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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, 1991

by

Larry E. Marsh

August 1992

Alaska Department of Fish and Game

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ABSTRACT

A direct expansion creel survey of the early-run Russian River recreational fishery was conducted in 1991 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. Anglers expended 255,854 angler-hours to harvest 65,390 sockeye salmon from the early run (10 June-25 July). The weighted harvest rate for the early run was 0.256 sockeye salmon per hour of angler effort. Approximately 70% of the effort and harvest during the early run was taken from the confluence area of the fishery.

A total of 32,389 sockeye salmon bound for spawning areas were counted through the weir at the outlet of Lower Russian Lake during the early run which met the escapement goal of 16,000 fish. Of the 32,389 early-run fish migrating through the weir, 729 were artificially spawned as a brood source for juvenile stocking in Bear Lake, near Seward, leaving 31,660 to spawn in the Russian River drainage.

Weighted estimates of the age composition for the total early return (apportioned harvest plus escapement) indicate that the early run was comprised primarily of age-1.3 and age-1.2 sockeye salmon (44.1% and 31.0%, respectively). Both the sport harvest and total return were near record highs for the early run.

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 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 during the early and late runs 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), and Carlon et al. (1991).

Sockeye salmon return to the Russian River in two temporal components, termed early and late runs. Historically, the total return 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 Russian/Kenai River confluence 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 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).

Presently, the early run of sockeye salmon bound for the Russian River is utilized fully 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 stocks. 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 takes place 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 Rivers 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 for each run pass through a weir at the outlet of Lower Russian Lake (Figure 2). The current 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 a single year, the escapement goal has been achieved during each year since the goals were established in 1979. Despite an emergency closure of the early-run fishery in 1989 (1 July through 15 July), the early-run goal was not achieved in that year (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

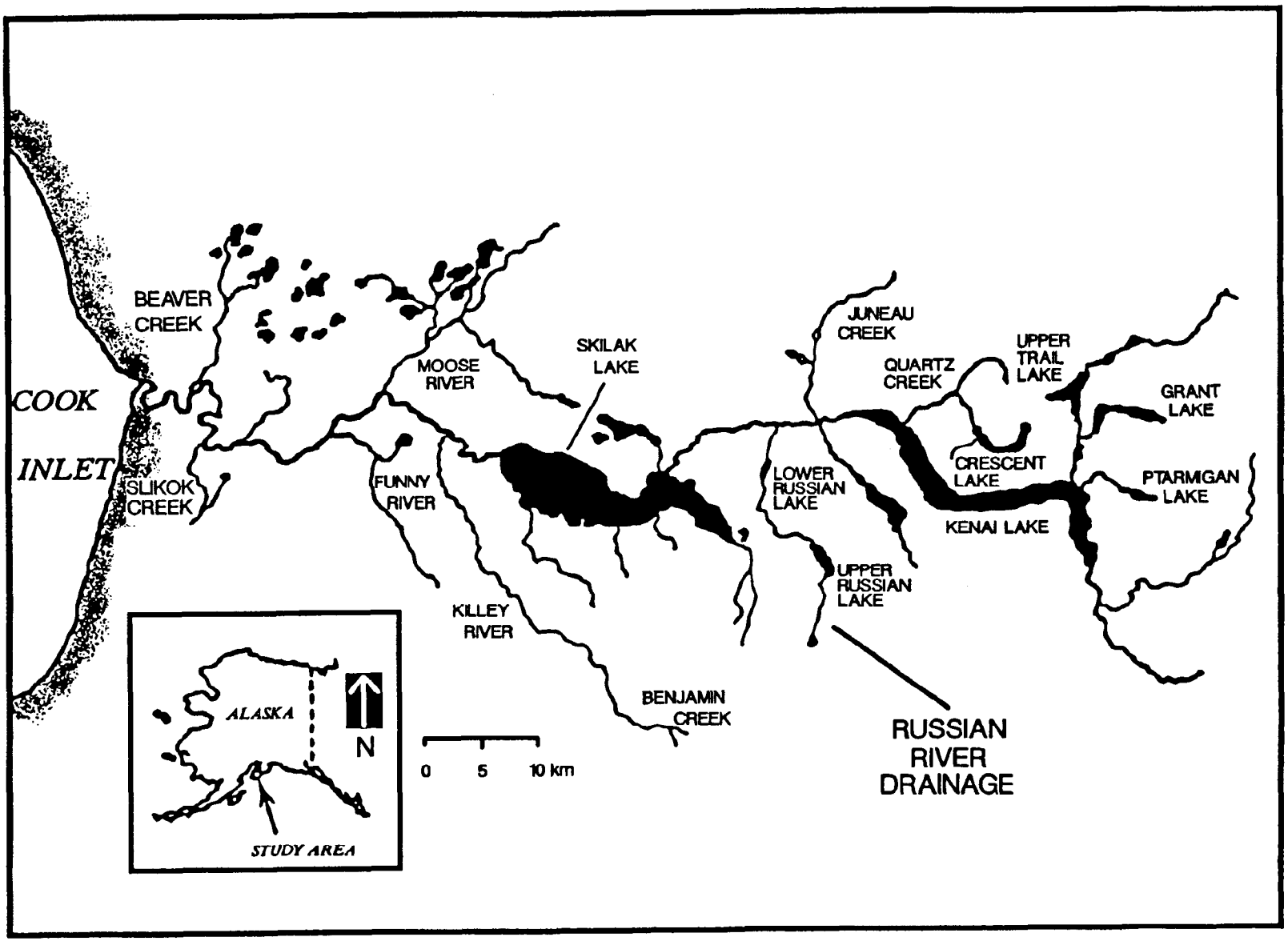

Figure 1. Map of the Kenai and Russian River drainages.

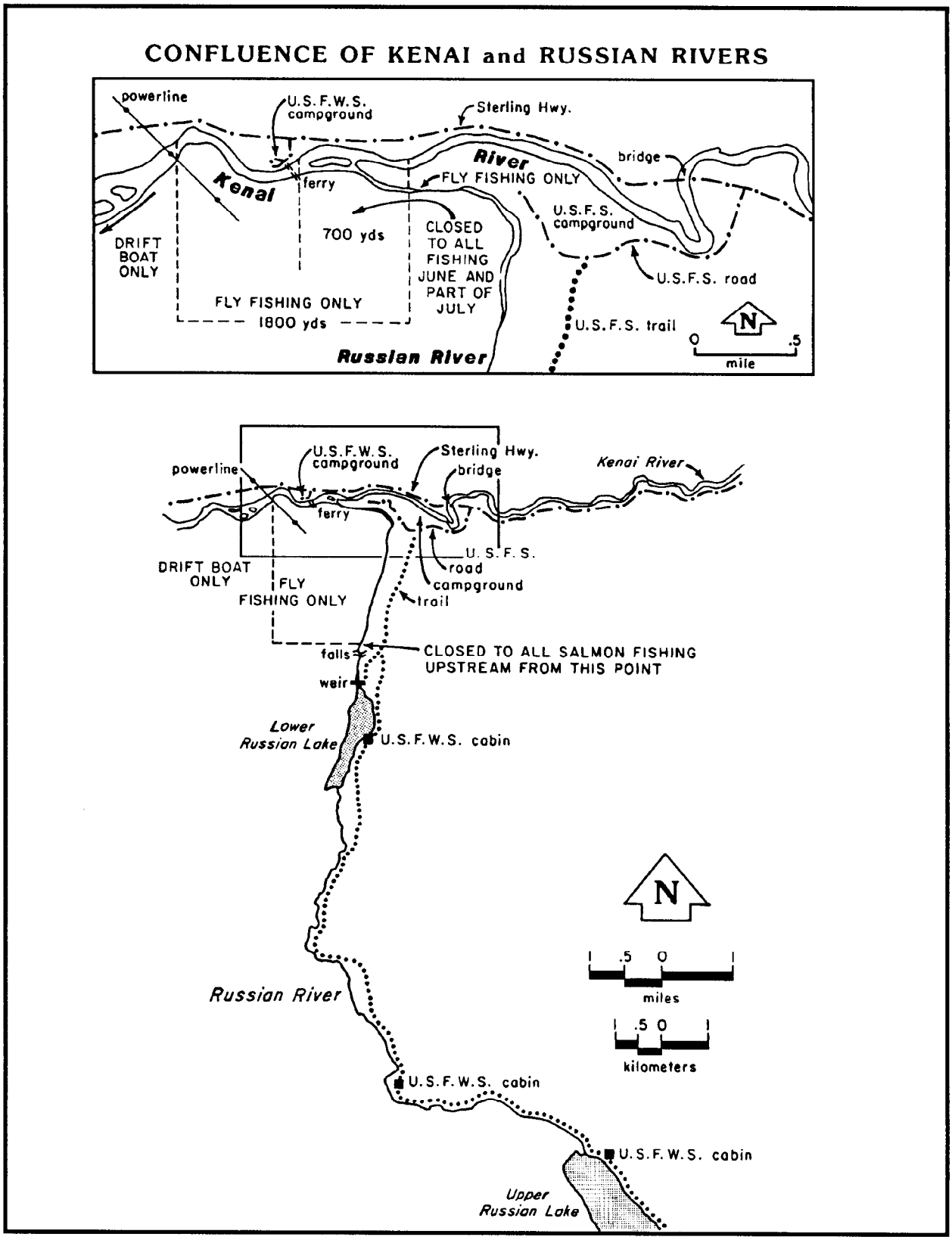

Figure 2. Detailed map of the Kenai and Russian River study area.

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

From 1 June through 20 August 1991, 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 1991: (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 return 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. An 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

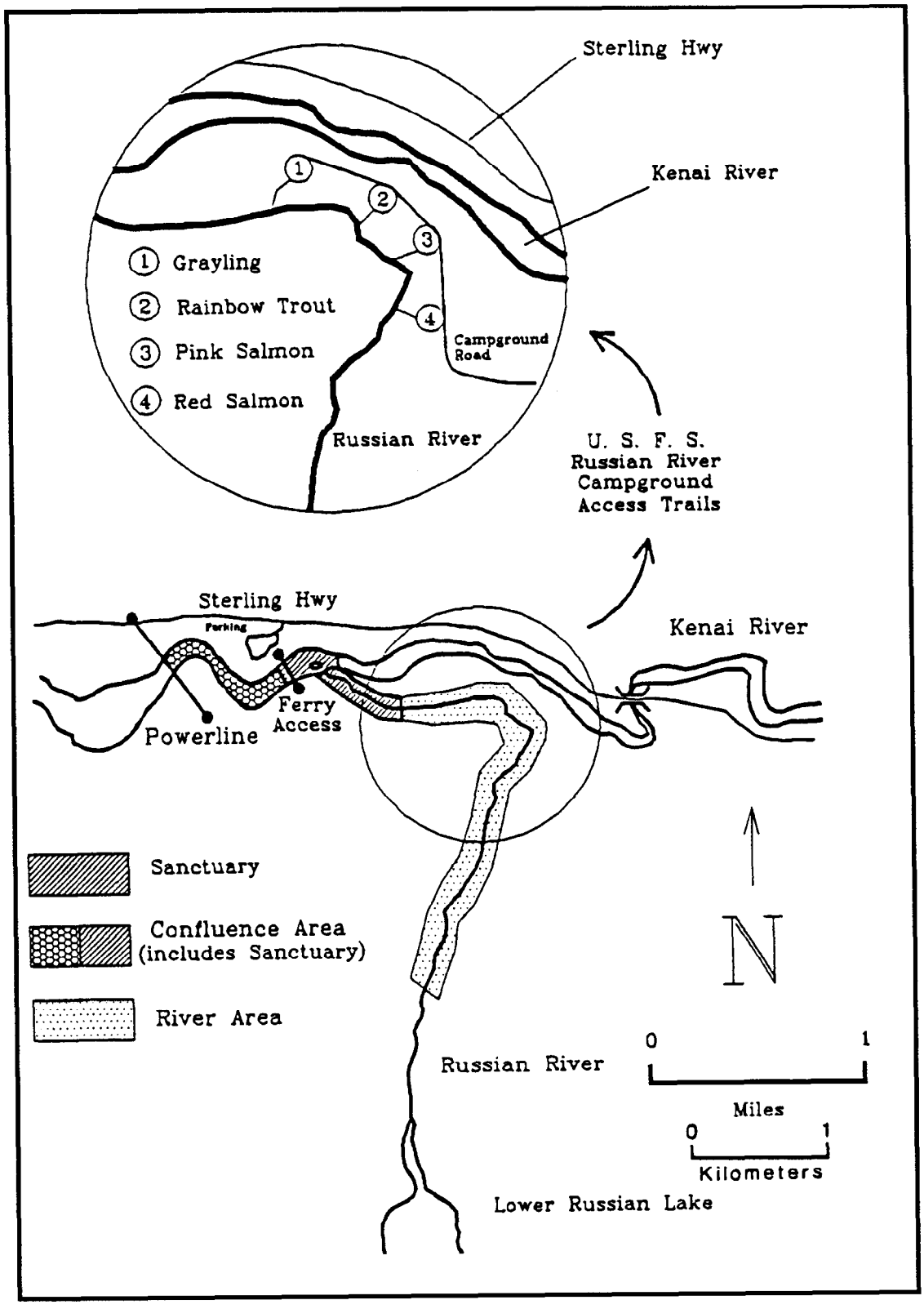

Figure 3. Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1991 creel survey.

concession administered by the USFWS. Some anglers also use the ferry to traverse the Kenai River and then walk upstream to fish the river area and some use one of the four USFS campground access trails to gain access to the confluence area via the riverside trail which terminates at 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 design was again utilized during the 1991 season. 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 for the 1990 season.

Sampling was stratified by access location and temporal component to estimate harvest and effort for anglers exiting the fishery at each access location during each temporal component. A survey stratum was defined as an access location/temporal component combination. The five main access locations for the Russian River sockeye salmon fishery included the ferry access to the confluence area and the four river trails connecting the USFS Russian River Campground with the Russian River. These locations were sampled over two temporal components to provide stratum estimates of sockeye salmon harvest and angler effort during the early run. The two temporal components were 10 to 27 June and 28 June to 25 July. Area-specific (river or confluence area) harvest and effort were estimated for each stratum by recording the area fished for each interviewed angler.

Sampling was stratified *a posteriori* to allow estimation of harvest by temporal components corresponding to changes within the fishery which influenced catch rates and the resulting harvest. The change in the fishery which directly influenced catch rates was the opening of the sanctuary area by emergency order on 28 June. The sport fishery was closed on 26 July via a temporary restraining order which closed all sport and commercial fisheries for sockeye salmon in Cook Inlet. The closure of the fishery coincided with the end of the early run and the appearance of the late-run stocks in the confluence area.

The creel survey sampling day was 18 hours in length and was divided into six, 3-hour periods from 0600 to 2400 hours. A three-stage sampling design was used with days as primary units, periods as secondary units, and anglers as tertiary units. Days were systematically sampled, and within each sampled day, two 3-hour periods were randomly selected from the possible six. 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 area 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 1989 and 1990, approximately two-thirds of the harvest and effort occurred in the confluence area (Carlon and Vincent-Lang 1990 and Carlon et al. 1991). This is typical of the effort distribution in most years (Nelson et al. 1986). As a result of this concentration of harvest and effort and because harvest rate (harvest per hour) is 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.

In 1990, all river access locations were sampled equally as no prior information was available concerning angler use patterns. Results from 1990 showed that there were significant differences in the level of use among locations (Carlon et al. 1991). Two access locations, Grayling and Pink Salmon, are at parking lots and the anglers exiting at these two locations represented 60% and 27% of the total number exiting the river. Anglers exiting at these locations contributed 44% of the total river area harvest, but accounted for 74% of the variance for the estimate of total harvest.

In order to reduce the overall variability of the estimates, a shift in the systematic sampling scheme was implemented. Estimated population variances were used to optimally allocate the possible number of sampling days among the river access locations (Cochran 1977). These optimal sample sizes were adjusted so no exit location was sampled fewer than 4 times during the early run. With only 1 year of data available, it was considered necessary to maintain this minimum level of sampling at all locations. During the early run, Grayling was sampled every 6 days, Rainbow every 8 days, and Pink salmon and Red Salmon every 4 days.

The following formulae were applied to generate harvest and effort estimates for each temporal component of the fishery. At access location h, on day i, and during sample period j, a total of m_{hij} completed anglers were interviewed as they exited through location h and a_{hij} anglers were "missed" anglers because they exited and were counted but were not interviewed. Interviewed anglers could be assigned to one of three groups:

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

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

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

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

To account for area-specific harvest attributable to missed anglers (a_{hij}), this group had to be prorated as fishing either the river area or the confluence area. The proportion of missed anglers that fished the river was estimated as:

$$\hat{P}_{rhij} = \frac{m_{rhij}}{m_{hij}}, \quad (2)$$

where:

m_{rhij} = the number of interviewed anglers fishing the river = $m_{1hij} + m_{3hij}$.

The number (a_{rhij}) of missed anglers prorated as fishing the river was estimated as:

$$\hat{a}_{rhij} = (a_{hij})\,(\hat{P}_{rhij}). \quad (3)$$

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

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

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

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

The mean river area harvest per interviewed angler was:

$$\bar{h}_{rhij} = \frac{\sum_{l=1}^{m_{rhij}} h_{rhijl}}{m_{rhij}} \quad (6)$$

where:

h_{rhijl} = the river area harvest for angler l at location h, on day i, during sample period j.

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

$$\hat{S}^2_{3rij} = \frac{\sum_{l=1}^{m_{rhij}} (h_{rhijl} - \bar{h}_{rhij})^2}{m_{rhij}-1}. \quad (7)$$

The total river area harvest exiting with anglers through access location h, on day i, and during sample period j (H_{rhij}) was estimated as:

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

The mean river area harvest per period ($\bar{H}_{rhi}$) is then estimated for day i and location h as:

$$\hat{\bar{H}}_{rhi} = \frac{\sum_{j=1}^{u} \hat{H}_{rhij}}{u} \quad (9)$$

and the variance among sample periods is estimated as:

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

The total river area harvest exiting with anglers through access location h, on day i was estimated by expanding the mean river area harvest per period on day i as:

$$\hat{H}_{rhi} = \underline{\Delta}\, U\, \hat{H}_{rhi} \quad (11)$$

where:

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

The mean river area harvest per day ($\bar{H}_{rh}$) is then estimated for location h as:

$$\underline{\Delta}\, \hat{H}_{rh} = \frac{\sum_{i=1}^{d} \hat{H}_{rhi}}{d} \quad (12)$$

where:

d = the number of days sampled.

The variance of river area harvest among days (S^2_{1rh}) at location h is estimated using the variance for a systematic sample (Wolter 1985) as:

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

The total river area harvest for location h (H_{rh}) was estimated by expanding the mean harvest per day as:

$$\hat{H}_{rh} = D\,\hat{\bar{H}}_{rh} \qquad (14)$$

where:

D = the total number of possible sampling days during a temporal component.

For any location h, the variance of the total river area harvest was estimated as:

$$\hat{V}(H_{rh}) = (1-f_1)\,D^2\,\frac{\hat{S}^2_{1rh}}{d} + D\,\frac{U^2}{u}\,(1-f_2)\,\frac{\sum_{i=1}^{d}\hat{S}^2_{2rhi}}{d} + D_{rh}\,U\sum_{i=1}^{d}\sum_{j=1}^{u} M^2_{rhij}\,(1-f_{3rhij})\,\frac{\hat{S}^2_{3rhij}}{d\,u\,m_{rhij}} \qquad (15)$$

where:

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

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

f_{3rhij} = the finite population correction factor for anglers (m_{rhij}/M_{rhij}).

This procedure (Equations 2 through 15) was also used to generate estimates of the confluence area harvest exiting with anglers through each access location. Likewise, the same procedure was used to estimate angler-hours of effort expended in the river area or 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 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 through sampled locations and reporting confluence targeted effort. The daily harvest rate for the confluence area was estimated as:

$$\hat{HPUE}_c = (1/n) \sum_{i=1}^{n} HPUE_i \qquad (16)$$

where:

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

$HPUE_i$ = confluence-area harvest per hour of effort for angler i.

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

The variance of this estimate was calculated as:

$$\hat{V}(HPUE) = \frac{\sum_{i=1}^{n} (HPUE_i - \overline{HPUE})^2}{n(n-1)}. \qquad (17)$$

The overall harvest rate for the early run has been historically estimated to provide a general basis for comparing seasonal fishing success among years (Nelson 1985, Hammarstrom and Athons 1989). A weighted 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 had not developed the reddish body coloration characteristic of more mature fish passing through the weir later in each run. Therefore, during the period of run overlap at the weir, the last of the early-run fish typically exhibit reddish body coloration while the late-run fish do not. The period of overlap began on 27 July when late-run fish were intermixed with mature, early-run fish and continued through 1 August, after which early-run fish were no longer present.

Biological Data:

Six time and area strata within the Russian River sockeye salmon return were sampled for biological data (Table 1). The sampling strata applying to the spatial harvest components correspond to those for which harvest estimates were generated by the creel survey. This allowed each harvest estimate to be apportioned in an unbiased manner by stratum estimates of age composition.

Table 1. Temporal components of the recreational harvest and escapement sampled for age composition during the 1991 early-run Russian River sockeye salmon return.

Return Component	Temporal Delineation
Early-run confluence area harvest	6/10 - 6/27 6/28 - 7/25
Early-run river area harvest	6/10 - 6/27 6/28 - 7/25
Early-run escapement through weir	6/13 - 6/29 6/30 - 7/25

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.

Contingency tests were applied to determine if age composition changed over temporal strata. Null hypotheses of equal age compositions among temporal strata were rejected if calculated tail-area probabilities (P values) were less than 0.10.

In prior years, the age composition of the early-run escapement was used to apportion both the escapement and early-run harvest from both the confluence and river areas (Nelson 1986, Carlon and Vincent-Lang 1990). This procedure assumes that the age composition of the escapement through the weir represents that of the river and confluence-area sport harvests. This assumption was tested in 1990 and significant differences among age compositions were found in the three sampled areas during some of the temporal strata (Carlon et al. 1991). These sampling procedures were again utilized in 1991 with each area sampled individually and tested for equality among age composition within each temporal stratum. Contingency tests were applied and the null hypotheses of equality of age compositions among components were rejected if calculated tail-area probabilities were less than 0.10.

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:

$$\hat{P}_{hi} = n_{hi}/n_{Ti}, \qquad (18)$$

where:

n_{hi} = the number of legible scales read from sockeye salmon sampled during stratum i and interpreted as age h, and

n_{Ti} = the total number of legible scales read from sockeye salmon sampled during stratum i.

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

$$\hat{V}(P_{hi}) = \hat{P}_{hi}(1-\hat{P}_{hi})/(n_{Ti}-1). \qquad (19)$$

The numbers of sockeye salmon (N_{hi}) by age group h were estimated by sex during each temporal stratum i for the early-run escapement using the estimates of the age group proportions (P_{hi}) as defined previously:

$$\hat{N}_{hi} = N_{Ti}\hat{P}_{hi}, \quad (20)$$

where:

N_{Ti} = the total number of sockeye salmon enumerated during stratum i at the weir.

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

$$V(\hat{N}_{hi}) = N^2_{Ti}\, V(\hat{P}_{hi}). \quad (21)$$

Weighted 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 r, the total number of fish of age h (N_{rh}) migrating through the weir was estimated as:

$$\hat{N}_{rh} = \sum_{i=1}^{p} \hat{N}_{hi}, \quad (22)$$

where:

p = the number of temporal strata (2) in early run r.

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

$$V(\hat{N}_{rh}) = \sum_{i=1}^{p} V(\hat{N}_{hi}). \quad (23)$$

The proportion of age h adults in the total escapement of the early run r (P_{rh}) migrating through the weir was estimated as:

$$\hat{P}_{rh} = \hat{N}_{rh}/E_r, \quad (24)$$

where:

E_r = the total escapement of early run r enumerated at the weir.

The variance of $\hat{P}_{rh}$ was estimated as the variance of the product of a random variable ($\hat{N}_{rh}$) and a constant ($1/E_r$) as:

$$V(\hat{P}_{rh}) = (1/E_r)^2\, V(\hat{N}_{rh}). \quad (25)$$

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

$$\hat{N}_{hi} = \hat{H}_{Ti}\hat{P}_{hi}, \quad (26)$$

where:

$\hat{H}_{Ti}$ = the estimate of total harvest of sockeye salmon during temporal component i.

The variance of $\hat{N}_{hi}$ was estimated using the formula for the product of two independent random variables (Goodman 1960):

$$\hat{V}(N_{hi}) = \hat{H}^2_{Ti}\,\hat{V}(P_{hi}) + \hat{P}^2_{hi}\,\hat{V}(H_{Ti}) - \hat{V}(P_{hi})\,\hat{V}(H_{Ti}), \quad (27)$$

where:

$\hat{V}(H_{Ti})$ = the variance of the harvest estimate during stratum i.

Weighted age composition estimates were generated for the total harvest occurring during the early run by summing estimated numbers by age over temporal strata. For the early run r, the total number of fish of age h harvested (N_{rh}) was estimated as per the procedure used for the escapement (Equation 22). The variance of the estimate was calculated by summing the variances of the individual stratum estimates as per the procedure used for the escapement (Equation 23).

The proportion of age h adults in the total sport harvest from early run r (P_{rh}) was estimated as:

$$\hat{P}_{rh} = \hat{N}_{rh}/\hat{H}_r, \quad (28)$$

where:

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

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

$$\hat{V}(P_{rh}) = \hat{P}^2_{rh}\,[\hat{V}(N_{rh})/\hat{N}^2_{rh} + \hat{V}(H_r)/\hat{H}^2_r], \quad [29)$$

where:

$\hat{V}(H_r)$ = the variance of the estimated harvest of fish from the early run r as defined previously.

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. To determine if temporal samples could be pooled to estimate mean length at age by sex, 95% confidence intervals for the mean lengths were examined for significant differences between the relative length frequencies among temporal strata within each spatial component.

RESULTS

Creel Statistics

Survey Interviews:

Sampling of access locations began on 10 June, when the ferry location was sampled. Sampling of this location continued every other day through the end of the early run on 25 July.

The systematic sampling of the four Russian River Campground access locations began on 17 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 17 June. On-site observations indicated that this was also the case in 1991.

A total of 6,921 anglers were enumerated as they exited sampled access locations during the 1991 early-run survey (Table 2). Of these, 3,709 (53.6%) were interviewed and 3,212 (46.4%) were not interviewed. A daily summary of the data collected during the 1991 creel survey is presented in Appendix A1. The total number of interviews collected in the early run represents an 8.3% decrease from 1990. 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 (72.2%) were made at the ferry access location as this location was sampled most intensely and typically accounts for the most effort (Appendix A2). Anglers exiting via the ferry location tended to fish the confluence area (91.2%) (Appendix A3).

Harvest and Effort:

Estimates of harvest, effort, and variances are presented by stratum (temporal component/access location) in Appendix A4. 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). Three access locations (the ferry, Grayling, and Pink Salmon) accounted for most of the effort and harvest during the early run (96.8%). The relative precisions of the early-run harvest and effort estimates were 21% and 19%, respectively (Table 3).

Table 2. Summary of the number of interviews collected during sampled periods for the early-run Russian River creel survey, 1991.

Exit Location	Area Fished			Total Interviews	Anglers Exiting and not interviewed	Total Anglers Exiting
	Confluence	River	Both			
Ferry	2,403	197	78	2,678	2,958	5,636
Grayling	150	285	6	441	108	549
Rainbow Trout	33	39	16	88	19	107
Pink Salmon	49	320	28	397	114	511
Red Salmon	6	99	0	105	13	118
Early Run Total	2,641	940	128	3,709	3,212	6,921

Table 3. Estimates of harvest, effort, and associated variances by access location during the early run of Russian River sockeye salmon, 1991.

Access Location	Harvest	(%)	Variance of Harvest	(%)	Relative Precision[a]	Effort	(%)	Variance of Effort	(%)	Relative Precision[a]
Early Run										
Ferry	43,966	67	26,273,503	54	23%	173,537	68	393,061,109	66	22%
Grayling	13,320	20	14,317,311	30	56%	44,450	17	104,054,616	17	45%
Rainbow Trout	1,151	2	76,023	<1	47%	7,339	3	10,169,641	2	85%
Pink Salmon	5,979	9	7,470,701	16	90%	25,025	10	84,677,936	14	72%
Red Salmon	974	2	123,826	<1	71%	5,503	2	3,584,182	1	67%
Total	65,390	100	48,261,364	100	21%	255,970	100	595,547,484	100	19%

[a] $\alpha = 0.05$

The 1991 early-run harvest estimate was 65,390 (SE = 6,947) sockeye salmon (Table 4). The effort estimate for the early run was 255,854 (SE = 24,404) angler-hours. During the early run, 69.9% of the harvest was taken from the confluence area and the remaining 30.1% 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 1991.

Spawning Escapement

A total of 32,389 early-run sockeye salmon passed through the weir (Figure 5 and Appendix A5). Late-run sockeye salmon began arriving on 27 July and the last early-run fish was passed on 1 August.

Of the 32,389 early-run adults enumerated at the weir, a total of 729 adults (443 females and 286 males) were captured near spawning locations in the upper reaches of the drainage and utilized as brood stock for planting of juveniles into Bear Lake near Seward. This reduced the effective size of the early-run spawning escapement to 31,660.

Biological Data

Comparisons among the three spatial components sampled during the early run (confluence area harvest, river area harvest, and weir escapement) indicated that there were differences in age compositions among the components. Contingency tests illustrated that there were significant differences between all spatial components during both of the temporal strata (Table 6). The age composition of the confluence area harvest differed from that of the weir escapement during both temporal strata (Table 6; $\chi^2_{\text{stratum 1}} = 9.75$, df = 2, $P < 0.01$; $\chi^2_{\text{stratum 2}} = 13.69$, df = 2, $P < 0.005$). The age composition of the river area harvest also differed from that of the weir escapement during all temporal strata ($\chi^2_{\text{stratum 1}} = 23.23$, df = 2, $P < 0.005$; $\chi^2_{\text{stratum 2}} = 20.62$, df = 2, $P < 0.005$). The age composition of the confluence harvest differed from that of the river area harvest during both of the strata as well, ($\chi^2_{\text{stratum 1}} = 17.65$, df = 2, $P < 0.005$; $\chi^2_{\text{stratum 2}} = 10.28$, df = 2, $P < 0.10$).

Additionally, differences in age distribution were indicated between temporal strata within individual spatial components at the weir and in the confluence harvest. The exception to this was the river area harvest with no significant temporal changes in age composition.

Sample data were therefore expanded within period and sample area to estimate age composition of the total return (Tables 7-9).

The early-run escapement through the weir was comprised predominantly of two age groups, ages 1.3 and 1.2. A third age group, age 2.3, comprised 13.3% of the escapement with the predominant age group (57.0%) being age 1.3. (Table 7). There was a significant difference in the composition of age-1.3 and -1.2 adults detected over the two temporal sampling strata ($\chi^2 = 20.07$, df = 2, $P < 0.005$).

Table 4. Summary of estimated angler-effort and harvest by component during the early run of sockeye salmon, 1991.

Component	Confluence Area	River Area	Total	95% Confidence Interval
Effort	182,535	73,319	255,854	208,022 - 303,686
SE	20,892	12,612	24,404	
Harvest	45,712	19,678	65,390	51,774 - 79,006
SE	5,362	4,417	6,947	

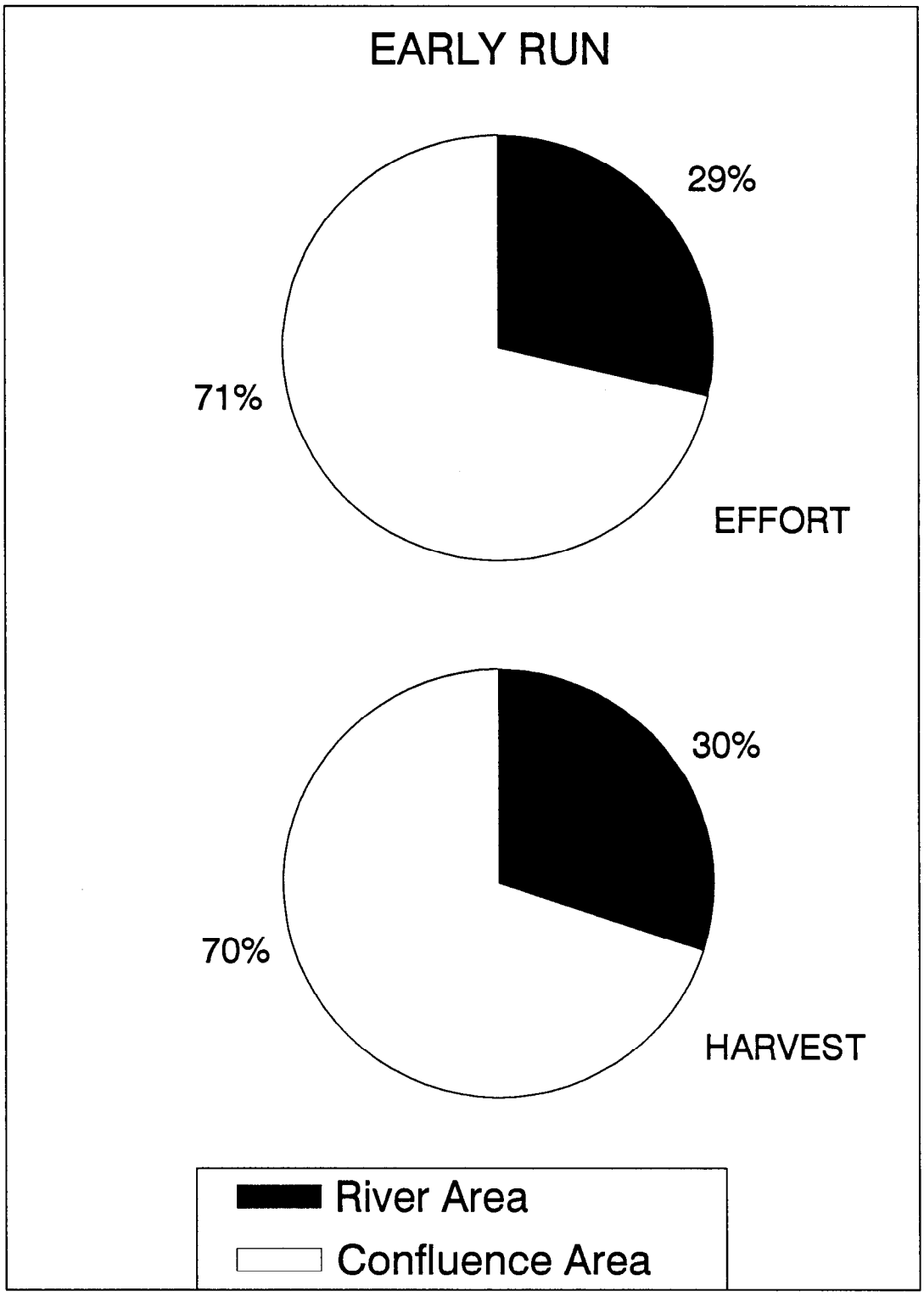

Figure 4. Harvest and angler effort by area for the Russian River early-run sockeye salmon recreational fishery, 1991.

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, 1991.

Run	Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Early	Confluence	31	46	2,705	0.250	0.0017
Early	River	29	40	1,004	0.268	0.0058
Early	Both			3,709	0.256	0.0013

[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.

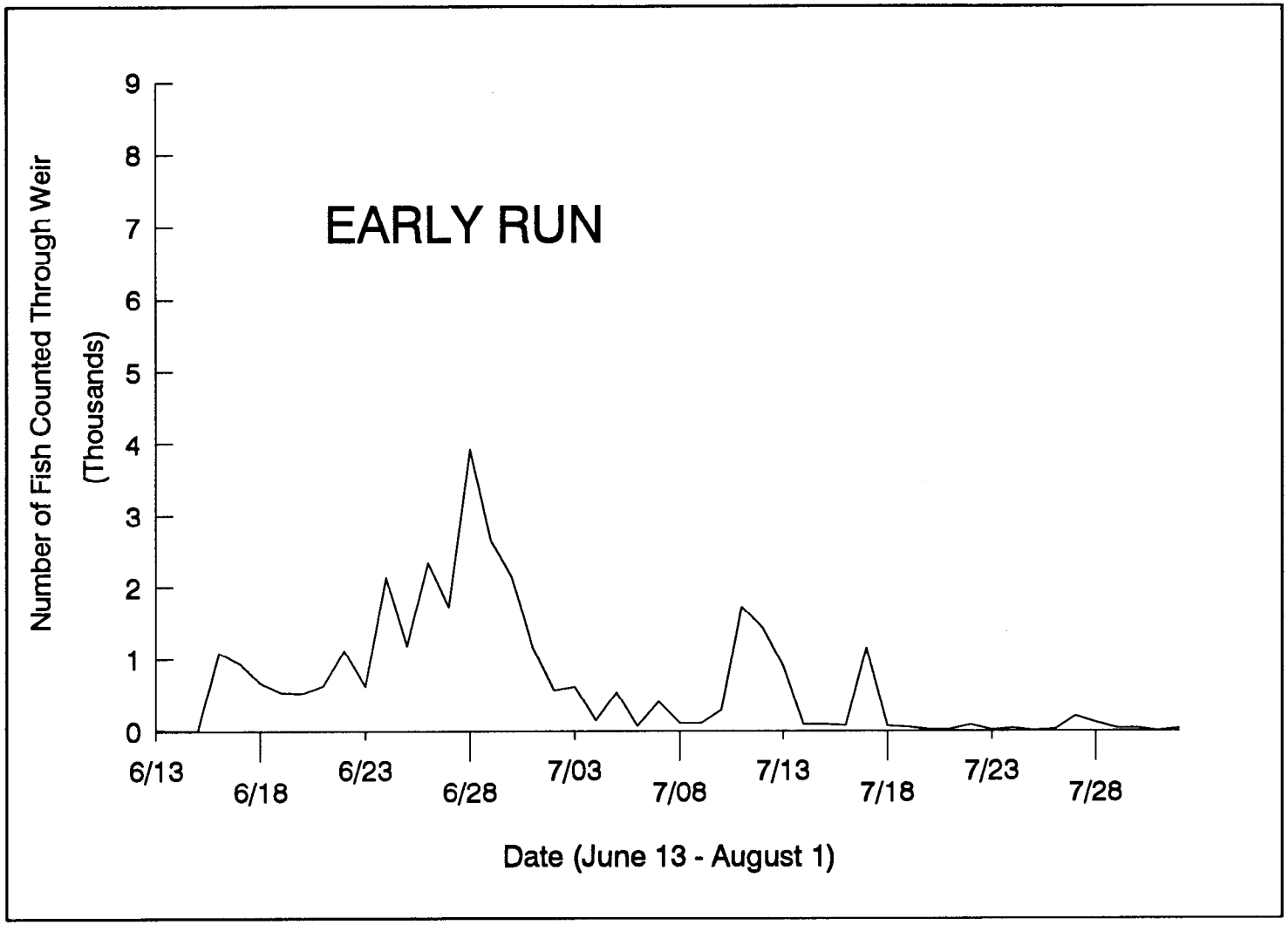

Figure 5. Daily escapement of early-run sockeye salmon through the Russian River weir, 1991.

Table 6. Results of contingency test comparisons of age composition between spatial fishery components for the early-run Russian River sockeye salmon recreational fishery, 1991.

Temporal Stratum[a]	Spatial Component: Confluence Harvest vs River Harvest	Confluence Harvest vs Weir Escapement	River Harvest vs Weir Escapement
1	S[b](P<0.005)	S(P<0.01)	S(P<0.005)
2	S(P<0.01)	S(P<0.005)	S(P<0.005)

[a] 1 = 6/10-6/27 (6/13-6/29 for weir escapement).
2 = 6/28-7/25 (6/30-7/25 for weir escapement).

[b] Significant difference.

Table 7. Estimated age and sex composition of the early-run sockeye salmon escapement through the Russian River weir, 1991.

Dates	Age Group 2.3	1.4	1.3	2.2	1.2	1.1	Total
6/13 - 6/29 (n^a = 146)							
Females							
Sample Size	13		41		13	1	68
Percent	8.9		28.1		8.9	0.7	46.6
Variance of Percent	5.6		13.9		5.6	0.5	17.2
Number	1,786		5,634		1,786	137	9,344
Variance of Number	225,149		560,593		225,149	18,882	690,682
Males							
Sample Size	11	1	50	1	15		78
Percent	7.5	0.7	34.2	0.7	10.3		53.4
Variance of Percent	4.8	0.5	15.5	0.5	6.4		17.2
Number	1,512	137	6,871	137	2,061		10,718
Variance of Number	193,375	18,882	625,052	18,882	255,881		690,682
Sexes Combined							
Sample Size	24	1	91	1	28	1	146
Percent	16.4	0.7	62.3	0.7	19.2	0.7	100.0
Variance of Percent	9.5	0.5	16.2	0.5	10.7	0.5	
Number	3,298	137	12,505	137	3,847	137	20,062
Variance of Number	381,282	18,882	651,747	18,882	430,244	18,882	

-continued-

Table 7. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
6/30 - 7/25 (n^a = 145)						
Females						
Sample Size	5	46		41		92
Percent	3.4	31.7		28.3		63.4
Variance of Percent	2.3	15.0		14.1		16.1
Number	425	3,911		3,486		7,821
Variance of Number	35,133	228,565		214,010		244,726
Males						
Sample Size	7	24	1	21		53
Percent	4.8	16.6	0.7	14.5		36.6
Variance of Percent	3.2	9.6	0.5	8.6		16.1
Number	595	2,040	85	1,785		4,506
Variance of Number	48,483	145,751	7,227	130,694		244,726
Sexes Combined						
Sample Size	12	70	1	62		145
Percent	8.3	48.3	0.7	42.8		100.0
Variance of Percent	5.3	17.3	0.5	17.0		
Number	1,020	5,951	85	5,271		12,327
Variance of Number	80,103	263,497	7,227	258,277		

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Table 7. (Page 3 of 3).

Dates	Age Group 2.3	1.4	1.3	2.2	1.2	1.1	Total
Early Run Total (n[a] = 291)							
Females							
Percent	6.8		29.5		16.3	0.4	53.0
Variance of Percent	2.2		7.2		4.7	0.1	8.6
Number	2,211		9,544		5,272	137	17,165
Variance of Number	260,282		789,158		439,159	18,882	935,408
Males							
Percent	6.5	0.4	27.5	0.7	11.9		47.0
Variance of Percent	2.1	0.1	6.9	0.2	3.6		8.6
Number	2,107	137	8,911	222	3,846		15,224
Variance of Number	241,859	18,882	770,803	26,109	386,575		935,408
Sexes Combined							
Percent	13.3	0.4	57.0	0.7	28.2	0.4	100.0
Variance of Percent	4.0	0.1	8.5	0.2	7.0	0.1	
Number	4,318	137	18,455	222	9,118	137	32,389
Variance of Number	461,385	18,882	915,244	26,109	688,521	18,882	

[a] n = sample size.

Table 8. Estimated age and sex composition of early-run sockeye salmon harvested from the confluence area of the Russian River recreational fishery, 1991.

Dates	Age Group 2.3	1.3	2.2	1.2	1.1	Total
6/10 - 6/27 (n[a] = 86)						
Females						
Sample Size	10	19		2		31
Percent	11.6	22.1		2.3		36.0
Variance of Percent	12.1	20.2		2.7		27.1
Number	1,344	2,554		269		4,166
Variance of Number	180,196	341,564		36,115		555,532
Males						
Sample Size	16	37		2		55
Percent	18.6	43.0		2.3		64.0
Variance of Percent	17.8	28.8		2.7		27.1
Number	2,150	4,973		269		7,392
Variance of Number	287,860	662,006		36,115		979,386
Sexes Combined						
Sample Size	26	56		4		86
Percent	30.2	65.1		4.7		100.0
Variance of Percent	24.8	26.7		5.2		
Number	3,494	7,526		538		11,558
Variance of Number	466,544	996,928		72,192		1,518,809

-continued-

Table 8. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	1.1	Total
6/28 - 7/25 (n^a = 338)						
Females						
Sample Size	24	53	7	94		178
Percent	7.1	15.7	2.1	29.5		52.7
Variance of Percent	2.0	3.9	0.6	6.0		7.4
Number	2,425	5,356	707	9,498		17,986
Variance of Number	360,305	1,116,581	80,243	2,785,021		8,395,568
Males						
Sample Size	34	48	19	58	1	141
Percent	10.1	14.2	5.6	17.2	0.3	47.3
Variance of Percent	2.7	3.6	1.6	4.2	0.1	7.4
Number	3,436	4,850	1,920	5,861	101	16,168
Variance of Number	581,420	961,134	265,406	1,282,467	10,211	6,945,267
Sexes Combined						
Sample Size	58	101	26	152	1	338
Percent	17.2	31.7	7.7	45.0	0.3	100.0
Variance of Percent	4.4	6.8	2.1	7.3	0.1	
Number	5,861	10,206	2,627	15,359	101	34,154
Variance of Number	1,282,467	3,140,030	401,187	6,344,117	10,211	27,233,422

-continued-

Table 8. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	1.1	Total
Early Run Total (n[a] = 424)						
Females						
Percent	8.2	17.3	1.5	21.4		48.5
Variance of Percent	3.5	11.1	0.4	19.8		75.2
Number	3,769	7,909	707	9,767		22,153
Variance of Number	540,501	1,458,145	80,243	2,821,136		8,951,100
Males						
Percent	12.2	21.5	4.2	13.4	0.2	51.5
Variance of Percent	6.2	14.1	1.5	8.8	0.05	74.5
Number	5,586	9,823	1,920	6,130	101	23,559
Variance of Number	869,280	1,623,139	265,406	1,318,582	10,211	7,924,653
Sexes Combined						
Percent	20.5	38.8	5.7	34.8	0.2	100.0
Variance of Percent	14.1	40.5	2.4	47.3	0.05	
Number	9,355	17,732	2,627	15,897	101	45,712
Variance of Number	1,749,011	4,136,958	401,187	6,416,309	10,211	28,752,231

[a] n = sample size.

Table 9. Estimated age and sex composition of early-run sockeye salmon harvested from the river area of the Russian River recreational fishery, 1991.

Dates	Age Group 2.3	1.3	2.2	1.2	1.1	Total
Early Run Total (n[a] = 203)						
Females						
Sample Size	29	37	3	32		101
Percent	14.3	18.2	1.5	15.8		49.8
Variance of Percent	6.1	7.4	0.7	6.6		12.4
Number	2,811	3,587	291	3,102		9,791
Variance of Number	621,063	919,453	30,765	726,520		5,284,617
Males						
Sample Size	42	35	2	23		102
Percent	20.7	17.2	1.0	11.3		50.2
Variance of Percent	8.1	7.1	0.5	5.0		12.4
Number	4,071	3,393	194	2,230		9,887
Variance of Number	1,133,848	839,704	19,652	433,329		5,380,725
Sexes Combined						
Sample Size	71	72	5	55		203
Percent	35.0	35.5	2.5	27.1		100.0
Variance of Percent	106.9	108.8	1.6	66.9		
Number	6,882	6,979	485	5,331		19,678
Variance of Number	1,754,911	1,759,157	50,417	1,159,849		19,509,889

[a] n = sample

The early run, confluence-area harvest was also comprised predominantly of age-1.3 and -1.2 adults with age-2.3 adults contributing (20.5%) to the sampled harvest (Table 8). Over the entire run, age-1.3 and age-1.2 adults contributed almost equally to the harvest from the confluence area, but there were significant temporal changes detected in the contribution by age ($\chi^2 = 55.95$, df = 2, $P < 0.005$); age-1.2 adults contributed proportionately more during the second stratum (45.0%) than during the first stratum (4.6%).

Age-2.3, -1.3, and -1.2 fish comprised similar proportions of the early-run river-area harvest (Table 9). There were no significant temporal changes detected in the contribution by age ($\chi^2 = 4.39$, df = 2, $P > 0.10$). The predominant age classes did not significantly change between the two temporal strata sampled in the river.

Mean length by age and sex was examined individually for the three spatial components sampled during the early run to determine if temporal samples could be pooled to generate single, unbiased estimates for age/sex combinations within each component. A Kolmogorov-Smirnov two-sample test was utilized to determine if there were significant differences between the length frequencies within each age/sex combination. However, because some sample sizes of *a posteriori* combinations were small (less than 30 fish) the validity of the Kolmogorov-Smirnov test results were suspect. Of 10 possible comparisons, none of the frequency distributions for the age/sex combinations were significantly different. Therefore, temporal samples drawn from each component were pooled to estimate mean length by age and sex within spatial components (Table 10).

Total Return Statistics

Overall, an estimated 97,779 early-run sockeye salmon returned to the Russian River in 1991 (Table 11). Of these, 44.1% were age 1.3 and 31.0% were age 1.2. Ages 2.3 and 2.2 comprised 21.0% and 3.4% of the return, respectively.

APPLICATION OF THE DATA FOR FISHERY MANAGEMENT

Both 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. Through 26 June 1991, a total of 11,789 sockeye salmon had migrated through the weir and an estimated 4,000 fish were holding immediately downstream from the weir. Stream survey observations also indicated significant numbers of sockeye salmon negotiating the Russian River falls on 26 June. These fish were observed upstream from the area open to fishing and as such, were all considered as having escaped fishing mortality and were projected to migrate through the weir and contribute to an escapement in excess of 16,000.

Since it was projected that the escapement goal of 16,000 would be achieved, it was deemed appropriate to liberalize the fishery by removing the no fishing restriction on the sanctuary area. Therefore, an emergency order was issued

Table 10. Mean length (millimeters) at age, by sex, for the early run of sockeye salmon sampled from the Russian River, 1991.

Component		Age Class					
		2.3	1.4	2.2	1.3	1.2	1.1
Escapement[a]							
Female	Mean Length	600			594	546	510
	SE	5.3			2.3	2.7	
	Sample Size	18			87	54	1
Male	Mean Length	606	655	535	594	540	
	SE	5.3		25.0	2.6	3.9	
	Sample Size	18	1	2	74	36	
Confluence Area Harvest							
Female	Mean Length	599		555	586	538	
	SE	3.2		9.7	3.0	2.2	
	Sample Size	34		7	72	96	
Male	Mean Length	594		559	594	543	466
	SE	3.1		7.9	2.5	4.1	
	Sample Size	50		19	85	60	1
River Area Harvest							
Female	Mean Length	598		560	579	549	
	SE	4.8		11.0	4.3	4.5	
	Sample Size	29		3	37	32	
Male	Mean Length	600		584	587	542	
	SE	3.1		4.5	3.7	5.7	
	Sample Size	42		2	35	23	

[a] Fish that migrated through the weir.

Table 11. Estimated age and sex composition of the early run of sockeye salmon to the Russian River, 1991.

Dates	Age Group 2.3	1.4	1.3	2.2	1.2	1.1	Total
Early Run Total[a] (n[b] = 918)							
Females							
Percent	9.0		21.5	1.0	18.6	0.1	50.2
Variance of Percent	1.6		4.8	0.1	5.4	0.0001	27.6
Number	8,791		21,040	998	18,141	137	49,109
Variance of Number	1,161,564		2,377,598	111,008	3,547,656	0	14,235,717
Males							
Percent	12.0	0.1	22.6	2.4	12.5	0.1	49.8
Variance of Percent	2.8	0.0001	5.2	0.3	2.6	0.01	26.4
Number	11,764	137	22,127	2,336	12,206	101	48,670
Variance of Number	2,003,128	0	2,462,843	285,058	1,751,911	10,211	13,305,378
Sexes Combined							
Percent	21.0	0.1	44.1	3.4	31.0	0.2	100.0
Variance of Percent	5.5	0.0001	14.9	0.5	10.4	0.01	
Number	20,555	137	43,167	3,334	30,347	238	97,779
Variance of Number	3,164,692	0	4,840,441	396,066	5,299,567	10,211	48,261,364

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

[b] n = sample size.

which opened the sanctuary area at 12:00 noon on 28 June to the taking of sockeye salmon. Anglers were therefore afforded increased fishing opportunity in 1991.

DISCUSSION

Relative Run Strength

The strength of the 1991 early run, as determined from total return estimates (harvest plus escapement), was one of the largest returns to the Russian River since records were first maintained in 1963 (Figure 6). The 1991 return was exceeded only by the 1987 and 1988 returns. This excellent return continues a 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 total harvest estimates is that all anglers exit the fishery through one of the five sampled access locations. While anglers were observed using other exit locations, the level at which this occurred during 1991 appeared to be insignificant throughout the Russian River proper. However, the number of anglers fishing the mainstem Kenai River on the highway side, and therefore unsurveyed, was significant. 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, generally, only small numbers of fishermen were engaged in fishing at those hours during 1991. However, random observations of access locations during the nighttime period should be continued in the future. This will provide additional information regarding any possible changes in angler use patterns which might prove useful in further refining the survey.

Age Composition:

The accurate assessment of the age composition of the sockeye salmon return is needed to establish accurate brood tables for the Russian River system. The sampling of time and area components adopted in 1990 was continued in 1991. This increase in sampling intensity over prior years is an effort to achieve more accurate age composition estimates. Significant temporal changes in age composition were detected within spatial components as well as changes between spatial components within temporal strata in 1990 (Carlon et al. 1991).

Statistical comparisons of the early-run age composition of the confluence and river harvests and the weir escapement revealed that differences continued to occur in 1991. Therefore, it was not appropriate to use the age composition from one area to apportion the harvest estimates or escapements for any other

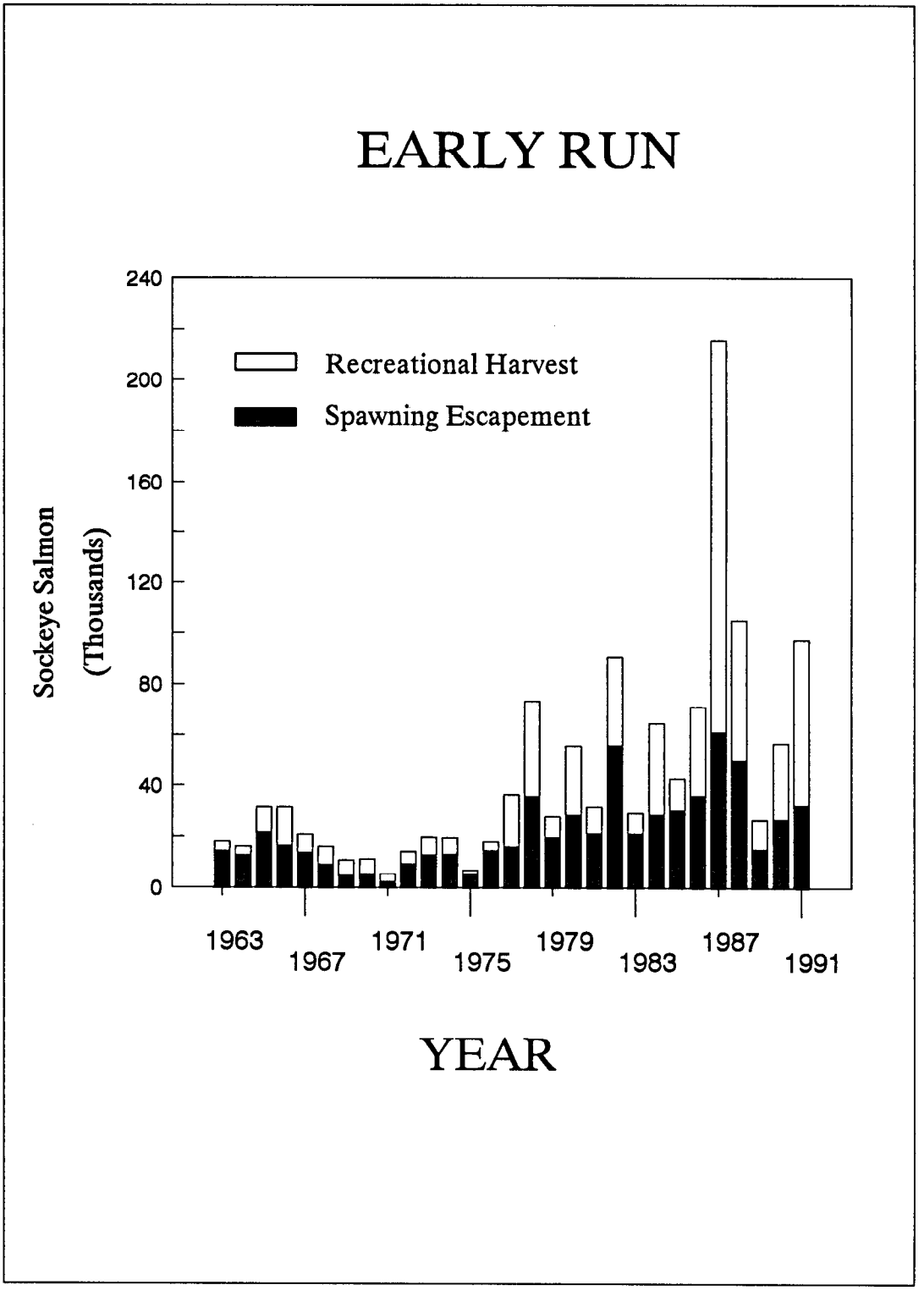

Figure 6. Historical returns of early-run sockeye salmon, to the Russian River.

spatial component. Each area was allocated independently and, in some cases, each temporal component must be allocated independently as well.

Assessment of the 1991 early run also indicated an apparent shift in age classes. The age class component contributing the majority of fish to the early run was age 1.3. This finding conflicts with historical observations in that the early run has been generally comprised of age-2.3 fish. Some ambiguity exists in interpretation of freshwater ages. It is recommended that the samples of scales collected from both the recreational harvest and weir escapement be evaluated by an independent agency in concert with project staff. Through the comparison of results from each source, and the establishment of a set of ageing criteria specific to the Russian River stock, future assessments will be more routine for any individual or agency involved.

Age group composition changes were detected between and among times and areas of the early-run fishery in 1991. Further, there was an indication of a shift in the relative proportions of those age groups. It is therefore recommended that the sampling of the individual spatial components be continued at the present sampling intensity in conjunction with an independent agency's evaluation of the early-run age compositions. This will help to better estimate the numbers of sockeye salmon returning by age and sex and to improve the evaluation of 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 be implemented experimentally in 1992 and subsequent years to begin evaluation of its value in managing the Russian River sockeye salmon resource.

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APPENDIX A

Selected Summaries of Fishery and Escapement Data
from the Russian River, 1991.

Appendix A1. Daily sample statistics for the 1991 early run Russian River creel survey.

Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	p_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
1	910610	1	1	0	0	0	0	0	0	0	0	0	0
1	910612	1	1	0	0	0	0	0	0	0	0	0	0
1	910612	6	1	0	0	0	0	0	0	0	0	0	0
1	910613	1	1	0	0	0	0	0	0	0	0	0	0
1	910613	3	1	0	0	6	0	0	0	0	0	0	0
1	910616	3	1	1	2	82	0.016	3	0	7	0	0	0
1	910616	1	1	0	0	13	0	0	0	0	0	0	0
1	910618	3	1	0	0	25	0	0	0	0	0	0	0
1	910618	1	1	0	0	3	0	0	0	0	0	0	0
1	910620	4	1	12	17	57	0.091	3.542	3.475	61	1.167	2.152	20
1	910620	5	1	0	0	41	0	0	0	0	0	0	0
1	910622	4	1	36	119	244	0.34	5.042	5.548	599	1.056	1.711	125
1	910622	1	1	4	14	69	0.138	6	9	81	3	0	41
1	910624	6	1	5	7	54	0.04	2	2.25	14	1.4	1.8	10
1	910624	5	1	48	59	41	0.277	4.771	6.414	283	1.938	1.507	115
1	910626	6	1	39	122	233	0.358	3.551	3.8	435	0.718	1.155	88
1	910626	5	1	64	141	151	0.508	4.453	4.156	627	1.125	1.381	158
1	910628	3	1	4	11	169	0.039	5.5	8.333	58	0.75	2.25	8
1	910628	4	1	0	0	223	0	0	0	0	0	0	0
1	910630	4	1	2	5	245	0.013	6.5	0	33	3	0	15
1	910630	5	1	5	15	298	0.033	7	14.375	104	1.8	2.7	27
1	910702	6	1	0	0	251	0	0	0	0	0	0	0
1	910702	1	1	0	0	4	0	0	0	0	0	0	0
1	910704	4	1	1	3	199	0.008	5	0	13	0	0	0
1	910704	3	1	5	20	204	0.075	2.8	3.075	57	0	0	0
1	910706	3	1	0	0	39	0	0	0	0	0	0	0
1	910706	1	1	0	0	10	0	0	0	0	0	0	0
1	910709	1	1	0	0	1	0	0	0	0	0	0	0
1	910709	3	1	0	0	38	0	0	0	0	0	0	0
1	910711	6	1	1	1	15	0.018	2	0	3	1	0	1

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Appendix A1. (Page 2 of 7).

Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
1	910711	3	1	1	2	22	0.026	4	0	6	0	0	0
1	910713	6	1	0	0	25	0	0	0	0	0	0	0
1	910713	2	1	8	18	63	0.154	4	5	71	0	0	0
1	910715	6	1	0	0	29	0	0	0	0	0	0	0
1	910715	4	1	0	0	7	0	0	0	0	0	0	0
1	910717	4	1	0	0	2	0	0	0	0	0	0	0
1	910717	2	1	0	0	0	0	0	0	0	0	0	0
1	910719	4	1	0	0	15	0	0	0	0	0	0	0
1	910719	1	1	0	0	0	0	0	0	0	0	0	0
1	910721	5	1	0	0	18	0	0	0	0	0	0	0
1	910721	3	1	0	0	17	0	0	0	0	0	0	0
1	910725	4	1	0	0	45	0	0	0	0	0	0	0
1	910725	1	1	0	0	0	0	0	0	0	0	0	0
2	910621	6	1	27	47	20	1	4.204	4.082	198	1.407	1.635	66
2	910621	3	1	44	50	8	0 .759	3.682	5.815	184	2.523	0.72	126
2	910627	6	1	64	82	19	0 .941	3.297	4.585	270	0.641	1.059	52
2	910627	4	1	49	86	37	1	4.469	6.588	384	1.184	1.778	102
2	910703	3	1	10	11	5	0 .169	3.5	3.389	38	0.8	1.289	9
2	910703	6	1	7	8	9	0 .099	3.214	1.571	25	0.143	0.143	1
2	910709	5	1	35	38	4	0 .833	4.171	3.205	160	2	1.529	77
2	910715	1	1	0	0	0	0	0	0	0	0	0	0
2	910715	4	1	27	27	0	0 .931	3.296	3.543	89	0.185	0.157	5
2	910723	1	1	11	14	3	1	1.455	0.723	20	0	0	0
2	910723	4	1	14	17	3	1	2	0.462	34	0	0	0
3	910617	2	1	5	6	1	0 .833	2.9	1.3	17	1.2	1.7	7
3	910617	1	1	3	3	0	1	2.333	0.083	7	2	1	6
3	910625	2	1	4	10	6	1	3.5	3	35	2.25	0.917	23
3	910625	3	1	1	1	0	1	4	0	4	0	0	0
3	910703	4	1	1	2	2	0.25	3	0	5	0	0	0
3	910703	6	1	2	2	2	0 .105	1	0	2	0	0	0

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Appendix A1. (Page 3 of 7).

Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
3	910704	3	1	13	14	1	0 .722	3.231	4.026	44	0.308	0.564	4
3	910704	2	1	17	22	7	0 .708	4.088	4.414	90	0.059	0.059	1
3	910711	1	1	0	0	0	0	0	0	0	0	0	0
3	910719	5	1	1	1	0	1	2	0	2	0	0	0
3	910719	3	1	0	0	0	0	0	0	0	0	0	0
4	910618	5	1	28	33	6	0 .824	3.5	7.537	115	0.357	0.534	12
4	910618	1	1	4	5	1	0 .571	2.125	0.229	10	0	0	0
4	910622	6	1	63	96	34	0 .984	3.071	4.273	296	0.46	0.704	44
4	910622	3	1	60	78	18	1	4.825	7.414	376	1.583	1.773	124
4	910626	4	1	0	0	8	0	0	0	0	0	0	0
4	910626	3	1	0	0	8	0	0	0	0	0	0	0
4	910630	6	1	35	51	16	1	3.214	2.519	164	0.886	1.339	45
4	910630	5	1	74	83	9	1	4.243	5.015	352	1.486	1.678	123
4	910708	6	1	15	15	0	0 .405	2.933	4.924	44	0.667	1.095	10
4	910708	1	1	7	9	3	0 .778	2.429	0.619	23	0.286	0.238	3
4	910712	5	1	16	19	4	0 .667	4.375	2.65	82	0.313	0.629	6
4	910712	4	1	11	14	5	0 .688	3.182	4.464	46	0.364	0.255	5
4	910716	5	1	4	4	0	0 .667	5	0	20	0	0	0
4	910716	6	1	4	4	0	1	3	0	12	0.25	0.25	1
4	910724	1	1	4	4	0	1	0.5	0	2	0	0	0
4	910724	3	1	9	11	2	1	0.611	0.049	7	0	0	0
5	910619	5	1	3	3	0	1	4.167	5.583	13	0	0	0
5	910619	2	1	0	0	0	0	0	0	0	0	0	0
5	910623	2	1	21	23	2	0 .875	3.81	3.037	87	0.429	0.557	10
5	910623	3	1	7	10	3	1	6.929	34.702	69	1.143	1.476	11
5	910627	1	1	7	8	1	1	3.071	2.119	25	2.143	1.143	17
5	910627	2	1	6	7	1	1	4.75	12.975	33	1.5	2.7	11
5	910701	6	1	2	5	4	0 .667	2	0	9	0	0	0
5	910701	1	1	2	2	0	1	2	0	4	0	0	0
5	910705	4	1	14	15	1	1	4.393	1.545	66	0.643	1.324	10

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Appendix A1. (Page 4 of 7).

Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
5	910705	3	1	15	15	0	1	2.733	3.924	41	0.733	1.067	11
5	910709	6	1	12	12	0	1	2.417	2.265	29	0	0	0
5	910709	1	1	0	0	0	0	0	0	0	0	0	0
5	910713	2	1	2	3	1	0.5	2	0	5	0	0	0
5	910717	5	1	8	8	0	1	1.313	0.067	11	0	0	0
5	910717	2	1	0	0	0	0	0	0	0	0	0	0
5	910722	6	1	0	0	0	0	0	0	0	0	0	0
5	910722	1	1	0	0	0	0	0	0	0	0	0	0
1	910610	1	2	6	6	0	1	2.667	3.467	16	0.167	0.167	1
1	910612	6	2	21	21	0	1	2.762	0.665	58	0.238	0.29	5
1	910612	1	2	0	0	0	0	0	0	0	0	0	0
1	910613	3	2	41	47	6	1	4.037	2.255	190	0.683	0.772	32
1	910613	1	2	3	3	0	1	5	3	15	2	3	6
1	910616	1	2	28	41	13	1	4.446	7.84	182	1.286	1.693	53
1	910616	3	2	63	144	82	0 .984	4.127	3.814	593	0.762	1.152	110
1	910618	1	2	0	0	3	0	0	0	0	0	0	0
1	910618	3	2	51	76	25	1	3.853	3.343	293	1.098	1.57	83
1	910620	5	2	19	60	41	1	3.947	4.942	237	0.474	0.596	28
1	910620	4	2	123	176	57	0 .932	5.081	4.575	895	0.984	1.262	173
1	910622	4	2	84	277	244	0 .792	5.851	11.758	1623	0.833	1.008	231
1	910622	1	2	25	84	69	0 .862	4.96	8.144	419	1.84	1.64	155
1	910624	6	2	121	173	54	0.96	4.12	7.3	712	1.256	1.125	217
1	910624	5	2	126	156	41	0 .728	4.544	5.312	708	1.278	1.482	199
1	910626	6	2	76	238	233	0 .697	3.592	3.465	857	1.092	1.071	260
1	910626	5	2	69	152	151	0 .548	4.478	6.312	679	1.275	1.32	193
1	910628	3	2	99	261	169	0 .961	4.712	5.827	1232	1.97	1.642	515
1	910628	4	2	144	367	223	1	5.722	4.992	2100	2.215	1.093	813
1	910630	4	2	155	397	245	0 .987	6.3	3.655	2500	1.819	1.37	722
1	910630	5	2	146	434	298	0 .967	5.771	5.987	2505	1.897	1.5	824
1	910702	1	2	10	14	4	1	2	0.389	28	1	1.556	14

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Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
1	910702	6	2	154	405	251	1	4.575	6.757	1853	1.065	1.251	431
1	910704	4	2	119	316	199	0 .992	6.214	6.396	1966	1.319	1.609	417
1	910704	3	2	62	251	204	0 .925	4.903	3.605	1230	1.097	1.368	275
1	910706	1	2	32	42	10	1	2.969	2.838	125	1.188	1.319	50
1	910706	3	2	80	119	39	1	4.681	5.407	557	0.775	1.24	92
1	910709	1	2	20	21	1	1	5.5	35.921	116	1.2	2.063	25
1	910709	3	2	57	95	38	1	3.684	3.318	350	1.386	1.777	132
1	910711	3	2	39	61	22	1	4.179	3.822	255	0.641	0.973	39
1	910711	6	2	56	71	15	0 .982	3.741	2.491	265	0.268	0.345	19
1	910713	6	2	52	77	25	1	4.452	9.189	343	0.327	0.538	25
1	910713	2	2	51	113	63	0 .981	3.451	14.883	389	0.078	0.074	9
1	910715	4	2	17	24	7	1	5.588	8.351	134	0.176	0.279	4
1	910715	6	2	23	52	29	1	5.87	8.891	305	0.261	0.292	14
1	910717	4	2	19	21	2	1	4.184	1.45	88	0.421	0.813	9
1	910717	2	2	9	9	0	1	1.833	0.438	17	0	0	0
1	910719	1	2	3	3	0	1	3	0	9	0	0	0
1	910719	4	2	32	47	15	1	4.609	4.851	217	0.125	0.113	6
1	910721	3	2	49	66	17	1	2.327	2.224	154	0.02	0.02	1
1	910721	5	2	29	47	18	1	3.828	8.148	180	0.276	0.35	13
1	910725	4	2	90	135	45	1	4.894	6.042	661	1.089	1.408	147
1	910725	1	2	5	5	0	1	4.4	0.3	22	3	0	15
2	910621	3	2	14	16	8	0 .241	5.786	1.989	92	2.071	1.764	33
2	910621	6	2	0	0	20	0	0	0	0	0	0	0
2	910627	6	2	4	5	19	0 .059	4	0	20	0.75	0.917	4
2	910627	4	2	0	0	37	0	0	0	0	0	0	0
2	910703	6	2	66	74	9	0.93	3.811	6.306	283	0.788	1.154	59
2	910703	3	2	50	54	5	0 .847	4.88	2.761	265	1.34	1.698	73
2	910709	5	2	7	8	4	0 .167	5.571	1.286	43	1.857	1.476	14
2	910715	1	2	10	10	0	1	4.4	10.322	44	0.4	0.489	4

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Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
2	910715	4	2	2	2	0	0 .069	5	0	10	0.5	0.5	1
2	910723	1	2	0	0	3	0	0	0	0	0	0	0
2	910723	4	2	0	0	3	0	0	0	0	0	0	0
3	910617	2	2	1	1	1	0 .167	2	0	2	3	0	4
3	910617	1	2	0	0	0	0	0	0	0	0	0	0
3	910625	2	2	0	0	6	0	0	0	0	0	0	0
3	910625	3	2	0	0	0	0	0	0	0	0	0	0
3	910703	6	2	17	19	2	0 .895	3.5	2.688	66	0.294	0.221	6
3	910703	4	2	3	5	2	0.75	5	3	23	1	3	5
3	910704	2	2	13	17	7	0 .542	2.962	1.269	50	0.385	0.59	6
3	910704	3	2	7	7	1	0 .389	2.357	0.976	17	0.286	0.238	2
3	910711	1	2	0	0	0	0	0	0	0	0	0	0
3	910719	3	2	0	0	0	0	0	0	0	0	0	0
3	910719	5	2	0	0	0	0	0	0	0	0	0	0
4	910618	5	2	11	13	6	0 .324	3.045	2.723	39	0.818	1.564	11
4	910618	1	2	3	3	1	0 .429	4	0	14	3	0	10
4	910622	3	2	0	0	18	0	0	0	0	0	0	0
4	910622	6	2	7	11	34	0 .109	3.571	0.952	38	0.714	1.571	8
4	910626	4	2	0	0	8	0	0	0	0	0	0	0
4	910626	3	2	0	0	8	0	0	0	0	0	0	0
4	910630	6	2	0	0	16	0	0	0	0	0	0	0
4	910630	5	2	0	0	9	0	0	0	0	0	0	0
4	910708	6	2	24	24	0	0 .649	3.521	3.837	85	0.708	1.259	17
4	910708	1	2	2	3	3	0 .222	3	0	8	1	0	3
4	910712	5	2	9	11	4	0 .375	2.944	3.028	31	0.444	0.278	5
4	910712	4	2	5	7	5	0 .313	4.1	0.3	27	0	0	0
4	910716	6	2	0	0	0	0	0	0	0	0	0	0
4	910716	5	2	2	2	0	0 .333	3	0	6	1	2	2
4	910724	1	2	0	0	0	0	0	0	0	0	0	0
4	910724	3	2	0	0	2	0	0	0	0	0	0	0

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Location Exited[a]	Date	Period[b]	Location Fished[c]	Location fished angler stats.[d] m_{hij}	M_{hij}	a_{hij}	P_{hij}	Effort Mean	Effort Variance	Effort Total	Harvest Mean	Harvest Variance	Harvest Total
5	910619	5	2	0	0	0	0	0	0	0	0	0	0
5	910619	2	2	0	0	0	0	0	0	0	0	0	0
5	910623	3	2	0	0	3	0	0	0	0	0	0	0
5	910623	2	2	3	3	2	0 .125	4.667	14.333	15	2.333	1.333	8
5	910627	1	2	0	0	1	0	0	0	0	0	0	0
5	910627	2	2	0	0	1	0	0	0	0	0	0	0
5	910701	6	2	1	2	4	0 .333	8	0	19	2	0	5
5	910701	1	2	0	0	0	0	0	0	0	0	0	0
5	910705	4	2	0	0	1	0	0	0	0	0	0	0
5	910705	3	2	0	0	0	0	0	0	0	0	0	0
5	910709	1	2	0	0	0	0	0	0	0	0	0	0
5	910709	6	2	0	0	0	0	0	0	0	0	0	0
5	910713	2	2	2	3	1	0.5	3	0	8	0	0	0
5	910717	2	2	0	0	0	0	0	0	0	0	0	0
5	910717	5	2	0	0	0	0	0	0	0	0	0	0
5	910722	6	2	0	0	0	0	0	0	0	0	0	0
5	910722	1	2	0	0	0	0	0	0	0	0	0	0

[a] Access codes: 1 = Ferry, 2 = Grayling, 3 = Rainbow Trout, 4 = Pink Salmon, and 5 = Red Salmon.

[b] Period codes: 1 = 0600-0900 hours, 2 = 0900-1200 hours, 3 = 1200-1500 hours, 4 = 1500-1800 hours, 5 = 1800-2100 hours, and 6 = 2100-2400 hours.

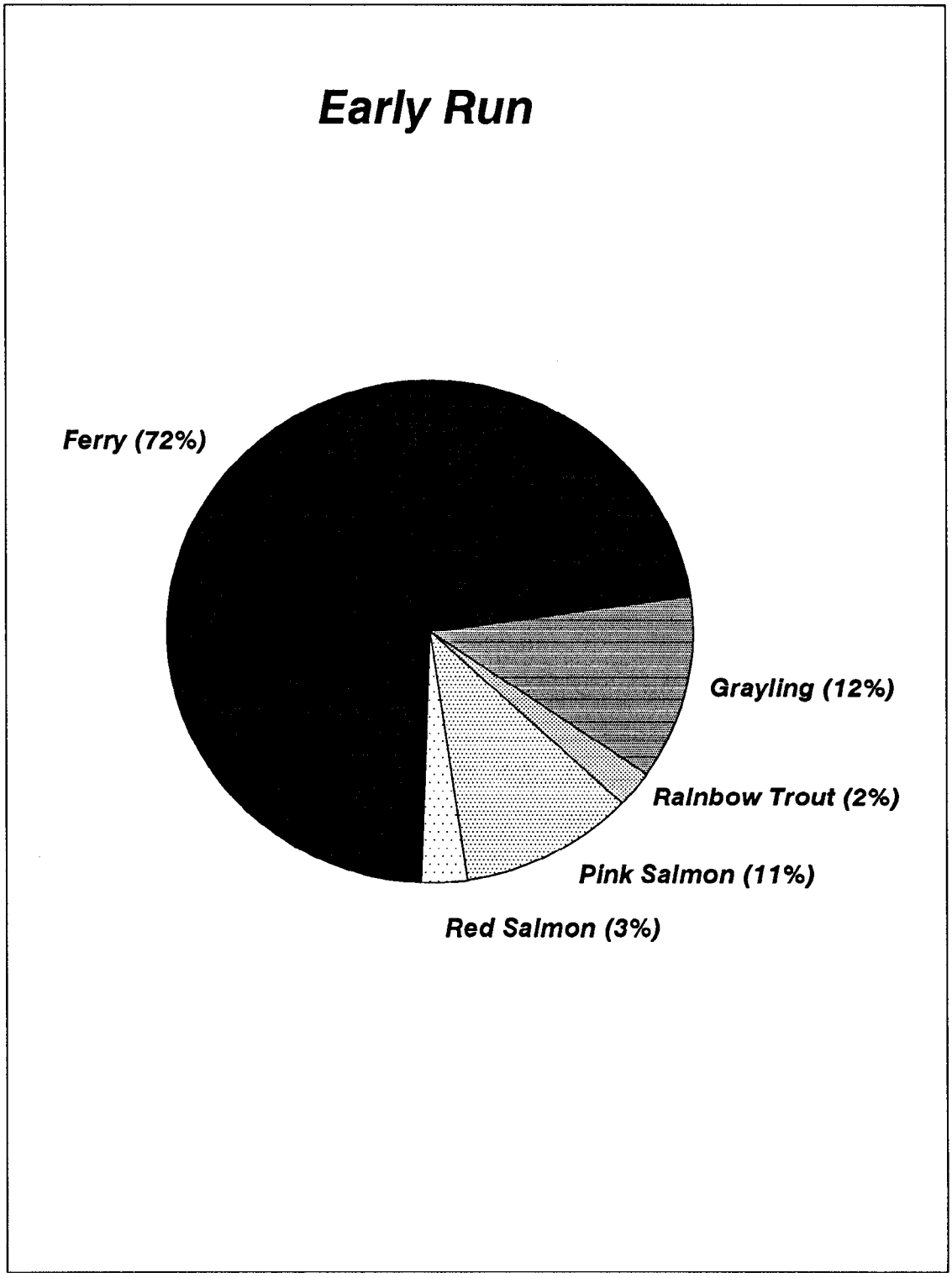
[c] Area Fished codes: 1 = river area, 2 = confluence area.

[d] Angler statistics: m_{hij} = number of anglers interviewed.

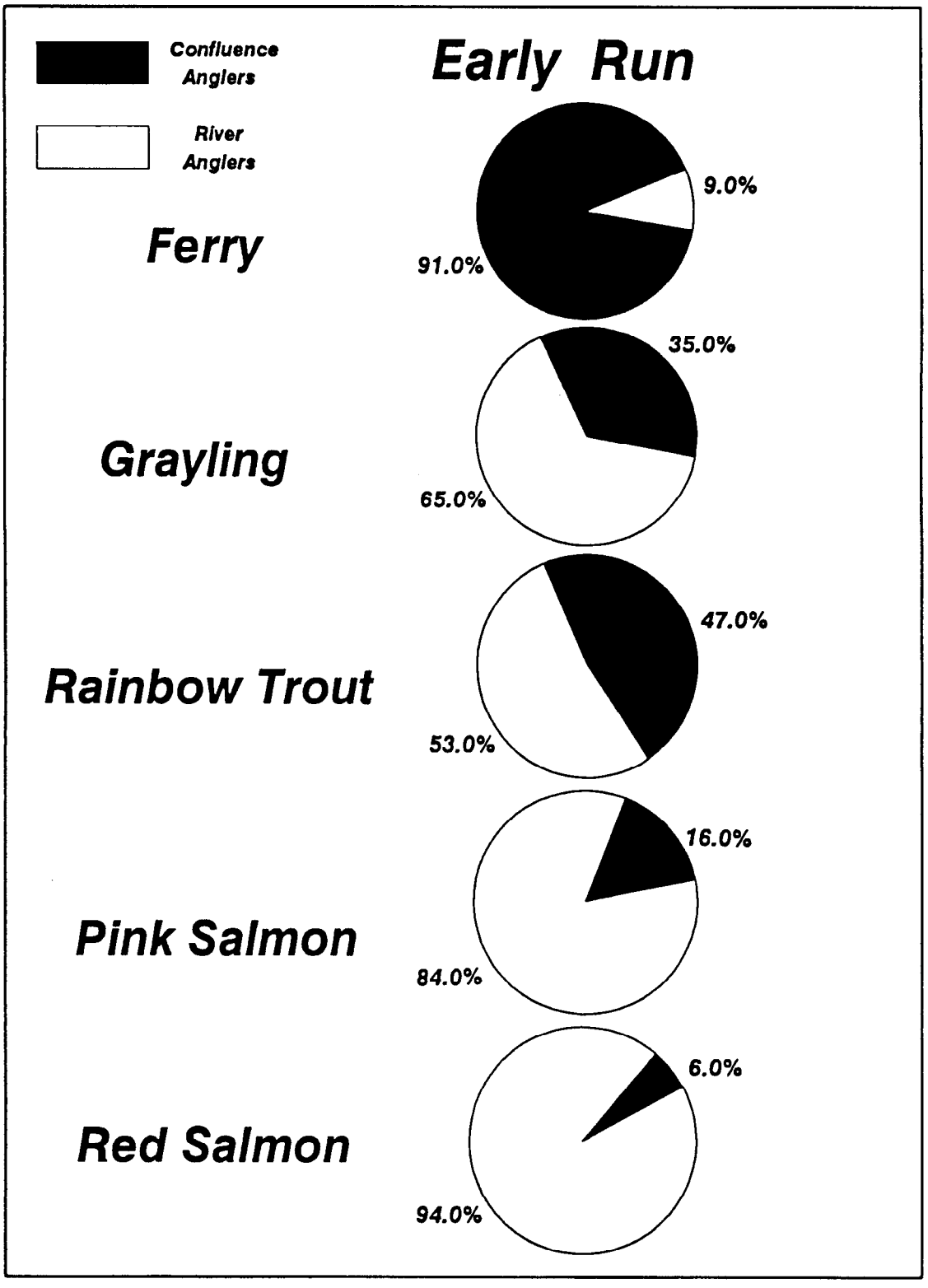
M_{hij} = estimated number of anglers exiting by location fished.

a_{hij} = number of anglers exiting and not interviewed.

P_{hij} = proportion of interviewed anglers by location fished.



Appendix A2. Relative proportions of interviews collected at the five access locations to the Russian River recreational sockeye salmon fishery, early run, 1991.



Appendix A3. Relative proportions of anglers interviewed during the 1991 Russian River creel survey by run, access location, and area fished.

Appendix A4. Temporal harvest and effort estimates for the 1991 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	%
Early run river effort:													
Ferry	6/10-6/27	18	9	702	628,428	12,641	15,911,240	11,311,698	71	4,577,790	29	21,752	0
Grayling	6/17-6/27	11	2	1,554	333,919	17,098	16,978,509	16,528,967	97	437,745	3	11,797	0
Rainbow	6/17-6/27	11	2	94	1,024	1,038	86,399	50,677	59	34,958	40	763	1
Pink salmon	6/17-6/27	11	3	798	1,692,814	8,774	50,046,897	49,655,873	99	386,223	1	4,801	0
Red salmon	6/17-6/27	11	3	226	67,969	2,489	2,007,379	1,993,746	99	11,741	1	1,892	0
	Total to 6/27					42,040	85,030,424						
Ferry	6/28-7/25	28	13	80	16,446	2,229	734,439	531,321	72	197,543	27	5,575	1
Grayling	6/28-7/25	28	4	395	180,391	11,056	30,653,505	30,305,647	99	347,175	1	683	0
Rainbow	6/28-7/25	28	4	107	51,326	2,999	8,710,459	8,622,701	99	87,100	1	658	0
Pink salmon	6/28-7/25	28	5	451	242,327	12,619	32,465,989	31,211,703	96	1,251,937	4	2,348	0
Red salmon	6/28-7/25	28	6	85	13,763	2,376	1,457,803	1,412,998	97	44,782	3	23	0
	Total 6/28-7/25					31,279	74,022,195						
	Early run river					73,319	159,052,619						
Early run confluence effort:													
Ferry	6/10-6/27	18	9	2,498	1,413,417	44,957	51,955,437	25,441,507	49	26,425,287	51	88,642	0
Grayling	6/17-6/27	11	2	169	23,135	1,859	1,439,452	1,145,192	80	294,188	20	72	0
Rainbow	6/17-6/27	11	2	4	25	39	1,392	1,213	87	180	13	0	0
Pink salmon	6/17-6/27	11	3	91	3,793	1,006	158,160	111,264	70	46,768	30	128	0
Red salmon	6/17-6/27	11	3	15	1,035	167	35,467	30,364	86	5,061	14	43	0
	Total 6/10-6/27					48,028	53,589,908						
Ferry	6/28-7/25	28	13	4,061	7,894,917	113,711	324,459,993	255,066,564	79	69,213,003	21	180,426	0
Grayling	6/28-7/25	28	4	516	326,895	14,437	54,983,150	54,918,353	100	63,243	0	1,554	0
Rainbow	6/28-7/25	28	4	117	7,432	3,264	1,371,391	1,248,535	91	122,464	9	392	0
Pink salmon	6/28-7/25	28	5	94	14,040	2,626	2,006,890	1,808,405	90	198,386	10	99	0
Red salmon	6/28-7/25	28	6	17	719	471	83,533	73,776	88	9,756	12	0	0
	Total 6/28-7/25					134,509	382,904,957						
	Early run confluence					182,537	436,494,865						
	Early run total					255,856	595,547,484						

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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	%
Early run river harvest:													
Ferry	6/10-6/27	18	9	186	21,406	3,343	674,880	385,315	57	283,290	42	6,275	1
Grayling	6/17-6/27	11	2	520	6,569	5,721	528,266	325,160	62	199,780	38	3,327	0
Rainbow	6/17-6/27	11	2	53	406	586	37,097	20,103	54	16,739	45	254	1
Pink salmon	6/17-6/27	11	3	180	118,289	1,976	3,611,358	3,469,798	96	140,673	4	887	0
Red salmon	6/17-6/27	11	3	50	1,103	537	33,524	32,361	97	1,033	3	130	0
	Total 6/10-6/27					12,163	4,885,125						
Ferry	6/28-7/25	28	13	12	1,105	332	38,984	35,710	92	2,511	6	764	2
Grayling	6/28-7/25	28	4	126	63,942	3,531	10,746,023	10,742,316	100	3,445	0	262	0
Rainbow	6/28-7/25	28	4	4	91	116	15,701	15,322	98	361	2	17	0
Pink salmon	6/28-7/25	28	5	116	27,455	3,247	3,744,480	3,536,246	94	207,361	6	874	0
Red salmon	6/28-7/25	28	6	10	767	289	78,820	78,748	100	52	0	20	0
	Total 6/28-7/25					7,515	14,624,008						
	Early run river					19,678	19,509,133						
Early run confluence harvest:													
Ferry	6/10-6/27	18	9	583	41,162	10,495	1,264,050	740,909	59	508,867	40	14,273	1
Grayling	6/17-6/27	11	2	55	3,827	608	225,937	189,428	84	36,423	16	86	0
Rainbow	6/17-6/27	11	2	5	55	58	3,133	2,729	87	404	13	0	0
Pink salmon	6/17-6/27	11	3	28	525	314	16,829	15,399	92	1,292	8	138	1
Red salmon	6/17-6/27	11	3	8	259	83	8,860	7,591	86	1,265	14	4	0
	Total 6/10-6/27					11,558	1,518,809						
Ferry	6/28-7/25	28	13	1,064	620,645	29,796	24,295,589	20,051,593	83	4,201,433	17	42,563	0
Grayling	6/28-7/25	28	4	124	16,714	3,460	2,817,085	2,807,935	100	8,712	0	438	0
Rainbow	6/28-7/25	28	4	14	113	391	20,092	19,041	95	838	4	214	1
Pink salmon	6/28-7/25	28	5	16	701	442	98,034	90,257	92	7,769	8	8	0
Red salmon	6/28-7/25	28	6	2	20	65	2,622	2,012	77	610	23	0	0
	Total 6/28-7/25					34,154	27,233,422						
	Early run confluence					45,712	28,752,231						
	Early run total					65,390	48,261,364						

[a] D = days possible in a stratum.

[b] d = days sampled in a stratum.

Appendix A5. Daily escapement of early- and late-run sockeye and chinook salmon through the Russian River weir, 13 June to 1 August 1991.

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
6/13	14			
6/14	11			
6/15	7			
6/16	1,084			
6/17	930			
6/18	669			
6/19	538			
6/20	521			
6/21	629			
6/22	1,117			
6/23	619			
6/24	2,136			
6/25	1,178			
6/26	2,336			
6/27	1,715			
6/28	3,913			
6/29	2,645			
6/30	2,142			
7/01	1,144			
7/02	569			
7/03	609			
7/04	146			
7/05	531			
7/06	72			
7/07	403			
7/08	106			
7/09	104			
7/10	291			
7/11	1,716			
7/12	1,426			
7/13	901			
7/14	94			
7/15	94			
7/16	80			
7/17	1,146			
7/18	66			
7/19	57			
7/20	23			
7/21	18			

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Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
7/22	84			
7/23	14			
7/24	36			
7/25	12			
7/26	20			1
7/27	206	5,560		
7/28	112	4,020		1
7/29	39	2,271		
7/30	34	2,303		2[d]
7/31	2	122		
8/01	30	1,542[c]		
Totals	32,389[b]			

[a] From 7/27 through 8/01, early-run fish were differentiated from late-run fish based on degree of external maturation, i.e., body coloration and kype development.

[b] Includes 729 fish removed from upper Russian Lake by CIAA for brood stock at Bear Lake on 8/10,11,12/91.

[c] There was a 6-day temporal overlap between early- and late-run fish. The total late-run sockeye escapement is tabulated in the Fishery Data Series report for the 1991 late run to the Russian River (Marsh *In prep*).

[d] Total estimated chinook escapement is tabulated in the Fishery Data Series report for the 1991 late run to the Russian River (Marsh *In prep*).