Fishery Data Series No. 00-21

Angler Effort and Harvest of Chinook Salmon by the Recreational Fisheries in the Lower Kenai River, 1998

by

Larry E. Marsh

October 2000

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

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

A creel survey to estimate angler effort, and catch and harvest of chinook salmon *Oncorhynchus tshawytscha* was conducted on the Kenai River between the Soldotna Bridge and Cook Inlet from 5 May through 31 July 1998. During the early run (May and June), estimated angler-effort was 56,137 (SE = 2,806) angler-hours and harvest was 648 (SE = 89) chinook salmon. During the late run (July), estimated angler effort was 188,726 (SE = 4,924) angler-hours and harvest was 5,981 (SE = 392) chinook salmon. Unguided anglers exerted 31% of the fishing effort and took 24% of the harvest during the early run, while guided anglers exerted 69% of the effort and took 76% of the harvest. During the late run, unguided anglers advanced 48% of the effort and garnered 40% of the harvest. Guided anglers had 52% of the effort and 60% of the harvest.

The predominant age class in the recreational harvest as well as the inriver return during both runs was age-1.4 chinook salmon, followed by age-1.3 fish and age-1.2 fish.

Key words: Kenai River, chinook salmon, creel survey, effort, harvest, *Oncorhynchus tshawytscha*.

INTRODUCTION

The Kenai River supports the largest freshwater recreational fishery in Alaska with an average annual effort of almost 340,000 angler-days from 1990–1997 (Mills 1991-1994, Howe et al. 1995-1998). This represents about 13% of the state's total recreational fishing effort. The majority of sport fishing effort on the Kenai River occurs during the chinook salmon *Oncorhynchus tshawytscha* fishery (May through July) between the outlet of Skilak Lake and Cook Inlet (Figure 1). Angler effort in the chinook salmon fisheries increased from 1974 through 1988. Effort and harvest dropped during 1989–1992 because of decreased run sizes which necessitated restrictions to the fishery. Effort and harvest since 1992 have been similar to historical averages (Figures 2 and 3). Although coho salmon *O. kisutch*, sockeye salmon *O. nerka*, pink salmon *O. gorbuscha*, Dolly Varden *Salvelinus malma*, and rainbow trout *O. mykiss* are also harvested by anglers in the Kenai River, this report focuses on the chinook salmon fisheries.

Prior to 1970, the recreational fishery in the Kenai River was composed of shorebased anglers targeting sockeye salmon in July and coho salmon in August and early September. In 1973, anglers began experimenting with new fishing techniques which proved very effective for harvesting chinook salmon in the Kenai River; thus, the chinook salmon fishery began to rapidly expand (Figures 2 and 3).

Chinook salmon return to the Kenai River in two distinct temporal components: an early run, typically entering the river in early May until late June; and a late run, typically entering the river from late June through early August. Recreational anglers value fish from both runs due to their large size, especially those from the late run which average about 18 kg (40 lb) and may exceed 36 kg (80 lb). The world record sport-caught chinook salmon, which weighed 44.1 kg (97 lb), was taken from the Kenai River in May 1985.

The early and late chinook salmon returns to the Kenai River are managed by separate management plans adopted by the Board of Fisheries (BOF) in 1988. Both plans rely on estimates of inriver abundance obtained with sonar (Bosch and Burwen 1999, *In prep*; Burwen and Bosch 1995a, 1995b, 1996, 1998). The Kenai River Early King Salmon Management Plan stipulates that the use of bait is prohibited from 1 January until an estimated optimum spawning escapement level of 9,000 fish is projected. If the projected spawning escapement is between

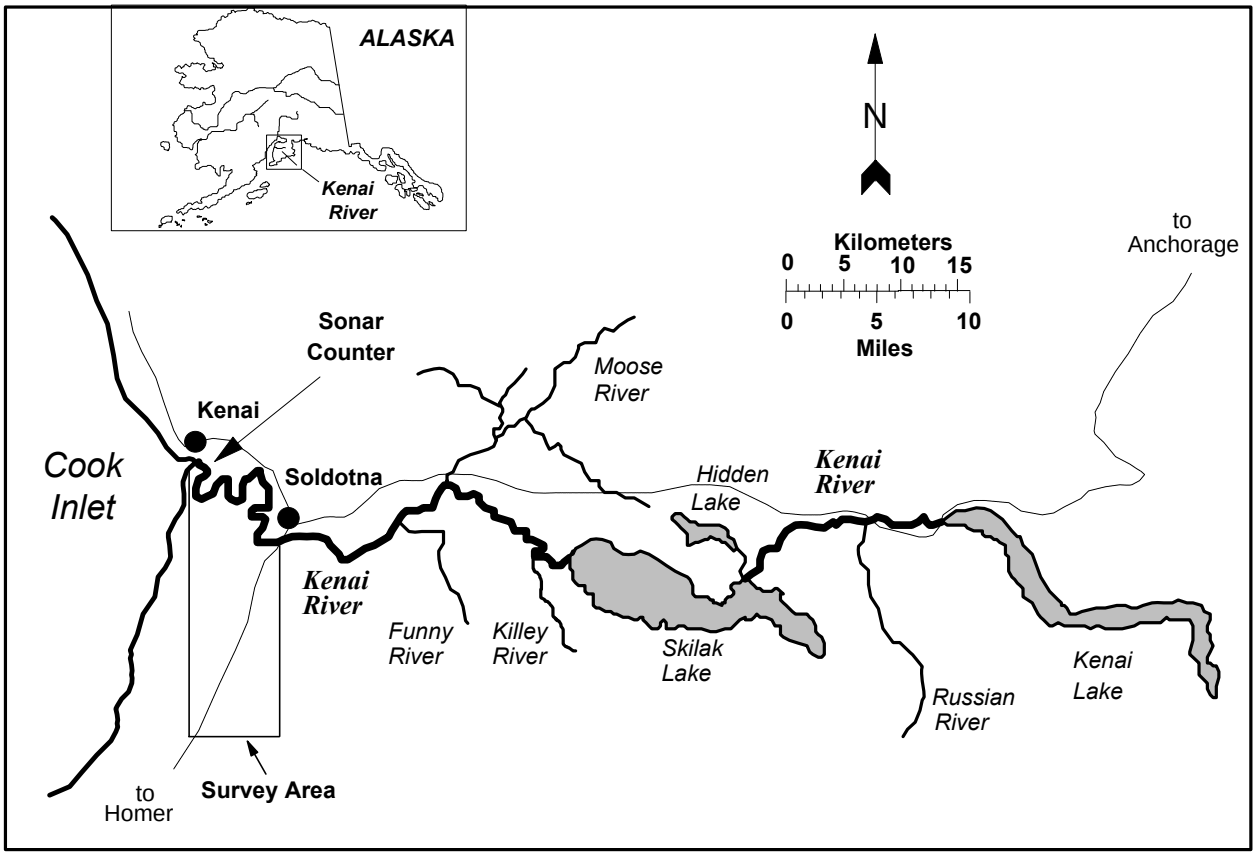
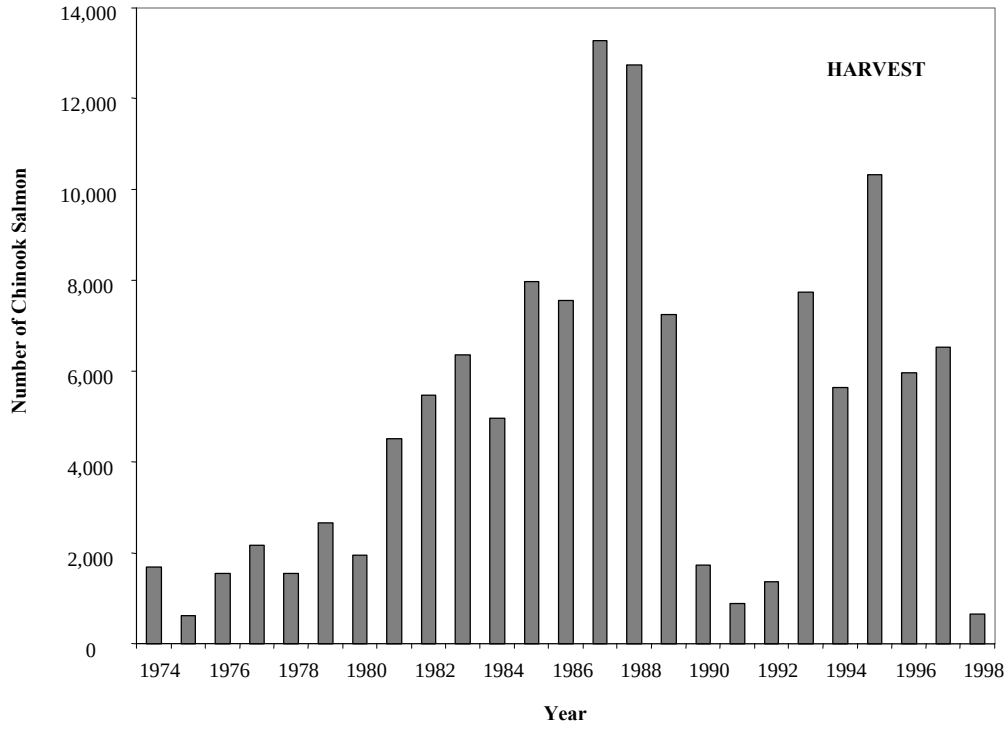


Figure 1.-Map of the Kenai River drainage.

5,300 and 9,000 fish, the department shall, by emergency order, restrict the fishery through bag limit reduction and/or time/area closure to achieve 9,000 fish in the escapement. If the projected escapement is less than 5,300, chinook salmon fishing is to be prohibited until 1 July downstream of the Funny River and 10 July upstream of the Funny River (Figure 4). A 1990 amendment to the plan, which was implemented in 1992, allowed retention of fish 132 cm (52 in) or larger if hook-and-release (trophy) fishing was imposed.

Management of the late-run recreational fishery in the Kenai River is complicated by the relatively large commercial harvest of returning chinook salmon. Chinook salmon are commercially harvested primarily by the setnet fishery along the eastern shore of Cook Inlet (McBride et al. 1985). User-group conflicts have required the Department of Fish and Game to manage the salmon resources of the Kenai River with increasing accuracy and precision.

In 1998, a creel survey was conducted to estimate angler effort and catch and harvest of chinook salmon by the recreational fishery in the Kenai River. Chinook salmon were sampled to estimate the length, age and sex composition of the harvest as well as the inriver return. This program provides relevant data used for inseason management decisions appropriate to the recreational fishery. The information is also used by the Board of Fisheries to refine long-term management objectives for Kenai River chinook salmon stocks as well as to allocate these salmon resources among user groups. Previous information on the chinook salmon fisheries in the Kenai River has



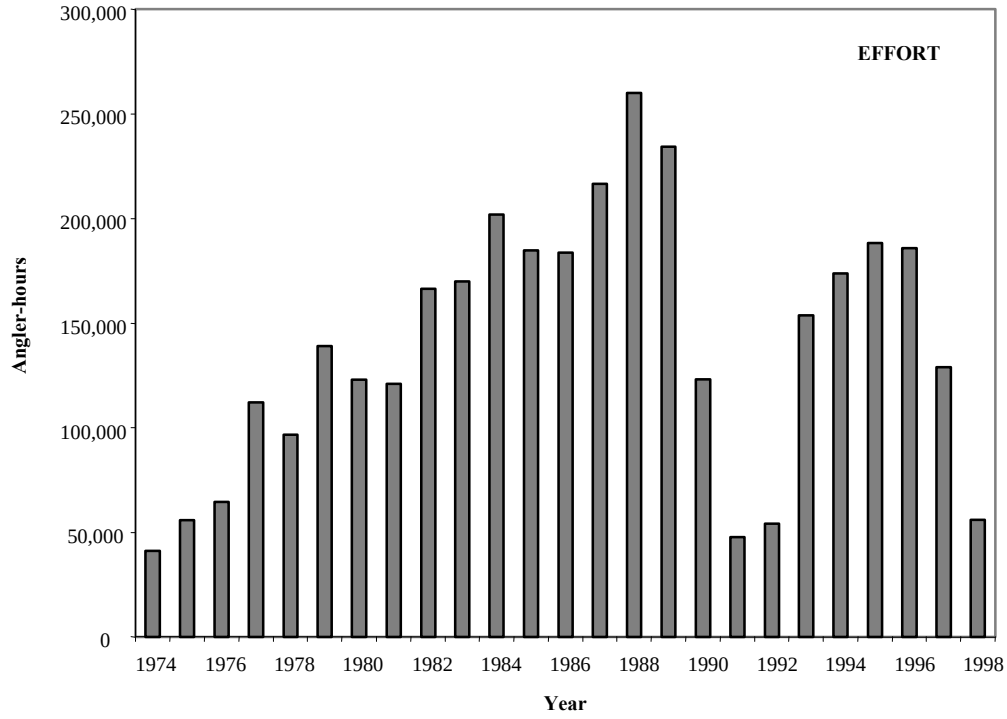
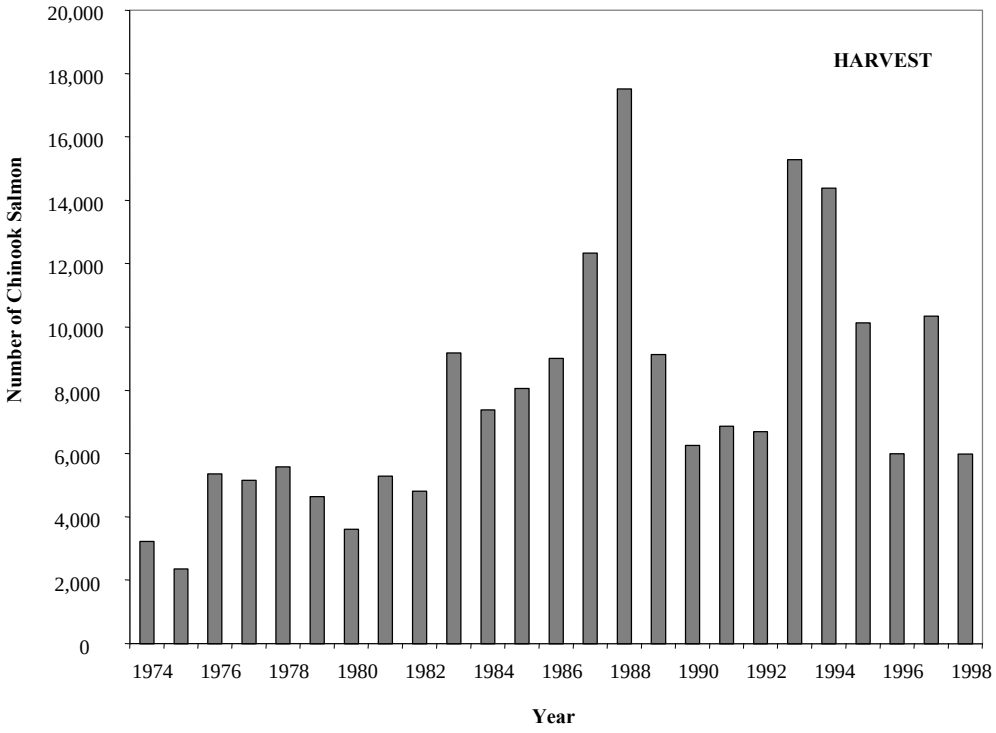


Figure 2.-Historical harvest and effort in the recreational fishery for early-run chinook salmon, Kenai River, 1974–1998.



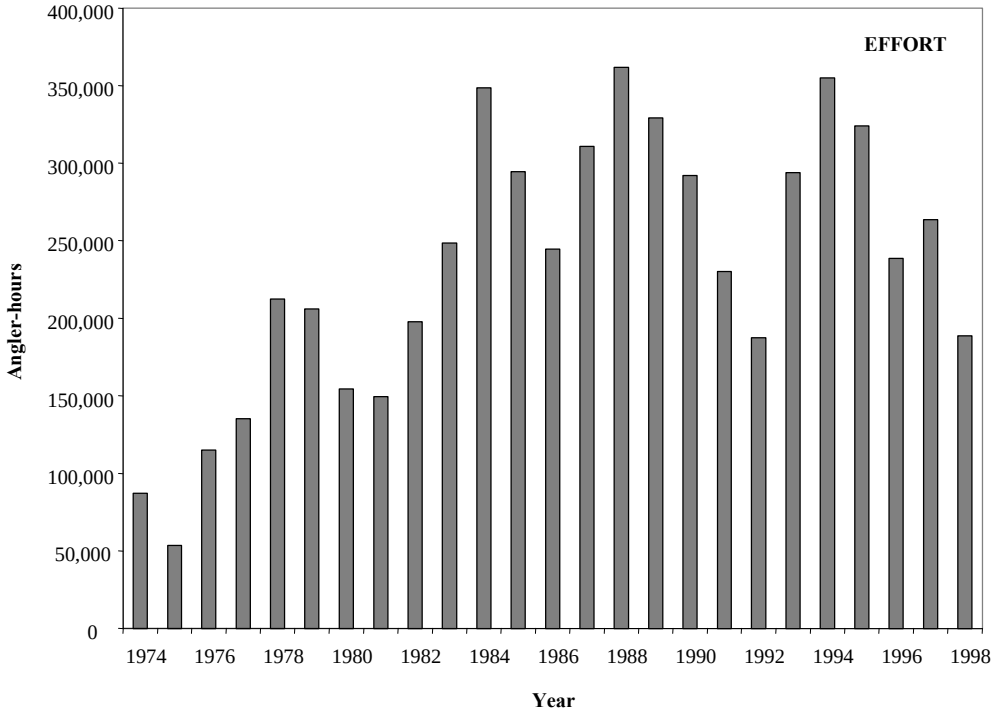


Figure 3.-Historical harvest and effort in the recreational fishery for late-run chinook salmon, Kenai River, 1974–1998.

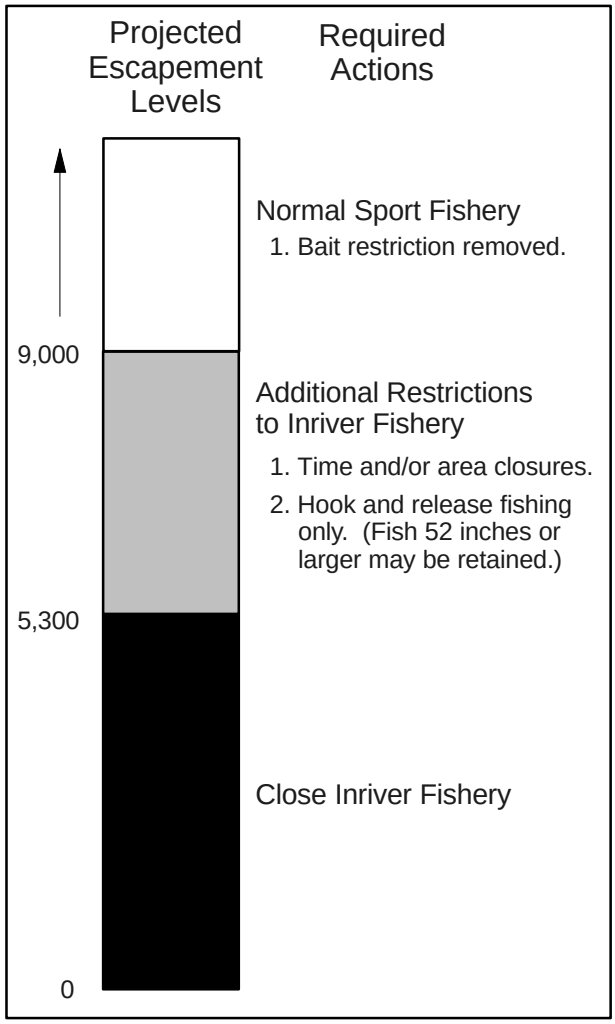


Figure 4.-Escapement levels and required actions according to the Kenai River Early Run Chinook Salmon Management Plan.

been presented by Hammarstrom (1975-1981, 1988-1994), Hammarstrom and Larson (1982-1984, 1986), Hammarstrom et al. (1985), Conrad and Hammarstrom (1987), King (1995-1997), and Marsh (1999). Additional harvest statistics for angler-effort and harvest by species for the Kenai River recreational fishery have been estimated by Mills (1979-1994) and Howe et al. (1995-1998) in the Alaska Statewide Sport Fish Harvest Survey.

FISHING REGULATIONS

Regulations for the chinook salmon fishery in the Kenai River are among the most restrictive of any open waters in Alaska. The river is open to fishing for chinook salmon between the outlet of Skilak Lake and Cook Inlet, with the exception of the confluence areas of the Funny River and Slikok Creek with the Kenai River. These waters are closed to fishing for chinook salmon until

15 July to protect early-run chinook salmon that stage in these locations prior to entering their natal streams. The season for chinook salmon is from 1 January through 31 July, but the fishery effectively begins in mid-May when the fish begin entering the river in significant numbers and the river becomes navigable for power-boat anglers. For management purposes the early run is defined as all chinook salmon entering the river prior to 1 July and the late run is defined as fish entering on or after 1 July.

The daily bag and possession limit are one chinook salmon per day greater than 41 cm (16 in) in length and a seasonal limit of two chinook salmon greater than 41 cm. Fishing from boats downstream from the outlet of Skilak Lake is prohibited on Mondays in May, June, and July, except Memorial Day Monday. Anyone retaining a chinook salmon that is 41 cm in length or greater is prohibited from fishing from a boat in the Kenai River downstream of Skilak Lake for the remainder of that day. The early-run fishery is further restricted from using bait, which is prohibited until the department is able to project an escapement of at least 9,000 fish or 1 July, whichever occurs first.

There are further restrictions for guided anglers. As well as prohibiting fishing from boats on Mondays, fishing from a registered guide vessel on Sundays in July is also prohibited. Fishing from a guided boat is only allowed between 0600 and 1800 hours during June and July. Guides are also prohibited from personally engaging in fishing during May, June, and July while conducting clients.

In 1998, the early-run fishery was restricted to catch-and-release fishing for all chinook salmon less than 132 cm (52 inches) by emergency order on 5 June. This management action was required to curtail harvest in response to low numbers of returning chinook salmon as estimated by sonar. The late-run fishery was also curtailed to "no bait" single-hook, artificial lure use only on 23 July and further restricted on 27 July to "trophy" fishing with catch-and-release fishing for all chinook salmon less then 132 cm (52 inches) in length. These emergency orders were issued in response to the magnitude of the early and late inriver returns, but allowed continued fishing opportunity while insuring that escapement goals were achieved.

METHODS

CREEL SURVEY

A stratified, two-stage roving-access site creel survey (Bernard et al. 1998a, 1998b) was utilized to estimate sport fishing effort, in angler-hours, and catch and harvest of chinook salmon in the Kenai River from Cook Inlet (river mile [rm]/river kilometer [rkm] 0) to the Soldotna Bridge (rm 21 or rkm 34) (Figure 5). Angler effort was estimated by conducting angler counts. Harvest per unit of effort (HPUE) and catch per unit of effort (CPUE) for chinook salmon were estimated from completed-trip angler interviews. The number of chinook salmon caught or harvested by the fishery was estimated as the product of the effort and harvest or catch rate estimates. Harvest refers to fish legally hooked and retained by anglers as part of their creel. Catch refers to fish legally hooked and retained plus those reported to be released by anglers, but not those fish that broke the line or escaped before being brought to the boat.

Regulations and the inherent character of the chinook salmon fishery determined how the stratification of the creel survey was implemented. The chinook salmon sonar site was originally

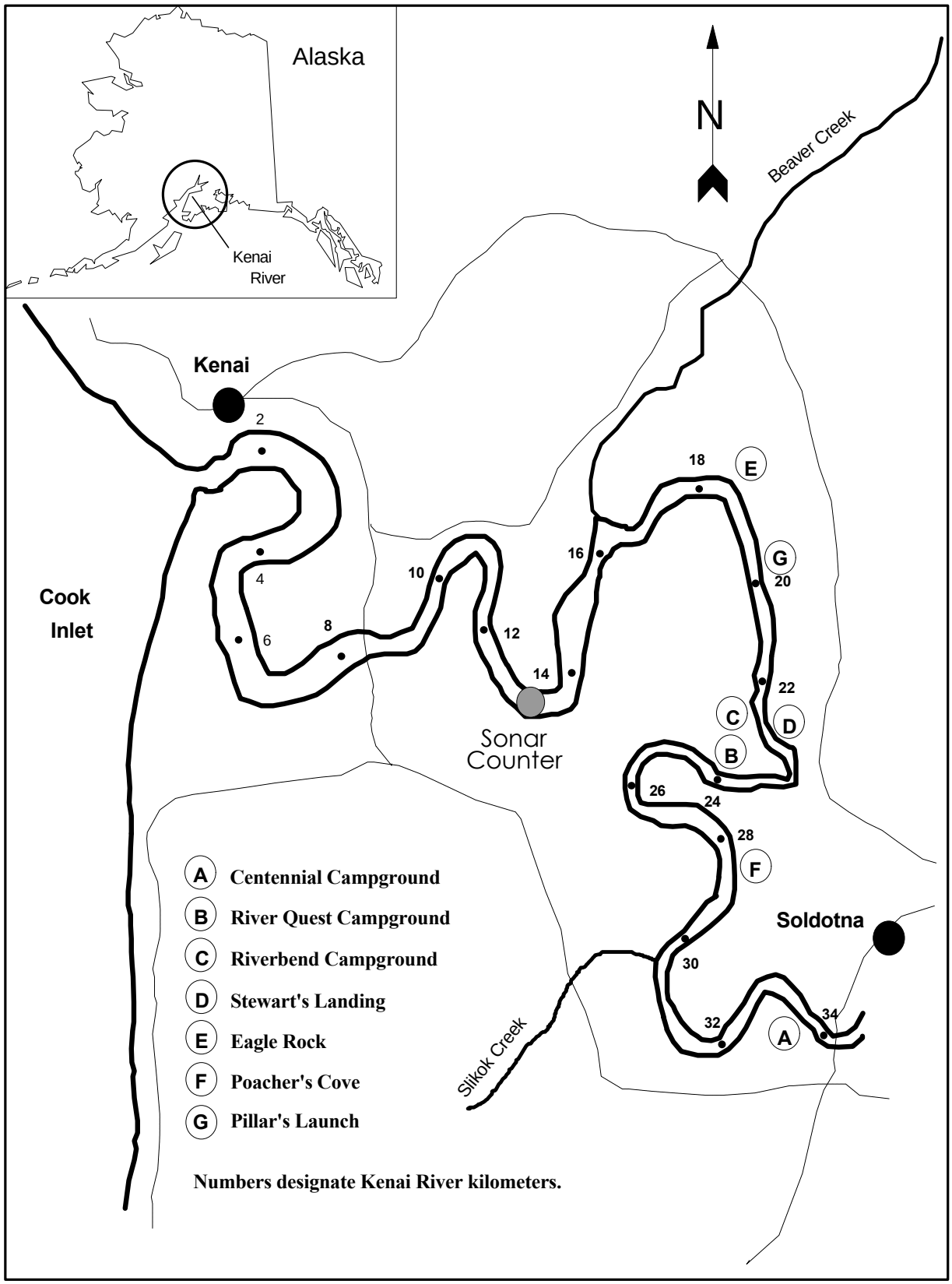


Figure 5.-Map of the Kenai River creel survey study area.

located downstream of the sport fishery. This allowed the returning chinook salmon to be enumerated prior to harvest by the recreational fishery. However, over time the fishery expanded downstream of the sonar site. Significant harvest downstream of the sonar site would conceivably affect the estimate of the inriver return. Thus, angler counts were stratified geographically by: (1) downstream of the Soldotna Bridge to the sonar site; and (2) downstream of the sonar site to the Warren Ames Bridge.

Both unguided and guided anglers participate in the Kenai River chinook salmon fishery, generally fishing from boats (Hammarstrom 1977). By regulation, guides are required to register and place a decal on their boat(s), making these two groups easily identifiable on the river. The times and days when guides may participate in the fishery are restricted, and harvest and catch rates between guided and unguided anglers are significantly different (King 1995-1997); therefore, angler counts and interviews were stratified by angler type.

Geographic location of effort, catch, and harvest and angler type (above or below the sonar site) was determined during completed-trip angler interviews and estimates were poststratified by these two factors. Harvest and catch rates have also differed significantly by time intervals and between weekdays and weekend/holidays (King 1995-1997). Therefore, the creel survey in 1998 was further stratified into approximate weekly time intervals and by day type (weekdays and weekends/holidays).

The creel survey began 5 May and continued through 31 July. The two-stage design consisted of periods, 12 or 20 hours in length (the entire angler-day) as the first stage and angler-trips the second stage. The entire fishing day was sampled to minimize problems with length-of-stay bias (Bernard et al. 1998a). The unguided angler-day was 20 hours long, from 0400 to 2400 hours during May, June and July. In May, the guided angler-day was also 20 hours long, but in June and July the guided angler-day is restricted by regulation from 0600 to 1800 hours. The guided angler-day is very structured during these 2 months because guides are limited to a 12-hour fishing day and the basic unit of charter time is generally one-half day.

Based upon these factors, the following strata were used for conducting angler counts and estimating creel statistics:

Geographic	2 strata	Upstream and downstream of the chinook salmon sonar site	
Temporal	13 strata	Early Run:	5-10 May, 11-17 May, 18-24 May, 25-31 May, 1-7 June, 8-14 June, 15-21 June, 22-30 June
		Late Run:	1-5 July, 6-12 July, 13-19 July, 20-26 July, 27-31 July
Day Type	2 strata	Weekday and Weekend/Holiday	
Angler Type	2 strata	Guided and Unguided	

This resulted in a total of 104 strata. All weekend/holiday days and one less than half of all possible weekday days (excluding Mondays when no boats were allowed on the river) were sampled within each temporal stratum. Weekday days to sample were chosen at random from all possible weekday days in each temporal stratum.

Anglers who had completed fishing were interviewed at the following seven popular campground/boat launch areas (Figure 5):

A) Centennial Campground
B) River Quest
C) Riverbend Campground
D) Stewart's Landing
E) Eagle Rock Launch Area
F) Poacher's Cove
G) Pillar's Launch Area.

Angler Counts

Five counts were made during each sample day. Time to begin the first count was chosen at random from a whole hour between 0400 to 0700 hours. All remaining counts in a day were made systematically, resulting in an angler count occurring every 4 hours. In June and July, when guided anglers were restricted to fishing from 0600-1800 hours, at least three counts of guided anglers were made. However, some deviation from the schedule did occur as a result of mechanical breakdown and/or other duties such as public assistance or enforcement activities.

Counts of anglers were conducted from a boat downstream of the Soldotna Bridge to the Warren Ames Bridge on the Kenai River. Two boat technicians, each working a 7.5-hour shift per day, conducted the angler counts downstream of the Soldotna Bridge. The starting point of each count (upstream or downstream extremity of the river section) was chosen at random. The technician counted anglers while attempting to drive the boat at a constant rate of speed through the survey area to the opposite end of the river section. The technician made a complete count for each geographic stratum. The entire count period usually required about 45 minutes to finish and every effort was made to ensure that the trip was completed in less than 1 hour. Angler counts were considered instantaneous and to reflect fishing effort at the time of the count. The boat technicians used multiple-station "tally-whackers" during each count. The following information was recorded for each count: (1) total number of unguided power boats; (2) total number of unguided drift boats; (3) total number of guided power boats; (4) total number of guided drift boats; (5) total number of unguided anglers in power boats; (6) total number of unguided anglers in drift boats; (7) total number of guided anglers in power boats (excluding the guide); (8) total number of guided anglers in drift boats (excluding the guide); and (9) total number of shore anglers.

Boats and anglers were considered engaged in fishing and were counted if the boat was in operation, regardless of whether or not an angler's line was in the water when the count was conducted. Guides were not included in the counts during the chinook salmon fishery as they are prohibited from fishing while guiding.

Angler Interviews

Two campground technicians, each working a 7.5-hour shift per day, conducted angler interviews at the designated access sites. The two boat technicians also conducted angler interviews when they were not engaged in angler counts, but only during times when the access technicians were not conducting interviews.

For each angler interviewed who had completed fishing, the technician inquired which geographic stratum the angler fished: downstream of the chinook salmon sonar site to the Warren Ames Bridge or upstream of the chinook salmon sonar site to the Soldotna Bridge. The technician obtained an interview for each stratum fished (possibly two interviews per angler) and

recorded the following information for each interview: (1) powered or nonpowered boat; (2) location fished (upstream or downstream, in reference to the chinook salmon sonar site); (3) guided or unguided angler; (4) number of hours spent fishing (to the nearest 0.5 hour); (5) number of fish, by species, retained; (6) number of fish, by species, released. All data were entered into a Hewlett-Packard HP95LX computerized data recorder.

During the interview, technicians inspected all harvested fish for an adipose finclip indicating that the fish had been tagged with a coded wire tag. This sampling was done to provide data for other projects, including estimating the proportion of chinook salmon marked with coded wire tags as juveniles in the Kenai River and interception of straying stocks marked with coded wire tags elsewhere in Cook Inlet. Flesh color (red or white) from fish missing the adipose fin was noted. Permission was requested from the angler to remove the fish head so that the coded wire tag could be recovered and decoded. Creel technicians marked the sampled fish observed during the interview procedure with a hole punch in the dorsal or caudal fin to prevent resampling. Data from coded wire tagged chinook salmon are presented in King and Breakfield (*In prep*).

BIOLOGICAL DATA

Recreational Harvest

Harvested chinook salmon were sampled for age, sex, and length during angler interviews. Mid-eye to fork-of-tail length was measured to the nearest one-half centimeter, the sex of the fish was identified, and scales were removed from the preferred area (Clutter and Whitesel 1956; Welander 1940). Three scales were collected from each fish and placed on an adhesive-coated card. Impressions of the scales were made on acetate, and the images, observed with a microfiche reader, were used to age the fish.

Inriver Return

To estimate the age and sex composition of the inriver return, chinook salmon were captured with 7 1/4-inch mesh gillnets in the intertidal area immediately downstream of the chinook salmon sonar counter (rm 8.4 to rm 7.9), using the techniques described by Hammarstrom and Larson (1984). Two, 2-person crews, each working a 9.5 hour shift per day, using a v-hull river boat conducted the sampling. Sampling was stratified into two 3-week strata during each run.

Fish were untangled from a drift gillnet and placed in a tagging cradle (Larson 1995) for sampling and released. Biological data collected included length (mid-eye to fork of tail), sex (using external characteristics) and three scales which were taken from the preferred area. Scale samples were prepared in the same manner as those from the creel survey. Each fish was also examined for the presence/absence of the adipose fin.

DATA ANALYSES

Total effort, catch, and harvest were estimated by expanding means over all days sampled in a stratum (i.e., location, weekly, day type, and angler type). During each sample day, five counts were made and interviews collected for the entire angler-day.

Angler effort, harvest and catch rates for chinook salmon, harvest and catch of chinook salmon, and associated variances were estimated using the same procedures for guided and unguided anglers.

Effort

The mean number of anglers counted on day i in stratum h was estimated by:

$$\bar{x}_{hi} = \frac{\sum_{g=1}^{r_{hi}} x_{hig}}{r_{hi}}, \quad (1)$$

where:

x_{hig} = the number of anglers observed in the gth count of day i in stratum h, and

r_{hi} = the number of counts on day i in stratum h.

Angler counts were conducted systematically within each sample day. The variance of the mean angler count was estimated by:

$$\hat{V}(\bar{x}_{hi}) = \frac{\sum_{g=2}^{r_{hi}} \left(x_{hig} - x_{hi(g-1)}\right)^2}{2r_{hi}(r_{hi}-1)}. \quad (2)$$

Effort (angler-hours) during day i in stratum h was estimated by:

$$\hat{E}_{hi} = L_{hi}\bar{x}_{hi}, \quad (3)$$

where:

L_{hi} = length of the sample day (= 20 hours for unguided anglers, = 20 hours for guided anglers in May, and = 12 hours for guided anglers in June and July) in each stratum.

The within day variance (effort) was estimated by:

$$\hat{V}(\hat{E}_{hi}) = L_{hi}^2 \hat{V}(\bar{x}_{hi}). \quad (4)$$

The mean effort of stratum h was estimated by:

$$\bar{E}_h = \frac{\sum_{i=1}^{d_h} \hat{E}_{hi}}{d_h}, \quad (5)$$

where:

d_h = number of days sampled in stratum h.

Days were sampled at random in each stratum; however, every weekend/holiday day was sampled. The variance of mean effort among days was estimated by:

$$\hat{V}(\bar{E}_h) = \frac{\sum_{i=1}^{d_h} \left(\hat{E}_{hi} - \bar{E}_h\right)^2}{(d_h - 1)}. \quad (6)$$

Total effort of stratum h was estimated by:

$$\hat{E}_h = D_h \overline{E}_h, \tag{7}$$

where:

D_h = total number of days the fishery was open in stratum h.

The variance of total effort of each stratum in a two-stage design, omitting the finite population correction factor for the second stage, was estimated by (Cochran 1977):

$$\hat{V}\left(\hat{E}_h\right) = (1-f)D_h^2 \frac{\hat{V}\left(\overline{E}_h\right)}{d_h} + fD_h^2 \frac{\sum_{i=1}^{d_h} \hat{V}\left(\hat{E}_{hi}\right)}{d_h^2}, \tag{8}$$

where:

f = finite population correction factor for days sampled ($= d_h / D_h$).

Harvest and Catch

Catch and harvest per unit of effort of each day sampled was estimated from angler interviews using the jackknife method to minimize the bias of these ratio estimators (Efron 1982). A jackknife estimate of CPUE (similarly HPUE) was made for each angler by:

$$CPUE^*_{hij} = \frac{\sum_{\substack{a=1 \\ a \neq j}}^{m_{hi}} c_{hia}}{\sum_{\substack{a=1 \\ a \neq j}}^{m_{hi}} e_{hia}}, \tag{9}$$

where:

c_{hia} = catches of all anglers interviewed on day i in stratum h except angler j,

e_{hia} = effort (hours fished) of all anglers interviewed on day i in stratum h except angler j, and

m_{hi} = number of anglers interviewed on day i in stratum h.

The jackknife estimate of mean CPUE of day i was the mean of the angler estimates:

$$\overline{CPUE}^*_{hi} = \frac{\sum_{j=1}^{m_{hi}} CPUE^*_{hij}}{m_{hi}}, \tag{10}$$

and the bias corrected mean was:

$$\overline{CPUE}^{**}_{hi} = m_{hi}\left(\overline{CPUE}_{hi} - \overline{CPUE}^*_{hi}\right) + \overline{CPUE}^*_{hi}, \tag{11}$$

where:

$\overline{CPUE}_{hi}$ = the standard estimate of CPUE, or the sum of all catches over the sum of all hours fished in a day.

The variance of the jackknife estimate of CPUE was estimated by:

$$\hat{V}\left(\overline{CPUE}_{hi}^{**}\right)=\frac{m_{hi}-1}{m_{hi}}\sum_{j=1}^{m_{hi}}\left(CPUE_{hij}^{*}-\overline{CPUE}_{hi}^{*}\right)^{2}. \quad (12)$$

Catch during each sample day was estimated as the product of effort and CPUE by:

$$\hat{C}_{hi}=\hat{E}_{hi}\overline{CPUE}_{hi}^{**}, \quad (13)$$

and the variance by (Goodman 1960):

$$\hat{V}\left(\hat{C}_{hi}\right)=\hat{V}\left(\hat{E}_{hi}\right)\left(\overline{CPUE}_{hi}^{**}\right)^{2}+\hat{V}\left(\overline{CPUE}_{hi}^{**}\right)\hat{E}_{hi}^{2}-\hat{V}\left(\hat{E}_{hi}\right)\hat{V}\left(\overline{CPUE}_{hi}^{**}\right) \quad (14)$$

HPUE was estimated by substituting angler harvest for angler catch in equations (9) through (12). Harvest during sample day i was estimated by substituting the appropriate $HPUE_{hi}$ statistics into equations (13) and (14). Total catch and harvest during stratum h was estimated using equations (5) through (8), substituting estimated catch ($\hat{C}_{hi}$) and harvest ($\hat{H}_{hi}$) during sample day i for the estimated effort ($\hat{E}_{hi}$) during day i.

The estimate of total effort, catch, and harvest, and their respective variances, were summed across the strata within each run as these estimates were considered independent. Covariances that arise because geographic locale and angler type were poststratified (i.e., estimates of these strata are not statistically independent) are likely too small to affect the precision of the estimates.

Biological Data

Age and sex composition of the chinook salmon harvest and inriver return was estimated for each run. The proportion of chinook salmon in age/sex group b in stratum t was estimated as:

$$\hat{p}_{bt}=\frac{n_{bt}}{n_{t}}, \quad (15)$$

where:

n_{bt} = the number of fish of age group b sampled during stratum t, and

n_{t} = the number of legible scales read from chinook salmon sampled during stratum t.

The variance of $\hat{p}_{bt}$ was estimated as (Scheaffer et al. 1979):

$$V(\hat{p}_{bt})=\frac{\hat{p}_{bt}(1-\hat{p}_{bt})}{(n_{t}-1)}. \quad (16)$$

Secchi Disc Measurements

During each day of the recreational fishery, the two boat technicians recorded a water clarity measurement using a Secchi disc at the beginning of their work shift. All measurements were made at approximately river mile 15.6. The average of the two daily measurements was used to reflect the water conditions for that particular day (Figure 6) and incorporated into the historical database. These historical data are utilized inseason for comparative purposes when reviewing seasonal catch rates between different years.

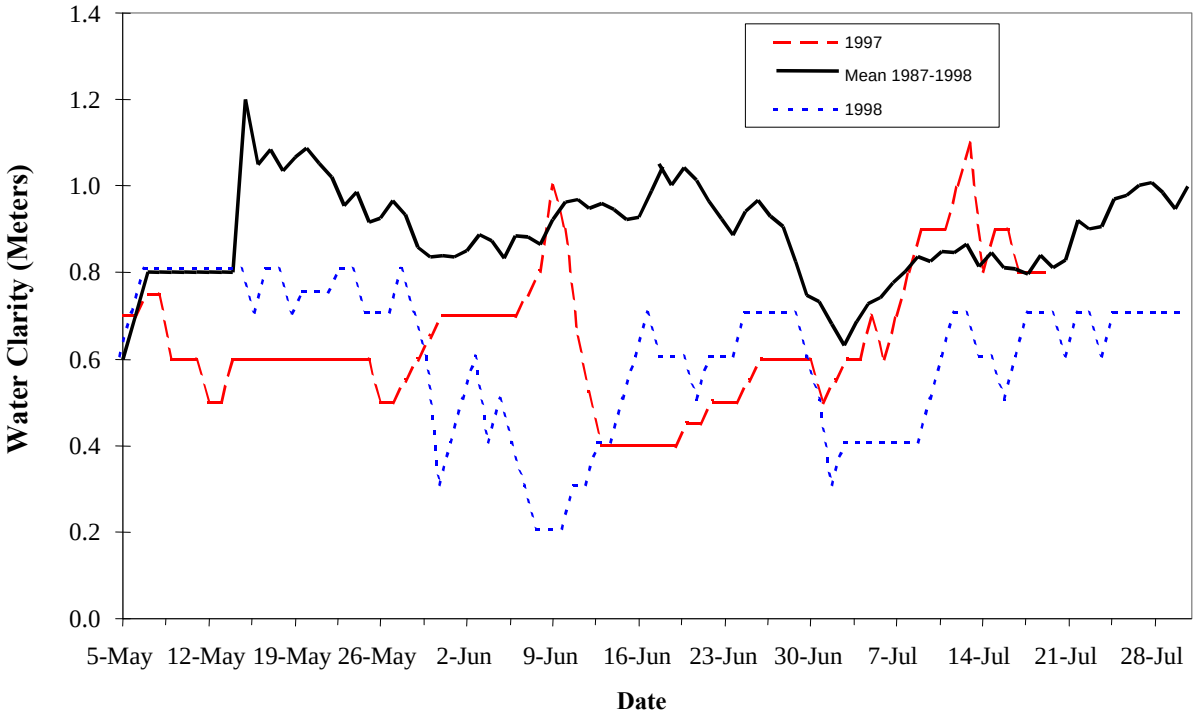


Figure 6.-Historic Kenai River Secchi transparency readings, 1987–1998.

RESULTS

CREEL SURVEY

The creel survey commenced on 5 May 1998. Angler counts were conducted on 60 of the 77 possible days: 35 of the 50 possible days during the early run were sampled and 25 of the possible 27 days during the late run were sampled. Because of the regulatory restrictions in place for guided anglers, there were only 24 possible sampling days during the late run for guided anglers and sampling efforts were made during 22 of those days. A total of 3,463 completed-trip angler interviews were collected during both early and late-run fisheries; 1,387 interviews during the early-run and 2,067 interviews during the late-run (Tables 1 and 2).

Relatively few anglers were observed fishing downstream of the sonar site, and on many days no anglers were counted in this area (Appendices A1 and A2). Estimates of effort showed that less than 0.5% of the total effort during the early run and about 5% of the total effort during the late

Table 1.-Estimated effort, and catch and harvest of chinook salmon by boat anglers during the fishery for early-run chinook salmon on the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

Angler Day Type	n[a]	N[b]	Number of Interviews[c]	Effort (Angler-hours) Est.	Effort (Angler-hours) SE	Catch Est.	Catch SE	Harvest Est.	Harvest SE
04 - 10 May									
Unguided weekdays	2	4	3	384	139	0	0	0	0
Unguided weekends	2	2	24	356	76	11	6	6	4
Guided weekdays	2	4	0	248	149	0	0	0	0
Guided weekends	2	2	9	220	76	4	5	4	5
11 - 17 May									
Unguided weekdays	2	4	12	704	93	25	23	25	23
Unguided weekends	2	2	69	1,064	246	7	5	2	2
Guided weekdays	2	4	32	1,208	487	50	31	50	31
Guided weekends	2	2	53	1,652	248	22	12	22	12
18 - 24 May									
Unguided weekdays	2	4	46	680	102	26	11	17	6
Unguided weekends	2	2	73	1,404	238	15	10	12	9
Guided weekdays	2	4	81	2,344	728	87	28	87	28
Guided weekends	2	2	38	2,528	418	57	31	57	31
25 - 31 May									
Unguided weekdays	2	4	50	1,848	297	75	26	42	16
Unguided weekends	3	3	124	1,712	231	36	14	27	13
Guided weekdays	2	4	82	4,376	1,182	114	41	107	44
Guided weekends	3	3	66	2,800	455	76	31	63	26
Subtotals:									
Unguided	17	25	401	8,152	550	195	41	131	33
Guided	17	25	361	15,376	1,623	410	74	390	74
May Total	17	25	762	23,528	1,714	605	85	521	81

-continued-

Table 1.-Page 2 of 2.

Angler Day Type	n[a]	N[b]	Number of Interviews[c]	Effort (Angler-hours) Est.	Effort (Angler-hours) SE	Catch Est.	Catch SE	Harvest Est.	Harvest SE
01 - 04 June									
Unguided weekdays	3	3	39	1,016	204	14	8	9	7
Unguided weekends	0	0	0	0	0	0	0	0	0
Guided weekdays	3	3	90	3,236	378	73	24	73	24
Guided weekends	0	0	0	0	0	0	0	0	0
05 - 07 June[d]									
Unguided weekdays	1	1	11	144	47	12	9	0	0
Unguided weekends	2	2	13	376	111	0	0	0	0
Guided weekdays	1	1	7	472	51	10	10	0	0
Guided weekends	2	2	29	864	154	5	5	0	0
08 - 14 June									
Unguided weekdays	2	4	4	448	150	0	0	0	0
Unguided weekends	2	2	14	856	156	66	36	0	0
Guided weekdays	2	4	29	1,464	179	0	0	0	0
Guided weekends	2	2	57	1,644	178	50	15	3	3
15 - 21 June									
Unguided weekdays	2	4	28	1,968	260	276	195	0	0
Unguided weekends	2	2	48	1,208	145	20	10	0	0
Guided weekdays	2	4	52	7,280	1,789	342	67	0	0
Guided weekends	2	2	37	2,628	267	40	20	14	15
22 - 30 June									
Unguided weekdays	2	5	31	2,238	285	122	35	17	17
Unguided weekends	2	2	40	1,100	251	31	20	0	0
Guided weekdays	2	5	74	4,355	999	170	50	11	11
Guided weekends	2	2	22	1,312	313	33	20	0	0
Subtotals:									
Unguided	18	25	228	9,354	580	541	203	26	18
Guided	18	25	397	23,255	2,145	723	93	101	31
June Total	18	25	625	32,609	2,222	1,264	223	127	36
Early Run Total	35	50	1,387	56,137	2,806	1,869	239	648	89

[a] Number of days during which interviews were collected.

[b] Number of days possible for interviewing.

[c] Complete trip interviews only.

[d] Fishery was restricted to catch and release fishing for all chinook salmon less than 132 cm in length by emergency order on 5 June.

Table 2.-Estimated effort, and catch and harvest of chinook salmon by boat anglers during the fishery for late-run chinook salmon on the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

Angler Day Type	n[a]	N[b]	Number of Interviews[c]	Effort (Angler-hours) Est.	Effort (Angler-hours) SE	Catch Est.	Catch SE	Harvest Est.	Harvest SE
01 - 05 July									
Unguided weekdays	2	2	28	3,462	547	178	87	20	20
Unguided weekends	3	3	106	5,152	683	40	20	9	9
Guided weekdays	2	2	59	7,104	1,503	473	163	315	115
Guided weekends	2	2	90	5,568	749	199	56	101	37
06 - 12 July									
Unguided weekdays	2	4	70	8,976	1,626	209	99	118	67
Unguided weekends	2	2	155	10,216	924	276	63	248	60
Guided weekdays	2	4	126	18,728	3,020	1,074	259	710	148
Guided weekends	1	1	61	3,528	437	151	43	94	30
13 - 15 July[a]									
Unguided weekdays	2	2	113	8,960	1,155	526	117	400	108
Unguided weekends	0	0	0	0	0	0	0	0	0
Guided weekdays	2	2	102	12,316	737	804	144	687	136
Guided weekends	0	0	0	0	0	0	0	0	0
16 - 19 July									
Unguided weekdays	2	2	156	10,316	943	419	95	264	74
Unguided weekends	2	2	149	15,464	1,057	732	152	579	123
Guided weekdays	2	2	90	11,324	808	993	182	462	114
Guided weekends	2	2	35	5,096	245	291	87	202	78
Subtotals:									
Unguided	15	17	777	62,546	2,758	2,380	260	1,638	202
Guided	13	15	563	63,664	3,659	3,985	400	2,571	274

-continued-

run occurred downstream of the sonar site. Because so few people fished downstream of the sonar site, very few completed-trip interviews were collected from anglers who fished in this area of the river. Based upon a lack of fishing effort and the potential for biases in estimating harvest and catch rates downstream of the sonar site, count and interview data were combined across spatial strata to provide more accurate estimates of total effort, catch, and harvest for both early and late runs.

Table 2.-Page 2 of 2.

Angler Day Type	n[a]	N[b]	Number of Interviews[c]	Effort (Angler-hours) Est.	Effort (Angler-hours) SE	Catch Est.	Catch SE	Harvest Est.	Harvest SE
20 - 22 July									
Unguided weekdays	2	2	113	12,060	844	398	94	203	64
Unguided weekends	0	0	0	0	0	0	0	0	0
Guided weekdays	2	2	135	12,004	816	701	117	613	112
Guided weekends	0	0	0	0	0	0	0	0	0
23 - 26 July									
Unguided weekdays	2	2	40	4,080	479	342	104	260	93
Unguided weekends	2	2	111	6,028	471	279	57	262	57
Guided weekdays	2	2	122	8,284	611	182	52	157	49
Guided weekends	1	1	38	3,420	361	206	65	206	65
27 - 31 July									
Unguided weekdays	4	4	49	5,140	508	264	99	43	46
Unguided weekends	0	0	0	0	0	0	0	0	0
Guided weekdays	4	4	119	11,500	813	1,178	167	28	20
Guided weekends	0	0	0	0	0	0	0	0	0
Subtotals:									
Unguided	10	10	313	27,308	1,192	1,283	181	768	135
Guided	9	9	414	35,208	1,353	2,267	220	1,004	140
Late Run Total	25	27	2,067	188,726	4,924	9,915	556	5,981	392

[a] Number of days during which interviews were collected.

[b] Number of days possible for interviewing.

[c] Complete trip interviews only.

[d] Poststratification on 15 July to reflect significant differences in age composition of sampled harvest.

During the early run, angler counts ranged from 0 to 82 for unguided anglers and from 0 to 277 for guided anglers (Appendix A1). The largest count of unguided anglers occurred on 24 May and for guided anglers on 16 June. During the late run, angler counts ranged from 0 to 649 for unguided anglers and from 42 to 621 for guided anglers (Appendix A2). The largest count of unguided anglers occurred on 19 July and for guided anglers on 22 July.

Estimated effort during the early run was 56,137 (SE = 2,806) angler-hours (Table 1). The relative precision of the total effort estimate (9.8%) for the early run was within the levels desired for this survey. Estimated effort during the late run was 188,726 (SE = 4,924) angler-hours (Table 2). The relative precision (5.1%) of the total effort estimate for the late run was also within the levels desired for the survey.

Daily catch rates of early-run chinook salmon by unguided anglers ranged from 0 to 0.221 (SE = 0.169) fish per hour and from 0 to 0.075 (SE = 0.023) fish per hour for anglers employing guides (Appendices B1 and B2). Peak daily catch rates of early-run chinook salmon by unguided anglers occurred on 16 June and on 17 June for guided anglers. Daily catch rates of late-run chinook salmon by unguided anglers ranged from 0 to 0.098 (SE = 0.049) fish per hour and from 0.016 (SE = 0.005) to 0.149 (SE = 0.055) fish per hour for guided anglers (Appendices B3 and B4). Peak daily catch rates of late-run chinook salmon by unguided anglers occurred on 29 July and by guided anglers on 30 July. During both runs, catch rates were generally higher for guided anglers than for unguided anglers (Appendices B1-B4).

An estimated 648 (SE = 89) chinook salmon were harvested during the early run (Table 1). Unguided anglers harvested 24% of the total and guided anglers the remaining 76%. The estimated catch of early-run chinook was 1,869 (SE = 239). The relative precision for total catch and harvest (25% and 27%, respectively) exceeded the desired levels of precision (15%). The catch-and-release emergency order for 5 June through 30 June (regulatory end of the early-run) increased the proportion of chinook salmon released by anglers. Prior to the emergency order, only 37% of the catch was released, but afterwards, 65% of the total early-run catch was released.

An estimated 5,981 (SE = 392) chinook salmon were harvested during the late run (Table 2). Unguided anglers accounted for 40% of the harvest and guided anglers 60%. The estimated catch of chinook salmon was 9,915 (SE = 556). The relative precision for total catch and harvest (11% and 13%, respectively) was within desired levels of precision (15%). Approximately 40% of the catch was voluntarily released during the late run.

The majority of the 1998 late-run effort was by guided anglers (52%). In general, catch per unit of effort (CPUE) and harvest per unit of effort (HPUE) for guided anglers was greater than that which unguided anglers reported during both runs.

BIOLOGICAL DATA

Recreational Harvest

Because the sport fishery was limited to catch-and-release fishing on 5–30 June, there was essentially no recorded harvest during the last time stratum. The age distribution of the early-run harvest differed significantly between temporal strata (5 May–24 May, 25 May-5 June) with differences (c^2 = 4.8, df = 1, P = 0.03) in the age composition between the major age classes. These differences were largely due to an increase in the number of fish aged 1.3 in the harvest. However, the overall estimates for the sport harvest were nearly identical between a poststratified approach and those estimates obtained without additional stratification. Therefore, with no change in either accuracy or precision of the estimates, the biological data from the temporal strata were combined to estimate the age composition of the harvest. The most abundant age group in the early-run harvest was age-1.4 fish, which comprised 72.7% (SE = 5.1) of the total

Table 3.-Age composition and mean length-at-age of chinook salmon sampled from the recreational harvest during the fishery for early-run chinook salmon in the Kenai River, 1998.

Parameter	1.2	1.3	1.4	1.5	Total
Male					
Percent		7.8	37.7	5.2	50.7
SE		3.1	5.6	2.6	5.7
Mean Length (mm)[a]		795	1,013	1,068	
SE		22	17	29	
Sample size		6	29	4	39
Female					
Percent	1.3	11.7	35.1	1.3	49.4
SE	1.3	3.7	5.5	1.3	5.7
Mean Length (mm)[a]	590	842	971	1,015	
SE		20	8		
Sample size	1	9	27	1	38
Combined					
Percent	1.3	19.5	72.7	6.5	100
SE	1.3	4.5	5.1	2.8	
Sample size	1	15	56	5	77

[a] Lengths measured mid-eye to fork-of-tail.

sampled harvest (Table 3). The only other major age class was 1.3 aged chinook salmon (19.5%; SE = 4.5). Chinook salmon aged 1.2 and 1.5 composed 1.3% (SE = 1.3) and 6.5% (SE = 2.8) of the harvest, respectively.

During the late-run, the age composition of the sampled harvest also differed significantly (c^2 = 6.0, df = 2, P = 0.05) between temporal strata (1 July-15 July and 16 July–31 July). However, the overall estimates for the sport harvest were nearly identical between a poststratified approach and those estimates obtained without additional stratification. Therefore, with no change in either accuracy or precision of the estimates, the biological data from the temporal strata were combined to estimate the age composition of the harvest. The most abundant age class in the late-run harvest was age-1.4 fish which comprised 71.0% (SE = 2.5) of the total sampled harvest (Table 4). Other age classes of significance were 1.3 and 1.2 aged fish which each comprised 12.4% (SE = 1.8) and 12.1% (SE = 1.8) of the harvest, respectively.

Table 4.-Age composition and mean length-at-age of chinook salmon sampled from the recreational harvest during the fishery for late-run chinook salmon in the Kenai River, 1998.

	Age					
Parameter	1.1	1.2	1.3	1.4	1.5	Total
Male						
Percent	1.2	7.3	4.2	27.8	0.9	41.4
SE	0.6	1.4	1.1	2.5	0.5	2.6
Mean Length (mm)[a]	365	667	815	1,050	1,115	
SE	25.3	8	18	8	32	
Sample size	4	24	14	92	3	137
Female						
Percent	0.3	4.8	8.2	43.2	2.1	58.6
SE	0.3	1.2	1.5	2.7	0.8	2.6
Mean Length (mm)[a]	490	635	834	1,002	1,091	
SE		14.6	19	5	20	
Sample size	1	16	27	143	7	194
Combined						
Percent	1.5	12.1	12.4	71.0	3.0	100
SE	0.7	1.8	1.8	2.5	0.9	
Sample size	5	40	41	235	10	331

[a] Lengths measured mid-eye to fork-of-tail.

Inriver Return

For the early run, there was no significant difference (c^2 = 0.9, df = 2, P = 0.63) in the age composition of the inriver return between the first 3-week stratum and second 3-week stratum (15 May-8 June, 9-30 June). Thus, it was not necessary to temporally stratify the netting data to estimate the age structure of the inriver return during the early run (Table 5). The most abundant age class was 1.4 aged fish, representing 41.1% (SE = 2.9) of the sampled fish. Age 1.3 (36.8%, SE = 2.9) was the second largest contributor, with age classes 1.2 (18.9%, SE = 2.3) and 1.5 (3.2%, SE = 1.0) also present.

During the late run, there was a detectable difference (c^2 = 20.0, df = 2, P = 0.01) in the age composition of the major age classes of the inriver return. The most abundant age class was 1.4 age fish, representing 67.8% (SE = 2.5) of the inriver return (Table 6). The inriver return also included age-1.3 (14.1%; SE = 1.9) and -1.2 fish (14.9%; SE = 1.9).

Table 5.-Age composition and mean length-at-age of chinook salmon sampled with large-mesh gillnets during the fishery for early-run chinook salmon in the Kenai River, 1998.

	Age				
Parameter	1.2	1.3	1.4	1.5	Total
Male					
Percent	18.2	19.6	14.4	1.4	53.6
SE	2.3	2.4	2.1	0.7	3.0
Mean Length (mm)[a]	643	794	1,008	1,130	
SE	5	8	14	43	
Sample size	52	56	41	4	153
Female					
Percent	0.7	17.2	26.7	1.8	46.4
SE	0.5	2.2	2.6	0.8	3.0
Mean Length (mm)[a]	643	830	963	1,114	
SE	43	8	7	18	
Sample size	2	49	76	5	132
Combined					
Percent	18.9	36.8	41.1	3.2	100
SE	2.3	2.9	2.9	1.0	
Sample size	54	105	117	9	285

[a] Lengths measured mid-eye to fork-of-tail.

Analysis-of-variance was used to test for differences in mean length-at-age by sex, run, and sampling method (recreational harvest or inriver gillnetting) for the predominate age classes. For age-1.3 fish, those sampled from the late run were significantly ($F = 5.31$; $df = 1, 201$; $P = 0.022$) larger than those sampled during the early run from both the sport harvest and the inriver return captured with gillnets. For age-1.4 fish, the mean length for late-run fish was also significantly larger than for early-run fish ($F = 68.30$; $df = 1, 625$; $P < 0.001$) from both the sport harvest as well as fish captured with gillnets.

Table 6.-Age composition and mean length-at-age of chinook salmon sampled with large-mesh gillnets during the fishery for late-run chinook salmon in the Kenai River, 1998.

	Age				
Parameter	1.2	1.3	1.4	1.5	Total
Males					
Percent	14.6	8.5	31.9	2.6	57.6
SE	1.9	1.5	2.5	0.9	2.6
Mean Length (mm)[a]	666	853	1,072	1,115	
SE	4	16	6	15	
Sample size	50	29	109	9	197
Females					
Percent	0.3	5.6	36.0	0.6	42.5
SE	0.3	1.2	2.6	0.4	2.6
Mean Length (mm)[a]	650	874	1,012	1,073	
SE		15	5	8	
Sample size	1	19	123	2	145
Combined					
Percent	14.9	14.1	67.8	3.2	100.0
SE	1.9	1.9	2.5	1.0	
Sample size	51	48	232	11	342

[a] Lengths measured mid-eye to fork-of-tail.

DISCUSSION

This was the second year that a stratified, two-stage roving-access creel design (Bernard et al. 1998a, 1998b) was used on the Kenai River. The study design replaced a roving creel survey (Neuhold and Lu 1957) used on the river for more than a decade. The new design was adopted so that effort, catch, and harvest could be estimated for each, individually sampled day. The previous creel design did not provide the necessary survey elements in order to estimate daily statistics inseason. In designing the survey, it was determined that sampling all weekend/holiday days and 1 day less than half of all possible weekdays of each biweekly stratum would provide estimates with the necessary accuracy and precision from which to base any management decisions. However, during the 1997 season, this sampling intensity was not adequate to provide

managers sufficient information during a critical period in the early run. The harvest was higher than expected and the final escapement was below the mandated escapement goal.

Therefore, the design was further modified for the 1998 season with the sampling stratification increased from biweekly to weekly strata. This effectively doubled the amount of sampling effort and provided managers additional information during critical decision periods. This increased sampling effort in the creel survey played a key role in the management actions exercised during the 1998 season. The 5 June implementation of "trophy" fishing was the earliest that such a decision has been made in the history of the fishery. Additional actions implemented during the late run to utilize a "no bait-artificial lure only, single-hook" restriction on 23 July and the "trophy" fishing restriction on 27 July were also influenced by the additional information provided by the creel survey.

In 1990-1992 and 1997 and 1998, emergency orders restricting the early-run fishery to catch-and-release fishing, or to a bag limit of one fish 132 cm or greater (trophy fishing) were implemented to meet escapement goals. These management actions reduced angler participation in the recreational fishery (Figure 2). For those years when trophy fishing has been implemented, total fishing effort has consistently declined below levels of previous historical estimates. During 1998, total fishing effort declined dramatically after the implementation of the emergency order on 5 June (Figure 7) and remained below levels experienced earlier in the season until 13 June when levels of angler participation began increasing with an upswing in guided fishing effort (Figure 8). Allowing fishermen to catch-and-release chinook salmon with the possibility of retaining a trophy 52 inch (132 cm) or larger fish apparently does not persuade as many unguided anglers to fish on the Kenai River as anglers employing guides. The increase in angler participation closely accompanied increasing numbers of chinook salmon entering the system as estimated by split-beam sonar (Bosch and Burwen *In prep*).

Angler effort during the 1998 early run was approximately 46,000 angler-hours (45%) less than the early-run fishery in 1997 (Marsh 1999). The most likely explanation for this reduction is the extended catch-and-release "trophy" fishing period during 5-30 June that was 12 days longer than the trophy fishing period during the 1997 early run. Unguided anglers had the greatest decrease in effort (54%) while effort by guided anglers declined by 40%. In 1998, guided anglers contributed 69% of the total effort and unguided anglers 31%.

Fishing effort during the 1998 late run declined by approximately 28% from the level of angler participation in 1997 (Marsh 1999). Unguided anglers had the greatest decrease in effort (34%), and guided angler participation declined by 22% from 1997 levels. A likely explanation for the reduction in fishing effort from the previous season is the management actions implemented on 23 and 27 July. The "no bait, artificial lure only, single hook" period beginning on 23 July and the catch-and-release trophy fishing on 27 July played a key role in the level of angler participation. The decrease in angler participation began on the first day of the 23 July emergency order and continued to gradually decline through the end of the season on 31 July (Figure 9).

The creel survey was geographically stratified to estimate harvest from the Warren Ames Bridge to the sonar site and from the sonar site to the Soldotna Bridge. This effort was made to provide

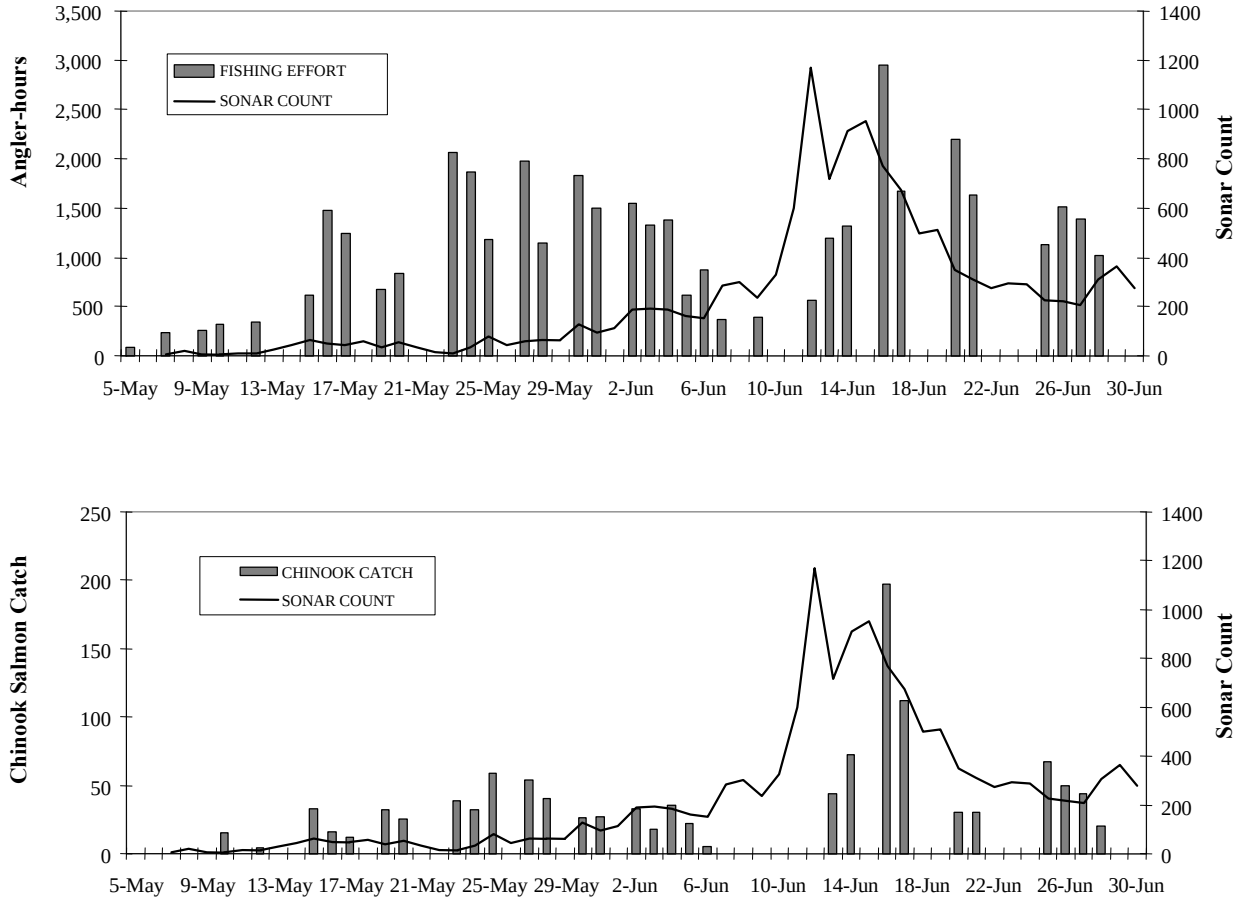


Figure 7.-Daily sonar counts of chinook salmon, recreational catch of chinook salmon (bottom) and angler effort (top) during the early run, Kenai River, 1998.

a more accurate and precise estimate of total inriver return (Hammarstrom and Timmons *In prep a, In prep b*). However, the estimated harvest downstream of the sonar site was virtually nonexistent, with 0 fish estimated for the early run and 268 fish for the late run. The early-run harvest in this river section was approximately 0% of the total inriver return of 13,103 (SE = 230) and the late-run harvest in the downstream area was approximately 0.7% of the total inriver return of 34,877 (SE = 500) (Bosch and Burwen *In prep*). The estimates of harvest and effort in this river section are very similar to the 1996 and 1997 results when the estimated early-run harvests were five and one fish, respectively. The late-run harvest estimates of 304 fish for 1996 and 473 fish for 1997 were also quite small in this section.

RECOMMENDATIONS

Although harvest downstream of the sonar site has remained a small part of the total harvest during the past three seasons, the creel survey should continue to estimate effort in this river section for the foreseeable future. This will provide fishery managers inseason information

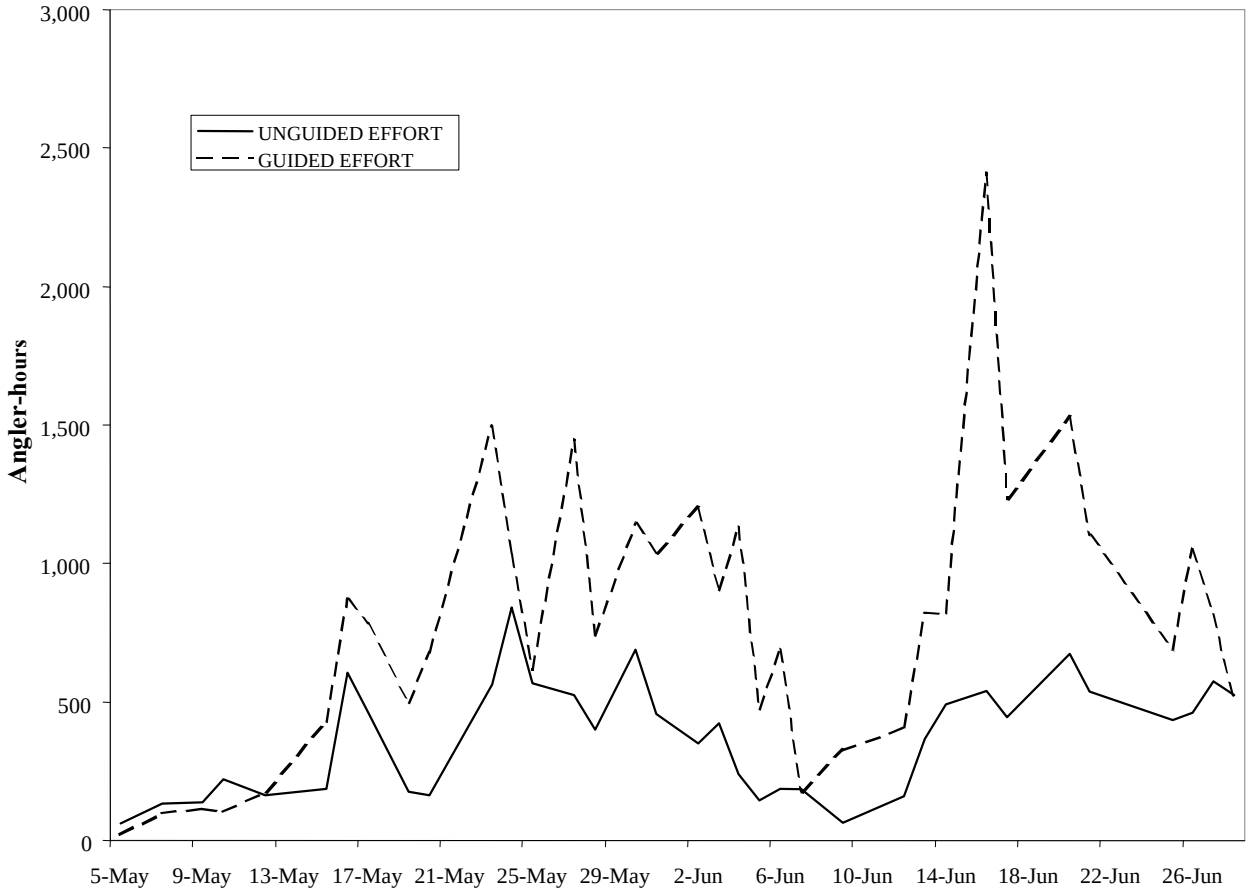


Figure 8.-Catch and effort for guided and unguided anglers in the recreational fishery for chinook salmon during the early run, Kenai River, 1998.

regarding the level of fishing pressure downstream of the sonar site. If the number of anglers fishing downstream of the sonar site increases in the future, such that the potential harvest would be a concern, the spatial stratification of angler interviews could be re-instated in order to estimate the harvest in this section of the river.

Sampling of the creel survey should be continued with weekly intervals. Maintaining this year's sampling levels of weekly stratification will provide additional information and allow fishery managers greater flexibility to insure that management objectives are accomplished. Increased sampling of the fishery during pivotal periods when historical data indicate that peak escapements and catches generally occur would also improve the department's ability to accurately project final harvests and escapements. Such measures would further refine the department's ability to provide for continued opportunity while meeting goals for spawning escapements.

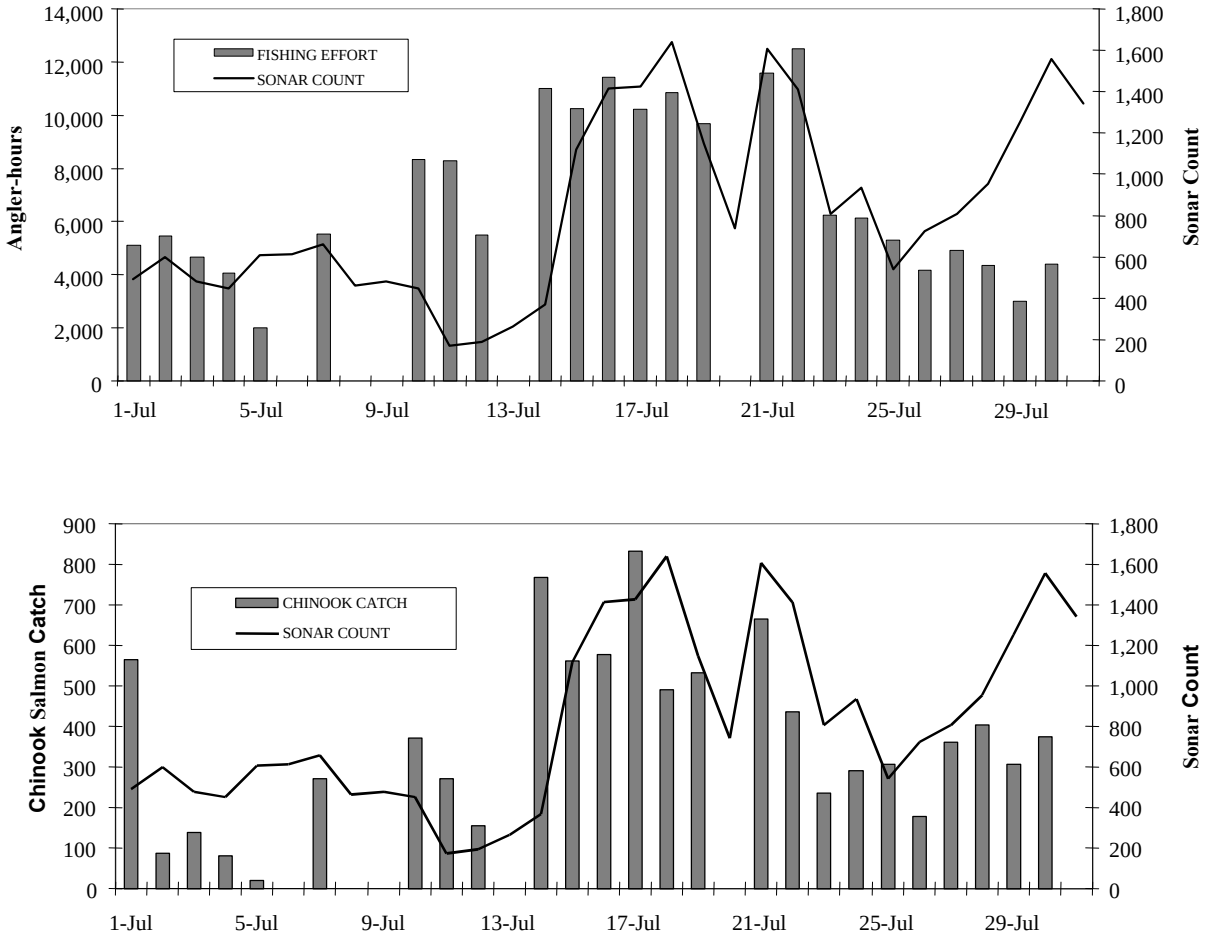


Figure 9.-Daily sonar counts of chinook salmon, recreational catch of chinook salmon (bottom) and angler effort (top) during the late run, Kenai River, 1998.

ACKNOWLEDGMENTS

I would like to express my gratitude to those individuals involved with the continued success of this project. The 1998 season was Steve Hammarstrom's last year as a research supervisor in the Soldotna office. Steve has been a source of innovation as well as a catalyst for the continued refinement of the Kenai River creel survey project since its beginning in 1974. He fostered the development of a computerized, data collection system for inseason estimates and provided the necessary guidance for implementing several different creel sample designs during the past 24 years. Steve has also provided a long-term, historical perspective of the fishery resources of the Kenai River and the Kenai Peninsula for myself and other staff biologists. His invaluable guidance and corporate knowledge will be greatly missed. Ed Borden and Gary Titus conducted the angler count surveys in the downstream section of the Kenai River. Kate Derning and Judy Brandt conducted angler interviews at the selected access locations downstream of the Soldotna Bridge and maintained a cheerful outlook despite the oftentimes contentious nature of the angling

public. Patti Berkhahn prepared scales for aging, read the scales, and entered the data into electronic files. I would also like to thank the Research and Technical Service staff, particularly Jim Hasbrouck who provided vital technical assistance with developing the survey design as well as the daily creel schedule.

LITERATURE CITED

Bernard, D. R., A. E. Bingham, and M. Alexandersdottir. 1998a. Robust harvest estimates from on-site roving-access creel surveys. Transactions of the American Fisheries Society 127:481-495.

Bernard, D. R., A. E. Bingham, and M. Alexandersdottir. 1998b. The mechanics of onsite creel surveys in Alaska. Alaska Department of Fish and Game, Special Publication No. 98-1, Anchorage.

Bosch, D. and D. Burwen. 1999. Estimates of chinook salmon abundance in the Kenai River using split-beam sonar, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-3, Anchorage.

Bosch, D. and D. Burwen. In prep. Estimates of chinook salmon abundance in the Kenai River using split-beam sonar, 1998. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Burwen, D. and D. Bosch. 1995a. Estimates of chinook salmon abundance in the Kenai River using dual-beam sonar, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 95-31, Anchorage.

Burwen, D. and D. Bosch. 1995b. Estimates of chinook salmon abundance in the Kenai River using dual-beam sonar, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-38, Anchorage.

Burwen, D. and D. Bosch. 1996. Estimates of chinook salmon abundance in the Kenai River using split-beam sonar, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-31, Anchorage.

Burwen, D. and D. Bosch. 1998. Estimates of chinook salmon abundance in the Kenai River using split-beam sonar, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 98-2, Anchorage.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9.

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

Conrad, R. H. and S. L. Hammarstrom. 1987. Harvest of chinook salmon Oncorhynchus tshawytscha and coho salmon O. kisutch and angler-effort by the lower Kenai River recreational fisheries, 1986. Alaska Department of Fish and Game, Fishery Data Series No. 6, Juneau.

Efron, B. 1982. The jackknife, the bootstrap and other resampling plans. Society for Industrial and Applied Mathematics, CBMS-NSF Monograph 38, Philadelphia, Pennsylvania.

Goodman, L. A. 1960. On the exact variance of products. Journal American Statistical Association 55:708-713.

Hammarstrom, S. L. 1975. Inventory and cataloging of Kenai Peninsula, Cook Inlet drainages and fish stocks. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1974-1975, Project F-9-7, 16 (G-I-C):27-68, Juneau.

Hammarstrom, S. L. 1976. Inventory and cataloging of Kenai Peninsula, Cook Inlet drainages and fish stocks. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1975-1976, Project F-9-8, 17 (G-I-C):35-62, Juneau.

Hammarstrom, S. L. 1977. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1976-1977, Project F-9-9, 18 (G-II-L):29-46, Juneau.

Hammarstrom, S. L. 1978. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1977-1978, Project F-9-10, 19 (G-II-L):42-56, Juneau.

LITERATURE CITED (Continued)

Hammarstrom, S. L. 1979. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (G-II-L):49-96, Juneau.

Hammarstrom, S. L. 1980. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (G-II-L):59-90, Juneau.

Hammarstrom, S. L. 1981. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (G-II-L):33-61, Juneau.

Hammarstrom, S. L. 1988. Angler effort and harvest of chinook salmon Oncorhynchus tshawytscha and coho salmon O. kisutch by the recreational fisheries in the lower Kenai River, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 50, Juneau.

Hammarstrom, S. L. 1989. Angler effort and harvest of chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 100, Juneau.

Hammarstrom, S. L. 1990. Angler effort and harvest of chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-22, Anchorage.

Hammarstrom, S. L. 1991. Angler effort and harvest of chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-44, Anchorage.

Hammarstrom, S. L. 1992. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-25, Anchorage.

Hammarstrom, S. L. 1993. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-40, Anchorage.

Hammarstrom, S. L. 1994. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-7, Anchorage.

Hammarstrom, S. L. and L. L. Larson. 1982. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (G-II-L):1-47, Juneau.

Hammarstrom, S. L. and L. L. Larson. 1983. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (G-II-L):36-67, Juneau.

Hammarstrom, S. L. and L. L. Larson. 1984. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (G-II-L):1-39, Juneau.

Hammarstrom, S. L. and L. L. Larson. 1986. Cook Inlet chinook and coho salmon studies. Alaska Department of Fish and Game, Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-9-18, 27 (G-32-1,2,4,5):1-56, Juneau.

Hammarstrom, S. L., L. L. Larson, M. Wenger, and J. Carlon. 1985. Kenai River chinook and coho salmon studies/Kenai River chinook salmon hook and release study. Alaska Department of Fish and Game, Federal Aid in Fish Restoration/Anadromous Fish Study, Annual Performance Report, 1984-1985, Project F-9-17/AFS-50, 26 (G-II-L), Juneau.

LITERATURE CITED (Continued)

Hammarstrom, S. L. and L. S. Timmons. In prep a. Stock assessment of early-run chinook salmon of the Kenai River, 1997 and 1998. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Hammarstrom, S. L. and L. S. Timmons. In prep b. Stock assessment of late-run chinook salmon of the Kenai River, 1997 and 1998. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

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

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

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1997. Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-29, Anchorage.

Howe, A. L., G. Fidler, A. E. Bingham, and M. J. Mills. 1998. Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25, Anchorage.

King, M. A. 1995. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-12, Anchorage.

King, M. A. 1996. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 96-32, Anchorage.

King, M. A. 1997. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-9, Anchorage.

King, B. E., and J. A. Breakfield. In prep. Chinook and coho salmon coded wire tagging studies in the Kenai River and Deep Creek, Alaska, 1998. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Larson, L. L. 1995. A portable restraint cradle for handling large salmonids. North American Journal of Fisheries Management 15:654-656.

Marsh, L. E. 1999. Angler effort and harvest of chinook salmon by the recreational fisheries in the lower Kenai River, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-4, Anchorage.

McBride, D. N., R. D. Harding, B. A. Cross, and R. H. Conrad. 1985. Origins of chinook salmon, Oncorhynchus tshawytscha (Walbaum), in the commercial catches from the central district eastside set gill net fishery in Upper Cook Inlet, 1984. Alaska Department of Fish and Game, Informational Leaflet No. 251.

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

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

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

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

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

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

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

LITERATURE CITED (Continued)

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

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

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

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

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

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

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

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

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

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

Neuhold, J. M. and H. K. Lu. 1957. Creel census methods. Utah State Department of Fish and Game, Publication 8, Salt Lake City, Utah.

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

Welander, A. D. 1940. A study of the development of the scale of the chinook salmon Oncorhynchus tshawytscha. Masters thesis, University of Washington, Seattle.

APPENDIX A. COUNTS OF BOAT ANGLERS DURING THE CREEL SURVEY OF THE FISHERY FOR CHINOOK SALMON ON THE KENAI RIVER, ALASKA, 1998

Appendix A1.-Counts of unguided and guided boat anglers, by stratum, during the fishery for early-run chinook salmon on the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

		Downstream[a]										Upstream[a]										Combined Strata									
	Day	Unguided Anglers					Guided Anglers					Unguided Anglers					Guided Anglers					Unguided Anglers					Guided Anglers				
Date	Type[b]	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
05-May	Wd	0	0	0	0	0	0	0	0	0	0	0	8	5	0	2	0	3	0	3	0	0	8	5	0	2	0	3	0	3	0
06-May	Wd	Not Sampled																													
07-May	Wd	0	0	0	0	0	0	0	0	0	0	0	3	18	9	3	0	17	4	0	4	0	3	18	9	3	0	17	4	0	4
08-May	Wd	Not Sampled																													
09-May	We	0	0	0	0	0	0	0	0	0	0	0	7	10	11	6	3	16	6	4	0	0	7	10	11	6	3	16	6	4	0
10-May	We	0	0	0	0	0	0	0	0	0	0	0	8	21	21	5	0	9	5	12	0	0	8	21	21	5	0	9	5	12	0
11-May	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
12-May	Wd	0	0	0	0	0	0	0	0	0	0	0	6	12	16	7	0	16	24	4	0	0	6	12	16	7	0	16	24	4	0
13-May	Wd	Not Sampled																													
14-May	Wd	Not Sampled																													
15-May	Wd	0	0	0	0	0	0	0	0	0	0	0	4	16	17	10	0	59	30	18	0	0	4	16	17	10	0	59	30	18	0
16-May	We	0	0	0	0	0	0	0	0	0	0	10	28	31	55	27	53	73	55	32	4	10	28	31	55	27	53	73	55	32	4
17-May	We	0	0	0	0	0	0	0	0	0	0	11	63	30	6	5	63	88	37	8	0	11	63	30	6	5	63	88	37	8	0
18-May	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
19-May	Wd	0	0	0	0	0	0	0	0	0	0	2	8	11	9	14	4	29	67	24	0	2	8	11	9	14	4	29	67	24	0
20-May	Wd	0	0	0	0	0	0	0	0	0	0	0	14	12	15	0	0	113	43	13	0	0	14	12	15	0	0	113	43	13	0
21-May	Wd	Not Sampled																													
22-May	Wd	Not Sampled																													
23-May	We	0	0	0	0	0	0	0	0	0	0	45	26	21	28	21	119	118	124	13	0	45	26	21	28	21	119	118	124	13	0
24-May	We	0	0	0	0	0	0	0	0	0	2	43	32	82	42	11	102	74	72	8	2	43	32	82	42	11	102	74	72	8	4
25-May	We	0	0	0	0	0	0	0	0	0	0	21	39	47	24	11	28	77	22	25	2	21	39	47	24	11	28	77	22	25	2
26-May	Wd	Not Sampled																													
27-May	Wd	0	0	0	0	0	0	0	0	0	0	33	43	20	18	17	151	141	49	13	8	33	43	20	18	17	151	141	49	13	8
28-May	Wd	0	0	0	0	0	0	0	0	0	0	2		32	16	30	4		73	46	25	2		32	16	30	4		73	46	25
29-May	Wd	Not Sampled																													
30-May	We	0	0	0	0	0	0	0	0	0	0	14	35	52	18	53	43	126	66	39	12	14	35	52	18	53	43	126	66	39	12
31-May	We	0	0	0	0	0	0	0	0	0	0	23	46	28	13	4	78	87	67	22	6	23	46	28	13	4	78	87	67	22	6

-continued-

Appendix A1.-Page 2 of 2.

Date	Day Type[b]	Downstream[a] Unguided Anglers A[c]	B	C	D	E	Downstream[a] Guided Anglers A	B	C	D	E	Upstream[a] Unguided Anglers A	B	C	D	E	Upstream[a] Guided Anglers A	B	C	D	E	Combined Strata Unguided Anglers A	B	C	D	E	Combined Strata Guided Anglers A	B	C	D	E
01-Jun	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
02-Jun	Wd	0	0	0	0	0	0	0	0			16	38	9	16	9	113	116	71			16	38	9	16	9	113	116	71		
03-Jun	Wd	0	0	0	0	0		0	0	0		11	24	52	16	3		116	87	23		11	24	52	16	3		116	87	23	
04-Jun	Wd	0	0	0	0	0		0	0	0		0	10	7	22	21		143	96	44		0	10	7	22	21		143	96	44	
05-Jun	Wd	0	0	0	0	0	0	0	0			4	7	16	9	0	39	46	33			4	7	16	9	0	39	46	33		
06-Jun	We	0	0	0	0	0		0	0	0		2	17	16	3	9		73	71	28		2	17	16	3	9		73	71	28	
07-Jun	We	0	0	0	0	0		0	0	0		0	6	26	7	8		22	16	6		0	6	26	7	8		22	16	6	
08-Jun	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
09-Jun	Wd	0	0	0	0	0		0	0	0		2	6	8	0	0		42	31	8		2	6	8	0	0		42	31	8	
10-Jun	Wd	Not Sampled																													
11-Jun	Wd	Not Sampled																													
12-Jun	Wd	0	0	0	0	0	0	4	0			6	7	11	13	3	29	34	35			6	7	11	13	3	29	38	35		
13-Jun	We	0	0	0	0	0	0	0	0			10	17	39	10	15	98	64	44			10	17	39	10	15	98	64	44		
14-Jun	We	0	0	0	0	0		2	0	0		2	34	30	29	28		90	60	53		2	34	30	29	28		92	60	53	
15-Jun	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
16-Jun	Wd	0	0	0	0	3		0	0	0		51	20	21	6	34		277	201	124		51	20	21	6	37		277	201	124	
17-Jun	Wd	0	0	0	0	0		0	4	0		7	14	30	29	31		162	85	57		7	14	30	29	31		162	89	57	
18-Jun	Wd	Not Sampled																													
19-Jun	Wd	Not Sampled																													
20-Jun	We	0	0	0	0	0	0	0	0			53	33	41	20	21		184	114	84		53	33	41	20	21		184	114	84	
21-Jun	We	0	0	0	4	0	0	0	0			29	47	30	22	2		83	94	98		29	47	30	26	2		83	94	98	
22-Jun	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
23-Jun	Wd	Not Sampled																													
24-Jun	Wd	Not Sampled																													
25-Jun	Wd	0	0		0	0		0		0		12	11		23	41		90		25		12	11		23	41		90		25	
26-Jun	Wd	0	0	0	0	0	0	0	0			15	27	17	46	10	134	87	42			15	27	17	46	10	134	87	42		
27-Jun	We	0	0	0	0	0	0	0	0			32	26	22	56	8	118	40	46			32	26	22	56	8	118	40	46		
28-Jun	We	0	0	0	0	0	0	0	0			30	42	15	40	4	66	50	8			30	42	15	40	4	66	50	8		
29-Jun	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
30-Jun	Wd	Not Sampled																													

[a] Downstream = downstream of the chinook salmon sonar counters to the Warren Ames Bridge. Upstream = upstream of the chinook salmon sonar counters to the Soldotna Bridge.

[b] Wd = weekday, We = weekend.

[c] Fishery was restricted to catch-and-release fishing by emergency order on 5 June for all chinook salmon less than 132 cm in length.

Appendix A2.-Counts of unguided and guided boat anglers, by stratum, during the fishery for late-run chinook salmon on the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

		Downstream[a]										Upstream[a]										Combined Strata									
	Day	Unguided Anglers					Guided Anglers					Unguided Anglers					Guided Anglers					Unguided Anglers					Guided Anglers				
Date	Type[b]	A[c]	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
01-Jul	Wd		0	0	0	0		0	0	0			176	78	48	88		511	239	42			176	78	48	88		511	239	42	
02-Jul	Wd	0	0	2	0	0	0	2	0			115	133	63	67	0	432	411	139			115	133	65	67	0	432	413	139		
03-Jul	We	0	0	2	0	0	0	27	4			78	96	43	47	57	301	331	180			78	96	45	47	57	301	358	184		
04-Jul	We	0	11	12	11	4		17	19	0		15	135	106	131	38		251	153	109		15	146	118	142	42		268	172	109	
05-Jul	We	0	20	7	0	0	CLOSED					90	151	130	87	17	CLOSED					90	171	137	87	17	CLOSED				
06-Jul	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
07-Jul	Wd	0	20	15	0	0		7	16	0		39	167	76	67	56		529	226	162		39	187	91	67	56		536	242	162	
08-Jul	Wd	Not Sampled																													
09-Jul	Wd	Not Sampled																													
10-Jul	Wd	0	0	8	0	0	0	5	4			133	190	129	118	104	500	475	417			133	190	137	118	104	500	480	421		
11-Jul	We	0	0	52	11	35	0	4	20			171	192	249	244	231	332	334	192			171	192	301	255	266	332	338	212		
12-Jul	We	0	10	29	22	0	CLOSED					166	387	328	248	179	CLOSED					166	397	357	270	179	CLOSED				
13-Jul	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
14-Jul	Wd	0	7	4	0	3	4	12	45			310	327	150	277	61	609	584	359			310	334	154	277	64	613	596	404		
15-Jul	Wd	0	0	30	25	0	0	0	68			218	222	234	270	102	550	493	355			218	222	264	295	102	550	493	423		
16-Jul	Wd	7	10	53	11	25		17	23	21		229	276	251	177	342		553	545	318		236	286	304	188	367		570	568	339	
17-Jul	Wd	26	41	16	15	0	57	27	12			243	251	292	110	204	404	441	413			269	292	308	125	204	461	468	425		
18-Jul	We	8	41	38	21	12	36	64	79			235	256	347	304	183	374	394	327			243	297	385	325	195	410	458	406		
19-Jul	We	8	33	43	28	11	CLOSED					444	616	477	448	313	CLOSED					452	649	520	476	324	CLOSED				
20-Jul	Wd	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
21-Jul	Wd	18	25	8	4	12	36	30	0			375	274	233	278	81	537	504	476			393	299	241	282	93	573	534	476		
22-Jul	Wd	0	39	63	8	11		47	69	0		327	352	226	301	380		574	327	401		327	391	289	309	391		621	396	401	
23-Jul	Wd[c]	0	10	0	0	0		0	56	0		131	102	60	119	67		466	295	254		131	112	60	119	67		466	351	254	
24-Jul	Wd	0	8	30	0	0	12	0	45			100	90	137	74	92	373	350	220			100	98	167	74	92	385	350	265		
25-Jul	We	0	0	0	0	0	8	0	4			129	136	88	91	21	322	314	207			129	136	88	91	21	330	314	211		
26-Jul	We	0	11	12	11	4	CLOSED					15	135	106	131	38	CLOSED					15	146	118	142	42	CLOSED				
27-Jul	Wd[d]	CLOSED					CLOSED					CLOSED					CLOSED					CLOSED					CLOSED				
28-Jul	Wd	0	0	4	0	0	0	6	22			83	69	48	59	5	360	365	208			83	69	52	59	5	360	371	230		
29-Jul	Wd	0	3	10	0	0	0	0	2			62	88	73	102	7	280	275	185			62	91	83	102	7	280	275	187		
30-Jul	Wd	0	7	5	0	0	0	0	0			0	77	58	59	54	247	151	89			0	84	63	59	54	247	151	89		
31-Jul	Wd	3	4	14	7	6	30	0	29			120	75	67	39	77	244	265	117			123	79	81	46	83	274	265	146		

[a] Downstream = downstream of the chinook salmon sonar site to the Warren Ames Bridge. Upstream = upstream of the chinook salmon sonar site to the Soldotna Bridge.

[b] Wd = weekday, We = weekend/holiday.

[c] Fishery was restricted to "no bait" artificial lures use only by emergency order on 23 July.

[d] Fishery was restricted to catch-and-release fishing by emergency order on 27 July for all chinook salmon less than 132 cm in length.

APPENDIX B. EFFORT, CATCH AND HARVEST OF CHINOOK SALMON ESTIMATED DURING THE CREEL SURVEY OF THE FISHERY FOR CHINOOK SALMON ON THE KENAI RIVER, ALASKA, 1998

Appendix B1.-Effort, catch, and harvest of chinook salmon by unguided boat anglers and other summary statistics estimated during each sampled day of the fishery for early-run chinook salmon of the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

Date	Wd/ We[a]	Number Counts	Mean Count	Number of Interviews[b]	Effort (hours) Total	Effort (hours) SE	Catch Total	Catch SE	Catch CPUE	Catch SE	Harvest Total	Harvest SE	Harvest HPUE	Harvest SE
05/05/1998	Wd	5	3	0	60[d]	32	0	0	0.000	0.000	0	0	0.000	0.000
05/07/1998	Wd	5	7	3	132	59	0	0	0.000	0.000	0	0	0.000	0.000
05/09/1998	We	5	7	2	136	29	0	0	0.000	0.000	0	0	0.000	0.000
05/10/1998	We	5	11	22	220	70	11	6	0.052	0.023	6	4	0.026	0.015
05/12/1998	Wd	5	8	3	164	41	0	0	0.000	0.000	0	0	0.000	0.000
05/15/1998	Wd	5	9	9	188	46	12	10	0.066	0.052	12	10	0.066	0.052
05/16/1998	We	5	30	46	604	130	2	2	0.004	0.004	2	2	0.004	0.004
05/17/1998	We	5	23	23	460	209	4	4	0.009	0.009	0	0	0.000	0.000
05/19/1998	Wd	5	9	31	176	27	9	4	0.053	0.021	5	3	0.027	0.015
05/20/1998	Wd	5	8	15	164	66	4	3	0.022	0.016	4	3	0.022	0.016
05/23/1998	We	5	28	52	564	70	6	4	0.010	0.008	3	3	0.005	0.005
05/24/1998	We	5	42	21	840	228	9	9	0.010	0.010	9	9	0.010	0.010
05/25/1998	We	5	28	29	568	104	21	12	0.037	0.021	21	12	0.037	0.021
05/27/1998	Wd	5	26	31	524	80	15	9	0.029	0.017	10	7	0.020	0.014
05/28/1998	Wd	4	20	19	400	150	22	15	0.056	0.033	11	8	0.027	0.020
05/30/1998	We	5	34	61	688	176	11	6	0.017	0.007	2	2	0.003	0.003
05/31/1998	We	5	23	34	456	108	4	4	0.009	0.009	4	4	0.009	0.009
06/02/1998	Wd	5	18	5	352	119	0	0	0.000	0.000	0	0	0.000	0.000
06/03/1998	Wd	5	21	19	424	155	9	7	0.022	0.016	9	7	0.022	0.016
06/04/1998	Wd	5	12	15	240	58	4	4	0.018	0.019	0	0	0.000	0.000
06/05/1998[c]	Wd	5	7	11	144	47	12	9	0.082	0.060	0	0	0.000	0.000
06/06/1998	We	5	9	10	188	66	0	0	0.000	0.000	0	0	0.000	0.000
06/07/1998	We	5	9	3	188	89	0	0	0.000	0.000	0	0	0.000	0.000
06/09/1998	Wd	5	3	2	64	29	0	0	0.000	0.000	0	0	0.000	0.000
06/12/1998	Wd	5	8	2	160	35	0	0	0.000	0.000	0	0	0.000	0.000
06/13/1998	We	5	18	4	364	118	17	17	0.046	0.045	0	0	0.000	0.000
06/14/1998	We	5	25	10	492	102	50	31	0.101	0.062	0	0	0.000	0.000
06/16/1998	Wd	5	27	10	540	147	119	94	0.221	0.169	0	0	0.000	0.000
06/17/1998	Wd	5	22	18	444	56	19	13	0.042	0.028	0	0	0.000	0.000
06/20/1998	We	5	34	24	672	95	16	9	0.024	0.013	0	0	0.000	0.000
06/21/1998	We	5	27	24	536	110	4	4	0.008	0.008	0	0	0.000	0.000
06/25/1998	Wd	4	22	19	435	88	27	14	0.062	0.030	7	7	0.016	0.016
06/26/1998	Wd	5	23	12	460	154	22	16	0.047	0.032	0	0	0.000	0.000
06/27/1998	We	5	29	17	576	187	25	19	0.044	0.031	0	0	0.000	0.000
06/28/1998	We	5	26	23	524	167	6	6	0.011	0.012	0	0	0.000	0.000

[a] Wd = weekdays, We = weekends.

[b] Complete trip interviews only.

[c] Fishery was restricted to catch-and-release fishing by emergency order on 5-30 June for all chinook salmon less than 132 cm in length.

[d] Inferential values for effort, harvest and catch based upon ratio of guided and unguided CPUE, HPUE for early run.

Appendix B2.-Effort, catch, and harvest of chinook salmon by guided boat anglers and other summary statistics estimated during each sampled day of the fishery for early-run chinook salmon of the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

Date	Wd/ We[a]	Number Counts	Mean Count	Number of Interviews[b]	Effort (hours) Total	Effort (hours) SE	Catch Total	Catch SE	Catch CPUE	Catch SE	Harvest Total	Harvest SE	Harvest HPUE	Harvest SE
05/05/1998	Wd	5	1	0	24[d]	19	0	0	0.000	0.000	0	0	0.000	0.000
05/07/1998	Wd	5	5	0	100[d]	70	0	0	0.000	0.000	0	0	0.000	0.000
05/09/1998	We	5	6	9	116	54	0	0	0.000	0.000	0	0	0.000	0.000
05/10/1998	We	5	5	0	104[d]	54	4	3	0.040	0.018	4	3	0.042	0.024
05/12/1998	Wd	5	9	6	176	86	4	4	0.021	0.023	4	4	0.021	0.023
05/15/1998	Wd	5	21	26	428	219	21	13	0.050	0.020	21	13	0.050	0.020
05/16/1998	We	5	43	39	868	143	14	7	0.016	0.008	14	7	0.016	0.008
05/17/1998	We	5	39	14	784	203	8	9	0.011	0.012	8	9	0.011	0.012
05/19/1998	Wd	5	25	24	496	212	23	14	0.046	0.021	23	14	0.046	0.021
05/20/1998	Wd	5	34	57	676	433	21	14	0.031	0.010	21	14	0.031	0.010
05/23/1998	We	5	75	14	1,496	354	33	27	0.022	0.018	33	27	0.022	0.018
05/24/1998	We	5	52	24	1,032	222	23	14	0.023	0.013	23	14	0.023	0.013
05/25/1998	We	5	31	9	616	244	38	26	0.061	0.037	24	20	0.040	0.031
05/27/1998	Wd	5	72	43	1,448	314	39	16	0.027	0.010	39	16	0.027	0.010
05/28/1998	Wd	4	37	39	740	314	18	11	0.024	0.011	14	9	0.019	0.010
05/30/1998	We	5	57	22	1,144	346	15	12	0.013	0.010	15	12	0.013	0.010
05/31/1998	We	5	52	35	1,040	166	23	12	0.022	0.011	23	12	0.022	0.011
06/02/1998	Wd	3	100	25	1,200	156	33	17	0.028	0.014	33	17	0.028	0.014
06/03/1998	Wd	3	75	34	904	243	9	6	0.010	0.007	9	6	0.010	0.007
06/04/1998	Wd	3	94	31	1,132	243	31	16	0.027	0.013	31	16	0.027	0.013
06/05/1998[c]	Wd	3	39	7	472	51	10	10	0.020	0.020	0	0	0.000	0.000
06/06/1998	We	3	57	20	688	149	5	5	0.007	0.007	0	0	0.000	0.000
06/07/1998	We	3	15	9	176	40	0	0	0.000	0.000	0	0	0.000	0.000
06/09/1998	Wd	3	27	21	324	88	0	0	0.000	0.000	0	0	0.000	0.000
06/12/1998	Wd	3	34	8	408	33	0	0	0.000	0.000	0	0	0.000	0.000
06/13/1998	We	3	69	23	824	137	27	13	0.033	0.014	0	0	0.000	0.000
06/14/1998	We	3	68	34	820	113	22	9	0.027	0.010	3	3	0.004	0.004
06/16/1998	Wd	3	201	29	2,408	375	78	29	0.033	0.011	0	0	0.000	0.000
06/17/1998	Wd	3	103	23	1,232	276	93	35	0.075	0.023	0	0	0.000	0.000
06/20/1998	We	3	127	16	1,528	264	14	15	0.009	0.010	14	15	0.009	0.010
06/21/1998	We	3	92	21	1,100	41	26	14	0.024	0.013	0	0	0.000	0.000
06/25/1998	Wd	2	58	32	690	390	40	25	0.059	0.017	0	0	0.000	0.000
06/26/1998	Wd	3	88	42	1,052	225	28	12	0.026	0.010	5	5	0.004	0.004
06/27/1998	We	3	68	8	816	271	19	18	0.023	0.021	0	0	0.000	0.000
06/28/1998	We	3	41	14	496	156	14	9	0.029	0.016	0	0	0.000	0.000

[a] Wd = weekdays, We = weekends.

[b] Complete trip interviews only.

[c] Fishery was restricted to catch-and-release fishing by emergency order on 5-30 June for all chinook salmon less than 132 cm in length.

[d] Inferential values for effort, harvest and catch based upon ratio of guided and unguided CPUE, HPUE for early run.

Appendix B3.-Effort, catch, and harvest of chinook salmon by unguided boat anglers and other summary statistics estimated during each sampled day of the fishery for late-run chinook salmon of the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

	Wd/	Number	Mean	Number of	Effort (hours)		Catch				Harvest			
Date	We[a]	Counts	Count	Interviews[b]	Total	SE	Total	SE	CPUE	SE	Total	SE	HPUE	SE
07/01/1998	Wd	4	98	19	1,950	449	178	87	0.091	0.040	20	20	0.010	0.010
07/02/1998	Wd	5	76	9	1,512	312	0	0	0.000	0.000	0	0	0.000	0.000
07/03/1998	We	5	65	12	1,292	174	0	0	0.000	0.000	0	0	0.000	0.000
07/04/1998	We	5	93	44	1,852	534	22	16	0.012	0.008	0	0	0.000	0.000
07/05/1998	We	5	100	50	2,008	389	18	13	0.009	0.006	9	9	0.004	0.004
07/07/1998	Wd	5	88	22	1,760	564	79	42	0.045	0.020	46	31	0.026	0.017
07/10/1998	Wd	5	136	48	2,728	257	25	18	0.009	0.006	13	13	0.005	0.005
07/11/1998	We	5	237	55	4,740	382	120	42	0.025	0.009	103	39	0.022	0.008
07/12/1998	We	5	274	100	5,476	841	156	47	0.029	0.007	145	45	0.027	0.007
07/14/1998	Wd	5	228	58	4,556	967	307	101	0.067	0.017	307	101	0.067	0.017
07/15/1998	Wd	5	220	55	4,404	632	219	60	0.050	0.012	93	40	0.021	0.009
07/16/1998	Wd	5	276	82	5,524	695	260	80	0.047	0.013	185	64	0.034	0.011
07/17/1998	Wd	5	240	74	4,792	637	158	51	0.033	0.010	78	38	0.016	0.008
07/18/1998	We	5	289	67	5,780	558	200	63	0.035	0.010	182	60	0.031	0.010
07/19/1998	We	5	484	82	9,684	897	532	139	0.055	0.013	397	108	0.041	0.010
07/21/1998	Wd	5	262	72	5,232	704	277	78	0.053	0.013	82	37	0.016	0.007
07/22/1998	Wd	5	341	41	6,828	465	121	53	0.018	0.008	121	53	0.018	0.008
07/23/1998[c]	Wd	5	98	12	1,956	304	168	84	0.086	0.041	124	75	0.064	0.038
07/24/1998	Wd	5	106	28	2,124	371	174	62	0.082	0.026	135	54	0.064	0.023
07/25/1998	We	5	93	50	1,860	269	102	32	0.055	0.015	84	30	0.045	0.015
07/26/1998	We	5	208	61	4,168	386	177	48	0.043	0.011	177	48	0.043	0.011
07/28/1998[d]	Wd	5	54	13	1,072	186	54	32	0.051	0.029	0	0	0.000	0.000
07/29/1998	Wd	5	69	9	1,380	321	135	73	0.098	0.049	43	46	0.031	0.033
07/30/1998	Wd	5	52	18	1,040	275	15	15	0.015	0.015	0	0	0.000	0.000
07/31/1998	Wd	5	82	9	1,648	213	60	57	0.036	0.035	0	0	0.000	0.000

[a] Wd = weekdays, We = weekends.

[b] Complete trip interviews only.

[c] Fishery was restricted to "no bait" artificial lures use only fishing by emergency order on 23 July for all chinook salmon.

[d] Fishery was restricted to catch-and-release fishing by emergency order on 27 July for all chinook salmon less than 132 cm in length.

Appendix B4.-Effort, catch, and harvest of chinook salmon by guided boat anglers and other summary statistics estimated during each sampled day of the fishery for late-run chinook salmon of the Kenai River, Soldotna Bridge to Cook Inlet, 1998.

	Wd/	Number	Mean	Number of	Effort (hours)		Catch				Harvest			
Date	We[a]	Counts	Count	Interviews[b]	Total	SE	Total	SE	CPUE	SE	Total	SE	HPUE	SE
07/01/1998	Wd	3	264	35	3,168	1,163	385	157	0.122	0.023	248	108	0.078	0.020
07/02/1998	Wd	3	328	24	3,936	951	88	46	0.023	0.011	67	39	0.017	0.009
07/03/1998	We	3	281	45	3,372	634	140	51	0.042	0.013	76	34	0.023	0.009
07/04/1998	We	3	183	45	2,196	398	58	23	0.027	0.010	25	15	0.011	0.007
07/07/1998	Wd	3	313	55	3,760	1,055	191	70	0.051	0.012	143	57	0.038	0.011
07/10/1998	Wd	3	467	71	5,604	216	346	69	0.062	0.012	212	54	0.038	0.010
07/11/1998	We	3	294	61	3,528	437	151	43	0.043	0.011	94	30	0.027	0.008
07/14/1998	Wd	3	538	80	6,452	668	461	94	0.071	0.013	431	91	0.067	0.012
07/15/1998	Wd	3	489	22	5,864	313	343	108	0.059	0.018	256	101	0.044	0.017
07/16/1998	Wd	3	492	57	5,908	793	318	86	0.054	0.013	261	78	0.044	0.012
07/17/1998	Wd	3	451	33	5,416	151	675	160	0.125	0.029	200	84	0.037	0.015
07/18/1998	We	3	425	35	5,096	245	291	87	0.057	0.017	202	78	0.040	0.015
07/21/1998	Wd	3	528	61	6,332	242	387	87	0.061	0.014	328	84	0.052	0.013
07/22/1998	Wd	3	473	74	5,672	780	314	77	0.055	0.011	285	74	0.050	0.011
07/23/1998[c]	Wd	3	357	85	4,284	521	67	25	0.016	0.005	58	23	0.014	0.005
07/24/1998	Wd	3	333	37	4,000	318	116	46	0.029	0.011	99	43	0.025	0.011
07/25/1998	We	3	285	38	3,420	361	206	65	0.060	0.018	206	65	0.060	0.018
07/28/1998[u]	Wd	3	320	44	3,844	490	306	63	0.080	0.013	15	15	0.004	0.004
07/29/1998	Wd	3	247	40	2,968	305	268	64	0.090	0.019	13	13	0.005	0.004
07/30/1998	Wd	3	162	19	1,948	396	291	121	0.149	0.055	0	0	0.000	0.000
07/31/1998	Wd	3	228	16	2,740	413	314	72	0.115	0.020	0	0	0.000	0.000

[a] Wd = weekdays, We = weekends.

[b] Complete trip interviews only.

[c] Fishery was restricted to "no bait" artificial lures use only fishing by emergency order on 23 July for all chinook salmon.

[d] Fishery was restricted to catch-and-release fishing by emergency order on 27 July for all chinook salmon less than 132 cm in length.