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Catch and Effort Statistics for the Sockeye Salmon Sport Fishery During the Early Run to the Russian River With Estimates of Escapement, 1992

by

Larry E. Marsh

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ABSTRACT

A direct expansion creel survey of the early-run Russian River recreational fishery was conducted in 1992 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 143,937 angler-hours to harvest 30,512 sockeye salmon from the early run (12 June-19 July). The weighted harvest rate for the early run was 0.212 sockeye salmon per hour of angler effort. Approximately 60% of the effort and harvest during the early run was taken from the confluence area of the fishery.

A total of 37,117 sockeye salmon bound for spawning areas was counted through the weir at the outlet of Lower Russian Lake during the early run. This escapement number exceeded the Board of Fisheries mandated escapement goal of 16,000 fish.

Estimates of the age composition of the total early run (apportioned harvest plus escapement) indicate that the return was primarily of age-2.3 and age-2.2 sockeye salmon (70.6% and 28.5%, respectively). Both the sport harvest and total return for the early run were at or near the mean historical values for the time frame 1976-present.

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

INTRODUCTION

The Russian River is a clearwater stream located in the central Kenai Peninsula near Cooper Landing, Alaska. The drainage includes two large clearwater lakes, Upper and Lower Russian lakes, and terminates in the Kenai River approximately midway between Kenai and Skilak lakes (Figure 1). The 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 pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965-1972), Nelson (1973-1985), Nelson et al. (1986), Athons and McBride (1987), Hammarstrom and Athons (1988, 1989), Carlon and Vincent-Lang (1990), Carlon et al. (1991), and Marsh (1992).

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

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

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

Given that the recreational fishery for sockeye salmon at the Russian River is the largest in the state in terms of angler effort, there is a potential for overharvest. Precise and timely management decisions are required to ensure that adequate escapement is obtained. The data necessary for these decisions are provided by a creel survey and a counting weir. The creel survey provides data regarding angler effort and harvest from the recreational fishery for

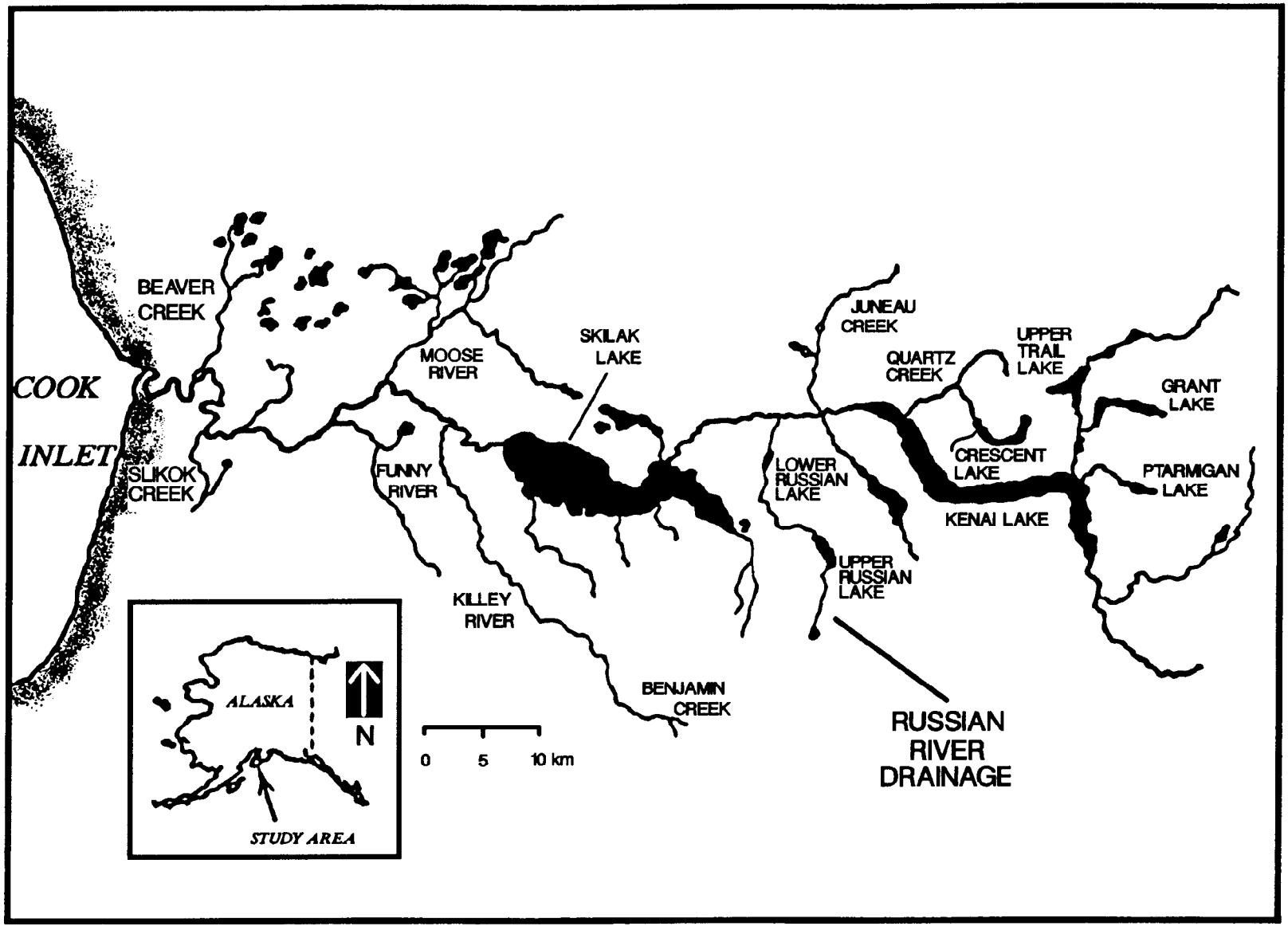

Figure 1. Map of the Kenai and Russian River drainages.

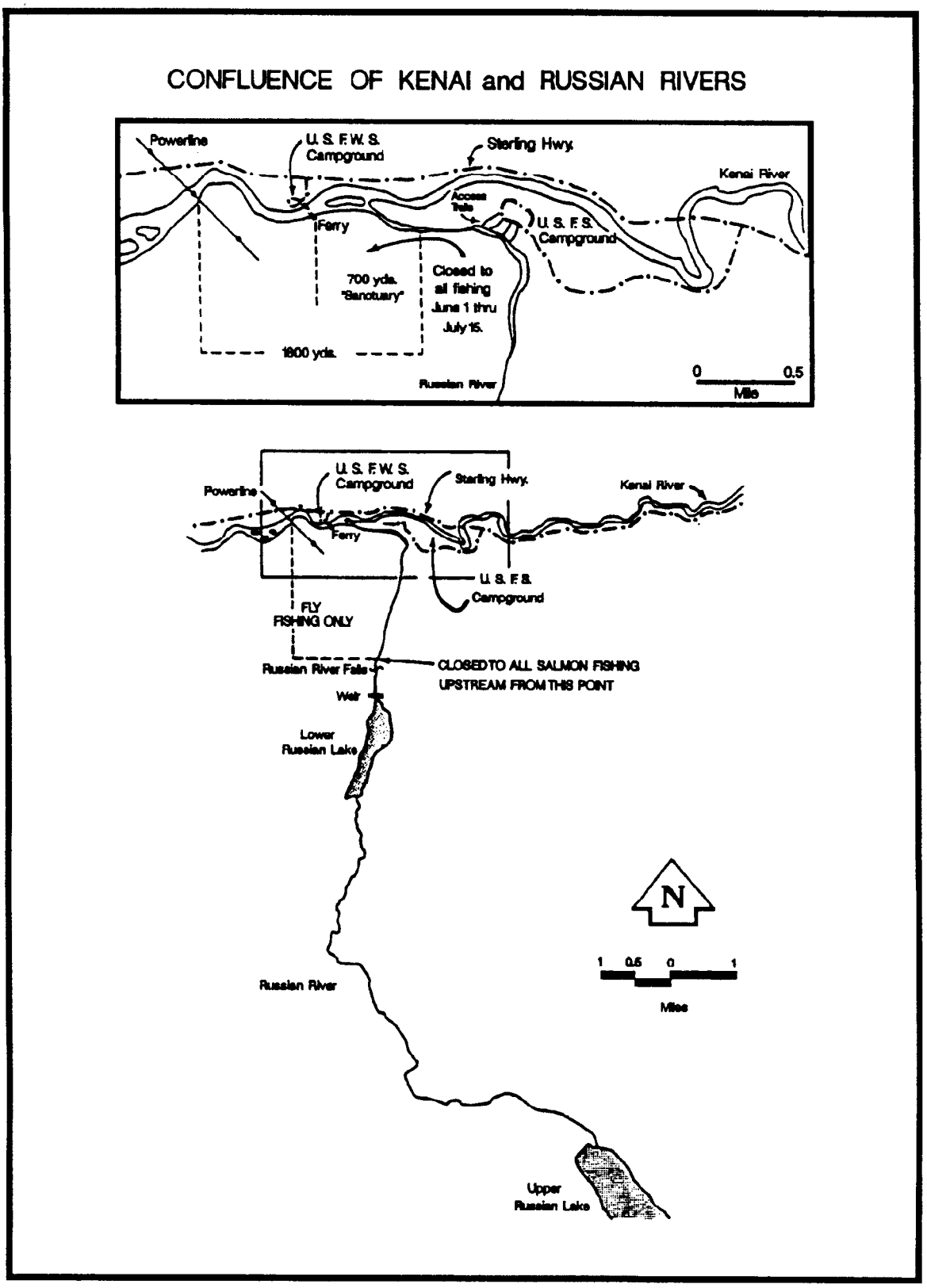

Figure 2. Detail map of the Kenai and Russian River study area.

sockeye salmon which occurs in the Kenai/Russian River "fly-fishing-only" area (Figure 2). Weir operations provide daily escapement information. Estimates of the total inriver return (harvest plus escapement) and the age, sex, and size compositions of the return provide necessary information required to evaluate production and to estimate optimum spawning escapement levels.

From 1 June through 20 August 1992, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River "fly-fishing-only" area was three fish of 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream from the confluence with the Russian River, only a single-hook unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook. Within this "fly-fishing-only" area, there is a sanctuary area which begins in the Russian River 137 m upstream of the confluence with the Kenai River and extends downstream to a marker placed approximately 25 m (75 ft) downstream of the ferry cable (approximately 640 m). This area is closed to all fishing from 1 June to 15 July by regulation.

The objectives of this report are to present for 1992: (1) estimates of effort and harvest of early-run sockeye salmon for the Russian River recreational fishery, (2) estimates of the escapement of the early run of sockeye salmon, and (3) estimates of the age, sex, and length distributions of the harvest and escapement of the early 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 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. The United States Forest Service (USFS) campground located on the east side of the Russian River provides four short trails which intersect the main riverside trail affording access to the river area. 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 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

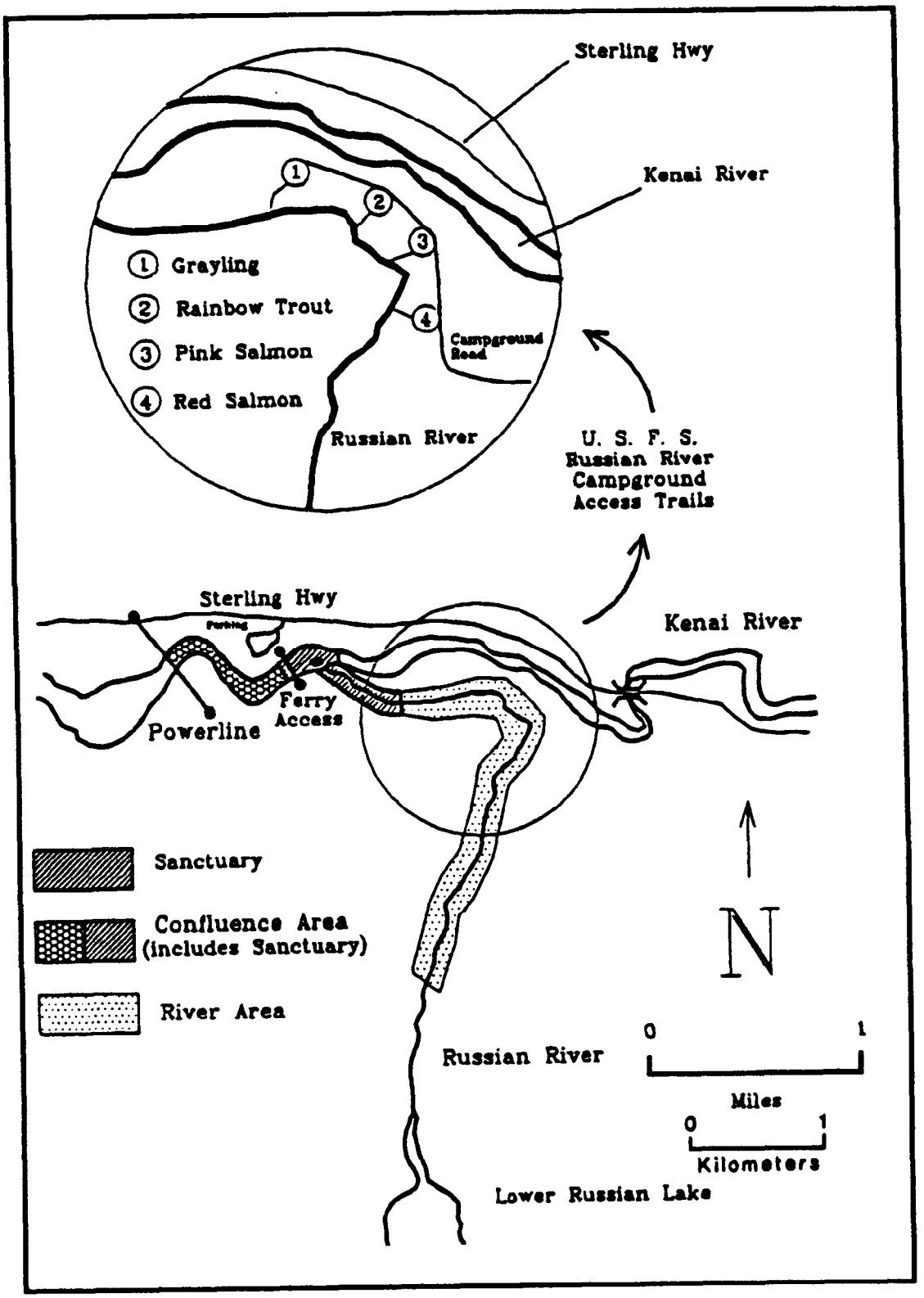

Figure 3. Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1992 creel survey.

traverse the Kenai River and then walk upstream to fish the Russian River area and others 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 by Nelson (1976) and provides a complete count of the early-run spawning escapement.

Study Design

Creel Survey:

A direct expansion creel survey was utilized during the 1992 season. This season was the third year that this creel survey design has been used. 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 for anglers exiting the fishery at each of the three sampled access locations. Analysis of the biological data collected from the harvest and weir escapement indicated that the age distribution changed over time during the run. Therefore, the data were post-stratified by time. A survey stratum was thus defined as an access location/temporal component combination. The sampled locations included the ferry access to the confluence area and two river trails from the Grayling and Pink Salmon parking areas. These locations were sampled over two temporal components; from 12 June to 30 June and from 1 July to 19 July. Area-specific (river or confluence area) harvest and effort were estimated for each stratum by recording the area fished for each interviewed angler.

The creel survey sampling day was 18 hours in length (0600 to 2400 hours) and was divided into six, 3-hour periods. A three-stage sampling design was used with days as primary units, periods as secondary units, and anglers as tertiary units. Days were systematically sampled, and within each sampled day, two 3-hour periods were randomly selected from the six possible periods. During each sampled period, anglers 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.

In 1990 and 1991, approximately three-fourths of the harvest and effort occurred in the confluence area (Carlon et al. 1991, Marsh 1992). This was typical of the early-run sport fishery 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 used as a management tool to index sockeye salmon

abundance at the confluence, the confluence access location (the ferry) was sampled every other day throughout the early run. This ensured that timely information regarding confluence harvest rates was available when formulating inseason management strategies.

Creel survey results from the 1990 and 1991 seasons indicated that angler use patterns differed among the access locations to the sport fishery (Carlon et al. 1991, Marsh 1992). Three access locations, the ferry, Grayling and Pink Salmon, represented more than 90% of the total effort and more than 90% of the total harvest during the annual sport fishery. These locations also contributed approximately 90% of the total variance for both the harvest and effort estimates. Therefore, to better utilize creel census personnel and potentially reduce the variability of the estimates of harvest and effort from the remaining access locations, Rainbow and Red Salmon were dropped from the sampling schedule during the 1992 season.

Estimates of effort, harvest, and their variances for the early run in 1990 and 1991 were used to optimally allocate the number of sampling days among the river access locations (Cochran 1977). In 1992 the ferry was sampled every other day while both Grayling and Pink Salmon were sampled approximately every 3 days.

The following formulae were applied to generate harvest and effort estimates for each temporal component of the fishery. 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 which were "missed" because they 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 (a_{rkij}) of missed anglers prorated as fishing the river was estimated as:

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

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

$$\hat{M}_{rkij} = m_{rkij} + \hat{a}_{rkij}. \tag{4}$$

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

$$\hat{M}_{ckij} = m_{ckij} + \hat{a}_{ckij}. \tag{5}$$

The mean river area harvest per interviewed angler was:

$$\bar{h}_{rkij} = \frac{\sum_{l=1}^{m_{rkij}} h_{rkijl}}{m_{rkij}} \tag{6}$$

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 as:

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

The total river area harvest of anglers exiting through access location k on day i during sample period j ($\hat{H}_{rkij}$) was estimated as:

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

The mean river area harvest per period ($\bar{H}_{rki}$) was estimated for location k on day i as:

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

where u = the number of sample periods on day i (u = 2) at location k, and the variance among sample periods was estimated as:

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

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

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

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

The mean river area harvest per day ($\bar{H}_{rk}$) was estimated at location k as:

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

where d = the number of days sampled.

The variance of river area harvest among days ($\hat{S}^2_{rk}$) at location k was estimated using the variance for a systematic sample as (Wolter 1985):

$$\hat{S}^2_{rk} = \frac{\sum_{i=2}^{d} (\hat{H}_{(i)} - \hat{H}_{(i-1)})^2}{2(d-1)} . \quad (13)$$

The total river area harvest at location k ($\hat{H}_{rk}$) was estimated by expanding the mean harvest per day by:

$$\hat{H}_{rk} = D \hat{\bar{H}}_{rk} \quad (14)$$

where D = the total number of days during the early run.

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

$$V(\hat{H}_{rk}) = (1-f_1)\, D^2 \frac{\hat{S}^2_{rk}}{d} + D \frac{U^2}{u}(1-f_2) \frac{\sum_{i=1}^{d} \hat{S}^2_{rki}}{d}$$

$$+ D_{rk}\, U \sum_{i=1}^{d} \sum_{j=1}^{u} M^2_{rkij} (1-f_{3rkij}) \frac{\hat{S}^2_{rkij}}{d\, u\, m_{rkij}} \qquad (15)$$

where:

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

f_{3rkij} = 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 estimates of harvest and effort were determined for the early run by summing the individual stratum estimates. The stratum estimates were assumed to be independent and, therefore, the variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates.

Daily harvest rates were estimated for inseason management as an indicator of sockeye salmon abundance. The daily confluence area harvest rate was based on interviews of anglers exiting the fishery that reported fishing the confluence area. The mean daily harvest rate for the confluence area was estimated as:

$$\overline{HPUE_c} = (1/n) \sum_{l=1}^{n} HPUE_l \qquad (16)$$

where:

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

$HPUE_l$ = confluence-area harvest per hour of effort for angler l.

The variance of this estimate was calculated as:

$$V(HPUE_c) = \frac{\sum_{l=1}^{n} (HPUE_l - \overline{HPUE_c})^2}{n(n-1)}. \qquad (17)$$

The same procedure was used to estimate river-area harvest rates ($HPUE_r$).

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

Spawning Escapement:

The escapement of spawning sockeye salmon to the Russian River drainage was enumerated at the stationary weir at the outlet of Lower Russian Lake. An adjustable gate system allowed fish to be passed individually and counted by the weir operator. During the period of overlap of early and late runs (mid to late July), fish from each run were subjectively identified by degree of external maturation (body color and kype development) and counted separately. Early in each run, adults have not yet developed the reddish body coloration and large green head with hooked jaws characteristic of more sexually mature fish which pass through the weir later in each run. Therefore, during the period of run overlap at the weir, the last of the early-run fish typically exhibit the reddish body coloration and green heads while the late-run fish have not yet developed these physical characteristics. The period of overlap began on 17 July when late-run fish were intermixed with mature, early-run fish and continued through 26 July, after which early-run fish were no longer present.

Biological Data:

Six time and area strata within the Russian River sockeye salmon return were sampled for biological data (Table 1). The sampling strata corresponded to those for which harvest was estimated by the creel survey. Schedules of each creel census clerk allowed for biological sampling of the harvest at least part of each day that angler interviews were conducted. In addition, a full day of sampling was scheduled for one or both creel clerks when fishing effort and harvest were the greatest.

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 was also determined and recorded. Scale impressions were made in clear acetate and examined with a microfiche reader for ageing. 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.

Age composition was estimated for each temporal stratum of all spatial return components. The proportion of fish of age group h in stratum i of a component was estimated for each sex as:

$$\hat{P}_{gf} = n_{gf}/n_{Tf}. \qquad (18)$$

Table 1. Temporal components of the recreational harvest and escapement sampled for age composition during the 1992 early-run Russian River sockeye salmon return.

Return Component	Temporal Delineation
Confluence area harvest	6/12 - 6/30 7/01 - 7/19
River area harvest	6/19 - 6/30 7/01 - 7/19
Escapement through weir	6/12 - 6/30 7/01 - 7/26

where,

n_{gf} = the number of legible scales read from sockeye salmon sampled during strata f and interpreted as age g, and

n_{Tf} = the total number of legible scales read from sockeye salmon sampled during strata f.

The variance of $\hat{P}_{gf}$ was estimated as (Scheaffer et al. 1978):

$$V(\hat{P}_{gf}) = \hat{P}_{gf}(1-\hat{P}_{gf})/(n_{Tf}-1). \quad (19)$$

The spatial/temporal estimates of the early-run sport harvest (H_{Tf}) were also apportioned by age group for each sex:

$$\hat{N}_{gf} = \hat{H}_{Tf}\hat{P}_{gf}, \quad (20)$$

where $\hat{H}_{Tf}$ = the estimated total harvest of sockeye salmon during spatial/temporal strata f.

The variance of $\hat{N}_{gf}$ was estimated as the product of two independent random variables (Goodman 1960):

$$V(\hat{N}_{gf}) = \hat{H}^2_{Tf}\, V(\hat{P}_{gf}) + \hat{P}^2_{gf}\, V(\hat{H}_{Tf}) - V(\hat{P}_{gf})\, V(\hat{H}_{Tf}), \quad (21)$$

where $V(\hat{H}_{Tf})$ = the variance of the harvest estimate during spatial/temporal stratum f.

Age composition estimates of each sex will be generated for the total harvest during the early run by summing estimated number harvested by age over the spatial/temporal strata. For the early run x, the total number of fish of age g harvested (N_{xg}) was estimated as:

$$\hat{N}_{xg} = \sum_{f=1}^{t} \hat{N}_{gf}, \quad (22)$$

where t = the number of spatial/temporal strata during the early run x.

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

$$V(\hat{N}_{xg}) = \sum_{f=1}^{t} V(\hat{N}_{gf}). \quad (23)$$

The proportion of age g adults in the total sport harvest from the early run x (P_{xg}) was estimated as:

$$\hat{P}_{xg} = \hat{N}_{xg}/\hat{H}_x, \tag{24}$$

where $\hat{H}_x$ = the estimated total harvest of sockeye salmon from the early run x.

The variance of $\hat{P}_{xg}$ was estimated as the variance of the quotient of two random variables as:

$$V(\hat{P}_{xg}) = \hat{P}^2_{xg} \left[V(\hat{N}_{xg})/\hat{N}^2_{xg} + V(\hat{H}_x)/\hat{H}^2_x - 2V(\hat{N}_{xg})/\hat{N}_{xg}\hat{H}_x\right], \tag{25}$$

where $V(\hat{H}_x)$ = the variance of the estimated harvest of fish from the early run x as defined previously.

The number of sockeye salmon of age group g in the escapement was estimated by sex during each spatial/temporal stratum f of the early run using the estimates of the age group proportions (P_{gf}) as defined previously:

$$\hat{N}_{gf} = N_{Tf}\hat{P}_{gf}, \tag{26}$$

where N_{Tf} = the total number of sockeye salmon enumerated during stratum f at the weir or spawning downstream from the falls.

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

$$V(\hat{N}_{gf}) = N^2_{Tf}\, V(\hat{P}_{gf}). \tag{27}$$

Age composition estimates of weir escapements were generated for the early run by summing estimated numbers by age over temporal strata. For the early run x, the total number of fish of age g (N_{xg}) migrating through the weir was estimated as:

$$\hat{N}_{xg} = \sum_{f=1}^{t} N_{gf}, \tag{28}$$

The variance of $\hat{N}_{xg}$ was estimated as the sum of the variances of the individual estimates as:

$$V(\hat{N}_{xg}) = \sum_{f=1}^{t} V(\hat{N}_{gf}). \tag{29}$$

The proportion of age g adults in the total escapement of the early run x (P_{xg}) migrating through the weir was estimated as:

$$\hat{P}_{xg} = \hat{N}_{xg}/E_x, \tag{30}$$

where E_x = the total escapement of the early run x enumerated at the weir.

The variance of $\hat{P}_{xg}$ was estimated by:

$$V(\hat{P}_{xg}) = (1/E_x)^2 \, V(\hat{N}_{xg}). \tag{31}$$

In prior years, the age composition of the early-run escapement was used to estimate the return by age for both the escapement and early-run harvest at both the confluence and river areas (Nelson 1986, Carlon and Vincent-Lang 1990). This assumed that the age composition of the escapement through the weir represented that of the river and confluence-area sport harvests. This assumption was tested in both 1990 and 1991. Significant differences in age compositions were found among the three sampled areas during some of the temporal strata (Carlon et al. 1991, Marsh 1992). Chi-square tests were applied and the null hypotheses of equality of age distributions among the three areas and between the two time frames was rejected if calculated tail-area probabilities were less than 0.10. 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 component within each of three spatial components 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, by temporal component, by sex and all interactions of these components. This analysis was conducted for the predominant age groups (age-2.2 and -2.3 fish) due to insufficient samples in the remaining age groups.

RESULTS

Creel Statistics

Survey Interviews:

Sampling began on 12 June at the ferry access location and continued every other day through the end of the early run on 19 July. The systematic sampling of the two Russian River Campground access locations began on 19 June, 1 week after sampling commenced at the ferry location. Because early-run sockeye salmon typically hold in the confluence area before entering the Russian River, harvest and effort are considered negligible until about 19 June. Onsite observations indicated that this was also the case in 1992.

A total of 5,153 anglers were enumerated as they exited sampled access locations during the 1992 early-run survey (Table 2). Of these, 3,580 (69.5%)

Table 2. Summary of the number of interviews collected during sampled periods for the early-run Russian River creel survey, 1992.

Exit Location	Area Fished			Total Interviews	Anglers Exiting and not interviewed	Total Anglers Exiting
	Confluence	River	Both			
Ferry	1,977	258	43	2,278	1,356	3,634
Grayling	274	460	45	779	117	896
Pink Salmon	65	439	19	523	100	623
Total	2,316	1,157	107	3,580	1,573	5,153

were interviewed and 1,573 (30.5%) were not interviewed. The total number of interviews collected in the early run represents a 3.5% decrease from 1991. However, this level of creel sampling remains more than 200% above the number collected in 1989 (Carlon and Vincent-Lang 1990) and 1988 (Hammarstrom and Athons 1989). Most of the interviews (63.6%) were made at the ferry access as this location was sampled the most intensely and typically accounts for the most effort (Appendix A1). Anglers exiting via the ferry location tended to fish the confluence area (87.7%) (Appendix A2).

Harvest and Effort:

Estimates of harvest, effort, and variances are presented by stratum (temporal component/access location) in Appendix A3. By examining stratum estimates and associated variance components by access location, it is possible to determine which access locations most affected the relative precision of early-run estimates of both harvest and effort (Table 3). Of the three access locations, (the ferry, Grayling, and Pink Salmon), the ferry accounted for most of the effort and harvest during the early run (59.2% and 63.6%, respectively). The relative precisions of the early-run harvest and effort estimates were 22% and 17%, respectively (Table 3). The 1992 early-run harvest estimate was 30,512 (SE = 3,492) sockeye salmon (Table 4). The effort estimate for the early run was 143,937 (SE = 12,743) angler-hours. During the early run, 58.6% of the harvest was taken from the confluence area and the remaining 41.4% was taken from the river area (Table 4 and Figure 4).

Table 5 documents the weighted harvest per hour of angler effort for both the confluence and river areas in 1992.

Spawning Escapement

A total of 37,117 early-run sockeye salmon passed through the weir (Figure 5 and Appendix A4). Late-run sockeye salmon began arriving on 17 July and the last early-run fish was passed on 26 July.

Biological Data

Chi-square tests indicated that there were significant differences between the three spatial components (confluence area harvest, river area harvest, and weir escapement) during both of the temporal strata (Table 6). The age composition of the weir escapement differed from that of the confluence area harvest during both temporal strata (Table 6; $\chi^2_{\text{stratum 1}} = 11.01$, df = 3, $P < 0.025$; $\chi^2_{\text{stratum 2}} = 9.11$, df = 3, $P < 0.050$) and the river area harvest ($\chi^2_{\text{stratum 1}} = 2.93$, df = 1, $P < 0.10$; $\chi^2_{\text{stratum 2}} = 5.54$, df = 2, $P < 0.10$). However, the age composition of the confluence harvest did not significantly differ from that of the river area harvest during either of the temporal strata ($\chi^2_{\text{stratum 1}} = 6.20$, df = 3, $P > 0.10$; $\chi^2_{\text{stratum 2}} = 2.97$, df =3, $P > 0.10$).

Additionally, age composition changed significantly over time within all individual spatial components.

Therefore, sample data for the confluence and river area harvest were pooled with estimates generated for each temporal strata and then these estimates were summed to estimate the age composition of the total harvest. Sample data for the weir escapement were also stratified with estimates for each temporal

Table 3. Estimates of harvest, effort, and associated variances by access location during the early run of Russian River sockeye salmon, 1992.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative Precision[a]	Effort	(%)	Variance of Effort	(%)	Relative Precision[a]
Ferry	18,051	59	4,954,691	41	24%	91,514	64	122,592,787	75	24%
Grayling	7,396	24	4,938,127	40	59%	27,220	19	22,353,360	14	34%
Pink Salmon	5,065	17	2,304,720	19	59%	25,203	17	17,443,733	11	32%
Total	30,512	100	12,197,538	100	22%	143,937	100	162,389,880	100	17%

[a] $\alpha = 0.05$

Table 4. Summary of estimated angler effort and harvest by component during the early run of sockeye salmon, 1992.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort	94,633	49,304	143,937	118,960 - 168,913
SE	10,796	6,771	12,743	
Harvest	17,866	12,646	30,512	23,667 - 37,357
SE	2,087	2,801	3,492	

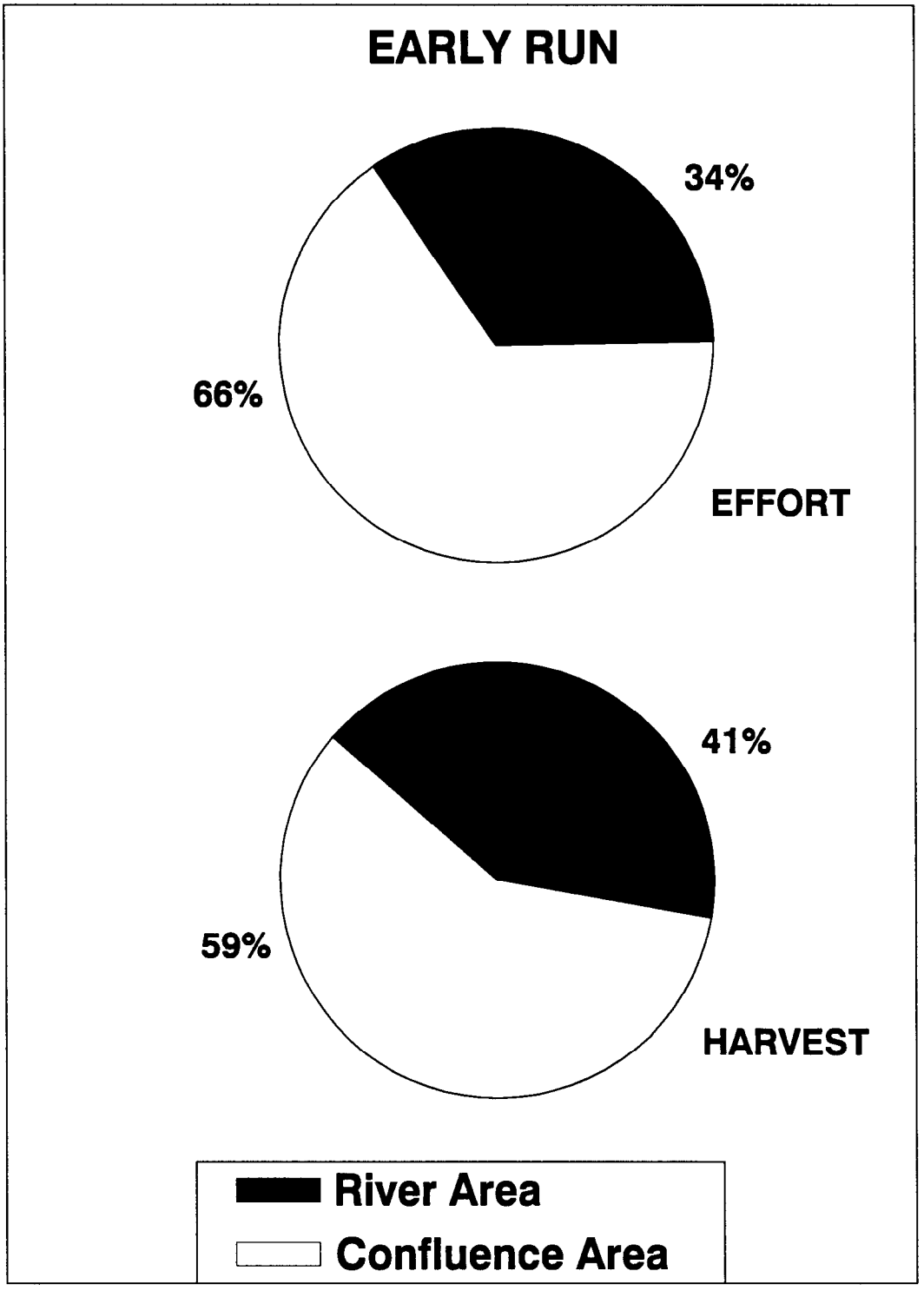

Figure 4. Harvest and angler effort by area for the Russian River early-run sockeye salmon recreational fishery, 1992.

Table 5. Estimated harvest per hour of angler effort (HPUE) by anglers interviewed during the early run of the Russian River sockeye salmon recreational fishery, 1992.

Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Confluence	26	38	2,369	0.189	0.0005
River	25	31	1,211	0.256	0.0032
Both			3,580	0.212	0.0006

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

[b] Number of days possible for conducting interviews.

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

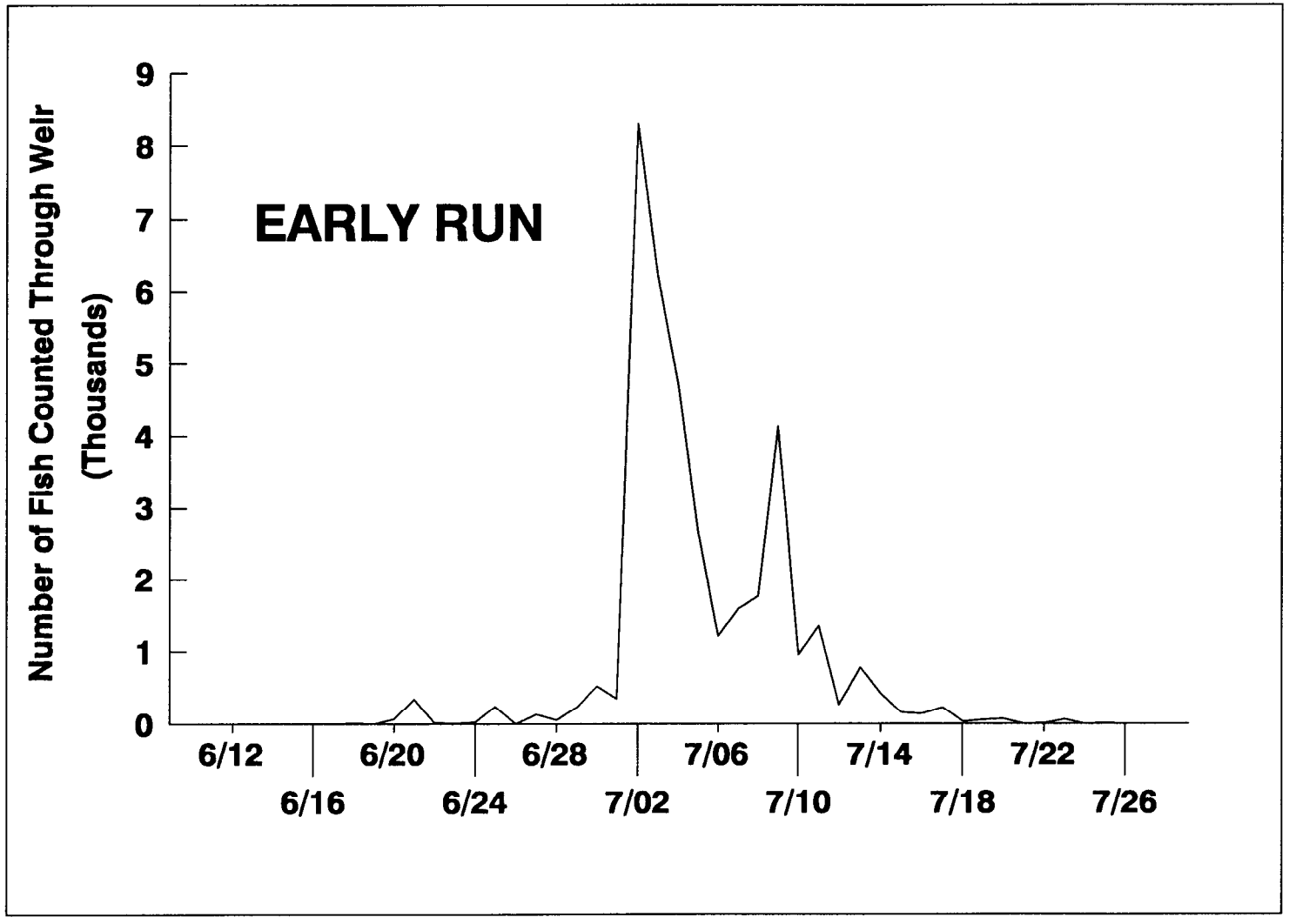

Figure 5. Daily escapement of sockeye salmon through the Russian River weir, 1992.

Table 6. Results of contingency test comparisons of age composition between spatial fishery components for the early-run Russian River sockeye salmon recreational fishery, 1992.

Temporal Stratum[a]	Spatial Component: Confluence Harvest vs. River Harvest	Spatial Component: Confluence Harvest vs. Weir Escapement	Spatial Component: River Harvest vs. Weir Escapement
1	NS[b](P>0.10)	S[c](P<0.025)	S(P<0.10)
2	NS(P>0.10)	S(P<0.050)	S(P<0.10)

[a] 1 = 6/12-6/30.
2 = 7/01-7/19 (7/01-7/26 for weir escapement).

[b] No significant difference.

[c] Significant difference.

Table 7. Estimated age and sex composition of the early-run sockeye salmon escapement through the Russian River weir, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total
6/18 - 6/30					
n[a]= 115					
Count= 1,676					
Females					
Sample Size	20	0	8	0	28
Percent	17.4	0.0	7.0	0.0	24.3
Variance of Percent	12.6	0.0	5.7	0.0	16.2
Number	291	0	117	0	408
Variance of Number	3,540	0	1,595	0	4,539
Males					
Sample Size	61	0	26	0	87
Percent	53.0	0.0	22.6	0.0	75.7
Variance of Percent	21.8	0.0	15.3	0.0	16.2
Number	889	0	379	0	1,268
Variance of Number	6,137	0	4,311	0	4,539
Sexes Combined					
Sample Size	81	0	34	0	115
Percent	70.4	0.0	29.6	0.0	100.0
Variance of Percent	18.3	0.0	18.3	0.0	
Number	1,180	0	496	0	1,676
Variance of Number	5,131	0	5,131	0	

-continued-

Table 7. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	2.1	Total
7/01 - 7/26					
n[a]= 191					
Count= 35,441					
Females					
Sample Size	48	0	51	0	99
Percent	25.1	0.0	26.7	0.0	51.8
Variance of Percent	9.9	0.0	10.3	0.0	13.1
Number	8,907	0	9,463	0	18,370
Variance of Number	1,243,852	0	1,293,868	0	1,650,497
Males					
Sample Size	55	0	35	2	92
Percent	28.8	0.0	18.3	1.0	48.2
Variance of Percent	10.8	0.0	7.9	0.5	13.1
Number	10,206	0	6,494	371	17,071
Variance of Number	1,355,480	0	989,428	68,499	1,650,497
Sexes Combined					
Sample Size	103	0	86	2	191
Percent	53.9	0.0	45.0	1.0	100.0
Variance of Percent	13.1	0.0	13.0	0.5	
Number	19,112	0	15,958	371	35,441
Variance of Number	1,642,523	0	1,636,362	68,499	

-continued-

Table 7. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	2.1	Total
Early Run Total					
n[a]= 306					
Count= 37,117					
Females					
Percent	24.8	0.0	25.8	0.0	50.6
Variance of Percent	9.1	0.0	9.4	0.0	12.0
Number	9,198	0	9,580	0	18,778
Variance of Number	1,247,392	0	1,295,462	0	1,655,035
Males					
Percent	29.9	0.0	18.5	1.0	49.4
Variance of Percent	9.9	0.0	7.2	0.5	12.0
Number	11,095	0	6,873	371	18,339
Variance of Number	1,361,617	0	993,739	68,499	1,655,035
Sexes Combined					
Percent	54.7	0.0	44.3	1.0	100.0
Variance of Percent	12.0	0.0	11.9	0.5	
Number	20,293	0	16,453	371	37,117
Variance of Number	1,647,654	0	1,641,493	68,499	

[a] n = sample size.

Table 8. Estimated age and sex composition of early-run sockeye salmon harvested during the Russian River recreational fishery, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total
6/12 - 6/30					
n[a]= 291					
Harvest= 20,477					
Var(Harvest)= 8,849,275					
Females					
Sample Size	72	3	23	0	98
Percent	24.7	1.0	7.9	0.0	33.7
Variance of Percent	6.4	0.4	2.5	0.0	7.7
Number	5,066	211	1,618	0	6,896
Variance of Number	805,284	15,382	158,307	0	1,319,762
Males					
Sample Size	162	0	29	2	193
Percent	55.7	0.0	10.0	0.7	66.3
Variance of Percent	8.5	0.0	3.1	0.2	7.7
Number	11,400	0	2,041	141	13,581
Variance of Number	3,091,825	0	214,880	10,079	4,208,701
Sexes Combined					
Sample Size	234	3	52	2	291
Percent	80.4	1.0	17.9	0.7	100.0
Variance of Percent	5.4	0.4	5.1	0.2	
Number	16,466	211	3,659	141	20,477
Variance of Number	5,945,007	15,382	490,295	10,079	8,849,275

-continued-

Table 8. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	2.1	Total
7/01 - 7/19					
n[a]= 182					
Harvest= 10,035					
Var(Harvest)= 3,348,263					
Females					
Sample Size	67	1	29	0	97
Percent	36.8	0.5	15.9	0.0	53.3
Variance of Percent	12.9	0.3	7.4	0.0	13.8
Number	3,694	55	1,599	0	5,348
Variance of Number	578,873	3,040	157,058	0	1,084,968
Males					
Sample Size	57	0	26	2	85
Percent	31.3	0.0	14.3	1.1	46.7
Variance of Percent	11.9	0.0	6.8	0.6	13.8
Number	3,143	0	1,434	110	4,687
Variance of Number	444,112	0	134,193	6,250	864,203
Sexes Combined					
Sample Size	124	1	55	2	182
Percent	68.1	0.5	30.2	1.1	100.0
Variance of Percent	12.0	0.3	11.7	0.6	
Number	6,837	55	3,033	110	10,035
Variance of Number	1,671,030	3,040	419,196	6,250	3,348,263

-continued-

Table 8. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	2.1	Total
Early Run Total					
n[a]= 473					
Harvest= 30,512					
Var(Harvest)= 12,197,538					
Females					
Percent	28.7	0.9	10.5	0.0	40.1
Variance of Percent	17.1	0.2	4.1		26.2
Number	8,761	266	3,217	0	12,244
Variance of Number	1,384,157	18,422	315,365	0	2,404,730
Males					
Percent	47.7	0.0	11.4	0.8	59.9
Variance of Percent	31.5		4.6	0.2	36.2
Number	14,542	0	3,474	251	18,268
Variance of Number	3,535,937	0	349,072	16,329	5,072,904
Sexes Combined					
Percent	76.4	0.9	21.9	0.8	100.0
Variance of Percent	33.3	0.2	11.8	0.2	
Number	23,303	266	6,692	251	30,512
Variance of Number	7,616,037	18,422	909,492	16,329	12,197,538

[a] n = sample size.

strata summed to estimate the age composition of the total return (Tables 7 and 8).

The early-run escapement through the weir was comprised predominantly of two age groups, ages 2.3 and 2.2 (Table 7). A third age group, age 2.1, comprised less than 1% of the escapement with the predominant age group (54.7%) being age 2.3. There was a significant difference in the composition of age-2.3 and -2.2 adults detected over the two temporal sampling strata (χ^2 = 17.47, df = 3, P < 0.005).

The early-run recreational harvest was also comprised predominantly of age-2.3 and -2.2 adults with age-2.3 adults contributing 76.4% to the harvest (Table 8). There were significant temporal changes detected in the contribution by age (χ^2 = 10.31, df = 3, P < 0.025); age-2.3 adults contributed proportionately less during the second stratum (68.1%) than during the first stratum (80.4%), and age-2.2 fish contributed proportionately more during the second stratum (30.2%) than was the case in the first stratum (17.9%).

Mean length-at-age was examined to determine if samples could be pooled among areas or between temporal components. There were no significant differences in length at age due to area (age 2.2: F = 1.37, df = 2,215, P = 0.26; age 2.3: F = 0.17, df = 2,530, P = 0.85), samples collected from the harvest at the river and the confluence were combined (Table 9). Sockeye salmon sampled during the first temporal component were significantly larger (age 2.2: F = 8.90, df = 1,215, P = 0.003; age 2.3: F = 8.20, df = 1,530, P = 0.004) than those sampled during the second temporal component.

Total Return Statistics

Overall, an estimated 67,629 early-run sockeye salmon returned to the Russian River in 1992 (Table 10). Brood years 1986 (age 2.3) and 1987 (age 1.3 and 2.2) were both significant contributors to the early-run return. However, age-2.3 fish returning from the 1986 brood year comprised the majority of the return (64.5%). The brood year 1987 contributed 34.6% to the early-run return with the 1988 (age 2.1) brood year comprising just 0.9% of the return. The 1986 escapement of approximately 36,000 spawners produced approximately 90,000 returning adults (Table 11).

APPLICATION OF THE DATA FOR FISHERY MANAGEMENT

Both the early and late sockeye salmon runs are managed for escapement. Based upon analyses of brood production data (Carlon and Vincent-Lang 1990), a sockeye salmon escapement goal of 16,000 was established by the Board of Fisheries during their 1989 forum. On Wednesday, 1 July 1992, a total of 2,028 sockeye salmon had migrated through the weir and an estimated 8,000 fish were holding immediately downstream from the falls with an additional 8,000-9,000 fish concentrated in the sanctuary area near the confluence of the Kenai and Russian rivers. Stream survey observations in conjunction with harvest data from the sport fishery indicated that as many as 14,000 fish would conceivably be available towards meeting the escapement goal. However, to reduce the congestion of fish at the base of the Russian River falls caused by unusually high water flows near the 400 cubic feet per second (cfs) barrier threshold, the fish-pass was opened on the evening of 1 July. On Thursday,

Table 9. Mean length (millimeters) at age, by sex, for the early run of sockeye salmon sampled from the Russian River, 1992.

			Age											
			2.3			2.2			2.1			1.3		
Date	Component	Sex	n	Mean	SE	n	Mean	SE	n	Mean	SE	n	Mean	SE
6/12-6/30	Harvest	F	72	589	2.1	23	532	4.2				3	543	10.1
		M	162	591	1.3	29	542	4.3	2	518	12.5			
	Escapement[a]	F	20	591	4.0	8	539	10.7						
		M	61	590	2.0	26	553	5.9						
7/01-7/26	Harvest	F	67	588	2.4	29	532	4.5				1	540	
		M	57	584	2.7	26	532	4.4	2	400	30.0			
	Escapement	F	48	580	3.0	51	520	2.8						
		M	55	586	2.4	35	531	3.3	2	449	33.5			

[a] Fish that migrated through the weir.

Table 10. Estimated age and sex composition of the early-run of sockeye salmon to the Russian River, 1992.

Dates	Age Group 2.3	1.3	2.2	2.1	Total
6/12 - 7/19					
Early Run Total [a] n[b]= 779					
Females					
Percent	26.6	0.4	18.9	0.0	45.9
Variance of Percent	4.6	0.0	3.1		6.3
Number	17,959	266	12,797	0	31,022
Variance of Number	2,631,549	18,422	1,610,828	0	4,059,766
Males					
Percent	37.9	0.0	15.3	0.9	54.1
Variance of Percent	6.4		2.7	0.2	6.6
Number	25,637	0	10,348	622	36,607
Variance of Number	4,897,555	0	1,342,812	84,828	6,727,940
Sexes Combined					
Percent	64.5	0.4	34.2	0.9	100.0
Variance of Percent	5.2	0.0	4.9	0.2	
Number	43,596	266	23,145	622	67,629
Variance of Number	9,263,691	18,422	2,550,985	84,828	12,197,538

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

[b] n = sample size.

Table 11. Summary of returns from each brood year, early-run Russian River sockeye salmon, 1974-1992.

Year	Spawning Escapement	Return Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3	(1.1,1.4) Misc.	Measured Return To Date	Return Per Spawner
1974	13,164	(1978) 216	(1978) 0	(1979) 1,264	(1979) 5,873	(1980) 45,271	0	52,624	4.00
1975	5,644	(1979) 0	(1979) 0	(1980) 4,528	(1980) 2,403	(1981) 9,016	0	15,947	2.83
1976	14,735	(1980) 3,465	(1980) 0	(1981) 14,783	(1981) 6,021	(1982) 89,040	0	113,309	7.69
1977	16,061	(1981) 2,008	(1981) 0	(1982) 1,087	(1982) 362	(1983) 14,218	0	17,675	1.10
1978	34,240	(1982) 0	(1982) 0	(1983) 11,055	(1983) 828	(1984) 5,053	0	16,936	0.49
1979	19,742	(1983) 3,310	(1983) 0	(1984) 56,173	(1984) 389	(1985) 34,971	0	94,843	4.80
1980	28,616	(1984) 3,109	(1984) 0	(1985) 3,090	(1985) 3,990	(1986) 32,798	0	42,987	1.50
1981	21,142	(1985) 430	(1985) 0	(1986) 9,697	(1986) 21,462	(1987) 43,722	0	75,311	3.56
1982	56,106	(1986) 7,273	(1986) 0	(1987) 162,612	(1987) 9,046	(1988) 95,055	0	273,986	4.88
1983	21,268	(1987) 0	(1987) 0	(1988) 3,847	(1988) 1,519	(1989) 17,914	0	23,280	1.09

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Table 11. (Page 2 of 2).

Year	Spawning Escapement	Return Age 1.2	Age 2.1	Age 1.3	Age 2.2	Age 2.3	(1.4,2.4) Misc.	Measured Return To Date	Return Per Spawner
		(1988)	(1988)	(1989)	(1989)	(1990)			
1984	28,899	810	0	4,149	4,324	33,543	0	42,826	1.48
		(1989)	(1989)	(1990)	(1990)	(1991)			
1985	30,601	236	0	264	22,584	20,555	137	43,776	1.43
		(1990)	(1990)	(1991)	(1991)	(1992)			
1986	36,336	540	0	43,166	3,334	43,596	0	90,636	2.49
		(1991)	(1991)	(1992)	(1992)	(1993)			
1987	61,513	30,346	0	266	23,145		0	53,757	0.87
		(1992)	(1992)	(1993)	(1993)	(1994)			
1988	50,406	0	622				238	860	0.02
		(1993)	(1993)	(1994)	(1994)	(1995)			
1989	15,338							0	0.00
		(1994)	(1994)	(1995)	(1995)	(1996)			
1990	25,144							0	0.00
		(1995)	(1995)	(1996)	(1996)	(1997)			
1991	32,389							0	0.00
		(1996)	(1996)	(1997)	(1997)	(1998)			
1992	37,117							0	0.00

2 July, 8,313 fish passed through the weir; the highest single-day passage for the early run. On Friday, 3 July, the single-day passage was 6,204 which brought the cumulative escapement to 16,545.

Since the escapement goal was assured, the decision to open the sanctuary area at the confluence of the Kenai and Russian rivers was deemed appropriate. Therefore, the fishery was liberalized by removing the no fishing restriction on the sanctuary area on Sunday, July 5, at 7:00 a.m. Anglers were therefore afforded increased fishing opportunity in 1992.

DISCUSSION

Relative Run Strength

The strength of the 1992 early run, as determined from total return estimates (harvest plus escapement), closely approximated the historical average (1976-1991) (Figure 6). This return maintains the trend, beginning in 1978, of greater numbers of early-run sockeye salmon returning to the Russian River system.

Sample Design

Creel Survey:

An underlying assumption necessary for accurate harvest estimates is that most, if not all, anglers exit the fishery through one of the three sampled access locations. While anglers were observed using other exit locations, the level at which this occurred during 1992 appeared to be insignificant. Creel survey personnel and the project leader maintained an informal accounting of the use of the other access sites at least twice a day during transit between other sites and during a shift change. However, the number of anglers fishing the mainstem Kenai River on the highway side, and therefore unsurveyed, continued to be significant during the 1992 early run. During the early run, all fish caught in the mainstem Kenai are believed to be of Russian River origin, as no other stock is believed to be present at that time. The addition of a formal monitoring schedule might be appropriate if the numbers of anglers utilizing the highway side of the Kenai River continues to expand.

Observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that small numbers of fishermen were engaged in fishing at those hours during 1992. Once again, an informal accounting of the activity during these hours was accomplished through interviews with the angling public and frequent queries of the campground and ferry employees. Additionally, the project staff was more than willing to randomly observe the level of fishing effort before and after a shift change, prior to 0600 hours and after 0000 hours, as this generally involved a personal fishing trip. 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.

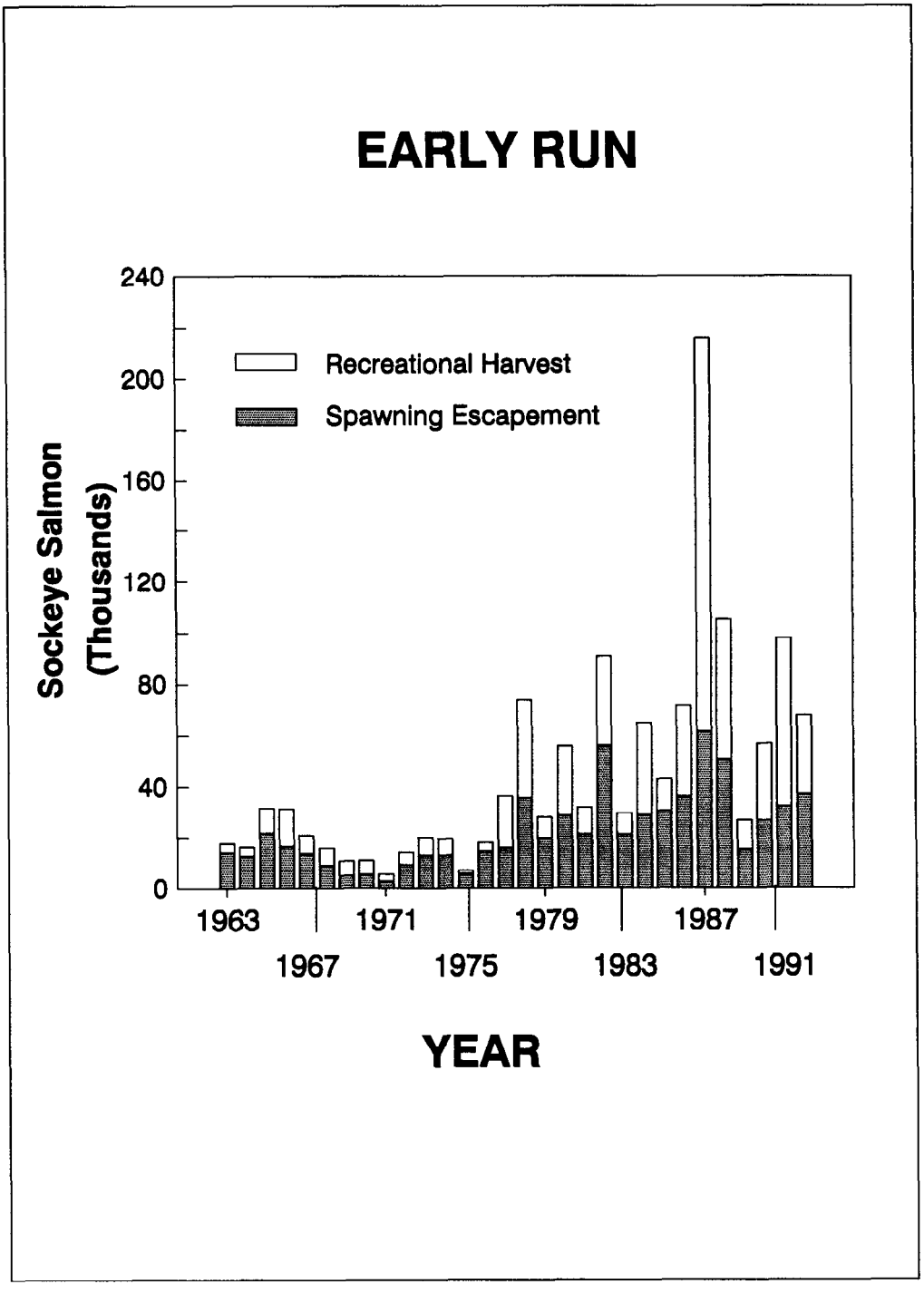

Figure 6. Historical returns of early-run sockeye salmon to the Russian River.

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 components adopted in 1990 was continued in 1992. This increase in sampling intensity over prior years is an effort to achieve more accurate age composition estimates. Significant temporal changes in age composition have been detected within spatial components as well as changes between spatial components within temporal strata since 1990 and 1991 (Carlon et al. 1991, Marsh 1992).

Statistical comparisons of the early-run age composition of the harvests and the weir escapement revealed that differences continued to occur in 1992. Therefore, it was not appropriate to use the age composition from one area to apportion the harvest estimates or escapements. The harvest and escapement were each allocated independently and each temporal component was allocated independently as well.

Because changes in the age composition of the early-run were detected over time and between areas in 1992, sampling of the individual spatial components should be continued at the present sampling intensity. This will improve both estimating the number of sockeye salmon returning by age and sex and evaluating those differences over time. The end result will be improved accuracy of brood production information necessary for the long term management of the Russian River system.

Management of the Fishery

The utilization of migratory timing statistics derived from weir counts and fishery harvest rates should be continued (Vincent-Lang and Carlon 1991). The technique of fitting a migratory timing distribution function to count and harvest rate data has been used successfully in the Kenai River to project escapements of chinook salmon (McBride et al. 1989) and was adapted from techniques used to quantify migratory timing of chinook salmon in the Yukon River drainage (Mundy 1982). It is recommended that this technique should be again utilized in 1993 and subsequent years to further evaluate its value in managing the Russian River sockeye salmon resource.

ACKNOWLEDGEMENTS

Steve Hammarstrom provided consistent, critical advice relating to all aspects of the project, from personnel matters to migratory timing influences to weir panels, which contributed greatly towards my understanding of the project and the fishery resource.

Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulation violations. His detailed observations of the fishery were vital to the conduct of the creel census 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. Her enthusiasm and conduct while performing her responsibilities proved to be an asset to the Russian River project.

Jay Carlon provided indispensable technical support and preliminary data analysis review.

Dave Athons assisted with vital logistical support and provided important suggestions about the day-to-day operations of the study.

Jim Hasbrouck provided detailed statistical analyses necessary to allocate the age compositions of the sport harvest and the escapement as well as much appreciated critical review.

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

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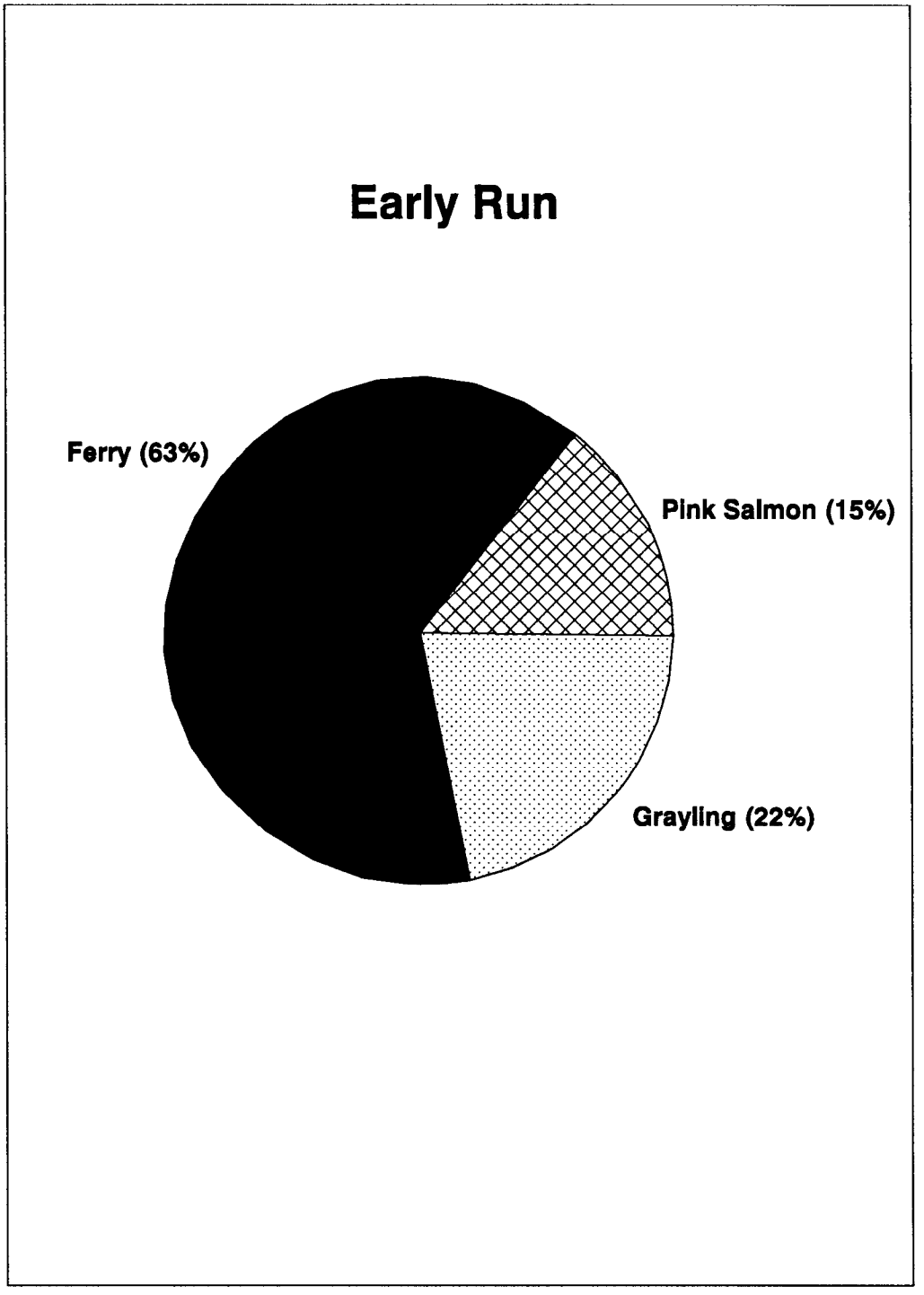
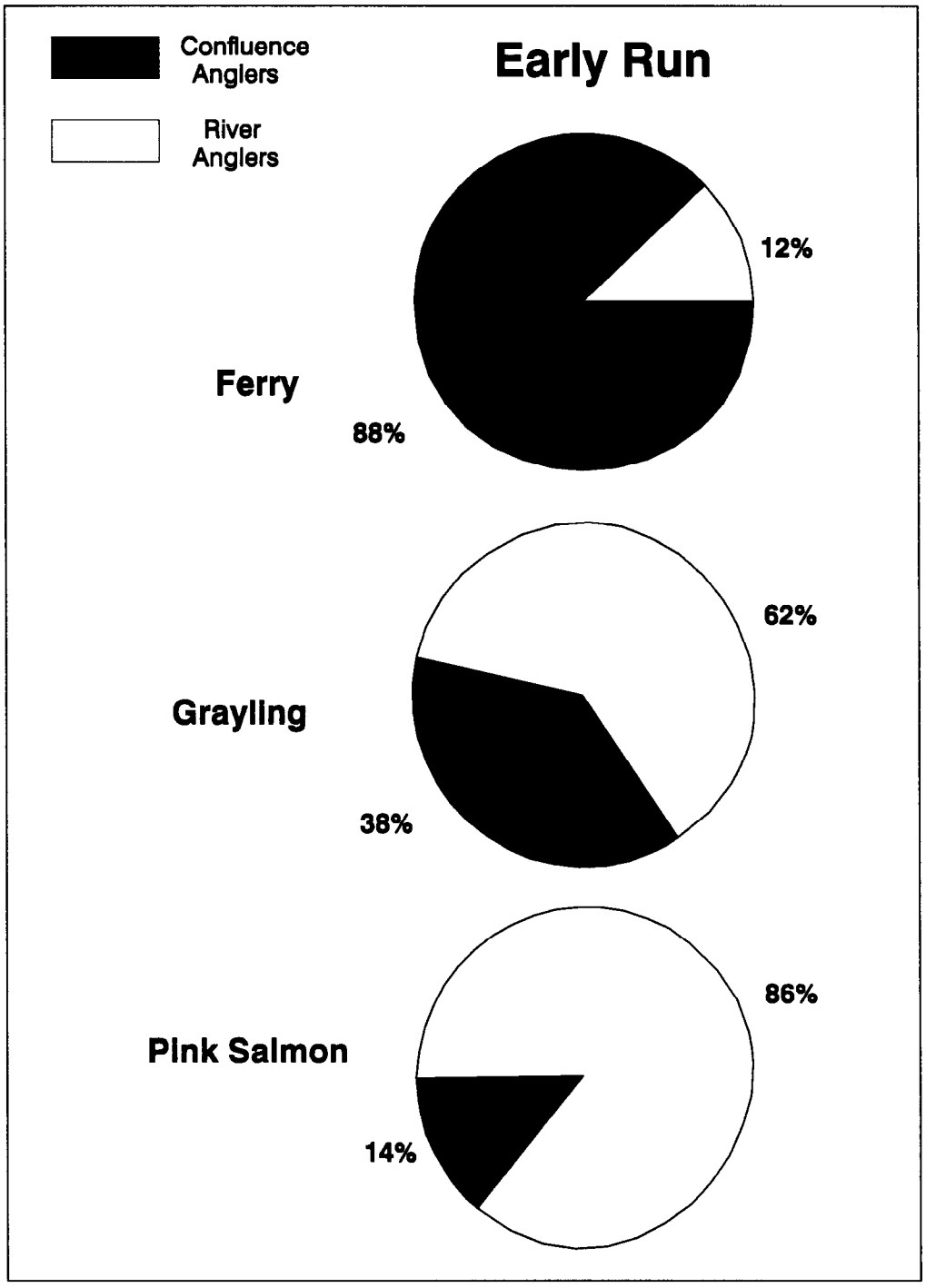
APPENDIX A

Selected Summaries of Fishery and Escapement Data
from the Russian River, 1992.



Appendix A1. Relative proportions of interviews collected at the sampled access locations to the Russian River sockeye salmon recreational fishery, early run, 1992.



Appendix A2. Relative proportions of confluence and river anglers interviewed during the Russian River creel survey by access location, early run, 1992.

Appendix A3. Temporal harvest and effort estimates for the 1992 early-run Russian River sockeye salmon recreational fishery by area and access location.

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance components: Days	%	Periods	%	Anglers	%
River effort:													
Ferry	6/12-6/30	19	10	299	287,973	5,677	5,927,706	4,924,344	83	1,000,525	17	2,837	0
Grayling	6/19-6/30	12	4	848	529,748	10,177	12,713,957	12,713,957	99	112,675	1	2,126	0
Pink salmon	6/19-6/30	12	4	775	366,164	9,295	8,787,942	8,787,942	98	140,723	2	3,082	0
	Total 6/12-6/30					25,148	27,688,211						
Ferry	7/01-7/19	19	9	315	81,832	5,986	6,467,782	1,727,555	27	4,734,715	73	5,513	0
Grayling	7/01-7/19	19	6	302	95,011	5,735	4,730,356	3,911,281	83	818,123	17	951	0
Pink salmon	7/01-7/19	19	5	654	112,727	12,435	6,957,200	5,997,074	86	958,224	14	1,902	0
	Total 7/01-7/19					24,156	18,155,338						
	Total river effort					49,304	45,843,549						
Confluence effort:													
Ferry	6/12-6/30	19	10	2,656	1,785,199	50,467	59,889,434	30,526,908	51	29,321,578	49	40,949	0
Grayling	6/19-6/30	12	4	501	84,512	6,012	2,265,260	2,028,299	90	235,379	10	1,581	0
Pink salmon	6/19-6/30	12	4	196	46,969	2,348	1,333,155	1,127,261	85	204,665	15	1,229	0
	Total 6/12-6/30					58,827	63,487,849						
Ferry	7/01-7/19	19	9	1,547	2,038,739	29,385	50,307,865	43,040,053	86	7,243,762	14	24,050	0
Grayling	7/01-7/19	19	6	279	41,919	5,296	2,528,986	1,725,656	68	802,099	32	1,231	0
Pink salmon	7/01-7/19	19	5	59	4,105	1,126	221,631	218,372	99	3,072	1	187	0
	Total 7/01-7/19					35,806	53,058,482						
	Total confluence effort					94,633	116,546,331						
	Total effort					143,937	162,389,880						

-continued-

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Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Harvest	Estimated Total Variance	Variance components: Days	%	Periods	%	Anglers	%
River harvest:													
Ferry	6/12-6/30	19	10	92	15,447	1,755	605,990	264,140	44	340,586	56	1,263	0
Grayling	6/19-6/30	12	4	273	156,447	3,279	3,831,639	3,754,735	98	76,370	2	534	0
Pink salmon	6/19-6/30	12	4	193	82,193	2,318	1,974,019	1,972,641	100	165	0	1,213	0
	Total 6/12-6/30					7,352	6,411,648						
Ferry	7/01-7/19	19	9	75	9,008	1,427	537,189	190,174	35	345,736	64	1,278	0
Grayling	7/01-7/19	19	6	80	12,540	1,523	579,632	516,213	89	63,173	11	246	0
Pink salmon	7/01-7/19	19	5	123	5,396	2,344	315,396	287,066	91	27,729	9	601	0
	Total 7/01-7/19					5,294	1,432,217						
	Total river harvest					12,646	7,843,865						
Confluence harvest:													
Ferry	6/12-6/30	19	10	594	52,048	11,279	2,318,088	890,019	38	1,419,307	61	8,762	0
Grayling	6/19-6/30	12	4	126	4,028	1,511	105,853	96,663	91	8,846	8	344	0
Pink salmon	6/19-6/30	12	4	28	554	335	13,686	13,307	97	302	2	76	1
	Total 6/12-6/30					13,125	2,437,627						
Ferry	7/01-7/19	19	9	189	62,152	3,590	1,493,424	1,312,104	88	177,364	12	3,957	0
Grayling	7/01-7/19	19	6	57	8,461	1,083	421,003	348,327	83	72,316	17	359	0
Pink salmon	7/01-7/19	19	5	4	22	68	1,619	1,189	73	419	26	12	1
	Total 7/01-7/19					4,741	1,916,046						
	Total confluence harvest					17,866	4,353,673						
	Total harvest					30,512	12,197,538						

[a] D = days possible in a stratum.

[b] d = days sampled in a stratum.

Appendix A4. Daily escapement of early- and late-run sockeye and chinook salmon through the Russian River weir, 12 June to 26 July 1992.

Date	Early Run Sockeye[a]	Late Run Sockeye	Chinook
6/12	0		
6/13	0		
6/14	0		
6/15	0		
6/16	0		
6/17	0		
6/18	11		
6/19	2		
6/20	72		
6/21	349		
6/22	17		
6/23	11		
6/24	23		
6/25	243		
6/26	2		
6/27	139		
6/28	60		
6/29	234		
6/30	513		
7/01	352		
7/02	8,313		
7/03	6,204		
7/04	4,706		
7/05	2,623		
7/06	1,213		
7/07	1,593		
7/08	1,768		
7/09	4,130		
7/10	953		
7/11	1344		
7/12	264		
7/13	775		
7/14	416		
7/15	152		
7/16	142		
7/17	231	16	
7/18	34	1	
7/19	58	9	
7/20	68	16	
7/21	3	0	

-continued-

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Date	Early Run Sockeye[a]	Late Run Sockeye	Chinook
7/22	9	2	
7/23	66	680	1[c]
7/24	7	194	
7/25	10	447	
7/26	7	406[b]	
Totals	37,117		

[a] From 7/17 through 7/26, early-run fish were differentiated from late-run fish based on degree of external maturation, i.e., body coloration and kype development.

[b] There was a 10-day temporal overlap between early-run and late-run fish. The total late-run sockeye salmon escapement is tabulated in the Fishery Data Series report for the 1992 late-run to the Russian River (Marsh *In prep*).

[c] Total estimated chinook escapement is tabulated in the Fishery Data Series report for the 1992 late-run to the Russian River (Marsh *In prep*).