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STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

KENAI PENINSULA CHINOOK AND COHO SALMON STUDIES

by

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Cooperators: Stephen Hammarstrom, Larry Larson, Mark Wenger and Jamie Carlon

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ABSTRACT

The recreational fishery for chinook salmon, *Oncorhynchus tshawytscha* (Walbaum), in the marine waters of Cook Inlet south of Deep Creek was monitored by creel census for the thirteenth consecutive year. Estimated harvest from early and late runs was 2,386 and 835, respectively. In addition, an estimated 13,799 Pacific halibut, *Hippoglossus stenolepis* Schmidt, were harvested from mid-May through July 31. Estimates were calculated on the basis of 3,067 angler interviews, 149 instantaneous boat counts, 219 creel-checked chinook salmon and 1,543 creel-checked Pacific halibut. Historical data for this fishery are presented.

Age composition of the recreational harvest of chinook salmon from salt water displayed a marked difference between early and late runs. Early and late run fish were comprised of 34.6 and 8.0 percent, respectively, of age class 1.3 (brood year 1979). Late run fish were predominantly (75.0 percent) from age class 1.4 (brood year 1978). Classifications were based on 178 readable scales collected during the fishery.

The freshwater spring fishery for chinook salmon on three southern Kenai Peninsula streams, Anchor River, Deep Creek and Ninilchik River, resulted in an estimated harvest of 1,515 fish by 20,860 man-days of effort. Individual stream harvest estimates, as determined by creel census, are: Anchor River, 735; Deep Creek, 340; and Ninilchik River, 440. Effort was estimated by vehicle counts on location. Minimum escapement counts for each stream were achieved by expanding results of a helicopter survey by a factor determined by a simultaneous limited ground survey.

Age composition of the recreational harvest of chinook salmon from the three southern Kenai Peninsula streams was based on 141 readable scales

collected during the fishery. The predominant (65.3 percent) age class was 1.4.

One of Alaska's most popular recreational fisheries, the Kenai River chinook salmon fishery, was monitored by creel census for the eleventh consecutive year in 1984. During June and July, 17,597 anglers were interviewed, 252 instantaneous angler counts were made, 10 aerial surveys were flown and 1,253 chinook salmon were creel-checked. These data were used to calculate an estimated harvest of 4,956 early-run fish by 50,455 man-days of effort and 7,376 late-run fish by 77,462 man-days of effort. Historical data for this fishery are presented.

Age composition of both early and late runs, as represented by the recreational harvest, was predominantly 1.4, based on 779 readable scales collected during the fishery.

During creel census activities on the Kenai River between August 1 and September 30, 194 instantaneous angler counts were made, 7,859 anglers were interviewed and 5,908 coho salmon, *Oncorhynchus kisutch* (Walbaum), were creel checked. Analysis of creel census data resulted in estimates of the total coho salmon harvest of 50,117 by 67,177 man-days of effort. There were an additional 10,359 coho salmon harvested incidentally to chinook salmon prior to August 1. Historical data regarding this fishery are presented.

For the first time in 3 years, harvest by guided anglers as determined by creel census and analysis of logbooks required to be completed by commercial fishing guides was in agreement. Methods of calculations and reasons for the similar estimates are discussed.

During May and June 1984, an estimated 5,135 chinook salmon were harvested by 22,415 man-days of effort in the Kasilof River fishery. The above estimates were based on data collected during 57 instantaneous angler counts and 837 completed angler interviews. Escapement of chinook salmon into Crooked Creek as determined by a total count through a weir, totaled 3,295. An additional 727 fish were retained for egg take purposes. Historical information regarding this fishery are presented.

A tag and recovery program was conducted during July 1984 to accurately assess the total run strength of late run Kenai River chinook salmon. A total of 1,311 late-run chinook salmon were tagged with Floy FT-4 spaghetti tags. A population estimate of 39,172 adult chinook salmon entering the Kenai River was calculated using Chapman's modification of the Peterson estimate. Confidence intervals were calculated at the 95 percent level using sport angler recaptures observed in a boat creel census as an entering variable in a Poisson frequency distribution table. Returning chinook salmon were captured using a 19-centimeter stretched mesh net in estuarine waters downstream from most of the recreational fishery. A specially designed tagging cradle was used to restrain the fish during tagging. Tidal influence affecting the fishing efficiency of drift netting is discussed.

A radio telemetry program was undertaken in 1984 to study the migrational behavior and spawning distribution of late-run chinook salmon in the Kenai River. Between June 25 and August 12, 85 chinook salmon received radio transmitters through esophogeal implant; 74 were captured by drift net and 11 by hook and line. In addition, three chinook salmon captured in the marine waters of Cook Inlet near Deep Creek received transmitters. Movements of the radio-tagged chinook salmon were monitored through boat and aerial tracking surveys. A total of 48 radio-tagged late-run chinook salmon were tracked to final spawning destinations. The remainder of the fish were not used in the spawner distribution analysis because of limited tracking data or sport harvest. The final spawning distribution of the 48 radio-tagged chinook salmon was: downstream section [river mile (RM) 10.2-21.1], 29.2 percent; midstream section (RM 21.1-39.5), 25.0 percent; upstream section (RM 39.5-50.0), 16.7 percent; between Skilak Lake and Kenai Lake (RM 64-82), 27.1 percent; and 2.1 percent in the Funny River. Date of tagging in the late run did not appear to influence spawning destination. Mean migration rates of radio-tagged salmon were significantly greater in upstream river sections RM 20.3+ [mean-2.7 miles per day (mpd)] than in the downstream river section (mean-1.4 mpd). This disparity in migration rate by river section as it pertains to management considerations is discussed.

Chinook salmon were captured using representative sport fishing gear and techniques, then tagged with a radio transmitter by esophogeal implant as part of a hook and release study. Of the fish captured, 21 received a transmitter; 3 (14 percent) yielded limited data (regurgitated tag or lost signal), 2 (10 percent) died before spawning and 16 (76 percent) were tracked to spawning locations. Comparisons of 16 radio-tagged, hook-and-line-captured fish showed no gross differences in spawning distribution or migrational behavior.

An additional 31 chinook salmon were captured for blood chemistry analysis for stress indicators (16 by hook and line and 15 by drift net). Fish were held in a live pen and sampled over time. Ranges of blood chemistry values were; glucose 30-144 milligrams/100 milliliters; chloride, 94-134 milequivalents/liter; cortisol, 0-509 nanograms/milliliter. Blood chemistry analysis indicates that the stress due to capture (by either method) was not excessive.

Hemoglobin test strips were quickly and easily applied to fish to test for a stress-induced occult blood response in the skin mucus. Although occult blood was detected, the sensitivity of this test in detecting the severity of angler-induced stress is questionable.

Excessive hemolysis occurred in all blood samples. This precluded analysis for lactic acid, but does not interfere with analysis for other stress indicators. Hemolysis was probably due to an inherent sensitive nature of erythrocytes rather than to blood sampling techniques.

KEY WORDS

Blood chemistry, chinook salmon, coho salmon, creel census, drift net, fish populations, fish tagging, hook and release, Kenai River, radio telemetry, spaghetti tags.

BACKGROUND

Chinook Salmon

Chinook salmon are the most popular species of game fish on the Kenai Peninsula. Historically, significant recreational fisheries occurred only on the southern peninsula streams, Anchor River, Deep Creek and Ninilchik River. Management on these streams has ranged from virtually unregulated to total closure. From the mid-1960's through the late 1970's, a punch card was used to enforce daily and/or seasonal bag limits. Since 1981, bag limits on chinook salmon have been enforced by requiring anglers to record the harvest of each fish over 20 inches on the back of their sport fishing license or on a special card in the case of an individual not required to possess a fishing license; i.e. juveniles.

Total harvest from each of the three southern peninsula streams open to taking chinook salmon is controlled by the allowable fishing time and area open to fishing. Each stream, from salt water upstream approximately 2 miles, is open to fishing during the last weekend of May (Saturday, Sunday and Monday) and the first 3 weekends of June, except Ninilchik River, which is closed after the second weekend of June. This management program has evolved through various quota schemes combined with restricted seasons. The current 12-day fishery has been in effect since 1978 and has had no emergency closures. However, there have been two 4-day emergency openings, 1978 and 1979, when surplus fish were available.

Pertinent historical data regarding the fishery on these three streams are presented in Reports of Progress by Dunn (1961), Logan (1962-1964), Engel and Logan (1965-1966), Engel (1967), Redick (1968), McHenry (1969), Watsjold (1970), Nelson (1971-1972a, 1972b), Hammarstrom (1974-1981), Hammarstrom and Larson (1982-1984).

In 1972, anglers discovered chinook salmon could be harvested in the marine waters of Cook Inlet in the vicinity of Deep Creek. As these fish return to their natal streams, there appears to be a natural holding area near the village of Ninilchik. The reason is undetermined, however, in this area is a definite demarcation between the turbid water of the upper inlet and the relatively clear waters of the lower inlet. Early-run fish (early May through mid June) are probably bound for many streams in Cook Inlet, but are predominately returning to the Kenai and Kasilof Rivers. Late-run fish (late June through July) are bound almost exclusively for the Kenai River. The Division of Sport Fish of the Alaska Department of Fish and Game (ADF&G) began monitoring this fishery in 1972 and has done so each season since with an onsite creel census. Because of the relatively poor boat launching facilities (high tide only in the mouth of Deep Creek or through the surf), boat size has been limited. As a result, local weather conditions have more influence on the fishery than does run strength.

On some years, available fishing time has been reduced significantly by inclement weather. Historical data regarding this fishery are presented in Reports of Progress by Hammarstrom (1974-1981), Hammarstrom and Larson (1982-1984).

Most chinook salmon returning to the Kasilof River are considered early-run fish. They enter the system in early May, are available to the angler through June and are completed with spawning by early August. Most of these early fish spawn in Crooked Creek or have been produced at the Kasilof Hatchery. There was no recreational fishery for chinook salmon in this system prior to 1978. That year the Board of Fisheries opened the river to chinook salmon fishing from January 1 through June 30. Most of the harvest occurs immediately downstream from the confluence of Crooked Creek with the Kasilof River. Crooked Creek itself is closed to chinook salmon fishing. In 1978, the Division of Sport Fish conducted a creel census to monitor the recreational harvest. It was determined that the total harvest was not large enough to warrant further funding of a creel census. However, from 1979-1983, the Fisheries Rehabilitation Enhancement and Development Division (F.R.E.D.) of ADF&G did monitor the fishery in conjunction with smolt studies being conducted in the immediate vicinity of the recreational fishery. Lack of F.R.E.D. funding required that the Division of Sport Fish monitor this fishery in 1984.

In 1985, the Kasilof River will remain open through July 31. There are some chinook salmon that are in the Kasilof River at a time which corresponds to the timing of late run Kenai River chinook salmon. The size of this run is unknown and the success of a recreational fishery may be hindered by the extreme glacial turbidity of this river. Pertinent historical data regarding this fishery are presented by Hammarstrom (1978) and Waite (1985).

Chinook salmon return to the Kenai River system in two segments, termed early-run and late run. Early run fish (mid-May through late June) are allocated almost entirely to recreational anglers by the Upper Cook Inlet Salmon Management Plan adopted by the Alaska Board of Fisheries in 1981. The plan prevents commercial fishing along the eastern shore of Cook Inlet from Ninilchik to Boulder Point, until June 25 the suspected route these fish travel, until June 25. Further restrictions in 1984 closed these commercial nets until July 1. This restriction was successfully challenged in court after the 1984 season. From 1973 through 1980, the commercial season was closed by regulation prior to June 25. As a result only the very latter portion of the early-run has been subject to a commercial harvest since 1973. Therefore, early-run fish are harvested by recreational anglers in the Deep Creek marine fishery and in the very intense Kenai River fishery.

Late-run fish (early July through mid-August) are harvested by both commercial and recreational interests. The commercial harvest is incidental to the more abundant sockeye salmon and is dominated by the set gill nets along the eastern shore of Cook Inlet. The harvest of chinook salmon by the commercial drift gill net fleet in July, although relatively small, is considered to be primarily of Kenai River origin as there are no other known populations of significant strength in Cook Inlet with similar timing.

The Kenai River became popular as a recreational fishery for chinook salmon in 1973. In 1974, the Division of Sport Fish initiated a creel census to monitor harvest and effort. That census was expanded in 1975 and has continued each summer. For the past 7 years, angling effort for chinook salmon on the Kenai River has made this fishery the largest in Alaska. Effort levels have gradually continued to increase each year and a new record was established in 1984.

This late run of chinook salmon to the Kenai River has been the subject of much controversy between sport and commercial entities. The harvest of these prime game fish by gill nets has been considered "sacrilegious" by many sport fishermen. While management of a commercial fishery only to accommodate those individuals who are "just having fun" does not seem justified to the commercial fishermen. The battle has resulted in much discussion at the annual Board of Fisheries meeting and some court action. The controversy promises to continue in the future. The overall result has been a greater demand upon ADF&G to provide more information regarding the total river system by those who have been charged with resolving some of the various problems confronting the Kenai River.

One of the most critical management needs on the Kenai River has been to define the spawning population of chinook salmon, especially the late run. Sonar, in its present state of the art, has not proven successful. New equipment was tested in 1984, however results are currently undergoing analysis. The Division of Sport Fish proposed a tag and recovery program in 1975. Various adult chinook capture devices have been evaluated since 1980. These include electroshocking, drift gill net (Hammarstrom, 1980), fish trap and fish wheel (Hammarstrom and Larson, 1982-1984). The drift gill net has been found to be the most effective to date and was employed in 1984 to capture the required fish to make a population estimate.

Another crucial question that has plagued fisheries managers is the spawning locations of late-run Kenai River chinook salmon. Previous work indicated a relatively unbalanced distribution, with most spawning located in that section most heavily fished (Burger et al., 1983). An attempt to expand Burger's study using many of the same techniques he employed resulted in a telemetry project in 1984. Additional information concerned travel time through the fishery and some behavior characteristics that could be defined through the use of radio telemetry.

Since the chinook salmon of the Kenai River are considered trophy fish, many anglers have attempted to promote hook-and-release fishing. The result of this type of management on such large anadromous fish had not been attempted in Alaska. Limited funding was made available through the Anadromous Fish Fund which allowed for a hook-and-release study. It was apparent that the project would not be funded in the future, thus the decision was made to employ telemetry. If all fish could survive the rigors of being caught on recreational gear, the handling associated with any tagging project and carrying an esophogeal implant to the spawning grounds, it could be assumed that most would survive hook-and-release fishing.

Coho Salmon

Another popular fishery on the Kenai River is the coho salmon fishery. This fishery differs from the chinook fishery in that it is essentially a stationary fishery. Anglers fish primarily from drifting boats or by trolling from a boat held in the current by an outboard motor when fishing for chinook salmon. In contrast, anglers will motor to a favorite location, anchor, then either cast lures or still fish with salmon roe. The popularity of this fishery seems more aligned with the strength of the returns and the conditions of the river than does the chinook fishery. Years with poor catch rates or flood conditions are usually years when effort is relatively low.

Coho salmon also return to the Kenai River in two segments, an early run and late run. Early-run fish begin to appear in late July and are available through early September. Late-run fish show in the river in late August and are available until freeze-up; however, the recreational fishery peaks in September. Early-run fish are also taken in the commercial gill net fishery in Cook Inlet. The commercial closing date of August 15 essentially prevents any harvest of late-run fish by commercial fishermen.

In 1982, Governor Jay Hammond appointed a task force to study the fisheries and habitat of the Kenai River. The findings of that committee and accompanying public concern prompted current Governor Bill Sheffield to appropriate additional monies for further studies. In addition, the Legislature created the Kenai River Special Management Area (KRSMA) during the 1984 session. In essence, this placed most of the Kenai River into the State Park system and gave control of the water and habitat to the Department of Natural Resources (DNR). A special advisory committee of local representatives from various agencies responsible for the river was formulated and charged with drafting a management plan over the next 2 years. Once a plan is adopted by DNR, it will direct the management of the river, at least for the foreseeable future. Table 1 presents common and scientific names of species mentioned in this report.

Table 1. List of common names, scientific names and abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Sockeye salmon	*Oncorhynchus nerka* (Walbaum)	RS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	PS
Rainbow trout	*Salmo gairdneri* Richardson	RT
Pacific halibut	*Hippoglossus stenolepis* Schmidt	H

RECOMMENDATIONS

1. The recreational fisheries for chinook and coho salmon continue to be monitored by creel census.

2. Escapement of late-run chinook salmon into the Kenai River should continue to be assessed and techniques further refined to ensure the accuracy of calculated estimates.

3. The spawning distribution and migrational behavior of late-run chinook salmon in the Kenai River should be further investigated with the use of radio telemetry.

OBJECTIVES*

1. To accurately assess the recreational harvest of chinook salmon and angler effort in the following fisheries:

    a. Kenai River (June-July)

    b. Deep Creek Marine (May-August)

    c. Kasilof River (June)

    d. Anchor River, Deep Creek, Ninilchik River (May-June)

2. To accurately assess total run strength of late-run Kenai River chinook salmon in July and August.

3. To determine chinook salmon spawning escapement in Anchor River, Deep Creek and Ninilchik River in late July.

4. To determine total harvest and angler effort in the Kenai River coho salmon fishery from July through September.

5. To determine the effects of hook and release fishing as related to the Kenai River chinook salmon fishery in June and July.

6. To determine final spawning destination of late run chinook salmon in the Kenai River during July and August.

* Objectives 1 through 4 relate to study number G-II and objectives 5 and 6 relate to study number AFS-50.

TECHNIQUES USED

Fisheries

The harvest of chinook salmon and angler effort on the three southern Kenai Peninsula streams, Anchor River, Deep Creek and Ninilchik River, were determined by personnel on location during each day of the fishery. The methods used were the same as has been employed since 1977 (Hammarstrom, 1978).

The creel census in the Deep Creek marine fishery was the same as described by Hammarstrom (1977).

The method used to determine the harvest and effort in the Kenai River recreational fishery was similar to that described by Hammarstrom (1977); however, a change in the regulations promulgated by the Board of Fisheries for the 1984 season altered the fishery. The effects upon the estimates generated are evaluated here.

Prior to 1984, an angler could continue to fish for other species after retaining a chinook salmon. For the 1984 season, it became illegal to fish from a boat on the Kenai River for the remainder of that calendar day after keeping a chinook salmon. Since the fishery is essentially a boat fishery with approximately three anglers per boat, the instantaneous count was altered because all anglers were not necessarily fishing. In the past, anglers utilized a boat bag limit, according to the number of anglers in the boat.

Although each angler was only allowed one chinook salmon over 20 inches per day and two per season, all anglers would continue to fish after keeping their chinook salmon limit. If a second fish hit the rod of an angler that already had his daily limit, that rod then belonged to one of the anglers that did not have a limit.

To compensate for the regulation change, each angler's data were recorded separately. In the past, for example, if the census taker interviewed a party of three anglers in one boat that had fished for 4 hours and had retained two chinook salmon, the catch per hour would be: 2 fish per 12 hours or 0.167. It was assumed all anglers had fished for the entire 4 hours. In 1984, each angler was interviewed individually, thus all successful anglers were completed anglers.

Additional restrictions were placed on recreational fishing guides which necessitated creating separate strata for this category of angler. Guides could operate only from 6:00 a.m. to 6:00 p.m. during June and July and could not operate on Sundays in July. Thus, harvest and effort were calculated on the basis of a 12-hour fishing day instead of a 20-hour fishing day as it is for nonguided anglers.

The above mentioned regulation changes altered the behavior of anglers sufficiently that the inseason technique developed for this fishery and described by Hammarstrom and Larson (1982) could not be used.

None of the regulatory changes affected the fishery occurring after July 31, which is primarily directed at coho salmon. The harvest and effort estimation techniques were the same as has been used since 1976 (Hammarstrom, 1977).

The estimate of chinook salmon harvest from the Kasilof River was accomplished with a creel census based on that described by Neuhold and Lu (1957). Angler counts were conducted by walking the length of the area used by fishermen, approximately 1 mile, at random times over a 20-hour fishing day (0400-2400). Each weekend day and 3 of 5 weekdays were censused. Completed angler interviews were conducted near the trail head where virtually every angler had to pass to get to the parking area. Information collected from each angler consisted of the following: length of time fished to the nearest 0.5 hours, total fish retained, total fish released, length, sex and a scale sample from any chinook salmon retained (each chinook salmon was also examined for fin clips which identified it as having been released from the Kasilof hatchery).

The fishery was divided into two strata, weekend and weekday. Estimates were generated separately for each stratum and added together to arrive at the total estimated harvest and effort. Effort in man-hours was determined according to the formula:

$$E = cN$$

E = Effort in man-hours
c = Mean angler count
N = (Number of days possible) x (20 hours per day)

The mean angler count is the total of all random angler counts made over the season in a given stratum divided by the number of counts made. Harvest was calculated according to the following formula:

$$H = Er$$

H = Harvest
E = Effort
r = rate of harvest

The rate of harvest was determined by dividing the total number of chinook salmon reported in a given stratum by the total hours reported in that stratum.

Escapement Estimate

The method for estimating the Kenai River late-run chinook salmon population involves a capture/recapture technique utilizing net webbing as the capture tool and the recreational fishery as the recapture mechanism. Originally, Hammarstrom (1980) used gill net webbing as the capture tool and the term "gill-netting" technique was coined, however, this term is misleading. The intent is to capture by entangling the fish with web material around the snout rather than gill the fish. Certainly some fish will be inadvertently gilled when using web material, however, those fish are suitable for tagging. To more accurately describe the capture technique, future reference to the original "gill-netting" technique will be referred to as the "drift-netting" technique.

The basic drift-netting technique has been described by Hammarstrom (1980), with improvements by Hammarstrom and Larson (1984). Further technique refinements in 1985 involve fish handling procedures, as a result of equipment improvements, to include a rigid tagging cradle and a tail restraining loop.

The tagging cradle (Figure 1) is designed to physically immobilize the entire fish during the tagging procedure and the tail loop prevents the captured fish from escaping during transfer from the net to the tagging cradle. The tagging cradle is an aluminum trough with the following dimensions: two sides, each of which are 1.22 meters long and 0.30 meters wide, joined together by a 15 centimeter wide base. One end is enclosed to prevent the captured fish from sliding out and one side is hinged to expedite fish insertion and removal. The hinged side is secured in the upright position during fish processing by an adjustable rope and clip located on each cradle handle. To prevent injury to the captured fish, the interior of the cradle is lined with a 9.5 millimeter thick closed cell pad and the outer edge of the 3.18 millimeter thick aluminum plate is bordered with a 9.5 millimeter diameter solid aluminum rod.

Chinook salmon were processed immediately after their entanglement in the net webbing. Prior to removal of a fish from the net, the handheld "loop," 12.7 millimeter diameter loose-braid poly line (preferred for its low abrasive qualities), is wrapped around the caudle peduncle area. The tagging cradle is lowered over the side of the vessel with the base of the cradle below the water line. The hinged side of the cradle is unclipped and lowered to allow easier access for the captured fish to enter the cradle. With the aid of the "loop", field personnel can maneuver the captured fish (head pointing toward the end plate) to the cradle with little fear of losing the fish. With the cradle base below the water line, removal of the fish from the water during this transfer is not necessary. Raising the hinged side of the cradle and snapping the retainer clips from the opposite handles secures the fish in the tagging cradle and completes the capture procedure. The time required to complete the restraining process is usually less than 1 minute from the time the fish first strikes the net until it is secured in the tagging cradle.

The net webbing used for capturing chinook salmon in the Kenai River is a twisted, three strand nylon seine lead web of 19 centimeter stretched mesh and 50 mesh depth.

Public cooperation is an essential element in obtaining an accurate fish population estimate in a capture/recapture program where the public is the recapture mechanism. To provide incentive for the public to report recovered tags, a cash drawing was conducted for eligible participants at the end of the chinook salmon recreational fishing season. To be eligible, a person was required to fill out a questionnaire providing name, mailing address, phone number, date and location of capture, and the condition of the fish when caught. The cash awards were:

1.	First prize	$1,000.00
2.	Second prize	500.00
3.	Third prize	250.00

To compute the adult chinook salmon population estimate, the tag recoveries collected through the boat creel census (Hammarstrom, 1976) were used. Chapman's modification of the Peterson estimate (Ricker, 1975)

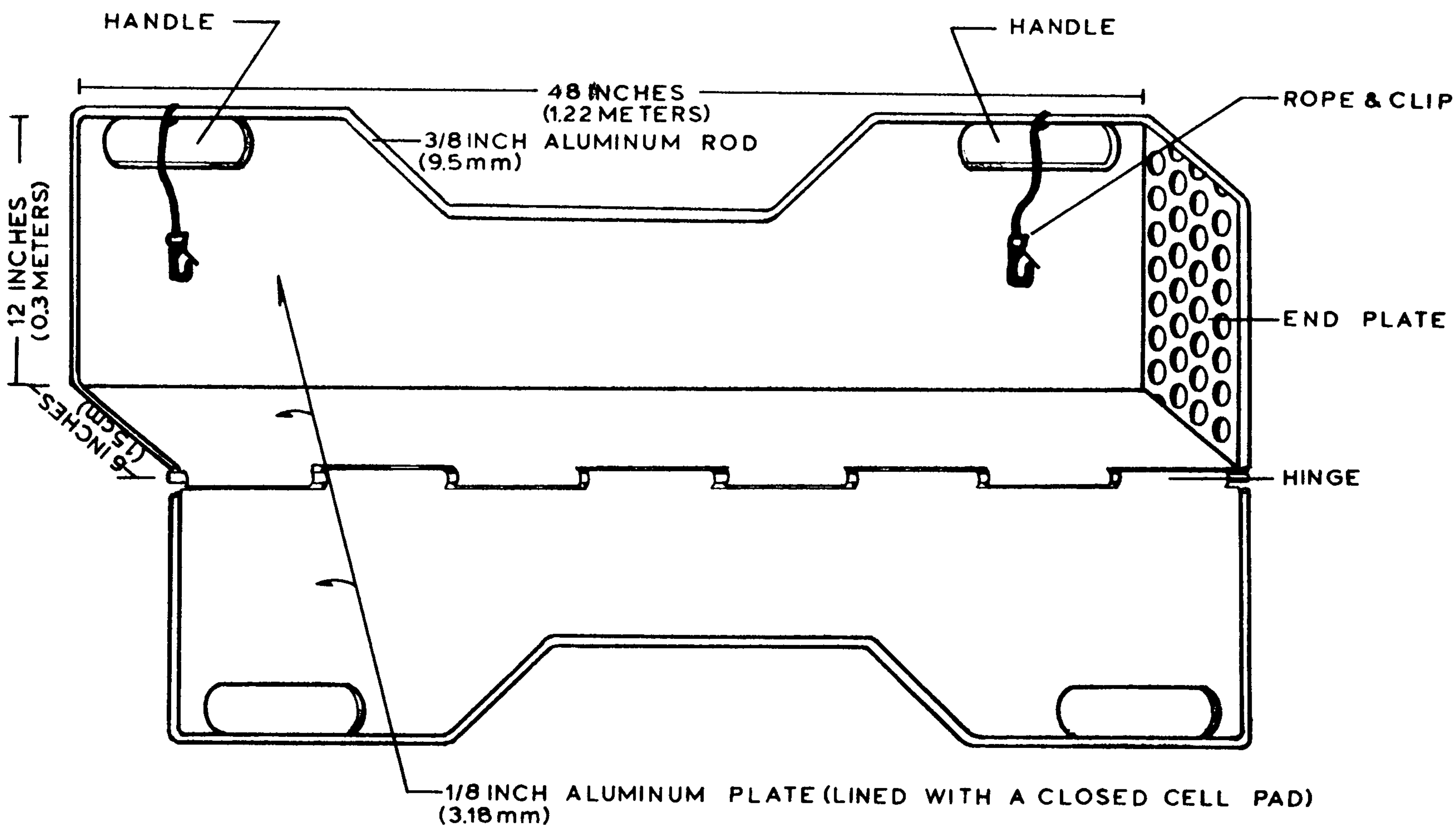

Figure 1. Salmon agging cradle used in chinook salmon population estimation study on the Kenai River, 1984.

was the method used to calculate an estimate of the chinook salmon population size that entered the Kenai River. Confidence intervals were calculated by using the number of sport angler recaptures observed in the boat creel census as an entering variable in a Poisson frequency distribution table (Ricker, 1975).

The tagging effort occurs in estuarine waters of the Kenai River which receive significant tidal influence. An experiment was conducted to determine if drift net catch rate was related to tidal stage. The catch per unit of effort (CPUE) for the entire field season was summarized and compared with time periods before and after low tide. Attempts to capture chinook salmon during periods of high tide were rare; a lack of sufficient river current during periods of high tide hampered drift-netting efforts and resulted in limited information for this period.

Migrational Behavior

Chinook salmon for the migrational behavior study were captured by the population enumeration project (PEP) crew using drift nets as discussed previously. Capture and radio tagging of chinook salmon commenced on June 25 and continued until August 12, 1984. Radio tagging during this period followed a schedule which approximated the run timing and abundance based on historical catch per hour data from the sport fishery. Capture of chinook salmon for radio tagging took place in the tide influenced zone between RM 7.0 and 11.5 (mean = RM 9.2).

As the PEP crew drifted the drift net, the radio telemetry (RT) crew drifted nearby in another riverboat. When a chinook salmon hit the drift net the fish was immediately retrieved alongside the PEP boat. A 45 cm X 45 cm X 140 cm holding tank was filled with river water and the entangled fish was transferred to the tank. The fish was freed from the drift net inside the holding tank and tricane methanesulfonate (MS-222) was gradually added until the fish could no longer right itself. While the fish was being sedated, length (mid-eye to fork of tail) and sex were determined, and coloration, presence of sea lice and general condition were noted. In addition, each fish was tagged at the base of the dorsal fin with a numbered pink spaghetti tag. The transmitter was placed in the holding tank and tested for the "best" signal. When the fish was unable to right itself, it was held in the holding tank ventral side up, supported near the dorsal fin and head, and its lower jaw was held open. The glycerin-coated radio transmitter was inserted through the esophogus into the anterior portion of the stomach using a veterinarian balling gun. The transmitter antenna trailed from the mouth after being fed through the maxillary tissue with a hollow needle (Figure 2). Upon completion of radio tagging, the transmitter signal was checked and the fish was transferred to the river in a flexible fabric (canvas or vinyl) trough (Hammarstrom and Larson, 1984) which evenly supported the weight of the fish. The tagged fish was held into the current until it forcefully swam off.

The following times were recorded when each fish was captured and radio tagged; capture time (hit net-free of net); MS-222 time (total time exposed to MS-222); and handling time (into holding tank-release).

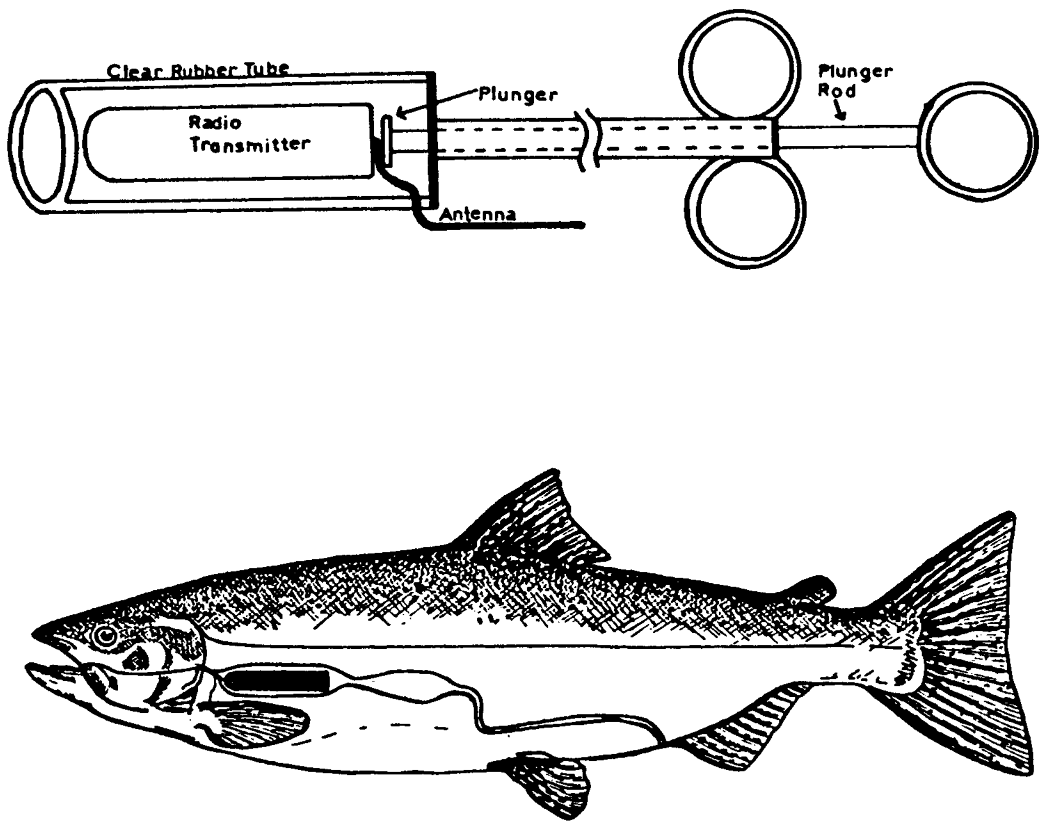

Figure 2. Veterinarian's balling gun used for esophogeal implant of radio transmitters in chinook salmon and internal placement of radio transmitter in the anterior portion of the stomach.

Radio telemetry equipment used on the project was manufactured by Advanced Telemetry Systems, Inc., Bethel, Minnesota. Radio transmitters had distinct frequencies in the 48-50 MHz range separated by 0.010 MHz, were powered by a single 1/2 A, 3 V lithium battery and were rated to have a 80 to 90-day transmitting life. The components and battery were encased in epoxy, making them cylindrical in shape. They measured 57-60 mm long, 21 mm in diameter, weighed 22-23 g in water, and had a 30 cm long teflon-coated wire antenna.

Three programmable scanning receivers were used in the study. Each active radio transmitter frequency programmed into the receiver could be monitored individually at a variable scan rate of 2 seconds to 16 minutes, or each could be dialed in manually. The audio signals were heard through the receiver's external speaker or with headphones. Receivers were powered by one of three sources: an internal rechargable nickle-cadmium battery, an external rechargable nickle-cadmium battery pack or a 12 V boat battery.

Two types of receiving antennas were used for radio tracking, a 4-element directional yagi antenna and a directional loop antenna. The yagi antenna had a 3.65 m long boom, element lengths of 2.74-3.05 m, a 3.05 m mast and was mounted on a 1.22 m high tripod in the bow of a riverboat. The yagi antenna provided a receiving range of approximately 1/2 mile. Hand-held directional loop antennas provided a receiving range of approximately 1/4 mile from the boat.

Radio tracking surveys were conducted on the average of two to three times per week from either a riverboat, a Cessna 180 airplane or, occasionally, from a helicopter.

Boat tracking was conducted in the Kenai River from the mouth to the outlet of Skilak Lake (RM 50.0). While searching for radio tags from the boat, two programmable receivers were connected to the yagi antenna using a coaxial T-adapter. Each receiver cycled through a different set of frequencies at a scan rate of 2-4 seconds, dependent upon the number of active radio-tagged fish in the river. The boat was operated near the 1/2 throttle range to avoid excessive outboard engine interference. As a signal was received, the boat was moved toward the signal until it could be received with the loop antenna. Radio tagged fish were located to the nearest 25-50 m with the loop antenna by triangulating from two points in the river. Because determining specific fish locations was not an objective of the study, locating a signal to within 25-50 m was sufficient; however, the equipment was capable of locating radio tags to within a 3 m radius with the loop antenna.

Aerial tracking from the Cessna 180 was done with two scanning receivers connected to separate loop antennas attached on each wing. Each receiver was programmed to scan a different set of frequencies at a 2-second scan rate. Loop antennas were attached with U-bolts to L-shaped brackets of aluminum tubing (3.8 cm outside diameter) and the brackets were inserted into a pipe (4.4 cm inside diameter) welded to the underside of each wing. During aerial tracking, the loop antennas were oriented such that the strongest directional plane of one antenna pointed forward and the other aft. For tracking from a helicopter, a handheld loop antenna was positioned inside the cockpit with the strong directional plane pointing forward. Weather permitting, aerial tracking was conducted at an altitude of 240-300 m above the river, providing a receiving range of up to 3.5 km.

Fish locations in the field were translated to the nearest 0.1 river mile from aerial photos of the Kenai River. Mean migration rates of radio-tagged chinook salmon were calculated from the time fish started upstream movement to their upstream-most location. Maximum migration rates were the fastest upstream movements recorded from each fish. For data analyses purposes, the river was divided into four sections; downstream section (below RM 21.1), midstream section (RM 21.1-39.5), upstream section (RM 39.5-50.0), and between Skilak Lake and Kenai Lake (RM 64.0-82.0). Spawning locations of radio-tagged chinook salmon were defined as areas where milling behavior was detected for at least a 5-day period, followed by rapid downstream movements or no further upstream movements. Statistical methods applied to the data were recommended by the Region II Sport Fish Biometrician and are described in Sokal and Rohlf (1969) and Snedecor and Cochran (1967).

Hook and Release

Chinook salmon for the hook and release study were captured with representative sport fishing gear. Medium to heavy action spinning rods with level-wind or spinning reels were used with 20 lb monofilament line. Terminal tackle consisted of a large "spin-n-glo" on a 60 lb test monofilament leader, 30-60cm in length. Two single beak-hooks (7/0 or 6/0) were tied to the end of the leader so that one hook trailed the other and the hooks were separated by 2.5 cm. Cured salmon roe was attached to the shank of the leading hook with a loop of the leader. A sinker slide was placed on the fishing line before a swivel was tied on. The leader was then tied to the swivel and a 42.5-85.0 g lead weight was attached to the sinker slide.

The drift fishing technique was used because it is the most common technique used on the Kenai River. Several rods were fished from a boat drifting downstream with the current. The tackle was cast upstream, allowed to settle to the river bottom and pulled downstream at or near the bottom.

When a fish was hooked, the boat motor was started and the operator maneuvered the boat to stay over the fish. The fish was played until it could be safely netted with a nylon landing net. It was held in the water with the net and the boat was allowed to drift with the current. If the area was congested, the boat was eased to the shore taking care not to expose the fish to excessive current.

The radio tagging procedure was accomplished without removing the fish from the water. The hook was released if it was loosely embedded. If hook removal was difficult and would result in excessive physical damage to the fish, the leader was cut at the eye of the hook and the hook was left in place. The fish was gently maneuvered into the tagging cradle and rolled ventral side up. Generally, fish struggled less in this position and it facilitated radio tagging. One person supported the fish near the dorsal fin and head and momentarily inclined the fish so that its head was out of the water. The lower jaw was held open and a second person implanted the radio tag in the same manner discussed previously. The fish was then submerged and rolled dorsal side up, length (mid-eye to fork of tail), sex and general condition were recorded, and a pink spaghetti tag was affixed just below the base of the dorsal fin. This completed the tagging process.

With tagging complete, the radio tag was checked to verify that it was still in place and the signal was tested with a receiver and a loop antenna. If tagging took place from the drifting boat, the fish was guided from the trough and held in the water at the side of the boat, facing forward. The boat was slowly turned into the current and enough power was applied so that the fish experienced a mild directional current. Too much current made it difficult to hold the fish. The fish was released when it could forcefully swim away. If tagging occurred near shore, the fish was guided from the trough to an area with sufficient current and released.

The following times were recorded during the capture and tagging process; capture time (hooking to netting) and tagging/handling time (netting to release).

Fish that were too small for esophogeal implant of the radio tag were released. One fish hooked in the gills was bleeding and was not tagged.

In addition to fish captured for radio tagging, other fish were captured for blood chemistry analysis. Blood samples were obtained from chinook salmon in each of two groups and analyzed for physiological indicators of stress. Group 1 was captured with the same sport fishing gear and techniques used to capture fish for radio tagging. Group 2 was captured with the drift-netting technique and served as the control group; it has been verified by radio telemetry studies that Kenai River chinook salmon captured with this method do achieve spawning success (Burger et al., 1983).

With the exception of capture technique, fish from each group were handled similarly. A fish was lifted from the river (with a landing net for hook and line captured fish, with the drift net for drift net captured fish) and transferred to an onboard holding tank containing fresh river water. The fish was rolled ventral side up to expose the blood sampling site on the ventral caudal surface. Approximately 3 cc of blood were drawn from a caudal vessel with a 6 cc syringe and an 8.9 cm long 18 gauge hypodermic needle (Metelev and Kozlov, 1965; Larson, 1984). An occult blood test strip (Hemastix, Miles Laboratories) was then applied to the side of the fish to test for occult blood in the skin mucus (Larson, 1984). Occult blood in the mucus has been associated with stress in several saltwater species and has been detected with this strip test (Smith and Ramos, 1976). However, the test has not been applied to adult chinook salmon (Wedemeyer, pers. comm., 1985).

After the initial blood sampling, the fish was lifted from the holding tank with a canvas trough (Hammarstrom and Larson, 1983) and transferred to an inriver, near shore live pen where it was measured and spaghetti-tagged. The live pen measured 120 cm X 120 cm X 60 cm deep and was constructed of perforated aluminum sheeting. All surfaces were painted dark green to reduce light reflection. No more than two fish were held simultaneously in the live pen. A removable canvas cover reduced light intrusion. Water flow through the live pen exceeded 500 gallons per minute. Each fish was blood sampled and strip tested in the live pen at approximately 50-minute intervals until three or four samples were obtained. Water temperatures were taken daily at river mile 21.1 by United States Geological Survey (USGS) personnel as part of an ongoing river monitoring program.

Several fish that had completed the holding and sampling process were rehooked in the live pen, released into the river, played with sport gear to exhaustion and sampled for blood chemistry. In addition, four fish were captured by an ADF&G operated fishwheel at river mile 19.3 and blood sampled. Five spawned out fish were captured from a spawning area by snagging them with a weighted treble hook. All fish were easily retrieved within 1 minute of hooking and were blood sampled immediately upon landing.

In the field, blood samples were transferred to heparinized collecting tubes (Vaccutainer) and cooled on ice in an insulated cooler until they could be processed to obtain the plasma from each sample (Larson, 1984). The plasma samples were then frozen until they could be shipped to the U.S. Fish and Wildlife Service (USF&WS) National Fishery Research Center (NFRC) in Seattle for analysis. The frozen samples were air-freighted in a small insulated cooler with frozed gel packs. This method of shipping was sufficient if the samples were received by the NFRC lab within 24 hours.

The protocol of holding fish and sampling over time was necessary to detect the response of lactic acid in the blood to the struggle of capture. Lactic acid is produced from hydrolysis of muscle glycogen at low blood oxygen concentrations; its production is related to muscular activity and not to other stressors inherent in handling and holding. Lactic acid is purged from the musculature via the vascular system and its response in the blood stream is somewhat delayed (Wedemeyer, pers. comm., 1985). Although the sampling protocol was implemented primarily for the purpose of detecting this delayed response, excessive hemolysis occurred in the samples and precluded analysis for lactic acid. Excessive amounts of hemoglobin in the plasma yields artificially variable and inaccurate results (Palmisano, pers. comm., 1985).

Other blood parameters were measured. However, the blood response of these parameters can be affected not only by the acute stressor of capture, but by other acute stressors such as handling when taking the sample and transferring the fish to the live pen, as well as by chronic stressors due to holding (Palmisano, pers. comm., 1985) such as confinement, crowding and atypical light, water flow and depth levels. Their response in the blood is therefore related to the combined effects of capture, handling, and holding.

FINDINGS

Southern Peninsula Fishery

The spring fishery for chinook salmon on Anchor River, Deep Creek and Ninilchik River was conducted under the same regulations as has occurred since 1978, with the exception that catches must be recorded on the back of an individual's sport fishing license or special card in ink (pencil was allowed in prior years). Each stream opened May 26, 1984 for a 3-day period (Saturday, Sunday and Monday) and remained open each of the next three weekends, except for Ninilchik River, which closed after the third weekend. Total harvest of chinook salmon over 51 cm (20 inches) was estimated at 1,515, and total effort for the entire fishery was estimated at 20,860 man-days.

Opening weekend found all three streams in fishable condition, however, Deep Creek was not as clear as it has been in the last 3 years. As the season continued, Anchor River and Ninilchik River received less flow. The waters continued to clear and recede throughout the length of the fishery. Thus, as the season progressed, fishing became more difficult as the fish became more apprehensive and exhibited an increased reluctance to strike. Historically, the second weekend has produced the greatest total harvest. In the Anchor River, the catch declined each successive weekend. Ninilchik River, which usually has a very high catch opening weekend, did not produce as well and actually produced more fish the second weekend. The best weekend on Deep Creek is usually the last weekend, because water conditions are the most conducive to fishing, but in 1984 was relatively poor fishing. A summary of daily harvest and effort is presented in Table 2.

Escapement surveys were conducted in late July by both helicopter and ground crews. Surveying conditions were ideal in 1984 in that all streams were relatively low and clear and sky conditions sunny and clear. Escapements into each stream were less than the 1966-1983 mean. However, the escapements were considered adequate as returns from similar sized escapements have produced near record returns. Escapement into each stream was as follows: Anchor River-1,170, Deep Creek-390 and Ninilchik River-600. Total harvest was equal to the historical mean. Overall exploitation rate was 12% greater than the 18-year mean of approximately 30%. A summary of harvest and escapement is presented in Table 3, while historical information on the fishery is presented in Table 4.

During the 1984 fishery, a total of 141 scales were collected from recreationally harvested chinook salmon from the three streams. Fish from age class 1.4 (brood year-1978) represented the largest segment contributing 65.3%. During the 1983 fishery this same brood year contributed only 32.7% to the harvest. Since 1976, the mean percent contribution to the creel has been primarily from two age classes, 1.3 and 1.4, 41.7% and 48.4%, respectively. Age composition data for 1984 are presented in Table 5, while historical information appears in Table 6.

Table 2. Summary of Angler Harvest and Effort During the Chinook Salmon Fisheries on Three Southern Kenai Peninsula Streams, 1984.*

Date	Anchor River		Deep Creek		Ninilchik River		Total	
	Harvest	Effort	Harvest	Effort	Harvest	Effort	Harvest	Effort
5/26	135	1,440	20	440	120	1,415	275	3,295
5/27	60	1,330	15	800	30	1,325	105	3,455
5/28	50	630	10	370	20	775	80	1,775
Subtotal	245	3,400	45	1,610	170	3,515	460	8,525
6/2	125	885	75	495	100	770	300	2,150
6/3	60	630	30	600	80	670	170	1,900
6/4	35	430	15	390	20	530	70	1,350
Subtotal	220	1,945	120	1,485	200	1,970	540	5,400
6/9	75	825	30	590	30	595	135	2,010
6/10	50	770	50	500	20	405	120	1,675
6/11	35	320	25	195	20	230	80	745
Subtotal	160	1,915	105	1,285	70	1,230	335	4,430
6/16	60	635	30	560	closed		90	1,195
6/17	30	530	20	320	closed		50	850
6/18	20	280	20	180	closed		40	460
Subtotal	110	1,445	70	1,060			180	2,505
Total	735	8,705	340	5,440	440	6,715	1,515	20,860

* Numbers have been rounded to the nearest 5.

Table 3. Historical harvest* and escapement for three southern Kenai Peninsula chinook salmon streams (Anchor River, Deep Creek, Ninilchik River), 1966-1984.

Year	Anchor River			Deep Creek			Ninilchik River			Total		
	Harvest	Escapement	%Harvest	Harvest	Escapement	%Harvest	Harvest	Escapement	%Harvest	Harvest	Escapement	Run
1966	290	1,330	18	50	540	9	200	670	23	540	2,540	3,080
1967	240	1,200	17	180	270	40	120	360	25	540	1,830	2,370
1968	250	530	32	160	200	44	210	450	32	620	1,180	1,800
1969	80	1,800	4	40	200	17	130	760	15	250	2,760	3,010
1970	170	1,850	8	60	...	...	280	...	...	510	1,850+	2,360+
1971	60	1,220	5	40	...	...	140	...	...	240	1,220+	1,460+
1972	180	1,890	9	140	530	21	170	1,360	11	490	3,780	4,270
1973	330	1,660	17	140	220	39	300	640	32	770	2,520	3,290
1974	440	1,000	31	290	740	28	350	510	41	1,080	2,250	3,330
1975	210	1,290	14	100	610	14	540	830	39	850	2,730	3,580
1976	830	3,080	21	220	1,680	12	630	1,180	35	1,680	5,940	7,620
1977	1,020	4,170	20	240	990	20	910	1,400	40	2,170	6,560	8,730
1978	1,680	2,410	41	590	1,010	37	1,130	990	53	3,400	4,410	7,810
1979	1,030	2,000	34	370	1,750	17	700	1,390	34	2,100	5,140	7,240
1980**	425	665	39	90	475	16	480	720	40	995	1,860	2,855
1981**	1,040	1,230	46	580	920	39	1,300	830	61	2,920	2,980	5,900
1982	760	1,540	33	660	2,670	20	1,070	1,430	43	2,490	5,640	8,130
1983	930	1,490	38	1,100	1,010	52	1,160	710	62	3,190	3,210	6,400
Mean***	610	1,710	26	310	860	26	590	890	40	1,510	3,460	4,970
1984	740	1,170	39	340	380	47	440	600	42	1,520	2,110	3,630

Numbers rounded to nearest 10.

* Percent of total return harvested.
** Escapement counts considered minimal due to high turbid water during escapement surveys.
*** Excludes all 1970 and 1971 data.

Table 4. Historical Chinook Salmon Harvest and Effort Data from Three Southern Kenai Peninsula Streams (Anchor River, Deep Creek and Ninilchik River), 1971-1984.

Year	Effort (Man-Days)	Harvest	Length of Season (Days)	Average Effort/Day	Average Harvest/Day	Man-Days Per Fish
1971	15,900	240	6	2,650	40	66
1972	13,520	490	4	3,380	123	28
1973	24,100	770	6	4,017	128	31
1974	21,000	1,080	6	3,500	180	19
1975	19,600	850	6	3,267	142	23
1976	36,920	1,680	8	4,615	210	22
1977	24,520	2,170	8	3,065	271	11
1978	45,540	3,400	16*	2,846	213	13
1979	36,640	2,100	16*	2,290	131	17
1980	28,790	995	12	2,399	83	29
1981	32,330	3,020	12	2,695	252	11
1982	33,420	2,485	12	2,785	207	14
1983	27,370	3,185	12	2,280	265	9
1984	20,860	1,515	12	1,738	126	14
Mean	27,180	1,715	10	2,965	169	16

* Anchor River only was open for 4 additional days.

Table 5. Length Data* for Major Age Classes of Chinook Salmon Harvested by Recreational Anglers in Three Southern Kenai Peninsula Streams (Anchor River, Deep Creek and Ninilchik River), 1984.

Age Class Brood Year	1.2 1980	1.3 1979	1.4 1978	1.5 1977
Number	19	26	92	4
Percent	13.5	18.4	65.3	2.8
Length Range (mm)	560-670	685-940	785-1,040	540-950
Mean Length (mm)	608	777	894	822
Standard Deviation	35.1	48.7	50.5	130.7

* Lengths are mid-eye to fork of tail.

Table 6. Historical Age Composition* of Chinook Salmon Harvested by Recreational Anglers from Three Southern Kenai Peninsula Streams (Anchor River, Deep Creek and Ninilchik River), 1976-1984.

Year	Age Class			
	1.2	1.3	1.4	1.5
1976	16.2	38.2	45.6	0.0
1977	10.6	60.8	28.1	0.5
1978	15.5	27.5	57.0	0.0
1979	6.5	43.2	49.4	0.9
1980	11.2	45.2	43.6	0.0
1981	8.7	60.8	30.2	0.3
1982	4.8	25.1	70.1	0.0
1983	4.2	32.7	63.1	0.0
Mean	9.7	41.7	48.4	0.2
1984	13.5	18.4	65.3	2.8

* Major age classes only by percent.

Deep Creek Marine Fishery

Creel census activities in 1984 commenced May 18 on the Deep Creek marine recreational fishery and was continuous through July 31. During that time, a total of 149 instantaneous boat counts were made, 4,721 boats were counted, 3,067 anglers were interviewed, 219 chinook salmon were creel checked and 1,543 Pacific halibut were also reported.

The season lasted 75 days and creel census activities were conducted on 51 days (68.0%). Of the 75-day season, early run fish were available for 40 days and late run fish were available for 35 days, May 18 through June 28 and June 29 through July 31, respectively. Only 2 of 40 days (5.0%) during the early run and 3 of 35 days (8.6%) of the late run were recorded as weather days when the water was too rough to allow significant effort. Total reduction in fishing time of 6.6% due to inclement weather is in contrast to 41% in 1981 and 35% in 1980.

An estimated 2,386 early run chinook salmon were harvested by 14,694 man-days of effort. Each man-day of effort averaged 4.1 hours in length. The overall catch rate for chinook salmon during the early run was 0.040 fish per hour (25 man-hours per fish). The 1984 catch rate was less than the 1972-1984 mean, but considerably greater than 1983. Harvest of chinook salmon during the late run was estimated at 835 by 11,895 man-days of effort with a catch rate of 0.019 (53 man-hours per fish). The late run harvest was approximately 15% less than the 1972-1983 mean, while effort was approximately 93% greater than the 12-year mean.

An additional 8,033 Pacific halibut (catch rate of 0.135) were taken during the time early run chinook salmon were available and 5,766 (catch rate of 0.131) were taken during the late run. This fishery that started as a chinook salmon fishery has become more diversified. Anglers are currently spending more time in pursuit of halibut than in the past. Most effort for chinook salmon centers around high tide, while effort for halibut occurs throughout the fishing day. There are some anglers who fish one species or the other exclusively, however, these people are in the minority. Historical data regarding the recreational marine fishery in the vicinity of Ninilchik are presented in Table 7.

A total of 178 readable scales were collected from chinook salmon harvested in the Deep Creek marine fishery in 1984; 78 from the early run and 100 from the late run. The predominate age class in both runs was 1.4. During the early run, this age class represented 52.6% of the harvest, while it represented 75.0% of the late run harvest. There was a relatively large component (11%) of age class 1.5 (brood year-1977) which has been the case only once since the program began. In 1979, age class 1.5 made up 17.5% of that year's recreational harvest of late run chinook salmon in this marine fishery (Hammarstrom, 1980). Mean lengths for all age classes were larger for late run fish than early run fish. Summarized age/weight/length (AWL) information obtained from the samples collected from recreationally harvested chinook salmon during 1984 is presented in Table 8.

Table 7. Historical Summary of the Chinook Salmon Sport Fishery in Marine Waters off Deep Creek, 1972-1984.

Year	Early Run			Late Run			Total		
	Harvest	Effort Man-Days	Catch/ Hour	Harvest	Effort Man-Days	Catch/ Hour	Harvest	Effort Man-Days	Catch/ Hour
1972	1,000	2,357	0.119	1,250	1,253	0.272	2,250	3,610	0.173
1973	519	5,245	0.028	491	2,795	0.050	1,010	8,040	0.034
1974	500	3,810	0.037	100	1,280	0.034	600	5,090	0.036
1975	540	3,370	0.061	345	4,680	0.031	885	8,050	0.044
1976	5,495	12,268	0.101	1,382	6,365	0.057	6,877	18,633	0.088
1977	4,617	18,803	0.069	366	6,938	0.017	4,983	25,741	0.056
1978	2,669	14,413	0.059	2,693	9,402	0.081	5,362	23,815	0.068
1979	3,088	13,352	0.053	1,164	8,728	0.034	4,252	22,080	0.046
1980	521	8,065	0.017	747	9,104	0.021	1,268	17,169	0.019
1981	2,363	11,601	0.051	170	3,325	0.018	2,533	14,926	0.042
1982	2,497	14,514	0.056	1,173	9,252	0.033	3,670	23,766	0.046
1983	1,000	21,707	0.011	1,707	10,640	0.045	2,707	32,347	0.021
Mean	2,067	10,792	0.055	966	6,147	0.058	3,033	16,939	0.056
1984	2,386	14,694	0.040	835	11,895	0.019	3,221	26,589	0.031

Table 8. Summarized Data from Readable Scales Collected from Recreationally Harvested Chinook Salmon in the Deep Creek Marine Fishery, 1984.

Age Class Brood Year	1.2 1980	1.3 1979	1.4 1978	1.5 1977	Total
	Early Run				
Number	8	27	41	2	78
Percent	10.3	34.6	52.6	2.5	100
Length Range (mm)*	580-725	740-950	835-1,165	940	580-1,165
Mean Length (mm)*	673	841	1004	940	912
Mean Weight (kg)	4.5	8.5	12.8	10.8	10.4
	Late Run				
Number	6	8	75	11	100
Percent	6.0	8.0	75.0	11.0	100
Length Range (mm)*	700-780	900-1,070	850-1,360	1,070-1,320	700-1,360
Mean Length (mm)*	737	979	1140	1164	1106
Mean Weight (kg)	5.7	14.0	21.7	21.0	20.0

* Mid-eye to fork of tail.

Kenai River Fishery

Formal creel census activities began on the Kenai River in 1984 on June 1 and were continuous through September 30. Anglers were successfully fishing for chinook salmon during late May, and an estimate for the period from May 15 to May 31 was achieved by analyzing data gathered from logbooks of professional guides, angler counts and interviews. Although fish have been harvested in late May in previous years, low water conditions and lack of fish abundance that early in the run kept effort at insignificant levels. In 1984, however, anglers managed to negotiate the various bars and rocks, especially with the use of guides, well enough to harvest an estimated 1,000 fish in May. Most of these fish were taken in the downstream section (Cook Inlet to Soldotna Bridge).

During the chinook salmon creel census (June 1 through July 31), a total of 252 instantaneous counts were made, 11,802 boats were counted and 35,226 boat anglers were enumerated. During the 17,597 angler interviews conducted, 49,446 angler-hours were reported and 1,253 chinook salmon over 51 cm were creel-checked. In addition, 2,762 anglers were interviewed, reporting 481 chinook salmon, during the late run as part of the escapement study. During ten aerial surveys, 1,669 boats were counted.

Analysis of the above data resulted in an estimated harvest of 12,332 chinook salmon; 4,956 during the early run and 7,376 during the late run. Effort during the fishery was estimated at 127,917 man-days, 50,455 and 77,462 during the early and late runs, respectively.

Early run fish were considered available in the downstream section from June 1 through July 1 (31 days) while late run fish were available from July 2 through the end of the season (30 days). In the upstream section (Naptowne Rapids to Skilak Lake), early run fish were available from June 1 through July 13 (43 days), while late run fish were present from July 14 through July 31 (18 days). The midstream section (Soldotna Bridge to Naptowne Rapids) estimates were achieved by combining the downstream and upstream section totals and expanding by a factor determined from the relative effort calculated from aerial survey data.

Total effort during the 1984 early run was 50,455 man-days with each man-day being equal to 4.0 man-hours. The average catch per hour for the entire early run was 0.025 (40 man-hours per fish). This success rate equaled the 1977-1983 mean.

No escapement estimates for the early run are generated, however, one semiclear stream, Benjamin Creek, is surveyed annually as an index to the relative escapement into the Killey River drainage, which is the primary spawning area for the early run. In 1981, an escapement estimate into the Killey River drainage was determined to be 8,000 (Burger et al., 1983). During a stream survey of Benjamin Creek conducted from a helicopter that same year, 800 spawning chinook salmon were enumerated. Over a 3-week period, an estimated 1,200 chinook salmon spawned in Benjamin Creek (Burger et al., 1983). In 1980, 900 fish were counted from a helicopter. In 1984, 560 fish were observed spawning in the stream, however, glacially turbid waters hindered the survey. Since 1980, survey results have ranged from 560 in 1984 to 900 in 1980. Escapement of early run chinook salmon into the Kenai River system was considered excellent in 1984, although probably not as large as the 3 previous years.

The separation date between the two runs is determined by examining daily catch rates and adjusting to the nearest weekly period. This determination was established because of various Board of Fisheries' policies over the years that have required a distinction between the runs. There are no current policies requiring a differentiation, however, the method was retained to preserve compatibility of data. Daily catch rates for the downstream section are presented graphically in Figure 3.

Due to the entry pattern of late run chinook salmon into the Kenai River, their migrational behavior and the seasonal closure date of July 31, the majority of the harvest and effort occurs in the downstream section. During 1984, the total late run harvest of chinook salmon over 51 cm in the Kenai River was 7,376 by 77,462 man-days of effort. Of these, 73% of the effort and 88% of the harvest occurred in the downstream section. Overall catch per hour was 0.021 (48 man-hours per fish). The catch rate in the downstream section was 0.026 while only 0.005 in the upstream section.

Effort during both early and late runs were new records. Participation in the early run fishery was 18% greater than the previous high, while it was 40% greater in the late run. Total effort increased by 32% over the previous record set in 1983. However, harvests during either run were not records, but were well above the 1974-1983 mean. A historical summary of the Kenai River chinook salmon fishery is presented in Table 9. Comparative data by river section appears in Tables 10 and 11.

Because the Kenai River has been such a focal point for dissension between the sport and commercial interests, the subject has received much attention at the annual meeting of the Board of Fisheries. For the 1984 season, slight modifications of the regulations significantly changed the complexity of the fishery. The changes that had the most impact were: (1) once an angler retained a chinook salmon over 51 cm, that angler could not fish from a boat for the remainder of that calendar day in the Kenai River; (2) anglers could fish with the assistance of a guide only from 6:00 a.m. to 6:00 p.m. The first regulation change mentioned had the effect of limiting the overall efficiency of the fishery by reducing the number of hooks that could be in the water. The second change mentioned had the effect of reducing the total time the very efficient guided angler could fish.

The result of these two regulation changes can be seen most dramatically in the reduction of harvest by guided anglers. In 1983, guided anglers accounted for approximately 59% of the total harvest of chinook salmon and 24% of the effort (Hammarstrom and Larson, 1984). In 1984, the share of the harvest was reduced by 15% and the effort by 7%. Total harvest dropped from 15,534 in 1983 to 12,332 in 1984, a reduction of

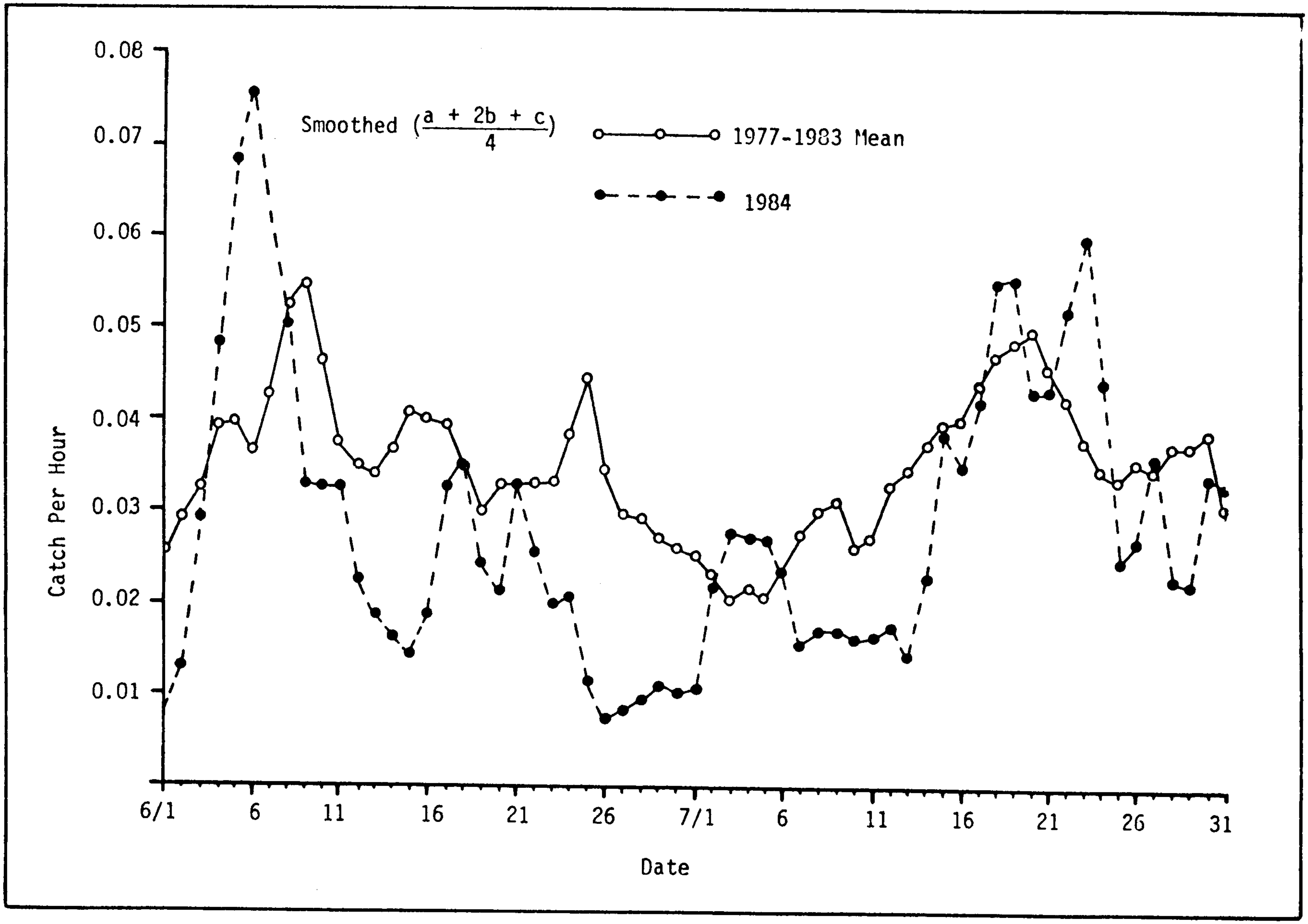

Figure 3. Catch per hour by date in the recreational fishery for chinook salmon in the Kenai River (downstream section), 1984 vs. 1977-1983 mean.

Table 9. Historical Summary of the Kenai River Recreational Chinook Salmon Fishery, 1974-1984.

	Early Run			Late Run			Total		
Year	Harvest	Effort Man-Days	Catch/ Hour	Harvest	Effort Man-Days	Catch/ Hour	Harvest	Effort Man-Days	Catch/ Hour
1974	1,685	11,275	0.041	3,225	12,335	0.037	4,910	23,910	0.038
1975	615	15,047	0.011	2,355	14,943	0.044	2,970	29,990	0.024
1976	1,554	16,430	0.024	4,477	28,030	0.039	6,031	44,460	0.033
1977	2,173	35,479	0.019	5,148	47,539	0.036	7,321	83,018	0.029
1978	1,542	19,569	0.018	5,578	60,636	0.026	7,120	80,232	0.024
1979	3,661	39,665	0.022	4,634	58,895	0.022	8,295	98,560	0.022
1980	1,946	32,365	0.016	3,608	38,260	0.018	5,554	70,625	0.017
1981	4,525	28,335	0.031	5,285	29,906	0.032	9,810	58,241	0.032
1982	5,466	45,723	0.033	4,810	43,366	0.028	10,276	89,089	0.030
1983	6,360	42,716	0.037	9,174	56,295	0.036	15,534	99,011	0.037
Mean	2,953	28,660	0.025	4,829	39,021	0.032	7,782	67,714	0.029
1984	4,956	50,455	0.025	7,376	77,462	0.021	12,332	127,917	0.022

Table 10. Comparative effort data in man-hours and man-days for the Kenai River recreational chinook salmon fishery, 1977-1984.

Year	Upstream Section			Midstream Section			Downstream Section			Shore Anglers			Total			CPUE
	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	
							EARLY RUN									
1977	35,928	10,679	3.4	7,793	2,484	3.1	49,704	16,426	3.0	18,582	5,890	3.2	112,007	35,479	3.2	0.021
1978	35,698	7,761	4.6	5,885	1,199	4.9	38,800	7,321	5.3	16,241	3,288	4.9	96,624	19,569	4.9	0.017
1979	23,416	7,280	3.2	10,600	2,992	3.5	94,366	26,230	3.6	10,772	3,163	3.4	139,154	39,665	3.5	0.022
1980	30,108	6,663	4.5	18,110	4,620	3.9	61,356	17,530	3.5	13,445	3,552	3.8	123,019	32,365	3.8	0.016
1981	29,502	6,066	4.9	13,306	3,119	4.3	67,770	16,735	4.0	10,303	2,415	4.3	120,881	28,335	4.3	0.031
1982	25,562	6,228	4.1	22,444	6,224	3.6	99,128	28,348	3.5	19,200	4,923	3.9	166,334	45,723	3.6	0.033
1983	31,550	9,940	3.2	15,963	3,996	4.0	108,474	25,109	4.3	14,010	3,671	3.8	169,997	42,716	4.0	0.037
1984	43,269	10,725	4.0	18,258	4,514	4.0	130,159	32,152	4.0	10,135	3,064	3.3	201,821	50,455	4.0	0.025
Mean	31,879	8,168	4.0	14,045	3,644	3.9	81,220	21,231	3.9	14,086	3,746	3.8	141,230	36,788	3.9	0.025
							LATE RUN									
1977	14,962	5,087	2.9	9,398	3,328	2.8	88,312	31,233	2.8	22,410	7,891	2.8	135,082	47,539	2.8	0.038
1978	24,660	7,046	3.5	15,169	4,334	3.5	137,120	39,177	3.5	35,268	10,076	3.5	212,217	60,633	3.5	0.029
1979	26,478	7,565	3.5	15,276	4,413	3.5	143,256	40,930	3.5	20,877	5,987	3.5	205,887	58,895	3.5	0.022
1980	29,416	6,742	4.4	23,684	5,311	4.5	90,200	23,401	3.9	11,135	2,806	4.0	154,435	38,260	4.0	0.018
1981	22,284	4,965	4.5	17,842	3,574	5.0	96,660	18,861	5.1	12,510	2,506	5.0	149,296	29,906	5.0	0.032
1982	14,792	3,237	4.6	17,970	3,907	4.6	127,828	28,086	4.6	37,185	8,136	4.6	197,775	43,366	4.6	0.024
1983	29,376	8,640	3.4	11,270	2,429	4.6	164,928	33,236	5.0	42,945	11,990	3.6	248,519	56,295	4.4	0.036
1984	22,651	5,699	4.0	26,756	5,221	5.1	250,371	56,380	4.4	48,801	10,162	4.8	348,579	77,462	4.5	0.021
Mean	23,077	6,123	3.9	17,171	4,065	4.2	137,334	33,913	4.1	28,891	7,444	4.0	206,474	51,545	4.0	0.028

Table 10. (Cont.) Comparative Effort Data in Man-Hours and Man-Days for the Kenai River Recreational Chinook Salmon Fishery, 1977-1984.

	Upstream Section			Midstream Section			Downstream Section			Shore Anglers			Total			
Year	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	Man Hours	Man Days	Hours/ Man-Day	CPUE
							BOTH RUNS									
1977	50,890	15,766	3.2	17,191	5,812	3.0	138,016	47,659	2.9	40,992	13,781	3.0	247,089	83,018	3.0	0.029
1978	60,358	14,807	4.1	21,054	5,533	3.8	175,920	46,498	3.8	51,509	13,364	3.9	308,841	80,202	3.9	0.024
1979	49,894	14,845	3.4	25,876	7,405	3.5	237,622	67,160	3.5	31,649	9,150	3.5	345,041	98,560	3.5	0.022
1980	59,524	13,405	4.4	41,794	9,931	4.2	151,556	40,931	3.7	24,580	6,358	3.9	277,454	70,625	3.9	0.017
1981	51,786	11,031	4.7	31,148	6,693	4.7	164,430	35,596	4.6	22,813	4,921	4.6	270,177	58,241	4.6	0.032
1982	40,354	9,465	4.3	40,414	10,131	4.0	226,956	56,434	4.0	56,385	13,059	4.3	364,109	89,089	4.1	0.030
1983	60,926	18,580	3.3	27,233	6,425	4.2	273,402	58,345	4.7	56,955	15,661	3.6	418,516	99,011	4.2	0.037
1984	65,920	16,424	4.0	45,014	9,735	4.6	380,530	88,532	4.3	58,936	13,226	4.5	550,400	127,917	4.3	0.022
Mean	54,957	14,290	3.9	31,216	7,708	4.0	218,554	55,144	3.9	42,977	11,190	3.9	347,703	88,333	3.9	0.027

Table 11. Historical harvest comparison by river section for Kenai River chinook salmon fishery, 1976-1984.

	Upstream Section		Midstream Section		Downstream Section		Shore Anglers		Total
	Harvest	Percent	Harvest	Percent	Harvest	Percent	Harvest	Percent	Harvest
					EARLY RUN				
1976	492	31.7	216	13.9	721	46.4	125	8.0	1,554
1977	737	33.9	166	7.6	1,083	49.9	187	8.6	2,173
1978	673	43.6	102	6.6	646	42.0	121	7.8	1,542
1979	103	3.9	290	10.9	2,156	81.0	112	4.2	2,661
1980	465	23.9	290	14.9	1,070	55.0	121	6.2	1,946
1981	346	7.6	528	11.7	3,464	76.6	187	4.1	4,525
1982	456	8.4	791	14.5	3,941	72.0	278	5.1	5,466
1983	400	6.3	645	10.1	5,255	82.7	60	0.9	6,360
Mean	459	19.9	379	11.3	2,292	63.2	149	5.6	3,278
1984	585	11.8	423	8.5	3,906	78.8	42	0.9	4,956
					LATE RUN				
1976	89	2.0	616	13.7	3,370	75.3	402	9.0	4,477
1977	232	4.5	389	7.6	4,046	78.6	481	9.3	5,148
1978	278	5.0	439	7.9	4,429	79.4	432	7.7	5,578
1979	226	4.9	364	7.9	3,819	82.4	225	4.8	4,634
1980	242	6.7	515	14.3	2,483	68.8	368	10.2	3,608
1981	255	4.8	660	12.5	4,150	78.5	220	4.2	5,285
1982	156	3.3	198	4.1	4,340	90.2	116	2.4	4,810
1983	133	1.4	490	5.3	8,324	90.8	227	2.5	9,174
Mean	201	4.0	459	9.2	4,370	80.5	309	6.3	5,339
1984	102	1.4	647	8.8	6,502	88.1	125	1.7	7,376

Table 11. (Cont.) Historical Harvest Comparison by River Section for Kenai River Chinook Salmon Fishery, 1976-1984.

	Upstream Section		Midstream Section		Downstream Section		Shore Anglers		Total
	Harvest	Percent	Harvest	Percent	Harvest	Percent	Harvest	Percent	Harvest
					BOTH RUNS				
1976	581	9.7	832	13.8	4,091	67.8	527	8.7	6,031
1977	969	13.2	555	7.6	5,129	70.1	668	9.1	7,321
1978	951	13.4	541	7.6	5,075	71.3	553	7.7	7,120
1979	329	4.5	654	9.0	5,975	81.9	337	4.6	7,295
1980	707	12.7	805	14.5	3,553	64.0	489	8.8	5,554
1981	601	5.8	1,188	12.1	7,614	77.9	407	4.2	9,810
1982	612	6.0	989	9.6	8,281	80.6	394	3.8	10,276
1983	533	3.4	1,135	7.3	13,579	87.5	287	1.8	15,534
Mean	660	8.6	837	10.2	6,662	75.1	458	6.1	8,618
1984	687	5.6	1,070	8.7	10,408	84.4	167	1.3	12,332

21%. Guided harvest dropped from 9,196 in 1983 to 5,488 in 1984, a 40% reduction. Corresponding figures for nonguided anglers are 6,338 in 1983 to 6,844 in 1984, an increase of 8%.

Guided angler effort dropped from 23,862 man-days in 1983 to 21,585 man-days in 1984, a reduction of 2,277 man-days (10%). Nonguided effort went from 75,149 man-days in 1983 to 106,332 in 1984, an increase of 31,183 man-days (41%). Catch per hour for nonguided anglers remained virtually unchanged from 1983 to 1984, 0.017 to 0.015, respectively, while guided angler catch rates dropped by 28% from 0.080 to 0.058. Data regarding guided vs. nonguided anglers are presented in Tables 12 and 13.

Since 1982, the number of registered guides operating on the Kenai River has remained relatively constant. In 1984, a total of 115 guide businesses registered 214 guides and 199 vessels. There were 283 logbooks issued.

Since 1982, commercial fishing guides on the Kenai River have had to maintain a daily logbook recording the number of each species retained and released by each client. Analysis of the books after the season has revealed a number of mistakes. In 1983, nearly 75% of the logbooks contained errors of one form or another, from failure to record a client's sport fishing license number to recording a chinook salmon as being retained after the season had closed. The result was a wide disparity between the number of chinook salmon claimed by the logbooks and that attributed to guided anglers through creel census estimation. In 1984, however, less than 10% of the logbooks contained the errors mentioned above and the number of chinook salmon claimed by the guides differed by 70 fish when compared to the creel census estimate.

During the 1984 fishery, a total of 779 recreationally harvested chinook salmon provided readable scale samples; 291 from the early run and 488 from the late run. The predominant age class for both runs was 1.4 (brood year-1978), contributing approximately 62% to each run. It is of interest to note the relatively large contribution to the late run of age class 1.5 (brood year-1977). This was also reflected in the age structure of the recreational harvest of chinook salmon, presumably bound for the Kenai River in the 1984 Deep Creek marine fishery. Age class 1.5 accounted for 11% of the late run harvest in that fishery. An average chinook salmon harvested in the Kenai River from the early run weighed 15.6 kg (34.3 lbs) and 22.1 kg (48.6 lbs) from the late run; this difference was significantly larger (p 0.05). Average fish from each age class were significantly larger (p 0.05) during the late run when compared with the early run. Summarized AWL information is presented in Table 14. Historical age composition data are presented in Table 15.

Kasilof River Chinook Salmon Fishery

The Kasilof River recreational chinook salmon fishery has been a relatively recent development. The stream was first opened to chinook salmon fishing in 1978. This was allowed by the Board of Fisheries following 2 years of very strong natural returns. Concurrently, the

Table 12. Summary of Kenai River Recreational Fishery for Chinook Salmon, Guided vs. Nonguided Anglers as Determined by Creel Census, 1984.

	Downstream		Midstream		Upstream		Shore		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Early Run										
Harvest										
Guided	2,210	56.6	212	50.1	138	23.6	0	0.0	2,560	51.7
Nonguided	1,696	43.4	211	49.9	447	76.4	42	100.0	2,396	48.3
Effort										
Guided	9,340	31.2	643	21.4	558	5.6	0	0.0	10,541	22.5
Nonguided	20,550	68.8	2,367	78.6	9,412	94.4	4,035	100.0	36,364	77.5
Late Run										
Harvest										
Guided	2,615	40.2	261	40.3	52	51.0	0	0.0	2,928	39.7
Nonguided	3,887	59.8	386	59.7	50	49.0	125	100.0	4,448	60.3
Effort										
Guided	9,984	16.9	857	15.7	203	3.4	0	0.0	11,044	13.6
Nonguided	48,980	83.1	4,603	84.3	5,757	96.6	10,628	100.0	69,968	86.4
Both Runs										
Harvest										
Guided	4,825	46.4	473	44.2	190	27.7	0	0.0	5,488	44.5
Nonguided	5,583	53.6	597	55.8	497	72.3	167	100.0	6,844	55.5
Effort										
Guided	19,324	21.7	1,500	17.7	761	4.8	0	0.0	21,585	16.9
Nonguided	69,530	78.3	6,970	82.3	15,169	95.2	14,663	100.0	106,332	83.1

Table 13. Historical Comparison Between Guided and Nonguided Chinook Salmon Anglers by River Section on the Kenai River, as Determined by Creel Census, 1981-1984.

	Early Run			Late Run			Both Runs		
	Percent Harvest	Percent Effort	CPUE	Percent Harvest	Percent Effort	CPUE	Percent Harvest	Percent Effort	CPUE
					1984				
Downstream Section									
Guided	56.6	31.2	0.055	40.2	16.9	0.062	46.4	21.7	0.058
Nonguided	43.4	68.8	0.019	59.8	83.1	0.019	53.6	78.3	0.019
Upstream Section									
Guided	23.6	5.6	0.060	51.0	3.4	0.067	27.7	4.8	0.061
Nonguided	76.4	94.4	0.011	49.0	96.6	0.002	72.3	95.2	0.008
Total River									
Guided	52.1	24.5	0.055	40.4	13.5	0.062	44.6	17.4	0.058
Nonguided	47.9	75.5	0.016	59.6	86.5	0.015	55.4	82.6	0.015
					1983				
Downstream Section									
Guided	67.1	40.4	0.076	59.1	33.2	0.087	62.2	36.3	0.083
Nonguided	32.9	59.6	0.025	40.9	66.8	0.030	37.8	63.7	0.029
Upstream Section									
Guided	47.0	10.5	0.057	11.3	1.8	0.031	38.1	6.5	0.053
Nonguided	53.0	89.5	0.008	88.7	98.2	0.004	61.9	93.5	0.006
Total River									
Guided	64.3	28.6	0.072	55.7	20.6	0.086	59.2	24.1	0.080
Nonguided	35.7	71.4	0.015	44.3	79.4	0.019	40.8	75.9	0.017

Table 13. (Cont.) Historical Comparison Between Guided and Nonguided Chinook Salmon Anglers by River Section on the Kenai River, as Determined by Creel Census, 1981-1984.

	Early Run			Late Run			Both Runs		
	Percent Harvest	Percent Effort	CPUE	Percent Harvest	Percent Effort	CPUE	Percent Harvest	Percent Effort	CPUE
				1982					
Downstream Section									
Guided	45.6	23.0	0.075	52.0	27.3	0.064	49.0	25.1	0.068
Nonguided	54.4	77.0	0.028	48.0	72.7	0.035	51.0	74.9	0.031
Upstream Section									
Guided	56.0	28.9	0.040	40.0	22.7	0.018	51.8	26.8	0.032
Nonguided	44.0	71.1	0.013	60.0	77.3	0.008	48.2	73.2	0.011
Total River									
Guided	44.9	21.7	0.061	50.1	21.6	0.056	47.3	21.7	0.058
Nonguided	55.1	78.3	0.023	49.9	78.4	0.027	52.7	78.3	0.025
				1981					
Downstream Section									
Guided	53.3	29.3	0.087	52.1	31.4	0.072	52.7	30.4	0.076
Nonguided	46.7	70.7	0.030	47.9	68.6	0.030	47.3	69.6	0.030
Upstream Section									
Guided	28.0	12.9	0.013	26.7	11.1	0.030	27.5	12.1	0.023
Nonguided	72.0	87.1	0.006	73.3	88.9	0.010	72.5	87.9	0.009
Total River									
Guided	49.0	22.6	0.072	48.5	24.9	0.066	48.7	23.9	0.070
Nonguided	51.0	77.4	0.021	51.5	75.1	0.022	51.3	76.1	0.022

Table 14. Summarized Age/Weight/Length Data from Readable Scales Collected from Chinook Salmon Taken in the Recreational Fishery on the Kenai River, 1984.

Age Class Brood Year	1.2 1980	1.3 1979	1.4 1978	1.5 1977	Total
			Early Run		
Number	10	81	180	20	291
Percent	3.4	27.8	61.9	6.9	100.0
Length Range (mm)*	420-690	660-990	790-1,190	950-1,210	420-1,210
Mean Length (mm)*	556	798	993	1,071	929
Mean Weight (kg)	3.5	9.6	18.2	22.1	15.6
			Late Run		
Number	43	78	305	62	488
Percent	8.8	16.0	62.5	12.7	100.0
Length Range (mm)*	560-780	670-1,010	810-1,220	970-1,295	560-1,295
Mean Length (mm)*	670	860	1,059	1,127	1,000
Mean Weight (kg)	5.9	12.4	22.1	25.7	22.1

* Lengths are mid-eye to fork of tail.

Table 15. Historical Age Composition in Percent of the Recreational Harvest of Chinook Salmon from the Kenai River, 1974-1984.

Harvest Year	Age Class 1.2	1.3	1.4	1.5
Early Run				
1976	27.8	25.3	44.3	2.6
1977	14.4	30.3	53.7	1.5
1978	15.9	18.8	65.3	0.0
1979	5.8	30.8	51.9	11.5
1980	9.0	14.9	69.8	6.3
1981	14.7	32.1	51.4	1.8
1982	6.5	24.2	64.7	4.6
1983	8.2	16.4	70.5	4.9
1984	3.4	27.8	61.9	6.9
Mean	11.7	24.6	59.3	4.4
Late Run				
1976	30.4	20.5	45.1	4.0
1977	11.6	41.6	45.0	1.7
1978	12.6	8.0	77.7	1.7
1979	15.1	17.8	54.8	12.3
1980	21.1	21.5	49.9	7.5
1981	12.8	22.2	62.4	2.6
1982	12.0	26.5	59.8	1.7
1983	4.4	26.3	68.7	0.6
1984	8.8	16.0	62.5	12.7
Mean	14.3	22.3	58.4	5.0
Both Runs				
1974	5.9	4.7	83.5	5.9
1975	44.5	32.5	20.0	3.0
1976	29.3	22.5	44.8	3.4
1977	13.1	35.6	49.7	1.6
1978	13.5	11.1	74.2	1.2
1979	9.6	25.4	53.1	11.9
1980	15.7	18.6	58.7	7.0
1981	14.0	28.7	55.2	2.1
1982	8.9	25.2	62.6	3.3
1983	5.0	24.8	69.0	1.2
1984	6.8	20.4	62.2	10.5
Mean	15.1	22.7	57.5	4.7

hatchery that had been recently constructed on Crooked Creek had been releasing chinook salmon smolts which promised to keep the strength of the return healthy.

In 1978, the Division of Sport Fish monitored the fishery with a creel census program. Total harvest was estimated at 250 fish by 1,750 man-days of effort. It was determined the fishery was not large enough to warrant future funding. However, the F.R.E.D. Division was conducting a sockeye salmon smolt enumeration program immediately upstream from the area where most of the recreational effort took place and was able to incorporate a monitoring program as time permitted. From 1979 to 1983, the fishery grew from 2,000 man-days to 24,000 man-days. Funding cutbacks prevented F.R.E.D. from monitoring the fishery in 1984, and the Division of Sport Fish again monitored the stream with a creel census.

The return of chinook salmon to the Kasilof River has similar timing to other early runs in Cook Inlet. Most of these fish are presumed to spawn in Crooked Creek. Fish were considered available from May 19 through June 30 (42 days) when the fishery closes by regulation. Some fish are taken earlier, however, the harvest is considered insignificant.

In 1984, creel census activities were conducted on 30 of the 42 days. During that time, a total of 57 instantaneous angler counts were performed totaling 5,482 fishermen; 837 completed anglers were interviewed who reported a total of 190 chinook salmon over 51 cm during 3,256 hours of fishing. The above aforementioned data were expanded to generate an estimate of 5,135 chinook salmon harvested by 22,415 man-days of effort with an overall catch per hour of 0.062 (16 man-hours per fish). The escapement into Crooked Creek, measured at the weir located on the hatchery grounds, was 3,295. An additional 727 fish were used in the egg take at the facility (Waite, 1985). Summarized historical data regarding the Kasilof River fishery are presented in Table 16.

Age composition was determined from 104 readable scales collected during the recreational fishery in 1984. The majority of fish were the result of brood year 1979, accounting for 77.9%. Escapement displayed similar age composition (Waite, 1985). Summarized age-length data are presented in Table 17.

Kenai River Coho Salmon Fishery

During August and September 1984, creel census personnel on the Kenai River conducted 194 instantaneous angler counts enumerating 22,923 anglers, and interviewed 7,859 anglers who reported 30,345 hours of fishing necessary to retain 5,908 coho salmon. Analysis of these data resulted in an estimated harvest of 50,117 coho salmon by 67,177 man-days of effort from August 1 through September 30. An additional 10,359 coho salmon were harvested in late July incidental to chinook salmon.

Early run coho salmon first appeared July 19 and gradually increased in abundance in the downstream section until mid-August. By August 26, the early run in that section was considered over. In the upstream section, early run coho salmon did not appear in the creel until July 26 and were

Table 16. Historical Data Regarding the Kasilof River Recreational Fishery for Chinook Salmon, 1978-1984.

	Kasilof River Harvest		Crooked Creek Egg Take		Crooked Creek Escapement		Total Run		Angler Effort	Catch Per
Year	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Angler-Days	Hour
1978	251	4.9	444	8.8	4,369	86.3	5,064	100.0	1,750	0.038
1979	283	7.0	422	10.5	3,327	82.5	4,032	100.0	2,015	0.040
1980	310	11.6	240	9.0	2,115	79.4	2,665	100.0	4,830	0.019
1981	1,242	30.0	54	1.3	2,850	68.7	4,146	100.0	8,750	0.061
1982	2,787	42.6	252	3.9	3,503	53.5	6,542	100.0	14,580	0.088
1983	4,361	46.6	686	7.4	4,305	46.0	9,352	100.0	24,394	0.044
Mean	1,539	23.8	350	6.8	3,412	69.4	5,300	100.0	9,387	0.048
1984	5,138	56.1	727	7.9	3,295	36.0	9,160	100.0	22,415	0.062

Table 17. Summarized Age/Length Data from Readable Scales Collected from Chinook Salmon Taken in the Recreational Fishery on the Kasilof River, 1984.

Age Class Brood Year	1.2 1980	1.3 1979	1.4 1978	Total
Number	8	81	15	104
Percent	7.7	77.9	14.4	100.0
Length Range (mm)*	610-800	670-1,010	850-1,200	610-1,200
Mean Length (mm)*	689	851	970	856
Standard Deviation	67.1	57.9	89.3	89.8

* Lengths are mid-eye to fork of tail.

considered available until August 26. Harvest of the early run was estimated at 28,447 fish by 32,522 man-days of effort with each man-day being equal to 4.3 hours. The catch rate for early run coho salmon was 0.134 fish per hour (7.5 man-hours per fish). The early run harvest, including those fish harvested in July, was the largest recreational harvest that has been recorded in the Kenai River. Effort, however, was second to that estimated for 1982. The overall catch rate was nearly equal to the historic (1976-1983) mean of 0.131.

Late run coho salmon were considered available from the end of the early run, August 26, through September 30. There is some fishing that occurs after September 30, however, it is quite dependent on environmental conditions and, when compared with the harvest prior to October 1, is considered insignificant. In 1984, an estimated 32,029 coho salmon were harvested by 34,655 man-days of effort, each man-day being equal to 3.9 hours. The catch rate was 0.238 fish per hour (4.2 man-hours per fish). Late run harvest was nearly 2.5 times greater than the previous record set in 1982. Effort was also a new record, twice that of the old record set in 1982. The catch per hour of 0.238 was the second highest recorded and 55% greater than the 1976-1983 mean of 0.154.

Graphs depicting run timing as determined by angler catch rates by date are presented for the downstream and upstream sections in Figures 4 and 5, respectively. Historical harvest and effort data for the Kenai River coho salmon fishery are presented in Table 18.

Escapement Estimate

A total of 1,331 adult chinook salmon were tagged from June 25 through August 12, 1984. Of this number, 1,311 were late run and 20 were considered early run fish. Of the 1,311 late run fish, 1,223 were tagged with Floy FT-4 spaghetti tags and 88 were tagged with both Floy FT-4 spaghetti tags and esophogeal implanted radio transmitters. In calculating the population estimate, the radio-tagged fish were not included in the total number of tagged fish available to the sport angler.

A total of 184 tags were recovered from the following sources:

1) Sport fishermen (boat creel census)	21*
2) Sport fishermen (campground creel census)	7
3) Sport fishermen (voluntary returns)	72
4) Cook Inlet commercial fishermen	10
5) Inseason carcasses	6
6) Post-season carcasses	64
7) Russian River weir	2
8) Quartz Creek weir	1
9) Unknown	1
TOTAL	184

* Only the boat creel census tag recoveries were used to estimate the late run chinook salmon population. Of the 21 chinook salmon recovered by the boat creel census, only 17 were usable in these calculations.

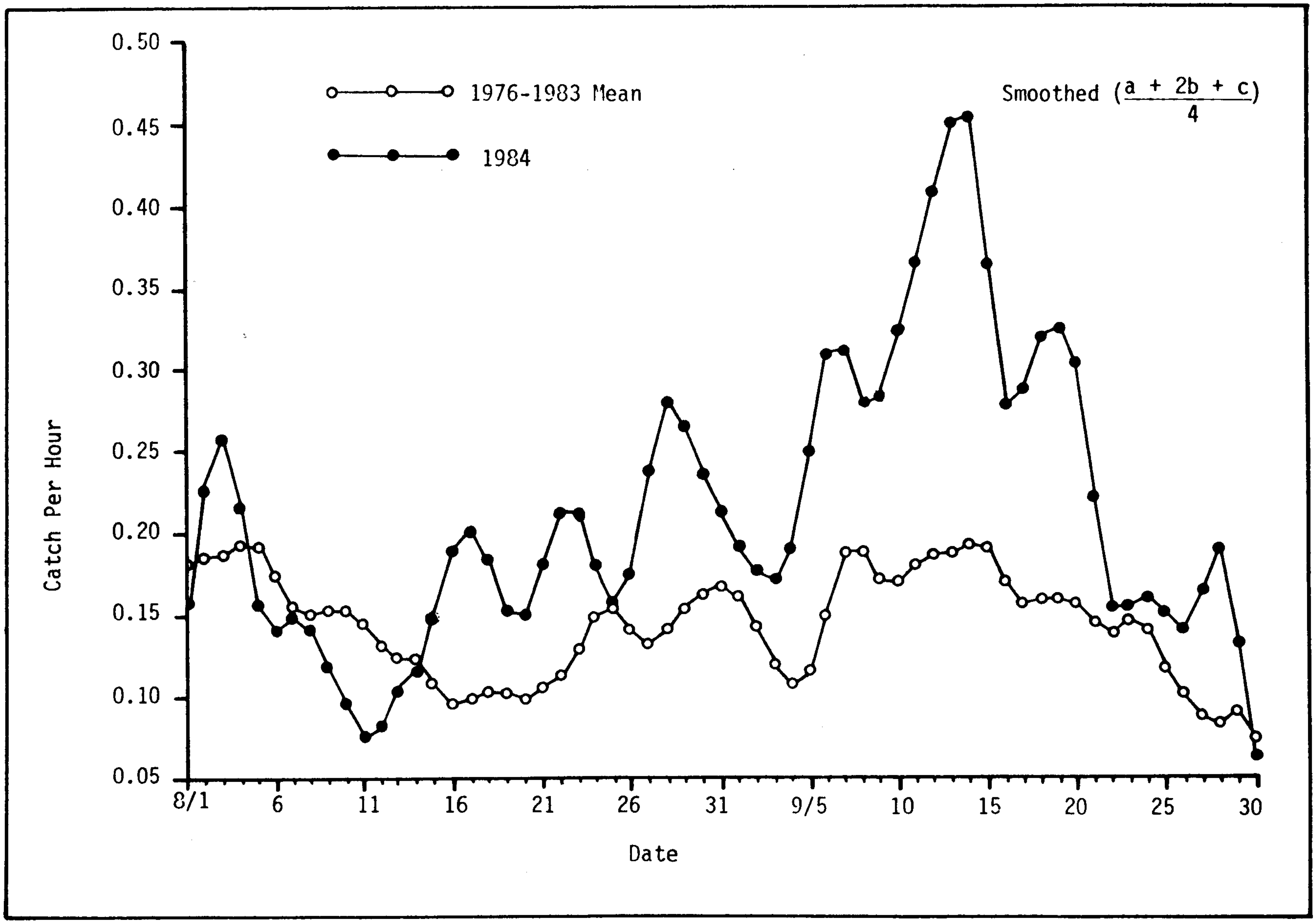

Figure 4. Catch per hour by date in the recreational fishery for coho salmon in the Kenai River (downstream section), 1984 vs. 1976-1983 mean.

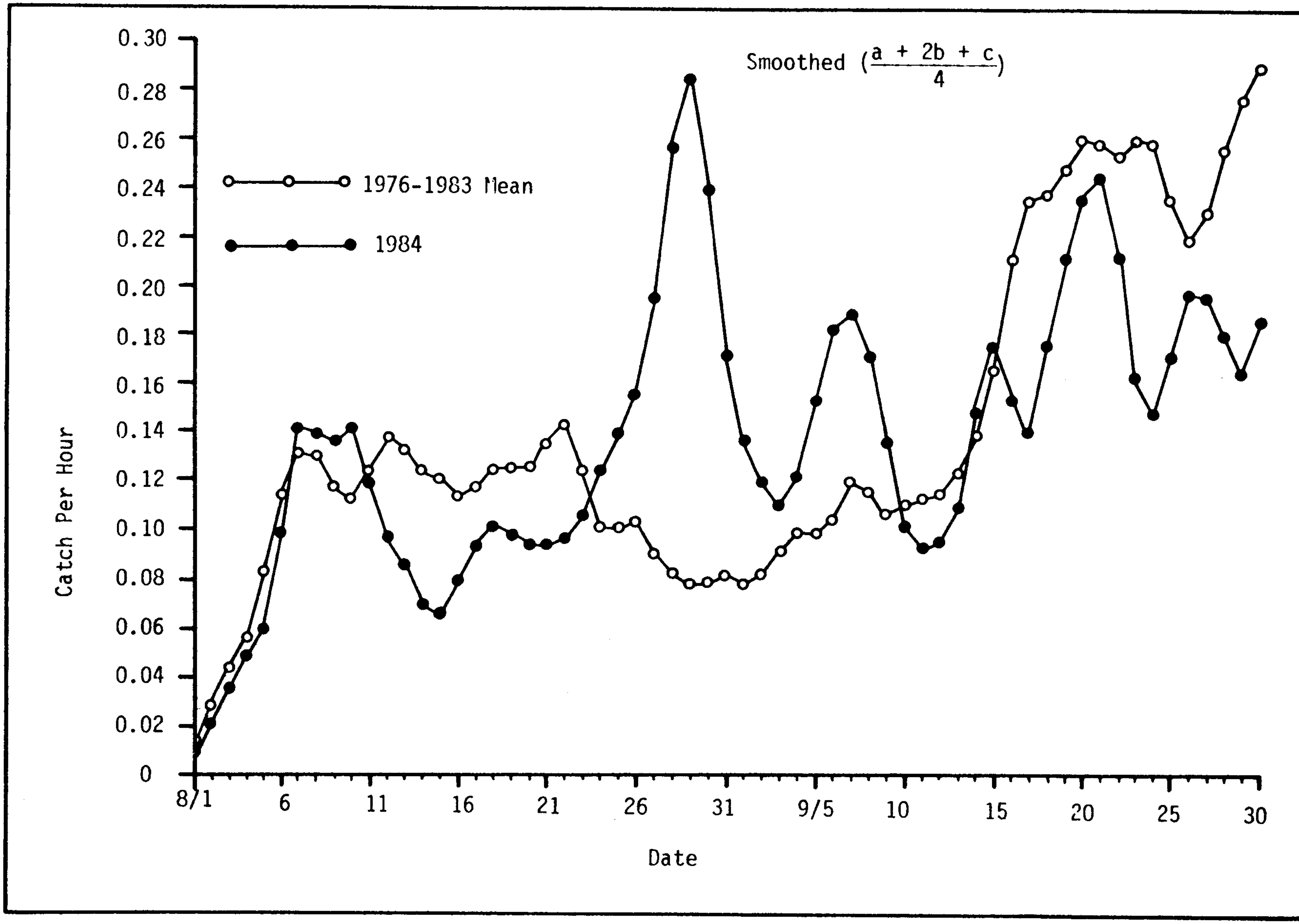

Figure 5. Catch per hour by date in the recreational fishery for coho salmon in the Kenai River (upstream section), 1984 vs. 1976-1983 mean.

Table 18. Historical data from the Kenai River recreational coho salmon fishery, 1976-1984.

	Early Run				Late Run			
Year	Harvest	Effort Man-Hours	Effort Man-Days	Catch Per Hour	Harvest	Effort Man-Hours	Effort Man-Days	Catch Per Hour
				Upstream				
1976	1,625	22,042	5,511	0.074	1,445	10,742	3,069	0.135
1977	3,349	24,046	5,465	0.139	898	6,020	1,281	0.149
1978	800	22,193	4,932	0.036	1,788	12,869	3,677	0.139
1979	1,831	23,562	4,284	0.078	2,003	16,427	4,323	0.122
1980	4,670	30,582	8,751	0.153	4,665	16,586	4,739	0.281
1981	4,719	36,392	8,768	0.130	2,900	20,628	5,157	0.141
1982	3,081	37,120	9,797	0.083	3,286	12,307	3,419	0.267
1983	1,993	34,141	8,503	0.058	1,543	11,176	2,483	0.138
Mean	2,759	28,760	7,001	0.096	2,316	13,344	3,519	0.174
1984	4,019	28,110	6,733	0.134	3,390	23,144	5,950	0.146
				Midstream				
1976	1,165	12,803	3,201	0.091	828	6,133	1,752	0.135
1977	617	4,976	1,131	0.124	198	2,087	444	0.095
1978	386	6,528	1,865	0.059	554	4,776	1,365	0.116
1979	918	5,646	1,027	0.163	290	2,423	638	0.120
1980	1,319	6,376	1,824	0.207	788	3,092	883	0.255
1981	1,804	13,087	3,153	0.138	817	6,472	1,618	0.126
1982	2,778	21,703	4,682	0.128	1,494	6,553	1,820	0.228
1983	1,083	9,747	2,354	0.111	636	3,897	753	0.163
Mean	1,259	10,108	2,405	0.125	701	4,429	1,159	0.158
1984	2,629	13,172	3,174	0.148	1,640	6,907	1,775	0.237

Table 18. (Cont.) Historical data from the Kenai River recreational coho salmon fishery, 1976-1984.

Year	Early Run Harvest	Early Run Effort Man-Hours	Early Run Effort Man-Days	Early Run Catch Per Hour	Late Run Harvest	Late Run Effort Man-Hours	Late Run Effort Man-Days	Late Run Catch Per Hour
Downstream								
1976	4,921	49,862	12,466	0.099	3,240	23,977	6,851	0.135
1977	3,449	30,711	6,980	0.112	1,275	16,883	3,592	0.076
1978	4,050	49,725	11,050	0.081	4,302	39,668	11,334	0.108
1979	8,373	39,205	7,128	0.214	1,217	10,489	2,760	0.116
1980	9,679	40,262	11,520	0.240	4,092	17,769	5,077	0.230
1981	8,157	57,064	13,749	0.143	2,947	25,690	6,423	0.115
1982	18,968	109,011	27,359	0.174	8,571	42,222	11,728	0.203
1983	9,775	71,085	17,081	0.138	5,370	31,187	5,698	0.172
Mean	8,422	55,866	13,417	0.150	3,877	25,986	6,683	0.144
1984	21,799	98,353	22,615	0.153	26,999	104,759	26,930	0.258
Total								
1976	7,711	84,707	21,178	0.091	5,513	40,852	11,672	0.135
1977	7,415	59,733	13,576	0.124	2,371	24,990	5,317	0.095
1978	5,236	78,446	17,847	0.067	6,644	57,313	16,376	0.116
1979	11,122	68,413	12,439	0.163	3,510	29,339	7,721	0.120
1980	15,668	77,220	22,095	0.203	9,545	37,447	10,699	0.255
1981	14,680	106,543	25,670	0.138	6,664	52,790	13,198	0.126
1982	24,827	167,834	41,838	0.148	13,351	61,082	16,967	0.219
1983	12,851	114,973	27,938	0.112	7,549	46,260	8,934	0.163
Mean	12,439	94,734	22,823	0.131	6,893	43,759	11,361	0.154
1984	28,447	139,635	32,522	0.134	32,029	134,810	34,655	0.238

Chapman's modification of the Peterson estimate is:

$$N = (M=1)\ (C+1)/(R+1)$$

Values for the variables are:

M = 947 (The total number of chinook salmon tagged from July 2-27)
C = 735 (The total number of chinook salmon captured and observed in the boat creel census)
R = 17 (The total number of tagged chinook salmon recovered during the boat creel census)

A point estimate of 39,172 adult chinook salmon with a low estimate of 25,003 and a high estimate of 64,687 at the 95% confidence level was obtained. These figures represent the total number of chinook salmon entering the Kenai River during the entire month of July. The total Cook Inlet return was calculated by adding the August segment (9,793) of the run (determined to be 25% of the July segment, or 20% of the total inriver population, Figure 6), plus the commercial harvest of 5,805 and the Deep Creek marine sport harvest of 835 to the point estimate to yield a total run strength of 55,605 late run Kenai River chinook salmon.

The improved fish handling techniques and new triage standards during tagging resulted in fewer tagged fish recovered by the Cook Inlet commercial salmon fishery in 1984 (10) than in 1983 (29) and fewer complaints by sport anglers of tagged fish being lethargic when hooked. All anglers who returned tags in 1984 were asked to comment on the condition of the tagged fish caught. A total of 89 comments were received and, of those, three anglers had reported lethargic fish in their catches.

All captured chinook salmon were examined for injuries. Salmon with deep scars or lesions, damaged gill filaments, a lethargic condition, or fish that required excessive processing time (due usually to a multiple capture situation) were not tagged. A total of 1,545 chinook salmon were examined, but only 1,331 (86%) were tagged.

The net webbing used in 1984 was preferred to all nets previously used. The three strand, twisted nylon, 19 cm stretched mesh net was not as mutilating as the filamentous twine mesh of similar size used in 1983. The mesh was large enough to allow most sockeye, coho and pink salmon to pass through undamaged, while allowing captured chinook salmon to be easily removed for processing. The heavy mesh twine (4.8 mm diameter) was also very durable.

A chinook salmon length frequency comparison was made between drift net catches, fish retained by sport anglers and a post-season carcass survey. The length frequency distribution of fish captured with drift nets and fish retained by sport anglers showed no significant difference ($P = 0.05$), chi-square = 5.80 with 6 degrees of freedom (df). Length frequency distribution for observed untagged carcasses were significantly different from both drift net-tagged fish ($P = 0.001$),

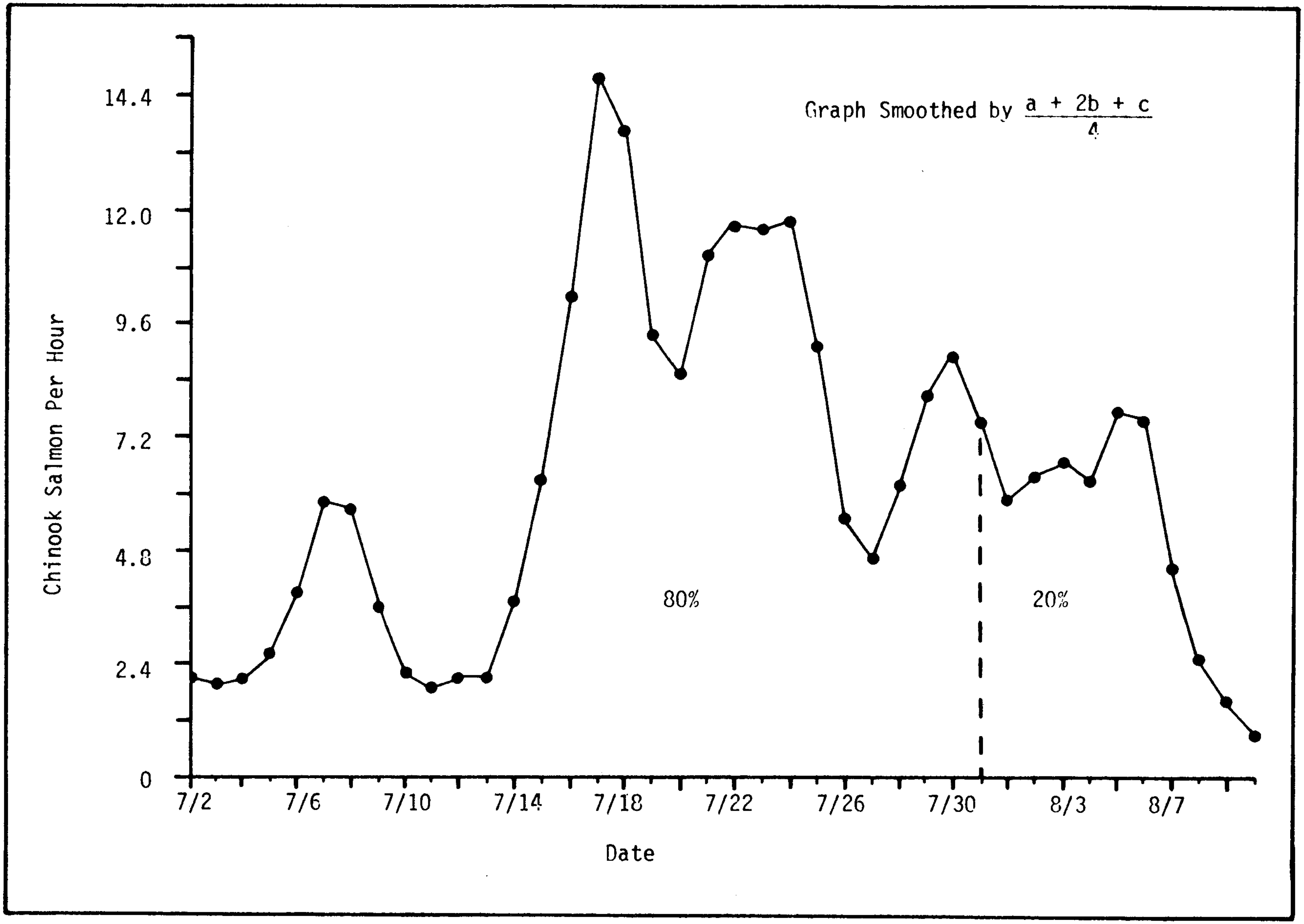

Figure 6. Catch rate for late run chinook salmon taken in drift nets by date near river mile 9.0 Kenai River, 1984.

chi-square = 34.42 with 6 df and untagged creel-checked fish (P = 0.001), chi-square = 40.78 df. Why a length frequency discrepancy exists in the carcass survey is unclear, but resulted in the rejection of these data for use in the population estimate.

Tidal Influence:

The results of how varying tidal stages influence the availability of chinook salmon for capture by drift nets are presented in Figure 7. Chinook salmon in the Kenai River are most available at river miles 7-9 within 2 hours of low tide (recorded at the river mouth), but the CPUE does not change appreciably until 5 hours after low tide when the water level at river mile 8 increases very rapidly (Figure 8). These water depth readings were observed at river mile 8 on June 28, 1984. Low tide was -2.0 feet at 10:04 a.m. and high tide was +19.6 feet at 5:00 p.m. The increasing tidal influence was very abrupt, quickly hampering drift netting efficiency.

The effect of tidal influence on the river current velocity determines the effectiveness of the drift net capture technique. When the drift net achieves its maximum drift velocity, it also achieves its maximum fishing depth and efficiency. If there is a tidal stage when chinook salmon are more prevalent than any other tidal stage, it was not detected using drift nets. There may be an influx of chinook salmon with the rising of the tide; however, the decrease in drift netting efficiency during this period of reduced current velocity renders the drift netting technique unable to verify what this population magnitude may be.

Migrational Behavior

Radio-tagging of chinook salmon followed a proposed tagging schedule which attempted to approximate the run timing and abundance based on historical catch per hour data from the recreational fishery. The best inseason measure of the relative abundance of chinook salmon in the downstream section was the PEP daily drift net catch per unit effort. The actual radio-tagging distribution throughout the late run closely coincided with the PEP drift net CPUE curve in that area of the river (Figure 9).

A total of 74 chinook salmon captured by drift net were esophogeally implanted with radio transmitters between June 25 and August 12. During the same period, 11 chinook salmon caught by hook and line were also radio tagged. Radio tagging took place between RM 6.9 and 12.0 (mean = 9.2) in the intertidal zone of the river. An additional three chinook salmon, believed to be bound for the Kenai River, were radio-tagged off of Deep Creek in Cook Inlet as part of a coastal migrational timing study conducted by the Commercial Fish Division. Forty-eight of the above 88 fish (38 captured by drift net, 9 by hook and line and 1 from Cook Inlet) were eventually tracked to their final spawning location. Limited tracking data were collected from the remaining radio-tagged fish because of one of the following reasons: 3 were sport

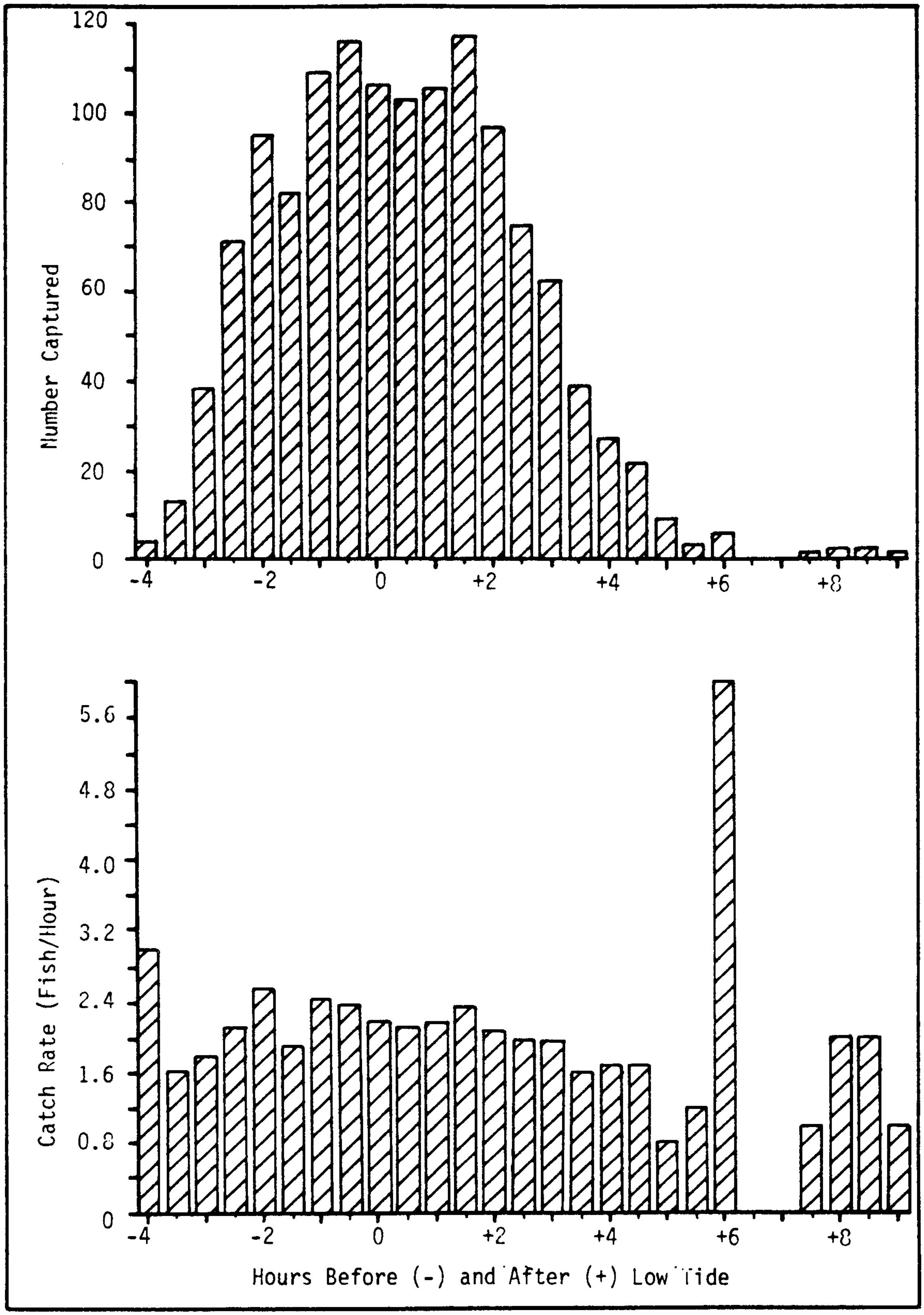

Figure 7. Comparison of drift net catch rate and sample size of late run chinook salmon with tidal stage as determined by time before or after low tide, Kenai River, 1984.

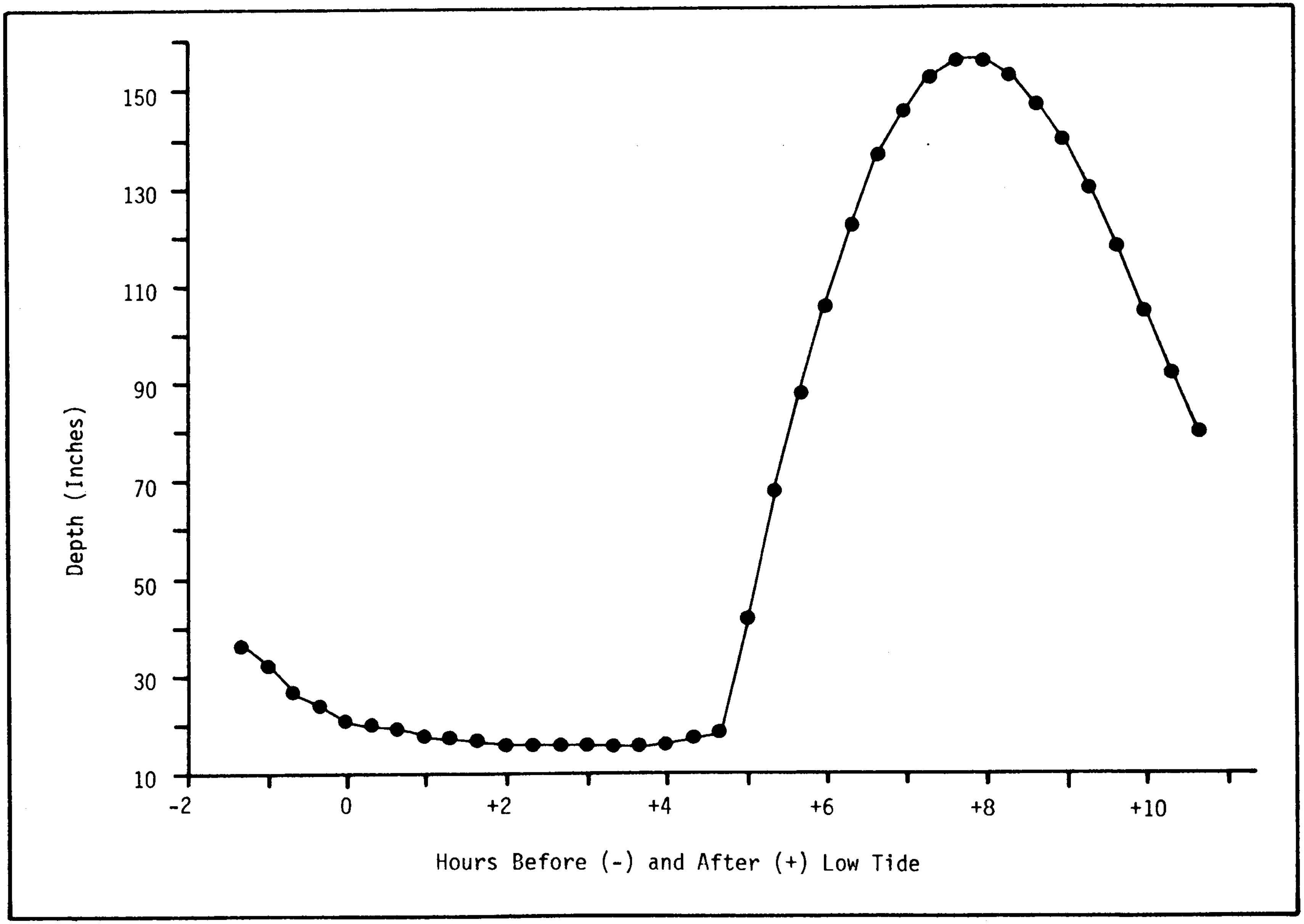

Figure 8. Comparison of water depth fluctuation recorded on a depth gauge located at river mile 8.0 with tidal stage as determined by time before or after low tide, Kenai River, June 28, 1984.

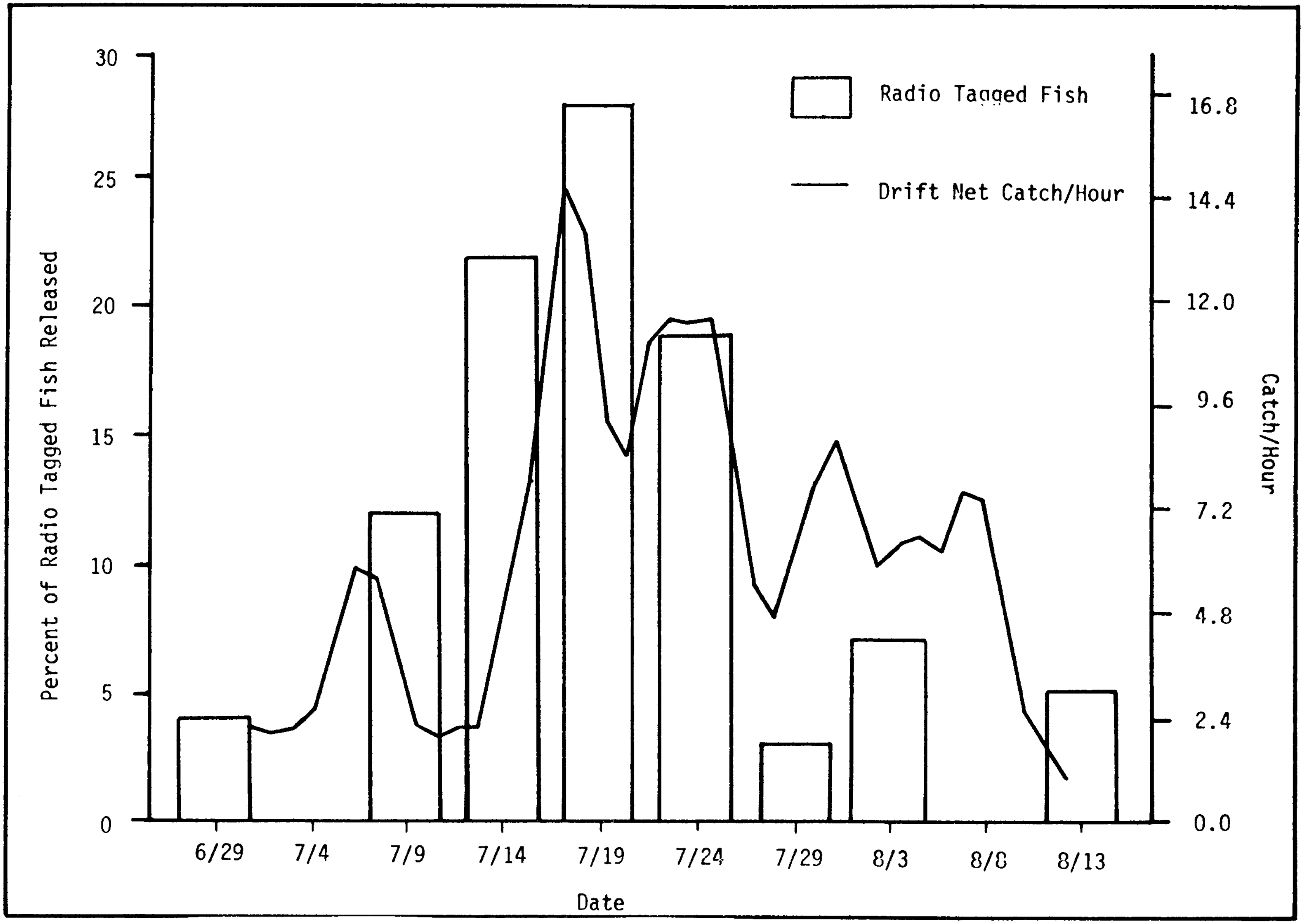

Figure 9. Comparison of the entry pattern of late run chinook salmon as determined by drift net catch rates to the frequency of tagging chinook salmon with radio transmitters in the Kenai River, 1984.

caught; 9 (including 1 hook and release fish) never migrated upstream of their tagging sites; 17 (including 1 hook and release fish) moved upstream initially, but dropped downstream of their tagging site before the spawning period; 5 were tracked upstream and eventually lost; 5 (including 1 Cook Inlet fish) were never located; and 1 Cook Inlet fish was located at the mouth of the Kenai River, but never moved upstream, possibly regurgitating the tag.

It is believed that a substantial number of the radio-tagged fish exhibiting initial downstream movement or delayed downstream movement did so because of an unanticipated reaction of the epoxy, used to seal return address labels on the transmitters, with the fish's stomach lining. This became apparent when five radio tags having the epoxy sealed labels were recovered from unspawned, dead fish. The epoxy was partially peeled away and the label area of the tags was covered with a thin layer of blood, indicating that stomach hemorrhaging had taken place. Approximately half of the chinook salmon were radio-tagged with transmitters having the cured epoxy coating, but because this problem was not anticipated, no record was kept of which tags had the cured epoxy sealed labels. However, the recovery of three fish having the epoxy sealed labels, two spawned out and one sport caught, indicates that some of these fish survived.

The data presented below on movement patterns, migration rates and spawning distribution refer only to the 48 "active" radio-tagged chinook salmon. In this section, 10 radio-tagged fish captured by either hook and line or purse seine are often combined with the drift net captured fish to provide a larger sample size. A more complete presentation of results from the hook and line captured fish and comparisons with the drift net captured fish are dealt with in the hook and release study section of this report.

Initially following radio tagging, most drift net captured chinook salmon (73.8%) moved upstream or held within 0.5 miles of their tagging site. The remaining 26.2% initially moved downstream 2.0-6.6 miles (mean = 4.2 miles) after tagging, and remained downstream of their tagging site for 3.1-15.0 days (mean = 8.2 days).

Following recovery from any tagging stress, radio-tagged chinook salmon did not always migrate directly upstream to their final spawning destination. Instead, milling behavior and periodic downstream movements were common during spawning migrations by radio-tagged salmon. Milling behavior was most apparent in the downstream section of the recreational fishery (RM 6.5-20.3). The downstream section residence period, beginning when radio-tagged chinook salmon initiated upstream movement until they migrated to midstream and upper sections, ranged from 1.3 to 41.9 days (mean = 14.0 days). Regression of days spent downstream of RM 20.3 by date of tagging, revealed that fish tagged earlier in the run held in the downstream section significantly longer than fish tagged later in the run (Figure 10).

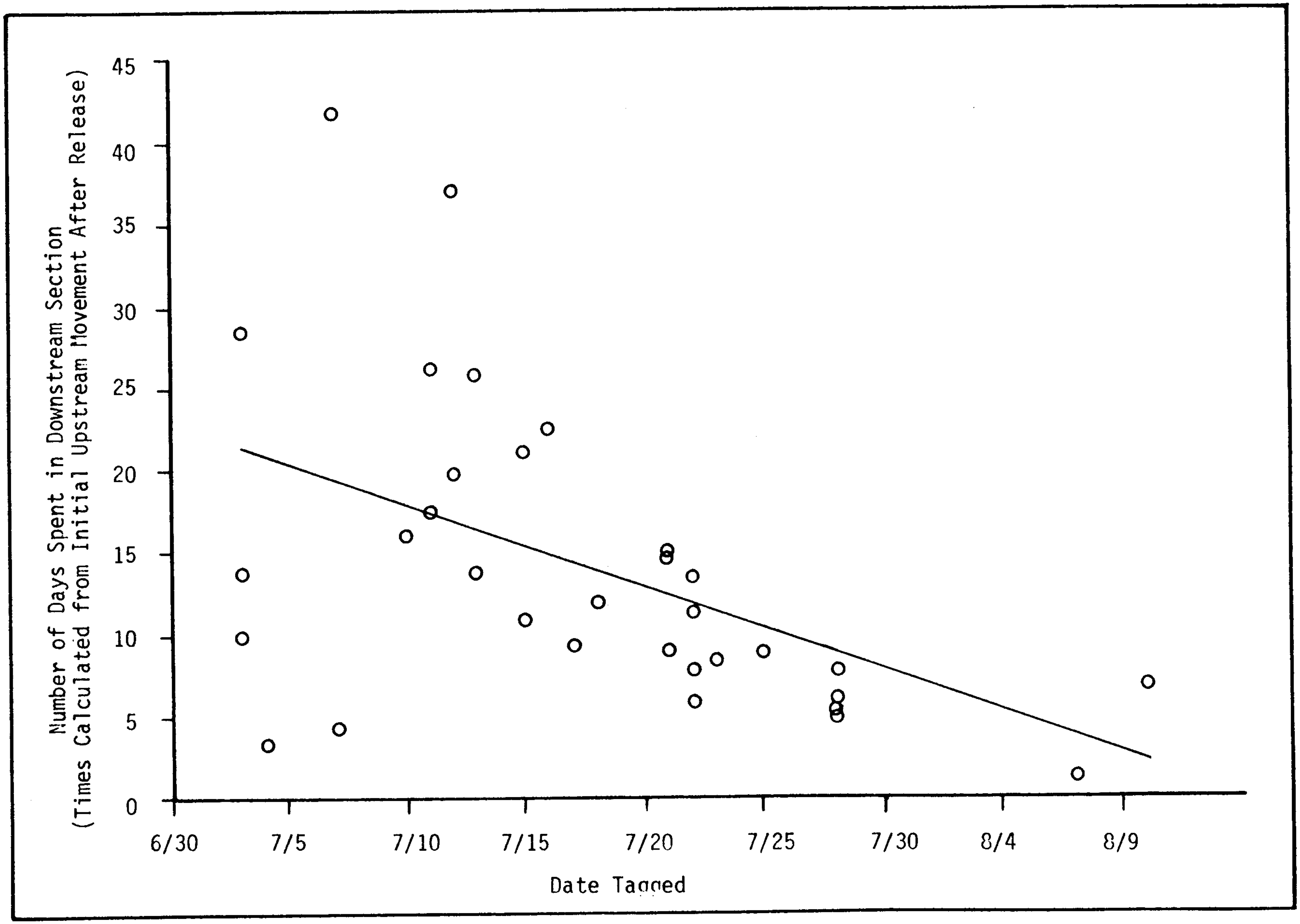

Figure 10. Comparison of date of tagging and length of time remaining in the downstream section (river mile 0.0-20.3) for late run chinook salmon tagged with radio transmitters in the Kenai River, 1984.

Further evidence of milling behavior in the downstream section is suggested by a paired-comparison analysis of variance (ANOVA) comparing migration rates of radio-tagged chinook salmon in the downstream section with their migration rates in other river sections. For radio-tagged fish migrating upstream of the downstream section fishery (upstream of RM 20.3), their migration rates were significantly slower ($P = 0.001$) in the downstream section (mean = 1.4 miles per day) than in other river sections (mean = 2.7 mpd); see Figure 11.

Along with milling behavior, radio-tagged chinook salmon often made downstream movements during their spawning migrations (excluding initial downstream movements after tagging). Downstream movements of 1 mile or greater during spawning migrations were exhibited by 14 (29%) radio-tagged fish. The maximum downstream movement observed was 30.4 miles with a mean of 10.4 miles. Following these downstream movements, seven returned upstream to spawn while the other seven milled near the destination of their downstream movement and spawned.

Mean overall migration rates of radio-tagged chinook salmon captured by drift net ranged from 0.2 to 8.7 mpd (mean = 2.0 mpd) and the mean maximum migration rates ranged from 0.4 to 11.5 mpd (mean = 4.4 mpd) (Table 19). When dividing late run radio tagging into 2 segments (fish tagged before July 15 and fish tagged after July 14), there was a tendency for fish tagged earlier to migrate slower, although a Mann-Whitney U-test indicates that this difference was not significant ($P = 0.05$). A final point to make on migration rates by radio-tagged chinook salmon was that fish migrating greater distances upstream exhibited faster migration rates.

A single classification ANOVA indicates that migration rates increased significantly ($P = 0.001$) among fish migrating less than 20 miles (mean = 0.9 mpd), 20-40 miles (mean = 1.8 mpd), or more than 40 miles (mean = 3.6 mpd).

Throughout the late run, the overall distribution of radio-tagged chinook salmon gradually moved upstream as would be expected, but over 70% of the active late-run radio-tagged fish were still located in the downstream section on July 31 (Figure 12). By August 5, 51.2% of the radio-tagged fish were still located in the downstream section, and it wasn't until August 10 that the number of radio-tagged chinook salmon in the downstream section began to stabilize.

The final spawning distribution of 47 radio-tagged late-run chinook salmon in the mainstem Kenai River was as follows: downstream section, 30%; midstream section, 25%; upstream section, 17%; and between Skilak Lake and Kenai Lake, 28%. The mainstem spawning distribution did not deviate significantly ($P > 0.05$) from an even distribution over the four river sections. Regression analysis indicates that date of entry into the Kenai River has little effect on the spawning location of radio-tagged salmon as the scattered distribution in Figure 13 illustrates (correlation coefficient = 0.04). In addition to the 47 Kenai River spawners, a chinook salmon radio tagged on June 25, spawned in the Funny

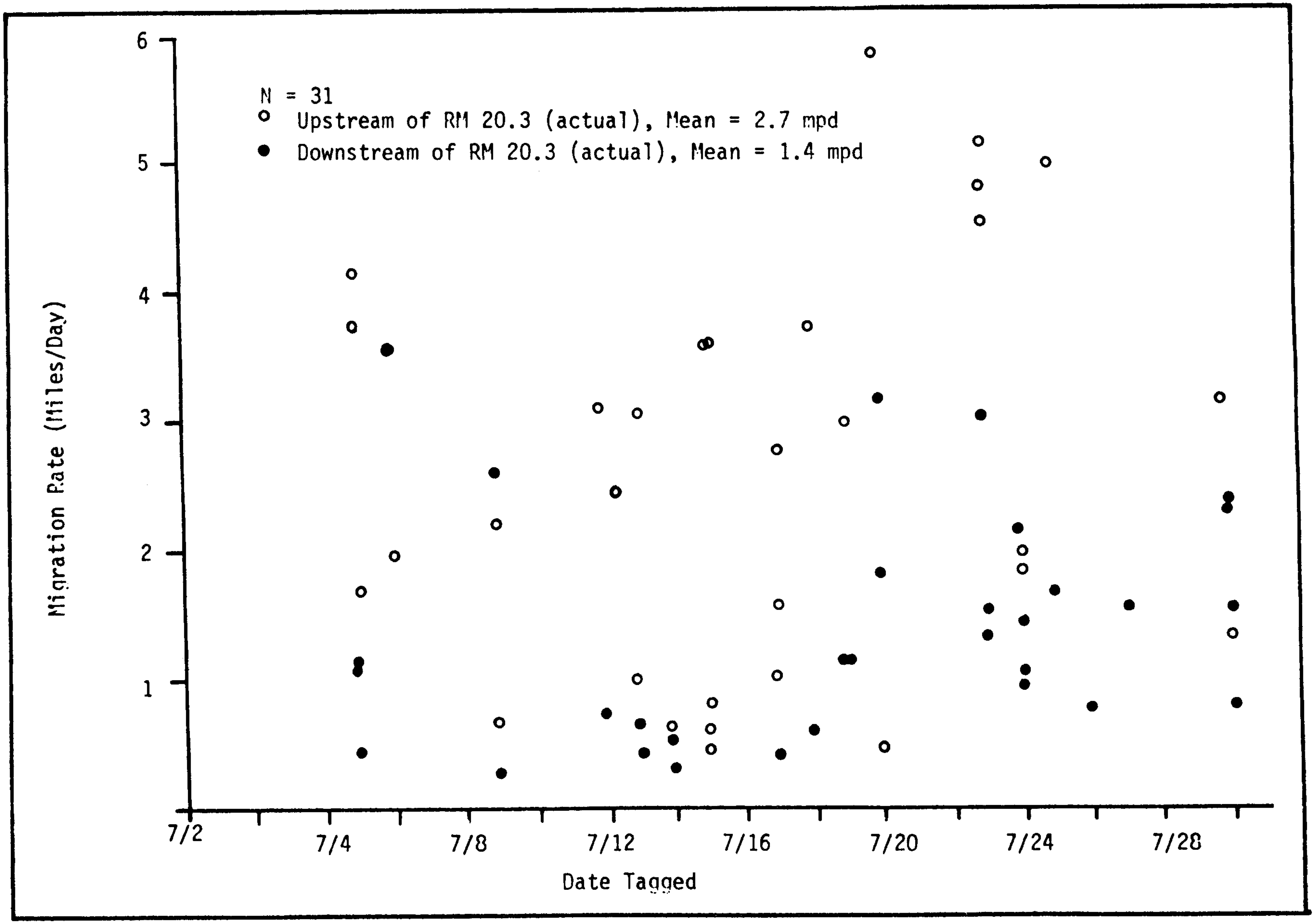

Figure 11. Comparison of mean migration rates of radio tagged chinook salmon downstream and upstream of river mile 20.3 for fish that migrated upstream of river mile 20.3, Kenai River, 1984.

Table 19. Summary of Migration Rates (Miles per Day) of Kenai River Late Run Chinook Salmon Captured by Drift Net and Radio Tagged Prior to July 16 or After July 15, 1984.

Distance of Upstream Migration		Date of Radio Tagging: June 25 to July 15	July 16 to August 12	Combined June 25 to August 12
< 20 Miles	n	7	10	17
	mean	0.8	1.0	0.9
	range	0.2-2.9	0.4-2.3	0.2-2.9
	mean maximum	2.8	1.7	2.2
	range	1.4-4.6	0.4-3.1	0.4-4.6
20-40 Miles	n	5	3	8
	mean	1.6	2.2	1.8
	range	1.0-2.3	1.4-3.7	1.0-3.7
	mean maximum	3.9	4.9	4.2
	range	3.5-4.4	2.4-9.3	2.4-9.3
> 40 Miles	n	6	7	13
	mean	2.5	4.5	3.6
	range	1.9-4.1	2.6-8.7	1.9-8.7
	mean maximum	7.3	8.0	7.6
	range	4.1-10.7	3.5-11.5	3.5-11.5
Overall	n	18	20	38
	mean	1.6	2.4	2.0
	mean maximum	4.5	4.4	4.4

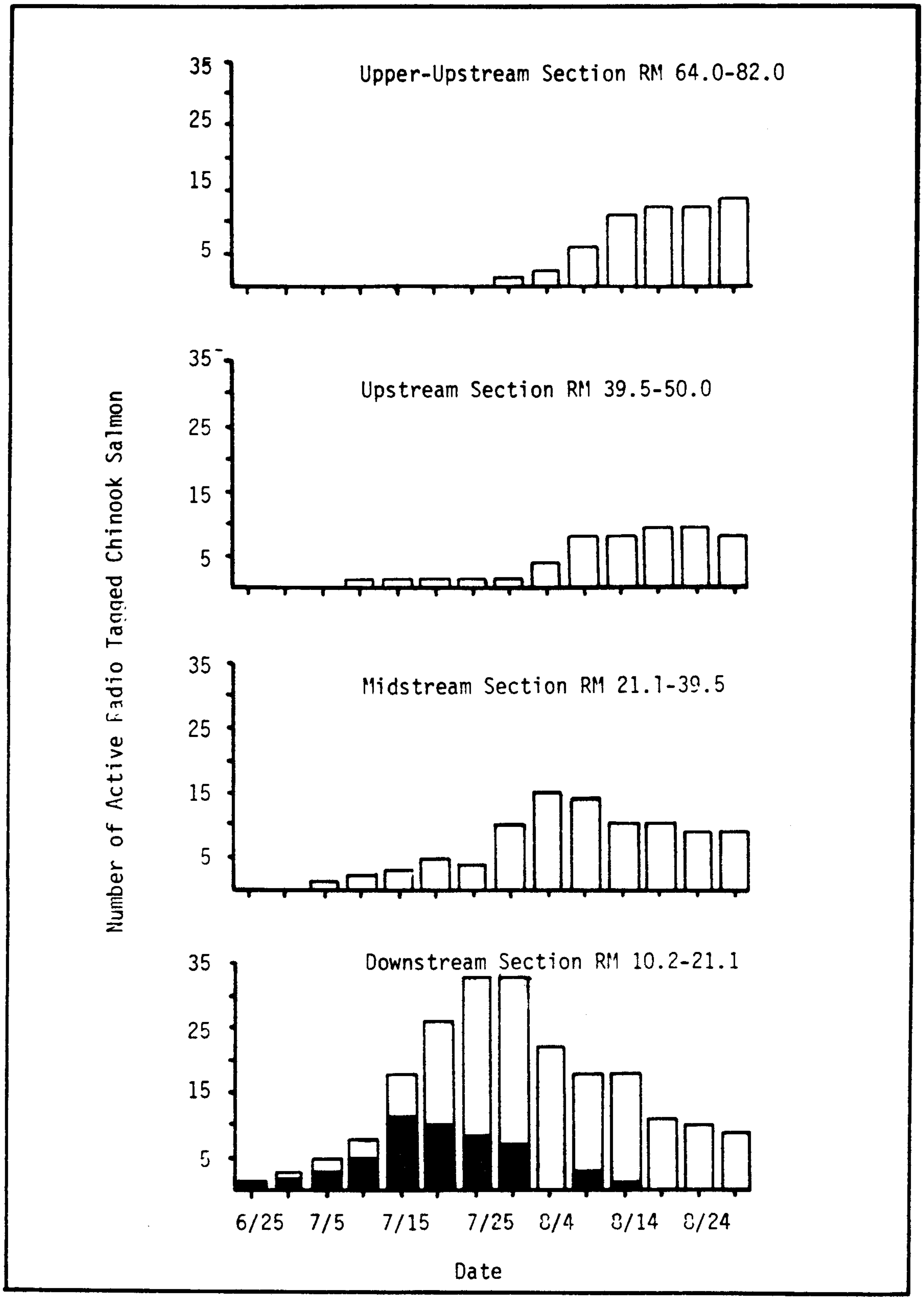

Figure 12. Location of active late run radio-tagged chinook salmon (N = 51) by river section, Kenai River, 1984 (shaded portion represents the number of fish tagged at river mile 9.0 during each 5-day period).

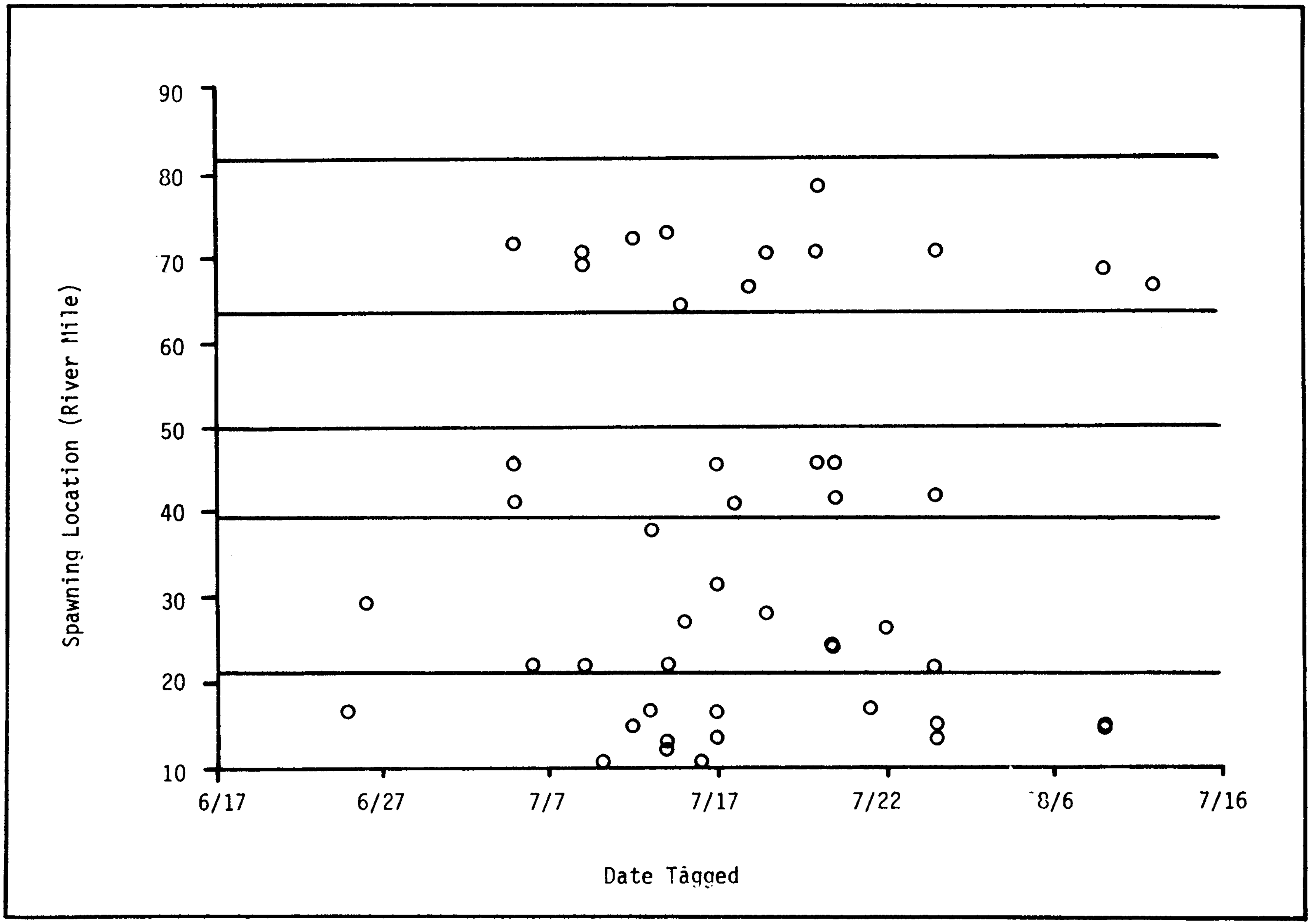

Figure 13. Relationship between date of tagging at river mile 9.0 and spawning location of late run chinook salmon, Kenai River, 1984.

River, possibly representing an early-run fish. Comparison of the 1984 late-run spawning distribution with the data from the 1979-1981 study by USF&WS (Burger et al., 1983) indicates that there is significant variation in the spawner distribution between years ($P = 0.005$; chi square = 24.6) (Figure 14). To eliminate any error in comparing downstream section distributions, because of different tagging locations in 1984 (RM 9.2) versus 1979-1981 (RM 12.5), the distribution of just the three upper river sections was included. A 2 x 3 contingency test revealed that the spawner distribution in the upper three river sections varied significantly ($0.025 < P < 0.01$) between 1984 and 1979-1981 as well (chi square = 8.2).

Hook and Release

Radio Telemetry:

From June 14 to July 27, 19 chinook salmon were captured with representative sport fishing gear between river miles 6.4 and 13.6 (mean = 10.3) and two were captured by a registered Kenai River sport fishing guide at river mile 43.5. Hook removal was difficult in 12 of 21 cases and these fish were radio tagged and released with the hook left in the lower or upper jaw, or the roof or floor of the mouth. In no case were hooks deeply ingested. Males outnumbered females by 2 to 1. Mean length of radio-tagged males and females was 944 mm and 943 mm, respectively. Fish were radio-tagged as they were captured unless deemed unfit for tagging. Among fish sport caught and not radio-tagged were several jacks (too small for esophogeal implant) and one fish that had been hooked in the gills and bleeding.

The mean fight time (time on the hook) for the 21 radio-tagged fish was 6 min 22 sec (range = 2 min 50 sec-11 min 30 sec). The mean handling time from landing to release was 10 min 30 sec (range = 4 min 50 sec-20 min 20 sec). Two of the 21 chinook salmon that were radio-tagged were caught by nonguided anglers, two were caught by a registered Kenai River sport fishing guide and 17 were caught by ADF&G personnel. While on the river, ADF&G personnel observed and timed 43 chinook salmon sport captures by guided and nonguided anglers. A single classification ANOVA indicates that there was no significant difference ($P > 0.05$) in fight times among fish caught by guided and nonguided anglers, and study fish captured by ADF&G personnel (Table 20).

Within 2 days of release, 11 (52%) radio-tagged chinook salmon were located more than 0.5 mile downstream of their release site. Of these, 8 (73%) returned upstream and were tracked to spawning locations, 1 (9%) never resumed upstream migration and apparently succumbed, 1 (9%) was lost and never relocated and 1 (9%) apparently spit out the radio transmitter. Within 2 days of release, 10 (48%) radio-tagged chinook salmon were located upstream or within 0.5 mile of their release site. Of these, 8 (80%) were tracked to spawning locations, 1 (10%) dropped downstream of its release site before exhibiting spawning behavior and apparently succumbed, and 1 (10%) apparently spit the radio tag near its release site. A 2 x 2 contingency test for independence indicates that

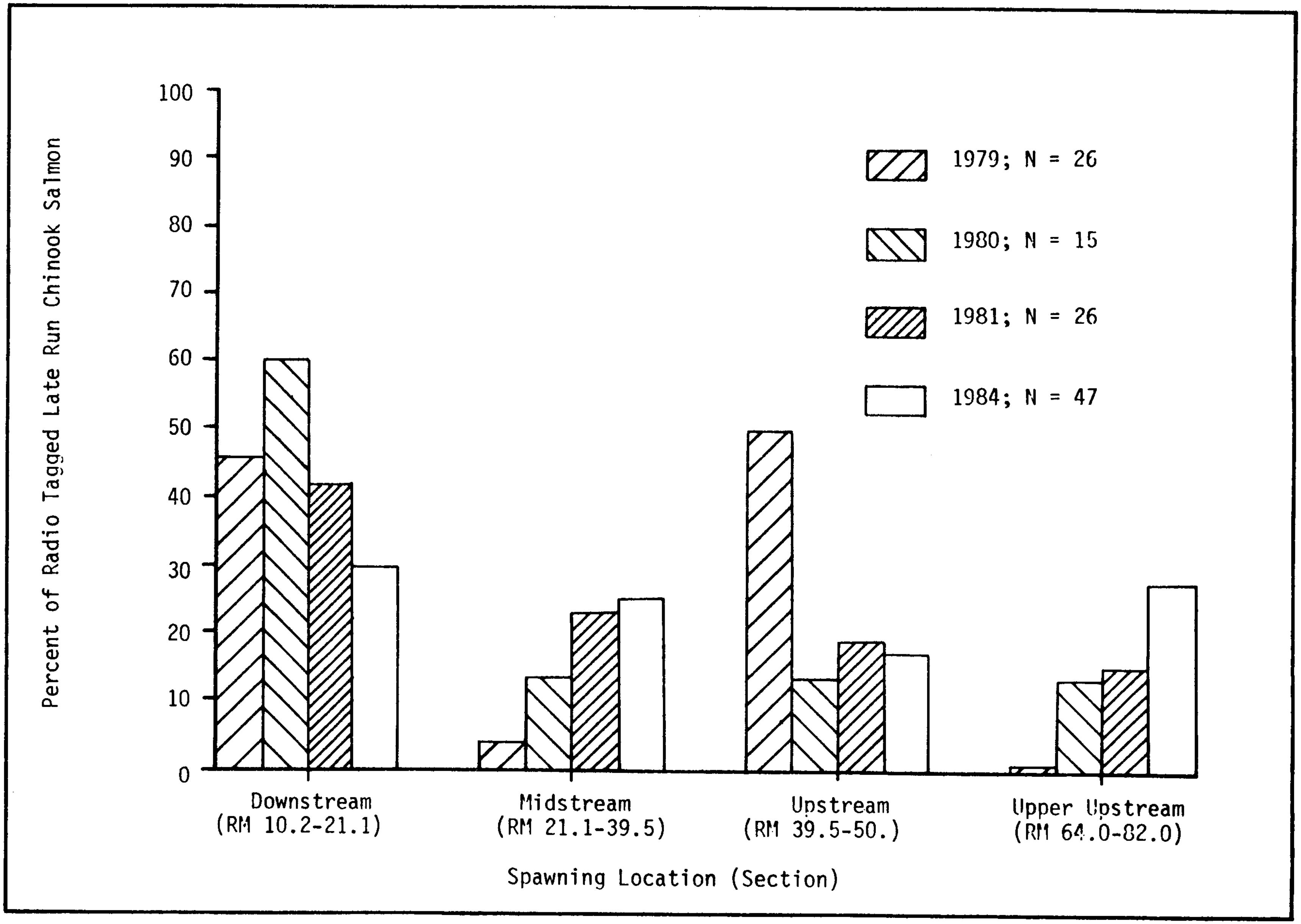

Figure 14. Comparison of spawning destination by river section of late run chinook salmon radio-tagged in 1984 with those radio-tagged in 1979-1981 (Burger et al., 1983) in the Kenai River.

Table 20. Comparison of Fight Time for Chinook Salmon Sport Caught by Various Anglers Fishing from a Boat in the Kenai River, 1984.

	Nonguided Anglers	Guided Anglers	ADF&G Personnel
Sample Size	18	25	28
Mean Fight Time*	5:43	6:10	6:12
Range	2:40-10:50	1:40-21:50	1:00-15:45

* Times are minutes:seconds.

the number of active chinook salmon ("active" refers to fish that were eventually tracked to spawning locations) initially moving downstream after hook and line capture, and radio tagging was not significantly different ($P > 0.05$) than the number of active fish initially moving downstream after drift net capture and radio tagging. The mean maximum downstream movement of eight hook and line captured fish was 2.8 miles (range = 1.1 to 6.4 miles) and these fish remained downstream of their release site for a mean of 4.6 days (range = 2.3 to 7.2 days). The mean maximum downstream movement of 10 drift net captured fish was 4.2 miles (range = 2.0 to 6.6 miles) and these fish remained downstream of their release site for a mean of 8.2 days (range = 3.1 to 15.0 days). Among fish that initially moved upstream but did not spawn (eventually dropped downstream of their release site before exhibiting spawning behavior) were seven drift net captured fish and one hook and line captured fish. The mean maximum upstream movement of drift net fish was 5.9 miles (range = 0.6-13.5 miles) and the last upstream movement occurred a mean of 11.9 days (range = 7.0-22.1 days) after release. The maximum upstream movement of the one hook and line captured fish was 6.3 miles and the last upstream movement occurred 16.4 days after release (Table 21).

Initial downstream movement followed by a period of holding occurred in both hook and line and drift net fish. Although the number of fish initially moving downstream after release was not significantly different between the two capture groups, there was a tendency for drift net fish to move farther downstream and remain below their release site for a longer period. This difference may be due to the difference in release locations between the two groups. Hook and line fish were captured and released on the average about 1 mile upstream of the mean capture and release site of drift net fish (river mile 9.2). Differences in channel characteristics between the two sites may have afforded more desirable "resting" areas (slackwater or low velocity) for hook and line fish. Also, hook and line fish were not anesthetized prior to radio tagging as were drift net fish. There is evidence that MS 222 elicits a stress response in rainbow trout and the variability in response is highest with MS 222 compared with other anesthetics (Wedemeyer, 1970). The prolonged downstream holding by drift net fish may have been required for homeostatic recovery.

Chinook salmon tagged prior to July 1 were considered early run fish and those tagged after June 30 were considered late run fish. The mean mainstem migration rates for seven early run and nine late run hook and line captured active chinook salmon were 2.0 and 1.4 miles per day, respectively. A Mann-Whitney U-test indicates that there was a significant difference ($P > 0.05$) in migration rates between these two groups. This difference is consistent with the differences occurring in 1980 and 1981 drift net captured fish (Burger et al., 1983) (Table 22). There was no significant difference in mean migration rates ($0.25 > P > 0.10$) or maximum migration rates ($P > 0.25$) between the group of nine active late run hook and line captured fish and the group of 38 active late run drift net captured fish. In addition, when pooling early and late run hook and line captured fish and dividing them into groups based on total distance of upstream migration, there was an increase in migration rate with distance traveled. This is consistent with the behavior of the drift net fish (Table 23).

Table 21. Summary of Initial Movements and Number Spawning for Chinook Salmon After Capture and Radio Tagging, Kenai River, 1984.

Initial Direction	Number (Percent)	Spawned	Miles Below Release Site	Days Below Release Site	Succumbed	Mean Days to Last Upstream Movement	Mean Maximum Upstream Movement	Limited Data**
				Drift-net Captured Fish*				
Upstream	42(60%)	28(66%)	...	...	7(17%)	11.9	5.9	7(17%)
Downstream	28(40%)	10(36%)	4.2	8.2	13(46%)	...	...	5(18%)
				Hook and Line Captured Fish				
Upstream	10(48%)	8(80%)	...	...	1(10%)	16.4	6.3	1(10%)
Downstream	11(52%)	8(73%)	2.8	4.6	1(9%)	...	...	2(18%)

* Four of 74 drift net-captured chinook salmon were never located after release.
** Fish either spit the radio tag, were sport caught, or signals were lost.

Table 22. Mean Migration Rates (Miles per Day) of Chinook Salmon Captured With Hook and Line or Drift Net, Kenai River, 1980, 1981 and 1984.

Year	Capture Method	Early Run	Late Run
1984	hook and line	2.0	1.4
1981*	drift net	1.9	1.3
1980*	drift net	2.2	1.4

* Burger et al., 1983.

Table 23. Comparison of Migration Rates (Miles per Day) of Radio Tagged Chinook Salmon Captured by Drift Net or Hook and Line, Kenai River, 1984.

Distance of Upstream Migration		Drift Net	All Hook and Line	Late Run Hook and Line
< 20 Miles	n	17	3	1
	mean	0.9	1.2	0.4
	range	0.2-2.9	0.4-1.6	...
	mean maximum	2.2	1.4	0.4
	range	0.4-4.6	0.4-2.1	...
20-40 Miles	n	8	8	4
	mean	1.8	1.5	1.6
	range	1.0-3.7	1.0-2.2	1.3-1.8
	mean maximum	4.2	3.4	2.6
	range	2.4-9.3	1.2-5.6	1.6-3.8
> 40 Miles	n	13	8	4
	mean	3.6	1.5	1.6
	range	1.9-8.7	1.7-2.5	1.0-2.3
	mean maximum	7.6	5.5	4.4
	range	3.5-11.5	4.5-6.9	2.8-5.6
Overall	n	38	19	9
	mean	2.0 *	1.6	1.4*
	range	4.4 **	3.7	3.1**

* Migration rates of late run drift net and hook and line fish not significantly different ($0.25 > p > 0.10$).

** Maximum migration rates of late run drift net and hook and line fish not significantly different ($P > 0.25$).

A 2 x 4 contingency test for independence indicates that there was no significant difference ($P > 0.10$) in spawner distribution over the four major mainstem river sections between hook and line and drift net captured chinook salmon. The spawning distribution of nine late run hook and line captured fish was as follows: downstream section, 1 (11%); midstream section, 4 (45%); upstream section, 3 (33%); and between Skilak Lake and Kenai Lake, 1 (11%) (Figure 15).

Comparisons of initial and subsequent movements of hook-and-line captured fish and drift net captured fish indicate similarities in behavior between the two groups. Migration rates and spawner distributions were not significantly different and hook-and-line fish showed the same general trend as drift net fish of increasing migration rate with increasing distance to spawning destination. There were no gross differences in these behavior characteristics between active hook-and-line and drift-net fish.

Excluding the fish that regurgitated their tags, 10 of 11 fish with the hook left in place were tracked to spawning locations. Leaving the hook in place was not detrimental. Although hooks were left in place, removal from jaw-and-mouth-hooked fish may not be detrimental; these areas have been identified as being noncritical in other salmonids (Mongillo, 1984).

The esophagus, and the gills, are dangerous anatomical hooking sites. Deep ingestion of hooks did not occur in any of the sport-captured fish in this study. This may be due to the cessation of feeding by adult chinook salmon in freshwater, and the incidence of deep hook ingestion in the Kenai River chinook salmon fishery may be low. However, if it does occur, mortality may be decreased substantially by leaving the hook in place as is suggested by hooking mortality studies of other salmonids (Mongillo, 1984).

The two early-run chinook salmon captured by a registered Kenai River sport fishing guide at river mile 43.5 were subsequently tracked to the known spawning area of Benjamin Creek (Hammarstrom and Larson, 1983; Burger et al., 1983).

Blood Chemistry:

From June 12 to July 31, 16 chinook salmon were captured with representative sport fishing gear between river miles 6.3 and 13.6 (mean = 10.7) and blood sampled. Blood samples were also taken from 15 fish captured by drift net from June 8 to August 9 between river miles 8.7 and 12.5 (mean = 9.3). During that same period, water temperatures at river mile 21.1 ranged from 9°C to 14°C (mean = 11°C). The protocol of sampling over time resulted in drawing 48 samples from the 16 hook-and-line fish and 53 samples from the 15 drift-net fish. Among other fish captured and blood sampled were five spawned-out fish that were captured by snagging them from a spawning area at river mile 72.0 and four fish that were captured by fishwheel at river mile 19.3. One sample was drawn from each of these fish (Table 24).

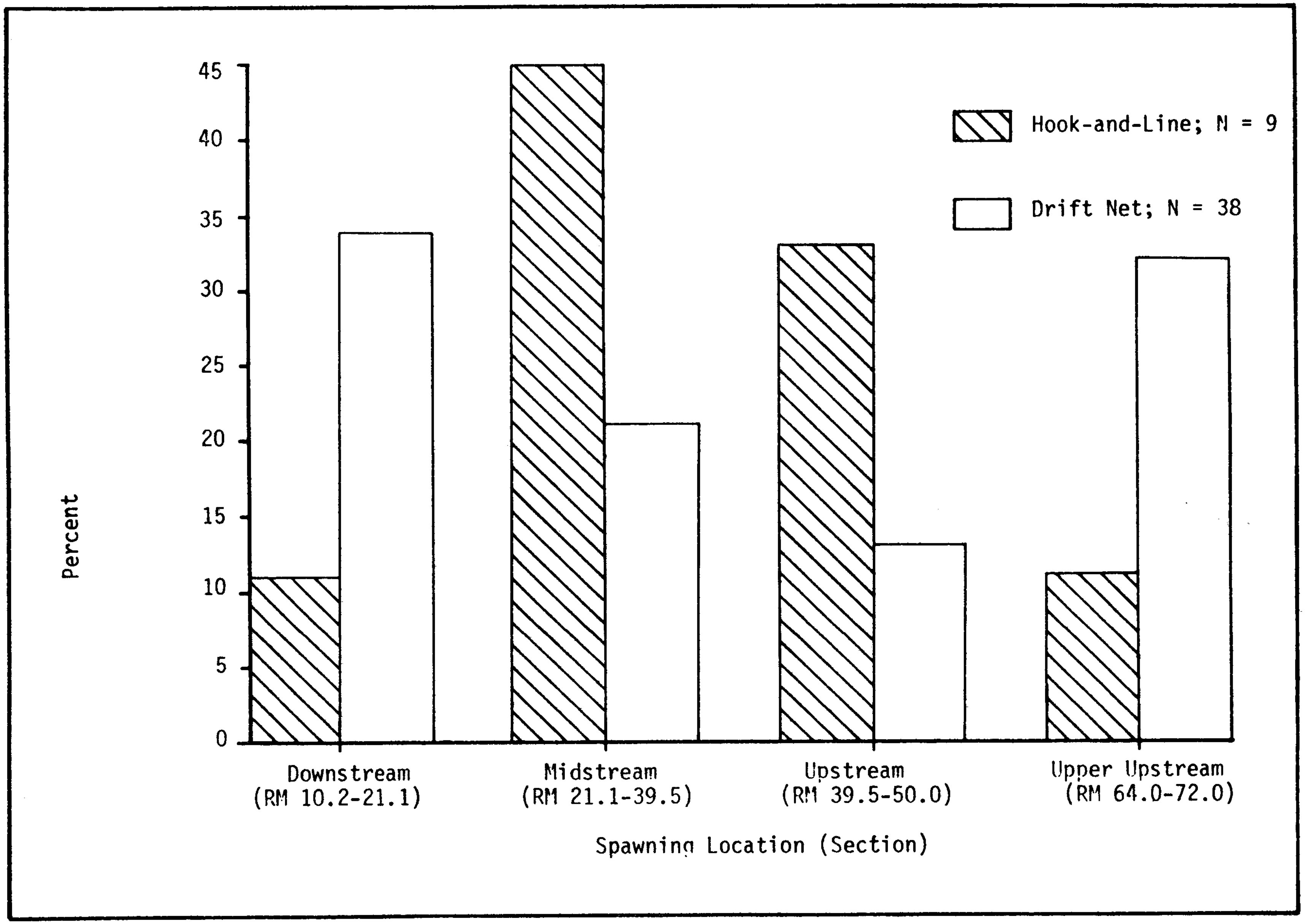

Figure 15. Comparison of spawning location by river section and river mile of late run chinook salmon captured by drift net with those captured by hook and line as determined through radio telemetry in the Kenai River, 1984.

Table 24. Summary of Chinook Salmon Captured for Blood Chemistry Analysis, Kenai River, 1984.

Capture Group	Males		Females		Total Number of Blood Samples
	n	mean length(mm)*	n	mean length(mm)*	
Hook and Line	5	1,025	11	906	48
Drift Net	9	1,023	6	964	53
Spawned Out	3	...	2	...	5
Fishwheel	3	...	1	...	4

* Mid-eye to fork of tail.

In subsequent discussion, the term "total time" refers to the time elapsed from initial encounter to the drawing of the blood sample. For hook and line fish initial encounter was at hookup and for drift net fish initial encounter was when the fish first encountered the net. "Exercise time" refers to time on the hook (hookup to landing) for hook and line fish and time in the drift net (first encounter until free from net) for drift net fish.

Overall samples there was a significant linear correlation ($P < 0.05$) of cortisol level with total time in both hook and line and drift net fish. Linear correlations of glucose and chloride levels with total time were not significant ($P > 0.05$) in either group. Linear correlations of blood parameter levels in initial samples with total time were significant ($P < 0.05$) for cortisol and glucose in the hook and line group only. However, the relationship was not extremely strong (correlation coefficient = 0.51 in both cases). Blood chemistry responses are summarized in Tables 25 and 26 and Figures 16, 17, and 18.

The lack of correlation of the dependent variables glucose and chloride with time indicates that the salmon were able to maintain somewhat stable levels and thus homeostatic mechanisms were functioning after the struggle of capture. It is unclear, however, if the glucose and chloride levels observed over the holding period indicate a physiological disturbance. The attempt to obtain blood samples from fish immediately upon capture by fishwheel was unsuccessful; "normal" levels of these parameters in Kenai River chinook salmon are undetermined. However, at similar water temperatures, wild rainbow trout that were hooked and played on sport gear experienced a significant increase in blood glucose after only 5 minutes of playing (Wydoski et al., 1976). Of 31 hook and line and drift net fish sampled, only 2 were sampled within 4 minutes of the initial encounter (both were drift net fish) and the mean times to first sample for 16 hook and line and 15 drift net fish were 20 and 11 minutes, respectively. Elevation of blood glucose to hyperglycemia may not have been detected. However, if a hyperglycemic condition was indicated, the holding period was sufficiently long to detect the additional increase in blood glucose that would be expected if the stress was severe enough to upset homeostasis (Wedemeyer, pers. comm., 1985; Wydoski et al., 1976). The range of glucose levels encountered in this experiment (30-144 mg/100 ml) was similar to a "normal" range reported for unstressed yearling rainbow trout (41-151 mg/100 ml) (Wedemeyer and Chatterton, 1970). In the case of chloride, a level below 90 mEq/l is generally considered life threatening for salmonids (Palmisano, pers. comm., 1985; Wedemeyer, pers. comm., 1985). Over the range of times tested, the lowest chloride level encountered by hook and line and drift net fish was 94 mEq/l (Figure 17). The stress response of glucose and chloride indicates that the stress due to capture (by either method) and subsequent handling and confinement was not excessive; i.e., the stress was within the expected tolerance limits of these fish (Wedemeyer, pers. comm., 1985).

Because the stress due to capture was not excessive and because initial cortisol levels were low compared with levels in subsequent samples, the

Table 25. Blood Chemistry Values for Chinook Salmon at Initial Sampling, Kenai River, 1984.

Group	n	Exercise Time (min:sec)		Total Time to Initial Sample (min:sec)		Glucose (mg/100ml)		Chloride (mEQ/1)		Cortisol (ng/ml)	
		mean	range	mean	range	mean	range	mean	range	mean	range
Hook and Line	16	6:50	1:00-21:50	19:40	7:20-46:50	87	64-115	122	112-134	43	0-139
Drift Net	15	3:30	1:00-12:00	11:20	3:00-23:00	77	38-111	114	100-126	52*	1-219*
Spawned Out	5	1:00	...	5:00	...	133**	54-205**	92***	84-108***	...	...
Fishwheel****	4	...	...	...	...	97	80-107	118	112-126	...	...

* Cortisol values for 11 drift net fish.
** Glucose mean for females = 58 mg/100ml, males = 182 mg/100ml.
*** Chloride mean for females = 100 mEQ/1, males = 87 mEQ/1.
**** All fishwheel fish had been in the holding tank for several hours prior to sampling.

Table 26. Blood Chemistry Values for Chinook Salmon Over a Holding Period in a Live Pen, Kenai River, 1984.

Group	n	Total Number of Samples Taken	mean holding time (min) +/- SD*	Glucose (mg/100ml)		Chloride (mEQ/1)		Cortisol (ng/ml)	
				mean	range	mean	range	mean	range
Hook and Line	16	48	123 +/- 29	90**	30-144**	121	94-134	206	0-449
Drift Net	15	53	137 +/- 32	92	38-137	115	94-132	213***	1-509***

* SD = Standard Deviation.
** Glucose values for 47 samples.
*** Cortisol values for 41 samples.

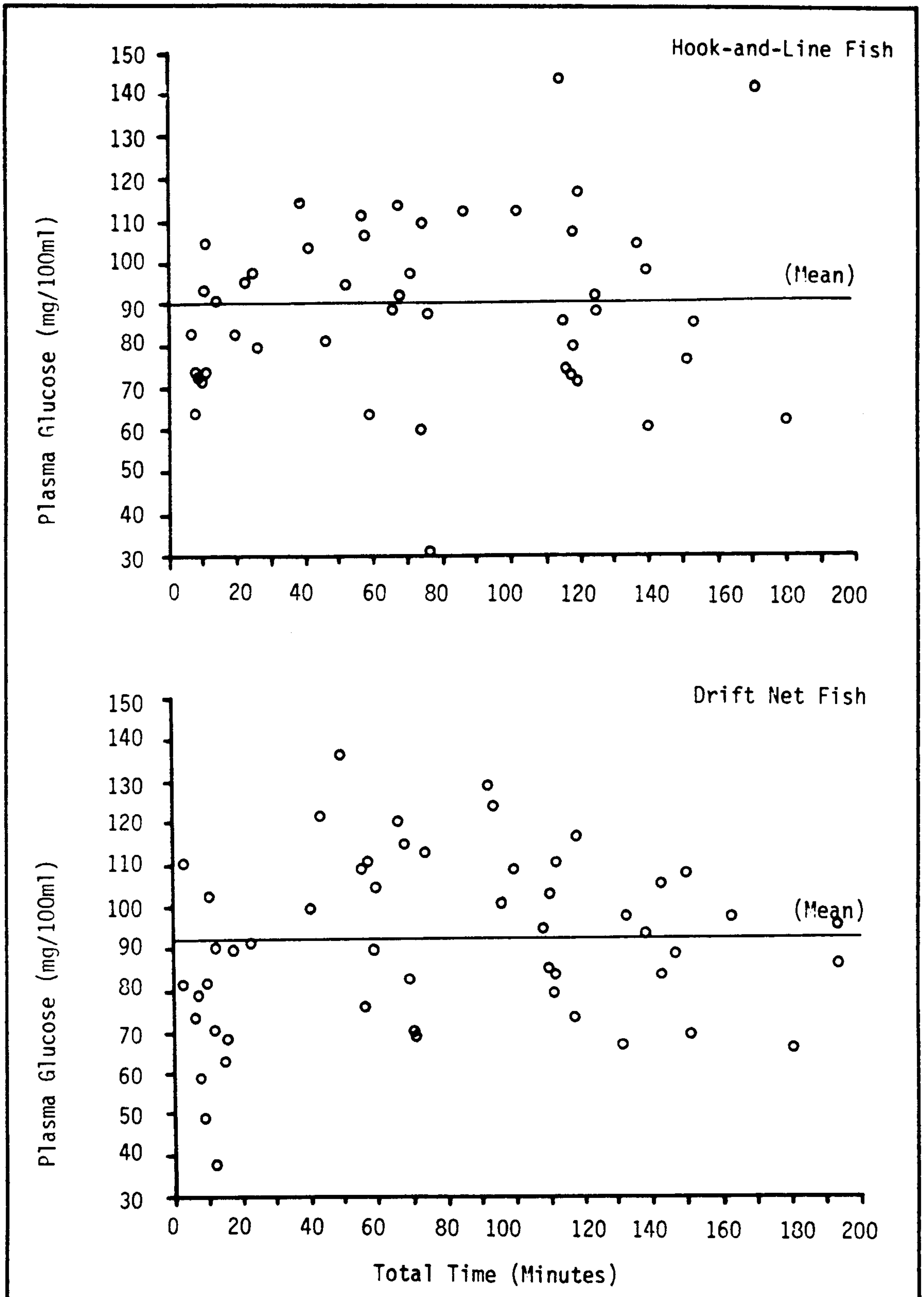

Figure 16. Plasma glucose response in chinook salmon during a holding period after capture by hook and line or drift net, Kenai River. 1984.

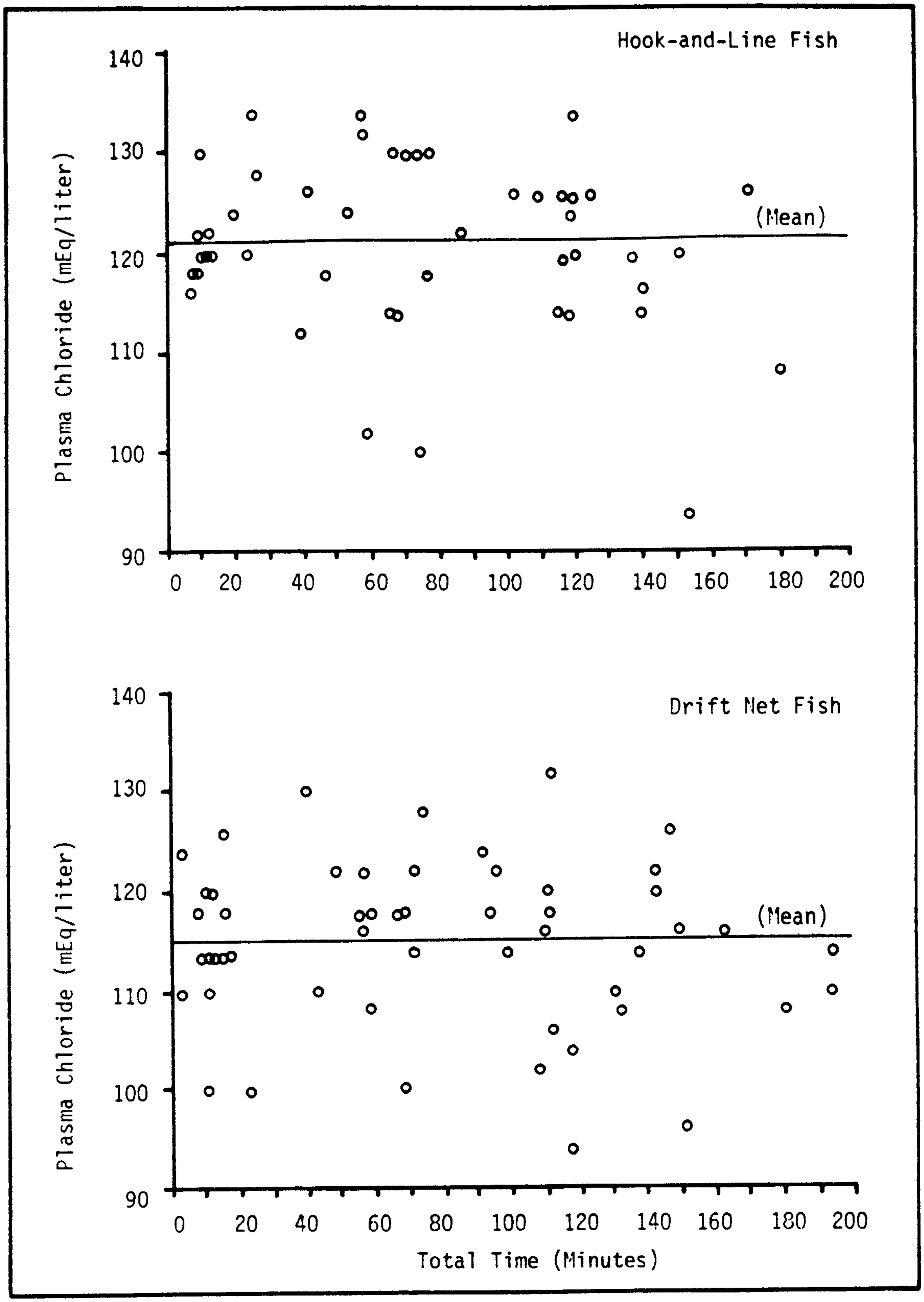

Figure 17. Plasma chloride response in chinook salmon during a holding period after capture by hook and line or drift net, Kenai River, 1984.

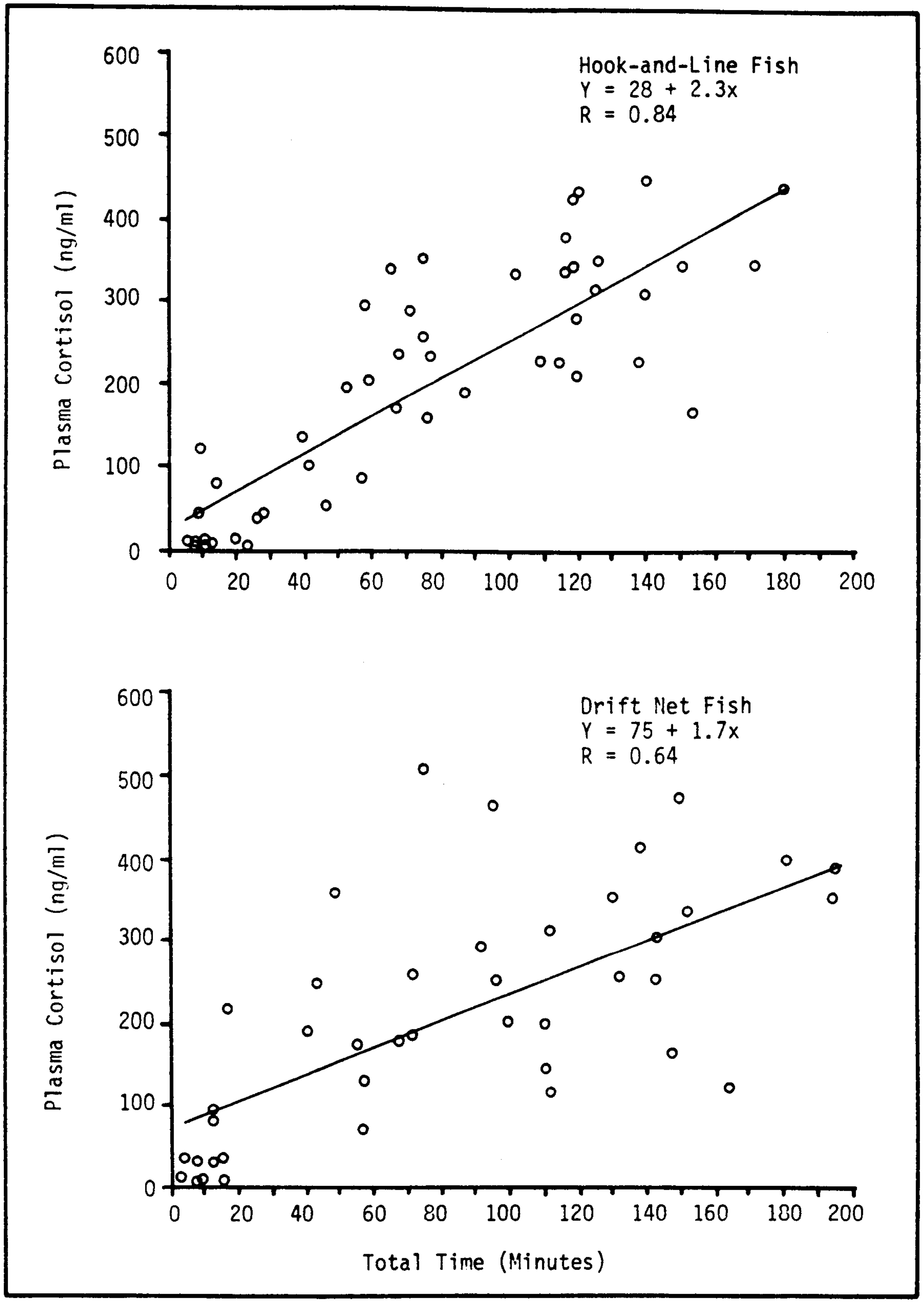

Figure 18. Plasma cortisol response in chinook salmon during a holding period after capture by hook and line or drift net, Kenai River, 1984.

increase in cortisol level (see Figure 18) was due mainly to the stressors of holding (Wedemeyer, pers. comm., 1985), where fish experienced atypical light, depth, water flow and space.

The blood chemistry responses of the three fish hooked and played to exhaustion are presented in Table 27.

A literature review by Mongillo (1984) suggests that there is little supporting evidence of the theory that hooking and playing a fish to exhaustion in fresh water and then releasing it results in death. Of the three fish rehooked and played to exhaustion after the initial holding and sampling period, two died within 10 minutes of taking the final blood sample. However, these fish were played for an excessive length of time (mean = 36 minutes) which was well over the mean fight time recorded for guided and nonguided anglers (see Table 20). The purpose was not to determine if playing to exhaustion would lead to death, but to determine levels of lactic acid associated with death. Death is strongly associated with high lactic acid levels in troll-caught chinook salmon (Parker and Black, 1959). Although the stress of initial capture and confinement may not have been excessive in itself, the additional stress of rehooking and playing to exhaustion exceeded the tolerance of these fish.

Excessive amounts of hemoglobin in the plasma samples precluded analysis for lactic acid. Some possible causes of hemolysis when processing blood samples are moisture contamination of the blood sample, inadequate mixing of the blood with the anticoagulant, inadequate cooling of the samples before freezing and forcing the blood sample through a small aperture (as from the syringe through the hypodermic needle). Care was taken to consider these points when processing the samples. That all plasma samples were tainted with hemoglobin indicates there may be an inherent sensitive nature in the erythrocytes of these chinook salmon. The abrasion associated with drawing the sample and transferring it among containers may be enough to hemolyze delicate erythrocytes (Wedemeyer, pers. comm., 1985).

The occult blood test strip reactions could be grouped into one of four categories: 0-negative reaction; 1-trace amounts of nonhemolyzed blood; 2-trace to small amounts of hemolyzed blood; 3-moderate to large amounts of hemolyzed blood. Only the results of the initial application of the test strip are presented (Table 28). There were no negative reactions in any of the initial test strip applications. The test strips indicated the presence of occult blood in all three of the fish that were rehooked and played to exhaustion. The reaction intensity was 3 for two fish and 2 for the third fish.

The large range in total times in each hemoglobin test strip reaction group may indicate a high variability in occult blood response to the stressors of capture or it is possible that the "natural" stressors associated with the spawning migration (rapid maturation, osmoregulatory changes, predation, etc.) may elicit an occult blood response prior to capture. The sensitivity of this test in detecting the severity of angler-induced stress is questionable.

Table 27. Summary of Blood Chemistry Response of Three Chinook Salmon Rehooked and Played to Exhaustion After Undergoing the Holding/Sampling Process, Kenai River, 1984.

Initial Capture Method	Exercise Time (minutes)	Total Time (minutes)	Glucose (mg/100ml)	Chloride (mEQ/1)	Cortisol (ng/ml)
Hook and Line*	3	7	83	116	11
		67	91	130	176
		116	75	126	380
		140	61	116	449
		185	Rehooked and played to exhaustion (27 min).		
		212	51	110	462
Drift Net	4	10	49	114	13
		72	70	114	187
		132	98	108	259
		150	Rehooked and played to exhaustion (49 min).		
		207	49	88	238
		231	60	112	316
Drift Net*	3	8	59	114	1
		57	111	122	131
		110	103	116	201
		147	Rehooked and played to exhaustion (32 min).		
		185	95	112	179
		259	30	108	113

* Two fish died within 10 minutes of drawing the last blood sample.

Table 28. Relationship of Hemastix Reaction Intensity and Time Elapsed From Initial Encounter For Chinook Salmon Captured By Hook and Line or Drift Net in the Kenai River, 1984.

Reaction Intensity*	Hook and Line			Drift Net		
	n	mean (minutes)	range	n	mean (minutes)	range
0	0	...	...	0	...	...
1	8	20	9-50	3	7	3-10
2	6	23	8-42	6	13	8-17
3	2	8	7-8	6	12	4-23

* Reaction key: 0 = negative reaction
1 = trace amounts of non-hemolyzed blood
2 = trace to small amounts of hemolyzed blood
3 = moderate to large amounts of hemolyzed blood

There was a tendency for more positive reactions to occur over shorter periods in drift net fish. Smith and Ramos (1976) collected mucus from unstressed fish that initially tested negatively and after collection the pooled mucus tested positively indicating that the collection process itself influenced occult blood levels. The mechanical abrasion of the drift net on an entangled fish may have had the same effect.

Discussion

Kenai River Salmon Fisheries:

The Kenai River chinook salmon fishery has grown into the state's largest recreational fishery. The tourist industry, through various promotion programs both public and private, has gained wide acclaim for the system and its large fish. Participation promises to continue to increase and the controversy around this resource shows no signs of disappearing. There are, however, steps being taken that are attempting to find solutions to some of the problems.

Legislation passed in 1984 created the Kenai River Special Management Area (KRSMA). The area encompassed is the water column extending from Kenai Lake to the Warren Ames Bridge located at river mile 5.1. The responsibility for management of this area has been given to the Department of Natural Resources through their Division of Parks with the assistance of the KRSMA Advisory Committee (KRSMAAC). This committee is comprised of 19 members representing various Federal, State, and local agencies with differing responsibilities to the river along with members from the public representing various concerns such as guiding, private land ownership, commercial and recreational fishing. Through the winter months, the KRSMA Advisory Committee, through public hearings and select subcommittees, have been working toward possible solutions.

One of the first issues confronted was that of commercial guides operating on the Kenai River. Alaska statute allowed the Board of Fisheries to regulate guides only as their activities related to conservation and development of the resource. Under DNR statutes, operation of a commercial business in a State park required a permit and it became the task of the KRSMAAC to advise DNR as to the conditions under which a permit would be issued. The result was a set of requirements that must be satisfied before the permit would be issued. Although there were attempts to put a limit on the number of guides that would be allowed, no action was taken; however, the industry was put on notice that the subject would be explored in depth over the next year. In addition, the mechanism for revoking and/or restricting an individual guide has been established, which was one the principle concerns voiced at the public hearings.

The Board of Fisheries passed a regulation allowing guides to operate only between 6:00 a.m. and 6:00 p.m., thus, reducing the possible time guided anglers could fish by 50%. The result was a reduction in total percentage harvest of chinook salmon attributed to guided anglers by approximately 15% (59% to 45%), from 1983 figures.

The KRSMAAC will be working, through their various subcommittees, over the next year to gain further public input on an overall management plan for both the water column and the habitat which legislation requires. They will be considering many subjects that may have drastic ramifications on the existing fisheries. Some of the mentioned changes they will be investigating are horsepower/boat size restrictions, areas where only nonpowered vessels could be used, increased access sites and further restrictions on stream side development.

There was a marked increase in activities by the law enforcement agencies on the river in 1984 which was well received by the angling public. There were noticeably fewer complaints received at the Soldotna ADF&G office and, in fact, many favorable comments were heard both through telephone conversations and at various public hearings; the overall impression was that compared to 1983, 1984 was a more orderly and courteous fishery.

Escapement Estimate:

Utilizing drift nets in the Kenai River has proven successful in capturing large numbers of adult chinook salmon, however, this technique is labor intensive and other capture techniques should be explored. A capture technique which would merit investigation is a vessel seining operation. Using smaller mesh size may prove indiscriminate in fish size selection and, depending on the number of chinook salmon captured, seining may prove less labor intensive.

Migrational Behavior:

Radio telemetry has proven to be an effective method of studying the movements and behavior of chinook salmon in the glacial waters of the Kenai River, both in this study and by Burger et al. (1983). Results from these studies have provided the most complete information available on the migrational behavior and spawning distribution of chinook salmon in the Kenai River. With the exception of the problems incurred from the epoxy-labeled radio tags, there appears to be an initial degree of radio-tagging stress on some fish, however, without a reliable control it is difficult to assess the degree that radio tagging influences long term spawning migration behavior. There have been enough telemetry studies conducted on chinook salmon in the Northwest (Burger et al., 1983; Grandstrand and Gibson 1981; Liscom et al. 1978) that most researchers feel confident that radio-tagged fish of suitable size (transmitter weight 2% of fish weight) (Ross and McCormick, 1981) will exhibit behavior which is representative of the actual population.

One of the objectives of the 1984 radio telemetry study was to determine the spawning distribution of late run chinook salmon, however, our findings on chinook salmon migrational behavior may be more applicable for management purposes. Milling behavior by radio-tagged chinook salmon was observed in all four river sections, but it was most common downstream from the Soldotna Bridge. This was evident by the significantly slower migration rates of radio-tagged chinook salmon in this section compared with migration rates by the same salmon in upper river sections. Burger et al. (1983) also noted increased migration rates as radio-tagged chinook salmon progressed upstream. The duration of milling behavior in the downstream section may be influenced by the date the fish enter the river, as fish radio tagged earlier in the late run held in the downstream section significantly longer than fish radio-tagged later. Over 70% of the radio-tagged chinook salmon were still in the downstream section as of July 31. Conversely, only three radio-tagged chinook salmon had migrated into the upstream section before the July 31 sport fish closure. Since approximately 80% of the late run sport fishing effort and harvest takes place in the downstream section, fish milling in this area are susceptible to the intense sport fishery for an extended period. This appears especially true for fish entering the river early in the late run.

One of the major criticisms of current management policies is the apparent lack of fish arriving in the upstream section in July. Many local residents of that area feel that fish are being overharvested by anglers further downstream. There appears to be adequate numbers of fish reaching the upstream section, however, many of them do not arrive until late July. Fish that do arrive earlier in July have exhibited a reluctance to strike. Unusually clear water conditions over the last few seasons may have influenced the migration pattern by delaying upstream movement until maturation is nearly complete.

The spawning distribution of late run chinook salmon in the Kenai River appears to fluctuate from year to year based on the 4 years of chinook salmon radio-tagging studies. During their 1979-1981 chinook salmon radio telemetry study, Burger et al. (1983) indicated that the down-stream and upstream sections were the most important spawning areas, with the midstream section and the section between Skilak Lake and Kenai Lake receiving fewer spawners. Between any 2 years of their study there was significant variability in the late run chinook salmon spawning distribution. In 1984, a relatively even distribution of spawners was observed throughout the river (25-30%), with slightly fewer selecting the upstream section (17%). This distribution varied significantly from that of 1979-1981.

Hook and Release:

Because of funding restrictions, the hook and release study conducted on Kenai River chinook salmon was quite limited in scope and built in biases were unavoidable. In order to utilize each available trans-mitter, only fish that appeared healthy were released. The specific capture gear was similar to what many anglers used, however, there are many who use much different gear, especially terminal gear.

The sample size was quite small which meant the apparent survival of 76% means only that some select healthy fish can survive the stresses of hook and release fishing. No definitive conclusions regarding hook and release fishing for large chinook salmon, either detrimental or not could be drawn. A more comprehensive study, costing significantly more, would be necessary to measure and test the spectrum of possible variables.

The regulation passed affecting the 1984 season requiring an angler to retain any chinook salmon removed from the water probably did more to ensure the survival of hook and release fish than any additional regulations would. The evidence supporting this premise comes from the population estimate study. In 1983, fish were processed in the bottom of the boat. These fish were handled as carefully as could be, but nevertheless were removed from the water for a short period of time. The result was a downstream drift of many fish; more fish were recaptured in the commercial fishery; many anglers reported recapturing lethargic fish; more unspawned carcasses were retrieved. A vast improvement was obvious in 1984 and the major difference was the way fish were handled; they were never taken from the water.

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