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ABSTRACT

Creel surveys of selected sport fisheries for chinook salmon *Oncorhynchus tshawytscha* in northern Cook Inlet, Alaska, were conducted during 1990. Roving creel surveys were conducted at Lake Creek, Willow Creek, and for shore anglers at the Little Susitna River. A direct expansion creel survey was conducted at the Little Susitna River for boat anglers. For all the fisheries surveyed, the estimated total angler effort was 121,729 (standard error = 10,247) angler-hours. An estimated 8,529 (standard error = 476) chinook salmon were harvested (fish kept only) by anglers and 9,024 (standard error = 663) chinook salmon were caught (fish kept and fish released). The 1.2, 1.3, and 1.4 age groups were the most abundant in the sport harvests in all streams. The contribution of hatchery-produced chinook salmon to the Willow Creek sport harvest was estimated to be 34%, all originating from 1985, 1986, 1988, and 1989 Willow Creek smolt releases. The entire contribution of hatchery-produced fish occurred in that portion of the sport fishery which occurs at the mouth of Willow Creek; the contribution of hatchery-produced fish to that portion of the fishery upstream of the mouth was zero. The contribution of hatchery-produced fish to the Willow Creek mouth fishery was estimated to be 42.5%. An escapement index of approximately 56,500 chinook salmon was counted in the northern Cook Inlet area. It is not possible at this time to estimate total return or exploitation rate of chinook salmon, as creel surveys and escapement counts were not conducted on all tributaries and an unknown number of chinook salmon are harvested in the mixed stock commercial fisheries of northern Cook Inlet.

KEY WORDS: creel survey, northern Cook Inlet, chinook salmon, *Oncorhynchus tshawytscha*, harvest, catch, effort, escapement counts, population age, hatchery contribution.

INTRODUCTION

The sport fishery for chinook salmon *Oncorhynchus tshawytscha* in northern Cook Inlet is among the largest recreational fisheries in Alaska (Mills 1990). This fishery occurs in tributaries to the Susitna River and other smaller rivers which drain directly into northern Cook Inlet (Figure 1). The areas where the sport fishery occurs can be categorized into three groups: (1) tributaries on the east side of the Susitna River that are accessible from the Parks Highway; (2) remote Susitna and Yentna River tributaries that are not road-accessible and primarily enter the mainstem of these rivers from the west and north; and (3) remote river systems that drain directly into northern Cook Inlet from the north and west.

During the 1960s and 1970s, the sport fishery for chinook salmon in northern Cook Inlet systems was periodically closed because of low escapement. The commercial fishery for chinook salmon returning to northern Cook Inlet systems was closed from 1963 to 1985. These closures helped increase the returns to a level that resource managers felt could once again be exploited. The sport fishery has been open every year since 1979 and a limited commercial fishery in northern Cook Inlet reopened in 1986.

Prior to 1986, only five streams along the Parks Highway were open to sport fishing for chinook salmon. Three of these streams (Willow, Montana, and Caswell creeks) were open only during four weekends from mid-June through early July, while the Talkeetna and Little Susitna rivers were open to continuous fishing from late May to early July. Effort in these fisheries was estimated in angler-days and increased from 9,532 angler-days in 1979 to 31,241 angler-days in 1985 (Hepler and Bentz 1986). During this period, the estimated harvests of chinook salmon by these fisheries ranged from 1,651 fish in 1979 to 4,868 fish in 1984. In 1986, five additional road-accessible streams (Little Willow, Sheep, Goose, Sunshine, and Birch creeks) were opened to chinook salmon fishing during four consecutive weekends beginning with the second weekend in June. In 1987, the entire Susitna River corridor between the mouth of the river and upstream to the confluence of the Talkeetna River was opened to chinook salmon fishing and the weekend fishing period on these streams was extended to include Mondays. The same regulations remained in effect in 1988 for all the streams, although the season on Willow Creek was extended for an additional 3 days by emergency order.

In 1989, regulatory changes extended the Willow Creek fishery to include weekdays until mid-June followed by weekends only until early July. The seasonal bag limit was also removed for all Susitna-West Cook Inlet area chinook salmon sport fisheries. The regulations for 1990 were identical to 1989 with the exception of the season on Willow Creek which was extended by emergency order for 2 additional days.

The number of remote streams open to chinook salmon fishing in the Susitna and Yentna River drainages and in western Cook Inlet has also increased since 1979. From 1979 to 1982, only the Deshka River, Lake Creek, and Alexander Creek were open to chinook salmon fishing (Kubik 1980, 1981; Watsjold 1980, 1981; Hepler and Kubik 1982; Bentz 1982, 1983; and Delaney and Hepler 1983). In 1983, the open area was expanded to include the entire Chuitna and Yentna River drainages (Hepler and Bentz 1984). In 1984, all coastal streams

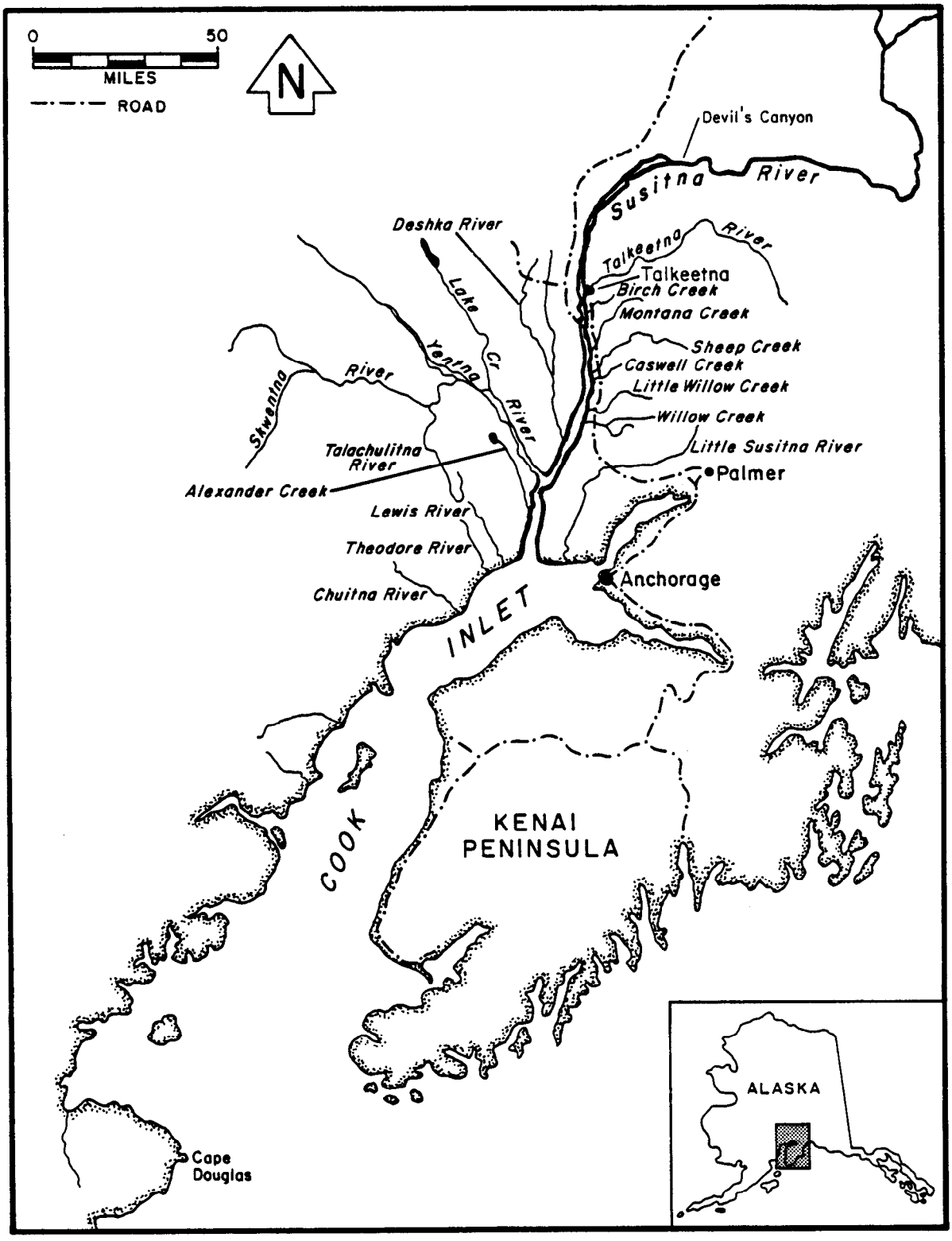

Figure 1. Map of the northern Cook Inlet area.

draining into western Cook Inlet north of Cape Douglas and all tributaries on the west side of the Susitna River downstream of the Deshka River were added to the open area (Figure 1) (Hepler and Bentz 1985). These additional openings increased angler-effort in the remote fisheries from an estimated 13,183 angler-days in 1979 to 22,271 angler-days in 1985 (Hepler and Bentz 1986). During the period 1979 through 1986, the estimated harvests of chinook salmon by these fisheries ranged from 3,166 fish in 1981 to 8,913 fish in 1985 (Hepler and Bentz 1986). In 1987, the upper Susitna River drainage above its confluence with the Talkeetna River was also opened to sport fishing and 1 additional week was added to the fishing season on the remote streams (Hepler et al. 1988). The same regulations remained in effect on all the remote streams in 1989 with the exception of the removal of the seasonal bag limit (Sweet and Webster 1990). There were no regulation changes in 1990.

The objectives of this report are to present:

1. estimates of angler-effort (total number of angler-hours expended) for sport fisheries in Lake Creek, Willow Creek, and the Little Susitna River during 1990;

2. estimates of the harvest (number of fish kept by anglers) and catch (number of fish kept plus number released) of chinook salmon in these streams during 1990;

3. estimates of the sex, age, and length compositions of chinook salmon harvested in these streams;

4. an estimate of angler-effort for chinook salmon in the Yentna and lower Skwentna rivers during the 1990 chinook salmon sport fishery;

5. estimates of the ordinal index of chinook salmon spawning in selected streams in northern Cook Inlet; and

6. estimates of the contribution of hatchery-reared chinook salmon to the sport harvest in Willow Creek.

METHODS

Creel Surveys

Two types of creel surveys, roving and direct expansion, were used in this study. Direct expansion surveys were used in locations where the majority of the anglers exit through one location (i.e., Little Susitna River boat anglers) whereas roving creel surveys were used where anglers can exit at a variety of locations (i.e., Lake Creek, Willow Creek, and Little Susitna River shore anglers). The sample design and methods of analysis for each survey are described below.

Lake Creek:

The entire drainage of Lake Creek was open to fishing for chinook salmon from 1 January to 13 July. Physical barriers within the river, however, restricted the majority of the anglers to the lower 3.2 km (2.0 mi) of the river. The survey area, therefore, only included the lower 3.2 km of the stream. Primary access by anglers to this fishery is by floatplane, wheelplane, and riverboat.

The following effort, catch, and harvest information was collected from each angler interviewed: completed-trip or incompleted-trip angler; number of hours fished; number of fish harvested (kept) and number of fish released, by species; whether the angler was guided or unguided; and whether the angler used a boat in his/her fishing effort. Additionally, anglers at Lake Creek were asked if they fished upstream or downstream of King Point Lodge.

Effort, Catch, and Harvest. A roving-type creel survey (Neuhold and Lu 1957) was used to obtain angler effort, catch, and harvest. The fishery was sampled using a stratified three-stage survey design. Strata were defined by weekly period (Monday-Sunday) during the 4 June through 13 July 1990 time period. Within each stratum, days were sampled at random and represent the first stage of sampling. Within each sampled day, sample periods were selected at random and represent the second sampling stage. Within each selected sample period, multiple random-systematically chosen angler counts were conducted and represent the third sampling stage for the angler count data. For the angler interview data, the anglers sampled for interviewing represent the third stage, for catch per unit effort (CPUE) or harvest per unit effort (HPUE) sampling.

Estimates of angler effort were obtained by taking a mean of the counts within each sampled period. Within each sampled day the mean counts for each sample period were averaged to obtain a mean of means count for the day.

The estimated daily mean counts were averaged over all days sampled within each stratum, and then expanded by the total number of hours in the stratum. The resulting values represent our total effort estimate for the stratum. These stratum estimates were then combined across strata by addition.

The jackknife approach for estimating CPUE and HPUE within each sample period was used since most other estimators are known to be biased (for use as ratio estimators, i.e., for expansion), and the jackknife estimate has been shown to be less biased and procedures exist for correcting some of this bias (as noted below) (see Cochran 1977, section 6.15, pages 174-177; and Smith 1980). Prior to applying the jackknife procedure, each angler's catch and harvest was weighted by the relative numbers of anglers utilizing the fishery during the interview period (as measured from the angler count). This weighting procedure ensures that each sample period's interview information is proportional to the angler effort at the time of the sample.

Within each sampled day the sample-mean-weighted-jackknife estimates of CPUE and HPUE were averaged to obtain daily mean estimates of CPUE and HPUE. Similarly, the mean daily values were averaged across all days sampled within each stratum to obtain stratum mean estimates of CPUE and HPUE. These

estimates of CPUE and HPUE were then multiplied by the angler effort estimate for the stratum to obtain the estimated catch and harvest, respectively, for the stratum.

A summary of the sampling characteristics follows:

1. Dates: 04 June - 13 July.

2. Strata:

   I = 04-10 June
   II = 11-17 June
   III = 18-24 June
   IV = 25 June-01 July
   V = 02-08 July
   VI = 09-13 July

   Note that strata were additionally defined by sampling areas defined as either downstream (area = 1) or upstream (area = 2) of King Point Lodge.

3. Four of 7 days (Monday through Sunday) were sampled at random during 4 June through 8 July strata; and 3 of 5 days were sampled at random during the 9 through 13 July stratum.

4. Fishing and sampling day:

   4 June through 17 June: 20 hours, 0500 - 0100.
   18 June through 1 July: 24 hours, 0501 - 0500.
   2 July through 13 July: 20 hours, 0500 - 0100.

5. Two, 4-hour periods were sampled at random each sampled day.

6. Three systematic angler counts (each 1 hour and 20 minutes apart, taking 40 minutes to conduct) were taken each period sampled at random (i.e., start time for first count selected at random).

Both completed-trip and incompleted-trip angler interviews were collected. An evaluation of the hypothesis of no difference between CPUE or HPUE by type of trip angler was conducted. This evaluation is necessary in that completed-trip catch and harvest rates are the parameters that need to be estimated to obtain unbiased estimates of catch and harvest by expansion. The test involved a two phase approach. First, a contingency table analysis (using the χ^2 statistic) was used to compare the proportion of incompleted-trip anglers who caught at least one fish with the proportion of completed-trip anglers who caught at least one fish. A series of these tests was conducted for each sampled day. Each test was conducted at an α level of 0.05. If more than 5% of all of these tests were rejected, then we assumed that CPUE (or HPUE) as estimated from incompleted-trip angler interviews was biased.

If less than 5% of these contingency table daily tests were rejected, the second phase of the evaluation was conducted. In the second phase, we conducted a series of tests comparing the daily mean CPUE (or HPUE) from completed-trip versus incompleted-trip anglers for only those anglers with CPUE (or HPUE) greater than 0 (i.e., not including angler interviews who reported catching, or harvesting, no fish). By excluding the 0 CPUE (or 0 HPUE) angler interviews, the population distribution of the CPUE's (or HPUE's) can be assumed to be unimodal and approximately normal[1] and as such the null hypotheses of no difference between mean CPUE by angler type could be tested using the Student's t test. Each daily t test was also conducted at an α level of 0.05. If more than 5% of all of these tests were rejected, then we assumed that CPUE (or HPUE) as estimated from incompleted-trip angler interviews was biased.

If neither the first series of tests (contingency tables) or second series (t tests) indicated more than 5% of the tests rejected, then we could assume that incompleted-trip anglers exhibited a similar catch (or harvest) rate as completed-trip anglers. If this occurred, then we could use both types of angler interviews for catch and harvest estimation. Otherwise, only completed-trip angler interviews were used.

To obtain the estimates of the catch, harvest, and angler effort, the following procedures were followed. First we estimated angler effort from the angler count data by estimating the mean angler count within each sampled period:

$$\bar{x}_{hij} = \frac{\sum_{q=1}^{r_{hij}} x_{hijq}}{r_{hij}} ; \qquad (1)$$

where: x_{hijq} equals the angler count q for sample j during day i within stratum h; and r_{hij} is the number of angler counts conducted within each sample.

Next we estimated the daily mean angler counts:

$$\bar{\bar{x}}_{hi} = \frac{\sum_{j=1}^{p_{xhi}} \bar{x}_{hij}}{p_{xhi}} ; \qquad (2)$$

where: p_{xhi} equals the number of periods sampled for angler counts within each day.

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[1] Note that the normality of these restricted CPUE's and HPUE's was also tested using the Shapiro-Wilk test (D'Agostino 1986).

The stratum mean angler count was then obtained as:

$$\bar{\bar{x}}_h = \frac{\sum_{i=1}^{d_{xh}} x_{hi}}{d_{xh}} ; \quad (3)$$

where: d_{xh} equals number of days sampled for angler counts within stratum *h*.

This mean of means angler count was then expanded by the total number of hours available for sampling to obtain the angler effort estimate (in angler-hours) for each stratum:

$$\hat{E}_h = D_h P_h H_h \bar{\bar{x}}_h ; \quad (4)$$

where: D_h is the number of days within stratum *h*; P_h equals number of total periods that could be sampled within any 1 day in stratum *h*; and H_h is the number of hours within each sampling period for all sample periods within stratum *h* (equal to 4 for this survey).

The variance of the estimated angler effort for the stratum was obtained by noting that the first three terms of equation 4 are constants, and as such the variance is obtained as follows (see Kish 1965, equation 2.8.5, page 60):

$$\hat{V}[\hat{E}_h] = (D_h P_h H_h)^2 \hat{V}[\bar{\bar{x}}_h] ; \quad (5)$$

where:

$\hat{V}[\bar{\bar{x}}_h]$ = estimated variance of the mean-of-means angler count for stratum *h*, obtained by the three-stage variance equation (following the approach outlined by Cochran 1977), omitting the finite population correction (FPC) factor for the third stage units;

$$= (1 - f_{x1h}) \frac{s^2_{x1h}}{d_{xh}} + \frac{f_{x1h}}{d^2_{xh}} \sum_{i=1}^{d_{xh}} \left[(1 - f_{x2hi}) \frac{s^2_{x2hi}}{p_{xhi}} \right] +$$

$$\frac{f_{x1h}}{d^2_{xh}} \sum_{i=1}^{d_{xh}} \left[\frac{f_{x2hi}}{p^2_{xhi}} \sum_{j=1}^{p_{xhi}} \frac{s^2_{x3hij}}{r_{hij}} \right] ; \quad (6)$$

f_{x1h} is the sampling fraction for days (= d_{xh}/D_h); f_{x2hi} is the sampling fraction for periods (= p_{xhi}/P_h);

s^2_{x1h} = the among day variance for the mean angler count estimate;

$$= \frac{\sum_{i=1}^{d_{xh}} (x_{hi} - \bar{\bar{x}}_h)^2}{d_{xh} - 1} ; \quad (7)$$

s^2_{x2hi} = the among period (within day) variance for the mean angler count estimate;

$$= \frac{\sum_{j=1}^{p_{xhi}} (x_{hij} - \bar{x}_{hi})^2}{p_{xhi} - 1} ; \text{ and} \quad (8)$$

s^2_{x3hij} = the within period variance for the mean angler count estimate using the successive differences formula appropriate for systematic samples (adapted from Wolter 1985, equation 7.2.4, page 251);

$$= \frac{\sum_{q=2}^{r_{hij}} \left[x_{hijq} - x_{hij(q-1)} \right]^2}{2 (r_{hij} - 1)} . \quad (9)$$

Next, estimates of CPUE (and HPUE) were obtained. First, catches (and harvests) for each interviewed angler were weighted by:

$$c'_{hijo} = \frac{\bar{x}_{hij}}{\bar{\bar{x}}_{hi}} c_{hijo} ; \quad (10)$$

where: c_{hijo} equals the catch of angler o during sample *j* and day *i* within stratum *h*.

Then using the weighted catches we obtained the jackknife sample estimate of mean CPUE as follows:

$$CPUE'^{*}_{hijk} = \frac{\sum_{\substack{o=1 \\ o \neq k}}^{m_{hij}} c'_{hijo}}{\sum_{\substack{o=1 \\ o \neq k}}^{m_{hij}} e_{hijo}} ; \quad (11)$$

where: m_{hij} equals the number of anglers interviewed within each sampled period; and e_{hijo} is the unweighted effort in hours expended by each interviewed angler.

The jackknife mean CPUE for each sample was then obtained by:

$$\overline{CPUE}'^{*}_{hij} = \frac{\sum_{k=1}^{m_{hij}} CPUE'^{*}_{hijk}}{m_{hij}} . \quad (12)$$

Then the bias correction (adapted from Efron 1982, equation 2.8, page 6) was performed:

$$\overline{CPUE}'^{*\dagger}_{hij} = [\, m_{hij} (\overline{CPUE}'_{hij} - \overline{CPUE}'^{*}_{hij}) \,] + [\, \overline{CPUE}'^{*}_{hij}) \,] ; \quad (13)^2$$

where:

$$\overline{CPUE}'_{hij} = \frac{\sum_{o=1}^{m_{hij}} c'_{hijo}}{\sum_{o=1}^{m_{hij}} e_{hijo}} . \quad (14)$$

The bias-corrected weighted jackknife mean was then averaged over all periods sampled within day *i*;

$$\overline{\overline{CPUE}}'^{*\dagger}_{hi} = \frac{\sum_{j=1}^{p_{chi}} \overline{CPUE}'^{*\dagger}_{hij}}{p_{chi}} ; \quad (15)$$

where: p_{chi} equals the number of periods sampled for angler interviews within each sampled day.

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[2] If the bias correction resulted in a mean value that was less then zero, we used the unbiased corrected value in further calculations.

Then the stratum mean CPUE was obtained by averaging over all days sampled:

$$\overline{\overline{CPUE_{hi}}}'*\dagger = \frac{\sum_{i=1}^{d_{ch}} \overline{\overline{CPUE_{hi}}}'*\dagger}{d_{ch}} ; \qquad (16)$$

where: d_{ch} equals the number of days sampled for angler interviews within each stratum.

This estimated mean CPUE for each stratum was then used to estimate the catch for the stratum by expansion:

$$\hat{C}_h = \hat{E}_h \overline{\overline{CPUE_h}}'*\dagger . \qquad (17)$$

The harvest for each stratum was estimated similarly by substituting the appropriate harvest statistics into equations 10 through 17, above.

The variance of the estimated catch for stratum *h* was obtained by the formula proposed by Goodman (1960) for the variance of a product of independent random variates:

$$\hat{V}[\hat{C}_h] = \hat{E}_h^2 \hat{V}[\overline{\overline{CPUE_h}}'*\dagger] + [\overline{\overline{CPUE_h}}'*\dagger]^2 \hat{V}[\hat{E}_h] - \hat{V}[\overline{\overline{CPUE_h}}'*\dagger] \hat{V}[\hat{E}_h] ; \qquad (18)$$

where:

$\hat{V}[\overline{\overline{CPUE_h}}'*\dagger]$ = estimated variance of the estimated mean bias-corrected weighted jackknife CPUE for stratum *h*, obtained by the three-stage variance equation (following the approach outlined by Cochran 1977), omitting the FPC factor for the third stage units;

$$= (1 - f_{c1h}) \frac{s_{c1h}^2}{d_{ch}} + \frac{f_{c1h}}{d_{ch}^2} \sum_{i=1}^{d_{ch}} \left\{ (1 - f_{c2hi}) \frac{s_{c2hi}^2}{p_{chi}} \right\} +$$

$$\frac{f_{c1h}}{d_{ch}^2} \sum_{i=1}^{d_{ch}} \left\{ \frac{f_{c2hi}}{p_{chi}^2} \sum_{j=1}^{p_{chi}} s_{c3hij}^{2'*} \right\} ; \qquad (19)$$

f_{c1h} is the sampling fraction for days (= d_{ch}/D_h); f_{c2hi} equals the sampling fraction for periods (= p_{chi}/P_h);

$$s^2_{c1h} = \frac{\sum_{i=1}^{d_{ch}} \left(\overline{\overline{CPUE}}'^*_{hi\dagger} - \overline{\overline{\overline{CPUE}}}'^*_{h\dagger} \right)^2}{d_{ch} - 1} ; \quad (20)$$

$$s^2_{c2hi} = \frac{\sum_{j=1}^{p_{chi}} \left(\overline{CPUE}'^*_{hij\dagger} - \overline{\overline{CPUE}}'^*_{hi\dagger} \right)^2}{p_{chi} - 1} ; \text{ and} \quad (21)$$

$s^{2'*}_{c3hij}$ = jackknife estimate of the variance for the jackknifed daily mean CPUE for sample j during day i within stratum h (adapted from Efron 1982, equation 3.2, page 13), note that the bias-corrected values for CPUE were not used in this calculation as bias-corrected CPUE's are not estimable for individual anglers;

$$= \frac{(m_{hij} - 1)}{m_{hij}} \sum_{k=1}^{m_{hij}} (CPUE'^*_{hijk} - \overline{CPUE}'^*_{hij})^2 . \quad (22)$$

Variance estimates for the estimated harvest were obtained by replacing the appropriate harvest statistics (h's and H's) for the catch statistics (c's and C's) in equations 18 through 22, above.

Total angler effort, catch, or harvest across all strata (or select combinations of strata) and the associated variances were obtained by summing (assuming independence of the stratum estimates, see Kish 1965, equation 2.8.7, page 61).

Since our estimates of angler effort, catch, and harvest are estimates of totals, then standard errors (SE's) were obtained by taking square roots of the associated variances.

Catch Rates and Harvest Rates. Catch per unit effort (CPUE) of anglers participating in the 1990 Lake Creek chinook salmon fishery was estimated by the procedures noted below. The estimates obtained by these procedures are reflective of the individual rates experienced by anglers rather than the rates obtained by the harvest and effort estimation procedures (i.e., the jackknifed CPUE's and HPUE's used for expansion purposes)[3].

The estimates of CPUE were again weighted by sample weights. The weighted CPUE for each angler was obtained as follows:

$$CPUE'_{hijo} = w_{hij} \frac{c_{hijo}}{e_{hijo}} ; \quad (23)$$

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[3] As obtained by equation 12 or 13, above.

where:

w_{hij} = sample weight for sample j within day i and stratum h;

$$= \frac{\bar{x}_{hij}}{\bar{\bar{x}}_{hi}} ; \qquad (24)$$

and all other terms are as defined above.

The weighted mean CPUE was estimated for each sample as:

$$\overline{CPUE}'_{hij} = \frac{\sum_{o=1}^{m_{hij}} CPUE'_{hijo}}{m_{hij}} ; \qquad (25)$$

where: m_{hij} is as defined above.

The daily estimates of CPUE were obtained as a mean of mean weighted CPUE:

$$\overline{CPUE}_{hi} = \frac{\sum_{j=1}^{p_{chi}} \overline{CPUE}'_{hij}}{p_{chi}} . \qquad (26)$$

where: p_{chi} is as defined above.

The stratum estimates of CPUE were then obtained as a mean of the daily mean weighted CPUE:

$$\overline{\overline{CPUE}}_{h} = \frac{\sum_{i=1}^{d_{ch}} \overline{CPUE}_{hi}}{d_{ch}} . \qquad (27)$$

where: d_{ch} is as defined above.

To obtain estimates of mean CPUE across all strata, or select combinations of strata, we weighted the individual stratum estimates of CPUE by the relative size of each stratum in terms of the estimated number of angler-trips (following the procedures explained in Cochran 1977, Equation 10.45, page 288), as follows:

$$\overline{\overline{CPUE}} = \sum_{h=1}^{s} \hat{W}_h \overline{\overline{CPUE}}_h ; \qquad (28)$$

where: s equals number of strata to be combined;

$\hat{W}_h$ = estimated relative stratum weight of stratum *h*;

$$= \frac{\hat{A}_h}{\hat{A}} ; \quad (29)$$

$\hat{A}_h$ = estimated number of anglers participating in the fishery within stratum *h*, which was obtained from the ratio of the angler effort estimate to the weighted mean effort expended by interviewed anglers who had completed their trips;

$$= \frac{\hat{E}_h}{\equiv' e_h} ; \quad (30)$$

$\hat{E}_h$ = angler effort estimate (in angler-hours) obtained by the procedures outlined above;

$\equiv' e_h$ = mean of means weighted angler effort for completed-trip anglers interviewed within stratum *h*;

$$= \frac{\sum_{i=1}^{d_{ch}} =' e_{hi}}{d_{ch}} ; \quad (31)$$

$$=' e_{hi} = \frac{\sum_{j=1}^{p_{chi}} _' e_{hij}}{p_{chi}} ; \quad (32)$$

$$_' e_{hij} = \frac{\sum_{o=1}^{m_{hij}} ' e_{hijo}}{m_{hij}} ; \quad (33)$$

$$' e_{hijo} = w_{hij} e_{hijo} ; \text{ and} \quad (34)$$

$\hat{A}$ equals the sum of the total estimated number of anglers participating in the fishery across all strata.

The variance of the across stratum CPUE estimate was obtained by treating the estimated stratum weights as if they were constants (see Kish 1965, equations 2.8.5 and 2.8.7, pages 60 and 61), accordingly our variance estimate is only approximate:

$$\hat{V}[\overline{\overline{CPUE}}] \approx \sum_{h=1}^{s} \hat{W}_h^2 \, \hat{V}[\overline{\overline{CPUE}}_h] \; ; \tag{35}$$

where:

$$\hat{V}[\overline{\overline{CPUE}}_h] = \left[(1 - f_{c1h}) \frac{s_{1h}^2}{d_{ch}} \right] + \left[\frac{f_{c1h}}{d_{ch}^2} \sum_{i=1}^{d_{ch}} (1 - f_{c2hi}) \frac{s_{2hi}^2}{p_{chi}} \right] + \left[\frac{f_{c1h}}{d_{ch}^2} \sum_{i=1}^{d_{ch}} \frac{f_{c2hi}}{p_{chi}^2} \sum_{j=1}^{p_{chi}} \frac{s_{3hij}^2}{m_{hij}} \right] ; \tag{36}$$

where: f_{c1h} and f_{c2hi} are as defined above;

$$s_{1h}^2 = \frac{\sum_{i=1}^{d_{ch}} (\overline{CPUE}_{hi} - \overline{\overline{CPUE}}_h)^2}{d_{ch} - 1} \; ; \tag{37}$$

$$s_{2hi}^2 = \frac{\sum_{j=1}^{p_{chi}} (\overline{CPUE}'_{hij} - \overline{CPUE}_{hi})^2}{p_{chi} - 1} \; ; \text{ and} \tag{38}$$

$$s_{3hij}^2 = \frac{\sum_{o=1}^{m_{hij}} (CPUE'_{hijo} - \overline{CPUE}'_{hij})^2}{m_{hij} - 1} \; . \tag{39}$$

Standard errors were obtained by taking the square roots of the variance estimates.

Assumptions. The assumptions necessary for unbiased point and variance estimates obtained by the procedures outlined above were:

1. no significant fishing effort occurred during the hours not surveyed (i.e., between 0100 and 0500 during the 20 hour sampling day strata);

2. anglers accurately reported their hours of fishing effort and the number of fish released;

3. catch and harvest rates were independent of duration of fishing trip (as per DiCostanzo 1956); and

4. the angler count process was approximately instantaneous, or we assumed that the creel clerk traveled substantially faster than anglers move about the fishery, or exit, or enter.

The above assumptions are most likely valid with the exception of assumption 2. Not all anglers are able to remember the hours of fishing effort and tend to report a number of hours between the length of the trip and the actual number of hours spent fishing on the trip.

Willow Creek:

The section open to fishing for chinook salmon in Willow Creek included all waters within a 0.4 km (0.25 mi) radius of the creek's confluence with the Susitna River and upstream to the Parks Highway. This section was open to fishing 1 January to 19 June and Saturday, Sunday, and Monday only for 2 consecutive weeks commencing on 24 June, with the addition by emergency order of Tuesday and Wednesday, 3 and 4 July. The stream is accessible by road and primary access to the fishery is by vehicle and foot. The majority of anglers fished within 0.8 km (0.5 mi) of the Parks Highway bridge and at the mouth. Relatively few anglers accessed the fishery through other locations. Therefore, the two major access locations that were surveyed are:

(1) the Parks Highway bridge, where anglers either access the creek from the road and fish near the bridge or use the private boat launch near the bridge; and

(2) the head of the trail that leads to the mouth of Willow Creek, where anglers reach the stream by foot and fish in the vicinity of the creek's confluence with the Susitna River. Relatively few anglers access the fishery through other locations.

The following effort, catch, and harvest information was collected from each completed-trip, exiting angler interviewed (incompleted-trip, exiting anglers, were not interviewed): number of hours fished; number of fish harvested (kept) and number of fish released, by species; whether the angler was guided or unguided; and whether the angler used a boat in his/her fishing effort.

A roving-type creel survey (Neuhold and Lu 1957) was conducted to obtain angler effort, catch, and harvest of chinook salmon in the Willow Creek fisheries. The fisheries were sampled using a stratified three-stage survey design. Strata were defined as follows:

Mouth Fishery:

I = 09 June - 15 June;
II = 16 June - 18 June;
III = 23 June - 25 June;
IV = 30 June - 02 July; and
V = 03 July - 04 July.

Parks Highway Fishery:

IV = 30 June - 02 July; and
V = 03 July - 04 July.

Note, that after 18 June this fishery is open by regulation only during the 3-day periods of 0001 hours each Saturday to 2400 hours on Monday. Also, note that during the last three periods the fishery essentially consists of a continuous 24-hour a day (72 continuous hours) fishery. By emergency order, Willow Creek remained open 3 July and 4 July.

Mouth Fishery (Stratum I). During stratum I, 5 of 7 days were sampled at random, without replacement, and represent the first stage of sampling. Within each sampled day, sample periods were selected at random and represent the second sampling stage. Within each selected sample period two random-systematically chosen angler counts were conducted and represent the third sampling stage for the angler count data. For the angler interview data, the anglers sampled for interviewing represent the third stage, for CPUE or HPUE sampling.

Estimates of angler effort were obtained by taking a mean of the counts within each sampled period, and then multiplying (expanding) the mean by the number of hours in the sample period. A jackknife (Efron 1982) estimate of mean CPUE and HPUE was obtained for all anglers interviewed within each sampled period. These estimates of CPUE and HPUE were multiplied by the angler effort estimate for the sample period to obtain the estimated catch and harvest, respectively, for the sample.

Within each sampled day the effort, catch, and harvest estimates for each sample period were used to obtain mean efforts, catches, and harvests for the day. These means were expanded by the number of possible sample periods in the day to obtain the estimated effort, catch, and harvest for the sampled day.

Finally, the estimated daily efforts, catches, and harvests were averaged over all days sampled within each stratum, and then expanded by the number of days in the stratum. The resulting values are our total effort, catch, and harvest estimate for the stratum. These stratum estimates were combined across strata by addition.

A summary of the sampling characteristics follows (for stratum I):

1. Dates: 9-15 June.

2. Five of 7 days are sampled at random.

3. Fishing and sampling day: 24 hours (0001 through 2400).

4. Two, 4-hour periods out of a possible six periods are sampled at random each sampled day.

5. Two systematic angler counts (each 2 hours apart, taking 30 minutes to conduct) are taken each period sampled at random (i.e., start time for first count selected at random).

Angler effort, catch, and harvest, their associated variances, and standard errors were estimated for the creel survey during stratum I using the procedures as presented in Bartlett and Bingham (1991: equations 27-44).

Catch per unit effort (CPUE) of anglers participating in the stratum I 1990 Willow Creek chinook salmon fishery was estimated by the procedures described above for Lake Creek in equations 23 through 39. As noted previously, the estimates obtained by these procedures are reflective of the individual rates experienced by anglers.

Mouth Fishery (Strata II-V) and Parks Highway Bridge Fishery (Strata IV-V). During the last four seasonal strata, the surveys of the two fisheries consisted of two-stage sample surveys. Each 72-hour period (strata II - IV) and the 48-hour period (stratum V) was treated as a continuous fishery. The 72-hour period was divided into 18, 4-hour sample periods. The 48-hour period was divided into 12, 4-hour sample periods. Sample periods were sampled at random during each stratum, and represent the first sampling stage. Within each selected sample period, random-systematically chosen angler counts were conducted and represent the second sampling stage for the angler count data. For the angler interview data, the anglers sampled for interviewing represent the second stage, for CPUE or HPUE sampling.

Estimates of angler effort were obtained by taking a mean of the counts within each sampled period, and then multiplying (expanding) the mean by the number of hours in the sample period. A jackknife (Efron 1982) estimate of mean CPUE and HPUE was obtained for all anglers interviewed within each sampled period. These estimates of CPUE and HPUE were then multiplied by the angler effort estimate for the sample period to obtain the estimated catch and harvest, respectively, for the sample.

The estimated sample efforts, catches, and harvests were averaged over all samples within each stratum, and then expanded by the number of periods in the stratum. The resulting values were the total effort, catch, and harvest estimate for the stratum. These stratum estimates were combined across strata by addition.

A summary of the sampling characteristics follows:

1. Dates: 16-18 June, 23-25 June, 30 June-2 July, 3-4 July.

2. Fishing and sampling period: 72 hours (0001 each Saturday through 2400 on Monday) except for 3-4 July which was 48 hours.

3. Sixteen, 4-hour periods out of a possible 18 periods were sampled at random except for 3-4 July which was sampled 10 of a possible 12 periods.

4. Two systematic angler counts (each 2 hours apart, taking 30 minutes to conduct) were taken each period sampled at random (i.e., start time for first count selected at random).

5. During the temporal components 30 June-2 July and 3-4 July, aerial surveys were conducted to count anglers between the mouth and the highway. The surveyed area did not include the fisheries at the mouth and highway.

Angler effort, catch, and harvest, along with their associated variances and standard errors, were estimated for the creel survey during strata II-V using the following procedures.

The first step involved obtaining the jackknife estimated sample mean of CPUE (or HPUE) as follows:

$$CPUE^{*}_{hij} = \frac{\sum_{\substack{o=1 \\ o \neq j}}^{m_{hi}} c_{hio}}{\sum_{\substack{o=1 \\ o \neq j}}^{m_{hi}} e_{hio}}; \quad (40)$$

where: m_{hi} is the number of anglers interviewed within a sample and stratum; c_{hio} is the angler catch of each interviewed angler within a sample and stratum; and e_{hio} is the angler effort (in hours) of each interviewed angler within a sample and stratum.

The jackknife mean CPUE for sample *i* and stratum *h* was then obtained as:

$$\overline{CPUE}^{*}_{hi} = \frac{\sum_{j=1}^{m_{hi}} CPUE^{*}_{hij}}{m_{hi}}. \quad (41)$$

Then the bias correction was performed:

$$\overline{CPUE}^{*\dagger}_{hi} = [m_{hi} (\overline{CPUE}_{hi} - \overline{CPUE}^{*}_{hi})] + [\overline{CPUE}^{*}_{hi}]; \quad (42)^{6}$$

where:

$$\overline{CPUE}_{hi} = \frac{\sum_{o=1}^{m_{hi}} c_{hio}}{\sum_{o=1}^{m_{hi}} e_{hio}}. \quad (43)$$

The bias-corrected jackknife mean was then expanded by the estimated angler effort for the sample to obtain the estimated catch for sample i and stratum h:

$$\hat{C}_{hi} = \hat{E}_{hi} \overline{CPUE}^{*}_{hi}; \quad (44)$$

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[6] If the bias correction resulted in a mean value that was less then zero, we used the unbiased corrected value in further calculations.

where:

$\hat{E}_{hi}$ = estimated angler effort (in hours) for sample i and stratum h;

$$= H_{hi}\,\bar{x}_{hi}; \tag{45}$$

$\bar{x}_{hi}$ = mean angler count for sample i and stratum h;

$$= \frac{\sum_{q=1}^{r_{hi}} x_{hiq}}{r_{hi}}; \tag{46}$$

where: H_{hi} equals the number of hours in sampling period i and stratum h; r_{hi} equals the total number of angler counts conducted for sample i and stratum h; and x_{hiq} equals the number of anglers counted fishing during count q during sample i and stratum h.

The harvest for the sample was estimated similarly by substituting the appropriate harvest statistics into equations 40 to 46, above.

We obtained estimates of effort, catch, and harvest (represented by Y in the following equations) for each sampling stratum as follows:

$$\bar{\hat{Y}}_h = \frac{\sum_{i=1}^{p_h} \hat{Y}_{hi}}{p_h}; \tag{47}$$

where: $\hat{Y}_{hi}$ equals the estimated sample value for effort (E_{hi}, as obtained from equation 45, above), catch or harvest (C_{hi} or H_{hi}, as obtained from equation 44, above); and p_h is the number of periods sampled within stratum h.

The estimated effort, catch, and harvest for each stratum was obtained by expanding by the number of sampling periods in the stratum:

$$\hat{Y}_h = P_h\,\bar{\hat{Y}}_h; \tag{48}$$

where: P_h equals the number of possible sampling periods within stratum h.

The variance of the estimated catch for stratum h was obtained by the two-stage variance equation (following the approach outlined by Cochran 1977), omitting the FPC factor for the second stage units:

$$\hat{V}[\hat{C}_h] = \left[(1 - f_{1h}) P_h^2 \frac{s_{1h}^2}{p_h} \right] + \left[f_{1h} \frac{P_h^2}{p_h^2} \sum_{i=1}^{p_h} \hat{V}[\hat{C}_{hi}] \right]; \quad (49)$$

where: f_{1h} equals the sampling fraction for periods ($= p_h/P_h$);

$$s_{1h}^2 = \frac{\sum_{i=1}^{p_h} (\hat{C}_{hi} - \hat{C}_h)^2}{p_h - 1}; \quad (50)$$

$$\hat{V}[\hat{C}_{hi}] = \hat{E}_{hi}^2 s_{3hi}^{*2} + (\overline{CPUE}_{hi}^{*\dagger})^2 \hat{V}[\hat{E}_{hi}] - s_{3hi}^{*2} \hat{V}[\hat{E}_{hi}]; \quad (51)$$

$$s_{3hi}^{*2} = \frac{(m_{hi} - 1)}{m_{hi}} \sum_{j=1}^{m_{hi}} (CPUE_{hij}^{*} - \overline{CPUE}_{hi}^{*})^2; \text{ and} \quad (52)$$

$$\hat{V}[\hat{E}_{hi}] = \frac{H_{hi}^2}{r_{hi}} \frac{\sum_{q=2}^{r_{hi}} \left[x_{hiq} - x_{hi(q-1)} \right]^2}{2 (r_{hi} - 1)}. \quad (53)$$

Variance estimates for the estimated harvest were obtained by replacing the appropriate harvest statistics (h's and H's) for the catch statistics (c's and C's) in equations 49 through 53, above.

Stratum estimates of the variance of the angler effort were obtained in a similar manner to those for catch and harvest. The primary difference occurs in the second major term in equation 49:

$$\hat{V}[\hat{E}_h] = \left[(1 - f_{1h}) P_h^2 \frac{s_{1h}^2}{p_h} \right] + \left[f_{1h} \frac{P_h^2}{p_h^2} \sum_{i=1}^{p_h} \hat{V}[\hat{E}_{hi}] \right]; \quad (54)$$

The values for the terms in equation 54 were obtained by replacing the catch statistics (C's) by the appropriate effort statistics (E's) in equation 50. Equation 53 is used as is, in the final term of equation 54.

Catch per unit effort (CPUE) of anglers participating in the strata II-V 1990 Willow Creek chinook salmon fishery was estimated by the procedures noted below. As before, the estimates obtained by these procedures are reflective of the individual rates experienced by anglers.

The estimates of CPUE were again weighted by sample weights. The weighted CPUE for each angler was obtained as follows:

$$CPUE'_{hio} = w_{hi} \frac{c_{hio}}{e_{hio}} ; \quad (55)$$

where:

$$w_{hi} = \frac{\bar{x}_{hi}}{\bar{\bar{x}}_h} ; \quad (56)$$

$$\bar{\bar{x}}_h = \frac{\sum_{j=1}^{p_h} \bar{x}_{hi}}{p_h} ; \quad (57)$$

and all other terms are as defined above.

The weighted mean CPUE was estimated for each sample as:

$$\overline{CPUE}'_{hi} = \frac{\sum_{o=1}^{m_{hi}} CPUE'_{hio}}{m_{hi}} ; \quad (58)$$

where: m_{hi} is as defined above.

The stratum estimates of CPUE were then obtained as a mean of the sample mean weighted CPUE:

$$\overline{CPUE}_h = \frac{\sum_{j=1}^{p_h} \overline{CPUE}'_{hi}}{p_h} . \quad (59)$$

To obtain estimates of mean CPUE across all strata, or select combinations of strata, we weighted the individual stratum estimates of CPUE by the relative size of each stratum in terms of the estimated number of angler-trips, as follows:

$$\overline{CPUE} = \sum_{h=1}^{s} \hat{W}_h \overline{CPUE}_h ; \quad (60)$$

where: s equals number of strata to be combined;

$\hat{W}_h$ = estimated relative stratum weight of stratum h, as obtained from equation 29, above, substituting the following values into equation 29;

$$\hat{A}_h = \frac{\hat{E}_h}{\bar{e}'_h} ; \quad (61)$$

$\hat{E}_h$ = angler effort estimate (in angler-hours) obtained by the procedures outlined above;

$\bar{e}'_h$ = mean of means weighted angler effort for completed-trip anglers interviewed within stratum h;

$$= \frac{\sum_{i=1}^{p_h} \bar{e}'_{hi}}{p_h} ; \quad (62)$$

$$\bar{e}'_{hi} = \frac{\sum_{o=1}^{m_{hi}} e'_{hio}}{m_{hi}} ; \quad (63)$$

$$e'_{hio} = w_{hi}\, e_{hio} \text{ ; and} \quad (64)$$

$\hat{A}$ equals the sum of the total estimated number of anglers participating in the fishery across all strata.

The variance of the across stratum CPUE estimate was obtained by treating the estimated stratum weights as if they were constants, accordingly our variance estimate is only approximate:

$$\hat{V}[\overline{CPUE}] \approx \sum_{h=1}^{s} \hat{W}_h^2\, \hat{V}[\overline{CPUE_h}] ; \quad (65)$$

where:

$$\hat{V}[\overline{CPUE_h}] = \left[(1 - f_{1h}) \frac{s_{1h}^2}{p_h} \right] + \left[\frac{f_{1h}}{p_h^2} \sum_{i=1}^{p_h} \frac{s_{2hi}^2}{m_{hi}} \right] ; \quad (66)$$

f_{1h} is as defined above;

$$s^2_{1h} = \frac{\sum_{i=1}^{P_h} (\overline{CPUE}'_{hi} - \overline{\overline{CPUE}}_h)^2}{P_h - 1}; \text{ and} \quad (67)$$

$$s^2_{2hi} = \frac{\sum_{o=1}^{m_{hi}} (CPUE'_{hio} - \overline{CPUE}'_{hi})^2}{m_{hi} - 1}. \quad (68)$$

Standard errors were obtained by taking the square roots of the variance estimates.

Angler Effort Between the Mouth and Highway. Aerial surveys to count anglers were conducted between the mouth and the highway to provide fishery managers with in-season assessments of angler effort for the area not included in the creel survey. Daily estimates of angler effort were estimated from a two-stage systematic "roving-type" aerial count of anglers fishing between the mouth and the highway bridge. Mean angler counts were expanded by the total number of hours available for sampling to obtain the total angler effort estimate in angler-hours for the temporal components 30 June-2 July and 3-4 July 1990. The survey was not stratified by periods.

Every day was sampled. Days represented the first stage of sampling in this two-stage design. The angling and sampling day was defined between the hours of 0000 and 2400. Two counts were selected at random-systematically oriented-from eight total count times in the sampling day, resulting in four possible start times (from the systematic perspective).

Daily angler effort estimates were obtained for the entire fishery by first averaging the two counts within each day. This mean daily count was then expanded by the number of hours available for sampling within the day (i.e., 24 hours) to obtain the daily estimate of angler effort in angler-hours. Then all of the daily counts were averaged over the 5-day period. This mean of the daily counts was multiplied by the total number of days in the temporal component (i.e., 5 days) to obtain the overall angler effort estimate.

Angler effort and its associated variance and standard errors were estimated for the aerial counts using the following procedures. A systematic-random two-stage estimator was used to estimate both daily angler effort (for sampled days) and the total estimate. Note that both days and counts to conduct within days are sampled systematically. The estimated daily angler effort was obtained as follows:

$$\hat{E}_i = H_i \bar{x}_i; \quad (69)$$

$$\bar{x}_i = \frac{\sum_{q=1}^{r_i} x_{iq}}{r_i}; \quad (70)$$

where: H_i equals the number of hours in day i (16 hours as per schedule); r_i equals the total number of angler counts conducted for day i (scheduled to be 2); and x_{iq} equals the number of anglers counted fishing during count q during day i.

We obtained estimates for the season as follows:

$$\bar{\hat{E}} = \frac{\sum_{i=1}^{d} \hat{E}_i}{d}; \quad (71)$$

where: d equals the number of days sampled within the season.

The estimated seasonal effort was obtained by expanding by the number of days in the season:

$$\hat{E} = D\,\bar{\hat{E}}; \quad (72)$$

where: D equals the number of days in the season.

The variance of the estimated angler effort was obtained by the two-stage variance equation, omitting the FPC factor for the second stage units:

$$\hat{V}[\hat{E}] = \left[(1 - f_1)\, D^2\, \frac{S_1^2}{d} \right] + \left[f_1\, \frac{D^2}{d^2} \sum_{i=1}^{d} S_{2i}^2 \right]; \quad (73)$$

where: f_{1h} equals the sampling fraction for days (= d/D);

S_1^2 = the among day variance for the total angler effort estimate over all days sampled, obtained by using the successive differences formula appropriate for systematic samples (adapted from Wolter 1985, equation 7.2.4, page 251);

$$= \frac{\sum_{i=2}^{d} \left[\hat{E}_i - \hat{E}_{(i-1)} \right]^2}{2(d - 1)}; \text{ and} \quad (74)$$

$$s_{2i}^2 = \frac{H_i^2}{r_i} \frac{\sum_{q=2}^{r_i} \left[x_{iq} - x_{i(q-1)} \right]^2}{2 (r_i - 1)}. \quad (75)$$

Standard error of the angler effort estimate was obtained by taking the square root of the variance estimate.

Assumptions. The assumptions necessary for unbiased point and variance estimates obtained by the procedures outlined above were:

1. anglers accurately reported their hours of fishing effort and the number of fish released;

2. catch and harvest rates were independent of duration of fishing trip (as per DiCostanzo 1956); and

3. the angler count process was approximately instantaneous, or we assumed that the creel clerk traveled substantially faster than anglers move about the fishery, or exit, or enter.

The above assumptions are most likely valid with the exception of assumption 1, as was noted for the Lake Creek survey.

Little Susitna River:

The lower 112 km of the Little Susitna River is open to chinook salmon fishing from 1 January to 13 July. The vast majority of the fishing effort, both shore anglers and boat anglers, access the river at the Burma Road launch site at river kilometer (RK) 45. This is the only boat launch facility on the lower portion of the river where chinook salmon fishing occurs.

A roving-type creel survey (Neuhold and Lu 1957) for shore anglers and a direct expansion creel survey for boat anglers were used to obtain angler effort, catch, and harvest of chinook salmon in the Little Susitna River. The fisheries were sampled using a stratified multi-stage sample survey.

A summary of the temporal components follows:

1. Dates: 04 June- 13 July.

2. Strata:
   I = 04-10 June
   II = 11-17 June
   III = 18-24 June
   IV = 25 June-01 July
   V = 02-08 July
   VI = 09-13 July

Boat Anglers. The following effort, catch, and harvest information was collected from each boat angler interviewed: completed-trip or incompleted-trip angler; number of hours spent fishing; number of fish harvested (kept)

and number of fish released, by species; and whether the angler was guided or unguided. Although incomplete-trip angler interviews were possible, no incomplete-trip anglers were interviewed. Additionally, anglers at the Little Susitna River were asked if they fished below the Burma Road launch, between the Burma Road launch and the ADFG weir, or above the weir.

Effort, catch, and harvest for boat anglers were estimated using a three-stage direct expansion design. This design involved the direct expansion of sampled interview data by expansion factors dependent upon the number of anglers counted (third-stage units), sample periods (second-stage units), and days (first-stage units). Since all anglers counted were interviewed during 1990, the design collapsed to a two-stage design, however estimates were still obtained in a three-stage manner (and were equivalent).

A summary of the sampling characteristics follows:

1. Three of 7 days were sampled at random, during each strata (weekly period).

2. Fishing and sampling day: 16 hours (0800 through 2400).

3. Two, 4-hour periods were sampled at random, within each sampled day.

4. All anglers departing the site were counted and interviewed.

The procedures presented in Bartlett and Bingham (1991: equations 1-10) were used to estimate effort, catch, and harvest for the boat-angler survey.

Estimates of CPUE, HPUE, and their variances were obtained for the direct expansion surveys by the following standard procedures for estimating a stratified 3-stage mean (as presented in Bartlett and Bingham 1991: equations 11-26).

The assumptions necessary for unbiased point and variance estimates of angler effort, catch, harvest, CPUE, and HPUE obtained by the procedures outlined above for the boat-angler survey were:

1. interviewed anglers accurately reported their hours of fishing effort and the number of coho salmon released;

2. no significant fishing effort occurred during the hours not included in the fishing day; and

3. all anglers participating in the fishery exited the fishery through a surveyed access site.

The above assumptions are valid with the exception of assumptions 1 and 3. For assumption 1, not all anglers are able to remember the hours of fishing effort and tend to report a number of hours somewhere between the length of the trip and the actual number of hours spent fishing on the trip. For assumption 3, a portion of boat anglers fishing within the tidal reach of the Little Susitna River exit the fishery through the Port of Anchorage.

Shore Anglers. Within each stratum, days were sampled at random from the days in the week not previously selected for sampling the boat fishery; the days selected represent the first stage of sampling. Within each sampled day, sample periods were selected at random and represent the second sampling stage. Within each selected sample period multiple-systematically chosen angler counts were conducted and represent the third sampling stage for the angler count data. For the angler interview data, the anglers sampled for interviewing represent the third stage, for CPUE or HPUE sampling.

A summary of the sampling characteristics follows:

1. Two of 4 remaining (after sampling the boat fishery) days in each 7-day week (Monday through Sunday) were sampled at random during each strata (weekly period).

2. Fishing and sampling day: 18 hours (0600 through 2400).

3. Only one, 6-hour period was sampled at random within each sampled day.

4. Two systematic angler counts (each 3 hours apart, taking 30 minutes to conduct) were taken each period sampled at random (i.e., start time for first count selected at random).

Shore angler effort, catch, and harvest, their associated variances, and standard errors were estimated using the same procedures described for Willow Creek mouth stratum I (equations 27-44 from Bartlett and Bingham 1991). However, since only one period was sampled within each day, we could not estimate the second stage component of variance. Accordingly, our estimates of variance are biased negatively.

Similarly, catch and harvest rates were accordingly estimated using the same procedures described for Lake Creek and Willow Creek mouth stratum I (equations 23 through 39). However, since only one period was sampled within each day, we could not estimate the second stage component of variance in equation 36. Accordingly, our estimates of variance are biased negatively.

Yentna River-Skwentna River Drainage:

A two-stage systematic "roving-type" aerial count of anglers fishing in the Yentna and Skwentna drainages was conducted in 1990 to provide fishery managers with an in-season assessment of angler effort. The survey area included the Fish Creek area on Kroto Slough, upstream on the Yentna River to 4th of July Creek, and the downstream portion of the Skwentna River from Canyon Creek to 8 Mile Creek (Figure 2). Mean angler counts were expanded by the total number of hours available for sampling to obtain the total angler effort estimate in angler-hours for the 16 June-13 July 1990 period. The survey was not stratified by periods.

Every third day was sampled, with the starting day selected at random. Days represented the first stage of sampling in this two-stage design. The angling and sampling day was defined between the hours of 0600 and 2200. Two (2-hour) counts were selected at random-systematically oriented-from eight

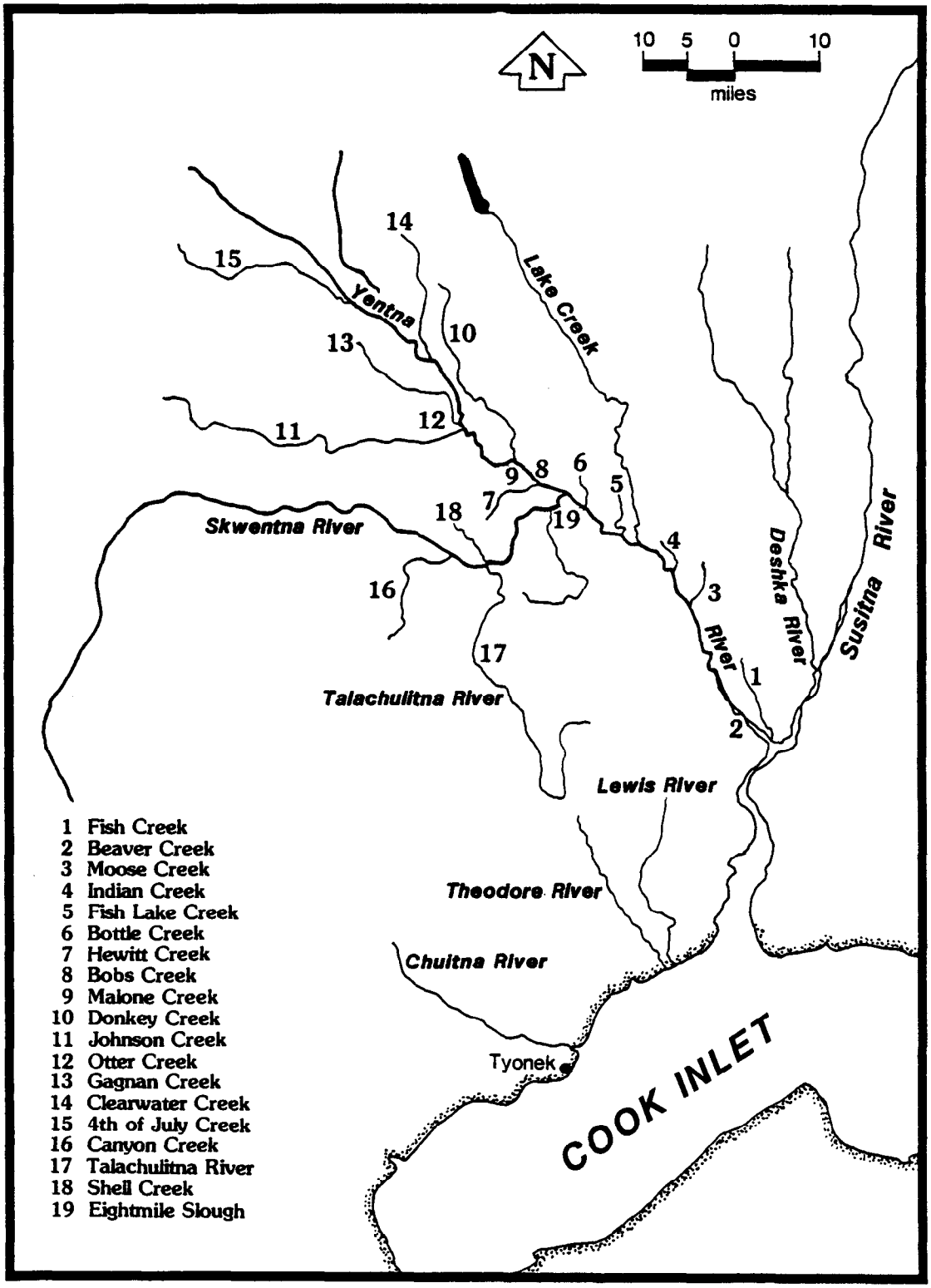

Figure 2. Map of the Yentna River and Skwentna River aerial effort survey locations.

total count times in the sampling day, resulting in four possible start times (from the systematic perspective), each count was 8 hours apart.

Daily angler effort estimates were obtained for the entire fishery by first averaging the two counts within each day. This mean daily count then was expanded by the number of hours available for sampling within the day (i.e., 16 hours) to obtain the daily estimate of angler effort in angler-hours. Then all of the daily counts were averaged over the season. This mean of the daily counts was multiplied by the total number of days in the season (i.e., 28 days) to obtain the season angler effort estimate.

The first flights established the locations frequently utilized by chinook salmon anglers. These locations were marked on an area map (Figure 2). For each location on each flight, the number of anglers actively fishing (angler count), the number of people present not fishing, the number of aircraft, and the number of boats were recorded.

Angler effort and its associated variance and standard errors were estimated using the same procedures described for the Willow Creek aerial counts (equations 69 through 75). A systematic-random two-stage estimator was used to estimate both daily angler effort (for sampled days) and the total estimate.

The assumption necessary for unbiased point and variance estimates of the angler effort for this survey was that the angler count process was approximately instantaneous, or we assumed that the creel clerk traveled substantially faster than anglers move about the fishery, or exit, or enter. Since the counts were done by flying the fishery, we assume that this assumption is valid.

Age, Length, and Sex Sampling

In each fishery, the chinook salmon harvested by the sport fishery were randomly sampled for age, length, and sex information. Three scales were collected on the left side of each fish approximately two rows above the lateral line and on the diagonal row downward from the posterior insertion of the dorsal fin as described in Clutter and Whitesel (1956). Scales were mounted on adhesive-coated cards and impressions were made in cellulose acetate. Age determinations were made by examination of scales using a microfiche reader. Ages were designated using the European method (Koo 1962), where winter checks are counted and the first number refers to the number of years (winters) of freshwater residence after emergence and the second number refers to the number of years (winters) of marine residence. Fish lengths were measured from the middle of the eye to fork of the tail to the nearest 0.5 cm.

Estimates of age composition (proportion) for the subsampled chinook salmon were also calculated. Each proportion was calculated according to the following procedures:

$\hat{p}_{ih}$ = estimated proportion of the sampled chinook salmon harvested that are age i within sampling stratum h;

$$= \frac{n_{ih}}{n_h}; \qquad (76)$$

where: n_{ih} denotes the number of the sampled chinook salmon harvested within sampling stratum *h* that are age *i* and n_h denotes the number of chinook salmon harvested within sampling stratum *h* that are subsampled for lengths;

The estimated proportion by age class (across all strata) was then obtained as follows:

$$\hat{p}_i = \sum_{h=1}^{s} \hat{W}_h \hat{p}_{ih} \qquad (77)$$

where: s is the number of sampling strata;

$\hat{W}_h$ = estimated stratum weight (relative size of harvest in stratum *h* compared to all other strata);

$$= \frac{\hat{H}_h}{\hat{H}}; \qquad (78)$$

where:

$\hat{H}_h$ = estimated harvest of chinook salmon in sampling stratum *h*; and

$\hat{H}$ = total harvest of all chinook salmon in the fishery, across all strata.

The variance of the estimate of p_i is obtained by viewing equation 77, above, as a product of a random variable and a constant, that is, treating the weights as constants. Since we must estimate the size of the harvest in each stratum, then our variance estimates are biased as the weights themselves are estimates. However, since the form of the variance for equation 78 is "intractable", this bias is not currently addressable. As such, the estimated variance was obtained approximately by:

$$\hat{V}[\hat{p}_i] \approx \hat{W}_h^2 \hat{V}[\hat{p}_{ih}] \qquad (79)$$

where:

$\hat{V}[\hat{p}_{ih}]$ = estimated variance of the estimated proportion of age class *i* fish in stratum *h*, obtained approximately by the standard equation for the variance of a binomial proportion (Cochran 1977, equation 3.8, page 52):

$$\approx \left[1 - \frac{n_h}{\hat{H}_h} \right] \frac{p_{ih}\,(1 - p_{ih})}{n_h - 1} \qquad (80)$$

Estimates of mean length by age group of chinook salmon sub-sampled from the sampled harvest were calculated by the procedures outlined in Sokal and Rohlf (1981, Boxes 4.2 and 7.1, pages 56 and 139).

Spawning Escapement Surveys

Chinook salmon spawning in established index streams within the study area were counted using aerial surveys (rotary-wing aircraft), foot surveys, and at a weir located on Deception Creek, a tributary to Willow Creek. Ease of access determined the survey type for each index stream. Surveys were conducted during the peak spawning period which was identified through frequent inspections of spawning activity in index streams. Escapement data reported were the number of fish, both alive and dead, observed during a single survey. No attempt has been made to account for fish not observed due to poor visibility, migrational timing, or decay.

Hatchery Contributions

Willow Creek:

In addition to the age, sex, and length information, creel survey personnel at Willow Creek examined harvested chinook salmon for a missing adipose fin (indicating the presence of a coded-wire tag). Daily records were kept of both the numbers of fish examined for a missing adipose fin as well as the number of fish observed to have a missing adipose fin. Heads were collected from the fish with a missing adipose fin and sent to the Fisheries Rehabilitation and Enhancement Division (FRED) for decoding. Adult chinook salmon were expected to return to Willow Creek from a stocking of 534,447 smolts during 1985; a stocking of 179,138 smolts in 1986; 201,091 in 1988; and 249,885 in 1989. In 1988 and 1989, Montana Creek was also stocked with 132,465 and 185,106 smolts and Sheep Creek with 132,125 and 208,179 smolts (Chlupach 1989).

Hatchery contributions, associated variances, and standard errors for each release group were estimated using the procedures described in Suchanek and Bingham (1990). These procedures essentially follow the approach outlined by Clark and Bernard (1987) as modified by Conrad and Larson (1987).

RESULTS

Creel Survey Estimates

Lake Creek:

Lake Creek was open to sport fishing for chinook salmon from 1 January through 13 July. The creel survey of Lake Creek was conducted from 4 June through 13 July. A total of 2,217 anglers were interviewed during the survey. Only 203 of these interviews were completed-trip angler interviews. Sample by sample comparison of completed- versus incompleted-trip angler CPUE and HPUE indicated that catch and harvest rate estimates were substantially higher as measured from completed-trip interviews (Table 1).

A contingency table analysis comparing individual angler CPUE and HPUE as estimated from incompleted-trip anglers versus completed-trip anglers resulted in rejecting the null hypothesis of no difference in the proportion of anglers catching at least one fish. A total of 16 days sampled during the season had adequate numbers of both types of interviews to conduct these tests. Of the 16 separate comparisons, the null hypothesis was rejected at an α level of 5% a total of 10 times (for both CPUE and HPUE); or 62.5% which was much more than the 5% expected if differences were only due to random variation[7]. Additional contingency table and t tests were conducted in which days were grouped (every 2 and every 3 days), and by filtering out interviews with only short duration angler effort. All of these tests resulted in a similar conclusion.

Effort. The estimated angler-effort during the survey was 41,975 (SE = 2,388) angler-hours (Table 2). Effort peaked during the temporal component of 25 June through 1 July (Table 2, Figure 3). Mean angler counts per period ranged from 2 to 127 in the downstream area and from 0 to 39 in the upstream area (Appendices A1 and A2).

Catch and Harvest. Estimates were calculated for completed-trip angler interview data and for a combination of completed- and incompleted-trip angler interview data. The completed-trip interview data produced catch and harvest estimates of 8,694 (SE = 1,135) and 6,556 (SE = 994) chinook salmon respectively (Table 3). The combined data produced estimates of 3,873 (SE = 393) and 2,882 (SE = 261) catch and harvest respectively (Table 4). The highest catch and harvest per temporal component occurred 18 June through 24 June (Tables 3 and 4, Figure 3). Anglers released 25% of the chinook salmon caught during the Lake Creek fishery.

Catch Rates and Harvest Rates. Catch and harvest rates were calculated for completed-trip interview data and for a combination of completed- and incompleted-trip interview data. Daily catch and harvest rates per period for completed anglers ranged from 0.000 to 0.811 and 0.000 to 0.576 fish per

[7] The Student's t tests further supported our conclusion of differences in CPUE and HPUE according to angler trip type, in that approximately 29% of the possible comparisons were rejected. Additionally, the Shapiro-Wilk test of the normality of the CPUE and HPUE of anglers with at least one fish indicated no significant departure from normality.

Table 1. Tabulation of numbers of completed- versus incompleted-trip angler interviews along with statistics on individual unweighted CPUE and HPUE for the 1990 Lake Creek, Susitna River drainage, Alaska, chinook salmon creel survey.[a]

		Completed trip[a]					Incompleted trip[a]				
		Sample	CPUE		HPUE		Sample	CPUE		HPUE	
Date	Period	size	Mean	SE	Mean	SE	size	Mean	SE	Mean	SE
900605	1	0					16	0.0000	0.0000	0.0000	0.0000
	5	2	0.0000	0.0000	0.0000	0.0000	9	0.0000	0.0000	0.0000	0.0000
900607	1	0					29	0.0230	0.0230	0.0230	0.0230
	3	0					23	0.0000	0.0000	0.0000	0.0000
900608	1	0					36	0.1574	0.1138	0.1574	0.1138
	4	0					34	0.0765	0.0439	0.0608	0.0414
900613	1	0					19	0.0105	0.0105	0.0105	0.0105
	5	3	0.2000	0.0000	0.2000	0.0000	35	0.0371	0.0193	0.0371	0.0193
900614	2	7	0.1905	0.0991	0.1905	0.0991	46	0.1471	0.0430	0.1471	0.0430
	4	6	0.0333	0.0333	0.0333	0.0333	78	0.0950	0.0571	0.0693	0.0364
900615	2	4	0.1429	0.0825	0.1429	0.0825	87	0.0644	0.0191	0.0615	0.0190
	4	0					58	0.0896	0.0362	0.0800	0.0359
900617	1	24	0.1194	0.0271	0.0778	0.0191	104	0.0377	0.0119	0.0326	0.0105
	4	21	0.1350	0.0349	0.1017	0.0296	71	0.0623	0.0176	0.0539	0.0168
900618	1	10	0.3000	0.0382	0.0750	0.0204	53	0.1428	0.0383	0.0965	0.0304
	5	24	0.1677	0.0271	0.1298	0.0237	71	0.1248	0.0308	0.0879	0.0180
900619	2	17	0.0589	0.0249	0.0270	0.0205	112	0.0801	0.0156	0.0647	0.0137
	5	3	0.3333	0.0476	0.2857	0.0000	70	0.0867	0.0163	0.0762	0.0154
900621	1	2	0.0000	0.0000	0.0000	0.0000	83	0.1482	0.0375	0.1241	0.0300
	5	15	0.6306	0.1768	0.4500	0.1748	72	0.1536	0.0223	0.1241	0.0195
900624	4	0					65	0.0438	0.0219	0.0438	0.0219
	6	4	0.3000	0.0577	0.3000	0.0577	14	0.0310	0.0169	0.0310	0.0169
900625	2	16	0.1910	0.0457	0.1076	0.0342	128	0.0907	0.0233	0.0608	0.0184
	6	0					45	0.1922	0.0690	0.1922	0.0690
900627	3	2	0.1304	0.0435	0.1304	0.0435	123	0.0876	0.0199	0.0512	0.0140
	6	0					19	0.0117	0.0117	0.0117	0.0117
900630	1	8	0.2690	0.0534	0.1082	0.0466	50	0.0222	0.0092	0.0175	0.0088
	6	6	0.1667	0.0896	0.0926	0.0446	19	0.0062	0.0062	0.0062	0.0062
900701	3	3	0.0000	0.0000	0.0000	0.0000	62	0.0935	0.0651	0.0179	0.0090
	5	0					70	0.0132	0.0049	0.0128	0.0049
900703	1	11	0.3727	0.0768	0.3364	0.0818	17	0.0560	0.0398	0.0168	0.0115
	3	0					39	0.0503	0.0189	0.0503	0.0189
900706	1	0					27	0.1138	0.0339	0.0926	0.0317
	2	0					40	0.2137	0.1033	0.1823	0.1022
900707	1	5	0.1600	0.0980	0.1600	0.0980	40	0.0518	0.0198	0.0430	0.0160
900708	3	4	0.4167	0.2097	0.4167	0.2097	39	0.0317	0.0154	0.0317	0.0154
	5	0					23	0.0978	0.0603	0.0543	0.0443
900709	2	6	0.0046	0.0046	0.0046	0.0046	39	0.0299	0.0259	0.0299	0.0259
900710	2	0					23	0.1573	0.0928	0.1573	0.0928
900713	2	0					16	0.0313	0.0313	0.0313	0.0313
	4	0					10	0.0000	0.0000	0.0000	0.0000

[a] Table only includes information for which at least one interview was collected.

Table 2. Estimated number of angler-hours of effort during each stratum of the fishery for chinook salmon in Lake Creek, Susitna River drainage, Alaska, 1990.

Stratum		Effort (Angler-hours)	Standard Error	95% Confidence Interval	Relative Precision[a]
I	6/04-6/10	2,698.9	460.5	1,796 - 3,601	33.4%
II	6/11-6/17	9,146.7	638.3	7,896 - 10,398	13.7%
III	6/18-6/24	11,763.5	916.6	9,967 - 13,560	15.3%
IV	6/25-7/01	12,957.0	2,012.8	9,012 - 1,6902	30.4%
V	7/02-7/08	3,502.9	308.5	2,898 - 4,108	17.3%
VI	7/09-7/13	1,905.6	310.9	1,296 - 2,515	32.0%
TOTAL		41,974.6	2,388.1	37,294 - 46,655	11.2%

[a] Relative precision of 95% confidence interval.

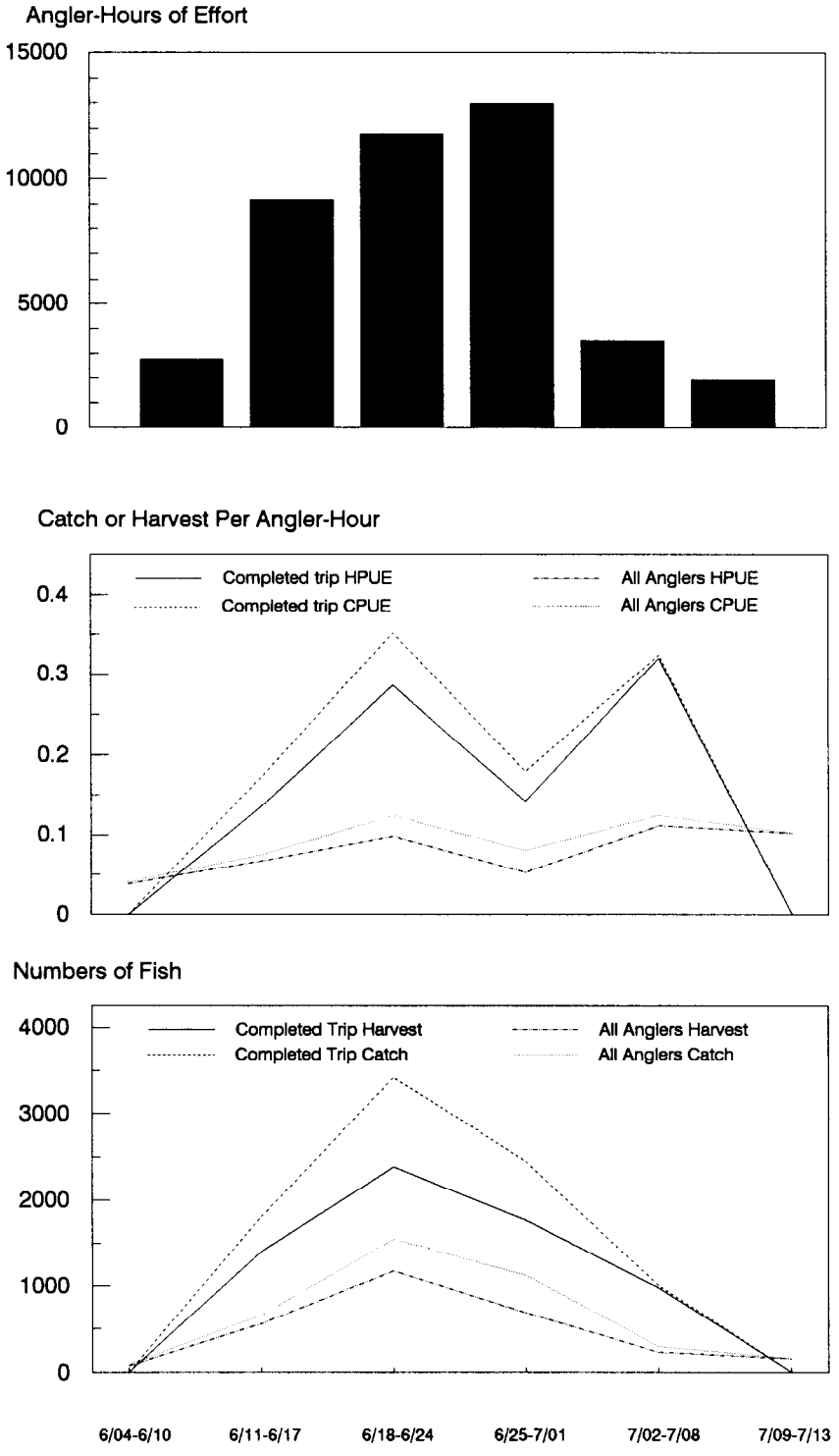

Figure 3. Angler-effort, catch and harvest per unit effort (CPUE and HPUE), and catch and harvest of chinook salmon for completed trip angler interviews and all (completed-trip plus incompleted-trip) angler interviews by stratums of the sport fishery in Lake Creek, Susitna River drainage, Alaska, 1990.

Table 3. Estimated number of chinook salmon harvested[a] and number caught[b] by completed-trip anglers during each stratum of the fishery for chinook salmon in Lake Creek, Susitna River drainage, Alaska, 1990.

Stratum		Harvest[a]	SE	95% Confidence Interval	Catch[b]	SE	95% Confidence Interval
I	6/04-6/10	0	0	0 - 0	0	0	0 - 0
II	6/11-6/17	1,406	309	800 - 2,012	1,811	291	1,240 - 2,382
III	6/18-6/24	2,392	554	1,307 - 3,477	3,423	883	1,692 - 5,154
IV	6/25-7/01	1,772	703	394 - 3,150	2,449	576	1,320 - 3,578
V	7/02-7/08	977	303	383 - 1,571	1,002	302	409 - 1,595
VI	7/09-7/13	9	3	3 - 15	9	3	3 - 15
TOTAL		6,556	994	4,608 - 8,504	8,694	1,135	6,469 -10,919

[a] Harvest includes only fish kept.

[b] Catch includes fish kept and fish reported as released.

Table 4. Estimated number of chinook salmon harvested[a] and number caught[b] by all[c] anglers during each stratum of the fishery for chinook salmon in Lake Creek, Susitna River drainage, Alaska, 1990.

Stratum		Harvest[a]	SE	95% Confidence Interval	Catch[b]	SE	95% Confidence Interval
1	6/04-6/10	75	46	0 - 164	88	55	0 - 195
2	6/11-6/17	561	92	381 - 741	666	107	457 - 875
3	6/18-6/24	1,178	160	864 - 1,492	1,547	253	1,052 - 2,042
4	6/25-7/01	680	160	366 - 994	1,121	259	613 - 1,629
5	7/02-7/08	233	47	141 - 325	296	69	160 - 432
6	7/09-7/13	155	62	34 - 276	155	62	34 - 276
TOTAL		2,882	261	2,371 - 3,393	3,873	393	3,104 - 4,642

[a] Harvest includes only fish kept.

[b] Catch includes fish kept and fish reported as released.

[c] Completed- and incompleted-trip interviews.

hour respectively, (Appendix A3), while catch and harvest rate data ranged from 0.000 to 0.406 and 0.000 to 0.339, respectively (Appendix A4). The temporal period 18 thru 24 June had the highest catch rate while the 2 through 8 July period had the highest harvest rate for completed anglers (Table 5, Figure 3). Combined data produced the highest catch and harvest rates during the 2 to 8 July temporal component (Table 6, Figure 3).

Willow Creek:

Willow Creek was open to sport fishing daily from 1 January through 18 June (the third Monday in June), followed by weekends only for the next two weekends (23-25 June and 30 June to 2 July) with an emergency order extending the season thru 4 July. A roving creel survey was conducted at the stream mouth daily from 9 June to 18 June and weekends from 23 June to 4 July. A roving creel survey was also conducted at the Parks Highway bridge from 30 June to 4 July.

Effort. The estimated effort for all survey sites was 39,114 (SE = 831) angler-hours of which 35,927 (SE = 818) angler-hours (92%) were at the mouth and 3,186 angler-hours (8%) were at the Parks Highway bridge (Table 7). An additional 4,512 (SE = 429) angler-hours were expended on the fishery between the highway and the mouth 30 June thru 4 July (Appendix A5). Also, a small but unmeasured amount of effort occurred at the bridge and between the mouth and bridge before 30 June. Effort at the mouth peaked during the temporal component 30 June thru 4 July with the preceding component only slightly lower (Table 7, Figure 4). Mean angler counts per period ranged from 9 to 227 at the mouth and from 6 to 92 at the Parks Highway bridge (Appendices A6 and A7).

Catch and Harvest. The estimated catch and harvest in Willow Creek during the mouth and highway creel surveys was 4,322 (SE = 265) and 2,789 (SE = 239) fish, respectively (Table 8). The highest catch and harvest per temporal component, 1,531 (SE = 93) and 836 (SE = 52) fish, respectively, occurred at the mouth during the 23 through 25 June period (Table 8, Figure 4). During the Willow Creek fishery, 35% of the chinook salmon caught by anglers were released.

Catch Rates and Harvest Rates. Daily catch and harvest rates per period at the mouth of Willow Creek ranged from 0.000 to 0.367 and 0.000 to 0.310 fish per hour, respectively (Appendices A8 and A9). At the highway bridge, daily catch and harvest rates ranged from 0.000 to 1.563 fish per hour (Appendix A10). The highest catch and harvest rate per temporal component, 0.319 and 0.313 fish per hour, respectively, occurred at the highway bridge from 30 June thru 2 July (Table 9, Figure 4).

Little Susitna River:

The Little Susitna River upstream to the Parks Highway was open to chinook salmon fishing from 1 January to 13 July. During the period of 4 June through 8 July, a direct expansion creel survey of boat anglers was conducted and a roving creel survey of shore anglers was conducted.

Table 5. Estimated harvest and catch rates for completed-trip anglers during each stratum of the fishery for chinook salmon in Lake Creek, Susitna River drainage, Alaska, 1990.

Stratum		Number of Interviews[b]	Harvest Rate[a]	Standard Error	Catch Rate[a]	Standard Error
I	6/04-6/10	2	0.0000	0.0000	0.0000	0.0000
II	6/11-6/17	65	0.1349	0.0297	0.1718	0.0294
III	6/18-6/24	76	0.2863	0.0634	0.3516	0.0939
IV	6/25-7/01	35	0.1419	0.0620	0.1796	0.0430
V	7/02-7/08	21	0.3203	0.1049	0.3238	0.1048
VI	7/09-7/13	9	0.0006	0.0001	0.0006	0.0001
Seasonal Total		208	0.1782	0.0268	0.2101	0.0310

[a] Harvest includes only fish kept and catch includes fish kept and fish reported as released. Rates are number of fish harvested or caught per hour fished for interviewed anglers.

[b] Completed-trip angler interviews only.

Table 6. Estimated harvest and catch rates for all anglers during each stratum of the fishery for chinook salmon in Lake Creek, Susitna River drainage, Alaska, 1990.

Stratum		Number of Interviews[b]	Harvest Rate[a]	Standard Error	Catch Rate[a]	Standard Error
I	6/04-6/10	149	0.0388	0.0278	0.0411	0.0291
II	6/11-6/17	601	0.0667	0.0129	0.0749	0.0137
III	6/18-6/24	617	0.0979	0.0171	0.1245	0.0230
IV	6/25-7/01	592	0.0527	0.0120	0.0806	0.0169
V	7/02-7/08	251	0.1113	0.0261	0.1251	0.0298
VI	7/09-7/13	139	0.1022	0.0362	0.1022	0.0362
Seasonal Total		2,349	0.0745	0.0077	0.0942	0.0096

[a] Harvest includes only fish kept and catch includes fish kept and fish reported as released. Rates are number of fish harvested or caught per hour fished for interviewed anglers.

[b] Completed- and incompleted-trip angler interviews.

Table 7. Estimated number of angler-hours of effort during each stratum of the fishery for chinook salmon in Willow Creek, Susitna River drainage, Alaska, 1990.

Fishery - Location Stratum		Effort (Angler-hours)	Standard Error	95% Confidence Interval		Relative Precision[a]
Willow Creek - Mouth:						
I	6/09-6/15	4,552.8	555.3	3,464 -	5,641	23.9%
II	6/16-6/18	4,806.0	201.7	4,411 -	5,201	8.2%
III	6/23-6/25	10,320.8	347.4	9,640 -	11,002	6.6%
IV	6/30-7/02	10,444.5	286.3	9,883 -	11,006	5.4%
V	7/03-7/04	5,803.2	342.0	5,133 -	6,474	11.6%
	Sub-total	35,927.3	817.7	34,325 -	37,530	4.5%
Willow Creek - Bridge:						
IV	6/30-7/02	2,056.0	117.5	1,826 -	2,286	11.2%
V	7/03-7/04	1,130.4	92.5	949 -	1,312	16.0%
	Sub-total	3,186.4	149.5	2,893 -	3,479	9.2%
Total		39,113.7	831.3	37,484 -	40,743	4.2%
Willow Creek - Between Mouth and Bridge:						
IV	6/30-7/02	4,512	429.0	3,671	5,353	18.6%
GRAND TOTAL		43,626	935.4	41,793	45,459	4.2%

[a] Relative precision of 95% confidence interval.

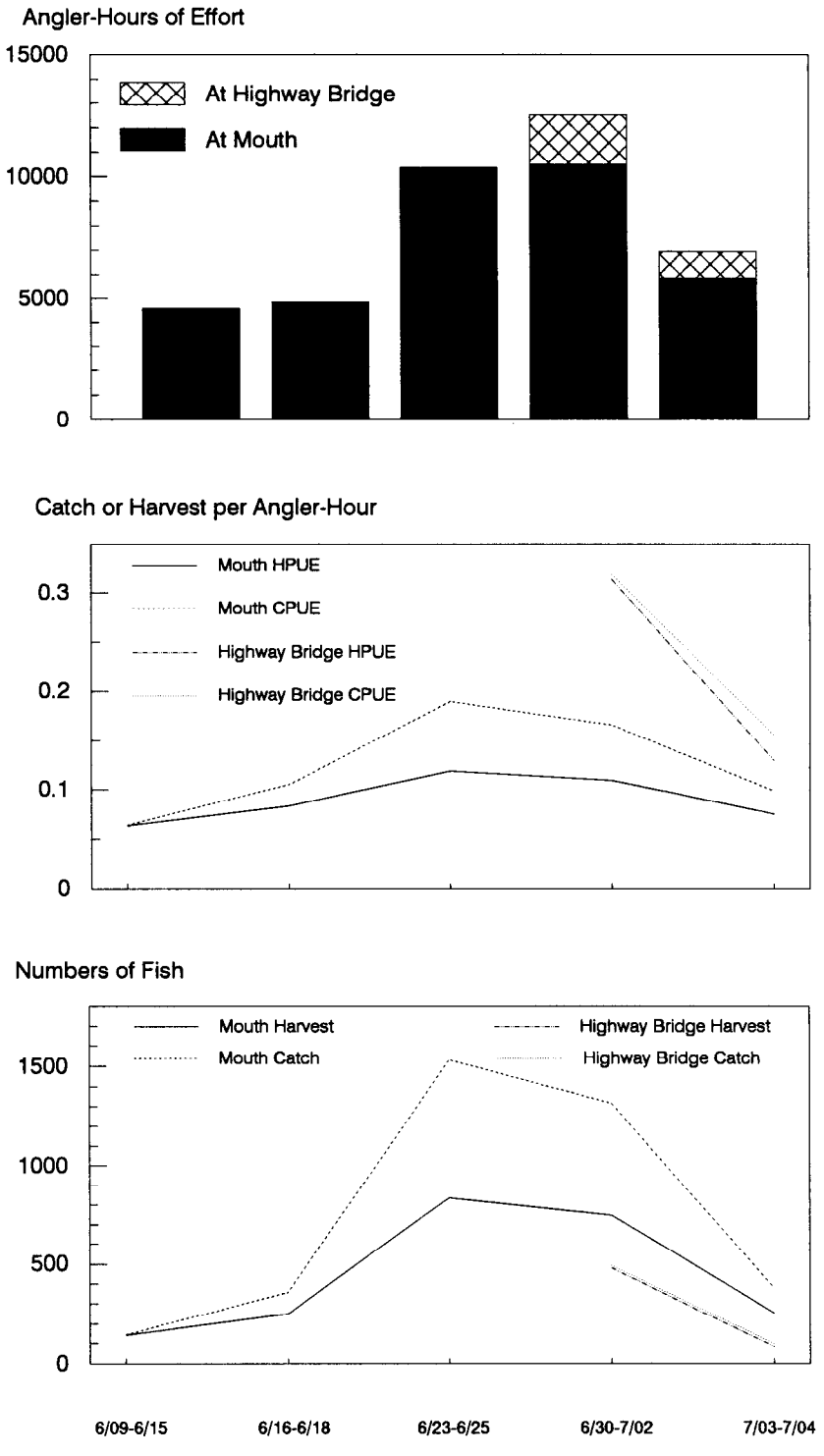

Figure 4. Angler-effort, catch and harvest per unit effort (CPUE and HPUE), and catch and harvest of chinook salmon for stratums of the sport fishery at the mouth and at the highway bridge on Willow Creek, Susitna River drainage, Alaska, 1990.

Table 8. Estimated number of chinook salmon harvested and number caught using each stratum of the fishery for chinook salmon in Willow Creek, Susitna River drainage, Alaska, 1990.

Location Stratum		Harvest[a]	SE	95% Confidence Interval	Catch[b]	SE	95% Confidence Interval
Willow Creek - Mouth							
I	6/09-6/15	143	34	77 - 209	146	33	81 - 211
II	6/16-6/18	251	19	214 - 288	359	30	300 - 418
III	6/23-6/25	836	52	735 - 937	1,531	93	1,349 - 1,713
IV	6/30-7/02	746	41	666 - 826	1,317	87	1,147 - 1,487
V	7/03-7/04	255	24	208 - 302	379	39	302 - 456
	Sub-total	2,231	80	2,055 - 2,407	3,732	140	3,457 - 4,007
Willow Creek - Bridge							
IV	6/30-7/02	478	224	39 - 917	492	224	53 - 931
V	7/03-7/04	80	20	41 - 119	98	22	55 - 141
	Sub-total	558	225	118 - 998	590	225	149 - 1,031
GRAND TOTAL		2,789	239	2,322 - 3,256	4,322	265	3,802 - 4,842

[a] Harvest includes only fish kept.

[b] Catch includes fish kept and fish reported as released.

Table 9. Estimated harvest and catch rates of chinook salmon during each stratum of the fishery for chinook salmon in Willow Creek, Susitna River drainage, Alaska, 1990.

Location Stratum		Number of Interviews[b]	Harvest Rate[a]	Standard Error	Catch Rate[a]	Standard Error
Willow Creek- Mouth						
I	6/09-6/15	337	0.0635	0.0262	0.0641	0.0262
II	6/16-6/18	1,263	0.0829	0.0090	0.1044	0.0101
III	6/23-6/25	1,750	0.1186	0.0080	0.1899	0.0118
IV	6/30-7/02	1,632	0.1092	0.0078	0.1654	0.0111
V	7/03-7/04	888	0.0747	0.0091	0.0986	0.0114
Sub-total		5,870	0.0957	0.0051	0.1377	0.0062
Willow Creek- Bridge						
IV	6/30-7/02	208	0.3131	0.1151	0.3186	0.1151
V	7/03-7/04	290	0.1297	0.0366	0.1553	0.0401
Sub-total		498	0.2494	0.0762	0.2619	0.0764
GRAND TOTAL		6,368	0.0965	0.0213	0.1465	0.0078

[a] Harvest includes only fish kept and catch includes fish kept and fish reported as released. Rates are number of fish harvested or caught per hour fished for interviewed anglers.

[b] Completed-trip angler interviews only.

Effort. Estimated effort by shore anglers during the survey was 7,749 (SE = 1,323) angler-hours (Table 10 and Appendix A11). Estimated effort by boat anglers was 32,712 (SE = 5,267) angler-hours (Table 11 and Appendix A12). Forty-seven percent of the boat angler effort occurred downstream of the Burma Road boat launch, 26% occurred between the launch and the ADFG weir site, and 27% occurred upstream of the weir (Table 12). Peak effort for both shore and boat anglers occurred during the temporal component of 11 thru 17 June (Tables 10 and 11).

Catch and Harvest. The estimated catch and harvest for shore anglers during the creel survey was 57 (SE = 30) fish (Table 13). The highest catch and harvest per temporal component, 24 (SE = 21) fish, occurred 25 June thru 1 July (Table 13, Figure 5). Estimated catch and harvest for boat anglers was 1,829 (SE = 270) and 1,489 (SE = 244) fish, respectively (Table 14). An estimated harvest of 597 (SE = 149) (40%) chinook salmon occurred downstream of the Burma Road boat launch, 355 (SE = 129) (24%) between the launch and the ADFG weir, and 537 (SE = 149) (36%) upstream of the weir (Table 12). The highest catch and harvest per temporal component for all areas combined, 859 (SE = 214) and 682 (SE = 201) fish, respectively, occurred 11 through 17 June (Table 14, Figure 6). Boat anglers released 19% of the chinook salmon caught.

Catch Rates and Harvest Rates. Daily catch and harvest rates for shore anglers ranged from 0.0 to 0.125 fish per hour (Appendix A13). Peak catch and harvest rates per temporal component occurred from 25 June through 1 July (Table 15, Figure 5). Boat angler daily catch and harvest rates per period ranged from 0.0 to 0.305 and 0.0 to 0.274, respectively (Appendix 14). Peak catch and harvest rates per temporal component occurred 11 through 17 June (Table 16, Figure 6).

Yentna River and Skwentna River Drainage:

Total estimated effort during the survey period for the Yentna and Skwentna rivers was 12,668 (SE = 2,153) (Table 17). Angler counts per period ranged from two to 95 (Appendix A15). The Talachulitna River represented the majority of the effort with 33%. Eight Mile Creek was second with 14% and Gagnon Creek third with 13% (Table 17). The total numbers of aircraft, boats, anglers, and people present but not fishing are presented in Appendix A16.

Age, Length, and Sex Sampling

Lake Creek:

Two hundred sixty-nine chinook salmon were sampled for age, length, and sex. Age class 1.4 dominated the harvest at 35.3%, age 1.3 contributed 34.9%, and age 1.2 contributed 23.8%. Mean lengths ranged from 1,047 mm for an age-1.5 fish to 320 mm for an age-1.1 fish (Table 18). The harvest consisted of 59.1% males and 40.9% females (Table 19).

Willow Creek, Mouth:

Four hundred twenty-four chinook salmon were sampled for age, length, and sex. Age class 1.4 dominated the harvest at 49.2%, age 1.3 contributed 16%

Table 10. Estimated number of angler-hours of effort by shore anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Effort (Angler-hours)	Standard Error	95% Confidence Interval	Relative Precision[a]
I	6/04-6/10	1,512.0	355.9	814 - 2,210	46.1%
II	6/11-6/17	1,890.0	587.8	739 - 3,042	61.0%
III	6/18-6/24	3,780.0	1,066.3	1,690 - 5,870	55.3%
IV	6/25-7/01	441.0	373.2	290 - 1.172	165.9%
V	7/02-7/08	126.0	55.0	18 - 234	85.6%
TOTAL		7,749.0	1,323.4	5,155 - 10,343	33.5%

[a] Relative precision of 95% confidence interval.

Table 11. Estimated number of angler-hours of effort by boat anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Effort (Angler-hours)	Standard Error	95% Confidence Interval	Relative Precision[a]
I	6/04-6/10	6,752.7	1,478.9	3,854 - 9,651	42.9%
II	6/11-6/17	16,226.0	4,866.8	5,687 - 25,765	58.8%
III	6/18-6/24	5,469.0	553.3	4,385 - 6,553	20.8%
IV	6/25-7/01	3,883.8	1,244.3	1,445 - 6,322	62.8%
V	7/02-7/08	380.3	95.8	2,727 - 4,875	49.4%
TOTAL		32,711.8	5,266.6	22,389 - 43,034	31.6%

[a] Relative precision of 95% confidence interval.

Table 12. Effort, harvest, and catch by boat anglers on the Little Susitna River, Alaska, downstream of the Burma Road launch, between the launch and the ADFG weir, and upstream of the ADFG weir, 1990.

Location	Effort[a] (Angler-hours)	Standard Error	Harvest	Standard Error	Catch	Standard Error
Downstream of Burma Rd. launch	15,379.0	2,343	597	149	719	188
Between launch and ADFG weir	8,513.2	2,194	355	129	401	125
Upstream of weir	8,642.7	2,571	537	149	709	174
TOTAL	32,534.9	4,113	1,489	247	1,829	285

[a] The total effort when combining the downstream, between and upstream fishing locations does not equal the overall effort in Table 11. For some anglers, the fishing location was not recorded, therefore, the effort could not be designated as downstream, between or upstream of the weir.

Table 13. Estimated number of chinook salmon harvested and number caught by shore anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Harvest[a]	SE	95% Confidence Interval	Catch[b]	SE	95% Confidence Interval
I	6/04-6/10	0	0	0 - 0	0	0	0 - 0
II	6/11-6/17	17	15	0 - 47	17	15	0 - 47
III	6/18-6/24	16	15	0 - 45	16	15	0 - 45
IV	6/25-7/01	24	21	0 - 65	24	21	0 - 65
V	7/02-7/08	0	0	0 - 0	0	0	0 - 0
TOTAL		57	30	0 - 116	57	30	0 - 116

[a] Harvest includes only fish kept.

[b] Catch includes fish kept and fish reported as released.

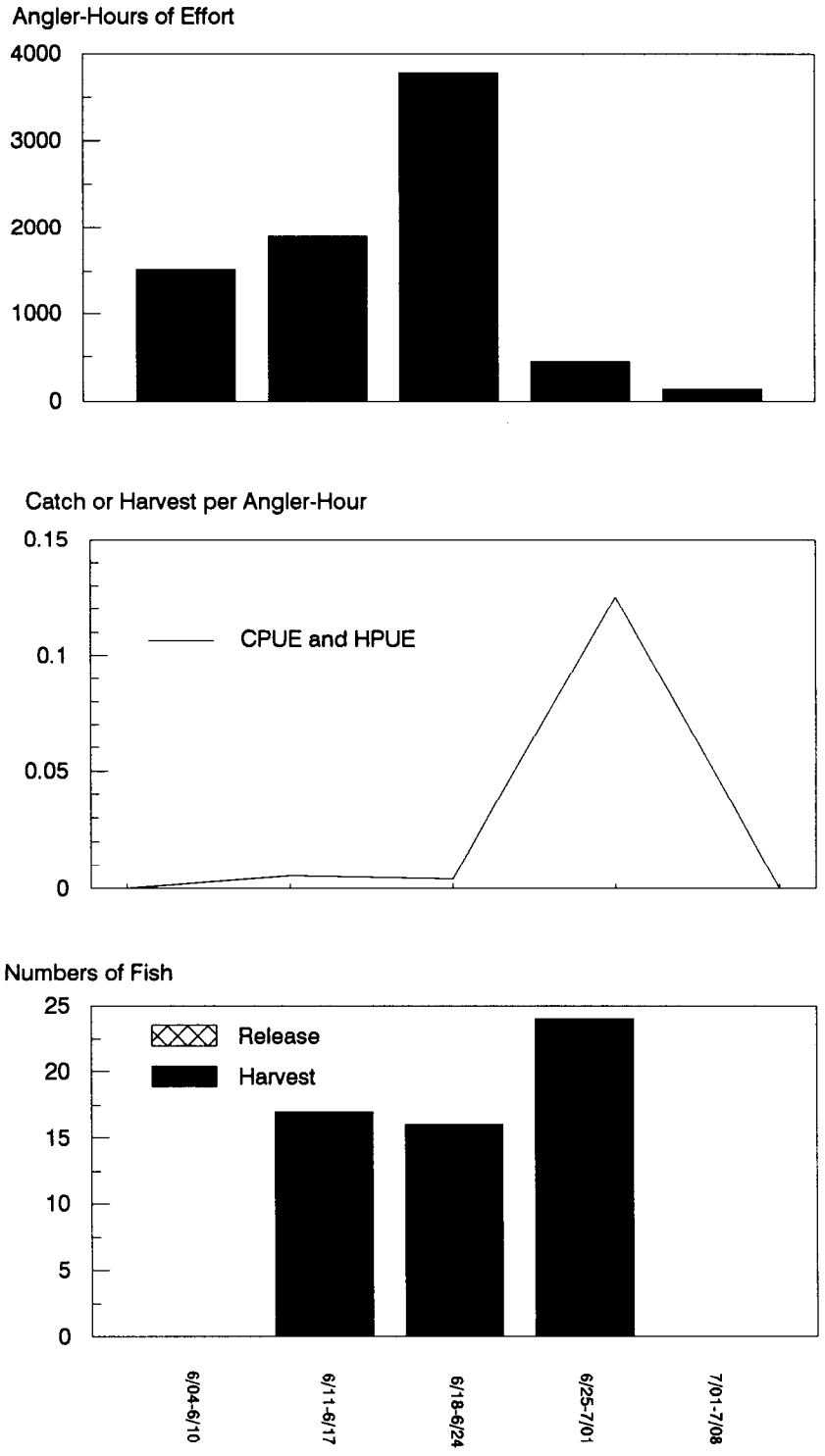

Figure 5. Angler-effort, catch and harvest per unit effort (CPUE and HPUE), and catch and harvest of chinook salmon in the Little Susitna River, Alaska, for temporal components of the sport fishery by shore anglers exiting the fishery at the Burma Road access, 1990.

Table 14. Estimated number of chinook salmon harvested and number caught by boat anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Harvest[a]	SE	95% Confidence Interval	Catch[b]	SE	95% Confidence Interval
I	6/04-6/10	387	120	152 - 622	448	145	164 - 732
II	6/11-6/17	682	201	288 - 1,074	859	214	440 - 1,278
III	6/18-6/24	285	56	175 - 395	368	61	249 - 489
IV	6/25-7/01	121	42	38 - 204	140	49	43 - 237
V	7/02-7/08	14	8	1 - 29	14	8	1 - 29
TOTAL		1,489	244	1,009 - 1,967	1,829	270	1,301 - 2,359

[a] Harvest includes only fish kept.

[b] Catch includes fish kept and fish reported as released.

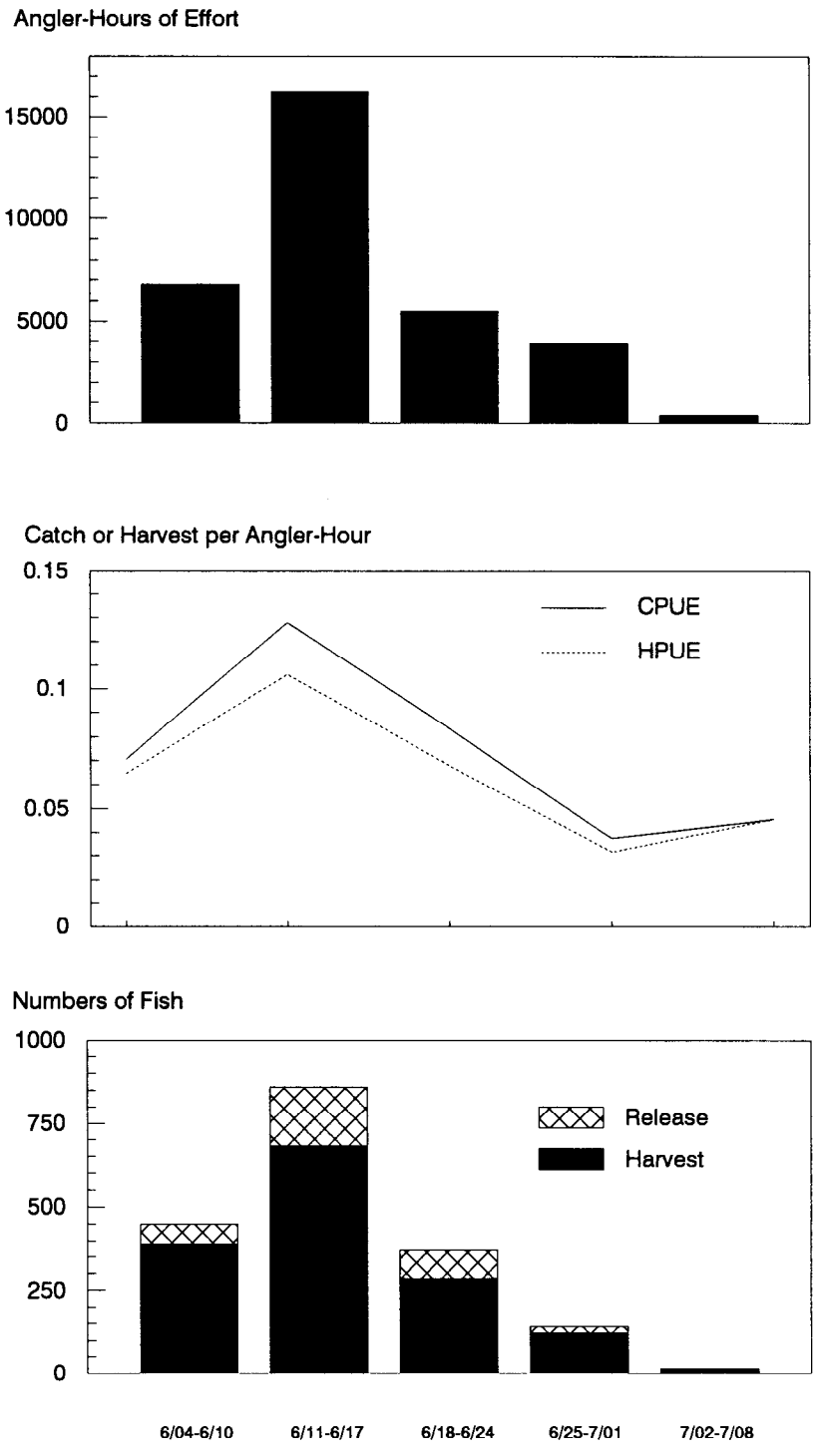

Figure 6. Angler-effort, catch and harvest per unit effort (CPUE and HPUE), and catch and harvest of chinook salmon in the Little Susitna River, Alaska, for temporal components of the sport fishery by boat anglers exiting the fishery at the Burma Road access, 1990.

Table 15. Estimated harvest and catch rates for shore anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Number of Interviews[b]	Harvest Rate[a]	Standard Error	Catch Rate[a]	Standard Error
I	6/04-6/10	24	0.0000	0.0000	0.0000	0.0000
II	6/11-6/17	44	0.0054	0.0048	0.0054	0.0048
III	6/18-6/24	62	0.0042	0.0037	0.0042	0.0037
IV	6/25-7/01	12	0.1250	0.0196	0.1250	0.0196
V	7/02-7/08	9	0.0000	0.0000	0.0000	0.0000

[a] Harvest includes only fish kept and catch includes fish kept and fish reported as released. Rates are number of fish harvested or caught per hour fished for interviewed anglers.

[b] Completed-trip angler interviews only.

Table 16. Estimated harvest and catch rates for boat anglers during each stratum of the fishery for chinook salmon in the Little Susitna River, Alaska, 1990.

Stratum		Number of Interviews[b]	Harvest Rate[a]	Standard Error	Catch Rate[a]	Standard Error
I	6/04-6/10	528	0.0648	0.0268	0.0706	0.0262
II	6/11-6/17	934	0.1060	0.0374	0.1279	0.0447
III	6/18-6/24	280	0.0678	0.0139	0.0834	0.0140
IV	6/25-7/01	121	0.0319	0.0075	0.0376	0.0102
V	7/02-7/08	50	0.0455	0.0222	0.0455	0.0222

[a] Harvest includes only fish kept and catch includes fish kept and fish reported as released. Rates are number of fish harvested or caught per hour fished for interviewed anglers.

[b] Completed-trip angler interviews only.

Table 17. Yentna River and Skwentna River estimated effort and percent of total effort at individual locations, for chinook salmon, 1990.

Location	Effort (hours)	Percent of Total Effort
Yentna River		
Fish Cr.	1,140	9
Beaver Cr.	0	0
Moose Cr.	1,013	8
Indian Cr.	253	2
Fish Lakes Cr.	507	4
Bottle Cr.	0	0
Hewitt Cr.	127	1
Bob's Cr.	127	1
Donkey Cr.	507	4
Malone Cr.	507	4
Johnson Cr.	127	1
Kichatna R.	0	0
Otter Cr.	633	5
Gagnon Cr.	1,647	13
Clearwater Cr.	127	1
Fourth of July Cr.	0	0
Total	6,715	53
Skwentna River		
Eight Mile Cr.	1,773	14
Talachulitna R.	4,180	33
Shell Cr.	0	0
Canyon Cr.	0	0
Total	5,953	47
Grand Total	12,668	100

Table 18. Mean length (mid-eye to fork-of-tail) in millimeters by sex and age group of chinook salmon sampled from sport fisheries in northern Cook Inlet, Alaska, 1990.

Fishery	Sex		Age Group 1.5	2.4	1.4	2.3	1.3	2.2	1.2	1.1
Lake Creek										
	Male	Mean	1,047	0	958	885	802	0	569	320
		Standard Error	20	0	10	35	8	0	8	0
		Sample Size (n=158)	4	0	37	2	51	0	63	1
	Female	Mean	950	0	918	815	803	0	0	0
		Standard Error	32	0	7	35	8	0	0	0
		Sample Size (n=108)	7	0	57	2	42	0	0	0
Willow Creek										
Mouth[a]:										
	Male	Mean	1,068	0	986	0	795	0	571	0
		Standard Error	52	0	9	0	7	0	4	0
		Sample Size (n=289)	5	0	71	0	54	0	159	0
	Female	Mean	960	0	931	0	833	0	0	0
		Standard Error	23	0	5	0	14	0	0	0
		Sample Size (n=124)	5	0	103	0	16	0	0	0
Highway:										
	Male	Mean	1,035	0	971	0	847	0	614	0
		Standard Error	27	0	17	0	24	0	15	0
		Sample Size (n=40)	2	0	17	0	7	0	14	0
	Female	Mean	1,018	0	946	0	842	0	0	0
		Standard Error	22	0	9	0	25	0	0	0
		Sample Size (n=43)	4	0	32	0	7	0	0	0
Mouth-Highway Combined:										
	Male	Mean	1,059	0	983	0	801	0	575	0
		Standard Error	59	0	19	0	25	0	16	0
		Sample Size (n=330)	7	0	88	0	61	0	173	0
	Female	Mean	986	0	934	0	871	0	0	0
		Standard Error	32	0	10	0	29	0	0	0
		Sample Size (n=167)	9	0	135	0	23	0	0	0
Little Susitna River										
	Male	Mean	1,020	0	970	0	804	0	586	375
		Standard Error	0	0	9	0	14	0	12	16
		Sample Size (n=115)	3	0	64	0	17	0	25	6
	Female	Mean	0	925	915	0	824	0	0	0
		Standard Error	0	0	6	0	6	0	0	0
		Sample Size (n=97)	0	1	74	0	22	0	0	0

[a] Forty-three percent of the Willow Creek mouth harvest consisted of hatchery-produced fish whose age was 0.2, 0.3, or 0.4. Scales from hatchery-produced fish were indistinguishable from wild fish scales aged 1.2, 1.3, and 1.4. Therefore, both are included in Willow Creek age groups 1.2, 1.3, and 1.4.

Table 19. Sex and age composition of chinook salmon sampled from sport fisheries in northern Cook Inlet, Alaska, 1990.

Fishery	Sex		Age Group 1.5	2.4	1.4	2.3	1.3	2.2	1.2	1.1	Total
Lake Creek											
	Male	Percent	1.5	0.0	13.8	0.7	19.3	0.0	23.4	0.4	59.1
	Female	Percent	2.6	0.0	21.6	0.7	15.6	0.0	0.4	0.0	40.9
(n = 269)[a]	Combined	Percent	4.1	0.0	35.3	1.5	34.9	0.0	23.8	0.4	100.0
		SE	1.21	0.00	2.92	0.74	2.91	0.00	2.60	0.37	
Willow Creek											
Mouth[b]:											
	Male	Percent	1.4	0.0	19.3	0.0	11.3	0.0	32.1	0.0	64.0
	Female	Percent	1.4	0.0	29.9	0.0	4.7	0.0	0.0	0.0	36.0
(n = 424)[a]	Combined	Percent	2.8	0.0	49.2	0.0	16.0	0.0	32.1	0.0	100.0
		SE	0.91	0.00	2.48	0.00	1.84	0.00	2.21	0.00	
Highway:											
	Male	Percent	1.4	0.0	22.8	0.0	8.3	0.0	17.3	0.0	49.7
	Female	Percent	4.1	0.0	37.9	0.0	8.3	0.0	0.0	0.0	50.3
(n = 83)[a]	Combined	Percent	5.5	0.0	60.7	0.0	16.6	0.0	17.3	0.0	100.0
		SE	2.11	0.00	5.13	0.00	3.92	0.00	4.03	0.00	
Mouth-Highway Combined:											
	Male	Percent	1.4	0.0	19.9	0.0	10.8	0.0	29.6	0.0	61.7
	Female	Percent	1.8	0.0	31.2	0.0	5.3	0.0	0.0	0.0	38.3
(n = 507)[a]	Combined	Percent	3.2	0.0	51.1	0.0	16.1	0.0	29.6	0.0	100.0
		SE	2.39	0.00	5.70	0.00	4.33	0.00	4.6	0.0	
Little Susitna River											
	Male	Percent	1.0	0.0	26.7	0.0	7.9	0.0	10.1	3.1	49.7
	Female	Percent	0.0	0.4	39.4	0.0	10.5	0.0	0.0	0.0	50.3
(n = 248)[a]	Combined	Percent	1.0	0.4	66.1	0.0	18.5	0.0	10.1	3.1	100.0
		SE	0.53	0.34	2.87	0.00	2.34	0.00	1.94	1.09	

[a] n = sample size.

[b] Forty-three percent of the Willow Creek mouth harvest consisted of hatchery-produced fish whose ages were 0.2, 0.3, or 0.4. Scales from hatchery-produced fish were indistinguishable from wild fish scales aged 1.2, 1.3, and 1.4. Therefore, both are included in the age groups 1.2, 1.3, and 1.4.

and age 1.2 contributed 32.1%. Mean lengths ranged from 1,068 mm for age-1.5 fish to 571 mm for age-1.2 fish (Table 18). The harvest consisted of 64% males and 36% females (Table 19).

Willow Creek, Highway Bridge:

Eighty-three chinook salmon were sampled for age, length, and sex. Age class 1.4 dominated the harvest at 60.7%, age 1.3 contributed 16.6%, and age 1.2 contributed 17.3%. Mean lengths ranged from 1,035 mm for age-1.5 fish to 614 mm for age-1.2 fish (Table 18). The harvest consisted of 49.7% males and 50.3% females (Table 19).

Little Susitna River:

Two hundred forty-eight chinook salmon were sampled for age, length, and sex. Age class 1.4 dominated the harvest with 66.1%, age 1.3 contributed 18.5%, and age 1.2 contributed 10.1%. Mean lengths ranged from 1,020 mm for age-1.5 fish to 375 mm for age-1.1 fish (Table 18). The harvest consisted of 49.7% males and 50.3% females (Table 19).

Spawning Escapement Surveys

Overall, 56,548 spawning chinook salmon were counted in index streams in northern Cook Inlet during 1990. A total of 53,752 chinook salmon were counted in Susitna River tributaries. In western Cook Inlet, a total of 1,329 chinook salmon were counted. Escapement surveys on the Little Susitna River and Moose Creek resulted in 922 and 545 chinook salmon, respectively (Table 20) during 1990.

Hatchery Contributions

Of the estimated sport harvest of 2,231 chinook salmon at the mouth of Willow Creek, 1,309 were examined and 41 were observed to have a missing adipose fin and a decodeable CWT (3% of the sample). These 41 fish represented five different lots released into Willow Creek from 1985 through 1989 (Table 21). The estimated contribution of hatchery-produced chinook salmon to the Willow Creek mouth harvest during 1990 was 949 fish or 42.5% (incorporating the bias-corrected variance associated with the harvest estimate, SE = 135) (Table 22, Appendix A17). Of the estimated sport harvest of 558 chinook salmon from the Willow Creek highway bridge fishery, 93 were examined and none were observed to have a missing adipose fin. While contribution of hatchery-produced fish to this portion of the fishery was estimated at zero, it was not likely that many tagged fish would have been found in such a small sample (3% of 93 fish examined for an expectation of 3 tagged fish). However, carcass surveys on Willow Creek and Deception Creek, a tributary of Willow Creek, recovered 2 adipose clipped fish in 703 inspected and 9 of 329 inspected, respectively. At the Deception Creek weir eggtake, 27 adipose clipped fish were observed of 330 inspected (Table 23). Preliminary estimates of proportional contribution of hatchery chinook are 2% in the Willow Creek carcass survey, 23% from Deception Creek carcass survey, and 74% at Deception Creek weir eggtake (Table 23) (R. S. Chlupach, ADFG, FRED Division, Big Lake, Alaska, personnel communication).

Table 20. Chinook salmon escapement counts in northern Cook Inlet, Alaska management area streams, 1979-1990[a].

Location	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Susitna River Eastside Streams											
Willow Creek	848	991	592	777	2,789	1,856	2,059	2,768	2,496	5,060	2,365
Deception Creek	239	366	229	121	675	1,044	521	692	790	800	700
Montana Creek	1,094	814	887	1,641	2,309	1,767	---	1,452	2,016	2,701	1,576
Little Willow Creek	327	459	316	1,042	---	1,305	2,133	1,320	1,515	1,325	1,115
Sheep Creek	778	1,013	527	975	1,028	1,634	1,285	895	1,215	610	634
Goose Creek	---	262	140	477	258	401	630	416	1,076	835	552
Clear Creek	864	---	982	938	1,520	2,430	---	1,949	4,850	---	2,380
Prairie Creek	---	---	3,844	3,200	9,000	6,500	8,500	9,138	8,650	9,463	9,113
Chulitna River	---	---	644	3,845	4,191	783	---	5,252	---	---	2,681
Other Streams	1,185	1,877	2,943	5,000	4,449	4,066	1,119	4,734	3,647	2,323	4,231 b
Total	5,335	5,782	11,104	18,016	26,219	21,786	16,247	28,616	26,255	23,117	25,347
Susitna River Westside Streams											
Alexander Creek	6,215	---	2,546	3,755	4,620	6,241	5,225	2,152	6,273	3,497	2,596
Deshka River	27,385	---	16,000	19,237	16,892	18,151	21,080	15,028	19,200	---	18,166
Lake Creek	4,196	---	3,577	7,075	---	5,803	---	4,898	6,633	---	2,075
Talachulitna River	1,648	2,025	3,101	10,014	6,138	5,145	3,686	---	4,112	---	2,694
Peters Creek	---	---	---	2,272	324	2,901	1,915	1,302	3,927	959	2,027
Other Streams	---	1,376	728	357	---	691	424	556	818	362	847 c
Total	39,444	3,401	25,952	42,710	27,974	38,932	32,330	23,936	40,963	4,813	28,405
Susitna River Sub-total	44,779	9,183	37,056	60,726	54,193	60,718	48,577	52,552	67,218	27,935	53,752
Little Susitna River	---	---	---	929	558	1,005	---	1,386	7,400	4,367	922
Moose Creek	253	238	406	452	541	475	403	957	1,072	999	545
West Cook Inlet Streams											
Chuitna River	1,246	---	3,438	4,043	2,845	1,600	3,946	---	3,024	990	480
Theodore river	512	535	1,368	1,519	1,251	1,458	1,281	1,548	1,906	1,026	642
Lewis River	546	560	606	---	947	861	722	875	616	452	207
Other Streams	225	1,400	1,000	500	---	700	165	---	---	---	---
Total	2,529	2,495	6,412	6,062	5,043	4,619	6,114	2,423	5,546	2,468	1,329
N. Cook Inlet Total	47,516	11,916	43,874	68,169	60,335	66,817	55,094	57,318	81,236	35,769	56,548

[a] No counts taken in 1980.

[b] Grizzly Creek, Kashwitna River, Portage Creek, Indian River.

[c] Cache Creek.

Table 21. Hatchery-produced chinook salmon tagging, release, and life history information for Willow Creek, Susitna River drainage, Alaska, 1983-1989.

Brood Year	Tag Code	Number Tagged	Number Released	Proportion Tagged	Mean Size (gms)	Lifestage	Release Date	Release Location	Dominant Return
1983	31-16-42	8,152	101,351	0.0804	18.0	smolt	6/13/85	Deception Cr. Downstream	89
1984	31-16-45	11,038	214,353	0.0515	14.0	smolt	6/10/85	Deception Cr. Downstream	89
	31-16-47	10,708	218,743	0.0490	14.0	smolt	6/20/85	Deception Cr. Downstream	89
	Total	21,746	433,096						
1985	31-17-27	18,400	130,178	0.1413	12.2	smolt	5/01/86	Deception Cr. Downstream	90
	31-17-33	15,396	99,336	0.1550	16.7	smolt	5/10/86	Deception Cr. Downstream	90
	Total	33,796	229,514						
1987	31-17-58	20,936	201,091	0.1041	10.9	smolt	7/12/88	Deception Cr. Downstream	92
1988	31-17-60	20,256	174,147	0.0841	12.9	smolt	5/31/89	Deception Cr. Downstream	93
			66,738					Deception Cr. Upstream	
	Total		240,885						
1989	31-17-34	41,570	219,362	0.1895	14.4	smolt	5/24/90	Deception Cr. Upstream	94
	31-18-51	40,575	219,432	0.1849	13.4	smolt	5/24/90		94
	31-18-52	40,438	216,697	0.1866	13.9	smolt	5/24/90		94
	Total	122,583	655,491						

Table 22. Estimated contribution of hatchery-produced chinook salmon to the Willow Creek, Susitna River drainage, Alaska, sport harvest in 1990.

Fishery/ Release Code	Year Stock	m_1[a]	m_2[b]	a_1[c]	a_2[d]	Estimated Sport Harvest Estimate	SE	n_2[e]	m_c[f]	p_r[g]	Estimated Hatchery Contribution Estimate	SE	Percent of Total Harvest
Willow Creek - Mouth													
31.16.42	1985	No CWT recovered.											
31.16.45	1985	41	41	66	48	2,231	90.0	1,309	1	0.0515	30	29.4	
31.16.47	1985	41	41	66	48	2,231	90.0	1,309	1	0.0490	56	55.7	
31.17.27	1986	41	41	66	48	2,231	90.0	1,309	5	0.1413	73	32.0	
31.17.33	1986	No CWT recovered.											
31.17.58	1988	41	41	66	48	2,231	90.0	1,309	33	0.1041	767	112.9	
31.17.60	1989	41	41	66	48	2,231	90.0	1,309	1	0.0841	23	22.7	
										Sub-total	949	135.1	42.5%
Willow Creek - Highway													
No CWT recovered		0	0	0	0	558	224.7	93	0		0		0.0%
TOTAL						2,789	265.1				949	135.1	34.0%

[a] Number of snouts collected from fish with ad-clips, sent to lab, and have a CWT.

[b] Number of snouts collected from fish with ad-clips, sent to lab, and have a decodeable CWT.

[c] Number of fish with ad-clips observed.

[d] Number of snouts collected from fish with ad-clips and sent to lab.

[e] Number of fish examined for ad-clips.

[f] Number of fish with a unique tag code.

[g] The proportion of the total release marked at the time of stocking for a unique tag code.

Table 23. Number of chinook salmon inspected for a clipped adipose fin, number clips observed and proportional contribution of hatchery fish for carcass surveys on Deception and Willow Creeks, Alaska and the eggtake at Deception Creek weir, Alaska, 1990.

Location	Release Code	Release Year	Proportion Clipped	Number Clips Observed	Number Fish Inspected	Proportion Hatchery Contribution
Deception Cr. weir eggtake	31-17-27	86	.1413	2	330	.04
	31-17-33	86	.1550	2	330	.04
	31-17-58	88	.1041	22	330	.64
	31-17-60	89	.0841	1	330	.04
Total contribution						76%
Deception Cr. carcass survey	31-17-27	86	.1413	2	329	.04
	31-17-33	86	.1550	1	329	.02
	31-17-58	88	.1041	6	329	.17
Total Contribution						23%
Willow Cr. carcass survey	31-17-27	86	.1413	1	703	.01
	31-17-58	88	.1041	1	703	.01
Total Contribution						2%

DISCUSSION

Lake Creek

Analysis of creel survey data from Lake Creek showed use of incompleted-trip interviews would result in a biased estimate of harvest. However, when using only completed-trip angler interview data, the lack or scarcity of interviews during many periods leaves a question as to the validity of this estimate. It is likely that neither estimate provides accurate estimates of harvest or catch. The harvest estimate generated with a combination of both completed- and incompleted-trip interviews was 2,882 (SE = 260) chinook salmon. The harvest estimate generated with only completed-trip interviews was 6,556 (SE = 994). Average harvest for the years 1986 through 1989 was 2,672 (Table 24). People involved in the fishery, lodge owners, guides, longtime fishermen, and fishery technicians felt that fishing success was equal to previous years with a slight increase in the number of fishermen. Anglers did not appear to be harvesting three times as many fish as in past seasons. The 1990 harvest estimate probably falls somewhere between 2,882 and 6,556, indicating the harvest for 1990 exceeded the previous 4-year average. An estimated angler effort of 41,975 (SE = 3,377) hours for 1990 is the largest on record for Lake Creek. Average effort during the previous 4 years was 34,086 hours (Table 24). The harvest rate for all sampled anglers (complete and incomplete) of 0.069 for 1990, is less than the previous 4-year average of 0.079 (Table 24).

Willow Creek

Angler effort at Willow Creek also increased in 1990 making it the highest on record. The estimated effort of 39,114 (SE = 831) angler-hours (excluding the effort between the mouth and highway) exceeded the previous year's 33,002 (SE = 1,625) angler-hours and the previous 4-year average of 21,580 angler-hours (Table 24). Estimated harvest was also the highest on record at 2,789 (SE = 239), exceeding the previous 4-year average of 1,873 (Table 24). The 1990 harvest rate was 0.071, lower than the previous 4-year average of 0.087, continuing the trend of the previous 4 years (Table 24).

A hatchery contribution of 42.5%, or 949 fish, played a large role in the harvest at the mouth of Willow Creek. However, of the estimated contribution of 949 chinook salmon, 790 (83%) were from the release years 1988 and 1989 (Table 22) and consequently jacks, less then 28 inches (710 mm) in length

Little Susitna River

An estimated effort of 40,461 (SE = 5,430) angler-hours for 1990 was a decrease from the 45,631 (SE = 2,637) angler-hours of the previous year, but only slightly lower then the previous 4-year average of 43,244 angler-hours (Table 24). The estimated harvest of 1,546 chinook salmon was also down from the previous year but similar to the previous 4-year average of 1,559 (Table 24). The harvest rate of 0.038 was comparable to the previous 4-year average of 0.037 (Table 24).

Table 24. Effort, harvest, and harvest rate for surveyed northern Cook Inlet Alaska chinook salmon fisheries, 1986-1990.

Stream	1986[a]	1987[b]	1988[c]	1989[d]	86-89 Mean	1990
Lake Creek						
Effort[e]	30,824	33,509	38,778	33,231	34,086	41,975
Harvest	3,094	2,149	2,631	2,812	2,672	2,882
Harvest Rate[f]	0.100	0.641	0.068	0.085	0.078	0.069
Willow Creek						
Effort[e]	12,190	17,721	23,409	33,002	21,580	39,114
Harvest	1,043	1,732	2,160	2,570	1,873	2,789
Harvest Rate[f]	0.086	0.098	0.092	0.078	0.087	0.071
Little Susitna River - Burma Rd. boat anglers						
Effort[e]	41,234	43,157	42,955	45,631	43,244	40,461
Harvest	871	1,580	1,960	1,825	1,559	1,546
Harvest Rate[f]	0.021	0.037	0.046	0.040	0.036	0.038
Total						
Effort[e]	84,248	94,387	105,142	111,864	103,606	121,729
Harvest	5,008	5,461	6,751	7,207	6,214	7,216
Harvest Rate[f]	0.059	0.058	0.064	0.064	0.060	0.059

[a] Hepler and Bentz 1987.

[b] Hepler, Conrad, and Vincent-Lang 1988.

[c] Bartlett and Vincent-Lang 1989; Hepler, Hoffmann, and Vincent-Lang 1989.

[d] Bartlett and Sonnichsen 1990; Sweet and Webster 1990.

[e] Angler effort in hours.

[f] Harvest estimate divided by effort estimate.

Summary

It is not possible at this time to estimate the total return of chinook salmon to northern Cook Inlet, or their exploitation rate, as an unknown number were harvested in northern Cook Inlet sport fisheries and in the mixed-stock commercial fisheries of upper Cook Inlet. However, 56,548 spawning chinook salmon were observed from aerial surveys of northern Cook Inlet streams and an estimated 8,529 (SE = 399) chinook salmon were harvested from selected roadside and remote stream sport fisheries (Table 25). This represents a minimum inriver return of 63,764 chinook salmon to northern Cook Inlet in 1990.

Angler count, angler interview, and biological data files developed for Lake Creek, Willow Creek, Little Susitna River, and Yentna River-Skwentna River drainage, during 1990, are listed in Appendix B1. These data files are archived with Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518-1519. Contact Gail Heineman or Donna Buchholz (907-267-2369) for copies of the files and descriptions of the file formats.

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Table 25. Summary of estimated angler-effort, chinook salmon harvest, and chinook salmon catch by sport fisheries surveyed in northern Cook Inlet, Alaska, 1990.

Fishery	Effort (angler-hours)	Standard Error	Rel. Pre.[a]	Harvest[b]	Standard Error	Rel. Pre.[a]	Catch[c]	Standard Error	Rel. Pre.[a]
Remote									
Lake Creek:	41,975	3,377	15.8%						
All anglers[d]				2,882	260	17.7%	3,873	393	19.9%
Complete anglers				6,556	994	29.7%	8,694	1,135	25.6%
Roadside									
Willow Creek:	39,114[e]	831	4.2%	2,789	239	16.8%	4,322	265	12.0%
	43,626[f]	935	4.2%						
Little Susitna River:									
Boat anglers	32,712	5,267	31.6%	1,489	244	32.2%	1,829	270	28.9%
Shore anglers	7,749	1,323	33.5%	57	30	103.2%	57	30	103.2%
Sub-total	40,461	5,430	26.3%	1,546	246	17.4%	1,886	384	14.6%
Roadside Sub-total	84,086	9,675	22.6%	3,926	348	17.4%	5,152	384	14.6%
GRAND TOTAL	121,729[e]	10,247	15.9%	8,529[g]	476	10.9%	9,024[g]	663	14.4%
				12,202[h]	1,438	23.1%	13,845[h]	1,645	23.3%

[a] Relative precision of 95% confidence interval.

[b] Harvest includes only fish kept.

[c] Catch includes fish kept and fish reported as released.

[d] Includes completed- and incompleted-angler interviews.

[e] Does not include Willow Creek effort estimate between mouth and bridge.

[f] Includes Willow Creek effort estimate between mouth and bridge.

[g] Includes Lake Creek all anglers estimate.

[h] Includes Lake Creek completed-trip angler only estimate.

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APPENDIX A

Appendix A1. Chinook salmon harvest and catch rates for all anglers interviewed and mean angler counts by day, period and area for Lake Creek, Susitna River drainage, Alaska, 1990.

Date	Period[b]	Area[c]	Number of Counts/ Period	Mean Count/ Period	Count Var.[d]	Inter-views/ Period	Mean Jack[a] HPUE[e]	HPUE Jack[a] Var.[d]	Mean Jack[a] CPUE[f]	CPUE Jack Var.[d]
605	1	1	3	14.3	13.3	16	0.0000	0.0000	0.0000	0.0000
605	5	1	3	12.0	101.3	9	0.0000	0.0000	0.0000	0.0000
607	1	1	3	16.7	135.3	29	0.0345	0.0013	0.0344	0.0013
607	3	1	3	12.3	31.3	15	0.0000	0.0000	0.0000	0.0000
608	1	1	3	28.3	1.3	35	0.0854	0.0017	0.0854	0.0017
608	4	1	3	24.0	16.3	31	0.0598	0.0018	0.0898	0.0038
613	1	1	3	43.0	46.3	19	0.0215	0.0004	0.0215	0.0004
613	5	1	3	57.0	40.5	38	0.0719	0.0006	0.0719	0.0006
614	2	1	3	62.0	29.3	52	0.1328	0.0011	0.1328	0.0011
614	4	1	3	58.7	162.5	77	0.0398	0.0002	0.0433	0.0002
615	2	1	3	50.7	27.3	77	0.0653	0.0004	0.0653	0.0004
615	4	1	3	47.0	38.3	47	0.0587	0.0002	0.0755	0.0002
617	1	1	3	82.3	26.5	111	0.0727	0.0002	0.1078	0.0004
617	4	1	3	65.3	138.5	53	0.0573	0.0002	0.0993	0.0005
618	1	1	3	41.7	42.5	43	0.0599	0.0003	0.0760	0.0004
618	5	1	3	56.3	56.5	65	0.1505	0.0005	0.2021	0.0016
619	2	1	3	73.7	45.3	107	0.0908	0.0002	0.1168	0.0003
619	5	1	3	70.3	783.3	58	0.1162	0.0002	0.1429	0.0003
621	1	1	3	59.0	29.3	70	0.1203	0.0007	0.1373	0.0011
621	5	1	3	76.0	1,014.5	76	0.1716	0.0007	0.2523	0.0017
624	4	1	2	70.0	128.0	65	0.0697	0.0004	0.0697	0.0004
624	6	1	3	33.0	36.0	18	0.0981	0.0006	0.0981	0.0006
625	2	1	3	127.3	238.3	91	0.0938	0.0003	0.1180	0.0005
625	6	1	3	42.7	74.0	45	0.0637	0.0003	0.0637	0.0003
627	3	1	3	107.0	146.3	80	0.0962	0.0006	0.1354	0.0011
627	6	1	3	45.0	83.3	19	0.0166	0.0003	0.0166	0.0003
630	1	1	3	58.3	120.3	50	0.0270	0.0002	0.0408	0.0002
630	6	1	3	31.3	21.3	25	0.0237	0.0001	0.0395	0.0005
701	3	1	3	40.0	16.3	27	0.0142	0.0000	0.0190	0.0001
701	5	1	3	37.3	30.3	39	0.0266	0.0002	0.0266	0.0002
703	1	1	3	11.0	17.0	9	0.0538	0.0028	0.0538	0.0028
703	3	1	3	16.3	24.3	10	0.1482	0.0011	0.1482	0.0011
706	1	1	3	16.0	12.5	13	0.1832	0.0024	0.2419	0.0057
706	2	1	3	13.3	5.0	15	0.1307	0.0020	0.2441	0.0063
707	1	1	3	8.0	2.0	20	0.0402	0.0004	0.0402	0.0004
707	3	1	3	13.7	15.3	0				
708	3	1	3	21.7	51.3	26	0.0609	0.0006	0.0609	0.0006
708	5	1	2	9.0	2.0	8	0.0463	0.0024	0.0463	0.0024
709	2	1	3	16.7	30.5	21	0.0381	0.0007	0.0381	0.0007
709	3	1	3	15.7	6.3	0				
710	2	1	3	9.7	8.5	7	0.1515	0.0062	0.1515	0.0062
710	4	1	3	1.7	0.3	0				
713	2	1	3	11.7	9.3	8	0.0684	0.0047	0.0684	0.0047
713	4	1	3	9.7	0.3	10	0.0000	0.0000	0.0000	0.0000
605	1	2	3	0.0	0.0	0				
605	5	2	3	1.3	4.0	2	0.0000	0.0000	0.0000	0.0000
607	1	2	3	0.0	0.0	0				
607	3	2	3	2.7	16.0	8	0.0000	0.0000	0.0000	0.0000
608	1	2	3	0.0	0.0	1	0.0000	0.0000	0.0000	0.0000
608	4	2	3	4.0	2.3	3	0.0000	0.0000	0.0000	0.0000
613	1	2	3	2.7	4.0	0				
613	5	2	3	2.3	24.5	0				
614	2	2	3	0.7	0.5	1	0.0000	0.0000	0.0000	0.0000
614	4	2	3	8.3	4.0	7	0.0000	0.0000	0.0000	0.0000
615	2	2	3	5.3	26.5	14	0.0428	0.0004	0.0564	0.0004
615	4	2	3	11.7	46.3	11	0.0865	0.0041	0.0865	0.0041
617	1	2	3	11.0	42.5	17	0.0000	0.0000	0.0130	0.0002
617	4	2	3	14.7	6.3	39	0.0579	0.0004	0.0644	0.0004
618	1	2	3	9.0	24.5	20	0.0929	0.0007	0.3290	0.0021
618	5	2	3	5.7	3.3	30	0.0606	0.0001	0.0847	0.0003
619	2	2	3	19.0	38.3	22	0.0302	0.0004	0.0756	0.0009
619	5	2	3	9.0	29.3	15	0.0235	0.0001	0.0273	0.0001

-continued-

Appendix A1. (Page 2 of 2).

Date	Period[b]	Area[c]	Number of Counts/ Period	Mean Count/ Period	Count Var.[d]	Inter-views/ Period	Mean Jack[a] HPUE[e]	HPUE Jack[a] Var.[d]	Mean Jack[a] CPUE[f]	CPUE Jack[a] Var.[d]
621	1	2	3	14.0	18.5	15	0.0196	0.0005	0.0196	0.0005
621	5	2	3	5.0	72.5	11	0.0328	0.0001	0.0582	0.0004
624	4	2	2	11.5	4.5	0				
624	6	2	1	7.0		0				
625	2	2	3	39.3	105.3	53	0.0995	0.0007	0.2121	0.0036
625	6	2	1	6.0		0				
627	3	2	3	25.3	50.5	45	0.0938	0.0006	0.1962	0.0025
627	6	2	1	3.0		0				
630	1	2	3	8.0	31.3	8	0.1176	0.0024	0.3615	0.0032
630	6	2	1	3.0		0				
701	3	2	3	22.7	121.0	38	0.0000	0.0000	0.0158	0.0002
701	5	2	3	20.7	102.5	31	0.0207	0.0000	0.0237	0.0000
703	1	2	3	13.3	25.3	19	0.0971	0.0004	0.1319	0.0008
703	3	2	3	18.7	232.3	29	0.0251	0.0001	0.0251	0.0001
706	1	2	3	6.3	86.5	14	0.0269	0.0002	0.0539	0.0004
706	2	2	3	9.0	32.0	25	0.0431	0.0009	0.0544	0.0011
707	1	2	3	6.3	42.3	25	0.0227	0.0001	0.0344	0.0003
707	3	2	3	8.7	14.5	0				
708	3	2	3	17.3	15.3	17	0.0777	0.0013	0.0777	0.0013
708	5	2	2	11.5	0.5	15	0.0135	0.0003	0.0262	0.0006
709	2	2	3	16.0	96.5	24	0.0071	0.0000	0.0071	0.0000
709	3	2	3	11.7	65.0	0				
710	2	2	3	11.3	4.3	16	0.2636	0.0322	0.2636	0.0322
710	4	2	3	3.0	1.3	0				
713	2	2	3	6.7	1.3	8	0.0000	0.0000	0.0000	0.0000
713	4	2	3	0.7	1.0	0				

[a] Jack = Jackknife estimate

[b] 1 = 0500-0900, 2 = 0901-1300, 3 = 1301-1700, 4 = 1701-2100, 5 = 2101-0100

[c] Area 1 = Downstream of King Point Lodge; Area 2 = Upstream of King Point Lodge.

[d] Var. = Variance

[e] HPUE = Harvest per angler-hour

[f] CPUE = Catch per angler-hour

Appendix A2. Chinook salmon harvest and catch rates for completed trip anglers and mean angler counts by day, period, and area for Lake Creek, Susitna River drainage, Alaska, 1990.

Date	Period[b]	Area[c]	Number of Counts/ Period	Mean Count/ Period	Count Var.[d]	Inter-views/ Period	Mean Jack[a] CPUE[f]	CPUE Jack[a] Var.[d]	Mean Jack[a] HPUE[e]	HPUE Jack[a] Var.[d]
605	1	1	3	14.3	13.3	0				
605	5	1	3	12.0	101.3	2	0.0000	0.0000	0.0000	0.0000
607	1	1	3	16.7	135.3	0				
607	3	1	3	12.3	31.3	0				
608	1	1	3	28.3	1.3	0				
608	4	1	3	24.0	16.3	0				
613	1	1	3	43.0	46.3	0				
613	5	1	3	57.0	40.5	3	0.2280	0.0000	0.2280	0.0000
614	2	1	3	62.0	29.3	7	0.2638	0.0137	0.2638	0.0137
614	4	1	3	58.7	162.5	6	0.0592	0.0029	0.0592	0.0029
615	2	1	3	50.7	27.3	0				
615	4	1	3	47.0	38.3	0				
617	1	1	3	82.3	26.5	20	0.2072	0.0012	0.1161	0.0004
617	4	1	3	65.3	138.5	3	0.2950	0.0009	0.0885	0.0000
618	1	1	3	41.7	42.5	0				
618	5	1	3	56.3	56.5	3	0.3284	0.0000	0.3285	0.0000
619	2	1	3	73.7	45.3	6	0.0000	0.0000	0.0000	0.0000
619	5	1	3	70.3	783.3	3	0.3256	0.0022	0.2791	0.0000
621	1	1	3	59.0	29.3	0				
621	5	1	3	76.0	1,014.5	13	0.5943	0.0267	0.2578	0.0081
624	4	1	2	70.0	128.0	0				
624	6	1	3	33.0	36.0	4	0.1922	0.0014	0.1922	0.0014
625	2	1	3	127.3	238.3	10	0.2181	0.0016	0.2181	0.0016
625	6	1	3	42.7	74.0	0				
627	3	1	3	107.0	146.3	0				
627	6	1	3	45.0	83.3	0				
630	1	1	3	58.3	120.3	0				
630	6	1	3	31.3	21.3	6	0.1243	0.0042	0.0691	0.0010
701	3	1	3	40.0	16.3	0				
701	5	1	3	37.3	30.3	0				
703	1	1	3	11.0	17.0	4	0.5031	0.0101	0.5030	0.0101
703	3	1	3	16.3	24.3	0				
706	1	1	3	16.0	12.5	0				
706	2	1	3	13.3	5.0	0				
707	1	1	3	8.0	2.0	3	0.1969	0.0097	0.1969	0.0097
707	3	1	3	13.7	15.3	0				
708	3	1	3	21.7	51.3	0				
708	5	1	2	9.0	2.0	0				
709	2	1	3	16.7	30.5	3	0.0000	0.0000	0.0000	0.0000
709	3	1	3	15.7	6.3	0				
710	2	1	3	9.7	8.5	0				
710	4	1	3	1.7	0.3	0				
713	2	1	3	11.7	9.3	0				
713	4	1	3	9.7	0.3	0				

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Appendix A2. (Page 2 of 2).

Date	Period[b]	Area[c]	Number of Counts/ Period	Mean Count/ Period	Count Var.[d]	Inter-views/ Period	Mean Jack[a] HPUE[e]	HPUE Jack[a] Var.[d]	Mean Jack[a] CPUE[f]	CPUE Jack[a] Var.[d]
605	1	2	3	0.0	0.0	0				
605	5	2	3	1.3	4.0	0				
607	1	2	3	0.0	0.0	0				
607	3	2	3	2.7	16.0	0				
608	1	2	3	0.0	0.0	0				
608	4	2	3	4.0	2.3	0				
613	1	2	3	2.7	4.0	0				
613	5	2	3	2.3	24.5	0				
614	2	2	3	0.7	0.5	0				
614	4	2	3	8.3	4.0	0				
615	2	2	3	5.3	26.5	4	0.0896	0.0027	0.0896	0.0027
615	4	2	3	11.7	46.3	0				
617	1	2	3	11.0	42.5	4	0.0000	0.0000	0.0000	0.0000
617	4	2	3	14.7	6.3	18	0.1008	0.0008	010085	0.0008
618	1	2	3	9.0	24.5	10	0.3682	0.0022	0.0921	0.0006
618	5	2	3	5.7	3.3	21	0.0971	0.0004	0.0703	0.0002
619	2	2	3	19.0	38.3	11	0.1159	0.0017	0.0463	0.0010
619	5	2	3	9.0	29.3	0				
621	1	2	3	14.0	18.5	2	0.0000	0.0000	0.0000	0.0000
621	5	2	3	5.0	72.5	2	0.0263	0.0007	0.0263	0.0007
624	4	2	2	11.5	4.5	0				
624	6	2	1	7.0		0				
625	2	2	3	39.3	105.3	6	0.4330	0.0418	0.0919	0.0074
625	6	2	1	6.0		0				
627	3	2	3	25.3	50.5	2	0.2333	0.0060	0.2333	0.0060
627	6	2	1	3.0		0				
630	1	2	3	8.0	31.3	8	0.3615	0.0032	0.1176	0.0024
630	6	2	1	3.0		0				
701	3	2	3	22.7	121.0	3	0.0000	0.0000	0.0000	0.0000
701	5	2	3	20.7	102.5	0				
703	1	2	3	13.3	25.3	7	0.1905	0.0010	0.1429	0.0004
703	3	2	3	18.7	232.3	0				
706	1	2	3	6.3	86.5	0				
706	2	2	3	9.0	32.0	0				
707	1	2	3	6.3	42.3	2	0.0000	0.0000	0.0000	0.0000
707	3	2	3	8.7	14.5	0				
708	3	2	3	17.3	15.3	4	0.4380	0.0131	0.4380	0.0131
708	5	2	2	11.5	0.5	0				
709	2	2	3	16.0	96.5	3	0.0107	0.0001	0.0107	0.0001
709	3	2	3	11.7	65.0	0				
710	2	2	3	11.3	4.3	0				
710	4	2	3	3.0	1.3	0				
713	2	2	3	6.7	1.3	0				
713	4	2	3	0.7	1.0	0				

[a] Jack = Jackknife estimate.
[b] 1 = 0500-0900, 2 = 0901-1300, 3 = 1301-1700, 4 = 1701-2100, 5 = 2101-0100
[c] Area 1 = Downstream of King Point Lodge; Area 2 = Upstream of King Point Lodge.
[d] Var. = Variance
[e] HPUE = Harvest per angler-hour
[f] CPUE = Catch per angler-hour

Appendix A3. Estimates of chinook salmon harvest and catch per hour by day, period, and area, for completed-trip angler interviews, at Lake Creek, Susitna River drainage, Alaska, 1990.

Area[a]	Stratum[b]	Date	Period[c]	# Angler Interviews	Weighted Mean HPUE[d]	Among Angler Variance	Variance of Weighted Mean	Weighted Mean CPUE[e]	Among Angler Variance	Variance of Weighted Mean	Mean Angler Effort	Sample Weight
1	1	900605	5	2	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	1.8228	0.91139
1	2	900613	5	3	0.22800	0.00000	0.000000	0.22800	0.00000	0.000000	5.7000	1.14000
1	2	900614	2	7	0.19574	0.07264	0.010377	0.19574	0.07264	0.010377	2.3489	1.02762
1	2	900614	4	6	0.03241	0.00630	0.001051	0.03241	0.00630	0.001051	2.9171	0.97238
1	2	900617	1	20	0.10408	0.01129	0.000564	0.15983	0.02198	0.001099	6.9695	1.11512
1	2	900617	4	3	0.08849	0.00000	0.000000	0.29496	0.00261	0.000870	8.8488	0.88488
1	3	900618	5	3	0.32847	0.00000	0.000000	0.32847	0.00000	0.000000	8.0476	1.14966
1	3	900619	2	6	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	1.0231	1.02315
1	3	900619	5	3	0.27910	0.00000	0.000000	0.32562	0.00649	0.002164	6.8380	0.97685
1	3	900621	5	13	0.57595	0.63838	0.049106	0.81052	0.61087	0.046990	3.9407	1.12593
1	3	900624	6	4	0.19223	0.00547	0.001369	0.19223	0.00547	0.001369	3.2039	0.64078
1	4	900625	2	10	0.22471	0.04779	0.004779	0.22471	0.04779	0.004779	7.1906	1.49804
1	4	900630	6	6	0.06471	0.00583	0.000972	0.11648	0.02352	0.003920	5.9405	0.69888
1	5	900703	1	4	0.50305	0.04049	0.010122	0.50305	0.04049	0.010122	1.6098	0.80488
1	5	900707	1	3	0.19692	0.02908	0.009695	0.19692	0.02908	0.009695	1.8462	0.73846
1	6	900709	2	3	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	3.0928	1.03093
2	2	900615	2	4	0.08964	0.01071	0.002678	0.08964	0.01071	0.002678	2.1961	0.62745
2	2	900617	1	4	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	3.4286	0.85714
2	2	900617	4	18	0.11653	0.02830	0.001572	0.11653	0.02830	0.001572	6.4444	1.14286
2	3	900618	1	10	0.09205	0.00628	0.000628	0.36818	0.02197	0.002197	9.8182	1.22727
2	3	900618	5	21	0.08307	0.00680	0.000324	0.11652	0.01065	0.000507	5.2251	0.77273
2	3	900619	2	11	0.05655	0.01983	0.001802	0.12352	0.02505	0.002277	7.1558	1.35714
2	3	900621	1	2	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	14.7368	1.47368
2	3	900621	5	2	0.02632	0.00139	0.000693	0.02632	0.00139	0.000693	5.2632	0.52632
2	4	900625	2	6	0.06427	0.02478	0.004131	0.44989	0.15981	0.026634	11.5686	1.73529
2	4	900627	3	2	0.23325	0.01209	0.006045	0.23325	0.01209	0.006045	20.5647	1.78824
2	4	900630	1	8	0.15744	0.03670	0.004587	0.39132	0.04834	0.006042	13.0909	1.45455
2	4	900701	3	3	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	23.0154	1.04615
2	5	900703	1	7	0.14286	0.00294	0.000420	0.19048	0.00705	0.001008	6.2500	0.83333
2	5	900707	1	2	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	6.7556	0.84444
2	5	900708	3	4	0.50096	0.25431	0.063578	0.50096	0.25431	0.063578	2.4046	1.20231
2	6	900709	2	3	0.01071	0.00034	0.000115	0.01071	0.00034	0.000115	41.6386	1.15663

[a] Area 1 = Downstream of King Point Lodge; Area 2 = Upstream of King Point Lodge

[b] 1 = 04-14 June, 2 = 11-17 June, 3 = 18-24 June, 4 = 25 June-01 July, 5 = 02-08 July, 6 = 09-13 July

[c] 1 = 0500-0900, 2 = 0901-1300, 3 = 1301-1700, 4 = 1701-2100, 5 = 2101-0100

[d] Harvest per unit of effort (hour)

[e] Catch per unit of effort (hour)

Appendix A4. Estimates of chinook salmon harvest and catch per hour by day, period, and area, for all angler interviews, at Lake Creek, Susitna River drainage, Alaska, 1990.

Area[a]	Stratum[b]	Date	Period[c]	# Angler Interviews	Weighted Mean HPUE[d]	Among Angler Variance	Variance of Weighted Mean	Weighted Mean CPUE[e]	Among Angler Variance	Variance of Weighted Mean	Mean Weighted Angler Effort	Sample Weight
1	1	900605	1	16	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	2.5174	1.08861
1	1	900605	5	9	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	6.2785	0.91139
1	1	900607	1	29	0.02642	0.02025	0.000698	0.02642	0.02025	0.000698	1.2981	1.14943
1	1	900607	3	15	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	1.3326	0.85057
1	1	900608	1	35	0.17531	0.56226	0.016064	0.17531	0.56226	0.016064	1.5623	1.08280
1	1	900608	4	31	0.06115	0.05359	0.001729	0.07693	0.06006	0.001938	2.7368	0.91720
1	2	900613	1	19	0.00905	0.00156	0.000082	0.00905	0.00156	0.000082	1.9011	0.86000
1	2	900613	5	38	0.05700	0.01809	0.000476	0.05700	0.01809	0.000476	3.8100	1.14000
1	2	900614	2	52	0.16007	0.08737	0.001680	0.16007	0.08737	0.001680	2.4208	1.02762
1	2	900614	4	77	0.07082	0.09883	0.001284	0.09608	0.24385	0.003167	3.3844	0.97238
1	2	900615	2	77	0.07074	0.03752	0.000487	0.07074	0.03752	0.000487	2.3345	1.03754
1	2	900615	4	47	0.07861	0.08044	0.001712	0.08999	0.08172	0.001739	4.7099	0.96246
1	2	900617	1	111	0.05277	0.01564	0.000141	0.06616	0.02232	0.000201	3.5513	1.11512
1	2	900617	4	53	0.06887	0.01979	0.000373	0.08890	0.02416	0.000456	4.6247	0.88488
1	3	900618	1	43	0.06954	0.02529	0.000588	0.11107	0.05221	0.001214	3.0355	0.85034
1	3	900618	5	65	0.12050	0.03392	0.000522	0.16429	0.09595	0.001476	4.3289	1.14966
1	3	900619	2	107	0.06934	0.02281	0.000213	0.08583	0.02949	0.000276	3.0216	1.02315
1	3	900619	5	58	0.09486	0.02001	0.000345	0.10750	0.02276	0.000392	4.9516	0.97685
1	3	900621	1	70	0.12234	0.06387	0.000912	0.14731	0.10132	0.001447	1.8949	0.87407
1	3	900621	5	76	0.22081	0.15972	0.002102	0.28048	0.19612	0.002581	4.1556	1.12593
1	3	900624	4	65	0.05960	0.05779	0.000889	0.05960	0.05779	0.000889	4.5168	1.35922
1	3	900624	6	18	0.05814	0.00766	0.000426	0.05814	0.00766	0.000426	2.1003	0.64078
1	4	900625	2	91	0.09893	0.04375	0.000481	0.14831	0.11867	0.001304	6.0333	1.49804
1	4	900625	6	45	0.09649	0.05394	0.001199	0.09649	0.05394	0.001199	0.9537	0.50196
1	4	900627	3	80	0.08072	0.04788	0.000599	0.12824	0.10984	0.001373	4.3865	1.40789
1	4	900627	6	19	0.00693	0.00091	0.000048	0.00693	0.00091	0.000048	1.1686	0.59211
1	4	900630	1	50	0.02277	0.00649	0.000130	0.02889	0.00712	0.000142	4.9572	1.30112
1	4	900630	6	25	0.01882	0.00217	0.000087	0.03124	0.00756	0.000302	4.9761	0.69888
1	4	900701	3	27	0.04246	0.01161	0.000430	0.05603	0.01481	0.000549	15.8046	1.03448
1	4	900701	5	39	0.01215	0.00201	0.000052	0.01215	0.00201	0.000052	2.7356	0.96552
1	5	900703	1	9	0.22358	0.08548	0.009497	0.22358	0.08548	0.009497	5.0976	0.80488
1	5	900703	3	10	0.18737	0.05303	0.005303	0.18737	0.05303	0.005303	6.6927	1.19512
1	5	900706	1	13	0.18074	0.05373	0.004133	0.20172	0.06088	0.004683	5.1189	1.09091
1	5	900706	2	15	0.33896	0.85507	0.057004	0.40630	0.85085	0.056724	2.5000	0.90909
1	5	900707	1	20	0.05723	0.01231	0.000616	0.05723	0.01231	0.000616	3.2492	0.73846
1	5	900708	3	26	0.04076	0.01990	0.000765	0.04076	0.01990	0.000765	5.1087	1.41304
1	5	900708	5	8	0.07337	0.04306	0.005383	0.07337	0.04306	0.005383	0.8804	0.58696
1	6	900709	2	21	0.05727	0.05117	0.002437	0.05727	0.05117	0.002437	2.6264	1.03093
1	6	900710	2	7	0.23209	0.17251	0.024644	0.23209	0.17251	0.024644	7.9202	1.70588
1	6	900713	2	8	0.06836	0.03738	0.004673	0.06836	0.03738	0.004673	2.1875	1.09375
1	6	900713	4	10	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	4.7125	0.90625
2	1	900605	5	2	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	2.0000	2.00000
2	1	900607	3	8	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	2.0000	2.00000

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Appendix A4. (Page 2 of 2).

Area[a]	Stratum[b]	Date	Period[c]	# Angler Interviews	Weighted Mean HPUE[d]	Among Angler Variance	Variance of Weighted Mean	Weighted Mean CPUE[e]	Among Angler Variance	Variance of Weighted Mean	Mean Weighted Angler Effort	Sample Weight
2	1	900608	1	1	0.00000	.		0.00000	.	.	0.0000	0.00000
2	1	900608	4	3	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	1.0000	2.00000
2	2	900614	2	1	0.00000	.		0.00000	.	.	0.5926	0.14815
2	2	900614	4	7	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	5.2910	1.85185
2	2	900615	2	14	0.03009	0.00427	0.000305	0.04130	0.00530	0.000379	2.0168	0.62745
2	2	900615	4	11	0.09982	0.04932	0.004484	0.09982	0.04932	0.004484	3.8057	1.37255
2	2	900617	1	17	0.00000	0.00000	0.000000	0.01008	0.00173	0.000102	3.3529	0.85714
2	2	900617	4	39	0.05378	0.01612	0.000413	0.05671	0.01613	0.000414	5.2015	1.14286
2	3	900618	1	20	0.14420	0.08701	0.004351	0.30375	0.09185	0.004592	6.4125	1.22727
2	3	900618	5	30	0.06551	0.00609	0.000203	0.09260	0.01041	0.000347	4.9197	0.77273
2	3	900619	2	22	0.02827	0.01028	0.000467	0.06176	0.01593	0.000724	5.5211	1.35714
2	3	900619	5	15	0.02393	0.00096	0.000064	0.02929	0.00204	0.000136	7.0286	0.64286
2	3	900621	1	15	0.04912	0.03620	0.002413	0.04912	0.03620	0.002413	6.8772	1.47368
2	3	900621	5	11	0.03748	0.00225	0.000204	0.07576	0.00634	0.000577	3.7799	0.52632
2	4	900625	2	53	0.11441	0.23678	0.004468	0.18535	0.27388	0.005168	8.6274	1.73529
2	4	900627	3	45	0.07855	0.07539	0.001675	0.14900	0.11343	0.002521	7.6695	1.78824
2	4	900630	1	8	0.15744	0.03670	0.004587	0.39132	0.04834	0.006042	13.0909	1.45455
2	4	900701	3	38	0.00000	0.00000	0.000000	0.11930	0.46194	0.012156	5.1757	1.04615
2	4	900701	5	31	0.01248	0.00103	0.000033	0.01333	0.00108	0.000035	9.9692	0.95385
2	5	900703	1	19	0.06516	0.00601	0.000316	0.11195	0.02195	0.001155	4.1667	0.83333
2	5	900703	3	29	0.01587	0.00210	0.000072	0.01587	0.00210	0.000072	15.0862	1.16667
2	5	900706	1	14	0.02049	0.00166	0.000119	0.03950	0.00355	0.000254	5.4286	0.82609
2	5	900706	2	25	0.07983	0.05365	0.002146	0.08653	0.05366	0.002146	4.7896	1.17391
2	5	900707	1	25	0.03281	0.00611	0.000244	0.04472	0.01255	0.000502	4.8809	0.84444
2	5	900708	3	17	0.15223	0.09679	0.005694	0.15223	0.09679	0.005694	5.2690	1.20231
2	5	900708	5	15	0.01329	0.00265	0.000177	0.06647	0.04356	0.002904	2.8185	0.79769
2	6	900709	2	24	0.00134	0.00004	0.000002	0.00134	0.00004	0.000002	8.4819	1.15663
2	6	900710	2	16	0.26357	0.66688	0.041680	0.26357	0.66688	0.041680	1.1860	1.58140
2	6	900713	2	8	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	16.3636	1.81818

[a] Area 1 = Downstream of King Point Lodge; Area 2 = Upstream of King Point Lodge

[b] 1 = 04-14 June, 2 = 11-17 June, 3 = 18-24 June, 4 = 25 June-01 July, 5 = 02-08 July, 6 = 09-13 July

[c] 1 = 0500-0900, 2 = 0901-1300, 3 = 1301-1700, 4 = 1701-2100, 5 = 2101-2400

[d] Harvest per unit of effort (hour)

[e] Catch per unit of effort (hour)

Appendix A5. Willow Creek aerial angler counts between the mouth and highway bridge creel surveys, mean daily counts, and daily angler effort for each period surveyed, 1990.

Period Date	A 0000-0600	B 0601-1200	C 1201-1800	D 1801-2400	Mean Daily Count	Daily Angler Effort	Within Day Variance
900630		48		60	54	1,296	20,736
900701	39		66		52.5	1,260	104,976
900702		33		21	27	648	20,736
900703		13	7		10	240	5,184
900704	52		37		44.5	1,068	32,400
					Mean Daily Effort Estimate	902	184,032
					Total Angler Effort Estimate	4,512	184,032

Appendix A6. Chinook salmon angler effort, harvest, harvest rates, catch, catch rates, and mean angler counts, by day and period, for Willow Creek shore anglers at the mouth, Susitna River drainage, Alaska, 1990.

Date	Period[a]	Hours/ Period	# of Counts/ Period	Mean Count/ Period	Count Var[b]	Est.[c] Effort	Est. Effort Var.	Inter- views/ Period	Mean Jack HPUE[d]	HPUE Jack Var.[e]	Est. Harvest/ Period	Harvest Var.	Mean Jack CPUE[f]	CPUE Jack Var.	Est. Catch/ Period	Catch Var.
609	3	4.0	2	18.5	4.5	74.0	36.0	21	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
609	6	4.0	2	32.5	40.5	130.0	324.0	49	0.0253	0.0001	3.3	2.4022	0.0253	0.0001	3.3	2.4022
610	4	4.0	2	44.5	144.5	178.0	1,156.0	44	0.0095	0.0001	1.7	3.1332	0.0095	0.0001	1.7	3.1332
610	6	4.0	2	37.0	338.0	148.0	2,704.0	57	0.0216	0.0001	3.2	2.9325	0.0216	0.0001	3.2	2.9325
611	2	4.0	2	8.5	0.5	34.0	4.0	8	0.0414	0.0009	1.4	1.0758	0.0649	0.0009	2.2	1.0945
611	5	4.0	2	25.0	32.0	100.0	256.0	28	0.0116	0.0001	1.2	1.4004	0.0116	0.0001	1.2	1.4004
612	3	4.0	2	11.0	2.0	44.0	16.0	17	0.0931	0.0024	4.1	4.7221	0.0931	0.0024	4.1	4.7221
612	6	4.0	2	27.0	98.0	108.0	784.0	39	0.0370	0.0002	4.0	2.9532	0.0370	0.0002	4.0	2.9532
615	2	4.0	2	28.0	8.0	112.0	64.0	27	0.0440	0.0003	4.9	4.0427	0.0440	0.0003	4.9	4.0427
615	4	4.0	2	39.0	72.0	156.0	576.0	47	0.0654	0.0002	10.2	8.1248	0.0654	0.0002	10.2	8.1248
616	1	4.0	2	43.5	112.5	174.0	900.0	60	0.0327	0.0001	5.7	4.9930	0.0327	0.0001	5.7	4.9900
616	2	4.0	2	35.5	60.5	142.0	484.0	52	0.0572	0.0003	8.1	6.7540	0.0616	0.0003	8.7	7.4500
616	3	4.0	2	51.5	144.5	206.0	1,156.0	52	0.0358	0.0002	7.4	11.3660	0.0430	0.0003	8.9	13.5800
616	4	4.0	2	77.0	338.0	308.0	2,704.0	107	0.0393	0.0001	12.1	15.8530	0.0570	0.0002	17.6	27.9300
616	5	4.0	2	102.5	60.5	410.0	484.0	140	0.0297	0.0001	12.2	11.1660	0.0445	0.0001	18.3	25.6000
616	6	4.0	2	86.5	4.5	346.0	36.0	123	0.0286	0.0001	9.9	7.5240	0.0455	0.0002	15.7	25.1500
617	1	4.0	2	37.5	60.5	150.0	484.0	73	0.0996	0.0004	14.9	12.6370	0.1255	0.0006	18.8	21.8100
617	2	4.0	2	49.0	18.0	196.0	144.0	42	0.0376	0.0002	7.4	8.4860	0.0628	0.0005	12.3	18.8500
617	3	4.0	2	60.0	8.0	240.0	64.0	47	0.0489	0.0003	11.7	15.3410	0.1203	0.0016	28.9	92.3200
617	4	4.0	2	66.0	8.0	264.0	64.0	82	0.0610	0.0002	16.1	16.8980	0.0742	0.0004	19.6	27.2800
617	5	4.0	2	94.0	128.0	376.0	1,024.0	109	0.0392	0.0001	14.8	16.3460	0.0392	0.0001	14.8	16.3500
617	6	4.0	2	72.0	2.0	288.0	16.0	77	0.0724	0.0002	20.9	17.8080	0.0876	0.0003	25.2	26.1100
618	2	4.0	2	37.0	8.0	148.0	64.0	37	0.1331	0.0007	19.7	15.5860	0.1398	0.0007	20.7	17.4200
618	4	4.0	2	59.5	112.5	238.0	900.0	58	0.0979	0.0004	23.3	32.2500	0.1440	0.0011	34.3	80.6400
618	5	4.0	2	85.5	60.5	342.0	484.0	76	0.0494	0.0002	16.9	28.3210	0.0825	0.0008	28.2	91.5500
618	6	4.0	2	111.0	1,058.0	444.0	8,464.0	128	0.0498	0.0001	22.1	37.8380	0.0927	0.0003	41.1	133.0800
623	1	4.0	2	226.5	1,860.5	906.0	14,884.0	131	0.1347	0.0004	122.1	574.9870	0.1835	0.0011	166.3	1,420.0200
623	2	4.0	2	111.0	648.0	444.0	5,184.0	151	0.0900	0.0001	40.0	57.5450	0.1917	0.0009	85.1	370.5500
623	3	4.0	2	130.0	288.0	520.0	2,304.0	73	0.0845	0.0002	43.9	68.4840	0.1573	0.0010	81.8	325.1700
623	4	4.0	2	183.5	312.5	734.0	2,500.0	107	0.0748	0.0001	54.9	78.4540	0.1258	0.0004	92.4	268.1200
623	5	4.0	2	167.0	18.0	668.0	144.0	183	0.0752	0.0001	50.2	34.1530	0.1545	0.0007	103.2	318.7700
623	6	4.0	2	148.5	180.5	594.0	1,444.0	86	0.0660	0.0001	39.2	56.2850	0.1493	0.0009	88.7	364.8200
624	2	4.0	2	124.5	4.5	498.0	36.0	89	0.0797	0.0002	39.7	39.0660	0.1704	0.0011	84.8	266.7700
624	3	4.0	2	139.5	312.5	558.0	2,500.0	73	0.0847	0.0002	47.2	68.4820	0.1480	0.0006	82.6	228.8600
624	4	4.0	2	145.5	112.5	582.0	900.0	139	0.0607	0.0001	35.3	32.4360	0.0929	0.0003	54.1	112.8300
624	5	4.0	2	155.0	8.0	620.0	64.0	114	0.0554	0.0001	34.4	28.7070	0.1109	0.0007	68.8	276.6800
624	6	4.0	2	165.5	40.5	662.0	324.0	138	0.0718	0.0001	47.6	42.5160	0.1141	0.0003	75.5	141.4400
625	1	4.0	2	103.0	512.0	412.0	4,096.0	142	0.0932	0.0001	38.4	58.3540	0.1514	0.0008	62.4	232.2700
625	2	4.0	2	76.0	18.0	304.0	144.0	65	0.0925	0.0003	28.1	25.7090	0.1888	0.0011	57.4	108.1100
625	3	4.0	2	138.0	648.0	552.0	5,184.0	114	0.0743	0.0001	41.0	59.9710	0.1404	0.0006	77.5	270.4400

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Appendix A6. (Page 2 of 2).

Date	Period[a]	Hours/ Period	# of Counts/ Period	Mean Count/ Period	Count Var[b]	Est.[c] Effort	Est. Effort Var.	Inter- views/ Period	Mean Jack[d] HPUE[e]	HPUE Jack Var.	Est. Harvest/ Period	Harvest Var.	Mean Jack CPUE[f]	CPUE Jack Var.	Est. Catch/ Period	Catch Var.
625	4	4.0	2	164.5	0.5	658.0	4.0	69	0.0734	0.0001	48.3	58.3440	0.1968	0.0018	129.5	796.6300
625	5	4.0	2	115.5	3,444.5	462.0	27,556.0	76	0.0716	0.0002	33.1	178.4170	0.1097	0.0006	50.7	437.0800
630	2	4.0	2	177.0	722.0	708.0	5,776.0	158	0.1262	0.0001	89.3	144.3930	0.2376	0.0009	168.2	788.5600
630	3	4.0	2	151.0	72.0	604.0	576.0	112	0.0898	0.0001	54.3	38.8520	0.1948	0.0008	117.6	317.2500
630	4	4.0	2	169.0	338.0	676.0	2,704.0	150	0.0635	0.0001	42.9	36.4350	0.1870	0.0009	126.4	496.7000
630	5	4.0	2	171.5	612.5	686.0	4,900.0	89	0.0644	0.0001	44.2	63.6510	0.1396	0.0006	95.8	394.1700
630	6	4.0	2	174.0	392.0	696.0	3,136.0	150	0.0748	0.0001	52.1	60.3280	0.1397	0.0004	97.3	245.6500
701	1	4.0	2	207.5	480.5	830.0	3,844.0	187	0.0692	0.0001	57.4	83.9240	0.0894	0.0002	74.2	153.1800
701	2	4.0	2	120.5	60.5	482.0	484.0	114	0.0719	0.0001	34.7	23.2440	0.1144	0.0003	55.1	69.9300
701	3	4.0	2	105.0	162.0	420.0	1,296.0	73	0.0612	0.0001	25.7	21.8980	0.1250	0.0005	52.5	111.2900
701	4	4.0	2	144.5	420.5	578.0	3,364.0	76	0.0801	0.0002	46.3	91.8440	0.1238	0.0008	71.6	307.2300
701	5	4.0	2	165.0	32.0	660.0	256.0	105	0.0648	0.0001	42.8	52.9890	0.0879	0.0003	58.0	115.9100
701	6	4.0	2	149.5	84.5	598.0	676.0	62	0.0394	0.0001	23.6	42.1210	0.0691	0.0006	41.3	230.1600
702	2	4.0	2	89.5	112.5	358.0	900.0	72	0.0715	0.0001	25.6	18.8370	0.0931	0.0002	33.3	36.3300
702	3	4.0	2	85.5	84.5	342.0	676.0	40	0.0699	0.0003	23.9	40.0980	0.1172	0.0011	40.1	139.9600
702	4	4.0	2	123.5	0.5	494.0	4.0	72	0.0662	0.0001	32.7	34.8110	0.0807	0.0003	39.9	69.1300
702	5	4.0	2	115.5	312.5	462.0	2,500.0	68	0.0521	0.0002	24.1	38.4430	0.0920	0.0006	42.5	140.0000
702	6	4.0	2	172.5	312.5	690.0	2,500.0	104	0.0628	0.0002	43.3	83.9860	0.0828	0.0003	57.1	158.3500
703	1	4.0	2	65.0	800.0	260.0	6,400.0	72	0.0526	0.0002	13.7	29.1540	0.0526	0.0002	13.7	29.1500
703	3	4.0	2	102.5	4.5	410.0	36.0	40	0.0754	0.0005	30.9	77.9180	0.0880	0.0008	36.1	130.9300
703	4	4.0	2	95.0	242.0	380.0	1,936.0	76	0.0625	0.0002	23.8	32.9239	0.1076	0.0004	40.9	78.6060
703	5	4.0	2	114.5	1,012.5	458.0	8,100.0	38	0.0386	0.0003	17.7	72.9083	0.0594	0.0004	27.2	108.3010
703	6	4.0	2	226.5	612.5	906.0	4,900.0	152	0.0242	0.0000	22.0	35.5886	0.0381	0.0001	34.5	80.6360
704	1	4.0	2	176.5	40.5	706.0	324.0	167	0.0308	0.0000	21.7	23.0438	0.0308	0.0000	21.7	23.0440
704	3	4.0	2	108.0	2.0	432.0	16.0	69	0.0759	0.0002	32.8	38.6885	0.1036	0.0006	44.7	108.2350
704	4	4.0	2	117.5	684.5	470.0	5,476.0	73	0.0505	0.0001	23.7	39.8663	0.1231	0.0009	57.9	271.7820
704	5	4.0	2	108.0	50.0	432.0	400.0	93	0.0445	0.0001	19.2	15.0950	0.0668	0.0002	28.9	31.6210
704	6	4.0	2	95.5	112.5	382.0	900.0	108	0.0179	0.0000	6.8	5.9034	0.0268	0.0001	10.2	13.2900

[a] 1 = 0001-0400, 2 = 0401-0800, 3 = 0801-1200, 4 = 1201-1600, 5 = 1601-2000, 6 = 2001-2400

[b] Variance

[c] Estimated effort in angler hours

[d] Jackknife

[e] Harvest per unit of effort (angler hours)

[f] Catch per unit of effort (angler hours)

Appendix A7. Chinook salmon angler effort, harvest, harvest rates, catch, catch rates, and mean angler counts, by day and period, for Willow Creek shore anglers, at the highway bridge, Susitna River drainage, Alaska, 1990.

Date	Period[a]	Hours/ Period	# of Counts/ Period	Mean Count/ Period	Count Var[b]	Est.[c] Effort	Est. Effort Var.	Inter- views/ Period	Mean Jack HPUE[d,e]	HPUE Jack Var.	Est. Harvest/ Period	Harvest Var.	Mean Jack CPUE[f]	CPUE Jack Var.	Est. Catch/ Period	Catch Var.
630	1	4.0	2	92.0	800.0	368.0	6,400.0	33	0.2235	0.0029	82.2	690.97	0.2235	0.0029	82.2	690.97
630	2	4.0	2	27.0	162.0	108.0	1,296.0	12	0.0631	0.0006	6.8	11.39	0.0631	0.0006	6.8	11.39
630	3	4.0	2	23.5	24.5	94.0	196.0	32	0.1434	0.0013	13.5	15.32	0.1434	0.0013	13.5	15.32
630	4	4.0	2	20.5	12.5	82.0	100.0	0								
630	5	4.0	2	29.0	2.0	116.0	16.0	0								
630	6	4.0	2	43.5	0.5	174.0	4.0	2	1.0263	0.9481	178.6	28,703.91	1.0263	0.9481	178.6	28,703.91
701	1	4.0	2	22.0	242.0	88.0	1,936.0	21	0.1043	0.0029	9.2	38.05	0.1043	0.0029	9.2	38.05
701	2	4.0	2	17.5	24.5	70.0	196.0	10	0.2342	0.0136	16.4	74.88	0.2342	0.0136	16.4	74.88
701	3	4.0	2	42.0	50.0	168.0	400.0	17	0.0000	0.0000	0.0	0.00	0.0000	0.0000	0.0	0.00
701	4	4.0	2	50.5	4.5	202.0	36.0	7	0.1215	0.0007	24.5	30.71	0.1215	0.0007	24.5	30.71
701	5	4.0	2	32.0	242.0	128.0	1,936.0	0								
701	6	4.0	2	28.0	2.0	112.0	16.0	22	0.0410	0.0004	4.6	4.84	0.1147	0.0034	12.8	42.61
702	1	4.0	2	7.5	24.5	30.0	196.0	4	0.0000	0.0000	0.0	0.00	0.0000	0.0000	0.0	0.00
702	2	4.0	2	11.5	60.5	46.0	484.0	0								
702	3	4.0	2	14.5	24.5	58.0	196.0	17	0.1404	0.0017	8.1	9.09	0.1404	0.0017	8.1	9.09
702	4	4.0	2	13.5	0.5	54.0	4.0	9	0.0995	0.0016	5.4	4.67	0.0995	0.0016	5.4	4.67
702	5	4.0	2	18.5	40.5	74.0	324.0	11	0.1406	0.0064	10.4	39.23	0.1847	0.0160	13.7	93.40
702	6	4.0	2	21.0	8.0	84.0	64.0	10	0.1393	0.0023	11.7	17.14	0.1393	0.0023	11.7	17.14
703	1	4.0	2	5.5	0.5	22.0	4.0	6	0.0000	0.0000	0.0	0.00	0.0000	0.0000	0.0	0.00
703	3	4.0	2	15.5	84.5	62.0	676.0	11	0.1085	0.0036	6.7	19.45	0.1768	0.0092	11.0	50.20
703	5	4.0	2	26.5	0.5	106.0	4.0	0								
703	6	4.0	2	52.0	128.0	208.0	1,024.0	8	0.0598	0.0008	12.4	36.34	0.0598	0.0008	12.4	36.34
704	1	4.0	2	27.0	8.0	108.0	64.0	0								
704	2	4.0	2	29.5	12.5	118.0	100.0	17	0.0545	0.0008	6.4	11.85	0.0736	0.0009	8.7	12.50
704	3	4.0	2	15.0	0.0	60.0	0.0	17	0.1745	0.0033	10.5	11.71	0.1745	0.0033	10.5	11.71
704	4	4.0	2	25.0	50.0	100.0	400.0	3	0.0476	0.0069	4.8	67.57	0.0476	0.0069	4.8	67.57
704	5	4.0	2	18.0	0.0	72.0	0.0	20	0.0781	0.0002	5.6	1.23	0.1338	0.0012	9.6	5.95
704	6	4.0	2	21.5	0.5	86.0	4.0	0								

[a] 1 = 0001-0400, 2 = 0401-0800, 3 = 0801-1200, 4 = 1201-1600, 5 = 1601-2000, 6 = 2001-2400

[b] Variance

[c] Estimated effort in angler hours

[d] Jackknife

[e] Harvest per unit of effort (angler hours)

[f] Catch per unit of effort (angler hours)

Appendix A8. Estimates of chinook salmon harvest and catch rates per hour fished, by day and period, for completed-trip shore anglers at the mouth of Willow Creek, Susitna River drainage, Alaska during the first stratum, 9-15 June 1990.

Date	Period[a]	# Angler Interviews	Weighted Mean HPUE[b]	Among Angler Variance HPUE	Variance of Weighted Mean HPUE	Weighted Mean CPUE[c]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler-hours)	Sample Weight
900609	3	21	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	2.14192	0.72549
900609	6	49	0.01710	0.00363	0.000074	0.01710	0.00363	0.000074	4.14866	1.27451
900610	4	44	0.02482	0.02710	0.000616	0.02482	0.02710	0.000616	2.51910	1.09202
900610	6	57	0.02628	0.00692	0.000121	0.02628	0.00692	0.000121	4.32483	0.90798
900611	2	8	0.02960	0.00374	0.000468	0.03595	0.00363	0.000454	2.91791	0.50746
900611	5	28	0.02665	0.01989	0.000710	0.02665	0.01989	0.000710	4.51759	1.49254
900612	3	17	0.31029	0.57686	0.033933	0.31029	0.57686	0.033933	1.71130	0.57895
900612	6	39	0.08415	0.09734	0.002496	0.08415	0.09734	0.002496	6.81377	1.42105
900615	2	27	0.03248	0.00537	0.000199	0.03248	0.00537	0.000199	3.52128	0.83582
900615	4	47	0.08324	0.02932	0.000624	0.08324	0.02932	0.000624	4.91061	1.16418

[a] 1 = 0001-0400, 2 = 0401-0800, 3 = 0801-1200, 4 = 1201-1600, 5 = 1601-2000, 6 = 2001-2400

[b] Harvest per unit of effort (angler hours)

[c] Catch per unit of effort (angler hours)

Appendix A9. Estimates of chinook salmon harvest and catch rates per hour fished, by day and period, for completed-trip shore anglers, at the mouth of Willow Creek, Susitna River drainage, Alaska, during the second through fifth strata, 1990.

Stratum[a]	Date	Period[b]	# Angler Interviews	Weighted Mean HPUE[c]	Among Angler Variance	Variance of Weighted Mean HPUE	Weighted Mean CPUE[d]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler-hours)	Sample Weight
II	900616	1	60	0.02752	0.00961	.0001601	0.02752	0.00961	.0001601	2.32163	0.65169
II	900616	2	52	0.11230	0.11759	.0022613	0.11741	0.11778	.0022649	2.29354	0.53184
II	900616	3	52	0.02720	0.00735	.0001414	0.03091	0.00786	.0001512	2.06979	0.77154
II	900616	4	107	0.05519	0.04026	.0003763	0.08079	0.05767	.0005389	3.01327	1.15356
II	900616	5	140	0.07410	0.15276	.0010912	0.09170	0.16342	.0011673	5.17436	1.53558
II	900616	6	123	0.16207	0.66885	.0054378	0.17436	0.67195	.0054630	4.40652	1.29588
II	900617	1	73	0.06107	0.01285	.0001760	0.07454	0.01894	.0002595	1.77774	0.56180
II	900617	2	42	0.03845	0.01672	.0003981	0.06164	0.03003	.0007149	2.76155	0.73408
II	900617	3	47	0.07923	0.04152	.0008833	0.12759	0.06355	.0013521	3.48076	0.89888
II	900617	4	82	0.13544	0.24722	.0030149	0.14348	0.24898	.0030363	2.75226	0.98876
II	900617	5	109	0.06969	0.05538	.0005080	0.06969	0.05538	.0005080	4.27317	1.40824
II	900617	6	77	0.12442	0.25362	.0032938	0.14668	0.27170	.0035286	3.66321	1.07865
II	900618	2	37	0.07815	0.00951	.0002570	0.08115	0.01004	.0002714	2.24719	0.55431
II	900618	4	58	0.10937	0.04935	.0008509	0.16316	0.16477	.0028409	2.65879	0.89139
II	900618	5	76	0.07697	0.07049	.0009275	0.10730	0.10070	.0013250	3.06742	1.28090
II	900618	6	128	0.09506	0.07052	.0005509	0.17192	0.16400	.0012812	5.74228	1.66292
III	900623	1	131	0.23122	0.17004	.0012980	0.29072	0.32026	.0024447	3.22055	1.58012
III	900623	2	151	0.10819	0.08793	.0005823	0.20213	0.25634	.0016976	3.52950	0.77436
III	900623	3	73	0.13551	0.10010	.0013712	0.19418	0.12614	.0017280	4.09973	0.90691
III	900623	4	107	0.22023	0.51865	.0048472	0.36297	0.85232	.0079656	6.05673	1.28014
III	900623	5	183	0.13396	0.07442	.0004067	0.20734	0.13550	.0007404	4.90205	1.16503
III	900623	6	86	0.11384	0.05222	.0006073	0.23229	0.28579	.0033231	4.90279	1.03597
III	900624	2	89	0.10250	0.07893	.0008868	0.17216	0.15280	.0017168	3.66934	0.86854
III	900624	3	73	0.08740	0.03769	.0005163	0.12643	0.04767	.0006530	4.24602	0.97319
III	900624	4	139	0.07668	0.03256	.0002342	0.10394	0.05421	.0003900	3.84840	1.01504
III	900624	5	114	0.08340	0.03318	.0002910	0.15881	0.14988	.0013148	5.63423	1.08132
III	900624	6	138	0.13879	0.07801	.0005653	0.21453	0.25281	.0018320	5.34615	1.15457
III	900625	1	142	0.09391	0.03676	.0002588	0.12872	0.06446	.0004540	2.87168	0.71855
III	900625	2	65	0.05733	0.00685	.0001054	0.10691	0.03073	.0004728	2.37364	0.53019
III	900625	3	114	0.11872	0.06628	.0005814	0.18727	0.16812	.0014747	4.08734	0.96272
III	900625	4	69	0.08649	0.03336	.0004835	0.22439	0.24508	.0035518	4.98953	1.14759
III	900625	5	76	0.10902	0.05680	.0007473	0.12528	0.06054	.0007965	3.09580	0.80576
IV	900630	2	158	0.18992	0.08203	.0005192	0.33025	0.39405	.0024940	5.19921	1.22016
IV	900630	3	112	0.25393	0.43221	.0038590	0.36667	0.50349	.0044955	5.57177	1.04093
IV	900630	4	150	0.12591	0.17327	.0011552	0.24232	0.26486	.0017657	6.10662	1.16502
IV	900630	5	89	0.11262	0.05913	.0006644	0.21667	0.14653	.0016464	6.17692	1.18225
IV	900630	6	150	0.15637	0.08917	.0005945	0.23793	0.16995	.0011330	5.54161	1.19948

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Stratum[a]	Date	Period[b]	# Angler Interviews	Weighted Mean HPUE[c]	Among Angler Variance	Variance of Weighted Mean HPUE	Weighted Mean CPUE[d]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler-hours)	Sample Weight
IV	900701	1	187	0.12705	0.08720	.0004663	0.15880	0.12124	.0006484	4.52838	1.43042
IV	900701	2	114	0.06661	0.01343	.0001178	0.10416	0.04270	.0003746	3.94571	0.83068
IV	900701	3	73	0.05625	0.01407	.0001928	0.10277	0.03111	.0004261	4.04054	0.72383
IV	900701	4	76	0.11447	0.05551	.0007304	0.15772	0.09769	.0012854	3.59128	0.99612
IV	900701	5	105	0.10123	0.05104	.0004861	0.14420	0.11128	.0010598	4.66892	1.13744
IV	900701	6	62	0.07439	0.04288	.0006917	0.10306	0.07281	.0011743	5.03659	1.03059
IV	900702	2	72	0.07000	0.01843	.0002559	0.08592	0.02718	.0003775	3.58403	0.61698
IV	900702	3	40	0.07003	0.02284	.0005709	0.09459	0.03551	.0008879	2.50495	0.58940
IV	900702	4	72	0.07725	0.02331	.0003238	0.08770	0.02842	.0003947	4.09124	0.85136
IV	900702	5	68	0.04500	0.01587	.0002334	0.07505	0.03491	.0005133	2.92724	0.79621
IV	900702	6	104	0.10634	0.06315	.0006072	0.13778	0.09058	.0008710	3.99049	1.18914
V	900703	1	72	0.02758	0.00502	.0000698	0.02758	0.00502	.0000698	1.70438	0.53763
V	900703	3	40	0.09608	0.03965	.0009912	0.10668	0.04666	.0011665	3.32235	0.84781
V	900703	4	76	0.07498	0.03250	.0004277	0.12781	0.07374	.0009702	2.96474	0.78577
V	900703	5	38	0.10301	0.07228	.0019020	0.10877	0.07174	.0018880	3.75087	0.94706
V	900703	6	152	0.09131	0.16287	.0010715	0.13671	0.45289	.0029796	7.09939	1.87345
V	900704	1	167	0.07207	0.05871	.0003516	0.07207	0.05871	.0003516	5.95318	1.45988
V	900704	3	69	0.09059	0.05726	.0008298	0.10775	0.06619	.0009593	3.74150	0.89330
V	900704	4	73	0.07312	0.06197	.0008488	0.14952	0.12901	.0017672	4.73624	0.97188
V	900704	5	93	0.09594	0.15774	.0016961	0.11899	0.16607	.0017857	4.73545	0.89330
V	900704	6	108	0.02250	0.00970	.0000898	0.03042	0.01321	.0001223	3.26203	0.78991

[a] I = 09-15 June, II = 16-18 June, III = 23-25 June, IV = 30 June-02 July, V = 03-04 July

[b] 1 = 0001-0400, 2 = 0401-0800, 3 = 0801-1200, 4 = 1201-1600, 5 = 1601-2000, 6 = 2001-2400

[c] Harvest per unit of effort (angler hours)

[d] Catch per unit of effort (angler hours)

Appendix A10. Estimates of chinook salmon harvest and catch rates per hour fished, by day and period, for completed-trip shore anglers at the highway bridge creel survey on Willow Creek, Susitna River drainage, Alaska, during the fourth and fifth strata, 1990.

Stratum[a]	Date	Period[b]	# Angler Interviews	Weighted Mean HPUE[c]	Among Angler Variance HPUE	Variance of Weighted Mean HPUE	Weighted Mean CPUE[d]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler hours)	Sample Weight
IV	900630	1	33	1.10213	5.52297	0.16736	1.10213	5.52297	0.16736	5.6381	3.22179
IV	900630	2	12	0.04812	0.00531	0.00044	0.04812	0.00531	0.00044	5.0428	0.94553
IV	900630	3	32	0.32747	0.72299	0.02259	0.32747	0.72299	0.02259	1.7809	0.82296
IV	900630	4	1	0.00000			0.00000			7.5379	0.71790
IV	900630	5	0								1.01556
IV	900630	6	2	1.56343	4.40011	2.20006	1.56343	4.40011	2.20006	14.8526	1.52335
IV	900701	1	21	0.22318	0.48458	0.02308	0.22318	0.48458	0.02308	1.3574	0.77043
IV	900701	2	10	0.31051	0.58578	0.05858	0.31051	0.58578	0.05858	0.7814	0.61284
IV	900701	3	17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	4.9316	1.47082
IV	900701	4	7	0.33843	0.06584	0.00941	0.33843	0.06584	0.00941	13.8952	1.76848
IV	900701	5	0								1.12062
IV	900701	6	22	0.03937	0.00777	0.00035	0.08224	0.03026	0.00138	4.3010	0.98054
IV	900702	1	4	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	2.1012	0.26265
IV	900702	2	0								0.40272
IV	900702	3	17	0.07633	0.02017	0.00119	0.07633	0.02017	0.00119	1.2545	0.50778
IV	900702	4	9	0.04127	0.00621	0.00069	0.04127	0.00621	0.00069	1.6153	0.47276
IV	900702	5	11	0.54213	1.03813	0.09438	0.58139	1.02691	0.09336	2.1497	0.64786
IV	900702	6	10	0.08457	0.01564	0.00156	0.08457	0.01564	0.00156	2.1327	0.73541
V	900703	1	6	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.2335	0.23355
V	900703	3	11	0.10471	0.04480	0.00407	0.22438	0.17475	0.01589	1.6155	0.65817
V	900703	5	0								1.12527
V	900703	6	8	0.11040	0.02786	0.00348	0.11040	0.02786	0.00348	13.8004	2.20807
V	900704	1	0								1.14650
V	900704	2	17	0.04912	0.01242	0.00073	0.05965	0.01320	0.00078	4.0527	1.25265
V	900704	3	17	0.25371	0.16215	0.00954	0.25371	0.16215	0.00954	2.0607	0.63694
V	900704	4	3	0.17693	0.09391	0.03130	0.17693	0.09391	0.03130	4.9540	1.06157
V	900704	5	20	0.21291	0.45176	0.02259	0.26217	0.45069	0.02253	6.7452	0.76433
V	900704	6	0								0.91295

[a] IV = 30 June-02 July, V = 03-04 July

[b] 1 = 0001-0400, 2 = 0401-0800, 3 = 0801-1200, 4 = 1201-1600, 5 = 1601-2000, 6 = 2001-2400

[c] Harvest per unit of effort (angler hours)

[d] Catch per unit of effort (angler hours)

Appendix A11. Chinook salmon angler effort, harvest, harvest rates, catch, catch rates and mean angler counts, by day and period, for Little Susitna River, Alaska, shore anglers, exiting the fishery at the Burma Road access, 1990.

Date	Period[a]	Hours/ Period	# of Counts/ Period	Mean Count/ Period	Count Var.[b]	Est.[c] Effort	Est. Effort Var.	Inter- views/ Period	Mean Jack HPUE[d]	HPUE Jack Var.[e]	Est. Harvest/ Period	Harvest Var.	Mean Jack CPUE[f]	CPUE Jack Var.	Est. Catch/ Period	Catch Var.
605	2	6.0	2	9.0	2.0	54.0	36.0	9	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
610	1	6.0	2	15.0	128.0	90.0	2,304.0	15	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
611	2	6.0	2	9.5	0.5	57.0	9.0	13	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
614	3	6.0	2	20.5	12.5	123.0	225.0	31	0.0132	0.0002	1.6	2.6388	0.0132	0.0002	1.6	2.6388
620	3	6.0	2	40.0	8.0	240.0	144.0	30	0.0065	0.0000	1.6	2.6192	0.0065	0.0000	1.6	2.6192
622	2	6.0	2	20.0	8.0	120.0	144.0	32	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
629	3	6.0	2	7.0	2.0	42.0	36.0	12	0.0544	0.0019	2.3	3.3810	0.0544	0.0019	2.3	3.3810
701	1	6.0	2	0.0	0.0	0.0	0.0	4	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
702	2	6.0	2	0.5	0.5	3.0	9.0	6	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000
704	3	6.0	2	1.5	0.5	9.0	9.0	3	0.0000	0.0000	0.0	0.0000	0.0000	0.0000	0.0	0.0000

[a] 1 = 0600-1200, 2 = 1201-1800, 3 = 1801-2400

[b] Variance

[c] Estimated effort in angler hours

[d] Jackknife

[e] Harvest per unit of effort (angler hours)

[f] Catch per unit of effort (angler hours)

Appendix A12. Chinook salmon estimated angler effort, harvest, and catch by day and period for Little Susitna River, Alaska, boat anglers, exiting the fishery at the Burma Road access, 1990.

Date	Period[a]	Sample Size[b]	Mean Effort	Effort Var.[c]	Est.[d] Effort	Mean Harvest	Harvest Var.[c]	Est.[d] Harvest	Mean Catch	Catch Var.[c]	Est.[d] Catch
604	1	5	3.40	0.3000	17.00	0.20	0.2000	1	0.20	0.2000	1
604	3	52	5.62	10.4962	292.00	0.15	0.1327	8	0.17	0.1459	9
608	1	22	4.80	13.6347	105.50	0.23	0.1840	5	0.23	0.1840	5
608	2	70	4.64	6.5590	325.00	0.43	0.3354	30	0.44	0.3952	31
609	2	65	6.25	10.6572	406.50	0.43	0.3740	28	0.54	0.4712	35
609	4	50	6.02	14.0506	301.00	0.22	0.2159	11	0.30	0.4184	15
612	1	13	4.73	3.9423	61.50	0.77	0.1923	10	0.92	0.4103	12
612	4	125	5.46	15.3428	682.00	0.15	0.1299	19	0.21	0.2306	26
613	1	43	8.45	71.5543	363.50	0.47	0.3499	20	0.63	0.7154	27
613	3	39	8.55	53.0762	333.50	0.28	0.2078	11	0.46	0.5709	18
617	2	108	8.25	47.8808	890.50	0.44	0.3053	48	0.46	0.3444	50
617	3	139	8.24	32.5992	1,146.00	0.27	0.2436	38	0.37	0.7702	51
618	1	34	7.66	13.3594	260.50	0.59	0.4920	20	0.68	1.0134	23
618	2	37	5.15	7.8176	190.50	0.24	0.2447	9	0.24	0.2447	9
619	1	16	5.25	10.3667	84.00	0.38	0.3833	6	0.44	0.5292	7
619	2	52	4.77	12.3183	248.00	0.23	0.1810	12	0.38	0.7511	20
621	2	35	4.50	6.7794	157.50	0.29	0.2101	10	0.46	0.4908	16
621	3	40	5.79	12.8319	231.50	0.10	0.0923	4	0.10	0.0923	4
625	2	46	6.86	34.3407	315.50	0.20	0.2942	9	0.24	0.3193	11
625	3	29	6.21	3.2235	180.00	0.24	0.1897	7	0.24	0.1897	7
628	1	6	3.54	7.4604	21.25	0.17	0.1667	1	0.17	0.1667	1
628	4	31	5.56	27.1457	172.50	0.06	0.0624	2	0.06	0.0624	2
630	2	16	4.34	21.4906	69.50	0.38	0.3833	6	0.50	0.8000	8
630	4	12	6.13	5.9602	73.50	0.08	0.0833	1	0.08	0.0833	1
703	1	0	0.00	0.0000	0.00	0.00	0.0000	0	0.00	0.0000	0
703	3	7	2.93	3.7857	20.50	0.00	0.0000	0	0.00	0.0000	0
705	2	0	0.00	0.0000	0.00	0.00	0.0000	0	0.00	0.0000	0
705	3	8	4.25	1.3571	34.00	0.13	0.1250	1	0.13	0.1250	1
708	2	4	2.75	2.0833	11.00	0.00	0.0000	0	0.00	0.0000	0
708	4	4	4.00	0.0000	16.00	0.50	0.3333	2	0.50	0.3333	2

[a] 1=0800-1200, 2=1201-1600, 3=1601-2000, 4=2001-2400

[b] Number of interviews

[c] Variance

[d] Estimated

Appendix A13. Estimates of chinook salmon harvest and catch rates per hour fished, by day and period, for completed-trip shore anglers at the Little Susitna River, Alaska, exiting the fishery at the Burma Road access, 1990.

Date	Period[a]	# Angler Interviews	Weighted Mean HPUE[b]	Among Angler Variance HPUE	Variance of Weighted Mean HPUE	Weighted Mean CPUE[c]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler-hours)	Sample Weight
900605	2	9	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	4.11111	1
900610	1	15	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	3.06667	1
900611	2	13	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	4.00000	1
900614	3	31	0.01075	0.003584	.0001156	0.01075	0.003584	.0001156	2.45161	1
900620	3	30	0.00833	0.002083	.0000694	0.00833	0.002083	.0000694	4.98333	1
900622	2	32	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	2.35937	1
900629	3	12	0.12500	0.096591	.0080492	0.12500	0.096591	.0080492	2.83333	1
900701	1	0								
900702	2	6	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	1.50000	1
900704	3	3	0.00000	0.000000	.0000000	0.00000	0.000000	.0000000	0.50000	1

[a] 1 = 0600-1200, 2 = 1201-1800, 3 = 1801-2400

[b] Harvest per unit of effort (angler hours)

[c] Catch per unit of effort (angler hours)

Appendix A14. Estimates of chinook salmon harvest and catch rates per hour fished by day and period for completed-trip boat anglers at the Little Susitna River, Alaska, exiting the fishery at the Burma Road access, 1990.

Stratum[a]	Date	Period[b]	# Angler Interviews	Weighted Mean HPUE[c]	Among Angler Variance HPUE	Variance of Weighted Mean HPUE	Weighted Mean CPUE[d]	Among Angler Variance CPUE	Variance of Weighted Mean CPUE	Mean Weighted Angler Effort (angler-hours)	Sample Weight
I	900604	1	5	0.00877	0.00038	0.000077	0.00877	0.00038	0.000077	0.5965	0.17544
I	900604	3	52	0.04013	0.00991	0.000191	0.04597	0.01121	0.000216	10.2456	1.82456
I	900608	1	22	0.02708	0.00528	0.000240	0.02708	0.00528	0.000240	2.2935	0.47826
I	900608	2	70	0.21286	0.21000	0.003000	0.21426	0.21009	0.003001	7.0652	1.52174
I	900609	2	65	0.07886	0.01742	0.000268	0.09472	0.01896	0.000292	7.0696	1.13043
I	900609	4	50	0.02082	0.00213	0.000043	0.03261	0.00626	0.000125	5.2348	0.86957
II	900612	1	13	0.04413	0.00154	0.000118	0.04827	0.00149	0.000114	0.8913	0.18841
II	900612	4	125	0.05891	0.02537	0.000203	0.08521	0.05822	0.000466	9.8841	1.81159
II	900613	1	43	0.27368	0.79299	0.018442	0.30526	0.79167	0.018411	8.8659	1.04878
II	900613	3	39	0.11244	0.11472	0.002941	0.16975	0.20116	0.005158	8.1341	0.95122
II	900617	2	108	0.09117	0.04181	0.000387	0.09387	0.04250	0.000394	7.2105	0.87449
II	900617	3	139	0.05575	0.04396	0.000316	0.06498	0.04755	0.000342	9.2794	1.12551
III	900618	1	34	0.10002	0.01637	0.000482	0.10891	0.02093	0.000615	7.3380	0.95775
III	900618	2	37	0.09671	0.04534	0.001225	0.09671	0.04534	0.001225	5.3662	1.04225
III	900619	1	16	0.02708	0.00189	0.000118	0.03361	0.00365	0.000228	2.4706	0.47059
III	900619	2	52	0.07950	0.02815	0.000541	0.12656	0.08064	0.001551	7.2941	1.52941
III	900621	2	35	0.08309	0.03399	0.000971	0.11438	0.04208	0.001202	4.2000	0.93333
III	900621	3	40	0.02021	0.00404	0.000101	0.02021	0.00404	0.000101	6.1733	1.06667
IV	900625	2	46	0.02712	0.00517	0.000112	0.03537	0.00625	0.000136	8.4133	1.22667
IV	900625	3	29	0.04937	0.02146	0.000740	0.04937	0.02146	0.000740	4.8000	0.77333
IV	900628	1	6	0.03604	0.00779	0.001299	0.03604	0.00779	0.001299	1.1486	0.32432
IV	900628	4	31	0.00901	0.00122	0.000039	0.00901	0.00122	0.000039	9.3243	1.67568
IV	900630	2	16	0.06281	0.00995	0.000622	0.08879	0.02878	0.001798	4.9643	1.14286
IV	900630	4	12	0.00714	0.00061	0.000051	0.00714	0.00061	0.000051	5.2500	0.85714
V	900703	1	0							0.0000	0.25000
V	900703	3	7	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	5.1250	1.75000
V	900705	2	0							0.0000	0.22222
V	900705	3	8	0.07407	0.04390	0.005487	0.07407	0.04390	0.005487	7.5556	1.77778
V	900708	2	4	0.00000	0.00000	0.000000	0.00000	0.00000	0.000000	2.7500	1.00000
V	900708	4	4	0.12500	0.02083	0.005208	0.12500	0.02083	0.005208	4.0000	1.00000

[a] I = 04-10 June, II = 11-17 June, III = 18-24 June, IV = 25 June-01 July, V = 02-08 July, VI = 09-13 July

[b] 1 = 0800-1200, 2 = 1201-1600, 3 = 1601-2000, 4 = 2001-2400

[c] Harvest per unit of effort (angler hours)

[d] Catch per unit of effort (angler hours)

Appendix A15. Yentna River and Skwentna River, Alaska, angler counts, mean daily counts, daily angler effort, and variance for each period surveyed, 1990.

Period	Count Time								Mean Daily	Daily Angler	Within Day	Among Day
Date	A 0600-0759	B 0800-0959	C 1000-1159	D 1200-1359	E 1400-1559	F 1600-1759	G 1800-1959	H 2000-2159	Daily Count	Angler Effort	Within Day Variance	Among Day Variance
900616												
900617				95				41	68	1,088	186,624	0
900618												
900619												
900620	23				54				38.5	616	61,504	222,784
900621												
900622												
900623		89				49			69	1,104	102,400	238,144
900624												
900625												
900626	22				35				28.5	456	10,816	419,904
900627												
900628												
900629	18				28				23	368	6,400	7,744
900630												
900701												
900702				17				12	14.5	232	1,600	18,496
900703												
900704												
900705		4				3			3.5	56	64	30,976
900706												
900707												
900708		3				9			6	96	2,304	1,600
900709												
900710												
900711	2					5			3.5	56	576	1,600
900712												
900713												

Number of Days Surveyed: 9	Mean Daily Effort Estimate	452	372,288	58,828
Number of Days in the Season: 28	Total Angler Effort Estimate	12,668	1,158,229	3,477,388
	Variance of total ang. effort	4,635,618		
	SE	2,153		

Appendix A16. Aerial survey results by individual count location for the Yentna River and Skwentna River, Alaska, during chinook salmon season, 16 June through 13 July 1990.

Location	# Aircraft	Percent of Total	# Boats	Percent of Total	# People Not Fishing	Percent of Total	# Anglers	Percent of Total
Skwentna River								
Eight Mile			23	13	5	4	64	14
Talachulitna			61	34	49	40	151	34
Shell Creek			0	0	0	0	0	0
Canyon Creek	4	13	1	1	5	4	0	0
Skwentna Total	4	13	85	48	59	48	215	48
Yentna River								
Fourth of July Cr.			0	0			0	0
Clearwater Creek	1	4	1	1			3	1
Gagnon Creek	7	27	10	6	12	10	56	13
Otter Creek			9	5	10	8	21	5
Kichatna River			1	1			0	0
Johnson Creek			6	3	4	3	5	1
Malone Creek			9	5	1	0	20	4
Donkey Creek			8	4	6	5	16	4
Bob's Creek			1	1			4	1
Hewitt Creek			1	1			3	1
Bottle Creek			0	0			0	0
Fish Lakes Creek	1	4	8	4			17	4
Indian Creek	8	31	9	5	5	4	11	2
Moose Creek	9	35	10	6	11	9	38	8
Beaver Creek			2	1	2	2	0	0
Fish Creek			17	10	12	10	39	9
Yentna Total	26	87	92	53	63	51	233	52
GRAND TOTAL	30	100	178	100	122	100	448	100

Appendix A17. Estimated contribution for individual release lots of hatchery-produced chinook salmon to the Willow Creek harvest, during each stratum of the creel survey, 1990.

Stratum	Date	Release Code #	Release Year	Estimated Contribution	Estimated Harvest	% Contribution to Harvest
Willow Creek Mouth						
I	609-615	31-17-58	88	31	143	21.7
II	616-618	31-17-58	88	44	251	17.5
		31-17-27	86	11		4.4
		31-16-45	85	30		12.0
III	623-625	31-17-58	88	373	836	44.6
IV	630-702	31-17-58	88	319	746	42.8
		31-17-27	86	20		2.7
		31-16-47	85	56		7.5
V	703-704	31-17-60	89	23	255	9.0
		31-17-27	86	42		16.5
Seasonal Total				949	2,231	42.5
Willow Creek Highway Bridge						
IV & V	630-704	No CWT recoveries		0	557	0.0

APPENDIX B

Appendix B1. Angler count, angler interview, and biological data files developed for Lake Creek, Willow Creek, Little Susitna River, and Yentna River-Skwentna River drainage, during 1990[a].

LSBOTS90.DTA	Little Susitna River creel survey angler interview data. All boat anglers exiting the fishery at the Burma Road access.
LSBDNS90.DTA	Little Susitna River creel survey angler interview data. Boat anglers fishing downstream of the Burma Road boat launch.
LSBBTS90.DTA	Little Susitna River creel survey angler interview data. Boat anglers fishing between Burma Road launch and the ADFG weir.
LSBUPS90.DTA	Little Susitna River creel survey angler interview data. Boat anglers fishing upstream of the ADFG weir.
LSU90SBK.DTA	Little Susitna River creel survey angler interview data. All shore anglers exiting the fishery at the Burma Road access.
LSU90CBK.DTA	Little Susitna River creel survey angler count data for shore anglers.
K004BBA0.DTA	Little Susitna River biological data.
M004DSM0.DTA	Willow Creek creel survey angler interview data. Interviews conducted at the mouth.
M004DCM0.DTA	Willow Creek creel survey angler count data. Angler counts conducted at the mouth.
M004DBA0.DTA	Willow Creek biological data collected at the mouth.
M004USA0.DTA	Willow Creek creel survey angler interview data. Interviews conducted at the highway bridge.
M004UCA0.DTA	Willow Creek creel survey angler count data. Angler counts conducted at the highway bridge.
M004UBA0.DTA	Willow Creek biological data collected at the highway bridge.
N0040SM0.DTA	Lake Creek creel survey angler interview data.
N0040CM0.DTA	Lake Creek creel survey angler count data.
N0040BA0.DTA	Lake Creek biological data.
YENSKW90.WK1	Yentna River and Skwentna River aerial angler counts.

[a] These data files are archived with Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518-1519. Contact Gail Heineman or Donna Buchholz (267-2369) for copies of the files and descriptions of the file formats.