Fishery Data Series No. 98-7

Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Late Run to the Russian River with Estimates of Escapement, 1996

by

Larry E. Marsh

May 1998

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

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

FISHERY DATA SERIES NO. 98-7

CATCH AND EFFORT STATISTICS FOR THE SOCKEYE SALMON SPORT FISHERY DURING THE LATE RUN TO THE RUSSIAN RIVER WITH ESTIMATES OF ESCAPEMENT, 1996

by

Larry E. Marsh
Division of Sport Fish, Soldotna

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

May 1998

This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under project F-10-12, Job No. S-2-7.

The Fishery Data Series was established in 1987 for the publication of technically-oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

Larry E. Marsh
Alaska Department of Fish and Game, Division of Sport Fish
34828 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669-8367, USA

This document should be cited as:
Marsh, L. E. 1998. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 98-7, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A direct expansion creel survey of the late-run Russian River recreational fishery was conducted from 21 July-2 August 1996 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 77,951 (SE = 6,930) hours to harvest 20,142 (SE = 1,651) sockeye salmon from the late run. The harvest rate for this fishery was 0.258 sockeye salmon per hour of angler effort. Approximately 90% of the total fish harvested during the late run were taken from the confluence area of the fishery.

During the late run, 34,691 sockeye salmon bound for spawning areas were counted through the weir at the outlet of Lower Russian Lake. This total exceeds the escapement goal of 30,000 sockeye salmon that has been established for the late run by the Board of Fisheries. An estimated 54,833 sockeye salmon returned to the Russian River during the 1996 late run.

Predominant age groups of the recreational harvest and the escapement were 2.2-, 2.3-, and 1.3-age fish. The majority of the fish in the recreational harvest were age 2.2 (40%), 2.3 (32%) and 1.3 (25%). Sockeye salmon that escaped through the weir at the outlet of Lower Russian Lake were mainly age 2.2 (41%), 2.1 (26%) and 2.3 (20%). The age composition of the harvest did not change significantly ($P = 0.33$) within the available sampling time frame between the confluence and the river areas of the recreational fishery. Data from the confluence area and the river area were combined because there were no significant differences in age class composition from the recreational harvest. Age composition of the escapement through the weir differed from that of the harvest ($P < 0.001$), and differed between the two temporal strata ($P < 0.001$). Estimated age composition of the total late return (harvest plus escapement) was predominantly age-2.2 and age-2.3 sockeye salmon (41% and 24%, respectively).

A stream survey indicated that a minimum of 31,601 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 88% 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 clearwater 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 (Mills 1979-1994, Howe et al. 1995, 1996). 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), Carlon et al. (1991), and Marsh (1992-1995, 1997).

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 occurring during 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 comprise two segments based upon spawning location: (1) those spawning upstream of the Russian River falls, and (2) those spawning downstream from the falls (Figure 2). Most fish migrating through the falls spawn in Upper Russian Lake, but others spawn in the tributaries to Upper Russian

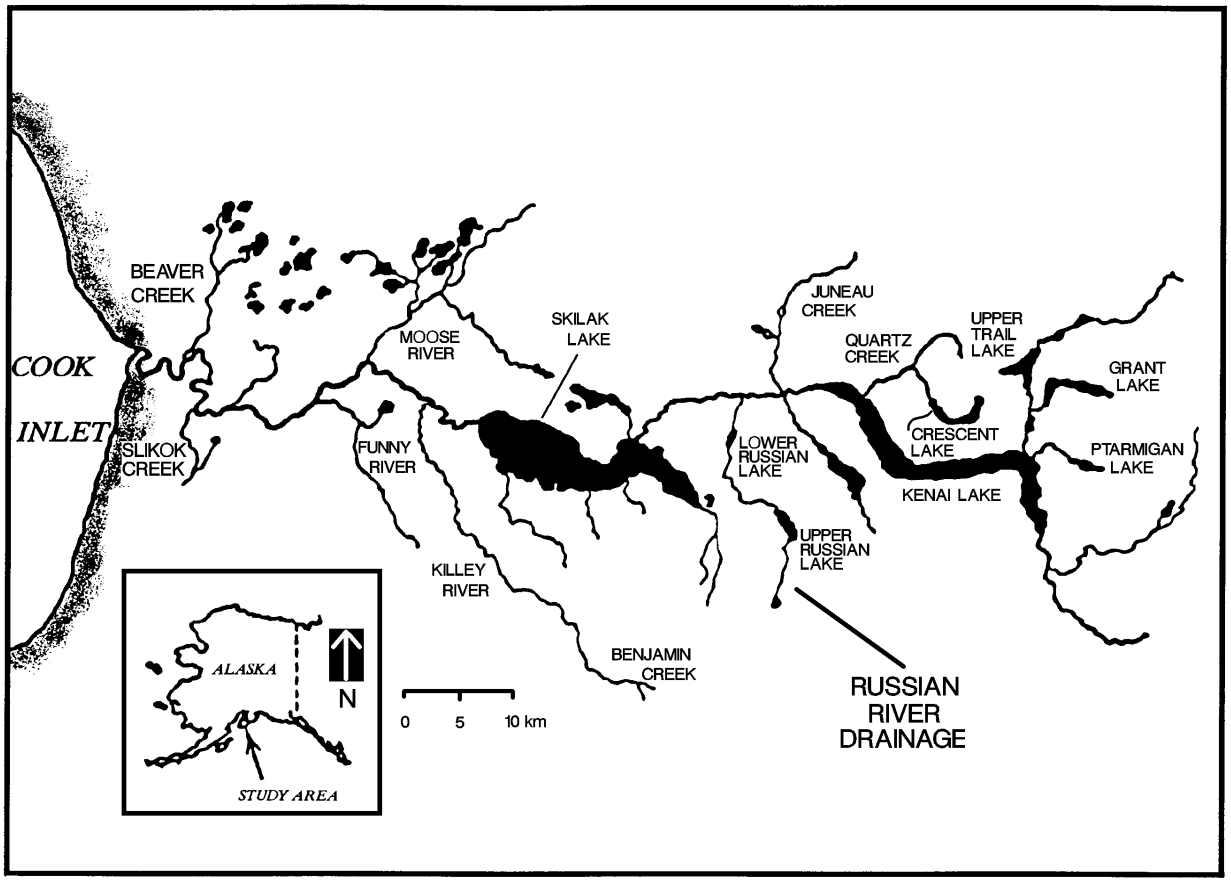


Figure 1.-Map of the Kenai and Russian River drainages.

Lake and in the river section between the two lakes. These fish are primarily 2-ocean fish and spend the majority of the freshwater growth period rearing in Upper Russian Lake.[1] The other segment spawns 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 freshwater residency in Skilak Lake.

In addition to the sport fisheries described above, 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 sport harvest of sockeye salmon in the mainstem of the Kenai River have been reported annually since 1977 (Mills 1979-1994, Howe et al. 1995, 1996). The personal use dip net harvest has been estimated in the Statewide Harvest Survey since 1983 (Mills 1984-1994, Howe et al. 1995, 1996). 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 escapement of 30,000 late-run sockeye salmon migrate

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

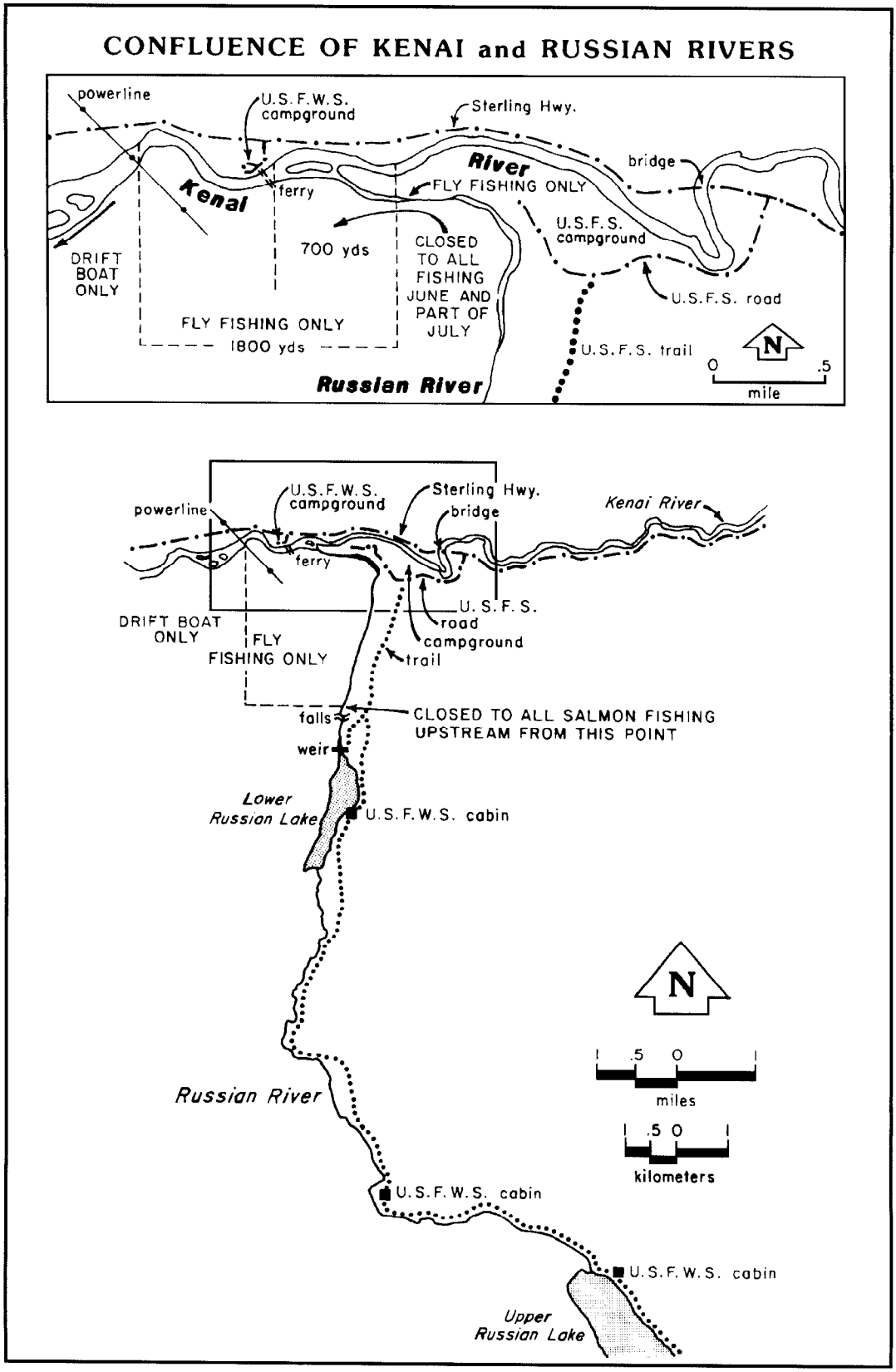


Figure 2.-Detailed map of the Kenai and Russian River study area.

through a weir at the outlet of Lower Russian Lake (Figure 2). This escapement goal, established in 1979, is based upon an evaluation of returns from past brood years.

With the exception of 1977 when the spawning 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 has one of the highest levels of angler participation in the state, there is a potential for overharvest. Accurate and timely management decisions are required to ensure that an adequate spawning 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 in the recreational 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 12 June through 2 August 1996, 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.

This report presents estimates for the 1996 late run: (1) effort and harvest for the recreational fishery; (2) spawning escapement; and (3) the age, sex, and length distributions of the harvest and escapement.

METHODS

STUDY AREA

The recreational fishery occurs in two areas (Figure 3): (1) the confluence, 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, 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 occurs 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. 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 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 traverses the Kenai River. Most anglers fishing the confluence 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

[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).

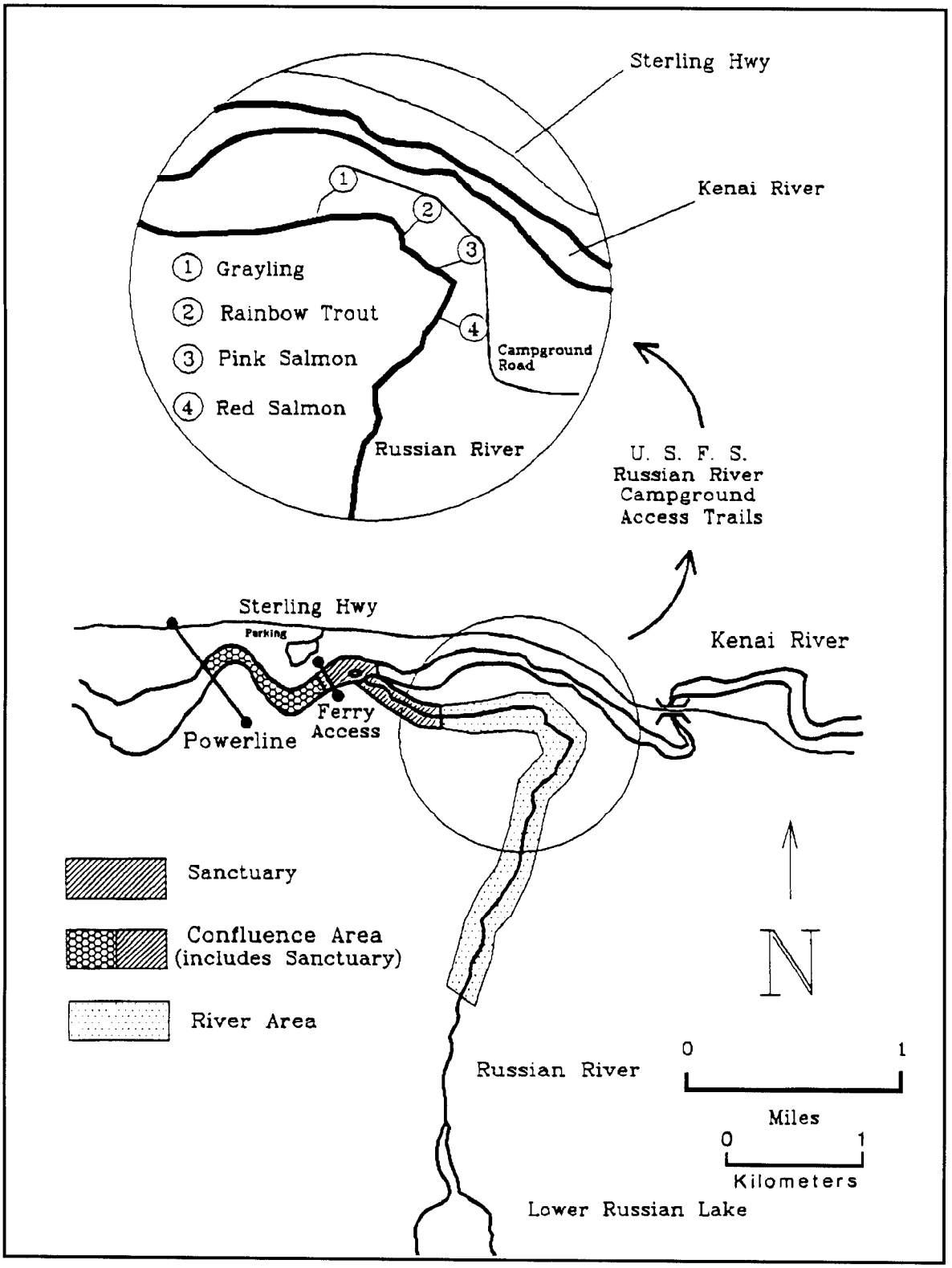


Figure 3.-Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1996 creel survey.

also use the ferry to cross the Kenai River and then walk upstream to fish the Russian River. Anglers may also use the USFS campground trails to gain access to the confluence.

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 (Figure 2). 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 utilizes the daily harvest rates as an index of fish abundance as well as the cumulative total harvest to track the harvest potential of the recreational fishery. These estimates, used in concert with the cumulative weir counts and migratory timing statistics from the historical weir counts, allow fishery managers to project the final escapement that accounts for the potential harvest (Vincent-Lang and Carlon 1991).

A direct expansion creel survey was utilized during the 1996 late run. Sampling was stratified by access location to estimate harvest and effort. Area-specific (river or confluence) 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 21 July to 2 August. Because the age composition of sockeye salmon from the sport harvest and the escapement differed within the time frame when the recreational fishery was open, the data were poststratified into two temporal components (Table 1).

The 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 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). Thus, all interviews were obtained from completed-trip anglers. 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.

Table 1.-Temporal components of the recreational harvest and escapement sampled for age composition during the 1996 late run Russian River sockeye salmon return.

Return Component	Temporal Strata
Confluence-area harvest	7/21 - 8/02
River-area harvest	7/21 - 8/02
Escapement through weir	7/16 - 8/02 8/03 - 9/11
Escapement spawning between the confluence and the falls	8/22, 8/25

Creel data collected in 1991 and 1992 indicated that three major access sites (the Ferry, Grayling and Pink Salmon) accounted for more than 90% of the total harvest and effort and also contributed approximately 90% of the total variance of both these estimates (Carlon et al. 1991, Marsh 1992). Therefore, beginning with the 1993 season, only these three access sites have been sampled.

Using data collected in 1990-1995, sample effort was optimally allocated among the available sampling days at each access site (Cochran 1977). During the late run, the Ferry was sampled during 9 out of 13 possible sampling days, Grayling was sampled 5 days out of 13 possible days and Pink Salmon was sampled 2 days out of 13 possible sampling 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 poststratified for the weir by temporal stratum.

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 only,

m_{2kij} = anglers that fished the confluence 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 data 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 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 estimate 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:

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

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:

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

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

$$\hat{H}_{rkij} = \hat{M}_{rkij}\,\bar{h}_{rkij} \, . \tag{8}$$

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

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

where:

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

and the variance among sample periods was estimated as:

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

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:

$$\hat{H}_{rki} = U_{ki}\bar{H}_{rki} \ , \tag{11}$$

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:

$$\bar{H}_{rk} = \frac{\sum_{i=1}^{d_k} \hat{H}_{rki}}{d_k} \ , \tag{12}$$

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:

$$\mathrm{Var}\left(\bar{H}_{rk}\right) = \frac{\sum_{i=2}^{d_k} \left(\hat{H}_{rki} - \hat{H}_{rk(i-1)}\right)^2}{2\left(d_k - 1\right)} \, . \tag{13}$$

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

$$\hat{H}_{rk} = D_k \bar{H}_{rk} \ , \tag{14}$$

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:

$$\begin{aligned} \mathrm{Var}\left(\hat{H}_{rk}\right) = \ & \left(1 - f_1\right) D_k^{\,2} \frac{\mathrm{Var}\left(\bar{H}_{rk}\right)}{d_k} + \\ & D_k \frac{U_{ki}^{\,2}}{u_{ki}} \left(1 - f_2\right) \frac{\sum_{i=1}^{d_k} \mathrm{Var}\left(\bar{H}_{rki}\right)}{d_k} + \\ & D_k U_{ki} \sum_{i=1}^{d_k} \sum_{j=1}^{u_{ki}} \hat{M}_{rkij}^{\,2} \left(1 - f_3\right) \frac{\mathrm{Var}\left(\bar{h}_{rkij}\right)}{d_k u_{ki} m_{rkij}} \ , \end{aligned} \tag{15}$$

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 (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 at the river and the confluence 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:

$$\overline{\mathrm{HPUE}_{ci}} = \frac{\sum_{l=1}^{m_{ci}} \mathrm{HPUE}_{cil}}{m_{ci}}, \qquad (16)$$

where:

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

The variance of this estimate was calculated as:

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

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 salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake. Foot surveys were used to estimate the segment of the sockeye salmon return (as well as other salmonid species) that spawned in the river area below the weir. 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. Initially, 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 during both returns of sockeye salmon. 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 body characteristics. The period of overlap began on 16 July when late-run fish were intermixed with mature, early-run fish and continued through 25 July, after which early-run fish were no longer present.

Biological Data

Four 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 1992-1995, 1997).

Scales were collected from the preferred area of each sampled fish and placed on adhesive-coated cards (Clutter and Whitesel 1956). 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.

Prior to 1990, age data of the sport harvest from the confluence were used to estimate the age composition of the harvest from both the confluence and river (Nelson et al. 1986, Carlon and Vincent-Lang 1990). This assumes that the age composition of the confluence harvest is the same as that of the river. However, significant differences in age composition were found among the three (confluence harvest, river harvest and weir escapement) sampled areas (Carlon et al. 1991, Marsh 1992-1995, 1997). Based on these results, each area was sampled during 1996. Chi-square tests were used to test the null hypotheses of equal age compositions among locations and time strata. These hypotheses 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. Since the age composition of the harvest was not different ($P > 0.05$; see Results) between areas, all creel and biological data were combined. Therefore, the proportion of fish of age-sex 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, 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):

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

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

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

where:

$\hat{H}_f$ = the estimated total harvest of sockeye salmon during stratum f.

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.

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 were 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 escapement through the weir was estimated by summing the stratum estimates. The total number of fish of age-sex g migrating through the weir was estimated as:

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

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

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

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

$$\hat{p}_{eg} = \frac{\hat{E}_g}{\hat{E}_T}, \tag{26}$$

where:

$\hat{E}_T$ = the total escapement enumerated at the weir.

The variance of this proportion was estimated by:

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

The total return, total return by age-sex, 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-sex g in the total return was estimated as:

$$\hat{p}_g = \frac{\hat{N}_g}{\hat{N}_T}, \tag{28}$$

where:

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

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

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

$$\mathrm{Var}\left(\hat{P}_g\right) \approx \frac{1}{\hat{N}_T^2}\left\{\frac{\mathrm{Var}\left(\hat{H}_c\right)\left[\hat{p}_{cg}\left(\hat{H}_r + E\right) - \left(\hat{H}_{rg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2} + \frac{\mathrm{Var}\left(\hat{H}_r\right)\left[\hat{p}_{rg}\left(\hat{H}_c + E\right) - \left(\hat{H}_{cg} + \hat{E}_g\right)\right]^2}{\hat{N}_T^2} + \mathrm{Var}\left(\hat{p}_{cg}\right)\hat{H}_c^2 + \mathrm{Var}\left(\hat{p}_{rg}\right)\hat{H}_r^2 + \mathrm{Var}\left(\hat{p}_{eg}\right)E^2\right\}, \tag{29}$$

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-sex g from the total harvest from the river (r) or the confluence, or from the escapement (e).

Previous studies utilized the age composition of the escapement 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 as well

as the harvest at the confluence. This assumption, initially tested in 1990, was invalidated as significant differences ($P > 0.05$) in age compositions have been found among the three sampled areas and/or during some of the temporal strata (Carlon et al. 1991, Marsh 1992-1995, 1997). 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 1996. 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 by age in the harvest and escapement.

Mean length at age was estimated for each temporal strata within each of the spatial strata 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 strata, and sex. This analysis was conducted for the predominant age groups (age-2.3, -1.3 and -2.2 fish).

RESULTS

CREEL STATISTICS

Sampling at access locations began on 21 July. Sampling at all locations, Ferry, Grayling and Pink Salmon continued until 2 August when the season was closed by emergency order to ensure an adequate number of sockeye salmon in the spawning escapement. The early closure of the recreational fishery prior to the regulatory closure date of 20 August marks the third occasion for such an action during the late run since 1978.

A total of 3,175 anglers were counted as they exited sampled access locations (Table 2). Of these, 3,055 (96%) were interviewed and 120 (4%) were not interviewed. Most of the interviews (70%) were obtained at the Ferry which typically accounts for the most effort. The remaining interviews were collected at Grayling (26%) and at Pink Salmon (4%).

Nearly all the anglers exiting via the ferry location fished the confluence exclusively (95%) during the late run (Appendix A1). Campground access locations were used to fish both areas. However, the majority of

Table 2.-Summary of the number of interviews collected during sampled periods for the late-run Russian River creel survey, 1996.

	Area Fished			Total	Anglers Exiting and Not	Total Anglers
Exit Location	Confluence	River	Both	Interviews	Interviewed	Exiting
Ferry	2,036	27	88	2,151	110	2,261
Grayling	654	89	34	777	7	784
Pink Salmon	48	79	0	127	3	130
Total	2,738	195	122	3,055	120	3,175

Table 3.-Estimates of harvest, effort, and associated variances by access location for the late-run Russian River sockeye salmon recreational fishery, 1996.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative Precision[a]	Effort[b]	(%)	Variance of Effort	(%)	Relative Precision[a]
Ferry	11,992	59	1,622,942	59	21%	46,424	59	33,220,660	69	24%
Grayling	5,569	28	1,056,118	39	36%	23,051	30	8,083,220	17	24%
Pink Salmon	2,581	13	47,811	2	17%	8,476	11	6,721,994	14	60%
Total	20,142	100	2,726,871	100	16%	77,951	100	48,025,874	100	17%

[a] $\alpha = 0.05$

[b] Angler-hours.

anglers exiting the Grayling access site fished the confluence (84%), while the majority of anglers who exited at Pink Salmon fished the river (62%).

HARVEST AND EFFORT

Anglers exiting the fishery at the ferry accounted for most of the harvest (59%) and the corresponding effort (59%) during the late run (Table 3). The relative precision of the late-run harvest and effort estimates were 16% and 17%, respectively (Table 3). Estimates of harvest, effort, and variances are presented by stratum (temporal/access location) in Appendix A2.

The 1996 late run harvest estimate was 20,142 (SE = 1,651) sockeye salmon (Table 4). The effort estimate for the late run was 77,951 (SE = 6,930) angler-hours. During the late run, 90% of the harvest was taken from the confluence and the remaining 10% was taken from the river (Table 4). Correspondingly, the effort during the late run sport fishery was directed primarily at the confluence (92%) and less so at the river (8%).

The estimated HPUE for the late run was 0.258 (Table 5), which was an increase of 58% in angler harvest efficiency from 1995 (Marsh 1997).

Table 4.-Summary of estimated angler effort and harvest by component during the late run of Russian River sockeye salmon, 1996.

Component	Confluence Area	Confluence %	River Area	River %	Total	95% Confidence Interval
Effort[a]	71,538	92	6,413	8	77,951	64,368 - 91,534
SE	6,786		1,406		6,930	
Harvest	18,119	90	2,023	10	20,142	16,905 - 23,379
SE	1,634		238		1,651	

[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, 1996.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	11	13	2,856	0.253	0.0005
River	8	13	199	0.315	0.0014
Both			3,055	0.258	0.0004

[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.

SPAWNING ESCAPEMENT

A total of 34,691 late-run sockeye salmon passed through the weir (Table 6, Appendix A3). The greatest daily counts at the weir occurred during the first 2 weeks in August (Figure 4). Transition between the two runs occurred from 16 July to 25 July. Weir enumeration ceased on 11 September.

An estimated 31,601 sockeye salmon were counted during foot surveys of the Russian River downstream from the Russian River falls (Table 6).

Coho salmon enumerated through the weir totaled 556 during the late run (Table 6 and Appendix A3). This was only a partial enumeration of the coho salmon return because the immigration of coho salmon continued after the weir was removed.

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 between the two temporal strata ($P = 0.001$). The late-run escapement through the weir comprised five age groups (Table 8). Age-2.2 and -2.3 fish dominated the first temporal stratum (44% and 36%, respectively). However, the proportion of age-2.2 and -2.3 fish declined later in the return, representing only 39% and 14%, respectively, while the proportion of age-2.1 fish increased to 33% during the second temporal stratum.

The age composition of the harvest at the confluence was not significantly different from the harvest in the river (Table 7). This allowed the biological data collected at the confluence to be combined with the biological data collected at the river to estimate the harvest in the recreational fishery by age-sex group. The late-run recreational harvest was comprised of predominantly age-2.2 (41%) and age-2.3 (32%) fish (Table 9).

The age composition of sockeye salmon that spawned in the Russian River downstream from the Russian River falls was primarily age-1.3 (88%) fish (Table 10). Mean length

Table 6.-Escapements of sockeye, coho, and chinook salmon during the late run to the Russian River drainage, 1996.

Component	Dates	Sockeye Salmon	Coho Salmon	Chinook Salmon
Late run	07/21 - 9/11	34,691[a]	556	47
Downstream[b]	08/25[c]	31,601[d]		75[e]

[a] From 7/16 through 7/25, 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 (8/22 and 8/25) were made downstream from the Russian River falls. A greater number of fish were enumerated on 8/25. The tabulated values are for 8/25 only and represent a minimum estimate.

[d] Includes 25,152 live fish and 6,449 dead fish that spawned downstream from the Russian River falls.

[e] Includes 33 live fish and 42 dead fish enumerated downstream from Russian River falls.

Error! No topic specified.

Figure 4.-Daily escapement of sockeye salmon through the Russian River weir during the late run, 1996.

Table 7.-Results of contingency test comparisons of age composition between spatial fishery components for the late-run Russian River sockeye salmon recreational fishery, 1996.

	Spatial Component		
Temporal Stratum[a]	Confluence Harvest vs. River Harvest	Confluence Harvest vs. Weir Escapement	River Harvest vs. Weir Escapement
1	df = 6, X^2 = 6.92, P = 0.33 NS[b] (P > 0.05)	df = 8, X^2 = 34.90, P = 0.001 S[b] (P < 0.05)	df = 3, X^2 = 3.35, P = 0.001 S[b] (P < 0.05)

[a] 1 = 7/21-8/02.

[b] NS = No significant difference, S = significant difference.

by age and sex was also estimated for this spawning component of the late run (Table 11).

Fish age 2.2 during the first temporal stratum were significantly larger (F = 19.58, df = 1;324, P = 0.0001) than those during the second stratum (Table 12). For fish age 2.3, males were significantly larger (F = 11.67, df = 1;187, P = 0.0008) than females.

TOTAL RETURN STATISTICS

Overall, an estimated 54,833 late-run sockeye salmon returned to the Russian River in 1996 (Table 13). 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 1996 late run was considerably less than the historical (1978-1995) average of nearly 104,000 sockeye salmon (Figure 5). However, the late run of sockeye salmon returning to the Russian River during 1996 continued to exceed the (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, these anglers were 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 1996. 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

Table 8.-Estimated age and sex composition of the late-run sockeye salmon escapement through the Russian River weir, 1996.

	Age Group						
Dates	2.3	1.3	2.2	2.1	1.2	1.1,3.2.etc. Misc.	Total
7/16 - 8/02							
n[a] = 123							
Count = 9,837							
			FEMALES				
Sample Size	18	4	29	0	0	1	52
Percent	14.6	3.3	23.6	0.0	0.0	0.8	42.3
Variance of Percent	10.2	2.6	14.8	0.0	0.0	0.7	20.0
Number	1,440	320	2,319	0	0	80	4,159
Variance of Number	99,087	24,955	142,916	0	0	6,396	193,561
			MALES				
Sample Size	26	7	25	9	2	2	71
Percent	21.1	5.7	20.3	7.3	1.6	1.6	57.7
Variance of Percent	13.7	4.4	13.3	5.6	1.3	1.3	20.0
Number	2,079	560	1,999	720	160	160	5,678
Variance of Number	132,221	42,571	128,446	53,790	12,687	12,687	193,561
			SEXES COMBINED				
Sample Size	44	11	54	9	2	3	123
Percent	35.8	8.9	43.9	7.3	1.6	2.4	100.0
Variance of Percent	18.8	6.7	20.2	5.6	1.3	2.0	
Number	3,519	880	4,319	720	160	240	9,837
Variance of Number	182,236	64,590	195,343	53,790	12,687	18,874	

-continued-

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 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

An accurate estimate of the age composition of the sockeye salmon return is needed to establish accurate brood tables for the Russian

Table 8.-Page 2 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	1.1,3.2.etc. Misc.	Total
8/03 - 9/11							
n[a] = 387							
Count = 24,854							
			FEMALES				
Sample Size	19	0	100	4	0	8	131
Percent	4.9	0.0	25.8	1.0	0.0	2.1	33.9
Variance of Percent	1.2	0.0	5.0	0.3	0.0	0.5	5.8
Number	1,220	0	6,422	257	0	514	8,413
Variance of Number	74,711	0	306,666	16,370	0	32,398	358,339
			MALES				
Sample Size	34	20	52	124	5	21	256
Percent	8.8	5.2	13.4	32.0	1.3	5.4	66.1
Variance of Percent	2.1	1.3	3.0	5.6	0.3	1.3	5.8
Number	2,184	1,284	3,340	7,964	321	1,349	16,441
Variance of Number	128,244	78,429	186,136	348,466	20,409	82,127	358,339
			SEXES COMBINED				
Sample Size	53	20	152	128	5	29	387
Percent	13.7	5.2	39.3	33.1	1.3	7.5	100.0
Variance of Percent	3.1	1.3	6.2	5.7	0.3	1.8	
Number	3,404	1,284	9,762	8,220	321	1,862	24,854
Variance of Number	189,150	78,429	381,676	354,236	20,409	110,934	

-continued-

River system. The sampling of time and area strata begun in 1990 was continued during the 1996 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 1992-1995, 1997).

The age composition of the confluence and river harvests and the weir escapement clearly differed during the late run in 1996 (Table 7). Because age compositions differed among the spatial strata, biological data could not be pooled to allocate the combined return (harvest + escapement). Therefore, a post-stratified estimate of escapement was calculated for each time stratum. Samples obtained from the two spatial strata of the harvest, river and confluence, were not

Table 8.-Page 3 of 3.

Dates	Age Group 2.3	1.3	2.2	2.1	1.2	1.1,3.2.etc. Misc.	Total
Late Run Total (7/16-9/11)							
n[a] = 510							
Count = 34,691							
			FEMALES				
Percent	7.7	0.9	25.2	0.7	0.0	1.7	36.2
Variance of Percent	1.4	0.2	3.7	0.1	0.0	0.3	4.6
Number	2,660	320	8,742	257	0	594	12,572
Variance of Number	173,798	24,955	449,582	16,370	0	38,794	551,900
			MALES				
Percent	12.3	5.3	15.4	25.0	1.4	4.3	63.8
Variance of Percent	2.2	1.0	2.6	3.3	0.3	0.8	4.6
Number	4,263	1,844	5,339	8,683	481	1,509	22,119
Variance of Number	260,465	121,000	314,583	402,256	33,096	94,814	551,900
			SEXES COMBINED				
Percent	20.0	6.2	40.6	25.8	1.4	6.1	100.0
Variance of Percent	3.1	1.2	4.8	3.4	0.3	1.1	
Number	6,923	2,164	14,080	8,940	481	2,102	34,691
Variance of Number	371,386	143,020	577,019	408,026	33,096	129,808	

[a] n = sample size.

significantly different, allowing biological data to be pooled to estimate the age composition of the recreational harvest.

Sampling the temporal and spatial strata should be continued at the present sampling intensity. This will improve the estimates of the numbers of sockeye salmon returning by age and sex and allow 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 *O. tshawytscha* (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

Table 9.-Estimated age and sex composition of the late-run sockeye salmon harvested in the recreational fishery at the Russian River, 1996.

		Age Group						
Dates		2.3	1.3	2.2	2.1	1.2	1.1,3.2,etc. Misc.	Total
7/21 - 8/02								
n[a] =	311							
Harvest[b] =	20,142							
Var(Harvest) =	2,726,871							
				FEMALES				
Sample Size		53	38	92	1	0	0	184
Percent		17.0	12.2	29.6	0.3	0.0	0.0	59.2
Variance of Percent		4.6	3.5	6.7	0.1	0.0	0.0	7.8
Number		3,433	2,461	5,958	65	0	0	11,917
Variance of Number		262,971	180,136	509,413	4,195	0	0	1,268,570
				MALES				
Sample Size		45	41	34	1	2	4	127
Percent		14.5	13.2	10.9	0.3	0.6	1.3	40.8
Variance of Percent		4.0	3.7	3.1	0.1	0.2	0.4	7.8
Number		2,914	2,655	2,202	65	130	259	8,225
Variance of Number		217,966	196,172	159,168	4,195	8,419	16,955	768,789
				SEXES COMBINED				
Sample Size		98	79	126	2	2	4	311
Percent		31.5	25.4	40.5	0.6	0.6	1.3	100.0
Variance of Percent		7.0	6.1	7.8	0.2	0.2	0.4	
Number		6,347	5,116	8,160	130	130	259	20,142
Variance of Number		551,310	422,279	760,877	8,419	8,419	16,955	2,726,871

[a] n = sample size.

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

recommended that this technique continue to be implemented in 1997 and subsequent years to further evaluate the value of these statistics in managing the Russian River sockeye salmon resource.

ACKNOWLEDGMENTS

Steve Hammarstrom has provided a consistent outlook regarding the research aspects of the Russian River project. His observations of the project have served to increase my understanding of the fishery resources of the Russian River.

Joe Richards collected creel survey interviews and biological data from the sport fishery. This was Joe's second season at the Russian River and he continued to establish exemplary standards for the completion of all responsibilities.

Amy Dolan collected creel survey interviews and biological data from the sport fishery. This was Amy's first season at the Russian

Table 10.-Estimated age and sex composition of sockeye salmon which spawned downstream from the Russian River Falls, 1996.

	Age Group				
	2.3	1.3	2.2	1.2	Total
		22 August and 25 August [a]			
Females					
Sample Size	1	65	0	9	75
Percent	0.7	45.1	0.0	6.3	52
Variance of Percent	0.5	17.3	0.0	4.1	17
Number	219	14,264	0	1,975	16,459
Variance of Number	48,159	1,729,343	0	409,182	1,742,814
Males					
Sample Size	2	62	2	3	69
Percent	1.4	43.1	1.4	2.1	48
Variance of Percent	1.0	17.1	1.0	1.4	17
Number	439	13,606	439	658	15,142
Variance of Number	95,644	1,712,167	95,644	142,456	1,742,814
Sexes Combined					
Percent	2.1	88.2	1.4	8.3	100
Variance of Percent	1.4	34.5	1.0	5.5	
Number	658	27,870	439	2,633	31,601
Variance of Number	143,803	3,441,510	95,644	551,638	

[a] Indicates two distinct sampling dates.

River. Amy's positive enthusiasm while performing her responsibilities were a valued contribution to the Russian River 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. This past season, Troy provided a new approach for the compilation and tracking of historical data collected at the weir site utilizing a computer. This transition will allow for a more efficient research effort to be implemented at the Russian River weir.

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

Pat Hansen provided the biometric review of the data analysis. In addition, Pat was a much appreciated "voice of reason" during the critical review of the written text.

Saree Timmons has been a "lead" technical editor for the final, pre-print editions of the Russian River reports. Saree's ability to interpret and understand the mechanics of the study design in concert with her capable hand as a technical author have provided for a clearer and more concise final document.

Table 11.-Mean length at age, by sex, for sampled sockeye salmon which spawned below the falls area during the late run of sockeye salmon to the Russian River, 1996.

Component			Age Class 2.3	1.3	2.2	1.2
Downstream Escapement[a]						
	Female	Mean Length (mm)	606	584		566
		SE		2.7		6.9
		Sample Size	1	65		9
	Male	Mean Length (mm)	614	615	603	599
		SE	9.5	2.8	11.5	3.3
		Sample Size	2	62	2	3

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

Table 12.-Mean length (millimeters) at age, by sex, for the late run of sockeye salmon sampled from the Russian River, 1996.

			Age 2.3			Age 2.2			Age 2.1			Age 1.3			Age 1.2		
Date	Component	Sex	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
21 July - 2 August																	
	Harvest[a]	F	53	588	3.6	92	534	2.2	1	430		38	597	4.3			
		M	45	605	5.1	34	537	2.6	1	415		41	619	3.6	2	470	20.0
	Escapement[b]	F	18	575	6.7	29	531	4.1				4	603	6.5			
		M	26	596	6.6	25	533	4.6	9	409	11.3	7	620	5.1	2	455	10.0
3 August - 11 September[b]																	
	Escapement	F	19	577	7.1	100	517	2.1	4	411	8.3						
		M	34	602	3.9	52	516	3.8	124	400	1.8	20	607	4.4	5	504	18.2

[a] Sampling concluded on 8/02 in the recreational harvest areas; river and confluence.

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

Table 13.-Estimated age and sex composition of the late run of sockeye salmon to the Russian River, 1996.

	Age Group						
Dates	2.3	1.3	2.2	2.1	1.2	1.1,3.2.etc. Misc.	Total
7/16 - 9/11							
Late Run Total[a] n[b] = 821							
			FEMALES				
Percent	11.1	5.1	26.8	0.6	0.0	1.1	44.7
Variance of Percent	1.30	0.60	2.71	0.07	0.00	0.13	4.14
Number	6,092	2,781	14,700	322	0	594	24,489
Variance of Number	436,769	205,091	958,994	20,564	0	38,794	1,820,470
			MALES				
Percent	13.1	8.2	13.8	16.0	1.1	3.2	55.3
Variance of Percent	1.48	0.96	1.51	1.35	0.14	0.37	3.47
Number	7,177	4,500	7,541	8,748	611	1,768	30,344
Variance of Number	478,431	317,172	473,750	406,451	41,515	111,769	1,320,690
			SEXES COMBINED				
Percent	24.2	13.3	40.6	16.5	1.1	4.3	100.0
Variance of Percent	2.53	1.53	3.55	1.38	0.14	0.49	3.56
Number	13,270	7,281	22,241	9,070	611	2,361	54,833
Variance of Number	922,696	565,298	1,337,896	416,445	41,515	146,763	2,726,871

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

[b] n = sample size.

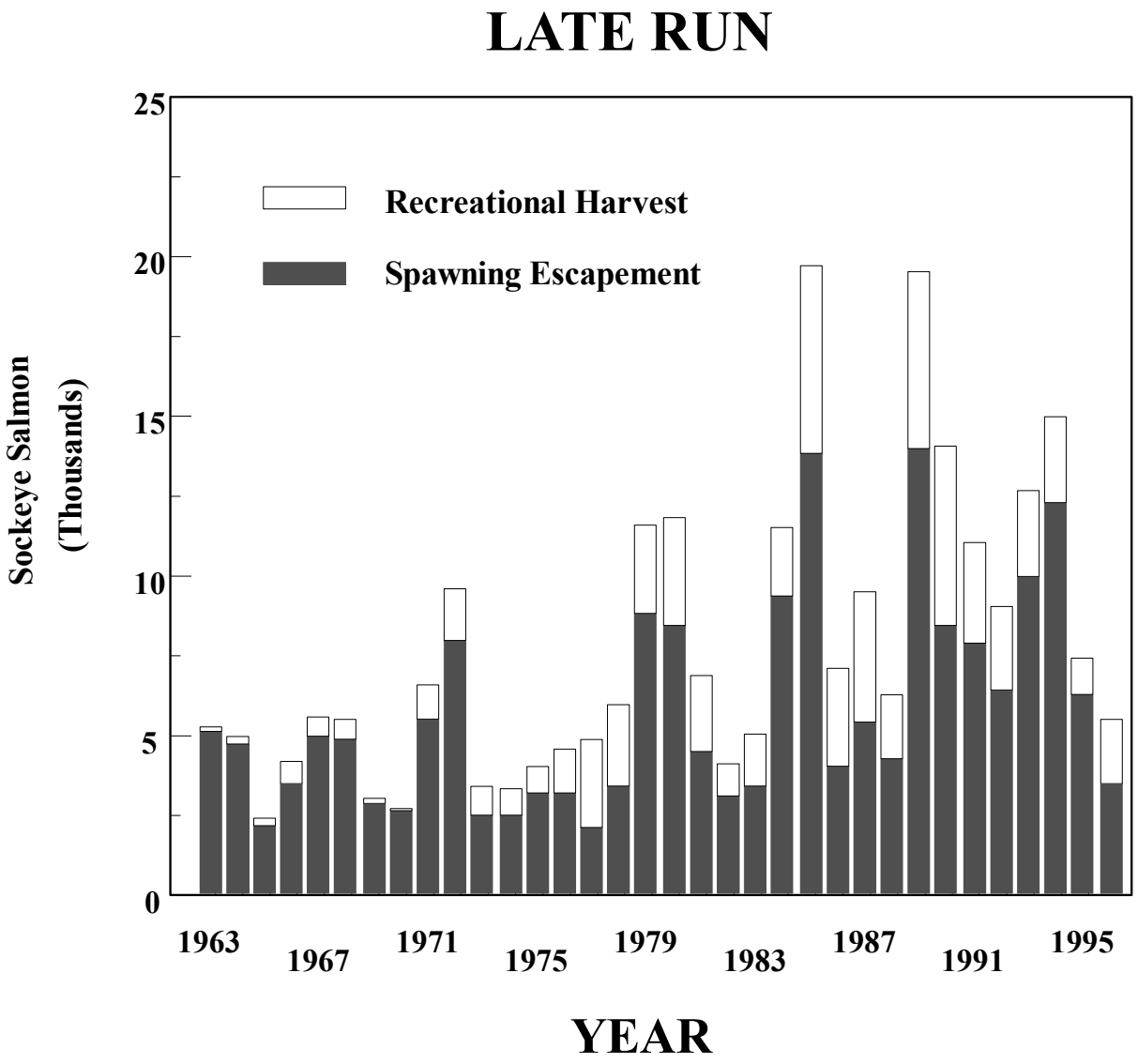


Figure 5.-Historical returns of sockeye salmon to the Russian River.

LITERATURE CITED

Athons, D. E. and D. N. McBride. 1987. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 7, Juneau.

Bernard, D. R., A. Bingham, and M. Alexandersdottir. *In prep*. The mechanics of conducting onsite creel surveys in Alaska. Alaska Department of Fish and Game, Special Publication, Anchorage.

Carlon, J. A. and D. Vincent-Lang. 1990. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-21, Anchorage.

Carlon, J. A., D. Vincent-Lang, and M. Alexandersdottir. 1991. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-26, Anchorage.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin No. 9, International Pacific Salmon Fisheries Commission, New Westminster, British Columbia, Canada.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley and Sons, Inc. New York.

Cross, B. A., D. R. Bernard, and S. L. Marshall. 1983. Returns per spawner ratios for sockeye salmon in Upper Cook Inlet, Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 221.

Cross, B. A., D. L. Hicks, and W. E. Goshert. 1985. Origins of sockeye salmon in the fisheries of Upper Cook Inlet in 1982. Alaska Department of Fish and Game, Technical Data Report No. 139.

Cross, B. A., D. L. Hicks, and W. E. Goshert. 1986. Origins of sockeye salmon in the fisheries of Upper Cook Inlet in 1983. Alaska Department of Fish and Game, Technical Data Report No. 181.

Engel, L. J. 1965. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6 (7-A):111-127, Juneau.

Engel, L. J. 1966. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Project F-5-R-7, 7 (7-A):59-78, Juneau.

Engel, L. J. 1967. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Project F-5-R-8, 8 (7-A):73-81, Juneau.

Engel, L. J. 1968. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9 (7-A):95-116, Juneau.

Engel, L. J. 1969. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10 (7-A):111-130, Juneau.

Engel, L. J. 1970. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11 (7-C-2):129-134, Juneau.

Engel, L. J. 1971. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12 (G-II-G):79-89, Juneau.

Engel, L. J. 1972. Studies of the Russian River red salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1971-1972, Project F-9-4, 13 (G-II-G):1-14, Juneau.

Goodman, L. A. 1960. On the exact variance of products. Journal of American Statistical Association 66:708-713.

LITERATURE CITED (Continued)

Hammarstrom, S. and D. Athons. 1988. Catch and effort statistics for the sockeye salmon Oncorhynchus nerka sport fishery in the Russian River with estimates of escapement, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 41, Juneau.

Hammarstrom, S. and D. Athons. 1989. Catch and effort statistics for the sockeye salmon sport fishery in the Russian River with estimates of escapement, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 88, Juneau.

Howe, Allen L., Gary Fidler, Allen E. Bingham, and Michael J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage.

Howe, Allen L., Gary Fidler, and Michael J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-24, Anchorage.

Lawler, R. R. 1963. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1962-1963, Project F-5-4-4, 4 (6-A):145-160, Juneau.

Lawler, R. R. 1964. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1963-1964, Project F-6-R-5, 5 (6-A):112-122, Juneau.

Marsh, L. E. 1992. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-39, Anchorage.

Marsh, L. E. 1993. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-35, Anchorage.

Marsh, L. E. 1994. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-15, Anchorage.

Marsh, L. E. 1995. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-10, Anchorage.

Marsh, L. E. 1997. Catch and effort statistics for the sockeye salmon sport fishery during the late run to the Russian River with estimates of escapement, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 97-1, Anchorage.

McBride, D., M. Alexandersdottir, S. Hammarstrom, and D. Vincent-Lang. 1989. Development and implementation of an escapement goal policy for the return of chinook salmon to the Kenai River. Alaska Department of Fish and Game, Fishery Manuscript Series No. 8, Juneau.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-1), Juneau.

Mills, M. J. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-1), Juneau.

Mills, M. J. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

Mills, M. J. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

Mills, M. J. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-I-A), Juneau.

LITERATURE CITED (Continued)

Mills, M. J. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-I-A), Juneau.

Mills, M. J. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-I-A), Juneau.

Mills, M. J. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-I-A), Juneau.

Mills, M. J. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2), Juneau.

Mills, M. J. 1987. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

Mills, M. J. 1989. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

Mills, M. J. 1992. Harvest, catch, and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-40, Anchorage.

Mills, M. J. 1993. Harvest, catch, and participation in Alaska sport fisheries during 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-42, Anchorage.

Mills, M. J. 1994. Harvest, catch, and participation in Alaska sport fisheries during 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-28, Anchorage.

Mundy, P. R. 1982. Migratory timing of adult chinook salmon (Oncorhynchus tshawytscha) in the lower Yukon, Alaska with respect to fisheries management. Technical Report No. 82-1. Department of Oceanography. Old Dominion University. Norfolk, Virginia.

Nelson, D. C. 1973. Studies on Russian River sockeye salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1972-1973, Project F-9-5, 14 (G-II-G):1-26, Juneau.

Nelson, D. C. 1974. Studies on Russian River sockeye salmon sport fishery. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1973-1974, Project F-9-6, 15 (G-II-G):21-48, Juneau.

Nelson, D. C. 1975. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1974-1975, Project AFS-44, 16 (AFS-44-1):1-41, Juneau.

Nelson, D. C. 1976. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1975-1976, Project AFS-44, 17 (AFS-44-2):1-54, Juneau.

Nelson, D. C. 1977. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1976-1977, Project AFS-44, 18 (AFS-44-3):1-54, Juneau.

Nelson, D. C. 1978. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1977-1978, Project AFS-44, 19 (AFS-44-4):1-57, Juneau.

Nelson, D. C. 1979. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1978-1979, Project AFS-44, 20 (AFS-44-5):1-60, Juneau.

LITERATURE CITED (Continued)

Nelson, D. C. 1980. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1979-1980, Project AFS-44, 21 (AFS-44-6):1-47, Juneau.

Nelson, D. C. 1981. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1980-1981, Project AFS-44, 22 (AFS-44-7):1-48, Juneau.

Nelson, D. C. 1982. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1981-1982, Project AFS-44, 23 (AFS-44-8):1-48, Juneau.

Nelson, D. C. 1983. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1982-1983, Project AFS-44, 24 (AFS-44-9):1-50, Juneau.

Nelson, D. C. 1984. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1983-1984, Project F-9-16, 25 (G-II-C):1-66, Juneau.

Nelson, D. C. 1985. Russian River sockeye salmon study. Alaska Department of Fish and Game. Anadromous Fish Studies, Annual Performance Report, 1984-1985, Project F-9-17, 26 (G-II-C):1-59, Juneau.

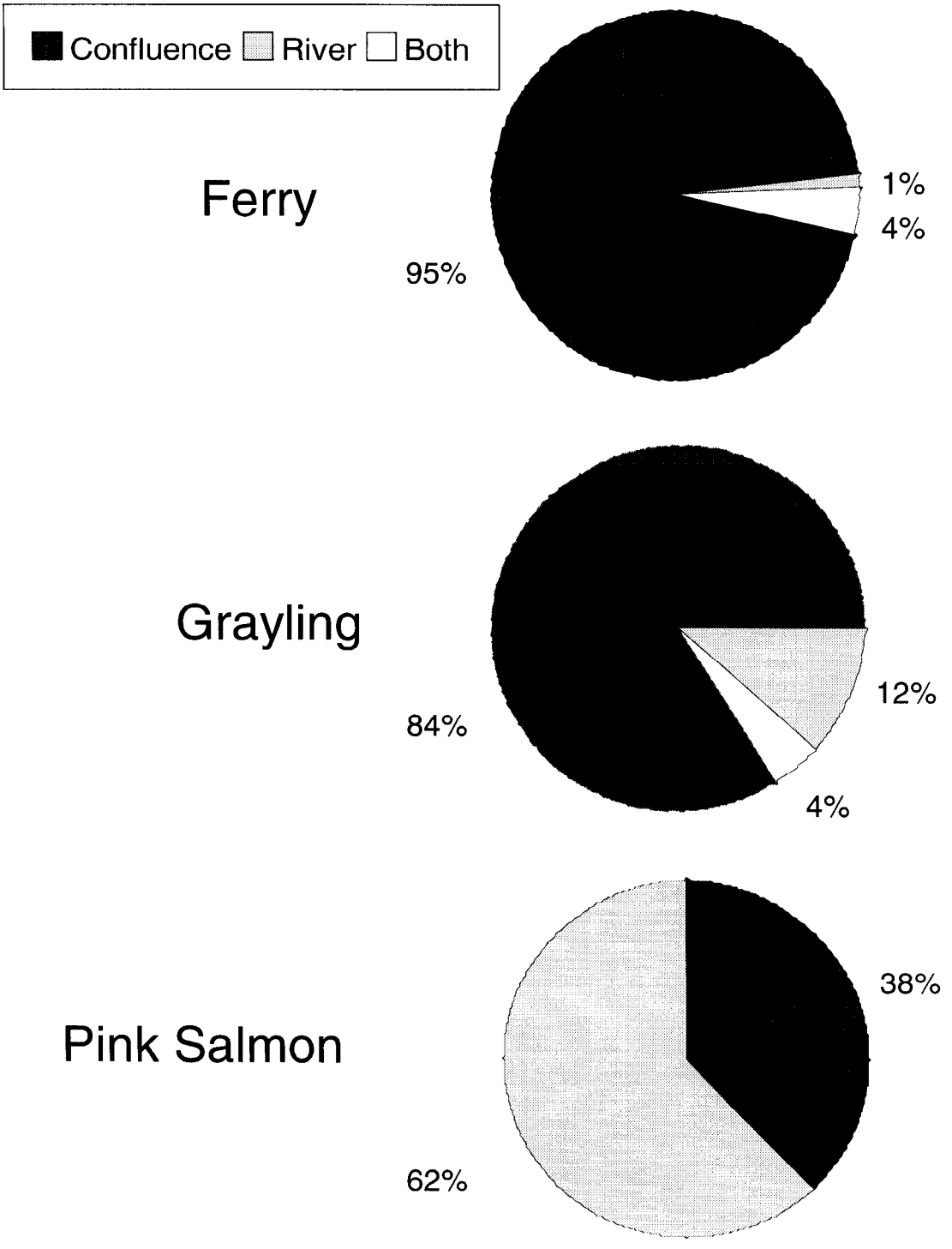
Nelson, D. C., D. E. Athons, and J. A. Carlon. 1986. Russian River sockeye salmon study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project AFS-44, 27 (AFS-44-11):1-59, Juneau.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1979. Elementary survey sampling. Duxbury Press. North Scituate, Massachusetts.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. Charles Griffin and Company Ltd., London.

Vincent-Lang, D. and J. A. Carlon. 1991. Development and implementation of escapement goals for the early return of sockeye salmon to the Russian River, Alaska. Alaska Department of Fish and Game, Fishery Manuscript Series No. 91-1, Anchorage.

APPENDIX A



Appendix A1.-Percent of anglers exiting three access locations that fished at the confluence area, river area, or both areas during the late-run fishery for sockeye salmon at the Russian River, 1996.

Appendix A2.-Temporal harvest and effort estimates for the 1996 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	7/21-8/02	13	9	37	1,481	485	34,042	8,558	25	25,434	75	51	0
Grayling	7/21-8/02	13	5	98	4,030	1,272	99,731	83,824	84	15,906	16	1	0
Pink Salmon	7/21-8/02	13	2	358	24,953	4,656	1,843,723	1,784,108	97	59,530	3	85	0
	Total 7/21-8/02					6,413	1,977,496						
	Total River Effort					6,413	1,977,496						
Confluence Effort:													
Ferry	7/21-8/02	13	9	3,534	1379478	45,939	33,186,618	7,970,315	24	25,213,360	76	2,944	0
Grayling	7/21-8/02	13	5	1,675	261,590	21,779	7,983,489	5,441,081	68	2,541,867	32	542	0
Pink Salmon	7/21-8/02	13	2	294	59,971	3,820	4,878,271	4,287,929	88	590,184	12	157	0
	Total 7/21-8/02					71,538	46,048,378						
	Total Confluence Effort					71,538	46,048,378						
	Total Effort					77,951	48,025,874						

-continued-

Appendix A2.-Page 2 of 2.

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Harvest	Estimated Total Variance	Days	%	Periods	%	Anglers	%
River Harvest:													
Ferry	7/21-8/02	13	9	7	130	92	1,458	748	51	707	48	3	0
Grayling	7/21-8/02	13	5	15	731	195	20,342	15,210	75	5,132	25	0	0
Pink Salmon	7/21-8/02	13	2	134	1	1,736	34,889	41	0	34,821	100	28	0
	Total 7/21-8/02					2,023	56,689						
	Total River Harvest					2,023	56,689						
Confluence Harvest:													
Ferry	7/21-8/02	13	9	915	39,521	11,900	1,621,484	228,345	14	1,392,448	86	691	0
Grayling	7/21-8/02	13	5	413	40,648	5,374	1,035,776	845,488	82	190,221	18	67	0
Pink Salmon	7/21-8/02	13	2	65	0	845	12,922	26	0	12,852	99	44	0
	Total 7/21-8/02					18,119	2,670,182						
	Total Confluence Harvest					18,119	2,670,182						
	Total Harvest					20,142	2,726,871						

[a] D = days possible in a stratum.

[b] d = days sampled in a stratum.

Appendix A3.-Daily escapement of sockeye, coho and chinook salmon through the Russian River weir during the late run, 1996.

Date	Early-Run Sockeye Salmon [a]	Late-Run Sockeye Salmon	Coho Salmon	Chinook Salmon
7/15	19	0		0
7/16	208	13		1
7/17	245	12		0
7/18	45	7		0
7/19	6	2		0
7/20	3	0		0
7/21	0	0		0
7/22	15	29		0
7/23	21	19		0
7/24	64	1,712		0
7/25	24	264		0
7/26		688		0
7/27		510		0
7/28		655		0
7/29		683		0
7/30		1,586		0
7/31		256		0
8/1		2,087	0	1
8/2		1,314	0	0
8/3		1,087	1	0
8/4		2,142	4	0
8/5		959	4	1
8/6		964	4	0
8/7		705	5	5
8/8		946	22	7
8/9		1,027	17	4
8/10		507	6	3
8/11		346	0	0
8/12		1,254	3	0
8/13		618	1	0
8/14		1,026	0	0
8/15		2,752	54	6
8/16		1,205	1	0
8/17		1,154	15	7
8/18		674	0	0
8/19		333	1	1
8/20		459	0	1
8/21		1,290	14	7
8/22		384	0	0
8/23		11	0	0
8/24		1,065	90	2
8/25		358	3	0
8/26		722	20	0
8/27		381	1	0
8/28		308	5	0
8/29		387	2	0
8/30		304	2	0
8/31		448	5	0
9/1		280	15	1
9/2		226	5	0
9/3		142	33	0
9/4		87	11	0
9/5		70	24	0
9/6		0	0	0
9/7		10	4	0
9/8		19	58	0
9/9		5	9	0
9/10		121	9	0
9/11		78	108	0
Total		34,691	556	47

[a] From 7/16 through 7/25, 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 10-day overlap between early-run and late-run fish.