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ABSTRACT

A creel survey of the Russian River recreational fishery was conducted in 1990 to determine angler effort for and harvest of sockeye salmon *Oncorhynchus nerka*. A direct expansion creel survey design was implemented during the 1990 season to replace the roving creel survey design used in previous years which had resulted in biased harvest and effort estimates. Estimates of harvest and effort in 1990 realized desired precision and the survey design provided all information required for management of the sockeye salmon resource. A total of 7,652 anglers were interviewed as they exited the fishery through any of five main access locations. Random observations of other potential access locations indicated that some anglers exited the fishery at unsurveyed locations.

Anglers expended 178,970 angler-hours to harvest 30,215 sockeye salmon from the early run (June 10-July 16) and 159,890 angler-hours to harvest 56,175 sockeye salmon from the late run (July 17-August 20). Weighted harvest rates for the early and late runs were 0.2 and 0.4 sockeye salmon per hour of angler effort. Approximately two-thirds of the harvest from each run was taken from the confluence area of the fishery and the confluence area accounted for approximately two-thirds of the fishing effort expended during each run.

A total of 110,052 sockeye salmon bound for spawning areas were counted through the weir at the outlet of Lower Russian Lake; 26,716 and 83,336 during the early and late runs, respectively. Of the 26,716 early run fish migrating through the weir, 1,572 were artificially spawned as a brood source for juvenile stocking in Bear Lake, near Seward, leaving 25,144 to spawn in the Russian River drainage.

Both the early and late run escapements were sampled at the weir and were comprised of five age groups: 2.3, 1.3, 2.2, 1.2, and 2.1. Early run fish sampled at the weir were predominantly age 2.3 (61.8 percent) while late run fish sampled at the weir were predominantly age 2.2 (74.1 percent). The harvest was also sampled for age structure. The age structure was similar to that of the weir in that it was composed of the same five age groups and the early and late run harvests were composed primarily of age-2.3 and -2.2 adults, respectively. The age compositions of both the confluence area harvest and the river area harvest, however, differed from that of the weir and from each other during some temporal components of each run. Weighted estimates of age composition for the total return (apportioned harvest plus escapement) indicate that the early run was comprised primarily of age-2.3 and -2.2 sockeye salmon (58.9 percent and 39.7 percent, respectively) and the late run was comprised primarily of age-2.2 sockeye salmon (74.6 percent) with age-2.1 fish comprising the next most abundant age group (12.0 percent).

A stream survey indicated that a minimum of 11,760 sockeye salmon spawned in the Russian River downstream from the Russian River falls. Carcass sampling indicated that the most abundant age group (1.3) comprised 44.8 percent of the population that spawned downstream from the falls.

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

INTRODUCTION

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

Unknown numbers of sockeye salmon of Russian River origin are also harvested by the sport fishery in the mainstem of the Kenai River, the personal-use dip net fishery in the Kenai River, and the commercial fishery in Upper Cook Inlet. Estimates of the total harvest of sockeye salmon by sport fisheries in the mainstem of the Kenai River have been reported annually since 1977 by Mills (1979-1990). The personal-use dip net harvest has been estimated in the Statewide Harvest Survey since 1983 (Mills 1984-1990). The commercial catch and total returns of sockeye salmon to the Kenai River have been reported by Cross et al. (1983, 1985, 1986).

Sockeye salmon return to the Russian River in two temporal components, termed early and late runs. The early run typically arrives at the Russian/Kenai River confluence in early June. 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). Early-run fish typically remain in the confluence area for up to 2 weeks before continuing their migration. Late-run sockeye salmon arrive at the confluence in mid to late July, move almost immediately into the Russian River, and are present in the area open to fishing through August. Late-run fish are comprised of two segments; those spawning upstream of the Russian River falls and those spawning downstream from the falls. While most fish migrating through the falls spawn in Upper Russian Lake, others spawn in the tributaries to Upper Russian Lake and in the river section between the upper and lower lakes. These fish are primarily 2-ocean fish and rear in the two lakes.[1] The other segment spawns in the Russian River downstream from the falls. These fish, which are primarily 3-ocean fish, are more closely associated with the age structure of sockeye salmon spawning in the mainstem Kenai River (Cross et al. 1983, 1985, 1986) and are believed to spend their freshwater residency in Skilak Lake.

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

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

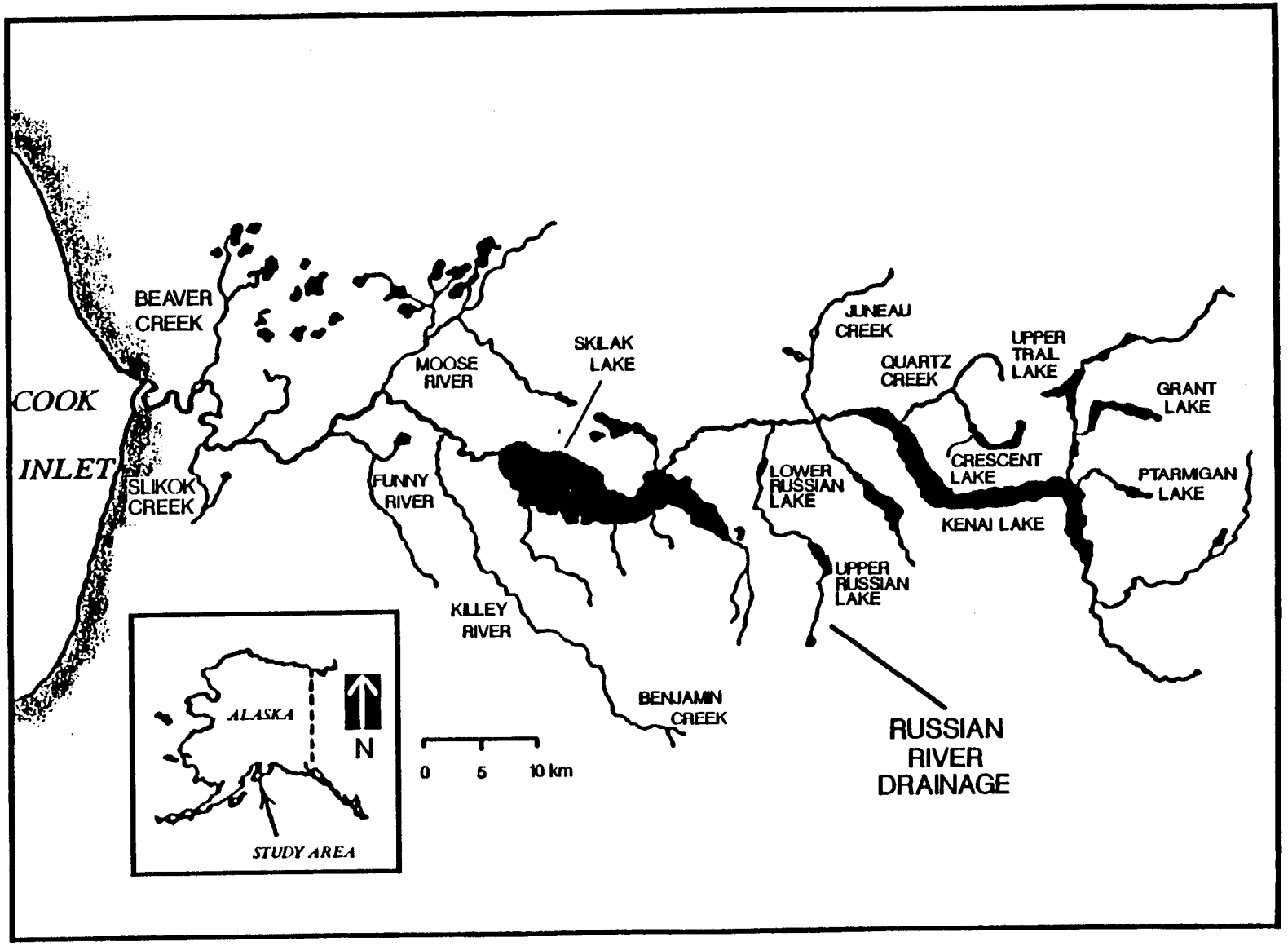

Figure 1. Map of the Kenai and Russian River drainages.

salmon for each run pass through a weir at the outlet of Lower Russian Lake (Figure 2). Current goals are 16,000 fish for the early run and 30,000 fish for the late run. These goals are based on evaluation of returns from past brood years. With the exception of 2 years, escapement goals have been achieved during each year since the goals were established in 1979. Despite an emergency closure of the early-run fishery in 1989 (July 1 through July 15), the early-run goal was not achieved in that year (Carlon and Vincent-Lang 1990). The 1977 late run escapement goal was the only other year in which the goal was not attained (Nelson 1978).

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 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 June 1 through August 20, 1990, the daily bag and possession limit for sockeye salmon taken from the Kenai/Russian River fly-fishing-only area was three fish which were 406 mm (16 in) or more in length. Within this area, from a marker located 540 m (600 yd) downstream from the Russian River falls to a marker located on the Kenai River 1,620 m (1,800 yd) downstream from the confluence with the Russian River, only a single-hook unbaited, unweighted fly with a point-to-shank measurement of 9.5 mm (3/8 in) or less constituted legal terminal tackle. Any weights attached to the line were required to be a minimum of 457 mm (18 in) above the hook.

The objectives of this report are to present, for 1990: (1) estimates of effort and harvest of sockeye salmon for the recreational fishery, (2) estimates of the escapements of the early and late-run return of sockeye salmon, and (3) estimates of the age, sex, and length distributions of the harvest and escapement of both early and late-run sockeye salmon.

METHODS

Study Area

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

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

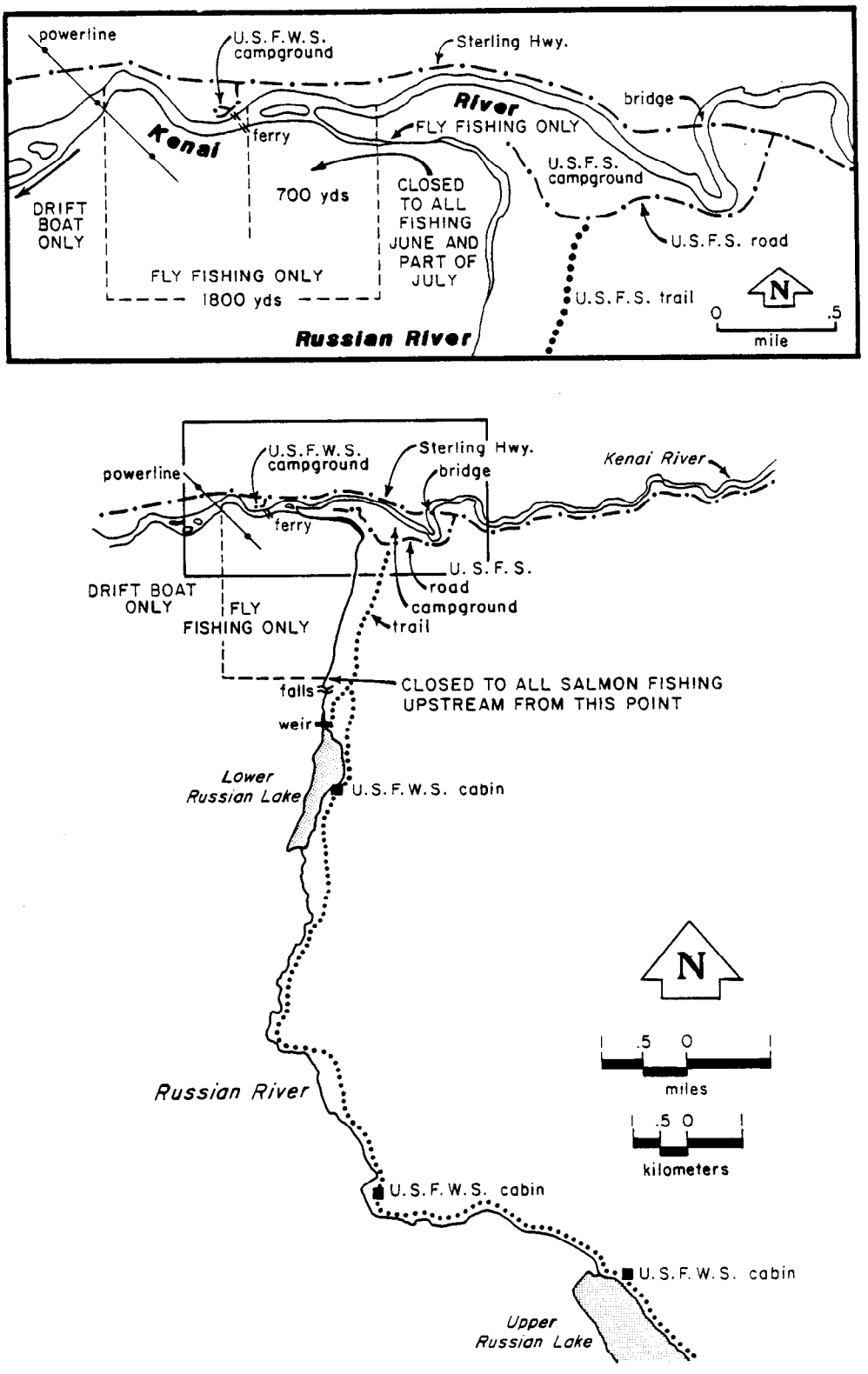

Figure 2. Detailed map of the Kenai and Russian River study area.

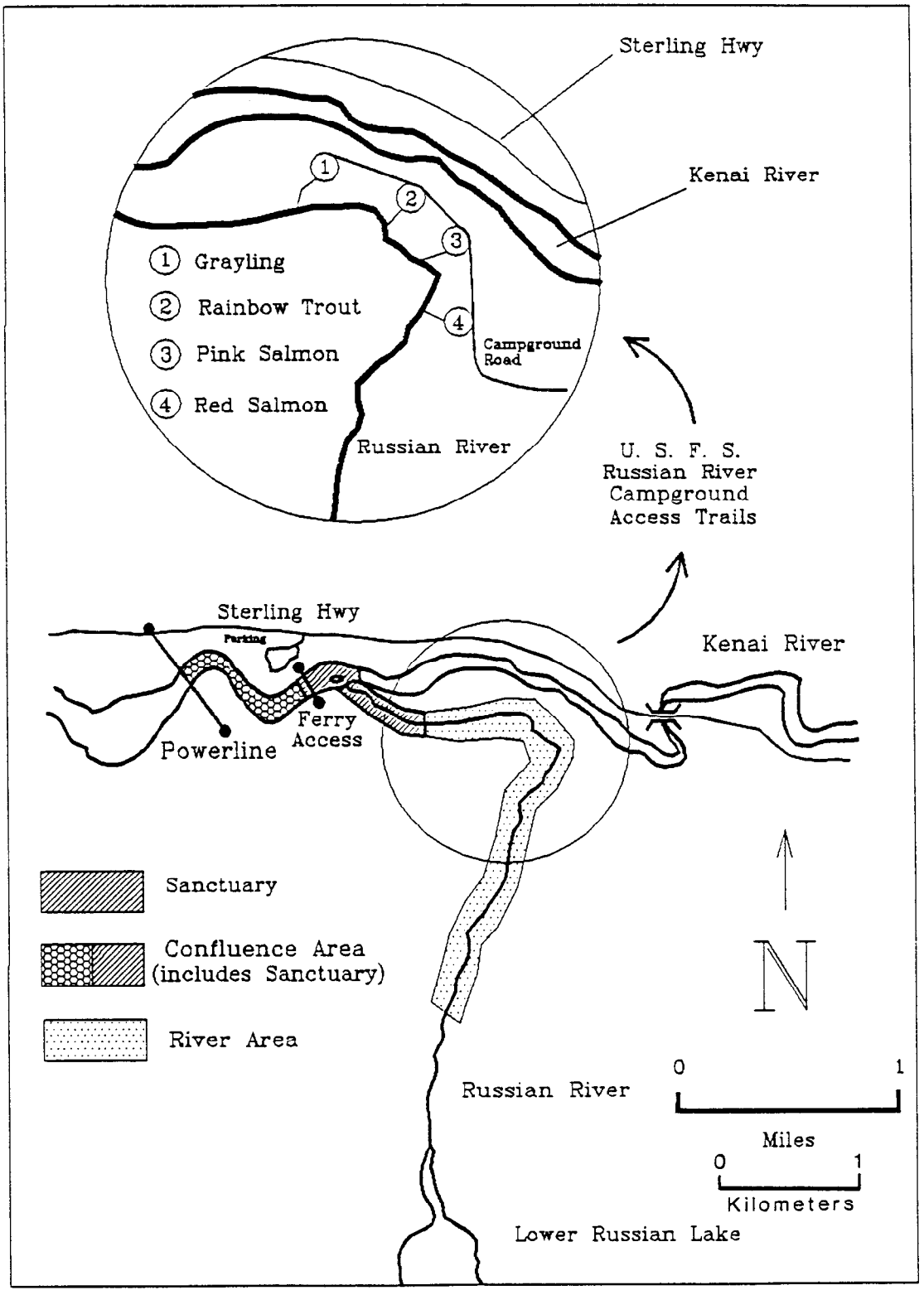

Figure 3. Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations sampled during the 1990 creel survey.

3.2 km on the Russian River to a marker identifying the upper limit of the "fly-fishing-only" area. Access to the two fishing areas is provided primarily at two locations. A United States Forest Service (USFS) campground located on the east side of the Russian River provides four short trails which intersect the main riverside trail affording access to the river area. The trails serve four camping/parking areas within the Russian River Campground. These areas are designated with the following names: (1) Grayling, (2) Rainbow Trout, (3) Pink Salmon, and (4) Red Salmon. Access to the confluence area is primarily through a parking area administered by the United States Fish and Wildlife Service (USFWS) and located on the north bank of the Kenai River directly across from the Russian River terminus. 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 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 and that portion of the late run that spawns upstream from the weir. Late-run fish that spawn downstream from the Russian River falls are visually counted during stream surveys.

Study Design

Creel Survey:

A restructured creel survey design was implemented for the first time in 1990. The survey used in previous years was a stratified modification of a roving creel survey design (Neuhold and Lu 1957). To achieve unbiased harvest and effort estimates using this design, several assumptions had to be met. Two of the assumptions, proportional sampling of anglers across fishery strata and independence of effort and harvest rates, were examined in 1989 and found to be violated (Carlon and Vincent-Lang 1990). Based on this review, the use of an alternative design that obviated these assumptions was recommended and a direct expansion design was chosen and implemented during 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 then, was defined as an access location/temporal component combination. In addition, area-specific (river or confluence area) harvest and effort were estimated for each stratum by recording the area fished for each interviewed angler. The five main access locations for the Russian River sockeye salmon fishery include the ferry access to the confluence area and the four river access trails connecting the USFS Russian River Campground with the Russian River. These locations were sampled over five temporal components (two during the early run and three

during the late run) to provide stratum estimates of sockeye salmon harvest and angler effort. Dates defining the temporal components are listed in Table 1.

Sampling was stratified *a posteriori* to allow estimation of harvest by temporal components corresponding to those over which age composition changes were measured. For each area (river or confluence), it was possible to apportion temporal estimates of harvest by the area-specific temporal estimates of age composition. This procedure allowed estimates of return by age to be calculated.

The creel survey sampling day was 18 hours in length and was divided into six, 3-hour periods from 0600 to 2400. 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 completed 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, approximately two-thirds of the harvest and effort occurred in the confluence area (Carlon and Vincent-Lang 1990). This is typical of the effort distribution in most years (Nelson et al. 1986, Hammarstrom and Athons 1988). Because of this, and because the confluence area 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 systematically sampled every other day throughout the fishing season from June 10 through August 12 when the ferry operation was discontinued by the concessionaire. This ensured that timely information regarding confluence harvest rate was available when formulating in-season management strategies.

The four main river access trails were sampled on a schedule that repeated every 5 days; each access trail was sampled every fifth day. Because access trails had not been sampled individually in the past, this provided baseline angler-use data for each river access trail and allowed detection of any in-season changes in the proportion of anglers exiting through each location. The information obtained will also be used to optimize sampling efforts for 1991 and subsequent years.

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:

Table 1. Temporal harvest components sampled during the 1990 Russian River sockeye salmon creel survey.

Harvest Component	Temporal Delineation
Early run confluence area harvest	6/10 - 6/30 7/01 - 7/16
Early run river area harvest	6/10 - 6/30 7/01 - 7/16
Late run confluence area harvest	7/16 - 7/31 8/01 - 8/10 8/11 - 8/20
Late run river area harvest	7/16 - 7/31 8/01 - 8/10 8/11 - 8/20

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:

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

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:

$$\hat{H}_{rhi} = \underline{\Delta}\, U\, \bar{H}_{rhi} \quad [11]$$

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:

$$\underset{\wedge}{\bar{H}}_{rh} = \frac{\sum_{i=1}^{d} \hat{H}_{rhi}}{d} \qquad [12]$$

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 (Walker 1985) as:

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

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

$$\hat{H}_{rh} = D \underset{\wedge}{\bar{H}}_{rh} \qquad [14]$$

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 each run by summing the individual stratum estimates. The variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates.

Daily harvest rates were estimated and used for in-season management as an indicator of sockeye salmon abundance. 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 each 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 each 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 temporal component of the recreational fishery.

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 to be visually enumerated 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 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 July 18 when late-run fish were intermixed with mature, early-run fish and continued through July 23, after which early-run fish were no longer present.

Sockeye salmon spawning in the river reach between the Russian River falls and the confluence of the Russian and Kenai Rivers were visually enumerated during stream surveys on two occasions. For each occasion, counts of live salmon were added to salmon carcass counts and the larger of the two sums provided a minimum estimate of escapement.

Biological Data:

Seven spatial components of the Russian River sockeye salmon return were sampled for biological data: (1) early-run fish harvested from the confluence area, (2) early-run fish harvested from the river area, (3) the early-run escapement passing the weir, (4) late-run fish harvested from the confluence area, (5) late-run fish harvested from the river area, (6) the late-run escapement passing the weir, and (7) the late-run escapement spawning between the falls and the confluence. Two temporal strata of the early run escapement and harvest were sampled while the late-run escapement and harvest were sampled over three temporal strata. Fish spawning between the falls and the confluence were sampled by examining carcasses found on gravel bars and along the river bank during 2 sampling days after large numbers of carcasses appeared on gravel bars. Table 2 summarizes the dates delineating temporal sampling strata for each of the seven components. The sampling strata applying to the spatial harvest components correspond to those for which harvest estimates were generated by the creel survey. This allows each harvest estimate to be apportioned in an unbiased manner by stratum estimates of age composition.

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 aging. The

Table 2. Temporal components sampled for age composition during the 1990 Russian River sockeye salmon return.

Return Component	Temporal Delineation
Early run confluence area harvest	6/10 - 6/30 7/01 - 7/16
Early run river area harvest	6/10 - 6/30 7/01 - 7/16
Early run escapement through weir	6/10 - 6/30 7/01 - 7/16
Late run confluence area harvest	7/16 - 7/31 8/01 - 8/10 8/11 - 8/20
Late run river area harvest	7/16 - 7/31 8/01 - 8/10 8/11 - 8/20
Late run escapement through weir	7/18 - 7/31 8/01 - 8/15 8/16 - 9/07
Escapement spawning between falls and confluence	8/27, 8/31[a]

[a] Escapement not stratified; dates listed are sampling dates.

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 within each of six of the spatial components. Null hypotheses of equal age compositions among temporal strata were rejected if calculated tail-area probabilities (P values) were less than 0.10. The seventh component, comprised of those fish which spawned between the falls and the confluence, was not temporally stratified as the majority have historically been of age group 1.3 (Athons and McBride 1987, Hammarstrom and Athons 1989).

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 for the first time in 1990 as all spatial components (river area harvest, confluence area harvest, and weir escapement) were sampled individually and tested for equality among components 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.

Additionally, the late-run, river area harvest has not been sampled for age composition and has been apportioned in prior years using the age composition of the late run harvest from the confluence area. Similar contingency tests were applied to determine if the age composition of the river-area harvest differed from that of the confluence harvest.

Age compositions were 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 and late-run escapements using the estimates of the age group proportions (P_{hi}) as defined previously:

$$\hat{N}_{hi} = \hat{N}_{Ti}\hat{P}_{hi}, \quad [20]$$

where:

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

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

$$\hat{V}(N_{hi}) = N^2_{Ti}\,\hat{V}(P_{hi}). \quad [21]$$

Weighted age composition estimates of weir escapements were generated for each run by summing estimated numbers by age over temporal strata. For each 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 in run r.

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

$$\hat{V}(N_{rh}) = \sum_{i=1}^{p} \hat{V}(N_{hi}). \quad [23]$$

The proportion of age h adults in the total escapement of 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 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 and late 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):

$$V(\hat{N}_{hi}) = \hat{H}^2_{Ti} V(\hat{P}_{hi}) + \hat{P}^2_{hi} V(\hat{H}_{Ti}) - V(\hat{P}_{hi}) V(\hat{H}_{Ti}), \quad [27]$$

where:

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

Weighted age composition estimates were generated for the total harvest occurring during each run by summing estimated numbers by age over temporal strata. For each 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 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 run r.

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

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

where:

$V(\hat{H}_r)$ = the variance of the estimated harvest of fish from 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 overlap among temporal strata within each spatial component.

RESULTS

Creel Statistics

Survey Interviews:

Sampling of access locations began on June 10, when the ferry location was sampled. Sampling of this location continued every other day through August 12. The ferry did not operate after August 12 as ticket sales dropped below the concessionaire's acceptable level by that date.

The systematic sampling of the four Russian River Campground access locations began on June 17, 1 week after sampling commenced at the ferry location. Because sockeye salmon typically hold in the confluence area before entering the Russian River, harvest and effort were considered negligible until about June 17, and on-site observations indicated that this was the case in 1990. Sampling continued through August 19, the day before regulatory closure of the fishery.

A total of 9,877 anglers were enumerated as they exited sampled access locations during the 1990 survey (Table 3). Of these, 7,652 (77.5%) were interviewed and 2,225 (22.5%) were not interviewed. Of anglers interviewed, 4,044 (52.8%) were interviewed during the early run and 3,608 (47.2%) were interviewed during the late run. A greater proportion (27.7%) of exiting anglers were not interviewed during the early run than during the late run (15.7%). A daily summary of the data collected during the 1990 creel survey is presented in Appendix A1. The total number of interviews collected represents a 228% increase over the number collected in 1989 (Carlon and Vincent-Lang 1990) and a 246% increase over the number collected in 1988 (Hammarstrom and Athons 1989).

Table 3. Summary of the number of interviews collected during sampled periods for the Russian River creel survey, 1990.

Exit Location	Area Fished				Total Interviews	Anglers Exiting and not interviewed	Total Anglers Exiting
	Confluence	River	Both	Unknown			
EARLY RUN							
Ferry	2,444	155	73		2,672	1,427	4,099
Grayling	309	382	26	1	718	57	775
Rainbow Trout	16	68	2		86		86
Pink Salmon	92	318	19		429	56	485
Red Salmon	16	122	1		139	11	150
Early Run Total	2,877	1,045	121	1	4,044	1,551	5,595
LATE RUN							
Ferry	2,229	11	5		2,245	552	2,797
Grayling	537	242	22	2	803	64	867
Rainbow Trout	18	79	4		101	1	102
Pink Salmon	131	203	15		349	51	400
Red Salmon	14	93	3		110	6	116
Late Run Total	2,929	628	49	2	3,608	674	4,282
RUNS COMBINED							
Ferry	4,673	166	78		4,917	1,979	6,896
Grayling	846	624	48	3	1,521	121	1,642
Rainbow Trout	34	147	6		187	1	188
Pink Salmon	223	521	34		778	107	885
Red Salmon	30	215	4		249	17	266
Grand Total	5,806	1,673	170	3	7,652	2,225	9,877

The majority of interviews (64.3%) were made at the ferry access location as this location was sampled most intensely and typically accounts for the most effort (Figure 4). The Grayling access location accounted for the next highest proportion of interviews collected (19.9%).

Anglers exiting via the ferry location tended to fish the confluence area during both runs (Table 1 and Figure 5) although small proportions did target the river area (8.6% and 0.7% during the early and late runs, respectively). The Russian River Campground access locations were also used to target both areas. With one exception (Grayling location, late run), the majority of anglers exiting these locations targeted the river area. Of these four locations, the proportion of interviewed anglers targeting the two areas changed significantly between runs at Grayling ($\chi^2 = 87.90$, df = 1, $P < 0.005$) and Pink Salmon ($\chi^2 = 24.70$, df = 1, $P < 0.005$). In both cases the proportion of interviewed anglers targeting the confluence area increased during the late run.

Harvest and Effort:

The 1990 early run harvest estimate was 30,215 sockeye salmon (Table 4) and the late run harvest was estimated as 56,175 sockeye salmon. Effort estimates in angler hours for the early and late runs were 178,970 and 159,890 angler-hours, respectively. During the early run, 64.1% of the harvest was taken from the confluence area and the remaining 35.9% was taken from the river area (Table 4 and Figure 6). The majority of the late run harvest (78.1%) was taken from the confluence area and the remaining 21.9% was taken from the river area. During both the early and late runs, greater proportions of effort were expended in the confluence area (66.4% and 79.1%, respectively) than in the river area.

Table 5 documents weighted harvest per hour of angler effort for both runs (early and late) and areas (confluence and river) in 1990.

Variance Components:

Estimates of harvest, effort, and associated variances and relative precisions of the estimates are presented by stratum (temporal component/access location) in Appendix A2. By examining stratum estimates and associated variance components, it is possible to determine which access locations most affected the relative precision of total run estimates of both harvest and effort. Three access locations (the ferry, Grayling, and Pink Salmon) accounted for the majority of the harvest during the early run (93%) as well as during the late run (97%) (Table 6). These also account for the majority of the variability in the total harvest estimates for the early and late runs (88% and 99%, respectively). The same three access locations also predominate in terms of effort and the variability of the effort estimates. The relative precisions of the early and late run harvest estimates were 17% and 21%, respectively (Table 5). The relative precisions of the early and late run effort estimates were 14% and 16%, respectively.

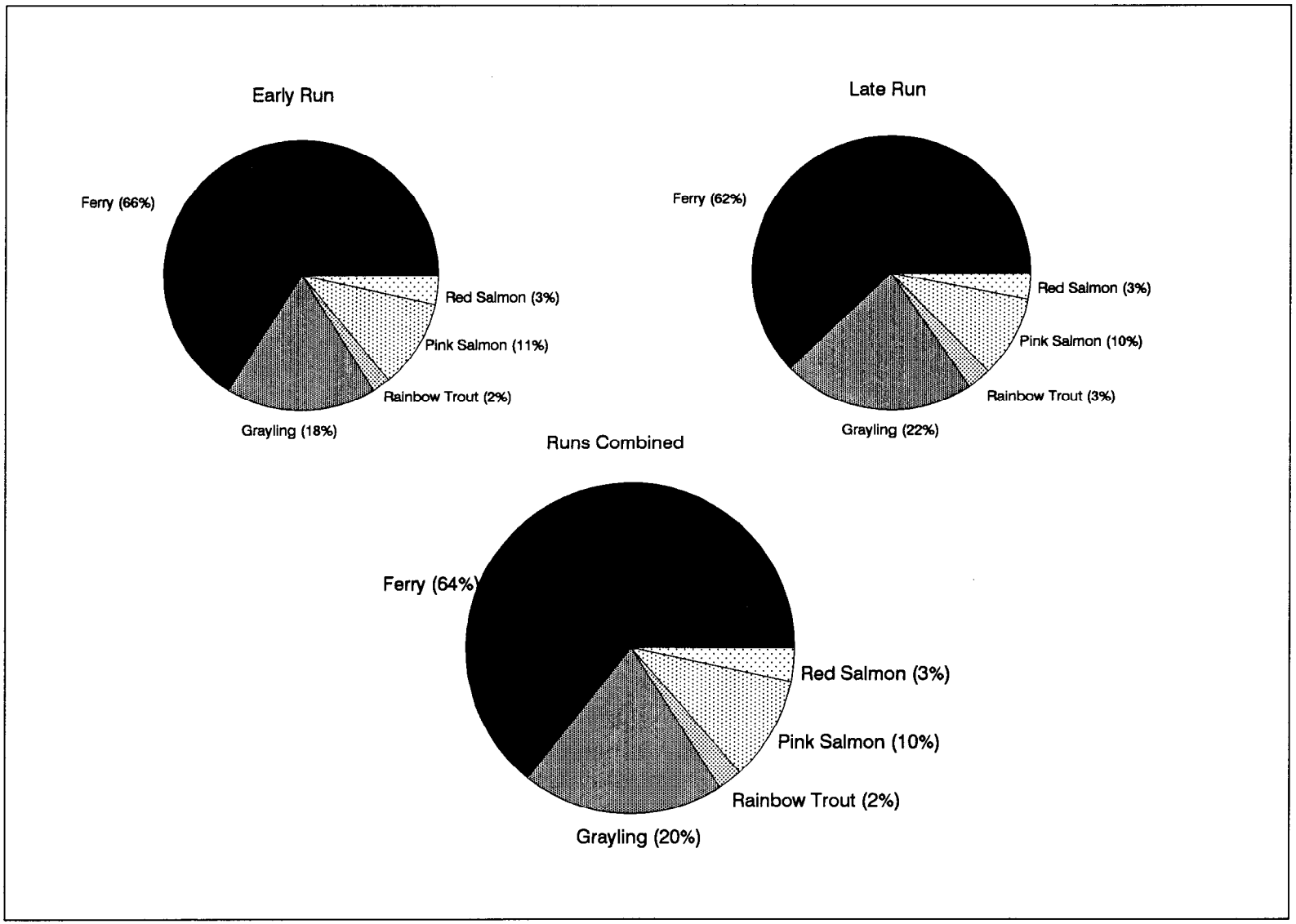

Figure 4. Relative proportions of interviews collected at the five access locations to the Russian River recreational sockeye salmon fishery, 1990.

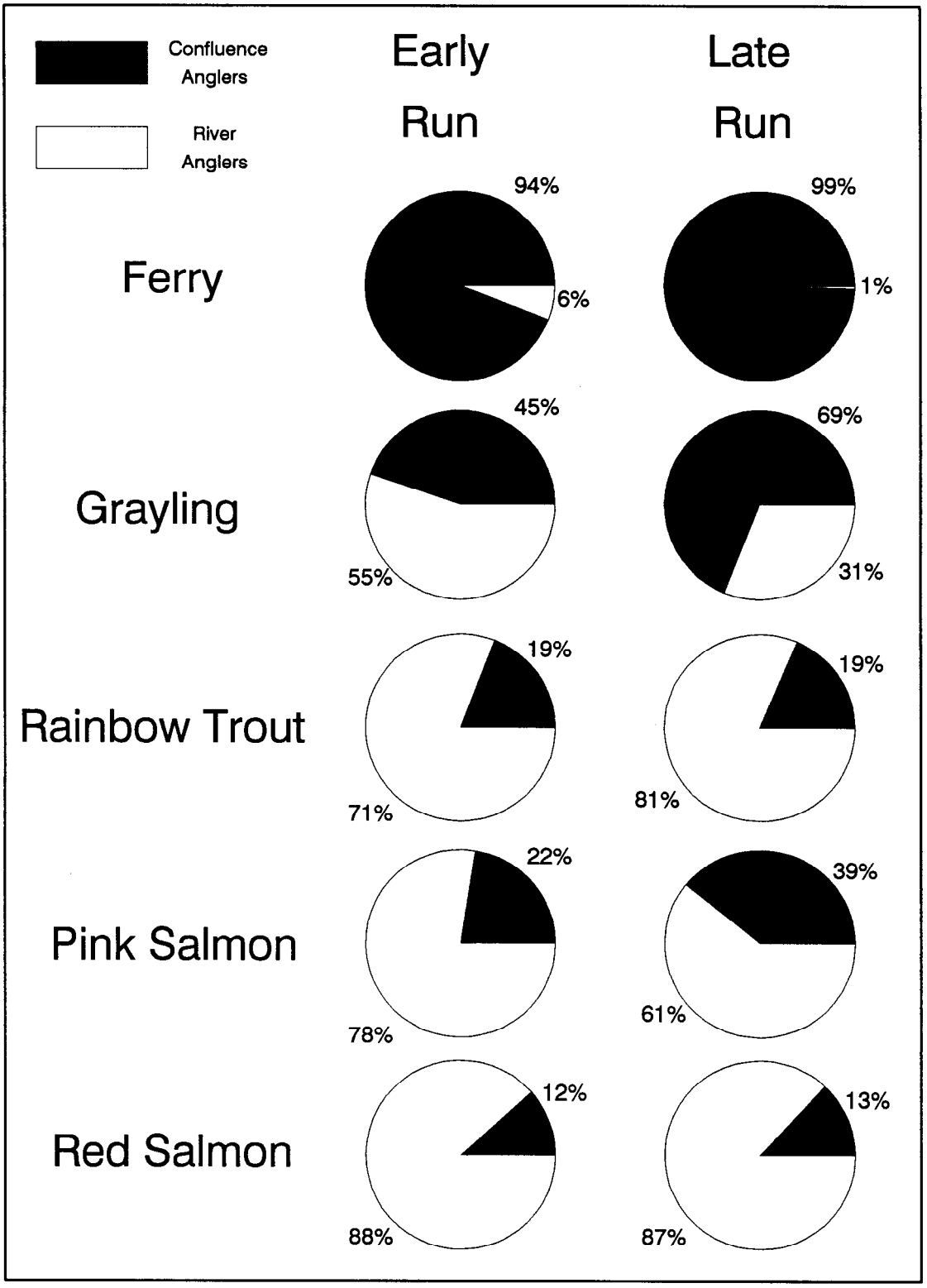

Figure 5. Relative proportions of anglers interviewed during the 1990 Russian River creel survey by run, access location, and area fished.

Table 4. Summary of estimated angler-effort and harvest of sockeye salmon, by run, for each area of the Russian River recreational fishery, 1990.

Component	Confluence Area	River Area	Total	95% Confidence Interval
EARLY RUN				
Effort	118,840	60,130	178,970	154,867 - 203,072
SE	8,986	9,292	12,297	
Harvest	19,358	10,857	30,215	25,088 - 35,342
SE	1,475	2,160	2,616	
LATE RUN				
Effort	126,478	33,412	159,890	133,763 - 186,017
SE	11,773	6,252	13,330	
Harvest	43,844	12,331	56,175	44,419 - 67,931
SE	4,986	3,334	5,998	
TOTAL BOTH RUNS				
Effort	245,318	93,542	338,860	303,313 - 374,407
SE	14,811	11,199	18,136	
Harvest	63,202	23,188	86,390	73,564 - 99,216
SE	5,200	3,973	6,544	

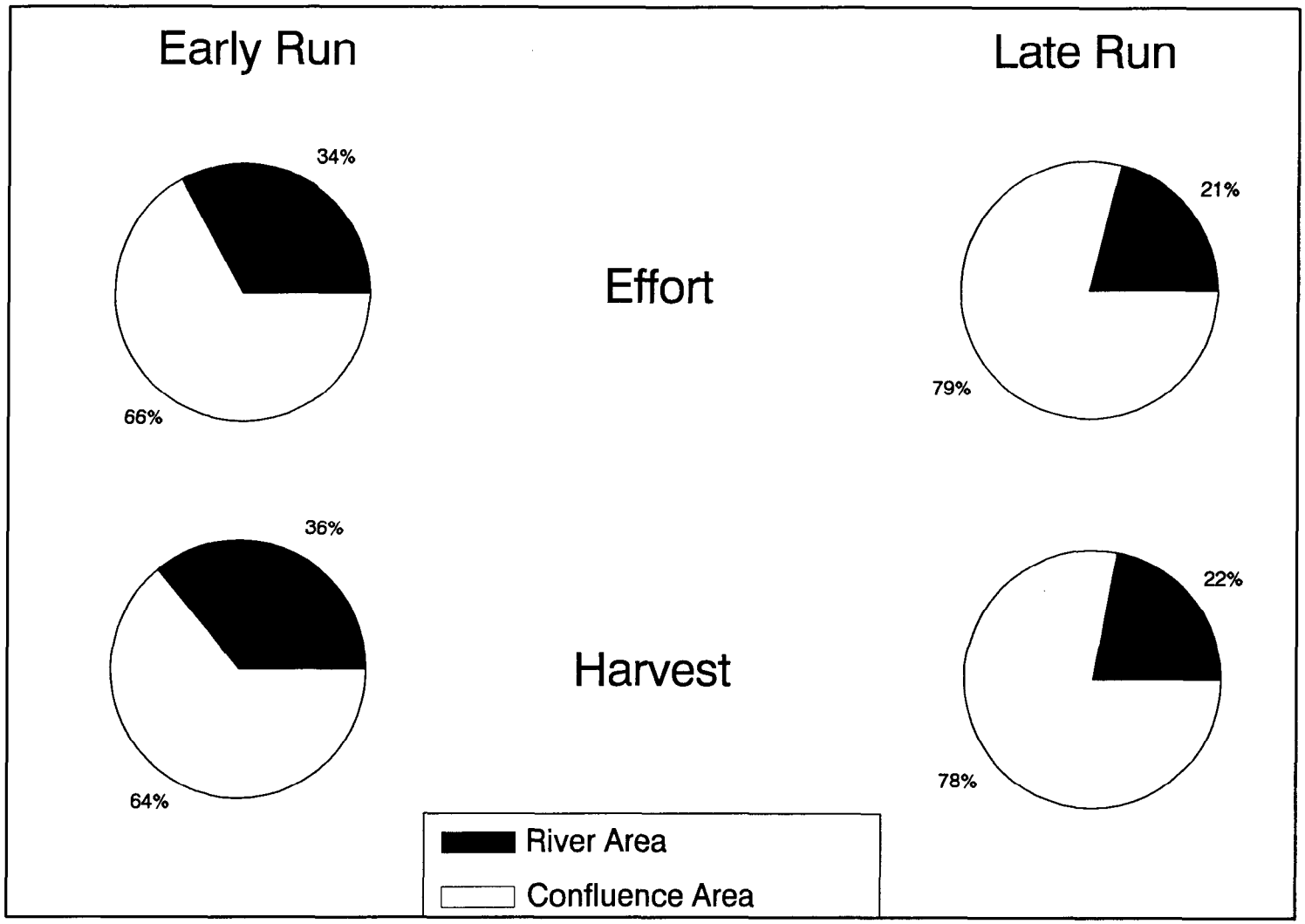

Figure 6. Harvest and angler effort by area for the Russian River sockeye salmon recreational fishery, 1990.

Table 5. Estimated harvest per hour of angler effort (HPUE) by anglers interviewed during each component of the Russian River sockeye salmon recreational fishery, 1990.

Run	Area	Days n[a]	Days N[b]	Number of Interviews[c]	HPUE	Variance of HPUE
Early	Confluence	25	37	2,998	0.163	0.0003
Early	River	25	30	1,128	0.181	0.0034
Early	Both			4,126	0.169	0.0006
Late	Confluence	23	35	2,978	0.346	0.0039
Late	River	29	35	677	0.369	0.0307
Late	Both			3,655	0.351	0.0037

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

[b] Number of days possible for conducting interviews.

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

Table 6. Estimates of harvest, effort, and associated variances by access location for the Russian River sockeye salmon recreational fishery, 1990.

	Harvest	(%)	Variance of Harvest	(%)	Relative Precision	Effort	(%)	Variance of Effort	(%)	Relative Precision
Early Run										
Ferry	16,910	56	1,905,259	28		98,061	55	45,316,962	28	
Grayling	5,833	19	698,360	10		43,101	24	27,384,970	16	
Rainbow Trout	696	2	124,776	2		3,784	2	2,196,255	1	
Pink Salmon	5,434	18	3,438,263	50		27,517	15	88,909,606	53	
Red Salmon	1,342	5	676,065	10		6,507	4	3,288,516	2	
Total	30,215	100	6,842,723	100	17%	178,970	100	167,096,309	100	14%
Late Run										
Ferry	25,771	46	9,196,373	26		76,868	48	62,422,372	35	
Grayling	24,093	43	25,183,892	70		56,380	35	101,994,089	57	
Rainbow Trout	470	1	30,627	<1		4,254	3	2,166,996	1	
Pink Salmon	4,387	8	1,101,946	3		17,820	11	10,564,947	6	
Red Salmon	1,454	2	467,639	1		4,568	3	557,091	<1	
Total	56,175	100	35,980,477	100	21%	159,890	100	177,705,495	100	16%

Spawning Escapement

The escapements of early and late run sockeye salmon passing through the weir were 26,716 and 83,336 fish, respectively (Table 7 and Appendix A3). Transition between the two runs occurred between July 18 and July 23 (Figure 7). Weir enumeration ceased on September 7 and the weir was dismantled on September 8. The late-run sockeye salmon migration was virtually complete by this time. However, there were an estimated 200 adults holding 100 to 200 m downstream from the weir when it was being dismantled and these fish were tabulated on September 8.

Of the 26,716 early run adults enumerated at the weir, a total of 1,572 adults (1,048 females and 524 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 25,144.

An estimated 11,760 adult sockeye were enumerated during stream surveys of the Russian River downstream from the Russian River falls (Table 7).

While the sockeye salmon migration was virtually complete by September 8, the coho salmon migration was still in progress and the count of 944 adults is therefore incomplete (Table 7 and Appendix A3).

Chinook salmon enumerated through the weir represent only a partial count of fish migrating in the drainage. A total of 32 chinook salmon were enumerated through the weir by August 25. The first stream survey of escapements between the weir and the river mouth was executed on August 25 during which 66 chinook salmon (42 live fish and 24 carcasses) were enumerated downstream from the weir. Therefore, at least 98 chinook salmon were present in the drainage on that date. The last chinook salmon to pass through the weir did so on August 31, bringing the cumulative count to 34. During a second stream survey on August 31, a total of 23 chinook salmon (3 live fish and 20 carcasses) were located between the weir and the river mouth. A total of 57 fish could be accounted for in the drainage on August 31. Therefore, 41 chinook salmon that were initially enumerated on August 25 could not be found on August 31 (Table 7 and Appendix A3).

Biological Data

Early Run:

The early run escapement through the weir was comprised predominantly of two age groups, ages 2.3 and 2.2. A third age group, age 1.2, comprised a minor proportion with the predominant age group (61.8%) being age 2.3. (Table 8). There was no significant difference in the composition of age-2.3 and -2.2 adults detected over the two temporal sampling strata ($\chi^2 = 0.07$, df = 1, $P > 0.90$).

The early run, confluence-area harvest was also comprised predominantly of age-2.3 and -2.2 adults with ages 1.2 and 1.3 contributing minor proportions (Table 9). Over the entire run, age-2.3 and age-2.2 adults contributed almost

Table 7. Escapements of sockeye, coho, and chinook salmon in the Russian River drainage, 1990.

Component	Dates	Sockeye Salmon	Coho Salmon	Chinook Salmon
Early Run	06/16 - 07/23	26,716[a,b]		
Late Run	07/18 - 09/08	83,336[a]	944[c]	34
Downstream[d]	08/31[e]	11,760[f]		23[g]

[a] From 7/18 through 7/23, early run fish were differentiated from late run fish based on the degree of external maturation (color).

[b] A total of 1,572 adults (1,048 females and 524 males) were used as an artificial brood source for the projected 1991 planting of Bear Lake making the effective spawning escapement in the Russian River drainage 25,144.

[c] Only a partial count as the weir was removed prior to completion of migration.

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

[e] Two stream counts (8/25 and 8/31) were made downstream from the Russian River Falls. A greater number of fish were enumerated on 8/31 and the tabulated values are for that date only and thus represent a best minimum estimate.

[f] 4,160 live fish and 7,600 dead fish that spawned downstream from the Russian River Falls.

[g] 3 live fish and 20 dead fish enumerated downstream from Russian River Falls.

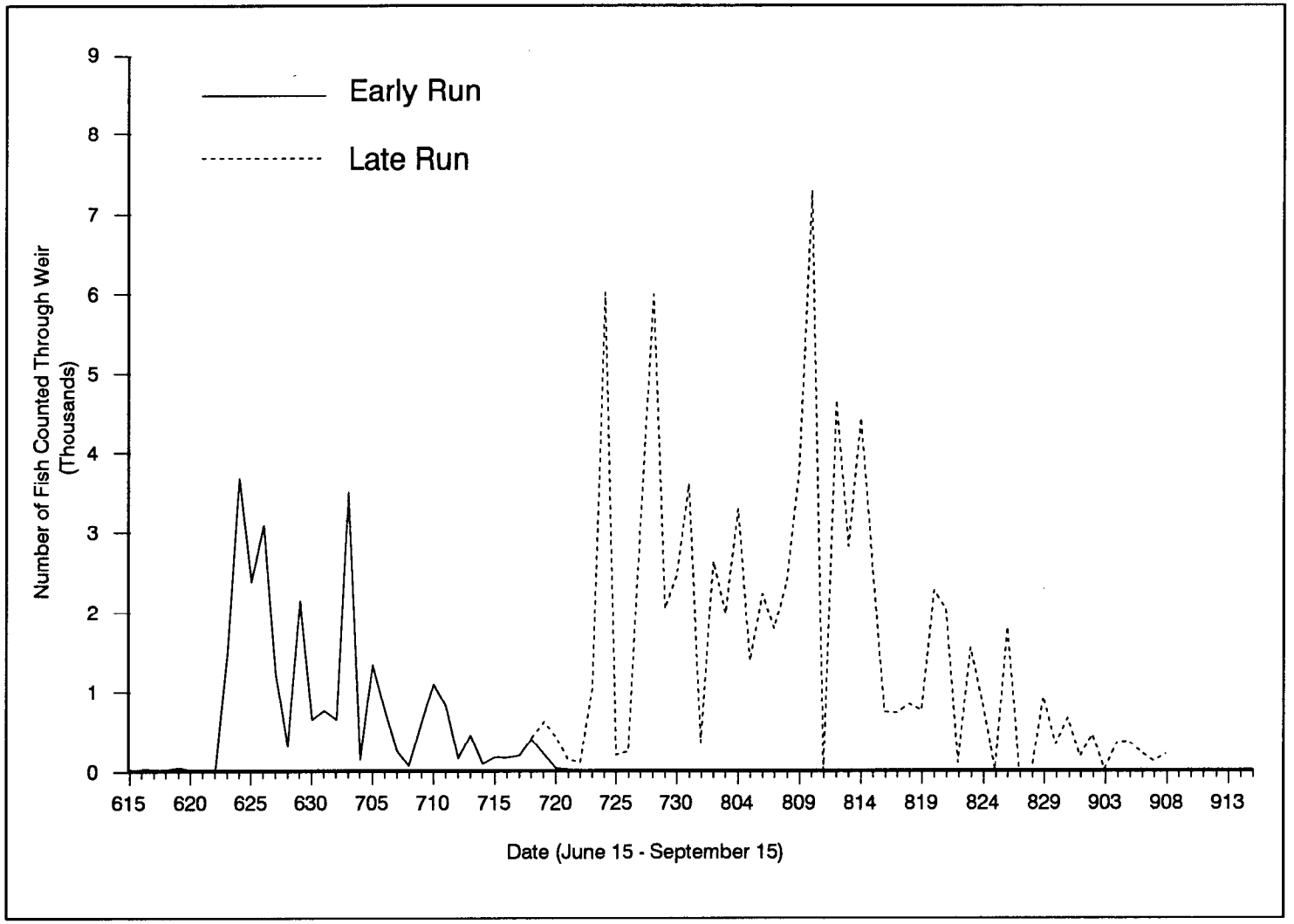

Figure 7. Daily escapement of sockeye salmon through the Russian River weir, 1990.

Table 8. Estimated age and sex composition of the early run sockeye salmon escapement through the Russian River weir, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
6/16 - 6/30 (n[a] = 136)						
Females						
Sample Size	49		20	1		70
Percent	36.0		14.7	0.8		51.5
Variance of Percent	17.1		9.3	0.5		18.5
Number	5,425		2,214	111		7,750
Variance of Number	387,114		210,674	12,259		419,532
Males						
Sample Size	36		30			66
Percent	26.5		22.1			48.5
Variance of Percent	14.4		12.7			18.5
Number	3,986		3,322			7,308
Variance of Number	326,908		288,769			419,532
Sexes Combined						
Sample Size	85		50	1		136
Percent	62.5		36.8	0.8		100.0
Variance of Percent	17.4		17.2	0.5		
Number	9,411		5,536	111		15,058
Variance of Number	393,652		390,473	12,259		

-continued-

Table 8. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/01 - 7/16 (n[a] = 133)						
Females						
Sample Size	53		28	1		82
Percent	39.8		21.1	0.8		61.7
Variance of Percent	18.2		12.6	0.6		17.9
Number	4,646		2,454	88		7,188
Variance of Number	246,795		171,127	7,683		243,419
Males						
Sample Size	28		23			51
Percent	21.1		17.2			38.3
Variance of Percent	12.6		10.8			17.9
Number	2,454		2,016			4,470
Variance of Number	171,127		147,262			243,419
Sexes Combined						
Sample Size	81		51	1		133
Percent	60.9		38.3	0.8		100.0
Variance of Percent	18.0		17.9	0.6		
Number	7,100		4,470	88		11,658
Variance of Number	245,165		243,419	7,683		

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Table 8. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Early Run Total (n[a] = 269)						
Females						
Percent	37.7		17.5	0.7		55.9
Variance of Percent	8.9		5.3	0.3		9.3
Number	10,071		4,668	199		14,938
Variance of Number	633,909		381,801	19,942		662,951
Males						
Percent	24.1		20.0			44.1
Variance of Percent	7.0		6.1			9.3
Number	6,440		5,338			11,778
Variance of Number	498,035		436,031			662,951
Sexes Combined						
Percent	61.8		37.5	0.7		100.0
Variance of Percent	9.0		8.9	0.3		
Number	16,511		10,006	199		26,716
Variance of Number	638,817		633,893	19,942		

[a] n = sample size.

Table 9. Estimated age and sex composition of early run sockeye salmon harvested from the confluence area of the Russian River recreational fishery, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
6/10 - 6/30 (n^a = 117)						
Females						
Sample Size	33	1	30			64
Percent	28.2	0.9	25.6			54.7
Variance of Percent	17.5	0.7	16.4			21.4
Number	3,096	94	2,813			6,003
Variance of Number	282,836	8,799	257,765			534,375
Males						
Sample Size	32		20	1		53
Percent	27.4		17.0	0.9		45.3
Variance of Percent	17.1		12.2	0.7		21.4
Number	3,002		1,876	94		4,972
Variance of Number	274,493		173,270	8,799		446,688
Sexes Combined						
Sample Size	65	1	50	1		117
Percent	55.6	0.9	42.6	0.9		100.0
Variance of Percent	21.3	0.7	21.1	0.7		
Number	6,098	94	4,689	94		10,975
Variance of Number	542,260	8,799	422,474	8,799		932,662

-continued-

Table 9. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/01 - 7/16 (n[a] = 136)						
Females						
Sample Size	27		46	4		77
Percent	19.9		33.8	2.9		56.6
Variance of Percent	11.8		16.6	2.1		18.2
Number	1,664		2,835	247		4,746
Variance of Number	130,306		256,516	15,672		523,644
Males						
Sample Size	32		27			59
Percent	23.5		19.9			43.4
Variance of Percent	13.3		11.8			18.2
Number	1,972		1,665			3,637
Variance of Number	160,755		130,306			359,297
Sexes Combined						
Sample Size	59		73	4		136
Percent	43.4		53.7	2.9		100.0
Variance of Percent	18.2		18.4	2.1		
Number	3,636		4,500	247		8,383
Variance of Number	359,297		484,911	15,672		1,241,732

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Table 9. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Early Run Total (n[a] = 253)						
Females						
Percent	24.5	0.5	29.2	1.3		55.5
Variance of Percent	14.6	0.2	18.7	0.4		46.2
Number	4,760	94	5,648	247		10,749
Variance of Number	413,142	8,799	514,281	15,672		1,058,018
Males						
Percent	25.7		18.3	0.5		44.5
Variance of Percent	15.5		10.1	0.2		33.0
Number	4,974		3,541	94		8,609
Variance of Number	435,248		303,577	8,799		805,985
Sexes Combined						
Percent	50.2	0.5	47.5	1.8		100.0
Variance of Percent	38.8	0.2	37.3	0.7		
Number	9,734	94	9,189	341		19,358
Variance of Number	901,557	8,799	907,385	24,471		2,174,394

[a] n = sample size.

equally to the harvest from the confluence area, but there were significant temporal changes detected in the contribution by age ($\chi^2 = 3.44$, df = 1, $P < 0.10$); age-2.2 adults contributed proportionately more during the second stratum (53.6%) than during the first stratum (42.6%).

The early run, river-area harvest was also comprised predominantly of age-2.3 and -2.2 adults with age 1.3 contributing a minor proportion (Table 10). There were significant temporal changes detected in the contribution by age ($\chi^2 = 6.33$, df = 1, $P < 0.03$). As demonstrated in the confluence area harvest, age-2.2 adults contributed proportionately more to the harvest later in the return (48.1%) than earlier (24.4%).

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. Three salient differences were detected. First, age composition of the confluence area harvest differed from that of the weir escapement during the second temporal stratum ($\chi^2 = 7.36$, df = 1, $P < 0.01$), but not during the first ($P > 0.10$). Second, age composition of the river area harvest differed from that of the weir during the early stratum ($\chi^2 = 3.52$, df = 1, $P < 0.01$), but not during the later stratum ($P > 0.10$). Third, the age composition of the confluence harvest differed from that of the river harvest during the early stratum ($\chi^2 = 7.31$, df = 1, $P < 0.01$), but not during the late stratum ($P > 0.10$).

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 graphical comparison of 95% confidence intervals among temporal strata was possible only for a portion of age/sex/return component combinations because some sample sizes of *a posteriori* combinations were small (less than 30 fish). Of 11 possible comparisons, all intervals overlapped except one (Figures 8 and 9). Therefore, temporal samples drawn from each component were pooled to estimate mean length by age and sex within spatial components (Table 11). In all cases, the relative precisions of the estimated mean lengths at age by sex were well within the guideline of 10% as designated in the project objective criteria.

Late Run:

The late run escapement through the weir was comprised predominantly of three age groups, ages 2.2, 2.1, and 2.3. Two other age groups, ages 1.3 and 1.2, comprised minor proportions with the predominant age group (74.2%) being age 2.2 (Table 12). A significant difference over temporal strata was detected in the composition of the three predominant ages ($\chi^2 = 50.73$, df = 4, $P < 0.005$) with the contribution of age-2.1 jacks increasing over the duration of the run.

The late run, confluence-area harvest was comprised predominantly of age-2.2 and -2.3 adults with ages 1.2, 1.3, and 2.1 contributing minor proportions (Table 13). Over the entire run, age-2.2 adults comprised the majority of the harvest (73.6%) taken from the confluence area, but there were significant

Table 10. Estimated age and sex composition of early run sockeye salmon harvested from the river area of the Russian River recreational fishery, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
6/10 - 6/30 (n[a] = 82)						
Females						
Sample Size	39		8			47
Percent	47.5		9.8			57.3
Variance of Percent	30.8		10.9			30.2
Number	3,684		756			4,440
Variance of Number	743,469		86,345			996,285
Males						
Sample Size	22	1	12			35
Percent	26.9	1.2	14.6			42.7
Variance of Percent	24.2	1.5	15.4			30.2
Number	2,079	94	1,134			3,307
Variance of Number	319,617	8,926	142,323			629,866
Sexes Combined						
Sample Size	61	1	20			82
Percent	74.4	1.2	24.4			100.0
Variance of Percent	23.5	1.5	22.8			
Number	5,763	94	1,890			7,747
Variance of Number	1,520,881	8,926	279,889			2,503,860

-continued-

Table 10. (Page 2 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/01 - 7/16 (n[a] = 81)						
Females						
Sample Size	16	1	18			35
Percent	19.8	1.2	22.2			43.2
Variance of Percent	19.8	1.5	21.6			30.7
Number	614	38	692			1,344
Variance of Number	99,330	1,474	123,108			427,155
Males						
Sample Size	24	1	21			46
Percent	29.7	1.2	25.9			56.8
Variance of Percent	26.1	1.5	24.0			30.7
Number	921	38	807			1,766
Variance of Number	209,589	1,474	163,508			721,095
Sexes Combined						
Sample Size	40	2	39			81
Percent	49.5	2.4	48.1			100.0
Variance of Percent	31.2	3.0	31.2			
Number	1,535	76	1,499			3,110
Variance of Number	551,297	3,580	525,206			2,164,469

-continued-

Table 10. (Page 3 of 3).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Early Run Total (n[a] = 163)						
Females						
Percent	39.6	0.4	13.3			53.3
Variance of Percent	133.6	0.1	24.8			233.2
Number	4,298	38	1,448			5,784
Variance of Number	842,799	1,474	209,452			1,423,440
Males						
Percent	27.6	1.2	17.9			46.7
Variance of Percent	75.1	0.9	38.6			201.1
Number	3,000	132	1,941			5,073
Variance of Number	529,206	10,400	305,831			1,350,962
Sexes Combined						
Percent	67.2	1.6	31.2			100.0
Variance of Percent	354.8	1.2	106.8			
Number	7,298	170	3,389			10,857
Variance of Number	2,072,178	12,505	805,095			4,668,329

[a] n = sample size.

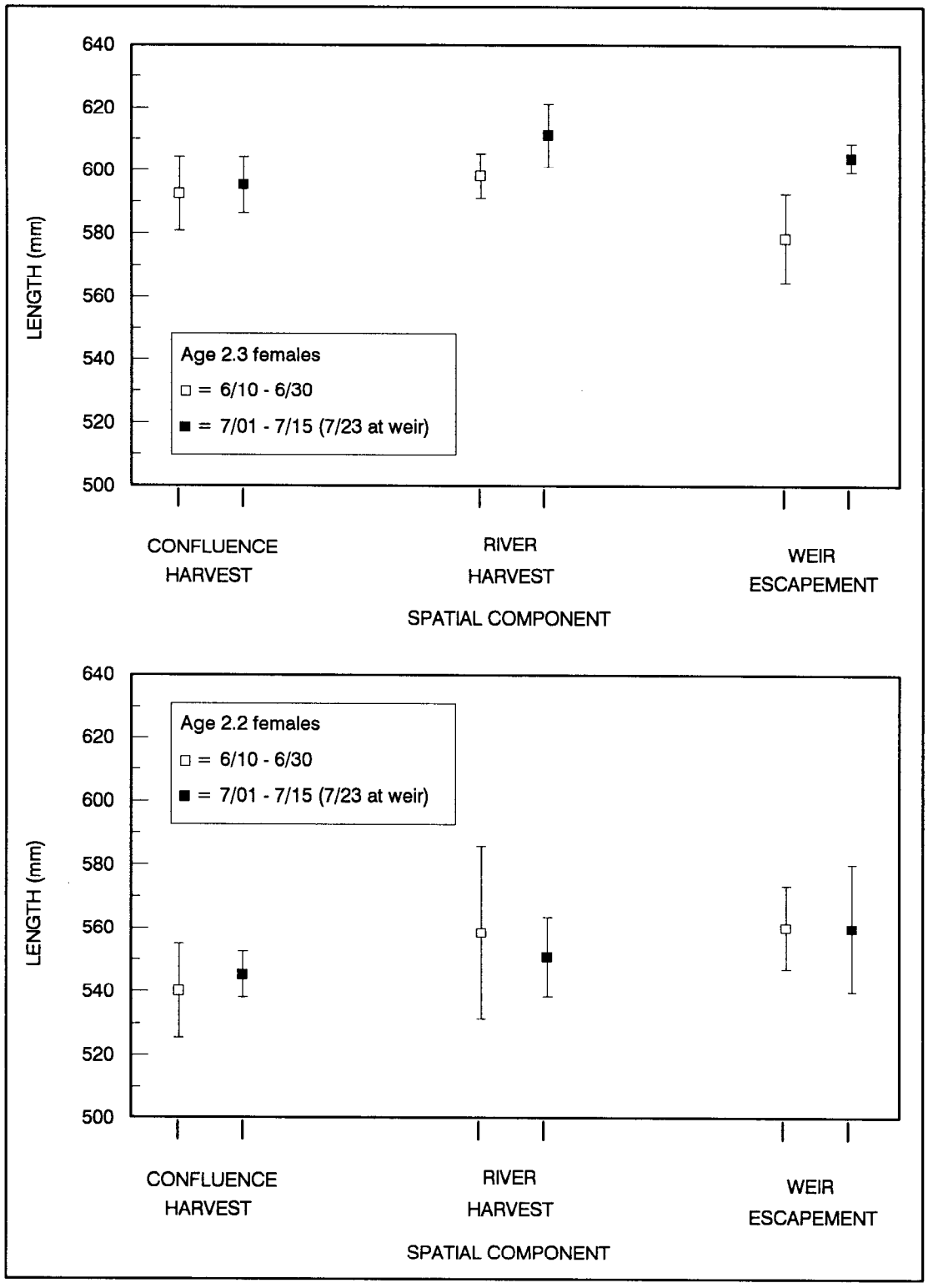

Figure 8. Mean lengths of age-2.3 and -2.2 Russian River sockeye salmon females by temporal stratum for three spatial components of the 1990 early run.

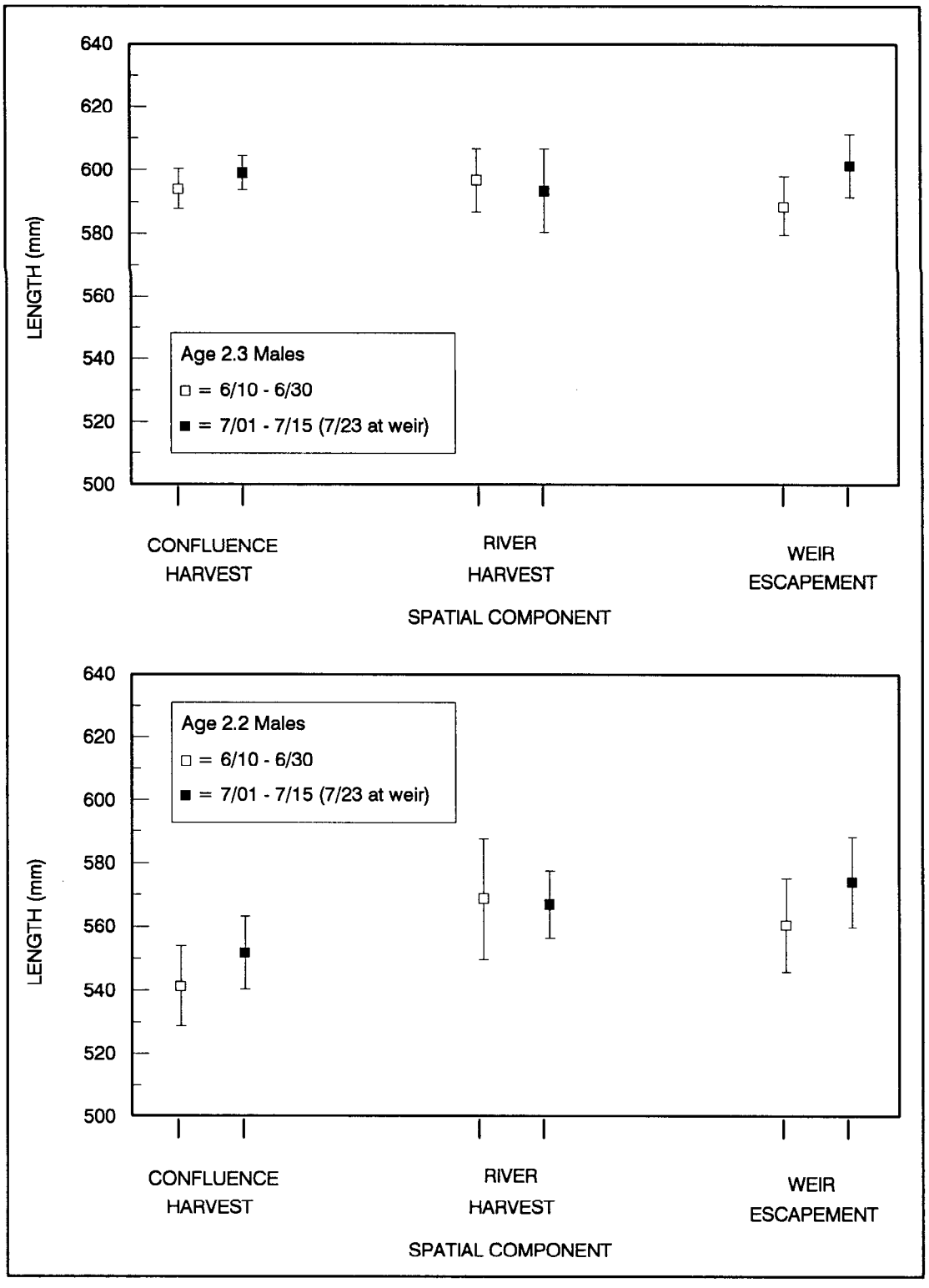

Figure 9. Mean lengths of age-2.3 and -2.2 Russian River sockeye salmon males by temporal stratum for three spatial components of the 1990 early run.

Table 11. Mean length (millimeters) at age, by sex, for the early run of sockeye salmon sampled from the Russian River, 1990.

Component		Age Class				
		2.3	1.3	2.2	1.2	2.1
Escapement[a]						
Female	Mean Length	591		561	542	
	SE	2.6		6.2	7.5	
	Sample Size	102		48	2	
Male	Mean Length	594		567		
	SE	3.2		5.6		
	Sample Size	64		53		
Confluence–Area Harvest						
Female	Mean Length	594	530	544	522	
	SE	3.5		3.5	6.4	
	Sample Size	60	1	76	4	
Male	Mean Length	597		549		
	SE	2.5		4.3		
	Sample Size	64		47		
River Area Harvest						
Female	Mean Length	601	620	554		
	SE	3.0		5.6		
	Sample Size	55	1	26		
Male	Mean Length	592	578	569		
	SE	3.8	37.5	4.8		
	Sample Size	46	2	33		

[a] Fish that migrated through the weir.

Table 12. Estimated age and sex composition of the late run sockeye salmon escapement through the Russian River weir, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/18 - 7/31 (n[a] = 130)						
Females						
Sample Size	9	2	49	1		61
Percent	6.9	1.5	37.7	0.8		46.9
Variance of Percent	5.0	1.2	18.2	0.6		19.3
Number	1,832	407	9,971	204		12,414
Variance of Number	349,623	82,189	1,274,245	41,415		1,351,297
Males						
Sample Size	6		57		6	69
Percent	4.6		43.8		4.7	53.1
Variance of Percent	3.4		19.1		3.4	19.3
Number	1,221		11,600		1,221	14,042
Variance of Number	238,861		1,335,887		238,861	1,351,297
Sexes Combined						
Sample Size	15	2	106	1	6	130
Percent	11.5	1.5	81.5	0.8	4.7	100.0
Variance of Percent	7.9	1.2	11.7	0.6	3.4	
Number	3,053	407	21,571	204	1,221	26,456
Variance of Number	553,810	82,189	816,750	41,415	238,861	

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Table 12. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/01 - 8/15 (n[a] = 129)						
Females						
Sample Size			66			66
Percent			51.2			51.2
Variance of Percent			19.5			19.5
Number			21,258			21,258
Variance of Number			3,369,894			3,369,894
Males						
Sample Size	5		31		27	63
Percent	3.9		24.0		20.9	48.8
Variance of Percent	2.9		14.3		12.9	19.5
Number	1,610		9,985		8,696	20,291
Variance of Number	502,485		2,462,178		2,232,008	3,369,894
Sexes Combined						
Sample Size	5		97		27	129
Percent	3.9		75.2		20.9	100.0
Variance of Percent	2.9		14.6		12.9	
Number	1,610		31,243		8,696	41,549
Variance of Number	502,485		2,515,669		2,232,008	

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Table 12. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/16 - 9/08 (n[a] = 134)						
Females						
Sample Size			53			53
Percent			39.6			39.6
Variance of Percent			18.0			18.0
Number			6,064			6,064
Variance of Number			422,514			422,514
Males						
Sample Size	4		25		52	81
Percent	3.0		18.6		38.8	60.4
Variance of Percent	2.2		11.4		17.9	18.0
Number	458		2,860		5,949	9,267
Variance of Number	51,178		268,192		419,659	422,514
Sexes Combined						
Sample Size	4		78		52	134
Percent	3.0		58.2		38.8	100.0
Variance of Percent	2.2		18.3		17.9	
Number	458		8,924		5,949	15,331
Variance of Number	51,178		429,895		419,659	

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Table 12. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Late Run Total (n[a] = 393)						
Females						
Percent	2.2	0.5	44.8	0.2		47.7
Variance of Percent	0.5	0.1	7.3	0.1		7.4
Number	1,832	407	37,293	204		39,735
Variance of Number	349,623	82,189	5,066,653	41,415		5,143,705
Males						
Percent	4.0		29.3		19.0	52.3
Variance of Percent	1.1		5.9		4.2	7.4
Number	3,289		24,445		15,866	43,601
Variance of Number	792,524		4,066,258		2,890,528	5,143,705
Sexes Combined						
Percent	6.2	0.5	74.1	0.2	19.0	100.0
Variance of Percent	1.6	0.1	5.4	0.1	4.2	
Number	5,121	407	61,738	204	15,866	83,336
Variance of Number	1,107,474	82,189	3,762,314	41,415	2,890,528	

[a] n = sample size.

Table 13. Estimated age and sex composition of late run sockeye salmon harvested from the confluence area of the Russian River recreational fishery, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/17 - 7/31 (n[a] = 141)						
Females						
Sample Size	13	4	67			84
Percent	9.2	2.8	47.6			59.6
Variance of Percent	6.0	2.0	17.8			17.2
Number	2,549	784	13,137			16,470
Variance of Number	588,539	160,604	5,092,023			7,196,616
Males						
Sample Size	19	6	31		1	56
Percent	13.5	4.3	21.9		0.7	40.4
Variance of Percent	8.3	2.9	12.3		0.5	17.2
Number	3,725	1,176	6,079		196	11,176
Variance of Number	925,043	247,734	1,720,964		38,444	4,007,668
Sexes Combined						
Sample Size	32	10	98		1	141
Percent	22.7	7.1	69.5		0. 7	100.0
Variance of Percent	12.5	4.7	15.1		0. 5	
Number	6,274	1,960	19,216		19 6	27,646
Variance of Number	1,794,688	435,652	9,176,772		38,44 4	16,653,395

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Table 13. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/01 - 8/10 (n[a] = 149)						
Females						
Sample Size	4	1	78			83
Percent	2.7	0.7	52.3			55.7
Variance of Percent	1.8	0.5	16.9			16.7
Number	300	75	5,847			6,222
Variance of Number	22,874	5,620	635,542			689,907
Males						
Sample Size	16	1	42	1	6	66
Percent	10.7	0.7	28.2	0.7	4.0	44.3
Variance of Percent	6.5	0.5	13.7	0.5	2.6	16.7
Number	1,199	75	3,149	75	450	4,948
Variance of Number	97,799	5,620	292,574	5,620	34,705	511,764
Sexes Combined						
Sample Size	20	2	120	1	6	149
Percent	13.4	1.4	80.5	0.7	4.0	100.0
Variance of Percent	7.9	0.9	10.6	0.5	2.6	
Number	1,499	150	8,996	75	450	11,170
Variance of Number	124,875	11,306	1,143,226	5,620	34,705	1,561,369

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Table 13. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/11 - 8/20 (n[a] = 81)						
Females						
Sample Size	8		43	1		52
Percent	9.9		53.1	1.2		64.2
Variance of Percent	11.1		31.1	1.5		28.7
Number	497		2,669	62		3,228
Variance of Number	85,593		1,931,930	3,853		2,793,984
Males						
Sample Size	5	1	22		1	29
Percent	6.2	1.2	27.2		1.2	35.8
Variance of Percent	7.2	1.5	24.7		1.5	28.7
Number	310	62	1,366		62	1,800
Variance of Number	38,826	3,853	536,600		3,853	905,867
Sexes Combined						
Sample Size	13	1	65	1	1	81
Percent	16.1	1.2	80.3	1.2	1.2	100.0
Variance of Percent	16.8	1.5	19.8	1.5	1.5	
Number	807	62	4,035	62	62	5,028
Variance of Number	202,657	3,853	4,318,879	3,853	3,853	6,649,457

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Table 13. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Late Run Total (n[a] = 371)						
Females						
Percent	7.6	2.0	49.4	0.1		59.1
Variance of Percent	4.4	0.9	71.4	0.1		100.8
Number	3,346	859	21,653	62		25,920
Variance of Number	697,006	166,224	7,659,494	3,853		10,680,507
Males						
Percent	11.9	3.0	24.2	0.2	1.6	40.9
Variance of Percent	7.4	1.5	20.8	0.1	0.4	49.8
Number	5,234	1,313	10,594	75	708	17,924
Variance of Number	1,061,668	257,207	2,550,137	5,620	77,002	5,425,298
Sexes Combined						
Percent	19.5	5.0	73.6	0.3	1.6	100.0
Variance of Percent	16.0	2.7	146.1	0.1	0.4	
Number	8,580	2,172	32,247	137	708	43,844
Variance of Number	2,122,220	450,810	14,638,877	9,473	77,002	24,864,221

[a] n = sample size.

temporal changes detected in the contribution by age ($\chi^2 = 3.44$, df = 1, $P < 0.10$); age-2.2 adults contributed proportionately more during the third stratum (80.3%) than during the first stratum (69.5%).

The late run, river-area harvest was also comprised predominantly of age-2.2 and -2.3 adults with ages 1.2, 1.3, and 2.1 contributing minor proportions (Table 14). There were significant temporal changes detected in the contribution of the two predominant ages ($\chi^2 = 38.01$, df = 2, $P < 0.005$). As demonstrated in the confluence area harvest, age-2.2 adults contributed proportionately more to the harvest later in the return (87.8%) than earlier (60.7%).

The age composition of sockeye salmon that spawned in the Russian River downstream from the Russian River Falls was estimated for a single stratum (Table 15). The predominant age group was age 1.3, however the combined ages of 2.2, 2.3, and 1.3 contributed a larger proportion than in previous years (Athons and McBride 1987, Hammarstrom and Athons 1988 and 1989, Carlon and Vincent-Lang 1990).

Age composition comparisons among three components sampled during the late run (confluence area harvest, river area harvest, and weir escapement) indicate that there were significant differences within temporal strata among the components. The age composition of the confluence area harvest differed from that of the weir escapement during all three temporal strata (Table 16; $\chi^2_{\text{stratum 1}} = 9.97$, df = 2, $P < 0.01$; $\chi^2_{\text{stratum 2}} = 23.84$, df = 2, $P < 0.005$; $\chi^2_{\text{stratum 3}} = 19.57$, df = 2, $P < 0.005$) with age-2.1 jacks comprising a substantially smaller proportion of the harvest than of the escapement through the weir (Table 13). The age composition of the river area harvest also differed from that of the weir escapement during all three temporal strata ($\chi^2_{\text{stratum 1}} = 22.48$, df = 2, $P < 0.005$; $\chi^2_{\text{stratum 2}} = 21.58$, df = 2, $P < 0.005$; $\chi^2_{\text{stratum 3}} = 38.99$, df = 2, $P < 0.005$), again with age-2.1 jacks comprising a smaller proportion of the harvest than of the escapement. The age composition of the confluence harvest differed from that of the river area harvest during the first two strata, but not during the third ($\chi^2_{\text{stratum 1}} = 3.36$, df = 1, $P < 0.10$; $\chi^2_{\text{stratum 2}} = 3.19$, df = 1, $P < 0.10$; $\chi^2_{\text{stratum 3}} = 1.87$, df = 1, $P > 0.10$).

Mean length by age and sex was examined over temporal strata for three components sampled during the late run to determine if temporal samples could be pooled to generate single, unbiased estimates for age/sex combinations within each component. A graphical comparison of 95% confidence intervals among temporal strata was possible only for a portion of age/sex/return component combinations because some sample sizes of *a posteriori* combinations were small (less than 30 fish). Of six possible comparisons, all intervals overlapped except one (Figure 10). Therefore, temporal samples drawn from each component were pooled to estimate mean length by age and sex within components (Table 17). In all cases, the relative precisions of the estimated mean lengths at age by sex were well within the required 10% as stated in the objective criteria.

Table 14. Estimated age and sex composition of late run sockeye salmon harvested from the river area of the Russian River recreational fishery, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
7/17 - 7/31 (n^a = 117)						
Females						
Sample Size	18		41	4		63
Percent	15.4		35.0	3.4		53.8
Variance of Percent	11.2		19.6	2.8		21.4
Number	539		1,226	120		1,885
Variance of Number	105,939		518,112	7,104		1,202,965
Males						
Sample Size	21	2	30	1		54
Percent	18.0	1.7	25.7	0.8		46.2
Variance of Percent	12.7	1.4	16.4	0.7		21.4
Number	628	60	898	30		1,616
Variance of Number	142,089	2,378	282,239	895		888,454
Sexes Combined						
Sample Size	39	2	71	5		117
Percent	33.4	1.7	60.7	4.2		100.0
Variance of Percent	19.2	1.4	20.6	3.5		
Number	1,167	60	2,124	150		3,501
Variance of Number	469,942	2,378	1,522,451	10,348		4,088,644

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Table 14. (Page 2 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/01 - 8/10 (n[a] = 137)						
Females						
Sample Size	4		88			92
Percent	2.9		64.3			67.2
Variance of Percent	2.1		16.9			16.2
Number	149		3,267			3,416
Variance of Number	7,148		1,163,045			1,265,983
Males						
Sample Size	6		35		4	45
Percent	4.4		25.5		2. 9	32.8
Variance of Percent	3.1		14.0		2. 1	16.2
Number	223		1,299		14 9	1,671
Variance of Number	12,354		210,174		7,14 8	331,453
Sexes Combined						
Sample Size	10		123		4	137
Percent	7.3		89.8		2. 9	100.0
Variance of Percent	5.0		6.7		2. 1	
Number	372		4,566		14 9	5,087
Variance of Number	26,033		2,211,381		7,14 8	2,724,056

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Table 14. (Page 3 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/11 - 8/20 (n[a] = 82)						
Females						
Sample Size	4	1	51			56
Percent	4.9	1.2	62.2			68.3
Variance of Percent	5.7	1.5	29.0			26.7
Number	183	46	2,327			2,556
Variance of Number	15,801	2,084	1,692,891			2,033,079
Males						
Sample Size	3	1	21		1	26
Percent	3.7	1.2	25.6		1.2	31.7
Variance of Percent	4.4	1.5	23.5		1.5	26.7
Number	137	46	958		46	1,187
Variance of Number	9.984	2,084	305,082		2,084	458,608
Sexes Combined						
Sample Size	7	1	72		1	82
Percent	8.6	2.4	87.8		1.2	100.0
Variance of Percent	9.6	2.9	13.2		1.5	
Number	320	92	3,285		46	3,743
Variance of Number	40,718	5,412	3,330,741		2,084	4,303,554

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Table 14. (Page 4 of 4).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Late Run Total (n^a = 336)						
Females						
Percent	7.1	0.4	55.2	1.0		63.7
Variance of Percent	12.1	0.1	445.7	0.5		592.9
Number	871	46	6,820	120		7,857
Variance of Number	128,888	2,084	3,374,048	7,104		4,502,027
Males						
Percent	8.0	0.9	25.6	0.2	1.6	36.3
Variance of Percent	15.5	0.3	100.3	0.1	0.8	206.6
Number	988	106	3,155	30	195	4,474
Variance of Number	164,427	4,461	797,495	895	9,231	1,678,514
Sexes Combined						
Percent	15.1	1.3	80.8	1.2	1.6	100.0
Variance of Percent	51.9	0.6	943.3	0.8	0.8	
Number	1,859	152	9,975	150	195	12,331
Variance of Number	536,693	7,789	7,064,573	10,348	9,231	11,116,254

[a] n = sample size.

Table 15. Estimated age and sex composition of sockeye salmon spawning downstream from the Russian River Falls, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
8/27, 8/31[a] (n^b = 126)						
Females						
Percent	6.4	16.8	5.6	5.6	0.0	34.4
Number	753	1,975	659	659	0	4,046
Standard Error	257	393	242	242		
Males						
Percent	10.4	28.0	15.2	11.2	0.8	65.6
Number	1,222	3,293	1,788	1,317	94	7,714
Standard Error	321	472	377	331	94	
Sexes Combined						
Percent	16.8	44.8	20.8	16.8	0.8	100.0
Number	1,175	5,268	2,447	1,976	94	11,760
Standard Error	411	614	448	410	94	

[a] Sampling took place on these two dates.

[b] n = sample size.

Table 16. Results of contingency test comparisons of age composition between spatial fishery components for the late run Russian River sockeye salmon recreational fishery, 1990.

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	S(P<0.10)	S(P<0.01)	S(P<0.005)
2	S(P<0.10)	S(P<0.005)	S(P<0.005)
3	NS(P>0.10)	S(P<0.005)	S(P<0.005)

[a] 1 = 7/16-7/31, 2 = 8/01-8/10 (8/01-8/15 for weir escapement), 3 = 8/11-8/20 (8/16-9/07 for weir escapement).

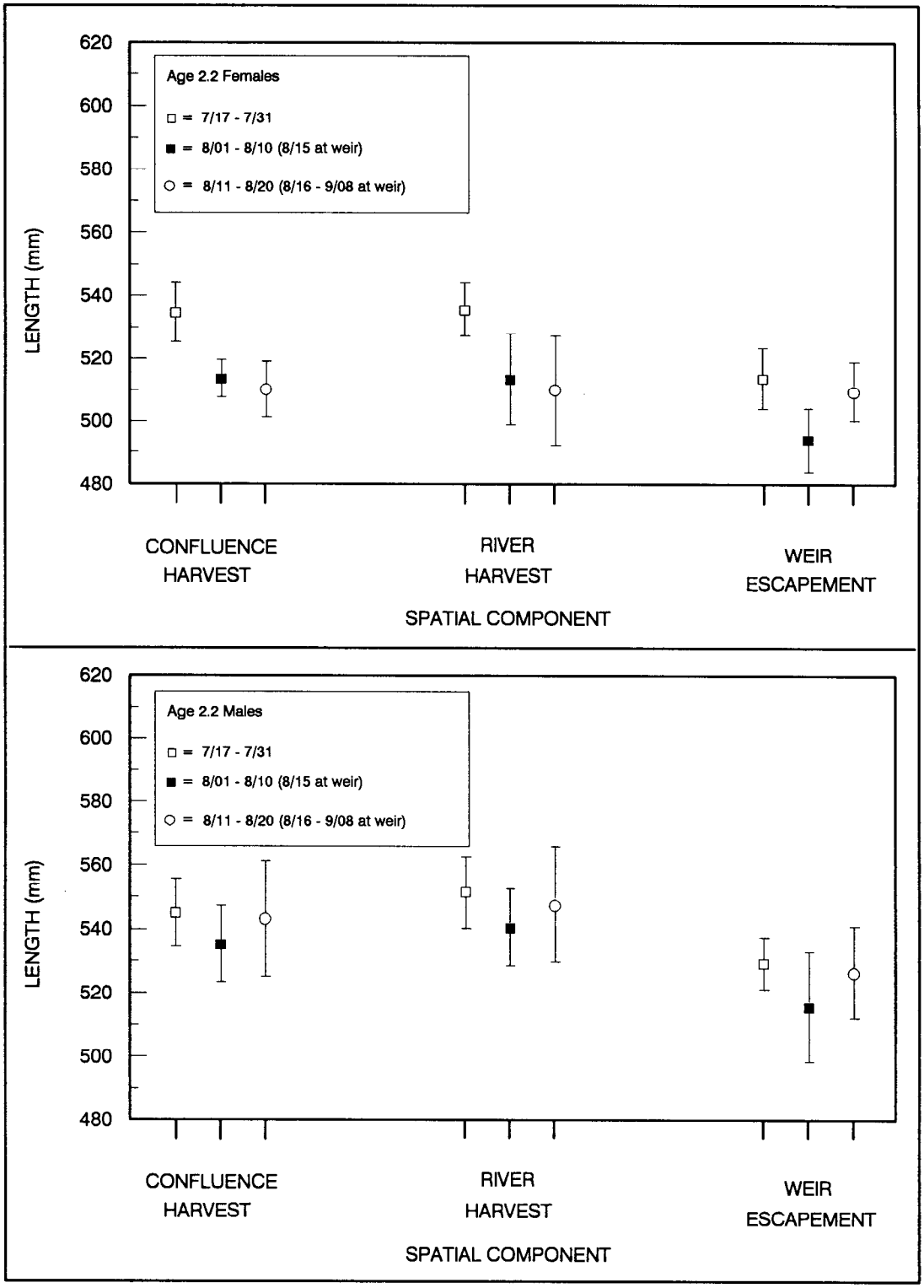

Figure 10. Mean lengths of age-2.3 and -2.2 Russian River sockeye salmon by temporal stratum for three spatial components of the 1990 late run.

Table 17. Mean length (millimeters) at age, by sex, for the late run of sockeye salmon sampled from the Russian River, 1990.

Component		Age Class 2.3	1.3	2.2	1.2	2.1
Escapement[a]						
Female	Mean Length	577	568	507	465	
	SE	5.1	12.5	2.6		
	Sample Size	9	2	168	1	
Male	Mean Length	588		526		385
	SE	8.9		3.6		4.9
	Sample Size	15		113		85
Confluence–Area Harvest						
Female	Mean Length	574	594	521	505	
	SE	6.7	5.6	2.2		
	Sample Size	25	5	188	1	
Male	Mean Length	596	601	540	510	389
	SE	5.1	10.2	3.8		6.2
	Sample Size	40	8	95	1	8
River Area Harvest						
Female	Mean Length	583	585	525	529	
	SE	6.4		2.2	10.2	
	Sample Size	26	1	180	4	
Male	Mean Length	596	604	547	620	375
	SE	5.8	19.9	3.6		14.7
	Sample Size	30	3	86	1	5
Downstream Escapement[b]						
Female	Mean Length	569	557	537	554	
	SE	10.8	5.3	16.9	15.0	
	Sample Size	8	21	7	7	
Male	Mean Length	622	607	603	562	430
	SE	8.2	4.8	7.8	9.4	
	Sample Size	13	35	19	14	1

[a] Fish that migrated through the weir.
[b] Fish that spawned downstream from Russian River Falls.

Total Return Statistics

Overall, an estimated 56,931 early run sockeye salmon returned to the Russian River in 1990 (Table 18). Of these, 58.9% were age 2.3 and 39.7% were age 2.2. Ages 1.3 and 1.2 comprised only minor proportions of the return. An estimated 139,511 late run sockeye salmon returned in 1990. The predominant age group of the entire return was 2.2 which comprised an estimated 74.6% of the return. Age-2.1 salmon comprised an additional 12.0% of the late run.

APPLICATION OF THE DATA FOR FISHERY MANAGEMENT

The sanctuary area remains closed to all fishing by regulation from June 1 through July 15. In 1990 however, an Emergency Order (Appendix B) was issued which opened the sanctuary area on July 2 to the taking of sockeye salmon. Because the escapement goal of 16,500 was projected, it was deemed appropriate to liberalize the fishery by removing the fishing restriction on the sanctuary area. Anglers were thus afforded increased fishing opportunity in 1990.

Both early and late runs are managed for escapement. Based on preliminary analyses of brood production data (Carlon and Vincent-Lang 1990), a sockeye salmon escapement goal of 16,500 was recommended for the 1990 early run. The goal was later refined to 16,000 when the 1990 return was included in the final analysis. Through July 1, 1990, a total of 15,802 sockeye salmon had migrated through the weir and an estimated 1,000 fish were holding immediately downstream from the weir. In addition, observations indicated substantial numbers of sockeye salmon negotiating the Russian River falls on July 1. These fish were observed upstream from the area open to fishing; they were all considered as having escaped fishing mortality and were projected as migrating through the weir and contributing to an escapement in excess of 16,500. Based on these observations and the weir count through July 1, the Emergency Order was issued.

DISCUSSION

Relative Run Strength

The run strength of the 1990 early run, as determined from total return estimates (harvest plus escapement), approximated the run strength measured in recent years (Figure 11). The 1990 return exceeded returns measured prior to 1978 when the average return was comparatively less than that since 1978. The creel survey design change in 1990, as well as annual refinements in the previous design, make direct comparisons of estimates somewhat misleading, but there is a general trend toward larger returns in recent years.

Similarly, the run strength of the 1990 late run approximated that of recent years (Figure 11). In fact, the late run return exceeded all but two of the total returns measured since 1963, indicating a general trend toward larger returns. However, as for the early run, fluctuations in total return to pre-1978 levels do occur.

Table 18. Estimated age and sex composition of early and late returns of sockeye salmon to the Russian River, 1990.

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Early Run Total[a] (n^b = 685)						
Females						
Percent	33.6	0.2	20.7	0.8		55.3
Variance of Percent	8.2	<0.1	4.3	0.1		16.2
Number	19,129	132	11,764	446		31,471
Variance of Number	1,889,850	10,273	1,105,534	35,614		3,144,409
Males						
Percent	25.3	0.2	19.0	0.2		44.7
Variance of Percent	5.9	<0.1	4.0	<0.1		10.9
Number	14,414	132	10,820	94		25,460
Variance of Number	1,462,489	10,400	1,045,439	8,799		2,156,947
Sexes Combined						
Percent	58.9	0.4	39.7	1.0		100.0
Variance of Percent	18.5	0.1	10.6	0.1		
Number	33,543	264	22,584	540		56,931
Variance of Number	3,612,552	21,304	2,346,373	44,413		6,842,723

-continued-

Table 18. (Page 2 of 2).

Dates	Age Group 2.3	1.3	2.2	1.2	2.1	Total
Late Run Total[a] (n[b] = 1100)						
Females						
Percent	4.3	0.9	47.2	0.3		52.7
Variance of Percent	0.6	0.1	12.4	<0.1		15.6
Number	6,049	1,312	65,766	386		73,513
Variance of Number	1,175,517	250,497	16,100,195	52,372		20,326,239
Males						
Percent	6.8	1.0	27.4	0.1	12.0	47.3
Variance of Percent	1.1	0.1	5.2	<0.1	1.8	10.4
Number	9,511	1,419	38,194	105	16,769	65,998
Variance of Number	2,018,619	261,668	7,413,890	6,515	2,976,761	12,247,517
Sexes Combined						
Percent	11.1	1.9	74.6	0.4	12.0	100.0
Variance of Percent	2.2	0.3	23.3	0.1	1.8	
Number	15,560	2,731	103,960	491	16,769	139,511
Variance of Number	3,766,387	540,788	25,465,764	61,236	2,976,761	35,980,475

[a] Confluence area harvest + river harvest + escapement through weir.
[b] n = sample size.

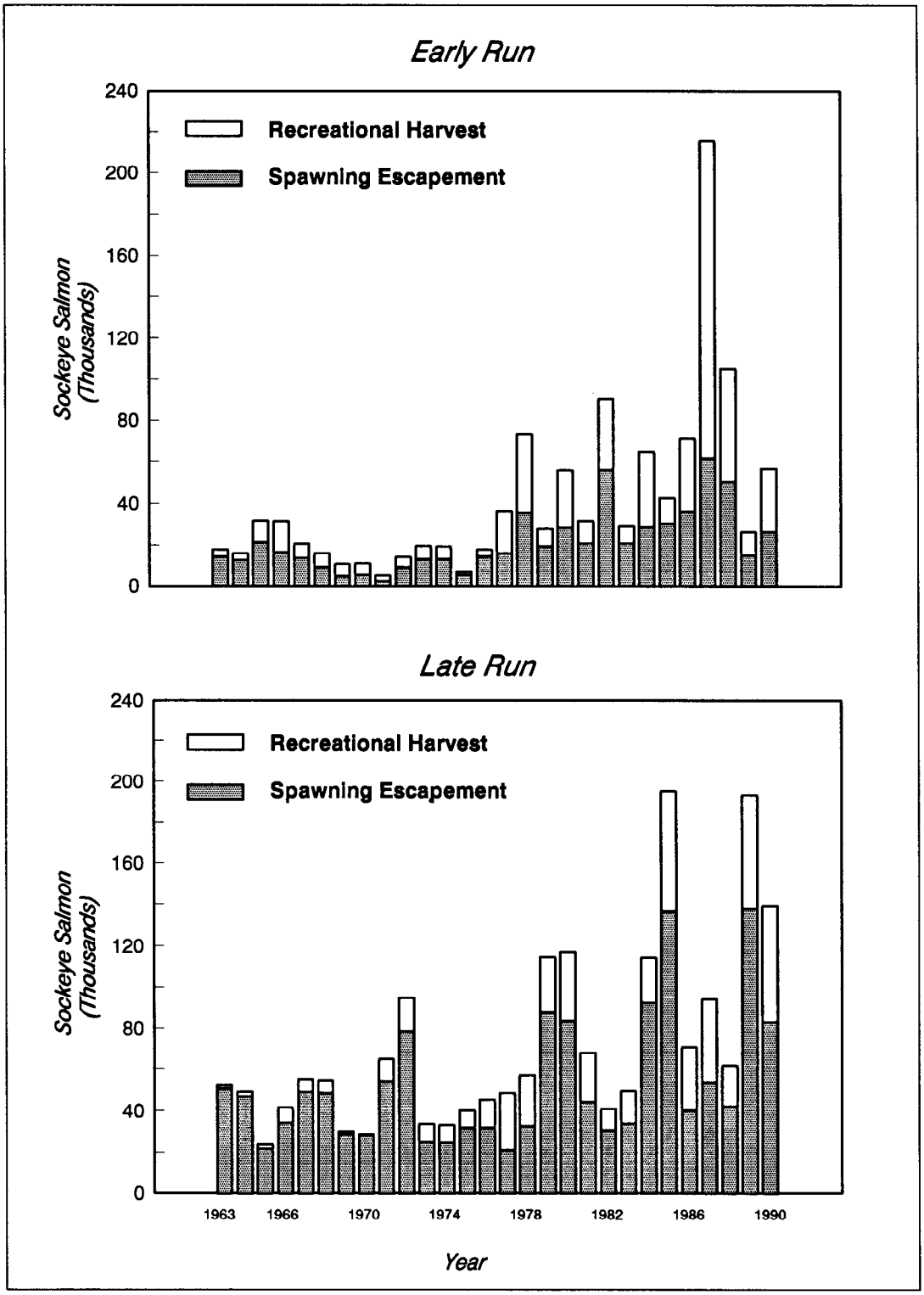

Figure 11. Historical returns of sockeye salmon to the Russian River.

Sample Design

Creel Survey:

The direct expansion creel survey design performed adequately during the 1990 pilot season of implementation. The precision of harvest and effort estimates approximated desired levels. Angler use patterns associated with the various Russian River Campground access locations were not considered when developing the sampling scheme because use data were not available on which to base sampling optimization. In 1990, two locations, Red Salmon and Rainbow Trout, did not account for a critical amount of harvest, effort, or variability in estimates of harvest or effort. However, these locations were sampled with the same intensity as Grayling and Pink Salmon. Sampling effort used at these minor locations can be redistributed among the three predominant locations to improve the precision of harvest and effort estimates.

During random observations of unsurveyed access locations, it was evident that some anglers exited the fishery through areas other than those sampled in 1990. Similar observations made in past years indicate that anglers have used unsurveyed access points to varying degrees in recent years (D. Athons, Alaska Department of Fish and Game, Soldotna, personal communication). 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, it is assumed, based on observations, that the number was small and insignificant. However, a more formal monitoring of these other locations may be warranted to determine if use patterns of unsurveyed exit locations change among years and if substantial numbers of anglers are being excluded from the survey.

In addition, observations of angler activity during the unsampled hours of 0000 to 0600 hours indicated that some anglers fished during this time period, especially during the early run when the longer days of June provided more twilight and better visibility than the shorter days of July and August. Future monitoring of access locations during the nighttime period will provide information regarding any changes in angler use patterns which would prove useful in refining the survey.

Age Composition:

The accurate assessment of the age composition of the sockeye salmon return is also a prerequisite to establishing accurate brood tables for the Russian River system. The comprehensive sampling of time and area components of the 1990 return represented an increase in sampling intensity over prior years in an effort to achieve more accurate age composition estimates. Statistical comparisons detected temporal changes in age composition within spatial components as well as changes among spatial components within temporal strata.

The comparison of the age composition of the confluence and river harvests indicated that differences do occur during each run. Therefore, it is not appropriate to use the age composition from one area to apportion the harvest estimates from both areas, and it is recommended that the sampling of the individual spatial components be continued at the present sampling intensity

to accurately estimate numbers of sockeye salmon returning by age and sex and to evaluate the extent of differences over years. This will result in improved accuracy of brood production information necessary for long term management of the Russian River system.

Management of the Fishery

The information used to liberalize the early run fishery in 1990 by opening the sanctuary came from two sources, the weir count and visual estimates of migrating adults in various sections of the river upstream from the area open to fishing. This information provided a projection of spawning escapement to and through the weir. This technique has been employed successfully for both early and late runs during prior years and worked adequately in 1990 as the early run fishery was liberalized before the escapement goal was met at the weir. In years of strong return, this conservative technique ensures that the escapement goal will be met while allowing for some increased level of fishing opportunity.

A more critical situation arises when the question is whether to restrict the fishery to achieve the escapement goal. Similar observations of the weir count and of fish migrating upstream from the area open to fishing are used in formulating a management decision. However, to avoid being unduly restrictive, harvest rates in the recreational fishery in the confluence area are examined and serve as an indicator of abundance; a positive correlation between harvest and sockeye salmon abundance has been demonstrated for the Russian River system (Vincent-Lang and Carlon 1991).

In either case of strong or weak returns, visual observations of fish actually in the closed area upstream from the area open to fishing provide a conservative basis on which to manage for escapement, and this should be continued. However, data are available to determine the value of examining migratory timing statistics in-season as an additional management tool (Vincent-Lang and Carlon 1991) which may allow an earlier liberalization in the case of a strong return or an earlier fishery restriction in the case of a weak return.

Historical migratory timing statistics are available from weir counts as well as fishery harvest rates. 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 1991 and subsequent years to begin evaluation of its value in managing the Russian River sockeye salmon resource.

ACKNOWLEDGEMENTS

The 1990 field season was Deric Marcorelle's last season as the weir biologist at the Russian River field camp. He has assisted with all aspects of field operations at the Russian River since 1983, including operating the Russian River weir, collecting age, sex, and length data, assisting with creel

surveys, and providing post-season logistical and technical support. In carrying out these duties, he has made a significant contribution to the quality of the information collected at the Russian River and to the long-term management of the Russian River and its fishery resources.

Paul Zallek collected creel survey data and age, sex, and length data from the fishery and monitored the fishery for regulation violations. He also provided operational support at the weir site and trained the new creel survey technician. His detailed observations of the fishery were invaluable to management of the sockeye salmon resource.

Colleen O'Brien also collected creel survey data and age, sex, and length data from the fishery. This was her first season with the Department and she proved to be an asset to the Russian River project.

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LITERATURE CITED

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

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

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bull. Int. Pac. Salmon Fish. Comm. No. 9.

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

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

_____. 1986. Origins of sockeye salmon in the fisheries of Upper Cook Inlet in 1983. Alaska Department of Fish and Game Technical Data Report No. 181.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

_____. 1987. Alaska statewide sport fish harvest studies (1986). Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

_____. 1988. Alaska statewide sport fish harvest studies (1987). Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

_____. 1989. Alaska statewide sport fish harvest studies (1988). Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

_____. 1990. Harvest and participation in Alaska sport fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Nelson, D. C., D. E. Athons, and J. A. Carlon. 1986. Russian River sockeye salmon study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project AFS-44, 26 (AFS-44-11):1-59.

Neuhold, J. M. and H. K. Lu. 1957. Creel census methods. Utah Department of Fish and Game Publication No. 8. Salt Lake City.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1978. Elementary survey sampling. Duxbury Press. North Scituate, Massachusetts.

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

Walker, K. M. 1985. Introduction to variance estimation. Springer-Verlas, New York.

APPENDIX A

Selected Summaries of Fishery and Escapement Data from the Russian River

Appendix A1. Daily sample statistics for the 1990 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	900610	5	1	10	12.66	17	0.16	1.50	0.50	19	0.00	0.00	0
1	900610	6	1	2	2.18	2	0.09	2.00	0.00	4	0.00	0.00	0
1	900612	2	1	3	4.50	12	0.13	2.00	0.00	9	0.00	0.00	0
1	900612	3	1	5	7.00	20	0.10	1.40	0.80	10	0.40	0.80	3
1	900614	2	1	4	8.39	34	0.13	1.75	0.25	15	0.00	0.00	0
1	900614	3	1	3	4.84	43	0.04	0.50	0.00	2	0.00	0.00	0
1	900616	2	1	4	7.28	73	0.04	1.50	1.00	11	0.00	0.00	0
1	900616	6	1	7	19.00	132	0.09	1.71	0.57	33	0.00	0.00	0
1	900618	4	1	4	5.53	45	0.03	1.00	1.33	6	0.00	0.00	0
1	900618	5	1	1	1.48	61	0.01	3.00	0.00	4	0.00	0.00	0
1	900620	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900620	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900622	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900622	2	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900624	1	1	5	7.83	34	0.08	7.60	36.30	60	0.20	0.20	2
1	900624	2	1	14	24.93	57	0.19	2.93	2.42	73	0.14	0.13	4
1	900626	5	1	43	93.17	105	0.48	4.19	9.66	390	0.88	1.30	82
1	900626	6	1	27	64.06	140	0.26	2.61	5.33	167	0.30	0.37	19
1	900628	1	1	1	1.06	1	0.06	7.00	0.00	7	1.00	0.00	1
1	900628	6	1	10	13.75	39	0.10	2.90	3.21	40	0.50	0.28	7
1	900630	2	1	17	32.89	57	0.28	4.26	15.19	140	0.24	0.19	8
1	900630	6	1	13	23.71	56	0.19	2.38	1.71	57	0.23	0.19	5
1	900702	3	1	37	49.01	25	0.48	2.85	4.94	140	0.59	1.03	29
1	900702	5	1	18	31.25	81	0.16	5.78	7.71	181	1.94	0.88	61
1	900704	5	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900704	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900706	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900706	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900708	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900708	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900710	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900710	5	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900712	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900714	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900714	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900716	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900716	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900718	3	1	1	1.00	0	0.02	4.00	0.00	4	0.00	0.00	0
1	900718	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900720	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900720	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900722	2	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900722	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900724	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900724	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0

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Appendix A1. (Page 2 of 8).

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	900726	3	1	4	7.09	78	0.04	2.00	1.33	14	0.00	0.00	0
1	900726	5	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900728	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900728	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900730	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900730	6	1	5	5.35	9	0.04	3.40	4.80	18	1.60	2.30	9
1	900801	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900801	5	1	3	4.89	58	0.03	1.50	0.00	7	0.00	0.00	0
1	900803	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900803	6	1	3	3.42	15	0.03	4.00	0.00	14	0.33	0.33	1
1	900805	2	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900805	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900807	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900807	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900809	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900809	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900811	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
1	900811	2	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
2	900619	4	1	43	50.17	9	0.80	2.98	3.26	149	0.51	0.83	26
2	900619	5	1	38	50.42	17	0.73	2.45	3.28	123	0.18	0.21	9
2	900624	3	1	80	82.96	3	0.99	3.51	4.87	291	0.41	0.68	34
2	900624	4	1	55	57.95	3	0.98	4.70	12.15	272	0.73	0.87	42
2	900629	4	1	97	99.00	2	1.00	4.02	7.02	398	0.64	1.13	63
2	900629	5	1	63	63.00	0	0.97	4.30	7.85	271	0.68	0.96	43
2	900704	3	1	1	1.00	0	0.01	1.00	0.00	1	0.00	0.00	0
2	900704	4	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
2	900709	2	1	20	25.24	11	0.48	2.83	2.11	71	0.55	0.68	14
2	900709	4	1	9	10.02	7	0.15	1.67	0.75	17	0.00	0.00	0
2	900714	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
2	900714	6	1	2	2.00	0	0.06	1.00	0.00	2	0.00	0.00	0
2	900719	4	1	11	16.87	8	0.73	2.91	2.49	49	0.73	1.02	12
2	900719	5	1	18	18.00	0	0.56	1.36	1.20	25	0.00	0.00	0
2	900724	2	1	54	65.66	19	0.61	2.87	1.56	188	1.81	1.70	119
2	900724	5	1	9	9.47	5	0.09	5.33	7.75	51	0.00	0.00	0
2	900729	5	1	3	3.16	4	0.04	2.17	0.58	7	2.33	1.33	7
2	900729	6	1	4	4.00	0	0.04	2.25	0.08	9	0.75	0.25	3
2	900803	2	1	34	36.31	4	0.58	3.78	2.26	137	2.29	0.94	83
2	900803	3	1	34	35.36	2	0.68	4.72	4.82	167	2.24	1.22	79
2	900808	1	1	9	9.00	0	0.31	1.89	0.86	17	1.89	2.11	17
2	900808	2	1	22	23.50	3	0.50	2.64	1.48	62	1.41	2.25	33
2	900813	3	1	22	24.97	5	0.59	4.32	4.13	108	2.41	1.02	60
2	900813	6	1	18	19.35	6	0.23	3.72	6.92	72	1.67	2.00	32
2	900818	5	1	14	15.35	5	0.27	2.11	1.74	32	0.71	0.68	11
2	900818	6	1	12	12.88	3	0.29	2.17	0.61	28	0.67	0.79	9
3	900621	2	1	3	3.00	0	1.00	1.67	0.08	5	0.00	0.00	0

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Appendix A1. (Page 3 of 8).

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	900621	3	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900626	1	1	7	7.00	0	1.00	2.64	2.98	19	0.43	1.29	3
3	900626	2	1	19	19.00	0	1.00	2.11	0.43	40	0.68	0.89	13
3	900701	2	1	11	11.00	0	1.00	3.55	4.87	39	0.64	1.05	7
3	900701	6	1	18	18.00	0	1.00	2.06	1.26	37	0.39	0.72	7
3	900706	2	1	8	8.00	0	0.57	1.44	1.10	12	0.25	0.50	2
3	900706	5	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900711	1	1	5	5.00	0	1.00	3.90	4.05	20	0.60	0.80	3
3	900711	4	1	7	7.00	0	1.00	4.93	17.62	35	0.43	0.62	3
3	900716	1	1	3	3.00	0	1.00	1.17	0.08	4	0.00	0.00	0
3	900716	2	1	1	1.00	0	1.00	2.00	0.00	2	0.00	0.00	0
3	900721	1	1	2	2.00	0	1.00	1.50	0.50	3	0.00	0.00	0
3	900721	4	1	2	2.00	0	1.00	3.00	8.00	6	0.00	0.00	0
3	900726	3	1	27	27.00	0	1.00	2.28	4.18	62	0.11	0.10	3
3	900726	4	1	8	8.00	0	0.73	4.69	2.78	38	0.13	0.13	1
3	900731	3	1	3	3.00	0	0.75	3.00	1.00	9	0.00	0.00	0
3	900731	6	1	4	4.00	0	0.36	3.25	0.75	13	0.25	0.25	1
3	900805	2	1	10	10.00	0	0.91	1.60	0.54	16	1.40	1.82	14
3	900805	5	1	5	5.00	0	0.45	1.50	0.38	8	0.00	0.00	0
3	900810	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900810	6	1	11	12.00	1	1.00	1.55	0.62	19	0.36	0.25	4
3	900815	3	1	4	4.00	0	1.00	3.50	0.33	14	0.25	0.25	1
3	900815	6	1	3	3.00	0	1.00	2.00	0.00	6	0.00	0.00	0
3	900820	1	1	1	1.00	0	1.00	2.00	0.00	2	0.00	0.00	0
3	900820	4	1	3	3.00	0	1.00	5.00	0.00	15	1.00	3.00	3
4	900617	1	1	3	3.00	0	0.38	0.67	0.33	2	0.33	0.33	1
4	900617	2	1	29	34.44	6	0.91	2.10	2.45	72	0.21	0.31	7
4	900622	2	1	10	10.00	0	0.71	2.90	1.88	29	0.40	0.93	4
4	900622	3	1	40	41.82	2	0.91	3.87	2.86	162	2.22	1.31	93
4	900627	4	1	86	91.00	5	1.00	5.29	9.27	481	0.80	1.31	73
4	900627	5	1	61	68.00	7	1.00	2.96	5.40	201	0.21	0.44	14
4	900702	1	1	25	25.00	0	1.00	2.14	1.41	54	0.20	0.17	5
4	900702	4	1	55	80.00	25	1.00	4.68	6.36	375	1.22	1.47	97
4	900707	2	1	6	6.53	3	0.18	1.75	0.78	11	0.00	0.00	0
4	900707	5	1	7	7.79	6	0.13	1.14	0.89	9	0.00	0.00	0
4	900712	1	1	3	3.00	0	1.00	1.50	0.75	5	0.00	0.00	0
4	900712	3	1	12	13.71	2	0.86	2.75	1.43	38	1.08	1.90	15
4	900717	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900717	3	1	15	17.73	4	0.68	2.03	1.52	36	0.73	1.64	13
4	900722	2	1	6	6.00	0	0.46	1.83	1.67	11	0.17	0.17	1
4	900722	6	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900727	1	1	5	6.00	2	0.50	2.30	0.95	14	1.60	2.30	10
4	900727	2	1	28	30.43	4	0.61	2.70	1.69	82	0.36	0.53	11
4	900801	3	1	44	51.47	9	0.83	2.89	2.31	149	1.34	1.63	69
4	900801	6	1	30	32.69	6	0.45	1.62	1.53	53	0.00	0.00	0

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Appendix A1. (Page 4 of 8).

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
4	900806	1	1	4	4.50	1	0.50	1.50	1.00	7	0.00	0.00	0
4	900806	4	1	35	36.89	2	0.95	4.00	5.59	148	0.86	1.54	32
4	900811	5	1	16	22.77	11	0.62	1.84	1.82	42	0.38	0.25	9
4	900811	6	1	13	16.90	6	0.65	1.92	0.49	33	0.08	0.08	1
4	900816	1	1	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900816	4	1	22	24.00	2	1.00	2.84	3.65	68	1.00	1.81	24
5	900618	5	1	4	4.00	0	0.67	3.50	3.00	14	0.25	0.25	1
5	900618	6	1	6	7.80	3	0.60	3.33	7.87	26	0.00	0.00	0
5	900623	2	1	12	13.00	1	1.00	3.25	3.52	42	0.33	0.79	4
5	900623	4	1	25	30.00	5	1.00	4.18	4.87	125	1.68	1.48	50
5	900628	2	1	22	22.00	0	1.00	2.59	2.71	57	0.23	0.37	5
5	900628	4	1	9	9.00	0	1.00	3.89	4.11	35	0.44	1.03	4
5	900703	2	1	6	6.00	0	0.55	2.08	0.94	13	0.00	0.00	0
5	900703	5	1	3	3.00	0	0.75	2.00	1.00	6	0.00	0.00	0
5	900708	4	1	4	4.00	0	1.00	1.75	0.08	7	0.00	0.00	0
5	900708	6	1	3	3.86	2	0.43	0.83	0.33	3	0.00	0.00	0
5	900713	1	1	2	2.00	0	1.00	1.50	0.50	3	0.00	0.00	0
5	900713	3	1	15	15.00	0	1.00	3.13	1.91	47	0.87	1.55	13
5	900718	3	1	5	7.00	2	1.00	2.80	3.07	20	0.00	0.00	0
5	900718	5	1	9	9.00	0	1.00	3.06	3.34	28	0.00	0.00	0
5	900723	1	1	4	5.00	1	1.00	2.50	0.33	13	2.25	0.92	11
5	900723	2	1	10	12.00	2	1.00	3.10	0.21	37	2.60	0.27	31
5	900728	1	1	16	16.00	0	1.00	1.22	0.33	20	0.38	0.38	6
5	900728	5	1	3	3.00	0	0.33	3.00	0.00	9	0.00	0.00	0
5	900802	4	1	5	5.00	0	1.00	2.10	1.67	11	0.00	0.00	0
5	900802	5	1	11	11.65	1	0.65	1.82	2.21	21	0.27	0.22	3
5	900807	4	1	5	5.00	0	0.71	2.30	0.95	12	0.00	0.00	0
5	900807	5	1	6	6.00	0	1.00	2.00	0.40	12	0.67	0.67	4
5	900812	2	1	7	7.00	0	1.00	2.79	2.74	20	1.43	1.95	10
5	900812	4	1	10	10.00	0	1.00	3.15	4.22	32	0.00	0.00	0
5	900817	1	1	2	2.00	0	1.00	3.00	0.00	6	2.00	2.00	4
5	900817	6	1	3	3.00	0	1.00	2.00	0.00	6	1.67	2.33	5
1	900610	5	2	57	72.14	17	0.89	3.23	5.68	233	0.28	0.53	20
1	900610	6	2	22	24.00	2	1.00	4.36	4.53	105	0.91	1.61	22
1	900612	2	2	24	36.00	12	1.00	4.50	1.91	162	0.63	1.11	23
1	900612	3	2	50	70.00	20	1.00	4.08	6.03	286	0.78	1.07	55
1	900614	2	2	28	58.71	34	0.90	2.79	1.58	164	0.61	0.99	36
1	900614	3	2	70	113.00	43	1.00	3.03	3.42	342	0.30	0.36	34
1	900616	2	2	85	154.72	73	0.96	3.21	2.34	497	0.47	0.56	73
1	900616	6	2	77	209.00	132	1.00	3.57	5.83	746	0.62	1.13	130
1	900618	4	2	116	160.24	45	0.98	4.63	6.90	742	0.88	1.03	141
1	900618	5	2	127	188.00	61	1.00	4.34	6.89	816	0.90	1.08	169
1	900620	3	2	110	120.00	10	1.00	4.24	3.96	508	0.81	1.04	97
1	900620	6	2	141	158.00	17	1.00	4.20	5.42	664	0.84	1.19	132
1	900622	1	2	30	113.00	83	1.00	4.43	5.69	501	1.33	1.89	151

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Appendix A1. (Page 5 of 8).

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	900622	2	2	63	102.00	39	1.00	4.02	4.34	410	0.76	1.15	78
1	900624	1	2	55	86.17	34	0.92	4.45	6.33	383	1.25	1.64	108
1	900624	2	2	64	113.97	57	0.88	3.01	2.67	343	0.56	0.63	64
1	900626	5	2	65	140.83	105	0.72	4.06	8.52	572	0.54	0.91	76
1	900626	6	2	84	199.29	140	0.82	3.81	7.46	759	0.61	0.94	121
1	900628	1	2	16	16.94	1	0.94	3.22	5.57	55	1.06	1.53	18
1	900628	6	2	95	130.62	39	0.91	4.02	7.35	525	0.61	0.92	80
1	900630	2	2	47	90.92	57	0.77	3.28	1.45	298	0.21	0.21	19
1	900630	6	2	62	113.06	56	0.91	4.27	6.60	483	0.71	0.87	80
1	900702	3	2	40	52.99	25	0.52	3.87	5.14	205	0.23	0.33	12
1	900702	5	2	95	164.95	81	0.86	4.15	3.97	685	1.14	1.27	188
1	900704	5	2	113	157.00	44	1.00	4.97	4.54	780	0.93	1.39	146
1	900704	6	2	110	186.00	76	1.00	3.25	3.83	605	0.83	1.25	154
1	900706	3	2	98	115.00	17	1.00	4.28	4.06	492	0.93	1.37	107
1	900706	6	2	109	134.00	25	1.00	4.50	6.49	604	0.66	0.93	89
1	900708	1	2	21	21.00	0	1.00	4.98	16.24	105	0.67	1.23	14
1	900708	6	2	79	88.00	9	1.00	4.35	8.07	383	0.77	0.84	68
1	900710	3	2	27	27.00	0	1.00	3.94	3.79	107	0.26	0.51	7
1	900710	5	2	58	58.00	0	1.00	4.05	4.83	235	0.38	0.52	22
1	900712	6	2	32	36.00	4	1.00	4.45	4.94	160	0.28	0.53	10
1	900714	4	2	109	113.00	4	1.00	4.43	6.98	500	0.32	0.50	36
1	900714	6	2	15	15.00	0	1.00	3.00	2.32	45	0.53	0.55	8
1	900716	3	2	56	59.00	3	1.00	4.05	2.72	239	0.59	0.97	35
1	900716	4	2	67	109.00	42	1.00	5.16	9.18	563	0.48	0.98	52
1	900718	3	2	57	57.00	0	0.98	4.15	4.61	237	0.44	0.79	25
1	900718	6	2	39	55.00	16	1.00	4.67	8.79	257	0.79	1.17	44
1	900720	1	2	6	6.00	0	1.00	5.33	11.87	32	1.33	2.27	8
1	900720	3	2	35	42.00	7	1.00	3.10	1.78	130	0.20	0.34	8
1	900722	2	2	60	89.00	29	1.00	3.39	1.81	302	1.95	1.64	174
1	900722	4	2	154	168.00	14	1.00	4.81	4.51	807	1.64	1.59	275
1	900724	3	2	156	208.00	52	1.00	4.38	3.05	912	2.04	1.47	424
1	900724	6	2	188	209.00	21	1.00	3.64	3.56	761	1.42	1.36	297
1	900726	3	2	99	175.46	78	0.98	4.04	3.66	708	1.03	1.54	181
1	900726	5	2	187	203.00	16	1.00	4.74	7.10	962	1.02	1.41	206
1	900728	1	2	26	32.00	6	1.00	6.12	12.19	196	2.15	1.74	69
1	900728	6	2	238	330.00	92	1.00	4.55	7.60	1,501	1.42	1.49	470
1	900730	3	2	144	166.00	22	1.00	4.52	2.74	750	2.02	1.49	335
1	900730	6	2	126	134.86	9	0.98	3.75	2.98	506	1.62	1.45	218
1	900801	1	2	13	17.00	4	1.00	3.96	10.27	67	2.15	1.81	37
1	900801	5	2	89	145.11	58	0.97	5.07	6.51	735	1.49	1.59	217
1	900803	3	2	86	111.00	25	1.00	4.78	2.31	531	1.44	1.71	160
1	900803	6	2	103	117.58	15	0.97	4.92	12.09	579	1.22	1.35	144
1	900805	2	2	55	78.00	23	1.00	2.94	0.93	229	1.69	1.74	132
1	900805	4	2	140	172.00	32	1.00	4.88	4.64	840	1.58	1.50	272
1	900807	3	2	66	74.00	8	1.00	3.47	2.74	257	1.26	1.27	93

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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	900807	4	2	57	72.00	15	1.00	4.62	3.21	333	1.46	1.36	105
1	900809	1	2	2	2.00	0	1.00	6.00	24.50	12	2.00	2.00	4
1	900809	4	2	69	77.00	8	1.00	4.86	5.06	374	1.55	1.66	119
1	900811	1	2	14	14.00	0	1.00	4.50	11.58	63	2.14	1.52	30
1	900811	2	2	25	27.00	2	1.00	3.50	4.79	95	1.60	1.58	43
2	900619	4	2	20	23.33	9	0.37	5.00	10.84	117	1.15	1.08	27
2	900619	5	2	23	30.52	17	0.44	3.83	5.33	117	0.39	0.34	12
2	900624	3	2	1	1.04	3	0.01	1.00	0.00	1	1.00	0.00	1
2	900624	4	2	1	1.05	3	0.02	1.00	0.00	1	1.00	0.00	1
2	900629	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
2	900629	5	2	2	2.00	0	0.03	3.00	0.00	6	2.00	0.00	4
2	900704	3	2	77	77.00	0	0.99	2.94	3.70	227	0.22	0.33	17
2	900704	4	2	74	74.00	0	1.00	3.86	6.39	286	0.58	0.99	43
2	900709	2	2	28	35.33	11	0.67	3.30	2.14	117	0.21	0.32	8
2	900709	4	2	55	61.21	7	0.89	3.20	2.54	196	0.47	0.88	29
2	900714	1	2	22	27.00	5	1.00	4.05	7.69	109	0.41	0.63	11
2	900714	6	2	32	32.00	0	0.94	4.34	5.72	139	0.41	0.57	13
2	900719	4	2	5	7.67	8	0.33	2.80	5.70	21	0.80	1.20	6
2	900719	5	2	19	19.00	0	0.59	2.61	3.52	50	0.21	0.29	4
2	900724	2	2	35	42.56	19	0.40	3.03	1.40	129	2.49	0.96	106
2	900724	5	2	86	90.53	5	0.91	3.74	4.49	338	0.99	1.21	89
2	900729	5	2	73	76.95	4	0.99	4.94	5.57	380	1.93	1.37	149
2	900729	6	2	103	103.00	0	0.98	4.19	4.25	432	2.06	1.27	212
2	900803	2	2	28	29.90	4	0.47	4.27	2.34	128	2.00	1.11	60
2	900803	3	2	17	17.68	2	0.34	4.68	6.22	83	2.18	1.15	38
2	900808	1	2	23	23.00	0	0.79	3.67	4.90	85	2.35	1.24	54
2	900808	2	2	23	24.57	3	0.52	3.11	1.07	76	1.83	2.06	45
2	900813	3	2	17	19.30	5	0.46	4.50	4.84	87	1.71	1.60	33
2	900813	6	2	62	66.65	6	0.78	3.90	2.94	260	1.42	1.33	95
2	900818	5	2	38	41.65	5	0.73	3.74	4.39	156	0.68	0.98	29
2	900818	6	2	30	32.20	3	0.73	3.38	3.03	109	0.73	0.82	24
3	900621	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900621	3	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900626	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900626	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900701	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900701	6	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900706	2	2	8	8.00	0	0.57	2.31	0.42	19	0.75	1.36	6
3	900706	5	2	10	10.00	0	1.00	3.90	2.49	39	0.20	0.40	2
3	900711	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900711	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900716	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900716	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900721	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900721	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	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
3	900726	3	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900726	4	2	6	6.00	0	0.55	2.67	3.57	16	0.50	1.50	3
3	900731	3	2	1	1.00	0	0.25	2.50	0.00	3	0.00	0.00	0
3	900731	6	2	7	7.00	0	0.64	4.50	2.75	32	0.00	0.00	0
3	900805	2	2	1	1.00	0	0.09	3.00	0.00	3	1.00	0.00	1
3	900805	5	2	7	7.00	0	0.64	3.07	2.29	22	0.00	0.00	0
3	900810	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900810	6	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900815	3	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900815	6	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900820	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
3	900820	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900617	1	2	5	5.00	0	0.63	3.00	1.00	15	0.40	0.80	2
4	900617	2	2	7	8.31	6	0.22	1.86	1.48	15	0.71	0.57	6
4	900622	2	2	7	7.00	0	0.50	3.64	2.39	26	1.43	2.29	10
4	900622	3	2	4	4.18	2	0.09	3.50	1.00	15	2.00	0.67	8
4	900627	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900627	5	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900702	1	2	4	4.00	0	0.16	5.50	8.33	22	0.75	0.92	3
4	900702	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900707	2	2	31	33.74	3	0.91	3.13	3.22	106	0.26	0.60	9
4	900707	5	2	50	55.66	6	0.94	3.63	2.41	202	0.32	0.63	18
4	900712	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900712	3	2	3	3.43	2	0.21	2.33	1.33	8	0.33	0.33	1
4	900717	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900717	3	2	7	8.27	4	0.32	4.29	3.24	35	1.14	2.14	9
4	900722	2	2	7	7.00	0	0.54	3.57	0.62	25	1.43	2.29	10
4	900722	6	2	25	29.00	4	1.00	3.88	4.92	113	1.56	1.67	45
4	900727	1	2	5	6.00	2	0.50	2.10	1.92	13	1.20	0.70	7
4	900727	2	2	21	22.83	4	0.46	3.19	2.69	73	0.76	0.89	17
4	900801	3	2	11	12.87	9	0.21	2.73	1.82	35	0.45	0.87	6
4	900801	6	2	43	46.85	6	0.64	3.12	1.65	146	0.35	0.47	16
4	900806	1	2	4	4.50	1	0.50	5.50	8.33	25	0.50	1.00	2
4	900806	4	2	2	2.11	2	0.05	1.50	0.00	3	0.00	0.00	0
4	900811	5	2	14	19.92	11	0.54	2.61	3.62	52	0.36	0.55	7
4	900811	6	2	7	9.10	6	0.35	3.00	0.33	27	0.29	0.24	3
4	900816	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
4	900816	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900618	5	2	2	2.00	0	0.33	3.50	0.50	7	0.00	0.00	0
5	900618	6	2	4	5.20	3	0.40	2.75	4.92	14	1.25	2.25	7
5	900623	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900623	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900628	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900628	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900703	2	2	5	5.00	0	0.45	3.00	1.00	15	0.80	1.20	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
5	900703	5	2	1	1.00	0	0.25	4.50	0.00	5	0.00	0.00	0
5	900708	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900708	6	2	5	6.43	2	0.71	4.30	7.70	28	0.60	1.80	4
5	900713	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900713	3	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900718	3	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900718	5	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900723	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900723	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900728	1	2	2	2.00	0	0.13	2.50	0.00	5	0.50	0.50	1
5	900728	5	2	6	6.00	0	0.67	3.50	0.60	21	2.00	1.20	12
5	900802	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900802	5	2	6	6.35	1	0.35	4.17	2.17	26	0.67	0.67	4
5	900807	4	2	2	2.00	0	0.29	2.75	1.12	6	2.50	0.50	5
5	900807	5	2	1	1.00	0	0.17	3.00	0.00	3	0.00	0.00	0
5	900812	2	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900812	4	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900817	1	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	0
5	900817	6	2	0	0.00	0	0.00	0.00	0.00	0	0.00	0.00	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. Temporal harvest and effort estimates for the 1990 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	6/10-6/30	21	11	285	217,045	5,994	4,831,783	4,143,582	86	672,262	14	15,939	0
Grayling	6/17-6/30	14	3	1,506	215,498	21,084	11,545,199	11,062,220	96	480,902	4	2,077	0
Rainbow	6/17-6/30	14	2	95	12,880	1,330	1,102,395	1,081,931	98	20,465	2	0	0
Pink salmon	6/17-6/30	14	3	948	574,400	13,272	32,320,949	29,485,853	91	2,833,521	9	1,575	0
Red salmon	6/17-6/30	14	3	300	49,539	4,200	2,754,910	2,543,015	92	211,174	8	721	0
	Total to 6/30					45,880	52,555,236						
Ferry	7/01-7/16	16	8	120	65,966	1,922	1,090,621	1,055,464	97	22,861	2	12,295	1
Grayling	7/01-7/16	16	3	91	33,664	1,456	2,429,990	2,334,063	96	95,571	4	355	0
Rainbow	7/01-7/16	16	4	110	12,478	1,764	607,674	598,950	99	8,724	1	0	0
Pink salmon	7/01-7/16	16	3	491	375,095	7,849	29,344,115	26,006,601	89	3,333,751	11	3,762	0
Red salmon	7/01-7/16	16	3	79	3,716	1,259	321,411	257,643	80	63,763	20	6	0
	Total 7/01-7/16					14,250	33,793,811						
	Early run river					60,130	86,349,047						
Early run confluence effort:													
Ferry	6/10-6/30	21	11	2,616	846,933	54,936	21,455,243	16,168,730	75	5,221,341	24	65,172	0
Grayling	6/17-6/30	14	3	242	120,456	3,388	6,186,009	6,183,399	100	1,008	0	1,602	0
Rainbow	6/17-6/30	14	2										
Pink salmon	6/17-6/30	14	3	71	3,836	994	200,289	196,927	98	3,310	2	52	0
Red salmon	6/17-6/30	14	3	21	1,021	294	54,215	52,401	97	1,492	3	322	1
	Total 6/10-6/30					59,612	27,895,756						
Ferry	7/01-7/16	16	8	2,201	537,941	35,209	17,939,315	8,607,052	48	9,316,967	52	15,296	0
Grayling	7/01-7/16	16	3	1,073	99,235	17,173	7,223,772	6,880,322	95	342,098	5	1,352	0
Rainbow	7/01-7/16	16	4	43	9,919	690	486,186	476,100	98	10,086	2	0	0
Pink salmon	7/01-7/16	16	3	338	385,503	5,402	27,044,253	26,728,187	99	315,456	1	609	0
Red salmon	7/01-7/16	16	3	47	1,868	754	157,980	129,548	82	27,980	18	453	0
	Total 7/01-7/16					59,228	52,851,506						
	Early run confluence					118,840	80,747,262						
	Early run total					178,970	167,096,309						

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Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance components Days	%	Periods	%	Anglers	%
Late run river effort:													
Ferry	7/17-7/31	15	7	16	562	234	16,952	9,631	57	7,047	42	273	2
Grayling	7/17-7/31	15	3	328	173,604	4,926	11,006,049	10,416,258	95	589,064	5	727	0
Rainbow	7/17-7/31	15	3	130	31,565	1,950	1,911,945	1,893,915	99	18,030	1	0	0
Pink salmon	7/17-7/31	15	3	143	17,616	2,144	1,239,615	1,056,966	85	182,412	15	236	0
Red salmon	7/17-7/31	15	3	125	1,026	1,880	85,213	61,587	72	23,483	28	143	0
	Total 7/17-7/31					11,134	14,259,774						
Ferry	8/01-8/10	10	5	13	257	126	5,464	2,566	47	2,898	53	0	0
Grayling	8/01-8/10	10	2	575	228,172	5,746	9,214,194	9,126,868	99	87,105	1	221	0
Rainbow	8/01-8/10	10	2	63	110	631	16,918	4,419	26	12,486	74	14	0
Pink salmon	8/01-8/10	10	2	534	9,979	5,336	1,269,493	399,174	31	869,773	69	546	0
Red salmon	8/01-8/10	10	2	83	301	828	15,484	12,034	78	3,427	22	23	0
	Total 8/01-8/10					12,667	10,521,553						
Grayling	8/11-8/20	10	2	597	346,796	5,971	13,873,266	13,871,834	100	1,180	0	253	0
Rainbow	8/11-8/20	10	2	56	41	555	8,610	1,620	19	6,990	81	0	0
Pink salmon	8/11-8/20	10	2	214	179	2,140	149,862	7,142	5	142,159	95	561	0
Red salmon	8/11-8/20	10	2	95	6,845	945	278,100	273,780	98	4,320	2	0	0
	Total 8/11-8/20					9,611	14,309,838						
	Late run river					33,412	39,091,165						

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Appendix A2. (Page 3 of 5).

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance components: Days	%	Periods	%	Anglers	%
Late run confluence effort:													
Ferry	7/17-7/31	15	7	3,455	1,139,142	51,818	46,749,831	19,528,141	42	27,206,054	58	15,636	0
Grayling	7/17-7/31	15	3	1,350	620,752	20,254	38,668,195	37,245,103	96	1,421,882	4	1,211	0
Rainbow	7/17-7/31	15	3	50	1,305	750	111,210	78,300	70	32,910	30	0	0
Pink salmon	7/17-7/31	15	3	258	29,545	3,876	2,149,658	1,772,703	82	376,319	18	636	0
Red salmon	7/17-7/31	15	3	26	1,521	390	98,940	91,260	92	7,680	8	0	0
	Total 7/17-7/31					77,088	87,777,834						
Ferry	8/01-8/10	10	5	2,374	412,817	23,744	15,638,156	4,128,168	26	11,502,380	74	7,607	0
Grayling	8/01-8/10	10	2	557	10,985	5,567	502,067	439,384	88	62,519	12	164	0
Rainbow	8/01-8/10	10	2	37	2,701	368	118,313	108,045	91	10,268	9	0	0
Pink salmon	8/01-8/10	10	2	314	105,592	3,135	4,606,877	4,223,660	92	382,983	8	234	0
Red salmon	8/01-8/10	10	2	52	1,453	525	79,354	58,130	73	21,208	27	16	0
	Total 8/01-8/10					33,339	20,944,767						
Ferry	8/10-8/12	2	1	473	0	946	11,969	0	0	11,907	99	62	1
Grayling	8/11-8/20	10	2	1,392	714,965	13,916	28,730,318	28,598,582	100	131,005	0	731	0
Rainbow	8/11-8/20	10	2										
Pink salmon	8/11-8/20	10	2	119	28,257	1,189	1,149,442	1,130,282	98	18,217	2	943	0
Red salmon	8/11-8/20	10	2										
	Total 8/10-8/20					16,051	29,891,729						
	Late run confluence					126,478	138,614,330						
	Late run total					159,890	177,705,495						
Early run river harvest:													
Ferry	6/10-6/30	21	11	36	8,119	747	202,877	154,991	76	46,556	23	1,331	1
Grayling	6/17-6/30	14	3	218	5,872	3,052	322,433	301,407	93	20,781	6	244	0
Rainbow	6/17-6/30	14	2	24	1,152	336	100,968	96,768	96	4,200	4	0	0
Pink salmon	6/17-6/30	14	3	193	17,995	2,702	1,242,918	923,757	74	318,953	26	208	0
Red salmon	6/17-6/30	14	3	65	11,202	910	634,664	575,052	91	59,476	9	136	0
	Total 6/10-6/30					7,747	2,503,860						
Ferry	7/01-7/16	16	8	34	5,197	539	98,633	83,158	84	13,720	14	1,754	2
Grayling	7/01-7/16	16	3	14	867	222	66,390	60,116	91	6,166	9	108	0
Rainbow	7/01-7/16	16	4	17	294	264	14,208	14,112	99	96	1	0	0
Pink salmon	7/01-7/16	16	3	117	24,115	1,877	1,953,466	1,671,956	86	280,594	14	915	0
Red salmon	7/01-7/16	16	3	13	380	208	31,772	26,364	83	5,408	17	0	0
	Total 7/01-/716					3,110	2,164,469						
	Early run river					10,857	4,668,329						

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Appendix A2. (Page 4 of 5).

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance components: Days	%	Periods	%	Anglers	%
Early run confluence harvest:													
Ferry	6/10-6/30	21	11	471	22,730	9,883	711,772	433,943	61	265,380	37	12,448	2
Grayling	6/17-6/30	14	3	45	3036	630	162,644	155,860	96	6,657	4	127	0
Rainbow	6/17-6/30	14	2										
Pink salmon	6/17-6/30	14	3	26	1003	364	52,035	51,504	99	509	1	21	0
Red salmon	6/17-6/30	14	3	7	95	98	6,211	4,880	79	1,183	19	147	2
	Total 6/10-6/30					10,975	932,662						
Ferry	7/01-7/16	16	8	359	25,129	5,741	891,977	402,061	45	486,438	55	3,478	0
Grayling	7/01-7/16	16	3	121	1,591	1,929	146,893	110,325	75	36,360	25	208	0
Rainbow	7/01-7/16	16	4	6	192	96	9,600	9,216	96	384	4	0	0
Pink salmon	7/01-7/16	16	3	31	2,693	491	189,844	186,719	98	2,983	2	142	0
Red salmon	7/01-7/16	16	3	8	34	126	3,418	2,324	68	988	29	106	3
	Total 7/01-7/16					8,383	1,241,732						
	Early run confluence					19,358	2,174,394						
	Early run total					30,215	6,842,723						
Late run river harvest:													
Ferry	7/17-7/31	15	7	4	55	55	1,911	943	49	943	49	26	1
Grayling	7/17-7/31	15	3	142	52,333	2,127	3,571,555	3,139,997	88	431,056	12	502	0
Rainbow	7/17-7/31	15	3	5	56	75	3,525	3,375	96	150	4	0	0
Pink salmon	7/17-7/31	15	3	34	1,177	517	75,975	70,614	93	5,148	7	213	0
Red salmon	7/17-7/31	15	3	48	7,044	727	435,679	422,632	97	13,020	3	27	0
	Total 7/17-7/31					3,501	4,088,645						
Ferry	8/01-8/10	10	5	1	3	7	50	29	58	16	32	5	10
Grayling	8/01-8/10	10	2	319	56,664	3,187	2,275,022	2,266,577	100	8,331	0	115	0
Rainbow	8/01-8/10	10	2	28	418	275	23,172	16,715	72	6,451	28	6	0
Pink salmon	8/01-8/10	10	2	151	6,293	1,510	424,905	251,740	59	172,906	41	259	0
Red salmon	8/01-8/10	10	2	11	3	108	907	122	13	783	86	2	0
	Total 8/01-8/10					5,087	2,724,056						
Grayling	8/11-8/20	10	2	289	106,095	2,890	4,244,238	4,243,809	100	339	0	91	0
Rainbow	8/11-8/20	10	2	6	18	60	1,020	720	71	300	29	0	0
Pink salmon	8/11-8/20	10	2	51	902	508	55,086	36,099	66	18,852	34	135	0
Red salmon	8/11-8/20	10	2	29	5	285	3,210	180	6	3,030	94	0	0
	Total 8/10-8/20					3,743	4,303,554						
	Late run river					12,331	11,116,255						

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Appendix A2. (Page 5 of 5).

Location Exited	Temporal Period	D[a]	d[b]	Mean	Variance	Estimated Total Effort	Estimated Total Variance	Variance components Days	%	Periods	%	Anglers	%
Late run confluence harvest													
Ferry	7/17-7/31	15	7	1,172	298,739	17,577	7,723,944	5,121,248	66	2,597,908	34	4,788	0
Grayling	7/17-7/31	15	3	566	138,637	8,490	8,447,196	8,318,195	98	128,622	2	378	0
Rainbow	7/17-7/31	15	3	3	41	45	2,700	2,430	90	270	10	0	0
Pink salmon	7/17-7/31	15	3	89	6,830	1,339	453,111	409,813	90	43,053	10	245	0
Red salmon	7/17-7/31	15	3	13	380	195	26,445	22,815	86	3,630	14	0	0
	Total 7/17-7/31					27,646	16,653,396						
Ferry	8/01-8/10	10	5	769	67,757	7,692	1,468,357	677,571	46	788,384	54	2,402	0
Grayling	8/01-8/10	10	2	296	2	2,957	16,296	62	0	16,136	99	98	1
Rainbow	8/01-8/10	10	2	2	5	15	210	180	86	30	14	0	0
Pink salmon	8/01-8/10	10	2	37	1,790	367	75,108	71,585	95	3,456	5	67	0
Red salmon	8/01-8/10	10	2	14	3	139	1,398	105	8	1,288	92	5	0
	Total 8/01-8/10					11,170	1,561,369						
Ferry	8/10-8/11	2	1	220	0	440	2,111	0	0	2,091	99	21	1
Grayling	8/11-8/20	10	2	444	165,698	4,442	6,629,585	6,627,936	100	1,435	0	214	0
Rainbow	8/11-8/20	10	2										
Pink salmon	8/11-8/20	10	2	15	425	146	17,761	16,990	96	612	3	160	1
Red salmon	8/11-8/20	10	2										
	Total 8/10-8/20					5,028	6,649,457						
	Late run confluence					43,844	24,864,222						
	Late run total					56,175	35,980,477						

[a] D = days possible in a stratum.

[b] d = days sampled in a stratum

Appendix A3. Daily escapement of sockeye, coho, and chinook salmon through the Russian River weir, 1990.

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
6/16	25			
6/17	8			
6/18	7			
6/19	37			
6/20	0			
6/21	1			
6/22	9			
6/23	1,514			
6/24	3,690			
6/25	2,379			
6/26	3,095			
6/27	1,221			
6/28	298			
6/29	2,140			
6/30	634			
7/01	744			
7/02	635			
7/03	3,511			
7/04	135			
7/05	1,335			
7/06	734			
7/07	240			
7/08	56			
7/09	574			
7/10	1,086			
7/11	803			
7/12	148			
7/13	437			
7/14	79			
7/15	164			
7/16	159			
7/17	180			
7/18	389	400		
7/19	201	605		
7/20	30	412		
7/21	13	141		

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Appendix A3. (Page 2 of 3).

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
7/22	1	97		
7/23	4	1,031		
7/24		6,029		
7/25		190		
7/26		232		
7/27		3,213		
7/28		6,010		
7/29		2,039		
7/30		2,454		
7/31		3,603		
8/01		340		
8/02		2,635		
8/03		1,976		
8/04		3,300		3
8/05		1,380		1
8/06		2,224		2
8/07		1,794		
8/08		2,375		
8/09		3,776		2
8/10		7,302	2	4
8/11		1		
8/12		4,666	3	
8/13		2,826	2	1
8/14		4,443	9	1
8/15		2,511	10	3
8/16		726	8	
8/17		721	17	4
8/18		826		
8/19		745	4	
8/20		2,264	54	2
8/21		2,036	73	9
8/22		90		
8/23		1,545	53	
8/24		824	26	
8/25		0		
8/26		1,800	104	
8/27		0		

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Appendix A3. (Page 3 of 3).

Date	Early Run Sockeye[a]	Late Run Sockeye	Coho	Chinook
8/28		4		
8/29		918	52	1
8/30		323	5	
8/31		646	79	1
9/01		169	6	
9/02		447	113	
9/03		8		
9/04		348	70	
9/05		358	117	
9/06		214	96	
9/07		109	41	
9/08		200[2]		
Totals	26,716	83,336	944	34

[a] From 7/18 through 7/23, early run fish were differentiated from late run fish based on degree of external maturation, i.e., body coloration and kype development.

[b] An estimated 200 sockeye salmon remained downstream from the weir when it was dismantled on 9/08/90.

APPENDIX B

Emergency Order Issued During Early Run Russian River
Sockeye Salmon Fishery, 1990

SPORT FISHING

Emergency Order

ALASKA DEPARTMENT
OF FISH AND GAME

Under Authority of AS 16.05.060

Emergency Order No. 2-RS-1-08-90

Issued at Soldotna, July 2, 1990

Effective Date: 6:00 p.m., July 2, 1990

Expiration Date: December 31, 1990 unless superseded by subsequent emergency order.

EXPLANATION:

This emergency order opens the Kenai-Russian River "Sanctuary" area from a marker below the ferry crossing on the Kenai River to a marker 700 yards upstream on the Russian River at 6:00 p.m., July 2, 1990.

REGULATION:

5 AAC 56.050 (b)(14) therefore is amended to read:

5 AAC 56.050 WATERS CLOSED TO SPORT FISHING.

(b)(14) Russian-Kenai Rivers in the zone between a department marker placed below the ferry crossing on the Kenai River and a department marker placed 700 yards upstream on the Russian River are closed to fishing from June 1 through 5:59 p.m., July 2.

Don W. Collinsworth
Commissioner

by delegation to: David C. Nelson
Area Management Biologist

JUSTIFICATION:

The early run Russian River sockeye salmon escapement goal of 16,500 fish can now be projected. As the spawning escapement is now assured, it is appropriate to liberalize the fishery by permitting anglers the opportunity to harvest sockeye salmon remaining in the "sanctuary area" at the confluence of the Kenai and Russian Rivers.