Volume 24 Study G-I-D

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

INVENTORY AND CATALOGING OF THE SPORT FISH AND SPORT FISH WATERS IN UPPER COOK INLET

by

Robert W. Bentz, Jr.

ALASKA DEPARTMENT OF FISH AND GAME
Don W. Collinsworth

SPORT FISH DIVISION
Richard Logan, Director

Volume 24 Study No. G-I

RESEARCH PROJECT SEGMENT

State ALASKA Name: Sport Fish Investigations of Alaska

Project No.: F-9-15

Study No.: G-I Study Title: INVENTORY AND CATALOGING

Job No.: G-I-D Job Title: Inventory and Cataloging of the Sport Fish and Sport Fish Waters in Upper Cook Inlet

Cooperator: Robert W. Bentz, Jr.

Period Covered: July 1, 1982 to June 30, 1983

ABSTRACT

Relative growth and survival rates, determined by early winter gillnetting, are presented for coho salmon, Oncorhynchus kisutch (Walbaum), and chinook salmon, Oncorhynchus tshawytscha (Walbaum), captured in five Matanuska-Susitna Valley managed lakes. Pertinent historical data regarding stocking size, time, densities and catch rates are examined.

A chinook salmon creel census was conducted on five streams for the fourth consecutive year. Total harvest and effort estimates were 1,928 chinook and 11,575 angler-days, respectively. The male to female sex ratio was 1.3 to 1.0. Examination of 686 scales revealed that 61 percent of the sport-caught chinook over 20 inches in length were Age 1.4.

Chinook salmon escapement counts were conducted by foot and aerial surveys on 19 streams. Estimated chinook escapement was the third highest since 1973.

A coho salmon creel census was conducted on the Little Susitna River for the second year. An estimated 7,308 fish were harvested in 8,666 angler-days of effort. Harvest and effort estimates at the Burma Road access site increased 87 percent and 128 percent, respectively, from 1981 to 1982. This doubling of effort is a direct result of the improved access road to the river. Coho spawning escapement was estimated at 6,800. The sport fishery harvested 52 percent of the total return.

Coho salmon life history studies on the Little Susitna were initiated to determine run timing and movement through the sport fishery and identify important holding areas and major spawning areas. Two capture and release tagging programs were conducted in the lower river utilizing Petersen disc tags and low frequency radio transmitters to monitor migration movements.

A creel census at Cottonwood Creek, a weekend-only fishery, estimated 1,895 coho salmon and 258 sockeye salmon, Oncorhynchus nerka (Walbaum), were harvested in 2,440 angler-days of effort. Forty-eight percent of the total coho salmon return was harvested by the sport fishery.

Coho escapement counts were conducted in established index areas. Counts in 1982 were the highest recorded since 1971.

KEY WORDS

Southcentral Alaska, chinook, coho, sport fishery, management, harvest, effort, escapement, stocked lakes.

BACKGROUND

Stocked Lake Evaluation

A fish stocking program was initiated in 1960 to provide angling opportunities in landlocked lakes lacking game fish populations in the Matanuska-Susitna Valleys. Lakes within this area exhibit a broad spectrum of environmental conditions ranging from deep and infertile to very shallow and rich in nutrients. The presence or absence of sticklebacks, a competitor species, in each of the lake types introduces an additional variable.

In an effort to determine the optimum productive capabilities of each of the various lake types, numerous studies have been conducted since the program began. Factors such as stocking density, size of fish stocked, time of stocking and multiple species stocking have been tested through actual stocking experiments throughout the range of lake environments. Results from these experiments have been utilized to develop strategies to maximize production of game fish populations in the specific environment into which they are stocked. Presently, 11 Matanuska-Susitna Valley lakes are stocked annually with approximately 235,000 coho salmon, while four lakes receive Arctic grayling.

In May 1981, chinook salmon fingerlings were stocked for the first time in landlocked systems in the Matanuska-Susitna Valleys. Victor, Rocky and Memory Lakes received equal numbers of nearly equal size chinook and coho fingerlings at stocking densities ranging from 50 to 104 fish/acre. After 5 months' residency, fish samples were collected from the three lakes and species identification was determined by electrophoretic analysis. Preliminary findings indicated higher survival and growth rates for chinook salmon. These three lakes were sampled again in 1982 to determine if this trend continued.

Stocked game fish populations are sampled each fall to evaluate survival, growth and stocking densities. Chemical parameters are monitored during winter months in lakes having a history of low dissolved oxygen. The results of these evaluations are used to determine future management decisions to maintain or improve the quantity and quality of sport fishing.

Chinook Salmon Studies

Susitna River chinook salmon, the largest single component of the total Cook Inlet chinook salmon run, were reduced to remnant conditions in the 1960's due to probable overharvest during the 1940's and 50's. Intensive management of these stocks was initiated in the early 1960's through extensive closures of commercial and sport fisheries. Further protection of these stocks was attained in 1973 when the Alaska Board of Fish and Game closed the sport and commercial chinook fisheries in upper Cook Inlet.

Results of these management efforts first appeared in 1976 when large increases in chinook salmon numbers were recorded in Susitna River spawning streams. High escapements were again observed in 1977 and 1978. Responding to this population increase, the Board of Fisheries allowed a limited sport fishery in 1979 on five streams within the Matanuska-Susitna Valleys.

Chunilna Creek and the Little Susitna River were opened to fishing 7 days a week from the fourth weekend in May through July 6. Caswell, Montana and Willow Creeks were opened on Saturdays and Sundays for 4 consecutive weekends commencing on the second Saturday in June.

A maximum catch quota was established for the five streams as follows: Willow, Montana and Chunilna Creeks, 300 each; Little Susitna River, 1,000; and Caswell Creek, 200. A non-transferable harvest card was a mandatory requirement for participation in these fisheries. The daily bag and possession limit was one chinook salmon and five per season over 20 inches in length. The seasonal limit applied to all waters of the Cook Inlet area. The streams open to chinook fishing, fishing seasons, harvest quotas and the mandatory harvest card requirement have remained constant since 1979. In 1980, the daily bag and possession limit was changed to two chinook over 20 inches in length, one of which could exceed 28 inches. A chinook salmon/steelhead permit requirement was also instituted. A reduced daily bag limit coupled with a more liberal possession limit was the only regulatory change in 1981. The daily bag limit was one chinook 20 inches or more in length and two in possession. The 1982 regulations remained identical to those in 1981.

During these 4 years, these fisheries were monitored closely on a day-to-day basis as instructed by the Board of Fisheries, for enforcement purposes, and to ensure that individual stream quotas were not exceeded and adequate escapement attained. Biological data such as angling effort, harvest, sex and age composition information were also collected. Results from previous years were relied upon to design more effective and efficient creel census programs.

Coho Salmon Studies

Coho stocks of the upper 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 this decline. 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 stock 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 upper Cook Inlet coho salmon populations began to increase substantially in 1975. Escapement counts in 1980 were the highest since these counts were initiated in the early 1960's.

There are approximately 25 streams within the management area of this project that currently sustain a sport fishery for coho salmon. The most important stream within this area and probably within the whole upper Cook Inlet area is the Little Susitna River. Data from the Statewide Harvest Study (Mills, 1978-1982), an annual publication of sport fishing effort and harvest, indicates that 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 river provides an exceptional opportunity to harvest coho in an aesthetically pleasing manner, and the waterway's physical features would accommodate substantial recreational use without excessive congestion. More than 70 miles of river are available for boat fishing. The Little Susitna coho are among the largest in upper Cook Inlet and are therefore highly prized by sport anglers.

The Statewide Harvest Study shows that fishing effort for all species on the Little Susitna has increased 136% over 5 years from 11,063 angler-days in 1977 to 26,162 angler-days in 1981. Harvest levels have also risen during this period with 3,415 coho taken in 1977, rising to 5,950 in 1981 which represents a 74% increase.

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 Lands 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 and recreation as the primary land uses.

The importance of 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 (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 ADG&f 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.

A statistically designed coho salmon creel census program was initiated in 1981 to estimate harvest and effort for this rapidly growing fishery. This creel census program was expanded and continued during the 1982 fishery. In addition to the creel census program, a life history study was initiated in 1982 to identify various aspects of the Little Susitna River coho salmon

adult population which included: run timing and movement through the sport fishery; migration rates and important holding areas; and major spawning areas and escapement counts.

To accomplish these objectives the study was divided into three segments. Two capture and release tagging programs were conducted simultaneously. Beginning in late July, adult coho salmon were captured in the lower river, just above the intertidal zone, where sport fishing effort began. The majority of these fish were tagged with a numbered Petersen disc 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 ongoing creel census programs.

A second group of captured adult coho salmon were tagged with a numbered Petersen disc and a low frequency radio transmitter prior to release. Upstream migration of these radio-tagged fish was monitored twice weekly with radio receivers to determine rates of migration through the sport fishery and to identify important holding or milling areas and mainstream and tributary spawning areas.

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.

The second coho salmon creel census that was initiated in 1981 and continued in 1982 was conducted on Cottonwood Creek. This system's coho population had been reduced to remnant conditions similar to the majority of upper Cook Inlet coho populations. To protect these remaining stocks in Cottonwood Creek, sport fishing regulations were tightened in 1971 when a single-hook-only stipulation coupled with weekend-only fishing in the lower section of stream open to fishing, were adopted by the Board of Fisheries. These regulatory changes served to reduce the catch efficiency of the anglers' gear and also reduced the available fishing time. This was a management attempt to reduce the sport fish harvest and increase escapement into the upstream spawning areas.

An enhancement program developed by the F.R.E.D. Division was initiated in 1977 to supplement natural production in the Cottonwood Creek system. Eggs were taken from Fish Creek coho salmon, incubated at the Big Lake Hatchery and the resulting fry released throughout the Cottonwood system in favorable lentic rearing areas. In 1982 eggs were taken from Cottonwood Creek coho salmon. The fry releases have continued on an annual basis since 1977 with an average number of 320,000 fry released each year.

Escapement counts conducted annually indicate that the strict regulations coupled with the enhancement effort are increasing coho salmon populations in Cottonwood Creek.

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

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

Common Name	Scientific Name and Author	Abbreviation
Arctic grayling	Thymallus articus (Pallus)	GR
Chinook salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Chum Salmon	Onchorhynchus keta (Walbaum)	CS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Sockeye salmon	Onchorhynchus nerka (Walbaum)	RS
Threespine stickleback	Gasterosteus aculeatus Linnaeus	TS

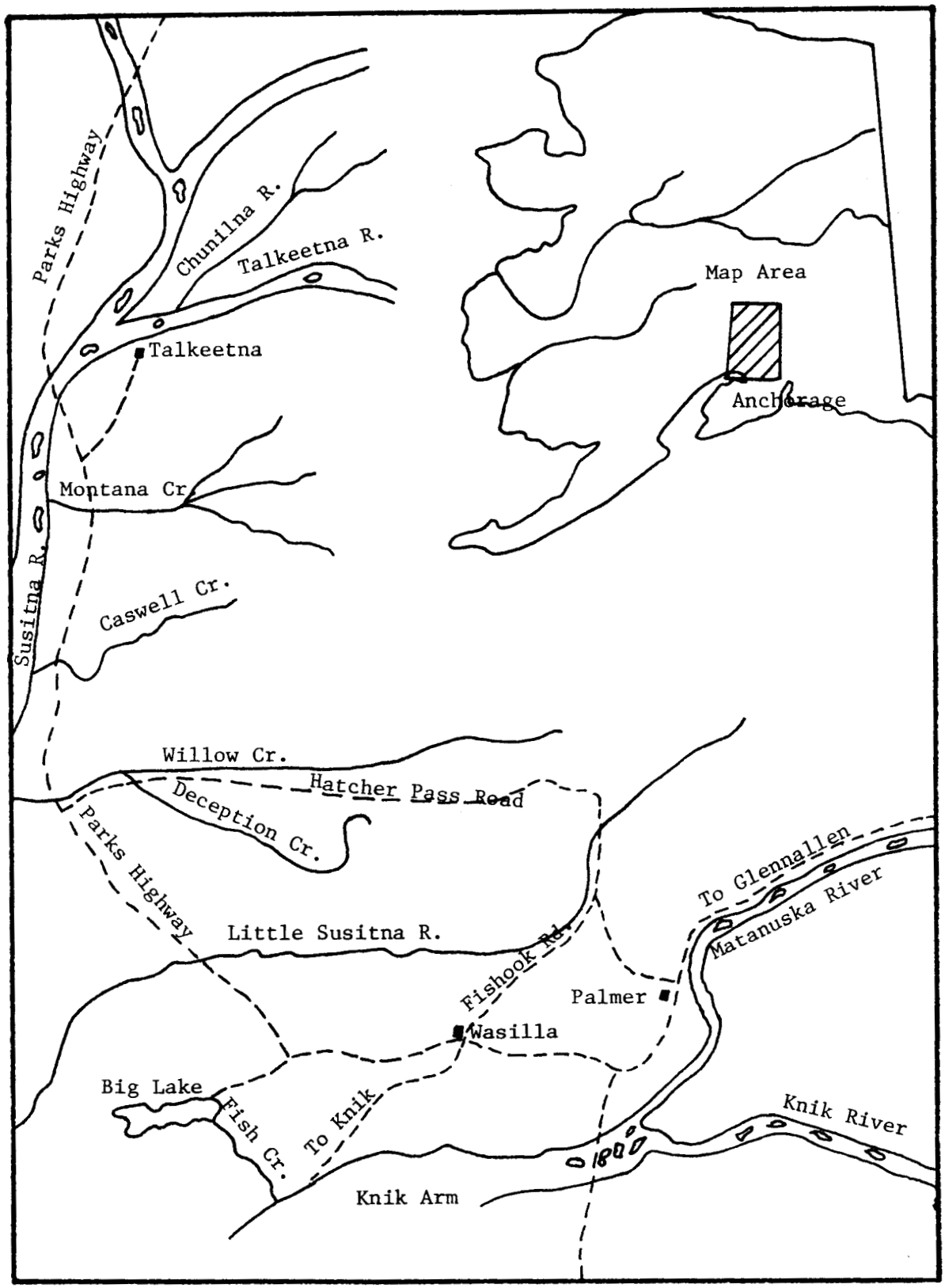

Figure 1. Study Area in Matanuska-Susitna Valleys.

Complete analysis of the 1982 chinook and coho salmon creel census data was not completed in time for inclusion in this report. Pertinent data will be included in next year's report.

RECOMMENDATIONS

1. A creel census should be continued on the five streams open to chinook salmon fishing to determine angler effort and harvest and to ensure harvest quotas are not exceeded.

2. The two coho salmon creel censuses should be continued to determine angler effort and harvest.

3. Studies on the Little Susitna River coho salmon should be continued and expanded to determine run timing, migration rate through the fishery and escapement surveys for development of future enhancement programs and management plans.

4. Escapement surveys for coho and chinook salmon in selected streams should be continued to evaluate results of current management practices.

5. Catalog and inventory of waters in the rapidly developing Point McKenzie area should be initiated to aid in development management guidelines.

6. Further evaluation of stocking chinook salmon in landlocked lakes should be conducted.

OBJECTIVES

1. To determine levels of abundance of anadromous and resident fish stocks and to evaluate densities to determine optimum levels necessary for maintenance of these stocks.

2. To determine anadromous fish harvest levels and fishing effort on selected streams in the job area.

3. To determine and record environmental characteristics of existing and potential fishery waters of the job area.

4. To make recommendations for the proper management of various sport fish waters in the area and to direct future studies.

TECHNIQUES USED

Stocked Lake Evaluations

Monofilament gill nets 6 ft x 135 ft, having six mesh sizes ranging from 1/2 in to 2 in bar measure, were used to collect fish specimens from stocked lakes. Nets were normally set for approximately 24 hours in each lake. All captured fish were weighed to the nearest gram and snout to fork lengths were recorded to the nearest millimeter.

Electrophoretic analysis was utilized to differentiate between chinook and coho salmon which were stocked in three lakes due to the disappearance of external identifying characteristics which had been present at the time the fish were stocked. The analysis was conducted at the Alaska Fish and Wildlife Protection Crime Laboratory located in Palmer. Eye extracts were phenotyped for one enzyme, phosphoglucose isomerase. Previous studies have shown that this enzyme can differentiate between chinook and coho salmon with less than 5% chance of error (May, 1975).

Chinook Salmon Studies

Chinook salmon creel censuses were statistically designed to estimate harvest and effort on four of the five streams open to chinook salmon fishing. Budget limitations precluded a complete census at Caswell Creek in 1982. Harvest and effort estimates for this stream were derived through periodic inspections of the fishery several times a day throughout the fishing season. Biological data were not obtained from Caswell Creek chinook.

Since the area open to chinook salmon 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.

At the Burma Road access site on the Little Susitna River and at Chunilna Creek, the two streams open to fishing on both weekdays and weekends, the sampling day was divided into five 4-hour periods between the hours of 4:00 a.m. and 12 midnight. Two random, preselected periods were sampled on 4 weekdays of each week. On weekend days and holidays all five periods were sampled. At the Parks Highway access site on the Little Susitna River, the sampling day was divided into four 5-hour periods between 4:00 a.m. and 12 midnight. One random period was sampled on 3 random weekdays of each week while two periods were sampled on weekend days and holidays. Weekday and weekend estimates were developed separately and then summed for the total estimate. On the two streams open to fishing on weekends only, the entire 24-hour period was sampled each day.

Randomly scheduled angler counts were conducted during sampling periods on those stream areas that received the greatest fishing intensity. Angler count information is necessary to estimate total fishing effort and

harvest. Frequency of the counts varied at each stream depending on the length of time required to complete a count.

During sampling periods only completed anglers were interviewed. Information collected from anglers included: number of hours fished; number and species of fish caught; and whether they were boat or shore anglers. Chinook salmon over 20 inches in length were weighed to the nearest 0.1 pound and measured from the tip of snout to fork of tail and from mid-eye to fork. Both measurements were recorded to the nearest 0.5 cm.

Scales were collected from all fish over 20 inches in length and placed in coin envelopes with appropriate biological data recorded on each envelope. The scales were mounted on gum paper and then pressed onto plastic acetate. Age determinations were accomplished using a Bruning Model 200 microfiche reader. The European method was used to denote anadromous salmon age classes.

Chinook salmon spawning populations were enumerated by aerial, boat and stream bank surveys. Ease of access determined the survey type for the various streams.

Chinook salmon carcass data were collected on three streams in 1982. Age structure of spawning populations was determined from length measurements. A chinook salmon fishery from 1979 through 1981 on four east side Susitna River tributaries has enabled collection of scales from these streams to analyze the accuracy of assessing age by length frequency distribution only. The Little Susitna River was included in the analysis because it is an upper Cook Inlet stream although it is not a tributary of the Susitna River.

The length frequency classes used to determine age classes are as follows: Age 1.2 (51-75 cm) Age 1.3 (76-95 cm) and Age 1.4 (96 cm and over). These are the dominant age groups of Susitna River chinook salmon. However, there are occasionally other age groups encountered with an additional year in saltwater or freshwater which will introduce minor errors in the analysis because these uncommon age groups cannot be accounted for when using the length frequency method.

Coho Salmon Studies

The statistically designed coho salmon creel censuses to estimate harvest and effort on two streams were similar to the chinook salmon censuses except for sampling periods. On the Little Susitna River which was open to fishing throughout the week, the sampling day was divided into two periods, from 6:00 a.m. through 2:00 p.m. and 2:00 p.m. through 10:00 p.m. At the Parks Highway census site, one randomly selected period was sampled on 3 weekdays of each week and every weekend day and holiday. At the Burma Road access site five randomly selected periods were sampled during weekdays each week while both periods were sampled each weekend day and holiday. Harvest and effort estimates were calculated separately for weekdays and weekends at each access point and then summed.

The Cottonwood Creek coho salmon fishery was open only on weekends. The sampling period was from 4:00 a.m. through 10:00 p.m. every weekend day.

Angler counts similar to those done during chinook censuses were conducted on foot at both streams in those areas which received the greatest fishing intensity. Additional angler counts were conducted by boat from the Burma Road access site to estimate fishing effort by anglers that boated across Knik Arm 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 per week during scheduled sampling periods.

Angler interviews were identical to those conducted during the chinook salmon creel censuses. All coho salmon were weighed and measured and scales were taken for age determinations.

Effort estimates for Anchorage based anglers were derived from actual count data of Anchorage anglers and Burma Road boat anglers in the lower river. A direct expansion proportion was then developed from Burma Road boat angler creel census effort data to determine total effort estimates of Anchorage anglers, since no census interview data were collected from these anglers. This direct proportion was not used to estimate harvest. Anchorage anglers fished for a longer time period than Burma Road boat anglers because they had to wait for the next high tide before they could safely cross Knik Arm.

Harvest estimates for Anchorage anglers were determined through calculating the total possible fishing hours of Anchorage anglers using the downriver angler data. The harvest per hour figure for Burma Road boat anglers was then used to estimate total harvest of Anchorage anglers. This extrapolation was felt to be fairly accurate, since both groups of anglers were fishing from boats in the same areas of the river throughout the majority of the fishing season.

Hook and line methods, using salmon egg clusters as bait, were utilized to capture adult coho salmon in the lower river for both tagging studies. Each coho, which was to be Petersen-disc-tagged only, was placed immediately in a canvas tray. With the fish immobilized in the tray, the sex was determined, a snout to fork measurement was recorded and a yellow, 1 inch diameter numbered tag was attached through the interneural rays just below the dorsal fin. The fish were returned to the water immediately after tagging and held lightly by the caudal peduncle while recovering.

The low frequency radio telemetry equipment utilized was produced by Smith-Root Inc. of Vancouver, Washington. This equipment consisted of automatic scanning receivers which monitored 15 frequency channels simultaneously, manual tracking receivers and a data logger which 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.

The encapsulated radio transmitters implanted in coho salmon were cylindrical measuring 7.5 cm long and 1.5 cm in diameter and weighed 22 g out of water. An external antenna approximately 10 cm long was attached to the transmitter. Lithium batteries with 80 to 90-day life expectancies powered the transmitters. The transmitters were set over 15 separate channels, each channel with three different pulse rates which allowed a total of 45 unique signals.

Fish which were captured to receive both a Petersen disc and radio transmitter were 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 anesthetizing in the cooler, snout to fork measurements were taken, sex determined and green disc attached. When the coho exhibited a loss of equilibrium and could no longer right itself, it was removed from the cooler for insertion of the radio transmitter. Time in the cooler averaged 7.5 minutes for anesthetization.

Two transmitter insertion techniques, a stomach insertion and a surgical implant, were utilized. Coho which received a transmitter directly into the stomach were held on their back with the lower jaw raised. A radio transmitter which had been dipped in glycerin was gently inserted past the esophogeal sphincter and into the stomach until it was no longer visible. The external antenna extended through the esophogeal sphincter and into the mouth where it was attached to the roof of the mouth with a stainless steel fishhook. After insertion the fish was immediately returned to the river and held lightly by the caudal peduncle until it had recovered sufficiently to swim out of this grasp.

Coho salmon which received a surgically implanted radio transmitter were removed from the cooler when fully anesthetized and laid on their back in an inclined canvas holding tray. This allowed the internal organs and sex products to slide both forward and against the dorsal side of the peritoneal cavity away from the ventral surface where the incision would be made. A 3 to 4 cm incision was then made on the ventral mid-line just anterior to the pelvic girdle. The transmitter and external antenna, which had been immersed in a betadine solution to aid in preventing infection, was inserted into the peritoneal cavity.

After the transmitter had been inserted into the peritoneal cavity, a broad spectrum aqueous procane penicillin G solution was applied into and around the incision. The incision was sutured with noncapillary, non-absorbable suture material and a #6 3/8 circle cutting suture needle. The fish was then released into the river as described earlier.

Coho salmon were captured and tagged with radio transmitters from August 2 through August 13, 1982. Migration movements were monitored twice weekly using radio receivers from August 3 through September 14, and also on September 21 and October 5. When the majority of radio-tagged coho were concentrated in the lower river, tracking was conducted by boat to determine upstream movement. Later when the tagged fish had distributed themselves throughout the river and low flow conditions made boat tracking impractical, tracking was conducted by low level aerial flights. The automatic data logger was operated from the creel census field camp which was located one river mile upstream from the Burma Road access site. The printout tape was checked every 24 hours to determine if radio-tagged coho had migrated past that point.

During both tagging techniques, each fish was handled for approximately 2 minutes for measurements and Petersen disc attachment. The time the fish was out of water for radio transmitter insertion varied between techniques. This critical time period out of water averaged 1:15 and 2:30 minutes for the stomach insertions and surgical implants, respectively.

Coho salmon spawning populations were enumerated by foot surveys within established index areas on major streams within the area. Enumeration of spawning coho in the Little Susitna River was accomplished by helicopter surveys.

FINDINGS

Stocked Lake Evaluation

In 1982 five stocked lakes containing landlocked salmon were sampled with variable mesh gill nets to determine relative growth and survival rates (Table 2). Three of these five lakes were stocked in 1981 with equal numbers of chinook and coho salmon. All three lakes were rehabilitated with rotenone, and Memory and Victor Lakes have remained free of sticklebacks, while Rocky Lake has been reinfested.

Results from the electrophoretic analysis conducted in 1981, after 5 months' lake residency, indicated that the Age 0+ chinook salmon fingerling experienced relatively higher survival and growth rates than the Age 0+ coho salmon stocked in the same lake. Age 0+ chinook salmon fry comprised 82%, 71% and 45% of the sample populations from Victor, Memory and Rocky Lakes, respectively, and averaged 186 mm in length while Age 0+ coho fingerling averaged 163 mm in length (Bentz, 1982).

After an additional 12 months' residency in these three lakes, the two salmon populations were sampled a second time for further comparative analysis. Species identification was once again determined by electrophoretical procedures. Three chinook salmon were identified out of a sample size of 35 from Memory Lake and no chinook were identified from samples of 16 and 4 specimens from Rocky and Victor Lakes, respectively. During the 12-month period between samples, the percentage of chinook salmon within the combined sample populations of all three lakes decreased from 65% to only 5%.

It seems unlikely that an environmental condition such as low dissolved oxygen later during the winter or a disease outbreak could nearly exterminate the chinook salmon populations in all three lakes while the coho salmon populations remained immune. One possible explanation may be that because the chinook salmon grew faster after stocking and reached a catchable size earlier than the coho salmon, they experienced a disproportionately higher harvest mortality.

In an effort to determine the causes for this differential mortality, four landlocked lakes within the Matanuska-Susitna Valley are scheduled to be stocked with chinook and coho salmon in 1983. Each species will receive a distinctive fin clip so visual identification can be made without the need for the time intensive electrophoretic analysis. Samples to determine relative growth and survival rates will be collected more frequently, and a limited creel census program will be developed to determine the relative proportions harvested by anglers.

Age 0+ coho salmon stocked in Finger and Lucille Lakes at 300 fish/lb averaged 128 mm and 111 mm in length, respectively, after 6 months

Table 2. Summary of Recent Stocking History and Gill Net Results of Matanuska-Susitna Valley Lakes Sampled in 1982.

Lake	Date Sampled	Species	Age Class	n	Length (mm) x	Length (mm) Range	Weight (gm) x	Weight (gm) Range	Catch/ Net Hr.	Date Stocked	Total Number	Fsih/ Lb.	Fsih/ Acre
Finger	11/18/82	SS	0+	49	128	100-149	28	15-47	1.00	5/21/82	72,400	300	200
			I+	96	220	172-263	122	62-189	1.96	5/13/81	72,952	330	202
			II+	2	332	314-331	411	373-450	0.04	5/7/80	44,177	140	120
Lucille	11/19/82	SS	0+	8	111	97-130	15	10-26	0.09	5/21/82	72,400	300	200
										8/9/82	32/000	162	88
			I+	42	212	150-275	116	40-230	0.046	5/13/81	72.838	310	201
			III+	11	318	294-354	375	302-506	0.12	5/21/79	72,500	670	200
			IV+	4	478	396-572	1,338	720-2,300	0.04	5/23/78	72,527	627	200
Memory**	11/23/82	SS	0+	14	131	112-160	25	14-52	1.56	5/21/82	12,400	300	149
		SS*	I+	32	237	207-271	145	96-212	2.33	5/29/81	8,300	26	100
		KS*	I+	3	222	216-228	120	108-134	0.33	5/26/81	8,300	33	100
Rocky	11/24/82	SS	0+	4	108	106-110	13	12-13	0.57	6/15/82	3,135	253	53
		SS*	I+	14	241	204-274	167	109-256	0.20	5/26/81	2,950	33	50
		SS*	III+	1	321	...	378	...	0.01	5/23/79	5,900	650	100
		SS*	IV+	1	387	...	740	...	0.01	7/11/78	8,900	277	152
Victor	11/23/82	SS	0+	31	150	122-200	43	22-104	0.82	5/21/82	2,700	300	200
		SS*	I+	4	362	342-387	642	520-784	0.11	5/26/81	1,400	26	104

* Species identification determined by electrophoretic analysis.

** Gill nets set for 9 hours only. Number of Age I+ SS and KS includes 14 fish collected by hook and line.

residency in the lakes. The average length increased in Finger Lake when compared to the previous year while a decrease was observed in Lucille Lake.

After 18 months' residency in Memory, Rocky and Victor Lakes, Age I+ coho salmon stocked at 26 fish/lb averaged 237, 241 and 362 mm in length, respectively, while Age I+ coho from Lucille and Finger Lakes stocked at 310 and 330 fish/lb averaged 212 and 220 mm in length, respectively.

Chinook Salmon Studies

Creel Census:

A chinook salmon creel census was conducted at the Little Susitna Burma Road site from May 29 through July 6, and at the Little Susitna Parks Highway site and Chunilna Creek from June 19 through July 6. Two weekend-only streams, Montana and Willow Creeks, were censused only during the last 3 weekends of the season. Run timing of chinook salmon at these streams during the previous 3 years indicated that few fish were available at the beginning of these fisheries which enabled the 1982 census schedule to be shortened to coincide with the arrival of the fish. Since the census covered only those periods when chinook salmon were available to anglers, estimated angling effort is somewhat less than what actually occurred during the entire fishery.

Angling effort and catch estimates were derived from 4,030 completed angler interviews which represented 35% of the total estimated effort. The most complete interview coverage occurred at the two streams open to fishing on weekends only, Montana and Willow Creeks, where 99% and 95% of the total estimated number of anglers were interviewed, respectively. The lowest coverage occurred at the Little Susitna River where 1,819 anglers, or 25% of the total estimated number of anglers were interviewed. Interviewed anglers harvested 843 chinook salmon which represents 44% of the total estimated catch. On the two weekend-only streams, which were censused 24 hours daily, 96% of the total estimated harvest was checked.

Total chinook salmon harvest for the five east side Susitna River streams was estimated at 1,928 with 11,575 angler-days of effort and an average harvest per hour and per angler-day of 0.038 and 0.17 respectively (Table 3). Harvest rates per angler-day on the five streams ranged from 0.10 at Montana Creek to 0.77 at Willow Creek. Age and biological data for harvested chinook salmon are summarized in Table 4.

Boat and shore anglers at the Burma Road access site on the Little Susitna River harvested 206 chinook with 2,300 angler-days of effort at a harvest rate of 0.09 fish per angler. Anglers from Anchorage that boated across Knik Arm expended 1,005 angler-days to harvest 103 chinook, a harvest rate of 0.10 fish per angler-day. Boat and shore anglers at the Parks Highway harvested 483 chinook with 3,880 angler-days at a harvest rate of 0.12 fish per angler-day. The number of anglers who floated downstream from the Parks Highway to the Burma Road during the chinook fishery was estimated at 227 which represents 3.2% of the total angler effort. Estimated harvest by these anglers was 10 chinook or 1.3% of the total Little Susitna harvest.

Table 3. Effort and Harvest Data of the Chinook Salmon Sport Fisheries, East Side Susitna River Streams, 1982.

Stream	Quota	Harvest	Sex Ratio Male : Female	Effort Angler-Days	Harvest/Hour	Harvest/Stream Angler-Day
Caswell Creek	200	220	*	1,225	.041	0.18
Chunilna Creek	300	441	1.3 : 1.0	1,764	.067	0.25
Little Susitna River	1,000	792	1.3 : 1.0	7,185	.025	0.11
Montana Creek	300	85	2.8 : 1.0	897	.030	0.10
Willow Creek	300	390	1.0 : 1.0	504	.085	0.77
Total	2,100	1,928	1.3 : 1.0	11,575	.038	0.17

* Biological data were not collected from chinook salmon harvested at Caswell Creek.

Table 4. Chinook Salmon Age and Biological Data From Sport Fish Harvest for Four East Side Susitna River Streams, 1982.*

Stream	Age Class	% of Total Sample	Length Range (cm)**	Mean Length** (cm)	Weight Range (lb)	Mean Weight (lb)
Chunilna Creek	1.2	17	53- 70	61	4.5-11.0	8.1
	1.3	24	62- 93	78	8.5-27.0	17.7
	1.4	59	63-112	95	14.0-54.0	31.2
Little Susitna River	1.2	15	51- 68	60	5.0-13.0	8.9
	1.3	38	63- 96	83	8.0-32.0	21.9
	1.4	47	73-107	94	23.0-46.0	33.6
Montana Creek	1.2	55	49- 67	58	5.0-10.5	7.5
	1.3	16	63- 87	74	8.0-25.5	15.1
	1.4	29	87-107	94	21.5-44.0	30.2
Willow Creek	1.2	7	55- 69	61	6.0-12.0	9.0
	1.3	18	58- 96	81	6.5-38.5	20.5
	1.4	75	84-113	98	21.5-59.0	34.9

* Biological data were not collected from Caswell Creek chinook salmon.

** Measured from mid-eye to fork-of-tail to the nearest 0.5 centimeter.

Stable water conditions prevailed during the 1982 chinook season, whereas high turbid water characterized substantial portions of past seasons. This factor combined with an apparent strong run of chinook resulted in favorable fishing success at four of the five fisheries during 1982. The only stream where a successful fishery was not attained was Montana Creek. Only 85 chinook salmon were harvested during the 4-weekend season. Montana Creek did receive an average run, as determined by subsequent escapement counts, but the fish remained in the Susitna River and did not enter the creek until after the season had ended.

While the total estimated harvest of 1,928 chinook salmon for the five east side Susitna River streams did not exceed the total harvest quota of 2,100 chinook in 1982, the individual stream quotas of Caswell, Chunilna and Willow Creeks were exceeded. The harvest quotas at Caswell and Willow Creeks, which were open to fishing only on weekends, were reached and surpassed during the final weekend of the season when 30% and 42% of the total harvests were taken, respectively. At Chunilna Creek the harvest quota was exceeded during the final 4 days of the season when 66% of the total harvest was taken.

Weekly angling effort and harvest on the five streams are shown in Tables 5 and 6 and Figure 2. Combined effort for all five streams peaked during the week of June 19 through June 25 when 29.5% of the seasonal effort was expended and then declined slightly through the end of the fisheries on July 6. Chinook salmon harvests increased steadily during the course of the fisheries and reached a peak during the final 4 days when 43% of the total harvest occurred.

Figure 3 illustrates chinook salmon harvest by week from 1979 to 1982 for the five east side Susitna River streams combined. The sharp decline in harvest during the last 2 weeks of the 1980 and 1981 seasons was due to the emergency closure of three and two streams in 1980 and 1981, respectively, which reduced total effort. The steady harvest increase in 1982 is very similar to that of 1979. These are the only 2 years in which emergency closures of one or more streams did not occur.

The harvest per hour of all streams combined was 0.038 for the 1982 season which is identical to the combined 1981 harvest per hour. Harvest rates on individual streams varied slightly between 1981 and 1982.

Caswell and Montana Creeks exhibited slight increases in harvest per hour in 1982, while the Little Susitna River and Willow and Chunilna Creeks harvest rates decreased slightly from 1981. Combined effort on the five streams in 1982 decreased 21% from the 1981 effort and the combined harvest decreased 11% from 1981.

Population Structure:

Scales were collected from all chinook salmon over 20 inches in length and age was determined by scale analysis. Age 1.4 fish, which comprised 61% of the sport caught chinook over 20 inches in length, was the dominant age class in four streams in 1982.

Table 5. Eastside Seasonal Chinook Salmon Fishing Effort Percentages by Weekly Period, 1982.

Date	Chunilna		Little Susitna		Willow		Caswell		Montana		Total	
	Angler Days	%	Angler Days	%	Angler Days	%	Angler Days	%	Angler Days	%	Angler Days	%
5/22-5/28	*		*		Closed		Closed		Closed		0	0
5/29-6/4	*		295	4.1	Closed		Closed		Closed		295	2.6
6/5-6/11	*		359	5.0	Closed		Closed		Closed		359	3.1
6/12-6/18	*		948	13.2	35	6.9	185	15.1	75	8.3	1,243	10.7
6/19-6/25	379	21.5	2,242	31.2	89	17.7	388	31.7	312	34.8	3,410	29.5
6/26-7/2	662	37.5	1,832	25.5	202	40.0	369	30.1	260	29.0	3,325	28.7
7/3-7/6	723	41.0	1,509	21.0	178	35.4	283	23.1	250	27.9	2,943	25.4
	1,764		7,185		504		1,225		897		11,575	

* Creel census not conducted during this weekly period of season because few fish are available in stream at this time.

Table 6. Eastside Seasonal Chinook Salmon Harvest Percentages by Weekly Period, 1982.

Date	Chunilna		Little Susitna		Willow		Caswell		Montana		Total	
	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest	%	Harvest	%
5/22-5/28	*		*		Closed		Closed		Closed		0	0
5/29-6/4	*		26	3.3	Closed		Closed		Closed		26	1.4
6/5-6/11	*		74	9.4	Closed		Closed		Closed		74	3.8
6/12-6/18	*		135	17.0	2	0.6	40	18.2	5	5.9	182	9.4
6/19-6/25	7	1.5	218	27.5	32	8.2	55	25.0	7	8.2	319	16.5
6/26-7/2	142	32.3	65	8.2	192	49.1	60	27.3	34	40.0	493	25.6
7/3-7/6	292	66.2	274	34.6	164	42.1	65	29.5	39	45.9	834	43.3
	441		792		390		220		85		1,928	

* Creel census not conducted during this weekly period of season because few fish are available in stream at this time.

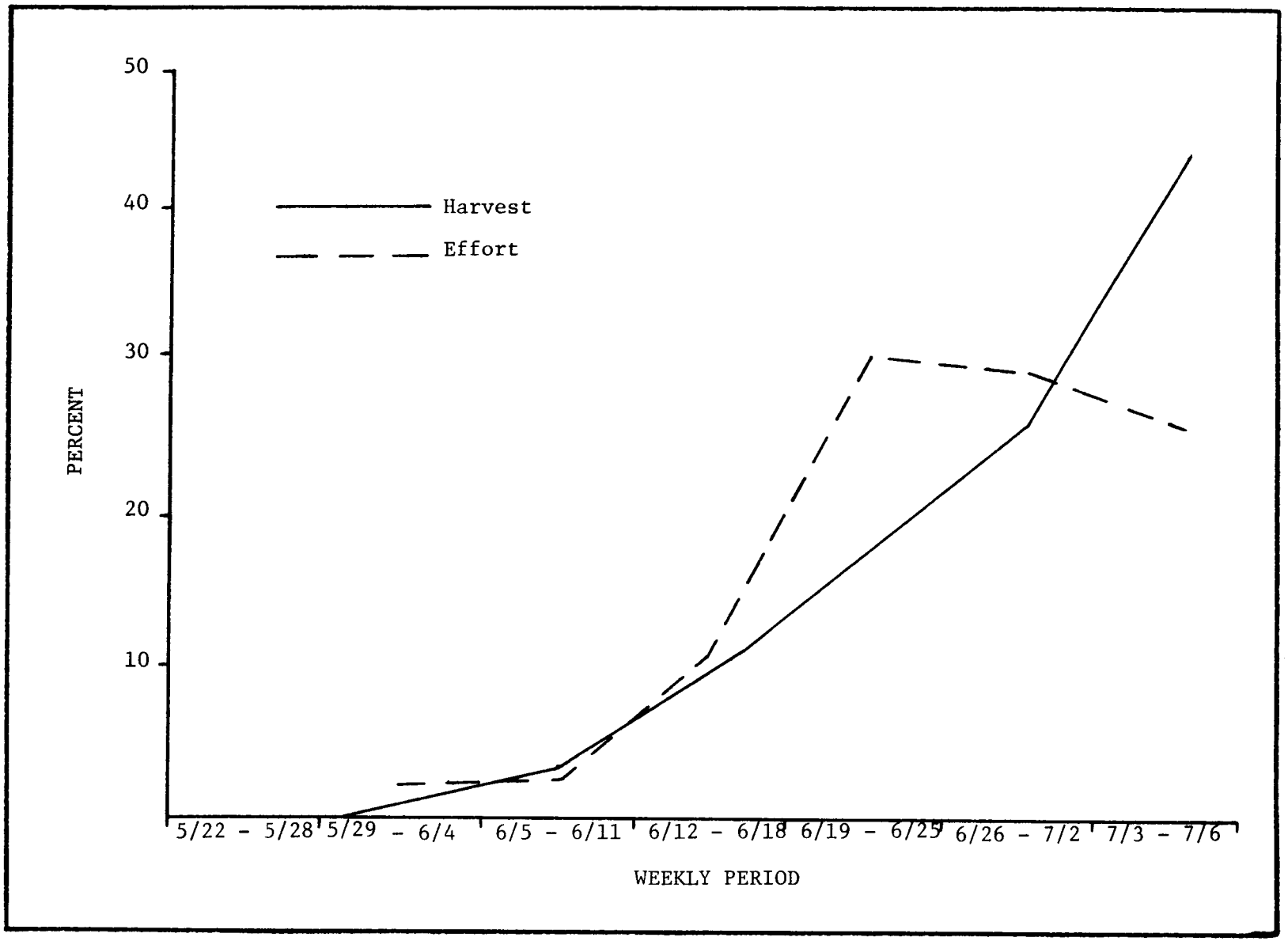

Figure 2. Chinook Salmon Harvest and Effort by Weekly Period, 1982.

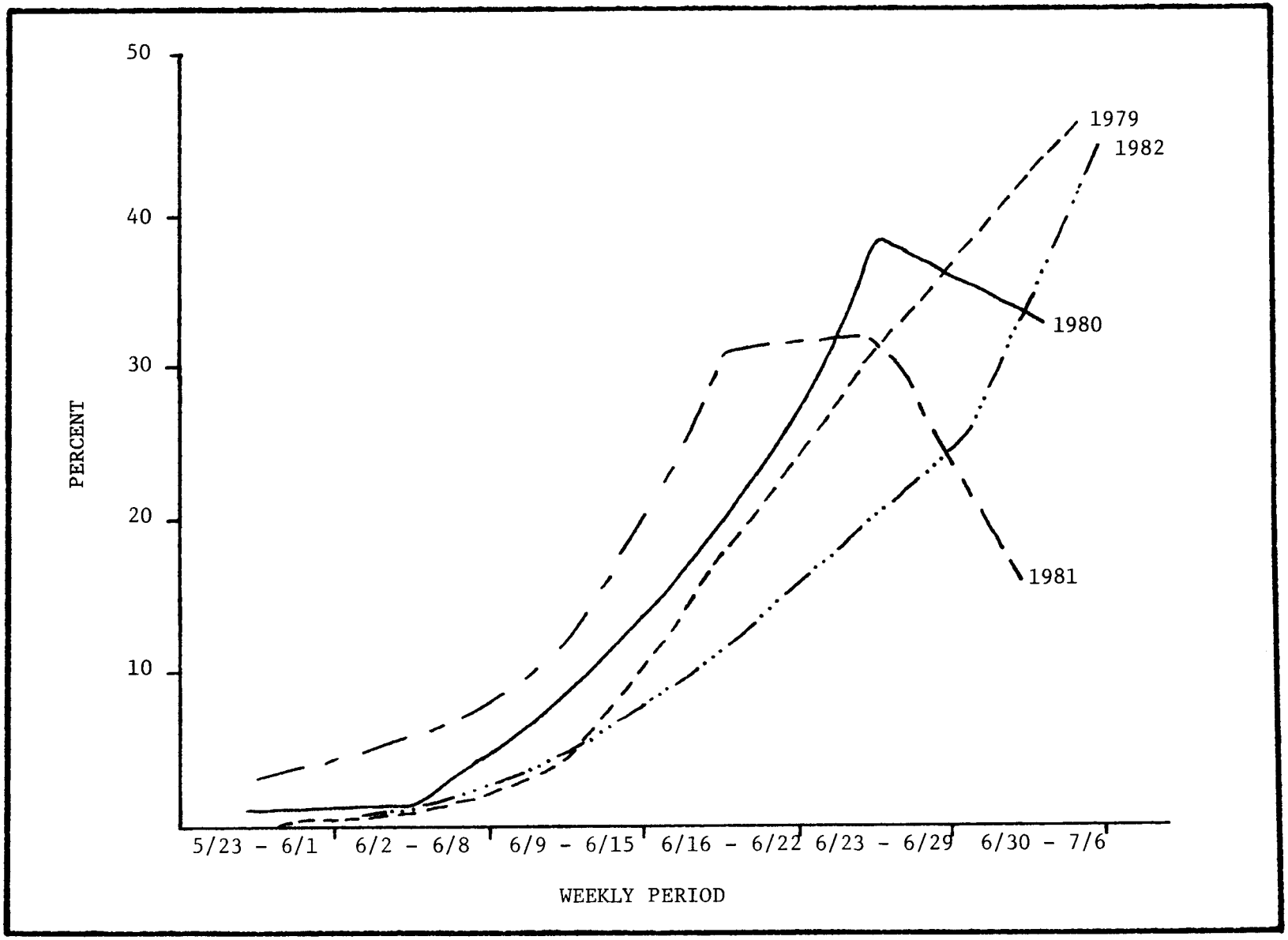

Figure 3. Chinook Salmon Harvest by Weekly Period, 1979 - 1982.

The strong showing of this age class was expected because these fish originated from the large 1976 parent escapement which previously had exhibited high returns in 1980 and 1981. It was thought that the 1977 escapement of 118,620 chinook, the highest in modern times, would likewise contribute a substantial return to the chinook population. This was not the case as determined from the sport harvest age analysis. In 1981 4-year-old chinook from the 1977 brood year composed 25% of the sport fish harvest, a decrease of 13% from the 1980 four-year-old harvest. During the 1982 sport fishery 5-year-old chinook from the 1977 brood year composed 23% of the harvest, again a 13% decrease from the 1981 five-year-old harvest which returned from the 1976 brood year.

These results may indicate that large escapements are not necessarily going to propagate even larger returns in an increasing stair step manner. Another explanation could be that there was some abnormal factor exerted on the 1977 brood offspring which caused significant mortality at some point in their life cycle.

The changes in chinook salmon age structure from 1979 to 1982 are listed in Table 7. In 1979, Montana and Willow Creeks and the Little Susitna River were strongly dominated by Age 1.4 fish (Watsjold, 1980). In 1980, the first year of adult returns from the 1976 parent escapement as four-year-old fish, this strong dominance of Age 1.4 fish began to diminish due to the return of large numbers of Age 1.2 chinook salmon. This trend continued in the 1981 fishery when the two age classes returning from large parent escapements (Age 1.2 and Age 1.3 fish) composed 65.0% of the chinook salmon harvested.

The 1982 season was the first year when all three major age classes returned from large parent escapements. Age structures dominated by Age 1.4 fish were reestablished at Chunilna and Willow Creeks where the 1982 age structure was nearly identical to that in 1979. The 1982 age structure of chinook harvested at the Little Susitna River did not shift toward Age 1.4 dominance but remained very similar to that of 1981 where the abundance of Age 1.3 fish in the sport harvest was comparable to the Age 1.4 fish.

Analysis of the age structure of 1982 chinook spawning populations by length frequency measurements was conducted on three streams (Table 8). Age class frequencies of spawning chinook at Willow Creek were nearly identical to the age classes harvested by anglers, while the age class frequencies of the Montana Creek spawning population differed sharply from the harvest age structure. This reversal from Age 1.2 fish in the harvest to older chinook in the spawning population was caused by two factors. First, the main body of chinook did not leave the Susitna River and enter Montana Creek until the scheduled fishery had ended. Therefore, the total chinook harvest contained a higher percentage of chinook "jacks" or smaller Age 1.2 fish which tend to enter the spawning streams slightly earlier than the larger Age 1.3 and 1.4 fish. Secondly, Montana Creek experienced flood conditions during the peak of spawning. These high water conditions flushed many of the carcasses and weakened post spawners out of the system. It has been observed that the carcasses of smaller fish are more easily removed by high water than those of larger fish and this would bias the carcass recovery surveys towards the larger Age 1.3 and 1.4 fish.

Table 7. Age Class Frequency From Chinook Salmon Harvest for Five East Side Susitna River Streams, 1979-1982.

Stream	Year	Sample Size	Age Class by Percent 1.2	1.3	1.4
*Caswell Creek	1979	56	50	20	30
	1980	208	46	23	31
	1981	21	28	50	22
Chunilna Creek	1979	151	17	31	52
	1980	82	43	21	36
	1981	51	45	33	22
	1982	188	17	24	59
Little Susitna River	1979	236	12	16	72
	1980	90	10	30	60
	1981	101	8	44	48
	1982	128	16	37	47
Montana Creek					
	1979	35	14	24	62
	1980	198	45	26	29
	1981	111	47	25	28
	1982	62	55	16	29
Willow Creek	1979	152	10	14	76
	1980	120	29	18	53
	1981	155	12	36	52
	1982	308	7	18	75

* Biological data were not collected from chinook salmon harvested in 1982. Age determinations were not possible.

Table 8. Age Structure and Sex Ratio of Chinook Salmon Spawning Populations in Willow and Montana Creeks and the Chulitna River, 1982.

Stream	Sample Size	Age Class by Percent				Sex Ratio
		1.1	1.2	1.3	1.4	Male : Female
Chulitna River	99	0	9.1	51.5	39.4	0.52 : 1.0
Montana Creek	85	0	10.6	16.5	72.9	1.66 : 1.0
Willow Creek	186	2.2	4.8	17.7	75.3	0.54 : 1.0
Total						0.70 : 1.0

Data collected from either carcasses or sport harvested chinook salmon may result in slightly biased age determinations. Carcass recoveries reflect a higher percentage of Age 1.4 chinook salmon than were caught by anglers while the sport catch reflects a larger number of Age 1.2 and Age 1.3 fish. Both methods identify general age structure characteristics of returning adults.

The male-to-female sex ratio for chinook salmon spawning populations in 1982 at Willow and Montana Creeks was 0.54:1.0 and 1.66:1.0, respectively, whereas the respective sport harvest sex ratio was 1.0:1.0 and 2.8:1.0. The combined sex ratio of chinook harvested by anglers at four streams in 1982 was 1.3:1.0 and the sex ratio of the combined spawning populations from three streams was 0.7:1.0. This elevated harvest of males over females in the sport fisheries in comparison to the sex ratio of the chinook spawning populations was evident in 1979 where the combined sex ratio of the sport harvest and spawning populations was 1.54:1.0 and 0.7:1.0, respectively (Watsjold, 1980). This comparison is not possible for 1980 and 1981 when persistent high water conditions prevented carcass surveys. Based on the sex ratio data from 1979 and 1982, it appears that the sport fisheries are harvesting a disproportionately higher number of males than occurs in the spawning populations.

Escapement:

In 1982, chinook salmon escapement surveys on east side Susitna River tributaries and tributaries of the Talkeetna and Chulitna Rivers were conducted from July 20 to August 12. Four streams were surveyed on foot and the remaining streams by helicopter. Watsjold (1974) found that, during aerial surveys, chinook salmon were observed at 70.0% efficiency in alpine stream areas with little or no canopy cover, while in heavily wooded areas the efficiency dropped to 55.0%. Based on these findings, it was estimated that the 1982 chinook salmon escapement was 16,390. This represents the third largest estimated escapement for east side Susitna River streams since 1973 (Table 9). An additional 1,928 chinook were harvested by anglers which, if added to the escapement number, would be an 18,858 total return.

The surveys were delayed on many streams due to high, turbid stream conditions during the peak of spawning when escapement surveys are traditionally conducted. These late counts coupled with high water conditions, which flushed many carcasses and weak post spawners out of the creek systems into areas where they could not be counted, contributed to below-average counts on several streams. Individual stream counts are presented in Table 10. Four streams, Moose, Portage and Bunco Creeks and Indian River, experienced the highest escapements recorded since 1973.

Coho Salmon Studies

Little Susitna River Creel Census:

Census data collected during the past 2 years has enabled area management biologists to characterize the coho salmon sport fishery. The Little Susitna River is a semi-glacial stream, which obscures visability during the summer months, with its headwaters originating in the Talkeetna

Table 9. Chinook Salmon Escapement Counts and Population Estimates, East Side Susitna River Tributaries, 1973-1982.

Year	Observed Counts	Estimated Escapements
1973	8,086	8,900
1974	3,356	4,100
1975	1,247	1,500
1976	16,753	19,900
1977	14,199	17,028
1978	12,853	15,365
1979	5,454*	15,000
1980	**	
1981	7,826***	13,300
1982	11,375	16,930

* Count does not include six streams which in the past three years represented 53% of the escapement.

** No counts were made due to poor conditions.

*** Count does not include seven streams which in the last three years of good counts represented 14% of the escapement.

Table 10. Chinook Salmon Escapement Counts, Eastside Susitna River Tributaries, 1973-1982.

Stream	1973	1974	1975	1976	1977	1978	1979	1980**	1981	1982
Willow Creek	1,074	402	177	1,660	1,065	1,166*	848	...	991	592
Upper Deception Creek	...	...	...	...	...	495	238	...	366	229
Montana Creek	527	280	229	1,445	1,443	881*	1,094*	...	814	887
Moose Creek	36	32	55	116	153	237	253	...	238	407
Prairie Creek	4,190	1,498	369	6,513	5,790	5,154	...**	...	1,875	3,844
Chunilna Creek	292	283	101	1,237	769	997	864*	...	169*	982
Kashwitna River (NF)	183	103	33	203	336	362	457	...	558	156
Little Willow Creek	371	139	103	833	598	436	324*	...	459	316
Sheep Creek	482	202	42	455	630	1,209	778	...	1,013	527
Indian River	122	102	31	537	393	114	285	...	422	1,053
Portage Creek	174	260	32	702	374	140	190	...	659	1,111
Chulitna River (EF)	42	41	7	112	168	59	...**	...	...**	119
Chulitna River (MF)	219	159	55	1,870	900	...**	...**	...	...**	644
Chulitna River (MS)	...	...	...	124	229	62	...**	...	...**	100
Goose Creek	...	41	13	160	133	283	...**	...	262	140
Honolulu Creek	...	...	...	24	36	13	37	...	...**	27
Byers Creek	...	...	...	53	69	...	28	...	...**	7
Troublesome Creek	...	...	...	92	95	...	58	...	...**	36
Bunco Creek	...	...	...	112	136	153	...**	...	...**	198

* Poor counting conditions. ** Streams uncountable due to high turbid water.

Mountains 113 river miles from Knik Arm. The river is open to salmon fishing downstream from the Parks Highway bridge to its mouth, a distance of 70 river miles (Figure 4). The highway crossing and private boat launch facilities just downstream of the highway bridge provide the only access to the upper river area. Upper river fishing pressure is currently concentrated from the highway bridge, downstream 8 river miles to the Lake Creek confluence (Mile Post 62). Bank anglers are restricted by lack of access to the first 1.5 miles of river immediately downstream of the highway bridge with the vast majority of effort concentrated within the first 1/2 mile downstream. Anglers fishing from boats disperse themselves throughout this 8-mile reach of river. However, during normal or low flow conditions, most boat anglers do not venture downstream of Mile Post (M.P.) 61 because the river becomes shallow, velocity increases and there are numerous boulders in the streambed creating hazardous boating conditions.

The middle section of river, from M.P. 61 downstream to M.P. 33 currently acts as a buffer zone between anglers utilizing the two access sites. Water velocity increases through this area because the river drops 150 vertical feet within the 28-mile stretch. The numerous riffles within this area can be navigated safely only when discharges exceed 750 cfs. [1]During the 1982 coho salmon fishery, discharges exceeded 750 cfs. on 8 days (USGS, 1982; in press) which enabled anglers to navigate the middle section of river more frequently than normal. During the period from July 15 through August 28, when coho salmon are available, there has been an average of only 3 days per year during the last 10-year period when discharge has exceeded 750 cfs (USGS 1973-81). Fishing effort is very sparse within this section, and is limited to anglers floating downstream from the Parks Highway bridge to the Burma Road access site in small inflatables, kayaks, or canoes and powerboats during high flow periods.

The entire river corridor within this section is owned by the State. Planning guidelines recommend fish and wildlife habitat protection and associated recreational activities as the primary land uses.

The lower section of river from M.P. 33 to the mouth is characterized by low velocities of 1.0 to 1.5 feet per second. There is less than a 50 foot elevation drop within this 33-mile reach. The river channel configuration changes from the long, straight riffles of the middle section to continuous meanders with deep, well-defined pools separated by very short, shallower runs. The river from M.P. 16 to the mouth is intertidal and extremely turbid from the glacial silts of Knik Arm. There is no fishing effort within this area.

Access to the lower river, which has previously limited fishing effort, has improved dramatically within the last 2 years from a 7-mile trail accessible only by four wheel drive vehicle to a modern gravel road within 3 miles of the river. A dirt road then continues on from this gravel road to within 1/2 mile of the river where four wheel drive is occasionally needed. The road reaches the Burma Road access site on the Little Susitna at M.P. 28.

Increased shore fishing effort and greater awareness of the better fishing areas have resulted in the dispersion of these anglers in both directions from the access site. During high flow periods, bank fishing is curtailed

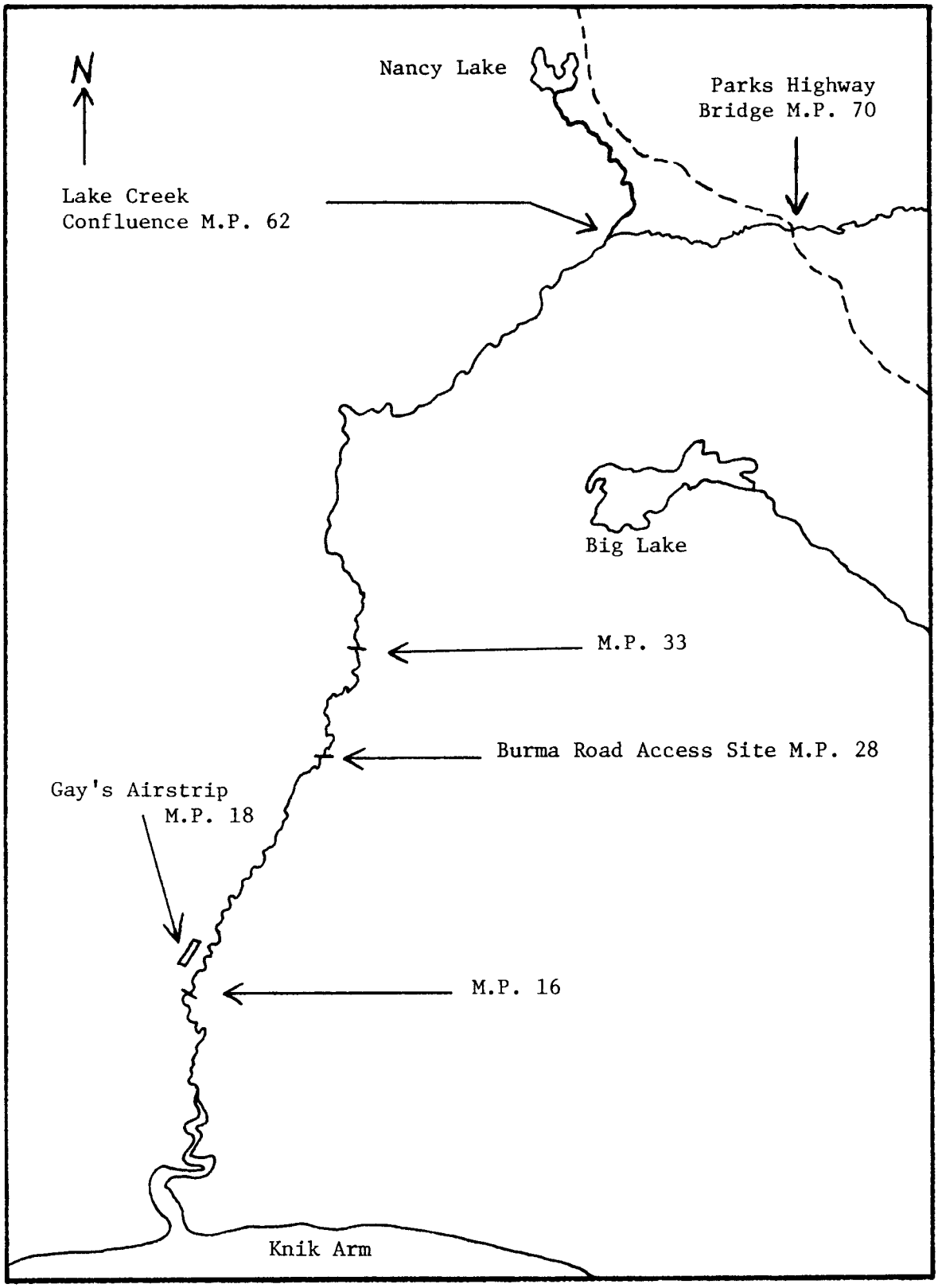

Figure 4. Area Map of the Little Susitna River Open to Salmon Fishing, M.P. 0 - M.P. 70.

or eliminated completely because fishing sites and bankside trails become inundated by flood waters.

[1]Discharges are recorded at a U.S.G.S. gauging station located above the Parks Highway bridge at M.P. 100. Actual discharges between M.P. 61 and 33 would be higher.

The Burma Road access site has no developed boat launch facilities. Boat anglers are generally restricted to using small boats with outboard motors which can be launched and retrieved manually. During the beginning of the coho salmon run in mid-July, boat anglers run downstream between M.P. 16 and M.P. 20 to intercept the fish. As the season progresses and the main body of fish move upstream, the boat anglers follow them. By late July the boat anglers are concentrated in areas around the Burma Road access site at M.P. 28 and by early to mid-August have followed the fish above the access site and are concentrated between M.P. 29 and M.P. 33.

Another group of boat anglers that harvest coho salmon in the lower river launch from Anchorage and cross Knik Arm at high tide, fish in the lower river and return to Anchorage on a later high tide. While some of these anglers utilize medium-sized inflatables or river boats with outboard motors, most are large inboard jet boats or conventional inboard/outboard cabin cruisers. These Anchorage based anglers will also follow the main body of coho as they migrate upstream from M.P. 16. However, due to the larger size of their boats, Anchorage anglers rarely venture upstream of M.P. 27. This limits their effective fishing season from mid-July through early August.

A private airstrip and lodge known as Ward Gays Lodge is located at M.P. 18. Clients are flown into the lodge from mid-July through mid-August to fish for coho salmon from shore near the lodge.

A creel census program that was initiated at the Little Susitna River in 1981 was continued in an expanded form during 1982. Censuses were conducted at the two major access sites in the section of river open to salmon fishing. The Burma Road census took place from July 17 through August 30, and the Parks Highway census, located 42 miles upstream of the Burma Road, was operational from July 31 through September 6.

The total coho salmon harvest at the Little Susitna River in 1982 was estimated at 7,308 fish with 8,666 angler-days of effort (Table 11). Harvest per hour and per angler-day averaged 0.21 and 0.84, respectively. At the Burma Road access site, boat and shore anglers harvested 2,580 coho with 2,262 angler-days of effort at a harvest rate of 1.14 coho per angler. Anglers from Anchorage that boated across Knik Arm expended 1,087 angler-days to harvest 1,817 coho salmon at a rate of 1.67 fish per angler-day. Boat and shore anglers at the Parks Highway harvested 2,911 coho with 5,317 angler-days of effort at a rate of 0.55 fish per angler-day.

The number of anglers which floated from the Parks Highway to the Burma Road during the 1982 coho salmon fishery was estimated at 200 which represents 2.3% of the total angler effort. Estimated harvest by these anglers was 158 coho or 2.2% of the total harvest.

Table 11. Harvest and Effort Data of the Little Susitna River Sport Fishery for Coho Salmon in 1982.

	Burma Road				Anchorage*		Parks Highway				
	Shore		Boat		Boat		Shore		Boat		
	WD**	WE	WD	WE	WD	WE	WD	WE	WD	WE	TOTAL
Expanded Harvest	362	62	1,145	1,011	927	890	300	133	1,573	905	7,308
Expanded Effort Angler-Days	533	279	753	697	560	527	1,224	2,104	1,142	847	8,666
x Hours Fished	3.4	2.8	4.2	5.0	4.6	5.0	4.1	1.6	5.2	6.0	4.0
Fish/Hour	0.20	0.08	0.36	0.29	0.36	0.29	0.06	0.04	0.26	0.18	0.21
Fish/Angler-Day	0.68	0.22	1.52	1.45	1.66	1.69	0.25	0.06	1.38	1.07	0.84

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

** WD = Weekday
WE = Weekend

The 1982 combined harvest and effort estimates increased 40% and 98% respectively from 1981 estimates (Bentz, 1982). These figures are not directly comparable however, because in 1981 the Parks Highway census was terminated prematurely on August 24 during the peak of the upstream fishery. The Burma Road estimates are comparable between 1981 and 1982, as complete census programs were conducted during both years. Harvest and effort estimates increased 87% and 128% respectively from 1981 to 1982 for this downstream fishery. This doubling of effort is a direct result of the improved access road into the river.

Effort is expected to continue to increase substantially as annual improvements to the access road are made. Although the coho salmon harvest estimates increased 87% in 1982 from 1981 at the Burma Road fishery, the harvest-per-angler rate decreased slightly from 0.31 fish per hour in 1981 to 0.28 fish per hour in 1982.

Weekly fishing effort is presented in Table 12 for Burma Road, Anchorage and Parks Highway anglers. Peak effort by Burma Road and Anchorage anglers occurred during the week of August 7-13, while peak effort occurred the following week at the Parks Highway. Weekly harvest and sex ratios are given in Table 13. The peak harvest at the Burma Road, from July 31 through August 6, occurred 2 weeks earlier than the maximum weekly harvest at the Parks Highway during August 14-20.

Figure 5 illustrates coho salmon harvest rates by weekly period at the Burma Road and Parks Highway fisheries. Peak harvest rates varied by 3 weeks between the two fisheries. Harvest rate data indicate that significant numbers of coho salmon begin to enter the sport fishery at M.P. 16 during the week of July 10-16 and are available to anglers for 7 weeks until most of the fish exit the fishery at the Parks Highway bridge in late August through early September.

The male to female sex ratio of coho salmon harvested at the Burma Road fishery was 0.64:1.0 for the entire season and 0.95:1.0 at the Parks Highway. The harvest of more females than males at the Burma Road in comparison to the Parks Highway was more pronounced in 1981 when the sex ratios were 0.59:1.0 and 2.30:1.0 respectively. A gradual seasonal shift towards the harvest of more males than females occurred at both fisheries in 1982. If this tendency continues in future years it will aid in the formulation of management plans during years of low adult returns.

Anglers at the Parks Highway fishery also harvested an estimated 1,060 sockeye and 350 chum salmon during the creel census. Total seasonal harvest was presumed to be nearly double these figures as the creel census began during the peak of the migration. Over 50% of the estimated harvest for both species occurred during the first week of the creel census (July 31 to August 6). The harvest of both species dropped sharply during the next 2 weeks.

Little Susitna Coho Salmon Life History Studies:

Adult coho salmon captured by hook and line for the Petersen disc tagging study were collected from July 22 through August 12 between M.P. 19 and M.P. 28 in the lower river. A total of 199 coho salmon were tagged and

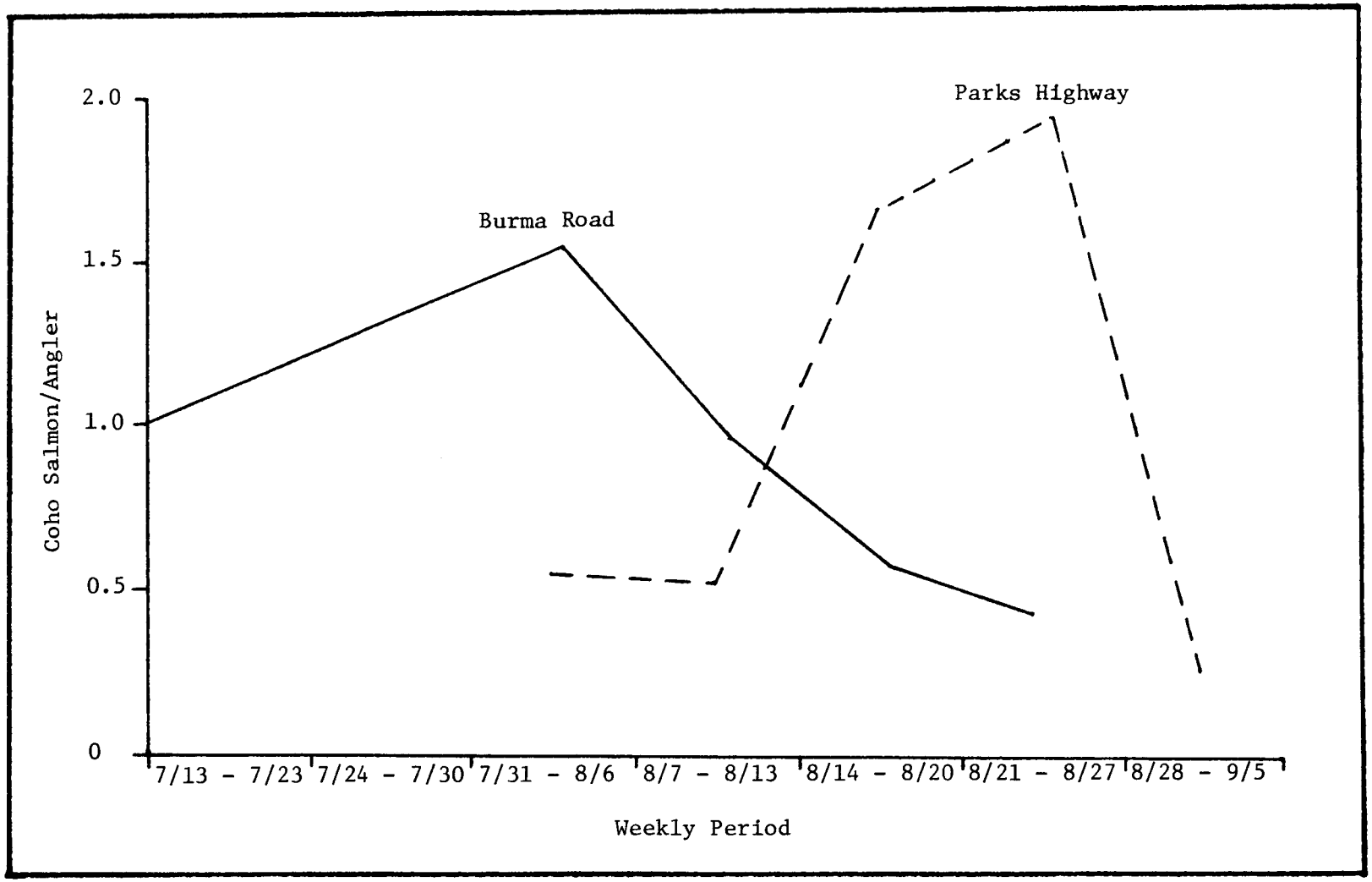

Figure 5. Coho Salmon Harvest Rates by Weekly Period at the Two Access Sites of the Little Susitna River, 1982.

Table 12. Little Susitna River Coho Salmon Fishing Effort Percentages by Weekly Period at Parks Highway and Burma Road Access Sites, 1982.

	7/17 - 7/23	7/24 - 7/30	7/31 - 8/6	8/7 - 8/13	8/14 - 8/20	8/21 - 8/27	8/28 - 9/5	Total
Burma Road Anglers*	294	420	541	679	170	140	18	2,262
%	13.0	18.6	23.9	30.0	7.5	6.2	0.8	100.0
Anchorage Anglers	188	125	292	332	66	84	0	1,087
% **	17.3	11.5	26.9	30.5	6.1	7.7	0	100.0
Parks Highway Anglers*	No Census Conducted	No Census Conducted	1,404	1,138	1,446	900	429	5,317
%			26.4	21.4	27.2	16.9	8.1	100.0
Total	482	545	2,237	2,149	1,682	1,124	447	8,666
%	5.5	6.3	25.8	24.8	19.4	13.0	5.2	100.0

* Includes both shore and boat anglers.

** Anglers from Anchorage that boated across Knik Arm during high tide to fish in the lower portion of the river. Effort estimates were calculated from angler counts in lower river by boat survey.

Table 13. Little Susitna River Coho Salmon Harvest Percentages and Sex Ratios by Weekly Period at the Parks Highway and Burma Road Access Site, 1982*.

	7/17 - 7/23	7/24 - 7/30	7/31 - 8/6	8/7 - 8/13	8/14 - 8/20	8/21 - 8/27	8/28 - 9/5	Total
Burma Road Harvest**	243	500	983	627	147	72	8	2,580
%	9.4	19.4	38.1	24.3	5.7	2.8	0.3	100.0
Sex Ratio Male:Female	.36 : 1.0	.47 : 1.0	.58 : 1.0	1.1 : 1.0	.79 : 1.0	2.0 : 1.0	0.5 : 1.0	0.64 : 1.0
Parks Highway Harvest**	No census Conducted	No census Conducted	437	309	1,173	870	122	2,911
%	...	...	15.0	10.6	40.3	29.9	4.2	100.0
Sex Ratio Male:Female	...	...	.65 : 1.0	.96 : 1.0	.84 : 1.0	1.4 : 1.0	1.8 : 1.0	0.95 : 1.0

* Harvest percentages by weekly period and sex ratios were not calculated for Anchorage anglers because they were not interviewed. Seasonal harvest estimates were derived using Burma Road boat angler harvest rates.

** Includes both boat and shore anglers.

released during this period. Subsequent recapture of these tagged fish was monitored by the two upstream creel census programs. Census results verified that 15 coho salmon, or 7.5% of the fish tagged, were recaptured in the sport fishery. An additional three fish or 1.5% were found dead by tagging personnel within 12 hours of release. Number of days from release to recapture ranged from 2 to 33 with an average of 19 days.

The assumption was made that only those coho which reached the Lake Creek confluence at M.P. 62 or above would be included in the analysis of migration rates. The confluence area is the most downstream area where coho salmon spawning has been observed. Fish which were recaptured downstream of this confluence area were recaptured within a few days of release and migration rates could not be determined.

Of the 15 coho salmon recaptured, only eight reached M.P. 62 or above before recapture. Average migration rates were estimated by dividing total miles of upstream migration by the number of days between release and recapture. These estimates do not take into account the possibility of a fish holding within the capture area for extended periods of time. Migration rates of these eight fish ranged between 1.0 and 3.4 miles per day and averaged 1.6 miles per day. Average distance of total upstream migration from release to recapture was 41 miles, with a range of 37.5 to 49 miles.

The approximate dates when the eight coho salmon entered the sport fishery were estimated by taking the individual average migration rate of each fish and back-calculating from the initial capture site downstream to M.P. 16. The estimated date each fish would have exited the sport fishery at the Parks Highway bridge was also based on the individual daily migration rate as calculated from the recapture site. Results of these calculations indicated that these eight fish entered the sport fishery at M.P. 16 between July 17 and July 31 and would have exited at the bridge between August 24 and September 10. The average time that these fish were available to the sport fishery was estimated at 5.4 weeks.

Coho salmon captured by hook and line for the radio telemetry study were collected from August 2-13 between M.P. 19 and M.P. 28. Twenty-six fish were tagged with radio transmitters during the study. Of the 26, 14 were females, 11 were males and the sex of 1 coho was not recorded. Nine fish were tagged using the esophogeal implant. The remaining 17 coho were tagged by surgical insertion of the transmitter into the peritoneal cavity.

Upon release, coho salmon tagged by esophogeal implant remained in the release area or moved downstream a short distance before resuming migration upstream. A longer recovery period was required by coho tagged by surgical methods, which was expected because this technique presumably exerted greater stress on the fish than the esophogeal method. These fish remained within the general release area from 2 to 4 days or drifted further downstream than the esophogeal fish before recovering and moving upstream.

Migration rates were determined for each fish through tracking surveys conducted twice weekly. Tracking was conducted by boat from August 3-20 when all tagged coho were concentrated in the lower river area. Exact location of each fish could be determined to within approximately 50 feet during most boat surveys. Aerial tracking was utilized from August 24

through October 5 because tagged coho had dispersed throughout the river, making boat tracking impractical. Exact location was determined to within 1/4 river mile. Daily migration rates were determined by dividing the distance each fish had migrated since the previous tracking survey by the number of days that had elapsed since the previous survey.

The assumption that only those radio-tagged coho which reached the lowest known spawning area at the Lake Creek confluence or above would be included in the data analysis was again made during this study. Only seven or 27% of the 26 radio-tagged fish met this criteria. Six of these seven fish were tagged by surgical insertion and one by esophogeal implant. Average upstream migration rates of these seven fish ranged from 1.3 to 2.8 miles per day with a mean rate of 1.8 miles per day. Maximum upstream migration rates ranged from 4.1 to 5.6 miles per day with an average of 4.8 miles. Total upstream migration averaged 52 miles from release sites for the seven fish.

The seven radio-tagged coho salmon reached the Lake Creek confluence area during August 24-31. This arrival corresponds to the time when the main body of coho salmon reached the confluence area as determined through the Parks Highway creel census (Figure 5). Four radio-tagged coho salmon migrated past the confluence to the Parks Highway bridge at M.P. 70 from August 31 through September 7. Three of the four radio-tagged coho reached the lower end of the major mainstem spawning area beginning at M.P. 85 from September 10-21 while the fourth dropped downstream below the Parks Highway bridge.

The approximate dates when the seven coho entered the sport fishery were estimated by taking each fish's average migration rate and back-calculating from the tagging and release site downstream to M.P. 16. This analysis indicated that the seven coho entered the sport fishery at M.P. 16 from July 30 through August 8. The four coho which reached the Parks Highway bridge exited the sport fishery from August 29 through September 7. The average time these four fish were available to the sport fishery was estimated at 4.5 weeks.

Of the remaining eight coho tagged esophogeally which did not reach the Lake Creek confluence, four fish migrated immediately upstream at an average rate of 1.25 miles per day for approximately 4 days. Suddenly, one coho tracked ceased all movement and the transmitter location remained constant for the duration of the study. One possible cause for this is that the fish suddenly died and the carcass, still containing the transmitter, was caught and held in place by some object. A more probable cause is that the fish regurgitated, or forced the transmitter from its stomach, the antenna wire connected to the roof of the fish's mouth broke, and the transmitter sank to the river bottom and became lodged in place while the fish continued upstream. Other coho telemetry researchers in Alaska have also experienced regurgitation problems (personal communication, Carl Burger, 1982). The remaining four fish tagged esophogeally migrated upstream approximately 13 miles in 2.5 weeks. Movement again ceased and the fish moved downstream an average of 9 miles within 1 week where the transmitters remained. Either the fish regurgitated their transmitters at this downstream location where they became lodged in the river bottom, or the fish died as a result of esophogeal rupture and the carcasses drifted

downstream until lodged or washed ashore. Glacial turbidity during the summer months prevented visual observation of carcasses or transmitters.

Eleven of the 17 coho salmon which were radio-tagged by surgical insertion did not reach the Lake Creek confluence. One transmitter failed due to a frequency change when the transmitter entered the water and the fish was never located after release. Five fish migrated upstream an average of 20 miles within 12 days, stopped and then moved downstream an average of 25 miles where they remained. Two fish moved downstream approximately 8 miles immediately after release and remained there while three fish migrated upstream an average of 18 miles during the first 2 weeks after release and remained there.

All of these fish, except the one which received the faulty transmitter, were thought to have died from surgical stress or subsequent surgery related infection. Since the fish could not rid themselves of the transmitter, they had to be at the transmitter location unless harvested by an angler that discarded the transmitter back into the river with the viscera. In all cases, transmitter movement ceased well downstream of any known spawning areas.

No firm conclusions or statements can be made regarding the results of the Petersen disc and radio telemetry tagging studies since there were few data points available for analysis. However, the estimates of dates when these fish entered the fishery, reached the Lake Creek confluence area and exited the sport fishery at the highway bridge compare favorably with the run timing established with harvest and effort data collected by the two creel census programs. While coho salmon were available to the sport fishery for over 7 weeks, individual fish may have been available for only 4 or 5 weeks.

Bert Gore, D.V.M., the Alaska State Veterinarian stationed in Palmer assisted with the surgical implant technique. His assistance and advice on proper technique and materials was invaluable and his efforts are gratefully acknowledged.

All of the telemetry equipment used in this study, including the transmitters, was furnished by Carl Burger of the U.S. Fish and Wildlife Service, National Fishery Research Center, Alaska Field Station in Anchorage. Mr. Burger also provided valuable technical advise on the various tagging techniques. His assistance is greatly appreciated.

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 M.P. 98 downstream to the Shrock Road bridge at M.P. 85, with a limited amount of spawning from M.P. 75 downstream to the Lake Creek confluence at M.P. 62. In 1982 a coho salmon escapement survey was conducted by helicopter on October 8 from M.P. 98 to M.P. 75. A total of 3,717 coho salmon were enumerated within this reach. The highest spawning concentrations were observed between M.P. 89 and M.P. 85 with 420 coho per river mile.

Estimates of observation efficiency developed by Watsjold (1974) for enumeration of spawning chinook salmon during aerial surveys were utilized

to estimate the total number of spawning coho within the 13-mile reach. Spawning escapement was estimated at 6,800 coho salmon. An additional 7,300 coho were harvested by anglers which, if added to the escapement number, would be a 14,100 total return. The 1982 sport fishery harvested 52% of the total return. If the Cook Inlet commercial fishery harvested Little Susitna coho salmon at the same rate as upper Cook Inlet sockeye salmon are harvested, which is often two out of three, or 66%, then the total production of coho salmon for 1982 would be 42,300 fish. Combined harvest by the commercial and sport fisheries could have reached 35,200 fish which is 83% of the total run.

Population estimates based on a marked to unmarked ratio through recovery of coho salmon tagged with Petersen disc tags on the spawning grounds was not attempted. Only two tagged fish were observed during numerous foot surveys within the major spawning area.

Only one coho salmon tagged with a radio transmitter was recovered during the study. This male fish was found dead on a gravel bar by a hunter and later retrieved by project personnel. Cause of death and spawning condition were not determined as the fish tissue had undergone complete post-mortum autolysis. Another radio-tagged coho was harvested illegally by a fisherman at M.P. 86. The transmitter was not returned.

Cottonwood Creek Creel Census:

The 1982 Cottonwood Creek creel census was conducted during 5 consecutive weekends beginning on July 24. Estimated harvest was 1,895 coho and 258 sockeye salmon with 2,440 angler-days of effort (Table 14). Harvest rates averaged 0.19 and 0.03 fish per hour for coho and sockeye salmon, respectively. The 1982 harvest of coho salmon increased 36% over the 1981 harvest while the sockeye harvest decreased 87%, and fishing effort decreased 27% from 1981 to 1982. The peak harvest of sockeye salmon occurred during the second weekend when 61% of the total harvest was taken. Coho harvest peaked during the fourth weekend of the census when 32% of the total harvest occurred.

The male to female sex ratio of coho salmon harvested in 1982 was 0.76:1.0, which is nearly identical to the 1981 sex ratio of 0.80:1.0. The selective harvest of females during the beginning of the Cottonwood Creek coho salmon run, with a gradual shift towards the harvest of more males than females as the run progressed, was also evident in the Little Susitna River fishery.

Creel census data together with escapement information from the F.R.E.D. Division weir located upstream from the fishing area indicated that the sport fishery harvested 48% of the total coho salmon run returning to the stream in 1982. This is an increase from the 1981 harvest rate of 31% of the total run. Based on returns of fin-clipped fish, the contribution of hatchery fish to the total 1982 run was estimated at 20%. The average catch rates were highest during early Saturday morning hours. This trend had been observed the past 3 years at the three weekend-only chinook salmon fisheries. It is probably due to a gradual concentration of fish built up during the week when there is no fishing pressure so there are relatively more fish available on Saturday morning than at any other time during the weekend.

Table 14. Expanded Harvest, Effort and Sex Ratio Data of the Cottonwood Creek Sport Fishery for Coho and Sockeye Salmon in 1982.

	1st Weekend 7/24,25		2nd Weekend 7/31, 8/1		3rd Weekend 8/7,8		4th Weekend 8/14,15		5th Weekend 8/21,22		Total	
	SS*	RS*	SS	RS	SS	RS	SS	RS	SS	RS	SS	RS
Harvest	17	6	385	158	433	85	603	9	457	0	1,895	258
Sex Ratio Male:Female	0.33:1	All Males	0.39:1	1.7:1	0.85:1	0.79:1	1.1:1	All Males	0.79:1	...	0.76:1	1.25:1
Angler Days	349		520		510		444		617		2,440	
Harvest/Hour**	...		...		...		...		...		0.19	0.03
Fish/ Angler Day	0.05	0.02	0.74	0.30	0.85	0.17	1.36	0.02	0.74	0	0.78	0.11

* SS = Coho Salmon
RS = Sockeye Salmon

** Harvest per hour estimates were only calculated for the entire season and not by weekly period.

Extreme high tides caused a temporary decrease in fishing effort and harvest at Cottonwood Creek. The entire intertidal flood plain through which the stream runs becomes flooded and anglers cannot reach the stream bank. Also, the stream becomes turbid with the influx of glacial water from Knik Arm and salmon cannot readily detect the lure.

Escapement:

Coho salmon spawning populations were enumerated by foot surveys in established index areas on four streams from late September through early October. A summary of escapement counts by index area is presented in Table 15. The 1982 coho salmon returns were from the 1978 parent escapement and equaled or exceeded the record-setting returns of 1980. Wasilla Creek escapement surveys were conducted well after the peak spawning period and during poor counting conditions which may explain the low counts when compared with the record-setting counts at Cottonwood and Question Creeks.

Coho salmon counted through the weir operated on Fish Creek by the F.R.E.D. Division totaled 5,200 fish in 1982 (Table 16). Coho returns in 1982 increased 113% over 1981 returns. While the 1982 return did not surpass the 8,832 coho return in 1980, it does represent the second largest return since 1969.

LITERATURE CITED

Alaska Department of Fish and Game. 1981. Plan for Supplemental Production of Salmon and Steelhead for Cook Inlet Recreational Fisheries. Division of Sport Fish, 73 pp.

Alaska Department of Natural Resources. 1982. Land Use Plan for Public Lands 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 Report of Performance, 1981-1982. Project F-9-14, 23 (G-I-D).

May, Bernie. 1975. Electrophoretic Variation in the Genus Oncorhynchus: the Methodology, Genetic Basis, and Practical Applications to Fisheries Research and Management. M.S. Thesis, University of Washington, 95 pp.

Mills, M.J. 1978. Statewide Harvest Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, Volume 20, SW-1, 112 pp.

_____. 1979. Statewide Harvest Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, Volume 21, SW-1, 65 pp.

_____. 1980. Statewide Harvest Study - 1979 Data. Alaska

Table 15. Number of Coho Salmon in Escapement Index Areas (foot count), Upper Cook Inlet, 1971-1982.

Stream	1971	1972	1973	1974	1975	1976	1977*	1978	1979	1980*	1981	1982
Wasilla (a)	104	19	28	30	49	151	...	74	61	...	58	28
Wasilla (b)	...	...	...	...	158	162	...	76	187	...	180	143
Cottonwood (a)	29	21	10	2	73	100	25	100	64	340	175	187
Cottonwood (b)	...	...	...	19	163	104	90	164	...	530	195	634
Birch	138	69	106	49	92	27	96	103	120	121	121	41
Question	...	...	59	3	111	126	87	45	384	321	230	397
Rabideaux	...	...	...	...	67	91	...	88	...	...	...	...
Total	271	109	203	103	713	761	298	650	816	1,312	959	1,430

* High water conditions made several index areas uncountable.

Table 16. Adult Coho Salmon Escapement Counts, Fish Creek, 1969-1982.

Year	Date of Operation	Weir Counts
1969	July 31 - September 2	4,253
1970	July 19 - August 8	1,048
1971	July 8 - August 7	583
1972	July 2 - September 10	710
1973	July 1 - September 6	210
1974	July 8 - September 6	1,154
1975	July 3 - September 11	1,601
1976	July 5 - September 11	765
1977	July 6 - August 15	930
1978	July 7 - September 30	3,121
1979	July 8 - August 30	2,511
1980	July 4 - September 1	8,832
1981	July 9 - August 23	2,444
1982	July 12 - September 8	5,200

Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, Volume 22, SW- 1, 78 pp.

_____. 1981. Statewide Harvest Study - 1980 Data. Alaska Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, Volume 22, SW- 1, 107 pp.

_____. 1982. Statewide Harvest Study - 1981 Data. Alaska Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, Volume 23, SW- 1, 115 pp.

United States Department of the Interior, Geological Survey. 1973. Water Resources Data for Alaska. Part 1. Surface Water Records. Part 2. Water Quality Records. Anchorage, Alaska, 298 pp.

_____. 1974. Water Resources Data for Alaska. Part 1. Surface Water Records. Part 2. Water Quality Records. Anchorage, Alaska, 323 pp.

_____. 1975. Water Resources Data for Alaska, Water Year 1975. Data Report AK-75-1. Anchorage, Alaska. 410 pp.

_____. 1976. Water Resources Data for Alaska, Water Year 1976. Data Report AK-76-1. Anchorage, Alaska. 401 pp.

_____. 1977. Water Resources Data for Alaska, Water Year 1977. Data Report AK-77-1. Anchorage, Alaska. 439 pp.

_____. 1978. Water Resources Data for Alaska, Water Year 1978. Data Report AK-78-1. 425 pp.

_____. 1979. Water Resources Data for Alaska, Water Year 1979. Data Report AK-79-1. Anchorage, Alaska. 365 pp.

_____. 1980. Water Resources Data for Alaska, Water Year 1980. Data Report AK-80-1. Anchorage, Alaska. 373 pp.

_____. 1981. Water Resources Data for Alaska, Water Year 1981. Data Report AK-81-1. Anchorage, Alaska. 395 pp.

Watsjold, D.A. 1974. Anadromous Fish Population Studies - Matanuska Valley and East Side Tributaries of the Susitna River, and Tributaries of the Chulitna River. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1973-1974, Project F-9-6, 15 (G-II-H): pp. 49-58.

_____. 1980. Inventory and Cataloging in the Sport Fish and Sport Fish Waters in Upper Cook Inlet. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1979-1980, Project F-9-12, 2 (G-I-D): pp. 91-120.

Prepared by:

Robert W. Bentz, Jr.
Fishery Biologist

Approved by:

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

Mark C. Warner, Ph.D.
Sport Fish Research Chief