Fishery Data Series No. 95-41

Assessment of the 1994 Return of Steelhead to the Karluk River, Alaska

by

Robert N. Begich

December 1995

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
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, ton, and metric 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

All standard mathematical signs, symbols, and abbreviations	
base of natural logarithm	e
catch per unit effort	CPUE
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 (specify base)	$\log_{10}$, etc.
minute (angular)	'
multiplied by	x
not significant	NS
percent	%
probability	P
probability of a type I error (false rejection of the null hypothesis)	α
probability of a type II error (false acceptance of the null hypothesis)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	V

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ABSTRACT

Beginning August 15, 1994, commercial set gillnet and purse seine catches from selected waters along the southwest side of Kodiak Island were sampled for the incidental harvest of steelhead trout *Oncorhynchus mykiss*. From returns of catch calendars, an estimated 184 steelhead were harvested for personal use and 48 were released from the set gillnet fishery. The commercial harvest sampled from tender deliveries resulted in 32 steelhead observed among 100,728 salmon *Oncorhynchus* harvested by the set gillnet fishery and 22 steelhead observed among 53,093 salmon in the purse seine fishery. Sampled purse seine and set gillnet fisheries harvested and sold an estimated 109 steelhead. The total estimated incidental commercial catch of steelhead from waters included in the Karluk study area between August 15 and September 30 was 341 fish.

Anglers interviewed at the Portage area of the Karluk River from October 4 through November 11 harvested 21 and released 2,598 steelhead. Subsistence fisheries harvested an estimated 35 steelhead.

A mark-recapture experiment was conducted on the Karluk River in the spring of 1995. The estimated abundance of spawning steelhead was 10,802 fish (SE = 437). Most of the spawning population was composed of initial spawners (83%), followed by repeat (15%) and multi-repeat (2%) spawners. Mean length for all spawning steelhead was 671 mm.

A record 7,014 steelhead emigrated through a weir on the Karluk River after spawning. From recaptures of marked fish, the estimated spawning survival of steelhead was 62%. Spawning survival was 68% for females and 54% for males. Survival of male steelhead was 55% for initial spawners and 46% for repeat spawners; for females survival was 75% for initial spawners and 38% for repeat spawners. No multi-repeat spawners captured in the marking event were observed at the weir.

Key words: Steelhead, *Oncorhynchus mykiss*, purse seine, set gillnet, kelts, statistical area, Kodiak Island, Karluk River, Portage area, harvest, abundance estimate, survival, initial spawners, repeat spawners, multi-repeat spawners.

INTRODUCTION

The Karluk River contains the largest steelhead *Oncorhynchus mykiss* population on Kodiak Island. From its source at the outlet of Karluk Lake, it flows approximately 35.2 km (22 mi) to its terminus at Karluk Lagoon and the Shelikof Strait (Figure 1). Adult steelhead begin immigration during late August and may continue immigration through the winter months. Steelhead overwinter, spawn and emigrate to sea as kelts from May through July.

Steelhead from the Karluk River are harvested in several fisheries. The autumn steelhead immigration coincides with the return of coho salmon *Oncorhynchus kisutch* and late-run sockeye salmon *O. nerka* to the Karluk River. When commercial set gillnet operators and purse seine vessels target these salmon stocks, steelhead are incidentally harvested in nearshore marine waters along the southwest portion of Kodiak Island. Adults are targeted in the Karluk River by sport anglers from September through November. In addition, adults are harvested in subsistence fisheries by residents of Karluk Village during June through September and by Larsen Bay residents during October through April. Emigrant kelts are harvested in commercial fisheries along southwest Kodiak Island during June. Additionally, steelhead from the Karluk River are incidentally harvested by commercial gear in nearshore marine waters along the Pacific side of the Alaska Peninsula (Figure 2).

Postspawn steelhead (kelts) counts obtained at the Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries Management and Development (CFMD) weir located at Karluk Lagoon have ranged from 210 to 7,014 since 1976 (Figure 3). The average annual kelt count of 2,385 fish from 1981 through 1985 declined to an average of

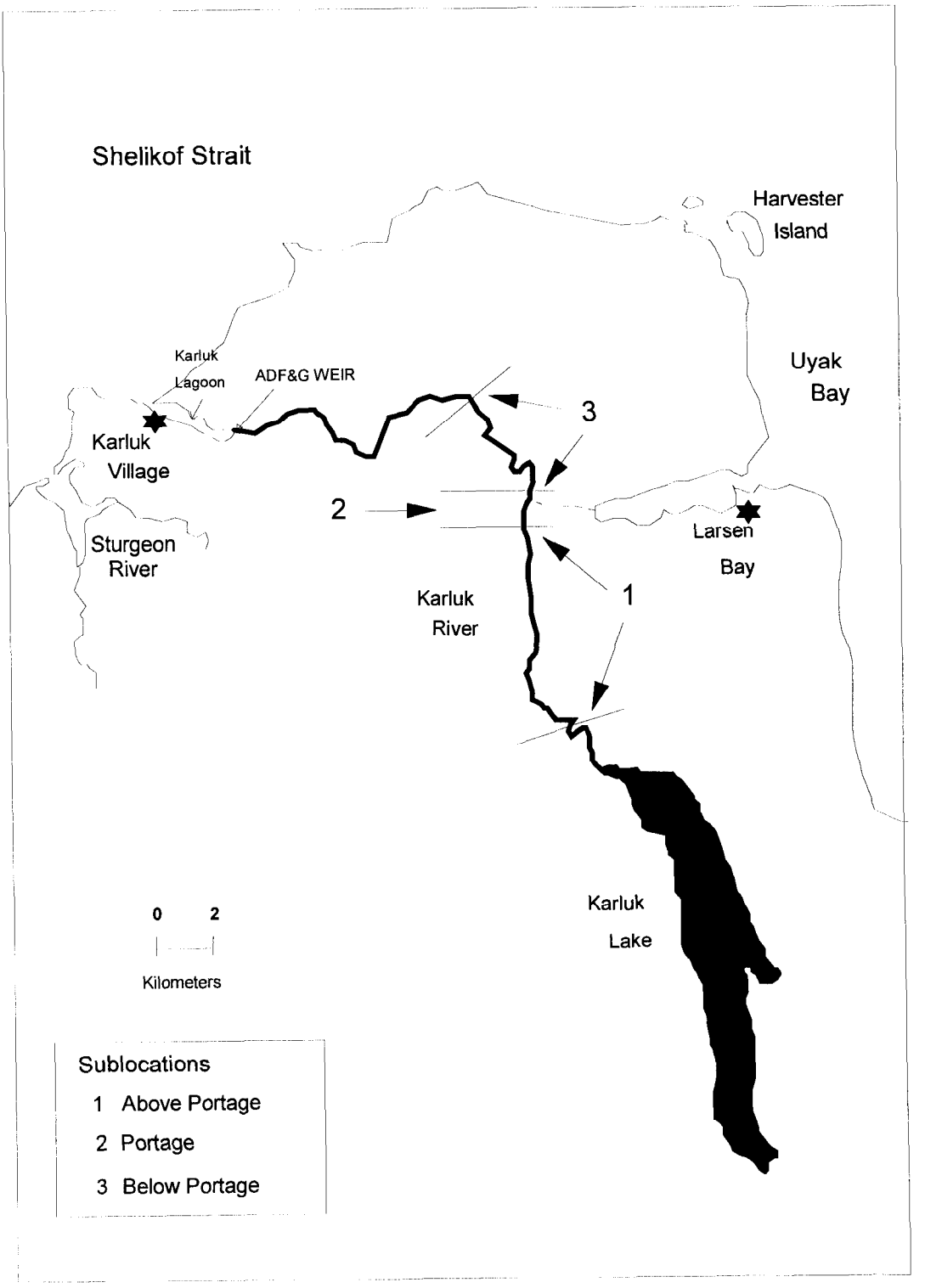

Figure 1.-Map of the Karluk River freshwater study area, Portage, Larsen Bay, weir and Karluk Village.

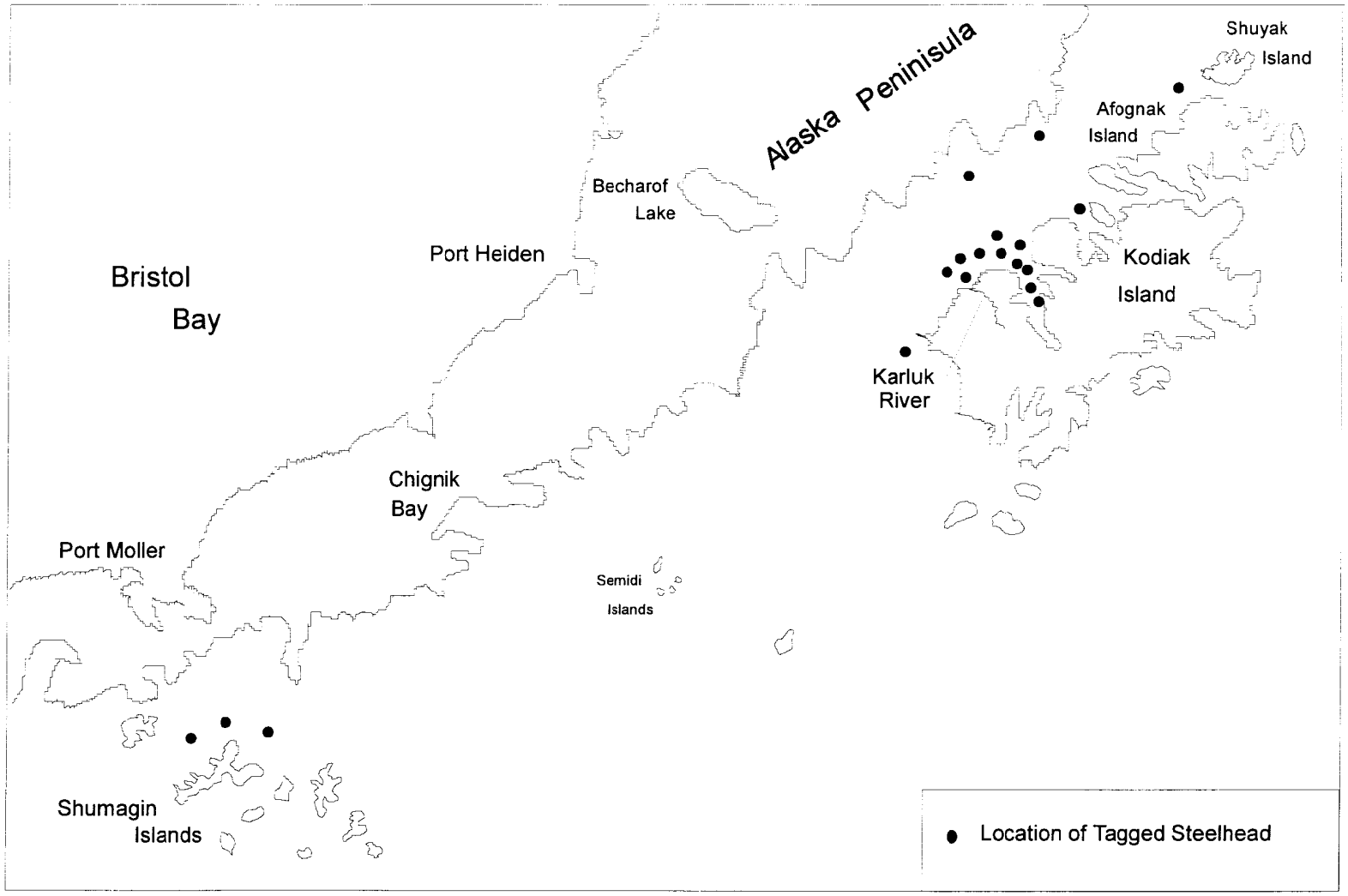

Figure 2.-Map of locations of Karluk River steelhead tag returns from Kodiak Island and Alaska Peninsula commercial salmon fisheries, from June 1992 through June 1995.

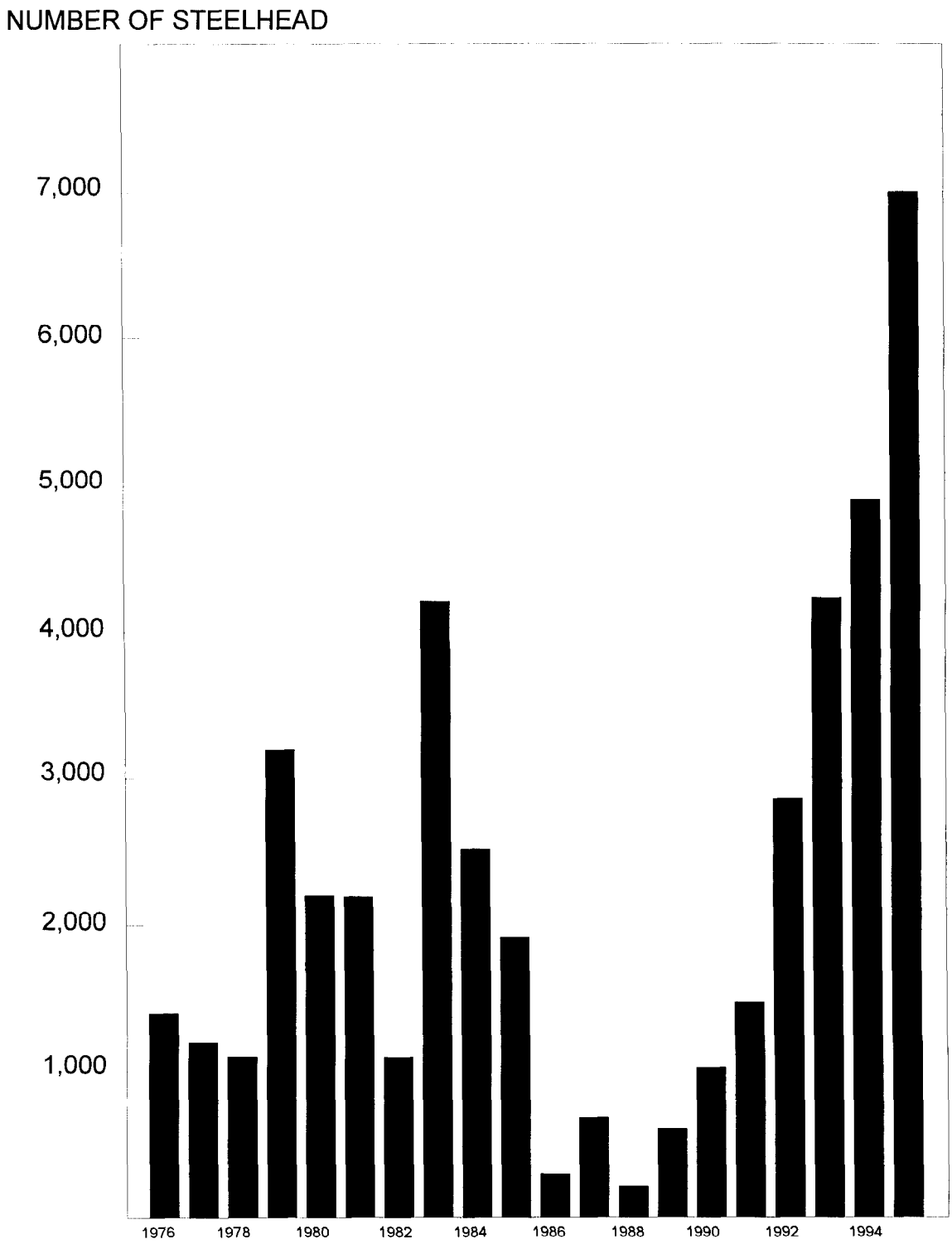

Figure 3.-Historic emigrating steelhead counts obtained at the Division of Commercial Fisheries Management and Development weir, Karluk River, 1976 through 1995.

566 fish from 1986 through 1990. This apparent decline of emigrating steelhead created concern that the population was declining and in danger of overexploitation. However from 1991 through 1995, emigration averaged 4,097 kelts.

In August 1991, a study was initiated to assess stock status of adult steelhead returning to and overwintering in the Karluk River. Estimated statistics included incidental commercial harvest of steelhead from marine waters near the Karluk River, sport and subsistence harvests within the Karluk River, and the number of spawning steelhead in the Karluk River from a single return year (Begich 1992, 1993, and 1995).

This report is part of a continuing study to assess the stock status of adult steelhead returning, overwintering, and spawning at the Karluk River. For the 1994 return, the study objectives were to:

Fishing Mortality:

1. Estimate the number of steelhead retained for personal use and the number released by commercial setnetters operating between West Point and Rocky Point from August 15 through September 30, 1994.
2. Estimate the number of steelhead sold in the commercial set gillnet fishery between West Point and Rocky Point from August 15 through September 30, 1994.
3. Estimate the number of steelhead harvested in the commercial purse seine fishery between West Point and Sturgeon Head from August 15 through September 30, 1994.
4. Census the effort of the autumn sport fishery at the Portage area of the Karluk River.
5. Census the sport catch of and harvest of steelhead at the Portage area of the Karluk River.
6. Estimate the age, sex and length composition of the sport harvest of steelhead.
7. Census the steelhead harvest in the Karluk Village and Larsen Bay subsistence fisheries from the 1994 return.

Spawning Population:

8. Estimate the number of spawning steelhead in the Karluk River during the spring of 1995.
9. Estimate the age, sex, and length composition of the spawning population.
10. Enumerate emigrating kelts through the Karluk River weir during spring 1995.
11. Estimate the age, sex, and length composition of the population of emigrating kelts.

ESTIMATION OF STEELHEAD BYCATCH IN SELECTED COMMERCIAL FISHERIES

METHODS

Commercial catches from waters of eight statistical areas between West Point and Sturgeon Head were sampled for the incidental harvest of steelhead (Figure 4). The sampling of these fisheries is based on the assumption that all steelhead harvested are of Karluk River origin, although stocks from other nearby rivers may also be present (Figure 5). All eight statistical areas were open to commercial purse seine fishing. Three of these eight statistical areas are permanently closed to the harvest of salmon with set gillnet gear. These fisheries are managed for the return of sockeye salmon, pink salmon *O. gorbuscha*, and coho salmon

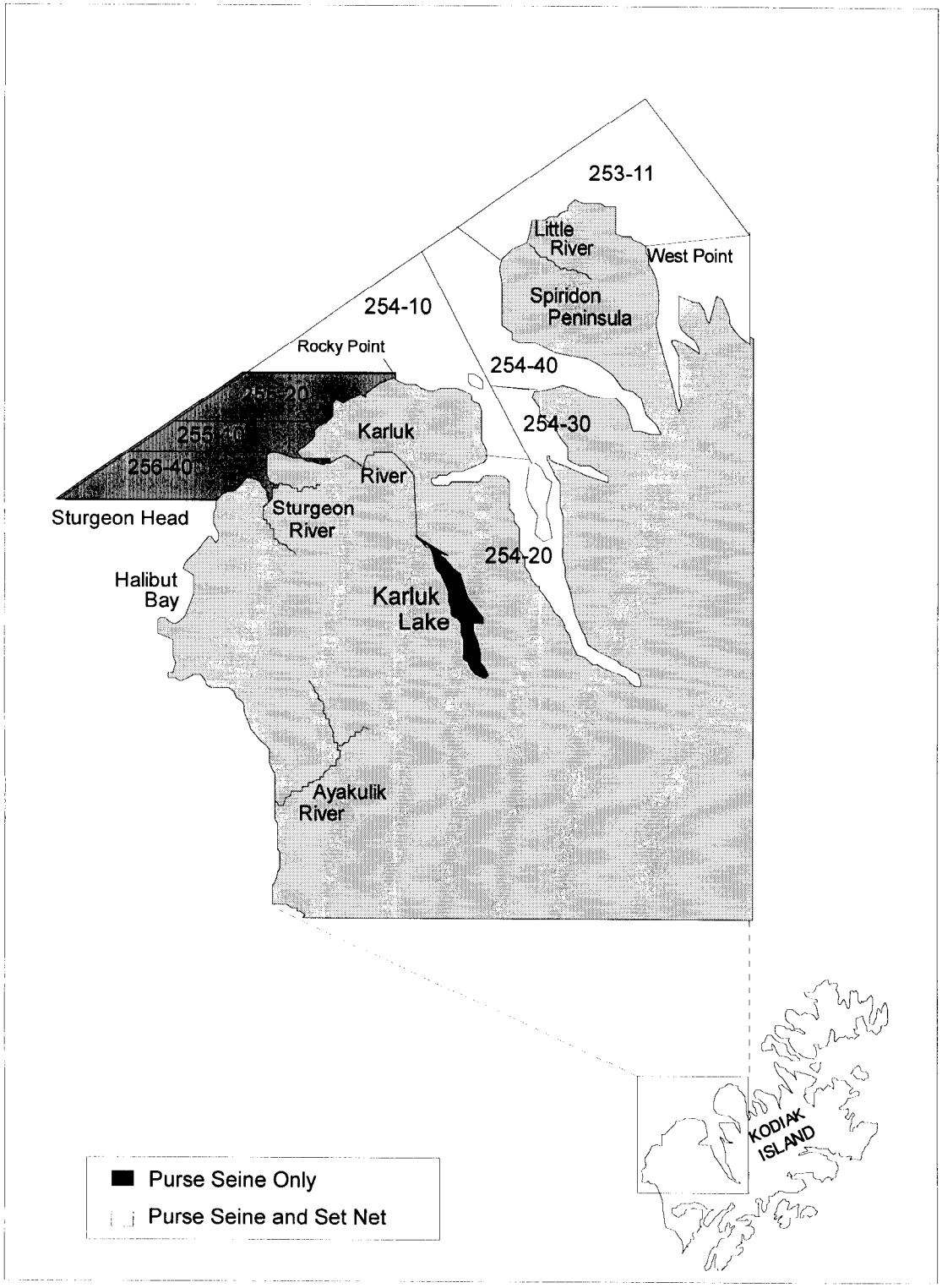

Figure 4.-Map of marine study area and Karluk River, 1995.

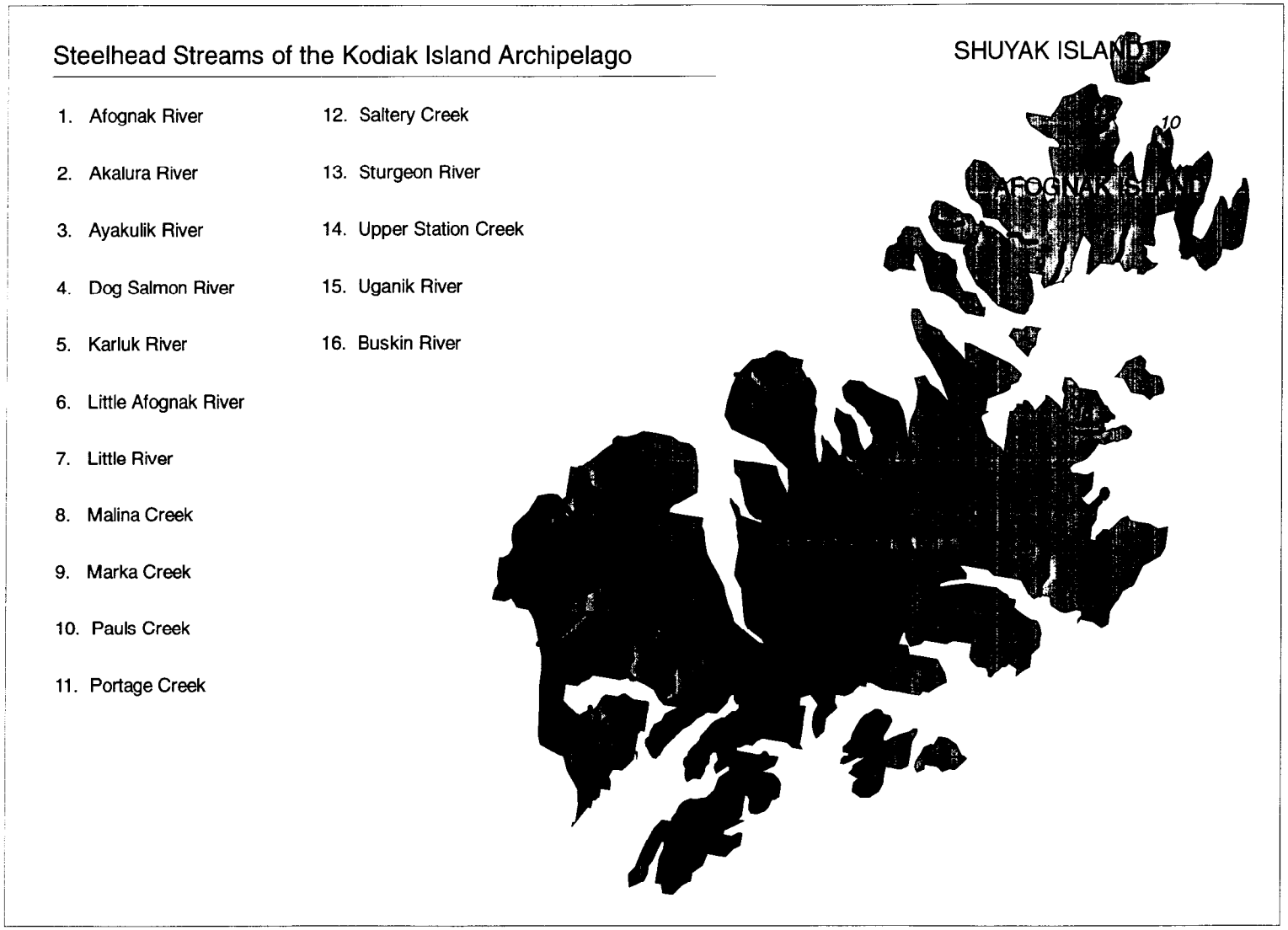

Figure 5.-Steelhead systems of the Kodiak Island Archipelago.

to the Karluk River by CFMD Division, Kodiak. Commercial catch sampling occurred over a 6-week period and was stratified by five temporal strata to detect spatial and temporal changes of steelhead bycatch. Temporal strata were:

Stratum	Date
1	8/15 - 8/31
2	9/01 - 9/07
3	9/08 - 9/14
4	9/15 - 9/21
5	9/22 - 9/30

Set Gillnet Fishery

Prior to August 15, catch calendars were distributed to all set gillnet permit holders operating within the Karluk marine study area. The data voluntarily recorded on the calendar included: name of permit holder; permit number; and number of steelhead caught, retained, and released by day. Calendar recipients were asked to mail the prepaid postage calendar to the Division of Sport Fish in Kodiak upon completion of fishing. Permit holders who did not return calendars were contacted by mail and asked to return calendars. This program provided data to estimate the number of steelhead retained and released by setnetters.

Calendar returns were used to expand steelhead catches to the unreturned calendars. The total salmon harvest of permit holders who returned calendars was obtained by period from sales receipts (fish tickets). These data were used to estimate the ratio of steelhead retained or released to the number of salmon harvested. First a series of jackknifed steelhead-to-salmon ratio estimates of fish retained for personal use or caught and released were calculated for each stratum by:

$$\hat{r}_i = \frac{\sum_{\substack{i=1 \\ i \neq j}}^{n} C_{si}}{\sum_{\substack{i=1 \\ i \neq j}}^{n} C_{oi}} \quad (1)$$

where:

C_{si} = number of steelhead harvested or released by setnetter i,

C_{oi} = harvest of salmon by setnetter i,

n = number of setnet permit holders who returned calendars.

Next the ratio estimate was calculated for each stratum:

$$\hat{r}_q = n\hat{g} - (n-1)\bar{r} \quad (2)$$

where:

$$\hat{g} = \frac{\bar{C}_s}{\bar{C}_o} \quad (3)$$

with variance:

$$\mathrm{Var}(\hat{r}_q) = \frac{(1-f)(n-1)}{n} \sum_{i=1}^{n} (\hat{r}_i - \bar{r})^2 \quad (4)$$

where:

$\bar{C}_s$ = mean harvest of steelhead among all reporting setnetters,

$\bar{C}_o$ = mean harvest of salmon among all reporting setnetters,

$\bar{r}$ = the average of the $\hat{r}_i$,

f = finite population correction factor = n/N, and

N = total number of setnet permit holders in study area.

The total number of steelhead taken in setnets (C_{sn}) for personal use or released in a stratum was then estimated by:

$$\hat{C}_{sn} = \hat{g} C_{on}\,; \quad (5)$$

where:

C_{on} = total harvest of species other than steelhead by all setnet permit holders in the study area.

The variance of the estimate of steelhead taken for personal use or released during each stratum is estimated (Cochran 1977) by:

$$\mathrm{Var}(\hat{C}_{sn}) = C_{op}^2 \mathrm{Var}(\hat{r}_q). \quad (6)$$

The total number of steelhead retained for personal use or released, and their respective variances, was estimated by summing the strata estimates.

Tender-Sampled Set Gillnet and Purse Seine Fishery

The number of steelhead harvested by setnetters and purse seiners and sold to tender vessels for delivery to canneries was estimated. Sampling of these fisheries was conducted on an opportunistic basis.

During off-loading, each fish in the catch was sorted by species. Vessel operators were interviewed to obtain the number of steelhead sorted on the fishing grounds prior to sampling and included in the sample total. As many catches were sampled as possible during each fishing period.

Fish tickets from sampled deliveries provided the weight and number of salmon sold so that a series of jackknife ratio estimates of steelhead to salmon could be computed by (Cochran 1977):

$$\hat{r}_j = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{v} C_{sj}}{\sum_{\substack{j=1 \\ j \neq i}}^{v} C_{oj}} \quad (7)$$

where:

C_{sj} = harvest of steelhead observed in vessel j,

C_{oj} = harvest of salmon by vessel j, and

v = number of vessels sampled for steelhead.

Next the ratio estimate was calculated:

$$\hat{r}_v = v\hat{h} - (v-1)\bar{r}; \quad (8)$$

where:

$$\hat{h} = \frac{\bar{C}_s}{\bar{C}_o}; \quad (9)$$

with variance:

$$\mathrm{Var}(\hat{r}_v) = \frac{(1-f_v)(v-1)}{v} \sum_{j=1}^{v} (\hat{r}_j - \bar{r})^2 \quad (10)$$

where:

$\bar{C}_s$ = mean harvest of steelhead among all sampled vessels,

$\bar{C}_o$ = mean harvest of salmon among all sampled vessels,

$\bar{r}$ = the average of the $\hat{r}_j$,

f_v = finite population correction factor = v/V, and

V = total number of vessels unloading fish (from fish ticket database).

The total harvest of steelhead in the purse seine and tender-sampled setnet fisheries (C_{sp}) in each stratum was then estimated by:

$$\hat{C}_{sp} = \hat{r}_v C_{op} \quad (11)$$

where:

C_{op} = total harvest of species other than steelhead in the purse seine fishery.

The variance of the estimate of steelhead catch was estimated by:

$$\mathrm{Var}(\hat{C}_{sp}) = C_{op}^2 \mathrm{Var}(\bar{r}_v). \quad (12)$$

The total harvest of steelhead and its variance were then estimated by summing the respective estimates among strata.

Steelhead observed in tender-sampled catches were measured from the tip-of-snout to the fork-of-tail (fork length) to the nearest millimeter, sexed and examined for tags or finclips. Four scales from the left side of the fish, two rows above the lateral line and on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, were taken for age determination (Paget 1920). Scales were mounted on gummed cards, pressed on acetate to make an impression and aged with a microfiche reader.

Scale analysis incorporated the methods of Mosher (1969), Jones (*Unpublished*) and Wallis (*Unpublished*). For example, an assigned age of 2.2s1s is an age-5 repeat spawner which: (1) spent 2 winters (years) in fresh water prior to smolt emigration, (2) returned to spawn in fresh water in October during its second year at sea, (3) returned to the sea as a kelt in June, and (4) returned to fresh water in October to spawn again. The letter "s" represents a freshwater immigration (spawning event) and numbers represent years between events. This represents a departure from the traditional method used for age assignment of fall immigrant steelhead (Narver and Withler 1971). Utilizing these methods, the assigned age of this fish would have been 2.1ss.

Scales without a legible spawning check were defined as fish that were initial or first time spawners. Fish with one previous spawning check legible on the scale impression were defined as repeat or second time spawners. Multi-repeat spawners were fish with at least two previous spawning checks legible on the scale impression.

RESULTS

Seventeen of the 42 (40%) set gillnet permit holders operating within the Karluk study area returned catch calendars. From August 15 to September 30, sampled permit holders retained 30 steelhead for personal use and released 15 steelhead (Tables 1 and 2). During the same period, these same permit holders harvested 67,954 (34%) of the 199,582 salmon harvested by the set gillnet fishery. An estimated 184 steelhead were retained for personal use by set gillnet permit holders and an additional 48 fish were released (Tables 1 and 2).

From August 15 to September 30, 534,693 salmon were harvested within the Karluk study area, 199,582 by set gillnetters and 335,111 by purse seiners (Tables 3 and 4). Thirty-two steelhead were observed in samples of set gillnet harvested salmon and 22 steelhead were observed in samples of purse seine harvested salmon. The total estimated harvest of steelhead in the tender sampled set gillnet and purse seine fisheries was 109 fish, 44 by set gillnetters and 65 by purse seine (Tables 3 and 4).

A total of seven tagged steelhead of Karluk origin were recovered during the August 15 through September 30 sampling period. Five were reported by set gillnet calendar recipients and two were observed during sampling of commercial purse seine catches. No marked steelhead were observed during the sampling of tender loads of set gillnet catches. These sample sizes were not sufficient for estimation of Karluk stock contribution of repeat spawning steelhead to total estimated steelhead bycatch.

Temporal trends in the steelhead bycatch were evident in both the set gillnet and purse seine fisheries (Tables 1-4). In both fisheries the ratio of steelhead-to-salmon was lowest during the first stratum (8/15-8/31), then increased during the remaining strata. In the set gillnet fishery, harvest of steelhead estimated from calendar returns was greatest during the fifth stratum (9/22-9/30), when 2% of the total salmon harvest occurred. In the

Table 1.-Estimated harvest of steelhead retained for personal use in commercial set gillnets near the Karluk River, August 15 through September 30, 1994.

Stratum	Total Salmon Harvested[a]	Sample Size[b]	Reported Number of Steelhead[c]	Ratio of Steelhead to Salmon	Estimated Steelhead Harvested	SE	Relative Precision[d]
8/15 - 8/31	177,921	62,682	14	0.000264	47	11	45%
9/01 - 9/07	13,972	3,958	6	0.001291	18	13	144%
9/08 - 9/14	0	0	0	0.0	0		
9/15 - 9/21	4,219	548	2	0.004348	18	12	130%
9/22 - 9/30	3,470	406	8	0.029002	101	19	37%
Total	199,582	67,594	30		184	28	30%

[a] From fish tickets.

[b] Salmon harvest of permit holders who returned calendars.

[c] Obtained from catch calendar survey.

[d] Relative precision of 95% confidence interval.

Table 2.- Estimated release of steelhead from commercial set gillnets near the Karluk River, August 15 through September 30, 1994.

Stratum	Total Salmon Harvested[a]	Sample Size[b]	Reported Number of Steelhead[c]	Ratio of Steelhead to Salmon	Estimated Steelhead Released	SE	Relative Precision[d]
8/15 - 8/31	177,921	62,682	12	0.000196	35	18	103%
9/01 - 9/07	13,972	3,958	2	0.000422	6	6	216%
9/08 - 9/14	0	0	0	0.0	0		
9/15 - 9/21	4,219	548	1	0.001607	7	7	210%
9/22 - 9/30	3,470	406	0	0.0	0		
Total	199,582	67,594	15		48	21	86%

[a] From fish tickets.

[b] Salmon harvest of permit holders who returned calendars.

[c] Obtained from catch calendar survey.

[d] Relative precision of 95% confidence interval.

Table 3.- Estimated harvest of steelhead from tender sampled commercial set gillnet catches, near the Karluk River, August 15 through September 30, 1994.

Stratum	Total Salmon Harvested[a]	Sample Size[b]	Steelhead Observed[c]	Ratio of Steelhead to Salmon	Estimated Steelhead Harvested	SE	Relative Precision[d]
8/15 - 8/31	177,921	86,690	8	0.000092	16	3	35%
9/01 - 9/07	13,972	9,940	8	0.000826	12	2	32%
9/08 - 9/14	0	0	0		0		
9/15 - 9/21	4,219	4,168	16	0.003813	16	2	29%
9/22 - 9/30	3,470	0	0		0		
Total	199,582	100,728	32		44	4	12%

[a] From fish tickets.

[b] Number examined in sample.

[c] Number steelhead in sample.

[d] Relative precision of 95% confidence interval.

Table 4.-Estimated harvest of steelhead from tender sampled commercial purse seine catches, near the Karluk River, August 15 through September 30, 1994.

Stratum	Total Salmon Harvested[a]	Sample Size[b]	Steelhead Observed[c]	Ratio of Steelhead to Salmon	Estimated Steelhead Harvested	SE	Relative Precision[d]
8/15 - 8/31	316,700	45,386	6	0.000126	40	15	75%
9/01 - 9/07	16,252	5,945	4	0.000564	9	10	78%
9/08 - 9/14	977	0	0		0		
9/15 - 9/21	2,159	1,762	12	0.007304	16	4	48%
9/22 - 9/30	2,324	0	0		0		
Total	335,111	53,093	22		65	19	56%

[a] From fish tickets.

[b] Number examined in sample.

[c] Number steelhead in sample.

[d] Relative precision of 95% confidence interval.

purse seine fishery most of the salmon harvest occurred during the first stratum (94%). Therefore, estimated steelhead harvest in the purse seine fishery was highest during stratum one and declined thereafter.

Trends in set gillnet steelhead harvest and release by area were evident (Table 5). No calendars were returned from statistical area 253-11 or 254-30, areas that accounted for 21% of the total set gillnet harvest of salmon. Harvest of steelhead was highest in statistical area 254-20 where 16% of the total salmon harvest occurred and 66% of the area catch was sampled by calendar returns. The estimated total harvest of steelhead in this area was 98 fish. Release of steelhead was greatest in statistical area 254-10 where 36% of the total salmon harvest occurred and 33% of the area catch was sampled by calendar returns (Table 5).

Age and length data were obtained from 53 steelhead observed in set gillnet (31) and purse seine (22) catches (Tables 6 and 7, Appendices A1 and A2). No multi-repeat spawners were observed in either fishery. In the set gillnet fishery, the majority of females were initial spawners, and females accounted for 72% of the harvest (Table 7). In the purse seine samples, females accounted for 57% of steelhead harvested and the estimated proportion for both initial spawning females and males was 43% (Table 7). Mean length of harvested steelhead across all ages was 653 mm for set gillnet and 627 mm for purse seine (Table 6).

ESTIMATION OF STEELHEAD HARVEST IN THE KARLUK RIVER SUBSISTENCE FISHERIES

METHODS

Karluk River steelhead are a component of subsistence fisheries of both Karluk Village and Larsen Bay. Karluk Village residents fish with beach seines within Karluk Lagoon during late May through September. Fishing effort increases with the influx and concentrations of immigrant sockeye and coho salmon in Karluk Lagoon. Both emigrant (May through July) and immigrant (late August through September) steelhead are exposed to the Karluk Lagoon fishery.

Larsen Bay residents target steelhead at a mid river location known as the Portage area (Figure 1), which is accessed by a trail from the head of Larsen Bay. Typically, residents target prespawning concentrations of adults that overwinter in this part of the river with rod and reel from October through April.

ADF&G personnel conducted household interviews at both Karluk Village and Larsen Bay to determine the number of steelhead harvested by sampled households. Average harvest per interviewed household was multiplied by the total number of households to estimate total harvest by each village.

The mean number of steelhead harvested for subsistence was estimated as:

$$\overline{C}_y = \frac{\sum_{b=1}^{n_y} C_{yb}}{n_y}; \qquad (13)$$

where:

C_{yb} = harvest of steelhead in household b of village y, and

n_y = total number of interviewed households in village y.

The total harvest of steelhead by the village was estimated by:

$$\hat{C}_y = N_y \overline{C}_y; \qquad (14)$$

where:

N_y = total number of households in village y.

Table 5.-Steelhead retained for personal use or released from the set gillnet fishery by statistical area and sampling strata, August 15 through September 30, 1994.

Stat Area	Number of Steelhead Reported by Catch Calendars 1	2	3[b]	4	5	Total	Proportion of Total Salmon Harvest	Estimated Steelhead Harvest	Proportion of Estimated Steelhead Harvest	Proportion of Total Salmon Harvest Sampled from Calendar Returns
253-11[a]							0.20			
254-10	0	1		2	8	11	0.36	68	0.37	0.33
254-20	11	5		0	[b]	16	0.16	98	0.53	0.66
254-30[a]							0.01			
254-40	3	0		0	[b]	3	0.27	18	0.10	0.42
Total	14	6		2	8	30	1.00	184	1.00	
Released										
253-11[a]							0.20			
254-10	8	2		1	0	11	0.36	35	0.73	0.33
254-20	0	0		0	[b]	0	0.16	0	0.00	0.66
254-30[a]							0.01			
254-40	4	0		0	[b]	4	0.27	13	0.27	0.42
Total	12	2		1	0	15	1.00	48	1.00	

[a] No catch calendars were returned by setnetters from these stat areas.

[b] No set gillnet harvest reported during strata.

Table 6.-Length-at-age by spawning history and sex of steelhead harvested by commercial set gillnets and purse seines near the Karluk River, August 15 through September 30, 1994.

		Females			Males			All		
Spawning History	Marine Age	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
Set Gillnet Harvest										
Initial[a]	1	3	557	9	5	552	1	8	554	4
	2	14	678	2	1	700		15	679	2
Repeat[b]	2	1	664		1	711	26	2	688	24
	3	2	706	31	0		8	2	706	31
	4	1	748		1	684	34	2	716	32
Initial		17	657	3	6	576	5	23	636	1
Repeat		4	706	12	2	698	11	6	703	6
Total[c]		23	667	2	8	607	10	31	653	2
Purse Seine Harvest										
Initial[a]	1	1	514		8	556	6	9	551	5
	2	8	684	2	1	608		9	676	4
Repeat[b]	2	2	665	18	0			2	665	18
	4	1	680		0			1	680	
Initial		9	665	7	9	561	5	18	614	5
Repeat		3	670	8	0			3	670	3
Total[c]		12	667	4	10	579	6	22	627	3

[a] Adults spawning for the first time spring of 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Totals may not add due to illegible or regenerated scales.

Table 7.-Age composition by sex and spawning history of steelhead harvested by commercial set gillnets and purse seines near the Karluk River, August 15 through September 30, 1994.

		Females					Males				
Spawning History	Marine Age	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE
Set Gillnet Harvest											
Initial[a]	1	3	0.103	0.057	4	2	5	0.172	0.070	8	3
	2	14	0.483	0.093	20	4	1	0.034	0.034	1	1
Repeat[b]	2	1	0.034	0.034	2	1	1	0.034	0.034	2	1
	3	2	0.069	0.047	3	2	0				
	4	1	0.034	0.034	2	1	1	0.034	0.034	2	1
Initial		17	0.586	0.091	24	5	6	0.207	0.075	9	3
Repeat		4	0.138	0.064	7	3	2	0.069	0.047	4	2
Total		21	0.724	0.083	31	5	8	0.276	0.084	13	4
Purse Seine Harvest											
Initial[a]	1	1	0.047	0.046	3	3	8	0.382	0.106	25	10
	2	8	0.382	0.105	25	9	1	0.047	0.046	3	3
Repeat[b]	2	2	0.095	0.064	6	4	0				
	4	1	0.047	0.046	3	3	0				
Initial		9	0.429	0.108	28	10	9	0.429	0.108	28	10
Repeat		3	0.142	0.076	9	5	0				
Total		12	0.571	0.108	37	12	9	0.429	0.108	28	10

[a] Adults spawning for the first time in spring of 1995.

[b] Adults spawning for the second time in spring of 1995.

The variance of harvest was estimated by (Cochran 1977:24): $\mathrm{Var}(\hat{C}_y) = \frac{N_y^2(1-f_y)}{n_y(n_y-1)} \sum_{b=1}^{n_y}(C_{by} - \bar{C}_y)^2$; (15)

where:

f_y = finite population correction factor = n_y/N_y.

RESULTS

Household surveys were conducted at Karluk Village in July of 1995. Eight households reported harvesting 20 steelhead during the autumn of 1994 or spring/summer of 1995. All households contacted responded to the survey. Mean harvest per household was estimated at 2.5. Estimated harvest of steelhead by residents of Karluk Village was 35 (SE = 8) fish (Table 8).

At Larsen Bay, where 31 households were contacted, 10 did not respond to the survey, and 21 reported harvesting no steelhead between September 1994 and August 1995 (Table 9).

Subsistence harvest of steelhead by these two villages has been sporadically estimated since 1982. Village harvests have ranged from 0 to 697 fish (Tables 8 and 9). Harvest estimates from both villages increased markedly from 1991 to 1992, then declined in 1993 and 1994 (Tables 8 and 9).

ESTIMATION OF STEELHEAD HARVEST IN THE KARLUK RIVER SPORT FISHERY

METHODS

Effort, catch, and harvest of the inriver sport fishery in the fall were obtained from two sources. First, from October 4 through November 11, an onsite creel census was conducted at the Portage area on the Karluk River. Secondly, a logbook was provided by department personnel to a commercial outfitter that established a camp downriver of the Portage area.

The Portage area is accessible by float plane from the city of Kodiak, by raft via Karluk Lake, and by trail from the head of Larsen Bay (Figure 1). Anglers participating in the autumn sport fishery camp or stay at any of the four public-use cabins located in the Portage area, which encompasses approximately 1.5 river miles. A technician stationed at the Portage interviewed all anglers as they exited the fishery each day to obtain a complete census of all angling activity. At the outfitters camp, information was collected daily and the logbook returned to division personnel at the end of the season.

Information collected from each angler each day they fished included effort, and catch and harvest by species and gear type. Since all anglers were interviewed or recorded in the logbook, the interview data were summed to calculate the aforementioned fishing statistics.

Estimates of effort, catch, and harvest from 1982 through 1993 were obtained only from postal surveys (Mills 1983-1994). In the postal survey, sport fishing statistics are estimated by location. Therefore, fishing effort (reported in angler-days) is the total fishing effort for the Karluk River and includes effort directed at other species over an entire calendar year. Due to the relatively small number of returned surveys from anglers who stated they fished at the Karluk River, estimates were not available in 1986, 1987, and prior to 1982.

RESULTS

The sport harvest of Karluk River steelhead during the 1994 season was 21 fish, an additional 2,598 fish were released (Table 10). The postal survey estimated a harvest of

Table 8.-Subsistence harvest of steelhead by residents of Karluk Village, since 1982.

Years	Total Reported Harvest[b]	Number Households in Sample	Mean Harvest per Household	Number Households in Community	Estimated Community Harvest[c]	SE
1982-83[a]	233	20	11.65	26	303	13
1986[a]	77	19	4.05	27	109	20
1989[a]	14	14	1.0	17	17	35
1991[a]	36	13	2.76	17	47	[d]
1992[e]	57	9	6.33	17	107	5
1993[e]	0	6	0.00	17	0	[d]
1994[e]	20	8	2.5	14	35	8

[a] Source: Community Profile Database, Division of Subsistence, Alaska Department of Fish and Game, Anchorage.

[b] From household interviews.

[c] Product of mean harvest per household and number of households in community.

[d] Standard error not available.

[e] Source: Alaska Department of Fish and Game, Division of Sport Fish survey, covered the period from the September prior to the survey year to July of the survey year.

Table 9.-Subsistence harvest of steelhead by residents of Larsen Bay, since 1982.

Years	Total Reported Harvest[b]	Number Households in Sample	Mean Harvest per Household	Number Households in Community	Estimated Community Harvest[c]	SE
1982-1983[a]	273	32	8.53	43	367	16
1986[a]	74	37	2.00	52	104	15
1989[a]	86	34	2.50	39	98	27
1990-1991[a]	215	38	5.66	43	243	[d]
1991-1992[a]	230	35	6.57	40	263	[d]
1992-1993[a]	614	37	16.6	42	697	6
1993-1994[a]	312	40	7.80	49	382	7
1994-1995[e]	0	21	0.00	45	0	

[a] Source: Community Profile Database, Division of Subsistence, Alaska Department of Fish and Game, Anchorage. Survey years 1990 through 1993 cover the period from April 1 of the survey year to March 31 of the following year.

[b] From household interviews.

[c] Product of mean harvest per household and number of households in community.

[d] Standard error not available.

[e] Source: Alaska Department of Fish and Game, Division of Sport Fish survey, August 1995.

Table 10.-Sport harvest and release of steelhead and total fishing effort from the Karluk River sport fishery, 1982-1994.

Year	Effort[b]	Harvest	Released[d]
1982[a]	1,552	90	
1983[a]	2,142	241	
1984[a]	534	150	
1985[a]	1,223	167	
1986[a]	[c]	[c]	
1987[a]	[c]	[c]	
1988[a]	990	18	
1989[a]	1,313	20	
1990[a]	2,191	86	
1991[a]	1,646	128	628
1992[a]	5,430	40	898
1993[a]	6,984	189	3,446
1994[e]	538	21	2,598
1994[f]	10,948	80	1,387

[a] Source: Postal surveys as reported by Mills (1983-1994).

[b] Angler-days of all sport fisheries on the Karluk River.

[c] No estimate due to a small number of returns from anglers who stated they fished at the Karluk River.

[d] First estimated in 1991.

[e] Obtained from onsite angler census and outfitter tent camp September 25 through November 11, 1994.

[f] Obtained from postal survey for all sport fisheries on the Karluk River (Howe et al. 1995).

80 and release of 1,387 fish for the 1994 calendar year (Howe et al. 1995). Mean length for steelhead harvested in the sport fishery was 683 mm; 691 mm for females and 659 mm for males (Table 11, Appendix A3).

ESTIMATION OF SPAWNING ABUNDANCE AND SURVIVAL

METHODS

Abundance

Steelhead overwinter in the upper Karluk River and tend to congregate in the Portage area of the river (Chatto 1987). Upon completion of spawning, surviving adults (kelts) emigrate through a weir located approximately 19 km (12 mi) downstream of the Portage area and 0.4 km above the tidal influence of Karluk Lagoon (Figure 1). This allowed for a mark-recapture experiment to estimate the abundance of the spawning population in the Karluk River drainage during the spring of 1995.

During April, a base camp was established at a cabin located at the Portage area. Fish were captured on hook and line, measured for fork length, sexed, scale sampled for age, tagged near the posterior insertion of the dorsal fin with a six-digit Floy FD-67 internal anchor tag, and a portion of the right pectoral fin was removed to serve as a secondary mark to assess tag loss. Sampling occurred from April 10 through April 20, in an 11.2 km (7 mi) section of the river around the Portage area. This section was divided into three sampling sublocations (Figure 1). Each location was sampled and effort was directed at multiple sites within each location where fish were known to congregate.

The first sampling event (mark event) for this experiment was the entire 11-day sampling experiment described above. The second sampling event (recapture event) occurred at the weir. Steelhead likely overwinter and spawn in areas other than the sampled sublocations, including Karluk Lake, and other sections of the river. If there was sufficient mixing of tagged and untagged steelhead during spawning and prior to emigration through the weir, the experiment will provide an estimate of spawner abundance for the entire drainage. From May 13 through July 31, 1995, all emigrating steelhead were captured in a downstream trap that was incorporated into the weir. Upon entry into the trap, steelhead were captured with a dip net, examined for a finclip and tag, sexed, measured for fork length to the nearest millimeter, and all untagged kelts were tagged and given a secondary mark (finclip) as previously described. We attempted to collect scale samples from 140 fish per week as described in the previous section on estimation of bycatch in commercial fisheries.

Population abundance ($\hat{N}_a$) was calculated using Chapman's modification of the Petersen estimator (Seber 1982):

$$\hat{N}_a = \frac{(M+1)(C+1)}{(R+1)} - 1; \qquad (16)$$

where:

M = number of steelhead tagged and released in the first event,

R = number of tagged fish recaptured in the second event, and

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

The variance was estimated by:

$$\mathrm{Var}(\hat{N}_a) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \qquad (17)$$

The following assumptions were necessary for this closed population estimate (Seber 1982):

1. there is no recruitment to the population over the duration of the experiment;

Table 11.-Length-at-age by spawning history and sex of steelhead harvested by the Karluk River sport fishery, October 4 through November 11, 1994.

		Females			Males			All		
Spawning History	Marine Age	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
Initial[a]	1	0			2	541	3	2	541	3
	2	10	694	10	1	793		11	703	5
Repeat[b]	4	2	674	33	0			2	674	33
	5	0			1	760		1	760	
Initial		10	694	10	3	625	59	13	678	6
Repeat		2	674	33	1	760		3	674	22
Total[c]		12	691	4	4	659	39	16	683	5

[a] Adults spawning for the first time spring of 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Totals may not add due to illegible or regenerated scale samples.

2. no marks are lost;
3. all fish have the same probability of capture in the second sample or marked fish are randomly distributed among the unmarked fish;
4. marking does not affect the probability of capture; and
5. all marked steelhead are reported when recovered during the recapture event.

Because steelhead enter the Karluk River throughout the fall and early winter, do not leave the system until after spawning, and do not grow during winter or spawning, there is no reason to believe that recruitment, immigration or emigration occurred during the experiment. Contingency tables and chi-squared tests (Conover 1980) were used to compare the probability of capture (assumptions 3 and 4) among the geographic sublocations, sex, spawning history and marine age between the mark event and the recapture event. In addition, chi-squared tests were used to test capture rate (marked:unmarked ratio) at the weir due to spawning history and sex. 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 first event with those recaptured in the second event and the second test compared the cumulative length distributions of all fish captured in the mark event with all fish captured in the recapture event. Differences in cumulative length distributions or capture rate among one of these groups may indicate whether the data must be stratified to provide an unbiased estimate of abundance (Seber 1982). All tests were conducted at $\alpha = 0.05$. The secondary mark (right pectoral finclip) provided the means to estimate tag loss (assumption 2). To minimize violation of the last two assumptions, all captured steelhead were handled carefully and thoroughly examined for marks.

Age and Length Composition

During the hook and line and weir operations, steelhead were sampled to estimate mean length-at-age and age composition. Samples were categorized by total marine age and spawning history as previously described.

The proportion of steelhead in each age category was estimated as:

$$\hat{p}_k = \frac{n_k}{n_t}; \quad (18)$$

where:

n_k = the number of steelhead in the sample from age category k,

n_t = the total number of steelhead in the sample.

The variance of the proportion by age was estimated as:

$$\mathrm{Var}(\hat{p}_k) = \frac{\hat{p}_k(1-\hat{p}_k)}{n_t - 1}. \quad (19)$$

Abundance by age was estimated as:

$$\hat{N}_k = \hat{N}\hat{p}_k, \quad (20)$$

with the variance (Goodman 1960):

$$V(\hat{N}_k) = V(\hat{N})\hat{p}_k^2 + V(\hat{p}_k)\hat{N}^2 + V(\hat{N})V(\hat{p}_k). \quad (21)$$

The age composition of the entire steelhead emigration through the weir was estimated by summing stratum estimates. The total number of age g fish migrating through the weir was estimated as:

$$\hat{E}_g = \sum_{f=1}^{t} \hat{E}_{gf} \quad (22)$$

where:

$\hat{E}_{gf}$ = the estimated number of age g fish in stratum f.

The variance was estimated as the sum of the variances as:

$$\mathrm{Var}\left(\hat{E}_g\right) = \sum_{f=1}^{t} \mathrm{Var}\left(\hat{E}_{gf}\right). \quad (23)$$

The proportion of steelhead of age g in the total escapement emigrating through the weir $\left(\hat{p}_{eg}\right)$ was estimated as:

$$\hat{p}_{eg} = \frac{\hat{E}_g}{E_T} \quad (24)$$

where:

E_T = the total emigration enumerated at the weir.

The variance of this proportion was estimated by:

$$\mathrm{Var}\left(\hat{p}_{eg}\right) = \frac{\mathrm{Var}\left(\hat{E}_g\right)}{E_T^2}. \quad (25)$$

Spawning Survival

The survival of tagged fish (S_c) from the marking event (hook and line) to emigration and recapture at the weir was calculated by spawning history, total marine age and sex, by:

$$S_c = \frac{n_{cw}}{n_{ct}}; \quad (26)$$

where:

n_{cw} = number of tagged fish at the weir of class c, and

n_{ct} = number of tagged fish released during the marking event of class c.

RESULTS

Abundance

From April 10 through April 20, 1995 a total of 353 steelhead were captured and released with tags. A total of 6,743 fish were examined for marks at the weir, of which 220 were marked (Table 12). Ten percent (n = 22) of the marked steelhead had lost their tags. The probability of capture at the weir of fish released in the first event was not significantly different among the geographic locations of release ($\chi^2 = 2.830$, df = 2, P = 0.24), or week of release ($\chi^2 = 0.452$, df = 1, P = 0.46). The probability of capture was significantly lower ($\chi^2 = 4.672$, df = 1, P = 0.03) for males than for females, and was significantly different among spawning histories ($\chi^2 = 32.129$, df = 2 $P < 0.001$). Differences among spawning histories were due to multi-repeat spawners, because no multi-repeat spawners marked during the first event were recaptured at the weir. Analysis with only initial and repeat spawning fish showed no significant difference. Temporal trends in the emigration of marked and unmarked steelhead through the weir were similar (Figure 6). There was no significant difference in the marked:unmarked ratio at the weir due to spawning histories ($\chi^2 = 0.698$, df = 2 P = 0.71) or sex ($\chi^2 = 1.250$, df = 1 P = 0.26). Since the proportion of marked relative to unmarked observed at the weir was similar, differences between the sexes among spawning histories were likely due to differences in survival and not from differences in probability of capture between events.

No significant difference was detected between the cumulative length distribution of all fish marked on the spawning grounds and all recaptured at the weir (D = 0.100, P = 0.156, n_1 = 352, n_2 = 198). A similar test of all fish marked on the spawning grounds and all captures at the weir that were measured did detect a significant difference in the length distribution of these groups (D = 0.172, P = 0.0001, n_1 = 352, n_2 = 6,569). Because the cumulative length distributions of these groups were parallel, rather than crossing as normally occurs in the presence of size selective sampling, the result of this test is

Table 12.-Summary of tagging data for steelhead released at the Portage and recaptured at the Karluk weir, Karluk River, 1995.

Marking Event at Portage 04/10-04/20		Recapture Event at Weir 05/09-07/13		
Tag Releases by Sublocation[a]	Number Released	Recovered	Not Recovered	Percent Recovered
1	151	77	74	50.9
2	49	30	19	61.2
3	153	91	62	59.5
Number Tag Releases	353	220[b]	155	
Number Untagged		6,523		
Number Examined		6,743		
Percent Marked Recoveries		3.3		

[a] 1 = Above Portage
2 = Portage Area
3 = Below Portage

[b] Includes 22 fish that lost their tags prior to the recapture event at the weir.

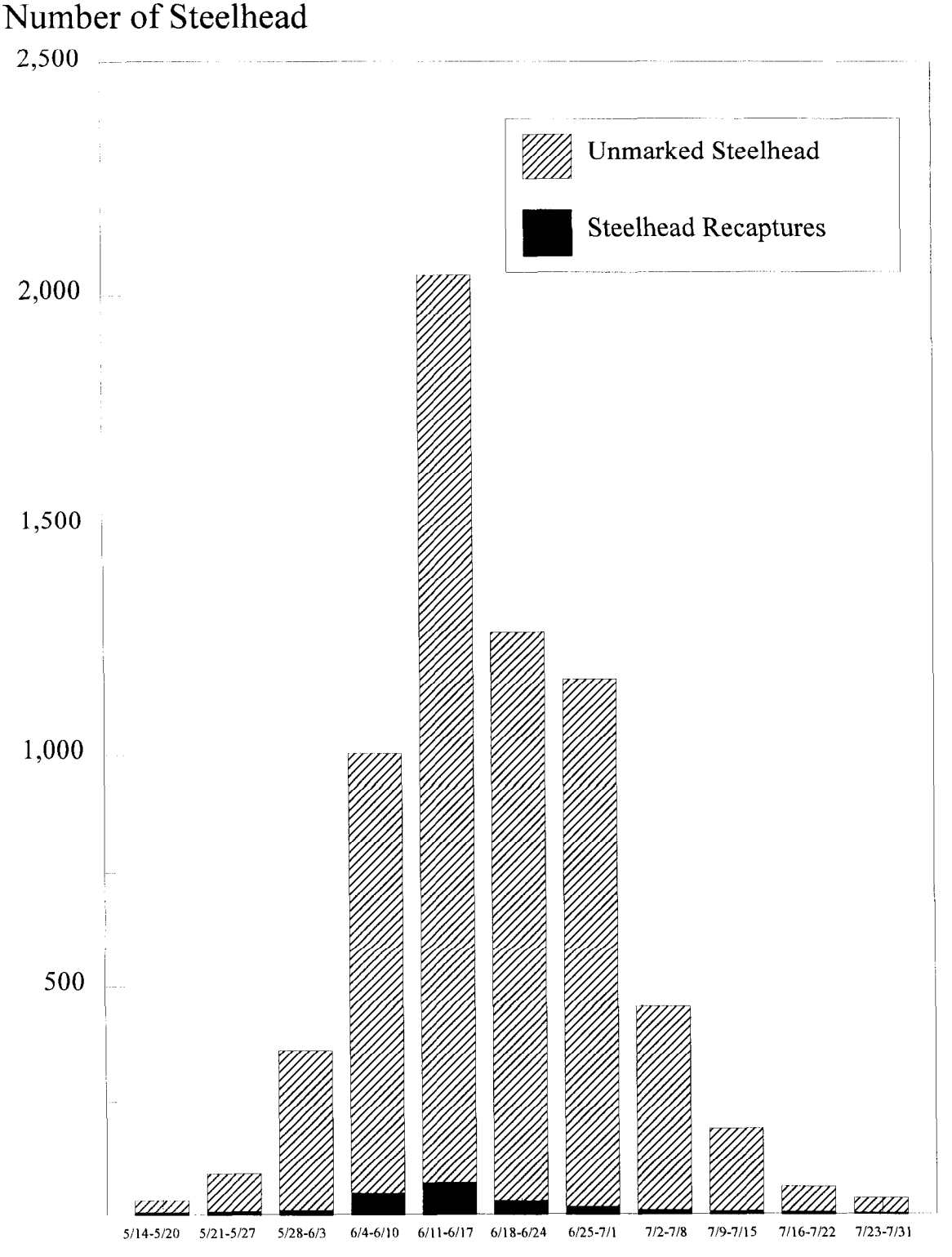

Figure 6.-Weekly comparison of marked and unmarked steelhead emigrating through the Karluk River weir, May 14 through July 31, 1995.

likely due to random measurement error and to the large sample size, allowing us to detect differences that are biologically meaningless. Therefore, a single unstratified estimate of abundance was calculated. The estimated abundance of steelhead spawning in the Karluk River drainage during the spring of 1995 was 10,802 fish (SE = 437).

There was a significant difference in the proportion of marked and unmarked steelhead through the weir among spawning histories between sexes (initial: $\chi^2 = 114.00$, df = 2, $P < 0.001$, repeat and multi-repeat pooled: $\chi^2 = 94.522$, df = 2, $P < 0.001$). This was largely due to an increase in the number of initial spawning females relative to males and the number of repeat spawning females observed at the weir (Table 13 and Figure 7). Subsequent testing between sexes and spawning histories detected a significant difference in the number of initial and repeat spawning fish at the weir, (initial: $\chi^2 = 114.00$, df = 2, $P < 0.001$, repeat: $\chi^2 = 109.27$, df = 2, $P < 0.001$). Therefore, estimates of the age composition by sex and spawning history of the emigrating population were stratified.

Biological Composition of the Spawning Population

The majority of steelhead sampled on the spawning grounds were initial spawners, (83%) with a mean length of 664 mm FL (SE = 63) (Tables 14 and 15 and Appendix A4). Mean length across all ages for spawning steelhead trout was 670 mm FL (SE = 4). Sixty-five percent of the spawning population was comprised of initial (55%) and repeat (10%) spawning females, while 33% were initial (28%) and repeat (5%) spawning males (Table 14). Within each spawning history, females tended to be older than males (except initial where nearly all females were 3-ocean fish but males comprised a near equal mix of 2- and 3-ocean fish) (Table 14). Repeat spawning females were mostly 5-ocean fish (69%). The majority of the male repeat spawner category was comprised of 3-ocean fish. Females accounted for 57% of the multi-repeat spawners with total marine age up to 7 years. Both sexes were dominated by initial spawners (83% females and 84% males) (Table 16).

Like the spawning population, the sex composition of emigrating steelhead was comprised of mostly females (63%) of which 71% were initial spawners (mean length 638 mm FL) and 27% repeat spawners (mean length 712 mm FL) (Tables 16 and 17 and Appendix A5). Seventy-three percent of the emigrating population were initial, followed by repeat (26%) and multi-repeat (1%) spawners (Table 16).

Spawning Survival

Survival of all steelhead was estimated at 62% (Table 18). Survival of initial spawning females was high (75%). Survival of males was similar for initial (55%) and repeat spawners (46%) (Table 18). No multi-repeat spawners marked were recaptured, consequently survival was estimated at 0.0 %. However, multi-repeat spawners were observed at the weir, thus survival for this spawning history is biased low due to a small sample marked on the spawning grounds. Still, survival is likely low for this group.

DISCUSSION

The total estimated bycatch of 341 steelhead during the 1994 commercial salmon fishery is within the range of estimated bycatch reported since sampling of these fisheries began in 1991 (Table 19). From 1992 through 1995 all steelhead kelts emigrating through the Karluk River weir have been tagged. Tag recoveries from sampled commercial fisheries could be used to estimate contribution of repeat

Table 13.-Sex composition by week of emigrating steelhead Karluk River, 1995.

Spawning History	Sex	Weekly Totals May 14 through July 14									Total
		1	2	3	4	5	6	7	8	9	
Initial[a]	F	2	8	36	71	46	60	44	64	61	392
	M	13	42	53	20	37	30	47	30	19	291
Total		15	50	89	91	83	90	91	94	80	683
Repeat[b]	F	0	6	15	22	19	15	19	21	30	147
	M	5	8	14	12	14	18	14	3	5	93
Total		5	14	29	34	33	33	33	24	35	240
Multi-Repeat[c]	F	0	1	4	1	0	1	2	0	2	11
	M	0	1	1	0	1	0	0	0	0	3
Total		0	2	5	1	1	1	2	0	2	14
Total	F	2	15	55	94	65	76	65	85	93	550
	M	18	51	68	32	52	48	61	33	24	387
Total		20	66	123	126	117	124	126	118	117	937

[a] Adults spawning for the first time in spring of 1995.

[b] Adults spawning for the second time in spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

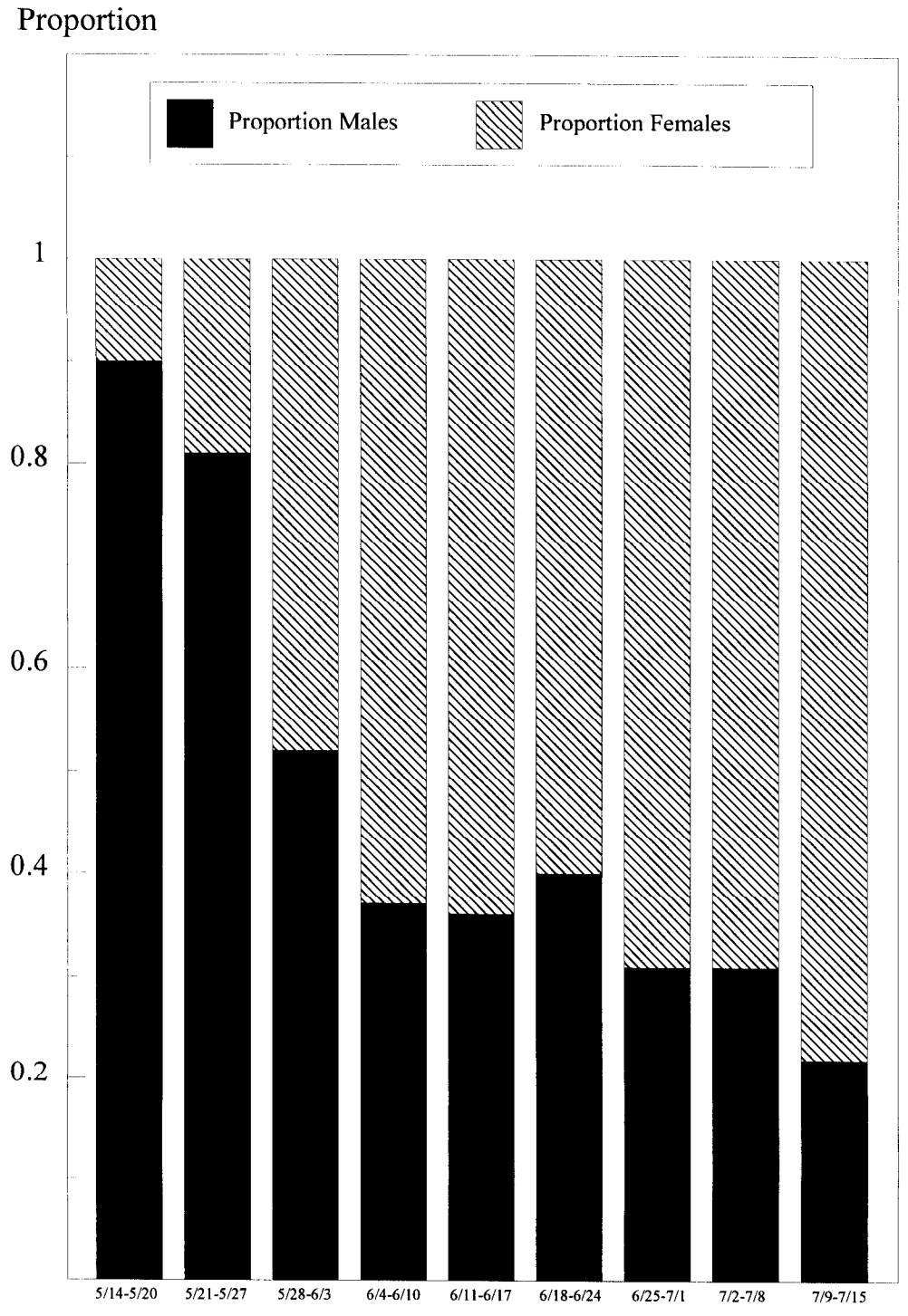

Figure 7.-Weekly comparison by sex of steelhead emigrating through the Karluk River weir, May 14 through July 15, 1995.

Table 14.-Age composition, by sex, of spawning steelhead trout in the Karluk River, April 1994. Based on hook and line captures of the spawning population.

Spawning History	Marine Age	Females					Males				
		Sample Size	Estimated Proportion	SE	Estimated Abundance	SE	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE
Initial[a]	2	9	0.032	0.010	338	111	30	0.105	0.018	1,125	200
	3	147	0.510	0.029	5,513	388	46	0.159	0.022	1,725	243
	4	2	0.007	0.005	75	52	5	0.017	0.008	187	83
Repeat[b]	3	3	0.010	0.006	113	64	8	0.028	0.009	300	105
	4	6	0.021	0.008	225	91	1	0.003	0.003	38	37
	5	20	0.069	0.015	750	164	4	0.014	0.007	150	75
Multi-Repeat[c]	5	0	0.000				3	0.010	0.006	113	65
	6	2	0.007	0.005	75	53	0	0.000			
	7	2	0.007	0.005	75	53	0	0.000			
Initial		158	0.549	0.029	5,926	397	81	0.281	0.026	3,037	311
Repeat		29	0.100	0.017	1,088	196	13	0.045	0.012	488	133
Multi-Repeat		4	0.014	0.007	150	75	3	0.010	0.006	113	65
Total[d]		216	0.614	0.027	6,629	388	136	0.386	0.026	4,174	327

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Table 14.-Page 2 of 2.

Spawning History	Marine Age	Total Sample Size	Total Estimated Proportion	Total SE	Total Estimated Abundance	Total SE
Initial[a]	2	39	0.135	0.020	1,463	226
	3	193	0.670	0.028	7,239	419
	4	7	0.024	0.009	263	99
Repeat[b]	3	11	0.038	0.011	413	123
	4	7	0.024	0.009	263	99
	5	24	0.083	0.016	900	180
Multi-Repeat[c]	5	3	0.010	0.006	113	65
	6	2	0.007	0.005	75	53
	7	2	0.007	0.005	75	53
Initial		239	0.830	0.022	8,964	435
Repeat		42	0.146	0.021	1,575	234
Multi-Repeat		7	0.024	0.009	263	99
Total[d]		352	1.000	0.000	10,802	437

[a] Adults spawning for the first time in spring of 1995.

[b] Adults spawning for the second time in spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Totals are not sum of samples because sex is known for all fish and not based on age samples.

Table 15.-Length-at-age by spawning history and sex of hook and line captures of the spawning population of the Karluk River, April 1995.

		Females			Males			All		
Spawning History	Marine Age	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
Initial[a]	2	9	545	20	30	562	33	39	558	31
	3	147	665	46	46	726	47	192	680	43
	4	2	798	5	5	843	45	7	830	52
Repeat[b]	3	3	571	58	8	598	40	12	584	50
	4	6	677	34	1	770		7	689	46
	5	20	744	33	4	768	13	25	749	32
Multi-Repeat[c]	5	0			3	717	44	3	717	15
	6	2	730	28	0			2	730	28
	7	2	774	4	0			2	774	4
Initial		158	660	43	81	673	43	239	664	63
Repeat		29	707	74	13	664	87	42	694	81
Multi-Repeat		4	752	45	3	717	44	7	737	48
Total[d]		216	670	4	136	669	9	352	670	4

[a] Adults spawning for the first time spring of 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Total may not add due to illegible or regenerated scale samples.

Table 16.-Age composition by spawning history and sex of steelhead emigrating through the Karluk River weir, May 15 through July 31, 1995.

Spawning History	Marine Age	Females					Males				
		Sample Size	Estimated Proportion	SE	Estimated Abundance	SE	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE
5/14-6/10/95											
Initial[a]	2	8	0.048	0.016	40	14	18	0.107	0.024	70	16
	3	109	0.657	0.037	542	31	104	0.619	0.038	406	25
	4	0	0.000				6	0.036	0.014	23	9
Repeat[b]	3	0	0.000				13	0.077	0.020	51	14
	4	15	0.090	0.022	75	18	14	0.083	0.021	54	14
	5	28	0.169	0.029	139	24	11	0.065	0.019	43	13
	6	0	0.000				0	0.000			
Multi-Repeat[c]	5	3	0.018	0.010	15	12	1	0.006	0.006	4	4
	6	3	0.018	0.010	15	12	1	0.006	0.006	4	4
	7	0	0.000				0	0.000			
Initial		117	0.705	0.001	582	29	128	0.762	0.033	499	22
Repeat		43	0.259	0.034	214	28	38	0.226	0.032	148	21
Multi-Repeat		6	0.036	0.015	30	12	2	0.012	0.008	8	5
Total[d]		166	0.558	0.017	826	0	168	0.442	0.019	655	0

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Table 16.-Page 2 of 6.

Spawning History	Marine Age	Total Sample Size	Total Estimated Proportion	Total SE	Total Estimated Abundance	Total SE
5/14-6/10/95						
Initial[a]	2	26	0.078	0.015	115	22
	3	213	0.638	0.026	944	39
	4	6	0.018	0.007	27	11
Repeat[b]	3	13	0.039	0.011	58	16
	4	29	0.087	0.015	129	23
	5	39	0.117	0.018	173	26
	6	0	0.000	0.000		
Multi-Repeat[c]	5	4	0.012	0.006	18	9
	6	4	0.012	0.006	18	9
	7	0	0.000	0.000		
Initial		245	0.734	0.024	1,086	36
Repeat		81	0.243	0.023	359	35
Multi-Repeat		8	0.024	0.008	35	12
Total[d]		1,481	1.000	0.000	1,481	0

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Table 16.-Page 3 of 6.

Spawning History	Marine Age	Females					Males				
		Sample Size	Estimated Proportion	SE	Estimated Abundance	SE	Sample Size	Estimated Proportion	SE	Estimated Abundance	SE
6/11-7/31/95											
Initial[a]	2	44	0.115	0.016	390	55	123	0.562	0.034	1,029	62
	3	230	0.598	0.025	2,027	85	38	0.174	0.026	318	47
	4	1	0.003	0.003	9	9	2	0.009	0.006	17	12
Repeat[b]	3	3	0.008	0.044	26	15	41	0.187	0.026	343	48
	4	17	0.044	0.011	150	36	7	0.032	0.012	59	22
	5	82	0.214	0.021	724	71	6	0.027	0.011	50	20
	6	2	0.005	0.003	18	12	1	0.005	0.005	8	8
Multi-Repeat[c]	5	3	0.008	0.004	26	15	0	0.000			
	6	0	0.000	0.000			1	0.005	0.005	8	8
	7	2	0.005	0.003	18	12	0	0.000			
Initial		275	0.716	0.023	2,426	78	163	0.744	0.029	1,364	54
Repeat		104	0.271	0.022	918	77	55	0.251	0.015	460	53
Multi-Repeat		5	0.013	0.006	44	20	1	0.005	0.005	8	8
Total[e]		384	0.637	0.024	3,388	0	219	0.363	0.032	1,832	0

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Table 16.-Page 4 of 6.

Spawning History	Marine Age	Total Sample Size	Total Estimated Proportion	Total SE	Total Estimated Abundance	Total SE
6/11-7/31/95						
Initial[a]	2	167	0.277	0.018	1,446	95
	3	268	0.444	0.020	2,320	106
	4	3	0.005	0.003	26	15
Repeat[b]	3	44	0.073	0.011	381	55
	4	24	0.040	0.008	208	42
	5	88	0.146	0.014	762	75
	6	3	0.005	0.003	26	15
Multi-Repeat[c]	5	3	0.005	0.003	26	15
	6	1	0.002	0.002	9	9
	7	2	0.003	0.002	17	12
Initial		438	0.726	0.018	3,792	95
Repeat		159	0.264	0.018	1,376	94
Multi-Repeat		6	0.010	0.004	52	21
Total[e]		5,220	1.000	0.000	5,220	0

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Table 16.-Page 5 of 6.

Spawning History	Marine Age	Females				Males			
		Estimated Proportion	SE	Estimated Abundance	SE	Estimated Proportion	SE	Estimated Abundance	SE
5/14-7/31/95									
Initial[a]	2	0.062	0.008	416	57	0.171	0.013	1,145	88
	3	0.369	0.016	2,474	110	0.118	0.010	790	64
	4	0.001	0.001	9	9	0.007	0.002	44	16
Repeat[b]	3	0.004	0.002	26	15	0.062	0.008	413	56
	4	0.032	0.006	214	39	0.018	0.004	123	28
	5	0.124	0.011	834	76	0.015	0.004	101	26
	6	0.003	0.002	17	12	0.001	0.001	9	9
Multi-Repeat[c]	5	0.006	0.003	39	17	0.001	0.001	4	4
	6	0.002	0.001	13	8	0.002	0.001	13	10
	7	0.003	0.002	17	12	0.000	0.000	0	0
Initial		0.433	0.017	2,899	113	0.295	0.015	1,979	102
Repeat		0.163	0.013	1,091	85	0.096	0.010	645	66
Multi-Repeat		0.010	0.003	70	22	0.003	0.002	18	11
Total[e]		0.629	0.000	4,214	0	0.371	0.000	2,487	0

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Table 16.-Page 6 of 6.

Spawning History	Marine Age	Total Estimated Proportion	SE	Total Estimated Abundance	SE
5/14-7/31/95					
Initial[a]	2	0.233	0.015	1,561	98
	3	0.487	0.017	3,264	113
	4	0.008	0.003	53	18
Repeat[b]	3	0.065	0.009	439	58
	4	0.050	0.007	336	47
	5	0.139	0.012	935	80
	6	0.004	0.002	26	15
Multi-Repeat[c]	5	0.007	0.003	44	17
	6	0.004	0.002	26	12
	7	0.003	0.002	17	12
Initial		0.728	0.015	4,878	101
Repeat		0.259	0.015	1,736	100
Multi-Repeat		0.013	0.004	87	24
Total[e]		1.000	0.000	6,701	0

[a] Adults spawning for the first time in spring of 1995.

[b] Adults spawning for the second time in spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Total not estimated, observed counts at weir.

[e] Age and sex composition obtained from 5/14 through 7/13. Total includes 128 fish that were collected from 7/14 through 7/31 and not sexed.

Table 17.-Length-at-age by spawning history and sex of emigrating steelhead, Karluk River, 1995.

Spawning History	Marine Age	Females			Males			All		
		Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
Initial[a]	2	52	547	32	141	546	28	193	546	29
	3	339	652	30	142	692	47	481	664	41
	4	1	746		8	758	28	9	756	27
Repeat[b]	3	3	591	25	54	568	27	57	569	27
	4	32	670	26	21	707	42	53	685	38
	5	110	726	38	17	736	42	127	727	38
	6	2	800	36	1	785		3	795	30
Multi-Repeat[c]	5	6	678	33	1	716		7	683	33
	6	3	758	19	2	724	27	5	744	28
	7	2	772	8	0			2	772	8
Initial		392	638	47	291	623	85	683	632	66
Repeat		147	712	46	93	632	84	240	681	74
Multi-Repeat		11	717	51	3	721	22	14	772	46
Total[d]		4,129	663	1	2,440	604	2	6,569	641	1

[a] Adults spawning for the first time spring of 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Totals are not sum of samples because sex is known for all fish and not based on age samples.

Table 18.-Spawning survival by sex and spawning history of steelhead, marked on the spawning grounds and recaptured at the weir, Karluk River, 1995.

	Females				Males				All			
Spawning History	Number Marked	Number Recaptured	Survival	SE	Number Marked	Number Recaptured	Survival	SE	Number Marked	Number Recaptured	Survival	SE
Initial[a]	158	119	0.753	0.039	81	45	0.555	0.074	239	164	0.686	0.036
Repeat[b]	29	11	0.379	0.146	13	6	0.462	0.204	42	13	0.309	0.128
Multi-Repeat[c]	4	0	0.000	0.000	3	0	0.000	0.000	7	0	0.000	0.000
Total[d]	216	146	0.676	0.039	136	74	0.544	0.058	353	220	0.623	0.033

[a] Adults spawning for the first time spring 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Totals may not add due to illegible or regenerated scales.

Table 19.-Summary of commercial catch sampling for the incidental catch of steelhead trout from the Karluk River marine study area, August 15 through September 30, 1991 through 1994.

	1991[a]			1992[b]			1993[c]				1994			
Strata	C.C. Ret.[d]	C.C. Rel.[e]	Tender PS[f]	C.C. Ret.	C.C. Rel.	Tender SN/PS[g]	C.C. Ret.	C.C. Rel.	Tender SN[h]	Tender PS	C.C. Ret.	C.C. Rel.	Tender SN	Tender PS
8/15-8/31	41	71	51	42	51	158	21	17	5	15	47	35	16	40
9/01-9/07	32	17	42	33	8	148					18	6	12	9
9/08-9/14	16	26	309	11	11	89					0	0	0	0
9/15-9/21	11	0	150	0	9	67					18	7	16	16
9/22-9/30	[i]	[i]	53	[i]	[i]	34					101	[i]	[i]	[i]
Totals	100	114	605	86	79	331	21	17	5	15	184	48	44	65
Annual Total Catch		819			496			58				341		

[a] No sampling of tenders unloading set gillnet catches.

[b] Tender sampling includes combined set gillnet and purse seine catches.

[c] No sampling of commercial catches following 8/15-8/31 strata due to commercial closures.

[d] C.C. Ret. = Number of steelhead retained for personal use, obtained from catch calendar survey.

[e] C.C. Rel. = Number of steelhead released from set gillnets, obtained from catch calendar survey.

[f] PS = Purse seine tender, sampled harvest of steelhead.

[g] SN/PS = Combined Purse seine and set gillnet, tender sampled harvest of steelhead.

[h] SN = Set gillnet tender sampled harvest of steelhead.

[i] Commercial harvest not sampled.

spawning fish of Karluk origin to commercial steelhead bycatch. However, because few tags were recovered during commercial catch sampling, contribution cannot be estimated. It is probable that bycatch is comprised of mixed stocks, including initial and repeat spawning fish of Karluk origin and adults from other systems that are within or are in close proximity to the statistical areas sampled such as the Ayakulik, Sturgeon, Little, and Uganik rivers (Figure 5). Commercial salmon harvests since 1991 in these fisheries have been variable, but harvest levels have increased in the set gillnet fishery over those observed since the mid to late 1980s (Figures 8 and 9). Increased participation and harvests extending into late September in these fisheries have the potential to impact adult steelhead returning to the Karluk River (Table 19).

The Karluk Village subsistence fishery targets immigrating salmon primarily beginning in May and continues until October. Effort increases in response to the influx of chinook, sockeye and coho salmon during those months. With large numbers of emigrant kelts available in this fishery during the latter part of May and June, and returning adults available in September, it is likely that steelhead are taken annually in the village subsistence salmonid harvest. Therefore, the reporting of catch and harvest of steelhead in this fishery should be included on subsistence harvest permits so impact of this fishery can be assessed. In Karluk Lagoon state regulations allow the incidental harvest of steelhead for subsistence use in net fisheries directed at immigrating salmon.

The Portage area subsistence fishery by Larsen Bay residents is a directed fishery targeting overwintering steelhead. Current federal and state regulations prohibit the directed harvest of steelhead trout for subsistence use in the Kodiak area. Furthermore, it is illegal to use rod and reel to harvest steelhead or salmon for subsistence purposes on federal land. Steelhead may be taken on the upper Karluk River by rod and reel from June 15 through March 31 with a limit of 2 fish per day of which only 1 may be in excess of 20 inches in length. Therefore, targeting steelhead on the upper Karluk River for subsistence purposes is illegal. Larsen Bay residents may fish for steelhead on the Karluk under the previously mentioned regulations, providing they have an Alaska state fishing license. The close proximity of the Portage area on the Karluk River to the village and historic subsistence survey results (Figure 1 and Table 9) make it apparent that residents annually target overwintering Karluk River steelhead for subsistence purposes. This accessibility combined with the high catchability and concentrations of these fish make them extremely vulnerable to exploitation during the aforementioned time period. Enforcement of current state and federal regulations for the Karluk River should be directed at residents of Larsen Bay to fully protect the spawning population and so that a lawful winter/spring sport fishery can proceed.

From 1991 through 1993 approximately 93% of all steelhead caught in the sport fishery were released (Mills 1992-1994). During the 1994 autumn angler and outfitter camp census conducted on the Karluk River, 99% of all steelhead caught were released (Table 10). Steelhead catch and harvest occur during the summer chinook salmon angling season, in the Lagoon during the August-September coho salmon angling season, and by anglers floating the river outside the Portage area from September through November. Therefore, the 1994 autumn census data represent a minimum estimate of steelhead catch. However, it is likely these data represent the majority of effort directed at

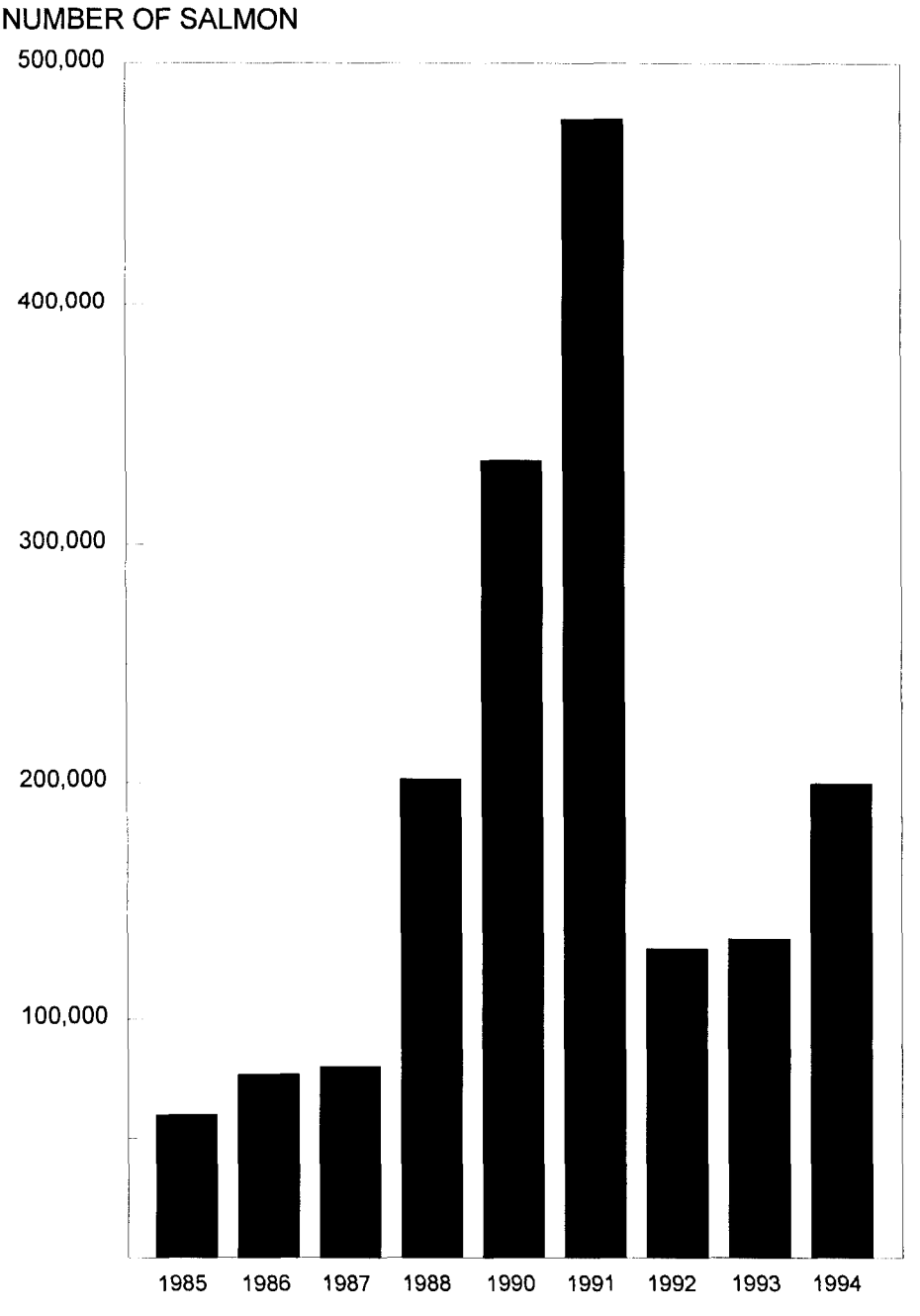

Figure 8.-Historic set gillnet harvest of salmon from the five statistical areas included in the Karluk River marine study area, August 15 through September 30, 1985 through 1994. There was no set gillnet fishery in 1989 due to the *Exxon Valdez* oil spill.

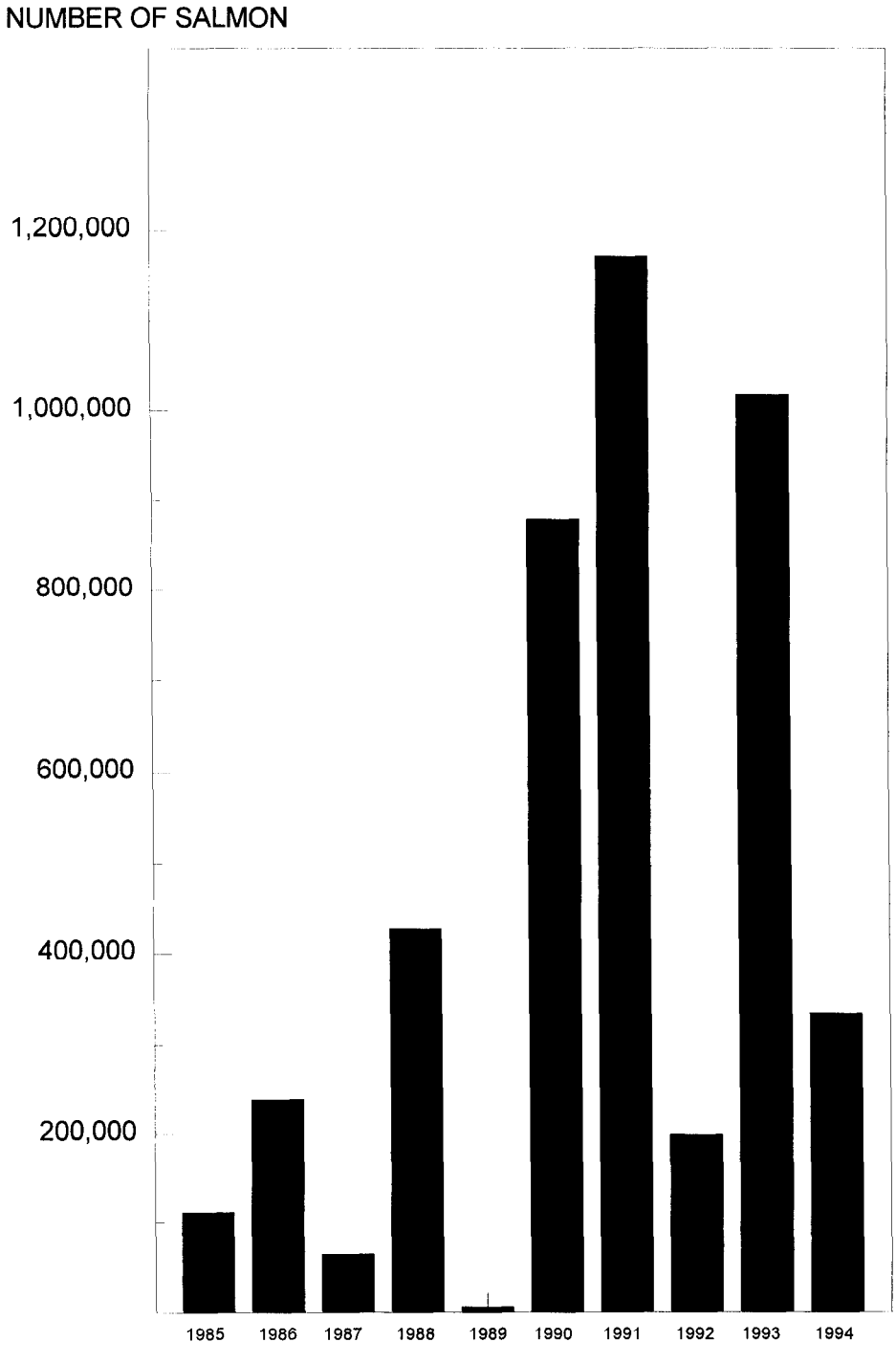

Figure 9.-Historic purse seine harvest of salmon from the five statistical areas included in the Karluk River marine study area, August 15 through September 30, 1985 through 1994.

steelhead during the late September through mid-November angling season. Estimates of the number of angler days of effort expended in the Karluk River sport fisheries obtained during the 1994 Statewide Harvest Survey (Howe et al. 1995), compared with census results obtained by the onsite angler census at the Portage area, may indicate that the 200% growth in angler effort experienced by the Karluk River sport fishery between 1990 and 1993 is likely attributable to expanding chinook and coho salmon sport fisheries (Table 10). The autumn sport fishery on the Karluk is currently characterized by low numbers of anglers and relatively high catch rates of steelhead per angler day (Table 10). Future trends in steelhead harvest can be monitored through the Statewide Harvest Survey.

The estimated abundance of 10,802 spawning steelhead is the highest estimate since this investigation began (Table 20). During 1992 and 1993 steelhead were observed in the lower river and lagoon prior to weir installation. However, in 1994 and 1995 the weir was in place before steelhead were seen. Estimates of survival in 1992 and 1993 are biased low, but not those for 1994 and 1995. Furthermore, spawning survival to emigration observed in 1995 is within the range of survival estimated since 1992 (Table 20). Continued capture and tagging of a portion of the spawning population and censusing of emigrating kelts at the weir will allow estimation of spawner abundance, providing relationships between kelt counts and spawning population size.

The component of initial spawners (83%) in the Karluk River during April of 1995 was within the range reported since this study began (78%-87%) (Begich 1992, 1993 and 1995). At the Ayakulik River weir, 64% of all steelhead sampled for age during 1995 were initial spawning fish (Appendix B1 and B2). Future inriver sampling and tag returns from the Karluk should provide insight into the annual fluctuations of the age composition of these populations.

Historic kelt counts obtained at the Karluk River weir prior to the 1992 installation of a downstream emigrant trap are unreliable. Karluk camp field logbooks for the years 1984 through 1991 indicate that a downstream pass/trap was not in place at the weir for the entire steelhead emigration and counts were sporadic and inaccurate. For instance, methods of kelt passage included use of hook and line, temporary removal of weir panels, beach seines, and passage through salmon counting gates. A downstream trap was in place during 1983 and 1992 through 1995 (Figure 10). Years without emigrant trap installation and daily operation delayed migration and may have increased mortality, which would reduce the number of spawning steelhead returning in future years. From recapture data obtained at the weir since 1992, subsequent recaptures indicate that steelhead which spawn and survive to successfully emigrate are important additions to annual spawner abundance (Table 21). Therefore, timely, efficient passage of postspawn downstream migrants in steelhead systems weired for enumeration of immigrating salmon is of paramount importance and greatly assists in facilitation of steelhead emigration (Figure 10). Future inriver tag returns should provide additional data to help quantify the impact of emigrating kelts on future adult returns and repeat spawning life history of Karluk River steelhead.

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Special thanks to the spring fishing crew: Len Schwarz, for catching the second biggest fish, Tim Motis for losing the biggest fish, Guy "no hip boot" Powel, and Carl Gravogal for telling us his bear stories. Thanks go to Jim

Table 20.-Population estimates and spawning survival to weir emigration by sex of Karluk River steelhead, 1992 through 1995.

	Females					Males				
Year	Estimated Spawning Population	SE	Weir Count[a]	Estimated Spawning Survival	SE	Estimated Spawning Population	SE	Weir Count[a]	Estimated Spawning Survival	SE
1992	1,602	132	999	0.624	0.039	2,505	109	1,583	0.632	0.048
1993	4,687	235	2,654	0.427	0.052	2,339	154	1,428	0.403	0.066
1994	4,188	321	2,203	0.457	0.065	4,928	347	2,435	0.542	0.055
1995	7,164	418	4,214	0.676	0.039	3,638	335	2,487	0.544	0.058

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Table 20.-Page 2 of 2.

	Total				
Year	Estimated Spawning Population	SE	Weir Count[a]	Estimated Spawning Survival	SE
1992	4,107	134	2,584	0.667	0.028
1993	7,026	308	4,084	0.538	0.035
1994	9,116	522	4,638	0.507	0.042
1995	10,802	437	6,701	0.623	0.033
Mean	7,763		4,402	0.595	

[a] Number of steelhead processed through emigrant kelt trap.

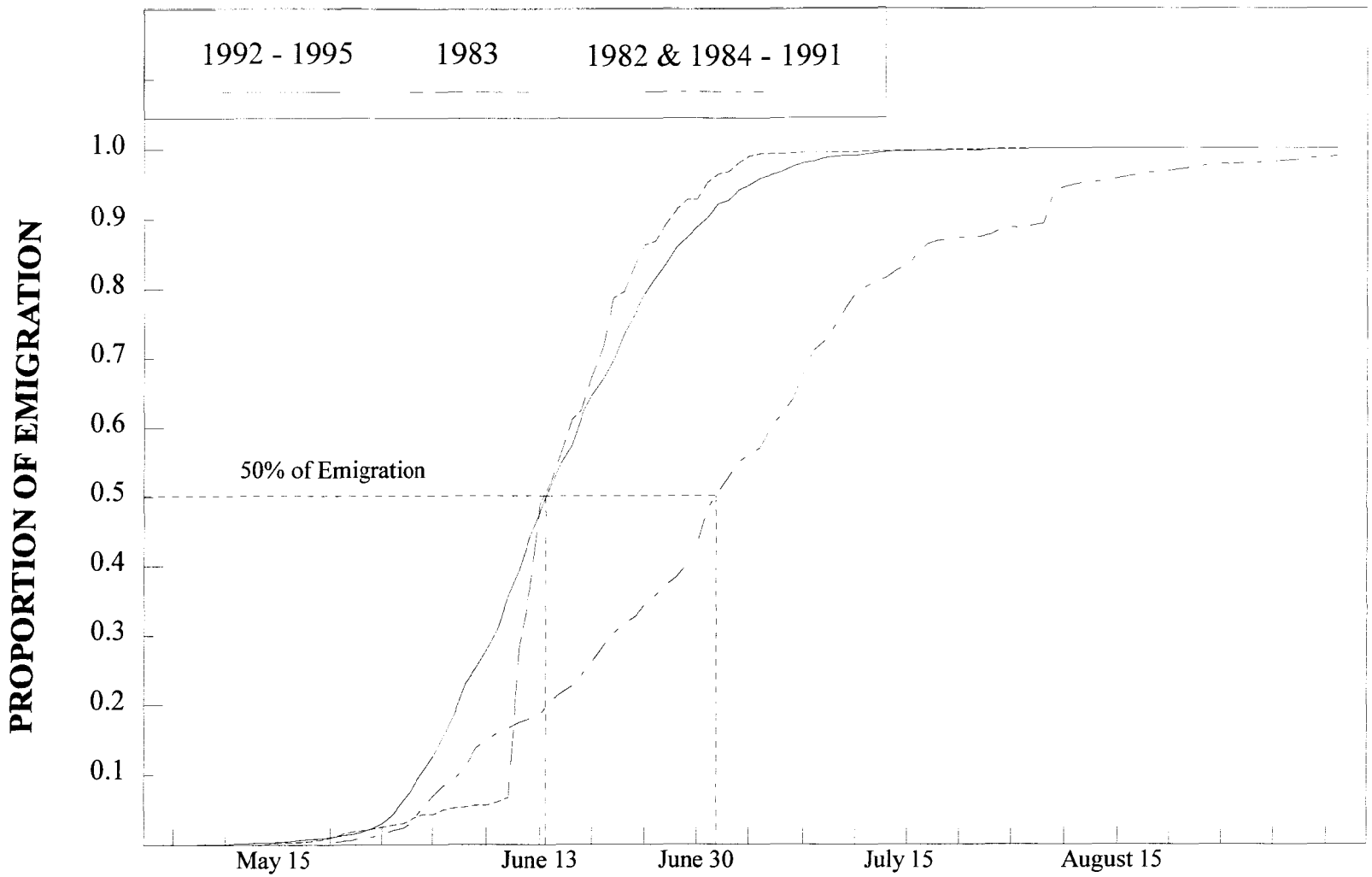

Figure 10.-Time of emigration of Karluk River steelhead, 1982 through 1995.

Table 21.-Recapture history of steelhead released with marks at Karluk weir 1992-1994, and recaptured at Karluk weir 1993 through 1995.

Year Released	Number Released With Marks	Recaptures at weir 1993	1994	1995	Total[a]
1992	2,584	236	487	66	789
1993	4,084		225	1,037	1,262
1994	4,910			414	414
Mean	3,859				822

[a] Number of marked repeat or multi-repeat spawners observed at weir and not the sum of individual fish.

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APPENDIX A. LENGTH-AT-AGE DATA FOR STEELHEAD FROM THE KARLUK RIVER STUDY AREA, 1994

Appendix A1.-Length-at-age of steelhead captured in the set gillnet fishery near the Karluk River, 1994.

Age Class[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.1	1	561		3	567	18	4	565	10
2.2	7	678	6	1	700		8	680	5
3.2	1	684					1	684	
2.2s	1	664		1	711		2	688	24
2.3s1	0			1	684		1	684	
R.1	2	555	21	2	529	13	4	542	7
R.2	6	677	4				6	677	4
R.3	1	675	8				1	675	
R.2s1	1	736					1	736	
R.3s1	1	748					1	748	
Total[b]	23	667	2	8	607	10	31	653	2

[a] R = regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

Appendix A2.-Length-at-age of steelhead captured in the purse seine fishery near the Karluk River, 1994.

Age Class[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.1	1	514		3	552	12	4	543	9
3.1	0			2	568	43	2	568	43
2.2	2	693	7	1	608		3	550	11
2.2s	2	665	18	0	838		2	665	18
R.1	0	551	23	3	551	23	3	551	23
R.2	6	681	3	0			6	681	3
R.2s2s	1	680		0			1	680	
Total[b]	12	667	4	10	579	6	22	627	3

[a] R = regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

Appendix A3.-Length-at-age of steelhead harvested in the Karluk River sport fishery October 4 through November 11, 1994.

Age Class[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.1	0			2	541	3	2	541	3
2.2	5	700	13	0			5	700	13
3.2	1	736		0			1	736	
2.3s1	1	641		0			1	641	
2.3s2	0			1	760		1	760	
R.2	4	677	3	1	793		5	700	7
R.3s1	1	707	22	0			1	707	
Total[b]	12	691	4	7	672	14	19	684	4

[a] R = regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

Appendix A4.-Length-at-age of hook and line captures of the spawning population, Karluk River, April 1995.

Age Class[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.2	3	532	6	11	558	44	14	552	31
2.3	70	667	28	18	719	35	88	677	43
2.4	1	755		2	810	40	3	792	44
3.3	3	693	24	0			3	693	24
3.4	0			1	900		1	900	
2.2s1	2	582	69	2	607	32	4	570	55
2.2s2	0			1	770		1	770	
2.3s1	4	675	25	0			4	675	25
2.3s2	15	746	32	3	768	15	18	751	23
3.3s2	3	745	30	0			3	745	30
2.2s1s1s1	0			1	658		1	658	
2.2s1s2	0			1	765		1	765	
2.3s1s1	0			1	728		1	728	
2.3s2s2	2	774	8	0			2	774	8
R.2	6	552	18	19	565	20	25	562	19
R.3	74	663	27	28	731	56	102	682	41
R.4	1	840		2	848	28	3	845	36
R.2s1	1	550		6	602	41	7	595	42
R.3s2	2	723	32	1	765		3	737	33
R.3s1	2	677	35	0			2	677	35
R.3s2s1	2	730	57	0			2	730	57
Total[b]	216	670	4	136	669	9	352	670	4

[a] R = regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

Appendix A5.-Length-at-age of emigrating steelhead captured at the Karluk weir, Karluk River, 1995.

Age[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.2s	32	541	33	91	542	27	123	542	29
2.3s	204	652	33	73	687	46	277	662	40
2.4s	0			6	753	31	6	753	31
3.2s	1	565		2	583	40	3	577	33
3.3s	2	688	2	3	737	29	5	717	33
2.2s1s	2	605	18	26	571	32	28	574	32
2.2s2s	2	666	30	9	721	31	11	711	36
2.3s1s	16	678	20	1	643		17	676	21
2.3s2s	64	723	36	6	720	45	70	723	37
2.4s2s	2	800	36	1	785		3	795	30
3.3s1s	1	644		0			1	644	
3.3s2s	5	749	33	1	755		6	750	31
2.2s2s1s	1	682		0			1	682	
2.2s2s2s	0			1	751		1	751	
2.3s1s1s	5	677	36	0			5	677	36
2.3s2s1s	1	786		1	697		2	742	45
2.3s2s2s	1	780		0			1	780	
3.3s2s1s	1	742		0			1	742	
2.2s1s1s1s	0			1	716		1	716	
R.2s	19	556	28	48	552	27	67	553	28
R.3s	133	651	26	66	694	49	199	665	41
R.4s	1	746		2	772	56	3	763	13
R.2s1s	1	562		28	565	21	29	565	21
R.2s2s	1	680		7	726	14	8	720	20
R.3s1s	12	662	38	4	659	48	16	661	37
R.3s2s	40	728	39	10	743	38	50	731	39
R.4s1s	1	703		0			1	703	
R.3s2s1s	1	746		0			1	746	
R.3s2s2s	1	764		0			1	764	
Total[b]	4,129	663	1	2,440	604	2	6,569	641	1

[a] R = regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

APPENDIX B. AYAKULIK RIVER STEELHEAD LENGTH-AT-AGE AND SPAWNING HISTORIES, 1995

Appendix B1.-Length-at-age of emigrating steelhead captured at the Ayakulik weir, Ayakulik River, 1995.

Age Class[a]	Females			Males			All		
	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
2.2s	0			22	553	21	22	553	17
2.3s	48	659	34	10	685	50	58	663	42
2.4s	1	775		3	808	65	4	795	58
3.2s	1	561		1	572		2	567	8
3.3s	1	687		0			1	687	
2.2s1s	0			5	573	19	5	573	18
2.2s2s	0			1	622		1	622	
2.3s1s	1	685		0			1	685	
2.3s2s	30	738	37	1	749		31	738	39
2.4s1s	1	802		0			1	802	
3.3s2s	0			1	710		1	710	
2.3s2s1s	1	708		1	761		2	734	54
2.3s2s2s	2	812	12	0			2	812	12
R.2s	0			12	557	24	12	557	23
R.3s	26	653	52	7	707	7	33	664	34
R.2s1s	0			4	598	3	4	598	10
R.2s2s	0			4	713	32	4	713	32
R.3s1s	2	710	32	0			2	710	32
R.3s2s	17	728	34	1	730		18	729	36
R.3s2s2s	1	756		0			1	756	
R.2s2s2s2s	1	749		0			1	749	
Total[b]	161	699	1	89	625	1	250	672	1

[a] R = Regenerated freshwater annulus.

[b] Totals may not add due to illegible or regenerated scales.

Appendix B2.-Length-at-age by spawning history and sex of emigrating steelhead Ayakulik River, 1995.

Spawning History	Marine Age	Females			Males			All		
		Sample Size	Mean Length	SE	Sample Size	Mean Length	SE	Sample Size	Mean Length	SE
Initial[a]	2	1	561	19	35	555	24	36	555	24
	3	75	657	2	17	694	58	92	664	43
	4	1	755		3	808	64	4	795	61
Repeat[b]	3	0		7	9	584	21	9	584	21
	4	3	701	6	5	695	46	8	697	41
	5	48	735	4	3	730	16	51	734	39
Multi-Repeat[c]	6	1	708		1	761		2	735	37
	7	3	793	46	0			3	793	46
	8	1	749		0			1	749	
Initial		77	657	38	55	612	89	132	638	68
Repeat		51	734	41	17	642	69	68	711	63
Multi-Repeat		5	767	41	1	761		6	766	37
Total[d]		161	699	1	89	625	1	250	672	1

[a] Adults spawning for the first time spring of 1995.

[b] Adults spawning for the second time spring of 1995.

[c] Adults spawning for at least the third time in the spring of 1995.

[d] Totals may not add due to illegible or regenerated scales.