Fishery Data Series No. 97-4

Fishery Surveys during the Recreational and Personal Use Dip Net Fisheries for Late-run Sockeye Salmon to the Kenai River, 1995

by

Mary A. King

February 1997

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

FISHERY DATA SERIES NO. 97-4

FISHERY SURVEYS DURING THE RECREATIONAL AND PERSONAL USE DIP NET FISHERIES FOR LATE-RUN SOCKEYE SALMON TO THE KENAI RIVER, 1995

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ABSTRACT

A creel survey was conducted from 1 July through 15 August 1995 on the Kenai River downstream of the Soldotna Bridge to estimate recreational angler effort, catch, harvest, and snag of sockeye salmon *Oncorhynchus nerka*. The creel survey area was divided into two strata: upstream of the Warren Ames Bridge to the sockeye salmon sonar counters (Stratum A), and upstream of the sonar counters to the Soldotna Bridge (Stratum B). Recreational anglers exerted an estimated 56,302 (SE = 3,849) angler-hours to harvest an estimated 28,996 (SE = 2,222) sockeye salmon in Stratum A, and an estimated 59,929 (3,522) angler hours to harvest an estimated 13,283 (1,280) sockeye salmon in Stratum B. Most fish caught were retained; only 4% of the fish caught were released. The estimated number of fish snagged was 18,760 (SE = 1,957) in Stratum A and 7,994 (SE = 1,210) in Stratum B. The total inriver return (sonar estimate plus harvest estimate for Stratum A) was estimated as 672,726 sockeye salmon.

A second survey (a fishery survey) was conducted downstream of the Soldotna Bridge to the Warren Ames Bridge from 1 July to 15 August 1995 to estimate angler demographics and success. Anglers participating in this fishery in the downriver section of the Kenai River were primarily residents of other areas: 55% U.S. (non-Alaskan), 23% Alaskan (non-Kenai Peninsula), 20% local (Kenai Peninsula), and 2% other (non-U.S. citizens). Most anglers started their fishing day between 1200 and 1539 hours. The most frequent length of an angler fishing day was 2 hours and 2.5 hours was the median for the length of an angler day.

Sixty-two percent of interviewed anglers harvested no fish, 8% harvested one fish, 7% harvested two fish, and 24% harvested three fish. In 1995, a three-fish bag limit reduced harvest since 24% of interviewed anglers harvested three fish. A bag limit reduction to two or one would have reduced harvest by 26% or 58%, respectively. Angler success showed a positive relationship with the sonar counts. When daily fish passage exceeded a sonar count of approximately 20,000, angler success was highest; at daily counts below this level, angler success was lowest and any alteration of the bag limit would have had little effect on the harvest.

A creel survey was conducted during each of two personal use dip net fisheries occurring on the Kenai River downstream of the Warren Ames Bridge to Cook Inlet. Estimates of harvest and HPUE were biased low.

Key words: Kenai River, sockeye salmon, creel survey, fishery survey, dip net fishery, personal use fishery, effort, harvest, snag, bag limit, demographics, sonar count, *Oncorhynchus nerka*.

INTRODUCTION

BACKGROUND

The Kenai River (Figure 1), a glacial river, is the most heavily fished river in Alaska, supporting 13% of Alaska's recreational fishing effort (Howe et al. 1995). Targeted species, both resident and anadromous, include chinook salmon *Oncorhynchus tshawytscha*, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, pink salmon *O. gorbuscha,* Dolly Varden *Salvelinus malma*, and rainbow trout *O. mykiss*.

In recent years sockeye salmon have become one of the major targeted species in the Kenai River. Historically, sockeye salmon were harvested from the Kenai River using snagging techniques. When snagging was prohibited in the 1970s, anglers applied the techniques used in the clearwater fishery of the Russian River and soon developed effective methods to harvest sockeye salmon from the Kenai River.

Sockeye salmon return annually to the Kenai River in two temporal components, termed early and late runs. The early-run stock typically enters the river in June and the late-run stock typically begins entering the river in early July, continuing into August. The early-run stock spawns primarily in the Russian River drainage. The late-run stock spawns throughout the Kenai River drainage, particularly in the mainstem Kenai River, Skilak Lake, and Kenai Lake.

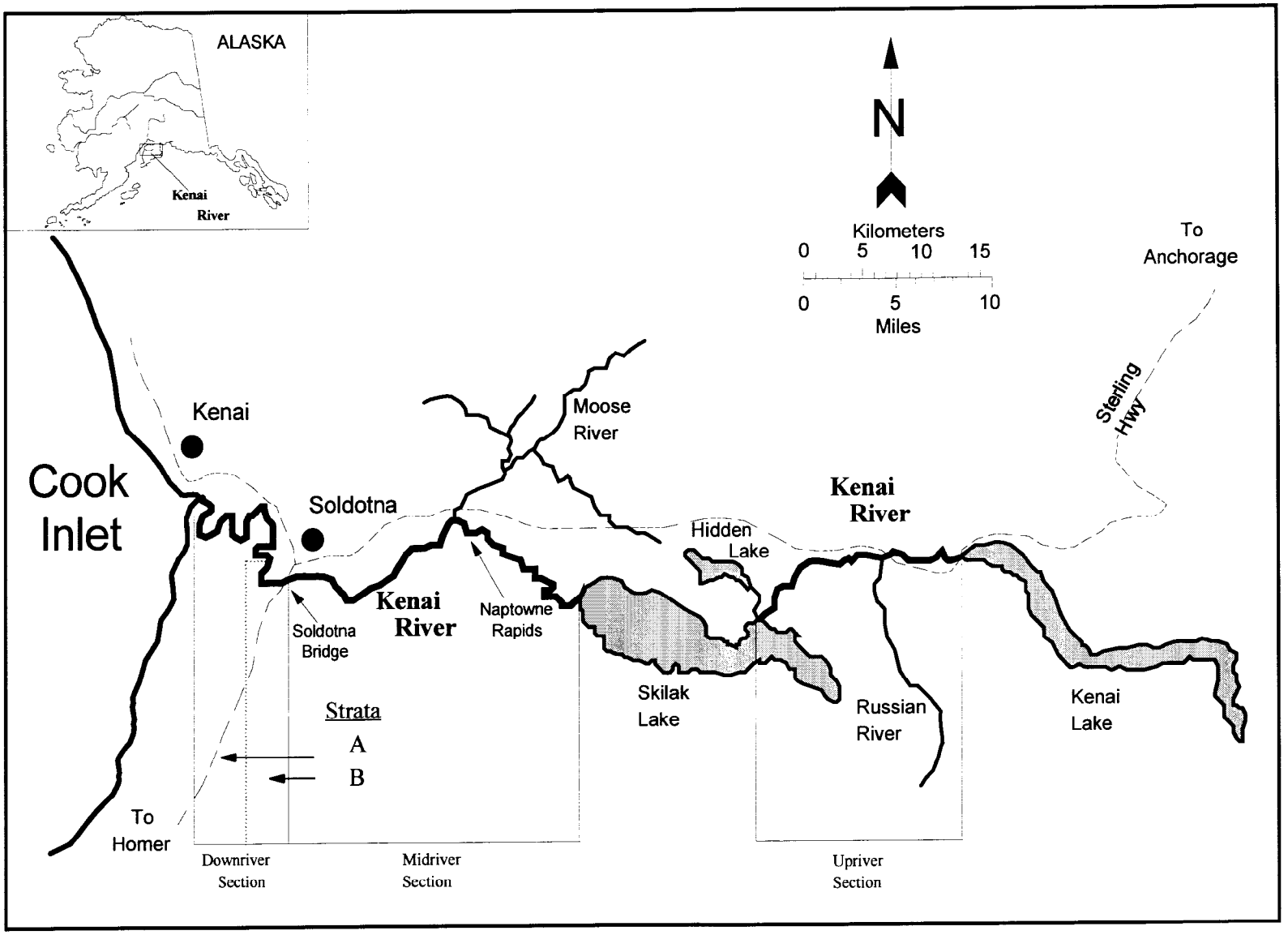


Figure 1.-Map of the Kenai River drainage.

Sport fishing effort during the recreational sockeye salmon fishery on the Kenai River is primarily directed at the late-run stock. Prior to 1987 annual harvest of the late run was less than 70,000 fish (Mills 1979-1987). In 1987 harvest increased to over 230,000 fish with average annual harvest now exceeding 100,000 fish (Mills 1988-1994; Howe et al 1995 and 1996) (Figure 2). Although no effort estimates are available for the Kenai River sockeye salmon recreational fishery, observations indicate that participation in the fishery has increased dramatically. Harvest by the sport fishery is estimated postseason through the Statewide Harvest Survey (SWHS), a mailout questionnaire, with estimates available in the fall of the following year. In 1994 a creel survey conducted downstream of the Soldotna Bridge estimated 117,048 angler hours of effort and a harvest of 23,397 sockeye salmon (King 1995).

A major commercial fishery in the marine waters of Upper Cook Inlet (UCI) also targets the late-run sockeye salmon return to the Kenai River. UCI fisheries harvesting sockeye salmon of Kenai River origin include the Central District drift and set gillnet fisheries, with a mean harvest from 1981-1995 of 3.0 million fish (range: 0.5-7.2 million) (D. Waltemyer, Alaska Department of Fish and Game, Soldotna, personal communication). The commercial harvest is determined from fish tickets with the data available within days after a commercial fishing period; the final estimate is calculated postseason.

The late-run stock is also subjected to harvest by personal use dip net and set gillnet, subsistence, and native educational subsistence fisheries. These fisheries have a combined annual harvest of less than 100,000 fish.

Participants in the personal use fishery must possess an Alaska sport fishing license while those in the subsistence fishery must obtain a permit (harvest record) from the department. Harvest by the personal use dip net fishery is estimated postseason through the SWHS, in years that it occurs (Figure 3). Final estimates are not available until fall of the following year. The subsistence (or in 1995, a separate personal use fishery) harvest is determined postseason after participants return their harvest records. The harvest in the native educational subsistence fishery is reported postseason as well.

The inriver return of late-run sockeye salmon is monitored by sonar counters at river kilometer (rkm) 31.4 (river mile 19.5). These provide daily estimates of fish passage.

Subsistence fisheries, which have priority use by statute, have been permitted intermittently in recent years. Subsistence gillnet and dip net fisheries for Kenai River salmon stocks were allowed in 1992 and 1994. Legal concerns prevented a subsistence fishery in 1993 and 1995; however, in 1995 a personal use fishery was designed and implemented with guidelines similar to the 1994 subsistence fishery.

The recreational fishery is managed under the Kenai River Sockeye Salmon Management Plan (Appendix A1) adopted into regulation by the Board of Fisheries (BOF) in 1980. This plan, modified by BOF action in 1995, establishes a desired inriver escapement goal of 450,000-700,000 sockeye salmon enumerated at the sonar counters. If the projected sonar count is less than 450,000, the recreational fishery for sockeye salmon is closed. If the projected sonar count is between 450,000 and 700,000, the recreational fishery is managed under normal guidelines. If the sonar count is projected to exceed 700,000, the recreational fishery is liberalized with the

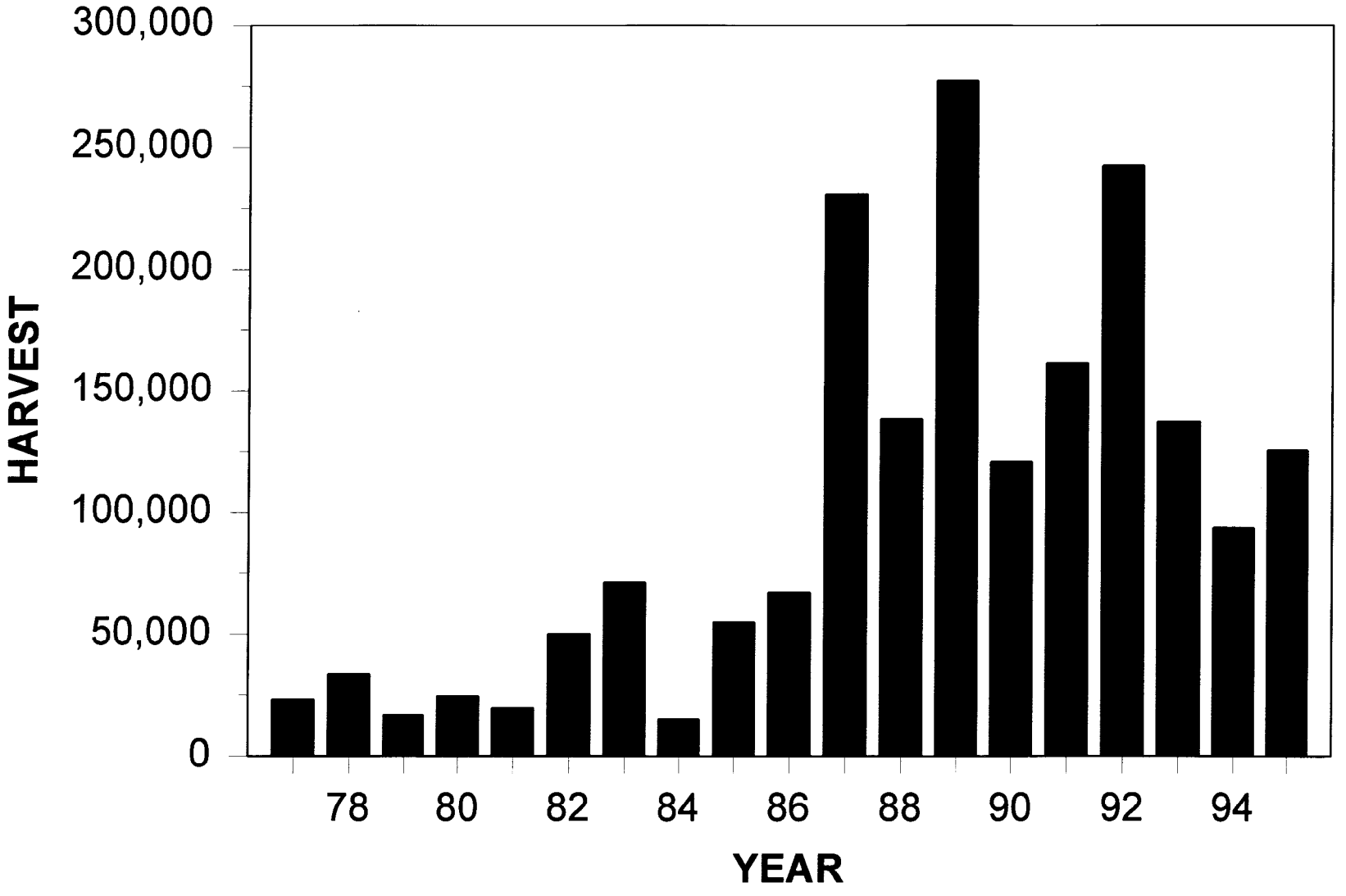
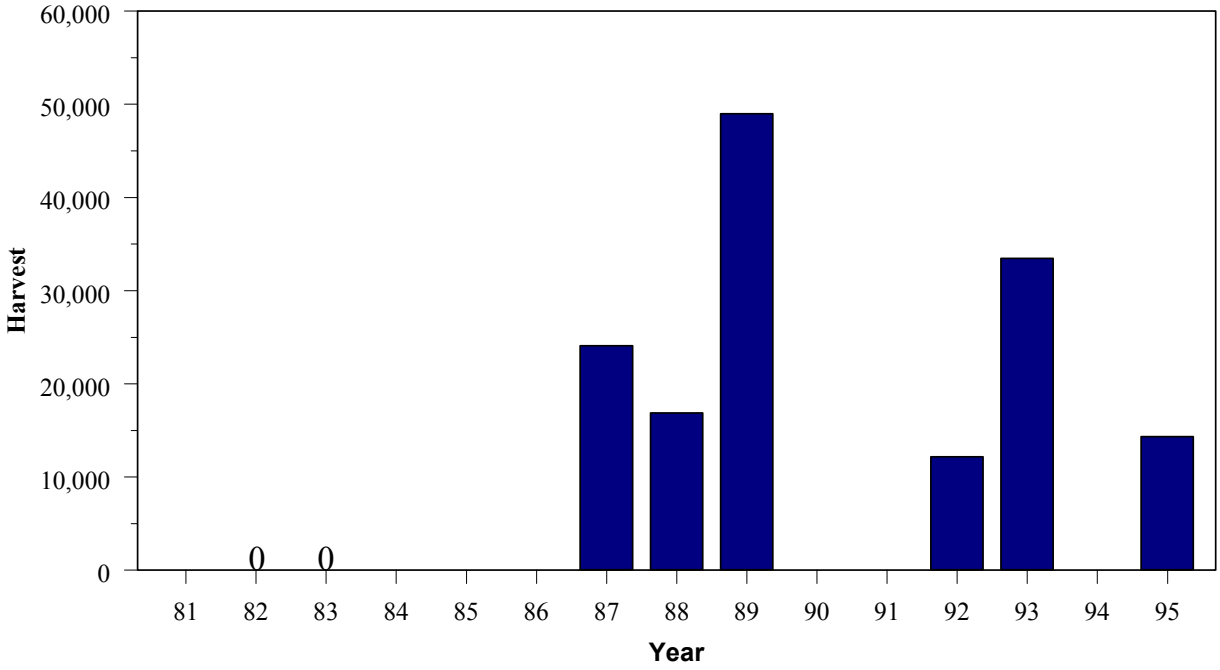


Figure 2.-Annual harvest of sockeye salmon in the Kenai River during the recreational fishery, 1977-1995 (Mills 1979-1994, Howe et al. 1995 and 1996).



Notes: No fishery occurred in 1981,1984-1986,1990,1991, and 1994.
In 1992 the fishery was closed on Wednesdays and Saturdays due to a subsistence fishery.
In 1995 the fishery was closed on Wednesdays and Saturdays due to a different personal use (old subsistence) fishery.

Figure 3.-Historic harvest estimates, from the Statewide Harvest Survey, for the personal use dip net fishery occurring on the Kenai River, 1981-1995 (Mills 1982-1994, Howe et al. 1995 and 1996).

daily bag limit of sockeye salmon increased from three fish to six fish.

The personal use dip net fishery is managed under the Cook Inlet Personal Use Salmon Dipnet Fishery Management Plan (Appendix B1), adopted into regulation by the BOF in 1981. This plan provides for a dip net fishery with a daily bag limit of six sockeye salmon when the projected sonar count exceeds 450,000.

At the 1992 BOF meeting, concerns were voiced that the annual recreational harvest exceeded the guideline level of 10% since 1986. The BOF directed the department to manage the 1993 fishery to comply with the 10% requirement of the Plan. The bag limit was reduced from three sockeye salmon to two and hours open to fishing were limited to 0600 to 2100 hours. The fishery was prosecuted with these directives until the sonar count surpassed 700,000 fish. At that time hourly restrictions were lifted and the bag limit was liberalized to six fish. Although this management strategy brought the recreational harvest into compliance with the Plan, vocalized public dissent to the department, BOF, and the Legislature resulted in regulations for the 1994 season reverting to the former three fish bag limit with no hourly restrictions. Actions by the BOF in 1995 deleted the 10% guideline harvest level from the Plan and retained the three fish bag limit.

DESCRIPTION OF THE KENAI RIVER SOCKEYE SALMON RECREATIONAL

AND PERSONAL USE DIP NET FISHERIES

Recreational Fishery

The recreational fishery targeting late-run sockeye salmon in the Kenai River usually begins in early July as fish begin to enter the river. Little effort is present in the fishery until after mid July when larger numbers of fish begin to enter the river. Typically, participation in the fishery remains high until the end of the first week of August when effort begins to decline.

The sockeye salmon fishery is primarily a shorebased fishery with high concentrations of anglers at public access sites. In recent years there has been an increase in anglers using boats to access bank areas not accessible by the road system. The fishery occurs along the entire 132 km (82 mile) reach of the Kenai River from Cook Inlet to Kenai Lake (Figure 1). Effort concentrates in the lower river as fish begin to enter and then shifts gradually upstream with fish migration. There has been little participation by guided anglers; however, guides will provide anglers with gear and "drop off" the anglers at various bank locations while the guide continues on with clients targeting chinook salmon.

The common technique used by anglers is to drift a streamer fly which is weighted about 12 inches above the hook. The fly is cast upstream within 15 feet of the bank and allowed to drift downstream, to be retrieved and roll casted upstream again.

Prior to 1994, no creel survey had been conducted on this fishery. Consequently, there were no estimates of effort for the sockeye salmon recreational fishery, although harvest was estimated by the SWHS. The creel and fishery surveys were initiated to better assess angler harvest, effort, and success during the sockeye salmon recreational fishery. Specifically, the surveys provided data to estimate the total inriver return, to determine the effectiveness of the three-fish bag limit to limit harvest, and to explore the effects of a more restrictive bag limit to further reduce harvest. Results also provided information for inseason management decisions and a means of corroborating estimates in the SWHS.

Data on snagging of sockeye salmon were also needed. Proposals to the BOF requested retention of snagged fish to allow anglers to attain their bag limits more quickly, which would hasten their exodus from the fishery and possibly reduce damage to habitat.

Regulations governing the recreational fishery categorize sockeye salmon with "salmon other than chinook salmon" and have an aggregate bag and possession limit of three salmon 41 cm in length or greater with no annual limit.

Personal Use Dip Net Fisheries

The Kenai River personal use dip net fisheries occur downstream of the Warren Ames Bridge to Cook Inlet. Most of the participation occurs near the mouth of the river with angler effort concentrated during the high tide period (3 hours before and 3 hours after high tide).

In 1995 there were two personal use dip net fisheries on the Kenai River. When Alaska Supreme Court decisions imposed a subsistence fishery for the Kenai River in 1995, the Department of Fish and Game provided fishing opportunity by implementing a second personal use dip net fishery regulated within the Upper Cook Inlet Personal Use Salmon Fishery Management Plan (Appendix B2), referred to in this report as personal use (old subsistence) dip net fishery. This fishery followed the guidelines of the former subsistence fishery. This fishery began in May and occurred on Wednesdays and Saturdays from 0800 to 2000 hours.

Anglers were required to obtain a permit which had to be returned postseason with their harvest record. Dipnetting was conducted from shore and retention of all species was allowed. Harvest was limited to 25 fish for the head of the household and 10 fish per additional member of the household, with no more than five chinook salmon for the permit holder and one chinook salmon per each additional household member.

The regular personal use dip net fishery begins when the sonar count is projected to exceed 450,000 fish and closes on 31 July, unless the fishery is liberalized. This fishery occurs on all days except Wednesdays and Saturdays with no hourly restrictions. Anglers are permitted to dip net from shore or boat and have a six fish aggregate bag limit, not to include chinook salmon.

OBJECTIVES

The primary goals of the 1995 project were to estimate the inriver harvest of sockeye salmon by Kenai River anglers downstream of the Soldotna Bridge and to estimate harvest during the personal use dip net fisheries. Other goals were to determine the effectiveness of bag limits by estimating the catch and harvest success of the recreational sockeye salmon fishery and to corroborate creel survey estimates of harvest for the recreational and personal use dip net fisheries with estimates from the SWHS. Specific objectives were to:

1. Estimate the total harvest, catch, and release due to snagging (foul hooking) of late-run sockeye salmon by the recreational fishery in the mainstem Kenai River downstream of the Soldotna Bridge stratified into two areas, downstream of the sonar counter (Stratum A) and upstream of the sonar counter to the Soldotna Bridge (Stratum B), from 1 July through 15 August 1995;
2. Estimate angler effort (angler hours) on late-run sockeye salmon by the recreational fishery for the locations and time periods listed in Objective 1;
3. Estimate the distribution of harvest and catch success of sockeye salmon among anglers (angler-day) in the recreational sockeye salmon fishery from 1 July through 15 August 1995, in the mainstem Kenai River downstream of the Soldotna Bridge;
4. Estimate total harvest of late-run sockeye salmon by the personal use (old subsistence) dip net fishery on the Kenai River downstream of the Warren Ames Bridge to Cook Inlet from 1 July to 12 August;
5. Estimate total angler effort (number of shore anglers per high tide) on late-run sockeye salmon by the personal use (old subsistence) dip net fishery for the locations and time periods in Objective 4;
6. Estimate total harvest of late-run sockeye salmon by the personal use dip net fishery on the Kenai River downstream of the Warren Ames Bridge to Cook Inlet when (if) it occurred; and
7. Estimate total angler effort (number of shore anglers per high tide) and boat high tide on late-run sockeye salmon by the personal use dip net fishery for the locations and time periods listed in Objective 6.

METHODS

CREEL SURVEY

A stratified roving creel survey (Bernard et al. *In prep*) was used to estimate sport fishing effort in units of angler-hours fished. Angler interviews were used to estimate harvest per unit of effort (HPUE, in units of numbers of sockeye salmon harvested per angler-hour

fished), catch per unit of effort (CPUE, in units of numbers of sockeye salmon caught per angler-hour fished) and snag per unit of effort (SPUE, in units of numbers of sockeye salmon snagged per angler-hour fished). Harvest, catch, and snag were estimated as the product of the estimated effort and HPUE, CPUE, or SPUE, respectively. 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 (excluding snag). Snag refers to fish which anglers foul hooked, landed, and released.

The creel survey was based on a stratified two-stage sample design and was conducted from 1 July to 15 August 1995. The survey encompassed the mainstem Kenai River downstream of the Soldotna Bridge to the Warren Ames Bridge, termed the downriver section. The downriver section was divided into two strata for the creel survey. Stratum A was defined as the Kenai River from the Warren Ames Bridge (rkm 8.1) upstream to the sonar counter (rkm 31.4). Stratum B was defined as the sonar counter (rkm 31.4) upstream to the Soldotna Bridge (rkm 33.8). The survey was also stratified by month. Days were the first stage units and angler trips were the second stage units. Each fishing day consisted of one 20-hour period (0400-2400 hours) in July and one 18-hour period (0400-2200 hours) in August. Periods were of shorter length during August due to decreasing daylight. Days were sampled systematically, randomly choosing the first day (either 1 July or 2 July) and sampling alternate days thereafter until 15 August.

Sampling levels were designed to estimate effort, harvest, and catch to within ±20% of their true values 95% of the time. A total of 23 days were sampled, 16 days in July and 7 days in August. Some deviation from the schedule occurred due to technician error with the schedule. Four people conducted the survey: two creel clerks who conducted shore angler counts from a boat in conjunction with responsibilities with the chinook salmon creel survey, and two access creel clerks who conducted interviews at designated access sites.

Four counts of anglers fishing from shore (shore anglers) were conducted during all scheduled sampling periods. In July, the first count was randomly chosen to start on a whole hour between 0400 and 0800 hours; the three subsequent counts occurred at 5-hour intervals. In August, the first count was randomly chosen to start on a whole or half hour between 0400 and 0730 hours; the three subsequent counts occurred at 4.5 hour intervals. Counts were conducted using a boat driven at a constant rate of speed through the length of the survey area, starting at one end of the area. The trip usually took 45 minutes or less to complete and every effort was made to ensure the trip was completed within 1 hour. Angler counts were considered instantaneous and reflected fishing effort at that time. During each count, the boat clerk recorded the total number of shore anglers in each stratum.

Angler interviews were conducted during all scheduled sampling periods. This enabled angler counts (effort) to be related to angler interviews (HPUE, CPUE, and SPUE estimates). The interviews were conducted by two access clerks, each working a 10-hour shift (0400-1400 hours or 1400-2400 hours) in July and a 9-hour shift (0400-1300 or 1300-2200 hours) in August. During a shift an

access clerk conducted interviews of completed-trip and -day anglers at 3 access sites, 2 (8 accessible) in Stratum A and 1 (2 accessible) in Stratum B.

Access clerks recorded the following information from anglers who had finished fishing for that trip (completed-trip anglers): (1) total hours fished, (2) total harvest by species, (3) total number released (legally landed and released) by species, and (4) total number snagged by species.

Total effort, catch, harvest, and snag were estimated by expanding means over all days sampled in a stratum (i.e., Stratum A and Stratum B). During each sample day four counts were made and interviews collected for the entire day.

The mean number of anglers counted on day i in river-month 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, which was four in each stratum.

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

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

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 in July and 18 hours in August) in each stratum.

The within day variance (effort) was estimated by:

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

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 systematically in each stratum. The variance of mean effort among days was estimated by:

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

Total effort of stratum h was estimated by:

$$\hat{E}_h = D_h \bar{E}_h, \quad (7)$$

where:

D_h = total number of days (= 31 days in July and 15 days in August).

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):

$$\mathrm{Var}(\hat{E}_h) = (1-f)D_h^2 \frac{\mathrm{Var}(\bar{E}_h)}{d_h} + fD_h^2 \frac{\sum_{i=1}^{d_h} \mathrm{Var}(\hat{E}_{hi})}{d_h^2}, \quad (8)$$

where:

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

Catch, harvest, and snag per unit of effort of each day sampled were 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 and SPUE) was made for each angler by:

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

where:

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

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

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

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

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

and the bias corrected mean was:

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

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:

$$Var\left(\overline{CPUE}^{**}_{hi}\right) =$$

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

Catch during each sample day was then 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):

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

$$Var\left(\overline{CPUE}^{**}_{hi}\right)\hat{E}^{2}_{hi} - Var\left(\hat{E}_{hi}\right)Var\left(\overline{CPUE}^{**}_{hi}\right). \quad (14)$$

HPUE and SPUE were estimated by substituting harvest and snag, respectively, for angler catch in equations (9) through (12). Harvest and snag during sample day i were estimated by substituting the appropriate $HPUE_{hi}$ and $SPUE_{hi}$ statistics into equations (13) and (14). Total catch, harvest, and snag during stratum h were estimated using equations (5) through (8), substituting estimated catch (C_{hi}), harvest (H_{hi}), and snag (S_{hi}), respectively, during sample day i for the estimated effort (E_{hi}) during day i.

The estimates of total effort, catch, harvest, snag, and their respective variances, were summed across the river and month strata as these estimates were considered independent.

FISHERY SURVEY

A stratified roving fishery survey was conducted in the downriver section of the Kenai River from 1 July to 15 August 1995 (Figure 1). The sampling design was systematic (the same as described above for the creel survey).

Angler interviews for the fishery survey were conducted by access clerks employed for the creel survey. To obtain the objective criteria, 128 completed-day angler interviews were required (Thompson 1987). There were 8 access sites, 6 in Stratum A and 2 in Stratum

B. Since the sockeye salmon fishery is primarily shorebased, the access clerks used automobiles for transportation to interview locations.

Access clerks interviewed only completed-day anglers. Anglers were queried as to whether or not guide services had been used, and as to their residency: (1) local (Kenai Borough), (2) Alaska (non Kenai Borough), (3) U.S. (non-Alaska), and (4) other. Access clerks also collected data for (1) total hours fished that day, (2) time of day the angler began fishing, (3) total number of sockeye salmon harvested, (4) total number of sockeye salmon released, and (5) total number of sockeye salmon snagged. It was assumed that all completed-day anglers exiting the fishery from an access site when a technician was present would be interviewed. In situations when this was not possible, the access clerk randomly selected the anglers to be interviewed, being careful not to select only those with fish, and counted anglers that were not interviewed.

Estimates of the distribution of harvest, catch, and snag success of each sampled day were calculated by treating the interview data of that day as a simple random sample of the angler days for the fishery. The distribution of angler catches was defined as the proportions p_z of angler-days in which z or more fish were caught, from z = 1 to the maximum number of fish caught by any one angler (z_{max}). Additionally, p_0 was defined as the proportion of angler-days with a catch of no fish. Similar estimates were calculated for the distributions of harvest and snag.

The value of z_{max} for harvest was set to one fish more than the bag limit for sockeye salmon in effect during the survey (=3). The value of z_{max} for catch and snag was determined postseason. Since few anglers actually caught or snagged three or more fish, z_{max} was the same for distribution of catch and snag as for harvest.

The proportion of angler days of each distribution of harvest, catch, or snag success category (e.g., z = 0 fish, 1 or more fish, 2 or more fish, etc.) was estimated as a binomial proportion (Cochran 1977) by:

$$\hat{p}_z = \frac{\sum_{z'=z}^{z_{max}} y_{z'}}{m}, \text{ and} \tag{15}$$

$$\mathrm{Var}\left[\hat{p}_z\right] = \frac{\hat{p}_z\left(1-\hat{p}_z\right)}{m-1}, \tag{16}$$

where:

y_z' = the number of interviewed completed-day anglers whose harvest, catch, or snag puts them in category z'+ (e.g., $y_{z'}$ for the estimate of p_2 is the number of anglers interviewed that caught 2 or more fish and z = 2, and

m = the total number of completed-day interviews.

The contributions to the harvest by each fish in the daily bag of interviewed anglers were calculated by using the harvest distribution estimates. Harvest contribution estimates (proportion of the harvest that is due to the z^{th} fish in each angler's daily bag) were calculated by:

$$\hat{s}_z = \frac{\sum_{z'=z}^{z_{max}} \hat{p}_{z'}}{\sum_{z'=1}^{z_{max}} \hat{p}_{z'}}. \tag{17}$$

The variance of $\hat{s}_z$ was estimated using the resampling techniques of Efron (1982). Each survey produced data {v}, in which each v was the harvest of each interviewed completed-day angler. There were m such data points (completed-day anglers). One thousand bootstrap samples were drawn by

resampling these original m angler-days with replacement. For each bootstrap sample m angler-days were randomly chosen with replacement from the m original angler-days. The numbers m'_z of completed angler-days in which z sockeye salmon were harvested were tallied from each bootstrap sample and the proportions $\hat{p}'_z$ of anglers interviewed harvesting z or more sockeye salmon were calculated. The proportions $\hat{s}'_z$ of sockeye salmon occupying the z^{th} position in the creel were calculated for each bootstrap sample using (17) above, after substituting m' for m. Finally, the variance of $\hat{s}_z$ was estimated calculating the sample variance of the 1,000 bootstrap values of $\hat{s}'_z$.

Chi-squared statistics were used to detect differences in catch, harvest, and snag success among 1-week time intervals.

PERSONAL USE DIP NET FISHERIES

For both personal use dip net fisheries, a roving creel survey (Bernard et al. *In prep*) was used to estimate angler effort in units of 6-hour high tide period fished. Angler interviews were used to estimate harvest per unit of effort (HPUE, in units of numbers of sockeye salmon harvested per 6-hour high tide).

The creel survey for the personal use (old subsistence) dip net fishery was based on a two-stage sample design and was conducted from 1 July-12 August 1995. High tides were the first stage units and completed-trip angler interviews were the second stage units. The survey occurred on the Kenai River downstream of the Warren Ames Bridge to Cook Inlet. Since this fishery was only open on Wednesdays and Saturdays between 0800 and 2000 hours, all available high tides were sampled. Due to time restrictions on the fishery in relation to the high tide, some periods sampled were less than 6 hours. Only that portion of the high tide occurring at hours open to fishing was sampled. On some days only 3 hours of the fall of the morning high tide and/or the rise of the evening high tide could be sampled.

Sampling levels were designed to estimate effort by shore angler high tide and harvest to within $\pm 25\%$ of their true value 95% of the time. A total of 16 high tides were sampled on 13 different days, 11 high tides in July and 5 in August. Two technicians conducted the survey: one technician conducted interviews at designated access sites and the other conducted interviews and angler counts.

Counts were conducted systematically at 2-hour intervals throughout the sample period with the first count chosen at random from the first or second hour of the period. Three counts were conducted during a sample period unless the available time to participate in the fishery during a given high tide period was less than 6 hours due to the regulatory hours (0800-2000 hours) for the fishery. During these high tides at least two counts were conducted systematically: time to begin the first count was chosen at random and the time interval between the counts was based upon the length of the sample period. Counts were conducted from three vantage points: at the Warren Ames Bridge, at a private residence near the middle of the study area, and at the bluff, near the mouth of the river, in the city of Kenai. All counts were considered instantaneous and completed in 1 hour or less. Only anglers actively dipnetting or at the shoreline handling a recently dip netted fish were counted.

Completed-trip interviews of shore anglers were conducted during the entire sample period. When less than 6 hours were available for a sample period, technicians were careful to interview only within the period 3 hours before or after the high tide. One technician was stationed at one of the three available interview locations and the

second technician, after completing a count, would conduct interviews at one of the remaining two sites, alternating interview sites after each count. Technicians attempted to interview all anglers exiting at the access site. When that was not possible, the technician would randomly select the angler to be interviewed, being careful not to select only those with fish. Since harvest rate was estimated for an angler high tide rather than an angler hour, an angler interview consisted of querying the angler as to the number of fish, by species, harvested.

The creel survey for the personal use dip net fishery used a stratified two-stage creel design and was conducted from 27-31 July. (The fishery opened on 25 July when the sonar count of sockeye salmon was projected to 450,000 fish.) The strata were defined by the time of the high tide (a.m. or p.m.) and angler type (boat or shore) with high tide being the first stage units and trips the second stage units. This fishery occurred on the Kenai River in the same location as the personal use (old subsistence) dip net fishery; however, it occurred on all days of the week except Wednesdays and Saturdays, with no hourly restrictions, and anglers were permitted to dipnet from a boat.

Sampling levels were designed to estimate effort by shore angler high tide and harvest to within $\pm 25\%$ of their true value 95% of the time. A total of 4 high tides were sampled on 3 different days. Three technicians, two employed on the personal use (old subsistence) dip net creel survey plus one other, conducted angler interviews and counts.

A systematic sampling regime within each a.m. and p.m. stratum was used. Of available a.m. tides (two) the first one to be sampled was selected at random from the first two available and then every other a.m. high tide was sampled. The same procedure was used for the available p.m. high tides (nine). In determining this schedule, high tides occurring on Wednesdays and Saturdays were omitted since this fishery does not occur on these days.

Procedures for conducting interviews and counts were similar to those for the personal use (old subsistence) dip net fishery with the following exceptions: (1) the technician conducting angler counts counted the number of shore anglers and the number of boats, not boat anglers; (2) the technician conducting the counts interviewed completed-trip anglers (mostly boat trip interviews) at the City of Kenai Docks at the completion of a count; (3) all technicians conducted completed-trip shore angler and boat interviews to gather data on the number of sockeye harvested per shore angler, the number of sockeye harvested per boat, and the number of anglers per boat. Counts included only shore anglers and boats actively engaged in this fishery, dipnetting or handling fish recently dipnetted.

Total effort and harvest of the personal use dip net fishery was estimated by expanding the means over all high tides in a temporal stratum (i.e. a.m. or p.m. high tide). Total effort and harvest during the personal use (old subsistence) fishery was estimated similarly except tides were not stratified by time of day. In addition, the personal use dip net fishery was stratified into shore anglers and boat anglers.

Effort (angler-high tide), or the mean number of anglers (or boats for boat anglers in the personal use fishery) counted, during high tide j of temporal stratum i was estimated by:

$$\hat{E}_{ij} = \sum_{g=1}^{r_{ij}} x_{ijg}, \qquad (18)$$

where:

x_{ijg} = the number of anglers (boats) observed in the gth count during tide j of stratum i, and

r_{ij} = the number of counts during tide j of stratum i.

Angler and boat counts were taken systematically within each sampled tide. The variance of effort (i.e., the variance of the mean number of anglers and boats counted) during each sampled tide was estimated by:

$$\mathrm{Var}\left(\hat{E}_{ij}\right) = \frac{\sum_{g=2}^{r_{ij}} \left(x_{ijg} - x_{ij(g-1)}\right)^2}{2r_{ij}\left(r_{ij} - 1\right)}. \quad (19)$$

This approach, both in design and analyses, was used because it was assumed most anglers would begin participation by 3 hours prior to high tide and would continue participating until at least 1-2 hours after high tide. Variation among counts would therefore be small and mostly reflect a combination of sampling error and not counting anglers taking a temporary break from dipnetting.

The mean effort of temporal stratum i was estimated by:

$$\overline{E}_i = \frac{\sum_{j=1}^{t_i} \hat{E}_{ij}}{t_i}, \quad (20)$$

where:

t_i = number of high tides sampled in stratum i.

High tides were sampled systematically in each temporal stratum of the personal use fishery. The variance of mean effort among high tides for this fishery was estimated by:

$$\mathrm{Var}\left(\overline{E}_i\right) = \frac{\sum_{j=2}^{t_i} \left(\hat{E}_{ij} - \hat{E}_{i(j-1)}\right)^2}{2t_i\left(t_i - 1\right)}, \quad (21)$$

and, that for the personal use (old subsistence) fishery which was not stratified temporally by:

$$\mathrm{Var}\left(\overline{E}_i\right) = \frac{\sum_{j=1}^{t_i} \left(\hat{E}_{ij} - \hat{E}_{i)}\right)^2}{t_i\left(t_i - 1\right)}. \quad (22)$$

Total effort of temporal stratum i was estimated by:

$$\hat{E}_i = T_i \overline{E}_i, \quad (23)$$

where:

T_i = total number of high tides available for dipnetting in each temporal stratum.

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):

$$\mathrm{Var}\left(\hat{E}_i\right) = \left(1 - f\right)T_i^2 \frac{\mathrm{Var}\left(\overline{E}_i\right)}{t_i} + fT_i^2 \frac{\sum_{j=1}^{t_i} \mathrm{Var}\left(\hat{E}_{ij}\right)}{t_i^2}, \quad (24)$$

where:

f = finite population correction factor for high tides sampled ($= t_i/T_i$).

The mean harvest per interviewed angler (boat) during high tide j of temporal stratum i was estimated as:

$$\overline{h}_{ij} = \frac{\sum_{k=1}^{a_{ij}} h_{kij}}{a_{ij}}, \quad (25)$$

where:

h_{kij} = the harvest of angler (boat) k during tide j of stratum i, and

a_{ij} = the number of completed-trip anglers (boats) interviewed during tide j of stratum i.

The variance of harvest among interviewed anglers (boats) within each sampled high tide was estimated assuming a normal variate as:

$$\mathrm{Var}\left(\bar{h}_{ij}\right) = \frac{\sum_{k=1}^{a_{ij}} \left(h_{kij} - \bar{h}_{ij}\right)^2}{a_{ij}\left(a_{ij} - 1\right)} \quad . \tag{26}$$

The total harvest of anglers (boats) during high tide j of temporal stratum i was estimated as:

$$\hat{H}_{ij} = \hat{E}_{ij}\bar{h}_{ij}, \tag{27}$$

and its variance was estimated by (Goodman 1960):

$$\mathrm{Var}\left(\hat{H}_{ij}\right) = \hat{E}_{ij}^2 \mathrm{Var}(\bar{h}_{ij}). \tag{28}$$

The mean harvest per sampled high tide and the total harvest of temporal stratum i, and their respective variances, were estimated using equations 20-24 by replacing effort with harvest statistics. Total harvest and effort were estimated for each fishery by summing the individual stratum estimates. The variances of the total estimates were calculated as the sum of the variances of the individual stratum estimates. Note that for the personal use (old subsistence) dip net fishery all available high tides were sampled. Using the average of the counts, rather than the maximum count, will produce estimates of effort and harvest that are biased low. However, it was assumed that angler and boat counts would remain relatively constant throughout sampled high tides and thus the biases should be minor.

RESULTS AND DISCUSSION

RECREATIONAL CREEL SURVEY

Angler counts and interviews were conducted on 22 of 46 possible days during the study period (1 July-15 August 1995).

Effort

During the late-run sockeye salmon recreational fishery, angler counts ranged from 0 to 503 with the highest count occurring on 23 July in Stratum A (Appendix C1).

The estimated effort in Stratum B (59,929 angler hours, SE = 3,522) was nearly equal to that in Stratum A (56,302 angler hours, SE = 3,849), accounting for 52% of the total effort (116,231 angler hours, SE = 5,217) downstream of the Soldotna Bridge (Table 1). The highest angler effort for each stratum (Stratum A: 5,550 angler hours and Stratum B: 5,825 angler hours) occurred on 23 July yielding a daily total of 11,375 angler hours (SE = 2,542) (Figure 4 and Appendix C2).

Harvest and Catch

A total of 541 completed-trip angler interviews was conducted, 214 in Stratum A and 327 in Stratum B (Appendix C2).

Estimates of catch and harvest in Stratum A were 29,056 (SE = 2,222) and 28,996 (SE = 2,222), respectively, and in Stratum B were 15,027 (SE = 1,567) and 13,283 (SE = 1,280), respectively (Table 1). The combined catch and harvest in the downriver section were 44,084 (SE = 2.719) and 42,279, (SE = 2,565) respectively. In each stratum, catch and harvest were nearly equal, with catch and harvest in Stratum A being approximately twice that of Stratum B. Overall, less than 4% of fish caught were released. Harvest occurred primarily during a small window between 17-27 July with the peak harvest (5,377) of both strata combined

Table 1.-Estimated effort (angler-hours), catch, harvest and snag during each stratum of the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

Stratum[a]	Estimate	Standard Error	95% Confidence Interval			Relative Precision
			EFFORT			
Stratum A	56,302	3,849	48,758	-	63,845	13.4
Stratum B	59,929	3,522	53,026	-	66,832	11.5
Total	116,231	5,217	106,005	-	126,456	8.8
			CATCH			
Stratum A	29,056	2,222	24,701	-	33,412	15.0
Stratum B	15,027	1,567	11,956	-	18,099	20.4
Total	44,084	2,719	38,754	-	49,414	12.1
			HARVEST			
Stratum A	28,996	2,222	24,641	-	33,351	15.0
Stratum B	13,283	1,280	10,773	-	15,792	18.9
Total	42,279	2,565	37,252	-	47,305	11.9
			SNAG			
Stratum A	18,760	1,957	14,925	-	22,595	20.4
Stratum B	7,994	1,210	5,623	-	10,365	29.7
Total	26,754	2,300	22,246	-	31,263	16.9

[a] Stratum A is the river section from the Warren Ames Bridge to the sonar counters and Stratum B is the river section from the sonar counters to the Soldotna Bridge.

occurring on 25 July (Figure 4). Catch and harvest rates for Stratum A were over twice those for Stratum B. The CPUE estimates for Strata A and B were 0.52 (SE = 0.05) and 0.25 (SE = 0.03), respectively; and the HPUE estimates were 0.52 (SE = 0.05) and 0.22 (SE = 0.03), respectively. Combining the strata, the total CPUE was 0.38 (SE = 0.03) and the total HPUE was 0.36 (SE = 0.03). The highest HPUE (0.72) (SE = 0.06) occurred on 21 July in Stratum A (Appendix C2).

Snag

The number of snagged fish in Stratum A (18,760) (SE = 1,957) was over twice that of Stratum B (7,994) (Table 1). The SPUE for Stratum A (0.33, SE = 0.06) was nearly three times that of Stratum B (0.13, SE = 0.04). The highest SPUE (0.77, SE = 0.14) occurred in Stratum A on 25 July (Appendix C2).

Summary

Estimates of effort, catch, harvest, and snag were within desired levels of precision (±20%) (Table 1). Effort estimates were

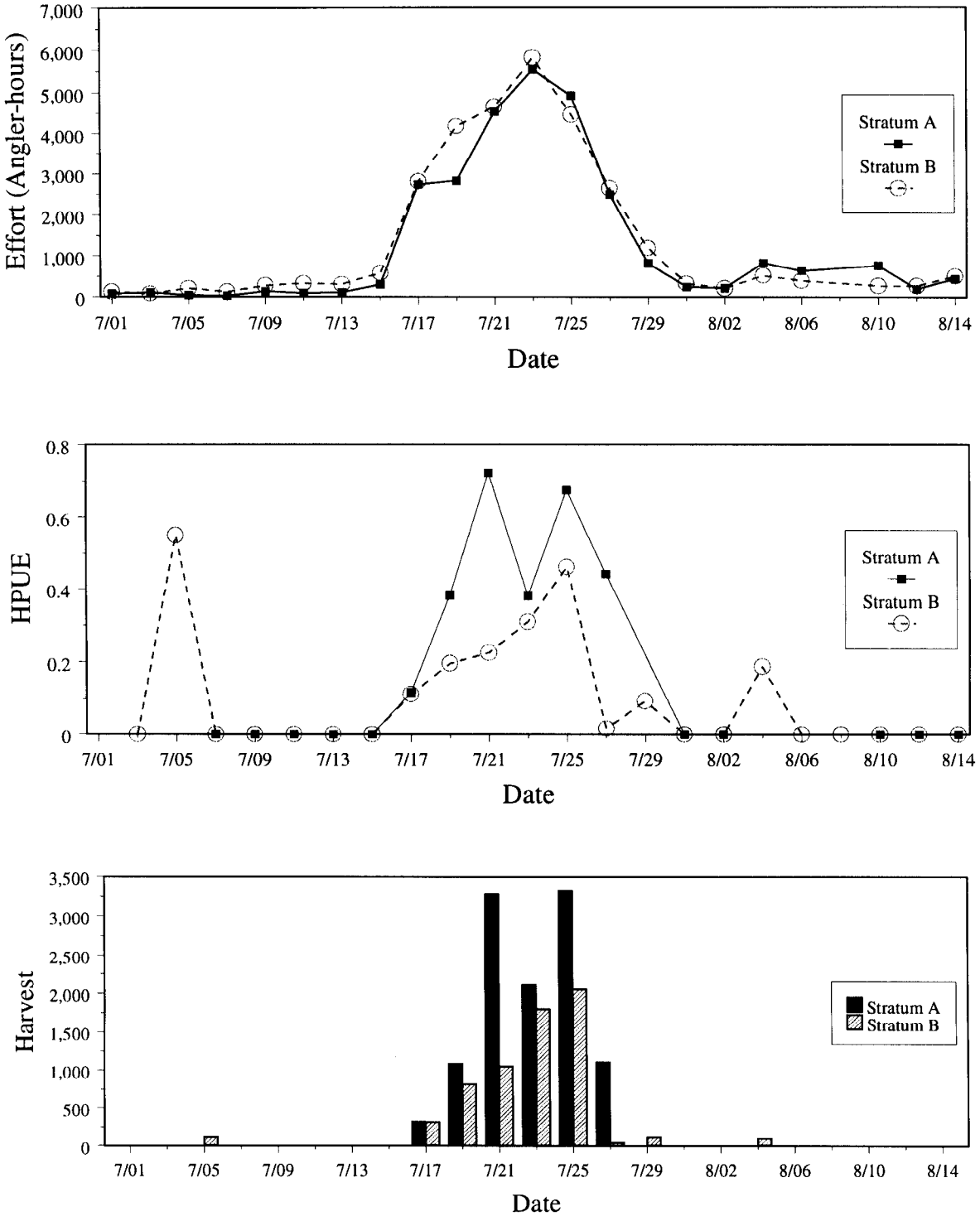


Figure 4.-Effort (angler hours), HPUE, and harvest for Stratum A (Warren Ames Bridge to the sonar counters) and Stratum B (sonar counters to the Soldotna Bridge) of the recreational fishery for sockeye salmon on the Kenai River, 1 July-15 August 1995.

similar between the two strata, contrary to what was expected considering that Stratum A is 23.3 km (14.5 river miles) in length versus 2.4 km (1.5 river miles) for Stratum B. Perhaps effort was similar because Stratum A, although encompassing more river miles than Stratum B, lacks public access sites which can accommodate large numbers of anglers and are in desirable locations for fishing for sockeye salmon. With similar effort in each stratum, harvest might be expected to be similar; however, there was a considerably larger harvest in Stratum A. On most sample days, harvest in Stratum A equaled or surpassed harvest in Stratum B (Figure 4). Possibly the greater harvest in Stratum A is the result of fewer anglers crowded into the same fishing area, i.e. smaller angler density than in Stratum B, which could allow increased angler success.

The events of the 1995 sockeye salmon fishery continue to support the hypothesis that angler success during this fishery is directly related to fish abundance. Trends in the daily HPUE of the 1995 sockeye salmon recreational fishery in the downriver section were very similar to trends in the sonar counts (Figure 5). Further analysis of this relationship will be addressed in the fishery survey section.

Liberalizing fishing regulations to allow the retention of snagged fish could greatly increase the number of fish legally retained. The daily incidence of landing a snagged fish was 10%-90% of the total fish caught (legally hooked) on that day (Figure 6). As with HPUE, there is an increase in SPUE with fish abundance (Figure 7). During 1995, in stratum B, the SPUE was usually zero when the daily sonar counts were below 15,000 at which point the incidence of snagging began to increase. There was a dramatic increase in SPUE when daily sonar counts exceeded 40,000 (Figure 7).

By summing the harvest estimate of Stratum A with the cumulative sonar count (Appendix C3), the total 1995 inriver return of sockeye salmon was estimated at 659,443 fish.

Effort in each stratum for each year was relatively equal. In 1994 the effort in Stratum A was 53,844 angler hours, 46% of the total, (King 1995) and in 1995 the effort in Stratum A was 56,302 angler hours, 48% of the total. Catch and harvest estimates were evenly split between river strata for 1994: Stratum A catch = 12,228 (49% of the total) (King 1995) and Stratum A harvest = 11,624 (50% of the total). In 1995 this relationship changed with increased catch and harvest in Stratum A: catch = 29,056 (66% of the total) and harvest = 28,996 (69% of the total). The reduced percentage of harvest in Stratum A in 1994 was likely due to the late return of the run. This resulted in many anglers departing from the fishery early with remaining anglers primarily concentrated in Stratum B. Thus, when the peak of the run occurred in early August, higher harvest occurred in Stratum B. This would also explain the difference in snag estimates for 1994 and 1995. In 1994 61% of the snagged fish were from Stratum B (King 1995), but in 1995 70% of the snagged fish were from Stratum A. The incidence of snagging increases with increased numbers of fish (discussed in the Fishery Survey section). In 1994 the highest harvest levels occurred in Stratum B when the run peaked in early August; thus explaining the higher percentage of snagging in Stratum B. In 1995 the run timing was more normal with angler effort being relatively equal in Strata A and B. The higher harvest in Stratum A would explain the higher incidence of snagging.

Figure 8 shows harvest downstream of the Soldotna Bridge as estimated by the SWHS and by the creel survey (1994, 1995). For both years the SWHS had a higher estimate of harvest with a difference of 6,966 fish for

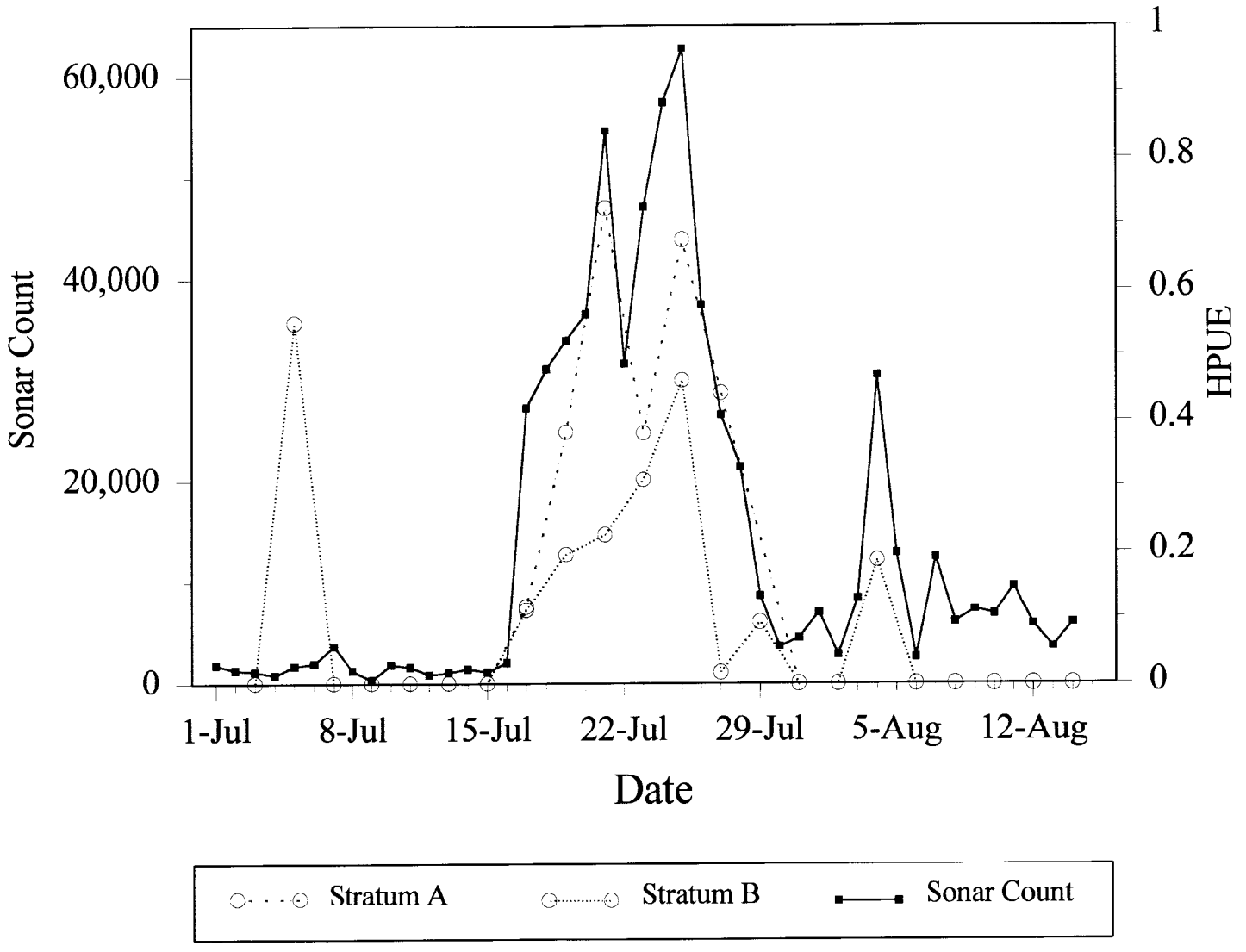


Figure 5.-Harvest rate (HPUE) for Stratum A (Warren Ames Bridge to the sonar counters) and Stratum B (sonar counters to the Soldotna Bridge) of the recreational fishery for sockeye salmon on the Kenai River and sockeye salmon sonar count at the river mile 19 sonar site, 1 July - 15 August 1995.

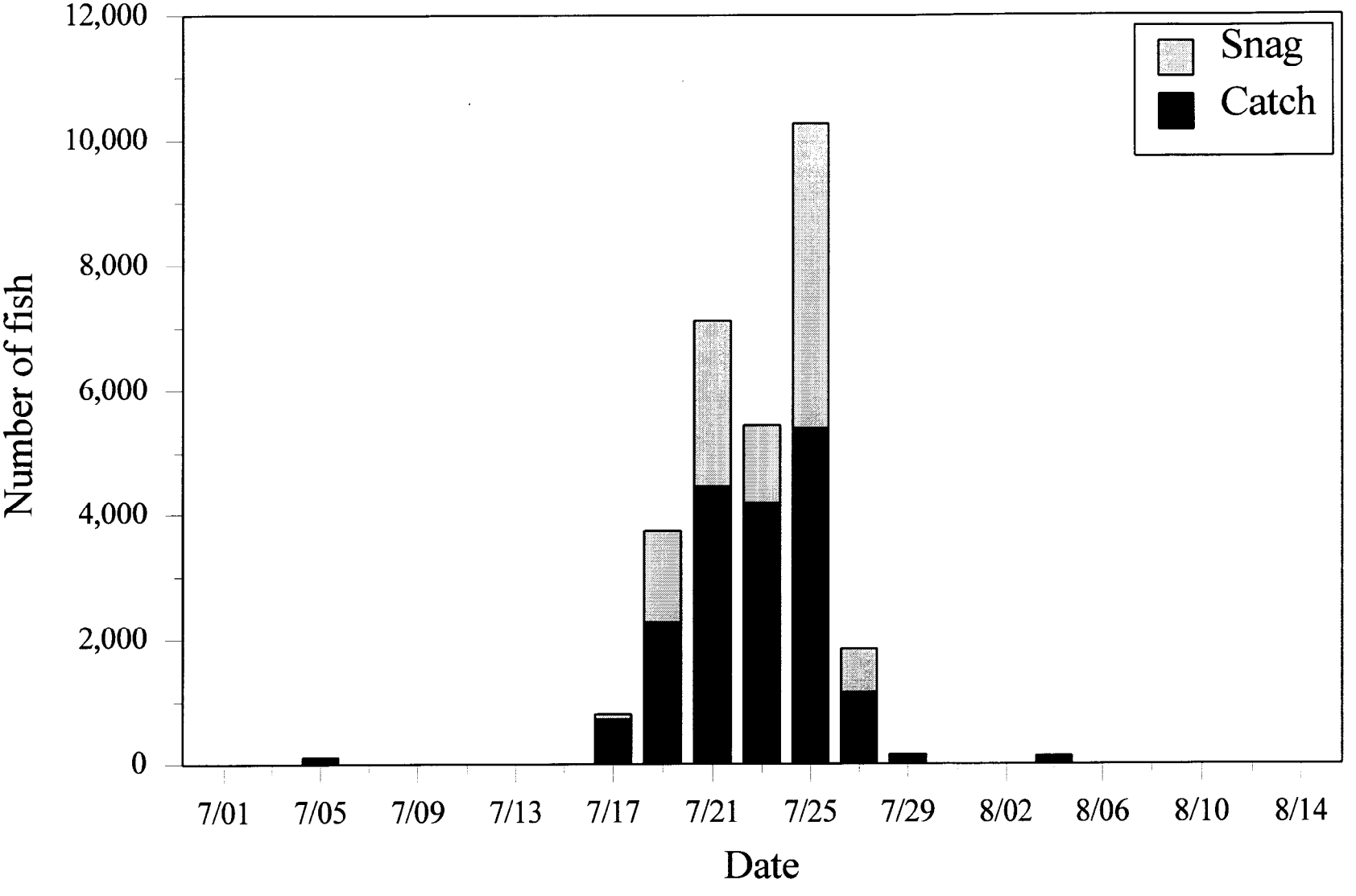


Figure 6.-Number of sockeye salmon landed (catch plus snag) downstream of the Soldotna Bridge (Strata A and B combined) during the recreational fishery on the Kenai River, 1 July-15 August 1995.

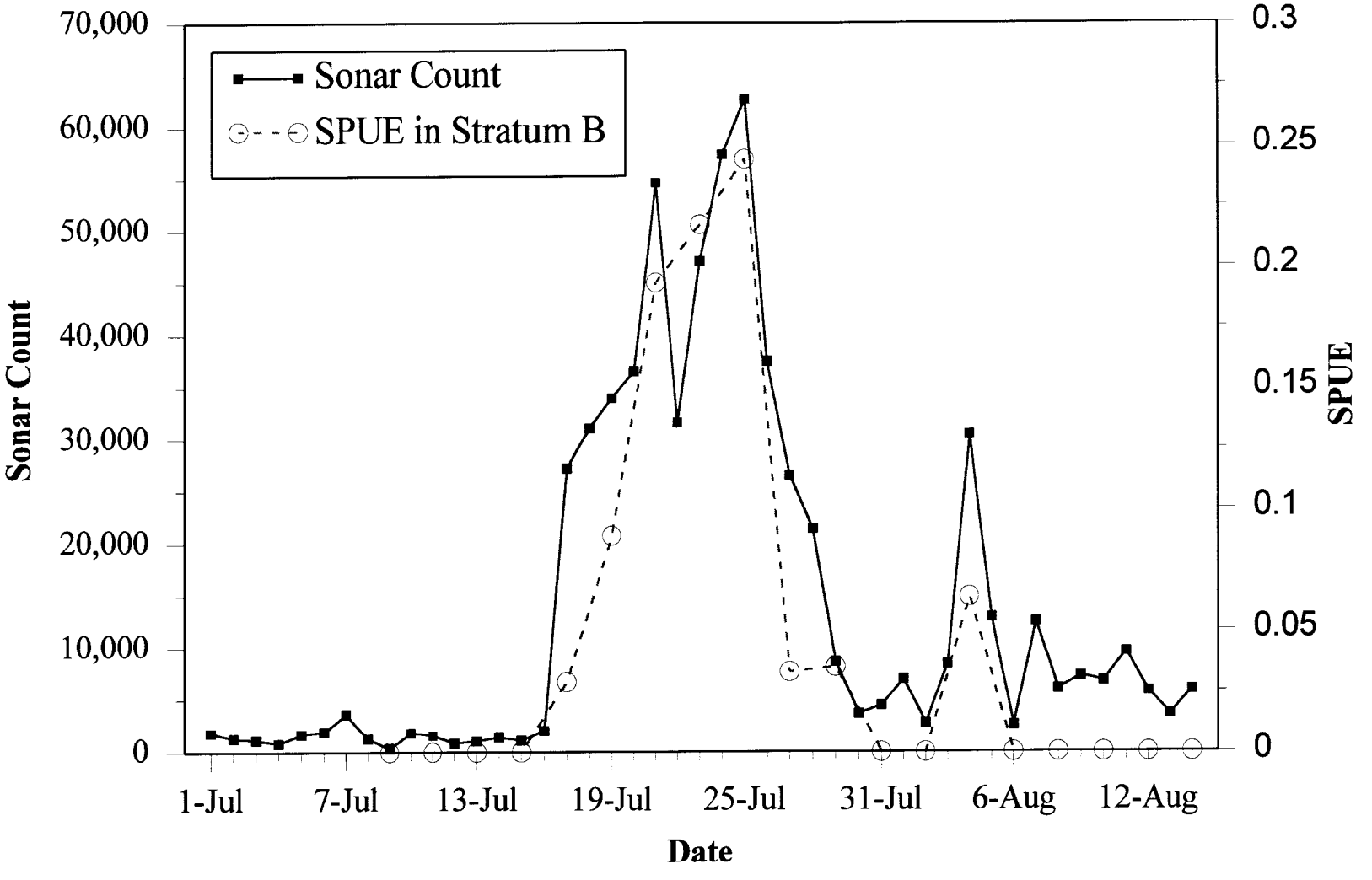


Figure 7.-Snag rate of completed-trip anglers during the recreational fishery for sockeye salmon in Stratum B (downstream of the Soldotna Bridge to the sonar counters) and sonar counts of sockeye salmon at the river mile 19 sonar site on the Kenai River, 1 July-14 August 1995.

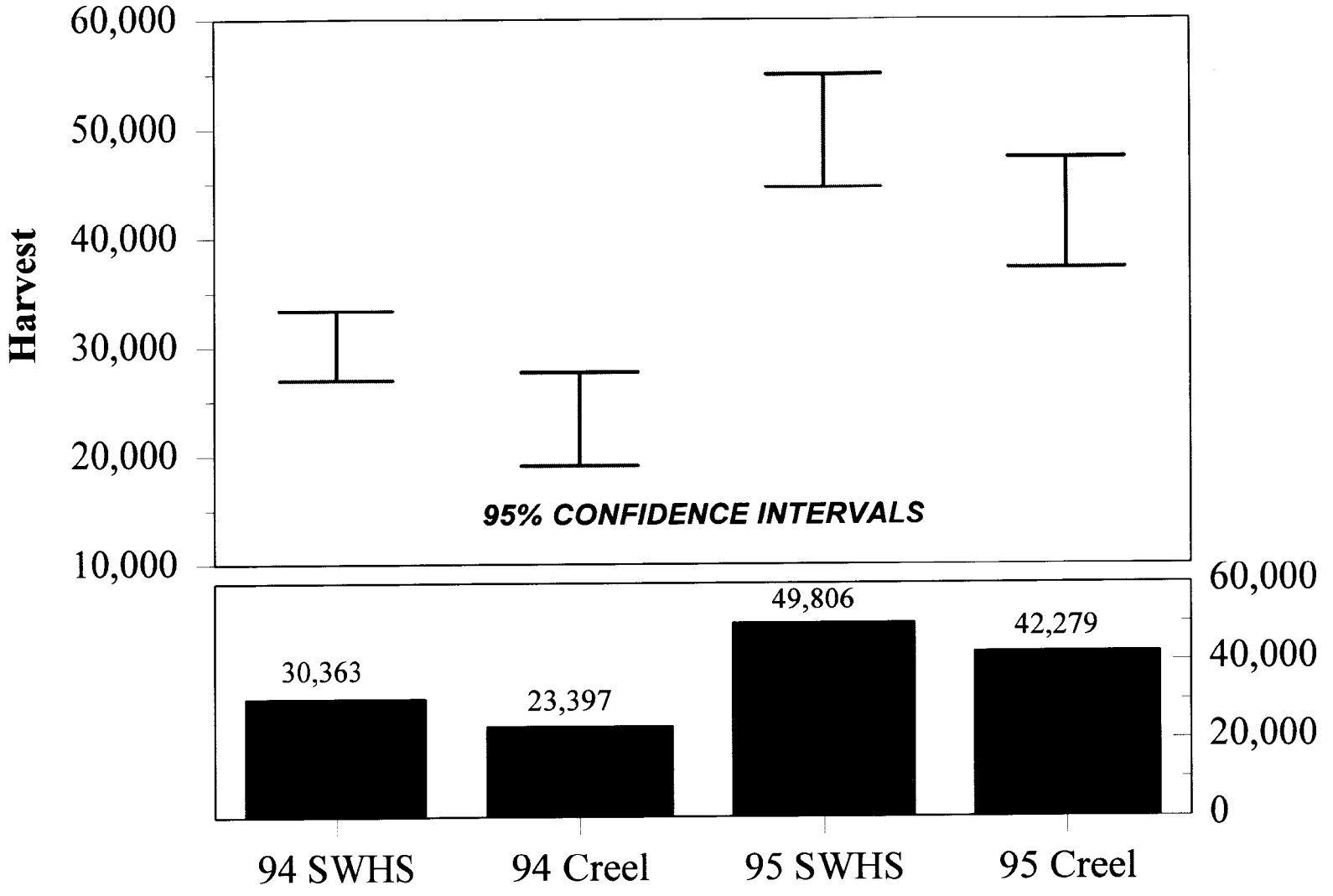


Figure 8.-Estimates of harvest of sockeye salmon by the recreational fishery downstream of the Soldotna Bridge using the Statewide Harvest Survey (Howe et al. 1995, 1996) and an onsite creel survey (King 1995), 1994 and 1995.

1994 and 7,527 fish for 1995. Since the 95% confidence intervals for the 1994 and 1995 estimates do overlap, the SWHS is considered to be an acceptable estimator of harvest for this fishery.

FISHERY SURVEY

During the fishery survey 364 completed-day anglers were interviewed downstream of the Soldotna Bridge, which easily made the sample goal of 128 interviews. A daily summary of completed-day angler interviews for catch, harvest and snag appears in Appendix C4.

Demographics and Angler Behavior

Based on all completed-day anglers interviewed, 20% were residents of the Kenai Borough (local), 23% were from other areas of Alaska (Alaska), 55% were from the United States other than Alaska (U.S.) and 2% were from other countries (Other) (Figure 9). There was a significant difference detected in residency for anglers interviewed downstream of the Soldotna Bridge in this fishery in 1994 and 1995 (χ^2 = 7.9, df = 3, P = 0.05).

The majority of interviewed anglers began their fishing day between 1200 hours and 1559 hours (Figure 10). Nearly as many interviewed anglers began their fishing day between 1600 and 1959 hours. The period between 0800 and 1159 hours was the next most popular time for anglers to begin their fishing day. Few anglers began their fishing day prior to 0400 and after 1959 hours. The

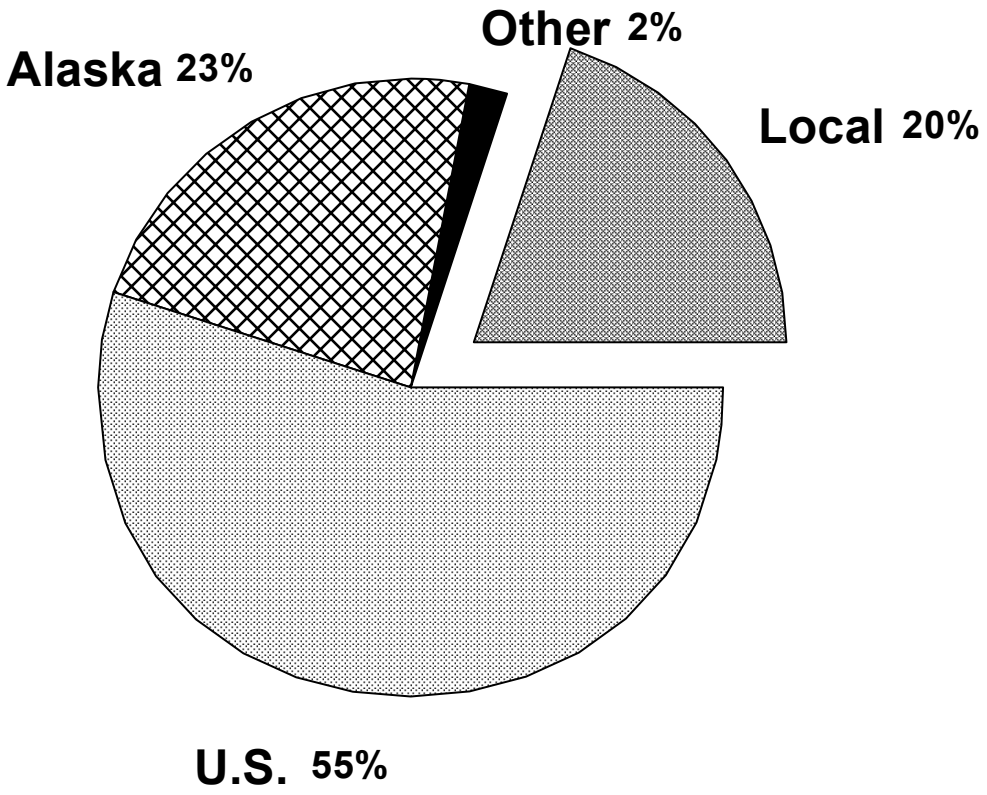


Figure 9.-Residency of interviewed anglers participating in the sockeye salmon recreational fishery downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

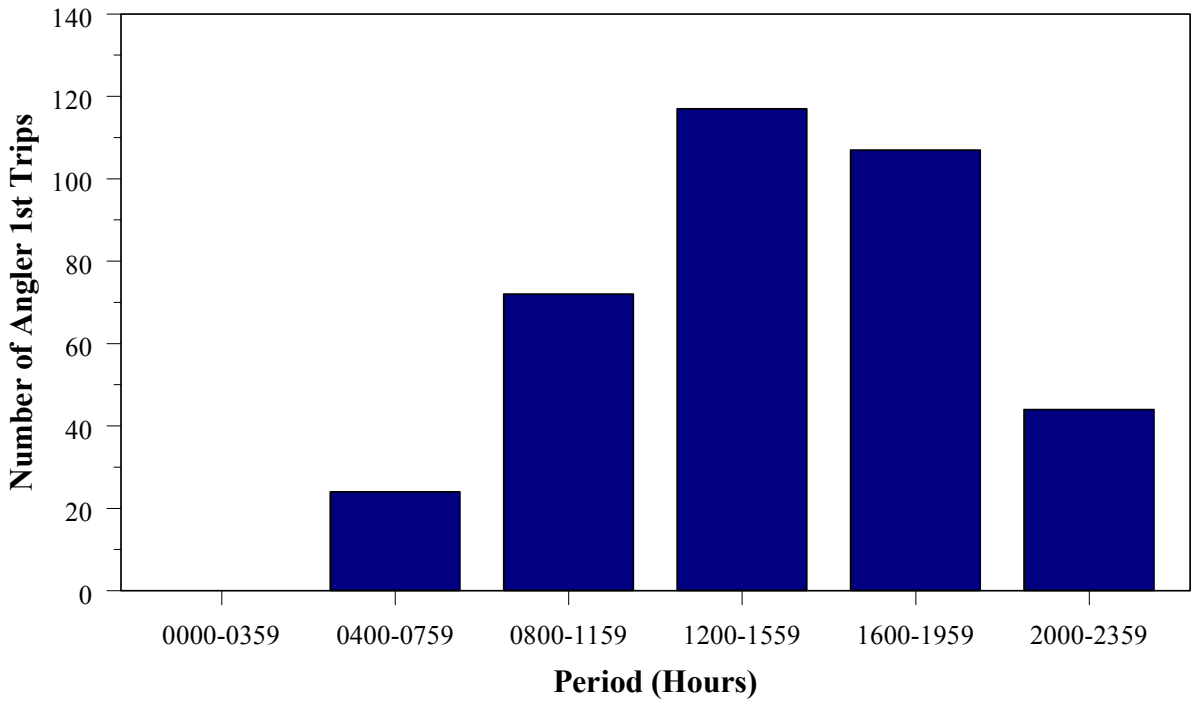


Figure 10.-Start time for anglers' first trip of the day by 4-hour periods during the recreational fishery downstream of the Soldotna Bridge on the Kenai River, 1 July-15-August 1995.

period between 0000 and 0359 hours was not surveyed due to darkness; but, there was little angler effort and likely the fewest angler first trips. Note that the number of anglers in each period of start times should not be construed to reflect effort during that period. These numbers are not indicative of the total anglers present during that time, but merely anglers beginning their angling day at that time.

Anglers tended to report their fishing day to the whole hour and to the half-hour so categories for the length of a fishing day were rounded up to make whole-hour categories. For example, fishing day lengths of 0.5 and 1 hour were combined, 1.5 and 2 hours were combined, etc. The most frequent length of an angler day was 2 hours and the median length of a fishing day was 2.5 hours (Figure 11). Overall, 81% of the interviewed anglers fished four or less hours per trip.

Angler Success

The harvest data were poststratified into 1-week intervals (Table 2). Although a difference in angler success was apparent among time intervals, this was likely due to changes in fish abundance over time, as discussed with the creel estimates, so differences among time intervals in and of themselves have no management implications.

Downstream of the Soldotna Bridge, 62% of all anglers interviewed failed to harvest any sockeye salmon, 8% harvested 1, 7% harvested 2, and 24% harvested 3, the bag limit (Table 2). Comparing 1994 and 1995, there was a significant difference detected for the distribution of harvest ($\chi^2 = 9.62$, df = 3, P = 0.02), catch ($\chi^2 = 9.42$, df = 3, P = 0.02), and snag ($\chi^2 = 9.02$, df = 3, P = 0.03) for anglers interviewed downstream of the Soldotna Bridge.

Distribution of catch and harvest were similar for 1994 (χ^2 = 0.12, df = 3, P = 0.99) and 1995 (χ^2 = 0.07, df = 3, P = 0.99) for those anglers interviewed downstream of the Soldotna Bridge. However, there was a significant difference detected between distribution of harvest, catch, and snag within 1994 (χ^2 = 41.08, df = 6, P < 0) and within 1995 (χ^2 = 47.78, df = 6, P < 0.001). For 1995, only 20% of interviewed anglers snagged one or more fish and 10% snagged three or more fish.

Summary

During the 1995 fishery the three-fish bag limit effectively reduced harvest since 24% of the interviewed anglers harvested three fish (Table 3 and Figure 12). Assuming effort is not affected by bag limit reductions, a two-fish bag limit during the 1995 fishery would have reduced harvest by 26% and a one-fish bag limit would have reduced harvest by 59% (Table 4).

As discussed earlier, harvest by anglers interviewed downstream of the Soldotna Bridge improved with an increase of fish abundance. Harvest, however, is not necessarily indicative of overall angler success (HPUE), so HPUE was used to develop a relationship with the daily sonar counts. Since data collected from completed-trip anglers in Stratum B are more reflective of fish passage at the sonar site, immediately downstream, only the HPUE for completed-trip anglers interviewed in this stratum were

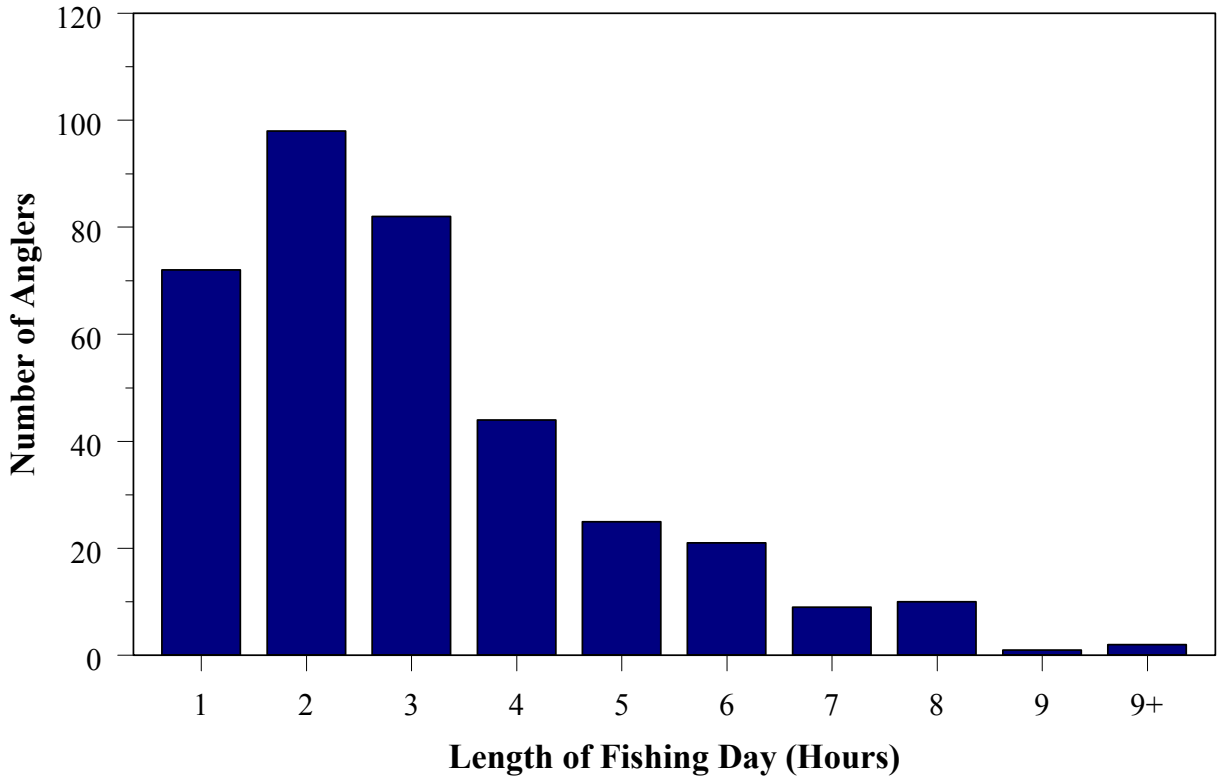


Figure 11.-Number of anglers, by length of fishing day, during the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

Table 2.-Harvest distribution of completed-day anglers, by period, during the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

Harvest	Number of Anglers	%	SE
1 - 7 July			
0	3	75	22
1	1	25	22
2	0		
3	0		
8 -14 July			
0	13	100	0
1	0		
2	0		
3	0		
15 - 22 July			
0	83	60	4
1	13	9	2
2	7	5	2
3	36	26	4
23 -30 July			
0	80	50	4
1	16	10	2
2	17	11	2
3	48	30	4
31 Jul - 7 August			
0	15	88	8
1	0		
2	0		
3	2	12	8
8 - 15 August			
0	30	100	0
1	0		
2	0		
3	0		
Total			
0	224	62	3
1	30	8	1
2	24	7	1
3	86	24	2

used for comparison to the daily sonar counts. A plot of the 1995 HPUE from Stratum B with daily sockeye salmon sonar counts indicated an increase in HPUE occurred at a sonar count of ~21,000 which is very near the median sonar count (20,973) used in the 1994 data analysis (Figure 13). For comparative purposes the 1994 median value was used for data analysis in 1995. There was a strong trend between angler success (HPUE) and the daily sonar counts in 1994 and 1995: when the daily sonar count reached a particular level then angler success began to increase and follow the trend of the daily sonar count, and when the daily sonar count fell below a given level the HPUE decreased to 0.15, or nearly so. For 1994 and 1995, distribution of harvest was significantly lower (1994: χ^2= 33.4, df = 3, P <0.001; and 1995: χ^2= 36.6, df = 3, P <0.001) among days when fish passage was below 20,973 versus days when counts were above 20,973 (King 1995) (Table 5). In 1994 and 1995, when fish passage was below 20,973, 98% and 93%, respectively, of the anglers had zero harvest, but when fish passage exceeded 20,973 only 58% and 47%, respectively, of the anglers had zero harvest. Therefore, the impact of bag limit modifications on angler harvest success is dependent upon fish passage, particularly the hourly passage rate. For example, in 1995, if the bag limit had been reduced to two fish, on days when fish passage was below 20,973 there would have been no effect on harvest in Stratum B; however, on days when the daily fish passage exceeded 20,973 there would have been a 26% reduction in harvest (Table 5).

PERSONAL USE DIP NET FISHERIES

During the personal use (old subsistence) dip net fishery, all possible high tide periods (16) were sampled between 1 July and 12 August. Shore angler counts ranged from 8 to 327 with the highest count occurring during the

Table 3.-Distribution of harvest, catch, and snag of completed-day anglers during the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

Number of Fish[a]	Anglers Number	%	SE	95% Confidence Interval
		HARVEST		
0	224	62	3	57 - 67
1+	140	38	3	33 - 43
2+	110	30	2	26 - 35
3	86	24	2	19 - 28
		CATCH		
0	222	61	3	56 - 66
1+	142	39	3	34 - 44
2+	110	30	2	26 - 35
3+	86	24	2	19 - 28
		SNAG		
0	291	80	2	76 - 84
1+	73	20	2	16 - 24
2+	50	14	2	10 - 17
3+	37	10	2	7 - 13

[a] "+" refers to equal to or greater than the number, i.e., 1+ means one or more fish.

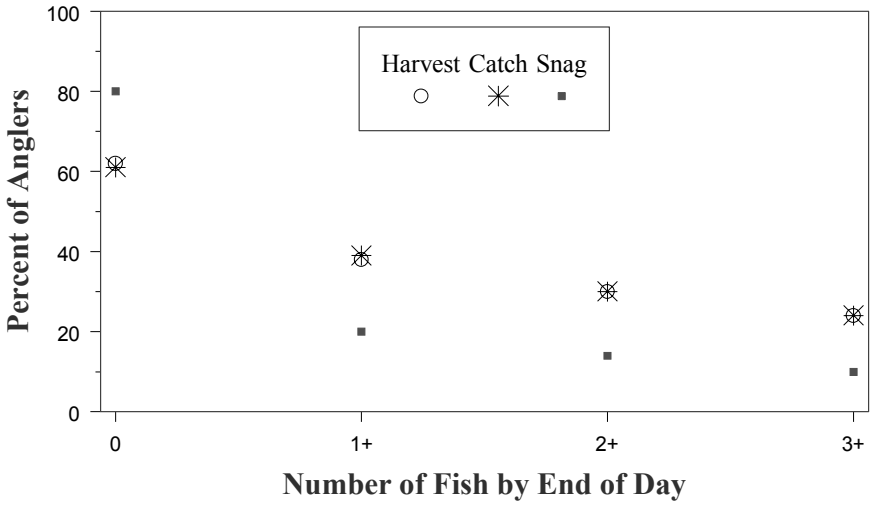


Figure 12.-Distribution of harvest, catch, and snag of sockeye during the recreational fishery downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

Table 4.-Numbers of sockeye salmon harvested by completed-day anglers during the recreational fishery downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995 (classified by fish position in the creel).

	Fish Position in Creel			
	1	2	3	Total
Harvest	140	110	86	336
Percent	42	33	26	100
SE (%)	1.2	0.7	1.1	

Table 5.-Number of completed-day anglers by harvest level, in relation to the 1994 median sonar count (20,973), during the recreational sockeye salmon fishery in Stratum B downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

	Harvest per Angler				Total	Fish Position in Creel			Total
Fish Passage	0	1	2	3	Anglers	1	2	3	Harvest
≤ 20,973	52	4	0	0	56	4	0	0	4
> 20,973	56	15	8	40	119	63	48	40	151
Total	108	19	8	40	175	67	48	40	155

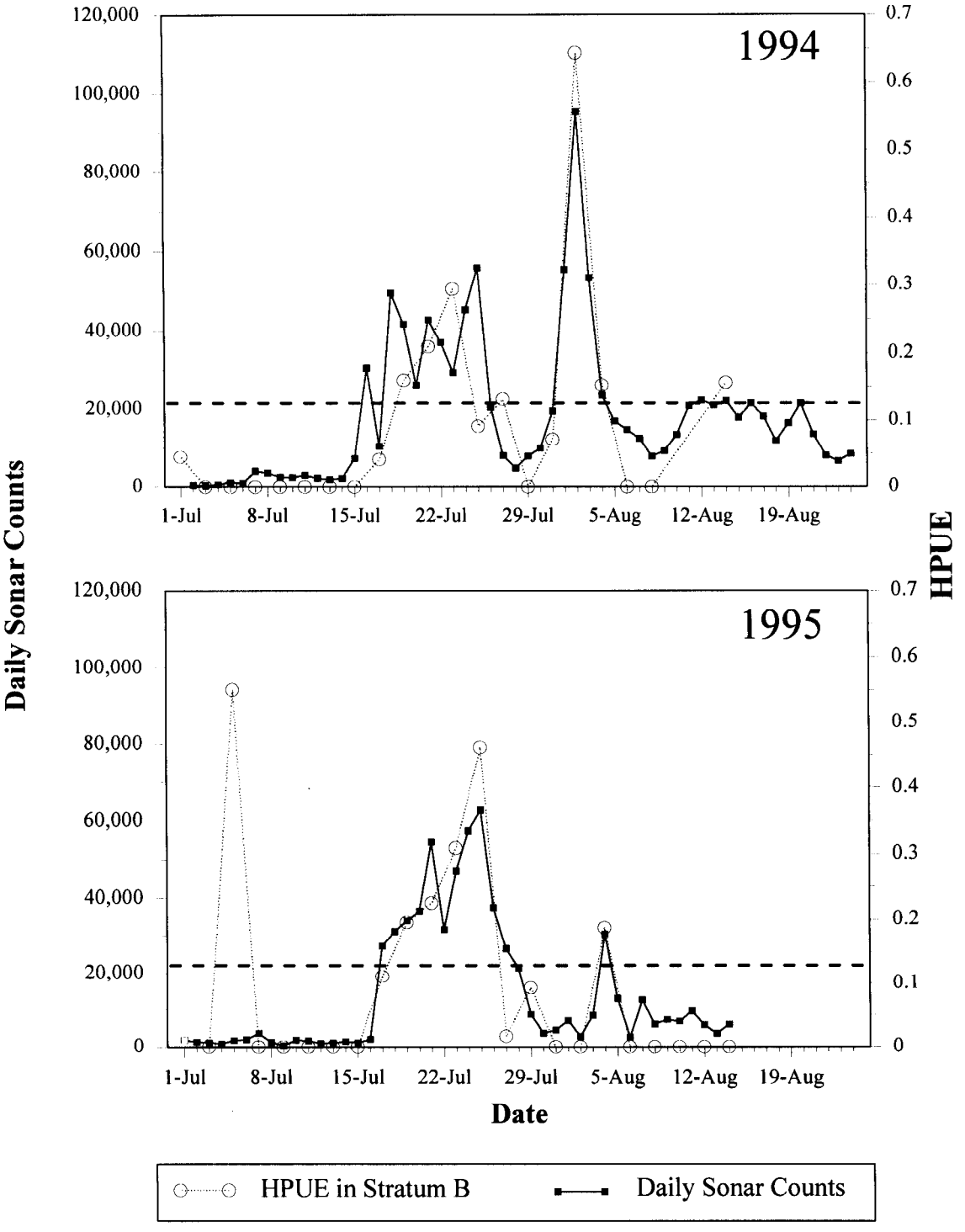


Figure 13.-Harvest rate of completed-trip anglers from the sonar counters upstream to the Soldotna Bridge (Stratum B) during the recreational fishery for sockeye salmon and sonar counts of sockeye salmon at the mile 19 sonar site on the Kenai River, 1994-1995.

evening tide on 22 July (Appendix C5). The total number of completed-trip angler interviews was 1,413 with the highest number of interviews (328) obtained during the evening tide on 29 July (Appendix C6).

During the personal use dip net fishery, four high tides were sampled of a possible seven high tides. Shore angler counts ranged from 0 to 37 with the highest count occurring on the morning high tide on 30 July. Boat counts ranged from 0 to 61 with the highest count occurring on the evening high tide on 27 July (Appendix C7). The total number of shore anglers interviewed was 105 with the highest number of interviews (74) occurring on the evening high tide on 30 July. The total number of boat interviews was 119 with the highest number of interviews occurring on the evening high tide of 27 July. The mean number of anglers per boat was 2.7 (Appendix C8).

For both personal use dip net fisheries there were high tides sampled in which the angler counts were highly variable and/or the number of anglers interviewed exceeded the highest count for that tide (Appendices C5-C8). During the personal use (old subsis-tence) dip net fishery this occurred on five (31%) of the sampled high tides. For the personal use dip net fishery, this occurred once (25%) for the shore anglers and twice (50%) for the boat anglers. The project design for these creel surveys predicates that the number of angler (boat) counts for a sample period will be greater than the number of angler interviews. This did not occur during several sample periods which indicated that participants tended to enter and leave the fishery throughout the 6-hour period surrounding the high tide. Since harvest rate may be related to the amount of time spent dipnetting, and we did not inquire about length of angling trip, estimates of harvest would be biased low. Therefore, it was not appropriate to make an expanded harvest estimate for each fishery. Instead the harvest data were summarized.

For the personal use (old subsistence) dip net fishery the summary of the harvest of sockeye salmon from interviewed anglers was 2,847 fish (Table 6). Of the permits issued for this fishery, 52% had been returned and the expanded estimate of harvest was 18,502 sockeye salmon (Brannian and Fox 1996). So, the harvest summary from this creel survey is biased very low.

During the personal use dip net fishery the summary of the harvest of sockeye salmon from interviewed anglers was 359; 304 for boat anglers and 55 for shore anglers (Table 7), again biased low.

RECOMMENDATIONS

By increasing the number of counts per period for the 1995 recreational fishery creel survey, the variance was reduced and the relative precision for catch and harvest were within desired levels. The length of the sample day was increased to 0400-2400 hours for 1995 which permitted interviewing anglers from 2200-2400 hours, observed to be a period of increased participation when fish abundance was high. Comparison of the 1994 and 1995 creel survey and SWHS harvest estimates showed the SWHS to be an acceptable estimator of harvest during the sockeye salmon recreational fishery. Therefore, with the current status and regulations governing the fishery it would not be necessary to repeat this survey.

Data from the 1995 fishery downstream of the Soldotna Bridge strongly corroborates conclusions drawn from the 1994 survey in this river section. Should this survey be repeated, it would be beneficial to conduct it upstream of the Soldotna Bridge, as well,

Table 6.-Angler harvest of sockeye salmon and estimated HPUE for completed-trip anglers interviewed during the personal use (old subsistence) dip net fishery on the Kenai River, 1 July-12 August 1995.

Date	Day	Tide	Sockeye Harvest	Angler Interviews
1-Jul	Sat	AM	1	4
		PM	91	63
5-Jul	Wed	AM	33	20
8-Jul	Sat	PM	31	53
12-Jul	Wed	PM	70	152
15-Jul	Sat	AM	6	10
		PM	61	69
19-Jul	Wed	AM	648	105
22-Jul	Sat	PM	856	272
26-Jul	Wed	PM	564	225
29-Jul	Sat	PM	263	328
2-Aug	Wed	AM	4	7
		PM	137	36
5-Aug	Sat	AM	2	23
9-Aug	Wed	PM	54	25
12-Aug	Sat	PM	26	21
Total			2,847	1,413

Table 7.-Angler harvest of sockeye salmon for completed-trip anglers interviewed during the personal use dip net fishery on the Kenai River, 25-31 July 1995.

			Boat Anglers		Shore Anglers	
Date	Day	Tide	Sockeye Harvest	Anglers Interviewed	Sockeye Harvest	Anglers Interviewed
27-Jul	Thu	PM	269	232	18	20
30-Jul	Sun	AM	1	13	1	9
		PM	34	74	36	74
31-Jul	Mon	AM	0	2	0	2
Total			304	321	55	105

since a large portion of the effort during the sockeye salmon fishery occurs there and fishery characteristics are different in those sections of the river (King 1995).

Should there be a need to repeat the creel surveys of the personal use dip net fisheries, several changes would be recommended in project design. First, due to the nature of each fishery, anglers dipnetting as a group activity, it was difficult to conduct accurate shore angler counts. Creel personnel were instructed to count only those individuals actively dipnetting or obviously handling recently dip netted fish. Fish being handled on the beach were not always easily observed from the count location, which may have excluded anglers from the count. Perhaps a direct expansion creel survey method would be more appropriate. Second, during interviews, anglers were not queried as to how many hours they actually dipnetted; instead, it was assumed they participated the entire 6-hour sample period since they may have been present that long. In fact, anglers dipnetted less time than anticipated. In repeating this project, individual angler effort should be collected. Lastly, most effort is concentrated at the mouth of the river. This season only one technician was located at the south mouth, of which there are two possible locations for dipnetters to exit the fishery. Assigning another technician to the other exit would increase the number of interviews and provide better precision.

As a result of actions taken by the BOF in February 1996, repetition of these surveys is not necessary. The BOF defined a single personal use fishery, to replace the two former personal use fisheries. This would be administered through a permit system with harvest estimated postseason using harvest records returned by the participants.

ACKNOWLEDGMENTS

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APPENDIX A. KENAI RIVER SOCKEYE SALMON MANAGEMENT PLAN

Appendix A1.-5 AAC 21.360. Kenai River sockeye salmon management plan.

I. The purpose of this management plan is to ensure an adequate escapement, as determined by the department, of sockeye salmon into the Kenai River system and to provide management guidelines to the department.

II. The department shall manage the Cook Inlet commercial salmon gillnet fisheries to achieve a sonar count of 450,000 to 700,000 late run sockeye salmon, as estimated by sonar counters at river mile 19.

III. The department shall manage the sport fishery on the Kenai River in a manner consistent with achieving the biological escapement goal, as follows:

A. fishing will occur seven days per week, 24 hours per day;

B. the daily bag and possession limits are three sockeye salmon;

C. if the inseason restrictions to the sport fishery become necessary to achieve the biological escapement goal, the commissioner shall close, by emergency order, the sport fishery and immediately reopen the sport fishery for a period during which

1. fishing time may be less than provided in A of this subsection; and

2. the daily bag limit is less than provided in B of this subsection; during such a period, the possession limit of sockeye salmon is the same as the bag limit established by the emergency order;

D. if the department can reasonably project that the sonar count will exceed 700,000 sockeye salmon, the commissioner shall increase, by emergency order, the daily bag limit to six sockeye salmon; during the time that an emergency order is in effect under this paragraph, the possession limit is six sockeye salmon.

APPENDIX B. PERSONAL USE SALMON DIP NET FISHERIES MANAGEMENT PLANS

Appendix B1.-5 AAC 77.545. Cook Inlet personal use salmon dip net fishery management plan.

I. Salmon, other than king salmon, may be taken with a dip net only in an area and during a season set out in this section or established by emergency order. The department may not allow the taking of salmon with a dip net in the Kenai River until a sonar count of 450,000 sockeye salmon, as measured by the sonar counters at river mile 19, is assured. The personal use dip net fishery is open through July 31, except as provided in 5 AAC 21.360. The department may not allow the taking of salmon with a dip net in the Kasilof River until the minimum escapement goal of 150,000 sockeye salmon is assured. The department may allow the taking of salmon with a dip net in a location where an artificially produced salmon stock is returning to an area that has no spawning grounds available for that salmon stock.

II. In the Kenai River, dip nets may be used to take salmon in the area from ADF&G regulatory markers located on the Cook Inlet beaches outside the terminus of the river upstream to the downstream side of the Warren Ames or new Kenai-Soldotna highway bridge.

Appendix B2.-5 AAC 77.540. Upper Cook Inlet personal use salmon fishery management plan.

(a) This section sets out a personal use salmon fishery management plan for the Northern and Central Districts except the Tyonek Subdistrict. Under a permit issued under 5 ACC 77.015 and 5 AAC 77.725, salmon may be taken for personal use in the Northern and Central Districts, except the Tyonek Subdistrict, as follows:

(2) in fresh water, salmon may be taken only by a dip net operated from shore or from a structure attached to shore; fishing periods are from 8:00 a.m. - 8:00 p.m. only on Saturdays from May 15 - June 30, and from 8:00 a.m. - 8:00 p.m. only on Wednesdays and Saturdays from July 1 - September 30, and only in the following areas:

(A) in the Kenai River from ADF&G regulatory markers located on the Cook Inlet beaches outside the terminus of the river upstream to the downstream side of the Warren Ames bridge;

(B) in the Kasilof River from ADF&G regulatory markers located on the Cook Inlet beaches outside of the terminus of the river upstream for a distance of one mile.

(b) Notwithstanding 5 AAC 77.225(c), the annual limit is 25 salmon per permit holder, of which no more than five may be king salmon; for each additional household member, 10 salmon, of which no more than one may be king salmon.

APPENDIX C. SUPPORTING STATISTICS

Appendix C1.-Daily shore angler counts and summary statistics by stratum during the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August 1995.

	Stratum A[a]						Stratum B[b]					
Date	#1	#2	#3	#4	Mean	Variance	#1	#2	#3	#4	Mean	Variance
1-Jul	0	0	5	10	3.8	2.1	0	2	8	14	6.0	3.2
3-Jul	0	0	17	4	5.3	19.1	0	4	6	5	3.8	.9
5-Jul	0	1	6	1	2.0	2.1	4	8	13	16	10.3	2.1
7-Jul	0	0	1	4	1.3	0.4	0	0	16	8	6.0	13.3
9-Jul	0	1	19	7	6.8	19.5	0	22	11	21	13.5	29.4
11-Jul	0	7	1	10	4.5	6.9	2	13	23	27	16.3	9.9
13-Jul	5	11	1	5	5.5	6.3	8	15	24	14	15.3	9.6
15-Jul	7	31	0	21	14.8	82.4	9	30	21	56	29.0	72.8
17-Jul	5	89	166	289	137.3	1,171.4	0	80	268	216	141.0	1,852.0
19-Jul	91	205	207	65	142.0	1,381.8	151	210	387	87	208.8	5,200.4
21-Jul	175	202	292	237	226.5	493.9	142	209	294	286	232.8	490.8
23-Jul	62	503	231	314	277.5	11,473.1	200	201	477	287	291.3	4,678.2
25-Jul		283	252	203	246.0	280.2		286	192	190	222.7	736.7
27-Jul	22	213	142	123	125.0	1,745.1	68	162	94	206	132.5	1,083.5
29-Jul	4	48	63	51	41.5	96.0	21	99	79	40	59.8	333.5
31-Jul	0	10	24	15	12.3	15.7	6	17	25	18	16.5	9.8
2-Aug	0	15	21	12	12.0	14.3	3	16	12	16	11.8	8.4
4-Aug	62	33	50	41	46.5	50.5	47	15	27	27	29.0	48.7
6-Aug	36	47	32	28	35.8	15.1	35	34	10	9	22.0	24.1
10-Aug	19	73	37	43	43.0	177.0	13	18	11	19	15.3	5.8
12-Aug	6	25	11	2	11.0	26.6	19	22	8	12	15.3	9.2
14-Aug	15	35			25.0	100.0	30	27			28.5	2.3

[a] Stratum A is the river section from sonar counters to the Warren Ames Bridge.

[b] Stratum B is the river section from Soldotna Bridge to the sonar counters.

Appendix C2.-Daily summary statistics for number of anglers interviewed, estimated fishing effort (E), and estimated HPUE, harvest (H), CPUE, catch (C), SPUE, and snag (S) of sockeye salmon, by stratum, for shore anglers interviewed during the fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-14 August 1995.

			Estimated		HPUE		Estimated		CPUE		Estimated		SPUE		Estimated	
Date[a]	Stratum[b]	Anglers Interviewed	Effort	Var	Mean	Var	Harvest	Var	Mean	Var	Catch	Var	Mean	Var	Snag	Var
1-Jul	A		75	833												
	B		120	1,267												
3-Jul	A		105	7,633												
	B	2	75	350	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
5-Jul	A		40	850												
	B	2	205	833	0.550	0.063	113	2,827	0.550	0.063	113	2,827	0.000	0.000	0	0
7-Jul	A	5	25	167	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	3	120	5,333	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
9-Jul	A	2	135	7,817	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	1	270	11,750	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
11-Jul	A	1	90	2,767	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	4	325	3,950	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
13-Jul	A	4	110	2,533	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	11	305	3,833	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
15-Jul	A	19	295	32,967	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	12	580	29,117	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
17-Jul	A	36	2,745	468,567	0.117	0.002	320	20,579	0.117	0.002	320	20,579	0.000	0.000	0	0
	B	25	2,820	740,800	0.112	0.003	315	32,276	0.141	0.005	396	54,159	0.029	0.001	82	6,666
19-Jul	A	32	2,840	552,733	0.382	0.002	1,086	94,814	0.390	0.002	1,109	96,930	0.387	0.005	1,098	119,383
	B	54	4,175	2,080,167	0.196	0.002	818	114,639	0.279	0.006	1,163	259,132	0.089	0.001	370	39,219
21-Jul	A	36	4,530	197,567	0.724	0.004	3,278	178,483	0.724	0.004	3,278	178,483	0.390	0.011	1,765	252,041
	B	28	4,655	196,300	0.226	0.004	1,051	95,184	0.253	0.006	1,176	140,926	0.193	0.005	898	114,858
23-Jul	A	11	5,550	4,589,233	0.381	0.020	2,113	1,180,029	0.381	0.020	2,113	1,180,029	0.000	0.000	0	0
	B	40	5,825	1,871,283	0.310	0.004	1,803	298,643	0.356	0.008	2,071	487,340	0.217	0.010	1,265	396,100
25-Jul	A	35	4,920	112,067	0.675	0.016	3,322	441,942	0.675	0.016	3,322	441,942	0.769	0.021	3,785	567,654
	B	54	4,453	294,667	0.461	0.003	2,055	125,333	0.467	0.003	2,079	127,133	0.244	0.006	1,085	142,127
27-Jul	A	13	2,500	698,050	0.442	0.015	1,106	219,161	0.442	0.015	1,106	219,161	0.245	0.015	613	125,561
	B	26	2,650	433,400	0.016	0.000	44	1,968	0.016	0.000	44	1,968	0.033	0.001	87	4,137
29-Jul	A		830	38,417												
	B	25	1,195	133,417	0.093	0.002	111	3,119	0.093	0.002	111	3,119	0.035	0.001	41	1,873
31-Jul	A	2	245	6,283	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	6	330	3,900	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0

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Date[a]	Stratum[b]	Anglers Interviewed	Estimated Effort	Estimated Var	HPUE Mean	HPUE Var	Estimated Harvest	Estimated Var	CPUE Mean	CPUE Var	Estimated Catch	Estimated Var	SPUE Mean	SPUE Var	Estimated Snag	Estimated Var
2-Aug	A	2	216	4,617	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	1	212	2,714	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
4-Aug	A		837	16,349												
	B	12	522	15,768	0.187	0.023	98	6,481	0.187	0.023	98	6,481	0.064	0.005	34	1,333
6-Aug	A		644	4,887												
	B	4	396	7,803	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
10-Aug	A	2	774	57,348	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	4	275	1,863	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
12-Aug	A	13	198	8,613	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	3	275	2,984	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
14-Aug	A	1	450	32,400	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0
	B	10	513	729	0.000	0.000	0	0	0.000	0.000	0	0	0.000	0.000	0	0

[a] No angler counts were conducted on 8 August so no statistics are available.

[b] Stratum A is the river section from the Warren Ames Bridge to the sonar counters.
Stratum B is the river section from the sonar counters to the Soldotna Bridge.

Appendix C3.-Daily and cumulative sonar estimates of late-run sockeye salmon entering the Kenai River, 1995.

Date	Daily Estimate	Cumulative Estimate
1-Jul	1,844	1,844
2-Jul	1,316	3,160
3-Jul	1,166	4,326
4-Jul	822	5,148
5-Jul	1,717	6,865
6-Jul	1,956	8,821
7-Jul	3,640	12,461
8-Jul	1,276	13,737
9-Jul	355	14,092
10-Jul	1,841	15,933
11-Jul	1,612	17,545
12-Jul	858	18,403
13-Jul	1,070	19,473
14-Jul	1,415	20,888
15-Jul	1,132	22,020
16-Jul	2,033	24,053
17-Jul	27,278	51,331
18-Jul	31,120	82,451
19-Jul	34,005	116,456
20-Jul	36,538	152,994
21-Jul	54,620	207,614
22-Jul	31,628	239,242
23-Jul	47,147	286,389
24-Jul	57,382	343,771
25-Jul	62,716	406,487
26-Jul	37,485	443,972
27-Jul	26,571	470,543
28-Jul	21,420	491,963
29-Jul	8,641	500,604
30-Jul	3,651	504,255
31-Jul	4,480	508,735
1-Aug	6,982	515,717
2-Aug	2,783	518,500
3-Aug	8,406	526,906
4-Aug	30,503	557,409
5-Aug	12,883	570,292
6-Aug	2,561	572,853
7-Aug	12,487	585,340
8-Aug	6,057	591,397
9-Aug	7,266	598,663
10-Aug	6,824	605,487
11-Aug	9,574	615,061
12-Aug	5,821	620,882
13-Aug	3,600	624,482
14-Aug	5,965	630,447

Data from: Davis et al. *In prep*

Appendix C4.-Numbers of anglers, by numbers of fish in the harvest, catch, and snag, by date, during the recreational fishery for sockeye salmon downstream of the Soldotna Bridge on the Kenai River, 1 July-15 August, 1995.

	Number of Fish															
Date	0	1	2	3	0	1	2	3	4-9[a]	0	1	2	3	4	5	6-9[b]
	Harvest				**Catch**					**Snag**						
1-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-Jul	1	1	0	0	1	1	0	0	0	2	0	0	0	0	0	0
7-Jul	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0
9-Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11-Jul	5	0	0	0	5	0	0	0	0	5	0	0	0	0	0	0
13-Jul	8	0	0	0	8	0	0	0	0	8	0	0	0	0	0	0
15-Jul	29	0	0	0	29	0	0	0	0	29	0	0	0	0	0	0
17-Jul	19	3	3	1	19	3	3	1	4	26	0	0	0	0	0	0
19-Jul	28	6	2	13	27	7	2	13	15	34	7	0	0	3	2	3
21-Jul	7	4	2	22	7	4	2	21	24	23	3	1	1	4	3	0
23-Jul	18	8	3	10	18	8	3	9	13	34	2	0	0	1	0	2
25-Jul	25	7	12	35	24	8	12	35	47	44	8	10	8	2	3	4
27-Jul	25	1	2	3	25	1	2	3	5	27	3	0	0	1	0	0
29-Jul	12	0	0	0	12	0	0	0	0	11	0	1	0	0	0	0
31-Jul	3	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0
2-Aug	3	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0
4-Aug	5	0	0	2	5	0	0	2	2	6	0	1	0	0	0	0
6-Aug	4	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0
8-Aug	2	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0
10-Aug	6	0	0	0	6	0	0	0	0	6	0	0	0	0	0	0
12-Aug	11	0	0	0	11	0	0	0	0	11	0	0	0	0	0	0
14-Aug	11	0	0	0	11	0	0	0	0	11	0	0	0	0	0	0

[a] On 21 July one angler caught 5 fish and on 23 July one angler caught 9 fish.

[b] On 19 July three anglers snagged 6 fish; on 23 July one angler snagged 6 fish and one angler snagged 9 fish; and on 25 July one angler snagged 6, one angler snagged 8, and two anglers snagged 9 fish.

Appendix C5.-Daily shore angler counts and summary statistics during the personal use (old subsistence) fishery on the Kenai River, 1 July-12 August 1995.

			Shore Angler Counts				
Date	Day	Tide	#1	#2	#3[a]	Mean	Variance
1-Jul	Sat	AM	58	93		75.5	306.3
		PM	58	30		44.0	196.0
5-Jul	Wed	AM	66	50	56	57.3	43.6
8-Jul	Sat	PM	66	43	48	52.3	97.6
12-Jul	Wed	PM	83	65	37	61.7	358.2
15-Jul	Sat	AM	71	149		110.0	1,521.0
		PM	114	65		89.5	600.3
19-Jul	Wed	AM	184	204	201	196.3	77.6
22-Jul	Sat	PM	318	241	327	295.3	1,489.6
26-Jul	Wed	PM	272	122	166	186.7	3,963.6
29-Jul	Sat	PM	163	34		98.5	4,160.3
2-Aug	Wed	AM	26	62		44.0	324.0
		PM	51	33		42.0	81.0
5-Aug	Sat	AM	38	14	24	25.3	96.9
9-Aug	Wed	PM	46	35	30	37.0	44.7
12-Aug	Sat	PM	8	9		8.5	0.3

[a] On some tides only two counts were conducted due to a portion of the high tide period to be sampled occurring outside the regulation fishing period.

Appendix C6.-Daily summary of harvest by interviewed anglers during the personal use (old subsistence) dip net fishery on the Kenai River, 1 July-12 August 1995.

			Anglers	Harvest[a]			
Date	Day	Tide	Interviewed	RS	KS	SS	PS
1-Jul	Sat	AM	4	1	0	0	0
		PM	63	91	1	0	1
5-Jul	Wed	AM	20	33	0	0	0
8-Jul	Sat	PM	53	31	0	0	0
12-Jul	Wed	PM	152	70	3	2	31
15-Jul	Sat	AM	10	6	0	1	0
		PM	69	61	1	0	2
19-Jul	Wed	AM	105	648	0	2	2
22-Jul	Sat	PM	272	856	1	4	9
26-Jul	Wed	PM	225	564	0	11	4
29-Jul	Sat	PM	328	263	0	1	4
2-Aug	Wed	AM	7	4	0	0	0
		PM	36	137	0	0	1
5-Aug	Sat	AM	23	2	0	0	0
9-Aug	Wed	PM	25	54	0	12	2
12-Aug	Sat	PM	21	26	0	13	0

[a] RS is sockeye salmon; KS is chinook salmon, SS is coho salmon; and PS is pink salmon.

Appendix C7.-Daily angler and boat counts and summary statistics during the personal use dip net fishery on the Kenai River, 25-31 July 1995.

			Shore Angler Counts					Boat Counts				
Date	Day	Tide	#1	#2	#3	Mean	Variance	#1	#2	#3	Mean	Variance
27-Jul	Thu	PM	35	11	16	20.7	106.9	40	61	54	51.7	76.2
30-Jul	Sun	AM	3	16	37	18.7	196.2	0	17	22	13.0	88.7
		PM	28	16	14	19.3	38.2	23	10	7	13.3	48.2
31-Jul	Mon	AM	0	4	18	7.3	59.6	0	2	9	3.7	14.9

Appendix C8.-Daily summary of harvest for boat and shore anglers interviewed during the personal use dip net fishery on the Kenai River, 25-31 July 1995.

			Boat						Shore			
			No. of	No. of	Mean no.of	Harvest[b]			No. of	Harvest[b]		
Date	Day	Tide	Interviews[a]	Anglers	Anglers/Boat	RS	SS	PS	Interviews	RS	SS	PS
27-Jul	Thu	PM	82	232	2.8	269	1	1	20	18	0	0
30-Jul	Sun	AM	6	13	2.2	1	0	0	9	1	0	0
		PM	30	74	2.5	34	0	0	74	36	0	0
31-Jul	Mon	AM	1	2	2.0	0	0	0	2	0	0	0

[a] Data collected during interviews were the total harvest by all anglers in the boat, not per angler.

[b] RS is sockeye salmon; SS is coho salmon; and PS is pink salmon.