Fishery Data Series No. 00-9

Sport Effort, Harvest, and Escapement of Coho Salmon in Selected Kodiak Management Area Streams, 1997 and 1998

by

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July 2000

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

Creel censuses were conducted during coho salmon sport fisheries in 1997 and 1998 on Unalaska and Afognak islands. During the 1997 creel census at the Nateekin River on Unalaska Island, 330 coho salmon *Oncorhynchus kisutch* were harvested and 232 were released by anglers. In 1998, creel censuses were conducted at three remote Afognak Island area fishing locations. At Discoverer Bay, 487 coho salmon were harvested and 1,267 were released; at Pauls Bay, 844 coho salmon were harvested and 1,557 released; and at Pauls Lake, 12 coho salmon were harvested and 422 were released.

During October 1997 and 1998, mark-recapture experiments were conducted to estimate the number of coho salmon spawning at the American and Olds rivers on Kodiak Island, Alaska. The estimated number of coho salmon in the American River was 3,576 (SE = 1,263) fish in 1997 and 1,263 (SE = 168) fish in 1998. The estimated abundance of spawning coho salmon in the Olds River was 5,872 (SE = 559) fish in 1997 and 2,199 (SE = 234) fish in 1998.

Key words: coho salmon, *Oncorhynchus kisutch*, Nateekin River, Unalaska Island, Afognak Island, Discoverer Bay, Pauls Bay, Pauls Lake, Kodiak Island, American River, Olds River, creel census, spawning abundance.

INTRODUCTION

The Kodiak Management Area (KMA) includes all freshwater and nearshore marine waters of the Alaska Peninsula, Aleutian Islands, and Kodiak Island (Figure 1). There are numerous tributaries supporting coho salmon *Oncorhynchus kisutch* throughout the KMA, most of which are remote. Some of these streams are relatively small and there is little information on coho salmon abundance and trends in angler participation at individual streams. Recently, increases in angler effort and conflicts between sport and commercial fishermen have created concern that some coho salmon stocks are being overharvested. This study focused on three popular coho salmon fishing areas in the KMA: Nateekin River on Unalaska Island; Perenosa Bay on Afognak Island; and the road system on Kodiak Island.

NATEEKIN RIVER

The largest coho salmon return near the city of Unalaska occurs at the Nateekin River, which is located approximately 5 miles from the Unalaska road system (Figures 2 and 3). Coho salmon escapement there was 1,421 fish in 1994, and 455 in 1996, based on foot surveys (Schwarz 1997). There is no directed commercial fishery for coho salmon in Unalaska Bay; subsistence harvest was 200 coho salmon in 1997 and 300 coho salmon in 1998. No other data about coho salmon stocks in this area are available.

PERENOSA BAY

Perenosa Bay was included in this study to assist the Alaska Board of Fisheries in dealing with a user group conflict that was developing between commercial salmon seiners and sport charter boat operators. Perenosa Bay is located on the northern end of Afognak Island and includes the smaller bays of Pauls and Discoverer bays (Figures 4 and 5). Portage Lake and Portage Creek, located at the head of Discoverer Bay, and Pauls Lake, at the head of Pauls Bay, were also included in the study (Figure 5). The major coho salmon producing drainages in Perenosa Bay are Portage and Pauls lakes.

Available information for Perenosa Bay coho salmon stocks consists of commercial harvest data, sport catch and harvest data from a creel survey conducted in 1987, and weir counts at Pauls Lake. Coho salmon returning to Portage and Pauls lakes during August and early September are harvested in salt water in commercial purse seine fisheries. Harvests in this area (Commercial Fisheries Division [CFD] statistical areas 251-82, 251-83, and 251-84) ranged from 0 to 21,763 fish,

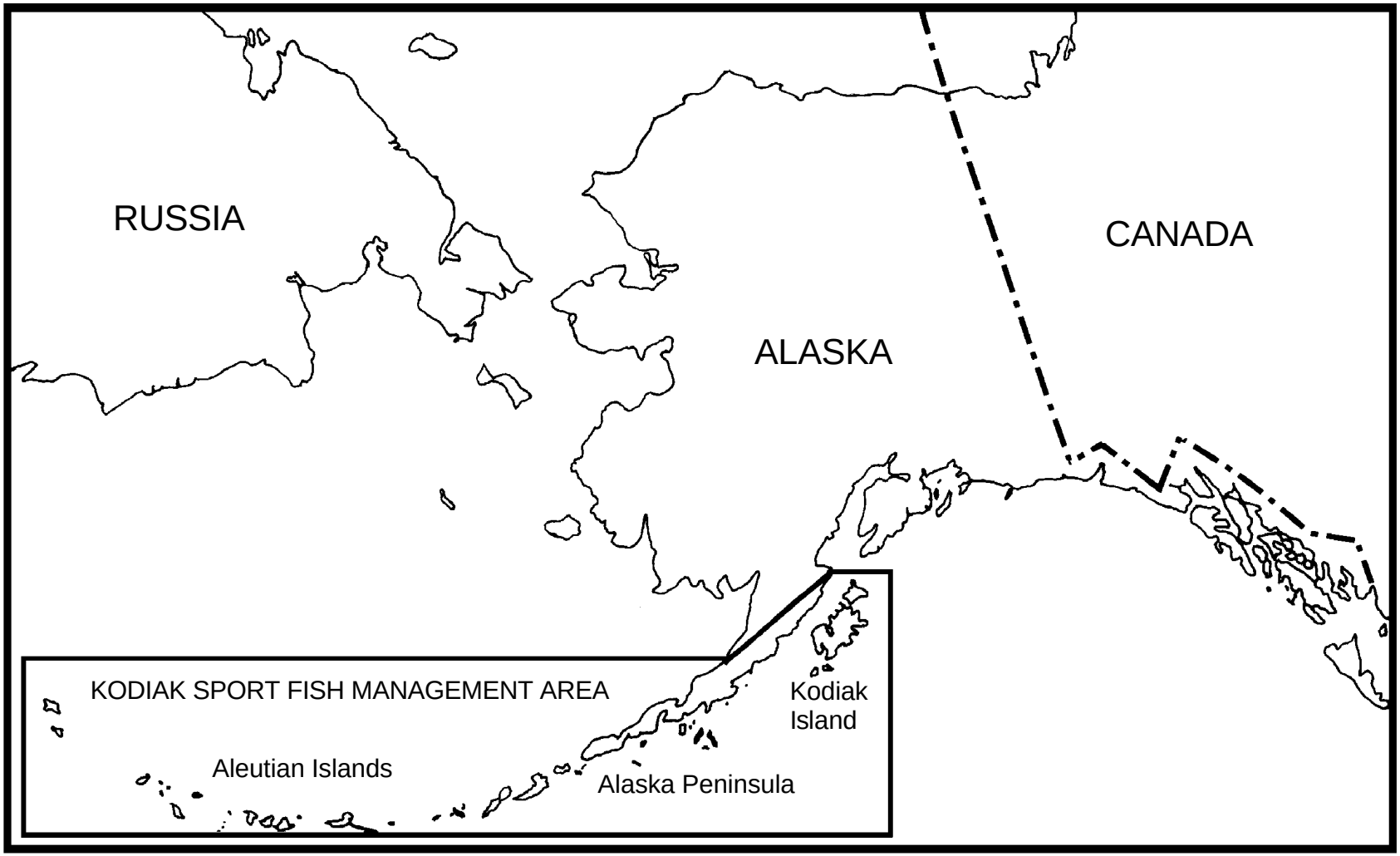

Figure 1.-The Kodiak Management Area: Kodiak Island Archipelago, Alaska Peninsula, and Aleutian Islands.

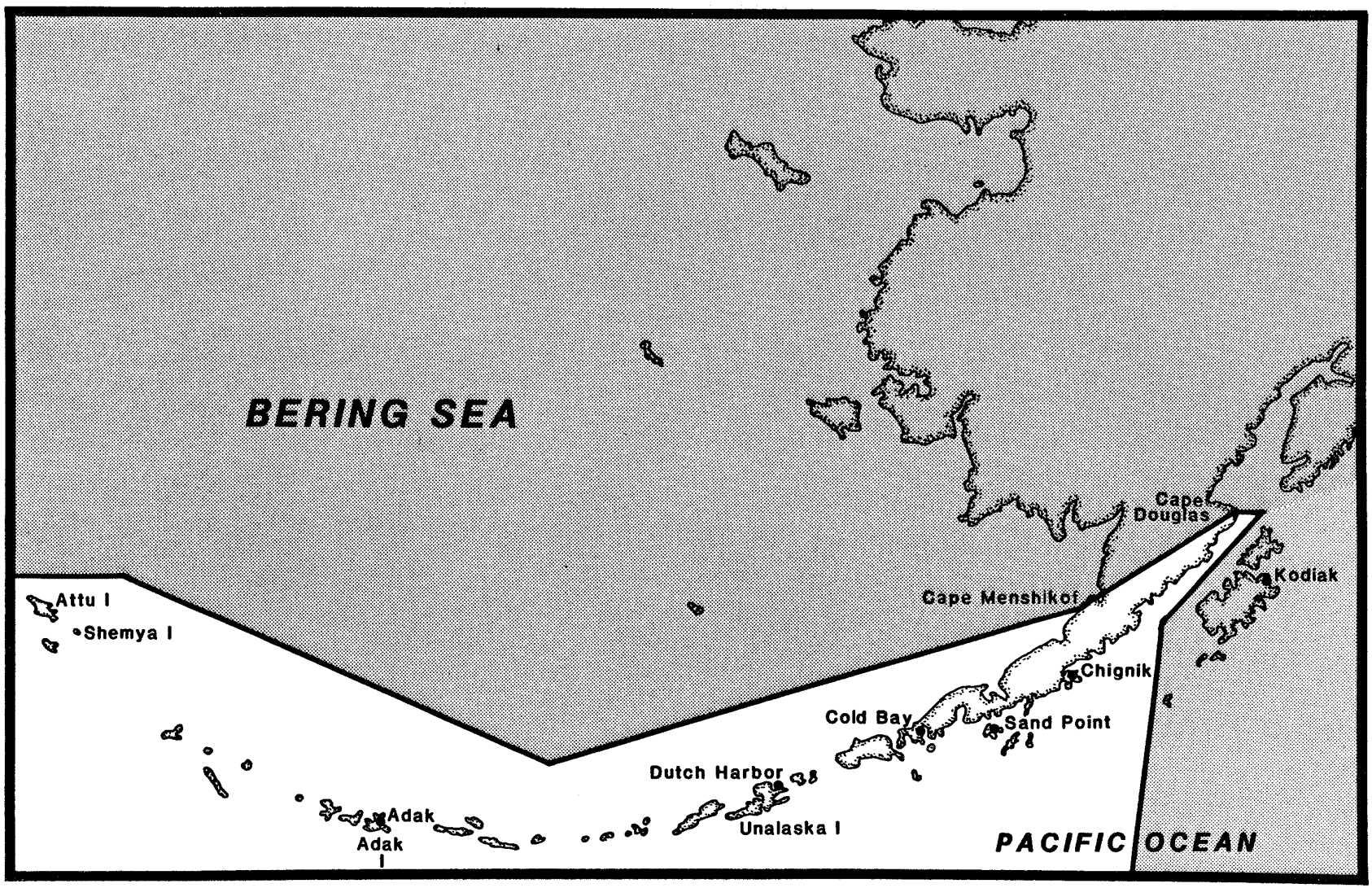

Figure 2.-Location of Unalaska Island, Aleutian Island chain.

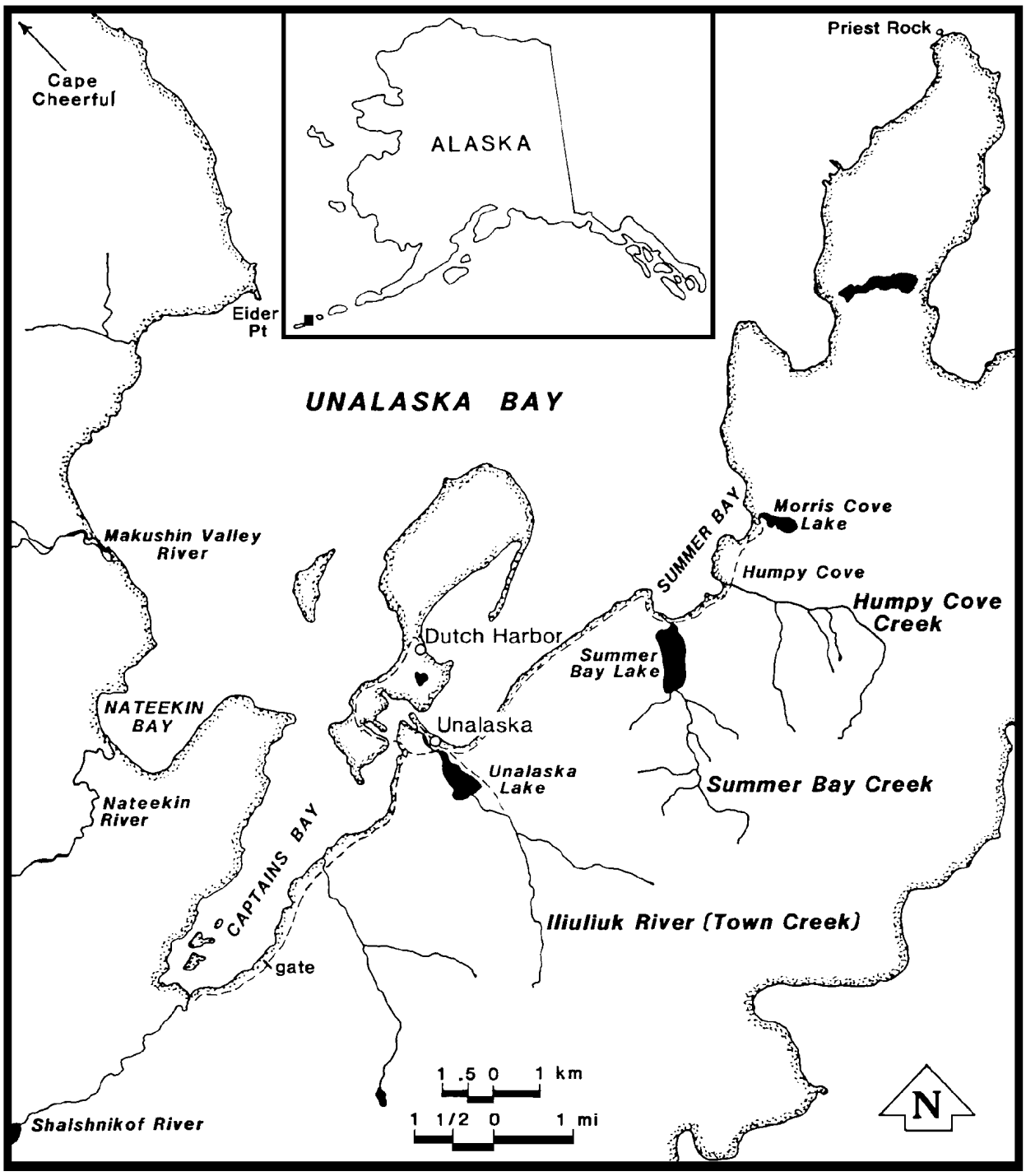

Figure 3.-Map of Unalaska road system.

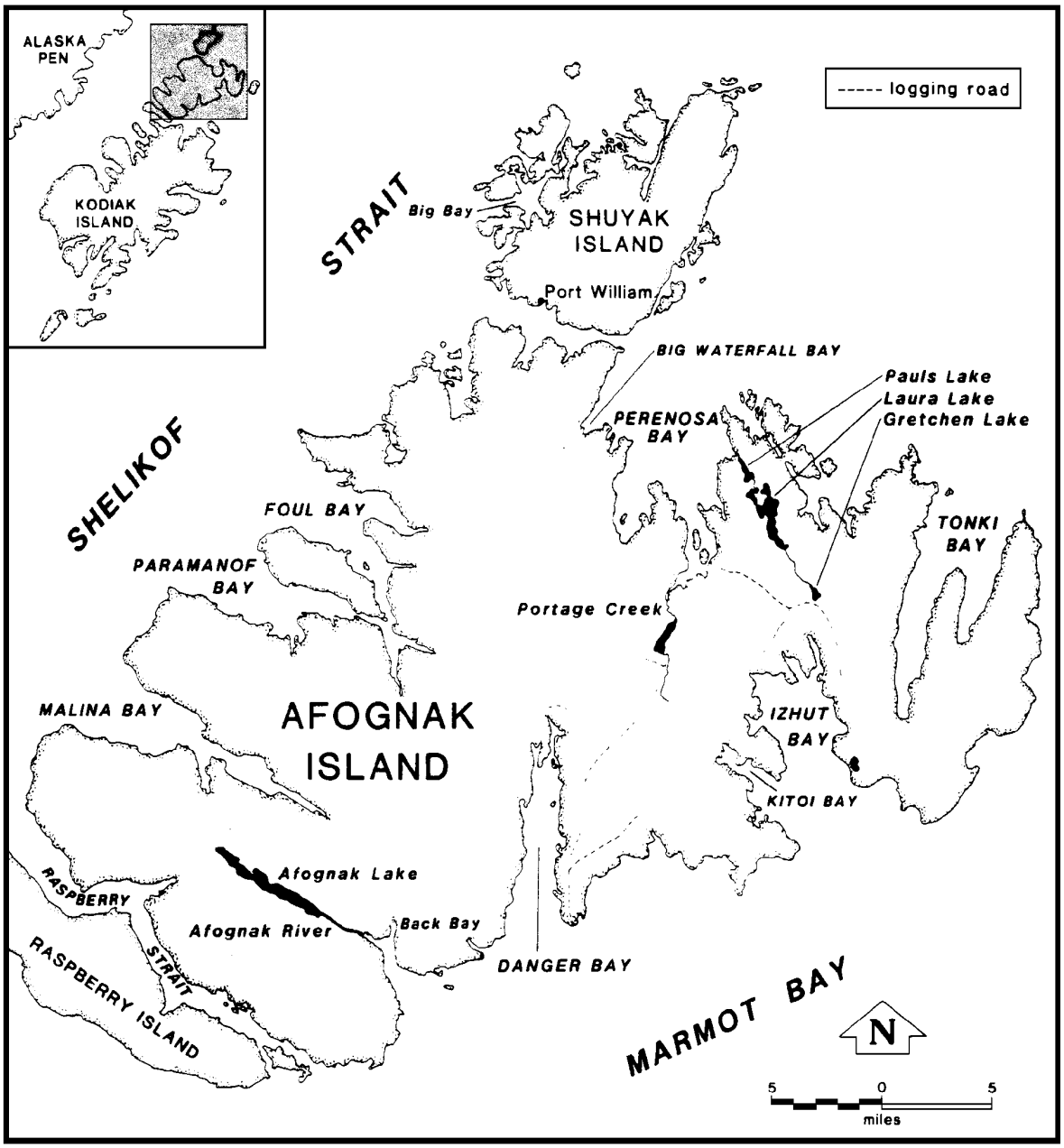

Figure 4.-Map of Afognak and Shuyak islands and surrounding waters.

averaging approximately 5,000 fish from 1989–1998 (Table 1). These commercial fisheries harvest mixed stocks, which likely include fish from all coho salmon producing drainages of Perenosa Bay, as well as other drainages near Perenosa Bay.

The majority of the sport fishing occurs in salt water near stream mouths, although some anglers also fish freshwater streams and lakes to a lesser extent. The annual Statewide Harvest Survey has been used to estimate sport fishing effort, catch and harvest at many locations in the KMA (Howe et al. 1998). However, due to the relatively small number of anglers participating in coho salmon fisheries in Perenosa Bay and the

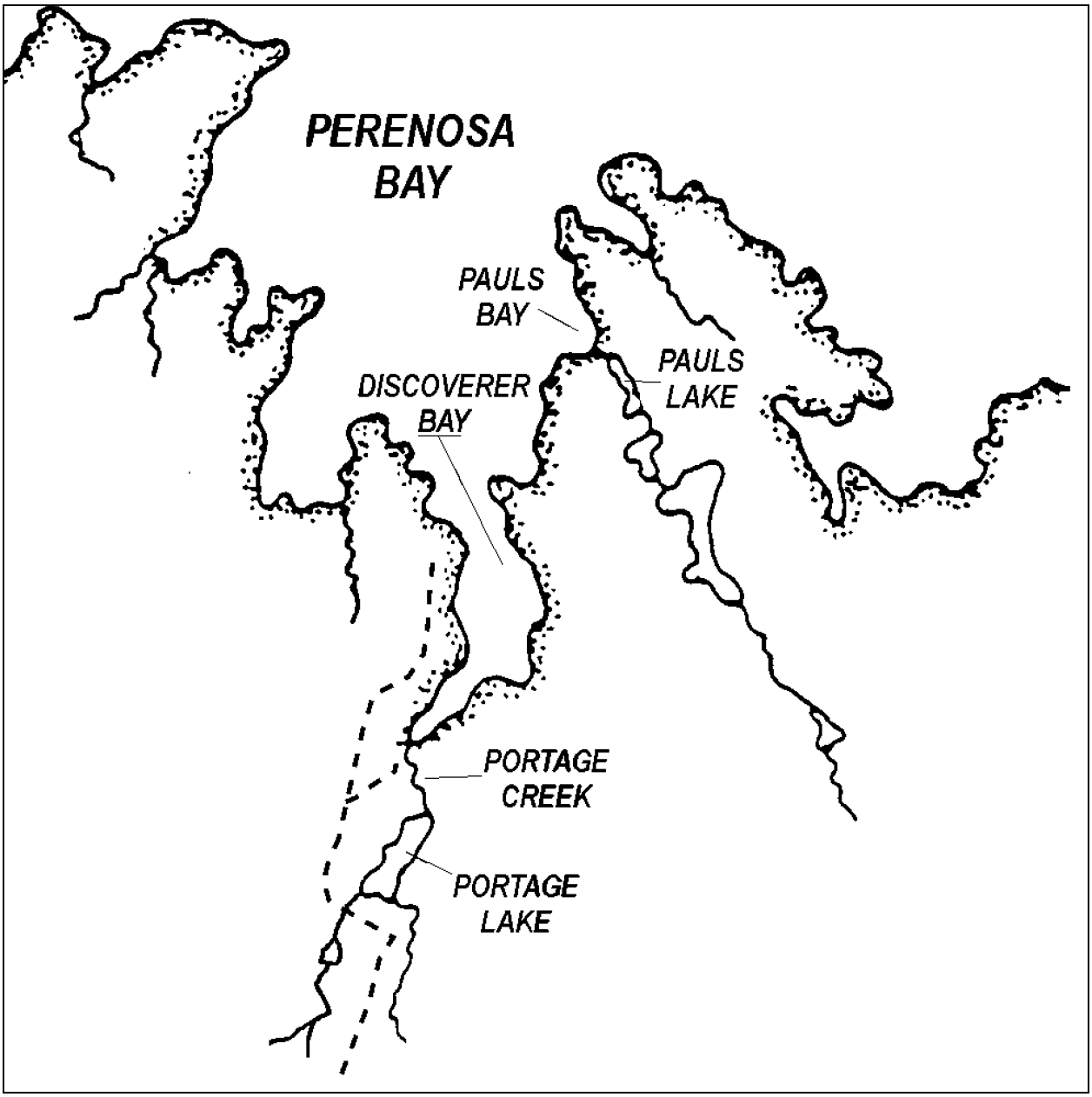

Figure 5.-Map of Perenosa Bay.

corresponding low number of surveys returned by anglers who fished this area, estimates of fishing effort, harvest and catch cannot be made. For small sport fisheries, creel surveys are used to obtain information on sport effort, catch and harvest. In 1987, a roving creel survey conducted on Portage Creek from August 9 through September 20 estimated a sport harvest of 589 coho salmon (Murray 1988). Periodic fisheries observations in Pauls Bay in 1987 documented a harvest of 159 coho salmon. This figure represents a minimum harvest, as observations were incomplete and not conducted on a schedule that would allow total harvest to be estimated.

Table 1.-Commercial harvests of coho salmon in Perenosa Bay, 1989–1998.

Year	Commercial Harvest
1989	0
1990	4,282
1991	251
1992	336
1993	466
1994	2,516
1995	6,015
1996	1,608
1997	21,763
1998	12,528
Average	4,977

Note: Perenosa Bay is made up of the following CFD statistical areas: Pauls Bay (251-83), Discoverer Bay (251-82), and Water Fall Bay (251-84).

Escapement at Pauls Lake, enumerated at a weir operated by CFD, averaged 10,592 coho salmon from 1989–1998 (Table 2). At Portage Creek, escapement was also enumerated at a weir, averaging 4,067 coho salmon for 1987–1990, the only years for which data are available (Table 3).

KODIAK ISLAND ROAD SYSTEM

Fisheries along the Kodiak Island road system, which can all be accessed by road or small boat launched from the city of Kodiak, take place in fresh water and saltwater bays on the east side of Kodiak Island (Figure 6). Due to easy access and the popularity of coho salmon as a game fish, coho salmon stocks in these streams and rivers are intensively fished, accounting for 49% (9,800 fish) of the total coho salmon harvest in the KMA (Howe et al. 1998). Four rivers, the Buskin, Pasagshak, American, and Olds, accounted for most (74% or 7,200 fish) of that harvest since 1988 (Howe et al. 1998; Schwarz 1997). However, most of these stocks are also small, making them susceptible to overfishing.

Monitoring coho salmon returns helps managers ensure that escapement objectives are achieved and returns remain at levels that allow sustained coho salmon runs. Escapements of coho salmon into Kodiak road system rivers are monitored by observers who walk along the riverbanks after the fisheries have closed and visually count fish (foot surveys), except for the Buskin River which is monitored with a weir. Results of foot surveys represent only an index of coho salmon escapement because not all coho salmon in the stream are counted on these surveys, either because of poor visibility or because it is impossible to walk the entire drainage where coho salmon are present. Information has not been available to determine whether past foot survey counts are indicative of abundance and whether they are a valid way to monitor coho salmon returns.

Table 2.-Escapement of coho salmon through a weir at Pauls Creek, 1989–1998.

Year	Escapement
1989	7,919
1990	3,668
1991	[a]
1992	[a]
1993	10,664
1994	12,538
1995	10,663
1996	15,491
1997	8,280
1998	15,514
Average	10,592

From: Brodie 1999.

[a] Unavailable.

Table 3.-Escapement of coho salmon through a weir at Portage Creek, 1987–1990.

Year	Escapement
1987	3,710
1988	2,354
1989	5,928
1990	4,277
Average	4,067

From: Schwarz 1997.

OBJECTIVES

Because sport fishing effort, catch, and harvest of coho salmon were not known for the Nateekin River and limited data were available to assess the magnitude of annual sport fisheries on Perenosa Bay coho salmon stocks, the Alaska Department of Fish and Game (ADF&G), Sport Fish Division, conducted creel censuses on the Nateekin River, Discoverer Bay, and Pauls Bay in 1997 and 1998. A creel census was also conducted at Pauls Lake and angler counts were conducted at both Pauls and Portage lakes. Furthermore, since previous investigations did not assess the accuracy of foot survey counts of coho salmon in rivers along the Kodiak road system, mark-recapture experiments were conducted to estimate the number of coho salmon spawning at the American and Olds rivers on the Kodiak road system.

The objectives of this study were to:

1. Census angler effort, catch, harvest, and demographics of the sport fishery for coho salmon at the Nateekin River during 1997;
2. Census angler effort, catch, harvest, and demographics of the sport fishery for coho salmon at Discoverer and Pauls bays during 1998; and
3. Estimate the abundance of coho salmon spawning in the American and Olds rivers during 1997 and 1998.

METHODS

CREEL CENSUSES

Nateekin River

Angler effort, catch, harvest and demographic information were obtained from an onsite creel census conducted at the Nateekin River in 1997. Anglers participating in the coho salmon fishery travel to the mouth of the river by boat. They fish near the river mouth and at upstream locations. Anglers leave the river after each day's fishing and return by boat to the Unalaska road system.

A technician, camped at the mouth of the river, interviewed all anglers as they exited the fishery each day, obtaining a complete census of all sport fishing activity. Daily information collected from each angler included effort, number of coho salmon harvested and number released, and demographic information. Demographic information included whether the angler was guided or unguided, chartered or not chartered, and residency (local Unalaska area resident, Alaska resident [but not Unalaska area resident], or non-Alaska resident). Since each angler interviewed had completed fishing for the day, each interview was equivalent to one day of angler effort. Interview data were summed to calculate total effort, catch and harvest. Additionally, a foot survey was conducted on the Nateekin River to count the number of coho salmon in the river at the end of the creel census in 1997; a foot survey was also conducted in 1998.

Perenosa Bay

Anglers access the Perenosa Bay fishery by private and chartered vessels and aircraft, and by vehicles based at logging camps located in Kazakof Bay. Sport fishing data were collected at two creel census sites, Discoverer

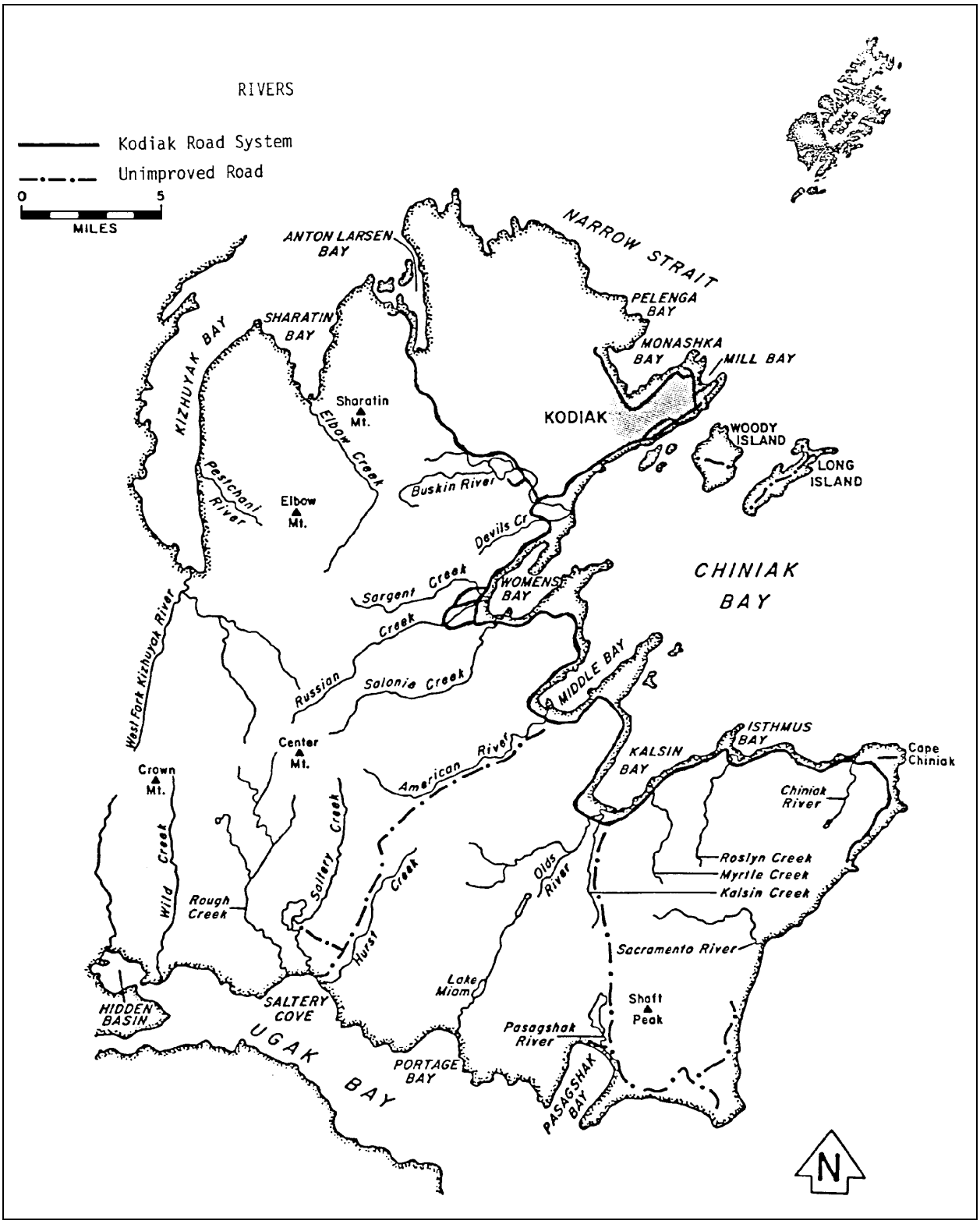

Figure 6.-Map of the Kodiak Island road system.

Bay and Pauls Bay, by ADF&G personnel or by charter operators.

At Discoverer Bay, creel technicians were stationed at an abandoned logging camp overlooking the Bay and a second tent camp at the mouth of Portage Creek. From these two camps all sport fishing activity in Discoverer Bay could be monitored so that a complete census of all sport fishing activity was obtained. Each day, anglers fishing in salt water that were not on charter vessels were interviewed when they stopped fishing for the day. Technicians used an inflatable raft equipped with an outboard motor to approach anglers exiting the fishery. Creel technicians also conducted counts of anglers at Portage Lake on an opportunistic basis. Sport anglers from charter vessels were monitored through logbooks that charter vessel operators are required to complete. Charter vessels were monitored daily by technicians to ensure that logbook data were consistent and correctly recorded. Logbook pages were collected when the charter vessels left Perenosa Bay.

At Pauls Bay, a creel technician was stationed on the CFD research vessel K-Hi-C. All saltwater angler activity in Pauls Bay was monitored daily by interviewing anglers when they had completed fishing for the day. Sport anglers from charter vessels were monitored through a logbook program, as with Discover Bay. The freshwater sport fishery in Pauls Lake was also monitored through logbooks provided to the commercial outfitter that operated there. Angler counts were obtained daily at Pauls Lake by the outfitter and recorded in the logbook.

Daily information collected for each angler included effort, number of coho salmon harvested and number released, and demographic information. Demographic information included whether the angler was guided or unguided, and residency (local Kodiak area resident or other Alaska resident [non-Kodiak area] or a non-Alaska resident), fished from shore or boat, or if access to the fishing location was via logging camps in Kazakof Bay or access was by other means. Information for each angler was obtained after the angler had completed fishing for the day, so each interview was equivalent to one day of angler effort. Data were summed to calculate total effort, catch and harvest.

Foot survey counts of coho salmon were also obtained at Portage Creek.

SPAWNING COHO SALMON AT THE AMERICAN AND OLDS RIVERS

Abundance Estimation

Coho salmon immigration at the American and Olds rivers begins in late August and continues through September. Both rivers are short coastal tributaries, and thus, all reaches can be surveyed and sampled for spawning fish. This situation allowed for mark-recapture experiments to be conducted in early October to estimate abundance of coho salmon spawning at each river during 1997 and 1998 for comparison to counts from foot surveys.

Foot surveys were conducted at the American and Olds rivers in 1997 and 1998 to obtain counts of spawning coho salmon. Observers walked along riverbanks and counted the number of coho salmon observed in each river. In addition, each river was divided into upper and lower river sections to determine inriver distribution of coho salmon.

For the mark-recapture experiment, the first sampling event (marking event) occurred after the foot surveys. During the marking event, coho salmon were captured by beach seine. Coho salmon were measured for length (mid-eye to fork-of-tail), sex was determined, and fish were tagged near the posterior insertion of the dorsal fin with an individually numbered Floy FD-67 internal anchor tag. A portion of the upper caudal fin was also clipped to serve as a secondary mark to assess

tag loss. River section of capture was recorded for each fish to test for mixing of marks. All accessible areas of each river were completely sampled and beach seining effort was directed at several sites within each river section where fish were congregated. In 1997, the marking event occurred on October 8 and 11 at the American River, and on October 9, 10 and 15 at the Olds River. During 1998, the marking event occurred on October 5 and 6 at the American River, and October 8 at the Olds River. During 1997, average foot survey data from past years were used to determine sample sizes for the mark-recapture study. During 1998, foot survey data collected prior to the marking event were used to determine sample sizes by area (upper or lower river) for the mark-recapture study.

The second sampling event (recapture event) occurred at least 1 day following the marking event. At the American River, the recapture event occurred on October 16 in 1997, and on October 7 in 1998. At the Olds River, the recapture event was on October 17 and 21 in 1997, and on October 9 in 1998. A beach seine was used to capture coho salmon. Each coho salmon captured was examined for a caudal finclip and tag, and was sampled as previously described. However, during the recapture event all coho salmon captured received a lower rather than upper caudal finclip to ensure that recaptured fish that had lost tags were not counted twice and that all captures could be assigned to the correct sampling event. Similar to the marking event, each river was completely sampled and beach seining effort during the recapture event was identical to that employed during the marking event, ensuring that all sites with fish were sampled.

The following assumptions were necessary for this closed abundance estimate:

1. Catching and handling the fish did not affect the probability of recapture, and
2. Marked fish did not lose their mark.

Additionally, at least one of the following assumptions had to be fulfilled:

3. Every fish had an equal probability of being marked and released during the marking event,
4. Every fish had an equal probability of being captured in the recapture event, or
5. Marked fish mixed completely with unmarked fish between events.

Since coho salmon enter the American and Olds rivers primarily in September and each river was completely sampled in October, it is unlikely that immigration or emigration occurred during the experiments. Additionally, we assumed that inriver spawning and fishing mortality were equal among marked and unmarked coho salmon during the experiments. To minimize violation of assumption number 1, all captured coho salmon were handled carefully and were thoroughly examined for marks. The secondary mark (caudal finclip) provided the means to estimate tag loss (assumption 2).

Contingency tables and chi-squared tests (Conover 1980) were used to compare the recapture to mark ratio among the river sections of release and by sex between the marking event and the recapture event (assumptions 3 through 5). Chi-squared tests were also used to test the marked to unmarked ratio during the recapture event due to release location, sex, and day of release. Two-sample Kolmogorov-Smirnov tests (Daniel 1978) were used to determine if capture rates differed due to size. The first test compared the cumulative length distributions of fish marked in the fist event with those recaptured in the second event and the second test compared the cumulative length distributions of all fish marked in the first event with all fish captured in the recapture event. Differences in cumulative length distributions or capture rate among one of these groups

help to determine if the data should be stratified by length group to provide an unbiased estimate of abundance (Seber 1982). All tests were conducted at $\alpha = 0.05$.

If at least one of assumptions 3 through 5 was met, abundance can be calculated using Chapman's modification of the Petersen estimator (Seber 1982):

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

where:

$\hat{N}$ = abundance of coho salmon during the first event;

M = number of fish marked and released in the first event;

R = number of marked fish recaptured in the second event; and

C = number of fish examined for marks in the second event.

Variance was estimated by:

$$\mathrm{Var}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \quad (2)$$

This estimator was used to calculate abundance of coho salmon in the Olds River during 1997 and 1998, and the American River during 1998.

If none of assumptions 3 through 5 were met relative to area, the stratified estimator of Darroch was used (Seber 1982; Bernard and Hansen 1992). The computer program SPAS (Arnason et al. 1996) was used to calculate maximum likelihood estimates of abundance by area, capture probability by area, and variance. This estimator was used to calculate abundance of coho salmon in the American River during 1997.

Length and Sex Composition

Coho salmon were sampled to estimate mean length (mid-eye to fork-of-tail) and sex composition. Mean lengths were estimated for each river. The proportion of coho salmon in each sex class (p_i) was estimated as a binomial proportion by:

$$\hat{p}_i = \frac{n_i}{n}; \quad (3)$$

where:

n_i = number of coho salmon sampled of sex class i, and

n = total number of coho salmon sampled.

Variance was estimated by:

$$\mathrm{Var}(\hat{p}_i) = \frac{p_i(1-p_i)}{n-1}\left(\frac{n-n_i}{n}\right). \quad (4)$$

An estimate of abundance of the spawning coho salmon population by sex class i was made by:

$$\hat{N}_i = \hat{N}p_i, \quad (5)$$

and the variance estimated by (Goodman 1960):

$$\mathrm{Var}(\hat{N}_i) = [V(\hat{N})\hat{p}_i^2 + V(\hat{p}_i)\hat{N}^2 - V(\hat{N})V(\hat{p}_i)]. \quad (6)$$

RESULTS

CREEL CENSUSES

From September 3 through October 5, 1997, 327 anglers harvested 330 and released 232 coho salmon at the Nateekin River (Table 4). In addition, anglers harvested 35 Dolly Varden and released 91 Dolly Varden; no pink salmon were harvested and 43 pink salmon were released. No anglers interviewed at the Nateekin were guided, 4% (13 anglers) used chartered vessels to access the fishery, and the majority (87%) of anglers interviewed were local Unalaska area residents (Table 5). A foot survey conducted on the Nateekin River after the sport fishery ended documented 576 coho salmon in 1997 and 414 coho salmon in 1998.

At Discoverer Bay, 263 anglers harvested 487 and released 1,267 coho salmon from

Table 4.-Daily cumulative summary of angler effort, coho salmon harvested and coho salmon released during the Nateekin River sport fishery, September 3–October 5, 1997.

Date	Angler Effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
9/03	6	6	1	1	2	2
9/04	6	12	8	9	4	6
9/05	14	26	15	24	3	9
9/06	9	35	10	34	21	30
9/07	4	39	0	34	0	30
9/08	25	64	34	68	13	43
9/09	25	89	19	87	3	46
9/10	32	121	42	129	24	70
9/11	20	141	9	138	4	74
9/12	10	151	17	155	17	91
9/13	19	170	19	174	13	104
9/14	13	183	17	191	9	113
9/15	10	193	13	204	1	114
9/16	3	196	0	204	0	114
9/17	0	196	0	204	0	114
9/18	25	221	29	233	27	141
9/19	15	236	16	249	10	151
9/20	16	252	22	271	18	169
9/21	4	256	8	279	7	176
9/22	0	256	0	279	0	176
9/23	0	256	0	279	0	176
9/24	0	256	0	279	0	176
9/25	5	261	3	282	0	176
9/26	3	264	5	287	5	181
9/27	18	282	14	301	6	187
9/28	10	292	1	302	0	187
9/29	3	295	6	308	5	192
9/30	6	301	6	314	29	221
10/01	0	301	0	314	0	221
10/02	0	301	0	314	0	221
10/03	9	310	8	322	10	231
10/04	14	324	2	324	0	231
10/05	3	327	6	330	1	232
Total	327		330		232	

[a] Angler effort is angler-days; value of zero indicates that no anglers fished at this location on that day.

Table 5.-Summary of angler characteristics during the coho salmon sport fishery at the Nateekin River, September 3–October 5, 1997.

Angler characteristic	Number of anglers	Percent of total[a]
Guided	0	0
Unguided	327	100
Total	327	100
Chartered	13	4
Non-chartered	314	96
Total	327	100
Local Unalaska resident	280	87
Other Alaska resident	3	1
Non-Alaska resident	44	12
Total	327	100

[a] Percent of the 327 anglers interviewed.

August 9 through September 6, 1998 (Table 6). Anglers fishing from charter vessels accounted for 29% of the effort, and harvested 170 coho salmon and released 305 coho salmon (Table 7). Anglers fishing from non-charter vessels accounted for 317 coho salmon harvested and 962 coho salmon released (Table 8). The majority of anglers interviewed at Discoverer Bay were unguided (73%), fished from boats (73%), were not Alaska residents (77%) and accessed Discoverer Bay by aircraft or boat (88%; Table 9). Four anglers were counted fishing during eight angler surveys conducted at Portage Lake from August 9 through September 6, 1998 (Table 10).

Foot surveys were conducted on the two tributaries to Portage Creek and a peak count of 1,480 coho salmon was obtained on September 5, 1998 (Table 11).

From August 9 through September 3, 1998, 334 anglers at Pauls Bay harvested 844 coho salmon and released 1,557 coho salmon (Table 12). Anglers fishing from charter vessels harvested 722 and released 1,217 coho salmon (Table 13). Anglers fishing from non-chartered vessels harvested 122 and released 340 coho salmon (Table 14). The majority of anglers at Pauls Bay were guided (82%), fished from boats (92%), were not Alaskan residents (77%), and accessed the fishery by aircraft or boat (100%; Table 9).

Ninety-one anglers were counted at Pauls Lake and all were interviewed (Tables 10 and 15). During August 12 through September 16, 1998, 12 coho salmon were harvested and 422 were released (Table 15). All anglers interviewed at Pauls Lake were guided, fished from the shore, and were non-Alaska residents that accessed the lake by boat or aircraft.

SPAWNING COHO SALMON AT THE AMERICAN AND OLDS RIVERS

American River

At the American River in 1997, 427 coho salmon were released with marks during the

Table 6.-Daily cumulative summary of effort, coho salmon harvested and coho salmon released during the sport fishery at Discoverer Bay, Afognak Island, August 9–September 6, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	11	11	52	52	200	200
8/10	5	16	25	77	0	0
8/11	5	21	25	102	0	0
8/12	4	25	6	108	7	207
8/13	4	29	11	119	11	218
8/14	12	41	10	129	5	223
8/15	14	55	30	159	23	246
8/16	17	72	49	208	4	250
8/17	21	93	21	229	38	288
8/18	19	112	18	247	75	363
8/19	14	126	8	255	64	427
8/20	8	134	30	285	32	459
8/21	11	145	12	297	91	550
8/22	9	154	35	332	43	593
8/23	9	163	22	354	55	648
8/24	18	181	30	384	109	757
8/25	8	189	0	384	105	862
8/26	7	196	14	398	36	898
8/27	7	203	20	418	37	935
8/28	4	207	0	418	35	970
8/29	6	213	10	428	50	1,020
8/30	12	225	10	438	6	1,026
8/31	6	231	0	438	0	1,026
9/01	0	231	0	438	0	1,026
9/02	0	231	0	438	0	1,026
9/03	6	237	18	456	85	1,111
9/04	6	243	10	466	65	1,176
9/05	6	249	6	472	56	1,232
9/06	14	263	15	487	35	1,267
Total	263		487		1,267	

[a] Angler effort is angler-days; value of zero indicates that no anglers fished at this location on that day.

Table 7.-Daily cumulative summary of effort, coho salmon harvested and coho salmon released by anglers fishing from charter vessels at Discoverer Bay, Afognak Island, August 9–August 31, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	8	8	40	40	200	200
8/10	5	13	25	65	0	200
8/11	5	18	25	90	0	200
8/12	0	18	0	90	0	200
8/13	0	18	0	90	0	200
8/14	0	18	0	90	0	200
8/15	2	20	10	100	23	223
8/16	6	26	16	116	0	223
8/17	12	38	19	135	12	235
8/18	9	47	8	143	40	275
8/19	0	47	0	143	0	275
8/20	0	47	0	143	0	275
8/21	0	47	0	143	0	275
8/22	0	47	0	143	0	275
8/23	6	53	12	155	30	305
8/24	4	57	5	160	0	305
8/25	0	57	0	160	0	305
8/26	0	57	0	160	0	305
8/27	0	57	0	160	0	305
8/28	0	57	0	160	0	305
8/29	0	57	0	160	0	305
8/30	8	65	10	170	0	305
8/31[b]	4	69	0	170	0	305
Total	69		170		305	

[a] Angler effort is angler-days; value of zero indicates no charter vessels fished at this location on that day.

[b] Charter vessels left the area after 8/31.

marking event and 247 were examined for marks during the recapture event, of which 71 were marked (Table 16). The recapture to mark ratio was significantly different among the river sections of release (χ^2 = 40.322, df = 1, P < 0.001). However, the recapture to mark ratio was not significantly different among sexes (χ^2 = 0.027, df = 1, P = 0.869). There was also a significant difference in the marked to unmarked ratio during the recapture event due to river section of capture (χ^2 = 23.705, df = 1, P < 0.001), but not due to differences among sexes (χ^2 = 0.238, df = 1, P = 0.625). No significant difference was

Table 8.-Daily cumulative summary for effort, coho salmon harvested and coho salmon released by anglers fishing from non-charter vessels, Discoverer Bay, Afognak Island, August 9–September 6, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	3	3	12	12	0	0
8/10	0	3	0	12	0	0
8/11	0	3	0	12	0	0
8/12	4	7	6	18	7	7
8/13	4	11	11	29	11	18
8/14	12	23	10	39	5	23
8/15	12	35	20	59	0	23
8/16	11	46	33	92	4	27
8/17	9	55	2	94	26	53
8/18	10	65	10	104	35	88
8/19	14	79	8	112	64	152
8/20	8	87	30	142	32	184
8/21	11	98	12	154	91	275
8/22	9	107	35	189	43	318
8/23	3	110	10	199	25	343
8/24	14	124	25	224	109	452
8/25	8	132	0	224	105	557
8/26	7	139	14	238	36	593
8/27	7	146	20	258	37	630
8/28	4	150	0	258	35	665
8/29	6	156	10	268	50	715
8/30	4	160	0	268	6	721
8/31	2	162	0	268	0	721
9/01	0	162	0	268	0	721
9/02	0	162	0	268	0	721
9/03	6	168	18	286	85	806
9/04	6	174	10	296	65	871
9/05	6	180	6	302	56	927
9/06	14	194	15	317	35	962
Total	194		317		962	

[a] Angler effort is angler-days; value of zero indicates no anglers fished at this location on that day.

Table 9.-Summary of angler characteristics at Discoverer Bay, Pauls Bay and Pauls Lake, Afognak Island, 1998.

	Discoverer Bay		Pauls Bay		Pauls Lake	
Angler characteristic	Number Anglers	Percent of Total	Number Anglers	Percent of Total	Number Anglers	Percent of Total
Guided	72	27	275	82	91	100
Unguided	191	73	59	18	0	0
Total	263	100	334	100	91	100
Boat	193	73	307	92	0	0
Shore	70	27	27	8	91	100
Total	263	100	334	100	91	100
Local Kodiak resident	29	11	22	7	0	0
Other Alaska resident	13	12	53	16	0	0
Non-Alaska resident	203	77	259	77	91	100
Total	263	100	334	100	91	
Local Access[a]	31	12	0	0	0	0
Non-local Access[b]	232	88	334	100	91	100
Total	263	100	334	100	91	100

[a] Angler access to fishing location from logging camps at Kazakof Bay.

[b] Angler access to fishing location from boat or plane, not from logging camps at Kazakof Bay.

detected between the cumulative length distributions of all fish marked in the first event and all marked fish recaptured in the second event ($D = 0.073$, $P = 0.898$, $n_1 = 427$, $n_2 = 70$). A similar test of all marked fish in the first event and all captured fish during the recapture event did not detect a significant difference in the length distributions of these two groups ($D = 0.034$, $P = 0.994$, $n_1 = 427$, $n_2 = 246$). Therefore, mark-recapture data were stratified by river section, and the stratified estimator of Darroch (Seber 1982) was used to calculate abundance during the second event.

The estimated number of coho salmon spawning in the upriver section of the American River in 1997 was 504 (SE = 109); an estimated 3,072 (SE = 1,330) coho salmon spawned in the lower river. This produced a spawning abundance estimate for the entire American River of 3,576 fish (SE = 1,263). A peak of 2,204 coho salmon was counted during the October 24, 1997 foot survey.

At the American River in 1998, 621 coho salmon were counted during the foot survey on October 2 just prior to the mark-recapture experiment, indicating that 156 coho salmon should be marked and examined for marks to estimate abundance with a precision of ±25%, 95% of the time. A total of 162 coho salmon were captured and released with tags. During the recapture event 286 coho salmon were captured and examined for marks, of which 36 were marked (Table 17). No coho salmon had lost their tags. The recapture to mark ratio was not significantly different among the river sections of release ($\chi^2 = 0.310$, df = 1, $P = 0.578$) or sex ($\chi^2 = 0.143$, df = 1, $P = 0.705$). There was no significant difference in the marked-to-unmarked ratio due to river

Table 10.-Summary of angler counts for Pauls Lake and Portage Lake, Afognak Island, 1998.

	Pauls Lake[a]			Portage Lake[b]		
Date	Surveyed[c]	Number anglers counted	Cumulative angler count	Surveyed[c]	Number anglers counted	Cumulative angler count
8/09				N		
8/10				N		
8/11				N		
8/12	Y	4	4	N		
8/13	Y	0	4	N		
8/14	Y	0	4	Y	0	0
8/15	Y	0	4	N		0
8/16	Y	4	8	Y	0	0
8/17	Y	4	12	N		0
8/18	Y	4	16	N		0
8/19	Y	0	16	N		0
8/20	Y	0	16	N		0
8/21	Y	4	20	Y	0	0
8/22	Y	0	20	N		0
8/23	Y	0	20	N		0
8/24	Y	3	23	Y	0	0
8/25	Y	3	26	N		0
8/26	Y	3	29	Y	0	0
8/27	Y	3	32	N		0
8/28	Y	3	35	N		0
8/29	Y	0	35	Y	0	0
8/30	Y	3	38	N		0
8/31	Y	3	41	N		0
9/01	Y	3	44	N		0
9/02	Y	3	47	N		0
9/03	Y	2	49	N		0
9/04	Y	2	51	Y	0	0
9/05	Y	0	51	N		0
9/06	Y	4	55	Y	4	4
9/07	Y	4	59			
9/08	Y	4	63			
9/09	Y	4	67			
9/10	Y	4	71			
9/11	Y	0	71			
9/12	Y	0	71			
9/13	Y	6	77			
9/14	Y	6	83			
9/15	Y	6	89			
9/16	Y	2	91			
Total[d]	37	91		8	4	

[a] Pauls Lake area creel census was conducted from 8/12/98 through 9/16/98.

[b] Portage Lake area creel census was conducted from 8/09/98 through 9/06/98.

[c] Y = lake surveyed for anglers; N = lake not surveyed for anglers.

[d] Total for surveyed column is total number of days lake was surveyed for anglers.

Table 11.-Foot survey counts of spawning coho salmon at two tributaries to Portage Creek, Discoverer Bay, 1998.

	Number of coho salmon, stream 825			Number of coho salmon, stream 830		
Date	At mouth	In stream	Total	At mouth	In stream	Total
8/14	0	22	22			
8/20				20	0	20
8/22	300	87	387			
8/28	500	120	620	40	0	40
9/05	230	1,250	1,480			

Table 12.-Daily cumulative summary of effort, coho salmon harvested and coho salmon released, by all anglers at Pauls Bay, Afognak Island, August 9–September 3, 1998.

Date	Angler effort	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	14	14	50	50	55	55
8/10	14	28	52	102	194	249
8/11	13	41	33	135	126	375
8/12	19	60	27	162	55	430
8/13	7	67	10	172	43	473
8/14	10	77	22	194	34	507
8/15	13	90	40	234	134	641
8/16	15	105	45	279	163	804
8/17	8	113	22	301	101	905
8/18	4	117	20	321	50	955
8/19	19	136	52	373	112	1,067
8/20	16	152	42	415	77	1,144
8/21	27	179	86	501	143	1,287
8/22	32	211	63	564	140	1,427
8/23	21	232	41	605	52	1,479
8/24	10	242	20	625	0	1,479
8/25	14	256	41	666	43	1,522
8/26	18	274	38	704	13	1,535
8/27	17	291	32	736	18	1,553
8/28	10	301	22	758	0	1,553
8/29	10	311	26	784	0	1,553
8/30	10	321	33	817	0	1,553
8/31	0	321	0	817	0	1,553
9/01	4	325	18	835	0	1,553
9/02	7	332	8	843	1	1,554
9/03	2	334	1	844	3	1,557
Total	334		844		1,557	

Table 13.-Daily cumulative summary of effort, coho salmon harvested and coho salmon released, by anglers fishing from charter vessels at Pauls Bay, Afognak Island, August 9–September 2, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	10	10	50	50	20	20
8/10	10	20	50	100	187	207
8/11	6	26	30	130	110	317
8/12	11	37	12	142	40	357
8/13	2	39	10	152	0	357
8/14	2	41	10	162	31	388
8/15	7	48	35	197	134	522
8/16	9	57	45	242	145	667
8/17	7	64	21	263	101	768
8/18	4	68	20	283	50	818
8/19	15	83	52	335	77	895
8/20	12	95	38	373	27	922
8/21	21	116	56	429	138	1,060
8/22	21	137	57	486	109	1,169
8/23	10	147	16	502	12	1,181
8/24	10	157	20	522	0	1,181
8/25	11	168	40	562	31	1,212
8/26	10	178	30	592	5	1,217
8/27	10	188	25	617	0	1,217
8/28	10	198	22	639	0	1,217
8/29	10	208	26	665	0	1,217
8/30	10	218	33	698	0	1,217
8/31	0	218	0	698	0	1,217
9/01	4	222	18	716	0	1,217
9/02	4	226	6	722	0	1,217
Total	226		722		1,217	

[a] Angler effort is angler-days; value of zero indicates no charter vessels fished at this location on that day.

section of capture (χ^2 = 0.030, df = 1, P = 0.863) or sex (χ^2 = 0.392, df = 1, P = 0.531). No significant difference was detected between the cumulative length distributions of all fish marked in the first event and all marked fish recaptured in the second event (D = 0.069, P = 0.999, n_1 = 161, n_2 = 36). A similar test of all fish marked in the first event and all fish captured during the recapture event did not detect a significant difference in the length distributions of these two groups (D = 0.089, P = 0.375, n_1 = 161, n_2 = 286). Therefore, a single unstratified estimate of abundance was calculated. The estimated abundance of coho salmon spawning in the American River during 1998 was 1,263 fish (SE = 168). A peak count of 1,360 coho salmon was obtained during the foot survey on October 21, 1998.

Table 14.-Daily cumulative summary of effort, coho salmon harvested and coho salmon released, by anglers fishing from saltwater non-chartered vessels at Pauls Bay, Afognak Island, August 9–September 3, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/09	4	4	0	0	35	35
8/10	4	8	2	2	7	42
8/11	7	15	3	5	16	58
8/12	8	23	15	20	15	73
8/13	5	28	0	20	43	116
8/14	8	36	12	32	3	119
8/15	6	42	5	37	0	119
8/16	6	48	0	37	18	137
8/17	1	49	1	38	0	137
8/18	0	49	0	38	0	137
8/19	4	53	0	38	35	172
8/20	4	57	4	42	50	222
8/21	6	63	30	72	5	227
8/22	11	74	6	78	31	258
8/23	11	85	25	103	40	298
8/24	0	85	0	103	0	298
8/25	3	88	1	104	12	310
8/26	8	96	8	112	8	318
8/27	7	103	7	119	18	336
8/28	0	103	0	119	0	336
8/29	0	103	0	119	0	336
8/30	0	103	0	119	0	336
8/31	0	103	0	119	0	336
9/01	0	103	0	119	0	336
9/02	3	106	2	121	1	337
9/03	2	108	1	122	3	340
Total	108		122		340	

[a] Angler effort is angler-days; value of zero indicates no anglers fished at this location on that day.

During 1997, 54.8% (SE = 2.0) of coho salmon were males, with a mean length of 625 (SE = 4) mm (Table 18). The estimated abundance by sex was 1,960 males (SE = 696) and 1,616 females (SE = 575). During 1998, 48.3% of coho salmon were males, with a mean length of 648 (SE = 2) mm (Table 18). The estimated abundance by sex was 610 (SE = 84) males and 653 (SE = 90) females.

Olds River

During 1997, 860 coho salmon were marked, 572 fish were recaptured and examined for tags, of which 83 fish were recaptured with

Table 15.-Daily cumulative summary of angler effort, coho salmon harvested and coho salmon released, Pauls Lake, Afognak Island, August 12–September 16, 1998.

Date	Angler effort[a]	Cumulative	Coho Harvested	Cumulative	Coho Released	Cumulative
8/12	4	4	0	0	4	4
8/13	0	4	0	0	0	4
8/14	0	4	0	0	0	4
8/15	0	4	0	0	0	4
8/16	4	8	0	0	4	8
8/17	4	12	1	1	16	24
8/18	4	16	0	1	7	31
8/19	0	16	0	1	0	31
8/20	0	16	0	1	0	31
8/21	4	20	0	1	3	34
8/22	0	20	0	1	0	34
8/23	0	20	0	1	0	34
8/24	3	23	0	1	9	43
8/25	3	26	1	2	8	51
8/26	3	29	0	2	20	71
8/27	3	32	0	2	25	96
8/28	3	35	1	3	6	102
8/29	0	35	0	3	0	102
8/30	3	38	0	3	15	117
8/31	3	41	0	3	30	147
9/01	3	44	1	4	20	167
9/02	3	47	2	6	2	269
9/03	2	49	2	8	3	172
9/04	2	51	1	9	4	176
9/05	0	51	0	9	0	176
9/06	4	55	0	9	25	201
9/07	4	59	1	10	25	226
9/08	4	63	0	10	35	261
9/09	4	67	0	10	45	306
9/10	4	71	1	11	45	351
9/11	0	71	0	11	0	351
9/12	0	71	0	11	0	351
9/13	6	77	0	11	25	376
9/14	6	83	1	12	30	406
9/15	6	89	0	12	6	412
9/16	2	91	0	12	10	422
Total	91		12		422	

[a] Angler effort is angler-days; value of zero indicates no anglers fished at this location on that day.

tags at the Olds River (Table 19). During the second event, six coho salmon had lost their tags. The recapture to mark ratio differed significantly by river section of release (χ^2 = 12.754 df = 1, P < 0.001), but not by sex of coho salmon (χ^2 = 0.190, df = 1, P = 0.663). However, no difference was detected in the marked to unmarked ratio by river section (χ^2 = 1.247, df = 1, P = 0.264) or sex (χ^2 = 0.446, df = 1, P = 0.504). No significant differences were detected in the cumulative length distributions of marks and recaptures

Table 16.-Summary of coho salmon mark-recapture experiments by event and river section, American River, 1997.

Marking Event 10/08 and 10/11		Recapture Event 10/16[b]				
		Tag Recoveries by Section			Number not	Percent
River Section[a]	Number released	1	2	Total	Recovered	Recovered
1	235	62	0	62	172	27.2
2	192	2	5	7	185	3.6
Number tagged	427	64	5	71	356	16.6
Number Untagged		101	75	71		
Number Examined		165	82	247		
Percent Tagged		38.8	6.1	28.7		

[a] 1 = Upper River; 2 = Lower River.

[b] Totals do not sum because one recaptured fish lost its tag and one recaptured fish had its tag number recorded incorrectly.

(D = 0.063, P = 0.929, n_1 = 859, n_2 = 82) or marks and catch (D = 0.037, P = 0.721, n_1 = 859, n_2 = 571). Based on these tests of assumptions, an unstratified estimate of abundance was calculated from all mark-recapture data. The estimated abundance of coho salmon spawning in the entire Olds River was 5,872 fish (SE = 559).

During 1998, 2,296 coho salmon were counted during the foot survey on October 2, indicating that 341 coho salmon should be marked and examined for marks to estimate abundance with a precision of ±25%, 95% of the time. A total of 297 coho salmon were released with marks during the marking event. During the recapture event, 442 were captured and examined for marks, of which 59 were marked (Table 20). No coho salmon had lost their tags. The recapture to mark ratio did not differ due to river section of release (χ^2 = 1.910, df = 1, P = 0.167) or sex

Table 17.-Summary of coho salmon mark-recapture experiments by event and river section, American River, 1998.

Marking Event 10/05 – 10/06		Recapture Event 10/07				
		Tag Recoveries by Section[a]			Number not	Percent
River Section[a]	Number released	1	2	Total	Recovered	Recovered
1	65	11	2	13	52	20.0
2	97	2	21	23	74	23.7
Number tagged	162	13	23	36	126	22.2
Number Untagged		94	156	250		
Number Examined		107	179	286		
Percent Tagged		12.1	12.8	12.5		

[a] 1 = Upper River; 2 = Lower River.

Table 18.-Sex composition and mean length of coho spawning at the American and Olds rivers, 1997 and 1998.

Year	Sex	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE	Mean Length (mm)	SE
			American River					
1997	Female	272	0.452	0.020	1,616	575	635	3
	Male	330	0.548	0.020	1,960	696	625	4
	All	602	1.000	0.000	3,576	1,263	630	3
1998	Female	213	0.517	0.017	653	90	642	2
	Male	199	0.483	0.018	610	84	648	3
	All	412	1.000	0.000	1,263	168	645	2
			Olds River					
1997	Female	667	0.495	0.009	2,906	118	654	1
	Male	681	0.505	0.009	2,966	120	642	2
	All	1,348	1.000	0.000	5,872	559	648	1
1998	Female	335	0.493	0.014	1,083	119	654	2
	Male	345	0.507	0.013	1,116	122	641	4
	All	680	1.000	0.000	2,199	234	648	2

Table 19.-Summary of coho salmon mark-recapture experiments by event and river section, Olds River, 1997.

Marking Event 10/09, 10/10 and 10/15		Recapture Event 10/17 and 10/ 21[b]				
		Tag Recoveries by Section			Number not	Percent
River Section[a]	Number released	1	2	Total	Recovered	Recovered
1	346	5	11	16	330	4.6
2	514	6	54	60	454	11.6
Number tagged	860	11	71	83	777	9.7
Number Untagged		122	368	490		
Number Examined		133	439	572		
Percent Tagged		8.2	16.2	14.5		

[a] 1 = Upper River; 2 = Lower River.

[b] Totals do not sum because six recaptured fish lost their tags and one recaptured fish had its tag number incorrectly recorded.

Table 20.-Summary of coho salmon mark-recapture experiments by event and river section, Olds River, 1998.

Marking Event 10/08		Recapture Event 10/09				
		Tag Recoveries by Section[a]			Number not	Percent
River Section[a]	Number released	1	2	Total	Recovered	Recovered
1	98	11	4	15	83	15.3
2	199	9	35	44	155	22.1
Number tagged	297	20	39	59	238	19.9
Number Untagged		91	292	383		
Number Examined		111	331	442		
Percent Tagged		21.9	13.3	15.4		

[a] 1 = Upper River; 2 = Lower River.

(χ^2 = 0.014, df = 1, P = 0.906). Additionally, no difference was detected in the marked-to-unmarked ratio due to river section (χ^2 = 0.078, df = 1, P = 0.781) or sex (χ^2 = 0.572, df = 1, P = 0.450). No significant differences were detected in the cumulative length distributions of marks and recaptures (D = 0.114, P = 0.546, n_1 = 297, n_2 = 59) or marks and catch (D = 0.076, P = 0.252, n_1 = 297, n_2 = 442). The unstratified estimate of abundance for coho salmon spawning at the Olds River during 1998 was 2,199 fish (SE = 234).

At the Olds River in 1997, an estimated 50.5% (SE = 0.9) of coho salmon were males, with a mean length 642 (SE = 2) mm. The estimated abundance of male coho salmon was 2,966 (SE = 120) and 2,906 (SE = 118) female coho salmon. In 1998, 50.7% (SE = 1.3) of coho salmon were male, with a mean length 641 (SE = 4) mm. An estimated 1,116 (SE = 122) fish were males and 1,083 (SE = 119) were females (Table 18).

DISCUSSION

NATEEKIN RIVER CREEL CENSUS

The Nateekin River creel census was conducted because of public concern that the sport fishery was growing and would compromise sustainability. Comparing this fishery to the long-established and monitored coho salmon fisheries of the American and Olds rivers will help put the Nateekin River fishery in perspective. There are a few weaknesses with this comparison. For example, estimates of effort for the American and Olds rivers include pink salmon and Dolly Varden fisheries, but the majority of the effort is directed at coho salmon. Estimates of escapement obtained from foot surveys are minimum estimates because it is usually not possible to count every fish during foot surveys. Thus, estimates of exploitation are maximum estimates. In addition, comparing foot surveys between streams can be problematic because the percentage of the total spawning escapement counted is probably a function of variables such as river morphology and probably differs for each stream. However, the Nateekin, American, and Olds rivers are similar enough that broad comparisons should be valid and are useful in determining if effort and harvest are excessive at the Nateekin River.

The creel census documented 327 angler-days during the Nateekin River fishery in 1997 compared to an average of over 4,000 angler

days annually from 1989–1997 at both the American and Olds rivers (Table 21). Harvest at the Nateekin River was 330 coho salmon in 1997, compared to average annual harvests of 1,098 coho salmon at the American River and 1,369 coho salmon at the Olds River during 1989–1998 (Table 21). Escapement at the Nateekin River, based on foot surveys, averaged 717 coho salmon for years with data (Table 21). The inriver exploitation rate for 1997 at the Nateekin River, the only year for which harvest data are available, was 36%. In comparison, at the American River escapement has averaged 613 coho salmon and exploitation has averaged 71% since 1989 (Table 21). On the Olds River, escapement has averaged 2,134 coho salmon and exploitation rate 48%. Thus, based on comparisons to other coho salmon fisheries in the KMA, the Nateekin River sport harvest is relatively small, escapement average, and exploitation rate low, so the sport fishery will probably not affect sustainability of the Nateekin River coho salmon population.

In response to concerns about the Nateekin River coho salmon stocks, the Alaska Board of Fisheries afforded additional protection to Nateekin River coho salmon at its January 1998 meeting by closing the upper river to sport fishing all year long. This closure begins approximately 2 miles upriver and creates a “pass through" fishery. Once a coho salmon passes through the first 2 river miles it is safe from harvest. The department will continue to monitor coho salmon spawning escapements through stream surveys. If a trend of decreasing numbers of spawning

Table 21.-Comparison of effort, harvest, escapement, and exploitation rate for the American, Olds, and Nateekin rivers, 1989-1998.

	American River				Olds River				Nateekin River			
Year	Effort[a]	Harvest[a]	Escapement[b]	Exploit. Rate[c]	Effort[a]	Harvest[a]	Escapement[b]	Exploit. Rate[c]	Effort[d]	Harvest[d]	Escapement[b]	Exploit. Rate[c]
1989	3,506	1,500			5,378	2,571	800	0.76				
1990	3,359	849	316	0.73	3,247	948	1,706	0.36				
1991	4,291	794			5,583	1,778	900	0.66				
1992	3,276	583	181	0.76	5,079	1,085	950	0.53				
1993	5,006	2,340	412	0.85	5,592	1,838	525	0.78				
1994	3,321	642	194	0.77	3,438	1,082	395	0.73			1,421	
1995	3,267	794	169	0.82	5,169	833	7,500	0.10				
1996	5,140	745	69	0.92	4,197	869	2,200	0.28			455	
1997	6,190	1,928	2,204[e]	0.47[e]	3,907	1,657	4,064	0.29	327	330	576	0.36
1998		806	1,360	0.37		1,033	2,296	0.31			414	
Avg.	4,151	1,098	613	0.71	4,621	1,369	2,134	0.48			717	

[a] From SWHS (Mills 1990-1994; Howe et al. 1995–1999); SWHS effort not available for 1998.

[b] From foot surveys (Schwarz 1997, 2000; and this report).

[c] Maximum exploitation rate because foot surveys do not count all fish in the escapement.

[d] From creel census, this report; effort = number of anglers.

[e] Based on mark-recapture experiments, escapement = 3,576 and exploitation = 0.35.

[f] Based on mark-recapture experiments, escapement = 5,872 and exploitation = 0.22.

coho salmon is observed, measures will be considered to reduce the sport harvest.

Perenosa Bay Creel Census

Based on this study, the sport fisheries at Pauls Bay and Discoverer Bay are small, and at this point will probably have negligible effect on the coho salmon stocks of Perenosa Bay. Harvest at Pauls Bay was 844 coho salmon in 1998, compared to an escapement of 15,514 coho salmon at Pauls Lake. In addition, the escapement goal of 6,000 coho salmon has been met in all years except one since 1989 (Table 2). Harvest at Discoverer Bay was 487 coho salmon in 1998, compared to an average escapement of 4,067 fish for 1987–1990, years for which escapement data are available (Table 3).

In January 1999, the Board of Fisheries examined all available sport, commercial, and escapement data. and developed a management plan for Perenosa Bay which accommodated both commercial and sport fisheries, as well as protecting the coho salmon resource. The plan allows commercial harvest of surplus fish by moving the commercial fishing boundary closure to the river mouth on August 1. This will allow some commercial harvest to occur early in the return and prevent a large build-up of coho salmon inside the area closed to commercial fishing. If weir counts are exceeding interim escapement goals, the commercial boundaries can be moved closer to the stream mouth to allow additional harvest of surplus fish. However, limitations are set on how close to the stream mouth the commercial fishery could be conducted. This provides a sanctuary area where the sport fishery can occur and an area where some coho salmon will not be harvested in the commercial fishery and will be available to the sport fishery. The controversy in past years arose when the commercial fishery was opened to the mouth of the river after escapement goals had been met, effectively harvesting surplus fish to the point that the sport fishery could not continue.

Spawning Abundance of Coho Salmon at the American and Olds Rivers

The purpose of estimating the spawning abundance was to determine if foot surveys are a valid method of monitoring spawning abundance. Another purpose was to determine if these stocks are large enough to support current exploitation rates.

Based on results of this study, foot surveys are a valid method of qualitatively tracking spawning abundance of coho salmon in the American River. Peak foot surveys on the American River correlated reasonably well with changes in spawning abundance. In 1997 the peak foot survey count accounted for 62% of the mark-recapture estimate, and was within the 95% confidence interval of the estimate (Table 22). In 1998, the peak foot survey accounted for 108% of the mark-recapture estimate, and was within the 95% confidence interval of the estimate (Table 22). The foot survey underestimated abundance in a high abundance year (1997) and accurately estimated abundance in an average abundance year (1998). Moreover, foot surveys indicated that there were 844 more coho salmon in the American River in 1997 than in 1998, while abundance estimates indicated that there were 2,313 more (95% CI of 0 to 4,810) fish in the river between years.

Variability of foot survey counts between observers may be a problem. For example, in 1997 one surveyor counted 940 coho salmon while another surveyor counted 2,204 coho salmon on the next survey. During 1998, the American River was surveyed simultaneously by independent observers on two occasions. On October 2 counts of 507 and 621 were obtained. On October 27 counts of 832 and 795 were obtained. This practice should be continued in order to validate that independent observers are obtaining similar results.

Table 22.-Summary of foot survey counts and mark-recapture abundance estimates for spawning coho salmon at the American and Olds rivers, Kodiak Island, 1997 and 1998.

American River		Olds River	
Date	Count	Date	Count
1997		1997	
10/01	1,467	10/04	3,380
10/09/	940	10/10	3,779
10/24	2,204	10/22	4,064
10/31[a]	2,450		
Abundance estimate[b]	3,576	Abundance estimate[b]	5,872
Standard Error	1,263	Standard Error	559
Lower 95% CI	1,101	Lower 95% CI	4,777
Upper 95% CI	6,051	Upper 95% CI	6,968
1998		1998	
09/08	14	09/08	1,033
09/13	33	10/02	2,296
09/14	80	10/20	1,133
10/02	507		
10/02	621		
10/08	534		
10/21	1,360		
10/27	832		
10/27	795		
Abundance estimate[b]	1,263	Abundance estimate[b]	2,199
Standard Error	168	Standard Error	234
Lower 95% CI	933	Lower 95% CI	1,740
Upper 95% CI	1,593	Upper 95% CI	2,658

[a] Helicopter survey.

[b] Mark-recapture experiment.

In addition to procedures in the adopted operational plan, a helicopter flight was conducted on October 31, 1997. Several days prior to the helicopter flight, an observer in a USFWS supercub flew the American and estimated coho salmon abundance at over three times the mark-and-recapture estimate. As a result a helicopter survey was flown on October 31 with an experienced ADF&G aerial surveyor and the observer from the supercub survey. The helicopter took both surveyors to the river, landed, and took one surveyor up the river at a time. The ADF&G surveyor counted 2,450 coho salmon and the

USFWS observer 6,800 coho salmon. This again points to the need to train and calibrate surveyors. The ADF&G surveyor began surveying in 1969 and has averaged approximately 100 hours surveying salmon each year since he began. He is probably the most experienced observer ADF&G has on staff. The ADF&G surveyor counted 1,126 coho salmon less than was estimated by the 1997 mark-recapture study while the USFWS surveyor estimated 3,224 coho salmon more than the mark-recapture estimate. The fact that the ADF&G helicopter estimate accounted for almost 70% of the mark-recapture estimate, where foot surveys ranged from only 59%-61% of the mark-recapture estimate, makes the possibility of monitoring populations by helicopter promising. A helicopter survey was planned for the American River in 1998 but helicopter availability and weather prevented a survey from being flown.

Peak foot surveys on the Olds River also correlated well with changes in the spawning abundance. In 1997, the peak foot survey accounted for 69% of the mark-recapture estimate, and was approximately 700 fish lower than the 95% confidence interval of the estimate (Table 22). In 1998, the peak foot survey accounted for 104% of the mark-recapture estimate, and was within the 95% confidence interval of the estimate (Table 22). The foot survey underestimated abundance in a high abundance year (1997) and accurately estimated abundance in an average abundance year (1998). Moreover, foot surveys indicated that there were 1,768 more coho salmon in the Olds River in 1997 than in 1998, while mark-recapture estimates indicated that there were 3,673 more (95% CI of 2,485 to 4,861) fish in the river between years. Although perhaps simplistic, this analysis shows that using peak foot surveys on the Olds River to qualitatively track spawning abundance is a valid technique.

The inriver exploitation rate on the American River in 1997 was between 35% (mark-recapture estimate) and 47% (foot survey count). To estimate exploitation of the total population, all harvests (commercial, subsistence, and sport) should be considered. However, the commercial (31 coho salmon from Middle Bay) and subsistence (six coho salmon) harvests are so small that there would be negligible effect on exploitation rate. The inriver exploitation rate on the Olds River in 1997 was 22% (mark-recapture estimate) to 29% (foot survey count). The 1997 commercial harvest was 3,011 and the subsistence harvest was 363 coho salmon. The overall exploitation rate of the Olds River coho salmon population was between 46% and 55%. The exploitation rates for both the American and Olds rivers in 1997 were fairly low and populations exploited at this level should be sustainable. However, the 1997 returns were at record levels. Exploitation rates for 1998 are not available at this time because the sport and subsistence harvests have not been estimated yet, but estimates of exploitation made for 1998 will be important as they will reflect average conditions.

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