

Fishery Data Series No. 91-44

**Angler Effort and Harvest of Chinook Salmon and
Coho Salmon by the Recreational Fisheries in the
Lower Kenai River, 1990**

by

S. L. Hammarstrom

September 1991

Alaska Department of Fish and Game

Division of Sport Fish



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Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

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TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	iii
LIST OF FIGURES.....	vii
LIST OF APPENDICES.....	viii
ABSTRACT.....	1
INTRODUCTION.....	2
Fishing Regulations.....	5
METHODS.....	6
Creel Survey of the Chinook Salmon Fishery.....	6
Angler Counts.....	7
Angler Interviews.....	8
Creel Survey of the Coho Salmon Fishery.....	9
Angler Counts.....	10
Angler Interviews.....	10
Biological Samples.....	10
Data Analyses.....	10
Downstream Section Chinook; Downstream and Upstream Sections Coho.....	11
Midstream Section Effort and Harvest; Chinook Salmon.....	16
Midstream Section Effort and Harvest; Coho Salmon..	20
Biological Data.....	22
RESULTS AND DISCUSSIONS.....	22
Chinook Salmon Fishery.....	22
Effort.....	26
Harvest Rates and Catch Rates.....	31
Harvest and Catch.....	31
Summary.....	38
Biological Data.....	38
Discussion.....	38
Coho Salmon Fishery.....	43
Effort.....	43
Harvest Rates and Catch Rates.....	47

TABLE OF CONTENTS (Continued)

	<u>Page</u>
Harvest and Catch.....	58
Biological Data.....	66
RECOMMENDATIONS.....	66
Chinook Salmon Fishery.....	66
Coho Salmon Fishery.....	66
ACKNOWLEDGEMENTS.....	66
LITERATURE CITED.....	69
APPENDIX A - Summarized data used to test the hypothesis of no difference in frequency of zero catch for completed-trip and incompleted-trip anglers interviewed during the recreational fishery for coho salmon in the Kenai River, Alaska, 1990....	73
APPENDIX B - Counts of boat anglers during the creel survey of the fishery for chinook salmon in the Kenai River, Alaska, 1990.....	75
APPENDIX C - Daily summary statistics for fishing effort, harvest rate, and catch rate for anglers interviewed during the fishery for chinook salmon in the Kenai River, Alaska, 1990.....	81
APPENDIX D - Multiple analysis of variance of boat angler counts during the creel survey of the fishery for chinook salmon in the Kenai River, Alaska, 1990.....	88
APPENDIX E - Counts of anglers during the creel survey of the fishery for coho salmon in the Kenai River, Alaska, 1990.....	90
APPENDIX F - Daily summary statistics for fishing effort, harvest rate, and catch rate for anglers interviewed during the fishery for coho salmon in the Kenai River, Alaska, 1990.....	93

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Mean counts of boat anglers by period for each of the components for the creel survey of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	23
2. Estimated number of angler-hours of fishing effort by boat anglers during each of the components of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	27
3. Summary of effort statistics for boat anglers by time period for the creel survey of the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	29
4. Estimated number of angler-hours of fishing effort by boat anglers during each period of the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	30
5. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of chinook salmon by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	32
6. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, coho salmon, pink salmon rainbow trout, and Dolly Varden by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	35
7. Estimated number of chinook salmon harvested and number caught by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	36
8. Estimate of total effort, catch and harvest by boat anglers during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	37
9. Estimated number of sockeye salmon, coho salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by boat anglers during the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	39

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
10. Summary of estimated angler effort, chinook salmon harvest, and chinook salmon catch by all boat anglers, for each river section of the fishery for chinook salmon in the Kenai River, Alaska, 1990.....	40
11. Age composition of chinook salmon sampled from the harvest during the early and late runs of the fishery for chinook salmon in the Kenai River, Alaska, 1990....	41
12. Mean length (millimeters) by age group of chinook salmon sampled from the harvest during the early and late runs of the fishery for chinook salmon in the Kenai River, Alaska, 1990.....	42
13. Mean counts of anglers by period for each component of the creel survey of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	44
14. Estimated number of angler-hours of fishing effort by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	46
15. Mean counts of anglers by period for each component of the creel survey of the fishery for coho salmon in the upstream section of the Kenai River, 1990.....	48
16. Estimated number of angler-hours of fishing effort by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	50
17. Counts of sportfishing boats and shore anglers by river section during aerial surveys of the fishery for early run coho salmon in the Kenai River, Alaska, 1990.....	51
18. Counts of sportfishing boats and shore anglers by river section during aerial surveys of the fishery for late-run coho salmon in the Kenai River, Alaska, 1990.....	52
19. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of coho salmon by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	53

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
20. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of coho salmon by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	54
21. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990....	56
22. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	59
23. Estimated number of coho salmon harvested and number caught by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	61
24. Estimated number of coho salmon harvested and number caught by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	62
25. Summary of estimated angler effort, coho salmon harvest and coho salmon catch by all anglers for each river section of the fishery for coho salmon in the Kenai River, Alaska, 1990.....	63
26. Estimated number of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by anglers during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990...	64
27. Estimated number of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by anglers during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	65

LIST OF TABLES (Continued)

<u>Table</u>	<u>Page</u>
28. Age composition of coho salmon sampled from the harvest during the early and late runs of the fishery for coho salmon in the Kenai River, Alaska, 1990.....	67
29. Mean length (millimeters) by age group of coho salmon sampled from the harvest during the early and late runs of the fishery for coho salmon in the Kenai River, Alaska, 1990.....	68

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Map of the Kenai River drainage, Alaska.....	3
2. Creel survey estimates of effort and harvest by the recreational fisheries for chinook and coho salmon in the Kenai River, Alaska, 1977-1990..	4
3. Percent of effort by date in the recreational fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	28
4. Daily catch per hour of chinook salmon by anglers in the recreational fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.....	34
5. Daily harvest per hour of coho salmon by anglers in the recreational fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	55

LIST OF APPENDICES

<u>Appendix</u>	<u>Page</u>
A1. Results of comparison of completed- versus incompleted-trip interviews for coho salmon creel survey in the Kenai River, Alaska, 1990.....	74
B1. Counts of unguided and guided boat anglers during the fishery for early-run chinook salmon in the downstream section of the Kenai River, Alaska, 1990....	76
B2. Counts of unguided and guided boat anglers during the fishery for late-run chinook salmon in the downstream section of the Kenai River, Alaska, 1990....	78
B3. Counts of boats during the fishery for early-run chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	79
B4. Counts of boats during the fishery for late-run chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	80
C1. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by unguided anglers interviewed during the early run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed- trip interviews only).....	82
C2. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by unguided anglers interviewed during the late run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).....	83
C3. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by guided anglers interviewed during the early run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).....	84
C4. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by guided anglers interviewed during the late run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).....	85

LIST OF APPENDICES (Continued)

<u>Appendix</u>	<u>Page</u>
C5. Daily summary statistics for fishing effort by boat anglers during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	86
C6. Daily summary statistics for fishing effort, chinook salmon harvest and chinook salmon catch by anglers interviewed during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.....	87
D1. Estimation of within-period variance for estimates of total effort during the recreational fishery for chinook salmon on the downstream section of the Kenai River, Alaska, 1990.....	89
E1. Counts of unguided and guided boat anglers and shore anglers during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.....	91
E2. Counts of unguided and guided boat anglers and shore anglers during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.....	92
F1. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by unguided boat anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).....	94
F2. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by guided boat anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).....	96
F3. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by shore anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).....	98

LIST OF APPENDICES (Continued)

<u>Appendix</u>	<u>Page</u>
F4. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by unguided boat anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).....	99
F5. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by guided boat anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).....	101
F6. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by shore anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).....	102

ABSTRACT

A creel survey was conducted on the Kenai River between the outlet of Skilak Lake and Cook Inlet from 16 May through 30 September 1990. The recreational fishery in this section of the Kenai River is primarily for two species, chinook salmon *Oncorhynchus tshawytscha* during May through July, and coho salmon *Oncorhynchus kisutch* during August and September. The estimated angler-effort and harvest during the early (May and June) chinook salmon run were 123,149 angler-hours and 1,735 chinook salmon, respectively. The estimated angler-effort and harvest during the late (July) chinook salmon run were 291,966 angler-hours and 6,247 chinook salmon, respectively. In-season restrictions to the recreational fisheries were issued for conservation reasons during both runs. Unguided anglers exerted 61.1% of the total effort and took 37.1% of the chinook salmon harvest while guided anglers exerted 38.9% of the effort and harvested 62.9% of the chinook salmon.

The estimated angler-effort and harvest during the coho salmon fishery (August and September) were 399,426 angler-hours and 51,786 coho salmon, respectively. Unguided anglers exerted 77.0% of the total effort and took 66.5% of the coho salmon harvest while guided anglers exerted 23.0% of the effort and harvested 33.5% of the coho salmon.

Harvest and catch estimates for sockeye salmon *Oncorhynchus nerka*, pink salmon *Oncorhynchus gorbuscha*, rainbow trout *Oncorhynchus mykiss*, and Dolly Varden *Salvelinus malma* are also presented.

KEY WORDS: Kenai River, chinook salmon, coho salmon, creel survey, effort, harvest, sockeye salmon, pink salmon, rainbow trout, Dolly Varden, *Oncorhynchus tshawytscha*, *Oncorhynchus kisutch*, *Oncorhynchus nerka*, *Oncorhynchus gorbuscha*, *Oncorhynchus mykiss*, *Salvelinus malma*.

INTRODUCTION

The largest freshwater recreational fishery in Alaska occurs in the Kenai River which received an average of nearly 260,000 angler-days of effort over the years 1983-1989 (Mills 1984-1990). This represents approximately 13% of the State's recreational fishing effort. The majority of the angler-effort occurs in the section of the river between the outlet of Skilak Lake and Cook Inlet (Figure 1) during a fishery directed primarily at returning chinook salmon *Oncorhynchus tshawytscha* during May, June, and July; and a second fishery directed primarily at returning coho salmon *O. kisutch* during August and September. Angler-effort in both fisheries has generally been increasing, except for a significant reduction in the 1990 chinook salmon fishery, since creel surveys began in 1977 (Figure 2). 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.

Prior to 1970, the recreational fishery in the Kenai River was comprised of shore-based anglers targeting on sockeye salmon in July and coho salmon in August and early September. In 1973, large numbers of anglers began experimenting with a new fishing method that involved bouncing brightly colored terminal gear along the river bottom from a drifting boat. This technique had been used effectively by anglers fishing for chinook salmon on rivers in the Pacific Northwest. It proved to be a very effective method for catching chinook salmon on the Kenai River, and the fishery began to expand rapidly.

The chinook salmon return to the Kenai River has two distinct components: (1) an early run which typically enters the river from mid-May until late June; and (2) a late run which typically enters the river from late June through early August. Fish from both runs are prized by recreational anglers due to their large size, especially those from the late run which average about 18 kg (40 lbs) and may exceed 36 kg (80 lbs). The world record sport-caught chinook salmon was taken from the Kenai River in 1985; it weighed 44.1 kg (97 lb).

The coho salmon return to the Kenai River also has two distinct components: an early run which typically peaks in August, and a late run which typically peaks in September. The late run continues to enter the river into November but fishing effort after September is minimal.

Management of these recreational fisheries in the Kenai River is complicated by the relatively large commercial harvests of returning chinook and coho salmon. Chinook salmon are commercially harvested primarily by the set net fishery along the eastern shore of Cook Inlet (McBride et al. 1985), and coho salmon are commercially harvested primarily by the drift gill net fishery. User-group conflicts have required the Department of Fish and Game to manage the salmon resources of the Kenai River with increasing precision. During the winter of 1988, the Alaska Board of Fisheries adopted management plans for both the early and late chinook salmon runs. These plans define escapement goals and mechanisms by which the various fisheries are to be regulated to achieve the stated goals. Another component of these plans defines the separation date between the two runs as 1 July. Both management plans were reviewed by the Alaska Board of Fisheries in late 1990. Minor changes were made which will affect the 1991 fisheries.

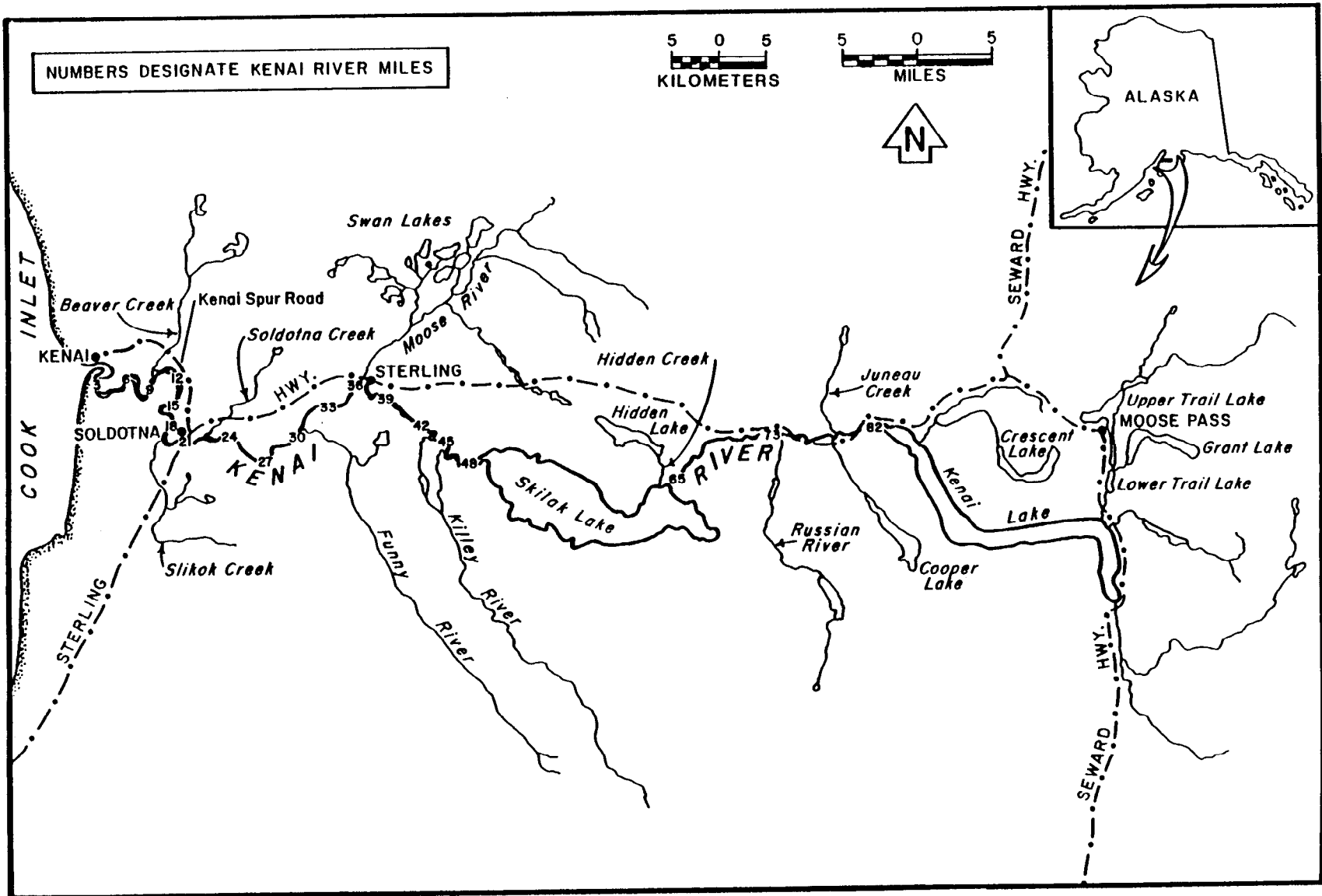


Figure 1. Map of the Kenai River drainage, Alaska.

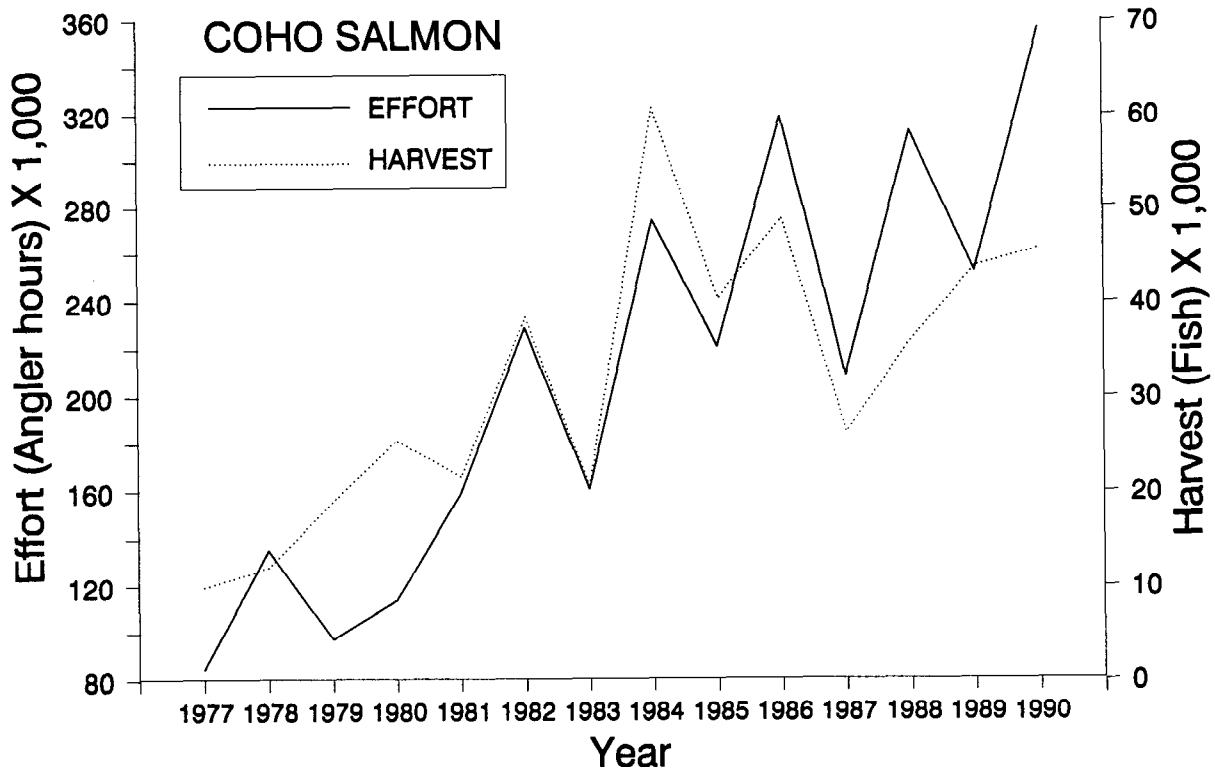
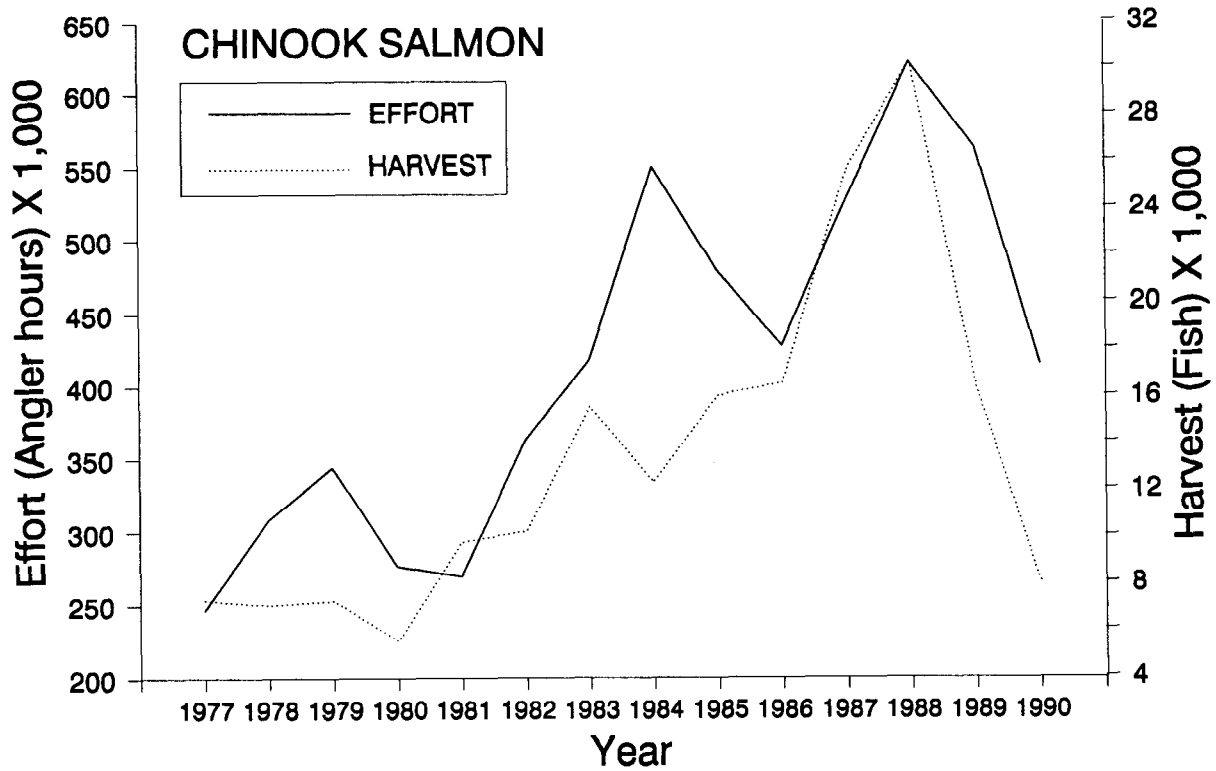


Figure 2. Creel survey estimates of effort and harvest by the recreational fisheries for chinook and coho salmon in the Kenai River, Alaska, 1977-1990.

Previous information pertaining to the chinook and coho salmon fisheries in the Kenai River has been presented by Hammarstrom (1975-1981, 1988-1990), Hammarstrom and Larson (1982-1984, 1986), Hammarstrom et al. (1985), and Conrad and Hammarstrom (1987). In addition, angler-effort and harvest by species for the recreational fishery has been estimated by Mills (1979-1990) in the Alaska Statewide Sport Fish Harvest Survey.

The current creel survey program in the Kenai River provides data which are used as a basis for in-season management decisions for the recreational fishery, evaluated to refine long-term management objectives, and used by the Alaska Board of Fisheries to allocate salmon resources. The objective of this report is to present detailed information of the creel surveys of the recreational fisheries for chinook salmon and coho salmon conducted in 1990.

Fishing Regulations

The regulations for the chinook salmon fishery in the Kenai River are the most restrictive of any open waters in Alaska. Only the section of the river between the outlet of Skilak Lake and Cook Inlet (Figure 1) is open to fishing for chinook salmon. By regulation, the season for chinook salmon is from 1 January through 31 July, but it effectively begins in mid-May when the fish first begin entering the river. The daily bag and possession limits 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. In 1990, fishing from boats downstream from the outlet of Skilak Lake was prohibited on Mondays in May, June, and July, except Monday of Memorial Day. Anyone retaining a chinook salmon that was 41 cm in length or greater was prohibited from fishing from a boat in the Kenai River for the remainder of that day. Additionally, the early-run fishery was further restricted in that the use of bait was prohibited until the Department was able to project an escapement of at least 9,000 fish or 1 July, whichever occurred first.

There were further restrictions for guided anglers. In addition to the regulation prohibiting fishing from boats on Mondays, fishing from a registered guide vessel on any Sunday in July was prohibited. In 1990, fishing from a guided boat was allowed only between 0600 and 1800 hours during June and July. There were no days or hours closed to boat fishing for either guided or unguided anglers during the remainder of the year.

The daily bag and possession limits for sockeye and coho salmon were an aggregate of three fish that were 41 cm in length or greater, and there was no annual limit. However, when an escapement of 700,000 sockeye salmon was realized, the daily bag and possession limit for sockeye and coho salmon increased to six; not more than three of which may have been coho salmon. The daily bag and possession limit for pink salmon was six fish that were 41 cm in length or greater, and there was no annual limit. The daily bag and possession limits for rainbow trout was two fish, only one of which may have been over 51 cm (20 in) in length, and there was an annual limit of two fish over 51 cm. The daily bag and possession limits for Dolly Varden were five fish.

METHODS

A roving creel survey (Neuhold and Lu 1957) was used to estimate sport fishing effort, in units of angler-hours, by the fisheries for chinook and coho salmon in the Kenai River. Harvest per unit effort (HPUE, number of fish harvested per hour fished) and catch per unit effort (CPUE, number of fish caught per hour fished) for each species were estimated from angler interviews. Harvest and catch of each species were estimated by the product of the effort and harvest (or catch) rate estimates.

During the chinook salmon fishery, angler-effort was estimated for two sections of the Kenai River below Skilak Lake (Figure 1): (1) downstream, from Cook Inlet (river mile 0) to the Soldotna Bridge (rm 21 or river kilometer 34), and (2) midstream, from the Soldotna bridge to Naptowne Rapids (rm 39.5 or rkm 64). The upstream section, from Naptowne Rapids to the outlet of Skilak Lake (rm 50 or rkm 80), was not surveyed during the chinook salmon fishery in 1990.

During the fishery for coho salmon, angler-effort was estimated for all three sections and interviews for HPUE and CPUE were conducted in only the downstream and upstream sections. These stratifications were selected because of the distance involved and effort patterns observed over the years. Effort, harvest and catch were estimated separately for the early- and late-run components of the fisheries for chinook and coho salmon.

Both unguided and guided anglers participate in the fisheries for chinook and coho salmon in the Kenai River. These two groups have very different harvest rates; therefore, effort, HPUE, CPUE, harvest, and catch were estimated separately for unguided anglers and guided anglers. Guided anglers fish exclusively from boats and are easily recognized because guided boats are required to display a prominent identifying decal. Shore anglers harvest very few chinook salmon, therefore, only boat anglers were surveyed during the chinook salmon fishery. During the coho salmon fishery, both boat and shore anglers were surveyed.

Creel Survey of the Chinook Salmon Fishery

The creel survey of the chinook salmon fishery in the downstream section began on 17 May and continued until the end of the chinook salmon season on 31 July. The fishing day for unguided anglers in the downstream section was defined as 20 hours long, from 0400 to 2400 hours, and was stratified into five, 4-hour daily time strata (referred to as periods) for estimation of effort. The periods were: A, from 0400 to 0759 hours; B, from 0800 to 1159 hours; C, from 1200 to 1559 hours; D, from 1600 to 1959 hours; and E, from 2000 to 2359 hours. In May, the stratification of the fishing day for guided anglers was the same as that for unguided anglers, in the downstream section. However, since most guides schedule two trips per day, one in the morning and one in the afternoon, the fishing day of guided anglers in June and July was stratified into only two periods: A, from 0600 to 1159 hours; and B, from 1200 to 1759 hours.

In the downstream section, estimates of effort and chinook salmon HPUE, CPUE, harvest, and catch for both guided and unguided anglers during each component

of the run were stratified into temporal units; early run, unit 1 (17 May-6 June), and unit 2 (7 June-30 June); late run, unit 3 (1 July-15 July), unit 4 (16 July-27 July) and unit 5 (28 July-31 July). These strata differ from those planned to accommodate in-season regulatory restrictions placed on the recreational fishery. Unguided anglers were stratified further by weekdays and weekends/holidays. Guided anglers were not similarly stratified because this would not significantly reduce the variance of the effort estimates nor the estimates for CPUE and HPUE (Conrad and Hammarstrom 1987).

In the midstream section, the angler day was considered to be 18 hours in length (0600-2400 hours), for both unguided and guided anglers. The day was divided into six 3-hr sample periods as follows: A, from 0600 to 0859 hours; B, from 0900 to 1159 hours; C, from 1200 to 1459 hours; D, from 1500 to 1759 hours; E, from 1800 to 2059 hours; F, from 2100 to 2359 hours.

Due to limited resources, guided and unguided anglers were not stratified nor were weekend and weekdays. The following temporal strata were employed: early run, unit 1 (28 May-6 June), unit 2 (7 June-30 June), and unit 3 (1 July-6 July); late run, unit 4 (15 July-27 July), and unit 5 (28 July-31 July). The fishery was closed in the midstream section between 7 July and 15 July, therefore, no survey activities were conducted during that time period in that section.

Angler Counts:

Separate sampling schedules for angler counts were established for the downstream and midstream sections of the river. Sampling levels were designed to estimate catch and harvest within 15% of the true value 95% of the time. Two creel survey clerks, each working 37.5 hours per week, conducted the angler counts in the downstream section. Angler counts in the midstream section were conducted from an aircraft.

Downstream Section. In the downstream section, on every weekend day/holiday, an unguided angler count was made during each of the five periods. One of the 4 whole-hours of each period (A through E) was selected randomly as a time that an unguided angler count was to be initiated. During each 4-day week (weekdays only Tuesday through Friday), 2 days for each strata, A through E, were selected randomly to be sampled. Within each sampled period, an angler count was initiated at one of the four randomly selected whole-hours. This sampling design allowed for 10 unguided angler counts on a typical weekend and 10 unguided angler counts during the 4 weekdays the fishery was open.

During May, guided and unguided anglers fished under similar regulations and, as such, guided angler counts were conducted as described above. However, during June and July, if a selected unguided angler count occurred during the A period (0600-1159 hours) or B period (1200-1759 hours) corresponding to the guided angler strata, then a guided angler count was also conducted. If no unguided angler counts were scheduled during the A or B period for guided anglers, an additional count for guided anglers only was conducted at a randomly selected whole-hour during the guided period in question. If two or more counts occurred during the guided period, A or B, then one was selected randomly as the guided angler count and the remaining counts were designated as unguided angler counts only.

Some deviation from the schedule did occur because of mechanical breakdown and/or other duties such as public assistance or enforcement activities.

Each week, two randomly selected periods (one from weekdays and one from weekends) were sampled to estimate within-period sampling variance. During these periods, a total of four angler counts were conducted. This study was conducted only during the early run. The time required to conduct this experiment reduced the time spent examining the harvest for marked-to-unmarked ratios from a tagging project and the tagging data was a higher priority during the late run. This design allowed for a total of 12 samples. Mechanical problems compromised one sample, thus a total of 11 samples were analyzed.

Counts of anglers were conducted from a boat in the downstream section of the Kenai River. At the time designated on the schedule, a creel survey clerk was at a randomly selected end of the section of the river to be surveyed. The angler count was made while the boat was driven at a constant rate of speed through the survey area to the opposite end of the river section. This trip usually took about 45 minutes and every effort was made to ensure that the trip was completed in less than 1 hour. Angler counts were considered to be instantaneous and to reflect fishing effort at the time of the count. During the angler count, the creel survey clerk recorded the following: (1) total number of unguided boats, (2) total number of guided boats, (3) total number of anglers in unguided boats, (4) total number of anglers in guided boats, and (5) total number of shore anglers. Boats and anglers were considered to be engaged in fishing and were counted if the boat was in operation, as opposed to tied to the shore, regardless of whether or not an angler's line was in the water when the count was being conducted. Guides were not included in the counts during the chinook salmon fishery as they are prohibited from fishing while guiding. When the clerks responsible for angler counts were not conducting a count, they contacted incompleting-trip anglers searching for tagged and untagged fish in the anglers creel that could be used as part of an abundance study being conducted concurrently.

Midstream Section. One angler count per day was conducted from an aircraft on the same days as the angler interviews; 4 of the 6 possible days per week (Tuesday-Sunday) were selected randomly. One period was chosen at random within each sample day and a count was made sometime during that period; weather and aircraft availability being the controlling factor.

A flight commencing at one end of the midstream section was conducted whereby the observer in the aircraft recorded all boats fishing in the area. Boats travelling as well as those fishing were counted. Those boats moored to the bank with no occupants were not counted.

Angler Interviews:

The creel survey in the downstream section was designed for two creel survey clerks, each working 37.5 hours per week. The creel survey in the midstream section was designed for one creel survey clerk working 37.5 hours per week.

The following information was recorded for each angler interview: (1) completed-trip or incompleting-trip; (2) powered or non-powered boat; (3) fished midstream section only, yes or no; (4) guided or unguided angler; (5)

number of hours spent fishing (to the nearest 0.5 hour); (6) number and species of fish retained; (7) number and species of fish released. Additional information regarding the presence of tags was also recorded as part of the recovery effort in the project to estimate the escapement of chinook salmon into the Kenai River.

Downstream Section. Interviews of completed-trip anglers for harvest and catch rate information were conducted primarily at seven popular boat landings in the downstream section. Two creel survey clerks conducted the interviews at the boat landings. Each clerk was scheduled to work five 7.5-hour days each week; on each weekend/holiday day and on three randomly selected weekdays. Two randomly selected landings were sampled by a clerk on a sample day. Thus on weekend/holidays, four landings were sampled each day and on weekdays either two or four landings were sampled. The starting time for the 7.5-hour interview period was randomly selected from either an early shift (possible start times: 0600, 0630, 0700, or 0730) or a late shift (possible start times: 1500, 1530, 1600, or 1630). The creel survey clerks conducted interviews for about 3.5 hours at each landing. The two landings frequented by guided anglers were sampled primarily around noon or early evening hours to correspond with the times guides normally end a fishing trip.

Midstream Section. Completed-trip anglers were contacted primarily at three public access sites, but, at times of relatively low angler effort, more anglers could be contacted by moving frequently to other sites throughout the area open to fishing. Completed-trip angler interviews were conducted by a single survey clerk at three primary locations: site #1-Swiftwater campground, #2-Isaac Walton Campground, #3-Scout Loop Road. Four of the 6 possible days per week (Tuesday-Sunday), selected randomly, were sampled. The creel survey clerk worked four 9-hour days per week. Each sample day, three 3-hour interview shifts, corresponding to the periods mentioned above, were conducted at randomly selected access sites. The remaining 1.5 hours during the 37.5-hour work-week were devoted to administrative duties, equipment maintenance, etc.

Biological Data. Chinook salmon observed in anglers' creels during the surveys were systematically selected for biological sampling. 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). Three scales were collected from each fish and placed on an adhesive-coated card. Impressions of scale cards were made on acetate and scale images were examined using a microfiche reader.

Creel Survey of the Coho Salmon Fishery

The coho salmon creel survey began on 1 August and ended on 30 September in both the downstream and upstream sections of the river. While information collected during interviews and angler counts was similar to that collected during the chinook salmon creel survey, there were notable differences in the manner in which the chinook and coho surveys were conducted. The fishing day was reduced to 16 hours in August (from 0600 to 2200 hours) and 12 hours in September (from 0800 to 2000 hours) to account for the decreased number of daylight hours. Daily time strata were adjusted for the coho salmon fishery by eliminating period E in August and shifting the starting time of period A

to 0600 hours, and in September eliminating period D and shifting the starting time of period A to 0800 hours. The fishing day was the same for both unguided and guided anglers during the creel survey of the coho salmon fishery. The weekday and weekend/holiday stratification was used for both unguided and guided anglers, also. Shore anglers as well as boat anglers were interviewed during the coho salmon creel survey and both completed-trip and incompleting-trip anglers were interviewed.

Angler Counts:

Similar angler count schedules were established for the downstream and upstream sections of the river. Sampling levels were determined by the amount of creel survey clerk time available. Both creel surveys were designed for one creel survey clerk working 37.5 hours per week.

Angler counts were scheduled for each weekend/holiday day and on 3 randomly selected weekdays each week in both the downstream and upstream sections. Two angler counts were scheduled on each sample day. Sample periods and count times were selected randomly.

Angler counts, during the coho salmon fishery, were conducted following the same procedures as described for the downstream section of the chinook salmon fishery. One exception was that guides were included in the count of guided anglers as they are permitted to fish after 31 July. Shore anglers were considered a separate stratum in both the downstream and upstream sections.

Effort in the midstream section of the river was estimated using the same procedure as described by Hammarstrom (1990).

Angler Interviews:

During August and September, both shore and boat anglers were interviewed by the creel survey clerks. All interviews were collected by the survey clerks conducting the angler counts; there were no clerks stationed at boat landings as during the creel survey of the chinook salmon fishery. The same information was recorded for each angler interviewed as during the chinook salmon creel survey, except that both completed-trip and incompleting-trip anglers were included and the docking location was not recorded. Emphasis was placed on collecting sufficient completed-trip angler interviews to determine if a bias existed between completed-trip and incompleting-trip anglers.

Biological Samples:

Biological samples for coho salmon (scales, sex, and length) were collected identically to those for the chinook salmon survey.

Data Analyses

Angler-effort, harvest and catch rates by species, harvest and catch by species, and associated variances were estimated using the same procedures for the downstream section of the chinook salmon fishery and the downstream and upstream sections of the coho salmon fishery. In the following sections,

harvest refers to fish retained by anglers and catch refers to fish retained plus those reported as released by anglers.

There were 15 strata in the chinook salmon fishery in the downstream section of the Kenai River, seven in the early run and eight in the late run. The early-run strata were: (1) unit 1 (5/17-6/06)-unguided anglers weekdays, (2) unit 1-unguided anglers weekends/holidays, (3) unit 2 (5/17-5/31)-guided anglers, (4) unit 3 (6/1-6/06)-guided anglers, (5) unit 4 (6/07-6/30)-unguided anglers weekdays, (6) unit 4 (6/07-6/30)-unguided anglers weekends/holidays, (7) unit 4-guided anglers. The strata to the late run of the downstream section were: (1) unit 5 (7/1-7/15)-unguided anglers weekdays, (2) unit 5-unguided anglers weekends/holidays, (3) unit 5-guided anglers, (4) unit 6 (7/16-7/27)-unguided anglers weekdays, (5) unit 6-unguided anglers weekends/holidays, (6) unit 6-guided anglers, (7) unit 7 (7/28-7/31)-unguided anglers, (8) unit 7 (7/28-7/31)-guided anglers.

There were five strata in the chinook salmon fishery in the midstream section of the Kenai River, three in the early run and two in the late run. The early-run strata were: (1) unit 1 (5/28-6/06), (2) unit 2 (6/07-6/30), (3) unit 3 (7/01-7/06). The late-run strata were: (1) unit 4 (7/15-7/27), (5) unit 5 (7/28-7/31).

There were 12 fishery components in the downstream section and 12 in the upstream section during the coho salmon fishery. The early (August 1-August 31) and late run (September 1-September 30) in each section had the same strata: (1) unguided anglers weekdays, (2) unguided anglers weekends/holidays, (3) guided anglers weekdays, (4) guided anglers weekends/holidays, (5) shore anglers weekdays, and (6) shore anglers weekends/holidays.

Downstream Section Chinook; Downstream and Upstream Sections Coho:

Effort. In the downstream section during the chinook salmon fishery and in both the downstream and upstream sections during the coho salmon fishery, the number of angler-hours of effort during fishery component t was estimated as follows (Neuhold and Lu 1957):

$$\hat{E}_t = \sum_{j=1}^s H_{tj} \bar{x}_{tj}, \quad (1)$$

where:

\bar{x}_{tj} = the mean number of anglers per count during period j of component t ;

H_{tj} = the total number of hours of possible fishing time during period j of component t ; and

s = the number of periods (A, B, C, etc.) in component t .

The variance of effort was estimated as follows (Scheaffer et al. 1979):

$$V(\hat{E}_t) = \sum_{j=1}^s H_{tj}^2 (s_{tj}^2/n_{tj}), \quad (2)$$

where:

$$s_{tj}^2 = \text{the variance of } \bar{x}_{tj}, \text{ and } = \frac{\sum_{o=1}^{n_{tj}} (x_{tjo} - \bar{x}_{tj})^2}{n_{tj} - 1}, \text{ and} \quad (3)$$

n_{tj} = the number of angler counts during period j of component t .

This method assumes a single-stage design with all possible counts within a stratum representing the population to be sampled. The finite population correction factor is not applied as angler counts are considered instantaneous, and so there are an infinite number of counts that can be taken.

In 1990, multiple counts (or samples) were taken in 11 periods during the early run. These data were used to estimate a mean second stage (within period) variance for each period by;

$$s_{2ji}^2 = \frac{[\sum_{k=2}^r (x_{ijk} - \bar{x}_{ij(k-1)})^2]}{2(r-1)}, \text{ and} \quad (4)$$

$$\bar{s}_2^2 = \frac{\sum_{i=1}^{n_p} s_{2ji}^2}{n} \quad (5)$$

where:

x_{ijk} = count k in sample i of period j ;

r = number of counts taken;

s_{2ji}^2 = among count variance for sample i for period j ;

n_{ti} = number of samples in period j ; and

\bar{s}_{2tj}^2 = mean second stage variance for period j .

The estimate of total variance then becomes;

$$V(\bar{x}_{tj}) = (1-f_{1t}) \frac{D_t^2 s_{tj}^2}{n_{tj}} + D_{tj}^2 \bar{s}_{2tj}^2 \quad (6)$$

where:

$$f_{1t} = \frac{n_{tj}}{D_{tj}}, \text{ and}$$

D_t = total days possible for sampling in component t.

Effort for period j is;

$$\hat{E}_{tj} = h_{tj} \bar{x}_{tj} \quad (7)$$

where:

h_{tj} = hours in period j within a day; and

$$V(E_{tj}) = h_{tj}^2 V(\bar{x}_{tj}). \quad (8)$$

As above, the total effort and variance for each component is the sum over all periods.

Harvest Rates. Mean effort and mean harvest by species per angler were estimated for each component using the angler interview data for the component. Only completed-trip interviews were used to make the estimates for the chinook salmon fishery in the downstream section.

In 1986, Conrad and Hammarstrom (1987) concluded that incompletd-trip interviews may not provide an unbiased estimate of CPUE and HPUE for coho salmon, but the number of completed-trip interviews was quite small.

The null hypothesis that the probability of zero catch is equal for completed- and incompletd-trip anglers was tested using a chi-square statistic. The test was carried out for 12 strata (Appendix A1) and was significant in eight. Higher proportions of incompletd-trip anglers had caught no fish when interviewed in all strata except for shore fishermen during the early run.

In the upstream section for the late run, seven of the eight tests were significantly different. There was a trend in the differences in that in six of the seven tests, completed-trip HPUE was greater than incompletd-trip HPUE. Therefore, I concluded that these differences were functionally different and used only completed-trip interviews to compile upstream section fishing statistics.

Mean effort per angler during component t was estimated as:

$$\bar{f}_t = \left(\sum_{i=1}^D \sum_{k=1}^{m_i} f_{ik} \right) / \sum_{i=1}^D m_i; \quad (9)$$

where:

f_{ik} = the effort (in hours) by angler k at the time of the interview on day i ;

m_i = the number of anglers interviewed on day i ; and

D = the number of days the fishery was open during component t .

A two-stage sample design with days representing the first-stage sample units and anglers the second-stage sample units was used to estimate the variance of mean effort (Von Geldern and Tomlinson 1973). The number of second-stage units available on a given sample day was unknown. The variance of mean effort was estimated as follows (Sukhatme et al. 1984):

$$V(\bar{f}_t) = [1 - (d/D)] s_B^2/d + (\sum_{i=1}^D s_{wi}^2/m_i)/dD, \quad (10)$$

where:

D = the number of days interviews were conducted during component t ;

s_{wi}^2 = the sample variance of mean effort per angler for interviews conducted on day i ; and

s_B^2 = the between-day variance of mean effort per angler.

The between-day variance, s_B^2 , was estimated as follows:

$$s_B^2 = [\sum_{i=1}^D (\bar{f}_{ti} - \bar{f}_t)^2] / (d-1), \quad (11)$$

where:

\bar{f}_{ti} = the mean effort per angler during day i of component t .

Mean harvest (or catch) of a species and its variance were estimated identically to effort except the corresponding quantities for harvest (or catch) were substituted for all occurrences of effort (f).

Harvest rate (HPUE) for a species during component t was estimated by:

$$\hat{HPUE}_t = \bar{c}_t / \bar{f}_t, \quad (12)$$

where:

\bar{c}_t = the mean harvest of the species per angler during component t, obtained by substituting catch for effort in equation 4.

The variance of $HPUE_t$ was approximated by the variance for the quotient of the mean of two random variables (Jessen 1978), which is:

$$\hat{V}(\bar{c}_t/\bar{f}_t) \approx (\bar{c}_t/\bar{f}_t)^2 (s_c^2/c_t^2 + s_f^2/f_t^2 - 2rs_c s_f/c_t f_t), \quad (13)$$

where:

s_c^2 = the two-stage estimate of variance for \bar{c}_t ;

s_f^2 = the two-stage estimate of variance for \bar{f}_t ; and

r = the correlation coefficient between the f_{ik} and the c_{ik} in component t.

Catch per unit effort (CPUE) for a species and its variance were estimated by replacing the mean and variance of number of fish harvested per angler with the mean and variance of the number of fish caught per angler in equations 12 and 13.

Harvest. The harvest of a species during each component was estimated by:

$$\hat{H}_t = \hat{E}_t \hat{HPUE}_t. \quad (14)$$

The variance of \hat{H}_t was estimated using Goodman's (1960) formula for the variance of the product of two independent random variables, which is:

$$\hat{V}(\hat{H}_t) = [\hat{E}_t^2 \hat{V}(\hat{HPUE}_t)] + [\hat{HPUE}_t^2 \hat{V}(\hat{E}_t)] - [\hat{V}(\hat{E}_t) \hat{V}(\hat{HPUE}_t)]. \quad (15)$$

Totals (for example, the total for unguided anglers during the early run) for effort and harvest were estimated by summing the appropriate component estimates. Estimates of effort and harvest for the components are considered independent estimates, therefore, the variance of the total was estimated by the sum of the appropriate variances.

Catch of a species and its variance were estimated by replacing HPUE with CPUE in equations 14 and 15.

Assumptions. The major assumptions necessary for these analyses are:

1. Significant fishing effort occurs only between the hours defined for the angler day;

2. Individual effort and harvest (or catch) by anglers are normally distributed random variables;
3. For the coho salmon creel survey, incompletd-trip angler interviews provide an unbiased estimate of completed-trip HPUE and CPUE (DiCostanzo 1956);
4. Anglers are interviewed in constant proportion to their abundance within each stratum (DiCostanzo 1956) and interviewed anglers are representative of the total angler population;
5. For the coho salmon creel survey, rates of harvest, or catch, and length of fishing trip are independent (DiCostanzo 1956).

Midstream Section Effort and Harvest; Chinook Salmon:

The following equations were used to obtain effort, catch, and harvest estimates for chinook salmon in the midstream section, along with their variances for each stratum. The catch and harvest were estimated for each day within a stratum, and estimated daily mean catch (or harvest) was expanded over all days in the stratum. The daily catch (or harvest) was estimated by expanding estimated CPUE (or HPUE) by estimated effort (in angler-hours).

The day represents the first stage in this sample design, and sample periods within day the second stage. However, sample periods were not identified in the data collection, and this component of variance cannot be estimated.

The first step in estimating the catch of chinook salmon involves estimating the catch per unit effort (CPUE) for expansion purposes:

$$\begin{aligned}
 \text{CPUE}_{hij}^* &= \text{the } j\text{th jackknifed estimate of CPUE;} \\
 &= \frac{\sum_{\substack{k=1 \\ k \neq j}}^{m_{hi}} c_{hik}}{\sum_{\substack{k=1 \\ k \neq j}}^{m_{hi}} e_{hik}} \tag{16}
 \end{aligned}$$

where:

- h = subscript denoting stratum;
- i = subscript denoting day sampled;
- j & k = subscripts denoting the angler interviewed;
- m_{hi} = number of anglers interviewed during day i within stratum h ;

c_{hik} = number of chinook salmon caught by the k th angler interviewed during day i within stratum h ; and

e_{hik} = number of hours fished by the k th angler interviewed during day i within stratum h .

The mean jackknifed CPUE over all anglers interviewed in each sample was obtained:

$$\overline{CPUE}_{hi}^* = \frac{1}{m_{hi}} \sum_{j=1}^{m_{hi}} CPUE_{hij}^* \quad (17)$$

A bias correction was performed (Efron 1982):

$$\overline{CPUE}_{hi}^* = m_{hi}(\overline{CPUE}_{hi} - \overline{CPUE}_{hi}^*) + \overline{CPUE}_{hi}^* \quad (18)$$

where:

\overline{CPUE}_{hi} = the "standard" mean CPUE (without jackknifing);

$$\overline{CPUE}_{hi} = \frac{\sum_{j=1}^{m_{hi}} c_{hij}}{\sum_{j=1}^{m_{hi}} e_{hij}} \quad (19)$$

The variance of CPUE was estimated by the jackknife estimate of the variance of the estimated sample CPUE as described by Efron (1982):

$$s_{2hi}^2 = \frac{(m_{hi} - 1)}{m_{hi}} \sum_{j=1}^{m_{hi}} (CPUE_{hij}^* - \overline{CPUE}_{hi}^*)^2 \quad (20)$$

Daily effort was estimated from aerial boat counts. The number of angler-hours of effort for each stratum was estimated by first expanding the aerial boat counts by the mean anglers/boat estimated from the interview data to estimate the number of anglers fishing for each count:

$$\overline{x}_{hi} = \overline{z}_{hi} \overline{y}_{hi} \quad (21)$$

where:

\overline{x}_{hi} = number of anglers fishing on day i during count;

\overline{z}_{hi} = mean number of anglers per boat estimated on day i ;

\overline{y}_{hi} = the mean boat count for day i ; and

the mean anglers per boat for day i is:

$$\bar{z}_{hi} = \frac{\sum_{j=1}^{b_{hi}} z_{hij}}{b_{hi}} ; \quad (22)$$

where:

z_{hij} = the number of anglers in boat j on day i;

b_{hi} = number of boats sampled on day i;

and the variance is:

$$V(\bar{z}_{hi}) = \frac{s_{zhi}^2}{b_{hi}} \quad (23)$$

where:

s_{zhi}^2 = the among boat variance for anglers/boat on day i.

The mean number of boats for day i is,

$$\bar{y}_{hi} = \frac{\sum_{j=1}^{r_{hi}} y_{hij}}{r_{hi}} ; \quad (24)$$

where:

y_{hij} = the number of boats counted during count j on day i;

r_{hi} = number of counts made on day i; and

the variance is:

$$\bar{V}(y_{hi}) = \frac{s_{yhi}^2}{r_{hi}} ; \quad (25)$$

where:

s_{yhi}^2 = the among count (or within-day) variance on day i.

The variance of the daily angler count is estimated by:

$$V[\bar{x}_{hi}] = \bar{y}_{hi}^2 V[\bar{z}_{hi}] + \bar{z}_{hi}^2 V[\bar{y}_{hi}] - V[\bar{y}_{hi}]V[\bar{z}_{hi}] . \quad (26)$$

Total effort in angler hours is estimated by:

$$\hat{E}_h = H D_h \bar{x}_h ; \quad (27)$$

where:

H = number of hours in the fishing day (18 hours); and

D_h = number of days in the stratum;

and the variance of the total effort is estimated by:

$$\text{Var}(\hat{E}_h) = [H D_h]^2 \text{Var}(\bar{x}_h) . \quad (28)$$

On most days only one boat count was made, and the within day variance component cannot be estimated.

To estimate daily catch, the bias-corrected mean jackknifed CPUE's were expanded by the estimated daily effort:

$$\hat{C}_{hi} = \hat{E}_{hi} \overline{CPUE}_{ehi}^* . \quad (29)$$

The estimated variance of the daily estimate of catch was obtained by the formula for the variance of a product of random variables as proposed by Goodman (1960):

$$\hat{V}[C_{hi}] = \hat{E}_{hi}^2 s_{hi}^2 + (\overline{CPUE}_{ehi}^*)^2 \hat{V}[\hat{E}_{hi}] - s_{hi}^2 \hat{E}_{hi} \hat{V}[\hat{E}_{hi}] . \quad (30)$$

The mean estimated catch is obtained over all samples within stratum h:

$$\hat{C}_h = \frac{1}{d_h} \sum_{i=1}^{d_h} \hat{C}_{hi} ; \quad (31)$$

where:

d_h = the number of days sampled (day = sampling unit) in stratum h.

The overall stratum catch estimate was then obtained by expanding for the number of days in each stratum:

$$\hat{C}_h = D_h \hat{C}_h \quad (32)$$

where:

D_h = total number of days or sampling units possible in stratum h.

The estimated variance for the stratum estimates of catch was obtained as follows (the variance of a total estimated in a stratified two-stage sampling design as described by Cochran 1977):

$$\hat{V}[C_h] = [(1 - f_{1h}) D_h^2 S_{1h}^2 / d_h] + [D_h \sum_{i=1}^{d_h} \hat{V}[C_{hi}] / d_h]; \quad (33)$$

where:

$$f_{1h} = \text{sampling fraction for days;} \\ = d_h / D_h ; \text{ and}$$

S_{1h}^2 is the among day variance for the C_{hi} .

The total catch over all strata (or select combinations of strata) was obtained by summing the appropriate catch estimates:

$$\hat{C} = \sum_{h=1}^L \hat{C}_h ; \quad (34)$$

where:

L = total number of strata in the fishery survey.

The overall variance for all strata (or select combinations of strata) was obtained by summing the variances for each strata:

$$\hat{V}[C] = \sum_{h=1}^L \hat{V}[C_h] . \quad (35)$$

Harvest estimates were obtained similarly by replacing the appropriate harvest statistics in place of the catch statistics in the above equations.

Effort was estimated similarly by expanding the mean daily estimated effort (E_{hi}) over all days available, and the variance was estimated substituting effort in place of catch.

The assumptions of this estimator were:

1. CPUE and HPUE of interviewed anglers were representative of the CPUE and HPUE of all anglers during the day; and
2. There was no significant fishing effort or catch taking place during times outside of the defined fishing day.

Midstream Section Effort and Harvest; Coho Salmon:

Fishing effort in the midstream section of the Kenai River during the coho salmon creel survey was estimated from the counts of boats made during aerial surveys of the river. The proportion of boat fishing effort occurring in the midstream section was calculated separately for the early run and the late

run. For each aerial survey, the proportion of effort in the midstream section (\bar{p}_m) was calculated as the quotient of the number of boats counted in the midstream section and the number of boats counted for all sections. Effort in the midstream section for both guided and unguided anglers (E_m) during either the early run or the late run was estimated as follows:

$$\hat{E}_m = \bar{p}_m (\hat{E}_d + \hat{E}_u) / (1 - \bar{p}_m), \quad (36)$$

where:

\bar{p}_m = the mean of all proportions (p_{ms}) for a run;

\hat{E}_d = the estimated number of angler-hours of effort in the downstream section for a run; and

\hat{E}_u = the estimated number of angler-hours of effort in the upstream section for a run.

The variances of the midstream effort estimates were approximated by the delta method (Seber 1982) using the following formula:

$$V(\hat{E}_m) \approx [(\hat{E}_d + \hat{E}_u) / (1 - \bar{p})]^2 V(\bar{p}) + [\bar{p} / (1 - \bar{p})]^2 V(\hat{E}_d + \hat{E}_u), \quad (37)$$

where the variance of \bar{p} is the sample variance of the p_{ms} divided by the number of flights, the variances of \hat{E}_d and \hat{E}_u are estimated as described under Effort, and the covariance between the estimated effort for the downstream and upstream sections and \bar{p} is assumed to be zero.

Harvest and catch rates during the coho salmon fishery in the midstream section were estimated using the total harvest and catch and total effort (angler-hours) for the downstream and upstream sections. This is expressed as:

$$HPUE_m = (\hat{H}_d + \hat{H}_u) / (\hat{E}_d + \hat{E}_u), \quad (38)$$

for the harvest rate and:

$$CPUE_m = (\hat{C}_d + \hat{C}_u) / (\hat{E}_d + \hat{E}_u), \quad (39)$$

for the catch rate, where the subscripts denote the middle (m), downstream (d), or upstream (u) sections of the river. The variances of the rates were approximated by the delta method, also. The following formula was used to estimate the variance of harvest rate (HPUE):

$$V(HPUE_m) \approx [1 / (\hat{E}_d + \hat{E}_u)]^2 V(\hat{H}_d + \hat{H}_u) + [-(\hat{C}_d + \hat{C}_u) / (\hat{E}_d + \hat{E}_u)^2]^2 V(\hat{E}_d + \hat{E}_u), \quad (40)$$

where the variances of $(\hat{E}_d + \hat{E}_u)$ and $(\hat{H}_d + \hat{H}_u)$ are calculated as described previously in equations 37 and 40. The covariance between the combined downstream and upstream effort and harvest is omitted from the above equation because it is unknown, although it is assumed positive (as effort increases harvest should increase). The product of the covariance and the derivatives of the numerator and denominator of $HPUE_m$ (or $CPUE_m$) would be subtracted from equation 38 because of the negative derivative for the denominator. Therefore, the formula above is probably a conservative estimate of the variance of $HPUE_m$. The variance of $CPUE_m$ was estimated using the same formula, but the combined downstream and upstream catches and their variances were substituted for the harvest counterparts.

The harvest and catch of coho salmon in the midstream section were estimated for unguided and guided anglers following the procedures described for the downstream and upstream sections. The variances of these estimates were also estimated as described previously in equations 37 and 40.

Biological Data:

Proportional age composition of the chinook and coho salmon harvest was estimated for each run. Letting p_{ht} equal the estimated proportion of age group h in component t , the variance of p_{ht} was estimated as (Scheaffer et al. 1979):

$$V(\hat{p}_{ht}) = \frac{\hat{p}_{ht}(1-\hat{p}_{ht})}{(n_{Tt}-1)}, \quad (41)$$

where:

n_{Tt} = the number of legible scales read from chinook or coho salmon sampled during component t .

Mean length at age by sex and its variance were estimated using standard normal procedures.

RESULTS AND DISCUSSION

The early and late runs in the chinook salmon fishery were defined as follows. The early run was from 16 May through 30 June and the late run from 1 July through 31 July in the downstream section. In the midstream section, the early run was from 28 May through 15 July and the late run from 16 July through 31 July. During the coho salmon fishery, the early run was designated from 1 August through 31 August and the late run from 1 September through 30 September in both the downstream and upstream sections of the river.

Chinook Salmon Fishery

By early June, it became apparent that without restrictions to the recreational fishery the escapement goal would not be achieved. The fishery was restricted to catch and release only on 7 June. Angler counts decreased in all comparable periods after 7 June (Table 1). The restrictions were not

Table 1. Mean counts of boat anglers by period for each of the components of the creel survey of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Period ^a				
	A	B	C	D	E
<u>Early Run</u>					
Period 1 (16 May - 6 June)					
Unguided anglers, weekdays:					
Number of counts	6	5	5	3	5
Mean count	29	30	29	36	53
Standard error	6	8	6	5	18
Unguided anglers, weekends:					
Number of counts	6	6	7	7	7
Mean count	42	122	121	99	47
Standard error	19	21	21	23	17
Guided anglers, all days (May):					
Number of counts	9	8	10	8	9
Mean count	47	82	62	39	6
Standard error	15	14	8	9	3
Guided anglers, all days (June):					
Number of counts	4	3			
Mean count	111	87			
Standard error	29	33			
Period 2 (7 June - 30 June)					
Unguided anglers, weekdays:					
Number of counts	7	6	10	5	7
Mean count	10	27	29	26	30
Standard error	3	7	6	5	8
Unguided anglers, weekends:					
Number of counts	7	7	6	7	7
Mean count	16	55	73	40	20
Standard error	7	8	5	11	7
Guided anglers, all days:					
Number of counts	21	21			
Mean count	90	60			
Standard error	9	6			

-Continued-

Table 1. (Page 2 of 3).

Component	Period ^a				
	A	B	C	D	E
<u>Late Run</u>					
Period 3 (1 July - 15 July)					
Unguided anglers, weekdays:					
Number of counts	4	3	4	3	3
Mean count	279	286	208	283	184
Standard error	25	58	15	8	55
Unguided anglers, weekends:					
Number of counts	6	6	4	6	6
Mean count	277	480	531	326	269
Standard error	74	85	72	26	88
Guided anglers, all days:					
Number of counts	10	10			
Mean count	416	264			
Standard error	41	24			
Period 4 (16 July - 27 July)					
Unguided anglers, weekdays:					
Number of counts	4	4	5	5	4
Mean count	481	342	353	305	248
Standard error	124	58	42	51	61
Unguided anglers, weekends:					
Number of counts	2	2	2	2	2
Mean count	632	662	572	559	497
Standard error	83	85	23	133	34
Guided anglers, all days:					
Number of counts	8	9			
Mean count	472	331			
Standard error	39	42			

-Continued-

Table 1. (Page 3 of 3).

Component	Period ^a				
	A	B	C	D	E
<u>Late Run</u>					
Period 5 (28 July - 31 July)					
Unguided anglers, all days:					
Number of counts	3	3	3	3	3
Mean count	20	44	76	31	30
Standard error	8	2	15	5	11
Guided anglers, all days:					
Number of counts	2	2			
Mean count	72	35			
Standard error	8	5			

^a Unguided anglers, all months:
 Period A = 0400 - 0759
 Period B = 0800 - 1159
 Period C = 1200 - 1559
 Period D = 1600 - 1959
 Period E = 2000 - 2359

Guided angler:
 May: Same as unguided angler
 June and July:
 Period A = 0600 - 1159
 Period B = 1200 - 1759

removed until 1 July. However, immediately upon reopening the fishery to allow the harvest of chinook salmon, anglers targeted early-run fish still present in the midstream section. On 6 July, an emergency order was issued closing the river to chinook salmon fishing upstream of the Soldotna Bridge. This pattern of fishing the midstream section in early July had not been observed in prior years. Most fish in this area exhibit advanced signs of sexual maturation by early July and are less desirable.

The recreational fishery during the late chinook salmon run was again restricted to catch and release fishing on 28 July. Again, the return did not appear strong enough to insure that the escapement goal would be achieved without restrictions to the recreational fishery.

Effort:

Because of mechanical and other logistical problems during the creel survey in the downstream section of the Kenai River, angler counts were conducted on only 65 of the 66 days possible and interviews were conducted on 63 of the 66 days. In the midstream section, 23 of the 57 days possible (the fishery was closed from 7 July through 15 July) were surveyed.

Between one and five angler counts were conducted on each sample day in the downstream section (Appendices B1 and B2). Between one and three angler counts were conducted on each sample day in the midstream section (Appendices B3 and B4) except for 3 days that a scheduled count was canceled due to inclement weather.

Downstream Section. Angler counts in the downstream section ranged from 0 to 765 for unguided anglers and from 0 to 662 for guided anglers (Appendices B1 and B2). The largest count of unguided anglers occurred on 15 July and of guided anglers on 24 July.

The estimated effort in the downstream section during the early run was 72,799 (SE = 3,040) angler-hours (Tables 1 and 2). During the early run, 46% of the total effort was by unguided anglers. Of the unguided effort, 48% occurred during weekdays and 52% during weekends/holidays. The estimated effort during the late run was 246,548 (SE = 8,254) angler-hours (Table 2). The majority of this effort (65%) was by unguided anglers. Effort declined dramatically immediately upon implementation of mandatory catch and release fishing (Figure 3).

Midstream Section. Boat counts in the midstream section ranged from 0 to 80 (Appendices B3 and B4). The largest count occurred on 17 July. Average daily effort was greatest during the period 1 July - 6 July, immediately after the river reopened to the retention of chinook salmon (Table 3).

The estimated effort during the early run was 27,146 (SE = 3,629) angler-hours (Table 4). The estimated effort during the late run was 22,710 (SE = 4,070) angler-hours (Table 4).

Table 2. Estimated number of angler-hours of fishing effort by boat anglers during each of the components of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Effort (Angler-hours)	SE	95% Confidence Interval	Relative Precision
<u>Early Run</u>				
Period 1 (16 May - 6 June)				
Unguided weekdays:	9,247	1,111	7,069 - 11,425	23.5%
Unguided weekends:	12,037	1,265	9,558 - 14,516	20.6%
Guided anglers (May):	14,125	1,451	11,281 - 16,969	20.1%
Guided anglers (June):	5,943	1,310	3,375 - 8,511	43.2%
Period 2 (7 June - 30 June)				
Unguided weekdays:	6,819	754	5,341 - 8,297	21.7%
Unguided weekends:	5,704	495	4,734 - 6,674	17.0%
Guided anglers:	18,924	1,331	16,315 - 21,533	13.8%
Sub-totals:				
Unguided:	33,807	1,910	30,063 - 37,551	11.1%
Guided:	38,992	2,365	34,357 - 43,627	11.9%
Early Run Total	72,799	3,040	66,841 - 78,757	8.2%
<u>Late Run</u>				
Period 3 (1 July - 15 July)				
Unguided weekdays:	34,743	2,398	30,043 - 39,443	13.5%
Unguided weekends:	45,200	3,892	37,572 - 52,828	16.9%
Guided anglers (June):	40,818	2,846	35,240 - 46,396	13.7%
Period 4 (16 July - 27 July)				
Unguided weekdays:	55,324	5,237	45,059 - 65,589	18.6%
Unguided weekends:	23,380	1,464	20,511 - 26,249	12.3%
Guided anglers:	43,375	3,080	37,338 - 49,412	13.9%
Period 5 (28 July - 31 July)				
Unguided Both:	2,424	249	1,936 - 2,912	20.1%
Guided anglers:	1,284	113	1,063 - 1,505	17.2%
Sub-totals:				
Unguided:	161,071	7,108	147,139 - 175,003	8.6%
Guided:	85,477	4,195	77,255 - 93,699	9.6%
Late Run Total	246,548	8,254	230,370 - 262,726	6.6%

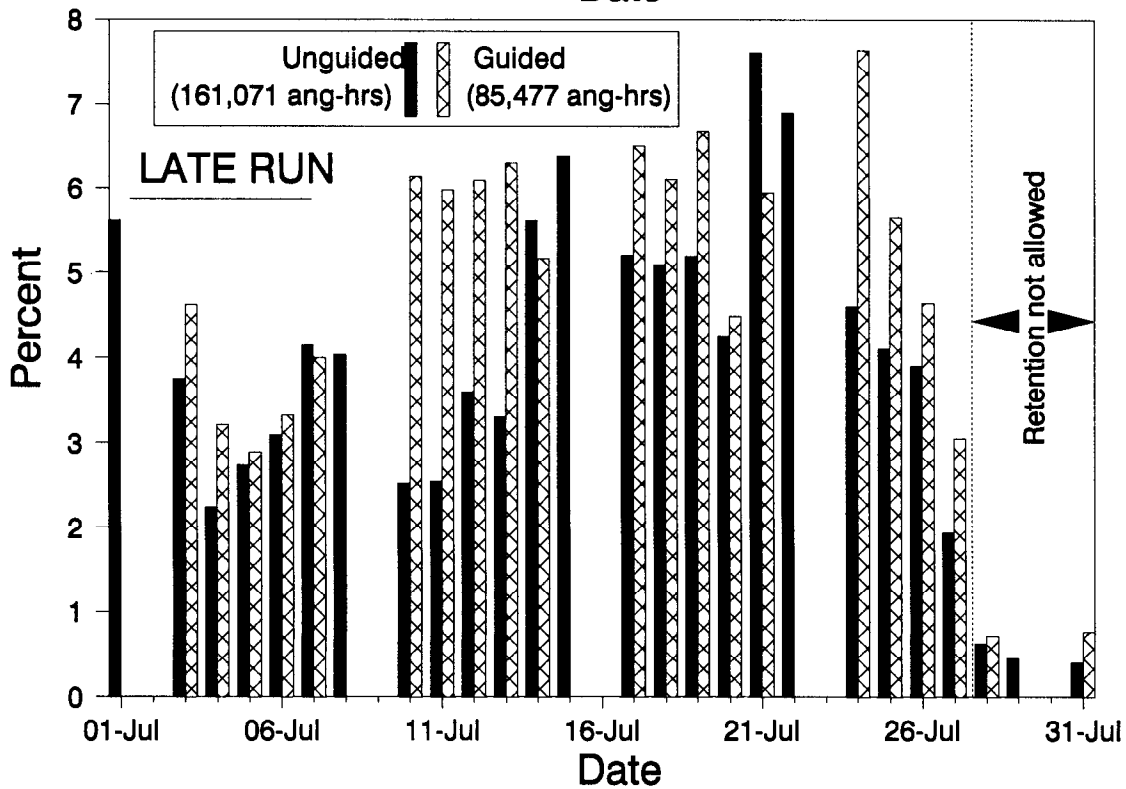
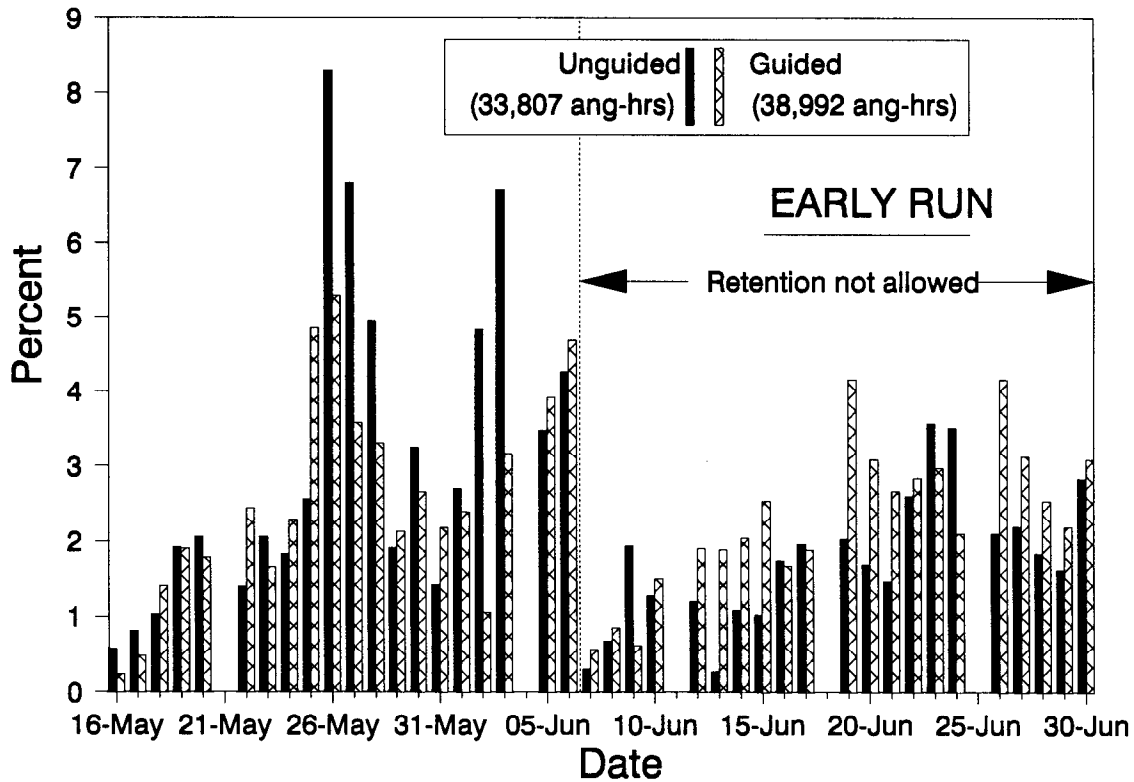


Figure 3. Percent of effort by date in the recreational fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Table 3. Summary of effort statistics for boat anglers by time period for the creel survey of the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

<u>Early Run</u>		<u>Late Run</u>	
Period 1 (28 May - 6 June)		Period 4 (15 July - 27 July)	
Days possible	9	Days possible	11
Days sampled	3	Days sampled	6
Mean (angler-hours/day)	438	Mean (angler-hours/day)	1,920
Standard error	478	Standard error	1,282
Variance		Variance	
Among day	4,113,504	Among day	15,061,458
Within day	117,612	Within day	1,467,497
Period 2 (7 June - 30 June) ^a		Period 5 (28 July - 31 July) ^a	
Days possible	21	Days possible	3
Days sampled	8	Days sampled	2
Mean (angler-hours/day)	584	Mean (angler-hours/day)	530
Standard error	456	Standard error	66
Variance		Variance	
Among day	7,088,094	Among day	6,487
Within day	200,954	Within day	29,974
Period 3 (1 July - 6 July)			
Days possible	5		
Days sampled	4		
Mean (angler hrs/day)	2,190		
Standard error	720		
Variance			
Among day	647,966		
Within day	1,004,655		

^a Retention of chinook salmon prohibited, hook and release fishing only.

Table 4. Estimated number of angler-hours of fishing effort by boat anglers during each period of the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

	Estimated Effort	Standard Error	95% Confidence Interval	Relative Precision
<u>Early Run</u>				
Period 1 (28 May - 6 June)	3,942	2,057	(90) - 7,974	102.3%
Period 2 (7 June - 30 June)	12,254	2,700	6,962 - 17,546	43.2%
Period 3 (1 July - 6 July)	10,950	1,286	8,430 - 13,470	23.0%
Early Run Total	27,146	3,629	20,032 - 34,260	26.2%
<u>Late Run</u>				
Period 4 (15 July - 27 July)	21,121	4,066	13,152 - 29,090	37.7%
Period 5 (28 July - 31 July)	1,589	191	1,215 - 1,963	23.6%
Late Run Total	22,710	4,070	14,733 - 30,687	35.1%

Harvest Rates and Catch Rates:

A total of 3,958 interviews with completed trip anglers were collected during the creel survey in the downstream section of the Kenai River, 1,074 interviews during the early run and 2,884 interviews during the late run (Table 5). In the midstream section, 120 boats containing 356 completed-trip anglers were interviewed during both runs.

Downstream Section. Daily catch rates of chinook salmon by unguided anglers ranged from 0.000 to 0.154 fish per hour during the early run and from 0.000 to 0.081 fish per hour during the late run (Appendices C1 and C2). Peak daily catch rates of chinook salmon by unguided anglers occurred on 1 June during the early run and on 17 July during the late run (Figure 4). Daily catch rates of chinook salmon by guided anglers ranged from 0.000 to 0.313 fish per hour during the early run and from 0.020 to 0.111 fish per hour during the late run (Appendices C3 and C4). Peak daily catch rates of chinook salmon by guided anglers occurred on 9 June during the early run and 31 July during the late run (Figure 4). Estimates of overall harvest and catch rates of chinook salmon for each of the components were higher for guided anglers than for unguided anglers in all components (Table 5).

Table 6 presents the harvest and catch rates for species other than chinook salmon by unguided and guided anglers during the fishery for chinook salmon.

Midstream Section. Daily catch rates of chinook salmon in the midstream section by all anglers ranged from 0.000 to 0.188 fish per hour during the early run and from 0.000 to 0.083 fish per hour during the late run (Appendices C5 and C6). Peak daily catch rates of chinook salmon by anglers occurred on 24 June during the early run and on 05 July during the late run.

Harvest and Catch:

The harvest and catch of chinook salmon by boat anglers were estimated for each run component in the downstream and midstream sections of the Kenai River. Estimated effort and catch rates for each run component from Tables 2 and 5, respectively, were used to estimate harvest and catch in the downstream section. For the midstream section, estimated effort and catch rates for each component from Table 4 and Appendix C6, respectively, were used to estimate harvest and catch.

Downstream Section. Harvest and catch statistics for boat anglers in the downstream section are as follows. A total of 723 (SE = 167) fish were harvested during the early run and 5,813 (SE = 432) fish during the late run (Table 7). Guided anglers harvested more fish than did unguided anglers during both runs. Because of the prohibition on retention of chinook salmon during the early run, 78% of the catch was released. Only 28% of the catch was released during the late run.

Midstream Section. Harvest and catch statistics for boat anglers in the midstream section are as follows (Table 8). A total of 616 fish (SE = 221) were harvested during the early run and 217 fish (SE = 105) during the late

Table 5. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of chinook salmon by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Time Period ^a	n ^b	N ^c	Number of Interviews ^d	HPUE	Standard Error	CPUE	Standard Error
<u>Early Run</u>								
Unguided weekdays	1	10	13	118	0.0065	0.00622	0.0065	0.00622
Unguided weekends	1	7	7	264	0.0077	0.00218	0.0132	0.00379
Guided all days (May)	1	10	15	174	0.0248	0.00847	0.0280	0.00895
Guided all days (June)	1	4	5	53	0.0370	0.01281	0.0535	0.01586
Unguided weekdays	2	12	14	114	0.0000	0.00000	0.0438	0.00892
Unguided weekends	2	7	7	118	0.0000	0.00000	0.0345	0.00959
Guided all days	2	14	21	233	0.0000	0.00000	0.0981	0.01587
<hr/>								
Sub-totals								
Unguided		36	41	614	0.0045	0.00201	0.0211	0.00366
Guided		28	41	460	0.0146	0.00402	0.0659	0.01030
<hr/>								
Early Run Total		36	41	1,074	0.0099	0.00233	0.0451	0.00566
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Table 5. (Page 2 of 2).

Component	Time Period ^a	n ^b	N ^c	Number of Interviews ^d	HPUE	Standard Error	CPUE	Standard Error
<u>Late Run</u>								
Unguided weekdays	3	7	7	256	0.0130	0.00380	0.0249	0.00486
Unguided weekends	3	6	6	612	0.0142	0.00235	0.0188	0.00279
Guided all days	3	10	10	571	0.0421	0.00492	0.0535	0.00520
Unguided weekdays	4	8	8	610	0.0157	0.00277	0.0213	0.00403
Unguided weekends	4	2	2	253	0.0131	0.00331	0.0181	0.00391
Guided all days	4	8	9	502	0.0421	0.00499	0.0562	0.00605
Unguided all days	5	3	3	41	0.0000	0.00000	0.0000	0.00000
Guided all days	5	2	2	39	0.0000	0.00000	0.0940	0.01504
<u>Sub-totals</u>								
Unguided		26	26	1,772	0.0141	0.00175	0.0206	0.02370
Guided		20	21	1,112	0.0415	0.00450	0.0555	0.00550
Late Run Total		26	26	2,884	0.0236	0.00192	0.0327	0.00244
<u>Totals</u>								
Unguided		62	67	2,386	0.0124		0.0207	
Guided		48	62	1,572	0.0331		0.0588	
GRAND TOTAL				3,958				

^a Period

- 1 (16 May - 6 June)
- 2 (7 June - 30 June)
- 3 (1 July - 15 July)
- 4 (16 July - 27 July)
- 5 (28 July - 31 July)

^b Number of days on which interviews were collected.

^c Number of days possible for interviewing.

^d Complete trip interviews only.

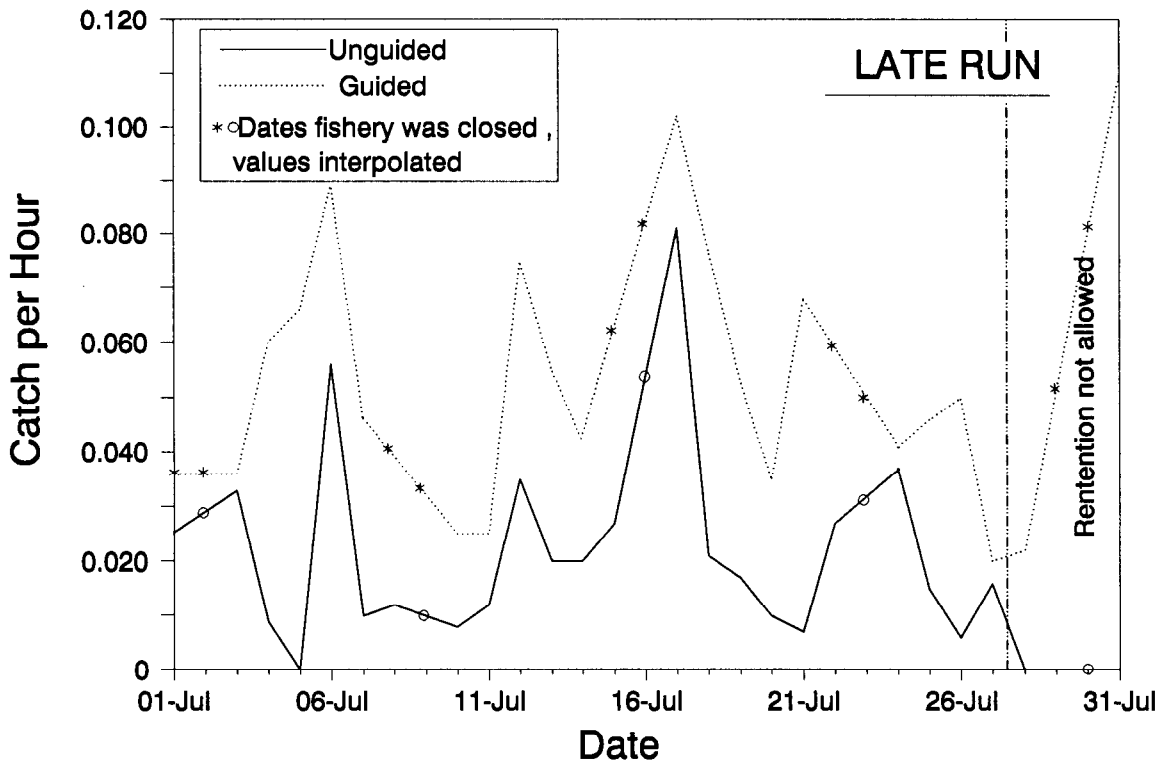
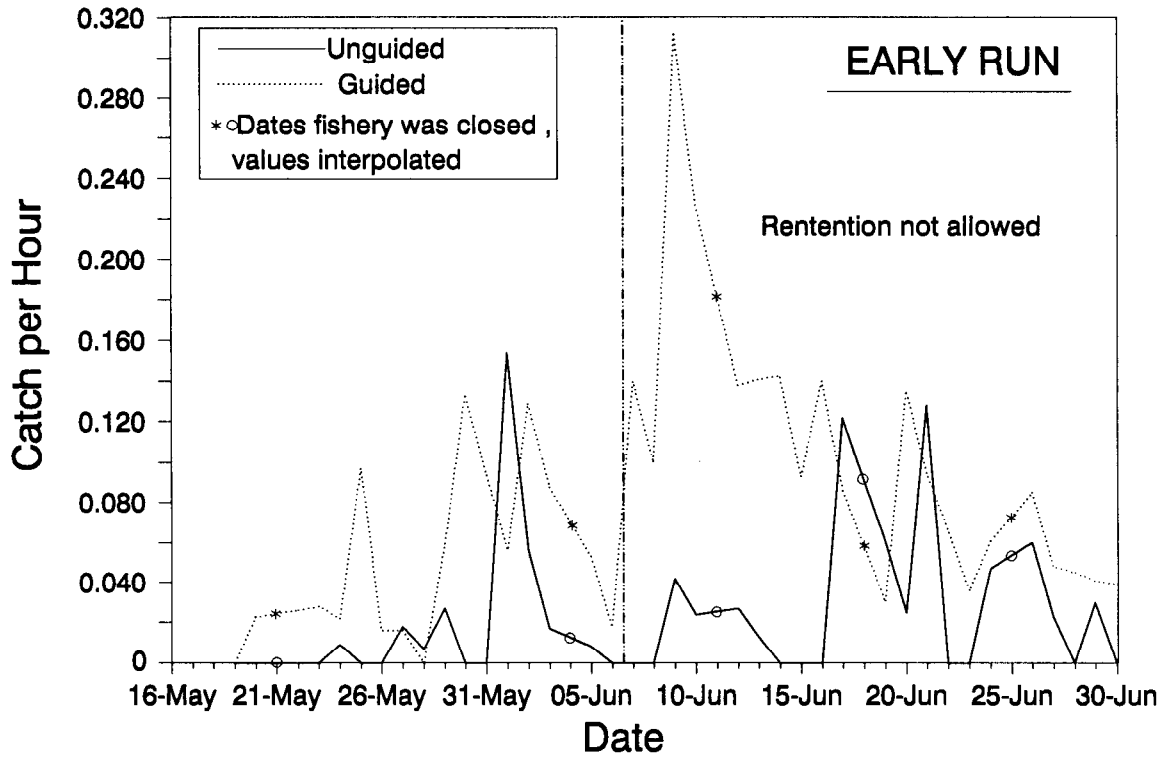


Figure 4. Daily catch per hour of chinook salmon by anglers in the recreational fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Table 6. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, coho salmon, pink salmon, rainbow trout, and Dolly Varden by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	<u>Sockeye Salmon</u>		<u>Coho Salmon</u>		<u>Pink Salmon</u>		<u>Rainbow Trout</u>		<u>Dolly Varden</u>	
	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE
<u>Early Run</u>										
Unguided weekdays (Standard Error)	0.0024 (0.0016)	0.0024 (0.0016)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Unguided weekends (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0008 (0.0008)	0.0000 (0.0000)	0.0008 (0.0004)
Guided all days (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0004 (0.0004)	0.0008 (0.0003)	0.0012 (0.0004)
<u>Late Run</u>										
Unguided weekdays (Standard Error)	0.0362 (0.0053)	0.0362 (0.0053)	0.0002 (0.0002)	0.0002 (0.0002)	0.0009 (0.0004)	0.0013 (0.0006)	0.0004 (0.0006)	0.0007 (0.0007)	0.0055 (0.0013)	0.0073 (0.0016)
Unguided weekends (Standard Error)	0.0017 (0.0008)	0.0017 (0.0008)	0.0000 (0.0000)	0.0000 (0.0000)	0.0003 (0.0003)	0.0003 (0.0003)	0.0000 (0.0000)	0.0003 (0.0003)	0.0069 (0.0016)	0.0098 (0.0020)
Guided all days (Standard Error)	0.0074 (0.0019)	0.0076 (0.0020)	0.0014 (0.0007)	0.0014 (0.0007)	0.0000 (0.0000)	0.0005 (0.0002)	0.0001 (0.0001)	0.0003 (0.0002)	0.0091 (0.0021)	0.0112 (0.0022)

Table 7. Estimated number of chinook salmon harvested and number caught by boat anglers during each component of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Harvest ^a	Standard Error	Rel. Pre. ^b	Catch ^c	Standard Error	Rel. Pre. ^b
<u>Early Run</u>						
Unguided weekdays	60	58	188.2%	359	90	49.0%
Unguided weekends	93	35	74.0%	356	75	41.2%
Guided all days	570	153	52.5%	2,570	371	28.3%
Sub-total:						
Unguided	153	67	86.4%	715	117	32.0%
Guided	570	153	52.5%	2,570	371	28.3%
Early Run Total	723	167	45.3%	3,285	389	23.2%
<u>Late Run</u>						
Unguided weekdays	1,321	220	32.6%	2,043	306	29.4%
Unguided weekends	948	144	29.7%	1,273	174	26.8%
Guided all days	3,544	343	19.0%	4,743	408	16.9%
Sub-total:						
Unguided	2,269	263	22.7%	3,316	352	20.8%
Guided	3,544	343	19.0%	4,743	408	16.9%
Late Run Total	5,813	432	14.6%	8,059	539	13.1%

^a Harvest includes only fish kept.

^b Relative precision for 95% confidence interval.

^c Catch includes fish kept and fish reported as released.

Table 8. Estimate of total effort, catch and harvest by boat anglers during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

	Total	Variance	RP %
Effort:			
Early	27,145	13,172,785	26
Late	22,709	16,565,416	35
Catch:			
Early	1,228	168,531	66
Late	289	14,263	81
Harvest:			
Early	616	48,892	70
Late	217	11,012	95

run. Because of the prohibition on retention of chinook salmon during the early run, 50% of the catch was released. Only 25% of the late-run catch was released.

Other Species. Sockeye salmon was the most common species caught in the downstream section; 4,095 (SE = 480) sockeye salmon were harvested; 23 were released (Table 9). Dolly Varden was the next most common species caught in the downstream section; 1,754 (SE = 236) fish were harvested and 2,300 (SE = 262) fish were caught.

Summary:

The utility to which these data are put is an accounting of harvest, effort, and catch by run component. While historically negligible, there is a small fishery that occurs in the upstream section (Naptowne Rapids to the outlet of Skilak Lake) which makes total estimates of these fishery statistics by run component biased low. Historically, there has been very little angler effort in the upstream section prior to early June. Because of the timing of the catch and release restriction (7 June - 30 June) during 1990, harvest of chinook salmon in the upstream section prior to 1 July was negligible. However, it was apparent through observation and phoned in reports from anglers, that some harvest of chinook salmon did take place after the prohibition on retention was removed on 1 July. To provide a closer approximation of actual fishing statistics, I assumed that catch and harvest after 1 July in the upstream section was equal to that estimated in the midstream section (Table 10). This level of harvest (several hundreds of fish) is consistent with historic data (Hammarstrom 1990).

For both runs, most of the effort, harvest, and catch occurred in the downstream fishery (Table 10). Including the approximations for the upstream fishery, harvest totaled 1,735 fish during the early run and 6,247 fish during the late run. Because of the restrictions placed on the early-run fishery, harvest retention was only 35% (1,735 harvest of 4,973 total catch) as opposed to 72% (6,247 harvest of 8,637 total catch) during the late run.

Biological Data:

The most abundant age groups in the early-run harvest were ages-1.4 and -1.5 chinook salmon which composed 75.4% and 12.3% of the sample, respectively (Table 11). Ages-1.3 and -1.4 chinook salmon were the most abundant age groups in the late-run harvest, contributing 16.4% and 62.0% to the sample, respectively (Table 11). The mean lengths at age for each sex were generally greater for late-run fish than for early-run fish (Table 12). For both the early and late runs, the mean lengths of 3-, 4-, and 5-ocean age male chinook salmon sampled from the harvest were generally larger than the mean lengths of females from the same age group.

Discussion:

One of the recommendations from the 1989 survey was to examine the variation of counts within a period. Eleven periods were sampled during the early run. Estimates were made of the variance among counts (Appendix D1) and the relative precisions (for 95% CI) ranged from 6% to 83%.

Table 9. Estimated number of sockeye salmon, coho salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by boat anglers during the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Species	Unguided Anglers				Guided Anglers				Total			
	Harvest ^a	SE	Catch ^b	SE	Harvest ^a	SE	Catch ^b	SE	Harvest ^a	SE	Catch ^b	SE
<u>Early Run</u>												
Sockeye salmon	38	26	38	26	0	0	0	0	38	26	38	26
Rainbow trout	0	0	14	15	0	0	15	14	0	0	29	20
Dolly Varden	0	0	14	8	30	10	45	17	30	10	59	18
<u>Late Run</u>												
Sockeye salmon	3,466	451	3,466	447	629	163	652	165	4,095	480	4,118	477
Coho salmon	22	21	22	21	123	63	123	63	145	67	145	67
Pink salmon	97	45	136	59	0	0	44	20	97	45	180	63
Rainbow trout	35	55	87	71	12	11	24	14	47	56	111	72
Dolly Varden	977	162	1,346	190	777	172	954	181	1,754	236	2,300	262

^a Harvest includes only fish kept.

^b Catch includes fish kept and fish reported as released.

Table 10. Summary of estimated angler effort, chinook salmon harvest, and chinook salmon catch by all boat anglers, for each river section of the fishery for chinook salmon in the Kenai River, Alaska, 1990.

Run	Downstream Section	Midstream Section	Combined Total	95% Confidence Interval	Upstream ^a Section	Total ^a
<u>Early Run</u>						
Effort	72,799	27,146	99,945	90,666 - 109,224	23,204	123,149
SE	3,040	3,629	4,734			
Harvest	723	616	1,339	796 - 1,882	396	1,735
SE	167	221	277			
Catch	3,285	1,228	4,513	3,404 - 5,622	460	4,973
SE	389	411	566			
<u>Late Run</u>						
Effort	246,548	22,710	269,258	251,221 - 287,295	22,709	291,967
SE	8,254	4,070	9,203			
Harvest	5,813	217	6,030	5,158 - 6,902	217	6,247
SE	432	105	445			
Catch	8,059	289	8,348	7,266 - 9,430	289	8,637
SE	539	119	552			

^a Upstream fishing assumed equal to midstream fishing based on observations after 1 July. This fishery was not directly sampled and there is no measure of accuracy or precision for these estimates. These numbers are presented to provide a closer approximation of the total fishery.

Table 11. Age composition of chinook salmon sampled from the harvest during the early and late runs of the fishery for chinook salmon in the Kenai River, Alaska, 1990.

Run	Sex		Age Group					Total
			1.1	1.2	1.3	1.4	1.5	
Early (n=73) ^a	Male	Percent		4.1	1.4	32.9	8.2	46.6
	Female	Percent		2.7	4.1	42.5	4.1	53.4
	Combined	Percent		6.8	5.5	75.4	12.3	100.0
		SE		3.0	2.7	5.1	3.9	
Late (n=330) ^a	Male	Percent	0.3	6.7	10.3	32.3	6.4	56.0
	Female	Percent		2.4	6.1	29.7	5.8	44.0
	Combined	Percent	0.3	9.1	16.4	62.0	12.2	100.0
		SE		1.6	2.0	2.7	1.8	

^a n = sample size.

Table 12. Mean length (millimeters) by age group of chinook salmon sampled from the harvest during the early and late runs of the fishery for chinook salmon in the Kenai River, Alaska, 1990.

Run	Sex	Age Group					
		1.1	1.2	1.3	1.4	1.5	
Early							
	Male	Mean Length	612	780	945	1,070	
		Standard Error	61		16	15	
		Sample size	3	1	24	6	
	Female	Mean Length	595	758	934	1,024	
		Standard Error	45	51	14	18	
		Sample size	2	3	31	4	
Late							
	Male	Mean Length	420	628	798	1,015	1,112
		Standard Error		13	13	10	17
		Sample size	1	22	34	107	21
	Female	Mean Length	619	840	978	1,062	
		Standard Error	17	16	8	16	
		Sample size	8	20	98	19	

The estimate of mean second stage variance (\bar{s}_p^2) was used to estimate a two stage variance for the period and total effort estimates in the stratum for unguided anglers on week days from 17 May to 6 June. The results in Appendix E1 show that the second stage component represents less than 1% of the total two-stage variance. This does assume the mean second stage variance is representative, but even if it is underestimated by a factor of 10, the second stage is a small portion of the total variance.

These results also show that the two-stage estimate of variance is more efficient and is reduced from the single-stage variance estimate (Appendix D1). However, the benefit of increased sampling to reduce variance of harvest or catch will also depend upon the precision of the HPUE and CPUE estimates. These estimates (Table 5) are far less precise than the effort estimates (Table 2).

Coho Salmon Fishery

During the coho salmon fishery, 42 of the 61 days possible during the survey period were sampled in the downstream section of the Kenai River. In the upstream section, 41 of the 61 days possible were surveyed.

Effort:

Two angler counts were usually conducted on each sample day in the downstream section; there was 1 day when only one angler count was conducted. Two angler counts were conducted on all but 3 days surveyed in the upstream section.

Downstream Section. Angler counts in the downstream section ranged from 27 to 601 for unguided boat anglers, from 16 to 290 for shore anglers, and from 0 to 256 for guided anglers (Appendix E1). The largest count for all components occurred on 12 August. For each period, the mean count of unguided boat anglers and shore anglers for the weekend/holiday component was larger than the mean count for the weekday component (Table 13). During the B period of the early run and the B and C period of the late run, the mean angler count for guided anglers was greater for the weekday component than the weekend/holiday component (Table 13).

The estimated effort during the early run (August) was 216,074 (SE = 7,682) angler-hours (Table 14). During the early run, 75% of the total effort was by unguided anglers (shore anglers are assumed to be unguided). Anglers fishing on weekdays accounted for 65% of the effort while weekend/holiday anglers accounted for 35% of the effort. The estimated effort during the late run (September) was 97,639 (SE = 5,338) angler-hours (Table 14). The majority of this effort (75%) was by unguided anglers. Also, 50% of the effort occurred during weekdays and 50% during weekends/holidays.

Upstream Section. Angler counts in the upstream section ranged from 0 to 163 for unguided anglers and from 0 to 32 for guided anglers (Appendix E2). The largest count of unguided anglers occurred on 2 September and the largest count of guided anglers on 10 September. For each period in both runs, the mean count of unguided anglers for the weekend/holiday component was larger

Table 13. Mean counts of anglers by period for each component of the creel survey of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Period ^a			
	A	B	C	D
<u>Early Run</u>				
Unguided boat anglers, weekdays:				
Number of counts	8	5	8	5
Mean count	147	182	144	139
Standard error	16	17	17	29
Unguided boat anglers, weekends:				
Number of counts	4	4	4	4
Mean count	345	411	280	214
Standard error	65	86	27	86
Guided boat anglers, weekdays:				
Number of counts	8	5	8	5
Mean count	159	182	72	18
Standard error	17	15	10	5
Guided boat anglers, weekends:				
Number of counts	4	4	4	4
Mean count	169	167	74	20
Standard error	18	38	10	6
Shore anglers, weekdays:				
Number of counts	8	5	8	5
Mean count	81	130	142	135
Standard error	10	12	23	29
Shore anglers, weekends:				
Number of counts	4	4	4	4
Mean count	119	172	204	178
Standard error	28	24	20	43

-Continued-

Table 13. (Page 2 of 2).

Component	Period ^a			
	A	B	C	D
<u>Late Run</u>				
Unguided boat anglers, weekdays:				
Number of counts		8	7	8
Mean count		147	104	68
Standard error		20	13	8
Unguided boat anglers, weekends:				
Number of counts		5	7	5
Mean count		291	241	175
Standard error		37	50	64
Guided boat anglers, weekdays:				
Number of counts		8	7	8
Mean count		111	65	29
Standard error		26	12	8
Guided boat anglers, weekends:				
Number of counts		5	7	5
Mean count		115	60	23
Standard error		20	12	12
Shore anglers, weekdays:				
Number of counts		8	7	8
Mean count		45	40	38
Standard error		10	6	7
Shore anglers, weekends:				
Number of counts		5	7	5
Mean count		68	72	59
Standard error		17	18	16

^a Early Run: Period A = 0600 - 0959
 Period B = 1000 - 1359
 Period C = 1400 - 1759
 Period D = 1800 - 2159

^b Late Run: Period A = 0800 - 1159
 Period B = 1200 - 1559
 Period C = 1600 - 1959

Table 14. Estimated number of angler-hours of fishing effort by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Effort (Angler-hours)	Standard Error	95% Confidence Interval	Relative Precision
<u>Early Run</u>				
Unguided boat anglers, wd: ^a	56,231	3,761	48,859 - 63,603	13.1%
Unguided boat anglers, we: ^b	40,008	4,503	31,182 - 48,834	22.1%
Guided boat anglers, wd: ^a	39,687	2,338	35,105 - 44,269	11.5%
Guided boat anglers, we: ^b	13,696	1,394	10,964 - 16,428	19.9%
Shore anglers, wd: ^a	44,924	3,669	37,733 - 52,115	16.0%
Shore anglers, we: ^b	21,528	1,927	17,751 - 25,305	17.5%
<u>Sub-totals:</u>				
Unguided:	96,239	5,867	84,740 - 107,738	11.9%
Guided:	53,383	2,722	48,048 - 58,718	10.0%
Shore:	66,452	4,144	58,329 - 74,575	12.2%
<u>Early Run Total</u>	<u>216,074</u>	<u>7,682</u>	<u>201,018 - 231,130</u>	<u>7.0%</u>
<u>Late Run</u>				
Unguided boat anglers, wd: ^a	24,145	1,934	20,354 - 27,936	15.7%
Unguided boat anglers, we: ^b	31,093	3,941	23,369 - 38,817	24.8%
Guided boat anglers, wd: ^a	15,619	2,274	11,162 - 20,076	28.5%
Guided boat anglers, we: ^b	8,703	1,163	6,424 - 10,982	26.2%
Shore anglers, wd: ^a	9,329	1,017	7,336 - 11,322	21.4%
Shore anglers, we: ^b	8,750	1,291	6,220 - 11,280	28.9%
<u>Sub-totals:</u>				
Unguided:	55,238	4,390	46,634 - 63,842	15.6%
Guided:	24,322	2,554	19,316 - 29,328	20.6%
Shore:	18,079	1,643	14,858 - 21,300	17.8%
<u>Late Run Total</u>	<u>97,639</u>	<u>5,338</u>	<u>87,176 - 108,102</u>	<u>10.7%</u>

^a wd = weekday

^b we = weekend

than the mean count for the weekday component (Table 15). However, the opposite was generally true for guided anglers.

The estimated effort during the early run was 28,512 (SE = 2,089) angler-hours (Table 16). During the early run, 88% of the total effort was by unguided anglers; 59% of the effort occurred during weekdays and 41% during weekends/holidays. The estimated effort during the late run was 18,528 (SE = 1,432) angler-hours (Table 16). The majority of this effort (89%) was by unguided anglers, also.

Midstream Section. The counts of anglers in each section of the Kenai River between Skilak Lake and Cook Inlet, conducted during aerial surveys during the fishery for coho salmon, are summarized in Tables 17 and 18. A total of 13 flights were made. The mean proportion of boats counted in the midstream section for the early run was 0.045 (SE = 0.010) and the late run was 0.049 (SE = 0.014). The mean proportion of shore anglers counted in the midstream section for the early run was 0.174 (SE = 0.046) and the late run was 0.336 (SE = 0.051). Each effort component was expanded accordingly to estimate the midstream component. Estimated effort occurring in the midstream section during the early and late runs was 23,735 (SE = 1,815) angler-hours and 14,938 (SE = 1,138) angler-hours, respectively.

Harvest Rates and Catch Rates:

A total of 2,242 angler interviews (both completed-trip and incompletd-trip) were collected during the creel survey in the downstream section of the Kenai River; 1,013 during the early run and 1,229 during the late run (Table 19). In the upstream section a total of 967 angler interviews (completed-trip only) were collected, 442 during the early run and 525 during the late run (Table 20).

Downstream Section. Daily harvest rates of coho salmon by unguided boat anglers ranged from 0.000 to 0.345 fish per hour during the early run and from 0.000 to 0.528 fish per hour during the late run (Appendix F1). Peak daily harvest rates of coho salmon by unguided anglers occurred on 17 August during the early run and on 19 September during the late run (Figure 5). Daily harvest rates of coho salmon by guided anglers ranged from 0.058 to 0.581 fish per hour during the early run and from 0.074 to 0.577 fish per hour during the late run (Appendix F2). Peak daily harvest rates by guided anglers occurred on 17 August during the early run and on 28 September during the late run (Figure 5). Daily harvest rates of coho salmon by shore anglers ranged from 0.000 to 0.230 fish per hour during the early run and from 0.033 to 0.476 fish per hour during the late run (Appendix F3). Peak daily harvest rates by shore anglers occurred on 18 August during the early run and on 18 September during the late run. The highest mean harvest rate among all components of the fishery was for unguided boat anglers on the weekdays of the late run (Table 19).

Other species harvests in the downstream section are considered incidental during the fishery for coho salmon except for pink salmon. Harvest and catch rates for other species are presented in Table 21.

Table 15. Mean counts of anglers by period for each component of the creel survey of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Component	Period ^a			
	A	B	C	D
<u>Early Run</u>				
Unguided boat anglers, weekdays:				
Number of counts	5	7	7	3
Mean count	16	41	30	13
Standard error	3	6	3	8
Unguided boat anglers, weekends:				
Number of counts	3	5	4	4
Mean count	46	94	79	21
Standard error	15	6	23	6
Guided boat anglers, weekdays:				
Number of counts	5	7	7	3
Mean count	9	9	9	1
Standard error	4	3	3	1
Guided boat anglers, weekends:				
Number of counts	3	5	4	4
Mean count	8	7	7	1
Standard error	1	4	2	1
Shore anglers, weekdays:				
Number of counts	5	7	7	3
Mean count	8	27	13	8
Standard error	6	10	5	5
Shore anglers, weekends:				
Number of counts	3	5	4	4
Mean count	22	40	18	21
Standard error	17	12	2	13

-Continued-

Table 15. (Page 2 of 2).

Component	Period ^a		
	A	B	C
<u>Late Run</u>			
Unguided boat anglers, weekdays:			
Number of counts	7	8	7
Mean count	28	29	18
Standard error	3	2	3
Unguided boat anglers, weekends:			
Number of counts	6	6	7
Mean count	66	86	61
Standard error	14	19	18
Guided boat anglers, weekdays:			
Number of counts	7	8	7
Mean count	10	6	1
Standard error	4	2	1
Guided boat anglers, weekends:			
Number of counts	6	6	7
Mean count	8	7	2
Standard error	2	1	1
Shore anglers, weekdays:			
Number of counts	7	8	7
Mean count	2	2	2
Standard error	2	1	1
Shore anglers, weekends:			
Number of counts	6	6	7
Mean count	5	9	9
Standard error	2	3	3

^a Early Run: Period A = 0600 - 0959
 Period B = 1000 - 1359
 Period C = 1400 - 1759
 Period D = 1800 - 2159

Late Run: Period A = 0800 - 1159
 Period B = 1200 - 1559
 Period C = 1600 - 1959

Table 16. Estimated number of angler-hours of fishing effort by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Component	Effort (Angler-hours)	Standard Error	95% Confidence Interval	Relative Precision
<u>Early Run</u>				
Unguided boat anglers, wd: ^a	9,156	988	7,220 - 11,092	21.1%
Unguided boat anglers, we: ^b	7,651	920	5,848 - 9,454	23.6%
Guided boat anglers, wd: ^a	2,563	543	1,499 - 3,627	41.5%
Guided boat anglers, we: ^b	752	48	658 - 846	12.5%
Shore anglers, wd: ^a	5,160	1,284	2,643 - 7,677	48.8%
Shore anglers, we: ^b	3,230	771	1,719 - 4,741	46.8%
Sub-totals:				
Unguided:	16,807	1,350	14,161 - 19,453	15.7%
Guided:	3,315	545	2,247 - 4,383	32.2%
Shore:	8,390	1,498	5,455 - 11,325	35.0%
Early Run Total	28,512	2,089	24,418 - 32,606	14.4%
<u>Late Run</u>				
Unguided boat anglers, wd: ^a	5,697	334	5,042 - 6,352	11.5%
Unguided boat anglers, we: ^b	9,337	1,312	6,765 - 11,909	27.5%
Guided boat anglers, wd: ^a	1,273	352	583 - 1,963	54.2%
Guided boat anglers, we: ^b	735	160	421 - 1,049	42.7%
Shore anglers, wd: ^a	476	134	213 - 739	55.2%
Shore anglers, we: ^b	1,010	227	565 - 1,455	44.1%
Sub-totals:				
Unguided:	15,034	1,354	12,380 - 17,688	17.7%
Guided:	2,008	387	1,250 - 2,766	37.7%
Shore:	1,486	264	969 - 2,003	34.8%
Late Run Total	18,528	1,432	15,720 - 21,336	15.2%

^a wd = weekday

^b we = weekend

Table 17. Counts of sportfishing boats and shore anglers by river section during aerial surveys of the fishery for early run coho salmon in the Kenai River, Alaska, 1990.

Date	<u>Downstream</u>		<u>Midstream</u>		<u>Upstream</u>		Total Count
	Count	Proportion	Count	Proportion	Count	Proportion	
<u>Boats</u>							
3 August	102	0.7786	6	0.0458	23	0.1755	131
8 August	157	0.8920	6	0.0340	13	0.0739	176
12 August	176	0.7652	8	0.0347	46	0.2000	230
15 August	103	0.7923	4	0.0307	23	0.1769	130
22 August	66	0.7674	3	0.0348	17	0.1977	86
25 August	183	0.7922	8	0.0346	40	0.1732	231
30 August	52	0.6667	8	0.1025	18	0.2308	78
Mean		0.7792		0.0454		0.1754	
SE		0.0249		0.0097		0.0186	
<u>Shore Anglers</u>							
8 August	92	0.7797	6	0.0508	20	0.1695	118
12 August	119	0.8095	21	0.1428	7	0.0476	147
15 August	110	0.8271	12	0.0902	11	0.0827	133
22 August	64	0.6275	38	0.3725	0	0.0000	102
25 August	66	0.8250	14	0.175	0	0.0000	80
30 August	34	0.7907	9	0.2093	0	0.0000	43
Mean		0.7766		0.1735		0.0500	
SE		0.0308		0.0461		0.0276	

Table 18. Counts of sportfishing boats and shore anglers by river section during aerial surveys of the fishery for late-run coho salmon in the Kenai River, Alaska, 1990.

Date	<u>Downstream</u>		<u>Midstream</u>		<u>Upstream</u>		Total Count
	Count	Proportion	Count	Proportion	Count	Proportion	
<u>Boats</u>							
11 September	132	0.8571	0	0	22	0.1428	154
16 September	52	0.8125	4	0.0625	8	0.1250	64
17 September	28	0.6829	4	0.0975	9	0.2195	41
23 September	104	0.6797	9	0.0588	40	0.2614	153
28 September	63	0.6848	2	0.0217	27	0.2935	92
29 September	59	0.5514	6	0.0560	42	0.3925	107
Mean		0.7114		0.0494		0.2391	
Standard Error		0.0446		0.0139		0.0407	
<u>Shore Anglers</u>							
11 September	10	0.5000	10	0.5	0	0.0000	20
16 September	41	0.8039	10	0.1960	0	0.0000	51
17 September	20	0.6897	9	0.3103	0	0.0000	29
23 September	20	0.5263	18	0.4736	0	0.0000	38
28 September	13	0.6842	6	0.3157	0	0.0000	19
29 September	15	0.5556	6	0.2222	6	0.2222	27
Mean		0.6266		0.3364		0.0370	
Standard Error		0.0483		0.0515		0.0370	

Table 19. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of coho salmon by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Days		Number of Interviews ^c	HPUE	Standard Error	CPUE	Standard Error
	n ^a	N ^b					
<u>Early Run</u>							
Unguided boat weekdays:	13	23	251	0.1117	0.01988	0.1129	0.01994
Unguided boat weekdays:	8	8	234	0.0927	0.01311	0.0927	0.01311
Guided boat, weekdays:	13	23	246	0.1863	0.02289	0.1915	0.02376
Guided boat, weekends:	8	8	125	0.1673	0.02921	0.1691	0.02929
Shore weekdays:	8	23	89	0.1046	0.02397	0.1046	0.02397
Shore weekends:	7	8	68	0.1122	0.03498	0.1173	0.03528
<u>Late Run</u>							
Unguided boat weekdays:	12	19	255	0.2250	0.02414	0.2250	0.02414
Unguided boat weekdays:	9	11	432	0.1128	0.01048	0.1141	0.01044
Guided boat, weekdays:	11	19	243	0.2220	0.02646	0.2238	0.02639
Guided boat, weekends:	9	11	205	0.1666	0.01421	0.1666	0.01421
Shore weekdays:	5	19	44	0.1414	0.09148	0.1414	0.09148
Shore weekends:	5	11	50	0.0769	0.02342	0.0769	0.02342

^a Number of days on which interviews were collected.

^b Number of days possible for interviewing.

^c Both completed-trip and incompleted-trip interviews.

Table 20. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of coho salmon by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Component	Days		Number of Interviews ^c	HPUE	Standard Error	CPUE	Standard Error
	n ^a	N ^b					
<u>Early Run</u>							
Unguided boat weekdays:	12	23	129	0.1240	0.04090	0.1319	0.04060
Unguided boat weekends:	8	8	216	0.0866	0.01072	0.0907	0.01114
Guided boat, weekdays:	7	23	33	0.2831	0.06711	0.2892	0.06787
Guided boat, weekends:	5	8	37	0.1887	0.04957	0.1887	0.04957
Shore weekdays:	2	23	16	0.0000	0.00000	0.0000	0.00000
Shore weekends:	2	8	11	0.0392	0.03527	0.0392	0.03527
<u>Late Run</u>							
Unguided boat weekdays:	11	19	145	0.1398	0.03285	0.1504	0.03259
Unguided boat weekends:	10	11	308	0.1320	0.02060	0.1396	0.02058
Guided boat, weekdays:	7	19	38	0.3039	0.06491	0.3121	0.06412
Guided boat, weekends:	5	11	19	0.3802	0.03794	0.3802	0.03794
Shore weekdays:	3	19	12	0.6122	0.02772	0.6122	0.02772
Shore weekends:	1	11	3	0.1429	0.81980	0.1429	0.81980

^a Number of days on which interviews were collected.

^b Number of days possible for interviewing.

^c Completed-trip interviews only.

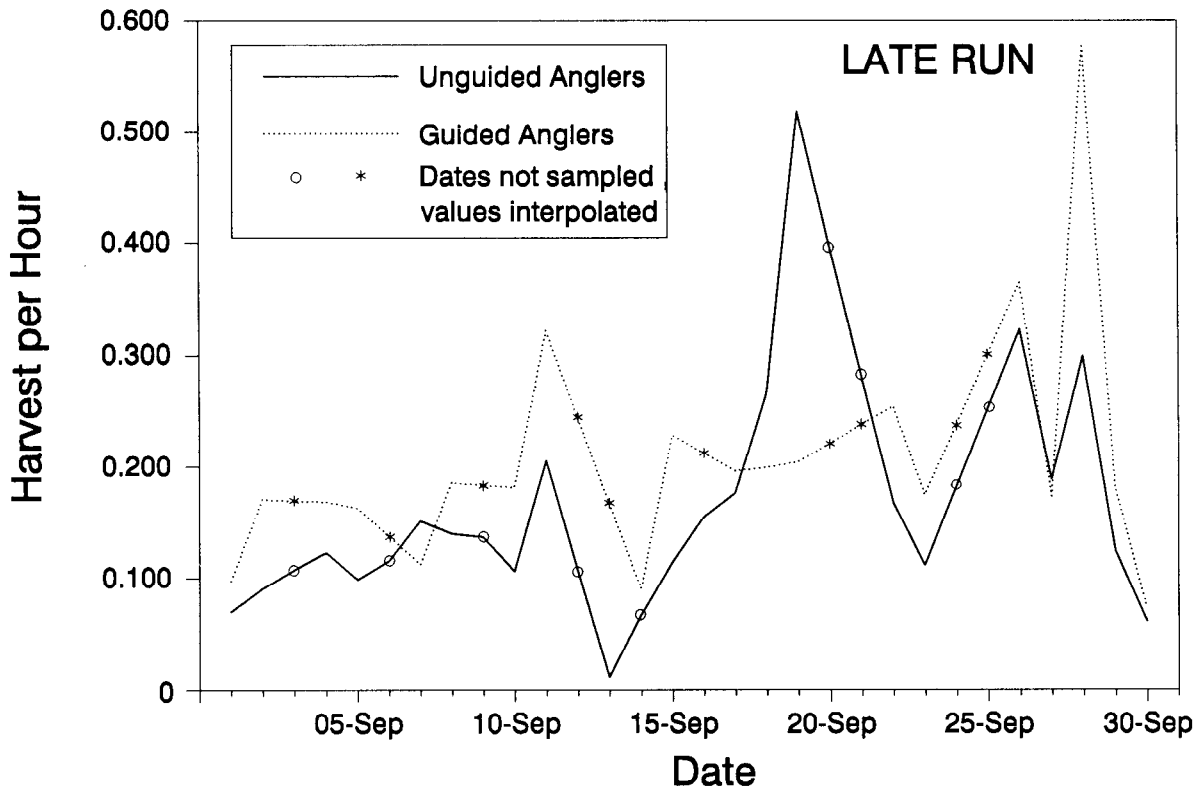
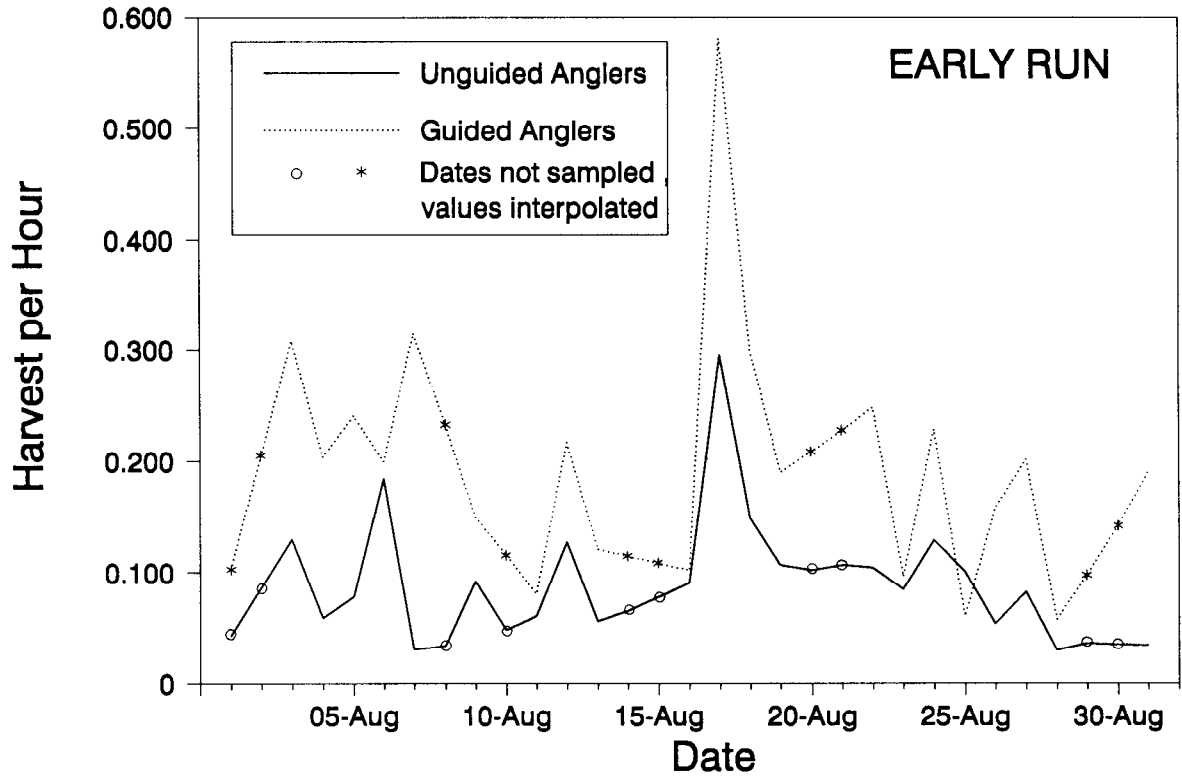


Figure 5. Daily harvest per hour of coho salmon by anglers in the recreational fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Table 21. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	<u>Sockeye Salmon</u>		<u>Pink Salmon</u>		<u>Rainbow Trout</u>		<u>Dolly Varden</u>	
	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE
<u>Early Run</u>								
Unguided weekdays (Standard Error)	0.0011 (0.0013)	0.0011 (0.0013)	0.1391 (0.0301)	0.4743 (0.0891)	0.0000 (0.0000)	0.0000 (0.0000)	0.0046 (0.0035)	0.0046 (0.0035)
Unguided weekends (Standard Error)	0.0013 (0.0010)	0.0013 (0.0010)	0.1581 (0.0280)	0.4324 (0.0547)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Guided weekdays (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.1173 (0.0262)	0.5425 (0.0857)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Guided weekends (Standard Error)	0.0019 (0.0029)	0.0019 (0.0029)	0.2138 (0.0338)	0.5056 (0.0608)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0019 (0.0026)
Shore weekdays (Standard Error)	0.0000 (0.0000)	0.0034 (0.0020)	0.1720 (0.0688)	0.5970 (0.2100)	0.0000 (0.0000)	0.0000 (0.0000)	0.0034 (0.0064)	0.0034 (0.0064)
Shore weekends (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0612 (0.0191)	0.2296 (0.0785)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)

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Table 21. (Page 2 of 2).

Component	<u>Sockeye Salmon</u>		<u>Pink Salmon</u>		<u>Rainbow Trout</u>		<u>Dolly Varden</u>	
	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE
<u>Late Run</u>								
Unguided weekdays (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0011 (0.0011)	0.0023 (0.0014)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Unguided weekends (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0058 (0.0019)	0.0686 (0.0152)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Guided weekdays (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0009 (0.0008)
Guided weekends (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0104 (0.0037)	0.1301 (0.0298)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Shore weekdays (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
Shore weekends (Standard Error)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)

Upstream Section. Daily harvest rates of coho salmon by unguided anglers ranged from 0.000 to 1.250 fish per hour during the early run and from 0.022 to 1.000 fish per hour during the late run (Appendix F4). Peak daily catch rates of coho salmon by unguided anglers occurred on 26 August during the early run and on 30 September during the late run. Daily harvest rates of coho salmon by guided anglers ranged from 0.000 to 0.500 fish per hour during the early run and from 0.000 to 0.667 fish per hour during the late run (Appendix F5). Peak daily catch rates of coho salmon by guided anglers occurred on 7 and 16 August during the early run and on 10 and 25 September during the late run. Daily harvest rates of coho salmon by shore anglers (both completed-trip and incompletd-trip) ranged from 0.000 to 0.056 fish per hour during the early run and from 0.000 to 1.143 fish per hour during the late run (Appendix F6). Peak daily catch rates of coho salmon by shore anglers occurred on 4 August during the early run and 14 September during the late run. Harvest and catch rates of coho salmon by guided anglers were generally greater than those for unguided anglers during both runs (Table 20).

In the upstream section, other species were more significant to the recreational harvest of both guided and unguided anglers than in the downstream section, as can be attested to by the comparatively larger harvest and catch rates, especially for sockeye salmon (Table 22).

Midstream Section. Harvest and catch rates for the midstream section were estimated by using the average downstream and upstream rates.

Harvest and Catch:

Harvest and catch of coho salmon by shore and boat anglers were estimated for each component in the downstream and upstream sections of the Kenai River. Estimated effort and catch rates for each component from Tables 14 and 19, respectively, were used to estimate harvest and catch in the downstream section. For the upstream section, estimated effort and catch rates for each component from Tables 16 and 20, respectively, were used to estimate harvest and catch.

Downstream Section. Effort, harvest, and catch were greatest during the early-run fishery (Tables 23, 24, and 25). Similar to the chinook salmon fisheries, most of the early-run effort, harvest, and catch occurred in the downstream fishery. Virtually all fish were harvested (2,311 harvest of 2,335 total catch or 99%).

Similar to the early-run fishery, most of the late-run effort, harvest, and catch occurred in the downstream fishery (Tables 23, 24, and 25). Also similar to the early-run fishery, virtually all the fish were harvested (24,041 harvest of 24,189 total catch or 99%).

The estimates of harvest and catch of species other than coho salmon for the downstream and upstream sections are summarized in Tables 26 and 27, respectively.

Table 22. Estimated harvest per unit effort (HPUE) and catch per unit effort (CPUE) of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Component	<u>Sockeye Salmon</u>		<u>Pink Salmon</u>		<u>Rainbow Trout</u>		<u>Dolly Varden</u>	
	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE
<u>Early Run</u>								
Unguided weekdays (Standard Error)	0.0773 (0.0203)	0.1447 (0.0288)	0.0182 (0.0083)	0.2602 (0.0881)	0.0018 (0.0012)	0.0146 (0.0054)	0.0446 (0.0145)	0.0910 (0.0334)
Unguided weekends (Standard Error)	0.0759 (0.0098)	0.1202 (0.0144)	0.0111 (0.0025)	0.1077 (0.0139)	0.0016 (0.0007)	0.0269 (0.0050)	0.0807 (0.0096)	0.2251 (0.0230)
Guided weekdays (Standard Error)	0.0751 (0.0618)	0.1399 (0.0613)	0.0285 (0.0120)	0.0829 (0.0290)	0.0000 (0.0000)	0.0181 (0.0119)	0.0000 (0.0000)	0.0052 (0.0035)
Guided weekends (Standard Error)	0.0586 (0.0203)	0.0937 (0.0356)	0.0527 (0.0138)	0.0966 (0.0179)	0.0059 (0.0078)	0.0059 (0.0078)	0.0146 (0.0051)	0.0293 (0.0078)
Shore weekdays (Standard Error)	0.2801 (0.0834)	0.2899 (0.0844)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0098 (0.0715)
Shore weekends (Standard Error)	0.2644 (0.0627)	0.3908 (0.0962)	0.0000 (0.0000)	0.0460 (0.0625)	0.0000 (0.0000)	0.0000 (0.0000)	0.0230 (0.0947)	0.0230 (0.0947)

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Table 22. (Page 2 of 2).

Component	<u>Sockeye Salmon</u>		<u>Pink Salmon</u>		<u>Rainbow Trout</u>		<u>Dolly Varden</u>	
	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE	HPUE	CPUE
<u>Late Run</u>								
Unguided weekdays	0.0000	0.0110	0.0011	0.0023	0.0000	0.0000	0.0000	0.0000
(Standard Error)	(0.0000)	(0.0082)	(0.0011)	(0.0014)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Unguided weekends	0.0000	0.0132	0.0058	0.0686	0.0000	0.0000	0.0000	0.0000
(Standard Error)	(0.0000)	(0.0042)	(0.0019)	(0.0152)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Guided weekdays	0.0000	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009
(Standard Error)	(0.0000)	(0.0042)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0008)
Guided weekends	0.0000	0.0642	0.0104	0.1301	0.0000	0.0000	0.0000	0.0000
(Standard Error)	(0.0000)	(0.0344)	(0.0037)	(0.0298)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Shore weekdays	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Standard Error)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Shore weekends	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(Standard Error)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 23. Estimated number of coho salmon harvested and number caught by anglers during each component of the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Component	Harvest ^a	Standard Error	Rel. Pre. ^b	Catch ^c	Standard Error	Rel. Pre. ^b
<u>Early Run</u>						
Unguided weekdays:	6,281	1,192	37.2 %	6,348	1,196	36.9%
Unguided weekends:	3,709	668	35.3 %	3,709	668	35.3%
Guided weekdays:	7,394	1,006	26.7 %	7,600	1,042	26.9%
Guided weekends:	2,291	461	39.4 %	2,316	464	39.3%
Shore weekdays:	4,699	1,140	47.6 %	4,699	1,140	47.6%
Shore weekends:	2,415	778	63.1 %	2,525	790	61.3%
<u>Sub-totals</u>						
Unguided:	9,990	1,366	26.8 %	10,057	1,370	26.7%
Guided:	9,685	1,107	22.4 %	9,916	1,141	22.5%
Shore:	7,114	1,380	38.0 %	7,224	1,387	37.6%
Early Run Total	26,789	2,235	16.4 %	27,197	2,259	16.3%
<u>Late Run</u>						
Unguided weekdays:	5,433	726	26.2 %	5,433	726	26.2%
Unguided weekends:	3,507	550	30.7 %	3,548	553	30.5%
Guided weekdays:	3,467	650	36.7 %	3,496	652	36.6%
Guided weekends:	1,450	229	31.0 %	1,450	229	31.0%
Shore weekdays:	1,319	860	127.8 %	1,319	860	127.8%
Shore weekends:	673	226	65.8 %	673	226	65.8%
<u>Sub-totals</u>						
Unguided:	8,940	911	20.0 %	8,981	913	19.9%
Guided:	4,917	689	27.5 %	4,946	691	27.4%
Shore:	1,992	889	87.5 %	1,992	889	87.5%
Late Run Total	15,849	1,447	17.9 %	15,919	1,450	17.8%

^a Harvest includes only fish kept.

^b Relative precision for 95% confidence interval.

^c Catch includes fish kept and fish reported as released.

Table 24. Estimated number of coho salmon harvested and number caught by anglers during each component of the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Component	Harvest ^a	Standard Error	Rel. Pre. ^b	Catch ^c	Standard Error	Rel. Pre. ^b
<u>Early Run</u>						
Unguided weekdays:	1,135	392	67.7%	1,208	392	63.6%
Unguided weekends:	663	114	33.7%	694	119	33.6%
Guided weekdays:	726	228	61.6%	741	232	61.4%
Guided weekends:	142	38	52.5%	142	38	52.5%
Shore weekdays:	0	0	%	0	0	%
Shore weekends:	127	115	177.5%	127	115	177.5%
<u>Sub-totals</u>						
Unguided:	1,798	408	44.5%	1,902	410	42.2%
Guided:	868	231	52.2%	883	235	52.2%
Shore:	127	115	177.5%	127	115	177.5%
Early Run Total	2,793	483	33.9%	2,912	486	32.7%
<u>Late Run</u>						
Unguided weekdays:	1,731	383	43.4%	1,778	379	41.8%
Unguided weekends:	3,550	610	33.7%	3,550	610	33.7%
Guided weekdays:	178	64	70.5%	191	66	67.7%
Guided weekends:	97	26	52.5%	103	52	99.0%
Shore weekdays:	291	151	101.7%	291	151	101.7%
Shore weekends:	144	43	58.5%	144	43	58.5%
<u>Sub-totals</u>						
Unguided:	5,281	720	26.7%	5,328	718	26.4%
Guided:	275	69	49.2%	294	84	56.0%
Shore:	435	157	70.7%	435	157	70.7%
Late Run Total	5,991	740	24.2%	6,057	740	23.9%

^a Harvest includes only fish kept.

^b Relative precision for 95% confidence interval.

^c Catch includes fish kept and fish reported as released.

Table 25. Summary of estimated angler effort, coho salmon harvest and coho salmon catch by all anglers for each river section of the fishery for coho salmon in the Kenai River, Alaska, 1990.

Run	Downstream Section	Midstream Section	Upstream Section	Total	95% Confidence Interval
<u>Early Run</u>					
Effort	216,074	23,735	28,512	268,321	252,317 - 284,325
SE	7,682	1,815	2,089	8,165	
Harvest	26,789	2,119	2,793	31,701	27,171 - 36,231
SE	2,235	336	483	2,311	
Catch	27,179	2,175	2,912	32,266	27,689 - 36,843
SE	2,259	338	486	2,335	
<u>Late Run</u>					
Effort	97,639	14,938	18,528	131,105	120,045 - 142,165
SE	5,338	1,138	1,432	5,643	
Harvest	15,849	2,201	5,991	24,041	20,709 - 27,373
SE	1,447	498	740	1,700	
Catch	15,919	2,213	6,057	24,189	20,852 - 27,526
SE	1,450	498	740	1,702	

Table 26. Estimated number of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by anglers during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Species	a Unguided Anglers				Guided Anglers				Total			
	Harvest ^b	SE ^c	Catch ^d	SE	Harvest ^b	SE ^c	Catch ^d	SE	Harvest ^b	SE ^c	Catch ^d	SE
<u>Early Run</u>												
Sockeye salmon	114	83	267	124	26	40	26	40	140	92	293	130
Pink salmon	23,192	3,866	75,732	11,543	7,583	1,206	28,455	3,786	30,775	4,050	104,187	12,148
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0	0
Dolly Varden	412	347	412	347	0	0	26	36	412	347	438	349
<u>Late Run</u>												
Sockeye salmon	0	0	0	0	0	0	0	0	0	0	0	0
Pink salmon	207	68	2,189	542	91	34	1,132	298	298	76	3,321	619
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0	0
Dolly Varden	0	0	0	0	0	0	14	12	0	0	14	12

a Includes all shore anglers.

b Harvest includes only fish kept.

c Standard error.

d Catch includes fish kept and fish reported as released.

Table 27. Estimated number of sockeye salmon, pink salmon, rainbow trout, and Dolly Varden harvested and caught by anglers during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Species	^a Unguided Anglers				Guided Anglers				Total			
	Harvest ^b	SE	Catch ^c	SE	Harvest ^b	SE	Catch ^c	SE	Harvest ^b	SE	Catch ^c	SE
<u>Early Run</u>												
Sockeye salmon	3,588	659	5,003	778	236	161	429	174	3,824	678	5,432	797
Pink Salmon	252	80	3,355	877	113	35	285	87	365	87	3,640	881
Rainbow trout	28	12	340	68	4	6	50	32	32	13	390	75
Dolly Varden	1,099	345	2,680	625	11	4	35	11	1,110	345	2,715	625
<u>Late Run</u>												
Sockeye salmon	0	0	186	63	0	0	54	27	0	0	240	69
Pink salmon	608	119	7,499	1,110	29	10	675	191	637	119	8,174	1,126
Rainbow trout	9	10	46	35	0	0	0	0	9	10	46	35
Dolly Varden	130	32	165	39	0	0	0	0	130	32	165	39

^a Includes all shore anglers.

^b Harvest includes only fish kept.

^c Catch includes fish kept and fish reported as released.

Biological Data:

The most abundant age groups in the early-run harvest were ages-2.1 and -3.1 coho salmon which composed 54.1% and 32.1% of the sample, respectively (Table 28). Ages-1.1 and -2.1 coho salmon were the most abundant age groups in the late-run harvest, contributing 18.2% and 66.8% of the sample, respectively (Table 28). The mean lengths at age for each sex were greater in late-run fish than in early-run fish for all age groups (Table 29).

RECOMMENDATIONS

I recommend the following changes to the sample design:

Chinook Salmon Fishery

Three spatial strata (downstream, midstream, and upstream) are unnecessary and should be simplified to two strata: downstream and upstream (combine the old midstream and upstream strata). The upstream fishery is significant for the early run and will be surveyed. However, the upstream fishery for the late run is insignificant, will not be surveyed, and will not be extrapolated for.

Coho Salmon Fishery

Spatial stratification should be conducted for the coho salmon fishery. The upstream fishery is significant for both runs and will be surveyed.

HPUE and CPUE will be estimated with completed-trip interviews only. As shown in 1990, the survey can be designed to collect sufficient completed-trip interviews. Elimination of incompleting-trip interviews eliminates a potential source of bias.

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I would like to express my gratitude to those individuals that assisted with data collection, compilation, and analysis. Gino Del Frate and Jeff Szarzi conducted the boat creel survey in the downstream section and took care of most of the mechanical problems. Carrie Wolfe and Michele Savoie conducted angler interviews at the selected launch facilities. Edward Weise conducted the creel survey in the midstream and upstream section. Dave Athons flew many of the aerial surveys as either pilot or observer. Larry Marsh provided most of the local data processing support, including programming and in-season repair to the Epson HX-20 field data recorders. I also thank the Research and Technical Service staff, especially Gary Fidler who provided microcomputer troubleshooting and Marianna Alexandersdottir who provided valuable technical assistance with survey design.

Table 28. Age composition of coho salmon sampled from the harvest during the early and late runs of the fishery for coho salmon in the Kenai River, Alaska, 1990.

Run	Sex		Age Group				Total
			1.1	2.1	3.1	Other	
<u>Early Run</u> (n=209) ^a	Male	Percent	7.6	23.0	15.7	1.5	47.7
	Female	Percent	4.3	31.1	16.3	0.5	52.2
	Combined	Percent	11.9	54.1	32.0	2.0	100.0
		SE	2.3	3.5	3.2	1.0	
Late run (n=214) ^a	Male	Percent	8.9	32.2	7.5	1.9	50.5
	Female	Percent	9.3	34.6	5.1	0.5	49.5
	Combined	Percent	18.2	66.8	12.6	2.4	100.0
		SE	2.7	3.2	2.3	1.0	

^a n = sample size.

Table 29. Mean length (millimeters) by age group of coho salmon sampled from the harvest during the early and late runs of the fishery for coho salmon in the Kenai River, Alaska, 1990.

Run	Sex		Age Group			
			1.1	2.1	3.1	Other
<u>Early Run</u>						
	Male	Mean Length	500	597	647	318
		Standard Error	18	5	4	11
		Sample size	16	48	32	3
	Female	Mean Length	539	593	629	
		Standard Error	7	4	5	
		Sample size	9	65	34	
<u>Late Run</u>						
	Male	Mean Length	586	652	679	526
		Standard Error	16	3	6	71
		Sample size	19	69	16	4
	Female	Mean Length	577	631	660	620
		Standard Error	9	5	8	
		Sample size	20	74	11	1

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APPENDIX A

Summarized data used to test the hypothesis of no difference in frequency of zero catch for completed-trip and incompleted-trip anglers interviewed during the recreational fishery for coho salmon in the Kenai River, Alaska, 1990.

Appendix A1. Results of comparison of completed- versus incompletd-trip interviews for coho salmon creel survey in the Kenai River, Alaska, 1990.

Fishery Component	Percent of Harvest	Interview Type		df	x ²	p-value	Percent of Anglers with 0 fish	
		Complete	Incomplete				Complete	Incomplete
Downstream:								
Early Boat Guided	19	142	229	3	24.4	<0.001	51	64
Early Boat Unguided	19	179	306	3	3.9	0.276	75	79
Early Shore	14	15	142	3	1.8	0.611	87	72
Late Boat Guided	10	111	337	3	22.2	<0.001	31	52
Late Boat Unguided	17	115	572	3	41.9	<0.001	50	66
Late Shore	4	4	92	3	5.6	0.062	25	73
Upstream:								
Early Boat Guided	2	70	106	3	15.1	0.002	49	57
Early Boat Unguided	3	345	594	3	48.4	<0.001	76	87
Early Shore	<1	28	100	2	1.5	0.476	96	97
Late Boat Guided	<1	73	167	3	50.3	<0.001	20	46
Late Boat Unguided	10	596	881	3	42.9	<0.001	69	76
Late Shore	1	19	41	3	11.2	0.011	53	83

APPENDIX B

Counts of boat anglers during the creel survey of the fishery
for chinook salmon in the Kenai River, Alaska, 1990.

Appendix B1. Counts of unguided and guided boat anglers during the fishery for early-run chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Date	Wd/ We	Unguided Anglers					Guided Anglers				
		Period					Period				
		A	B	C	D	E	A	B	C	D	E
05/17	Wd	10	12				7	17			
05/18	Wd			14					34		
05/19	We	0	66	54	34	14	0	69	70	36	0
05/20	We	0	74	68	38	0	0	77	45	42	0
05/21	Wd			CLOSED					CLOSED		
05/22	Wd		19					78			
05/23	Wd		25	38	27			59	50	9	
05/24	Wd	19		28	44	33	47		46	44	0
05/25	Wd	30				67	77				23
05/26	We	85		115	182	137	126		122	64	5
05/27	We	46	204	158	154	33	19	155	73	80	2
05/28	We	109	132	83	50	58	91	120	45	31	17
05/29	Wd			21	38	45			80	4	5
05/30	Wd	32	56				53	80			
05/31	Wd			46		8			54		4
06/01	Wd	37	36				92				
06/02	We	9	110	181	99	23	48	25			
06/03	We		145	188	134	63	118	100			
06/04	Wd			CLOSED					CLOSED		
06/05	Wd										
06/06	Wd	49				112	185	137			

-Continued-

Appendix B1. (Page 2 of 2).

Date	Wd/ We	Unguided Anglers					Guided Anglers				
		Period					Period				
		A	B	C	D	E	A	B	C	D	E
06/07	Wd ^a			2			23	14			
06/08	Wd ^a	12		10	12	9	20	36			
06/09	We ^a	23	38	52	45	2	16	24			
06/10	We ^a	2	28		23	15	60	38			
06/11	Wd			CLOSED					CLOSED		
06/12	Wd ^a	1				31	82	42			
06/13	Wd ^a	7	1	4			78	45			
06/14	Wd ^a		20				80	53			
06/15	Wd ^a			38		3	108	57			
06/16	We ^a	0	49	69	13	13	81	28			
06/17	We ^a	2	68	80	7	5	68	55			
06/18	Wd			CLOSED					CLOSED		
06/19	Wd ^a		41	50	25		150	121			
06/20	Wd ^a	16	25	35	24	39	115	86			
06/21	Wd ^a			29			108	66			
06/22	Wd ^a	0				69	115	70			
06/23	We ^a	23	41	85	87	59	98	96			
06/24	We ^a	54	68	83	60	25	84	53			
06/25	Wd			CLOSED					CLOSED		
06/26	Wd ^a		45	35			176	95			
06/27	Wd ^a	25	32		45	35	132	72			
06/28	Wd ^a	6		42			84	81			
06/29	Wd ^a			47	23	23	99	44			
06/30	We ^a	9	91	69	44	21	115	86			

^a Closed to the retention of chinook salmon; hook and release fishing only.

Appendix B2. Counts of unguided and guided boat anglers during the fishery for late-run chinook salmon in the downstream section of the Kenai River, Alaska, 1990.

Date	Wd/ We	Unguided Anglers					Guided Anglers	
		Period					Period	
		A	B	C	D	E	A	B
07/01	We	511	606	541	286	225	CLOSED TO GUIDES	
07/02	Wd	CLOSED					CLOSED	
07/03	Wd	242	373			288	430	232
07/04	We	75	276		255	16	296	164
07/05	Wd		175	234	274		203	184
07/06	Wd			207			276	201
07/07	We	300	255	375	360	313	365	208
07/08	We	234	368		278	243	CLOSED TO GUIDES	
07/09	Wd	CLOSED					CLOSED	
07/10	Wd				277	101	592	286
07/11	Wd	230		168			523	332
07/12	Wd	323					508	363
07/13	Wd	321	310	225	299	163	555	346
07/14	We	88	609	487	417	656	412	327
07/15	We	454	765	721	361	163	CLOSED TO GUIDES	
07/16	Wd	CLOSED					CLOSED	
07/17	Wd		425	455			443	483
07/18	Wd			445	371		427	443
07/19	Wd	493				426	558	394
07/20	Wd	526	346	331	433	152	494	147
07/21	We	715	577	550	692	531	506	342
07/22	We	549	747	595	426	463	CLOSED TO GUIDES	
07/23	Wd	CLOSED					CLOSED	
07/24	Wd	752		295	287	220	662	427
07/25	Wd				305			332
07/26	Wd		421	240			375	288
07/27	Wd ^a	152	177		130	192	312	124
07/28	We ^b	14	47	102	40	52	64	40
07/29	We ^b	11	45	76	32	23	CLOSED TO GUIDES	
07/30	Wd	CLOSED					CLOSED	
07/31	Wd ^b	35	41	51	22	15	80	30

^a Closed to the use of bait.

^b Closed to the retention of chinook salmon; hook and release fishing only.

Appendix B3. Counts of boats during the fishery for early-run chinook salmon in the midstream of the Kenai River, Alaska, 1990.

Date	Wd/ We	Boat Count Period		
		A	B	C
05/28	We	11		
05/29	Wd			
05/30	Wd		8	
05/31	Wd	3		
06/01	Wd		3	
06/02	We			5
06/03	We			
06/04	Wd	CLOSED	CLOSED	CLOSED
06/05	Wd		22	
06/06	Wd			(Weather)
06/07	Wd ^a	2		
06/08	Wd ^a		9	
06/09	We ^a			
06/10	We ^a			
06/11	Wd	CLOSED	CLOSED	CLOSED
06/12	Wd ^a	0	6	6
06/13	Wd ^a		2	
06/14	Wd ^a	5		
06/15	Wd ^a			
06/16	We ^a			(Weather)
06/17	We ^a			3
06/18	Wd	CLOSED	CLOSED	CLOSED
06/19	Wd ^a	22		
06/20	Wd ^a		12	
06/21	Wd ^a		19	
06/22	Wd ^a			
06/23	We ^a			
06/24	We ^a	11		
06/25	Wd	CLOSED	CLOSED	CLOSED
06/26	Wd ^a			1
06/27	Wd ^a			
06/28	Wd ^a			
06/29	Wd ^a	9		
06/30	We ^a		13	
07/01	We	41	24	13
07/02	Wd	CLOSED	CLOSED	CLOSED
07/03	Wd	57	33	
07/04	We			51
07/05	Wd		32	
07/06	Wd			
07/07	We	CLOSED	CLOSED	CLOSED
07/08	We	CLOSED	CLOSED	CLOSED
07/09	Wd	CLOSED	CLOSED	CLOSED
07/10	Wd	CLOSED	CLOSED	CLOSED
07/11	Wd	CLOSED	CLOSED	CLOSED
07/12	Wd	CLOSED	CLOSED	CLOSED
07/13	Wd	CLOSED	CLOSED	CLOSED
07/14	We	CLOSED	CLOSED	CLOSED
07/15	We	CLOSED	CLOSED	CLOSED

^a Closed to retention of chinook salmon; hook and release fishing only.

Appendix B4. Counts of boats during the fishery for late-run chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

Date	Wd/ We	Boat Count		
		A	B	C
07/16	Wd	CLOSED	CLOSED	CLOSED
07/17	Wd	80		
07/18	Wd			10
07/19	Wd			
07/20	Wd			
07/21	We	41	43	12
07/22	We		35	
07/23	Wd	CLOSED	CLOSED	CLOSED
07/24	Wd	48		
07/25	Wd			(Weather)
07/26	Wd	45	17	
07/27	Wd ^a			
07/28	We ^b			
07/29	We ^b		8	
07/30	Wd	CLOSED	CLOSED	CLOSED
07/31	Wd ^b		7	

^a Closed to the use of bait.

^b Closed to retention of chinook salmon; hook and release fishing only.

APPENDIX C

Daily summary statistics for fishing effort, harvest rate,
and catch rate for anglers interviewed during the fishery
for chinook salmon in the Kenai River, Alaska, 1990

Appendix C1. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by unguided anglers interviewed during the early run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).

Date	WD/ WE	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
517	Wd	9	5.4	0.47	0.00	0.000	0.000	0.00	0.000	0.000
518	Wd	4	2.5	0.29	0.00	0.000	0.000	0.00	0.000	0.000
519	We	39	3.6	0.29	0.00	0.000	0.000	0.00	0.000	0.000
520	We	12	2.5	0.26	0.00	0.000	0.000	0.00	0.000	0.000
523	Wd	15	3.2	0.34	0.00	0.000	0.000	0.00	0.000	0.000
524	Wd	13	8.3	0.50	0.08	0.077	0.009	0.08	0.077	0.009
525	Wd	3	4.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
526	We	46	2.7	0.19	0.00	0.000	0.000	0.00	0.000	0.000
527	We	49	3.4	0.19	0.06	0.035	0.018	0.06	0.035	0.018
528	We	40	3.4	0.22	0.00	0.000	0.000	0.03	0.025	0.007
529	Wd	8	4.6	1.01	0.13	0.125	0.027	0.13	0.125	0.027
530	Wd	16	3.3	0.14	0.00	0.000	0.000	0.00	0.000	0.000
531	Wd	7	2.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
601	Wd	5	1.3	0.12	0.20	0.200	0.154	0.20	0.200	0.154
602	We	31	2.9	0.30	0.06	0.045	0.022	0.16	0.067	0.056
603	We	38	4.7	0.52	0.05	0.037	0.011	0.08	0.044	0.017
606	Wd	38	3.3	0.46	0.00	0.000	0.000	0.00	0.000	0.000
608	Wd	2	0.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
609	We	19	2.5	0.34	0.00	0.000	0.000	0.11	0.072	0.042
610	We	15	2.7	0.44	0.00	0.000	0.000	0.07	0.067	0.024
612	Wd	10	3.7	0.27	0.00	0.000	0.000	0.10	0.100	0.027
614	Wd	13	2.7	0.18	0.00	0.000	0.000	0.00	0.000	0.000
615	Wd	5	1.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
616	We	6	4.0	0.89	0.00	0.000	0.000	0.00	0.000	0.000
617	We	16	2.6	0.27	0.00	0.000	0.000	0.31	0.198	0.122
619	Wd	9	3.7	0.32	0.00	0.000	0.000	0.22	0.147	0.061
620	Wd	7	5.7	1.39	0.00	0.000	0.000	0.14	0.143	0.025
621	Wd	19	2.9	0.28	0.00	0.000	0.000	0.37	0.114	0.128
622	Wd	8	3.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
623	We	19	3.4	0.28	0.00	0.000	0.000	0.00	0.000	0.000
624	We	31	4.1	0.43	0.00	0.000	0.000	0.19	0.072	0.047
626	Wd	15	3.3	0.39	0.00	0.000	0.000	0.20	0.107	0.060
627	Wd	12	3.6	0.48	0.00	0.000	0.000	0.08	0.083	0.023
628	Wd	4	1.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
629	Wd	10	3.4	0.33	0.00	0.000	0.000	0.10	0.100	0.030
630	We	12	4.9	0.83	0.00	0.000	0.000	0.00	0.000	0.000

a Sample size, number of anglers interviewed.

b Standard Error.

c Harvest per hour.

d Catch per hour.

Appendix C2. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by unguided anglers interviewed during the late run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).

Date	WD/ WE	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
701	We	101	4.8	0.29	0.10	0.030	0.021	0.12	0.032	0.025
703	Wd	32	3.8	0.31	0.13	0.059	0.033	0.13	0.059	0.033
704	We	56	3.8	0.26	0.04	0.025	0.009	0.04	0.025	0.009
705	Wd	2	3.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
706	Wd	23	2.3	0.27	0.09	0.060	0.037	0.13	0.072	0.056
707	We	81	3.8	0.23	0.01	0.012	0.003	0.04	0.021	0.010
708	We	129	3.2	0.13	0.02	0.013	0.007	0.04	0.017	0.012
710	Wd	57	4.2	0.31	0.02	0.018	0.004	0.04	0.025	0.008
711	Wd	23	3.7	0.24	0.00	0.000	0.000	0.04	0.043	0.012
712	Wd	92	3.7	0.17	0.04	0.021	0.012	0.13	0.047	0.035
713	Wd	27	5.6	0.61	0.07	0.051	0.013	0.11	0.062	0.020
714	We	110	4.2	0.18	0.04	0.018	0.009	0.08	0.032	0.020
715	We	135	3.8	0.15	0.10	0.026	0.027	0.10	0.026	0.027
717	Wd	46	3.5	0.24	0.11	0.046	0.031	0.28	0.102	0.081
718	Wd	101	3.3	0.20	0.06	0.024	0.018	0.07	0.025	0.021
719	Wd	59	4.1	0.26	0.07	0.033	0.017	0.07	0.033	0.017
720	Wd	65	4.5	0.33	0.02	0.015	0.003	0.05	0.026	0.010
721	We	115	3.8	0.18	0.01	0.009	0.002	0.03	0.015	0.007
722	We	138	4.0	0.14	0.09	0.024	0.022	0.11	0.027	0.027
724	Wd	83	3.5	0.14	0.12	0.036	0.034	0.13	0.037	0.037
725	Wd	132	4.9	0.22	0.06	0.021	0.012	0.08	0.023	0.015
726	Wd	82	3.9	0.14	0.02	0.017	0.006	0.02	0.017	0.006
727	Wd	42	4.5	0.43	0.07	0.040	0.016	0.07	0.040	0.016
728	We	16	3.3	0.42	0.00	0.000	0.000	0.00	0.000	0.000
729	We	13	3.3	0.56	0.00	0.000	0.000	0.00	0.000	0.000
731	Wd	12	2.5	0.18	0.00	0.000	0.000	0.00	0.000	0.000

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix C3. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by guided anglers interviewed during the early run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).

Date	WD/ WE	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
519	We	8	4.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
520	We	19	4.6	0.42	0.11	0.072	0.023	0.11	0.072	0.023
523	Wd	6	6.0	0.00	0.17	0.167	0.028	0.17	0.167	0.028
524	Wd	14	5.6	0.06	0.07	0.071	0.013	0.07	0.071	0.013
525	Wd	20	4.7	0.32	0.30	0.105	0.065	0.45	0.114	0.097
526	We	51	5.9	0.13	0.08	0.038	0.013	0.08	0.038	0.013
527	We	22	5.5	0.13	0.09	0.063	0.016	0.09	0.063	0.016
528	We	15	5.2	0.59	0.00	0.000	0.000	0.00	0.000	0.000
529	Wd	9	5.7	0.59	0.33	0.167	0.059	0.33	0.167	0.059
530	Wd	4	3.8	0.83	0.50	0.289	0.133	0.50	0.289	0.133
601	Wd	9	4.0	0.87	0.22	0.147	0.056	0.22	0.147	0.056
602	We	8	1.9	0.06	0.13	0.125	0.065	0.25	0.164	0.129
603	We	16	5.0	0.45	0.25	0.112	0.050	0.44	0.128	0.088
606	Wd	20	5.6	0.28	0.10	0.069	0.018	0.10	0.069	0.018
607	Wd	6	4.8	0.34	0.00	0.000	0.000	0.67	0.333	0.140
608	Wd	2	5.0	0.00	0.00	0.000	0.000	0.50	0.500	0.100
609	We	6	5.3	0.42	0.00	0.000	0.000	1.67	0.667	0.313
612	Wd	18	5.6	0.23	0.00	0.000	0.000	0.78	0.263	0.138
614	Wd	8	5.3	0.54	0.00	0.000	0.000	0.75	0.250	0.143
615	Wd	15	5.7	0.07	0.00	0.000	0.000	0.53	0.192	0.093
616	We	10	5.7	0.08	0.00	0.000	0.000	0.80	0.359	0.140
619	Wd	7	4.6	0.51	0.00	0.000	0.000	0.14	0.143	0.031
620	Wd	27	6.0	0.32	0.00	0.000	0.000	0.81	0.151	0.135
621	Wd	34	5.3	0.16	0.00	0.000	0.000	0.50	0.142	0.095
623	We	18	4.7	0.34	0.00	0.000	0.000	0.17	0.090	0.036
626	Wd	45	5.8	0.14	0.00	0.000	0.000	0.49	0.113	0.085
627	Wd	24	5.2	0.07	0.00	0.000	0.000	0.25	0.109	0.048
629	Wd	13	5.7	0.45	0.00	0.000	0.000	0.23	0.166	0.041

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix C4. Daily summary statistics for fishing effort, chinook salmon harvest, and chinook salmon catch by guided anglers interviewed during the late run of the fishery for chinook salmon in the downstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).

Date	WD/ WE	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
703	Wd	45	6.2	0.40	0.16	0.055	0.025	0.22	0.063	0.036
704	We	18	6.5	0.46	0.39	0.118	0.060	0.39	0.118	0.060
705	Wd	16	5.7	0.06	0.31	0.120	0.055	0.38	0.125	0.066
706	Wd	84	5.3	0.27	0.40	0.054	0.076	0.48	0.064	0.089
707	We	112	5.2	0.19	0.19	0.037	0.036	0.24	0.041	0.046
710	Wd	8	4.9	0.66	0.13	0.125	0.025	0.13	0.125	0.025
711	Wd	52	5.4	0.15	0.10	0.041	0.018	0.13	0.048	0.025
712	Wd	67	5.0	0.26	0.28	0.055	0.057	0.37	0.060	0.075
713	Wd	69	5.0	0.14	0.22	0.050	0.043	0.28	0.058	0.055
714	We	100	6.2	0.23	0.18	0.039	0.029	0.26	0.050	0.042
717	Wd	68	4.3	0.19	0.32	0.057	0.075	0.44	0.077	0.102
718	Wd	65	5.6	0.38	0.23	0.053	0.041	0.43	0.098	0.077
719	Wd	129	5.4	0.20	0.20	0.035	0.038	0.29	0.046	0.053
720	Wd	13	6.5	0.49	0.15	0.104	0.024	0.23	0.122	0.035
721	We	37	5.2	0.37	0.32	0.078	0.063	0.35	0.080	0.068
724	Wd	81	5.5	0.15	0.19	0.043	0.034	0.22	0.046	0.041
726	Wd	48	5.0	0.21	0.25	0.063	0.050	0.25	0.063	0.050
727	Wd	61	5.0	0.20	0.10	0.038	0.020	0.10	0.038	0.020
728	We	8	5.6	0.18	0.00	0.000	0.000	0.13	0.125	0.022
731	Wd	31	6.1	0.44	0.00	0.000	0.000	0.68	0.149	0.111

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix C5. Daily summary statistics for fishing effort by boat anglers during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

Date	Boats Sampled	Anglers per Boat		Number Counts	Boat Count		Daily Effort	
		Mean	Variance		Mean	Variance	Mean	Variance
531	1	3.00	0.000	1	3	0	162	0
601	1	3.00	0.000	1	3	0	162	0
605	2	2.50	0.250	1	22	0	990	39,204
607	2	3.50	0.250	1	2	0	126	324
612	1	3.00	0.000	3	4	4	216	11,664
619	2	2.50	0.250	1	22	0	990	39,204
620	2	2.50	0.250	1	12	0	540	11,664
621	3	4.00	0.000	1	19	0	1,368	0
624	1	4.00	0.000	1	11	0	792	0
626	6	2.83	0.028	1	1	0	51	9
630	2	2.50	0.250	1	13	0	585	13,689
701	7	3.29	0.367	3	26	66	1,538	304,589
703	19	2.58	0.025	2	45	144	2,089	325,689
704	4	3.50	0.083	1	51	0	3,213	70,227
705	6	3.33	0.311	1	32	0	1,920	103,219
717	12	2.83	0.058	1	80	0	4,080	120,436
718	6	2.83	0.028	1	10	0	510	900
721	8	2.38	0.033	3	32	100	1,368	193,386
722	11	3.09	0.063	1	35	0	1,947	24,924
724	5	3.00	0.300	1	48	0	2,592	223,949
726	6	1.83	0.094	2	31	196	1,023	236,853
729	7	4.00	0.381	1	8	0	576	7,899
731	6	3.83	0.761	1	7	0	483	12,083

Appendix C6. Daily summary statistics for fishing effort, chinook salmon harvest and chinook salmon catch by anglers interviewed during the fishery for chinook salmon in the midstream section of the Kenai River, Alaska, 1990.

Date	Estimated		SS ^d	HPUE ^a		Estimated		CPUE ^b		Estimated	
	Effort	SE ^c		Mean	SE	Harvest	SE	Mean	SE	Catch	SE
531	162	0	3	0.000	0.000	0	0	0.000	0.000	0	0
601	162	0	3	0.000	0.000	0	0	0.000	0.000	0	0
605	990	198	5	0.074	0.037	73	40	0.074	0.037	73	40
607	126	18	7	0.000	0.000	0	0	0.000	0.000	0	0
612	216	108	3	0.000	0.000	0	0	0.000	0.000	0	0
619	990	198	5	0.000	0.000	0	0	0.000	0.000	0	0
620	540	108	5	0.000	0.000	0	0	0.026	0.024	14	14
621	1,368	0	12	0.000	0.000	0	0	0.033	0.022	46	31
624	792	0	4	0.000	0.000	0	0	0.188	0.120	149	95
626	51	3	17	0.000	0.000	0	0	0.016	0.010	1	0
630	585	117	5	0.000	0.000	0	0	0.000	0.000	0	0
701	1,538	186	23	0.023	0.010	35	21	0.023	0.010	35	21
703	2,089	571	49	0.037	0.010	78	29	0.040	0.010	84	30
704	3,213	265	14	0.014	0.014	44	44	0.028	0.017	89	57
705	1,920	321	20	0.083	0.026	160	56	0.083	0.026	160	56
717	4,080	347	34	0.016	0.010	65	33	0.020	0.010	81	36
718	510	30	17	0.011	0.010	5	6	0.011	0.010	5	6
721	1,368	440	19	0.000	0.000	0	0	0.009	0.010	13	13
722	1,947	158	34	0.006	0.000	11	11	0.006	0.000	11	11
724	2,592	490	15	0.014	0.014	37	37	0.014	0.014	37	37
726	1,023	487	11	0.000	0.000	0	0	0.000	0.000	0	0
729	576	89	28	0.000	0.000	0	0	0.000	0.000	0	0
731	483	110	23	0.000	0.000	0	0	0.025	0.014	12	7

^a Harvest per hour

^b Catch per hour

^c Standard error

^d Sample size (anglers interviewed)

APPENDIX D

Multiple analysis of variance of boat angler counts
during the creel survey of the fishery for chinook salmon
in the Kenai River, Alaska, 1990

Appendix D1. Estimation of within-period variance for estimates of total effort during the recreational fishery for chinook salmon on the downstream section of the Kenai River, Alaska, 1990.

	Period A		Period B		Period C		Period D		Period E		Total
	Date	Count	Date	Count	Date	Count	Date	Count	Date	Count	
	5/20	0	5/23	25	6/26	35	5/24	44	6/03	63	
		0		25		35		47		37	
		9		26		27		40		21	
		23		33		41		48		18	
Mean count		8.0		27.3		34.5		44.8		34.8	
Variance		46.2		8.3		43.3		20.3		156.8	
Rel. Prec. (95% CI) ^a		83.2		10.4		18.7		9.9		35.3	
	6/22	0	6/01	26			5/28	52	6/23	69	
		12		24				55		59	
		12		41				50		50	
		29		36				56		24	
Mean count		13.3		31.8				53.3		50.5	
Variance		72.2		53.0				11.7		142.8	
Rel. Prec. (95% CI)		62.8		22.5				6.3		23.2	
			6/30	42					6/27	34	
				42						35	
				91						29	
				96						9	
Mean count				67.8						26.8	
Variance				404.3						72.8	
Rel. Prec. (95% CI)				29.1						31.3	
Mean 2nd stage variance		59.2		155.2		43.3		16.0		124.2	
Estimates for unguided weekdays 5/16 - 6/06											
Total effort		1,652		1,941		1,428		2,240		2,725	9,987
Single stage variance ^b		97,582		507,335		64,967		12,544		703,440	1,385,868
Two stage variance (est.) ^c		56,589		400,794		37,731		10,080		403,704	908,898
2nd stage component (est.)		828		2,173		607		224		1,738	5,570
Percent of total two stage		1.46		0.54		1.61		2.22		0.43	0.61

^a Relative Precision (95% Confidence Interval).

^b Variance estimated by existing method assuming one stage sample design, among counts.

^c Estimate of variance when design has two stages, among days and among counts within days.

APPENDIX E

Counts of anglers during the creel survey of the fishery
for coho salmon in the Kenai River, Alaska, 1990

Appendix E1. Counts of unguided and guided boat anglers and shore anglers during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990.

Date	Wd/ We	Unguided Anglers				Guided Anglers				Shore Anglers			
		Period				Period				Period			
		A	B	C	D	A	B	C	D	A	B	C	D
08/03	Wd	164			236	189			23	130			168
08/04	We		182		256		82		23		121		173
08/05	We	233		261		147		65		96		230	
08/06	Wd		126	106			198	54			112	124	
08/07	Wd	175	166			234	141			111	170		
08/09	Wd			144	162			85	23			164	214
08/11	We	490			431	191			29	195			290
08/12	We		601	325			256	104			191	179	
08/13	Wd		183	159			168	43			140	147	
08/16	Wd			219	106			119	32			204	67
08/17	Wd	147	210			177	231			79	129		
08/18	We	420	425			207	131			123	229		
08/19	We			213	143			57	24			243	171
08/22	Wd	136		175		113		102		62		199	
08/23	Wd			164	121			58	11			198	157
08/24	Wd	223	223			174	170			85	101		
08/25	We		436	321			194	68			147	162	
08/26	We	237			27	130			4	63			78
08/27	Wd	108		53		174		47		59		27	
08/28	Wd	71			68	80			3	46			71
08/31	Wd	149		135		133		69		74		71	
09/01	We		329	162			69	0			101	81	
09/02	We	329	407			129	55			123	134		
09/04	Wd		85	103			106				43	59	
09/05	Wd	160		79		135		40		46		48	
09/07	Wd	234	144			250	91			110	56		
09/08	We	371	166			179	61			80	86		
09/10	Wd	122		87		135		67		45		66	
09/11	Wd		150	71			93	17			55	38	
09/13	Wd	232				166				55			
09/15	We		384	420			121	70			109	112	
09/16	We	345		49		119		17		73		28	
09/17	Wd	115	75			62	34			32	47		
09/18	Wd		90	55			37	7			39	33	
09/19	Wd	121		37		28		11		23		22	
09/22	We	173	91			67	29			32	23		
09/23	We		214	105			64	23			25	38	
09/26	Wd	80		52		46		52		26		19	
09/27	Wd		60	56			32	14			19	16	
09/28	Wd	109	121			68	63			24	21		
09/29	We	235		140		79		6		33		35	
09/30	We		95				21				25		

Appendix E2. Counts of unguided and guided boat anglers and shore anglers during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990.

Date	Wd/ We	Unguided Anglers				Guided Anglers				Shore Anglers			
		Period				Period				Period			
		A	B	C	D	A	B	C	D	A	B	C	D
08/03	Wd		67				2				59		
08/04	We		109		29		0		0		67		56
08/05	We	17		64		6		2		55	83		
08/06	Wd		29	23			3	8			41	39	
08/07	Wd	10	50			4	13			32	64		
08/09	Wd			44	26			7	0			28	18
08/11	We		78		34		2		0		39		21
08/12	We		90	65			8	12			16	23	
08/13	Wd		36	27			7	2			4	3	
08/16	Wd			24	0			0	4			7	3
08/17	Wd	6	32			0	4			2	9		
08/18	We	65	104			9	4			10	18		
08/19	We			39	10			9	3			16	3
08/22	Wd			30				18				3	
08/23	Wd			25	12			15	0			9	3
08/24	Wd	24	51			23	28			1	7		
08/25	We		90	146			23	5			16	16	
08/26	We	55			10	10			0	1			3
08/27	Wd	19	19			7	7			1	4		
08/31	Wd	21		39		10		10			35		
09/01	We	97		138		16		0		14		18	
09/02	We		163	48			9	3			25	24	
09/04	Wd		33	18			18	0			2	1	
09/05	Wd	20		22		3		6		0		3	
09/07	Wd	30	31			0	0			1		3	
09/08	We	49	54			4	8			0	10		
09/09	We	48		17		14		0		7		3	
09/10	Wd	18		9		32		0		11		2	
09/11	Wd		26	5			5	0			0	0	
09/14	Wd	29	36			14	6			1	2		
09/15	We		106	58			8	5			6	9	
09/16	We	39		10		1		0		5		0	
09/17	Wd	31	25			10	0			0	0		
09/18	Wd		25	24			5	0			1	4	
09/22	We	41	31			6	6			0	6		
09/23	We		61	42			6	0			4	5	
09/24	Wd	28	33			5	4			0	5		
09/25	Wd		25	19			8	0			4	4	
09/26	Wd	37		30		5		2		2		0	
09/29	We		101	112			3	4			3	6	
09/30	We	119				9				2			

APPENDIX F

Daily summary statistics for fishing effort, harvest rate,
and catch rate for anglers interviewed during the fishery
for coho salmon in the Kenai River, Alaska, 1990

Appendix F1. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by unguided boat anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompletd-trip interviews).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
803	Wd	13	3.6	0.72	0.62	0.311	0.172	0.62	0.311	0.172
804	We	32	3.0	0.29	0.19	0.083	0.063	0.19	0.083	0.063
805	We	38	3.2	0.13	0.21	0.094	0.065	0.21	0.094	0.065
806	Wd	7	5.5	0.00	1.14	0.404	0.208	1.14	0.404	0.208
807	Wd	17	3.4	0.38	0.06	0.059	0.018	0.06	0.059	0.018
809	Wd	2	5.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
811	We	32	2.8	0.21	0.22	0.117	0.078	0.22	0.117	0.078
812	We	27	4.6	0.37	0.67	0.207	0.146	0.67	0.207	0.146
813	Wd	31	4.1	0.36	0.16	0.094	0.039	0.16	0.094	0.039
816	Wd	18	3.7	0.38	0.33	0.198	0.090	0.33	0.198	0.090
817	Wd	27	2.1	0.22	0.74	0.224	0.345	0.74	0.224	0.345
818	We	20	4.2	0.44	0.35	0.131	0.084	0.35	0.131	0.084
819	We	20	2.2	0.32	0.25	0.123	0.112	0.25	0.123	0.112
822	Wd	17	5.0	0.49	0.59	0.173	0.118	0.65	0.170	0.129
823	Wd	23	5.5	0.61	0.57	0.152	0.104	0.57	0.152	0.104
824	Wd	34	3.5	0.26	0.53	0.154	0.151	0.53	0.154	0.151
825	We	42	3.3	0.31	0.38	0.118	0.116	0.38	0.118	0.116
826	We	23	3.0	0.60	0.17	0.102	0.057	0.17	0.102	0.057
827	Wd	21	2.8	0.24	0.29	0.122	0.102	0.29	0.122	0.102
828	Wd	28	1.9	0.19	0.07	0.050	0.037	0.07	0.050	0.037
831	Wd	13	2.2	0.42	0.08	0.077	0.034	0.08	0.077	0.034

-Continued-

Appendix F1. (Page 2 of 2).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
901	We	76	4.8	0.35	0.37	0.086	0.076	0.39	0.092	0.082
902	We	85	2.9	0.18	0.28	0.074	0.096	0.28	0.074	0.096
904	Wd	21	2.3	0.44	0.29	0.140	0.125	0.29	0.140	0.125
905	Wd	14	3.1	0.61	0.21	0.114	0.070	0.21	0.114	0.070
907	Wd	27	4.5	0.35	0.70	0.158	0.155	0.70	0.158	0.155
908	We	27	4.4	0.39	0.67	0.177	0.153	0.67	0.177	0.153
910	Wd	22	4.2	0.41	0.55	0.194	0.131	0.55	0.194	0.131
911	Wd	30	4.4	0.41	0.93	0.191	0.211	0.93	0.191	0.211
913	Wd	3	2.0	0.50	0.00	0.000	0.000	0.00	0.000	0.000
915	We	51	4.8	0.33	0.63	0.079	0.132	0.63	0.079	0.132
916	We	37	2.8	0.20	0.43	0.137	0.155	0.43	0.137	0.155
917	Wd	27	4.0	0.39	0.63	0.152	0.158	0.63	0.152	0.158
918	Wd	19	4.7	0.66	0.79	0.196	0.168	0.79	0.196	0.168
919	Wd	31	3.1	0.18	1.65	0.183	0.528	1.65	0.183	0.528
922	We	25	2.3	0.32	0.40	0.115	0.175	0.40	0.115	0.175
923	We	43	3.6	0.32	0.44	0.107	0.123	0.44	0.107	0.123
926	Wd	26	2.0	0.26	0.73	0.219	0.362	0.73	0.219	0.362
927	Wd	8	2.4	0.63	0.50	0.267	0.211	0.50	0.267	0.211
928	Wd	27	2.6	0.22	0.89	0.209	0.336	0.89	0.209	0.336
929	We	54	3.2	0.34	0.43	0.094	0.135	0.43	0.094	0.135
930	We	34	2.8	0.35	0.18	0.066	0.062	0.18	0.066	0.062

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix F2. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by guided boat anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
803	Wd	12	1.6	0.25	0.50	0.261	0.308	0.50	0.261	0.308
804	We	11	6.2	0.25	1.27	0.407	0.204	1.27	0.407	0.204
805	We	10	2.9	0.21	0.70	0.367	0.241	0.70	0.367	0.241
806	Wd	4	5.0	0.00	1.00	0.577	0.200	1.00	0.577	0.200
807	Wd	8	5.6	0.27	1.75	0.491	0.315	1.88	0.441	0.337
809	Wd	17	7.5	1.06	1.12	0.331	0.150	1.12	0.331	0.150
811	We	27	3.2	0.17	0.26	0.137	0.081	0.30	0.149	0.092
812	We	17	6.2	0.11	1.35	0.363	0.217	1.35	0.363	0.217
813	Wd	26	7.7	0.41	0.92	0.241	0.121	1.04	0.251	0.136
816	Wd	23	5.6	0.48	0.57	0.234	0.102	0.57	0.234	0.102
817	Wd	17	2.5	0.26	1.47	0.333	0.581	1.59	0.384	0.628
818	We	15	4.9	0.22	1.47	0.336	0.301	1.47	0.336	0.301
819	We	3	3.5	0.00	0.67	0.667	0.190	0.67	0.667	0.190
822	Wd	20	5.5	0.17	1.35	0.244	0.248	1.35	0.244	0.248
823	Wd	10	6.2	0.76	0.60	0.306	0.097	0.60	0.306	0.097
824	Wd	20	3.3	0.06	0.75	0.204	0.229	0.75	0.204	0.229
825	We	20	5.7	0.16	0.35	0.182	0.061	0.35	0.182	0.061
826	We	22	2.3	0.05	0.36	0.124	0.158	0.36	0.124	0.158
827	Wd	43	5.0	0.27	1.00	0.176	0.202	1.00	0.176	0.202
828	Wd	15	2.3	0.07	0.13	0.133	0.058	0.13	0.133	0.058
831	Wd	31	3.0	0.42	0.58	0.145	0.190	0.58	0.145	0.190

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Appendix F2. (Page 2 of 2).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
901	We	15	6.8	0.60	0.67	0.287	0.098	0.67	0.287	0.098
902	We	43	5.0	0.25	0.86	0.181	0.171	0.86	0.181	0.171
904	Wd	24	3.7	0.40	0.63	0.179	0.169	0.63	0.179	0.169
905	Wd	38	4.0	0.32	0.66	0.132	0.163	0.66	0.132	0.163
907	Wd	25	6.4	0.32	0.72	0.169	0.113	0.76	0.166	0.119
908	We	31	5.0	0.29	0.94	0.196	0.186	0.94	0.196	0.186
910	Wd	27	6.5	0.26	1.19	0.185	0.182	1.19	0.185	0.182
911	Wd	16	8.2	0.46	2.63	0.155	0.322	2.63	0.155	0.322
915	We	15	5.9	0.56	0.53	0.215	0.091	0.53	0.215	0.091
916	We	29	3.8	0.34	0.86	0.170	0.229	0.86	0.170	0.229
917	Wd	22	5.3	0.39	1.05	0.167	0.197	1.09	0.185	0.205
918	Wd	12	7.5	0.26	1.50	0.289	0.200	1.50	0.289	0.200
919	Wd	13	3.4	0.30	0.69	0.237	0.205	0.69	0.237	0.205
922	We	14	3.6	0.57	0.93	0.195	0.255	0.93	0.195	0.255
923	We	22	5.7	0.46	1.00	0.197	0.175	1.00	0.197	0.175
926	Wd	35	3.1	0.11	1.11	0.227	0.364	1.11	0.227	0.364
927	Wd	9	3.8	1.04	0.67	0.333	0.174	0.67	0.333	0.174
928	Wd	22	2.2	0.32	1.27	0.239	0.577	1.27	0.239	0.577
929	We	26	2.8	0.17	0.50	0.127	0.181	0.50	0.127	0.181
930	We	10	4.1	0.69	0.30	0.153	0.074	0.30	0.153	0.074

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix F3. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by shore anglers interviewed during the fishery for coho salmon in the downstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
804	We	2	1.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
805	We	6	4.2	0.11	0.67	0.422	0.160	0.67	0.422	0.160
807	Wd	6	2.6	0.52	0.17	0.167	0.065	0.17	0.167	0.065
809	Wd	3	4.3	1.96	0.67	0.667	0.154	0.67	0.667	0.154
811	We	9	1.8	0.32	0.00	0.000	0.000	0.11	0.111	0.061
812	We	15	2.1	0.52	0.20	0.107	0.094	0.20	0.107	0.094
813	Wd	13	7.2	0.84	0.69	0.208	0.097	0.69	0.208	0.097
816	Wd	12	2.7	0.75	0.25	0.179	0.092	0.25	0.179	0.092
817	Wd	20	2.0	0.17	0.45	0.170	0.228	0.45	0.170	0.228
818	We	16	2.7	0.30	0.63	0.202	0.230	0.63	0.202	0.230
819	We	2	9.0	0.00	0.50	0.500	0.056	0.50	0.500	0.056
822	Wd	14	4.1	0.62	0.36	0.133	0.088	0.36	0.133	0.088
823	Wd	14	2.6	0.39	0.14	0.097	0.054	0.14	0.097	0.054
825	We	18	3.3	0.33	0.22	0.129	0.068	0.22	0.129	0.068
828	Wd	7	1.3	0.18	0.00	0.000	0.000	0.00	0.000	0.000
905	Wd	10	2.2	0.13	0.30	0.153	0.140	0.30	0.153	0.140
908	We	18	3.3	0.40	0.39	0.164	0.120	0.39	0.164	0.120
910	Wd	21	4.1	0.23	0.33	0.126	0.081	0.33	0.126	0.081
911	Wd	2	11.0	0.00	1.50	0.500	0.136	1.50	0.500	0.136
915	We	16	2.1	0.30	0.13	0.085	0.059	0.13	0.085	0.059
916	We	4	1.6	0.38	0.25	0.250	0.154	0.25	0.250	0.154
918	Wd	9	1.2	0.51	0.56	0.176	0.476	0.56	0.176	0.476
919	Wd	2	4.0	0.00	1.50	0.500	0.375	1.50	0.500	0.375
923	We	6	5.0	1.32	0.17	0.167	0.033	0.17	0.167	0.033
929	We	6	4.5	1.12	0.17	0.167	0.037	0.17	0.167	0.037

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix F4. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by unguided boat anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (completed-trip interview only).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
803	Wd	8	4.1	0.72	0.00	0.000	0.000	0.00	0.000	0.000
804	We	7	5.3	0.36	0.00	0.000	0.000	0.00	0.000	0.000
805	We	5	3.7	0.24	0.00	0.000	0.000	0.00	0.000	0.000
806	Wd	3	2.8	0.67	0.33	0.333	0.118	0.33	0.333	0.118
807	Wd	4	3.0	0.50	0.50	0.500	0.167	0.50	0.500	0.167
809	Wd	3	5.4	1.03	0.46	0.183	0.086	0.46	0.183	0.086
811	We	5	3.6	0.36	0.36	0.151	0.099	0.36	0.151	0.099
812	We	5	5.1	0.41	0.24	0.079	0.048	0.24	0.079	0.048
813	Wd	3	3.2	0.32	0.31	0.175	0.096	0.31	0.175	0.096
816	Wd	5	5.0	0.63	2.20	0.374	0.440	2.20	0.374	0.440
817	Wd	6	4.7	0.50	0.75	0.323	0.160	0.75	0.323	0.160
818	We	1	3.5	0.23	0.90	0.234	0.259	0.90	0.234	0.259
819	We	2	4.8	0.37	0.95	0.232	0.198	0.95	0.232	0.198
822	Wd	6	1.8	0.11	0.17	0.167	0.091	0.17	0.167	0.091
823	Wd	2	4.8	0.51	0.25	0.131	0.052	0.25	0.131	0.052
824	Wd	5	2.7	0.37	2.00	0.632	0.741	2.00	0.632	0.741
825	We	6	5.2	0.44	0.15	0.091	0.030	0.15	0.091	0.030
826	We	5	2.4	0.48	3.00	0.000	1.250	3.00	0.000	1.250
827	Wd	8	3.5	0.31	0.78	0.250	0.220	0.78	0.250	0.220
831	Wd	6	3.5	0.44	0.19	0.101	0.054	0.19	0.101	0.054

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Appendix F4. (Page 2 of 2).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
901	We	1	3.7	0.34	0.47	0.123	0.128	0.51	0.123	0.139
902	We	8	4.6	0.31	0.51	0.114	0.113	0.59	0.131	0.129
904	Wd	8	2.4	0.27	0.13	0.125	0.051	0.13	0.125	0.051
905	Wd	6	2.2	0.18	0.13	0.085	0.056	0.13	0.085	0.056
907	Wd	5	4.0	1.22	1.00	0.447	0.250	1.00	0.447	0.250
908	We	8	2.6	0.18	0.13	0.125	0.048	0.13	0.125	0.048
909	We	8	4.8	0.53	0.11	0.076	0.023	0.11	0.076	0.023
910	Wd	0	2.9	0.18	0.63	0.137	0.213	0.63	0.137	0.213
911	Wd	0	4.5	0.20	0.10	0.100	0.022	0.20	0.200	0.045
914	Wd	8	3.0	0.18	0.39	0.200	0.130	0.50	0.218	0.167
915	We	5	5.2	0.32	0.40	0.099	0.077	0.45	0.110	0.088
916	We	4	3.3	0.38	0.43	0.202	0.130	0.43	0.202	0.130
917	Wd	9	3.3	0.35	0.47	0.193	0.145	0.53	0.193	0.161
918	Wd	0	5.6	0.34	0.60	0.340	0.107	0.70	0.335	0.125
922	We	5	3.8	0.71	0.40	0.214	0.105	0.40	0.214	0.105
923	We	8	4.2	0.48	0.61	0.216	0.145	0.61	0.216	0.145
924	Wd	7	3.7	0.63	0.71	0.474	0.192	0.71	0.474	0.192
925	Wd	9	3.0	0.60	0.22	0.147	0.074	0.22	0.147	0.074
926	Wd	3	3.3	0.67	1.00	1.000	0.300	1.00	1.000	0.300
929	We	7	4.1	0.25	1.02	0.145	0.246	1.02	0.145	0.246
930	We	4	2.0	0.35	2.00	0.577	1.000	2.00	0.577	1.000

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix F5. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by guided boat anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (completed-trip interviews only).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
804	We	4	5.00	0.00	0.00	0.000	0.000	0.00	0.000	0.000
806	Wd	4	4.50	0.00	0.00	0.000	0.000	0.00	0.000	0.000
807	Wd	3	4.00	0.00	2.00	0.000	0.500	2.00	0.000	0.500
811	We	6	6.00	0.00	0.00	0.000	0.000	0.00	0.000	0.000
816	Wd	5	6.00	0.00	3.00	0.000	0.500	3.00	0.000	0.500
819	We	1	4.00	0.39	1.09	0.315	0.273	1.09	0.315	0.273
822	Wd	5	6.00	0.00	0.00	0.000	0.000	0.00	0.000	0.000
823	Wd	3	3.00	0.00	0.33	0.333	0.111	0.33	0.333	0.111
824	Wd	9	4.10	0.78	1.89	0.484	0.459	2.00	0.527	0.486
825	We	3	6.50	0.12	2.08	0.366	0.318	2.08	0.366	0.318
826	We	3	9.00	0.00	0.33	0.333	0.037	0.33	0.333	0.037
831	Wd	4	7.50	0.00	2.00	0.408	0.267	2.00	0.408	0.267
901	We	4	5.00	0.00	1.00	0.577	0.200	1.00	0.577	0.200
902	We	4	7.00	0.00	2.75	0.250	0.393	2.75	0.250	0.393
904	Wd	8	8.00	0.00	1.00	0.267	0.125	1.00	0.267	0.125
907	Wd	3	4.00	0.00	0.00	0.000	0.000	0.00	0.000	0.000
910	Wd	9	4.50	0.00	3.00	0.000	0.667	3.00	0.000	0.667
911	Wd	3	6.50	0.00	2.00	0.000	0.308	2.00	0.000	0.308
914	Wd	7	7.40	0.20	1.29	0.606	0.173	1.57	0.528	0.212
915	We	4	6.00	0.00	3.00	0.000	0.500	3.00	0.000	0.500
918	Wd	6	7.80	0.11	3.00	0.000	0.387	3.00	0.000	0.387
923	We	3	7.00	0.00	2.33	0.333	0.333	2.33	0.333	0.333
925	Wd	2	4.50	0.00	3.00	0.000	0.667	3.00	0.000	0.667
929	We	4	7.00	0.29	3.00	0.000	0.429	3.00	0.000	0.429

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.

Appendix F6. Daily summary statistics for fishing effort, coho salmon harvest, and coho salmon catch by shore anglers interviewed during the fishery for coho salmon in the upstream section of the Kenai River, Alaska, 1990 (both completed-trip and incompleted-trip interviews).

Date	Wd/ We	EFFORT (hrs)			HARVEST			CATCH		
		SS ^a	Mean	SE ^b	Mean	SE	HPUE ^c	Mean	SE	CPUE ^d
803	Wd	22	2.6	0.46	0.00	0.000	0.000	0.00	0.000	0.000
804	We	11	1.6	0.47	0.09	0.091	0.056	0.09	0.091	0.056
805	We	26	1.2	0.09	0.04	0.038	0.032	0.04	0.038	0.032
806	Wd	28	3.2	0.31	0.07	0.071	0.022	0.07	0.071	0.022
809	Wd	14	3.4	0.38	0.00	0.000	0.000	0.00	0.000	0.000
812	We	5	1.1	0.24	0.00	0.000	0.000	0.00	0.000	0.000
817	Wd	2	3.3	1.25	0.00	0.000	0.000	0.00	0.000	0.000
818	We	6	2.3	0.78	0.00	0.000	0.000	0.00	0.000	0.000
819	We	2	1.8	1.25	0.00	0.000	0.000	0.00	0.000	0.000
825	We	4	2.8	0.75	0.00	0.000	0.000	0.00	0.000	0.000
826	We	3	1.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
827	Wd	2	1.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
901	We	3	4.5	0.00	0.00	0.000	0.000	0.00	0.000	0.000
902	We	3	2.3	0.88	0.33	0.333	0.143	0.33	0.333	0.143
904	Wd	2	5.0	0.00	0.00	0.000	0.000	0.00	0.000	0.000
910	Wd	21	1.9	0.04	0.43	0.235	0.222	0.43	0.235	0.222
914	Wd	3	1.2	0.17	1.33	0.667	1.143	1.33	0.667	1.143
915	We	5	2.3	0.44	0.00	0.000	0.000	0.00	0.000	0.000
916	We	4	1.4	0.43	1.25	0.629	0.909	1.25	0.629	0.909
923	We	3	4.8	1.17	0.67	0.667	0.138	0.67	0.667	0.138
925	Wd	3	3.5	0.00	0.67	0.667	0.190	0.67	0.667	0.190
926	Wd	3	1.0	0.00	1.00	0.577	1.000	1.00	0.577	1.000
929	We	2	3.5	1.50	1.50	0.500	0.429	1.50	0.500	0.429

^a Sample size, number of anglers interviewed.

^b Standard Error.

^c Harvest per hour.

^d Catch per hour.