Fishery Data Series No. 95-10

Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Late Run to the Russian River with Estimates of Escapement, 1994

by

Larry E. Marsh

July 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
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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ABSTRACT

A direct expansion creel survey of the late-run Russian River recreational fishery was conducted in 1994 to determine angler effort for and harvest of sockeye salmon Oncorhynchus nerka. Anglers expended 91,192 angler-hours to harvest 26,375 sockeye salmon from the late run (20 July-20 August). The harvest rate for the late run was 0.289 sockeye salmon per hour of angler effort. Approximately 74% of the total fish harvested during the late run were taken from the confluence area of the fishery.

A total of 122,277 sockeye salmon bound for spawning areas were counted through the weir at the outlet of Lower Russian Lake during the late run. This total exceeds the escapement goal of 30,000 that has been established for the late run.

Predominant age groups of the harvest and the escapement for the late run were 2.2 and 2.3 aged fish. The majority of the fish harvested from the confluence area were age 2.2 (89.4%) and 2.3 (7.3%). The majority of fish harvested in the river area of the sport fishery were also age 2.2 (80.1%) and 2.3 (10.2%). The sockeye salmon that escaped through the weir at the outlet of Lower Russian Lake were mainly age 2.2 (81.7%) and 2.3 (11.6%). The age composition of the confluence area harvest, the river area harvest, and the weir escapement differed among locations during the late run in 1994. In addition, the age composition changed significantly over time at each location. Estimates of the age composition of the total late return (harvest plus escapement) indicated that the late run was predominantly comprised of age-2.2 and age-2.3 sockeye salmon (82.7% and 11.0%, respectively).

A stream survey indicated that a minimum of 15,211 sockeye salmon spawned in the Russian River downstream from the Russian River falls. Carcass sampling indicated that the most abundant age group (1.3) comprised 95.7% of the population that spawned downstream from the falls.

Key words: Russian River, sockeye salmon, Oncorhynchus nerka, creel survey, direct expansion, harvest, effort, weir, escapement, age composition, recreational fishery, mean length at age, 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 clear-water lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes (Figure 1). The second largest recreational fishery for sockeye salmon *Oncorhynchus nerka* in Alaska occurs in the Russian River and at its confluence with the Kenai River. Annual effort by anglers in this fishery has exceeded 450,000 angler-hours and annual harvests have exceeded 190,000 fish. Prior information on this fishery was 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), and Carlon et al. (1991).

Sockeye salmon return to the Russian River in two temporal components, termed early and late runs. Historically, the total return of the late run has numbered nearly twice that of the total return of the early run. The late run typically arrives at the confluence of the Russian and Kenai rivers in mid to late July. Late-run fish typically move immediately into the Russian River and are present in the area open to fishing through August. Late-run fish are comprised of two segments based upon spawning location: (1) those spawning upstream of the Russian River falls, and (2) those spawning downstream from the falls. While most fish migrating through the falls spawn in Upper Russian Lake, others spawn in the tributaries to Upper Russian Lake and in the river section between the two lakes. These fish are primarily 2-ocean fish and rear in the two lakes.[1] The other segment spawns

[1] Juvenile sockeye salmon have been captured in nets in both lakes.

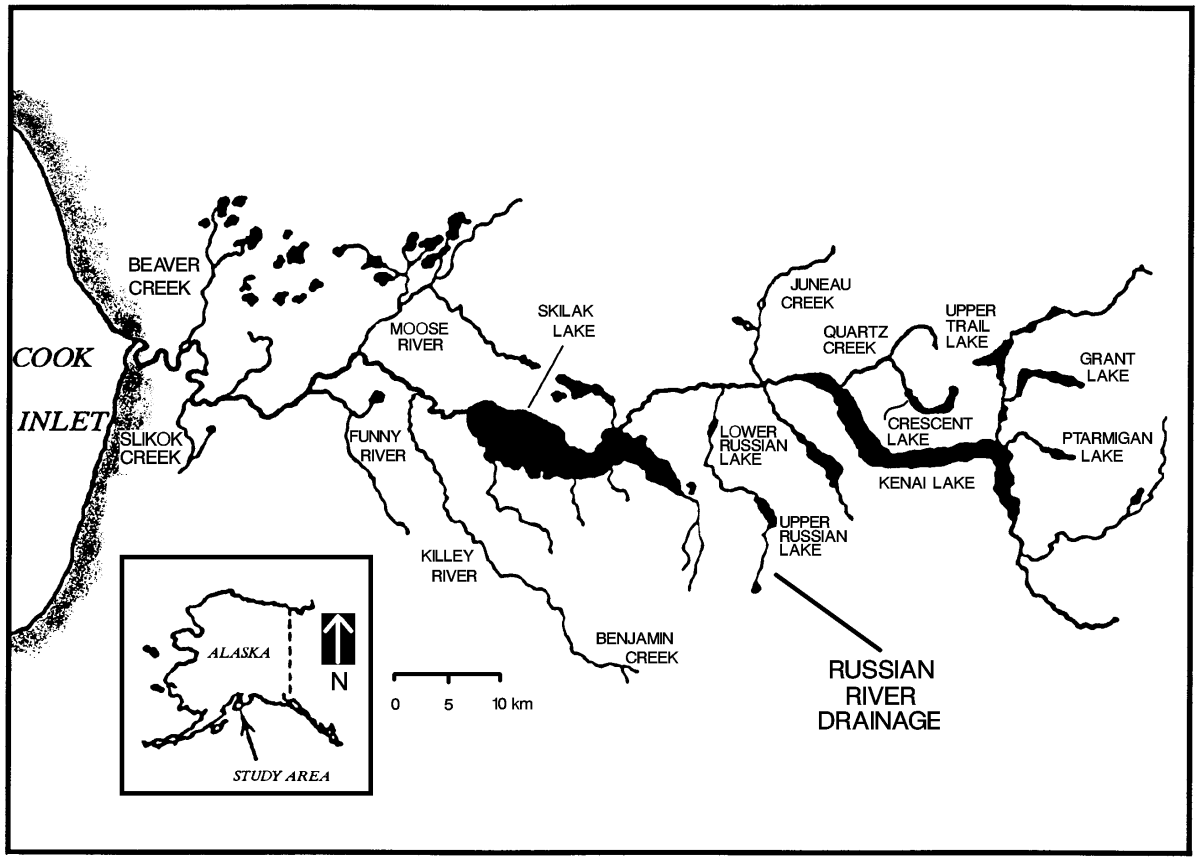

Figure 1.-Map of the Kenai and Russian River Drainages.

in the Russian River downstream from the falls. These fish, primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986). These fish are believed to spend their fresh-water residency in Skilak Lake.

In addition to the sport harvest at the confluence of the Kenai and Russian rivers and in the Russian River, late-run sockeye salmon of Russian River origin are also harvested by a sport fishery in the mainstem Kenai River, a personal-use dip net fishery near the mouth of the Kenai River, and a commercial fishery in upper Cook Inlet. Estimates of the total harvest of sockeye salmon by sport fisheries in the mainstem of the Kenai River have been reported annually since 1977 (Mills 1979-1994). The personal use dip net harvest has been estimated in the Statewide Harvest Survey since 1983 (Mills 1984-1994). The commercial catch and total return of sockeye salmon to the Kenai River have been reported by Cross et al. (1983, 1985, 1986).

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 during the late run migrate through a weir at the outlet of Lower Russian Lake (Figure 2). The escapement goal of the late run, established in 1979 is 30,000 fish. This goal is based upon evaluation of returns from past brood years.

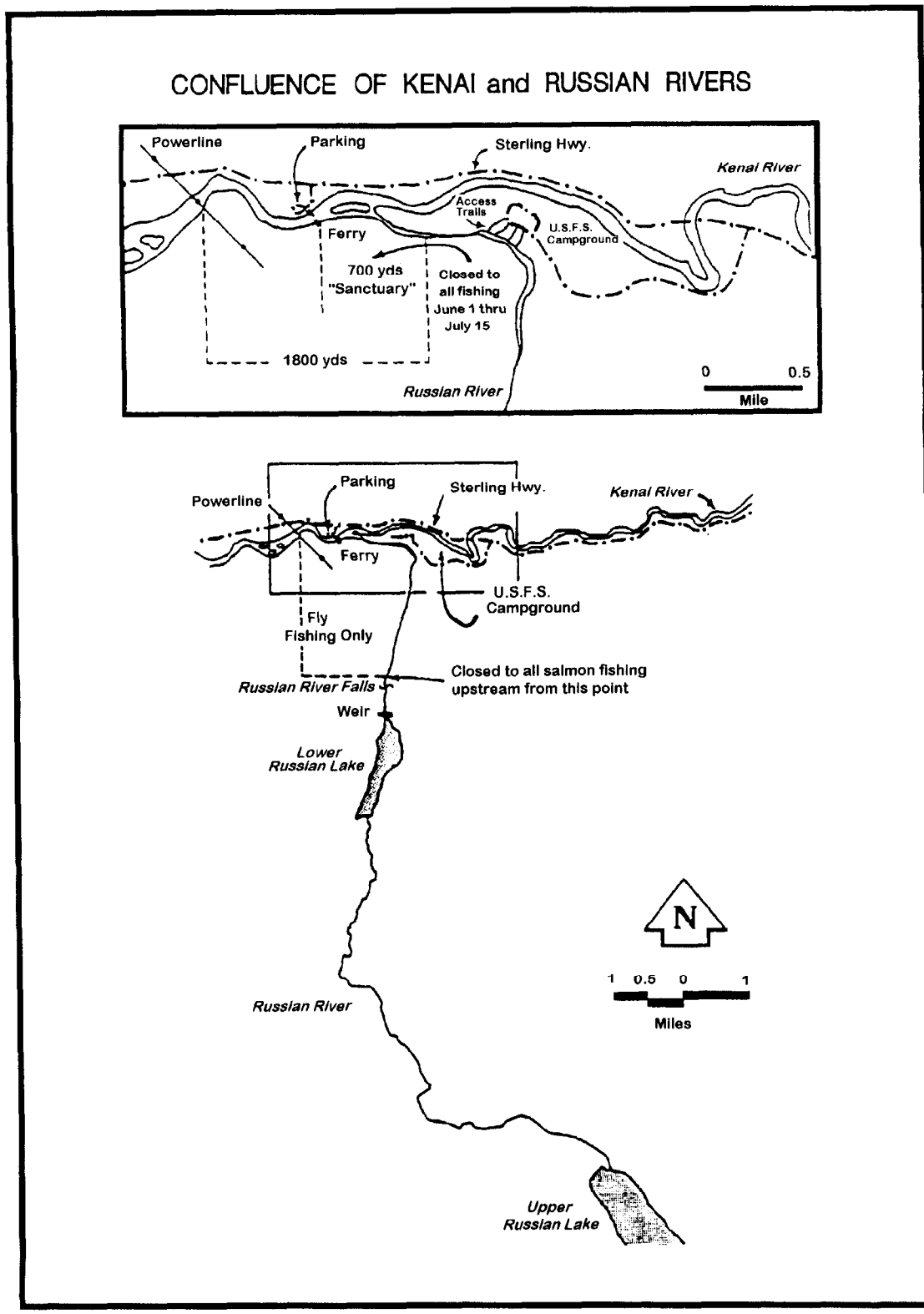

Figure 2.-Detailed map of the Kenai and Russian River study area.

With the exception of 1977 when the escapement was 21,410 (Nelson 1978), the escapement goal has been achieved each year since 1975. Because the recreational fishery for sockeye salmon at the Russian River is one of the largest in the state, there is a potential for over harvest. Precise and timely management decisions are required to ensure that an adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a counting weir. The creel survey provides estimates of angler effort and harvest of the recreational sockeye salmon fishery. This recreational fishery occurs in the Kenai and Russian River "fly-fishing-only" area (Figure 2). Weir operations census the daily escapement. Estimates of the total inriver return (harvest plus escapement) and the age, sex, and size compositions of the return provide information to evaluate overall production and to estimate optimum spawning escapement levels.

From 11 June through 20 August 1994, 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.

The objectives of this report are to present for 1994: (1) estimates of effort and harvest of late-run sockeye salmon for the recreational fishery, (2) estimates of the escapement of the late run of sockeye salmon, and (3) estimates of the age, sex, and length distributions of the harvest and escapement of the late run of 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[2] 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.

Access to the two fishing areas is provided primarily at two locations. A 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.

The 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. Access to the confluence area is primarily through a parking 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

[2] The sanctuary area begins in the Russian River 137 m upstream of the confluence with the Kenai River and extends downstream to a marker placed approximately 25 m (75 ft) immediately down river of the ferry cable crossing (approximately 640 m).

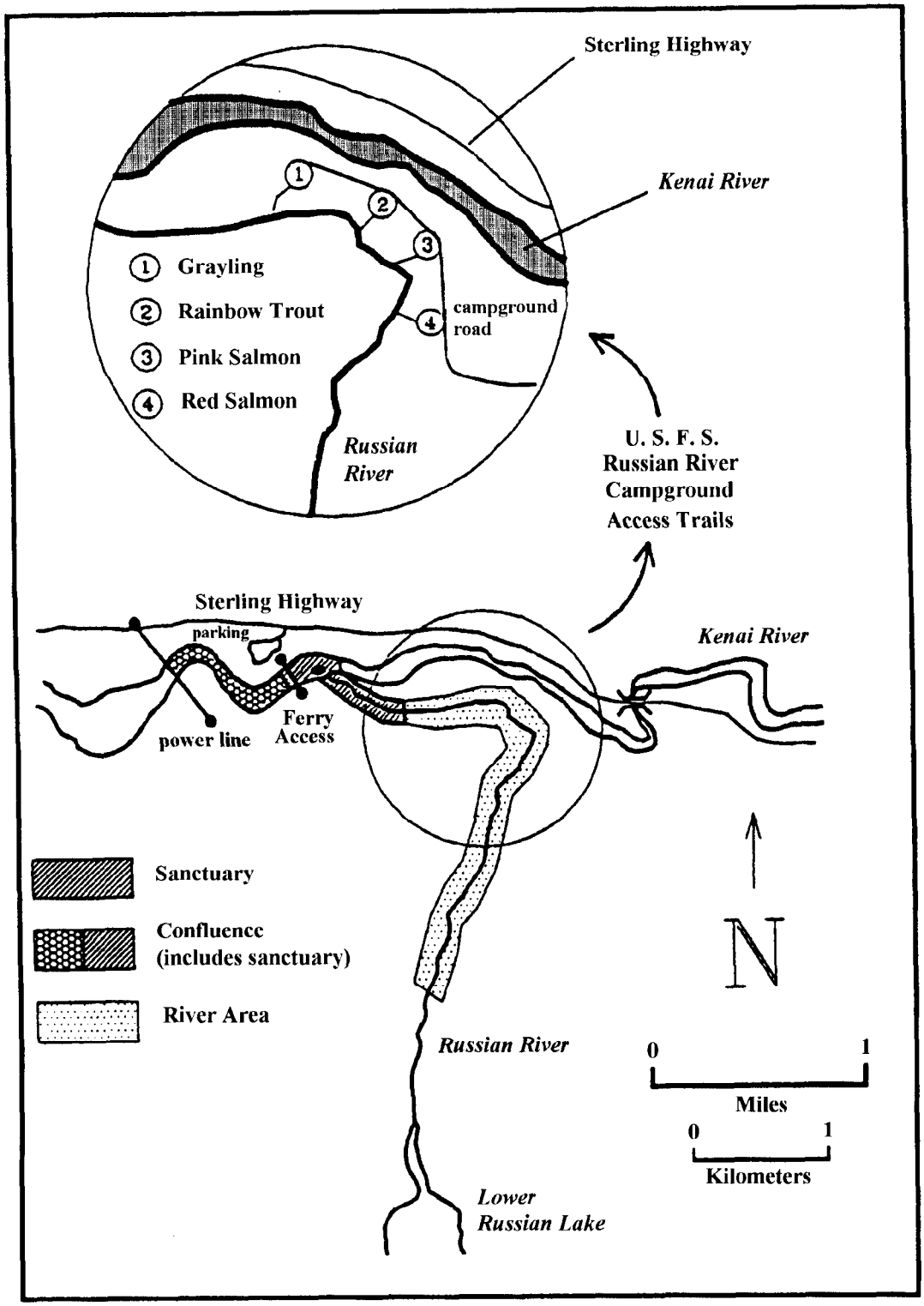

Figure 3.-Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1994 creel survey.

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. Anglers may also 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 yds) upstream from the Russian River Falls. The weir has been described in detail (Nelson 1976) and provides a complete count of the late-run spawning escapement.

STUDY DESIGN

Creel Survey

Inseason management of the sport fishery during the past five seasons has utilized the daily harvest rates in conjuction with the current esimated total harvest to track abundance and the harvest potential of the recreational fishery. These estimates, when used in concert with the migratory timing statistics from the historical weir counts have allowed fishery managers to project the final escapement by accounting for the potential harvest, while charting the potential escapement based upon past returns (Vincent-Lang and Carlon 1991).

A direct expansion creel survey was utilized during the 1994 late run. Previous concerns with biased harvest and effort estimates (Carlon and Vincent-Lang 1990) obtained with a stratified roving creel design (Neuhold and Lu 1957) necessitated a change in creel design beginning with the 1990 season.

Sampling was stratified by access location to estimate harvest and effort. Area-specific (river or confluence area) harvest and effort were estimated by recording the area fished for each interviewed angler. Three of the five main access locations for the Russian River sockeye salmon fishery, the Ferry, Grayling and Pink Salmon were sampled. The fishery was surveyed from 20 July to 20 August. Because the age distribution of sockeye salmon changed over time, the data were post-stratified into three temporal components (Table 1).

The creel survey sampling day was 18 hours in length and was divided into six, 3-hour periods from 0600 to 2400 hours. 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 randomly selected from the six possible periods. During each sampled period, anglers

Table 1.-Temporal components of the recreational harvest and escapement sampled for age composition during the 1994 late-run Russian River sockeye salmon return.

Return Component	Temporal Strata
Confluence-area harvest	7/20 - 7/27 7/28 - 8/09 8/10 - 8/20
River-area harvest	7/20 - 7/27 7/28 - 8/09 8/10 - 8/20
Escapement through weir	7/20 - 7/27 7/28 - 8/09 8/10 - 8/20 8/21 - 9/15
Escapement spawing between the confluence and the falls	8/24, 9/09

were interviewed as they exited the fishery through a sampled location. Thus, all interviews were of completed-trip anglers. 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). Anglers exiting a location during a sampled period and not interviewed were prorated as river or confluence anglers based on proportions determined from anglers that were 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.

During 1990, 1991 and 1992, approximately three-fourths of the harvest and effort occurred in the confluence area during the late run (Carlon et al. 1991; Marsh 1992, 1993). This is typical of the effort distribution in most years (Nelson et al. 1986). As a result of this concentration of harvest and effort and because harvest rate (harvest per hour) is considered a management tool to index sockeye salmon abundance at the confluence, the confluence access location (the ferry) was sampled every other day throughout the late run. This ensured that timely information regarding confluence harvest rates was available when formulating inseason management strategies.

In 1990 and 1991, there were significant differences in use among the five access locations (Carlon et al. 1991, Marsh 1992). Creel data indicated that angler use was consistently dominated by the three major sites (the Ferry, Grayling and Pink Salmon). These access sites represented more than 90% of the total harvest and effort and also contributed approximately 90% of the total variance for both the harvest and effort estimates.

In an effort to reduce the overall variability of the estimates, a shift in the systematic sampling design was implemented in 1992. Estimates of effort, harvest, and their variances for the late run based upon data collected in 1990, 1991, 1992 and 1993 were used to optimally allocate the available sampling days among the three major river access sites (Cochran 1977). This approach was continued during 1994 with the three major sites sampled and the available sampling time optimally allocated between them based upon total effort, harvest and the variance surrounding those estimates. During the late run, the ferry was sampled approximately every 2 days, Grayling every 4-5 days and Pink Salmon every 5-6 days.

The following formulae were applied to estimate angler effort and harvest for a stratified, three-stage (day/period/trip) direct expansion creel survey (Bernard et al. *In prep*). Total effort, harvest, and their variances were estimated for the entire run by summing the stratum (access location) estimates. In addition, the estimates were post-stratified by area fished (river or confluence) and by temporal stratum within the run.

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 prorated 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 prorated as fishing the river ($\hat{a}_{rkij}$) were estimated as:

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

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:

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

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

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

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

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

where:

h_{rkijl} = the river area harvest of angler l 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:

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

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

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

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

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

where:

u = the number of sample periods on day i (u = 2),

and the variance among sample periods was estimated as:

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

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:

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

where:

U = the total number of periods on a day (U = 6).

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

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

where:

d = the number of days sampled.

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

$$\mathrm{Var}\left(\overline{H}_{rk}\right) = \frac{\sum_{i=2}^{d}\left(\hat{H}_i - \hat{H}_{i-1}\right)^2}{2(d-1)} \quad . \tag{13}$$

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

$$\hat{H}_{rk} = D\overline{H}_{rk} \quad , \tag{14}$$

where:

D = the total number of days during the run.

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

$$\mathrm{Var}\left(\hat{H}_{rk}\right) = (1-f_1)D^2\frac{\mathrm{Var}\left(\overline{H}_{rk}\right)}{d} + D\frac{U^2}{u}(1-f_2)\frac{\sum_{i=1}^{d}\mathrm{Var}\left(\overline{H}_{rki}\right)}{d} + D_{rk}U\sum_{i=1}^{d}\sum_{j=1}^{u}M_{rkij}^2(1-f_3)\frac{\mathrm{Var}\left(\overline{h}_{rkij}\right)}{dum_{rkij}}, \tag{15}$$

where:

D_{rk} = the total number of sampling days at location k during the run,

f_1 = the finite population correction factor for days (d_{rk}/D_{rk}),

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

f_3 = the finite population correction factor for anglers (m_{rkij}/M_{rkij}).

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 in-season 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:

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

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:

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

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

The overall harvest rate for the late run was historically estimated to provide a general basis for comparing seasonal fishing success among years (Nelson 1985, Hammarstrom and Athons 1989). A harvest rate for the late run was estimated by dividing the total harvest estimate by the total 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 and coho salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake to tally that segment of the return which migrates above the lower lake to spawn. Estimates of the segment of the sockeye salmon return, (as well as other salmonid species), that spawn in the river area below the weir were accomplished by foot-surveys to enumerate spawners in that area. 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 of sockeye salmon (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, sockeye salmon adults have not yet developed the reddish body coloration and large green head with hooked jaws that is characteristic of more sexually mature fish passing 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 heads while the late-run fish have not yet developed these body characteristics. The period of overlap began on 15 July when late-run fish were intermixed with mature, early-run fish and continued through 1 August, after which early-run fish were no longer present.

Biological Data

Ten time-and-area strata were sampled for biological data to estimate the age, sex, and length composition of the late run (Table 1). Differences in age composition over time among spatial strata have been demonstrated in the past (Carlon and Vincent-Lang 1990, Carlon et al. 1991, Marsh 1992 - 1994).

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 from brood is therefore the sum of the two numbers plus one.

In prior years, the late-run river-area harvest was not sampled for age composition. The age composition from the confluence-area harvest was used to allocate the river area harvest (Nelson et al. 1986, Carlon and Vincent-Lang 1990). This procedure assumes that the age composition of the confluence harvest represents that of the river area; however, significant differences in age composition were found among the three sampled areas (Carlon et al. 1991, Marsh 1992, 1993). Based upon these previous results, each area was sampled individually during 1994. Chi-square tests were used to test the null hypotheses of equal age compositions among locations and time strata. These tests were rejected if calculated tail-area probabilities (P values) were less than 0.05.

Age and sex composition of the run was estimated for each stratum. The proportion of fish of age group g in stratum f 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 g.

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):

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

The age composition by sex of the harvest within each stratum 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.

The variance of the age composition was estimated as the product of two independent random variables (Goodman 1960):

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

where:

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

Age composition of the total harvest from the confluence and total harvest from the river was estimated by sex by summing the age composition estimates among the temporal strata. The total number of fish of age g in the harvest from the river was estimated as:

$$\hat{H}_{rg} = \sum_{f=1}^{t} \hat{H}_{rgf} \quad , \tag{22}$$

where:

t = the number of strata in the run.

The variance of the estimate was calculated by summing the variances of the individual temporal stratum estimates as:

$$\mathrm{Var}\left(\hat{H}_{rg}\right) = \sum_{f=1}^{t} \mathrm{Var}\left(\hat{H}_{rgf}\right). \tag{23}$$

The proportion of sockeye salmon of age g in the total sport harvest from the river was estimated as:

$$\hat{p}_{rg} = \frac{\hat{H}_{rg}}{\hat{H}_r}, \tag{24}$$

where:

$\hat{H}_r$ = the estimated total harvest of sockeye salmon from the river.

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

$$\mathrm{Var}\left(\hat{P}_{rg}\right) \approx$$

$$\frac{1}{\hat{H}_r^2}\left\{\frac{\mathrm{Var}\left(\hat{H}_{r1}\right)\left[\hat{p}_{rg1}\left(\hat{H}_{r2}+\hat{H}_{r3}\right)-\left(\hat{H}_{rg2}+\hat{H}_{rg3}\right)\right]^2}{\hat{H}_r^2}\right.$$

$$+\frac{\mathrm{Var}\left(\hat{H}_{r2}\right)\left[\hat{p}_{rg2}\left(\hat{H}_{r1}+\hat{H}_{r3}\right)-\left(\hat{H}_{rg1}+\hat{H}_{rg3}\right)\right]^2}{\hat{H}_r^2}$$

$$+\frac{\mathrm{Var}\left(\hat{H}_{r3}\right)\left[\hat{p}_{rg3}\left(\hat{H}_{r1}+\hat{H}_{r2}\right)-\left(\hat{H}_{rg1}+\hat{H}_{rg2}\right)\right]^2}{\hat{H}_r^2}$$

$$+\ \mathrm{Var}\left(\hat{p}_{rg1}\right)\hat{H}_{r1}^2+\mathrm{Var}\left(\hat{p}_{rg2}\right)\hat{H}_{r2}^2$$

$$\left.+\ \mathrm{Var}\left(\hat{p}_{rg3}\right)\hat{H}_{r3}^2\right\}, \qquad (25)$$

where:

$\hat{H}_{rf}$ and $\mathrm{Var}\left(\hat{H}_{rf}\right)$ = the estimates of harvest and variance of harvest from the river during temporal stratum f,

$\hat{p}_{rgf}$ and $\mathrm{Var}\left(\hat{p}_{rgf}\right)$ = the estimates of proportion and variance of proportion of fish of age g sampled from the harvest from the river during temporal stratum f, and

$\hat{H}_{rgf}$ = the estimated harvest of fish of age g from the river during temporal stratum f.

This proportion and its variance were estimated similarly for the harvest of sockeye salmon from the confluence.

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:

$$\hat{E}_{gf} = E_f \hat{p}_{gf}, \qquad (26)$$

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:

$$\mathrm{Var}\left(\hat{E}_{gf}\right) = E_f^2 \mathrm{Var}\left(\hat{p}_{gf}\right) . \qquad (27)$$

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

$$\hat{E}_g = \sum_{f=1}^{t} \hat{E}_{gf} . \qquad (28)$$

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

$$\mathrm{Var}\left(\hat{E}_g\right) = \sum_{f=1}^{t} \hat{E}_{gf} . \qquad (29)$$

The proportion of sockeye salmon of age g in the total escapement migrating through the weir was estimated as:

$$\hat{p}_{eg} = \frac{\hat{E}_g}{E_T}, \qquad (30)$$

where:

E_T = the total escapement enumerated at the weir.

The variance of this proportion was estimated by:

$$\mathrm{Var}\left(\hat{p}_{eg}\right) = \frac{\mathrm{Var}\left(\hat{E}_g\right)}{E_T^2}. \qquad (31)$$

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:

$$\hat{p}_g = \frac{\hat{N}_g}{\hat{N}_T}, \quad (32)$$

where:

E_T = the total escapement enumerated at the weir.

$\hat{N}_g$ = 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:

$$\mathrm{Var}\left(\hat{P}_g\right) \approx$$

$$\frac{1}{\hat{N}_T^2}\left\{\frac{\mathrm{Var}\left(\hat{H}_c\right)\left[\hat{p}_{cg}\left(\hat{H}_r + E\right) - \left(\hat{H}_{rg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2}\right.$$

$$+\frac{\mathrm{Var}\left(\hat{H}_r\right)\left[\hat{p}_{rg}\left(\hat{H}_c + E\right) - \left(\hat{H}_{cg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2}$$

$$+ \mathrm{Var}\left(\hat{p}_{cg}\right)\hat{H}_c^2 + \mathrm{Var}\left(\hat{p}_{rg}\right)\hat{H}_r^2$$

$$\left. + \mathrm{Var}\left(\hat{p}_{eg}\right)E^2\right\}, \quad (33)$$

where:

$\hat{H}_\bullet$ and $\mathrm{Var}\left(\hat{H}_\bullet\right)$ = the estimates of total harvest and variance of total harvest from the river (= r) or the confluence (= c), and

$\hat{p}_{\bullet g}$ and $\mathrm{Var}\left(\hat{p}_{\bullet g}\right)$ = the estimates of proportion and variance of proportion of fish of age g from the total harvest from the river (= r) or the confluence, or from the escapement (= e).

Mean length at age was estimated by sex for each spatial/temporal stratum of the return: the confluence area harvest, the river harvest, and the weir escapement. To determine if individual spatial/temporal samples could be pooled to estimate overall mean length at age by sex, an analysis of variance (ANOVA) and Tukey's studentized multiple range test were utilized. The null hypothesis of no difference in mean length at age was rejected if the calculated tail-area probabilities (P values) were less than 0.05.

RESULTS

CREEL STATISTICS

Survey Interviews

Sampling at access locations began on 20 July. Sampling at Grayling and Pink Salmon access locations continued until 17 August, just three days before the normal regulatory closure date. The third access location (Ferry) discontinued operation on 14 August when ticket sales dropped below an acceptable level for the concessionaire who ran the ferry.

The temporal date marking the beginning of the late run was determined by the appearance of fresh, ocean-bright sockeye salmon in the confluence area of the fishery. Prior to the arrival of these late-run fish, the sport fishery can be characterized by poor catch-rates with reddish colored, maturing fish dominating the small harvest. The few remaining early-run fish all exhibit signs of prespawning sexual maturity.

A total of 1,991 anglers were counted as they exited sampled access locations during the 1994 late-run survey (Table 2). Of these, 1,118 (56%) were interviewed and 873 (44%) were not interviewed. Most of the interviews (57%) were obtained from the ferry access location as this location was sampled most intensely and typically accounts for the most effort (Appendix Figure A1).

Anglers exiting via the ferry location fished the confluence area exclusively (100%) during the late run (Appendix A2). Campground access locations were used to fish both areas. However, the majority of anglers exiting the Grayling access site fished the confluence area (58.0%), while the majority of anglers who exited at Pink Salmon fished the river area (75.4%).

Harvest and Effort:

Anglers exiting the fishery at the ferry accounted for most of the harvest (50%) and the corresponding effort (53%) during the late run (Table 3). The relative precision of the late-run harvest and effort estimates were 25% and 19%, respectively (Table 3). Estimates of harvest, effort, and variances are presented by stratum (temporal/access location) in Appendix A3.

The 1994 late-run harvest estimate was 26,375 (SE = 3,383) sockeye salmon

Table 2.-Summary of the number of interviews collected during sampled periods for the late-run Russian River creel survey, 1994.

	Area Fished			Total	Anglers Exiting and not	Total Anglers
Exit Location	Confluence	River	Both	Interviews	Interviewed	Exiting
Ferry	638	0	0	638	665	1,303
Grayling	192	136	22	350	190	540
Pink Salmon	27	94	9	130	18	148
Total	857	230	31	1,118	873	1,991

Table 3.-Estimates of harvest, effort, and associated variances by access location for the late-run Russian River sockeye salmon recreational fishery, 1994.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative[a] Precision	Effort	(%)	Variance of Effort	(%)	Relative[a] Precision
Ferry	13,066	50%	1,603,010	14%	19%	48,683	53%	39,320,761	51%	25%
Grayling	10,226	39%	9,198,281	80%	58%	30,863	34%	35,438,748	46%	38%
Pink Salmon	3,083	12%	640,310	6%	51%	11,646	13%	1,868,614	2%	23%
Total	26,375	100%	11,441,601	100%	25%	91,192	100%	76,628,123	100%	19%

[a] alpha = 0.05

(Figure 4). The effort estimate for the late run was 91,192 (SE = 8,754) angler-hours. During the late run, 74% of the harvest was taken from the confluence area and the remaining 26% was taken from the river area (Table 4). Correspondingly, the effort during the late-run sport fishery was directed primarily at the confluence area (79%) and less so at the river area (21%).

The estimated HPUE for the late run was 0.289 (Table 5), which was a 3.2% increase in angler harvest efficiency from 1993 (Marsh 1994).

SPAWNING ESCAPEMENT

A total of 122,277 late-run sockeye salmon passed through the weir (Table 6, Appendix A4). The greatest daily counts at the weir occurred near the middle of August (Figure 5). Transition between the two runs occurred from 15 July to 01 August. Weir enumeration ceased on 21 October. However, the last sockeye salmon migrated through the weir on 09 October.

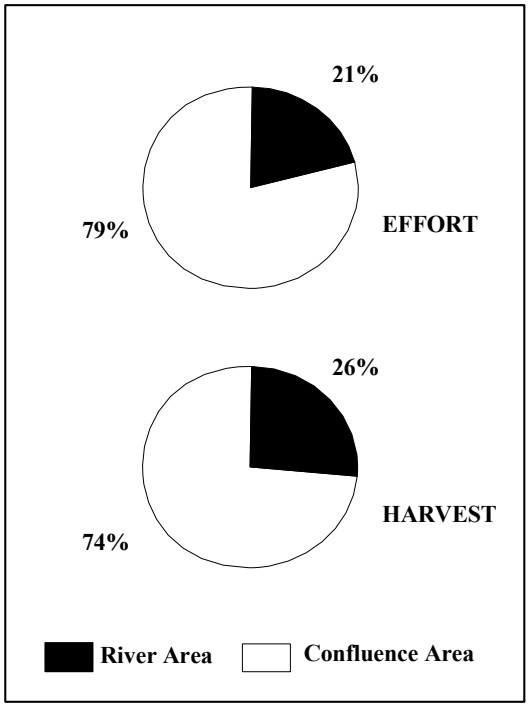

Figure 4.-Harvest and angler effort by area for the Russian River late-run sockeye salmon recreational fishery

An estimated 15,211 sockeye salmon were counted during foot surveys of the Russian River downstream from the Russian River Falls (Table 6).

The number of coho salmon enumerated through the weir during the late run was 2,974 (Table 6 and Appendix A4). This was only the second time since 1960 that a complete tally of migrating coho salmon has been attempted. The final coho salmon migrating through the weir was recorded on 16 October (Appendix A4).

BIOLOGICAL DATA

There was a significant difference in the age composition of sockeye salmon sampled at the weir relative to those harvested at the river and the confluence (Table 7). There was also a significant difference in the age composition of sockeye salmon at the weir among all the temporal strata (Table 8). The late-run escapement through the weir was comprised of five age groups: age-2.2 (81.7%), age-2.3 (11.6%), age-2.1 (3.7%), age-1.3 (2.1%), and age-1.2 (0.9%) (Table 9). Age-2.2 and -2.3 fish dominated the first temporal stratum (76.4% and 15.5%, respectively). However, the proportion of age-2.2 fish continued to increase throughout the duration of the return while the proportion of age-2.3 and age-1.3 fish declined gradually through the latter stages of the migration to 1.6% and 0%, respectively, during the last time stratum. Age-2.1 fish increased from 3.4% during the first time stratum to 9.8% during the last stratum.

There was a significant difference in the age composition of the harvest of sockeye salmon at the confluence relative to those harvested from the river (Table 7). The late-run

Table 4.-Summary of estimated angler effort and harvest by component during the late run of Russian River sockeye salmon, 1994.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort[a]	72,404	18,788	91,192	74,035 - 108,349
SE	8,514	2,033	8,754	
Harvest	19,468	6,907	26,375	19,745 - 33,005
SE	2,925	1,700	3,383	

[a] Angler-hours.

Table 5.-Estimated harvest per hour of angler effort (HPUE) by anglers interviewed during the late run of the Russian River sockeye salmon recreational fishery, 1994.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	19	32	888	0.269	0.0016
River	10	32	261	0.368	0.0082
Both			1,149	0.289	0.0014

[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.

Table 6.-Escapements of sockeye, coho, and chinook salmon during the late run to the Russian River drainage, 1994.

Component	Dates	Sockeye Salmon	Coho Salmon	Chinook Salmon
Late-Run	07/20 - 10/21	122,277[a]	2,974	69
Downstream[b]	08/24[c]	15,211[d]		86[e]

[a] From 7/20 through 8/01, early-run fish were differentiated from late-run fish based on the degree of external maturation (color).

[b] Fish that spawned downstream from the Russian River Falls.

[c] Two foot surveys (8/24 and 9/06) were made downstream from the Russian River Falls. A greater number of fish were enumerated on 8/24. The tabulated values are for 8/24 only and represent a minimum estimate.

[d] 13,022 live fish and 2,189 dead fish that spawned downstream from the Russian River Falls.

[e] 52 live fish and 34 dead fish enumerated downstream from Russian River Falls.

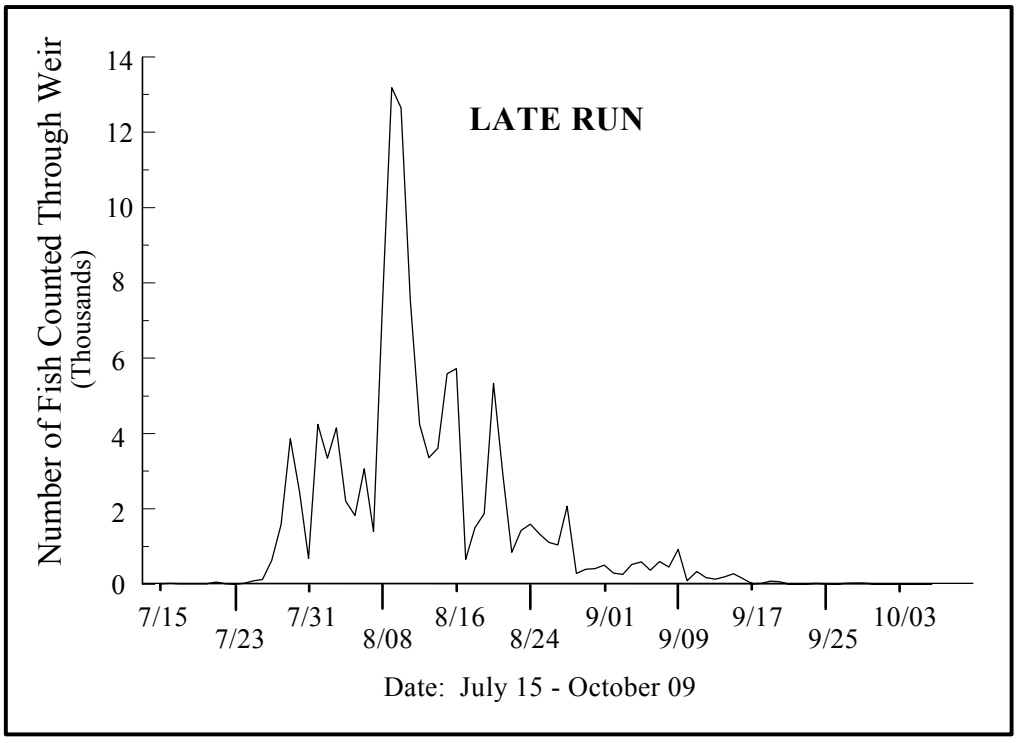

Figure 5.-Daily escapement of sockeye salmon through the Russian River weir, 1994.

Table 7.-Results of chi-square tests of age composition between spatial strata for the late-run Russian River sockeye salmon return, 1994.

Temporal Stratum	Spatial Strata: Confluence Harvest vs. River Harvest	Spatial Strata: Confluence Harvest vs. Weir Escapement	Spatial Strata: River Harvest vs. Weir Escapement
1 7/20-7/27	df = 3 χ^2 = 26.49, P < 0.001 S[a] (P < 0.05)	N/A[c]	N/A[c]
2 7/28-8/09	df = 4 χ^2 = 10.56, P = 0.032 S[a] (P < 0.05)	df = 4 χ^2 = 7.81, P = 0.099 NS[b] (P > 0.05)	df = 4 χ^2 =14.66, P = 0.005 S[a] (P < 0.05)
3 8/10-8/20	df = 4 χ^2 = 16.18, P = 0.003 S[a] (P < 0.05)	df = 4 χ^2 = 21.82, P < 0.001 S[a] (P < 0.05)	df = 4 χ^2 = 9.62, P = 0.047 S[a] (P < 0.05)
4 8/21-10/21	N/A[c]	N/A[c]	N/A[c]

[a] Significant difference.

[b] No Significant difference.

[c] There were insufficient samples from the weir during the first temporal strata for Chi-Square analysis, and no samples were available from either the confluence or the river after the closure of the fishery on 8/20.

Table 8.-Results of chi-square tests of age composition among temporal strata for the late-run Russian River sockeye salmon return, 1994.

Spatial Stratum	All Temporal Strata: 20 July to 27 July vs 28 July to 10 August vs 10 August to 20 August
Confluence	df = 6, χ^2 = 75.02, P < 0.001 Significant, P < 0.05
River Harvest	df = 8, χ^2 = 99.56, P < 0.001 Significant, P < 0.05
Weir Escapement	df = 8, χ^2 =33.76, P < 0.001 Significant, P < 0.05

[a] 7/20 - 10/21 for weir escapement.

Table 9.-Estimated age and sex composition of the late-run sockeye salmon escapement through the Russian River weir, 1994.

Dates	Age Group 2.3	2.2	2.1	1.2	Total
7/28 - 8/09					
n^a = 174					
Count = 50,475					
Females					
Sample Size	12	71	2	0	89
Percent	6.9	40.8	1.1	0.0	51.1
Variance of Percent	3.7	14.0	0.7	0.0	14.4
Number	3,481	20,596	580	0	25,818
Variance of Number	945,593	3,557,162	167,327	0	3,679,739
Males					
Sample Size	15	62	4	0	85
Percent	8.6	35.6	2.3	0.0	48.9
Variance of Percent	4.6	13.3	1.3	0.0	14.4
Number	4,351	17,985	1,160	0	24,657
Variance of Number	1,160,103	3,377,674	330,763	0	3,679,739
Sexes Combined					
Sample Size	27	133	6	0	174
Percent	15.5	76.4	3.4	0.0	100.0
Variance of Percent	7.6	10.4	1.9	0.0	
Number	7,832	38,581	1,741	0	50,475
Variance of Number	1,930,586	2,652,428	490,308	0	

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Table 9.-Page 2 of 4.

Dates	Age Group 2.3	2.2	2.1	1.2	Total
8/10 - 8/20					
n^a = 241					
Count = 52,073					
Females					
Sample Size	11	128	2	4	145
Percent	4.6	53.1	0.8	1.7	60.2
Variance of Percent	1.8	10.4	0.3	0.7	10.0
Number	2,377	27,657	432	864	31,330
Variance of Number	492,153	2,813,638	92,984	184,412	2,707,816
Males					
Sample Size	17	75	2	1	96
Percent	7.1	31.1	0.8	0.4	39.8
Variance of Percent	2.7	8.9	0.3	0.2	10.0
Number	3,673	16,205	432	216	20,743
Variance of Number	740,759	2,421,861	92,984	46,686	2,707,816
Sexes Combined					
Sample Size	28	203	4	5	241
Percent	11.6	84.2	1.7	2.1	100.0
Variance of Percent	4.3	5.5	0.7	0.8	
Number	6,050	43,862	864	1,080	52,073
Variance of Number	1,160,159	1,500,581	184,412	229,542	

-continued-

Table 9.-Page 3 of 4.

Dates	Age Group 2.3	2.2	2.1	1.2	Total
8/21 - 10/21					
n^a = 61					
Count = 19,729					
Females					
Sample Size	0	43	1	0	44
Percent	0.0	70.5	1.6	0.0	72.1
Variance of Percent	0.0	34.7	2.7	0.0	33.5
Number	0	13,907	323	0	14,231
Variance of Number	0	1,349,398	104,605	0	1,304,070
Males					
Sample Size	1	11	5	0	17
Percent	1.6	18.0	8.2	0.0	27.9
Variance of Percent	2.7	24.6	12.5	0.0	33.5
Number	323	3,558	1,617	0	5,498
Variance of Number	104,605	958,875	488,154	0	1,304,070
Sexes Combined					
Sample Size	1	54	6	0	61
Percent	1.6	88.5	9.8	0.0	100.0
Variance of Percent	2.7	16.9	14.8	0.0	
Number	323	17,465	1,941	0	19,729
Variance of Number	104,605	659,009	575,325	0	

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Table 9.-Page 4 of 4.

Dates	Age Group 2.3	2.2	2.1	1.2	Total
Late Run Total					
n[a] = 476					
Count = 122,277					
Females					
Percent	4.8	50.8	1.1	0.7	58.4
Variance of Percent	1.0	5.2	0.2	0.1	5.1
Number	5,858	62,160	1,336	864	71,379
Variance of Number	1,437,746	7,720,199	364,916	184,412	7,691,624
Males					
Percent	6.8	30.9	2.6	0.2	41.6
Variance of Percent	1.3	4.5	0.6	0.0	5.1
Number	8,348	37,748	3,210	216	50,898
Variance of Number	2,005,466	6,758,410	911,901	46,686	7,691,624
Sexes Combined					
Percent	11.6	81.7	3.7	0.9	100.0
Variance of Percent	2.1	3.2	0.8	0.2	
Number	14,206	99,909	4,545	1,080	122,277
Variance of Number	3,195,350	4,812,017	1,250,044	229,542	

[a] n = sample size.

confluence area harvest was comprised predominantly of age-2.2 (89.2%), and age-2.3 (7.4%) fish (Table 10). There were significant temporal changes in the age composition (Table 8) of the sampled harvest at the confluence. Similar to the weir escapement, age-2.2 and age-2.3 fish appeared to comprise the bulk of the fish harvested at the confluence area early in the return and the proportion of age-2.2 fish increased during the later temporal stratum. Age-2.2 adults ranged from 59.2% in the first time stratum to 98.0% in the third stratum and age-2.3 fish represented 31.0% in the first stratum but declined to 0.0% by the third time stratum.

The proportion of age-1.3 adults declined from 8.5% during the first time stratum to 0.7% during the final stratum while age-1.2 fish represented approximately 1.4% throughout the return.

The late-run river area harvest was also primarily age-2.2 (80.1%) and age-2.3 (10.2%) fish with age-1.3 and -1.2 contributing 4.9% and 3.1%, respectively, to the harvest (Table 11). There were significant temporal changes detected in the sampled age composition of the river harvest (Table 8). The sampled harvest from the river area was also largely age-2.2, and age-2.3 adults early in the return with the proportion of age-2.2 adults increasing throughout the run. The predominant age class in the first temporal stratum was age-1.3 fish (35.5%) with age-2.3 and -2.2 adults contributing 32.3% and 22.6% respectively. These age classes subsequently contributed 0.0%, 5.5% and 91 5% during the third time stratum.

The age composition of sockeye salmon that spawned in the Russian River downstream from the Russian River falls was primarily aged-1.3 (95.7%) fish (Table 12). Ages-2.3 and 2.2 fish each contributed 2.2%. Mean length by age and sex was also estimated for this spawning component of the late run (Table 13).

Fish aged-2.2 were significantly larger ($F = 30.89$, $df = 2;996$, $P < 0.0001$) during the early stages of the return than later in the migration (Table 14). Fish age-2.3 also had a significant difference ($F = 11.45$, $df = 2;143$, $P < 0.0001$) in length-at-age among sites over time.

TOTAL RETURN STATISTICS

Overall, an estimated 148,652 late-run sockeye salmon returned to the Russian River in 1994 (Table 15). Of these, 82.6% were age-2.2 and 11.0% were age-2.3. Ages-2.1 and 1.3 comprised just 3.1% and 2.2% of the return, respectively. Spawners below the falls were not included in this total. These fish, which are primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986) and are believed to spend their freshwater residency in Skilak Lake.

DISCUSSION

RELATIVE RUN STRENGTH

Total return of the 1994 late run was considerably above the historical (1976 - 1993) average of 87,950 (Figure 6). The 1994 late run continued to follow a general trend, beginning in 1978, of greater numbers of sockeye salmon returning to the Russian River system which surpass the long-term (1963 - 1977) average of 46,454 sockeye salmon.

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. Although anglers left the fishery from other locations,

Table 10.-Estimated age and sex composition of late-run sockeye salmon harvested in the confluence area of the Russian River recreational fishery, 1994.

	Age Group					
Dates	2.3	1.3	2.2	2.1	1.2	Total
7/20 - 7/27						
n[a] = 142						
Harvest= 1,942						
Var(Harvest)= 337,995						
Females						
Sample Size	21	8	48	0	1	78
Percent	14.8	5.6	33.8	0.0	0.7	54.9
Variance of Percent	8.9	3.8	15.9	0.0	0.5	17.6
Number	287	109	656	0	14	1,067
Variance of Number	10,461	2,367	44,069	0	187	108,010
Males						
Sample Size	23	4	36	0	1	64
Percent	16.2	2.8	25.4	0.0	0.7	45.1
Variance of Percent	9.6	1.9	13.4	0.0	0.5	17.6
Number	315	55	492	0	14	875
Variance of Number	12,172	935	26,332	0	187	74,687
Sexes Combined						
Sample Size	44	12	84	0	2	142
Percent	31.0	8.5	59.2	0.0	1.4	100.0
Variance of Percent	15.2	5.5	17.1	0.0	1.0	
Number	602	164	1,149	0	27	1,942
Variance of Number	37,659	4,298	124,158	0	405	337,995

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Table 10.-Page 2 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
7/28 - 8/09						
n[a] = 139						
Harvest= 6,843						
Var(Harvest)= 909,691						
Females						
Sample Size	8	3	70	0	1	82
Percent	5.8	2.2	50.4	0.0	0.7	59.0
Variance of Percent	3.9	1.5	18.1	0.0	0.5	17.5
Number	394	148	3,446	0	49	4,037
Variance of Number	21,061	7,450	313,885	0	2,424	397,078
Males						
Sample Size	9	1	47	0	0	57
Percent	6.5	0.7	33.8	0.0	0.0	41.0
Variance of Percent	4.4	0.5	16.2	0.0	0.0	17.5
Number	443	49	2,314	0	0	2,806
Variance of Number	23,963	2,424	178,471	0	0	233,465
Sexes Combined						
Sample Size	17	4	117	0	1	139
Percent	12.2	2.9	84.2	0.0	0.7	100.0
Variance of Percent	7.8	2.0	9.7	0.0	0.5	
Number	837	197	5,760	0	49	6,843
Variance of Number	49,324	10,053	688,847	0	2,424	909,691

-continued-

Table 10.-Page 3 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
8/10 - 8/20						
n[a] = 147						
Harvest= 10,683						
Var(Harvest)= 7,305,549						
Females						
Sample Size	0	1	91	0	1	93
Percent	0.0	0.7	61.9	0.0	0.7	63.3
Variance of Percent	0.0	0.5	16.2	0.0	0.5	15.9
Number	0	73	6,613	0	73	6,759
Variance of Number	0	5,281	2,972,176	0	5,281	3,094,083
Males						
Sample Size	0	0	53	0	1	54
Percent	0.0	0.0	36.1	0.0	0.7	36.7
Variance of Percent	0.0	0.0	15.8	0.0	0.5	15.9
Number	0	0	3,852	0	73	3,924
Variance of Number	0	0	1,118,347	0	5,281	1,155,876
Sexes Combined						
Sample Size	0	1	144	0	2	147
Percent	0.0	0.7	98.0	0.0	1.4	100.0
Variance of Percent	0.0	0.5	1.4	0.0	0.9	
Number	0	73	10,465	0	145	10,683
Variance of Number	0	5,281	7,025,033	0	11,171	7,305,549

-continued-

Table 10.-Page 4 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
Late Run Total						
n[a] = 428						
Harvest= 19,468						
Var(Harvest)= 8,553,235						
Females						
Percent	3.5	1.7	55.0	0.0	0.7	60.9
Variance of Percent	0.9	0.4	8.6	0.0	0.2	7.3
Number	681	330	10,716	0	136	11,862
Variance of Number	31,522	15,099	3,330,130	0	7,892	3,599,172
Males						
Percent	3.9	0.5	34.2	0.0	0.4	39.1
Variance of Percent	1.1	0.0	7.0	0.0	0.1	7.3
Number	758	104	6,658	0	86	7,606
Variance of Number	36,135	3,358	1,323,151	0	5,468	1,464,028
Sexes Combined						
Percent	7.4	2.2	89.2	0.0	1.1	100.0
Variance of Percent	2.7	0.5	4.1	0.0	0.4	0.0
Number	1,439	434	17,374	0	222	19,468
Variance of Number	86,983	19,632	7,838,038	0	14,000	8,553,235

[a] n = sample size.

Table 11.-Estimated age and sex composition of late-run sockeye salmon harvested in the river area of the Russian River recreational fishery, 1994.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
7/20 - 7/27						
n[a] = 31						
Harvest= 145						
Var(Harvest)= 705						
Females						
Sample Size	7	7	4	0	1	19
Percent	22.6	22.6	12.9	0.0	3.2	61.3
Variance of Percent	58.3	58.3	37.5	0.0	10.4	79.1
Number	33	33	19	0	5	89
Variance of Number	154	154	88	0	22	426
Males						
Sample Size	3	4	3	0	2	12
Percent	9.7	12.9	9.7	0.0	6.5	38.7
Variance of Percent	29.1	37.5	29.1	0.0	20.1	79.1
Number	14	19	14	0	9	56
Variance of Number	66	88	66	0	44	266
Sexes Combined						
Sample Size	10	11	7	0	3	31
Percent	32.3	35.5	22.6	0.0	9.7	100.0
Variance of Percent	72.8	76.3	58.3	0.0	29.1	
Number	47	51	33	0	14	145
Variance of Number	221	244	154	0	66	705

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Table 11-Page 2 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
7/28 - 8/09						
n[a] = 166						
Harvest= 3,687						
Var(Harvest)= 2,317,344						
Females						
Sample Size	9	5	72	1	7	94
Percent	5.4	3.0	43.4	0.6	4.2	56.6
Variance of Percent	3.1	1.8	14.9	0.4	2.4	14.9
Number	200	111	1,599	22	155	2,088
Variance of Number	10,316	4,099	452,738	493	6,881	759,856
Males						
Sample Size	13	8	49	0	2	72
Percent	7.8	4.8	29.5	0.0	1.2	43.4
Variance of Percent	4.4	2.8	12.6	0.0	0.7	14.9
Number	289	178	1,088	0	44	1,599
Variance of Number	19,145	8,517	216,133	0	1,150	452,738
Sexes Combined						
Sample Size	22	13	121	1	9	166
Percent	13.3	7.8	72.9	0.6	5.4	100.0
Variance of Percent	7.0	4.4	12.0	0.4	3.1	
Number	489	289	2,688	22	200	3,687
Variance of Number	48,560	19,145	1,244,751	493	10,316	2,317,344

-continued-

Table 11.-Page 3 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
8/10 - 8/20						
n[a] = 165						
Harvest= 3,075						
Var(Harvest)= 570,317						
Females						
Sample Size	6	0	109	2	0	117
Percent	3.6	0.0	66.1	1.2	0.0	70.9
Variance of Percent	2.1	0.0	13.7	0.7	0.0	12.6
Number	112	0	2,031	37	0	2,180
Variance of Number	2,653	0	261,034	733	0	297,937
Males						
Sample Size	3	0	42	3	0	48
Percent	1.8	0.0	25.5	1.8	0.0	29.1
Variance of Percent	1.1	0.0	11.6	1.1	0.0	12.6
Number	56	0	783	56	0	895
Variance of Number	1,156	0	47,233	1,156	0	59,441
Sexes Combined						
Sample Size	9	0	151	5	0	165
Percent	5.5	0.0	91.5	3.0	0.0	100.0
Variance of Percent	3.1	0.0	4.7	1.8	0.0	
Number	168	0	2,814	93	0	3,075
Variance of Number	4,491	0	481,849	2,116	0	570,317

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Table 11.-Page 4 of 4.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
Late Run Total						
n[a] = 362						
Harvest= 6,907						
Var(Harvest)= 2,888,366						
Females						
Percent	5.0	2.1	52.8	0.9	2.3	63.1
Variance of Percent	1.4	0.6	13.4	0.3	0.9	9.5
Number	344	144	3,649	59	160	4,357
Variance of Number	13,123	4,253	713,860	1,226	6,903	1,058,219
Males						
Percent	5.2	2.8	27.3	0.8	0.8	36.9
Variance of Percent	1.9	1.1	6.2	0.3	0.2	9.5
Number	359	196	1,885	56	54	2,550
Variance of Number	20,367	8,605	263,432	1,156	1,194	512,446
Sexes Combined						
Percent	10.2	4.9	80.1	1.7	3.1	100.0
Variance of Percent	3.4	2.0	8.5	0.5	1.3	0.0
Number	703	340	5,534	115	214	6,907
Variance of Number	53,272	19,389	1,726,754	2,609	10,382	2,888,366

[a] n = sample size.

Table 12.-Estimated age and sex composition of sockeye salmon which spawn downstream from the Russian River Falls, 1994.

	Age Group				
Dates	2.3	1.3	2.2	1.2	Total
8/24 - 9/09[b]					
n[a] = 138					
Count= 15,211					
Females					
Sample Size	3	71	2	0	76
Percent	2.2	51.4	1.4	0.0	55
Variance of Percent	1.6	18.2	1.0	0.0	18
Number	331	7,826	220	0	8,377
Variance of Number	35,916	421,862	24,122	0	417,871
Males					
Sample Size	0	61	1	0	62
Percent	0.0	44.2	0.7	0.0	45
Variance of Percent	0.0	18.0	0.5	0.0	18
Number	0	6,724	110	0	6,834
Variance of Number	0	416,541	12,149	0	417,871
Sexes Combined					
Percent	2.2	95.7	2.2	0.0	100
Variance of Percent	1.6	36.2	1.6	0.0	
Number	331	14,550	331	0	15,211
Variance of Number	35,916	838,402	36,271	0	

[a] n = sample size.

[b] Indicates 2 distinct sampling dates.

Table 13.-Mean length (millimeters) at age, by sex, for sampled sockeye salmon which spawn below the falls area during the late-run of sockeye salmon to the Russian River, 1994.

		Age Class			
		2.3	1.3	2.2	1.2
Component					
Downstream Escapement[a]					
Female	Mean Length	517	554	517	
	SE	26.7	4.4	55.0	
	Sample Size	3	71	2	
Male	Mean Length	601	560		
	SE	4.8			
	Sample Size	61	1		

[a] Fish that spawned downstream from Russian River Falls.

Table 14.-Mean length (millimeters) at age by sex for the late-run of sockeye salmon sampled from the Russian River, 1994.

		Time Strata											
		7/20-27			7/28-8/09			8/10-20			8/21-10/21		
Area	Age	N[a]	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Confluence													
	1.2												
	Female	1	530		1	475		1	500				
	Male	1	425					1	385				
	1.3												
	Female	8	563	6.4	3	540	5.8	1	515				
	Male	4	582	12.8	1	590							
	2.1												
	Female												
	Male												
	2.2												
	Female	48	533	4.6	70	511	3.1	91	503	2.4			
	Male	36	538	7.2	47	512	5.2	53	493	4.9			
	2.3												
	Female	21	568	4.8	8	534	15.4						
	Male	23	588	7.0	9	523	16.2						
River													
	1.2												
	Female	1	520		7	510	8.7						
	Male	2	522	7.5	2	511	9.5						
	1.3												
	Female	7	586	3.4	5	573	5.4						
	Male	4	561	10.5	8	559	9.7						
	2.1												
	Female				1	405		2	458	52.5			
	Male							3	408	48.4			
	2.2												
	Female	4	544	16.8	72	508	3.2	109	501	2.0			
	Male	3	533	11.7	49	514	3.8	42	493	3.6			
	2.3												
	Female	7	547	17.5	9	549	12.4	6	566	8.0			
	Male	3	592	10.9	13	569	8.0	3	587	12.0			

-continued-

Table 14.-Page 2 of 2.

		Time Strata											
		7/20-27			7/28-8/09			8/10-20			8/21-10/21		
Area	Age	N[a]	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Weir[b]													
	1.2												
	Female							4	507	4.8			
	Male							1	465				
	1.3												
	Female				4	564	4.9						
	Male				4	578	11.2	1	585				
	2.1												
	Female				2	426	4.5	2	385	5.0	1	405	
	Male				4	398	8.9	2	384	14.0	5	383	9.0
	2.2												
	Female				71	510	2.1	128	496	2.4	43	486	3.3
	Male				62	508	2.5	75	489	4.3	11	496	12.9
	2.3												
	Female				12	580	5.7	11	517	4.2			
	Male				15	565	6.9	17	556	7.1	1	575	

[a] N = Sample size.

[b] Fish that migrated through the weir.

Table 15.-Estimated age and sex composition of the late run of sockeye salmon to the Russian River, 1994.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	Total
7/20 - 10/21						
Females						
Percent	4.6	1.1	51.5	0.9	0.8	58.9
Variance of Percent	0.7	0.2	3.7	0.2	0.0	3.6
Number	6,883	1,634	76,526	1,395	1,160	87,598
Variance of Number	1,482,392	350,115	11,764,189	366,141	199,207	12,349,015
Males						
Percent	6.4	1.1	31.1	2.2	0.2	41.1
Variance of Percent	0.9	0.2	3.2	0.4	0.0	3.6
Number	9,464	1,677	46,291	3,266	356	61,054
Variance of Number	2,061,968	389,413	8,344,993	913,057	53,349	9,668,098
Sexes Combined						
Percent	11.0	2.2	82.6	3.1	1.0	100.0
Variance of Percent	1.5	0.3	2.3	0.6	0.1	0.0
Number	16,348	3,311	122,817	4,661	1,516	148,652
Variance of Number	3,335,604	731,668	14,376,810	1,252,653	253,924	11,441,601

[a] Confluence area harvest + river area harvest + escapement through the weir.

[b] n = sample size.

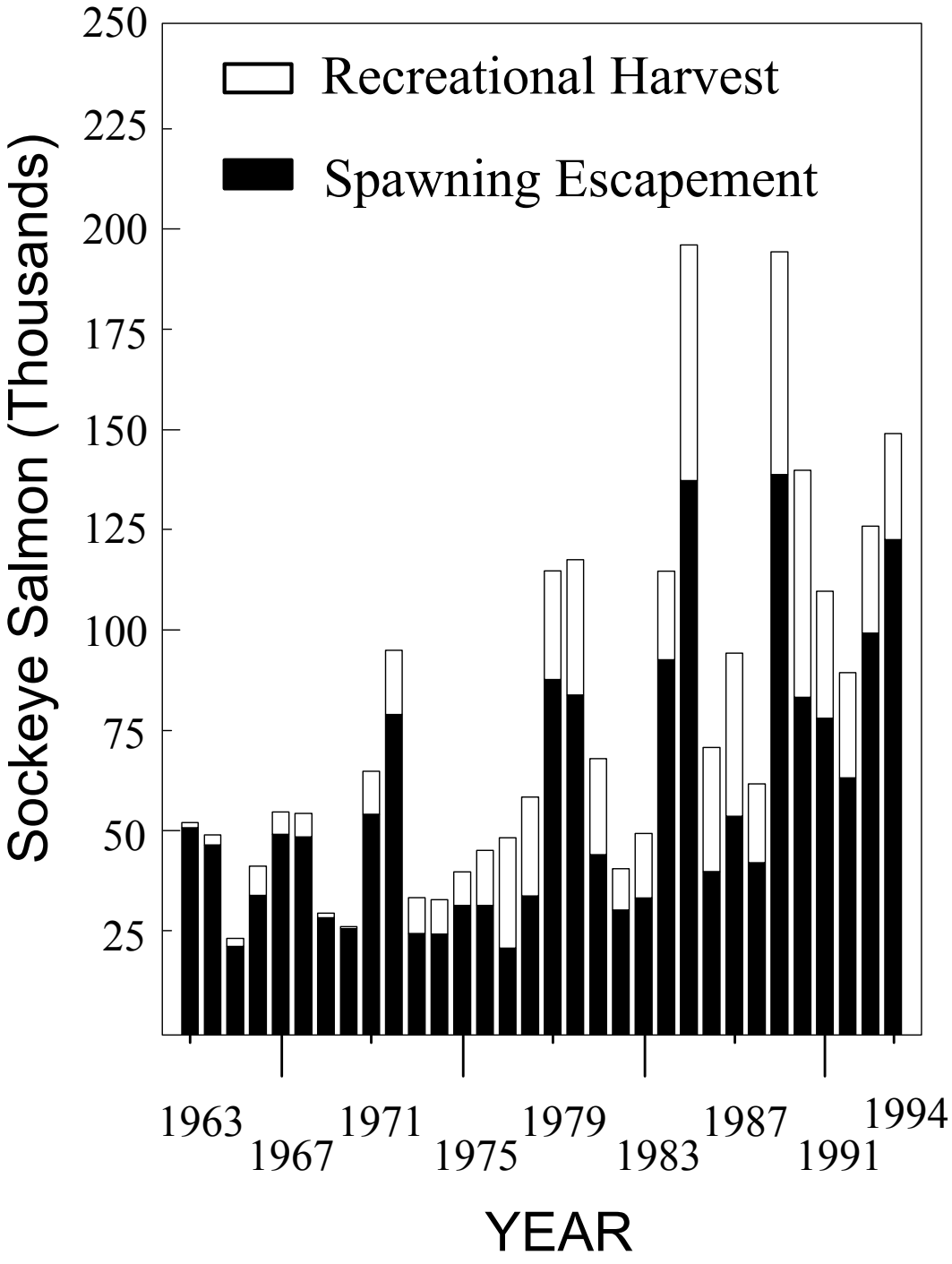

Figure 6.-Historical returns of sockeye salmon to the Russian River.

these anglers comprised only a minor portion of the total fishery. Creel survey personnel and the project leader informally monitored the other access sites during the process of shift and site changes and found that use was relatively minor.

Observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that, generally, only small numbers of anglers were fishing at those hours during 1994. Here again, an informal accounting of activity during these hours was accomplished through conversations with anglers and frequent queries of the campground and ferry employees. Additionally, the project staff was instructed to maintain field note records of numbers of anglers observed fishing during non-surveyed hours. Generally, such observations occurred just prior to beginning the early morning shift (0600 hrs.) or after the completion of the sampling day (2400 hrs.). Further observations were made when project staff conducted personal fishing trips during non-surveyed hours. However, random observations of access locations during the nighttime period should be continued in the future. This will provide additional information regarding any 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 begun in 1990 was continued during the 1994 season. This increase in sampling intensity over previous years is an effort to achieve more accurate age composition estimates. Significant temporal changes in age composition have been detected within spatial strata as well as differences among temporal strata at the sampled locations since 1990 (Carlon et al. 1991, Marsh 1992-1994).

The respective age compositions of the confluence and river harvests and the weir escapement clearly differed during the late run in 1994 (Table 7). Because age compositions differed over time and among the spatial strata, samples could not be pooled together. A harvest estimate or escapement number of each time stratum was calculated for each spatial stratum. This harvest or escapement and data from the biological sampling was then used to estimate the sex and age proportions of each temporal/spatial stratum. This method provided an unbiased estimate of the harvest or escapement from the different areas of the Russian River.

It is recommended that sampling of the temporal and spatial strata be continued at the present sampling intensity. This will continue to improve estimates of the numbers of sockeye salmon returning by age and sex and the evaluation of 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 from weir counts and fishery harvest rates should be continued (Vincent-Lang and Carlon 1991). The technique of fitting a 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 continue to be implemented in 1995 and subsequent years to further evaluate the value of these statistics in managing the Russian River sockeye salmon resource.

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Steve Hammarstrom continued to provide consistent, critical review and assistance. Steve contributed much of the design work and preliminary fabrication of the new, replacement aluminum weir panels installed after nearly twenty years of using the old, wood and steel panels. Steve has also provided a seasoned voice of experience regarding all aspects of the project, from personnel matters to migratory timing influences, which contributed greatly towards my understanding of the project and the fishery resource.

Larry DuBois operated the Russian River weir and field camp. Larry collected biological data and assisted with the ground escapement counts and sampling surveys. Larry has been employed by the Department of Fish and Game during the past four seasons at the Russian River weir. During that time, he has provided important initiative and skills towards constructing, refurbishing and making the field camp a much safer and enjoyable place to conduct the necessary research of studying the salmon resources of the Russian River drainage.

Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulation violations. Paul has been employed by the Department of Fish and Game at the Russian River for the past six seasons. His observations of the fishery were important to the conduct of the creel survey and the management of the sockeye salmon resource.

Colleen O'Brien also collected creel survey data and age, sex, and length data from the fishery. Colleen has also been a long term seasonal employee at the Russian River with five seasons employment. Colleen's experience with the sport fishery and her continuing, positive, "can do" enthusiasm while performing her responsibilities have proven to be an invaluable asset to the Russian River project.

Dave Athons provided vital aircraft logistical support and assisted with installing and removing the weir structures. His 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 necessary review of the statistical data analysis required to estimate the age compositions of the sport harvest and the escapement as well as much appreciated critical review of the text.

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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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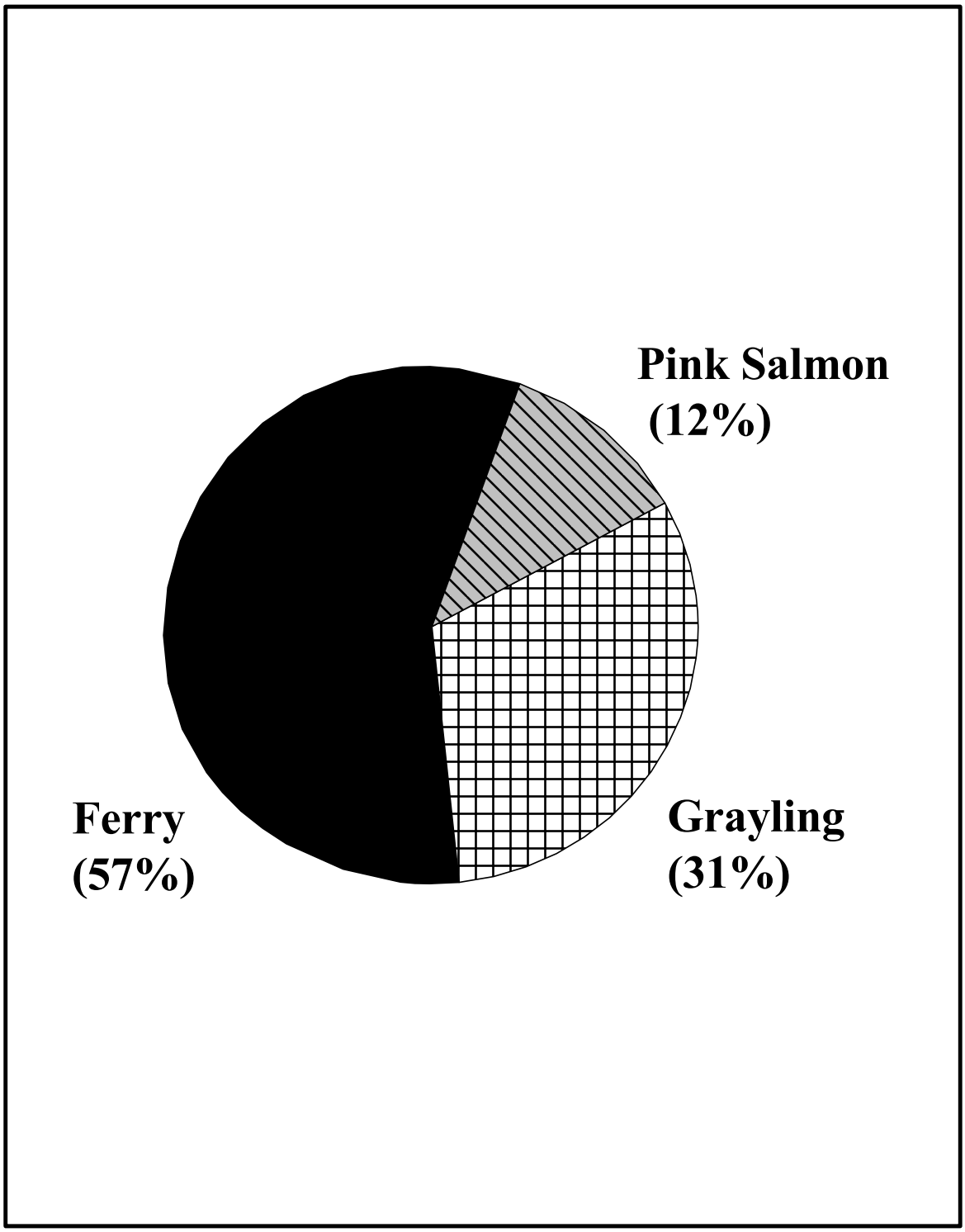
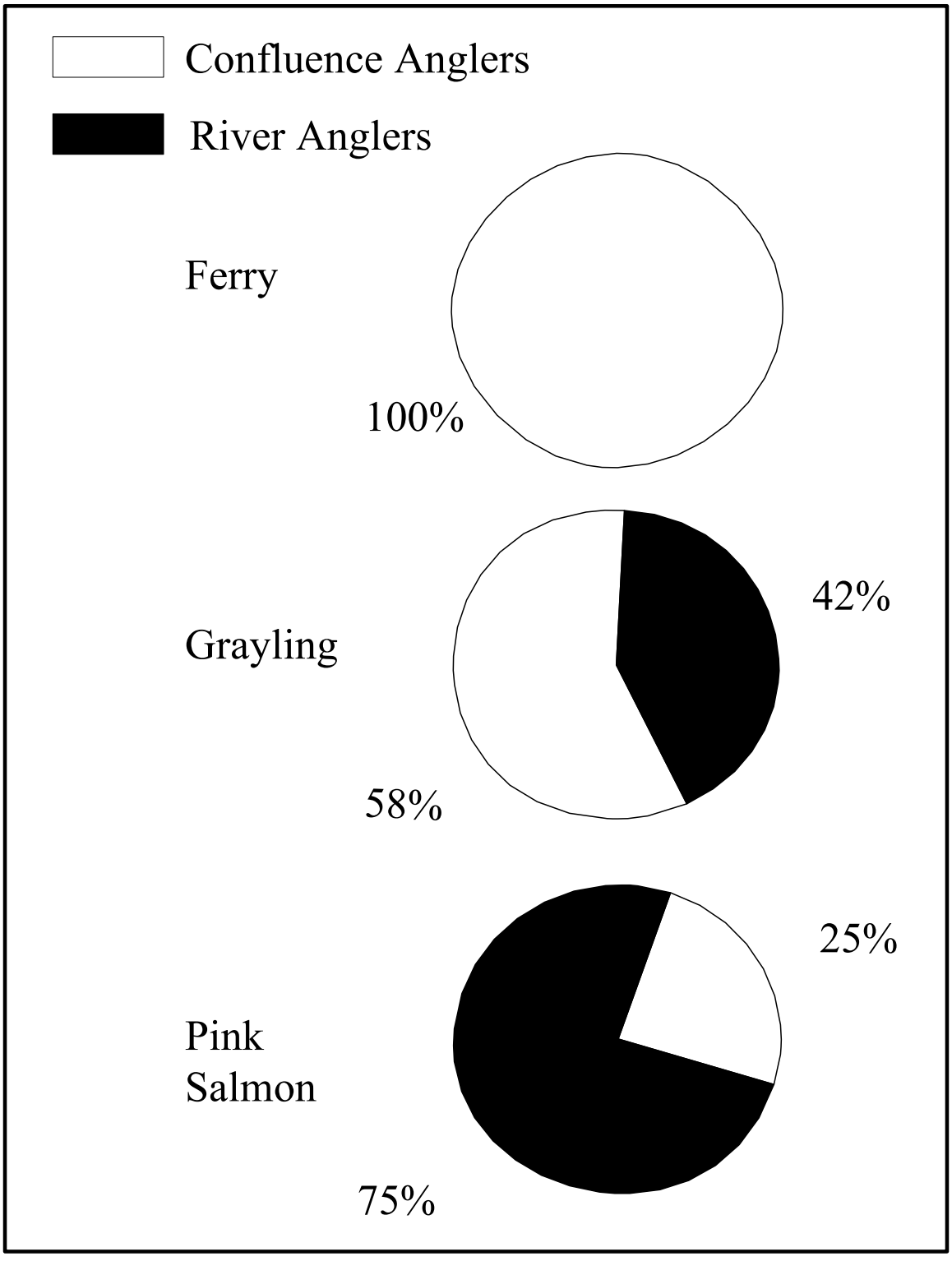
APPENDIX A. SELECTED SUMMARIES OF FISHERY AND ESCAPEMENT DATA FROM THE RUSSIAN RIVER, 1994.



Appendix A1.-Relative proportions of interviews collected at the three sampled access locations to the Russian River late-run sockeye salmon recreational fishery, 1994.



Appendix A2.-Relative proportions of confluence and river anglers interviewed during the Russian River creel survey by access location, late run, 1994.

Appendix A3.-Temporal harvest and effort estimates for the 1994 late-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	7/20-7/27	8	4	0	0	0		0		0			
Grayling	7/20-7/27	8	1	59	0	476	1,805	0	0	1,797	100	8	0
Pink Salmon	7/20-7/27	8	1	52	0	416	1,382	0	0	1,365	99	17	1
		Total 7/20-7/27				892	3.187						
Ferry	7/28-8/09	13	5	0	0	0		0		0			
Grayling	7/28-8/09	13	3	373	41,448	4,843	2,234,649	1,796,067	80	436,810	20	1,772	0
Pink Salmon	7/28-8/09	13	2	248	19,943	3,229	1,446,683	1,425,917	99	20,691	1	75	0
		Total 7/28-8/09				8.072	3.681.332						
Ferry	8/10-8/20	11	3	0	0	0		0		0			
Grayling	8/10-8/20	11	2	468	8	5,149	173,125	407	0	161,178	93	11,539	7
Pink Salmon	8/10-8/20	11	2	425	1,649	4,675	274,367	81,627	30	191,693	70	1,048	0
		Total 8/10-8/20				9.824	447.492						
		Total River Effort				18,788	4,132,011						
Confluence Effort:													
Ferry	7/20-7/27	8	4	994	446,121	7,951	6,318,781	3,568,967	56	2,741,228	43	8,586	0
Grayling	7/20-7/27	8	1	719	0	5,751	77,061	0	0	75,086	97	1,975	3
Pink Salmon	7/20-7/27	8	1	40	0	320	8,533	0	0	8,533	100	0	0
		Total 7/20-7/27				14.022	6.404.375						
Ferry	7/28-8/09	13	5	1,204	521,421	15,648	21,093,656	10,845,554	51	10,224,663	48	23,439	0
Grayling	7/28-8/09	13	3	635	128,041	8,254	6,150,575	5,548,441	90	597,122	10	5,012	0
Pink Salmon	7/28-8/09	13	2	133	91	1,726	102,114	6,515	6	95,599	94	0	0
		Total 7/28-8/09				25.628	27.346.345						
Ferry	8/10-8/20	11	3	2,280	266,660	25,084	11,908,324	7,822,035	66	4,054,703	34	31,586	0
Grayling	8/10-8/20	11	2	581	539,535	6,390	26,801,533	26,706,978	100	72,160	0	22,395	0
Pink Salmon	8/10-8/20	11	2	116	110	1,280	35,535	5,458	15	29,944	84	134	0
		Total 8/10-8/20				32.754	38.745.392						
		Total Confluence Effort				72,404	72,496,112						
		Total Effort				91,192	76,628,123						

-continued-

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Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Days	%	Periods	%	Anglers	%
River Harvest:													
Ferry	7/20-7/27	8	4	0	0	0		0		0			
Grayling	7/20-7/27	8	1	11	0	89	689	0	0	659	96	30	4
Pink Salmon	7/20-7/27	8	1	7	0	56	16	0	0	5	33	11	67
		Total 7/20-7/27				145	705						
Ferry	7/28-8/09	13	5	0	0	0		0		0			
Grayling	7/28-8/09	13	3	215	41,724	2,792	1,860,149	1,808,023	97	51,632	3	494	0
Pink Salmon	7/28-8/09	13	2	69	5,801	895	457,195	414,785	91	42,265	9	145	0
		Total 7/28-8/09				3.687	2.317.344						
Ferry	8/10-8/20	11	3	0	0	0		0		0			
Grayling	8/10-8/20	11	2	135	8,492	1,489	431,714	420,348	97	10,092	2	1,274	0
Pink Salmon	8/10-8/20	11	2	144	2,731	1,586	138,603	135,191	98	3,065	2	348	0
		Total 8/10-8/20				3.075	570.317						
		Total River Harvest				6,907	2,888,366						
Confluence Harvest:													
Ferry	7/20-7/27	8	4	163	18,090	1,303	329,717	144,719	44	179,207	54	5,790	2
Grayling	7/20-7/27	8	1	80	0	639	8,278	0	0	8,004	97	275	3
Pink Salmon	7/20-7/27	8	1	0	0	0		0					
		Total 7/20-7/27				1.942	337.995						
Ferry	7/28-8/09	13	5	338	25,397	4,389	680,639	528,258	78	144,261	21	8,121	1
Grayling	7/28-8/09	13	3	174	4,232	2,259	216,689	183,378	85	32,273	15	1,038	0
Pink Salmon	7/28-8/09	13	2	15	162	195	12.363	11.583	94	780	6	0	0
		Total 7/28-8/09				6,843	909,691						
Ferry	8/10-8/20	11	3	670	14,046	7,374	592,654	412,012	70	170,741	29	9,901	2
Grayling	8/10-8/20	11	2	269	134,322	2,958	6,680,762	6,648,933	100	26,945	0	4,884	0
Pink Salmon	8/10-8/20	11	2	32	616	351	32,133	30,492	95	1,521	5	121	0
		Total 8/10-8/20				10.683	7.305.549						
		Total Confluence Harvest				19,468	8,553,235						
		Total Harvest				26,375	11,441,601						

[a] D=days possible in a stratum.

[b] d=days sampled in a stratum.

Appendix A4.-Daily escapement of sockeye, coho, and chinook salmon through the Russian River weir during the late run, 1994.

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
7/15	442	15		
7/16	1,725	20		
7/17	716	13		
7/18	535	15		
7/19	204	13		
7/20	84	13		
7/21	173	61		
7/22	65	17		
7/23	76	6		
7/24	153	18		
7/25	247	92		
7/26	146	126		
7/27	192	633		
7/28	191	1,576		
7/29	159	3,863		
7/30	21	2,446		1
7/31	45	684		1
8/1	20	4,246		1
8/2		3,350		0
8/3		4,151	1	1
8/4		2,208	0	3
8/5		1,825	2	17
8/6		3,062	0	2
8/7		1,400	0	0
8/8		7,438	1	2
8/9		13,184	5	3
8/10		12,644	3	2
8/11		7,538	4	3
8/12		4,248	4	2
8/13		3,361	7	0
8/14		3,607	5	4
8/15		5,590	17	10
8/16		5,722	14	4
8/17		656	0	0
8/18		1,501	3	3
8/19		1,875	3	1
8/20		5,331	21	1
8/21		2,935	20	2
8/22		846	3	0
8/23		1,427	4	0
8/24		1,600	7	0
8/25		1,331	4	0
8/26		1,111	12	2
8/27		1,045	17	0
8/28		2,068	35	4
8/29		286	11	0
8/30		394	3	0
8/31		418	2	0

-continued-

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Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
9/1		500	2	0
9/2		294	2	0
9/3		261	0	0
9/4		525	1	0
9/5		592	2	0
9/6		374	2	0
9/7		604	3	0
9/8		457	12	0
9/9		921	14	0
9/10		90	8	0
9/11		336	27	0
9/12		170	14	0
9/13		137	17	0
9/14		2	16	0
9/15		7	24	0
9/16		149	53	0
9/17		14	19	0
9/18		25	30	0
9/19		82	53	0
9/20		67	24	0
9/21		2	11	0
9/22		7	23	0
9/23		14	19	0
9/24		21	67	0
9/25		12	28	0
9/26		7	80	0
9/27		26	33	0
9/28		36	68	0
9/29		36	424	0
9/30		16	293	0
10/1		7	325	0
10/2		6	943	0
10/3		6	74	0
10/4		3	10	0
10/5		1	5	0
10/6		5	11	0
10/7		0	6	0
10/8		0	2	0
10/9		1	1	0
10/10		0	0	0
10/11		0	6	0
10/12		0	2	0
10/13		0	7	0
10/14		0	3	0
10/15		0	0	0
10/16		0	2	0
10/17		0	0	0
10/18		0	0	0
10/19		0	0	0
10/20		0	0	0
10/21		0	0	0
Total		122,277	2,974	69

[a] From 7/15 through 8/01, early-run fish were differentiated from late-run fish based upon degree of external sexual maturation characteristics, i.e., body coloration and kype development. There was a 18-day overlap between early-run and late-run fish.