

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

LITTLE SUSITNA RIVER COHO SALMON LIFE
HISTORY AND ANGLER USE STUDIES

by

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RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish
Investigations
of Alaska

Project: F-9-17

Study: G-II Study Title: SPORT FISH STUDIES

Job: G-II-B Job Title: Little Susitna River
Coho Salmon Life
History and Angler
Use Studies

Cooperator: Robert W. Bentz, Jr.

Period Covered: July 1, 1984 to June 30, 1985

ABSTRACT

A coho salmon, *Oncorhynchus kisutch* (Walbaum), creel census was conducted at two sites on the Little Susitna River for the fourth consecutive year. An estimated 14,308 coho were harvested in 18,955 angler-days of effort. Harvest and effort estimates were the highest recorded since the census program was initiated in 1981. The coho salmon per hour harvest rate for the entire river was 0.20 and ranged from 0.51 coho per hour for boat anglers which crossed Knik Arm to fish in the lower river, to 0.02 coho per hour for shore anglers at the upper river fishery. Angling effort at the lower river fishery has increased 942 percent, from 993 angler-days in 1981 to 10,344 in 1984, making it the fastest growing segment of the coho sport fishery. This rapid growth is a direct result of improvements over the past 2 years to the road which 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 20,990, the largest escapement since surveys were initiated in 1978. The total in-river return was estimated at 35,298 coho.

Two tagging programs utilizing jaw tags and low frequency radio transmitters were conducted in the lower river to monitor migration movements. Less than 10 percent of the coho radio tagged when re-entering freshwater migrated upstream to known spawning areas. Over 71 percent of the coho radio tagged after readjusting to the freshwater environment migrated into the spawning area. Coho salmon just re-entering freshwater 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.

Therefore, management techniques have been conducted primarily through the 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, so too did sport fishing effort and harvest in the numerous freshwater streams of the Matanuska-Susitna Valley. Data from the Statewide Harvest Study (Mills, 1979-1984), an annual publication of sport fishing effort and harvest by area, indicate fishing effort has increased 49% from 1977 to 1983 within the Knik Arm and east side Susitna River areas. Coho salmon harvest estimates over the same period have fluctuated from 10,075 in 1977, rising to 26,400 in 1980 and falling to 9,819 in 1983.

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 Statewide Harvest Study data, 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).

The Statewide Harvest Survey shows total angling effort on the Little Susitna has increased 221% over 7 years from 11,063 angler-days in 1977 to 35,477 angler-days in 1983. During 1983, the Little Susitna sustained the second highest fishing effort occurring in freshwater in the state, surpassed only by the Kenai River. Most of this increased

effort is a direct result of improvements during the past 2 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 7,116 in 1982--a 108% increase. Harvest in the Little Susitna declined to 2,835 coho in 1983, the lowest since the Statewide Harvest Survey was initiated in 1977.

The importance of the Little Susitna River and its potential for recreation and fishing opportunities was acknowledged by the Department of Natural Resources when they included and granted it special protective status in the Land Use Plan for Public Land in the Willow Sub-Basin (Dept. of Natural Resources, 1982). 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 in the Plan for Supplemental Production of Salmon and Steelhead for Cook Inlet Recreational Fisheries (A.D.F. & G., 1981). This plan lists a coho 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, with 3,113 eggs collected. The eggs were incubated at the Big Lake Hatchery complex and nearly 3,000 coho fry were released into the river in 1982. This program was expanded in 1982, when 500,800 eggs were taken from Little Susitna coho and the fry released in 1983. During 1983, 547,000 coho eggs were collected and the fry were released into the system in 1984. An additional 56,000 eggs were taken and are being incubated at the Fort Richardson Hatchery facilities. These fish will be raised to smolt size for release in 1985. Over 2 million eggs were taken from Little Susitna coho in 1984. The Big Lake Hatchery received 1.35 million eggs which will be raised to fry and released in 1985. The remaining 675,000 eggs were transported to the Fort Richardson Hatchery and will be raised to smolt size for release in 1986.

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 1984. 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 which included: run timing and movement through the sport fishery; migration rates and important holding areas; and distribution and magnitude of spawning.

To accomplish these objectives the study was divided into three segments.

Two capture and release tagging programs were conducted simultaneously, beginning in mid-July. Adult coho salmon were captured in the lower

river where sport fishing effort began. The majority of these fish were tagged with a numbered jaw tag and released. Run timing and migration rate estimates were determined by recapture of these fish in the upstream sport fishery and monitored by the two creel census programs.

A second group of adult coho salmon were tagged with a numbered jaw 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 important holding or milling areas and mainstream and tributary spawning areas were 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 attempted for examination of tagging effects on the fish and to determine if these fish 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 Burma Road and Parks Highway to determine angler effort and harvest.
2. Coho salmon life history studies should be continued to determine run timing and migration rates through the sport fishery.
3. Escapement counts by helicopter and foot surveys should be continued for development of management plans and to establish the aerial efficiency for counting coho salmon.

OBJECTIVES

1. To determine abundance, distribution and run timing of coho salmon in the Little Susitna River from July to October.
2. To determine harvest levels and fishing effort for coho salmon between July and September and identify various biological characteristics of the population.
3. To make recommendations for proper management of the wild stock and identify potential enhancement opportunities.

TECHNIQUES USED

Creel Census Program

The Little Susitna coho salmon creel census was statistically designed to estimate harvest and effort. Since the area open to coho salmon

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
Chinook salmon	<i>Oncorhynchus tshawytscha</i> (Walbaum)	KS

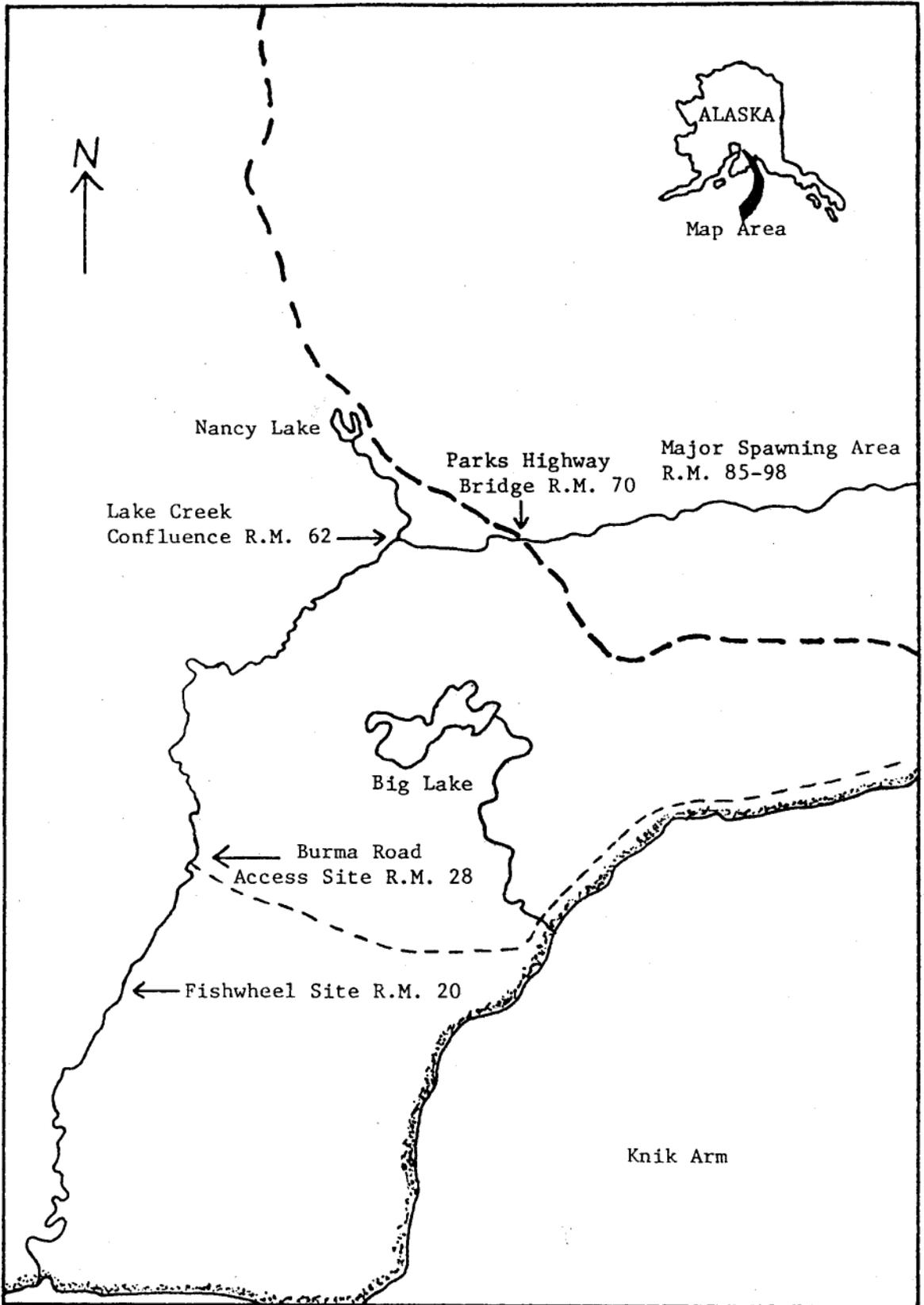


Figure 1. Study area map of the Little Susitna River.

fishing on the Little Susitna River encompasses 70 river miles, 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, which access the lower and upper river fishing areas, respectively. Catch and effort estimates were calculated separately for each access point and then summed.

The census at the Burma Road access site was conducted from July 14 through September 6. The sampling day was divided into four 4-hour periods between the hours of 6:00 am and 10:00 pm. Six random, pre-selected periods were sampled during 4 weekdays of each week. Three periods were sampled on each weekend day and holiday.

Angler counts by foot were not conducted at the Burma Road access site because the majority of shore anglers began fishing outside the established count area. This resulted in incorrect estimates of total fishing effort and harvest. All completed anglers were interviewed as they exited the fishery at the access site and a direct expansion was utilized to generate these estimates. Angler counts and interviews were conducted by boat from the Burma Road access site to estimate harvest and effort by anglers that boated across the marine waters of Knik Arm from Anchorage and fished in the lower river, 4 to 12 miles below the access site. These boat counts were conducted at randomly selected times five times weekly.

The census at the Parks Highway access site was conducted from July 28 through September 6 at three locations. The sampling day was identical to that used at the Burma Road. Ten random, preselected 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 two access sites. Information collected from anglers included: number of hours fished; number, species and sex of fish caught; and whether they were boat or shore anglers. Boat type and motor size information was also collected from boat anglers, as well as whether they traveled in a private or charter boat. All coho salmon 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.

All anglers, both completed and incompletd, who boated across Knik Arm to fish in the lower river were interviewed during the downstream angler counts from the Burma Road. Only number of hours fished and number and species of fish caught were collected to estimate harvest and effort for this group of anglers. Coho salmon harvested by these anglers were not physically examined to obtain biological information because of the inconvenience caused by census personnel boarding boats.

Life History Studies

An aluminum fishwheel and hook and line methods were utilized to capture adult coho salmon for the jaw tagging program. The fishwheel design was similar to fishwheels used on the Susitna River to capture adult salmon (A.D.F. & G., Phase I Final Draft Report, Adult Anadromous Fisheries Project, 1981). Each of the two baskets had an average length, width and depth of 6.0, 5.0 and 2.3 feet, respectively. The fishwheel was equipped with an adjustable axle which allowed the baskets and paddles to be raised or lowered according to fluctuations in water depth.

The wheel was located 8 miles below the Burma Road access site at river mile (R.M.) 20. Fishwheel operations began on July 11 and continued through August 20. Captured coho were removed from the fishwheel holding tank with a landing net. While immobilized in the net, the sex was determined and a numbered jaw tag was clamped with pliers around the maxillary bone of the upper jaw. The fish were transferred immediately to a recovery tank and held from 2 to 6 hours for observation prior to release. Coho salmon caught by hook and line were captured at the fishwheel site. The fish was landed, the hook removed and the fish placed immediately into the fishwheel holding tank. Jaw tagging procedures for coho caught by hook and line were identical to coho captured by the fishwheel.

Coho salmon tagged with both numbered jaw tags and a low frequency radio transmitter were captured at R.M. 20 by fishwheel or hook and line from July 20 through August 4. The Smith-Root low frequency radio telemetry equipment and tagging techniques used are described in detail by Bentz (1983). Esophageal implants were utilized exclusively during this year's study. All of the coho were anesthetized prior to transmitter insertion. After tagging, the fish were placed in the recovery tank and held for observation for 5 to 12 hours to observe any post-capture stress mortality. Parker, et. al. (1959) recorded mortality rates between 34 and 52% for troll-caught coho in marine waters. Cause of death was attributed to elevated blood lactate levels which peaked 2 to 3 hours after capture. Mortality was substantially complete by the end of 6 hours.

A second group of coho were captured by hook and line at R.M. 31 for radio tagging on August 15. After the fish were landed and the hook removed, they were placed in an 8 ft x 3 ft holding pen for approximately 1 hour prior to tagging. Tagging procedures were identical to those at the fishwheel. After tagging, the coho were allowed to recover in the holding pen for 3 hours prior to release.

Migrational movements were monitored using radio receivers from July 21 through September 26. 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 September 26 by foot and helicopter surveys for comparative counts.

FINDINGS

Creel Census Program

The total coho salmon sport harvest at the Little Susitna River in 1984 was estimated at 14,308 fish with 18,955 angler-days of effort (Table 2). Harvest per hour and angler-day averaged 0.20 and 0.75, respectively. The 1984 coho harvest increased 383% over the 1983 harvest of 2,965 (Bentz, 1984), while total effort in 1984 rose 146% from 7,720 angler-days estimated during the 1983 census (Table 3). The 1984 harvest and effort estimates are the highest recorded since 1981, when coho salmon harvest levels were first estimated through the creel census program. The average coho salmon harvest per hour from 1981 through 1984 at the Little Susitna was 0.19. This catch rate compares favorably with other coho salmon fisheries in southcentral Alaska. Wallis and Hammarstrom (1984) reported an average coho harvest per hour of 0.13 for the Kenai River from 1976 through 1982. Catch rates on the Deshka River averaged 0.05 and 0.19 coho per hour in 1977 and 1978, respectively (Kubik and Wadman, 1979).

Anglers at the Burma Road access site harvested 8,575 coho salmon during 10,344 angler-days, which represents 59.9 and 54.6% of the river's total harvest and effort, respectively. Harvest per hour and angler-day was 0.21 and 0.83, respectively. Of the total effort and harvest expended in the Burma Road area, shore anglers fished 6,319 days and harvested 2,870 coho. Coho harvest per hour was 0.13. Boat anglers harvested 5,705 coho in 4,025 angler-days at a harvest per hour of 0.30. Included in these estimates are anglers which boated from the Parks Highway, 42 river miles above the Burma Road. These anglers harvested 163 or 1.1% of the river's total coho harvest during 449 angler-days, which is 2.4% of the total effort. Coho harvest per angler-day and hour was 0.36 and 0.10, respectively. Fishing effort has increased 125% from 200 angler-days in 1982 (Bentz, 1983) for this type of angler. However, due to larger increases in effort at the Burma Road fishery, the percentage of the total river's effort has decreased from the 3.9% recorded in 1983 (Bentz, 1984).

Boat anglers at the Burma Road utilized six different boat types in 1984 (Table 4). The most popular type was a small, lightweight boat powered by an outboard motor with a propeller, which was used by 76% of the boat anglers. Sixty-seven percent of these outboard motors were less than 16 horsepower. Anglers which boated from the Parks Highway to the Burma Road used four different boat types. The two predominant types were canoes (52.3%) and boats powered by an outboard motor with a propeller (34.4%). Fifty-three percent of these anglers floated in canoes or

Table 2. Harvest and effort data of the Little Susitna River sport fishery for coho salmon in 1984.

	Burma Road				Anchorage*		Parks Highway				TOTAL
	Shore		Boat		Boat		Shore		Boat		
	WD**	WE	WD	WE	WD	WE	WD	WE	WD	WE	
Harvest	1,636	1,234	3,125	2,580	2,319	2,226	141	76	473	498	14,308
Effort- Angler-Days	3,493	2,826	1,872	2,153	887	987	2,663	1,772	1,182	1,120	18,955
\bar{x} Hours Fished	3.40	3.60	4.80	4.80	4.20	5.30	1.90	2.10	5.00	4.90	3.70
Fish/Hour	0.14	0.12	0.35	0.25	0.62	0.43	0.03	0.02	0.08	0.09	0.20
Fish/Angler-Day	0.47	0.44	1.67	1.20	2.61	2.26	0.05	0.04	0.40	0.44	0.75

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

** WD means Weekday.

WE means Weekend.

Table 3. Little Susitna River coho salmon harvest, effort and catch per unit effort, 1981-1984.

	Year	Burma Road Anglers*	Anchorage 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
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
\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
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
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

* Includes both shore and boat anglers.

Table 4. Percentage of anglers utilizing different chartered and private boat types on the Little Susitna River in 1984.

Boat Type	Anchorage Anglers	Burma Road Anglers	Burma Road Anglers from the Parks Highway	Parks Highway Anglers
<u>Private Boats</u>				
Inbrd. Jet	24.1	1.8	0	3.7
Outbrd. Prop	48.8	76.0	34.4	8.7
Outbrd. Jet	27.1	13.8	9.4	42.8
Airboat	0	0.5	0	2.2
Canoe	0	7.3	52.3	1.6
Raft	0	0.6	3.9	1.0
TOTAL	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>60.0</u>
<u>Charter Boats</u>				
Outbrd. Jet	0	0	0	39.6
Airboat	0	0	0	0.4
TOTAL	<u>0</u>	<u>0</u>	<u>0</u>	<u>40.0</u>

inflatable rafts without motors and achieved harvest rates of 0.37 and 0.11 coho per angler-day and hour, respectively. The remaining 47% of the anglers utilized boats powered by outboard motors with propellers or jet units. Eighty-three percent of the motors used were less than 16 horsepower. Harvest rates for motorized anglers were estimated at 0.36 coho per angler-day and 0.09 coho per hour, slightly less than the harvest rates for non-motorized anglers.

Anglers that crossed Knik Arm from Anchorage during high tides to fish in the lower river harvested 4,545 coho salmon during 1,874 angler-days, 31.8 and 9.9% of the entire river's respective harvest and effort totals. Coho harvest per hour and angler-day was 0.51 and 2.43 respectively, which was the highest harvest rate achieved by any group of anglers on the Little Susitna in 1984. Anglers that launched from Anchorage utilized three different boat types. The dominant type (48.8%) was a boat powered by an outboard motor with a propeller. Nearly 73% of the motors used by these anglers were greater than 75 horsepower. The lower river fishery, composed of Burma Road and Anchorage anglers, caught 13,120 coho salmon or 91.7% of the total river's harvest during 12,218 angler-days which is 64.5% of the total river's effort.

Parks Highway anglers harvested 1,188 coho with 6,737 angler-days of effort. These figures represent 8.3 and 35.5% of the respective harvest and effort totals for the entire river. Coho harvest per hour was 0.06 and 0.18 per angler-day. Boat anglers harvested 971 coho salmon in 2,302 angler-days. Coho harvest per hour was 0.08. Shore anglers harvested 217 coho in 4,435 angler-days at a harvest per hour of 0.02. Anglers that chartered comprised 40.0% of the total Parks Highway boat fishing effort, an increase of 9.8% over the percentage of chartered anglers estimated in 1983 (Bentz, 1984). 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 40.2% of all coho taken by boat anglers in the upper river. Chartered boat anglers experienced a slightly higher coho harvest per angler-day than private boat anglers because their average trip was longer. However, private boat anglers achieved a coho harvest per hour of 0.09 which was higher than the 0.08 harvest per hour recorded for chartered anglers.

Chartered anglers at the Parks Highway were transported in two different types of boats (Table 4). The predominant type was a large boat powered by an outboard motor with a jet unit, which was used by 99% of the chartered anglers. Ninety-seven percent of these outboard motors were greater than 75 horsepower. Private boat anglers utilized six different boat types. The most popular type used (42.8%) was also a boat powered by an outboard motor with a jet unit. Fifty-eight percent of these motors were greater than 75 horsepower and 37% were between 36 and 75 horsepower.

Total fishing effort for coho salmon on the Little Susitna River has increased 333%, from 4,380 angler-days in 1981 to 18,955 angler-days in

1984. During this same period, effort at the Burma Road has increased 942% from 993 to 10,344 angler-days (Table 3), making this the fastest growing segment of the coho salmon sport fishery on the entire river. Coho harvest at the Burma Road has increased 522% from 1981 through 1984, while the entire river's harvest has increased 174% during the same period. These impressive increases in harvest and effort at the Burma Road are a direct result of improvements during the past 2 years to the road that accesses this portion of river. With further road improvements scheduled and support facilities such as campgrounds, parking lots and boat launch sites in the planning stages, fishing effort in the lower river is expected to continue to increase substantially.

While fishing effort has steadily increased at the Burma Road, coho salmon catch per unit effort, expressed as harvest per hour, has decreased substantially (Figure 2). Anglers experienced a steady decrease in catch rates from 0.31 coho per hour in 1981 to 0.10 in 1983. Although the harvest per hour increased to 0.21 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 1984 can probably be attributed to increased angling pressure, boat traffic and general disturbance which usually alarms fish confined in a small stream such as the Little Susitna.

Harvest and effort estimates at the Parks Highway are only comparable from 1982 to 1984 because the 1981 census was terminated prematurely on August 24 during the peak of the upstream fishery. Angling effort increased 27% from 1982 to 1984, while coho salmon harvest decreased 59% during the same period (Table 3). Harvest rates also declined from 0.15 coho per hour in 1982 to 0.06 in 1984 even though 21,000 coho passed through the fishery and were enumerated in subsequent escapement counts in 1984, compared to escapement estimates of 6,800 in 1982. The Parks Highway contribution to the total river's harvest in 1983 and 1984 was 11.3 and 8.3%, respectively.

One possible factor influencing the coho harvest in the upper river fishery could be flow conditions encountered by the fish upon entering the lower river from Cook Inlet. Schmidt (1984) reported a positive relationship between water level or discharge and upstream migration for coho salmon in a stream in southeast Alaska. The greatest numbers of migrating coho were observed during the highest periods of discharge over a 1.5-month period.

It has also been observed that after adult salmon have been in freshwater for some time and are in the advanced stages of sexual maturation, they become much more reluctant to take bait and essentially become less available to anglers (Steve Hammarstrom, pers. comm., 1984).

Discharge measurements on the Little Susitna are recorded at a U.S. Geological Survey gauging station located above the Parks Highway at R.M. 100. During the last 2 weeks of July and the first week of August when most of the coho salmon enter the river, the average daily discharge in 1982 was 953 cfs (U.S.G.S., 1982). Daily discharge during

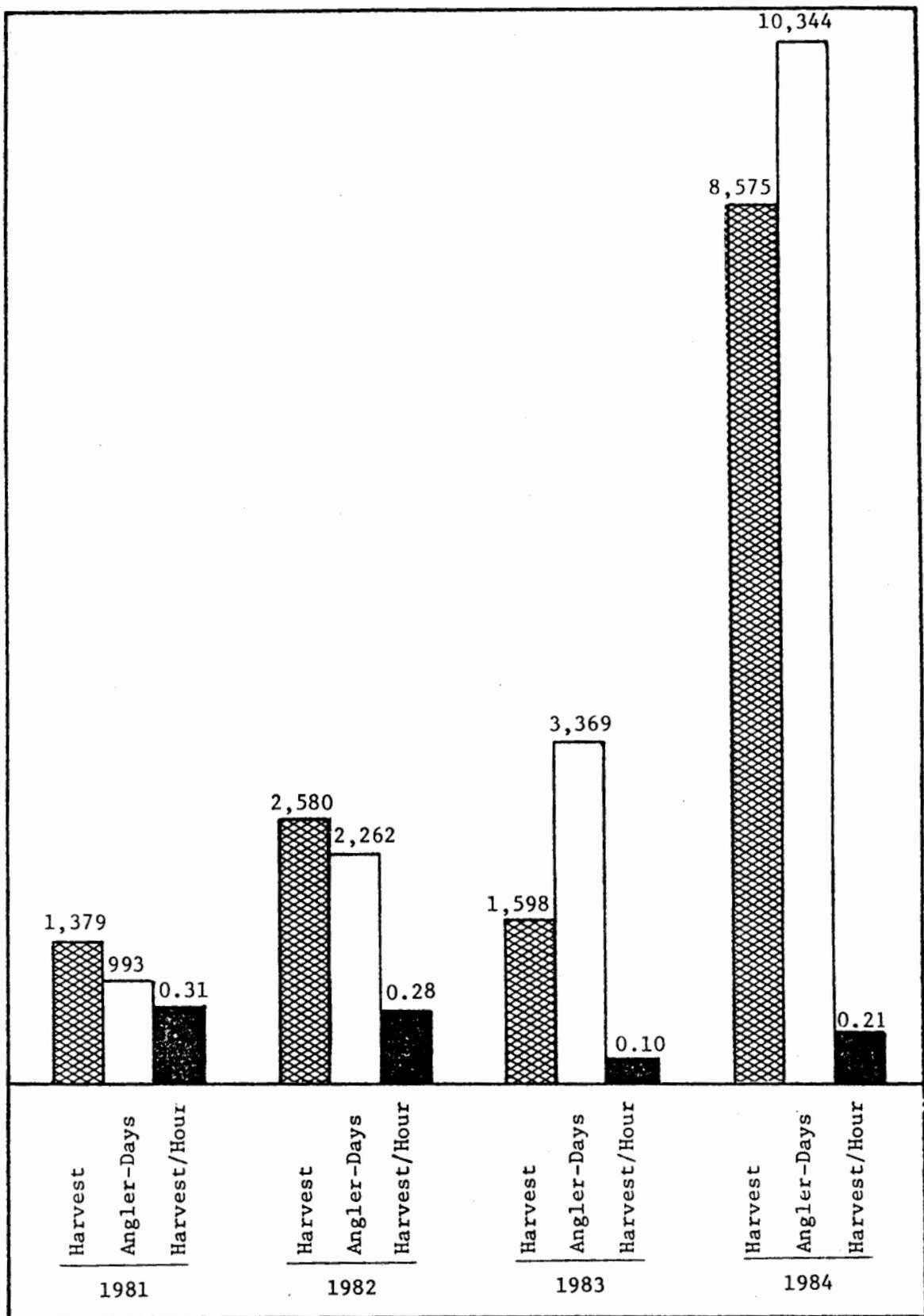


Figure 2. Harvest, effort and harvest per hour of coho salmon at the Burma Road access site, 1981-1984.

the same period in 1983 and 1984 averaged 346 and 489 cfs, respectively (U.S.G.S., 1983; 1984, in press).

Coho salmon entering the Little Susitna in 1982 encountered high discharges and may have migrated rapidly to the Parks Highway area in a sexually immature condition and therefore were more vulnerable to capture. In 1983 and 1984, coho encountered low flow conditions and large schools of fish were observed in the shallow, clear water midway between the Burma Road and Parks Highway fisheries for several weeks. These fish may have ripened sexually during this time. When flows subsequently increased, these maturing fish migrated through the upper river fishery and were not interested in the anglers' offerings. Another possible explanation for the higher coho harvest by Parks Highway anglers in 1982 could be that, due to high flows, boat anglers were able to travel further downstream into areas normally inaccessible because of shallow water conditions and were able to intercept the main group of fish earlier than usual.

Weekly fishing effort in 1984 is presented in Table 5 for Burma Road, Anchorage and Parks Highway anglers. Peak effort by Anchorage anglers occurred during the week of July 21-27, the second week of the lower river creel census. Burma Road angling effort peaked the following week, July 28-August 3. The highest fishing effort in 1984 occurred 1 week later than the peak weeks in 1983 for both angling groups in the lower river (Bentz, 1984). Angling effort at the Parks Highway reached its apex during the first week of the upper river census on July 28-August 3, which was also the week of highest effort in 1983. 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 this time.

Weekly harvest and sex ratios are given in Table 6. The peak harvest for Anchorage and Burma Road anglers occurred during the second and third weeks of the lower river census, respectively. Peak effort at the Parks Highway occurred during August 18-24, 3 to 4 weeks later than peak effort in the lower river. This is the largest time difference observed between peak harvest periods at the two fisheries. Peak harvest periods between the lower and upper river differed by only 2 weeks in 1982 and 1983 (Bentz, 1983; 1984).

Figure 3 provides a comparison of coho salmon harvest rates by week at the Burma Road and Parks Highway fisheries from 1982 through 1984. The Burma Road harvest rate in 1984 rose during the first 2 weeks of the census to 1.08 coho per angler-day and then declined during the next 3 weeks to 0.50 coho per angler-day during the fifth week. Harvest rates increased to a seasonal high of 1.27 coho per angler-day the following week before tapering off during the final 2 weeks of the census. A very similar bimodal curve in harvest rates also occurred in 1983. Reasons for this are unclear at this time. Harvest rates at the Parks Highway in 1984 were also similar in pattern to 1983. Coho salmon harvest rates increased from 0.06 coho per angler-day during the first week of census to a peak of 0.52 in the fourth week before falling during the final 2 weeks.

Table 5. Little Susitna River coho salmon fishing effort percentages by weekly period in 1984.

	7/14-7/20	7/21-7/27	7/28-8/3	8/4-8/10	8/11-8/17	8/18-8/24	8/25-8/31	9/1-9/6	Total
Burma Road Anglers*	709	1,448	3,129	2,686	1,677	423	130	142	10,344
%	6.8	14.0	30.2	26.0	16.2	4.1	1.3	1.4	100.0
Anchorage Anglers	165	570	331	496	165	147	0	0	1,874
%	8.8	30.4	17.7	26.5	8.8	7.8	0	0	100.0
Parks Highway Anglers*	No Census	No Census	2,146	1,745	1,453	657	322	414	6,737
%	...	...	31.8	25.9	21.6	9.7	4.8	6.2	100.0
Total Anglers	874	2,018	5,606	4,927	3,295	1,227	452	556	18,955
%	4.6	10.6	29.6	26.0	17.4	6.5	2.4	2.9	100.0

* Includes both boat and shore anglers.

Table 6. Little Susitna River coho salmon harvest percentages and sex ratios by weekly period in 1984.

	7/14-7/20	7/21-7/27	7/28-8/3	8/4-8/10	8/11-8/17	8/18-8/24	8/25-8/31	9/1-9/6	Total
Burma Road Harvest*	128	1,562	3,303	2,096	841	537	64	44	8,575
%	1.5	18.2	38.5	24.4	9.8	6.3	0.8	0.5	100.0
Sex Ratio Male:Female	1.45:1.0	0.56:1.0	0.62:1.0	1.06:1.0	1.58:1.0	1.66:1.0	0.87:1.0	1.38:1.0	0.80:1.0
Anchorage Anglers Harvest**	539	1,654	857	1,096	359	40	0	0	4,545
%	11.8	36.4	18.9	24.1	7.9	0.9	0	0	100.0
Parks Highway Harvest*	No Census Conducted	No Census Conducted	123	261	267	340	130	67	1,188
%	...	...	10.4	22.0	22.5	28.6	10.9	5.6	100.0
Sex Ratio Male:Female	...	...	0.64:1.0	0.58:1.0	0.64:1.0	1.0:1.0	1.06:1.0	1.67:1.0	0.75:1.0
Total Harvest	667	3,216	4,283	3,453	1,467	917	194	111	14,308
%	4.7	22.5	29.9	24.1	10.2	6.4	1.4	0.8	100.0
Sex Ratio Male:Female	1.45:1.0	0.56:1.0	0.62:1.0	1.0:1.0	1.32:1.0	1.47:1.0	0.97:1.0	1.45:1.0	0.80:1.0

* Includes both boat and shore anglers.

** Biological data not collected for coho caught by Anchorage anglers.

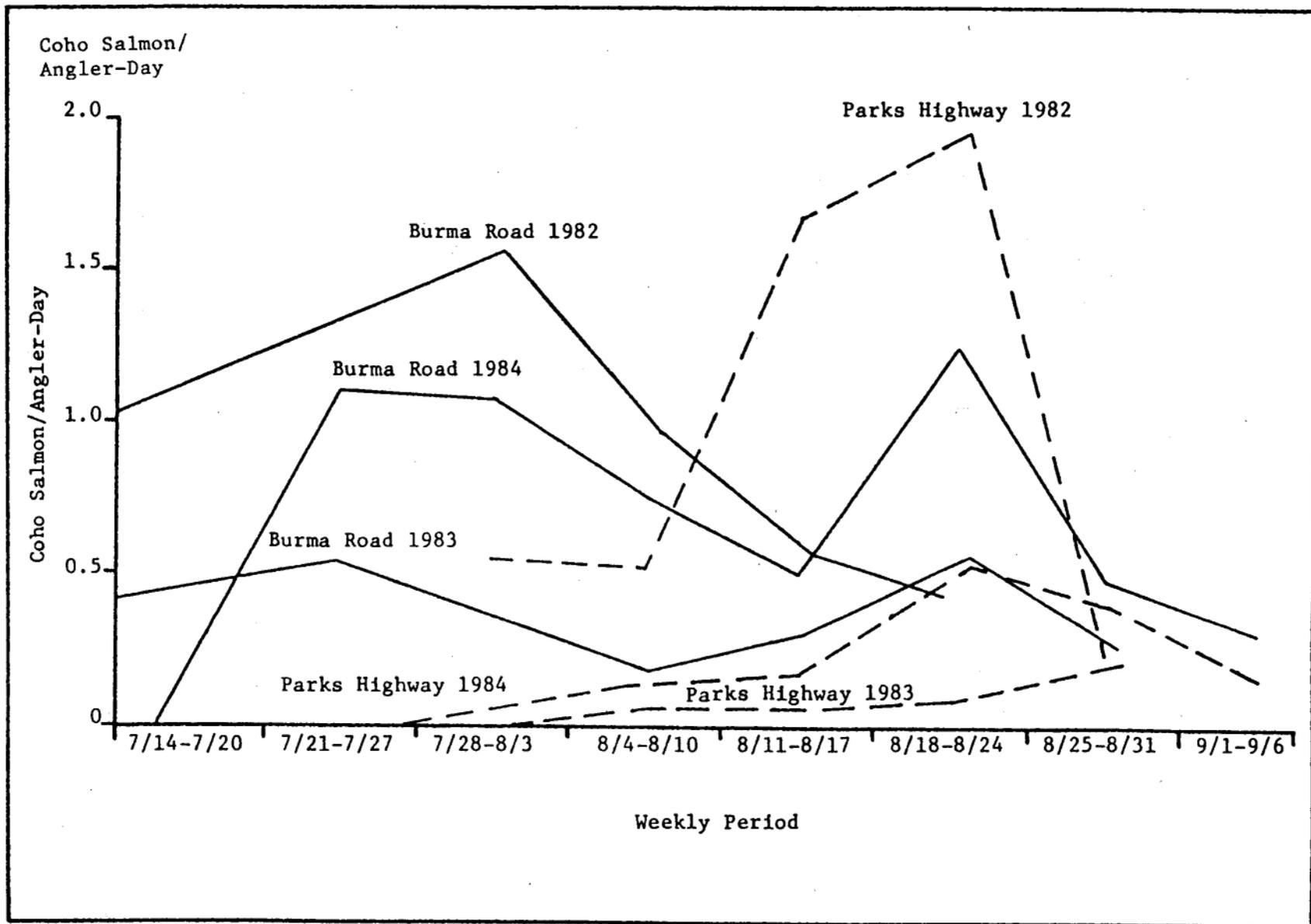


Figure 3. Coho salmon harvest rates by weekly period at the two access sites of the Little Susitna River, 1982-1984.

The male to female sex ratio of coho salmon harvested at the Burma Road sport fishery was 0.80:1.0 and 0.75:1.0 at the Parks Highway. The combined sex ratio of all coho harvested in 1984 was 0.80:1.0. The combined sex ratios at the Burma Road and Parks Highway in 1981, 1982 and 1983 were 1.13:1.0, 0.69:1.0 and 0.88:1.0, respectively (Bentz, 1982-1984). Weekly sex ratios at the Burma Road have followed a similar pattern the last 3 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. This same seasonal shift from a female- to male-dominant harvest has also been observed at the Parks Highway in 1982 and 1984. The small number of coho observed during the 1983 Parks Highway census precludes comparison.

Sex ratios were compared for gutted and ungutted coho at both census locations in 1984. It was assumed that the sex of gutted fish was always correct because the angler observed the sex products as they were removed during the cleaning process. Census personnel determined the sex of ungutted fish by examination of external sexual characteristics. A chi-square test ($P=0.05$) was used to determine that there was no significant difference between gutted and ungutted sex ratios for coho salmon at the Burma Road. These ratios were significantly different at the Parks Highway, but the sample size of gutted coho was only 23 fish for the entire season which was too small for a valid comparison. Census personnel at the Burma Road tend to identify males as females. Most coho harvested in the lower river have just re-entered fresh water and exhibit few of the external sexual characteristics that become more pronounced as maturation occurs. The opposite situation was true for the Parks Highway. Census personnel tended to identify females as males. When coho reach the upper river, 70 miles from salt water, they are often in advanced stages of sexual maturation. Some female coho had developed external characteristics similar to those of males and were misidentified.

A comparison of mid-eye to fork length and weight data of coho salmon harvested at the Burma Road and Parks Highway in 1984 is presented in Table 7. Male coho were slightly longer and nearly 2 pounds heavier than females at the Burma Road in 1984. Males harvested in 1981 and 1983 at the Burma Road were also longer and heavier (Bentz, 1982; 1984). The combined weight for male and female coho of 9.31 pounds in 1984 is substantially higher than the combined weight of 7.81 and 7.88 pounds recorded in 1981 and 1983, respectively. This may be indicative of better marine feeding conditions, resulting in a higher ocean survival rate.

Anglers at the Little Susitna River also harvested an estimated 2,971 sockeye, 808 chum and 730 pink salmon during the creel census. Parks Highway anglers harvested 2,918 sockeye and 387 chum salmon. Boat anglers in the upper river fishery harvested 90% of all sockeye salmon caught throughout the river. Most of these anglers fished at the Lake Creek confluence, 8 river miles below the Parks Highway bridge. Burma Road anglers caught 53 sockeye, 730 pink and 421 chum salmon. Total seasonal harvest for sockeye and chum salmon was presumed to be at least double these figures as the creel census programs began during the peak

Table 7. 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 1984.

<u>Location</u>	Length (cm)				Weight (lb)			
	n	\bar{x}	\pm SD	Range	n	\bar{x}	\pm SD	Range
Burma Road								
Females	624	59.30	3.22	43.0-68.0	236	8.44	1.45	4.0-13.0
Males	567	60.92	4.37	30.0-69.0	191	10.38	2.21	2.5-15.0
Combined	1191	60.08	3.89	30.0-69.0	427	9.31	2.06	2.5-15.0
Parks Highway								
Females	48	57.60	4.82	43.0-67.0	38	6.92	1.90	3.0-10.5
Males	46	60.52	3.53	49.0-67.0	35	9.19	1.71	5.5-12.5
Combined	94	59.03	4.46	43.0-67.0	73	8.00	2.13	3.0-12.5

of migrations for both species. Over 80% of the sockeye harvest at the Parks Highway occurred during the first 2 weeks of the census and 80% of all chums harvested at the Burma road were caught during the first week. Harvest of both species dropped sharply during succeeding weeks.

Life History Studies

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

In 1984 preliminary spawning counts to determine peak spawning time were conducted by foot and helicopter surveys throughout mid-September. Based on these preliminary surveys, extensive escapement counts were conducted on September 26 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 20,990 coho were enumerated within this 43-mile section of river. Foot surveys were conducted from R.M. 98 to R.M. 82 with a total of 16,444 coho observed. The 20,990 coho escapement in 1984 is the highest since counts were initiated in 1978 (Table 8). The highest spawning concentrations were between R.M. 85 and 93 with 1,513 coho per river mile observed. Prior escapement estimates have ranged from 2,666 in 1983 to 6,800 in 1982. The total coho salmon return to the Little Susitna River in 1984 was estimated at 35,298, of which the sport fishery harvested 14,308 or 41% of the in-river return.

Helicopter counts were higher than foot counts in two out of four established index areas where both helicopter and foot surveys were conducted. This is contrary to count comparisons between the two survey types during 1983 within the same index areas, when only 36% of the coho counted by foot were observed by helicopter surveys (Bentz, 1984). Helicopter counts were higher than foot counts in 1984 because as the traditional spawning areas became overcrowded, large numbers of fish moved into lateral tributaries or side channels which are normally not utilized as spawning areas by many coho. Helicopter survey crews were able to count fish in these numerous areas branching off from the main river channel. However, foot survey crews could not survey these areas and still complete their counts during daylight hours.

Adult coho salmon were captured at the fishwheel site located at R.M. 20 from July 16 through August 5. A total of 51 coho were jaw-tagged and released during this period. The fishwheel captured 41 coho and 10 were caught by hook and line. Peak capture rates occurred during the second week of the creel census, July 21-27, when 20 coho were tagged. Seventy-one sockeye, 88 pink and 120 chum salmon were also captured in the fishwheel, tagged and released.

Table 8. Coho salmon peak escapement counts on the Little Susitna River, 1978-1984.

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

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

Low flow conditions, which persisted during most of the tagging program, were felt to be the major cause for the poor capture rate of coho salmon at the fishwheel. Flows were 50 to 66% lower than those recorded in 1981 and 1982 during the same period (U.S.G.S., 1981-1982). The river was low and the water unusually clear during the period when the majority of coho salmon migrated past the fishwheel. Groups of coho were observed moving upstream toward the fishwheel, stopping just short of it and then moving in a wide arc around it before continuing upstream.

One tagged coho was recaptured in the sport fishery 10 days after release, at the Lake Creek confluence (R.M. 62). Four tagged sockeye were recaptured by anglers at Lake Creek. Migration time ranged from 5 to 8 days. Three tagged sockeye moved out of the Little Susitna after release and were recaptured in commercial set nets along the northern Cook Inlet beaches. Two of the three fish were recaptured east of the mouth of the Little Susitna and one was netted west of the mouth. Time from release to recapture ranged from 5 to 18 days. No other jaw-tagged salmon were reported recaptured in the sport or commercial fisheries and none were observed during escapement surveys.

Coho salmon used in the radio telemetry study were captured at the fishwheel site from July 20 through August 4. A total of 42 coho were tagged with both a jaw tag and a low frequency radio transmitter and released. All coho captured at R.M. 20 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. Twenty coho were captured in the fishwheel and 17 were collected by hook and line. Capture method could not be determined for 5 coho because fish captured by hook and line were put in the holding pen which already contained coho captured by the fishwheel. When these coho were radio-tagged, study personnel could not identify the type of capture.

A second group of seven coho were captured by hook and line at R.M. 31 on August 15 and tagged with a jaw tag and radio transmitter. These coho had readjusted to the freshwater environment and had begun to mature sexually. All of these fish exhibited external characteristics of coho nearing spawning such as dark pink or red bodies, imbedded scales and a pronounced kype on the males.

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

Only four or 9.5% of the 42 coho radio tagged at the fishwheel reached the Lake Creek confluence. Three of these fish were captured in the fishwheel and the other was caught on hook and line. Only two of the four coho which reached the Lake Creek confluence migrated past the Parks Highway bridge at R.M. 70 and only one fish reached the main spawning area which begins at R.M. 85. One coho was recaptured by an angler at the Lake Creek confluence 24 days after being released. Average upstream migration rates of the four coho ranged from 1.3 to

3.4 miles per day with a mean rate of 2.2 miles per day. Maximum upstream migration rates ranged from 3.3 to 5.9 miles per day and averaged 4.9 miles. These migration rates are similar to the 1.8 average and 4.8 maximum miles per day migration rates recorded for seven radio-tagged coho in the Little Susitna in 1982 (Bentz, 1983).

Twenty-four of the remaining 38 coho radio tagged at R.M. 20 which did not reach the Lake Creek confluence migrated upstream after release from 1 to 13 days. Upstream movement then ceased and the fish moved downstream past the release site and were recorded on the data logger located at R.M. 19. This downstream movement began within 7 days after release for 88% of the fish. They remained below the data logger for the duration of the telemetry study and were presumed dead. Mortality was probably caused by stress from capture and handling during tagging operations. Five radio-tagged coho moved downstream immediately after release and remained there throughout the study and were also presumed dead.

Seven radio-tagged coho migrated upstream from 1 to 22 miles, ceased all movement and the transmitter location remained constant for the duration of the study. This lack of movement could have been caused by the death of the fish and the carcass, still containing the transmitter, being lodged out of view of the tracking personnel. A more probable cause is that the fish regurgitated, or forced the transmitter from its stomach, and the transmitter sank to the river bottom where it became lodged. Three coho regurgitated the radio transmitter within 6 hours after transmitter insertion while being held in the recovery tank at the fishwheel. Other coho telemetry researchers in Alaska have also experienced regurgitation problems (Carl Burger, pers. comm., 1982). Two radio transmitters failed within 48 hours after entering the water due to a frequency change or leak in the transmitter capsule and the fish were not located again.

Five or 71.4% of the seven coho radio-tagged at R.M. 31 reached the Lake Creek confluence. All of these fish migrated past the Parks Highway bridge and four reached the main spawning area which begins at R.M. 85. Average upstream migration rates ranged from 1.3 to 2.1 miles per day with a mean rate of 1.9 miles per day. Maximum upstream migration rates ranged from 2.3 to 6.8 miles per day and averaged 4.1 miles per day.

Of the remaining two coho radio tagged at R.M. 31 which did not reach the Lake Creek confluence, one fish migrated upstream 0.8 miles in 2 days and the radio signal was not located again during the study. Presumably the transmitter failed. The other fish migrated upstream 2.8 miles in 6 days and remained at this location for 8 days. It then moved downstream 4.5 miles in 2 days and the radio signal was not located again.

There was a significant difference between the two groups of coho radio tagged in response to stress from capture and handling. The coho tagged at R.M. 31, which had presumably completed the complex osmoregulatory changes associated with re-entering freshwater, were able to recover

from these tagging stresses and continue upstream with the main body of untagged coho to the spawning area. The coho radio tagged at the fishwheel were probably already undergoing natural osmoregulatory stress and were not able to cope with the additional stresses from capture and handling. These findings are similar to the results of experiments conducted on two groups of coho in different phases of sexual maturation in 1983 (Bentz, 1984). Coho which have just re-entered fresh water are very fragile. Any studies involving capture or handling of coho during this period must be designed to eliminate stress as much as possible to ensure survival and normal behavior after release.

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