Fishery Data Series No. 96-38

Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Early Run to the Russian River with Estimates of Escapement, 1995

by

Larry E. Marsh

November 1996

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

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

Spell out year, month, and week.

Physics and chemistry

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

General

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

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A direct expansion creel survey of the early-run Russian River recreational fishery was conducted in 1995 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 124,076 angler-hours to harvest 23,572 sockeye salmon from the early run (11 June-11 July). The harvest rate was 0.190 sockeye salmon per hour of angler effort. Approximately 69% of the effort and 74% of the harvest were from the confluence area of the fishery.

A total of 28,603 sockeye salmon bound for spawning areas within the Russian River system were counted through the weir at the outlet of Lower Russian Lake during the early run. This escapement exceeded the Board of Fisheries' mandated escapement goal of 16,000 fish.

Estimates of the age composition (harvest plus escapement) indicate that the return primarily comprised age-2.3 and age-2.2 sockeye salmon (55% and 33%, respectively). Both the sport harvest and total return for the early run were greater than the mean historical values for 1976-1994.

Key words: Russian River, sockeye salmon, *Oncorhynchus nerka*, creel survey, direct expansion, harvest, effort, weir, escapement, age composition, recreational fishery, harvest rate.

INTRODUCTION

The Russian River is a clearwater stream located in the central Kenai Peninsula near Cooper Landing, Alaska. The drainage includes two large clearwater lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes (Figure 1). One of the largest recreational fisheries for sockeye salmon *Oncorhynchus nerka* in Alaska occurs in the Russian River and at its confluence with the Kenai River (Mills 1979-1994; Howe et al. 1995). Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965-1972), Nelson (1973-1985), Nelson et al. (1986), Athons and McBride (1987), Hammarstrom and Athons (1988, 1989), Carlon and Vincent-Lang (1990), Carlon et al. (1991), and Marsh (1992-1995).

Sockeye salmon return to the Russian River in two temporal components, termed early and late runs. Historically, the total return during the early run has averaged approximately one-half that of the total return during the late run. The early run typically arrives at the confluence of the Russian and Kenai rivers in early June. Early-run fish typically remain in the confluence area for up to 2 weeks before continuing their upstream migration. By mid July, these fish will have migrated through the Russian River and into Upper Russian Lake. The early run spawns almost exclusively in Upper Russian Creek (Nelson 1973, 1974) and comprises primarily 3-ocean fish (Nelson 1973-1985, Nelson et al. 1986, Athons and McBride 1987, Hammarstrom and Athons 1988 and 1989, Carlon and Vincent-Lang 1990, Carlon et al. 1991, Marsh 1992-1995).

The early run of sockeye salmon bound for the Russian River is utilized predominantly by the recreational fishery. The run migrates through the waters of Cook Inlet prior to the opening of the commercial fishery. Numerically, this stock is much smaller than the later arriving Kenai River mainstem stocks, which include late-run Russian River sockeye salmon. Early-run fish tend to migrate rapidly through the Kenai River, minimizing the possibility for harvest in the mainstem Kenai River. Thus, all management decisions regarding harvest and stock conservation issues for the early run are focused upon the confluence area of the Kenai and Russian rivers and a short stretch of the mainstem Russian River.

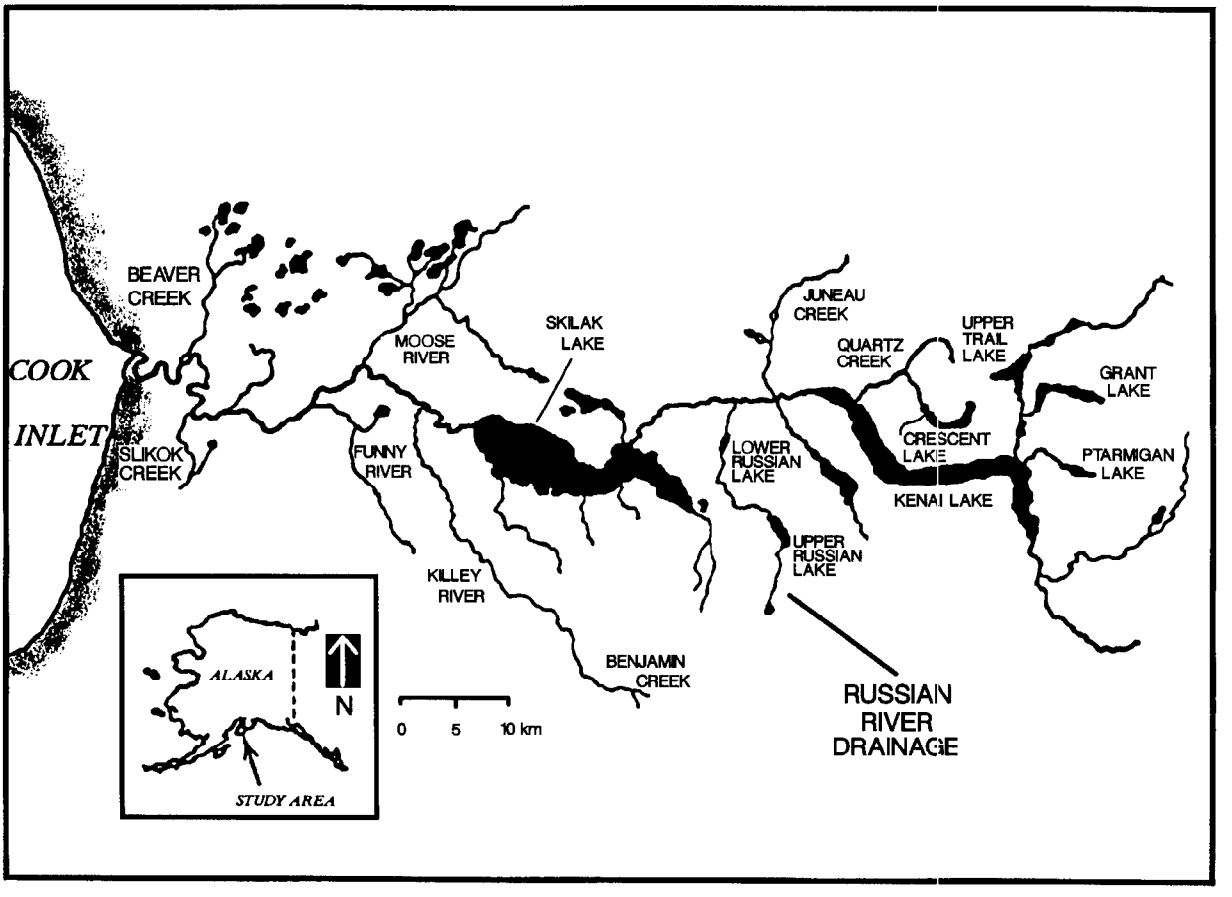

Figure 1.-Map of the Kenai River and Russian River drainages.

The Division of Sport Fish of the Department of Fish and Game manages the recreational fishery to ensure that a minimum number of spawning sockeye salmon from each run passes through a weir at the outlet of Lower Russian Lake (Figure 2). The current escapement goal for the early run is 16,000 fish. This goal is based upon evaluation of returns from past brood years. With the exception of 1989, the escapement goal has been achieved each year since the goals were formally adopted in 1979. Despite an emergency closure of the early-run fishery in 1989 (1 July through 15 July), the early-run escapement goal was not achieved (Carlon and Vincent-Lang 1990).

Given that the recreational fishery for sockeye salmon at the Russian River is one of the largest in the state in terms of angler effort, there is a potential for overharvest. Precise and timely management decisions are required to ensure that adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a fish weir. The creel survey provides data on angler effort and harvest from the recreational fishery in the Kenai/Russian River "fly-fishing-only" area (Figure 2) and in a short stretch, approximately 4.2 km (2.5 miles), of the mainstem Russian River. Weir operations provide daily escapement information. Estimates of the total inriver return (harvest

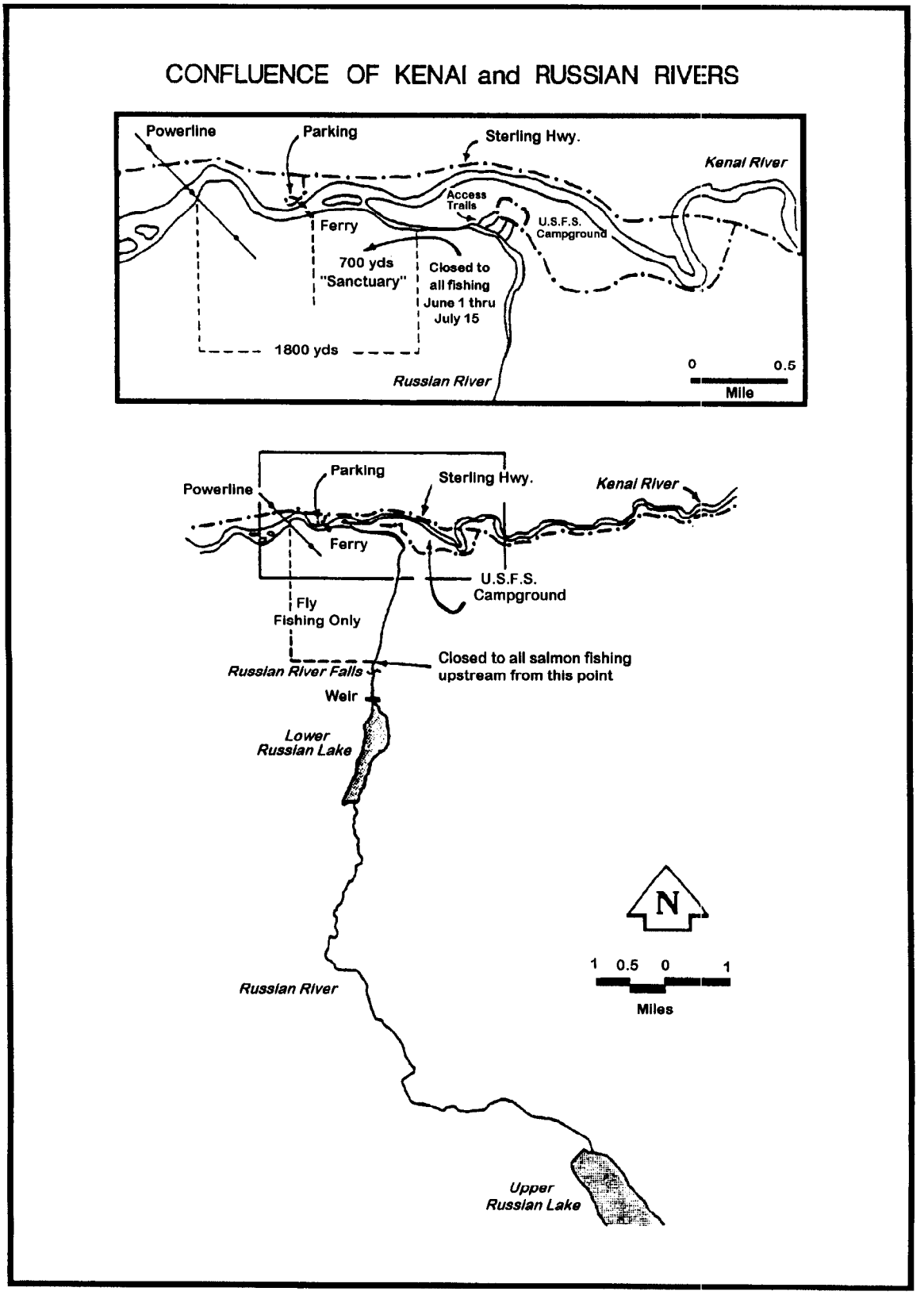

Figure 2.-Detailed map of the Kenai River and Russian River study area.

plus escapement) and the age, sex, and size compositions of the return provide necessary information required to evaluate production and to estimate optimum spawning escapement levels.

From 1 June through 20 August 1995, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River "fly-fishing-only" area was three fish of 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream from the confluence with the Russian River, only a single-hook unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook. Within this "fly-fishing-only" area, there is a sanctuary area which begins in the Russian River 137 m (150 yd) upstream of the confluence with the Kenai River and extends downstream to a marker placed approximately 25 m (75 ft) downstream of the ferry cable (approximately 640 m). This area is closed to all fishing from 1 June to 15 July by regulation.

The objectives of this report are to present for 1995: (1) estimated effort and harvest of early-run sockeye salmon for the Russian River recreational fishery, (2) estimated escapement of early-run sockeye salmon, and (3) estimated age, sex, and length distributions of the harvest and escapement of early-run sockeye salmon.

METHODS

STUDY AREA

The recreational fishery occurs in two areas (Figure 3): (1) the confluence area, which extends from the upper limit marker of the sanctuary area downstream approximately 1.6 km to a marker on the Kenai River identifying the downstream limit of the "fly-fishing-only" area; and (2) the river area, which extends from the upper limit of the sanctuary area upstream approximately 3.2 km on the Russian River to a marker identifying the upper limit of the "fly-fishing-only" area.

Primary access to the confluence and river fishing areas is provided at two locations. The United States Forest Service (USFS) campground located on the east side of the Russian River provides four short trails which intersect the main riverside trail affording access to the river area. These trails serve four camping/parking areas within the Russian River Campground. These areas are designated with the following names: (1) Grayling, (2) Rainbow Trout, (3) Pink Salmon, and (4) Red Salmon. Primary access to the confluence area of the Kenai and Russian rivers is through a parking and campground area administered by the United States Fish and Wildlife Service (USFWS) and located on the north bank of the Kenai River directly across from the Russian River confluence. Immediately adjacent to the USFWS parking area is a cable ferry which traverses the Kenai River. Most anglers fishing the confluence area use the ferry to reach the south bank of the Kenai River. Both the parking area and the ferry are operated privately under a concession administered by the USFWS. Some anglers also use the ferry to cross the Kenai River and then walk upstream to fish the Russian River area, while other anglers use the USFS campground trails to gain access to the confluence area.

A stationary weir, constructed of metal and wood, is located just downstream from the outlet of Lower Russian Lake and approximately 360 m (400 yd) upstream from the Russian River falls. The weir has been

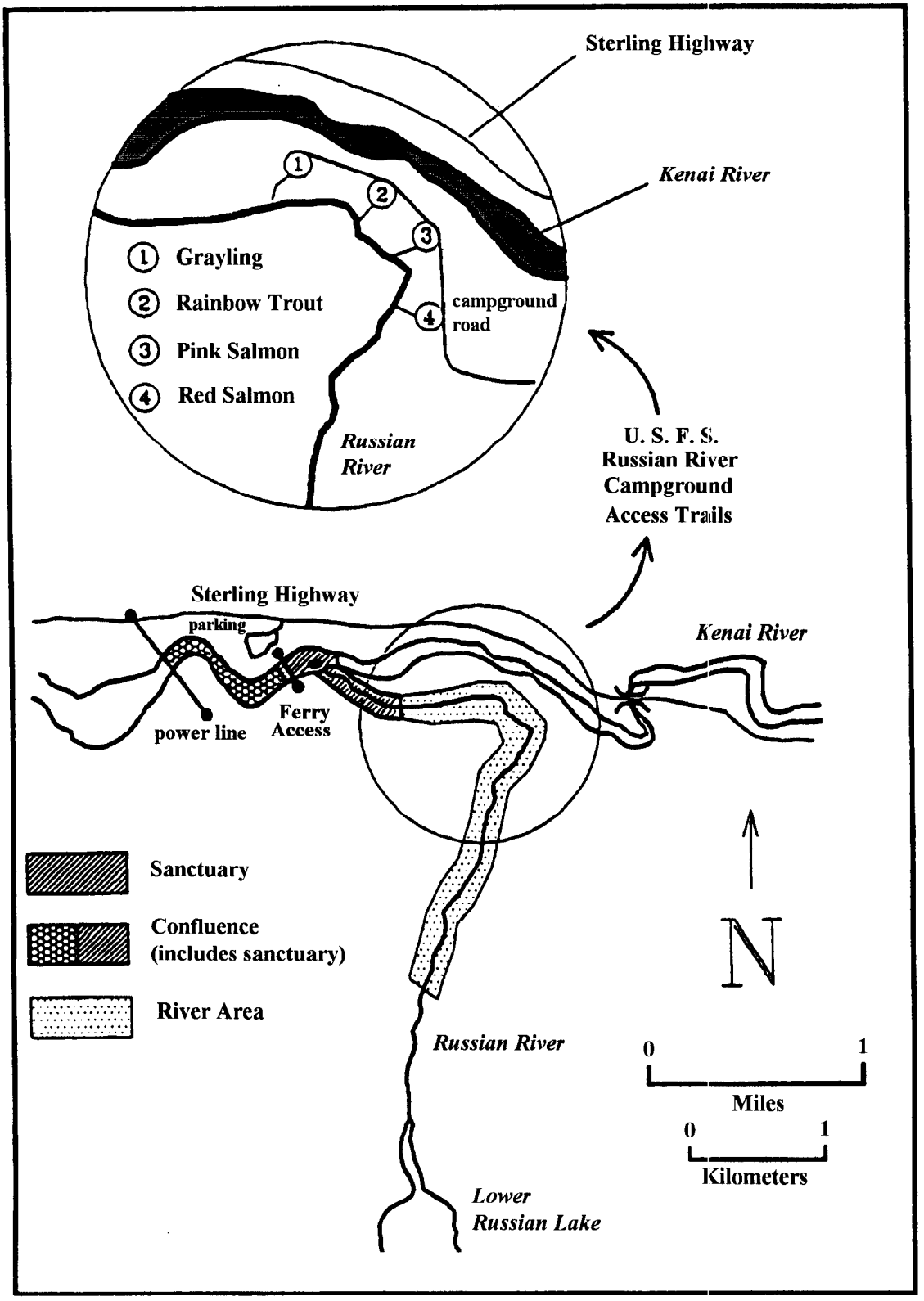

Figure 3.-Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1995 creel survey.

described in detail by Nelson (1976) and provides a complete count of the early-run spawning escapement.

STUDY DESIGN

Creel Survey

A direct expansion creel survey was utilized during the 1995 season. Sampling was stratified by access location to estimate harvest and effort for anglers exiting the fishery at each of three sampled access locations. In addition to stratification by area, harvest and effort estimates were post-stratified by time to reflect changes in the age composition of the harvest. This temporal stratification coincided with the opening of the sanctuary area of the confluence of the Kenai and Russian rivers. The opening of the sanctuary occurred on 30 June at 12 noon. A survey stratum was thus defined as an access location/temporal component combination.

Sampled locations included the ferry access to the confluence area and two river trails from the Grayling and Pink Salmon parking areas. These locations were sampled over two temporal components: from 11 June to 29 June and from 30 June to 11 July. Area-specific (river or confluence-area) harvest and effort were estimated for each stratum by recording the area fished for each interviewed angler. The sampling day was 18 hours in length (0600 to 2400 hours) and was divided into six, 3-hour periods.

A three-stage sampling design was used with days as primary units, periods as secondary units, and anglers as tertiary units. Days were systematically sampled, and within each sampled day, two 3-hour periods were selected from the six possible periods at random using a weighted selection procedure.

All anglers exiting an access location during a sampled period were counted and as many as possible were interviewed for harvest and effort data by area fished (river or confluence area). Thus, all interviews were of completed-trip anglers. Anglers exiting a location during a sampled period and not interviewed were prorated as river or confluence anglers based upon the proportion of the area fished as determined from anglers that were actually interviewed. Count and interview data were then expanded for each stratum to account for area-specific harvest and effort during periods and days that were not sampled.

Creel survey results from the 1990 and 1991 seasons (Carlon et al. 1991; Marsh 1992) indicated that sampling at the ferry, Grayling, and Pink Salmon access locations represented more than 90% of the total effort and more than 90% of the total harvest during the annual sport fishery. These locations also contributed approximately 90% of the total variance for both the harvest and effort estimates. Therefore, to better utilize creel survey personnel as well as improve the precision of harvest and effort estimates from the remaining access locations, Rainbow and Red Salmon were dropped from the sampling schedule beginning with the 1992 season. This sampling regime was continued during the 1995 season.

Estimates of effort, harvest, and their variances for the early run in 1990-1994 were used to optimally allocate the number of sampling days among the surveyed access locations (Cochran 1977). In 1995, the ferry was sampled every other day, while Grayling was sampled every 3 days and Pink Salmon sampled every 4 days.

Angler effort and harvest were estimated for a stratified, three-stage (day/period/angler) direct expansion creel survey (Bernard et al. *In prep*). Total effort, harvest, and their variances were estimated for the entire run by summing the strata (access location) estimates.

At access location k on day i during sample period j, m_{kij} represents those completed anglers interviewed as they exited through location k and a_{kij} represents those anglers that exited and were counted but were not interviewed. Interviewed anglers were assigned to one of three groups:

m_{1kij} = anglers that fished the river area only,

m_{2kij} = anglers that fished the confluence area only, or

m_{3kij} = anglers that fished both areas, and

$$m_{kij} = m_{1kij} + m_{2kij} + m_{3kij} . \quad (1)$$

Area-specific harvest of missed anglers (a_{kij}) was estimated based on information obtained in interviews. The proportion of missed anglers that fished the river was estimated as:

$$\hat{P}_{rkij} = \frac{m_{rkij}}{m_{kij}}, \quad (2)$$

where:

m_{rkij} = the number of interviewed anglers fishing the river,

= $m_{1kij} + m_{3kij}$.

The number of missed anglers fishing the river ($\hat{a}_{rkij}$) was estimated as:

$$\hat{a}_{rkij} = a_{kij}\hat{P}_{rkij} . \quad (3)$$

The total number of anglers fishing the river area and exiting the fishery at location k on day i during sample period j was estimated as:

$$\hat{M}_{rkij} = m_{rkij} + \hat{a}_{rkij} . \quad (4)$$

The same procedure was used to estimate the missed anglers who fished the confluence area:

$$\hat{M}_{ckij} = m_{ckij} + \hat{a}_{ckij} . \quad (5)$$

The mean river-area harvest per interviewed angler was estimated as:

$$\bar{h}_{rkij} = \frac{\sum_{l=1}^{m_{rkij}} h_{rkijl}}{m_{rkij}}, \quad (6)$$

where:

h_{rkijl} = the river-area harvest of angler l exiting at location k on day i during sample period j.

The variance of river-area harvest among interviewed anglers was estimated assuming a normal variate as:

$$Var(\bar{h}_{rkij}) = \frac{\sum_{l=1}^{m_{rkij}} (h_{rkijl} - \bar{h}_{rkij})^2}{m_{rkij} - 1} . \quad (7)$$

The total river-area harvest of anglers exiting through access location k on day i during sample period j was estimated as:

$$\hat{H}_{rkij} = \hat{M}_{rkij}\bar{h}_{rkij} . \quad (8)$$

The mean river-area harvest per period was then estimated for location k on day i as:

$$\bar{H}_{rki} = \frac{\sum_{j=1}^{u_{ki}} \hat{H}_{rkij}}{u_{ki}}, \quad (9)$$

where:

u_{ki} = the number of sample periods at location k on day i ($u_{ki} = 2$),

and the variance among sample periods was estimated as:

$$Var(\bar{H}_{rki}) = \frac{\sum_{j=1}^{u_{ki}} (\hat{H}_{rkij} - \bar{H}_{rki})^2}{u_{ki} - 1} . \quad (10)$$

The total river-area harvest of anglers exiting through access location k on day i was estimated by expanding the mean river-area harvest per period on day i by:

$$\hat{H}_{rki} = U_{ki}\bar{H}_{rki} , \quad (11)$$

where:

U_{ki} = the total number of periods at location k on a day (U = 6).

The mean river-area harvest per day was estimated at location k as:

$$\overline{H}_{rk} = \frac{\sum_{i=1}^{d_k} \hat{H}_{rki}}{d_k}, \quad (12)$$

where:

d_k = the number of days sampled at location k.

The variance of river-area harvest among days at location k was estimated using the variance for a systematic sample as:

$$Var(\overline{H}_{rk}) = \frac{\sum_{i=2}^{d_k} (\hat{H}_{rki} - \hat{H}_{rk(i-1)})^2}{2(d_k - 1)}. \quad (13)$$

The total river-area harvest at location k was estimated by expanding the mean harvest per day by:

$$\hat{H}_{rk} = D_k \overline{H}_{rk}, \quad (14)$$

where:

D_k = the total number of days during the run at location k.

The variance of the total river-area harvest at location k was estimated as:

$$Var(\hat{H}_{rk}) = (1 - f_1) D_k^2 \frac{Var(\overline{H}_{rk})}{d_k} + D_k \frac{U_{ki}^2}{u_{ki}} (1 - f_2) \frac{\sum_{i=1}^{d_k} Var(\overline{H}_{rki})}{d_k} + D_k U_{ki} \sum_{i=1}^{d_k} \sum_{j=1}^{u_{ki}} \hat{M}_{rkij}^2 (1 - f_3) \frac{Var(\overline{h}_{rkij})}{d_k u_{ki} m_{rkij}}, \quad (15)$$

where:

f_1 = the finite population correction factor for days (d_k/D_k),

f_2 = the finite population correction factor for periods (u_{ki}/U_{ki}), and

f_3 = the finite population correction factor for anglers $\left(m_{kij} / \hat{M}_{kij}\right)$.

These procedures (Equations 2 through 15) were also used to estimate the confluence-area harvest of anglers exiting through each access location. Likewise, the same procedures were used to estimate effort (in angler-hours) expended in the river area and the confluence area by substituting the area-specific hours of effort reported by interviewed anglers for the reported harvest in Equations 2 through 15.

Total harvest and effort were estimated for the run by summing the individual stratum estimates. The variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates.

Daily harvest rates were estimated and used for inseason management as an indicator of sockeye salmon abundance. Regardless of access location, the daily confluence area harvest rate was based solely on confluence effort and the resultant harvest reported by interviewed anglers. The mean daily harvest rate of the confluence area was estimated as:

$$\overline{HPUE}_c = \frac{\sum_{l=1}^{n_c} HPUE_{cl}}{n_c}, \quad (16)$$

where:

n_c = number of interviewed anglers reporting confluence-area effort, and

$HPUE_{cl}$ = confluence-area harvest per hour of effort for angler l.

The variance of this estimate was calculated as:

$$\mathrm{Var}\left(\overline{\mathrm{HPUE}}_c\right) = \frac{\sum_{l=1}^{n_c}\left(\mathrm{HPUE}_{cl} - \overline{\mathrm{HPUE}}_c\right)^2}{n_c\left(n_c - 1\right)}. \qquad (17)$$

The same procedure was used to estimate river-area harvest rates.

The overall harvest rate for the early run provides a relative basis for comparing seasonal fishing success among years (Nelson 1985, Hammarstrom and Athons 1988). A harvest rate for the early run was estimated by dividing the total run-specific harvest estimate by the total run-specific effort estimate. The associated variance was then calculated as the variance of a quotient of two random variables. The same procedure was applied to estimate the harvest rate within each spatial component of the recreational fishery (confluence and river).

Spawning Escapement

The escapement of spawning sockeye salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake. An adjustable gate system allowed fish to be passed individually and counted by the weir operator. During the period of overlap of early and late runs (mid to late July), fish from each run were subjectively identified by degree of external sexual maturation (body color and kype development) and counted separately. Early in each run, adults have not yet developed the red body coloration and green head with distended, hooked jaws characteristic of more sexually mature fish which pass through the weir later in each run. Therefore, during the period of run overlap at the weir, the last of the early-run fish typically exhibit the reddish body coloration and green head while the late-run fish have not yet developed these physical characteristics. The period of overlap began on 24 July when late-run fish were intermixed with mature, early-run fish and continued through 31 July, after which early-run fish were no longer present.

Biological Data

Six time and area strata within the Russian River sockeye salmon return were sampled for biological data to estimate the age, sex, and length composition of the early run (Table 1).

Table 1.-Temporal components of the recreational harvest and escapement sampled for age composition during the 1995 early-run Russian River sockeye salmon return.

Return Component	Temporal Strata
Confluence-area harvest	6/11 - 6/29
	6/30 - 7/11
River-area harvest	6/11 - 6/29
	6/30 - 7/11
Escapement through weir	6/13 - 6/29
	6/30 - 7/31

Creel survey technicians collected biological data from harvested sockeye salmon when possible on days that the creel survey was conducted. In addition, several days of biological sampling without creel interviews were scheduled to ensure that desired sample sizes were attained.

Scales were collected from the preferred area of each sampled fish and placed on adhesive-coated cards (Clutter and Whitesel 1956). The sex and length (measured from the mid-eye to the fork-of-tail to the nearest millimeter) of each sampled fish were also determined and recorded. Scale impressions were made in clear acetate and examined with a microfiche reader for aging. The European method of age description was used to record ages: the numeral preceding the decimal

represents the number of freshwater annuli and the numeral following the decimal represents the number of marine annuli. Total age is therefore the sum of the two numbers plus one.

Age and sex composition of the run was estimated for each stratum. Since the age composition of the harvest was not different (P>0.05; see Results) between areas or time, all creel and biological data were combined. Therefore, the proportion of fish of age-sex group g in stratum f (i.e., during the entire run) was estimated as:

$$\hat{p}_{gf} = \frac{x_{gf}}{n_f}, \tag{18}$$

where:

x_{gf} = the number of legible scales read from sockeye salmon sampled during stratum f and interpreted as age-sex g, and

n_f = the total number of legible scales read from sockeye salmon sampled during stratum f.

The variance of this proportion was estimated as (Scheaffer et al. 1979):

$$\mathrm{Var}\left(\hat{p}_{gf}\right) = \frac{\hat{p}_{gf}\left(1-\hat{p}_{gf}\right)}{n_f - 1} \ . \tag{19}$$

The harvest of sockeye salmon of each age-sex group was estimated by:

$$\hat{H}_{gf} = \hat{H}_f \, \hat{p}_{gf} \ , \tag{20}$$

where:

H_f = the estimated total harvest of sockeye salmon during stratum f, (i.e., during the entire run).

The variance of the harvest by age-sex group was estimated as the product of two independent random variables (Goodman 1960):

$$\begin{aligned}\mathrm{Var}\left(\hat{H}_{gf}\right) = \quad & \hat{H}_f^2 \, \mathrm{Var}\left(\hat{p}_{gf}\right) + \\ & \hat{p}_{gf}^2 \, \mathrm{Var}\left(\hat{H}_f\right) - \\ & \mathrm{Var}\left(\hat{p}_{gf}\right)\mathrm{Var}\left(\hat{H}_f\right) \ ,\end{aligned} \tag{21}$$

where:

$\mathrm{Var}\left(\hat{H}_f\right)$ = the variance of the harvest estimate during stratum f, i.e., during the entire run.

The age composition of the escapement differed significantly over time ($P < 0.05$; see Results), therefore the weir counts and the number of sockeye salmon of age group g of stratum f in the escapement was estimated by sex using the estimates of the age group proportions defined previously:

$$\hat{E}_{gf} = E_f \, \hat{p}_{gf}, \tag{22}$$

where:

E_f = the total number of sockeye salmon enumerated during stratum f at the weir or spawning downstream from the falls.

The variance of $\hat{E}_{gf}$ was estimated as:

$$\mathrm{Var}\left(\hat{E}_{gf}\right) = E_f^2 \mathrm{Var}\left(\hat{p}_{gf}\right) \ . \tag{23}$$

The age composition of the entire escapement past the weir was estimated by summing the strata estimates. The total number of fish of age g migrating through the weir was estimated as:

$$\hat{E}_g = \sum_{f=1}^{t} \hat{E}_{gf}, \tag{24}$$

where:

t = the number of strata in the run.

Similarly, the variance was estimated as the sum of the variances as:

$$\mathrm{Var}\left(\hat{E}_g\right) = \sum_{f=1}^{t} \mathrm{Var}\left(\hat{E}_{gf}\right). \quad (25)$$

The proportion of sockeye salmon of age-sex g in the total escapement was estimated as:

$$\hat{p}_{eg} = \frac{\hat{E}_g}{E_T}, \quad (26)$$

where:

E_T = the total escapement enumerated at the weir.

The variance of this proportion was estimated by:

$$\mathrm{Var}\left(\hat{p}_{eg}\right) = \frac{\mathrm{Var}\left(\hat{E}_g\right)}{E_T^2}. \quad (27)$$

The total return, total return by age, and their respective variances were estimated by summing the estimates from the total harvest at the confluence and at the river, and from the escapement. The proportion of sockeye salmon of age g in the total return was estimated as:

$$\hat{p}_g = \frac{\hat{N}_g}{\hat{N}_T}, \quad (28)$$

where:

$\hat{N}_g$ = the estimated total return of fish of age g, and

$\hat{N}_T$ = the estimate of the total return.

The variance of this proportion was estimated as an approximation using the delta method (Seber 1982:7-8) as:

$$\mathrm{Var}\left(\hat{P}_g\right) \approx \frac{1}{\hat{N}_T^2}\left\{\frac{\mathrm{Var}\left(\hat{H}\right)\left[p_{hg}E_t - \hat{E}_g\right]^2}{\hat{N}_T^2} + \mathrm{Var}\left(\hat{p}_{hg}\right)\hat{H}^2 + \mathrm{Var}\left(\hat{p}_{eg}\right)E_T^2\right\}. \quad (29)$$

escapement was used to estimate the total return by age (Nelson et al. 1986, Carlon and Vincent-Lang 1990). This assumed that the age composition of the escapement was the same as that of the harvest at the river and at the confluence. This assumption, initially tested in 1990, was invalidated as significant differences ($P>0.05$) in age compositions were found among the three sampled areas and/or during some of the temporal strata (Carlon et al. 1991, Marsh 1992-1995). Chi-square tests were used to test the null hypotheses that the age distributions were equal among the three areas and between the two temporal strata in 1995. The null hypothesis was rejected if $\alpha \leq 0.05$. Failure to reject the null hypothesis would allow the age samples to be pooled to achieve a more precise estimate of the number of sockeye salmon by age in the harvest and escapement.

Mean length at age was estimated for each temporal stratum within each spatial stratum of the return: the confluence-area harvest, the river harvest, and the weir escapement. Associated variances were estimated using standard normal procedures. An analysis of variance (ANOVA) was used to determine if mean length at age differed by area, temporal stratum, and sex. This analysis was conducted for the predominant age groups (age-2.3, -1.3 and -2.2 fish). This analysis was not conducted for age 1.2 due to insufficient samples.

RESULTS

CREEL STATISTICS

Survey Interviews

Sampling began on 11 June 1995 at the ferry access location and continued every other day through the end of the early run on 11 July. The systematic sampling of the two Russian River Campground access locations began on 16 June, 5 days after sampling commenced at

Table 2.-Summary of the number of interviews collected during sampled periods for the early-run Russian River creel survey, 1995.

Exit Location	Area Fished			Total Interviews	Anglers Exiting and not Interviewed	Total Anglers Exiting
	Confluence	River	Both			
Ferry	2,236	34	12	2,282	394	2,676
Grayling	265	517	44	826	124	950
Pink Salmon	81	415	36	532	54	586
Total	2,582	966	92	3,640	572	4,212

the ferry location. Because early-run sockeye salmon typically hold in the confluence area of the Kenai and Russian rivers for up to 2 weeks before continuing their upstream migration, harvest and effort in the mainstem Russian River is generally considered negligible until approximately the third week in June. Onsite observations and creel data collected during the 1995 early run indicated that effort and the resulting harvest in the clear waters of the mainstem Russian River began somewhat earlier with significant catches observed on 13 June.

A total of 4,212 anglers were enumerated as they exited sampled access locations during the 1995 early-run creel survey (Table 2). Of these, 3,640 (86%) were interviewed and 572 (14%) were not interviewed. The level of creel sampling remains similar to the first year (1990) that the three-stage direct expansion survey was implemented (Carlon et al. 1991). Most of the interviews (63%) were made at the ferry access (Appendix A1). This area typically accounts for most of the sport fishing effort. Anglers exiting via the ferry location tended to fish the confluence area (98%) (Appendix A2).

Harvest and Effort

Estimates of harvest, effort, and variances are presented by stratum (temporal/access location) in Appendix A3. Of the three access locations (the ferry, Grayling, and Pink Salmon), the ferry accounted for most of the effort (56%) and harvest (59%) during the early run (Table 3, Appendix A3). Anglers harvested an estimated 23,572 (SE = 2,271) early-run sockeye salmon from the Russian River in 1995 (Table 3). The effort estimate for the early run was 124,076 (SE = 9,009) angler-hours. The relative precision of the early-run harvest and effort estimates were 19% and 14%, respectively. During the early run, 74% of the harvest was taken from the confluence area and the remaining 26% was taken from the river area (Table 4 and Figure 4). HPUE was 0.204 for anglers fishing the confluence area and 0.159 for the river area (Table 5).

Spawning Escapement

A total of 28,603 sockeye salmon passed through the weir, peaking on July 7 (Figure 5 and Appendix A4). Late-run sockeye salmon began arriving on 24 July and the last early-run fish was passed on 31 July.

Biological Data

The age composition of the weir escapement differed from that of the confluence-area harvest during the second temporal stratum and from the river-area harvest during both

Table 3.-Estimates of harvest, effort, and associated variances by access location for the recreational fishery for early-run sockeye salmon at the Russian River, 1995.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative Precision[a]	Effort[b]	(%)	Variance of Effort	(%)	Relative Precision[a]
Ferry	13,860	59	2,771,129	54	24%	70,095	56	49,447,707	61	20%
Grayling	6,419	27	1,659,519	32	39%	30,417	25	20,164,828	25	29%
Pink Salmon	3,293	14	725,961	14	51%	23,564	19	11,530,859	14	28%
Total	23,572	100	5,156,609	100	19%	124,076	100	81,143,394	100	14%

[a] $\alpha = 0.05$

[b] Angler-hours.

temporal strata (Table 6). However, the age composition of the confluence-area harvest did not significantly differ from that of the river-area harvest during either of the temporal strata.

Age composition of the harvest did not change significantly over time at either the river or the confluence (Table 7). However, significant temporal differences in the age composition were detected in the escapement at the weir (Table 7). Based on these results, the estimated escapement of sockeye salmon by age and sex was stratified temporally.

The escapement comprised two predominant age groups, ages 2.3 and 2.2 (Table 8). There was a significant decrease in fish aged 2.3 and a subsequent increase in fish aged 2.2 between temporal strata ($\chi^2 = 11.32$, df = 1, $P < 0.001$) which accounted for the temporal changes in the age composition of the escapement. A third age group, age 1.3, was less than 15% of the escapement.

Table 4.-Summary of estimated angler effort and harvest by component during the early run of Russian River sockeye salmon, 1995.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort[a]	85,177	38,899	124,076	106,420 - 141,732
SE	7,561	4,896	9,009	
Harvest	17,391	6,181	23,572	19,121 - 28,023
SE	1,813	1,367	2,271	

[a] Angler-hours.

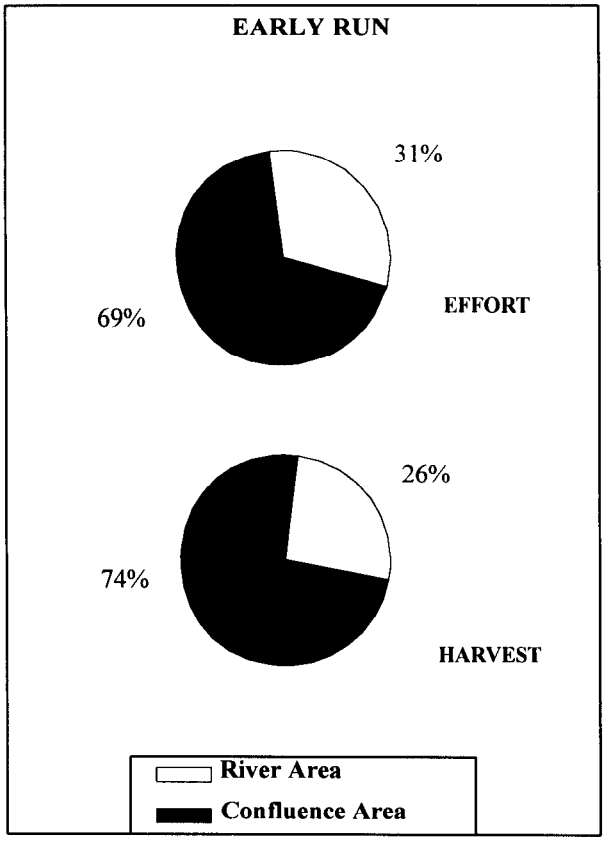

Figure 4.-Harvest and angler effort by area for the Russian River early-run sockeye salmon recreational fishery, 1995.

Results of hypothesis testing indicated that biological data of the harvest from the confluence and river areas could be pooled by area and time (Table 9). Similar to what was observed with the escapement, the harvest was also predominantly age-2.3 adults (63%) and age-2.2 adults (29%). Estimates of the age-sex composition in the escapement and harvest were summed to estimate the age-sex composition of the total return. Fish aged 2.2 and 2.3 made up nearly 90% of the total return (Table 10).

There were no significant differences in length at age among areas (Table 11) for age-1.3 fish ($F = 0.21$; $df = 2, 62$; $P = 0.81$) and age-2.2 fish ($F = 0.38$; $df = 2, 219$; $P = 0.68$). However, age-2.3 sockeye salmon sampled at the weir were larger than those sampled at the confluence ($F = 2.87$; $df = 2, 401$; $P = 0.06$). In addition, there were significant differences in length-at-age detected between sampled age-1.3 fish ($F = 7.69$; $df = 1, 62$; $P = 0.007$) during the first temporal stratum when compared to those sampled in the second stratum.

Table 5.-Estimated harvest-per-hour of angler effort (HPUE) by anglers interviewed during the recreational fishery for early-run sockeye salmon at the Russian River, 1995.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	23	31	2,628	0.204	0.0005
River	21	26	1,012	0.159	0.0012
Both			3,640	0.190	0.0003

[a] Number of days on which at least one angler reported fishing effort.

[b] Number of days possible for conducting interviews.

[c] Anglers who fished both areas are represented twice.

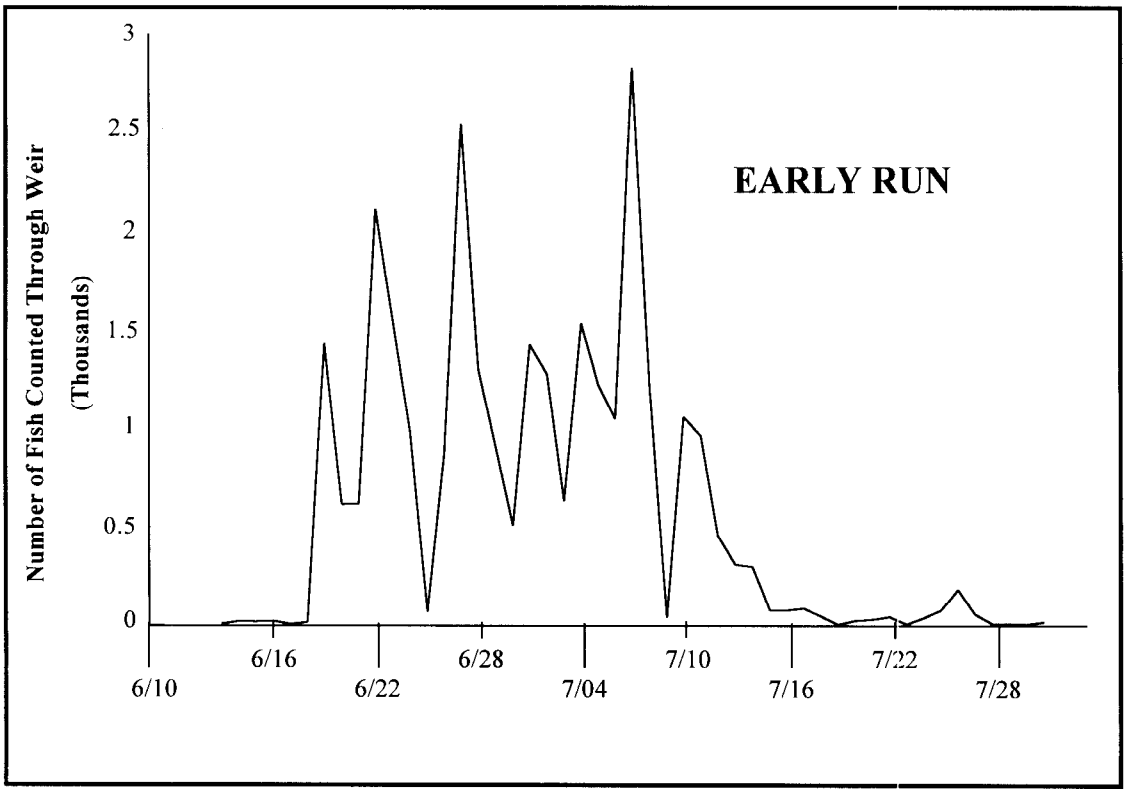

Figure 5.-Daily escapement of sockeye salmon through the Russian River weir, 1995.

TOTAL RETURN STATISTICS

Overall, an estimated 52,175 early-run sockeye salmon returned to the Russian River in 1995 (Table 10). Brood years 1989 (age 2.3) and 1990 (age 1.3 and 2.2) were both significant contributors to the early-run return. The majority of the return (55%) was age 2.3. Brood year 1990 contributed 44% to the early-run return; the 1991 brood year (age 1.2) contributed just 1% of the return. The 1989 escapement of about 15,000 spawners produced about 57,000 returning adults (Table 12).

DISCUSSION

APPLICATION OF THE DATA FOR FISHERY MANAGEMENT

The early run of sockeye salmon is managed for escapement. Based upon analyses of brood production data (Carlon and Vincent-Lang 1990), an escapement goal of 16,000 sockeye salmon was established by the Board of Fisheries during their 1989 forum. On 21 June 1995, a total of 2,738 sockeye salmon had migrated through the weir with an estimated 2,000 fish holding immediately downstream from the weir. An additional 2,000 fish were estimated to be holding in the falls area of the river, upstream of the sport fishery. Observations of the sport fishery and an estimated HPUE of 0.250 in the confluence area indicated that the sport fishery was quite successful.

Based upon the harvest rate as well as onsite observations, the sockeye salmon return appeared to evidence signs of reasonable abundance. However, fewer than 1,000 fish were estimated to be holding in the sanctuary

area of the Russian River. Given this status, no immediate management action was warranted but the development of the fishery and weir escapement counts was closely monitored. By 28 June the weir escapements had reached 12,142 with a final escapement projection of 32,500 fish. Stream surveys indicated that sufficient numbers of fish were present in the river above the sport fishery to ensure that the escapement goal of 16,000 fish would be met. Therefore, the sanctuary area at the confluence of the Kenai and Russian rivers was opened to fishing on 30 June at 12:00 p.m. Anglers were therefore afforded increased fishing opportunity in 1995.

RELATIVE RUN STRENGTH

The strength of the 1995 early run, as determined from total return estimates (harvest plus escapement), was slightly below the historical average (1976-1994) (Figure 6). However, this level of return greatly exceeds the historical average for years (1963-1975) and generally maintains the trend, beginning in 1978, of greater numbers of early-run sockeye salmon returning to the Russian River system.

SAMPLE DESIGN

Creel Survey

An underlying assumption necessary for accurate harvest estimates is that most, if not all, anglers exit the fishery through one of the three sampled access locations. While anglers were observed using other exit locations, the level at which this occurred during 1995 appeared insignificant. Creel survey personnel and the project leader continued to maintain an informal accounting of the use of

Table 6.-Results of chi-square tests of age composition between spatial strata for the early-run Russian River sockeye salmon return, 1995.

Spatial Component		
Confluence Harvest vs. River Harvest	Confluence Harvest vs. Weir Escapement	River Harvest vs. Weir Escapement
Temporal Stratum 1[a]		
$df = 2, \chi^2 = 1.32, P = 0.518$ NS[b] ($P > 0.05$)	$df = 2, \chi^2 = 3.78, P = 0.150$ NS[b] ($P > 0.05$)	$df = 2, \chi^2 = 6.72, P = 0.034$ S[b] ($P < 0.05$)
Temporal Stratum 2[a]		
$df = 2, \chi^2 = 2.28, P = 0.320$ NS[b] ($P > 0.05$)	$df = 2, \chi^2 = 8.26, P = 0.016$ S[b] ($P < 0.05$)	$df = 2, \chi^2 = 11.45, P = 0.003$ S[b] ($P < 0.05$)

[a] 1 = 6/11/-6/29.
2 = 6/30-7/11 (6/30-7/31 for weir escapement).

[b] NS = no significant difference; S = significant difference.

Table 7.-Results of chi-square tests of age composition between temporal strata for the early-run Russian River sockeye salmon return, 1995.

Spatial Component	Temporal Component: 11 June to 29 June vs. 30 June to 11 July[a]
Confluence Harvest	df = 2, χ^2 = 1.80, P = 0.406 Not Significant, P > 0.05
River Harvest	df = 2, χ^2 = 2.19, P = 0.333 Not Significant, P > 0.05
Weir Escapement	df = 2, χ^2 = 12.36, P = 0.002 Significant, P < 0.05

[a] 6/13-6/29, and 6/30-7/31 for weir escapement

the other access sites at least twice a day during transit between other sites and during shift changes. Observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that small numbers of anglers were engaged in fishing at those hours during 1995. Once again, an informal monitoring of the activity during these hours was accomplished through interviews with the angling public and frequent queries of the campground and ferry employees. Additionally, the project staff were instructed to maintain field notes to record the number of anglers observed fishing during nonsurveyed hours. Generally, such observations occurred just prior to beginning the early morning shift (0600 hours) or after the completion of the sampling day (2400 hours). Further observations were made when project staff conducted personal fishing trips during nonsurveyed hours. However, random observations of access locations during the nighttime period should continue in the future. This will provide for any additional information regarding possible changes in angler use patterns which might prove useful in further refining the survey.

Age Composition

The accurate assessment of the age composition of the sockeye salmon return is needed to establish accurate brood tables for the Russian River system. The sampling of time and area strata adopted in 1990 was continued in 1995. This increase in sampling intensity over prior years is an effort to achieve more accurate age composition estimates. Significant temporal changes and spatial differences in age composition have been detected since 1990 (Carlon et al. 1991, Marsh 1992-1995).

Statistical comparisons of the age composition of the harvest and of the escapement revealed that differences continued to occur in 1995. Therefore, it was not appropriate to use the age composition from one area to estimate the age composition of the total return. The age composition of the return was estimated separately for the recreational harvest and for the escapement.

Because changes in the age composition of the early run were detected between areas in 1995, sampling of the individual spatial strata should continue at the present sampling intensity. This will improve both estimating the number of sockeye salmon returning by age and sex as well as evaluating those differences over time. The end result will be improved accuracy of brood production information necessary for the long-term management of the Russian River system.

MANAGEMENT OF THE FISHERY

The utilization of migratory timing statistics derived from weir counts and fishery harvest rates should be continued (Vincent-Lang and Carlon 1991). The technique of fitting a

Table 8.-Estimated age and sex composition of the early-run sockeye salmon escapement through the Russian River weir, 1995.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/13 - 6/29						
n[a]= 135						
Count= 13,053						
	FEMALES					
Sample Size	36	15	22	0	0	73
Percent	26.7	11.1	16.3	0.0	0.0	54.1
Variance of Percent	14.6	7.4	10.2	0.0	0.0	18.5
Number	3,481	1,450	2,127	0	0	7,058
Variance of Number	248,649	125,580	173,440	0	0	315,764
	MALES					
Sample Size	41	8	13	0	0	62
Percent	30.4	5.9	9.6	0.0	0.0	45.9
Variance of Percent	15.8	4.2	6.5	0.0	0.0	18.5
Number	3,964	774	1,257	0	0	5,995
Variance of Number	268,881	70,883	110,650	0	0	315,764
	SEXES COMBINED					
Sample Size	77	23	35	0	0	135
Percent	57.0	17.0	25.9	0.0	0.0	100.0
Variance of Percent	18.3	10.5	14.3	0.0	0.0	
Number	7,445	2,224	3,384	0	0	13,053
Variance of Number	311,578	179,719	244,184	0	0	

-continued-

Table 8.-Page 2 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/30 - 7/31						
n[a]= 157						
Count= 15,550						
FEMALES						
Sample Size	28	5	42	0	5	80
Percent	17.8	3.2	26.8	0.0	3.2	51.0
Variance of Percent	9.4	2.0	12.6	0.0	2.0	16.0
Number	2,773	495	4,160	0	495	7,924
Variance of Number	227,135	47,791	303,727	0	47,791	387,363
MALES						
Sample Size	34	14	27	0	2	77
Percent	21.7	8.9	17.2	0.0	1.3	49.0
Variance of Percent	10.9	5.2	9.1	0.0	0.8	16.0
Number	3,368	1,387	2,674	0	198	7,626
Variance of Number	262,979	125,893	220,721	0	19,494	387,363
SEXES COMBINED						
Sample Size	62	19	69	0	7	157
Percent	39.5	12.1	43.9	0.0	4.5	100.0
Variance of Percent	15.3	6.8	15.8	0.0	2.7	
Number	6,141	1,882	6,834	0	693	15,550
Variance of Number	370,384	164,881	381,829	0	66,028	

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Table 8.-Page 3 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
Early Run Total						
n[a]= 292						
Count= 28,603						
			FEMALES			
Percent	21.9	6.8	22.0	0.0	1.7	52.4
Variance of Percent	5.8	2.1	5.8	0.0	0.6	8.6
Number	6,254	1,946	6,287	0	495	14,982
Variance of Number	475,784	173,372	477,168	0	47,791	703,127
			MALES			
Percent	25.6	7.6	13.7	0.0	0.7	47.6
Variance of Percent	6.5	2.4	4.1	0.0	0.2	8.6
Number	7,332	2,160	3,931	0	198	13,621
Variance of Number	531,860	196,776	331,371	0	19,494	703,127
			SEXES COMBINED			
Percent	47.5	14.4	35.7	0.0	2.4	100.0
Variance of Percent	8.3	4.2	7.7	0.0	0.8	
Number	13,586	4,106	10,218	0	693	28,603
Variance of Number	681,962	344,600	626,012	0	66,028	

[a] n = sample size.

Table 9.-Estimated age and sex composition of early-run sockeye salmon harvested in the recreational fishery at the Russian River, 1995

Dates		Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/11 - 7/11							
n[a]=	432						
Harvest[b]=	23,572						
Var(Harvest)=	5,156,609						
		FEMALES					
Sample Size		159	18	97	0	0	274
Percent		36.8	4.2	22.5	0.0	0.0	63.4
Variance of Percent		5.4	0.9	4.0	0.0	0.0	5.4
Number		8,676	982	5,293	0	0	14,951
Variance of Number		995,609	59,953	482,370	0	0	2,370,708
		MALES					
Sample Size		115	13	30	0	0	158
Percent		26.6	3.0	6.9	0.0	0.0	36.6
Variance of Percent		4.5	0.7	1.5	0.0	0.0	5.4
Number		6,275	709	1,637	0	0	8,621
Variance of Number		614,912	41,948	107,404	0	0	986,063
		SEXES COMBINED					
Sample Size		274	31	127	0	0	432
Percent		63.4	7.2	29.4	0.0	0.0	100.0
Variance of Percent		5.4	1.5	4.8	0.0	0.0	
Number		14,951	1,692	6,930	0	0	23,572
Variance of Number		2,370,708	111,629	710,756	0	0	5,156,609

[a] n = sample size.

[b] Total harvest from the confluence and river areas.

Table 10.-Estimated age and sex composition of the early run of sockeye salmon to the Russian River, 1995.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
6/11 - 7/31						
Early Run Total[a] n[b] = 724						
FEMALES						
Percent	28.6	5.6	22.2	0.0	0.9	57.4
Variance of Percent	3.61	0.84	2.86	0.00	0.18	5.93
Number	14,930	2,928	11,580	0	495	29,933
Variance of Number	1,471,393	233,324	959,538	0	47,791	3,073,835
MALES						
Percent	26.1	5.5	10.7	0.0	0.4	42.6
Variance of Percent	3.27	0.87	1.55	0.00	0.07	4.42
Number	13,607	2,869	5,568	0	198	22,242
Variance of Number	1,146,772	238,724	438,776	0	19,494	1,689,190
SEXES COMBINED						
Percent	54.7	11.1	32.9	0.0	1.3	100.0
Variance of Percent	5.86	1.61	3.76	0.00	0.24	5.58
Number	28,537	5,797	17,148	0	693	52,175
Variance of Number	3,052,670	456,229	1,336,768	0	66,028	5,156,609

[a] Harvest plus escapement.

[b] n = sample size.

Table 11.-Mean length (millimeters) at age, by sex, for the early run of sockeye salmon sampled from the Russian River, 1995.

		Age											
		2.3			2.2			1.3			1.2		
Component	Sex	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
						6/11 - 6/29							
Confluence	F	53	580	2.9	26	535	4.1	7	584	6.9			
	M	37	586	3.8	8	528	5.4	6	587	8.5			
River	F	47	587	3.2	31	531	3.2	7	605	5.5			
	M	43	592	3.9	12	530	5.6	3	607	32.6			
Escapement[a]	F	36	588	3.6	22	531	2.7	15	591	4.2			
	M	41	593	3.5	13	535	7.3	8	585	9.4			
						6/30 - 7/31							
Confluence	F	34	584	4.1	24	531	3.6	4	578	8.0			
	M	23	588	4.6	7	539	4.6	3	579	10.3			
River	F	25	589	5.0	16	537	3.4						
	M	12	584	4.3	3	537	6.8	1	540				
Escapement[a]	F	28	590	4.6	42	537	3.0	5	578	10.5	5	500	6.7
	M	34	594	3.3	27	541	3.6	14	584	6.2	2	526	12.0

[a] Fish sampled through the weir at the outlet of Lower Russian Lake.

Table 12.-Summary of returns from each brood year, early-run Russian River sockeye salmon, 1974-1995.

Year	Spawning Escapement	Return Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3	(1.1,1.4) Misc.	Measured Return To Date	Return Per Spawner
		(1978)	(1978)	(1979)	(1979)	(1980)			
1974	13,164	216	0	1,264	5,873	45,495	0	52,848	4.01
		(1979)	(1979)	(1980)	(1980)	(1981)			
1975	5,644	0	0	4,528	2,403	7,200	0	14,131	2.50
		(1980)	(1980)	(1981)	(1981)	(1982)			
1976	14,735	3,465	0	15,787	7,025	89,131	0	115,408	7.83
		(1981)	(1981)	(1982)	(1982)	(1983)			
1977	16,061	1,848	0	1,087	362	14,218	0	17,515	1.09
		(1982)	(1982)	(1983)	(1983)	(1984)			
1978	34,240	0	0	11,055	828	5,118	0	17,001	0.50
		(1983)	(1983)	(1984)	(1984)	(1985)			
1979	19,742	3,311	0	56,173	389	34,963	0	94,836	4.80
		(1984)	(1984)	(1985)	(1985)	(1986)			
1980	28,616	3,110	0	3,201	4,101	31,989	0	42,401	1.48
		(1985)	(1985)	(1986)	(1986)	(1987)			
1981	21,142	430	0	9,969	21,734	43,907	0	76,040	3.60
		(1986)	(1986)	(1987)	(1987)	(1988)			
1982	56,106	7,602	0	162,686	9,120	98,771	0	278,179	4.96
		(1987)	(1987)	(1988)	(1988)	(1989)			
1983	21,268	0	0	3,981	1,653	17,915	0	23,549	1.11

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Table 12.-Page 2 of 2.

Year	Spawning Escapement	Return Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3	(1.4,2.4) Misc.	Measured Return To Date	Return Per Spawner
		(1988)	(1988)	(1989)	(1989)	(1990)			
1984	28,899	842	0	4,148	4,324	33,543	0	42,857	1.48
		(1989)	(1989)	(1990)	(1990)	(1991)			
1985	30,601	236	0	196	22,515	20,692	137	43,776	1.43
		(1990)	(1990)	(1991)	(1991)	(1992)			
1986	36,336	540	0	43,166	3,335	43,596	0	90,637	2.49
		(1991)	(1991)	(1992)	(1992)	(1993)			
1987	61,513	30,347	0	266	23,145	55,457	0	109,215	1.78
		(1992)	(1992)	(1993)	(1993)	(1994)			
1988	50,406	0	622	511	21,305	65,172	238	87,848	1.74
		(1993)	(1993)	(1994)	(1994)	(1995)			
1989	15,338	465	0	20,420	7,633	28,537		57,055	3.72
		(1994)	(1994)	(1995)	(1995)	(1996)			
1990	25,144	570	0	5,797	17,148			23,515	0.94
		(1995)	(1995)	(1996)	(1996)	(1997)			
1991	32,389	693	0					693	0.02
		(1996)	(1996)	(1997)	(1997)	(1998)			
1992	37,117							0	0.00
		(1997)	(1997)	(1998)	(1998)	(1999)			
1993	39,857							0	0.00
		(1998)	(1998)	(1999)	(1999)	(2000)			
1994	44,872								
		(1999)	(1999)	(2000)	(2000)	(2001)			
1995	28,603								

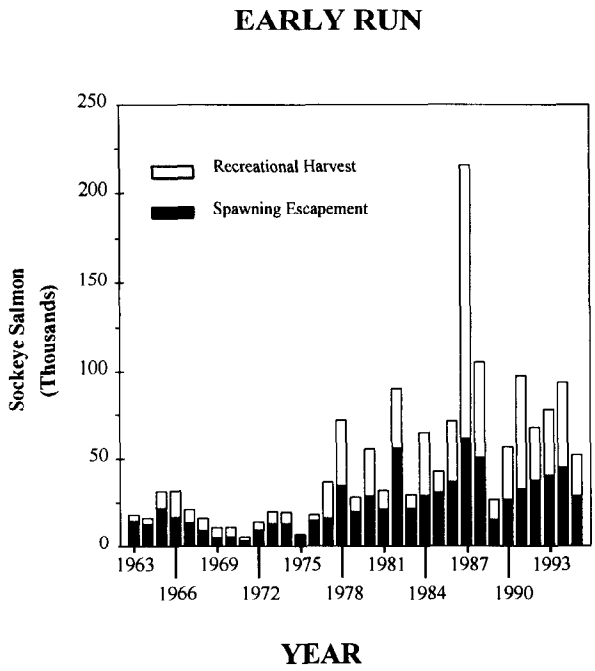

Figure 6.-Historical returns of early-run sockeye salmon to the Russian River.

migratory timing distribution function to count and harvest rate data has been used successfully in the Kenai River to project escapements of chinook salmon (McBride et al. 1989) and was adapted from techniques used to quantify migratory timing of chinook salmon in the Yukon River drainage (Mundy 1982). It is recommended that this technique should again be utilized in 1996 and subsequent years to further evaluate its value in managing the Russian River sockeye salmon resource.

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Steve Hammarstrom has provided a consistent and reasoned voice of experience regarding all aspects of the project, from personnel matters to migratory timing influences, which has served to increase my understanding of the project and the fishery resources of the Russian River.

Colleen O'Brien collected creel survey interviews and age, sex, and length data from the sport fishery. Colleen has been a long-term seasonal employee at the Russian River with six seasons of employment. Colleen's experience with the sport fishery and her observations of the fishery were a valued element towards the management of the sockeye salmon resources. In addition, Colleen's positive, "can do" enthusiasm while performing her responsibilities has proven to be an invaluable asset to the Russian River project.

Joe Richards collected creel survey interviews and age, sex, and length data from the sport fishery. While this was Joe's first season at the Russian River, he was instrumental in refining the necessary forms required for biological sampling. In addition, Joe's personal regard for job responsibilities was a much appreciated benefit to the conduct of the project.

Troy Tydingco operated the Russian River weir and field camp. Troy was responsible for collecting biological data and conducting inriver escapement counts and sampling surveys. Troy provided a new outlook and differing approaches towards constructing, refurbishing and making the field camp and weir facility a more efficient place to conduct the necessary research of studying the salmon resources of the Russian River drainage.

Dave Athons provided vital aircraft logistical support. Dave's prior work experience at the weir and knowledge of the sport fishery were also valuable towards the day-to-day operations of the study.

Jim Hasbrouck provided statistical review of the data analysis necessary to estimate the age compositions of the sport harvest and the escapement as well as much appreciated critical review.

Dave Nelson provided a long-term perspective towards achieving project objectives.

Sandy Sonnichsen wrote and streamlined the SAS statistical analysis code necessary to generate harvest and effort estimates for the direct expansion creel design used for the Russian River project.

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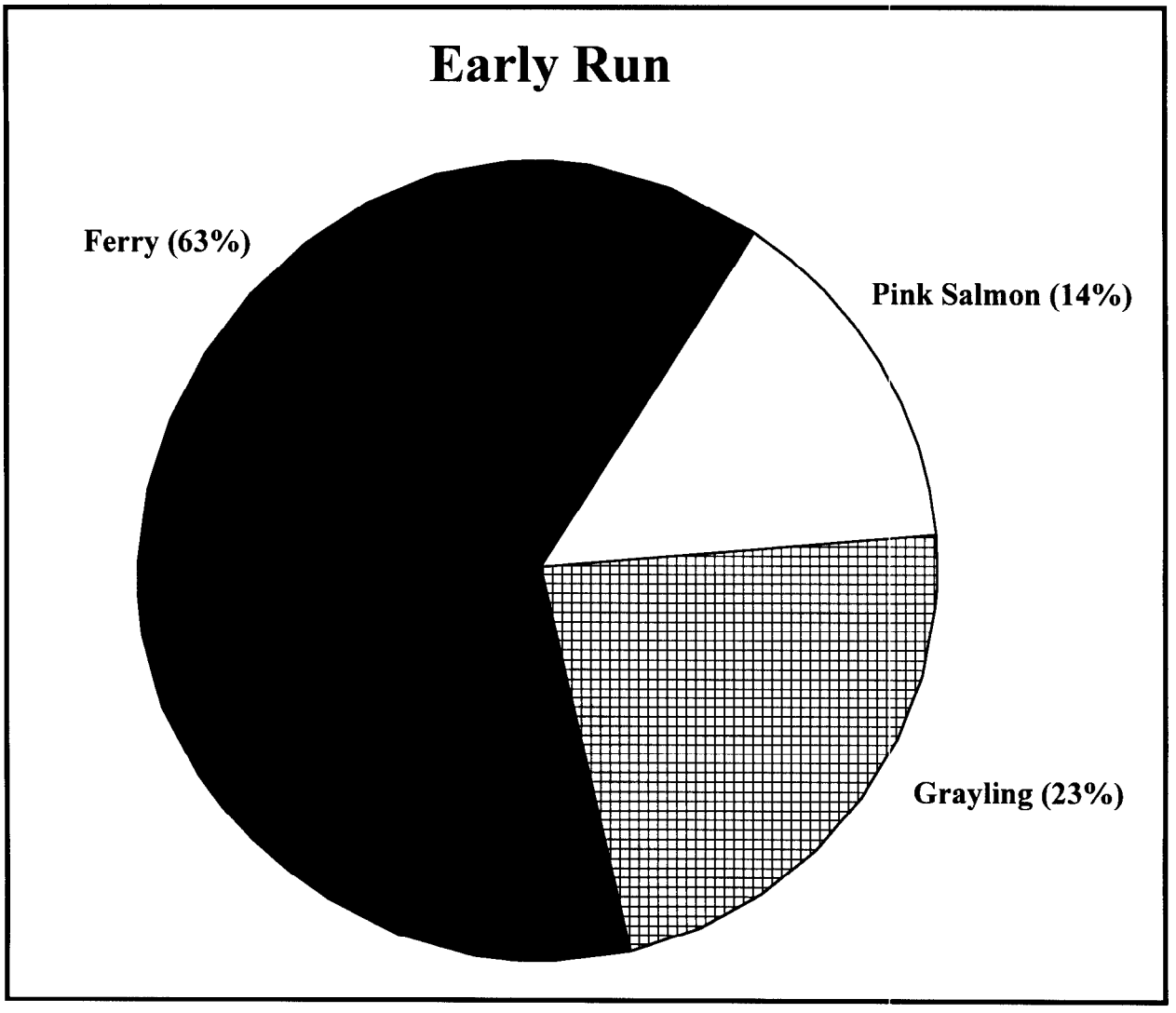
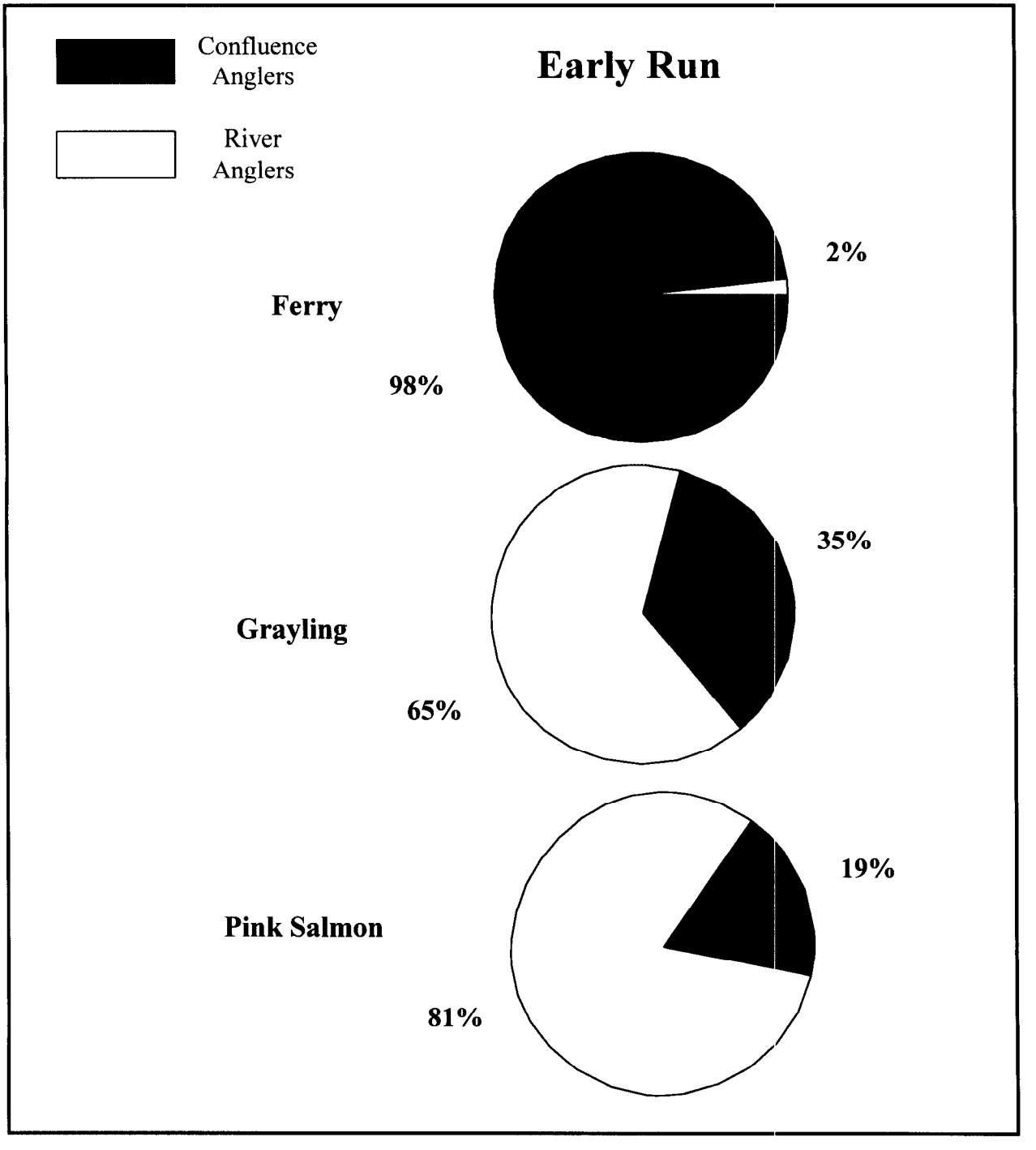
APPENDIX A. SELECTED SUMMARIES OF FISHERY AND ESCAPEMENT DATA FROM THE RUSSIAN RIVER, 1995



Appendix A1.-Relative proportions of interviews collected at the sampled access locations to the Russian River sockeye salmon recreational fishery, early run, 1995.



Appendix A2.-Relative proportions of confluence and river anglers interviewed during the Russian River creel survey by access location, early run, 1995.

Appendix A3.-Temporal harvest and effort estimates for the 1995 early-run Russian River sockeye salmon recreational fishery by area and access location.

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Days	%	Periods	%	Anglers	%
						River Effort							
Ferry	6/11-7/11	31	17	28	1,575	880	100,131	40,198	40	59,803	60	130	0
Grayling	6/11-7/11	26	10	771	286,841	20,037	14,425,275	11,932,600	83	2,487,404	17	5,271	0
Pink Salmon	6/11-7/11	26	7	692	113,951	17,982	9,443,886	8,041,674	85	1,399,943	15	2,270	0
Total River Effort						38,899	23,969,292						
						Confluence Effort							
Ferry	6/11-7/11	31	17	2,233	820,077	69,215	49,347,576	20,936,073	42	28,394,301	58	1,720	0
Grayling	6/11-7/11	26	10	399	133,962	10,380	5,739,553	5,572,812	97	164,638	3	2,103	0
Pink Salmon	6/11-7/11	26	7	215	28,303	5,582	2,086,973	1,997,361	96	88,905	4	707	0
Total Confluence Effort						85,177	57,174,102						
Total Effort						124,076	81,143,394						
						River Harvest							
Ferry	6/11-7/11	31	17	6	201	183	10,855	5,130	47	5,655	52	70	1
Grayling	6/11-7/11	26	10	143	25,935	3,715	1,197,148	1,078,909	90	116,980	10	1,259	0
Pink Salmon	6/11-7/11	26	7	88	8,770	2,283	661,574	618,916	94	42,210	6	449	0
Total River Harvest						6,181	1,869,577						
						Confluence Harvest							
Ferry	6/11-7/11	31	17	441	79,366	13,677	2,760,274	2,026,155	73	730,874	26	3,245	0
Grayling	6/11-7/11	26	10	104	10,762	2,704	462,371	447,681	97	14,029	3	661	0
Pink Salmon	6/11-7/11	26	7	39	764	1,010	64,387	53,934	84	10,164	16	289	0
Total Confluence Harvest						17,391	3,287,032						
Total Harvest						23,572	5,156,609						

[a] D = total number of days during the run.

[b] d = number of days sampled

Appendix A4.-Daily escapement of early- and late-run sockeye salmon and chinook salmon through the Russian River weir, 13 June to 31 July 1995.

Date	Early-Run Sockeye[a]	Late-Run Sockeye	Chinook[b]
6/13	4		
6/14	17		
6/15	15		
6/16	18		
6/17	2		
6/18	11		
6/19	1,436		
6/20	616		
6/21	619		
6/22	2,106		
6/23	1,550		
6/24	982		
6/25	64		
6/26	867		
6/27	2,528		
6/28	1,307		
6/29	911		
6/30	508		
7/1	1,431		
7/2	1,281		
7/3	632		
7/4	1,539		
7/5	1,230		
7/6	1,052		
7/7	2,819		
7/8	1,218		
7/9	36		
7/10	1,062		

-continued-

Appendix A4.-Page 2 of 2.

Date	Early-Run Sockeye[a]	Late-Run Sockeye	Chinook[b]
7/11	965		
7/12	454		
7/13	307		
7/14	296		
7/15	72		
7/16	74		
7/17	83		
7/18	42		
7/19	0		
7/20	20		
7/21	25		
7/22	39		
7/23	2		
7/24	35	44	
7/25	74	161	
7/26	176	3,302	
7/27	52	963	
7/28	4	101	
7/29	6	1,636	
7/30	3	39	
7/31	13	155	
Total	28,603	6,401	

[a] From 7/24 through 7/31, early-run fish were differentiated from late-run fish based on degree of external maturation, i.e., body coloration and kype development. There was an 8-day overlap between early-run and late-run fish. The total late-run sockeye salmon escapement is tabulated in the Fishery Data Series report for the 1995 late-run to the Russian River (Marsh *In Prep*).

[b] Total estimated chinook escapement is tabulated in the Fishery Data Series report for the 1995 late-run to the Russian River (Marsh *In Prep*).