

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

MAT-SU COHO STUDIES

by

Robert W. Bentz, Jr.

ALASKA DEPARTMENT OF FISH AND GAME  
Don W. Collinsworth, Commissioner

DIVISION OF SPORT FISH  
E. Richard Logan, Director

## TABLE OF CONTENTS

Study:	S-32 COOK INLET COHO SALMON STUDIES	Page
Job:	S-32-6 Mat-Su Coho Studies by: Robert W. Bentz, Jr.	
Abstract . . . . .		150
Key Words . . . . .		151
Background . . . . .		151
Recommendations . . . . .		153
Objectives . . . . .		153
Techniques Used . . . . .		153
Creel Census Program . . . . .		153
Life History Studies . . . . .		156
Findings . . . . .		158
Creel Census Program . . . . .		158
Life History Studies . . . . .		165
Literature Cited . . . . .		171

## LIST OF TABLES AND FIGURES

Table	1. List of common names, scientific names and abbreviations . . . . .	154
Figure	1. Study area map of the Little Susitna River. . . . .	155
Table	2. Harvest and effort data of the Little Susitna River sport fishery for coho salmon in 1985 . . . . .	159
Table	3. Little Susitna River coho salmon harvest, effort and catch per unit effort, 1981-1985. . . . .	160
Table	4. Little Susitna River coho salmon fishing effort percentages by weekly period in 1985. . . . .	163
Table	5. Little Susitna River coho salmon harvest percentages and sex ratios by weekly period in 1985 . . . . .	164
Figure	2. Coho salmon harvest rates by weekly period at the three access sites of the Little Susitna River in 1985. . . . .	166
Table	6. Comparison of mid-eye to fork length and weight data of coho salmon harvested at the Burma Road and Parks Highway access sites of the Little Susitna River in 1985. . . . .	167
Table	7. Coho salmon peak escapement counts on the Little Susitna River, 1978-1985. . . . .	169

TABLE OF CONTENTS (CONT'D)

Page

Table 24. Early run Russian River sockeye salmon total returns and mean lengths by ocean-age of fish sampled, 1975-1985. . . . . 134

Table 25. Late run Russian River sockeye salmon total returns and mean lengths by ocean-age of fish sampled, 1975-1985. . . . . 135

Figure 5. Length frequency distributions of early and late run Russian River sockeye salmon sampled at Lower Russian Lake weir, 1985 . . . . . 137

Table 26. Estimated production from known escapements of early run Russian River sockeye salmon, 1963-1979 . . . . . 138

Table 27. Fecundity of early run Russian River sockeye salmon as determined by sampling at Lower Russian Lake weir, 1985. . . . . 139

Table 28. Fecundity of late run Russian River sockeye salmon as determined by sampling at Lower Russian Lake weir, 1985. . . . . 140

Table 29. Historical fecundity data collected at Lower Russian Lake weir during the early run Russian River sockeye salmon migration, 1973-1985 . . . . . 142

Table 30. Historical fecundity data collected at Lower Russian Lake weir during the late run Russian River sockeye salmon migration, 1973-1985 . . . . . 143

Table 31. Potential egg deposition from the early run sockeye salmon escapement in Upper Russian Creek and known adult returns produced from a given potential egg deposition, 1972-1985 . . . . . 144

Table 32. Climatological and hydrological observations by 5-day periods recorded at Lower Russian Lake weir, June 6 through September 13, 1985. . . . . 145

## RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish  
Investigations  
of Alaska

Project: F-10-1

Study: S-32 Study Title: COOK INLET COHO  
SALMON STUDIES

Job: S-32-6 Job Title: Mat-Su Coho Studies

Cooperator: Robert W. Bentz, Jr.

Period Covered: July 1, 1985 to June 30, 1986

## ABSTRACT

A coho salmon, *Oncorhynchus kisutch* (Walbaum), creel census was conducted at three access sites on the Little Susitna River. An estimated 4,586 coho salmon were harvested in 13,104 angler-days of effort. The coho salmon per hour harvest rate for the entire river was 0.09 and ranged from 0.22 coho per hour for boat anglers, who crossed Knik Arm to fish in the lower river, to 0.004 coho per hour for shore anglers at the upper river fishery. Angling effort at the lower river fishery has increased 666 percent, from 933 angler-days in 1981 to 7,142 in 1985, making it the fastest growing segment of the coho sport fishery. This rapid growth is a direct result of improvements over the past 3 years to the road that accesses this portion of river. Fishing effort is expected to continue to increase substantially as additional improvements are completed. Coho spawning escapement was estimated by helicopter and foot surveys at 4,500 fish. The total in-river return was estimated at 9,086 coho.

Two tagging programs utilizing spaghetti tags and low frequency radio transmitters were conducted in the lower river to monitor migration movements. Eighty-seven percent of the radio-tagged coho salmon migrated upstream to known spawning areas. The average migration rate was 2.0 miles per day, and the maximal migration rate was 7.0 miles per day.

Coho salmon just re-entering fresh water are undergoing osmoregulatory stress and may be unable to survive the additional stress associated with radio-tagging procedures. Capture and tagging techniques during this period should be designed to minimize handling stress.

## KEY WORDS

Southcentral Alaska, coho, sport fishery, creel census, management, escapement, life history, radio telemetry.

## BACKGROUND

Coho salmon stocks of the northern Cook Inlet area experienced declines to very low levels in the early 1970's. An intense commercial fishery harvest in Cook Inlet and possible habitat degradation or loss are probable factors associated with these declines. Since coho salmon run timing through the commercial fishery in Cook Inlet coincides with that of all other species except chinook salmon, it is difficult to specifically manage coho salmon by manipulation of the mixed stocked commercial fishery.

Management techniques have been conducted primarily through regulation of the sport fisheries. Various techniques that are used include protection of known spawning areas, restriction to weekend-only fishing, regulation of methods and means, and emergency closures when runs appear below average. As a result of these stringent regulations and more favorable environmental conditions, the northern Cook Inlet coho salmon populations began to increase substantially in 1975.

As the northern Cook Inlet coho stocks increased, the sport fishing effort and harvest in numerous freshwater streams of the Matanuska-Susitna Valley also increased. Data from an annual publication of sport fishing effort and harvest by area (Mills 1979-1985) indicate fishing effort has increased 53% from 1977 through 1984 within the Knik Arm and eastside Susitna River areas; while coho salmon harvest estimates over the same period have increased over 270%.

There are approximately 25 streams within these areas that presently support a sport fishery for coho salmon. The most important stream within these areas and probably within the entire northern Cook Inlet area is the Little Susitna River. According to Mills (1979-1985), the Little Susitna is the second largest producer of freshwater caught coho salmon in the state. Only the Kenai River has a larger coho harvest. The Little Susitna provides an exceptional opportunity to harvest coho in an aesthetically pleasing manner, and the waterway's physical features will accommodate substantial recreational use without excessive congestion. More than 70 miles of river are available to fishing by boat. Little Susitna coho are among the largest in northern Cook Inlet and are therefore highly prized by sport anglers. A detailed description of the river and the existing coho sport fishery was presented by Bentz (1983).

Mills (1979-1985) shows total angling effort on the Little Susitna has increased 339% over 8 years: from 11,063 angler-days in 1977 to 48,517 angler-days in 1984. During 1983 the Little Susitna sustained the second highest fishing effort occurring in fresh water in the state, surpassed only by the Kenai River. Most of this increased effort is a

direct result of improvements during the past 3 years to the road that accesses the lower river. Substantial increases in fishing effort are expected to continue as access road improvements are completed and other support facilities such as campgrounds and boat launch sites are constructed. Coho salmon harvest estimates have also risen dramatically: from 3,415 in 1977 to 14,253 in 1984, a 317% increase.

The importance of the Little Susitna River and its potential for recreation and fishing opportunities were acknowledged by the Alaska Department of Natural Resources (1982) when they included and granted it special protective status. These land-use guidelines emphasize retention of all public lands within the Little Susitna corridor, with fish and wildlife recreation as the primary land uses.

The value placed on this system as a high quality productive sport fishery is reflected by Alaska Department of Fish and Game (1981a); this publication lists a coho salmon stock enhancement program on the Little Susitna as the number one priority. In response to this priority, the Fisheries Rehabilitation, Enhancement, and Development (F.R.E.D.) Division began a brood stock enhancement and egg-take program in 1981. Over 4.1 million eggs have been collected from Little Susitna River coho from 1981 through 1985. Coho fingerling resulting from these egg-takes have been released into five connecting lake systems since 1982. Coho smolts have also been released since 1985. The first significant adult returns from this stocking program are anticipated in 1986, when over 2,100 hatchery reared adult coho salmon are expected to enter the Little Susitna River.

A statistically designed coho salmon creel census was initiated in 1981 and expanded during 1982 to determine harvest and effort estimates for this rapidly expanding fishery. This expanded census program has continued through 1985. In addition to the creel census program, a life history study was initiated in 1982 to identify various aspects of the Little Susitna coho salmon adult population, including run timing, movement through the sport fishery, migration rates, important holding areas, and distribution and magnitude of spawning.

To accomplish these objectives, the study was divided into three segments, which included two capture-and-release tagging programs conducted simultaneously, beginning in mid-July.

Adult coho salmon were captured in the lower river where sport fishing effort began. A portion of these fish were tagged with a numbered spaghetti tag and released. Run timing and migration rate estimates were determined by recapture of these fish in the upstream sport fishery, and the fish monitored by the three creel census programs.

A second group of adult coho salmon were tagged with a numbered spaghetti tag and a low frequency radio transmitter prior to release. Upstream migration of these radio-tagged fish was monitored with radio receivers. Rates of migration through the sport fishery were determined and spawning areas identified.

The third segment of this coho life history study involved escapement surveys at major spawning areas to enumerate the spawning population. Recovery of radio-tagged fish was also conducted to examine tagging effects on the fish and determine if they had spawned successfully.

Table 1 lists all species mentioned in this report and Figure 1 is a map of the study area.

#### RECOMMENDATIONS

1. The coho salmon creel census should be continued at the Ship Creek, Burma Road, and Parks Highway access sites to determine angler effort and coho harvest.
2. A full-river weir should be constructed to achieve a total enumeration of coho salmon migrating past the weir. Escapement counts by helicopter and foot surveys should be continued to compare with the total enumeration at the weir.
3. A study should be initiated to estimate the hook and release mortality of adult coho salmon in the lower river.
4. The number of hatchery-reared adult coho salmon returning to the Little Susitna River should be estimated by inspection of sport harvested fish by census personnel and by inspection of coho migrating past the weir.
5. Various biological characteristics (including sex ratio, length and age composition) of adult coho salmon harvested by the sport fishery should be compared with coho salmon migrating past the weir.

#### OBJECTIVES

1. To determine sport fishing effort for and harvest of coho salmon in the Little Susitna River from mid-July through early September.
2. To determine run timing, distribution and peak escapement levels of coho salmon in the Little Susitna River from July through late September.

#### TECHNIQUES USED

##### Creel Census Program

The Little Susitna coho salmon creel census program was statistically designed to estimate harvest and effort. Since the area open to coho salmon fishing in the Little Susitna River encompasses 70 river miles,

Table 1. List of Common Names, Scientific Names and Abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Chum salmon	<i>Oncorhynchus keta</i> (Walbaum)	CS
Coho salmon	<i>Oncorhynchus kisutch</i> (Walbaum)	SS
Pink salmon	<i>Oncorhynchus gorbuscha</i> (Walbaum)	PS
Sockeye salmon	<i>Oncorhynchus nerka</i> (Walbaum)	RS

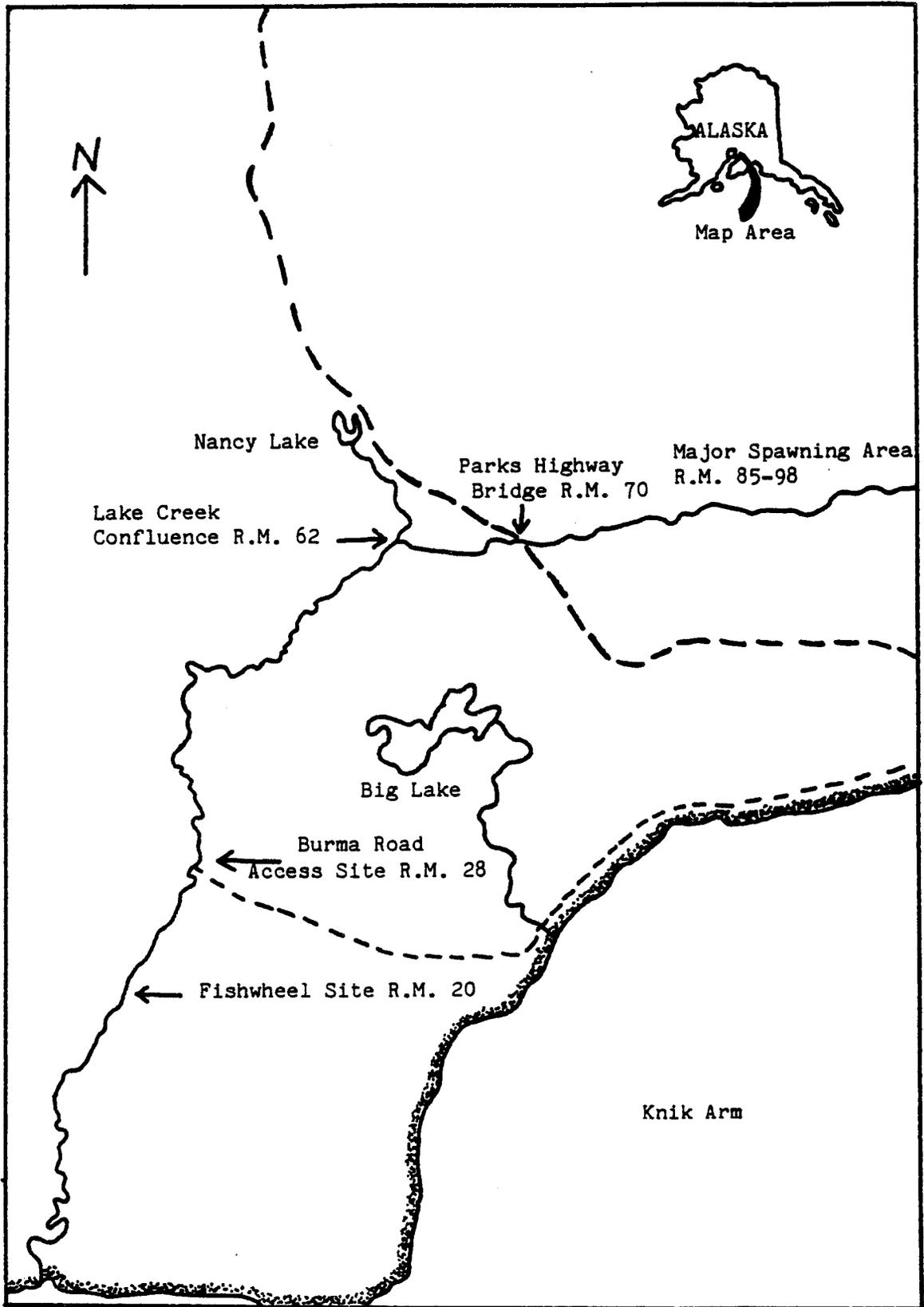


Figure 1. Study area map of the Little Susitna River.

it was necessary to conduct a creel census at both major access points, which are 42 river miles apart. These access points are referred to throughout this report as the Burma Road and Parks Highway, and they provide access to the lower and upper river fishing areas, respectively. A third census was conducted at the Ship Creek boat launch site in Anchorage to interview anglers that boated across the marine waters of Knik Arm and fished in the lower river, 4 to 12 miles below the Burma Road access site. Catch and effort estimates were calculated separately for each access point and then summed.

The census at the Ship Creek access site was conducted from July 13 through August 15. Boat travel to and from Ship Creek is restricted to the two daily periods of high tide because of extreme tidal fluctuations in Knik Arm. The sampling day was divided into two 4-hour sample periods. Each sample period began 2 hours prior to the time of high slack tide and continued until 2 hours past this point. Both high tide periods were sampled each weekend day, and three randomly selected periods were sampled during weekdays of each week.

The census at the Burma Road access site was conducted from July 13 through September 2. The sampling day was divided into four 4-hour periods between the hours of 6:00 a.m. and 10:00 p.m. All four periods were sampled during each weekend day and holiday. Two randomly selected periods were sampled each weekday. Angler counts were conducted five times weekly to enumerate shore anglers that did not enter or exit the fishery through the census interview site. The harvest rate of interviewed shore anglers was applied to these anglers to estimate harvest.

The census at the Parks Highway access site was conducted from July 27 through September 6 at three locations. The sampling day was identical to that used at the Burma Road site. Ten randomly selected periods were sampled during weekdays of each week, while four periods were sampled on each weekend day and holiday. Randomly scheduled angler counts were conducted during sampling periods within areas that received the greatest fishing intensity.

Only completed anglers were interviewed at the three access sites. Information collected from anglers included total number of hours fished; number, species and sex of fish caught; number and species of fish caught and released, time to harvest one, two or three coho salmon; whether they were boat or shore anglers; if artificial lures or bait was used; and if boat anglers traveled in a private or charter boat. All coho salmon observed during census periods at the Burma Road and Parks Highway were weighed to the nearest 0.1 pound and measured from tip of snout to fork-of-tail and from mid-eye to fork. Both measurements were recorded to the nearest 0.5 cm.

#### Life History Studies

An aluminum fishwheel was utilized to secure adult coho salmon for the capture and release tagging program. The fishwheel design was similar to fishwheels used on the Susitna River to capture adult salmon (ADF&G 1981b). Each of the two baskets had an average length, width

and depth of 6.0, 5.0 and 2.3 ft, respectively. The fishwheel was equipped with an adjustable axle that allowed the baskets and paddles to be raised or lowered according to fluctuations in water depth.

The fishwheel was located 8 miles below the Burma Road access site at river mile (R.M.) 20. Fishwheel operations began on July 26 and continued through August 28. Captured coho were removed from the fishwheel holding tank with a landing net. While immobilized in the net, the sex was determined and, just below and posterior to the dorsal fin, a numbered Floy-4 spaghetti tag was inserted with a hollow needle through the skin. The tag was secured against the back of the fish by a tightly drawn overhand knot. The fish were returned to the water immediately after tagging and held lightly by the caudal peduncle while recovering.

Coho salmon tagged with both a numbered spaghetti tag and a low frequency radio transmitter were captured at R.M. 20 by fishwheel or hook and line from July 31 through August 23.

The externally attached radio transmitters utilized were Model RM625s produced by Advanced Telemetry Systems, Inc., of Bethel, Minnesota. The encapsulated transmitters were 28 mm long, 12 mm wide and 10 mm thick and weighed approximately 4.3 g when submerged in water. An external antenna 24 cm long was attached to the transmitters. The transmitters were set over 15 separate channels; each channel had two different pulse rates, which allowed a total of 30 unique signals. A mercury battery with a 45- or 90-day life expectancy, depending on pulse rate, powered the transmitters.

The radio-receiver equipment utilized was produced by Smith-Root, Inc., of Vancouver, Washington and consisted of automatic scanning receivers that monitored 15 frequency channels simultaneously and manual tracking receivers and data loggers that automatically recorded the date, time and frequency of a radio-tagged coho as it passed the logger. Various loop and paddle antennas were used with these receivers.

Captured coho salmon that were to receive both a spaghetti tag and radio transmitter were removed from the holding tank with a landing net and placed in an 80-quart capacity ice cooler containing a solution of fresh river water and the anesthetic methanesulfonate (MS-222). While the fish was anesthetized in the cooler, a snout-to-fork measurement was taken, sex determined and spaghetti tag attached. When the coho exhibited a loss of equilibrium and could no longer right itself, it was held upright in the cooler, and the radio transmitter was attached with two Peterson disc pins through the interneural rays just below the dorsal fin. The fish were immediately placed into a recovery tank in the river. The tank's upstream panel had been removed, and the fish were held lightly by the caudal peduncle while recovering; they were released and allowed to swim out of the recovery tank on their own accord.

Coho salmon caught by hook and line were captured at the fishwheel site. After each fish was landed and the hook removed, they were placed immediately into the fishwheel holding tank. Tagging procedures for

Migrational movements were monitored using radio receivers from July 31 through October 10. Tracking in the lower river (R.M. 20-35) was conducted daily by boat to determine upstream movement. Low level flights were also conducted twice weekly to track coho as the fish distributed themselves throughout the river. Two automatic data loggers were operated continuously during the tracking period, and printout tapes were checked daily to identify passage of radio-tagged coho. One data logger was located approximately 1 mile below the fishwheel tagging site (R.M. 19) to record radio-tagged coho moving downstream after release. The other data logger was located 9 miles above the fishwheel (R.M. 29) to monitor upstream migration.

Little Susitna River coho salmon spawning populations were enumerated within established index areas on October 1 by foot and helicopter surveys for comparative counts. Coho salmon carcasses were examined for spaghetti tags and/or radio transmitters by foot survey personnel. Additional tag recovery surveys were conducted during egg-take operations in mid-October.

## FINDINGS

### Creel Census Program

The total coho salmon sport harvest at the Little Susitna River in 1985 was estimated at 4,586 fish with 13,104 angler-days of effort (Table 2). Harvest per hour and angler-day averaged 0.09 and 0.35 fish, respectively. The 1985 coho harvest dropped 68% from the 1984 harvest of 14,308 (Bentz 1985), while the total effort in 1985 decreased 31% from 18,955 angler-days estimated during the 1984 census (Table 3). The 1985 harvest estimate is the second lowest and the coho harvest per angler-day is the lowest recorded since 1981, when coho salmon harvest levels were first estimated through the creel census program.

Sixty percent of all anglers that fished in the Little Susitna River utilized artificial lures. These anglers harvested 22% of all coho taken by the sport fishery. Anglers that used salmon eggs as bait comprised 40% of the total effort and caught 78% of all coho salmon harvested in 1985.

Anglers that launched from Ship Creek in Anchorage and boated across Knik Arm during high tides to fish in the lower river harvested 1,166 coho salmon during 1,175 angler-days, representing 25% and 9% of the entire river's respective harvest and effort totals. Coho harvests per hour and angler-day were 0.16 and 0.99 fish, respectively; these were the highest harvest rates achieved by any group of anglers on the Little Susitna in 1985. The Ship Creek harvest and effort estimates decreased 74% and 37%, respectively from 1984 estimates (Bentz 1985). Anglers that used salmon eggs accounted for over 99% of all the effort and coho harvested by Ship Creek anglers. The lower river fishery, composed of Burma Road and Ship Creek anglers, caught 4,090 coho salmon (89% of the total river's harvest) during 8,317 angler-days, representing 63% of the total river's effort.

Table 2. Harvest and Effort Data of the Little Susitna River Sport Fishery for Coho Salmon in 1985.

	Burma Road				Ship Creek*		Parks Highway				TOTAL
	Shore		Boat		WD	WE	Shore		Boat		
	WD**	WE	WD	WE			WD	WE	WD	WE	
Harvest	452	259	1329	884	723	443	13	13	176	294	4586
Effort Angler-Days 13,104		2183	1618	1671	1670	569	606	1527	1200	1087	973
$\bar{x}$ Hours Fished	3.24	3.39	4.78	5.05	5.76	6.34	1.95	1.94	3.82	3.44	3.73
Fish/Hour	0.06	0.05	0.17	0.11	0.22	0.12	.004	.006	0.07	0.05	0.09
Fish/Angler-Day	0.21	0.16	0.80	0.53	1.27	0.73	0.01	0.01	0.27	0.18	0.35

\* Anglers from Anchorage that boated across Knik Arm during high tide to fish in the lower portion of the river.

\*\* WD = Weekday  
WE = Weekend

Table 3. Little Susitna River Coho Salmon Harvest, Effort and Catch Per Unit Effort, 1981-1985.

	Year	Burma Road Anglers*	Ship Creek Anglers	Parks Highway Anglers*	Total Anglers
Harvest	1981	1,379	3,100	743	5,222
	1982	2,580	1,817	2,911	7,308
	1983	1,598	1,031	336	2,965
	1984	8,575	4,545	1,188	14,308
	1985	2,924	1,166	496	4,586
Effort Angler-Days	1981	993	1,673	1,714	4,380
	1982	2,262	1,087	5,317	8,666
	1983	3,639	1,148	2,933	7,720
	1984	10,344	1,874	6,737	18,955
	1985	7,142	1,175	4,787	13,104
$\bar{x}$ Hours Fished	1981	4.5	4.8	2.6	4.3
	1982	4.1	4.8	3.6	4.0
	1983	4.4	6.2	3.0	4.1
	1984	4.0	4.8	3.0	3.7
	1985	4.1	6.1	2.7	3.7
Fish/Hour	1981	0.31	0.38	0.17	0.31
	1982	0.28	0.35	0.15	0.21
	1983	0.10	0.15	0.04	0.09
	1984	0.21	0.51	0.06	0.20
	1985	0.10	0.16	0.04	0.09
Fish/ Angler-Day	1981	1.39	1.85	0.43	1.19
	1982	1.14	1.67	0.55	0.84
	1983	0.44	0.90	0.11	0.38
	1984	0.83	2.43	0.18	0.75
	1985	0.41	0.99	0.10	0.35

\* Includes both shore and boat anglers.

Burma Road and Ship Creek anglers, caught 4,090 coho salmon (89% of the total river's harvest) during 8,317 angler-days, representing 63% of the total river's effort.

Anglers at the Burma Road access site harvested 2,924 coho salmon during 7,142 angler-days, representing 64% and 54% of the river's total harvest and effort, respectively. The 1985 harvest and effort estimates decreased 66% and 31%, respectively, from 1984 estimates. Coho salmon harvests per hour and angler-day were 0.10 and 0.41 fish, respectively. Of the total effort and harvest expended in the Burma Road area, shore anglers fished 3,801 days and harvested 711 coho salmon. Coho harvests per hour and angler-day were 0.06 and 0.19 fish, respectively. Sixty-nine percent of the shore anglers used artificial lures, harvesting 36% of all the coho salmon taken by shore anglers at the Burma Road. Shore anglers using salmon eggs as bait comprised 31% of the effort and caught 64% of the coho salmon.

Boat anglers harvested 2,213 coho in 3,341 angler-days at a harvest rate of 0.14 and 0.66 coho per hour and angler-day, respectively. Included in these estimates are anglers that boated from the Parks Highway, which is 42 river miles above the Burma Road. These anglers caught 149 coho (3.3% of the river's total harvest) during 436 angler-days, which is 3.3% of the total effort. Coho harvests per hour and angler-day were 0.13 and 0.34 fish, respectively. Fishing effort has increased 118% from 200 angler-days estimated in 1982 (Bentz 1983) for these anglers. Sixty-eight percent of these anglers floated in canoes or inflatable rafts without motors and achieved harvest rates of 0.14 and 0.41 coho per hour and angler-day, respectively. The remaining 32% of these anglers utilized boats powered by an outboard motor. Coho harvest rates per hour and angler-day for motorized anglers were 0.08 and 0.20 fish, respectively.

Artificial lures were utilized by 36% of all Burma Road boat anglers. These anglers harvested 28% of all coho taken. Salmon eggs were used by 64% of these boat anglers, and they caught 72% of all coho salmon harvested by Burma Road boat anglers.

Parks Highway anglers harvested 496 coho with 4,787 angler-days of effort. These figures represent 11% and 37% of the respective harvest and effort totals for the entire river. The harvest rates per hour and angler-day were 0.04 and 0.10 coho, respectively. Harvest and effort estimates decreased 58% and 29%, respectively, from 1984 estimates. Shore anglers harvested 26 coho in 2,727 angler-days: a harvest rate of 0.005 fish per hour. Boat anglers harvested 470 coho in 2,060 angler-days: a harvest rate of 0.06 fish per hour. Anglers that chartered comprised 35% of the total Parks Highway boat fishing effort, a decrease of 15% over the percentage of chartered anglers estimated in 1984 (Bentz 1985). These anglers were usually transported to a downstream fishing area, dropped off, and picked up again later in the day, although charter operators would sometimes remain with their clients and guide them to different areas. Chartered anglers harvested 56% of all coho taken by boat anglers in the upper river. Chartered boat anglers experienced coho harvest rates of 0.10 and 0.51 fish per hour and angler-day, respectively. Anglers transported in private boats

accounted for 75% of all boat fishing effort but caught only 44% of the coho harvested by upper river boat anglers. Their coho harvest rates per hour and angler-day were 0.04 and 0.13 fish, respectively, which are much lower than the harvest rates achieved by chartered anglers.

Although most anglers in the upper river used artificial lures to fish for coho salmon, the majority of fish were caught by anglers using salmon eggs as bait. Twenty percent of all boat anglers used salmon eggs and accounted for 70% of all coho harvested by boat anglers. Eighty-six percent of all shore anglers used artificial lures but harvested only 33% of the coho salmon caught by anglers fishing from shore.

Total fishing effort for coho salmon on the Little Susitna River has increased from 4,380 angler-days in 1981 (Bentz 1982) to 13,104 angler-days in 1985 (199%). During this period, effort at the Burma Road has increased from 993 to 7,142 angler-days (619%), making this the fastest growing segment of the coho salmon sport fishery on the entire river (Table 3).

While fishing effort has steadily increased at the Burma Road, coho salmon catch per unit effort (expressed as harvest per angler-day) has decreased substantially. Anglers experienced a steady decrease in catch rates from 1.19 coho per angler-day in 1981 to 0.35 in 1985. Although the harvest per day increased to 0.75 in 1984, when the Little Susitna River attained a record in-river return of coho salmon, it did not reach the harvest rates achieved in 1981 and 1982 (Table 3). The lower catch per unit effort in 1985 can probably be attributed to increased angling pressure, boat traffic, and general disturbances that usually alarm fish confined in a small stream such as the Little Susitna.

Weekly fishing effort in 1985 is presented in Table 4 for Ship Creek, Burma Road, and Parks Highway anglers. Peak effort by Ship Creek and Burma Road anglers occurred during the week of July 27 - August 2, the third week of these two lower river censuses. The highest fishing effort by Ship Creek anglers in 1985 occurred 1 week later than the peak in 1984 (Bentz 1985).

Peak fishing effort by Burma Road anglers occurred during the same weekly period in 1984 and 1985. The period of highest fishing effort by lower river anglers corresponds with the highest weekly coho salmon catch rates recorded during the creel census. Angling effort at the Parks Highway reached its apex during the second week of the upper river census on August 3-9, which was 1 week later than the peak week in 1984 (Bentz 1985). High angling effort early in the season at the Parks Highway was caused by large numbers of sockeye salmon concentrated at the Lake Creek confluence. Very few coho were available in the upper river area at that time.

Weekly harvest and sex ratios are presented in Table 5. The peak harvest for Ship Creek and Burma Road anglers occurred during the third week of the lower river census. Peak harvest at the Parks Highway occurred during August 24-30, 4 weeks later than the peak harvest in the lower river. This is the same time difference observed between peak

Table 4. Little Susitna River Coho Salmon Fishing Effort Percentages by Weekly Period in 1985.

	7/13-7/19	7/20-7/26	7/27-8/2	8/3-8/9	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/6	Total
Burma Road Anglers*	441	986	2,650	1,872	602	236	250	105	7,142
%	6.2	13.8	37.1	26.2	8.4	3.3	3.5	1.5	100.0
Ship Creek Anglers	113	263	416	379	4	0	0	0	1,175
%	9.6	22.4	35.4	32.3	0.3	0	0	0	100.0
Parks Highway Anglers*	No Census Conducted	No Census Conducted	922	1,650	898	470	453	394	4,787
%	...	...	19.3	34.5	18.7	9.7	9.5	8.3	100.0
Total Anglers	554	1,249	3,988	3,901	1,504	706	703	499	13,104
%	4.2	9.5	30.4	29.8	11.5	5.4	5.4	3.8	100.0

\* Includes both boat and shore anglers.

Table 5. Little Susitna River Coho Salmon Harvest Percentages and Sex Ratios by Weekly Period in 1985.

	7/13-7/19	7/20-7/26	7/27-8/02	8/03-8/09	8/10-8/16	8/17-8/23	8/24-8/30	8/31-9/06	Total
Burma Road Harvest*	41	488	1,416	584	184	82	102	27	2,924
Z	1.4	16.7	48.4	20.0	6.3	2.8	3.5	0.9	100.0
Sex Ratio Male : Female	1.11:1.0	0.70:1.0	0.97:1.0	1.05:1.0	1.88:1.0	1.52:1.0	1.28:1.0	0.64:1.0	1.01:1.0
Ship Creek Harvest**	46	232	656	230	2	0	0	0	1,166
Z	4.0	19.9	56.3	19.7	0.1	0	0	0	100.0
Parks Highway Harvest*	No Census Conducted	No Census Conducted	9	49	55	26	222	135	496
Z	...	...	1.7	9.9	11.1	5.2	44.8	27.3	100.0
Sex Ratio Male : Female	...	...	...	...	2.00:1.0	...	0.36:1.0	1.40:1.0	0.95:1.0
Total Harvest	87	720	2,081	863	241	108	324	162	4,586
Z	1.9	15.7	45.4	18.8	5.3	2.4	7.1	3.5	100.0
Sex Ratio Male : Female	1.11:1.0	0.70:1.0	0.97:1.0	1.05:1.0	1.89:1.0	1.52:1.0	1.02:1.0	0.87:1.0	1.01:1.0

\* Includes both boat and shore anglers.

\*\* Biological data not collected for coho caught by Ship Creek anglers.

harvest periods at the two fisheries in 1984 (Bentz 1985). Peak harvest periods between the lower and upper river differed by only 2 weeks in 1982 and 1983 (Bentz 1983, 1984).

Figure 2 provides a comparison of coho salmon harvest rates by weekly periods for Ship Creek, Burma Road and Parks Highway anglers during 1985.

The Ship Creek harvest rate increased during the first 3 weeks of the census to 1.58 coho per angler-day and then declined during the next 2 weeks to 0.50 coho per angler-day. The Burma Road harvest rate rose during the first 3 weeks of the census to 0.53 coho per angler-day and then declined during the next 2 weeks before rising to 0.41 coho per angler-day during the seventh week. A very similar bimodal curve in harvest rates also occurred in 1983 and 1984 (Bentz 1984, 1985); reasons for this are unclear at this time. Harvest rates at the Parks Highway were also similar in pattern to 1983 and 1984. Coho harvest rates increased from 0.01 coho per angler-day during the first week of census to a peak of 0.49 coho in the fifth week.

The male-to-female sex ratio of coho salmon harvested by anglers at the Burma Road was 1.01:1.0 and 0.95:1.0 at the Parks Highway. The combined sex ratio of all coho harvested in 1985 was 1.01:1.0. Weekly sex ratios at the Burma Road have followed a similar pattern the last 4 years. During the beginning of the census the harvest is predominately female coho. As the season progresses, a gradual shift to a male dominant harvest occurs.

A comparison of mid-eye to fork length and weight data of coho salmon harvested at the Burma Road and Parks Highway in 1985 is presented in Table 6.

#### Life History Studies

Escapement surveys during previous years have revealed that the majority of coho spawning in the Little Susitna River occurs from Edgerton Parks Bridge (R.M. 98) downstream to the Shrock Road bridge (R.M. 85). Limited spawning occurs from R.M. 85 downstream to the Lake Creek confluence at R.M. 62 (Figure 1). The peak spawning period usually occurs within the last 10 days of September through the first 10 days of October.

To determine peak spawning time, preliminary spawning counts were conducted by foot surveys throughout mid-September 1985. Based on these preliminary surveys, extensive escapement counts were conducted on October 1 by foot and helicopter. Helicopter surveys were conducted from the Hatcher Pass Roadhouse (R.M. 105) to the Lake Creek confluence (R.M. 62). A total of 3,540 coho were enumerated within this 43-mile section of river. Foot surveys were conducted from R.M. 98 to R.M. 85; a total of 2,093 coho were observed. The highest spawning concentrations were between R.M. 93 and R.M. 88; 376 coho per river mile were observed.

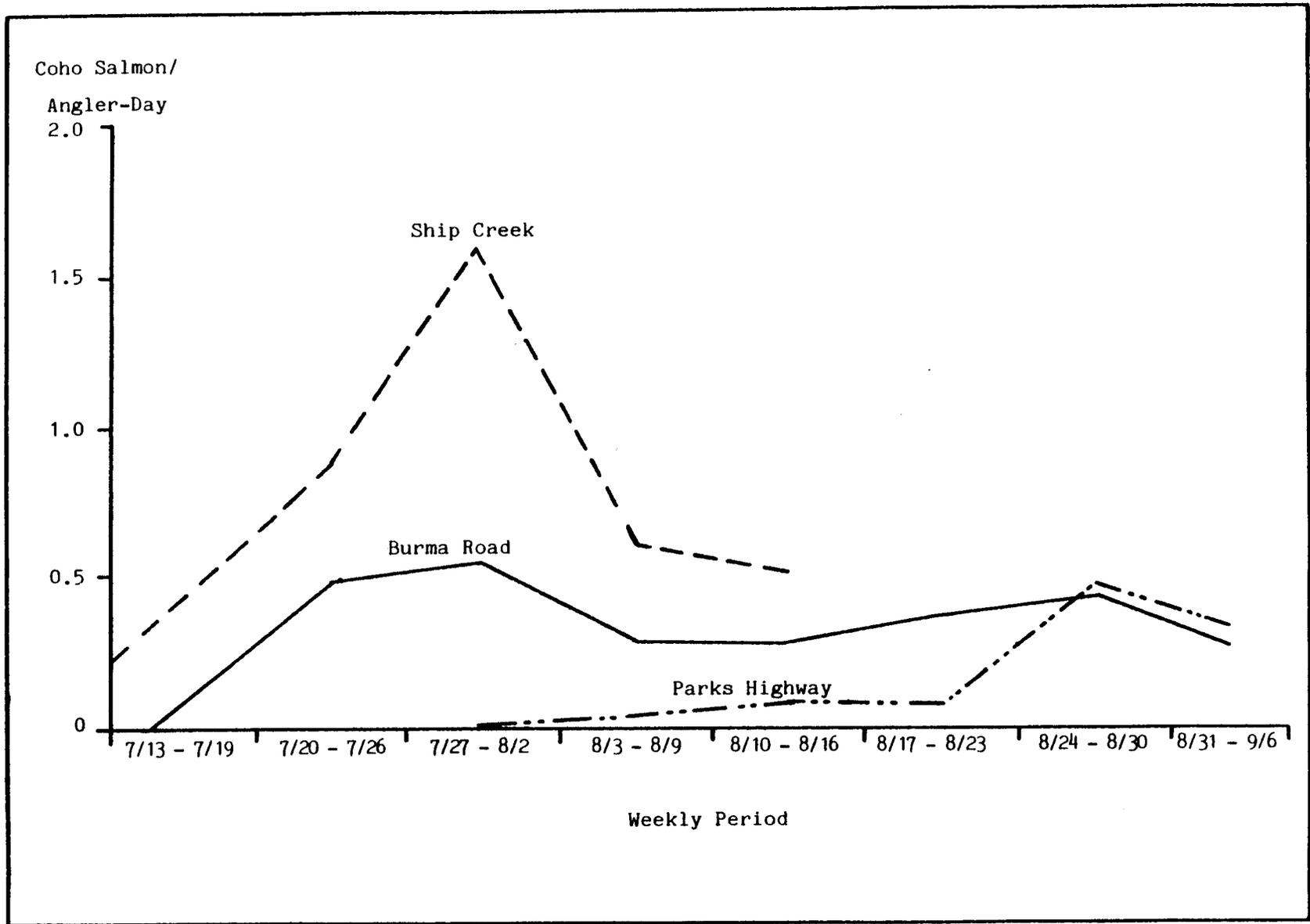


Figure 2. Coho salmon harvest rates by weekly period at the three access sites of the Little Susitna River in 1985.

Table 6. Comparison of Mid-Eye to Fork Length and Weight Data of Coho Salmon Harvested at the Burma Road and Parks Highway Access Sites of the Little Susitna River in 1985.

<u>Location</u>	<u>Length (cm)</u>				<u>Weight (lb)</u>			
	<u>n</u>	<u>x</u>	<u>- SD</u>	<u>Range</u>	<u>n</u>	<u>x</u>	<u>- SD</u>	<u>Range</u>
Burma Road	168	58.45	4.91	42.0-69.0	91	8.53	2.13	3.0-14.0
Parks Highway	47	59.64	5.40	42.5-66.5	34	8.18	2.80	2.0-12.0
Burma Road and Parks Highway Combined	215	58.71	5.03	42.0-69.0	125	8.44	2.32	2.0-14.0

Helicopter counts were higher than foot counts in one of the two established index areas where both helicopter and foot surveys were conducted and lower than foot counts in the other index area. Similar results were obtained in 1984, when comparative escapement surveys were conducted within four index areas (Bentz 1985). No trends or expansion ratios between the two types of surveys could be determined. The total number of coho salmon enumerated by both survey types was considered minimal. Based on the experience of survey personnel who have conducted the escapement counts since 1978, the number of spawning coho salmon was estimated to be 4,500 (Table 7). The total coho salmon return to the Little Susitna River in 1985 was estimated at 9,086 fish; the sport fishery harvested 4,586 of these fish, or 50% of the in-river return.

Adult coho salmon were captured at the fishwheel site located at R.M. 20 from July 24 through August 18. A total of 22 coho were spaghetti tagged and released during this period. All coho were captured in the fishwheel. Peak capture rates occurred during the third week of the creel census (July 27-August 2) when 15 coho were tagged. A total of 169 sockeye, 40 chum and 10 pink salmon were also captured, tagged and released.

None of the tagged coho were recaptured in the sport fishery. Seventeen tagged sockeye salmon were recaptured by anglers at the Lake Creek confluence (R.M. 62). The time from release to recapture ranged from 5 to 26 days and averaged 15 days.

Coho salmon used in the radio telemetry study were captured at the fishwheel site from July 31 through August 23. A total of 30 coho were tagged with both a spaghetti tag and an externally attached low frequency radio transmitter and released. Fourteen coho were captured in the fishwheel and 16 coho were captured by hook and line. Peak capture rates occurred during the fifth and sixth weeks of the creel census (August 10-23) when 26 coho were radio-tagged.

It was assumed that coho that reached the Lake Creek confluence (R.M. 62) or beyond exhibited behavior like that of untagged coho. The confluence area is the most downstream area where coho salmon spawning of any magnitude has been observed. Coho that did not reach this lower end of the spawning area were assumed to be exhibiting abnormal behavior.

Twenty-six of the 30 coho salmon (87%) radio-tagged and released at R.M. 20 reached the Lake Creek confluence. Twenty-four of these coho (80%) migrated past the Parks Highway bridge (R.M. 70), and 12 coho (40%) reached the main spawning area that begins at R.M. 85. Average upstream migration rates of the 26 coho reaching R.M. 62 ranged from 0.8 to 3.1 miles per day: a mean rate of 2.0 miles per day. Maximal upstream migration rates ranged from 3.0 to 12.0 miles per day and averaged 7.0 miles per day. These migration rates are similar to the 1982 and 1984 radio-tagged coho salmon that reached R.M. 62: a 1.8 mi average (4.8 mi maximum) and 2.2 mile average (4.9 mile maximum), respectively (Bentz 1983, 1985).

Table 7. Coho Salmon Peak Escapement Counts on the Little Susitna River, 1978-1985.

Year	Escapement Counts
1978	6,156
1979	*
1980	*
1981	6,750
1982	6,800
1983	2,666
1984	20,990
1985	4,500

\* Surveys were not conducted because of persistent high water and poor counting conditions during the coho spawning period.

Four of the coho salmon radio-tagged and released at R.M. 20 did not reach the Lake Creek confluence at R.M. 62. Initially, two of these fish were captured in the fishwheel, and two were captured by hook and line. One radio-tagged coho moved downstream immediately after release, remained there throughout the study, and was presumed dead. One fish migrated 13 miles upstream in 4 days after release. Upstream movement then ceased, and the fish moved downstream past the release site and was recorded on the data logger located at R.M. 19. The fish remained below the data logger for the duration of the tracking period and was presumed dead. Another radio-tagged coho migrated 4.25 miles upstream in 11 days and ceased all movement; the transmitter location remained constant for the duration of the study. The fish was presumed dead. The remaining radio-tagged coho migrated upstream to R.M. 59.5 in 27 days. The radio signal was not located again during the study. This fish may have continued its upstream migration, but the final destination could not be determined because of supposed transmitter failure.

The behavior and migration patterns of radio-tagged coho salmon captured in the fishwheel and by hook and line were very similar. Eighty-six, 79 and 29 percent of the 14 radio-tagged coho captured in the fishwheel reached R.M. 62, 70 and 85, respectively. The average migration rate of these fish was 2.2 miles per day, and the maximal migration rate was 7.2 miles per day. Eighty-eight, 81 and 50 percent of the 16 radio-tagged coho captured by hook and line reached R.M. 62, 70 and 85, respectively. These fish averaged 1.9 miles per day, and their maximal migration rate was 6.8 miles per day.

Eight radio-tagged coho salmon were recovered on the spawning grounds from R.M. 85-93.25 by escapement survey and coho egg-take personnel. Two of these fish were found as carcasses; the sex gametes were absent from the peritoneal cavity and these fish were presumed to have spawned successfully. One radio-tagged coho was captured that exhibited external postspawning characteristics. The sexual products were absent from the peritoneal cavity, and it was presumed this fish had also spawned. The remaining five radio-tagged coho were captured prior to spawning. These fish were sexually mature and were found interspersed with other sexually mature coho in areas where spawning activity was occurring.

There was a significant difference between the percentage of radio-tagged coho salmon that exhibited normal behavior and migrated upstream to the major spawning areas in 1985 and those percentages from previous radio-tagging studies. Seventy-seven coho salmon were radio-tagged and released from 1982 through 1984. These coho were captured by similar methods and were radio-tagged and released at the same locations as in 1985. All of these coho had just re-entered fresh water, and nearly all exhibited marine characteristics such as external copepods (commonly called "sea lice"), bright shiny bodies and loose scales. Only 12 (16%) of these fish reached the Lake Creek confluence at R.M. 62, and only four (5%) reached the major spawning area beginning at R.M. 85 (Bentz 1983, 1984, 1985).

Results of the 1985 radio-tagging study are very similar to those observed for an experimental group of radio-tagged coho salmon. In

1984 seven coho were captured by hook and line and radio-tagged at R.M. 31 of the Little Susitna River, approximately 11 miles upstream of the normal capture site. The fish were captured 2 to 3 weeks later than coho that were radio-tagged at R.M. 20. These coho had readjusted to the freshwater environment and had begun to mature sexually. All of these fish exhibited the external characteristics of coho nearing spawning; i.e., dark pink or red bodies, imbedded scales and a pronounced kype on the males. Five (71%) of these coho reached the Lake Creek confluence at R.M. 62, and four (57%) reached the major spawning area at R.M. 85 (Bentz 1985).

Although coho salmon radio-tagged in 1985 were captured at R.M. 20, their entry pattern into the river was later than normal. Eighty-seven percent of coho radio-tagged in 1985 were captured on or after August 14, while coho salmon radio-tagged during previous years were captured from late July through the first week of August. Coho captured in 1985 at R.M. 20 exhibited external copepods and bright shiny bodies; however, the scales were not as loose as in previous years. Tagging personnel noted very little scale loss during radio-tagging procedures.

The 1985 radio-tagging data suggest coho salmon had begun the natural sexual maturation process, which includes scales becoming set, prior to reaching R.M. 20. There are indications that scale loss and the associated layer of body mucus may compound the osmoregulatory stress experienced by adult coho salmon that are re-entering fresh water. Coho salmon that have just re-entered fresh water seem very susceptible to any additional stress during this period. It is recommended that any future studies involving capture or handling of coho that have just re-entered freshwater be designed to reduce stress and scale loss to a minimum to ensure survival and normal behavior after release.

#### LITERATURE CITED

Alaska Department of Fish and Game. 1981a. Plan for supplemental production of salmon and steelhead for Cook Inlet recreational fisheries. Division of Sport Fish: 73 pp.

Alaska Department of Fish and Game, Susitna Hydro Aquatic Studies. 1981b. Phase I final draft report, adult anadromous fisheries project. Division of Sport Fish: 307 pp.

Alaska Department of Natural Resources. 1982. Land use plan for public land in the Willow Sub-Basin. 348 pp.

Bentz, R.W. 1982. Inventory and cataloging of the sport fish and sport fish waters in upper Cook Inlet. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23(G-I-D): 76-112.

\_\_\_\_\_. 1983. Inventory and cataloging of the sport fish and sport fish waters in upper Cook Inlet. Alaska Department of Fish and

Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24(G-I-D): 60-104.

\_\_\_\_\_. 1984. Little Susitna River coho salmon life history and angler use studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25(G-II-B): 38-63.

\_\_\_\_\_. 1985. Little Susitna River coho salmon life history and angler use studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26(G-II-B): 37-64.

Mills, M.J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20(SW-I-A): 122 pp.

\_\_\_\_\_. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21(SW-I-A): 65 pp.

\_\_\_\_\_. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22(SW-I-A): 77 pp.

\_\_\_\_\_. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22(SW-I-A): 107 pp.

\_\_\_\_\_. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23(SW-I-A): 115 pp.

\_\_\_\_\_. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24(SW-I-A): 118 pp.

\_\_\_\_\_. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25(SW-I-A): 85 pp.

\_\_\_\_\_. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26(SW-I-A): 135 pp.

Prepared by:

Robert W. Bentz, Jr.  
Fishery Biologist

Approved by:

E. Richard Logan, Ph.D., Director  
Division of Sport Fish

Louis S. Bandirola, Deputy Director  
Division of Sport Fish