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Estimates of Commercial and Sport Harvest and Escapement of Coho Salmon Stocked Into Northern Cook Inlet Streams, 1997

by

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May 1999

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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ABSTRACT

Juvenile coho salmon *Oncorhynchus kisutch* reared in hatcheries and released into several Northern Cook Inlet (NCI) freshwater systems in 1996 returned to Upper Cook Inlet (UCI) in 1997. Some fish in each release group were marked with an adipose finclip and a coded wire tag (CWT). Marked coho salmon were recovered in 1997 from selected UCI commercial fisheries and were used to estimate harvest of hatchery-produced coho salmon.

In 1997 the UCI mixed-stock commercial fisheries harvested 152,836 coho salmon. The majority (89%) of coho salmon were harvested in the Central District drift gillnet fishery (79,094; 52%), the Northern District set gillnet fishery (37,369; 24%), and the Central District Upper Subdistrict (eastside) set gillnet fishery (19,668; 13%). Sample effort focused on coho salmon harvested in these three fisheries. NCI hatchery-stocked coho salmon contributed an estimated 9,534 (SE = 549) fish to the Central District driftnet fishery; 2,056 (SE = 232) fish to the Central District eastside setnet fishery; and 4,389 (SE = 138) fish to the Northern District setnet fishery.

An escapement of 1,205 coho salmon into Ship Creek and 1,007 coho salmon into Campbell Creek exceeded the biological escapement goal of 200 coho salmon for each creek. Effort, harvest, and catch estimated from the Statewide Harvest Survey increased in 1997 relative to the 1988-1992 (prestocking) averages at Ship, Campbell, and Bird creeks, most likely due to the return of stocked coho salmon.

Key words: coho salmon, *Oncorhynchus kisutch,* commercial harvest, sport harvest, escapement, coded wire tag, Northern Cook Inlet, stocking, straying.

INTRODUCTION

Upper Cook Inlet (UCI) includes all waters of Cook Inlet north of a line at the latitude of Anchor Point light. Coho salmon *Oncorhynchus kisutch* stocks are distributed throughout UCI and support large commercial and sport harvests. In 1997, approximately 50% of the total central region commercial harvest (ADF&G 1998) and 20% of the total statewide sport harvest (Howe et al. 1998) of coho salmon occurred in UCI. The primary UCI coho salmon commercial fisheries are: (1) Central District drift gillnet, (2) Central District Upper Subdistrict (eastside) set gillnet, and (3) Northern District set gillnet fisheries (Figure 1). Based on angler effort, the most popular directed sport fisheries in UCI are: Kenai River on the Kenai Peninsula, Susitna and Little Susitna rivers in Northern Cook Inlet, and Ship Creek in the Anchorage area (Howe et al. 1998).

The Northern Cook Inlet (NCI) urban area extends from Ingram Creek in Turnagain Arm north to the Little Susitna River drainage (Figure 2). Recreational fishing effort in this area increased from an average of about 195,300 angler-days from 1978-1987 to nearly 281,000 angler-days annually from 1988-1997 (Mills 1979-1994, Howe et al. 1995-1998). Anglers fishing in NCI target five species of Pacific salmon *Oncorhynchus*, rainbow trout *O. mykiss*, Dolly Varden *Salvelinus malma*, Arctic char *S. alpinus,* Arctic grayling *Thymallus arcticus*, and northern pike *Esox lucius*. Sport fisheries for these species are supported by a combination of wild and hatchery-produced stocks.

As the NCI human population grows, the demand for sport fishing opportunities increases. Hatchery-produced stocks play an important role in supporting these growing sport fisheries as wild stocks become fully utilized. A coho salmon smolt stocking program was initiated in 1992 to increase recreational sport fishing opportunities in the NCI urban area, specifically in Bird, Campbell, and Ship creeks. To succeed, the stocking program must be cost-effective, have minimal impact on wild stocks and/or other fisheries, and maintain historic levels of spawning escapements in stocked streams.

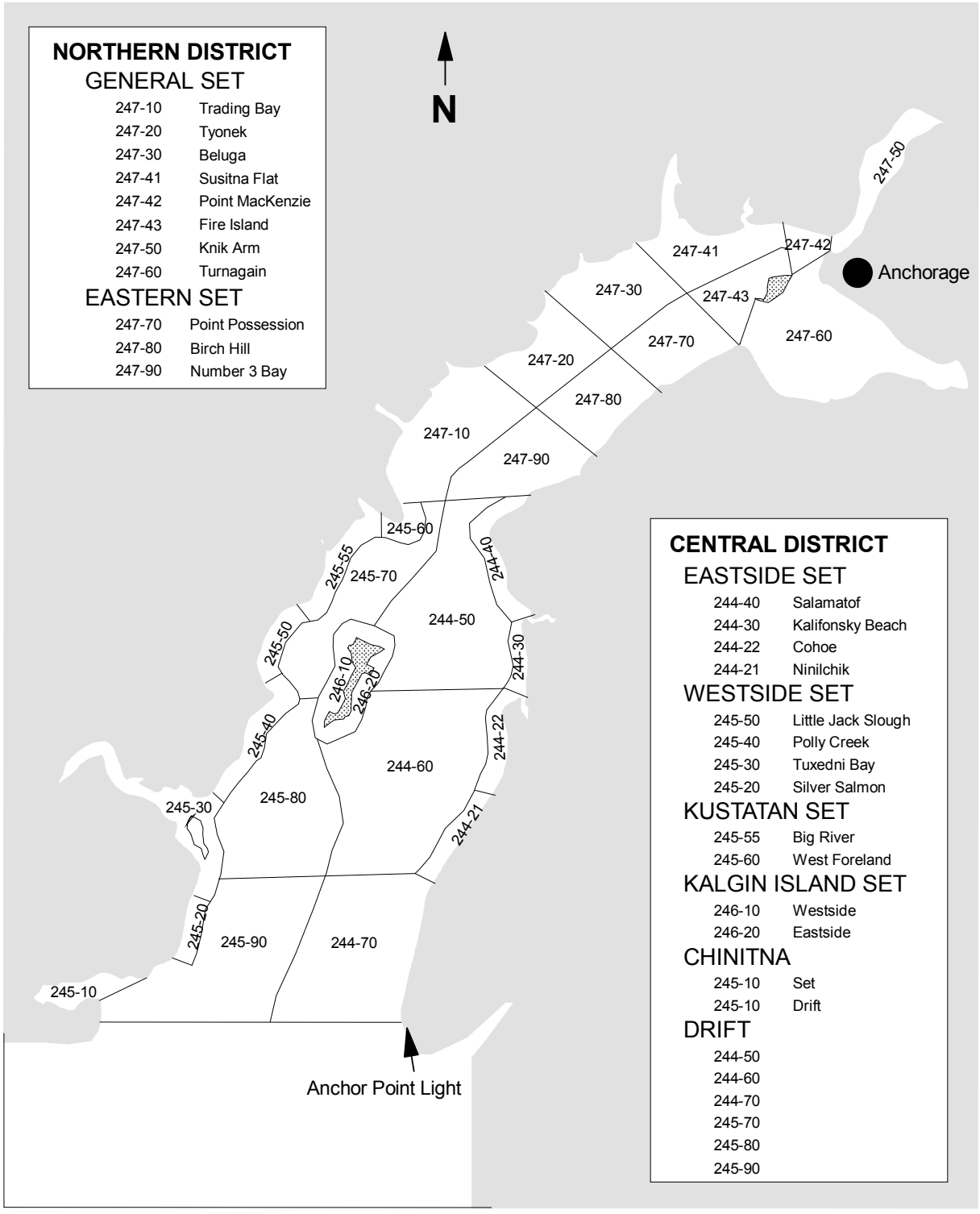


Figure 1.-Upper Cook Inlet commercial salmon fishing districts and statistical areas.

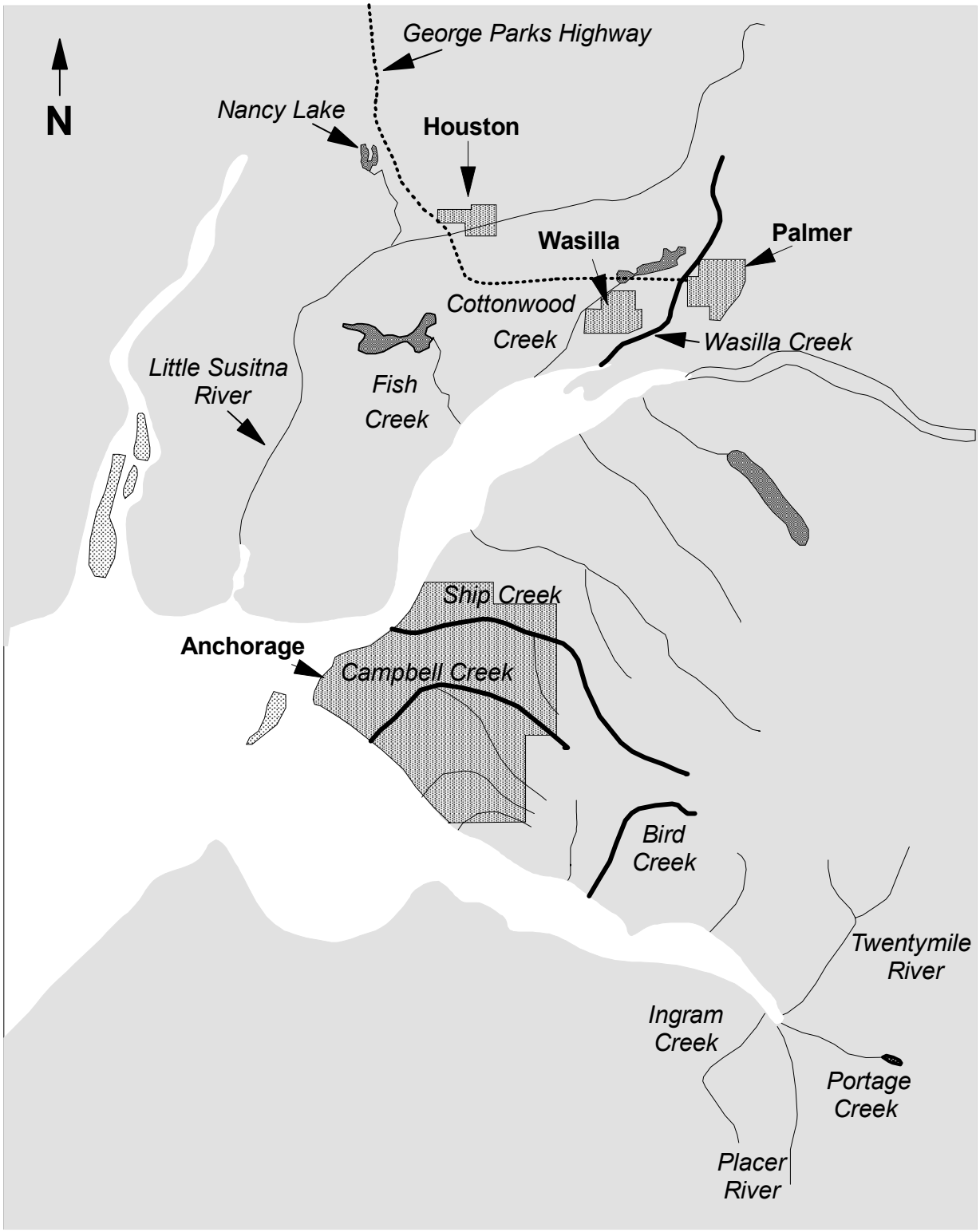


Figure 2.-Northern Cook Inlet urban area. Streams stocked with coho salmon in 1996 are in bold.

The goal of the program is to create or enhance terminal sport fisheries in selected NCI urban area streams and attract additional recreational fishing participation. The program is targeted to increase recreational angler effort by 25,000 angler-days and harvest by 10,000 coho salmon relative to the 5-year pre-stocking mean levels among all stocked streams. The Statewide Harvest Survey (SWHS) is used to evaluate increases in angler effort (for all species combined) and coho salmon harvest. In 1996 a portion of the smolt released into each stream were marked with an adipose finclip and a coded wire tag (CWT) (Table 1).

Prior to the start of this program in 1992, there was no quantifiable information of stock composition from the mixed-stock commercial harvests and virtually no information on the magnitude of inriver runs or spawning escapements. To provide information needed to manage these fisheries, an assessment program was initiated in 1991 to evaluate coho salmon stocks in UCI (Meyer et al. *Unpublished*). This program was designed to estimate harvest of selected wild and hatchery-reared coho salmon stocks in major UCI commercial fisheries and to evaluate the success of the coho salmon hatchery stocking programs in NCI. The overall program consists of three distinct but interrelated components: (1) estimation of commercial and inriver sport harvests and escapement of coho salmon stocked in NCI streams; (2) marking of wild stock juvenile coho salmon, inriver recovery of marked adults, and estimation of UCI commercial harvests of coho salmon from the Kenai River; and (3) production, marking, and release of coho salmon smolt by the hatcheries.

This report focuses on the first component above and primarily on results of coho salmon stocked in 1996 that returned to UCI in 1997. The remaining two program components are reported elsewhere (Carlon and Hasbrouck 1993, 1996, 1997, 1998, and *In prep*; Peltz and Starkey 1993; Peltz and Hansen 1994; Starkey et al. 1996, 1997). In 1997 the NCI coho salmon hatchery-stocking assessment program was in its fifth year. Results from previous years can be found in Hoffmann and Hasbrouck (1994), Stratton et al. (1996), and Cyr et al. (1997, 1998).

OBJECTIVES

Objectives for the 1997 NCI coho salmon assessment fall into two categories: commercial harvest and escapement.

Commercial harvest objectives were:

1. Estimate harvest in the Northern District setnet fishery, the Central District Upper Subdistrict (eastside) setnet fishery, and the Central District driftnet fishery of hatchery-produced coho salmon stocked into NCI urban streams.

Escapement objectives were:

1. Estimate the hatchery contribution to the inriver returns (sport harvest and spawning escapement) to Campbell, Ship, and Wasilla creeks.
2. Index coho salmon spawning escapements in Bird, Campbell, and Ship creeks using foot surveys, and selected Twentymile and Placer river drainages and Portage Creek tributaries using a combination of foot and aerial surveys.

Data collected from other components of the overall UCI coho salmon assessment program are also pertinent to this project. Coho salmon were examined for a missing adipose fin from the

Table 1.-Summary of coded wire tagging data by release site for coho salmon reared at Fort Richardson hatchery and stocked in Northern Cook Inlet streams, 1996.

	Bird Creek	Anchorage Urban Streams (Campbell Creek)	Anchorage Urban Streams (Ship Creek)	Anchorage Urban Streams Total	Wasilla Creek
Raceway	E1	E2	E3	E2 & E3	E4
Tag Codes	31-25-04	31-25-06	31-25-06	31-25-06	31-25-05
Total marked and tagged[a]	46,762	46,886	47,668	94,554	47,306
Mortalities	234	221	358	579	326
Marked fish released	46,528	46,665	47,310	93,975	46,980
Tag retention sample size	762	753	755	1,508	752
Tag retention at release	97.60%	98.70%	98.30%	98.50%	99.70%
Tag retention variance	3.08E-05	1.71E-05	2.00E-05	3.71E-05	3.98E-05
Tagged fish released	45,411	46,058	46,506	92,564	46,839
Tagged fish variance	66,635	37,156	49,606	86,762	8,790
Total fish released for mark-recapture estimate	147,618	156,050[b]	146,807[c]	302,857	145,923
Theta[d]	0.3076	0.2951	0.3168	0.3056	0.321
Tagging dates	10/16/95 10/24/96	11/8/95 11/15/95	11/1/95 11/8/95	11/1/95 11/15/95	10/25/95 10/31/95
Date of tag retention check	5/24/96	5/29/96	5/20/96		5/16/96
Days elapsed[e]	212	196	194		211

Taken from: Starkey et al. 1997.

[a] Marked refers to fish with an adipose finclip, tagged refers to fish with an adipose finclip and a coded wire tag.

[b] Actual number of fish released into Campbell Creek was approximately 77,300 (about 1/2 the fish in raceway E2).

[c] Actual number of fish released into Ship Creek was approximately 226,500 and includes about 79,800 fish from raceway E2.

[d] Calculated using proportion of tagged fish in total fish released.

[e] Number of days between last tagging date and tag retention check date.

escapement at the Wasilla Creek weir. Results of the coho salmon hatchery stocking program in Wasilla Creek can be found in Whitmore and Sweet (1998).

METHODS

STUDY DESIGN

This project was designed to estimate the harvest of hatchery-produced coho salmon stocked into NCI streams in the UCI mixed-stock commercial fishery and to estimate the total run of stocked fish to Bird and Wasilla creeks and Anchorage Urban Streams (Ship and Campbell creeks).

Coho salmon smolt were marked by inserting a CWT into their snout and removing their adipose fin. Marked smolt were mixed and released with unmarked smolt into each stream. A catch sampling program of adult coho salmon in the commercial harvest was conducted in 1997 to recover marked fish. Heads were collected from coho salmon missing the adipose fin and sent to the Alaska Department of Fish and Game (ADF&G) Coded Wire Tag Laboratory (Tag Lab) in Juneau. The Tag Lab determined if a tag was present and decoded recovered tags to determine year and stream of release. Catch sampling data were used to estimate harvest of marked cohorts and to calculate final estimates of harvest and their variances. Survival of hatchery-reared coho salmon from smolt to adult was estimated.

DATA COLLECTION

Stocking and Marking

Coho salmon from Little Susitna River were used as brood stock for 1996 hatchery releases into Bird, Campbell, Ship, and Wasilla creeks. Nancy Lake is the hatchery release and brood stock collection site for Little Susitna River and drains into the Little Susitna River via Nancy Lake Creek approximately 5 miles downstream of the George Parks Highway. Gametes collected in 1994 from coho salmon in Nancy Lake were fertilized, then incubated, and the resultant fry reared at ADF&G's Fort Richardson Hatchery. The subsequent smolt were stocked in 1996 (Starkey et al. 1997) and returned as adults in 1997.

A portion of smolt from each release cohort was marked with an adipose finclip and a uniquely numbered coded wire tag inserted in their snout. In 1996 smolt to be stocked into Ship and Campbell creeks were reared in two raceways and were marked with the same tag code series (31-25-06). Ship Creek was stocked with approximately 226,500 coho salmon smolt (from 1½ raceways) while about 77,300 smolt (½ of one raceway) were stocked into Campbell Creek. It was assumed that the marked proportion stocked into each creek was equal to the marked proportion for each raceway; hereafter, coho salmon smolt stocked into Campbell and Ship creeks will be referred to as Anchorage Urban Streams stock. The tagging goal of 40,000 smolt per release stream was exceeded for all releases in 1996 (Table 1). The cohorts recovered in 1997 were primarily from 1996 releases and ranged from approximately 303,000 smolt released into Anchorage Urban Streams to approximately 146,000 smolt released into Wasilla Creek (Table 1). Details of the rearing, marking, and release of hatchery-stocked coho salmon are discussed in detail by Starkey et al. (1997).

Commercial Harvest Sampling

Sampling of the UCI commercial coho salmon harvest was conducted from 2 July-4 August 1997. An emergency order (2S-26-97) that took effect 7 August 1997 closed all waters of UCI to commercial fishing for the remainder of the season due to extremely poor coho salmon returns

throughout UCI. Coho salmon were sampled on sorting lines at processors, at buying stations, or on board tenders. All regular commercial fishing periods (7:00 a.m. to 7:00 p.m., Mondays and Fridays) that occurred from mid-July through early August in the three fisheries of interest were sampled. Additional Central District fishing periods (as allowed through emergency order) were sampled as time and budget allowed.

Coho salmon delivered to processors, buying stations, or tenders were counted and examined for the absence of the adipose fin. As many fish as possible were examined from deliveries during the sampling shift. All coho salmon observed with a missing adipose fin were retrieved, the head removed, and a uniquely numbered cinch strap affixed to the head. Each head was placed in an individual clear plastic bag with the cinch strap number visible. Collected data included: date of harvest, date of sampling, processor, delivery location, name of tender or buying station, statistical area, number of coho salmon examined, number of coho salmon missing the adipose fin, number of heads collected from coho salmon missing the adipose fin, and the cinch strap number of each head collected. All coho salmon heads with cinch straps were returned to ADF&G offices in Soldotna or Anchorage. The heads were frozen and shipped weekly to the Tag Lab for tag removal and decoding. After each commercial fishing period, the preliminary commercial harvest of coho salmon in UCI by statistical area was obtained from Commercial Fisheries Management and Development Division (CFMD) staff in Soldotna. Final commercial harvest data by statistical area and date were obtained on 23 March 1998.

In general, totes sampled from setnet harvested coho salmon were of fish harvested in a single statistical area. Thus, the total harvest and catch sample data could be summarized by statistical area. Totes of coho salmon sampled from the Central District driftnet fishery were a mixture of fish harvested in different statistical areas. Thus, harvest and catch sample data from the Central District driftnet fishery were combined for statistical areas 244-50, 244-60, 244-70, 245-70, 245-80, and 245-90.

Northern District

The Northern District is subdivided into 11 statistical areas (Figure 1). By regulation, commercial fishing periods occur between 7:00 a.m. and 7:00 p.m. on Mondays and Fridays from 25 June until closed by emergency order (5 AAC 21.320 *Weekly Fishing Periods*). Additional fishing periods are allowed and/or regularly scheduled periods may be closed by emergency order; however, no additional fishing periods may be allowed after 15 August (5 AAC 21.363 *Upper Cook Inlet Salmon Management Plan*). Only set gillnet gear is allowed in Northern District waters (5 AAC 21.330 *Gear*). Statistical area 247-50 is only opened through emergency order (5 AAC 21.364 *Fish Creek Sockeye Salmon Management Plan*) and statistical area 247-60 is closed to commercial fishing (5 AAC 21.350 *Closed Waters*).

Coho salmon processed in the Anchorage area during 1997 were composed entirely of fish harvested in Northern District statistical areas. Three technicians and one college intern in Anchorage sampled commercial harvests primarily at two shorebased processors, North Alaska Fisheries and Great Pacific Seafoods. Some sampling also occurred at Alaska Smoked Salmon International and Sahalee of Alaska. Setnet harvests from statistical areas 247-70, 247-80, and 247-90, purchased by Cook Inlet Processors in Nikiski, were sampled regularly by personnel from Soldotna. Some coho salmon harvested from statistical areas 247-10, 247-20, and 247-30 were sampled at Icicle Seafoods in Homer by Soldotna-based technicians. We needed to examine 35% of the harvest of each Northern District statistical area in order to achieve the

desired accuracy and precision of the estimated harvest of hatchery-reared coho salmon. The project biologist and/or the technicians contacted processors throughout the season to coordinate sampling logistics and to ensure that all fish possible were examined.

Harvest from the Northern District was sampled in Anchorage, Homer, and Nikiski from 14 July-4 August 1997.

Central District

The Central District driftnet fleet operates in seven statistical areas and the setnet fishery occurs in 13 statistical areas (Figure 1). Coho salmon harvested by driftnet were sampled from six statistical areas (244-50, 244-60, 244-70, 245-70, 245-80, and 245-90) and those harvested by setnet were sampled from four statistical areas (244-21, 244-22, 244-30, and 244-40) composing the Upper Subdistrict (eastside) setnet fishery. We needed to examine 25% of the Central District driftnet harvest and 15% of the coho salmon harvested from each Central District eastside setnet statistical area to achieve the desired accuracy and precision of our estimates of commercial harvest.

Commercial fishing periods of both the driftnet and eastside setnet fisheries occur between 7:00 a.m. and 7:00 p.m. on Mondays and Fridays (5 AAC 21.320 *Weekly Fishing Periods*). Dates of the driftnet fishery are restricted to 25 June (except when 25 June falls within a closed weekly period, then the season will open the next following open weekly period) through 9 August (5 AAC 21.310). The *Upper Cook Inlet Salmon Management Plan* (5 AAC 21.363) restricts the dates of the setnet fishery from 1 July through 15 August. Additional fishing periods are allowed through emergency order and regularly scheduled periods may be closed by emergency order. Several management plans affect time and area closures or openings of both fisheries (5 AAC 21.358 *Northern District Coho Salmon Management Plan;* 5 AAC 21.359 *Kenai River Late Run Chinook Salmon Management Plan;* 5 AAC 21.360 *Kenai River Late Run Sockeye Salmon Management Plan;* 5 AAC 21.361 *Russian River Sockeye Salmon Management Plan;* 5 AAC 21.363 *Upper Cook Inlet Salmon Management Plan;* and 5 AAC 21.365 *Kasilof River Sockeye Salmon Special Harvest Area Management Plan*).

Most coho salmon harvested from the Central District driftnet and Central District eastside setnet fisheries as well as some coho salmon harvested by Northern District setnet fisheries were processed at facilities on the Kenai Peninsula. Commercial catch sampling of these coho salmon harvests was conducted under the supervision of CFMD biologists in Soldotna. Sampling of the driftnet harvest occurred at Carlson Seafoods, Cook Inlet Processing, Deep Creek, Dragnet Fisheries, Icicle Seafoods, Inlet Salmon, Pacific Star, Royal Pacific Fisheries, Salamatof Seafoods, Snug Harbor Seafoods, Trans-Aqua International, and Wards Cove Packing. The Central District eastside setnet harvest was sampled at buying stations of major fish processors. These processors included: Cook Inlet Processing, Deep Creek, Dragnet Fisheries, Fishhawk Fisheries, Icicle Seafoods, Inlet Salmon, Pacific Star, R & J Seafoods, Royal Pacific Fisheries, Salamatof Seafoods, Snug Harbor, Trans-Aqua International, and Wards Cove Packing.

The driftnet harvest was sampled by six technicians from 2 July-4 August 1997. The harvest in the eastside setnet fishery was sampled by four technicians from 11 July-4 August 1997.

Escapement

Multiple foot surveys were conducted on Ship Creek to index the coho salmon escapement and insure that the biological escapement goal (BEG) was being met. The peak coho salmon count

was used as the final tally (Appendix A1). Returning adult coho salmon were examined for the presence or absence of an adipose fin during brood stock collection. The total number of coho salmon examined and the number of fish missing the adipose fin was recorded.

A single foot survey conducted during peak spawning was used to index coho salmon escapements in both Bird and Campbell creeks (Appendix A1). Coho salmon in the Campbell Creek escapement were captured using a beach seine and examined for the presence or absence of an adipose fin one day each week from 12 September-2 October 1997. Seining occurred upstream of Lake Otis Parkway. Captured fish were marked with a caudal hole punch to prevent double sampling.

A weir was operated on Wasilla Creek (Whitmore and Sweet 1998) at river mile 5 to enumerate the coho salmon escapement and examine coho salmon for a missing adipose fin. The weir was approximately 4 miles upstream of Spring Creek, a tributary of Wasilla Creek located on the Matanuska River Flats that was also the release site for coho salmon stocked into Wasilla Creek. Coho salmon were also enumerated and examined for missing adipose fins during foot surveys near the confluence of Spring and Wasilla creeks and at a weir located on Spring Creek near the Wasilla Creek confluence.

Multiple foot and aerial surveys were conducted to index wild stock coho salmon escapements in selected Twentymile and Placer river drainages and selected Portage Creek tributaries. Peak coho salmon counts were used as the final tally (Appendix A2).

DATA ANALYSIS

Estimating Commercial Harvest of Stocked Coho Salmon

Estimating the commercial harvest of a cohort required determining the proportion of fish marked with a coded wire tag and adipose finclip. The proportion of tagged coho salmon stocked at each location and tag retention was assumed known prior to release (Starkey et al. 1997). Based on inriver tag recoveries from adult coho salmon in previous years (Hoffmann and Hasbrouck 1994; Stratton et al. 1996; Cyr et al. 1997, 1998) we assumed tag loss after release was insignificant in 1997.

Harvest of a single marked cohort (release group) of fish in a stratum was estimated by (Bernard and Clark 1996):

$$\hat{r}_{ij} = N_i \theta_j^{-1} \left(\frac{m_{ij}}{\lambda_i n_i} \right), \qquad (1)$$

where:

N_i = total number of fish harvested in stratum i,

θ_j = proportion of cohort j marked and released with a coded wire tag,

m_{ij} = number of decoded coded wire tags from cohort j in stratum i,

n_i = number of fish in stratum i sampled for a missing adipose fin,

λ_i = $\frac{t_i' a_i'}{t_i a_i}$, which is the decoding rate of coded wire tags from marked fish sampled in stratum i,

a_i = number of fish sampled in stratum i missing their adipose fin,

a_i' = number of heads from a_i that arrived at the Tag Lab,

t_i = number of heads from a_i' with coded wire tags detected, and

t_i' = number of tags from t_i that were decoded.

This estimator is statistically unbiased when sampling is from a simple random or pseudo-random process (Bernard and Clark 1996).

When the harvest (N_i) and the proportion marked (θ_j) are known without error the large-sample approximation of an unbiased estimate of the variance is:

$$\hat{V}(\hat{r}_{ij}) = \frac{\hat{r}_{ij}}{\lambda_i \phi_i \theta_j}(1 - \lambda_i \phi_i \theta_j), \quad (2)$$

where: $\phi_i = \frac{n_i}{N_i}$.

Values of harvest from the fish ticket database are assumed known and measured without error. The values of θ_j at the time of release (Starkey et al. 1997) were used and treated as known values measured without error for all 1996 releases.

Harvest of each cohort was stratified by date and statistical area for each sampled fishery. Statistical area was unknown when catch sampling the Central District driftnet fishery so harvest of this fishery was stratified only by date. The total harvest of a cohort in a fishery was estimated by summing the estimates among the strata. Variance of the total estimate was also calculated by summing the variances of the strata estimates since strata were assumed independent and there were no additional covariance terms.

In 1997 nearly all catch sample data from Northern District statistical areas 247-10, 247-20, 247-30, 247-70, 247-80, and 247-90 contained a mixture of coho salmon harvested from more than one statistical area. Most coho salmon harvested from statistical areas 247-41, 247-42, and 247-43 were sampled throughout the season without being combined with fish harvested from other statistical areas. Sample data and harvest from all Northern District statistical areas except 247-43 were combined into three larger geographic areas: westside (247-10, 247-20, and 247-30); eastside (247-70, 247-80, and 247-90); and Susitna Flat/Point MacKenzie (247-41 and 247-42). Analyses of data collected in previous years indicated that combining catch sample and harvest data into these larger areas did not bias estimates of harvest of hatchery-reared coho salmon (Hoffmann and Hasbrouck 1994, Stratton et al. 1996, Cyr et al. 1997, 1998).

Estimating Sport Harvest and Escapement of Stocked Coho Salmon

The harvest of hatchery-produced coho salmon by the sport fisheries in Campbell, Ship, and Wasilla creeks was estimated using SWHS estimates of total sport harvest, the proportion of fish

marked with an adipose finclip at time of release, and recovery data collected from returning adults during beach seining (Campbell Creek), brood stock collection (Ship Creek), and weir operation at Spring Creek (Wasilla Creek). No heads were collected from coho salmon missing the adipose fin and all finclipped fish observed were assumed to be from hatchery stockings into the respective stream. Based on recovery data in previous years (Hoffmann and Hasbrouck 1994, Stratton et al. 1996, and Cyr et al. 1997, 1998) the straying rate from stream of origin was assumed insignificant. Field observations indicated that sport anglers were not selective in harvesting coho salmon in these streams, so it was assumed that the marked proportion of fish observed in the escapement was the same as that in the respective sport harvest. Contribution of hatchery-produced coho salmon to the sport harvest of each creek was estimated by:

$$\hat{r}_i = \hat{N}_i \ \psi_j^{-1}\left(\frac{m_{ij}}{n_i}\right), \tag{3}$$

$$\hat{V}(\hat{r}_i) = \hat{r}_i^2\left[\left(\frac{1-\hat{\phi}_i\psi_j}{m_{ij}}\right) + G\left(\hat{N}_i\right) - \left(\frac{1-\hat{\phi}_i\psi_j}{m_{ij}}\right)G\left(\hat{N}_i\right)\right], \tag{4}$$

where:

$\hat{N}_i$ = SWHS estimates of coho salmon sport harvest for stream i,

m_{ij} = number of fish missing the adipose fin observed from cohort j in stream i,

n_i = total number of coho salmon sampled in stream i,

ψ_j^{-1} = proportion of cohort j marked with an adipose finclip at time of release,

$\hat{\phi}_i$ = $\frac{n_i}{\hat{N}_i}$, and

$G\left(\hat{N}_i\right)$ = coefficient of variation squared of total sport harvest.

The contribution of hatchery-produced coho salmon to the indexed escapements in Campbell, Ship, and Wasilla creeks was estimated using equations (3) and (4). The indexed escapements from foot surveys $\left(\hat{N}_i\right)$ were measured without error, therefore, the coefficient of variation $G\left(\hat{N}_i\right)$ was zero.

All coho salmon in the sport harvest and indexed escapement at Bird Creek were assumed from hatchery releases because no significant numbers of coho salmon were observed in Bird Creek prior to the initial stocking in 1992.

RESULTS

COMMERCIAL HARVEST OF STOCKED COHO SALMON

A total of 152,836 coho salmon were harvested in (UCI) mixed-stock fisheries in 1997 (Table 2). A combined total of 136,014 coho salmon were harvested in the sampled fisheries (Table 3). Catch sampling did not occur over the entire fishing season; however, only 1% of the overall

Table 2.-Commercial salmon harvest in Upper Cook Inlet, 1997.

Fishery	Statistical Area	Chinook	Sockeye	Coho	Pink	Chum	Total Catch	% Coho
Central District Drift								
General (East/West Sides)	245-70,80,90; 244-50,60,70	632	2,199,903	79,094	30,100	92,546	2,402,275	3.3%
Central District Set								
Westside								
Western, Kustatan	245-20,30,40,50,55,60	179	19,794	7,789	2,403	1,461	31,626	24.6%
Kalgin Island	246-10,20	28	28,757	8,905	2,287	207	40,184	22.2%
Chinitna Bay	245-10	0	172	11	11	102	296	3.7%
Total		207	48,723	16,705	4,701	1,770	72,106	23.2%
Eastside								
Ninilchik	244-21	2,280	240,422	1,504	12,874	163	257,243	0.6%
Cohoe	244-22	2,872	405,545	3,037	10,169	240	421,863	0.7%
Kalifonsky	244-30	3,932	492,739	3,883	3,918	507	504,979	0.8%
Salamatof	244-40	2,197	694,110	11,244	5,085	312	712,948	1.6%
Total		11,281	1,832,816	19,668	32,046	1,222	1,897,033	1.0%
Central District total		12,120	4,081,442	115,467	66,847	95,538	4,371,414	2.6%
Northern District Set								
Susitna Flat	247-41	119	4,239	3,843	140	896	9,237	41.6%
Pt. MacKenzie	247-42	71	2,373	1,140	48	258	3,890	29.3%
Fire Island	247-43	45	3,352	3,748	257	1,191	8,593	43.6%
Knik Arm	247-50	1	13,224	117	2	42	13,386	0.9%
Total		236	23,188	8,848	447	2,387	35,106	25.2%
Westside								
Trading Bay	247-10	262	8,454	1,965	272	94	11,047	17.8%
Tyonek	247-20	275	15,519	7,472	1,034	740	25,040	29.8%
Beluga	247-30	159	39,926	16,865	2,187	4,225	63,362	26.6%
Total		696	63,899	26,302	3,493	5,059	99,449	26.4%
Eastside								
Pt. Possession	247-70	160	5,000	2,054	213	430	7,857	26.1%
Birch Hill	247-80	10	1,370	88	26	3	1,497	5.9%
Number 3 Bay	247-90	18	3,994	77	90	2	4,181	1.8%
Total		188	10,364	2,219	329	435	13,535	16.4%
Northern District setnet total		1,120	97,451	37,369	4,269	7,881	148,090	25.2%
Upper Cook Inlet total		13,240	4,178,893	152,836	71,116	103,419	4,519,504	3.4%

Table 3.-Commercial coho salmon harvest, harvest dates, and sampling dates for sampled Upper Cook Inlet fisheries, 1997.

Fishery	Statistical Area	Catch Dates	Total Coho Catch	Sampling Dates	Catch During Sampling	Sampled[a]
Central District Drift	244, 245	6/27-8/04	79,094	6/27-8/04	79,094	100.0%
Central District Set						
Ninilchik	244-21	7/04-8/04	1,504	7/04-8/04	1,504	100.0%
Cohoe	244-22	7/02-8/04	3,037	7/11-8/04	2,986	98.3%
Kalifonsky	244-30	6/30-8/04	3,883	7/05-8/04	3,879	99.9%
Salamatof	244-40	7/11-8/04	11,244	7/11-8/04	11,244	100.0%
Eastside Setnet Total			19,668		19,613	99.7%
Northern District Set						
Westside	247-10,20,30	6/30-8/04	26,302	7/14-8/04	25,275	96.1%
Susitna Flats/Pt. MacKenzie	247-41,42	7/07-8/04	4,983	7/14-8/04	4,787	96.1%
Fire Island	247-43	6/27-8/04	3,748	7/14-8/04	3,738	99.7%
Eastside	247-70/80/90	6/27-8/04	2,219	7/14-8/04	2,181	98.3%
Northern Setnet Total			37,252		35,981	96.6%
Upper Cook Inlet Total			136,014		134,688	99.0%

[a] Percentage of total coho salmon harvest represented by sampling.

UCI coho salmon harvest in the selected fisheries occurred on days not sampled. Harvest on days not sampled was combined with the nearest day the harvest was sampled to estimate harvest of marked cohorts for the entire season.

Technicians examined 43% of the total harvest for sampled UCI fisheries and 5% of the fish examined had a missing adipose fin. In the Northern District, 65% of the coho salmon harvested were examined for a missing adipose fin. In the Central District, 38% were sampled in the driftnet and 21% were examined in the eastside setnet fisheries. It was possible to sample a greater proportion of the Northern District harvest than the Central District harvest because fewer processors purchased fish, there were fewer fishing periods, and all fishing periods were scheduled openings rather than a combination of scheduled and emergency order openings.

Z-tests to determine if estimates of harvest between data stratified and the data combined were not significantly different could not be performed for the majority of sample data collected from Northern District statistical areas. As a result, sample data from statistical areas 247-10, 247-20, and 247-30 were combined and sample data from areas 247-70, 247-80, and 247-90 were combined based on historical treatment of these areas. Most samples collected from statistical areas 247-41 and 247-42 were pure loads. Previously, the harvest estimates from these two areas were also combined when it was determined that the estimates of harvest between data stratified and with the data combined were not significantly different and combining the data improved the precision of the overall estimates (Cyr et al. 1997, 1998). In 1997, for 3 days when pure loads were sampled from 247-41 and 247-42, harvest estimates of stocked coho salmon were not

significantly different (|z| = 0.16, P = 0.87) between data stratified by statistical area or with the data combined among the two areas; therefore, data from 247-41 and 247-42 were combined. Combining statistical areas in this fashion allowed the use of sample data from mixed loads collected from adjacent statistical areas. There was no pooling of statistical areas from the Central District eastside setnet fishery because precision of the estimates did not improve appreciably when the areas were combined. Therefore, harvest estimates of marked cohorts were stratified by statistical area and by date.

The majority of the UCI coho salmon harvest in the sampled fisheries occurred in the Central District driftnet fishery (58%), followed by the Northern District setnet fishery (27%), and the Central District eastside setnet fishery (15%) (Figure 3). Most of the coded wire tags recovered (Table 4) and most of the harvest of hatchery-produced coho salmon occurred in the Central

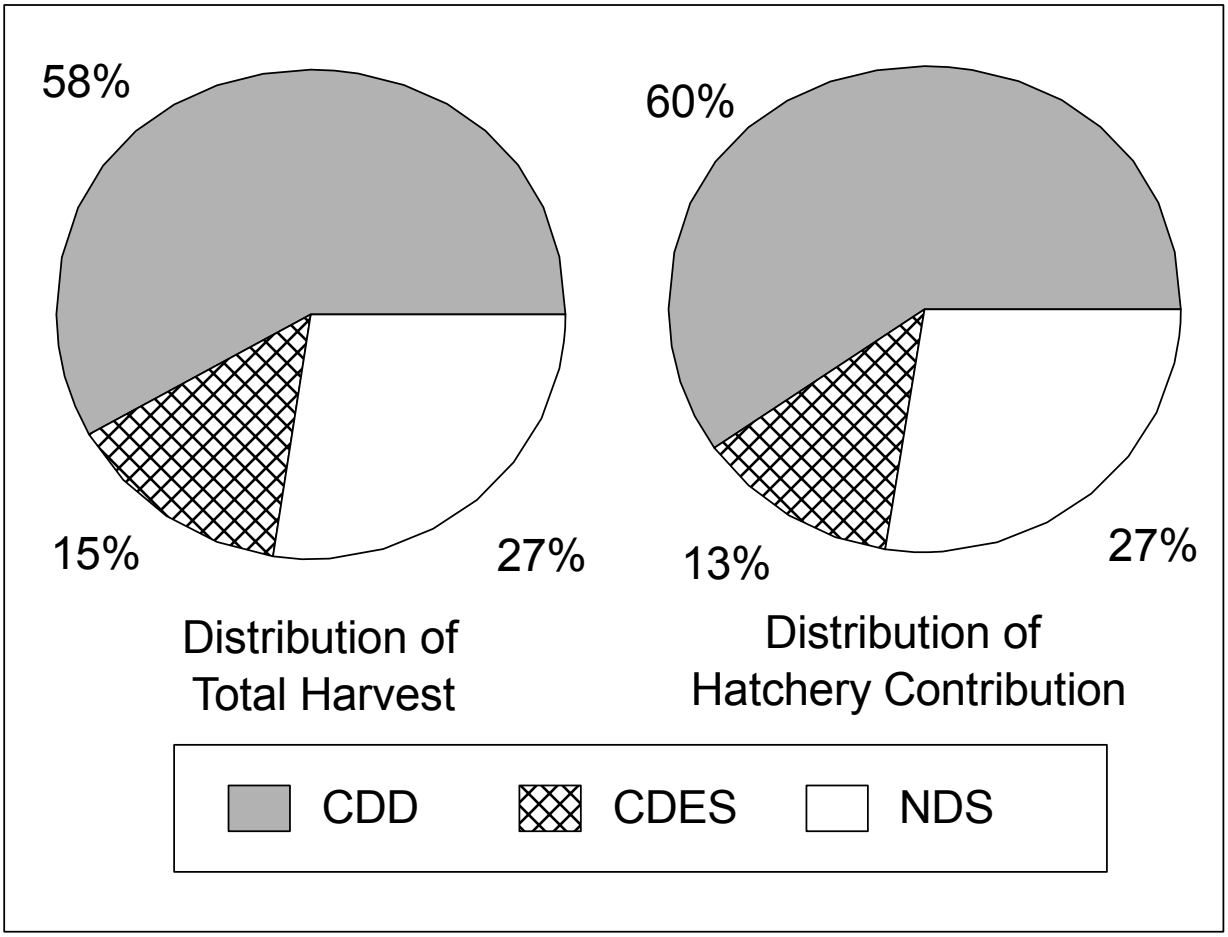


Figure 3.-Distribution of coho salmon harvest and hatchery contribution among three Upper Cook Inlet fisheries: Central District driftnet (CDD), Central District eastside setnet (CDES), and Northern District setnet (NDS), 1997.

Table 4.-Harvest, sampling data, and coded wire tag recoveries for selected Upper Cook Inlet commercial coho salmon fisheries, 1997.

Fishery	Catch During Sampling	Number of Coho Observed	Number of Heads Collected	1996 Release Sites: Bird Creek	1996 Release Sites: Anch Urban Streams	1996 Release Sites: Wasilla Creek	Tag Not Detected	Tag/Head Lost	Total[a]
Central District									
Driftnet	79,094	29,830	1,193	279	512	222	89	8	1,110
Eastside Setnet									
Ninilchik	1,504	371	25	2	4	1		2	9
Cohoe	2,986	607	38	5	11	4	2	1	23
Kalifonsky Beach	3,879	842	25	3	6	2			11
Salamatof	11,244	2,237	142	30	35	25	7	1	98
Eastside Setnet Total	19,613	4,057	230	40	56	32	9	4	141
Central District Total	98,707	33,887	1,423	319	568	254	98	12	1,251
Northern District									
Westside[b]	25,275	15,164	132	12	56	35	22	1	126
Susitna Flat/Pt. MacKenzie[c]	4,787	5,049	584	61	309	182	31		583
Fire Island	3,738	2,274	366	63	237	46	20		366
Eastside[d]	2,181	1,661	107	40	42	13	10		105
Northern District Total	35,981	24,148	1,189	176	644	276	83	1	1,180
Upper Cook Inlet Total	134,688	58,035	2,612	495	1,212	530	181	13	2,431

[a] Total does not include heads collected with Kenai River (1), Moose River (157), or Deshka River (21) coded wire tags and 2 heads collected from 1995 releases.

[b] Combination of statistical areas 247-10, 247-20, and 247-30.

[c] Combination of statistical areas 247-41 and 247-42.

[d] Combination of statistical areas 247-70, 247-80, and 247-90.

District driftnet and Northern District setnet fisheries (Table 5, Figure 3). Overall, stocked coho salmon represented 11.7% (SE = 0.5%) of the total UCI coho salmon commercial harvest (Table 6, Figure 4). When estimated by fishery, 12.1% (SE = 0.7%) of the Central District driftnet fishery, 10.5% (SE = 1.2%) of the Central District eastside setnet, and 11.8% (SE = 0.4%) of the Northern District setnet harvests were composed of hatchery-produced fish (Table 6, Figure 5). The Central District driftnet fishery took 59% of the total commercial harvest of coho salmon stocked into Anchorage Urban Streams; 65% of the total commercial harvest of coho salmon stocked into Bird Creek, and 57% of the total commercial harvest of coho salmon stocked into Wasilla Creek. The Northern District setnet fishery took 30% of the estimated total commercial harvest of coho salmon stocked into Anchorage Urban Streams, 19% of the estimated total commercial harvest of coho salmon stocked into Bird Creek, and 30% of the total commercial harvest of coho salmon stocked into Wasilla Creek. The Central District eastside setnet fishery

Table 5.-Estimated harvest ($\hat{r}_{ij}$) and standard error (SE) of coho salmon stocked in Northern Cook Inlet streams in 1996 by sampled Upper Cook Inlet commercial fisheries, 1997.

	Stocking Location							
	Anch. Urban Streams		Bird Creek		Wasilla Creek		Total	
Fishery	$\hat{r}_{ij}$	SE	$\hat{r}_{ij}$	SE	$\hat{r}_{ij}$	SE	$\hat{r}_{ij}$	SE
Central District								
Drifnet [a]	5,106	512	2,474	147	1,955	130	9,535	549
Eastside Setnet								
Ninilchik [b]	53	26	30	21	13	12	96	35
Cohoe [c]	230	78	91	41	73	36	394	95
Kalifonsky [d]	66	27	28	16	26	18	120	36
Salamatof [e]	627	136	465	127	354	90	1,446	206
Eastside setnet total	976	161	614	135	466	99	2,056	232
Northern District								
Westside [f]	308	38	66	18	182	28	556	50
Su Flat/ Pt. MacKenzie [g]	966	57	166	20	572	52	1,704	79
Fire Island [h]	1,165	76	323	40	230	34	1,718	92
Eastside [i]	182	27	175	27	54	14	411	41
Northern District total	2,621	105	730	55	1,038	70	4,389	138
Upper Cook Inlet Total	8,703	547	3,818	207	3,459	178	15,980	612

[a] Includes statistical areas 244-50, 244-60, 244-70, 245-70, 245-80, and 245-90.

[b] Statistical area 244-21.

[c] Statistical area 244-22.

[d] Statistical area 244-30.

[e] Statistical area 244-40.

[f] Includes statistical areas 247-10, 247-20, and 247-30.

[g] Includes statistical areas 247-41 and 247-42.

[h] Statistical area 247-43.

[i] Includes statistical areas 247-70, 247-80, and 247-90.

took only 11% of the total commercial harvest of coho salmon stocked into the Anchorage Urban Streams, 16% of the coho salmon stocked into Bird Creek, and 13% of the total commercial harvest of coho salmon stocked into Wasilla Creek (Figure 6). Most of the harvest of hatchery coho salmon in the Central District eastside setnet fishery occurred in statistical areas 244-22 and 244-40.

About 80% of the commercially harvested hatchery-origin coho salmon were harvested in the aforementioned fisheries from 25 July to 4 August (Appendices B3-B11). In the Northern

Table 6.-Estimated harvest ($\hat{r}_{ij}$) and standard error (SE) of Northern Cook Inlet hatchery-produced coho salmon from 1996 releases in sampled commercial fisheries, 1997.

Sampled Fishery	Statistical Area	Coho Catch	1996 Releases $\hat{r}_{ij}$	SE	%	SE
Central District Drift[a]	244, 245	79,094	9,535	549	12.1%	0.7
Central District Eastside Set						
Ninilchik	244-21	1,504	96	35	6.3%	2.4
Cohoe	244-22	3,037	394	95	13.0%	3.1
Kalifonsky	244-30	3,883	120	36	3.1%	0.9
Salamatof	244-40	11,244	1,446	206	12.9%	1.8
Eastside Setnet Total		19,668	2,056	232	10.5%	1.2
Northern District Set[b]						
Westside	247-10,20,30	26,302	556		2.1%	0.2
Susitna Flats/Pt. MacKenzie	247-41,42	4,983	1,704		34.2%	1.6
Fire Island	247-43	3,748	1,718		45.8%	2.5
Eastside	247-70/80/90	2,219	411	41	18.5%	1.8
Northern Setnet Total		37,252	4,389	138	11.8%	0.4
Sampled Upper Cook Inlet Fisheries Total		136,014	15,980	612	11.7%	0.5

[a] Excluding Chinitna Bay substat area.

[b] Excluding Knik Arm substat area.

District, 78% of fish stocked into Bird Creek and Anchorage Urban Streams were harvested around Fire Island (247-43) and in the Susitna Flats (247-41) and Pt. MacKenzie (247-42) statistical areas near Anchorage. Over 50% of coho salmon stocked into Wasilla Creek and recovered in the Northern District were harvested in the Susitna Flats (247-41) and Pt. MacKenzie (247-42) statistical areas. The returns of coho salmon stocked into Anchorage Urban Streams in 1996 composed 54% (8,703 coho salmon) of the hatchery returns in all sampled commercial fisheries (Figure 4). Coho salmon stocked into Bird Creek in 1996 provided 24% (3,818 coho salmon), and coho salmon stocked in Wasilla Creek in 1996 provided 22% (3,458 coho salmon) of hatchery returns in all sampled fisheries (Figure 4). Contributions to the sampled commercial fisheries from 1995 smolt releases into Bird Creek and Little Susitna River can be found in Appendices B1-B2.

SPORT HARVEST AND ESCAPEMENT

An estimated 9,689 (SE = 1,182) coho salmon were harvested in the Ship Creek sport fishery (Howe et al. 1998). A total of 171 coho salmon were missing the adipose fin from 549 fish examined during brood stock collection at Ship Creek from 27 August-17 September 1997. An

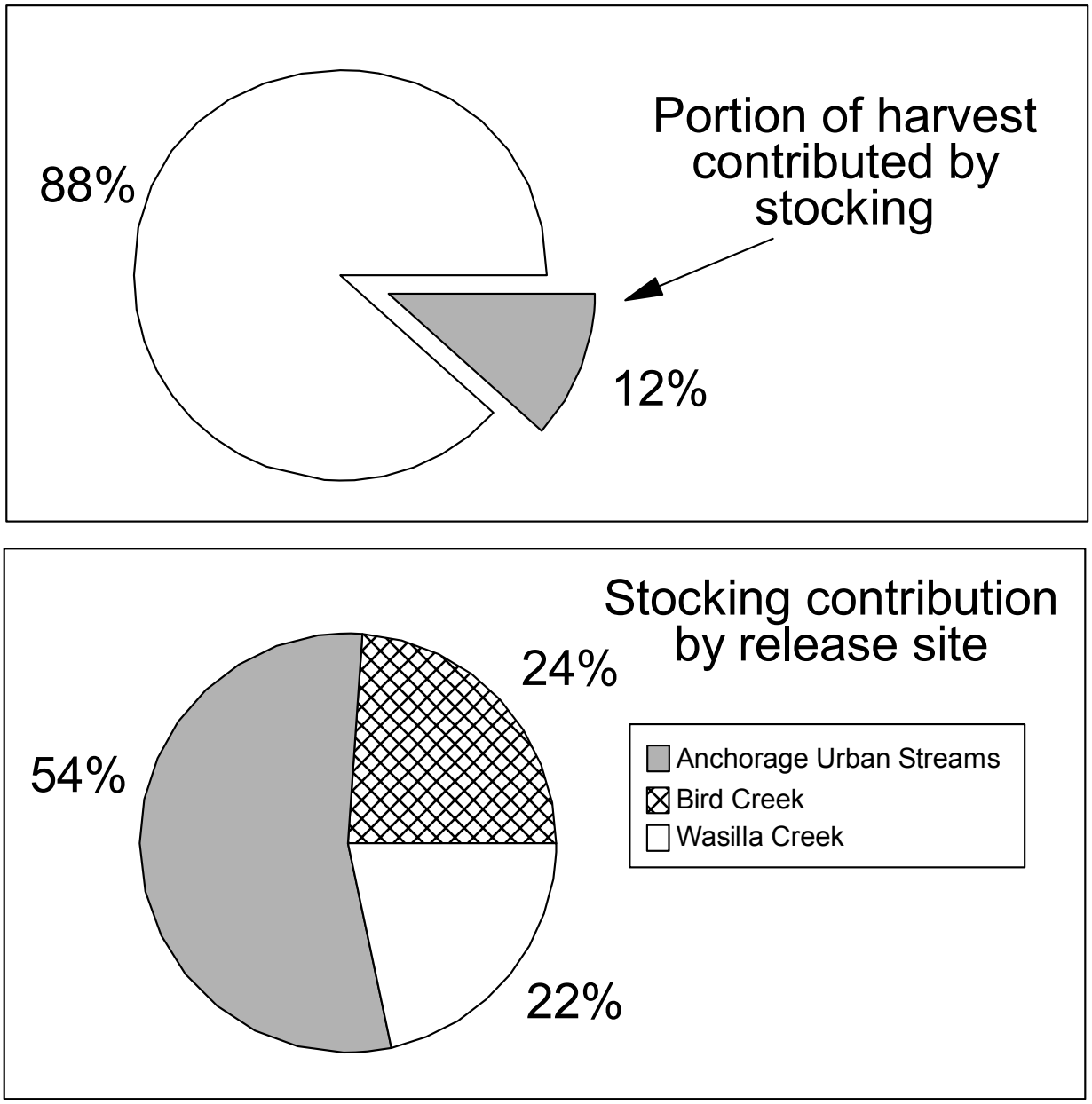


Figure 4.-Portion of 1997 Upper Cook Inlet coho salmon commercial harvest represented by urban stocked fish.

estimated 9,611 (SE = 1,377) coho salmon, or 99%, of the Ship Creek sport harvest was from hatchery releases. On 14 August 1,205 coho salmon were counted upstream of Chugach dam during the final escapement index on Ship Creek (Appendix A1). An estimated 1,195 (SE = 85), or 99%, of these fish were from hatchery releases.

An estimated 1,801 (SE = 487) coho salmon were sport harvested in Campbell Creek (Howe et al. 1998). A total of 295 coho salmon were examined during beach seining of returning adults

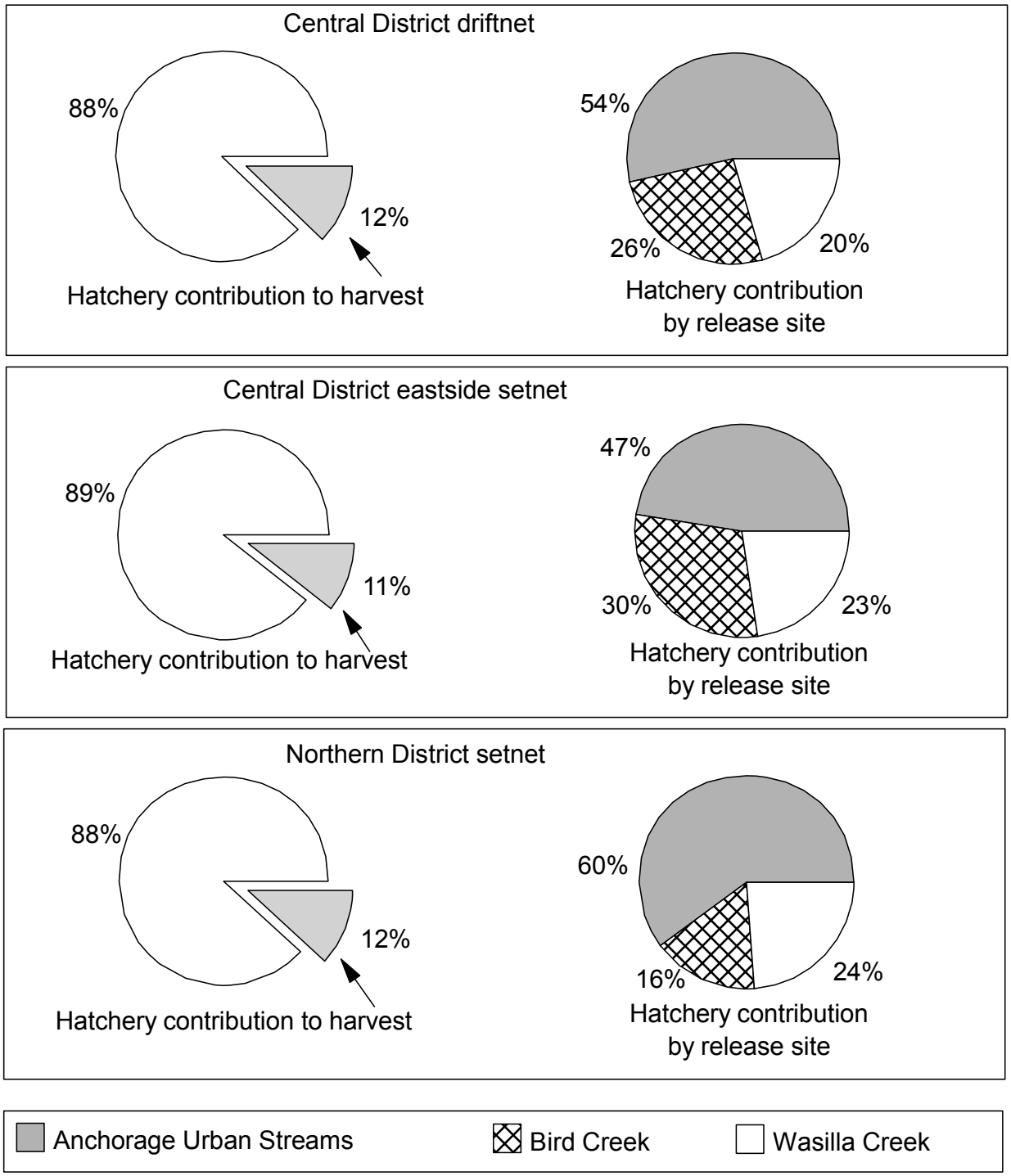


Figure 5.-Portion of 1997 Central District driftnet, Central District eastside setnet, and Northern District setnet coho salmon commercial harvests represented by urban stocked fish.

from 12 September-2 October 1997, of which 70 fish were missing the adipose fin. An estimated 1,429 (SE = 418), or 79%, of coho salmon in the Campbell Creek sport harvest were from hatchery releases. The coho salmon escapement index into Campbell Creek on 26 September was 1,007 fish (Appendix A1). An estimated 799 (SE = 91), or 79%, of the indexed escapement was from hatchery releases. The remaining 208 (SE = 91) coho salmon were assumed to be from natural production.

The estimated Bird Creek coho salmon sport harvest was 7,428 (SE = 1,023) fish (Howe et al. 1998). A coho salmon escapement index conducted on 3 October in Bird Creek and Penguin Creek (a tributary of Bird Creek) counted 603 coho salmon (Appendix A1).

An estimated 775 (SE = 190) coho salmon were sport harvested in Wasilla Creek (Howe et al. 1998). A total of 437 coho salmon were passed through the Wasilla Creek weir from 7 July to 19 September. None of these fish were missing the adipose fin. A total of 296 coho salmon, 22 of which were missing the adipose fin, were sampled at the weir on Spring Creek from 19 September to 8 October. No heads were collected from coho salmon missing the adipose fin, all were assumed originally stocked into the Wasilla Creek drainage at Spring Creek. In addition, heads were collected from 14 coho salmon gillnetted on 20 November that were missing the adipose fin. All decodable tags were from coho salmon released into the Wasilla Creek drainage in 1996. An estimated 179 (SE = 56) coho salmon, or 23%, of the Wasilla Creek sport harvest were from hatchery releases. The indexed coho salmon escapement into Spring Creek was 296 fish. An estimated 68 fish (SE = 12), or 23%, of the escapement were from hatchery releases. The total coho salmon escapement (665 fish) in Wasilla Creek was the combined escapements to the weirs on Wasilla and Spring creeks.

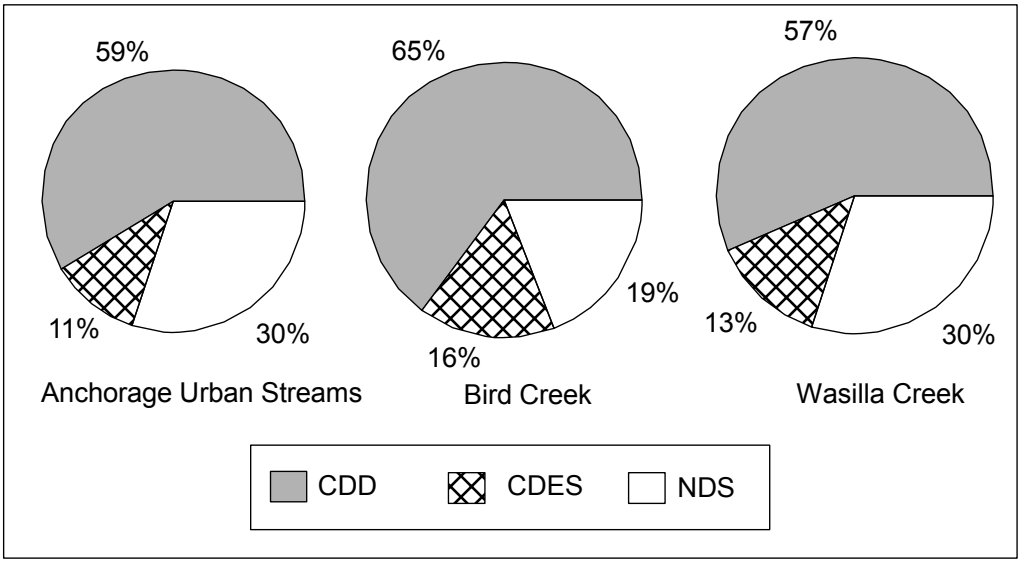


Figure 6.-Percent of the commercial harvest of each 1996 hatchery release group attributed to the Central District driftnet (CDD), Central District eastside setnet (CDES), and Northern district setnet (NDS) fisheries, 1997.

Aerial surveys conducted on 3 and 16 October tallied a total of 1,000 and 560 coho salmon in Twentymile and Placer (including sloughs and Skookum Creek) river drainages, respectively (Appendix A2). A total of 80 coho salmon were observed in selected Portage Creek sloughs and streams (Appendix A2). Turnagain Arm escapement surveys were conducted later in the season because peak spawning of these native coho salmon stocks is generally 3-6 weeks later than streams stocked with Little Susitna brood stock.

RETURNS

Total returns of coho salmon to urban area streams are made up of three measurable components: commercial harvest, inriver sport harvest, and spawning escapement (Table 7). The indexed escapements and estimates of commercial harvest are presented in this report. Total inriver sport harvest was estimated by the SWHS (Howe et al. 1998). Approximately 40% of Anchorage Urban Streams hatchery returns, 32% of Bird Creek hatchery returns, and 93% of Wasilla Creek hatchery returns were harvested by the commercial fishery (Figure 7).

Inseason observations of the sport fishery in the Anchorage urban streams indicated that the coho salmon stocking program met expectations. Estimates from the SWHS (Howe et al. 1998) indicated sport harvest estimates for 1997 increased at Ship, Bird, and Campbell creeks compared to 1996 and sport effort estimates for 1997 increased in Ship and Campbell creeks and decreased slightly in Bird Creek compared to 1996 (Figure 8). Estimates of sport catch in 1997 increased in Ship and Bird creeks and remained essentially unchanged in Campbell Creek compared to 1996. Total effort in Bird, Campbell, and Ship creeks was nearly 86,000 angler-days in 1997 compared to the 1988-1992 (prestocking) annual average of 34,700 angler-days. A total harvest and catch of 18,918 (SE = 1,637) and 27,125 (SE = 2,420) coho salmon, respectively, also occurred in the three stocked streams.

The 1997 SWHS (Howe et al. 1998) estimates of sport harvest, catch, and angler effort at Wasilla Creek indicated a slight decrease compared to the 1996 estimates. The total coho salmon harvest and catch for Wasilla Creek in 1997 was 775 (SE = 190) and 1,217 (SE = 351).

MARINE SURVIVAL

Overall marine survival of the three major coho salmon cohorts released in 1996 and recovered in 1997 was 6.3% (SE = 0.3%) (Table 8). Survival estimates ranged from 2.5% (SE = 0.1%) for smolt released into Wasilla Creek to 8.0% (SE = 0.7%) for smolt released into Bird Creek. Estimated survival for smolt released into Anchorage Urban Streams was 7.2% (SE = 0.5%). Depending on release site, escapements were indexed and sport harvests and escapements were not sampled. Therefore, estimates of the total run, and thus survival, of stocked coho salmon are biased low.

DISCUSSION

COMMERCIAL CATCH ASSESSMENT

The sampling goal of examining 25% of the Central District driftnet harvest, and 15% of the coho salmon harvested from each Central District eastside setnet statistical area was met in 1997. Due to the low volume of coho salmon harvested by the Central District driftnet fleet, it was possible to examine a greater percentage of the total driftnet harvest (approximately 38%). Coho salmon examined in the Central District eastside setnet total harvests ranged from 20%-25% for each statistical area. The goal of examining 35% of the coho salmon harvested from each

Table 7.-Estimated hatchery and natural contributions to total coho salmon runs into Northern Cook Inlet stocked streams, 1997.

		Hatchery Production							
		Number Released				Natural Production		Total Production	
Stream		1995	1996	Total	%	Number	%	Number	%
Bird Creek	Commercial Harvest	5	3,818	3,823	32%	unknown		3,823	32%
	Sport Harvest	unknown	unknown	7,428	63%	unknown		7,428	63%
	Escapement[a]	unknown	unknown	603	5%	unknown		603	5%
	Total	5	3,818	11,854	100%			11,854	100%
Anchorage Urban Streams	Commercial Harvest	0	8,703	8,703	40%	unknown		8,703	39%
	Sport Harvest	unknown	unknown	11,040[b]	51%	450[c]	67%	11,490	51%
	Escapement[a]	unknown	unknown	1,994[b]	9%	218[c]	33%	2,212	10%
	Total	0	8,703	21,737	100%	668	100%	22,405	100%
Wasilla Creek	Commercial Harvest	0	3,458	3,458	93%	unknown		3,458	70%
	Sport Harvest	unknown	unknown	179	5%	596[e]		775	16%
	Escapement[d]	unknown	unknown	68	2%	665[f]		733	15%
	Total	0	3,458	3,705	100%	1,261		4,966	100%

[a] Estimated escapement index from foot surveys.

[b] Sport harvest and escapement is combined totals from Ship and Campbell creeks.

[c] Combined natural production from Campbell and Ship creeks estimated using proportion of natural production of coho salmon surveyed during beach seining operations at Campbell Creek and during brood stock collection at Ship Creek.

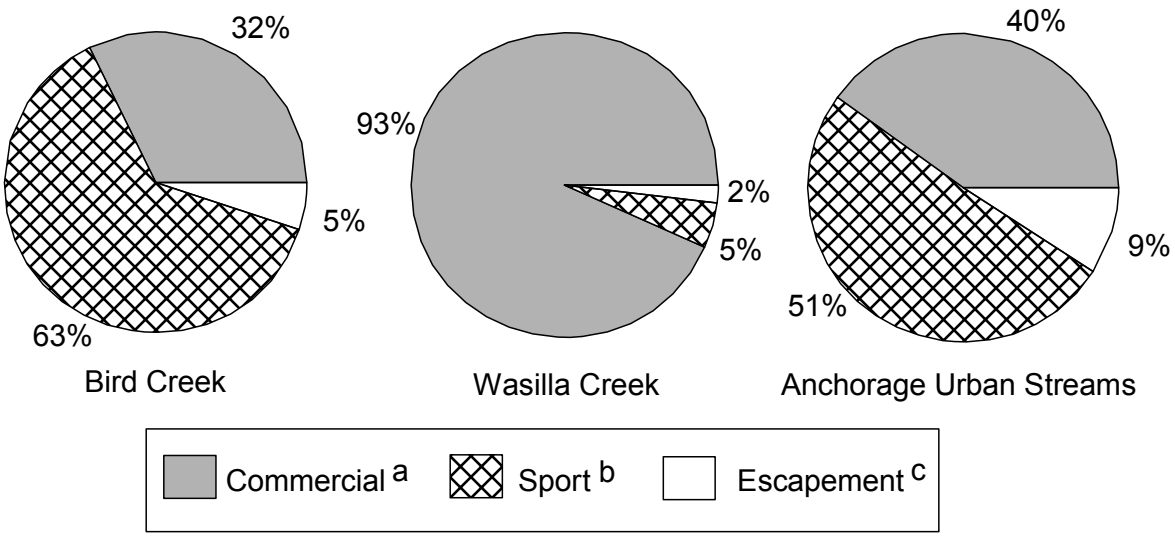
[d] Combined escapement from Wasilla Creek weir (7 July-19 September, weir pulled on 9 September due to high water) and Spring Creek (a tributary of Wasilla Creek) livebox (19 September-8 October).

[e] Natural production estimated using proportion of natural production of coho salmon to Spring Creek livebox.

[f] Combined natural production from Spring Creek livebox and total Wasilla Creek weir count.

Northern District statistical area was not met for statistical areas 247-10, 247-20, 247-30, 247-80, and 247-90. It was not always possible to examine pure loads from the aforementioned statistical areas as tender operators would often mix coho salmon from these areas with coho salmon harvested in adjacent or other statistical areas prior to reaching port. When harvests from adjacent statistical areas 247-10, 247-20, and 247-30 were combined and harvests from adjacent statistical areas 247-70, 247-80, and 247-90 were combined, 58% and 73% of the total harvests were sampled, respectively.

The sampling effort of the commercial harvest provided relatively precise estimates. Relative precision of the total harvest of hatchery-produced fish by the UCI commercial fisheries was 8%. Estimates were most precise for the Northern District setnet fisheries (6%) and the Central



[a] Estimate of hatchery contribution to the harvest from catch sampling data.

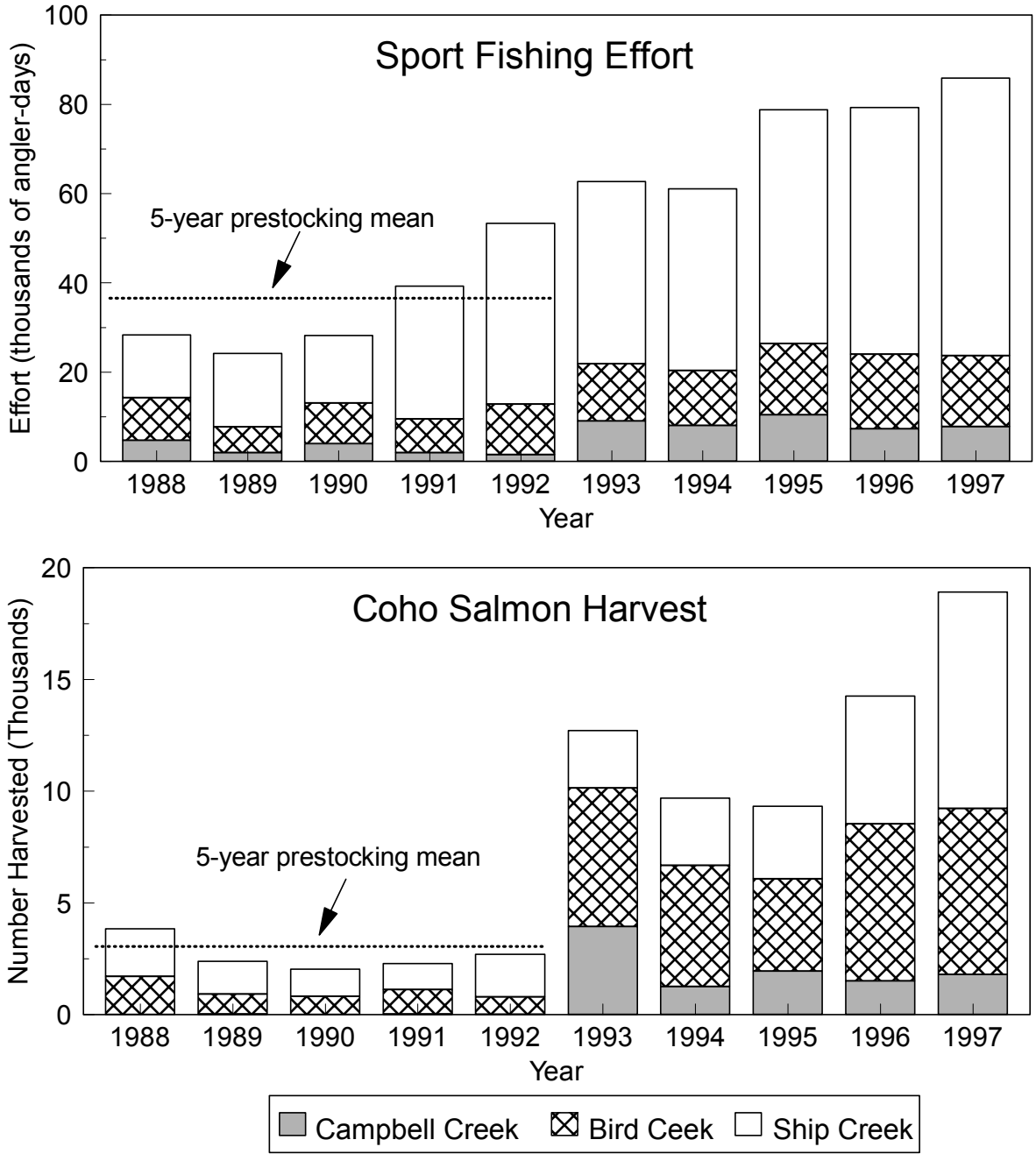
[b] Estimate of sport harvest of coho salmon from Statewide Harvest Survey (Howe et al. 1998). Hatchery releases in 1996 are assumed to comprise the total harvest at Bird Creek. Estimate of hatchery contribution to Anchorage Urban Streams sport harvest is the combined estimates for Ship and Campbell creeks and is based on data collected during beach seining in Campbell Creek and brood stock collection in Ship Creek. Estimate of hatchery contribution to Wasilla Creek sport harvest based on coho salmon collected at Spring Creek livebox.

[c] Estimate of hatchery contribution to Wasilla Creek escapement based on coho salmon collected at Spring Creek livebox. Estimate of hatchery contribution to Bird Creek and Anchorage Urban Streams escapements are minimum estimates of the total escapements from foot surveys. Estimate of hatchery contribution to Anchorage Urban Streams escapement is the combined hatchery contributions to Campbell and Ship creeks foot surveys. Estimate of hatchery contribution based on data collected during beach seining in Campbell Creek and brood stock collection in Ship Creek.

Figure 7.-Distribution of coho salmon total returns among commercial and sport fisheries and the escapement in three stocked sites, 1997.

District driftnet (11%), and much less precise for the Central District eastside setnet fishery (22%). The estimated harvest by the eastside setnet fishery was not as precise because a lower proportion of the harvest was sampled and because fewer tags were recovered from this fishery. The target precision levels by fishery were 20% for the Northern District setnet fishery, 15% for the Central District driftnet fishery, and 55% for the Central District eastside setnet fishery.

Target precision levels for commercial harvest estimates by release site were 10% for each stream. Harvest estimates of coho salmon stocked into Bird Creek and Anchorage Urban



Source: Mills 1989-1994, Howe et al. 1995-1998.

Figure 8.-Sport harvest and effort from 1988 to 1997 in Anchorage urban streams stocked with coho salmon.

Table 8.-Estimates and associated standard errors (in parentheses) used to estimate marine survival of coho salmon stocked into Northern Cook Inlet streams in 1996 based on return data in 1997.

	Smolt Releases [a]		Commercial Harvest		Sport Harvest		Escapement		Total Return [b]		Estimated Smolt Survival [c]	
Bird Creek	147,618	(1,953)	3,818	(207)	7,428 [d]	(1,023)	603 [e]		11,849	(1,044)	0.080	(0.007)
Anchorage Urban Streams	302,857	(4,853)	8,703	(547)	11,040 [f]	(1,440)	1,994 [g]	(124)	21,737	(1,545)	0.072	(0.005)
Wasilla Creek	145,923	(1,886)	3,458	(178)	179 [h]	(56)	68 [h]	(12)	3,705	(187)	0.025	(0.001)
Total	596,398	(5,561)	15,979	(612)	18,647	(1,767)	2,665	(125)	37,291	(1,874)	0.063	(0.003)

[a] Starkey et al. 1997.

[b] Does not include coho salmon expected to return in low numbers in 1998.

[c] Standard error of survival estimates are biased low because sampling variance not estimated for total escapement.

[d] Estimated total harvest (Howe et al. 1998). Total harvest assumed to be from 1996 releases, though negligible returns from previous years are likely included.

[e] Escapement index from foot survey represents a minimal estimate of the total escapement, with no estimate of sampling variability available.

[f] Estimated total harvest is the combined harvests from Campbell and Ship creeks. Hatchery contribution estimated using data from Ship Creek brood stock collection and from beach seining at Campbell Creek.

[g] Estimated total escapement is the combined foot survey indices from Campbell and Ship creeks and represents a minimal estimate of the total escapement, with no estimate of sampling variability available. Hatchery contribution and associated standard error estimated using data from Ship Creek brood stock collection and from beach seining at Campbell Creek.

[h] Estimated using data collected at Spring Creek livebox. Escapement represents a minimal estimate of the total escapement, with no estimate of sampling variability available. Assumed proportion of hatchery-stocked coho salmon in the sport harvest was the same as that observed at livebox.

Streams had good precision (relative precision < 13%) because: (1) approximately 30% of the smolt in each release group were tagged, and (2) a large sample from the commercial harvest was obtained. Estimates of harvest of fish stocked into Wasilla Creek were also relatively precise (10%).

The pattern of commercial coho salmon harvest was typical of previous years. Since 1993, the Central District driftnet fishery has harvested 45% or more of the total coho salmon harvested in the sampled UCI fisheries, the Central District eastside setnet fishery has harvested at least 12%, and the Northern District setnet fishery has harvested at least 24%.

The proportion of hatchery-stocked coho salmon in the Central District driftnet fishery and in most statistical areas in the Northern District setnet fishery remained largely unchanged from past years. The proportion of stocked fish in the Central District eastside setnet fishery did increase from the 1993-1996 average of 5% of the harvest (prior to 6 August) to 10% of the total Central District eastside setnet harvest in 1997. The increased proportion of stocked fish was most likely due to the shorter commercial fishing season in UCI, which was closed by emergency order after the scheduled commercial opening on Monday, 4 August. The majority of hatchery-stocked coho salmon harvested by the Central District eastside setnet fishery occurs prior to the first scheduled Monday commercial opening in August (4 August in 1997). In 1993-1996 the Central District eastside setnet fishery commercial harvest, which occurred after 5 August, ranged from 21% to 39% of the total harvest; however, hatchery contribution during this time was only 5% to 19%. Because commercial fishing ended early in 1997 (7 August) wild stocks (e.g. Kenai River) harvested primarily in early August contributed less to the harvest in 1997, thus increasing the relative proportion of hatchery-stocked fish.

The proportion of hatchery-stocked coho salmon to setnet harvests in Northern District statistical areas 247-70, 247-80, and 247-90 also increased, from a 1993-1996 average of 9% of the harvest (prior to 6 August) to 19% of the total harvest in these statistical areas in 1997. The total harvest prior to 6 August in these statistical areas was lower in 1997 relative to 1993-1996. Poor returns of wild stock coho salmon throughout UCI in 1997 may be the cause of the decline in harvest and thus the increased proportion of hatchery-stocked coho salmon.

Estimates of harvest of all marked cohorts observed within the statistical area/day strata are not independent. Incorporation of covariance terms in previous years (Hoffmann and Hasbrouck 1994, Stratton et al. 1996), resulted in insignificant differences in total variance estimates (Bernard and Clark 1996). As such, covariance terms were not used in 1997 calculations, and therefore estimates of total variance are biased somewhat high.

SPORT FISHERY

We believe results presented in this report and field observations of the sport fisheries indicate that the urban coho salmon stocking program exceeded all expectations in 1997.

The NCI urban area coho salmon stocking program is considered successful if it increases recreational angler effort by 25,000 angler-days and sport harvest by 10,000 coho salmon among all stocked streams. The prestocking 5-year mean (1988-1992) total effort in Ship, Campbell, and Bird creeks was 34,700 angler days with a mean harvest of 2,516 coho salmon. The targeted increase in harvest of 10,000 fish was achieved in 1997. Harvest increased by 16,402 coho salmon in 1997 relative to the prestocking 5-year mean. The estimated harvest is species specific so this increase is easily quantified. The ultimate measure of success, however, is increased

angler effort. The Statewide Harvest Survey estimates angling effort for all species combined. Increased angler effort for a specific species is not easily quantified and may be masked or exaggerated by fluctuations in effort of other fisheries. The targeted increase in angler effort of 25,000 angler-days was achieved with an increase of 51,236 angler-days of effort over the prestocking 5-year mean effort, and an increase of 32,555 angler-days of effort compared to effort in 1992, the last year before stocked fish returned. The true increase in angler effort for coho salmon may be masked by the continually increasing popularity of the chinook salmon fishery in Ship Creek. This fishery has grown dramatically in recent years and is included in the estimate of angler effort. In addition, a weakness of using the SWHS is that the survey targets households with a licensed angler. Field observations indicate that urban streams, especially Campbell Creek, are fished primarily by young anglers who are not required to purchase a license. Thus, estimates of harvest and effort in Campbell Creek are considered minimal estimates.

A substantial increase in the catch of coho salmon has occurred in Ship, Campbell, and Bird creeks since the start of the stocking program**.** The prestocking 3-year (SWHS did not estimate catch until 1990) mean catch for Ship, Campbell, and Bird creeks is 3,077 coho salmon. Catch increased by 24,048 coho salmon in 1997 relative to the prestocking 3-year mean.

As a result of extremely poor coho salmon returns throughout UCI, an emergency order (2-SS-2-31-97) took effect on 9 August reducing the coho salmon bag limit to one fish and prohibiting the use of bait in flowing waters of Cook Inlet. Bird, Campbell, and Ship creeks were excluded from these restrictions. Increases in harvest, catch, and effort in these stocked Anchorage area streams may have occurred due to the restrictions placed on other surrounding coho salmon sport fisheries.

Past observations in Campbell Creek indicated that the majority of coho salmon often stay in the lower reaches of the creek or Campbell Lake from late July through mid to late August and move into the upper areas of the creek in late August or early September. In 1997 anglers concentrated their efforts primarily in the areas of Campbell Creek from Dowling Road downstream to Dimond Boulevard in July and August. By late August and September most angler effort occurred from Dowling Road upstream to the ADF&G marker near Piper Street. Observations made after heavy rains and cooler weather in August suggested an increase in the availability of coho salmon throughout the creek compared to prior years when many of the fish stayed in Campbell Lake until later in the season. Many coho salmon caught in Campbell Creek after the peak of the run are not retained due to the condition of the pre-spawning and spawning fish. Of the estimated 3,285 coho salmon caught by anglers at Campbell Creek in 1997 (Howe et al. 1998), about 45% (approximately 1,500) were released.

Hatchery coho salmon returning to Bird and Ship creeks were available from mid-July through late August. The peak of the run occurred during the last week of July through the first week of August. The fisheries in Bird and Ship creeks, being essentially intertidal, were more closely related to the tides than at Campbell Creek. Greatest success appeared to occur on incoming and high tidal periods, although during the peak of the return, fish were available at all tide stages. Approximately 26% of the coho salmon caught in Bird Creek were released and 30% of the coho salmon in Ship Creek were released. Angler effort in Bird Creek was about 750 angler-days less in 1997 than in 1996 while in Ship Creek angler effort in 1997 was about 6,800 angler-days

greater than that in 1996. The increase in angler effort in Ship Creek was likely a result of the greater number of coho salmon smolt stocked into Ship Creek in 1996.

ESCAPEMENT

The individual BEGs of 200 coho salmon into Ship and Campbell creeks were met in 1997. Foot survey escapement counts in these creeks were five to six times greater than the BEGs. Ship Creek has become increasingly popular with sport anglers while angler effort at Campbell Creek has seen a decline. To reduce run size in Campbell Creek and increase angler opportunity in Ship Creek, stocking was reduced in Campbell Creek from approximately 150,000 smolt to about 75,000 smolt starting in 1996, with the difference being stocked into Ship Creek.

Prior to coho salmon stocking, Bird Creek had no significant natural spawning population of coho salmon, therefore, no BEG has been set for Bird Creek. Escapement indices of coho salmon into Bird Creek from 1993-1997 ranged from 121 to 603 fish.

Sufficient coho salmon spawning escapement data has not been collected yet to set BEGs for wild coho salmon escapements in Twentymile and Placer river drainages and Portage Creek drainage.

Escapement counts were greater in Bird and Ship creeks and Placer River drainage compared to those in 1996. Coho salmon escapement counts in Campbell Creek, Twentymile River, and Portage Creek drainage were smaller than those in 1996. The greater escapement count into Ship Creek was likely due to the increased number of coho salmon smolt stocked in 1996, while the lower escapement count into Campbell creek was likely due to fewer fish stocked in 1996.

MARINE SURVIVAL

The total estimated marine survival for coho salmon smolt stocked in 1996 and returning as adults in 1997 was 0.6% less than the estimated marine survival for coho salmon stocked in 1995 that returned in 1996. The total estimated marine smolt survival has ranged from a high of 10.6% (from fish stocked in 1993 and returning in 1994) to a low of 6.3% (for fish stocked in 1996 and returning in 1997). It would appear that there has been a general decrease in the estimated marine survival in returns of coho salmon in 1996-1997 relative to returns in 1993-1995. Overall smolt survival estimates are biased low in the last couple years due to the use of foot surveys to index spawning escapements that were previously enumerated by weirs. Other factors contributing to the seeming decrease in marine smolt survival may include a change in brood stock and hatchery rearing location of brood stock used in Ship Creek, and an increasingly greater number of fish being raised in the individual hatchery raceways. Additionally, there may be marine factors responsible for the apparent decrease in ocean survival of these hatchery coho salmon smolt; however, the exact cause for this decrease is unknown.

Our results justify continuation of the stocking program. Additional streams flowing into Knik and Turnagain arms may be stocked depending on availability of brood stock. The terminal and commercial sampling programs should continue to evaluate and measure the success of the stocking program. The commercial sampling program will be necessary for assessment of any future coded wire tagging of wild stock coho salmon from the Susitna River drainage.

The 1996 hatchery releases used one CWT code number for coho salmon smolt released into both Ship and Campbell creeks. In the commercial harvest it was not possible to distinguish stream of release for these hatchery recoveries. Commercial harvest, total coho salmon return,

and marine smolt survival could not be estimated for coho salmon smolt released into the individual streams. In the future coho salmon smolt releases should use individual tag codes for each cohort to keep project data analysis consistent. Other recommendations for the future include modified sampling of several statistical areas in the Northern District (i.e., 247-10, 247-20, 247-30, 247-50, 247-70, 247-80, and 247-90) to obtain samples specific to each statistical area. This could be accomplished by placing technicians on board tenders, closely following buying patterns of processors inseason, and obtaining assistance from tender boat operators and processors in keeping harvested coho salmon separated by statistical area. These steps would improve our ability to sample pure loads of coho salmon harvested in these statistical areas.

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APPENDIX A. COHO SALMON ESCAPEMENT COUNTS AT BIRD, CAMPBELL, AND SHIP CREEKS AND SELECTED TURNAGAIN ARM STREAMS

Appendix A1.-Coho salmon escapement index counts from foot surveys in Bird, Campbell, and Ship creeks, 1997.

Stream	Date	Live	Dead	Total
Bird Creek Drainage				
Bird Ck. Falls downstream to Penguin Ck.	3-Oct	37	0	37
Penguin Ck.	3-Oct	517	25	542
Bird Ck. from Penguin Ck. to Seward Hwy.	3-Oct	21	3	24
Total		575	28	603
Campbell Creek Drainage				
Upper S. Fork	26-Sep	86	1	87
Lower S. Fork	26-Sep	496	5	501
Upper N. Fork	26-Sep	89	1	90
Lower N. Fork	26-Sep	44	3	47
Piper St. to Lake Otis Pkwy.	26-Sep	110	5	115
Lake Otis Pkwy. to C St	26-Sep	161	6	167
Total		986	21	1,007
Ship Creek Drainage				
Elmendorf Hatchery downstream to Reeve Blvd.	14-Aug	681	0	681
Reeve Blvd. downstream to Post Rd.	14-Aug	398	0	398
Post Rd. downstream to Chugach dam	14-Aug	126	0	126
Total		1,205	0	1,205

Appendix A2.-Coho salmon escapement index peak counts from aerial surveys in selected Turnagain Arm streams, 1994-1997.

Stream	1994	1995	1996	1997
Twentymile River Drainage				
Ahjo Creek	75	65	0	0
NE Fork	75	210	275	140
Mainstem	780	560	940	770
Beaver Pond	[a]	120	30	90
Glacier River	50	0	[a]	[a]
Upper Carmen River	0	0	0	[a]
South Fork Carmen River	6	0	0	[a]
Total	986	955	1,245	1,000
Portage Creek Drainage				
Mainstem[b]	40	10	[a]	[a]
Upper Railroad Slough	0	210	120	[c]
Lower Railroad Slough	0	40	60	75
Williwaw[b]	30	35	2	0
Placer Creek	0	57	10	5
Total	70	352	192	80
Placer River Drainage				
Sloughs and Mainstem	55	90	45	110
Skookum Creek	750	720	410	420
Explorer Creek[b]	804	350	75	30
Total	1,609	1,160	530	560

[a] Glacial water, no count possible.

[b] Foot survey counts conducted by United States Forest Service personnel.

[c] Creek and slough dry, no count possible.

APPENDIX B. ESTIMATES BY RELEASE SITE OF COHO SALMON STOCKED IN 1995 AND 1996 THAT WERE HARVESTED IN SAMPLED UPPER COOK INLET COMMERCIAL FISHERIES IN 1997

Appendix B1.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1995 by release site in Upper Cook Inlet Central District driftnet (244-00, 245-00) commercial harvest, 1997.

	Coho	Little Susitna River		NCI Hatchery Contribution			
Date	Catch	$\hat{r}_{ij}$	SE	$\hat{r}_{ij}$	SE	%	SE
6/27/97	13	0	0	0	0	0.00%	0.00%
6/30/97	47	0		0	0	0.00%	0.00%
7/02-7/05	267	0	0	0	0	0.00%	0.00%
7/07-7/08	863	0	0	0	0	0.00%	0.00%
7/09-7/10	290	0	0	0	0	0.00%	0.00%
7/11/97	493	0	0	0	0	0.00%	0.00%
7/13/97	1,763	0	0	0	0	0.00%	0.00%
7/14/97	5,901	0	0	0	0	0.00%	0.00%
7/17/97	816	0	0	0	0	0.00%	0.00%
7/18/97	1,330	0	0	0	0	0.00%	0.00%
7/19/97	1,586	0	0	0	0	0.00%	0.00%
7/20/97	1,130	0	0	0	0	0.00%	0.00%
7/21/97	1,196	0	0	0	0	0.00%	0.00%
7/23/97	2,874	0	0	0	0	0.00%	0.00%
7/24/97	2,255	0	0	0	0	0.00%	0.00%
7/25/97	26,950	8	7	8	7	0.03%	0.03%
7/26/97	1,190	0	0	0	0	0.00%	0.00%
7/27/97	3,497	0	0	0	0	0.00%	0.00%
7/28/97	2,780	0	0	0	0	0.00%	0.00%
7/29/97	1,024	0	0	0	0	0.00%	0.00%
7/30/97	865	0	0	0	0	0.00%	0.00%
7/31/97	642	0	0	0	0	0.00%	0.00%
8/01-8/02	12,928	0	0	0	0	0.00%	0.00%
8/03-8/04	8,394	0	0	0	0	0.00%	0.00%
Total[a]	79,094	8	7	8	7	0.01%	0.01%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B2.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1995 by release site in Upper Cook Inlet Northern District westside (247-10, 242-20, 247-30) setnet commercial harvest, 1997.

	Coho	Bird Creek		NCI Hatchery Contribution			
Date	Catch	$\hat{r}_{ij}$	SE	$\hat{r}_{ij}$	SE	%	SE
6/30-7/14/97	2,316	0	0	0	0	0.00%	0.00%
7/25/97	7,231	0	0	0	0	0.00%	0.00%
7/28/97	7,335	0	0	0	0	0.00%	0.00%
8/1/97	5,671	5	4	5	4	0.09%	0.04%
8/4/97	3,749	0	0	0	0	0.00%	0.00%
Total[a]	26,302	5	4	5	4	0.02%	0.01%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B3.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District driftnet (244-00, 245-00) commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27/97	13	0	0	0	0	0	0	0	0	0.0%	0.0%
6/30/97	47	0	0	0	0	0	0	0	0	0.0%	0.0%
7/02-7/05	267	14	14	0	0	0	0	14	14	5.4%	5.2%
7/07-7/08	863	8	8	33	15	0	0	41	17	4.7%	2.0%
7/09-7/10	290	0	0	13	8	6	6	19	10	6.5%	3.4%
7/11/97	493	13	9	7	6	0	0	20	11	4.1%	2.2%
7/13/97	1,763	46	16	65	19	12	8	123	26	7.0%	1.5%
7/14/97	5,901	96	23	186	32	61	18	343	43	5.8%	0.7%
7/17/97	816	6	5	45	15	32	12	83	20	10.2%	2.4%
7/18/97	1,330	37	13	58	16	25	10	121	23	9.1%	1.7%
7/19/97	1,586	0	0	471	471	0	0	471	471	29.7%	29.7%
7/20/97	1,130	23	12	30	14	36	15	89	24	7.9%	2.1%
7/21/97	1,196	34	11	29	11	28	10	91	18	7.6%	1.5%
7/23/97	2,874	103	28	181	37	74	23	358	52	12.5%	1.8%
7/24/97	2,255	65	25	195	44	83	28	343	58	15.2%	2.6%
7/25/97	26,950	820	74	1,565	102	566	60	2,951	140	11.0%	0.5%
7/26/97	1,190	39	27	20	19	56	32	115	46	9.7%	3.9%
7/27/97	3,497	144	30	196	35	90	23	431	52	12.3%	1.5%
7/28/97	2,780	105	25	141	29	47	16	293	42	10.5%	1.5%
7/29/97	1,024	26	26	27	26	0	0	53	37	5.2%	3.6%
7/30/97	865	61	24	41	19	58	23	160	38	18.5%	4.4%
7/31/97	642	18	12	46	20	18	12	83	26	12.9%	4.0%
8/01-8/02	12,928	619	85	1,132	115	533	77	2,284	162	17.7%	1.3%
8/03-8/04	8,394	198	49	624	87	228	52	1,049	113	12.5%	1.3%
Total[a]	79,094	2,474	147	5,106	512	1,955	130	9,534	549	12.1%	0.7%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B4.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District Ninilchik Beach (244-21) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27-7/11	56	0	0	0	0	0	0	0	0	0.0%	0.0%
7/13/97	29	0	0	0	0	0	0	0	0	0.0%	0.0%
7/14/97	15	0	0	0	0	0	0	0	0	0.0%	0.0%
7/17/97	26	0	0	14	14	0	0	14	14	54.5%	52.5%
7/18/97	8	0	0	0	0	0	0	0	0	0.0%	0.0%
7/19-7/20	34	0	0	0	0	0	0	0	0	0.0%	0.0%
7/21/97	28	0	0	0	0	0	0	0	0	0.0%	0.0%
7/23/97	185	0	0	0	0	0	0	0	0	0.0%	0.0%
7/24/97	64	0	0	9	8	0	0	9	8	13.6%	12.8%
7/25-7/26	105	0	0	0	0	0	0	0	0	0.0%	0.0%
7/27-7/28	202	18	17	0	0	0	0	18	17	8.8%	8.5%
7/29/97	130	0	0	0	0	0	0	0	0	0.0%	0.0%
7/30-7/31	177	0	0	13	13	13	12	26	17	14.5%	9.9%
8/01-8/02	176	0	0	17	16	0	0	17	16	9.6%	9.3%
8/03-8/04	269	12	12	0	0	0	0	12	12	4.5%	4.3%
Total[a]	1,504	30	21	53	26	13	12	95	35	6.3%	2.4%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B5.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District Cohoe Beach (244-22) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27-7/11	103	0	0	0	0	0	0	0	0	0.0%	0.0%
7/13/97	32	0	0	0	0	0	0	0	0	0.0%	0.0%
7/14/97	33	0	0	0	0	0	0	0	0	0.0%	0.0%
7/17/97	33	0	0	0	0	0	0	0	0	0.0%	0.0%
7/18/97	26	0	0	0	0	0	0	0	0	0.0%	0.0%
7/19-7/20	69	15	14	0	0	0	0	15	14	21.6%	20.9%
7/21/97	79	0	0	0	0	0	0	0	0	0.0%	0.0%
7/23/97	157	0	0	0	0	0	0	0	0	0.0%	0.0%
7/24/97	94	0	0	7	7	0	0	7	7	8.0%	7.4%
7/25-7/26	309	0	0	21	20	20	19	40	28	13.0%	9.0%
7/27-7/28	504	34	23	34	24	0	0	68	33	13.6%	6.6%
7/29/97	326	0	0	24	24	23	23	47	33	14.5%	10.0%
7/30-7/31	470	26	26	26	26	0	0	53	37	11.2%	7.8%
8/01-8/02	315	0	0	54	54	0	0	54	54	17.2%	17.0%
8/03-8/04	487	16	15	63	30	30	20	108	40	22.3%	8.1%
Total[a]	3,037	91	41	230	78	73	36	394	95	13.0%	3.1%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B6.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District Kalifonsky Beach (244-30) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27-7/05	7	0	0	0	0	0	0	0	0	0.0%	0.0%
7/07-7/10	66	0	0	0	0	0	0	0	0	0.0%	0.0%
7/11/97	39	0	0	0	0	0	0	0	0	0.0%	0.0%
7/13/97	48	0	0	0	0	0	0	0	0	0.0%	0.0%
7/14/97	27	0	0	0	0	0	0	0	0	0.0%	0.0%
7/17/97	47	0	0	0	0	0	0	0	0	0.0%	0.0%
7/18/97	17	0	0	0	0	0	0	0	0	0.0%	0.0%
7/19-7/20	147	0	0	0	0	0	0	0	0	0.0%	0.0%
7/21/97	228	0	0	0	0	0	0	0	0	0.0%	0.0%
7/23/97	291	0	0	17	16	0	0	17	16	5.7%	5.6%
7/24/97	205	0	0	0	0	0	0	0	0	0.0%	0.0%
7/25/97	203	0	0	0	0	0	0	0	0	0.0%	0.0%
7/26/97	275	0	0	0	0	0	0	0	0	0.0%	0.0%
7/27/97	234	0	0	0	0	0	0	0	0	0.0%	0.0%
7/28/97	361	0	0	10	9	10	9	20	13	5.4%	3.6%
7/29/97	414	0	0	0	0	0	0	0	0	0.0%	0.0%
7/30/97	211	0	0	0	0	0	0	0	0	0.0%	0.0%
7/31/97	173	0	0	0	0	0	0	0	0	0.0%	0.0%
8/1/97	108	0	0	0	0	0	0	0	0	0.0%	0.0%
8/2/97	232	0	0	0	0	16	16	16	16	6.9%	6.7%
8/3/97	357	21	14	32	18	0	0	53	23	15.0%	6.4%
8/4/97	193	7	7	7	7	0	0	14	9	7.3%	4.8%
Total[a]	3,883	28	16	66	27	26	18	120	36	3.1%	0.9%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B7.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Central District Salamatof Beach (244-40) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
7/11/97	133	0	0	0	0	0	0	0	0	0.0%	0.0%
7/13/97	409	34	34	34	34	0	0	68	48	16.7%	11.6%
7/14/97	342	28	28	29	28	0	0	57	40	16.7%	11.6%
7/17-7/18	490	32	32	0	0	0	0	32	32	6.6%	6.5%
7/19-7/20	445	90	90	0	0	0	0	90	90	20.3%	20.2%
7/21/97	517	13	12	0	0	24	17	37	21	7.2%	4.0%
7/23/97	591	55	54	55	55	0	0	110	77	18.6%	13.0%
7/24/97	691	0	0	85	60	41	40	126	72	18.2%	10.4%
7/25/97	680	0	0	32	32	61	43	94	53	13.8%	7.8%
7/26/97	962	0	0	73	51	35	34	108	61	11.2%	6.4%
7/27/97	513	9	9	38	18	18	12	65	23	12.7%	4.6%
7/28/97	1,117	38	21	13	12	36	20	87	32	7.8%	2.8%
7/29-7/30	1,714	0	0	93	65	44	44	138	79	8.0%	4.6%
7/31/97	687	42	16	56	18	20	11	118	26	17.1%	3.8%
8/1/97	394	33	13	13	9	19	10	65	19	16.4%	4.8%
8/2/97	361	12	8	18	10	18	9	48	16	13.4%	4.3%
8/3/97	692	31	15	24	13	22	12	77	23	11.2%	3.3%
8/4/97	506	47	26	64	31	15	15	126	43	24.9%	8.5%
Total[a]	11,244	465	127	627	136	354	90	1,447	206	12.9%	1.8%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B8.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Northern District westside (247-10, 247-20, 247-30) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/30-7/14/97	2,316	6	5	12	8	6	5	23	11	1.0%	0.5%
7/25/97	7,231	5	5	47	14	35	12	88	19	1.2%	0.3%
7/28/97	7,335	19	10	90	22	43	15	153	29	2.1%	0.4%
8/1/97	5,671	29	10	129	22	78	17	236	30	4.2%	0.5%
8/4/97	3,749	7	7	29	14	21	11	58	19	1.5%	0.5%
Total[a]	26,302	66	18	308	38	182	28	557	50	2.1%	0.2%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B9.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Northern District Susitna Flats/Point MacKenzie (247-41, 247-42) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
7/07-7/14/97	248	0	0	29	28	55	38	84	48	33.9%	19.2%
7/25/97	651	12	5	94	15	61	11	167	19	25.6%	3.0%
7/28/97	828	13	6	172	20	61	12	246	24	29.7%	2.9%
8/1/97	1,678	112	16	375	29	222	22	709	40	42.3%	2.4%
8/4/97	1,578	29	9	296	30	172	22	497	39	31.5%	2.5%
Total[a]	4,983	166	20	966	57	572	52	1,703	79	34.2%	1.6%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B10.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Northern District Fire Island (247-43) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27-7/14/97	54	0	0	0	0	0	0	0	0	0.0%	0.0%
7/25-7/28/97	1,718	103	27	484	58	98	25	685	69	39.9%	4.0%
8/1/97	897	116	26	227	36	59	18	401	48	44.7%	5.4%
8/4/97	1,079	104	15	454	32	73	12	631	38	58.5%	3.5%
Total[a]	3,748	323	40	1,165	76	230	34	1,718	92	45.8%	2.5%

[a] Totals may not equal sum of individual estimates due to rounding.

Appendix B11.-Estimates ($\hat{r}_{ij}$) and standard errors (SE) of coho salmon stocked in 1996 by release site in Upper Cook Inlet Northern District eastside (247-70, 247-80, 247-90) setnet commercial harvest, 1997.

	Coho	Bird Creek		Anchorage Urban Streams		Wasilla Creek		NCI Hatchery Contribution			
Date	Catch	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	r_{ij}	SE	%	SE
6/27-7/14/97	269	8	7	8	7	0	0	16	10	5.8%	3.8%
7/25/97	429	42	10	36	9	11	5	89	14	20.8%	3.3%
7/28/97	281	6	4	19	7	5	3	30	8	10.8%	2.9%
8/1/97	772	68	20	75	21	26	12	168	31	21.8%	4.0%
8/4/97	468	52	12	44	12	12	6	108	18	23.0%	3.8%
Total[a]	2,219	175	27	182	27	54	14	411	41	18.5%	1.8%

[a] Totals may not equal sum of individual estimates due to rounding.

Table 8.-Estimates and associated standard errors (in parentheses) used to estimate marine survival of coho salmon stocked into Northern Cook Inlet streams in 1996 based on return data in 1997.

	Smolt Releases [a]		Commercial Harvest		Sport Harvest		Escapement		Total Return [b]		Estimated Smolt Survival [c]	
Bird Creek	147,618	(1,953)	3,818	(207)	7,428 [d]	(1,023)	603 [e]		11,849	(1,044)	0.080	(0.007)
Anchorage Urban Streams	302,857	(4,853)	8,703	(547)	11,040 [f]	(1,440)	1,994 [g]	(124)	21,737	(1,545)	0.072	(0.005)
Wasilla Creek	145,923	(1,886)	3,458	(178)	179 [h]	(56)	68 [h]	(12)	3,705	(187)	0.025	(0.001)
Total	596,398	(5,561)	15,979	(612)	18,647	(1,767)	2,665	(125)	37,291	(1,874)	0.063	(0.003)

[a] Starkey et al. 1997.

[b] Does not include coho salmon expected to return in low numbers in 1998.

[c] Standard error of survival estimates are biased low because sampling variance not estimated for total escapement.

[d] Estimated total harvest (Howe et al. 1998). Total harvest assumed to be from 1996 releases, though negligible returns from previous years are likely included.

[e] Escapement index from foot survey represents a minimal estimate of the total escapement, with no estimate of sampling variability available.

[f] Estimated total harvest is the combined harvests from Campbell and Ship creeks. Hatchery contribution estimated using data from Ship Creek brood stock collection and from beach seining at Campbell Creek.

[g] Estimated total escapement is the combined foot survey indices from Campbell and Ship creeks and represents a minimal estimate of the total escapement, with no estimate of sampling variability available. Hatchery contribution and associated standard error estimated using data from Ship Creek brood stock collection and from beach seining at Campbell Creek.

[h] Estimated using data collected at Spring Creek livebox. Escapement represents a minimal estimate of the total escapement, with no estimate of sampling variability available. Assumed proportion of hatchery-stocked coho salmon in the sport harvest was the same as that observed at livebox.