and Question creeks are recommended because of their access and because they are buffered by lakes which regulate flows.
3. Discontinue indexing Rabideux Creek. The beaver population on Rabideux Creek

is high and in excess of 50% of the index area has been flooded by beaver dams for the past several years. Much of the water has become too deep and dark for reliable indexing.

4. Reliable and consistent monitoring of Susitna River drainage coho salmon is needed. Investigate the feasibility of developing unstaffed, electronic or video counting weirs on some smaller Susitna River tributaries (or on Wasilla Creek). Weigh the risks of monitoring smaller populations (300 to 500 fish) versus the potential, long-term savings in operational costs and quality of information.

5. Investigate anecdotal reports of northern pike in the Little Susitna River drainage. Set a gillnet at the outlet of Nancy Lake (Figure 1) in the early spring of 1996 to test for the presence of pike during their spring spawning migration. If pike are present in small numbers, develop a program to attempt extermination.

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APPENDIX A. DAILY CENSUS OF PACIFIC SALMON AT THE LITTLE SUSITNA RIVER WEIR IN 1994

Appendix A1.-Daily census of Pacific salmon at the Little Susitna River weir 2 July-6 September 1994.

Date	Coho		Sockeye		Chum		Pink		Chinook	
	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]
02-Jul	1	1	8	1,598	11	31	2	5	143	2,664
03-Jul	0	1	13	1,611	11	42	0	5	16	2,680
04-Jul	0	1	12	1,623	1	43	0	5	8	2,688
05-Jul	0	1	2	1,625	6	49	0	5	7	2,695
06-Jul	0	1	1	1,626	92	141	0	5	8	2,703
07-Jul	0	1	9	1,635	54	195	2	7	23	2,726
08-Jul	0	1	12	1,647	108	303	1	8	17	2,743
09-Jul	1	2	8	1,655	237	540	1	9	40	2,783
10-Jul	0	2	18	1,673	99	639	1	10	13	2,796
11-Jul	5	7	32	1,705	203	842	1	11	24	2,820
12-Jul	0	7	15	1,720	263	1,105	3	14	28	2,848
13-Jul	5	12	33	1,753	436	1,541	2	16	4	2,852
14-Jul	13	25	23	1,776	204	1,745	2	18	13	2,865
15-Jul	43	68	29	1,805	337	2,082	0	18	9	2,874
16-Jul	12	80	30	1,835	346	2,428	9	27	5	2,879
17-Jul	9	89	31	1,866	764	3,192	15	42	8	2,887
18-Jul	8	97	39	1,905	956	4,148	66	108	12	2,899
19-Jul	34	131	366	2,271	848	4,996	90	198	8	2,907
20-Jul	25	156	196	2,467	1,234	6,230	135	333	8	2,915
21-Jul	68	224	385	2,852	1,532	7,762	467	800	2	2,917
22-Jul	10	234	162	3,014	1,251	9,013	320	1,120	0	2,917
23-Jul	544	778	1,635	4,649	2,299	11,312	1,322	2,442	10	2,927
24-Jul	209	987	1,027	5,676	75	12,287	702	3,144	6	2,933
25-Jul	13	1,000	429	6,105	427	12,714	69	3,213	1	2,934
26-Jul	17	1,017	131	6,236	787	13,501	110	3,323	1	2,935
27-Jul	117	1,134	929	7,165	733	14,234	248	3,571	3	2,938
28-Jul	499	1,633	1,376	8,541	1,477	15,711	1,156	4,727	8	2,946
29-Jul	839	2,472	1,403	9,944	1,541	17,252	2,129	6,856	2	2,948
30-Jul	1,235	3,707	890	10,834	943	18,195	1,681	8,537	5	2,953
31-Jul	1,294	5,001	824	11,658	881	19,076	1,911	10,448	7	2,960
01-Aug	431	5,432	1,040	12,698	1,266	20,342	1,766	12,214	5	2,965
02-Aug	135	5,567	606	13,304	1,434	21,776	981	13,195	1	2,966
03-Aug	508	6,075	1,048	14,352	1,493	23,269	902	14,097	0	2,966
04-Aug	828	6,903	787	15,139	1,470	24,739	1,271	15,368	0	2,966
05-Aug	256	7,159	365	15,504	371	25,110	488	15,856	3	2,969
06-Aug	701	7,860	341	15,845	418	25,528	580	16,436	1	2,970
07-Aug	4,332	12,192	190	16,035	394	25,922	804	17,240	3	2,973
08-Aug	2,317	14,509	127	16,162	245	26,167	358	17,598	2	2,975
09-Aug	1,325	15,834	128	16,290	182	26,349	176	17,774	2	2,977
10-Aug	1,719	17,553	119	16,409	265	26,614	173	17,947	0	2,977
11-Aug	849	18,402	63	16,472	245	26,859	103	18,050	0	2,977
12-Aug	789	19,191	53	16,525	228	27,087	82	18,132	0	2,977
13-Aug	109	19,300	35	16,560	177	27,264	40	18,172	0	2,977
14-Aug	75	19,375	41	16,601	88	27,352	25	18,197	0	2,977
15-Aug	192	19,567	40	16,641	77	27,429	13	18,210	0	2,977
16-Aug	872	20,439	58	16,699	73	27,502	12	18,222	1	2,978
17-Aug	287	20,726	29	16,728	113	27,615	4	18,226	1	2,979
18-Aug	324	21,050	48	16,776	105	27,720	7	18,233	1	2,980
19-Aug	157	21,207	51	16,827	85	27,805	1	18,234	0	2,980
20-Aug	273	21,480	24	16,851	114	27,919	2	18,236	0	2,980
21-Aug	68	21,548	16	16,867	55	27,974	1	18,237	1	2,981
22-Aug	157	21,705	2	16,869	35	28,009	2	18,239	0	2,981

-continued-

Appendix A1.-Page 2 of 2.

Date	Coho		Sockeye		Chum		Pink		Chinook	
	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]	Daily	Cum[a]
23-Aug	34	21,739	5	16,874	23	28,032	1	18,240	0	2,981
24-Aug	7	21,746	1	16,875	8	28,040	0	18,240	0	2,981
25-Aug	10	21,756	0	16,875	8	28,048	0	18,240	0	2,981
26-Aug	1,412	23,168	9	16,884	28	28,076	1	18,241	0	2,981
27-Aug	3,674	26,842	10	16,894	18	28,094	1	18,242	0	2,981
28-Aug	688	27,530	2	16,896	8	28,102	1	18,243	0	2,981
29-Aug	542	28,072	4	16,900	14	28,116	2	18,245	0	2,981
30-Aug	550	28,622	6	16,906	8	28,124	1	18,246	0	2,981
31-Aug	227	28,849	2	16,908	4	28,128	1	18,247	0	2,981
01-Sep	57	28,906	3	16,911	12	28,140	1	18,248	0	2,981
02-Sep	13	28,919	2	16,913	2	28,142	1	18,249	0	2,981
03-Sep	12	28,931	2	16,915	2	28,144	0	18,249	0	2,981
04-Sep	7	28,938	3	16,918	2	28,146	0	18,249	0	2,981
05-Sep	9	28,947	0	16,918	2	28,148	1	18,250	0	2,981
06-Sep[b]	1	28,948	0	16,918	0	28,148	0	18,250	0	2,981

[a] Cumulative numbers of salmon.

[b] Note: Weir was dismantled at 6:00 p.m. 6 September 1994. The water was low and clear. Very low numbers of salmon were holding in the 5.6 km (3.5 mile) reach between landing and weir.

APPENDIX B. CREEL INSPECTION SCHEDULE FOR 1994 LITTLE SUSITNA RIVER SURVEY OF THE BOAT ANGLERS AND THEIR HARVEST

Appendix B1.-Days and hours of creel inspection for hatchery-marked coho salmon in the Little Susitna River boat angler sport harvest during 1994.

Date	Day	Hours of Inspection		Number of Hours Per Day Surveyed	Minimum Number of Fish Expected[a]
16-Jul	Sat	1000-1242	1343-1743	6.7	3
17-Jul	Sun	1000-1242	1343-1743	6.7	3
18-Jul	Mon	1000-1242	1343-1743	6.7	2
19-Jul	Tue	OFF			
20-Jul	Wed	OFF			
21-Jul	Thu	OFF			
22-Jul	Fri	1000-1242	1343-1743	6.7	8
23-Jul	Sat	1000-1242	1343-1743	6.7	12
24-Jul	Sun	1000-1242	1343-1743	6.7	0
25-Jul	Mon	1000-1242	1343-1743	6.7	0
26-Jul	Tue	OFF			
27-Jul	Wed	OFF			
28-Jul	Thu	OFF			
29-Jul	Fri	1000-1242	1343-1743	6.7	33
30-Jul	Sat	1000-1242	1343-1743	6.7	38
31-Jul	Sun	1000-1242	1343-1743	6.7	99
01-Aug	Mon	1000-1242	1343-1743	6.7	0
02-Aug	Tue	OFF			
03-Aug	Wed	OFF			
04-Aug	Thu	OFF			
05-Aug	Fri	1000-1242	1343-1743	6.7	31
06-Aug	Sat	1000-1242	1343-1743	6.7	334
07-Aug	Sun	1000-1242	1343-1743	6.7	139
08-Aug	Mon	1000-1242	1343-1743	6.7	100
09-Aug	Tue	OFF			
10-Aug	Wed	OFF			
11-Aug	Thu	OFF			
12-Aug	Fri	1000-1242	1343-1743	6.7	173
13-Aug	Sat	1000-1242	1343-1743	6.7	126
14-Aug	Sun	1000-1242	1343-1743	6.7	100
15-Aug	Mon	1000-1242	1343-1743	6.7	114
16-Aug	Tue	OFF			
17-Aug	Wed	OFF			
18-Aug	Thu	OFF			
19-Aug	Fri	1000-1242	1343-1743	6.7	0
20-Aug	Sat	1000-1242	1343-1743	6.7	89
21-Aug	Sun	1000-1242	1343-1743	6.7	19
22-Aug	Mon	1000-1242	1343-1743	6.7	58
23-Aug	Tue	OFF			
24-Aug	Wed	OFF			
25-Aug	Thu	OFF			
26-Aug	Fri	1000-1242	1343-1743	6.7	0
27-Aug	Sat	1000-1242	1343-1743	6.7	0
28-Aug	Sun	1000-1242	1343-1743	6.7	17
29-Aug	Mon	1000-1242	1343-1743	6.7	0
				Total =	1,498

[a] The minimum number of fish expected to be examined is based on returns to the landing in 1993 during the proposed 1994 hours of inspection. Zero fish days represent days during the 1993 season when these hours were not surveyed or, on rare occasion, fish were not landed. Had only these times been inspected during the 1993 season, a minimum of 14% of the 1993 harvest of 11,000 fish would have been examined. A higher percent of the 1994 harvest is expected to be examined.

APPENDIX C. COMPUTER DATA FILES AND ANALYSIS PROGRAMS

Appendix C1.-Computer data files and analysis programs developed for the coho salmon escapement studies on the Little Susitna River, 1994.

Data Files[a]	
K0040BD4.DTA	Data file of coho salmon ages from a scale sample collected from the Little Susitna River spawning escapement in 1978.
K004DBC4.DTA	Data file for the re-aging of the 1988 Little Susitna River weir scale sample.
K004DBB4.DTA	Data file of coho salmon biological data collected at the Little Susitna River weir in 1994.
K004BSA4.DTA	Data file of angler demographic data collected at the Little Susitna River Burma Road boat angler interview program.
Analysis Programs[b]	
CWT3.EXE	Program used to estimate the contribution of hatchery fish in the escapement by strata.
LSU94RHC.WK4	Worksheet used to estimate the relative contribution of hatchery fish in the harvest.
SFXTAB.EXE	Program used to cross-tabulate biological data files and produce tables of age, sex, length, and weight data.
MENU91.BAT	Series of programs used to generate listing and frequency reports from raw data.

[a] Data files are archived with the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518. Contact Gretchen Jennings or Donna Buchholz (267-2369) for copies of the files and descriptions of the file format.

[b] Analysis programs and worksheets are maintained by the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518. Contact Allen Bingham (267-2369) for copies of the programs.