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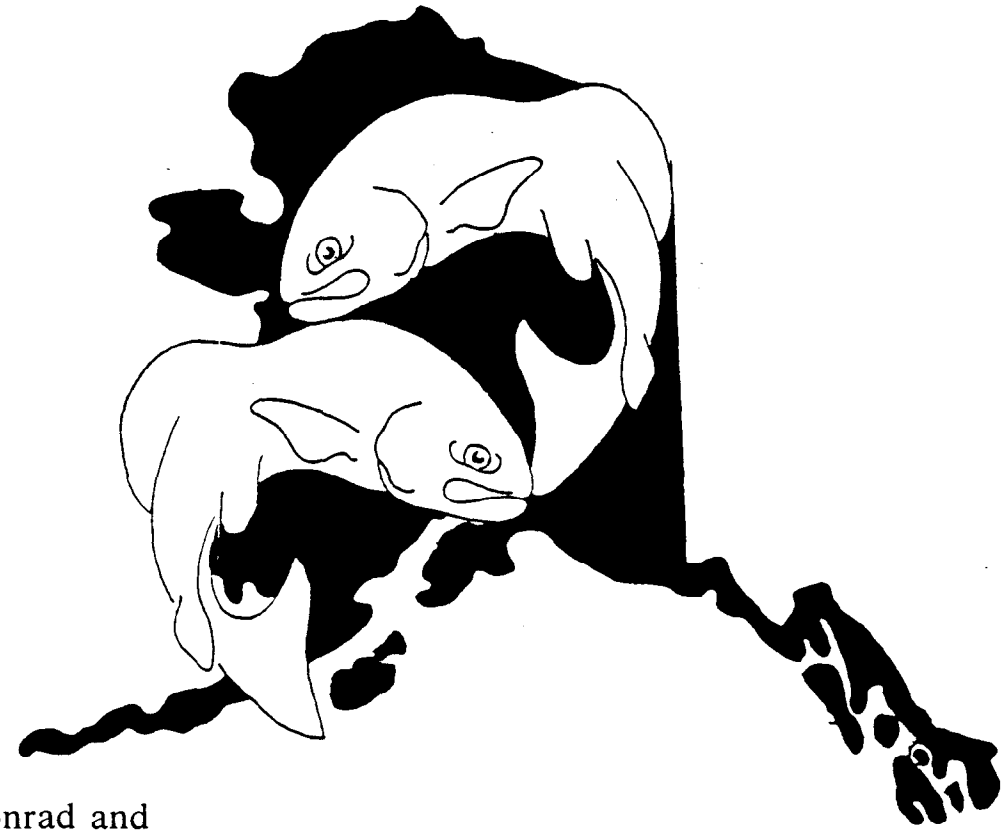
ABUNDANCE ESTIMATES FOR CHINOOK SALMON *(Oncorhynchus tshawytscha)* IN THE ESCAPEMENT INTO THE KENAI RIVER, ALASKA, BY ANALYSIS OF TAGGING DATA, 1986



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ABSTRACT

Drift gillnets were used to capture adult chinook salmon *(Oncorhynchus tshawytscha)* in the lower Kenai River for tagging. Tagged fish were recovered during creel surveys of the recreational fishery. The tag release-and-recapture data were used to estimate the number of chinook salmon entering the Kenai River from 17 May to 28 July. Effort and catch data from the gillnets were used to estimate the abundance of chinook salmon from 29 July to 14 August. From 17 May to 14 August, 84,643 chinook salmon were estimated to have entered the lower Kenai River. The abundance of late-run fish (57,563) was more than twice that of early-run fish (27,080). The major age groups of returning chinook salmon were 1.3 (46 percent) and 1.4 (36 percent). The mean length-at-age of male and female chinook salmon increased throughout the return.

KEY WORDS: Kenai River, chinook salmon, *Oncorhynchus tshawytscha*, tag release-and-recapture, abundance estimate, gillnet effort and catch statistics, age-sex-length compositions.

INTRODUCTION

More fishing effort occurs on the Kenai River (Figure 1) than in any other freshwater recreational fishery in Alaska (Mills 1986). Most of the effort is directed at returning chinook salmon (*Oncorhynchus tshawytscha*) and occurs during June and July in the mainstem of the river downstream from Skilak Lake. Effort in this fishery has increased in seven of the last ten years (Figure 2). Because the Kenai River is near a major population center and is easily accessible, fishing effort is expected to increase.

There are two stocks of chinook salmon in the Kenai River: (1) an early run which enters the river from mid-May until late June; and (2) a late run which enters the river from late June through early August. Fish from both stocks are highly valued because of their large size, especially fish from the late run. Chinook salmon in the late run average about 18 kg (40 lbs), and often exceed 36 kg (80 lbs). The world record for a sport-caught chinook salmon is from the Kenai River; it was caught in 1985 and weighed 44 kg (97 lbs).

Management of the inriver recreational fishery is complicated by the relatively large harvests of chinook salmon returning to the Kenai River by sport and commercial fisheries in the marine waters of Cook Inlet, particularly by the commercial setnet fishery along the east side of the Inlet (McBride et al. 1985). Harvests by marine and inriver sport fisheries, coupled with a large commercial harvest, may prevent an optimum escapement of brood stock. Estimates of the abundance and biological characteristics of the chinook salmon escapement are critical for management of the inriver sport fishery. The Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) proposed a tag release-and-recovery program in 1975 to provide the required estimates. Electrofishing equipment, drift gillnets (Hammarstrom 1980), fish traps, and

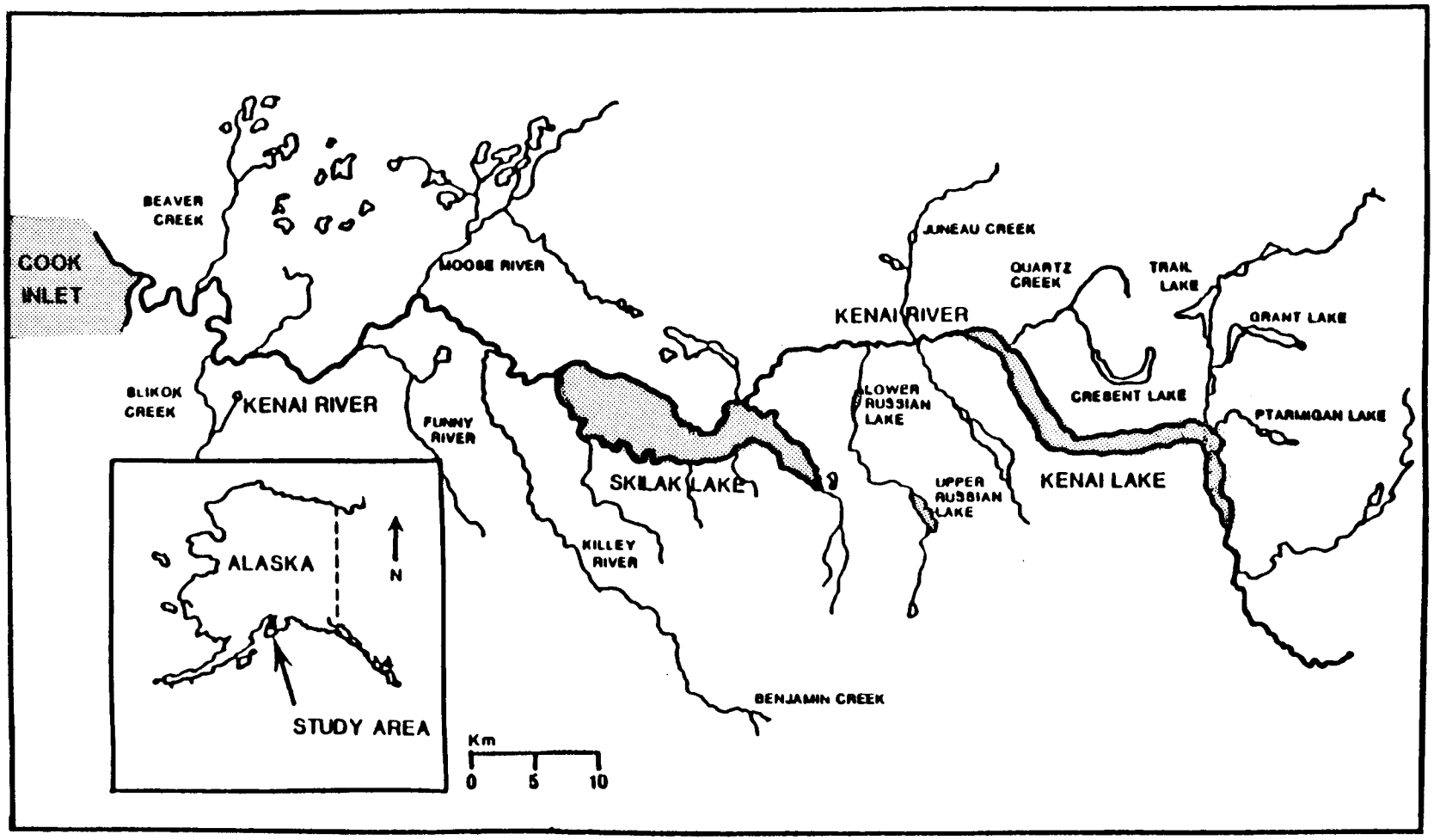

Figure 1. Map of the Kenai River system.

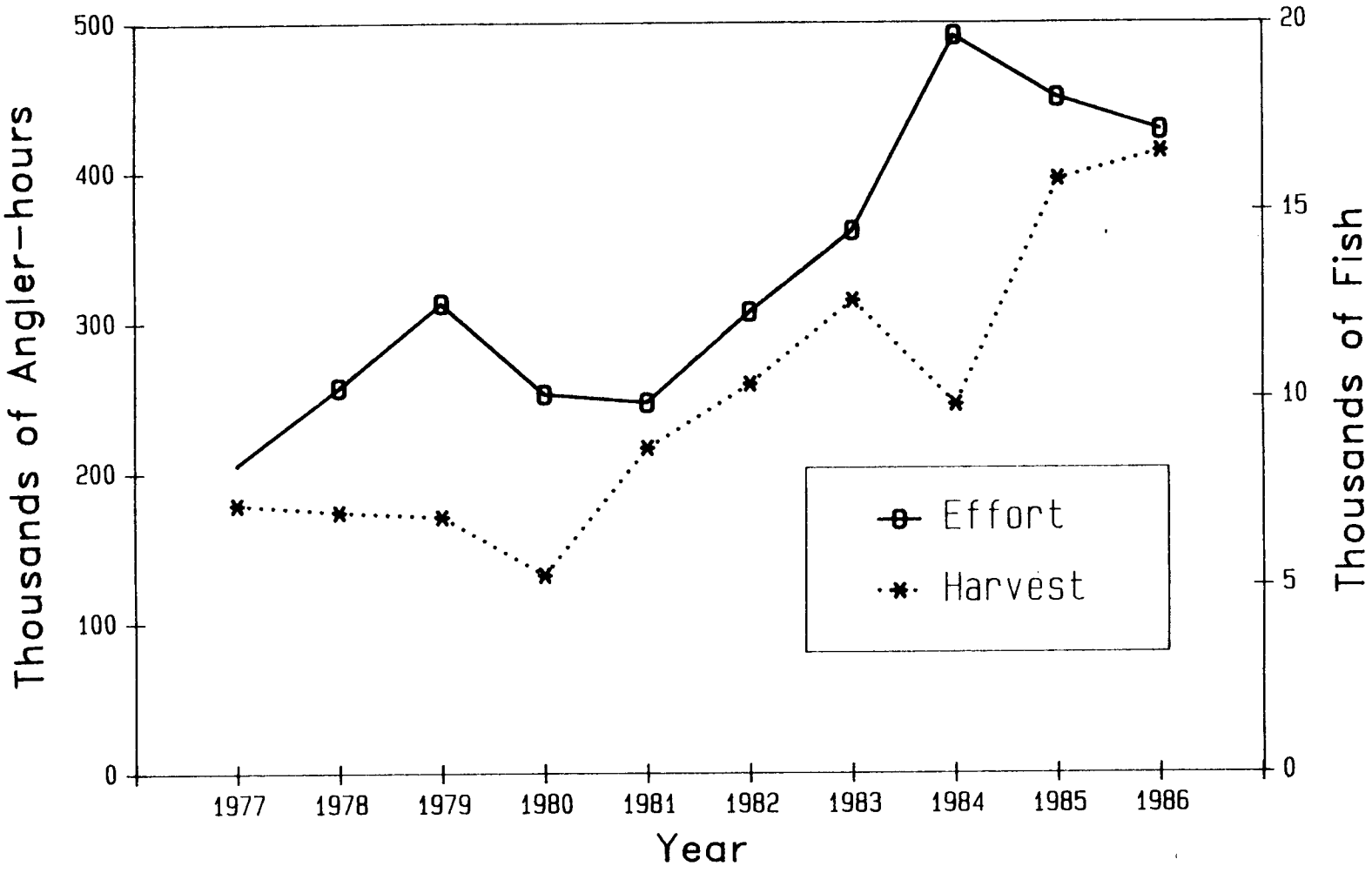

Figure 2. Estimates of angler-effort and chinook salmon harvest for the Kenai River, 1977-1986.

fish wheels (Hammarstrom and Larson 1982, 1983, 1984) were tested as means of catching chinook salmon. Drift gillnets were found to be the most effective and were used to estimate abundance of late-run chinook salmon in 1984 (Hammarstrom et al. 1985) and 1985 (Hammarstrom and Larson 1986). The abundance of early-run fish was first estimated in 1985 (Hammarstrom and Larson 1986). Improved equipment and tagging techniques in 1984 increased the number of fish tagged, while improved data collection procedures and more recovery personnel in 1985 increased the number of fish inspected for tags. Other Sport Fish Division programs related to the management of Kenai River chinook salmon include a creel survey to estimate the inriver recreational harvest (Conrad and Hammarstrom in press) and surveys of the marine recreational fisheries in Cook Inlet (Hammarstrom et al. in press).

This report describes the methods used to estimate the number of chinook salmon in the escapement to the Kenai River during 1986. In addition to an abundance estimate, biological data from chinook salmon sampled during tagging and spawning ground surveys are presented. These data, in conjunction with estimates of numbers of fish and age composition for the recreational harvest, are used to estimate the numbers of fish and age composition of the spawning population. These data supply an integral part of the long-term database of total return information so that spawner-return relationships may be estimated in the future.

METHODS

Because the sport fishery for chinook salmon is closed by regulation on 31 July, the tag release-and-recovery data could be used to estimate the number of chinook salmon that entered the Kenai River from 17 May to 28 July. Effort and catch statistics for the drift gillnets were analyzed to estimate the number of chinook salmon entering the river from 29 July to 14 August.

Tagging

Four, two-person crews tagged chinook salmon. Tagging was conducted between 11 and 15 km above the mouth of the Kenai River (Figure 3) each day between 17 May and 14 August, inclusive. Two crews usually operated on 4 days of each week and all four crews operated on the remaining 3 days of each week. Because catches of chinook salmon had been highest in the 9 hours before high tide in other years (Hammarstrom and Larson 1982, 1983, 1984) sampling was restricted to this time. On those days when two high tides occurred during daylight, two crews gillnetted. When only one high tide occurred during daylight, two, three, or four crews gillnetted depending on crew availability. Each sampling period was about 6.5 hrs long.

Nineteen centimeter stretched-mesh drift gillnets about 15 m long were used to capture chinook salmon. The nets were set from an outboard-powered skiff by releasing one end of the net near the shoreline and rapidly backing the skiff toward the middle of the river channel. Once the net was extended, it was allowed to drift downstream with the current. The net was usually allowed to drift downstream until either a

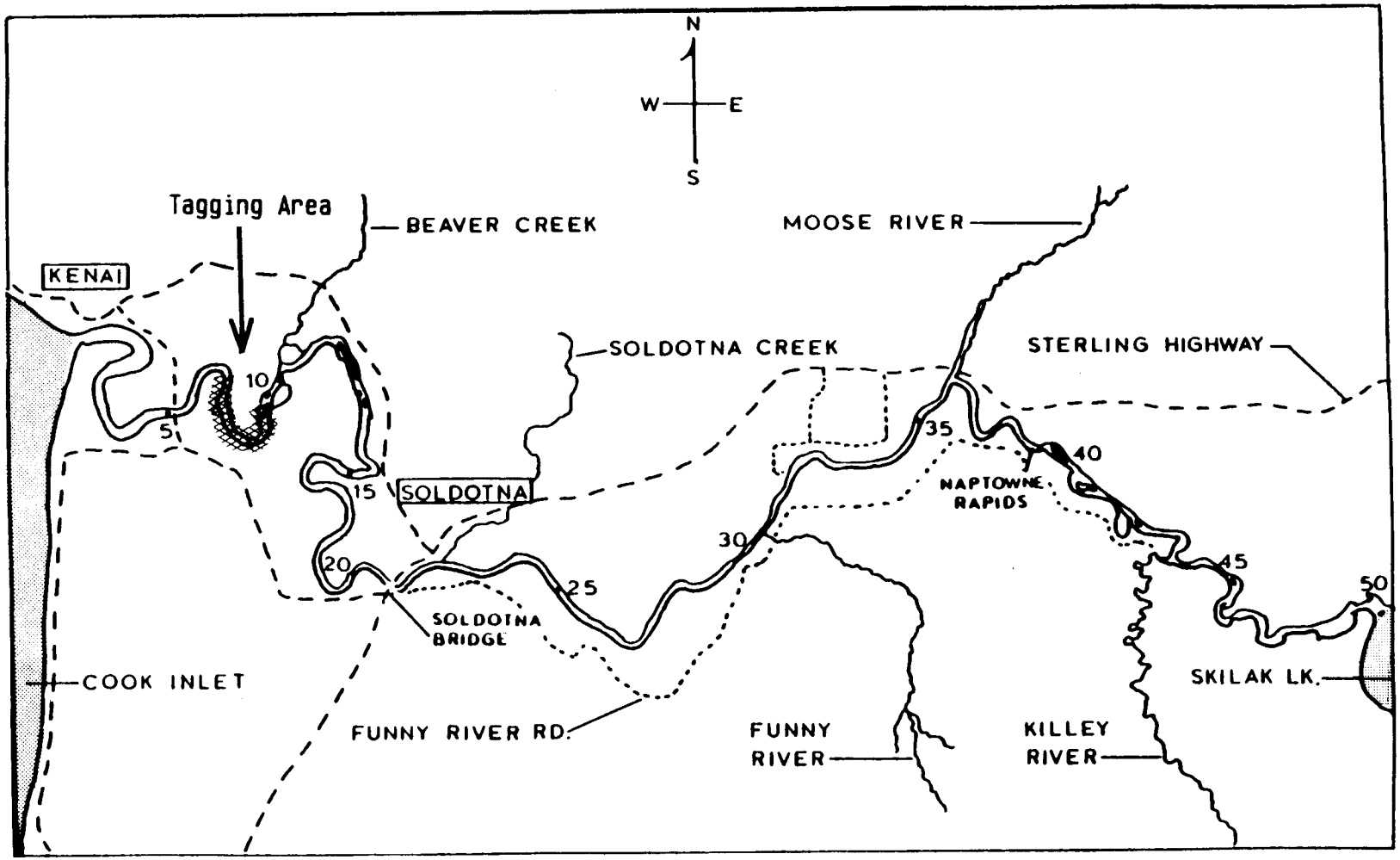

Figure 3. Map of the lower Kenai River between Cook Inlet and the outlet of Skilak Lake.

chinook salmon was caught, the net encountered a snag on the river bottom, or the boundary of the tagging area was reached.

When a chinook salmon became entangled in the net, the floats on the net would bob violently. Chinook salmon were retrieved immediately after entanglement in the net. A soft, braided-rope was then looped around the caudal peduncle of each fish. The fish was then untangled from the net and slipped into a cradle for processing. The tagging cradle was a rigid, foam-padded device which hung from the side of the skiff with its base about 15 cm below the water line. The cradle immobilized the captured fish and kept it in the water during processing. The date, time of capture, and location of capture (approximate river mile [RM]) were recorded for each chinook salmon brought to the skiff, in addition to the tag number for those fish tagged.

The condition of each captured chinook salmon was assessed prior to tagging. Chinook salmon with deep scars, damaged gill filaments, a lethargic condition, or fish requiring extended processing time were not tagged. Fish were tagged with individually numbered, 50-cm, orange Floy FT-4 plastic spaghetti tags. Each tag was inserted below the posterior insertion of the dorsal fin with a large needle and secured with an overhand knot. The adipose fin of each chinook salmon tagged was removed so that any tag loss could be identified. The mid-eye to fork-of-tail length (measured to the nearest 5 mm) and the sex (identified from inspection of external characteristics) of tagged fish were recorded. Three scales were removed from the preferred area (Clutter and Whitesel 1956) of each chinook salmon and mounted on an adhesive-coated card.

Effort and catch for each set with the gillnet were recorded. Effort was measured as the number of minutes the net drifted before being retrieved, and catch as the number of chinook salmon caught. Captured chinook salmon were tallied according to five categories: (1) untagged fish which were captured and tagged; (2) untagged fish which were captured but not tagged because of a poor condition; (3) fish which were captured and positively identified as chinook salmon but escaped before being processed; (4) previously tagged fish which were recaptured; and (5) fish with healed adipose finclips[1]. Any chinook salmon with a healed adipose finclip was sacrificed so that the head could be inspected for the presence of a coded-wire tag (CWT). The tag numbers of fish in category 4 were recorded.

Tag Recovery

The inriver recreational fishery, which is restricted by regulation to the area between the outlet of Skilak Lake and Cook Inlet, was the

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[1] Healed adipose finclips were easily distinguished from the adipose fin scars caused by adipose fin removal during the inriver tagging. Fish with healed adipose finclips were probably hatchery fish from an area other than the Kenai River. The heads of these fish were sent to the Fisheries Rehabilitation, Enhancement, and Development (FRED) Division of the ADF&G for processing.

mechanism for tag recovery. Roving creel surveys of the fishery and an access-site creel survey were used to estimate the proportion of tagged chinook salmon in the population. Nearly all recreational fishing in the Kenai River occurs upstream of the area where the chinook salmon tagging occurred. The fishery and the roving creel surveys are described in detail by Conrad and Hammarstrom (in press).

Roving creel surveys were conducted in the downstream (Cook Inlet to Soldotna Bridge) and upstream (Naptowne Rapids to the outlet of Skilak Lake) sections of the Kenai River (Figure 3). In 1986, approximately 82% of the angler-effort and 87% of the chinook salmon harvest occurred in the downstream section (Conrad and Hammarstrom in press). The downstream creel survey was conducted between 17 May and 31 July (when the chinook salmon fishery was closed by regulation) and the upstream creel survey was conducted from 3 June to 31 July. Two creel survey technicians worked in the downstream section and one in the upstream section.

Each technician was scheduled for two, 4-hour shifts on 5 days each week, 3 weekdays and both weekend days. In the upstream section, the creel survey was conducted on 3 randomly selected weekdays and on both weekend days each week. All days were scheduled for survey in the downstream section. Each day was stratified into five, 4-hour sampling periods, A, B, C, D, and E, which began at 0400 hrs, 0800 hrs, 1200 hrs, 1600 hrs, and 2000 hrs, respectively. In the upstream section, two periods were selected on each designated sampling day and, in the downstream section, either two (if one technician was working) or four (if both technicians were working) periods were randomly selected without replacement.

Three hours were spent interviewing anglers for effort and catch data and 1 hour was spent counting anglers during each period. The technicians drove a skiff through the river section and randomly contacted anglers in proportion to the abundance of anglers in each area within a section. During interviews, the technician recorded the number of chinook salmon in possession by an angler and whether the fish was tagged or not. The following information was recorded for tagged fish: date of capture, location of capture, and tag number. Untagged chinook salmon were carefully inspected for the presence of a fresh adipose finclip. Tags recovered during contacts initiated by anglers were considered voluntary recoveries and were not used for the abundance estimate because anglers with tagged fish might be more inclined to contact technicians.

One technician conducted a survey at 7 major access sites to the downstream section of the fishery:

1. Soldotna Bridge (RM 21.5),
2. Centennial Park (RM 20.5),
3. Poacher's Cove (RM 17.5),
4. King Run resort (RM 15.0),
5. Big Eddy jetty (RM 14.0),
6. Big Bend campground (RM 13.9), and
7. Eagle Rock (RM 11.5).

The access-site survey was conducted on 3 randomly selected weekdays and both weekend days each week from 17 May through 31 July. A 7.5 hr sample period was scheduled to start on a randomly selected whole hour between 0600 and 1600 hrs, inclusive (0600, 0700, 0800, etc.). Because guided anglers harvest chinook salmon at a rate two to three times greater than unguided anglers (Conrad and Hammarstrom in press), this survey was designed to interview more of these anglers. By regulation, guided anglers were allowed to fish on the Kenai River only between 0600 and 1800 hrs in June and 0700 and 1900 hrs in July. Guided anglers have a very regimented day because guides typically charter anglers for 6 hours and each guide usually schedules a morning charter and an afternoon charter. The majority of guided anglers are returned to an access site during two, 1.5-hour periods daily: 1130 to 1300 hrs and 1730 to 1900 hrs. Soldotna Bridge and Poacher's Cove are major access sites for guided anglers so one of these sites was randomly selected for surveying on each sample day during one of the high-use time periods. Three of the remaining access sites were then randomly selected without replacement. On days when the Kenai River was closed by regulation to guided anglers (Mondays in May and June, and Sundays and Mondays in July), four sites were randomly selected from all seven available sites.

The technician randomly selected returning anglers to interview during a 1.75 hour sampling period. Data identical to that collected during the roving creel survey were collected from interviewed anglers. In addition, if an angler had a chinook salmon in possession, the technician asked if the fish had been observed previously by the roving creel survey. If a fish had been previously examined by the roving creel survey that fish was not included in the data used to estimate the proportion of tagged chinook salmon.

Spawning Ground Surveys

Spawning grounds on the Funny and Killey Rivers (Figure 1) and the mainstem of the Kenai River were surveyed. The Funny and Killey Rivers are spawning areas for early-run chinook salmon and the mainstem is the primary spawning area for late-run chinook salmon (Burger et al. 1985). The objective of the surveys was to estimate the age, sex, and length compositions of the chinook salmon using each spawning area.

The Funny and Killey Rivers were surveyed on 11 August. Three people walked the Funny River for 5 km upstream from its confluence with the Kenai River. The Killey River was surveyed for 16 km upstream from its confluence with the Kenai River by two people using a jet boat. The Kenai River was surveyed between 8 and 12 September from the mouth of the Kenai River upstream to the outlet of Kenai Lake by three people using a jet boat.

All chinook salmon carcasses observed during the surveys were measured for mid-eye to fork-of-tail length (measured to the nearest 5 mm), sex identified, and three scales were removed from the preferred area and mounted on an adhesive-coated card. The number of any tag present and the presence/absence of the adipose fin were recorded, also. The pectoral fins of all chinook salmon carcasses observed were removed to prevent duplicate counts.

Analyses

There were three sets of data analyzed: (1) the chinook salmon tag release-and-recovery data; (2) the effort and catch data from the gillnets used to capture the chinook salmon; and (3) the biological data collected during tagging and surveys of the spawning grounds.

Abundance Estimate using Tagging Data:

The hypothesis that recovery rates of tagged chinook salmon by the three creel surveys (upstream roving survey, downstream roving survey, and access-site survey) were equal was tested with a chi-square statistic. The numbers of tagged and untagged chinook salmon observed by each survey were compared.

Two chi-square tests described by Seber (1982) were used to determine if tagging and recovery samples were random with respect to length of the fish. Three length categories were established based on the length frequency distribution of tagged chinook salmon: small fish (≤ 775 mm in length); medium fish (> 775 mm and ≤ 975 mm); and large fish (> 975 mm). The numbers of fish in each length category for the tagged and untagged recoveries were compared to test the randomness of the releases. The recaptures were tested by partitioning the release sample into the portion recovered and that which was not and comparing the numbers in each length category.

Constant probabilities of capture at times of tagging and recapture are important assumptions necessary for Petersen-type population estimates (Seber 1982). When tagging and recovery occur over an extended period of time these assumptions are often violated. The tagging data were tested to determine if they were consistent with these assumptions. A series of chi-square tests described by Seber (1982, pages 438-439) were used to test these hypotheses. Probabilities of capture were <u>not</u> constant (all $P < 0.05$), therefore, a stratified population estimator that is not predicated on a closed population (i.e., no immigration, no emigration, and no mortality) was used (Darroch 1961). When there are equal numbers of release and recovery strata, the stratified estimator is (Seber 1982):

$$\hat{\underline{W}} = D_u M^{-1} \underline{a}$$

where: $\hat{\underline{W}}$ = a vector with the estimates of the number of <u>untagged</u> chinook salmon in each tagging stratum <u>just after the release of the tagged fish</u>,

D_u = a diagonal matrix of the number of untagged fish observed in each recovery stratum j,

M = a matrix of m_{ij}, the number of tagged fish in each recovery stratum, j, which were released in tagging stratum i, and

$\underline{a}$ = a vector of the number of tagged fish released in tagging stratum i.

The number of chinook salmon in each stratum at the time of tagging is the sum of the estimated number of untagged fish present and the number of tagged fish released during the stratum. The variance-covariance matrix of $\hat{\underline{w}}$ was estimated with equations 11.20-11.23 on page 441 of Seber (1982). The variance of the point estimate for the total number of chinook salmon present is the sum of the variance and covariance estimates for the individual strata.

Abundance estimates from these procedures are accurate when (Seber 1982):

1. All chinook salmon in the j^{th} recovery stratum, whether tagged or untagged, have the same probability of being harvested (caught and kept) by the recreational fishery.

2. Tagged fish behave independently of one another with regard to moving among strata and being caught.

3. An angler is equally as likely to release a tagged chinook salmon as an untagged fish.

4. There is no tag loss, either naturally or by anglers removing tags from chinook salmon which they catch and subsequently release.

5. All tagged fish are recognized as such during recovery.

6. There is no tagging induced mortality.

The five temporal strata for the tagging estimate were defined so that separate estimates for the early and late runs could be generated and the algebraic conditions necessary for the stratified estimator were met. Other temporal stratifications meeting these criteria were possible and we examined some of them to determine how sensitive the estimates and their variances were to different stratifications. Five alternate stratifications were generated and the point estimate and variance of each calculated using the procedures described previously.

Abundance Estimate using Gillnet Effort and Catch Data:

To estimate the number of fish that entered the river from 29 July through 14 August, we examined relationships between the effort and catch statistics from the gillnets and the abundance estimates. Fourteen statistics in addition to the traditional measure of fishing success, catch per unit effort (CPUE), were investigated (Table 1). Those fish that were recaptured on the same day that they had been tagged were excluded from compilation of the catch statistics.

It was hypothesized that effort (duration of a set in minutes) would be significantly different between sets which caught no fish and sets which caught at least one chinook salmon. This hypothesis was tested with a chi-square statistic after grouping the effort data into four duration-

Table 1. Definitions of the effort and catch statistics analyzed.

Acronym	Definition
1. TOTSETS	The total number of drift gillnet sets made during a stratum.
2. TOTEFF	The total number of minutes of gillnet effort during a stratum.
3. MNDUR	The mean duration (in minutes) of the gillnet sets during a stratum.
4. TOTCAT	The total catch of chinook salmon during a stratum.
5. MNCAT	The mean catch of chinook salmon per gillnet set during a stratum.
6. CPUE	The quotient of the total catch of chinook salmon and the total effort during a stratum.
7. MNCPUE	The mean of the individual set CPUE during a stratum.
8. MNLNCPUE	The mean of the natural log of (CPUE+1) for sets during a stratum.
9. TOTEFF=0	The total number of minutes of effort by sets which caught no chinook salmon during a stratum.
10. MNDUR=0	The mean duration (in minutes) of sets which caught no chinook salmon during a stratum.
11. MNEFFBET	The mean number of minutes of effort between sets by a single crew which caught at least one chinook salmon during a stratum.
12. %EFF>0	The percent of the total effort (as measured in minutes) during a stratum by sets which caught at least one chinook salmon.
13. SETS>0	The total number of drift gillnet sets which caught at least one chinook salmon during a stratum.
14. %SETS>0	The percent of the total number of sets that caught at least one chinook salmon during a stratum.
15. MNDUR>0	The mean duration (in minutes) of sets which caught at least one chinook salmon during a stratum.

of-set categories: (1) 1 to 5 minutes; (2) 6 to 10 minutes; (3) 11 to 15 minutes; and (4) more than 15 minutes.

Only data from tides when three or fewer crews worked were used in the analysis of the effort and catch statistics because gear competition influenced the statistics when all four crews worked a single tide (Appendix A). The 15 statistics were estimated for the five tagging (temporal) strata and the linear correlations between the statistics and estimated abundance of chinook salmon were calculated. The statistics with the highest correlation were used to build linear, power, and exponential models describing chinook salmon abundance as a function of the statistic. The models were (Zar 1974):

for the linear model, $\hat{Y} = aX + b$,

for the power curve, $\hat{Y} = aX^b$, and

for the exponential curve, $\hat{Y} = ae^{bX}$,

where, $\hat{Y}$ is the estimated abundance of chinook salmon, X is the effort or catch statistic, and a, b are regression coefficients. Procedure NLIN of SAS (1982) and the Marquardt method of minimizing the error sum-of-squares were used to calculate least-square estimates for the parameters of the nonlinear models. Models were compared by computing a chi-square statistic for the fit of each model to the observed data. The statistic and model having the smallest chi-square statistic were selected to estimate the number of chinook salmon entering the Kenai River from 29 July to 14 August (stratum 6).

We estimated the variance of the estimate of abundance for stratum 6 empirically by Monte Carlo simulation. Rubinstein (1981) describes a procedure for generating values from random variates with a multinormal distribution using the variance-covariance matrix of the variates. We let the regression parameters (a and b) represent a vector of random variates and, using the variance-covariance matrix for a and b supplied by procedure NLIN, generated 1,000 new estimates of the regression parameters. These were then used to generate 1,000 estimates of abundance for stratum 6 using the value of the effort and catch statistic for that stratum. The variance for the estimate of chinook salmon abundance for stratum 6 was then calculated empirically from the 1,000 estimates.

Biological Data:

The age compositions of the chinook salmon tagged and those recovered during the spawning ground surveys were estimated from the scale samples collected. Letting p_{ghj} equal the proportion of the sample from stratum

j belonging to sex g and age group h, the variance of p_{ghj} was estimated using the normal approximation to the binomial (Scheaffer et al. 1979):

$$V(\hat{p}_{ghj}) = \hat{p}_{ghj}(1-\hat{p}_{ghj})/(n_{Tj}-1),$$

where, n_{Tj} is the number of legible scales read from chinook salmon sampled during stratum j. A chi-square test was performed on the numbers assigned to each of the major age groups for the three temporal strata in each run (early run and late run) to determine if there were significant changes in age composition during a run. The age composition of each sex was tested separately. Chi-square tests of the numbers assigned to each of the major age groups were used to determine if the age compositions of the scale samples collected during creel surveys were significantly different from those collected during tagging. The sexes were tested separately in each stratum.

The numbers of chinook salmon entering the Kenai River were estimated by sex and age group for each stratum as follows:

$$\hat{N}_{ghj} = \hat{N}_j(\hat{p}_{ghj}),$$

and the variance of $\hat{N}_{ghj}$ was estimated using Goodman's (1960) formula for the variance of the product of two independent random variables:

$$V(\hat{N}_{ghj}) = \hat{N}_j^2 V(\hat{p}_{ghj}) + p_{ghj}^2 V(\hat{N}_j) - V(\hat{p}_{ghj})V(\hat{N}_j)$$

where; $\hat{N}_{ghj}$ = the estimated numbers of chinook salmon of sex g and age group h entering the Kenai River during stratum j, and

$\hat{N}_j$ = the estimated numbers of chinook salmon entering the Kenai River during stratum j.

The numbers of males and females in an age group were summed for stratum totals. The male and female estimates for an age group were considered independent estimates, therefore the variance of the sum was the sum of the variances. Totals, and variances, by sex and age group for the early and late runs were calculated by summing the stratum estimates.

The numbers by sex and age group for the chinook salmon spawning escapement to the Kenai River for the early and late runs were estimated by subtracting the numbers estimated for the recreational harvest from those estimated for the total inriver return. The variances of the differences were estimated as the sum of the variances.

Mean length at age by sex and its variance were estimated using standard procedures for normally distributed random variables. For each sex-age group, the mean length of chinook salmon sampled by the tagging crews was compared to the mean length of the recreational harvest samples with a two-sample t-test (Zar 1974).

RESULTS

Abundance Estimate using Tagging Data

Fifteen-day periods were selected so that the abundance of early-run and late-run chinook salmon could be estimated separately and temporal changes in abundance within each run examined. The five temporal strata were: (1) 17 May to 31 May; (2) 1 June to 15 June; (3) 16 June to 30 June; (4) 1 July to 15 July; and (5) 16 July to 28 July.

Tag Releases:

During the period 17 May through 14 August, 3,742 chinook salmon were tagged (Table 2). Although tagging continued until 14 August, only the 2,998 chinook salmon tagged and released between 17 May and 28 July were used for the abundance estimate. Because tag recovery ended on 31 July when the sport fishery closed, releases after 28 July were omitted to ensure that fish tagged during the last temporal stratum had approximately the same probability of recovery as earlier releases. The ending date of 28 July was selected because more than 50% of the tag recoveries by the creel surveys occurred within 3 days of the time of release (Figure 4).

Twenty-one chinook salmon tagged in the Kenai River were eventually recovered outside of the system: 2 in the Susitna River; 5 in the Kasilof River; 3 in the commercial drift gillnet fishery; and 11 in the commercial setnet fishery (Table 2). Tagged chinook salmon caught by the commercial fisheries in the marine waters outside of the Kenai River should not be interpreted as all being from systems other than the Kenai River. This group of fish probably includes fish from other systems and Kenai River fish which backed out of the system, possibly due to the effects of tagging.

Twelve chinook salmon with healed adipose finclips were captured during the tagging. Heads were removed from 8 of the 12 chinook salmon with healed adipose finclips observed during tagging. Four of the 8 heads had tags identifying them as releases from Crooked Creek (Kasilof River) hatchery. The other four heads did not have tags.

Tag Recoveries:

A total of 1,863 chinook salmon was examined for tags and 80 tags were recovered during the period 17 May through 31 July (Table 3 and Appendix Table 1). The majority of fish examined and tags recovered were by the roving creel survey in the downstream area (1,108 examined, 50 tags recovered). A total of 26 tags was recovered during the access-site creel survey. Only four tags were recovered during the upstream boat creel survey. Because recovery rates of tags in the roving surveys and in the access-site survey were not significantly different ($P > 0.50$), the recovery data from all three surveys were combined.

The chi-square test of the hypothesis that the tagging (capture) sample was random with respect to fish length was not significant ($P > 0.75$). However, the chi-square test of the hypothesis of randomness of the

Table 2. Tag releases by day and recoveries from each daily release for Kenai River chinook salmon, 1986.

Date of Release	Number Tagged	Out-of-[1] System	Adipose[2] Clips	Number[3] Recovered
17-May	1			
18-May	1			
19-May	13	1 (S)		2
20-May	3	1 (S)		
21-May	2			1
22-May	2			
23-May	12	1 (K)	1	
24-May	23			1
25-May	19			
26-May	16			1
27-May	12			
28-May	13			1
29-May	30	1 (K)		3
30-May	12		1	1
31-May	21	1 (K)	1	1
Subtotal	180	5	3	11
01-Jun	26			
02-Jun	34		2	1
03-Jun	14			1
04-Jun	28		1	2
05-Jun	20			
06-Jun	53			4
07-Jun	58			1
08-Jun	89			2
09-Jun	57			3
10-Jun	123			3
11-Jun	69		1	2
12-Jun	61			2
13-Jun	61	1 (K)		3
14-Jun	41			2
15-Jun	69			2
Subtotal	803	1	4	28
16-Jun	61			
17-Jun	45	1 (K)		
18-Jun	18			
19-Jun	24			2
20-Jun	13			
21-Jun	17			1
22-Jun	23		1	1
23-Jun	40			4
24-Jun	47			2
25-Jun	37			
26-Jun	35	1 (CS)	1	
27-Jun	49			4
28-Jun	47			
29-Jun	19			
30-Jun	41			2
Subtotal	516	2	2	16

-continued-

Table 2. Tag releases by day and recoveries from each daily release for Kenai River chinook salmon, 1986 (continued).

Date of Release	Number Tagged	Out-of-[1] System	Adipose[2] Clips	Number[3] Recovered
01-Jul	28			
02-Jul	46	1 (CS)		1
03-Jul	44			
04-Jul	25			
05-Jul	5			1
06-Jul	17			
07-Jul	12	1 (CD)	1	
08-Jul	9			
09-Jul	21			
10-Jul	21			3
11-Jul	25			1
12-Jul	30	1 (CS)		1
13-Jul	152	1 (CS)		3
14-Jul	114	1 (CS)		2
15-Jul	122	2 (CS)		2
Subtotal	671	7	1	14
16-Jul	95	1 (CS)		2
17-Jul	82			
18-Jul	38			3
19-Jul	43			
20-Jul	70	1 (CS)		
21-Jul	87	1 (CS)		1
22-Jul	88			3
23-Jul	68			1
24-Jul	53			1
25-Jul	24			
26-Jul	47			
27-Jul	66	1 (CD)		
28-Jul	67		1	
Subtotal	828	4	1	11
TOTAL[4]	2,998	19	11	80

-continued-

Table 2. Tag releases by day and recoveries from each daily release for Kenai River chinook salmon, 1986 (continued).

Date of Release	Number Tagged	Out-of-[1] System	Adipose[2] Clips	Number[3] Recovered
29-Jul	57			
30-Jul	52	1 (CD)		
31-Jul	44			
01-Aug	46			
02-Aug	41			
03-Aug	109	1 (CS)		
04-Aug	96			
05-Aug	71			
06-Aug	33			
07-Aug	41			
08-Aug	32			
09-Aug	37			
10-Aug	29			
11-Aug	12			
12-Aug	16			
13-Aug	15			
14-Aug	13		1	
Subtotal	744	2	1	0
GRAND TOTAL	3,742	21	12	80

[1] Tags recovered outside the Kenai River:
CD = recovered in commercial drift net catch,
CS = recovered in commercial set net catch,
K = recovered in the Kasilof River,
S = recovered in the Susitna River.

[2] Number of fish captured by the tagging crews with healed-over or missing adipose fins (not freshly clipped).

[3] Recoveries from roving and access-site creel surveys only.

[4] Total for the data included in the tagging estimate.

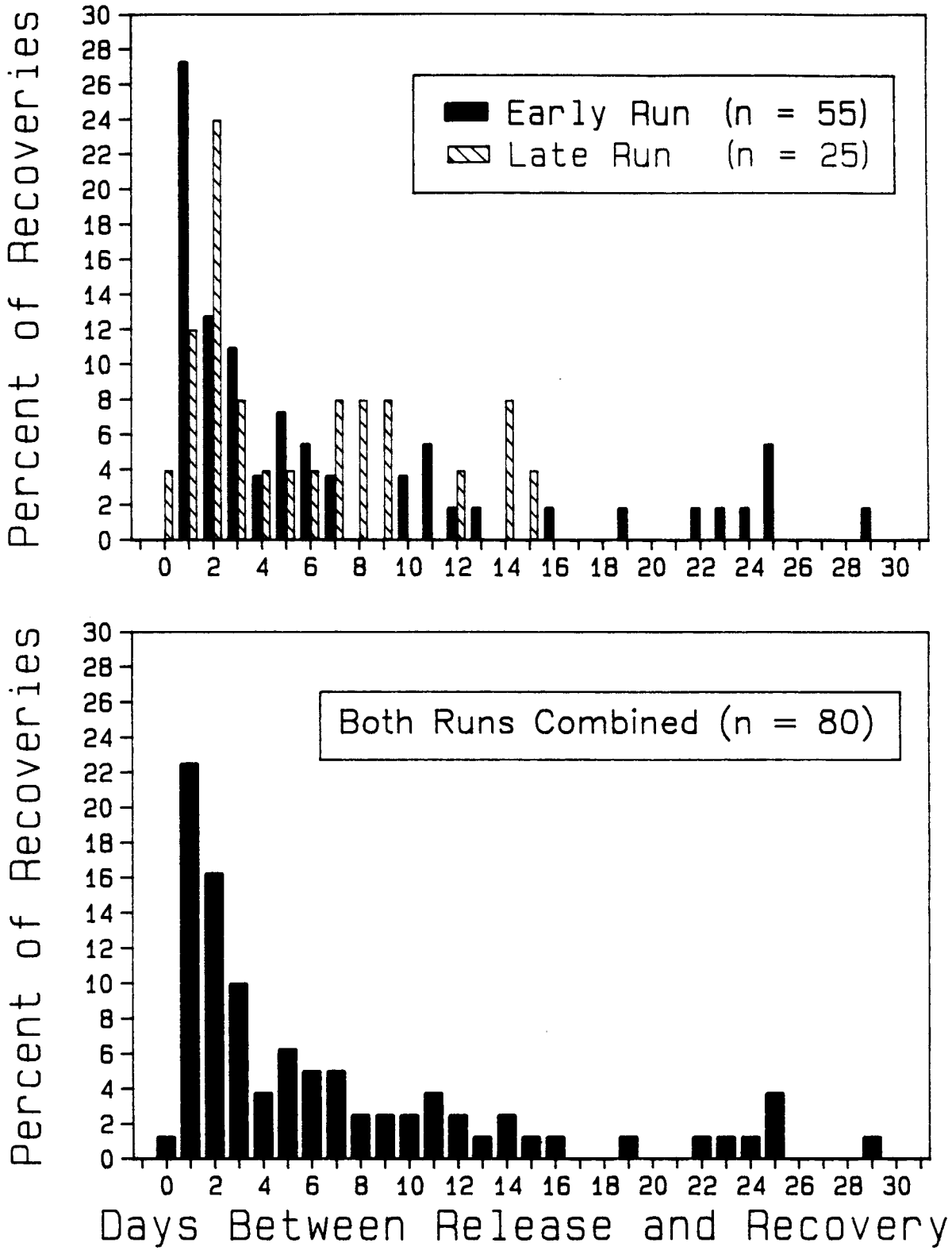

Figure 4. Number of days between tag release and recovery in the sport fishery for chinook salmon in the Kenai River, 1986.

Table 3. Recoveries of tagged chinook salmon by the roving and access-site creel surveys of the Kenai River, 1986.

	ROVING						ACCESS-SITE	
	Number Examined			Number Recaptured			Number	Number
Date	Dwnstr	Upstr	Total	Dwnstr	Upstr	Total	Examined	Recap.
17-May	0	0	0	0	0	0	0	0
18-May	1	0	1	0	0	0	0	0
19-May	0	0	0	0	0	0	0	0
20-May	9	0	9	1	0	1	1	0
21-May	0	0	0	0	0	0	0	0
22-May	4	0	4	2	0	2	1	0
23-May	2	0	2	0	0	0	2	0
24-May	7	0	7	0	0	0	1	0
25-May	19	0	19	0	0	0	4	0
26-May	1	0	1	0	0	0	1	0
27-May	1	0	1	0	0	0	0	0
28-May	8	0	8	1	0	1	0	0
29-May	10	0	10	0	0	0	0	0
30-May	5	0	5	0	0	0	4	1
31-May	13	0	13	1	0	1	1	0
Subtotal	80	0	80	5	0	5	15	1
01-Jun	15	0	15	2	0	2	1	0
02-Jun	0	0	0	0	0	0	0	0
03-Jun	19	0	19	0	0	0	0	0
04-Jun	12	0	12	0	0	0	0	0
05-Jun	18	0	18	0	0	0	19	2
06-Jun	2	0	2	0	0	0	21	0
07-Jun	22	0	22	2	0	2	20	3
08-Jun	32	0	32	1	0	1	29	0
09-Jun	0	0	0	0	0	0	0	0
10-Jun	17	0	17	1	0	1	0	0
11-Jun	41	0	41	1	0	1	22	0
12-Jun	20	0	20	0	0	0	18	1
13-Jun	34	0	34	2	0	2	17	1
14-Jun	33	0	33	0	0	0	16	0
15-Jun	38	2	40	0	0	0	14	4
Subtotal	303	2	305	9	0	9	177	11
16-Jun	0	0	0	0	0	0	0	0
17-Jun	25	4	29	1	0	1	0	0
18-Jun	2	6	8	0	0	0	4	0
19-Jun	0	10	10	0	0	0	15	0
20-Jun	0	0	0	0	0	0	9	0
21-Jun	25	7	32	2	0	2	4	1
22-Jun	29	11	40	1	1	2	7	0
23-Jun	0	0	0	0	0	0	0	0
24-Jun	20	0	20	4	0	4	11	1
25-Jun	29	18	47	2	0	2	0	0
26-Jun	15	10	25	0	0	0	18	1
27-Jun	17	0	17	0	0	0	14	0
28-Jun	30	1	31	3	0	3	15	2
29-Jun	12	7	19	1	0	1	0	0
30-Jun	0	0	0	0	0	0	0	0
Subtotal	204	74	278	14	1	15	97	5

-continued-

Table 3. Recoveries of tagged chinook salmon by the roving and access-site creel surveys of the Kenai River, 1986 (continued).

	ROVING						ACCESS-SITE	
	Number Examined			Number Recaptured			Number	Number
Date	Dwnstr	Upstr	Total	Dwnstr	Upstr	Total	Examined	Recap.
01-Jul	16	3	19	1	0	1	7	0
02-Jul	3	2	5	0	0	0	7	1
03-Jul	15	13	28	2	1	3	0	0
04-Jul	6	0	6	0	0	0	10	0
05-Jul	13	3	16	0	1	1	6	1
06-Jul	4	2	6	0	0	0	1	0
07-Jul	0	0	0	0	0	0	0	0
08-Jul	12	5	17	0	0	0	15	0
09-Jul	10	1	11	0	0	0	9	0
10-Jul	11	0	11	1	0	1	0	0
11-Jul	23	1	24	1	0	1	0	0
12-Jul	6	1	7	1	0	1	7	1
13-Jul	23	2	25	0	0	0	8	0
14-Jul	0	0	0	0	0	0	0	0
15-Jul	57	0	57	2	0	2	23	0
Subtotal	199	33	232	8	2	10	93	3
16-Jul	15	0	15	0	0	0	24	1
17-Jul	31	2	33	0	0	0	0	0
18-Jul	9	1	10	1	0	1	24	1
19-Jul	22	4	26	2	1	3	12	0
20-Jul	7	3	10	1	0	1	4	0
21-Jul	0	0	0	0	0	0	0	0
22-Jul	11	0	11	2	0	2	0	0
23-Jul	18	0	18	0	0	0	21	1
24-Jul	40	1	41	1	0	1	15	0
25-Jul	30	3	33	2	0	2	23	1
26-Jul	16	1	17	1	0	1	20	0
27-Jul	16	1	17	2	0	2	9	0
28-Jul	0	0	0	0	0	0	0	0
29-Jul	41	0	41	2	0	2	55	1
30-Jul	35	3	38	0	0	0	17	1
31-Jul	31	1	32	0	0	0	22	0
Subtotal	322	20	342	14	1	15	246	6
TOTAL	1,108	129	1,237	50	4	54	628	26

recovery (creel survey) sample with respect to length of fish was significant ($0.025 < P < 0.050$). There were fewer small (≤ 775 mm) chinook salmon than expected and more large (> 975 mm) fish than expected in the sample from the sport fishery (Figure 5). Although the hypothesis was not accepted ($\alpha = 0.05$), it was not possible to estimate chinook salmon abundance separately for the three length categories because the lengths of all untagged fish observed during the creel surveys were not recorded, therefore, the numbers of small, medium, and large fish inspected for tags were unknown.

Abundance Estimate:

The chi-square tests of columns A and B and rows C and D in Table 4 showed that the methods of Darroch (1961) were appropriate for this data. The last column of Table 4 shows that the percentage of tags released in each stratum that were recovered during the creel surveys declined as the season progressed.

A necessary condition of the stratified estimator is that the estimated probability for an animal surviving and, if present in the j^{th} stratum, being captured in that stratum must be positive for all strata (Seber 1982). This condition was met.

The estimates of the abundance of chinook salmon ranged from 592 for the first stratum to 43,508 for stratum 5 (Table 5). The estimated abundance was 27,080 chinook salmon for the early run (17 May to 30 June). The estimated number of chinook salmon entering the Kenai River from 17 May to 28 July was 74,837 fish. This total includes fish which are from the Kenai River system and those which have "strayed" into the river from non-Kenai systems.

Sensitivity of Tagging Estimate:

The estimates of abundance from the tagging data were not sensitive to the definition of the temporal strata. Coefficients of variation for the point estimates of total inriver abundance and its variance were 1.0% and 3.8%, respectively (Table 6). The largest coefficients of variation were for the point estimate of the early run and its variance, 12.4% and 17.4%, respectively. Some of this variation can be attributed to the different ending dates used to define the early run (from 25 June through 30 June).

Abundance Estimate using Gillnet Effort and Catch Data

This is the first year that the effort and chinook salmon catch statistics for the gillnets have been used to estimate abundance during the last portion of the chinook salmon run to the Kenai River.

Duration of Sets:

The distributions of the duration of sets which did not catch a chinook salmon were significantly different ($P < 0.01$) from those that caught at least one chinook salmon in five of the six strata; the exception was the stratum from 16 July to 28 July. Generally, the distribution for

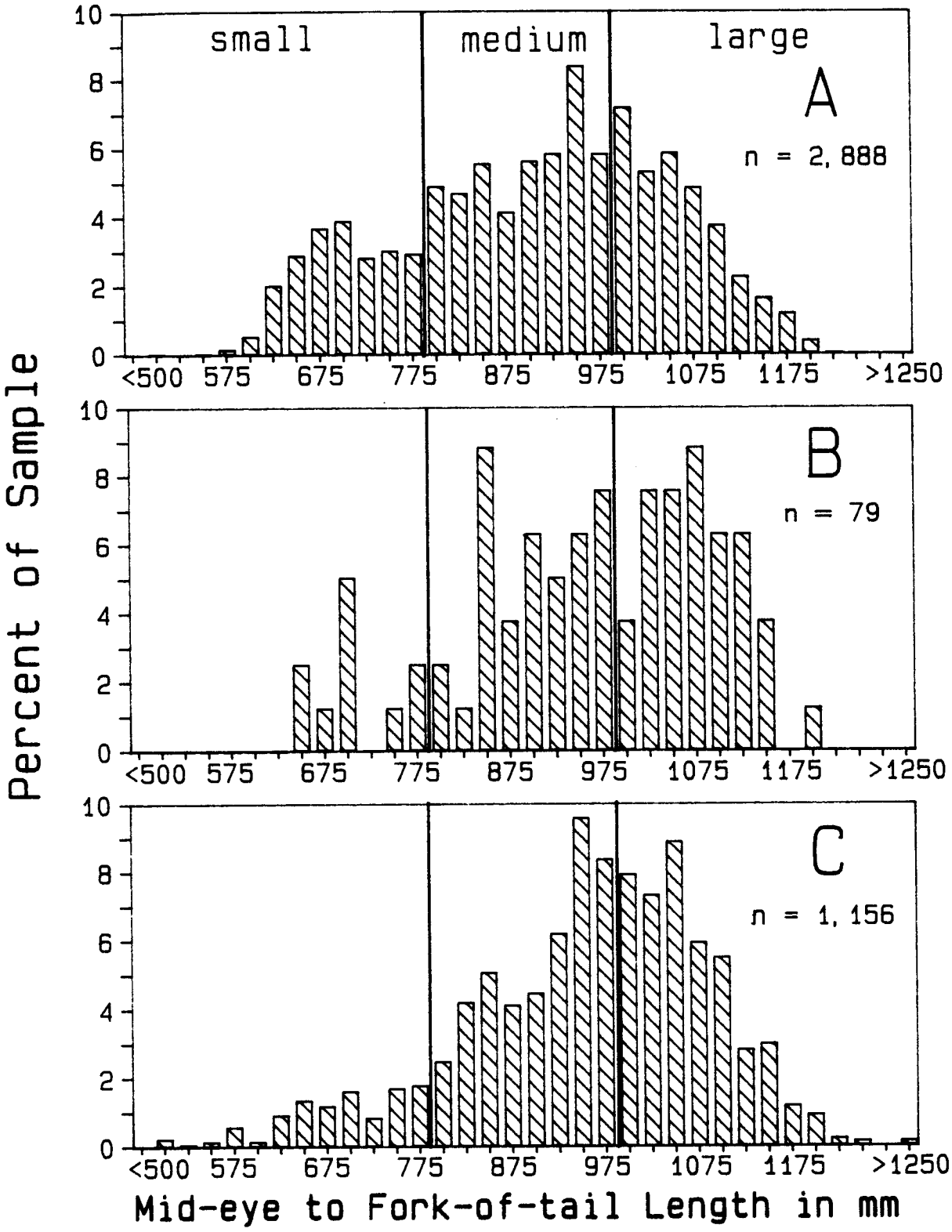

Figure 5. Length frequencies of chinook salmon which were: (A) tagged but not recovered during the creel surveys of the sport fishery; (B) tagged and recovered by the creel survey (these were used for the abundance estimate); and (C) never tagged but examined during the creel survey.

Table 4. Summary of tag release-and-recovery data, by stratum, for chinook salmon in the Kenai River, 1986[1].

Stratum[2]		Creel survey tag recoveries 1	2	3	4	5	(A) Number Recovered	(B) Not Recovered	Number Released	Percent Recovered
Tag Releases	1	6	4	1	0	0	11	169	180	6.1
	2	0	16	9	3	0	28	775	803	3.5
	3	0	0	10	4	2	16	500	516	3.1
	4	0	0	0	6	8	14	657	671	2.1
	5	0	0	0	0	11	11	817	828	1.3
(C) Tagged		6	20	20	13	21	80	2,918	2,998	
(D) Untagged		89	462	353	312	567	1,783			
Examined		95	482	373	325	588	1,863			
% Tagged		6.3	4.2	5.4	4.0	3.6				

[1] The matrix defined by each of the five release and recovery strata corresponds to the M matrix; a diagonal matrix of the first five elements of row D is the D_u matrix; and the column of Number Released is the vector $\underline{a}$.

[2] Release and recovery strata:
1 = 17 May - 31 May,
2 = 1 June - 15 June,
3 = 16 June - 30 June,
4 = 1 July - 15 July,
5 = 16 July - 28 July (release) and 16 July - 31 July (recovery).

Table 5. Numbers of chinook salmon entering the Kenai River during each stratum estimated by analysis of the tagging data, 1986.

Stratum	Point Estimate	Standard Error[1]	95% Confidence Interval[2]
1. 17 May - 31 May	592	1,208	204 - 2,961
2. 1 June - 15 June	14,691	5,928	3,072 - 26,310
3. 16 June - 30 June	11,797	7,708	581 - 26,905
Early Run Total	27,080	6,860	13,633 - 40,527
4. 1 July - 15 July	4,249	14,522	760 - 32,712
5. 16 July - 28 July	43,508	12,906	18,211 - 68,804
Total Strata 1-5	74,837	10,548	54,164 - 95,511

[1] Standard errors for the early run total and strata 1-5 total include covariance terms and are not simply the sum of the variances of the stratum estimates.

[2] If the lower limit of the 95% confidence interval was equal to zero, it was adjusted to the total number of chinook salmon captured by the drift gillnets during the stratum (not including any recaptures of previously tagged fish).

Table 6. Numbers of chinook salmon estimated using different temporal stratifications of the Kenai River tagging data, 1986.

Strata Number	Strata Definitions	TOTAL Est.[1]	TOTAL SE[2]	EARLY RUN Est.	EARLY RUN SE	LATE RUN[3] Est.	LATE RUN[3] SE
6	Original	74,837	10,548	27,080	6,860	47,757	11,734
6	E[4] 5/17-5/26	75,913	10,134	19,909	4,815	56,004	9,880
	E 5/27-6/05						
	E 6/06-6/15						
	E 6/16-6/25						
	L 6/26-7/05						
	L 7/06-7/28						
5	E 5/17-6/05	76,827	10,799	23,931	4,730	52,896	10,012
	E 6/06-6/15						
	E 6/16-6/26						
	L 6/27-7/12						
	L 7/13-7/28						
4	E 5/17-6/05	75,035	10,349	23,250	6,489	51,785	10,520
	E 6/06-6/25						
	L 6/26-7/15						
	L 7/16-7/28						
3	E 5/17-5/31	74,869	9,638	20,665	5,281	54,204	10,600
	E 6/01-6/30						
	L 7/01-7/28						
3	5/17-5/31	75,486	10,381	NA[5]		NA	
	6/01-7/15						
	7/16-7/28						
Mean		75,495	10,308	22,967	5,635	52,529	10,549
Coef. of Variation[6]		1.0%	3.8%	12.4%	17.4%	5.9%	6.9%

[1] Point estimate.

[2] SE = standard error.

[3] Late run through 28 July only.

[4] Run designation, E = early run and L = late run.

[5] Not able to calculate early run and late run totals.

[6] Coefficient of variation x 100.

the duration of sets which caught a chinook salmon was positively skewed while the distribution of the duration of sets which did not catch a chinook salmon had a nearly uniform distribution (Appendix Figure 1).

Statistics Examined:

The six effort and catch statistics having the highest linear correlation with the estimated abundance of chinook salmon were (Table 7): the total number of gillnet sets made during a stratum (TOTSETS); the mean duration (in minutes) of sets which did not catch a chinook salmon during a stratum (MNDUR=0); the total catch of chinook salmon during a stratum (TOTCAT); the number of sets made during a stratum which caught at least one chinook salmon (SETS>0); the percent of effort (in minutes) by sets which caught at least one chinook salmon (%EFF>0); and catch per unit effort (CPUE). The correlation coefficients for these statistics were all greater than 0.87; the next highest correlation coefficient after these was 0.808 (Table 7). Much daily variation in each statistic was evident during each temporal stratum (Appendix Figure 2).

Those statistics which were a function of the number of crew-days of effort exerted during a stratum were eliminated from further consideration because these would be useful only if the numbers of crew-days of effort were relatively constant during each stratum. This was not true as stratum 5 (16 July to 28 July) had 21 crew-days of effort while stratum 6 (29 July to 14 August) had 30 crew-days. Therefore, TOTSETS, TOTCAT, and SETS>0 were not included in the evaluation of a model to estimate abundance during stratum 6.

Model Evaluation:

There was a nonlinear relationship between the three remaining statistics (MNDUR=0, %EFF>0, and CPUE) and the estimated abundance of chinook salmon (Figure 6). The power curve model for the statistic %EFF>0 had a much smaller chi-square statistic for the fit of the observed abundance to predicted abundance than any other model (Table 8). This model was selected to estimate the number of chinook salmon entering the Kenai River from 29 July to 14 August.

Abundance Estimate:

The nonlinear, least-squares parameter estimates for the power curve using the statistic %EFF>0 resulted in the following model (Figure 7):

$$\hat{Y} = 156{,}000(\%EFF>0)^{6.4},$$

where, $\hat{Y}$ is the estimated abundance of chinook salmon. For stratum 6, %EFF>0 = 0.649 (expressed as a proportion) which gives an estimate of 9,806 chinook salmon entering the Kenai River from 29 July through 14 August. The empirical estimate of the variance for this estimate from the Monte Carlo simulation was 1,137,728 (standard error [SE] = 1,067).

Table 7. Correlation between the temporal estimates of chinook salmon abundance and the effort and catch statistics computed using all available data and using data from tides when three or fewer crews worked.

Statistic[1]	All Crews	Three or Fewer Crews	Difference[2]
1. TOTSETS	0.599	0.918	+
2. TOTEFF	-0.780	-0.761	-
3. MNDUR	-0.650	-0.792	+
4. TOTCAT	0.680	0.897	+
5. MNCAT	0.653	0.778	+
6. CPUE	0.784	0.877	+
7. MNCPUE	0.510	0.803	+
8. MNLNCPUE	0.542	0.808	+
9. TOTEFF=0	-0.825	-0.804	-
10. MNDUR=0	-0.842	-0.898	+
11. MNEFFBET	-0.612	-0.714	+
12. %EFF>0	0.839	0.882	+
13. SETS>0	0.639	0.892	+
14. %SETS>0	0.618	0.719	+
15. MNDUR>0	-0.580	-0.756	+

[1] Statistics defined in Table 1.

[2] Sign of the difference between the correlation coefficient for when three or fewer crews worked a tide and and the correlation coefficient using all available data.

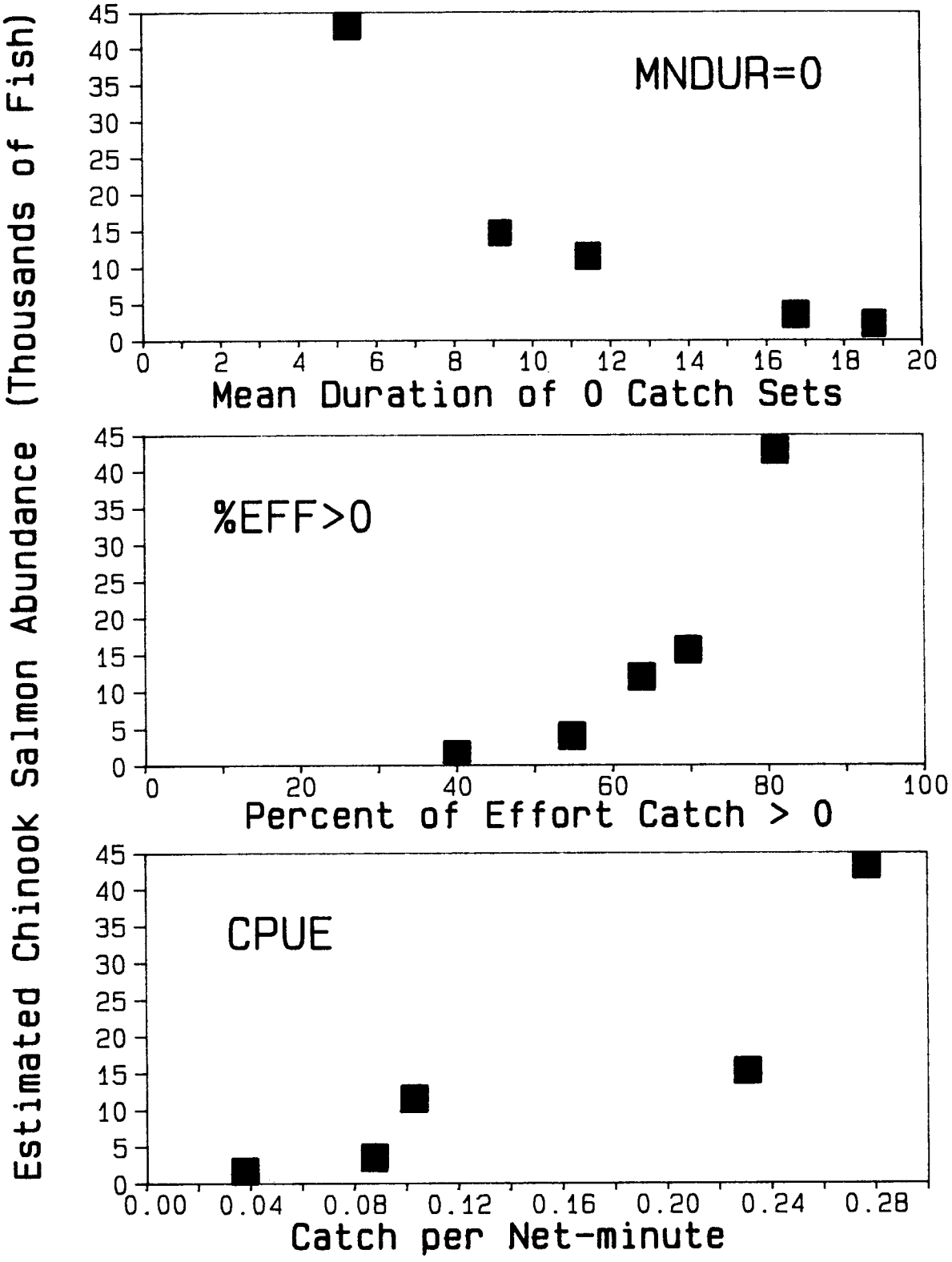

Figure 6. Selected gillnet effort and catch statistics versus estimated abundance of chinook salmon in the Kenai River, 1986.

Table 8. Comparison of the chi-square statistics[1] for the three regression models fit to each of the effort and catch statistics.

Statistic[2]	Linear	Curves	
		Power	Exponential
MNDUR=0	3,640	2,945	1,969
%EFF>0	1,867	825	1,677
CPUE	7,882	11,863	12,759

[1] The chi-square statistic for the fit of each model was computed as:

$$\chi^2 = \frac{\Sigma(\text{predicted} - \text{observed})^2}{\text{predicted}}.$$

[2] Statistics defined in Table 1.

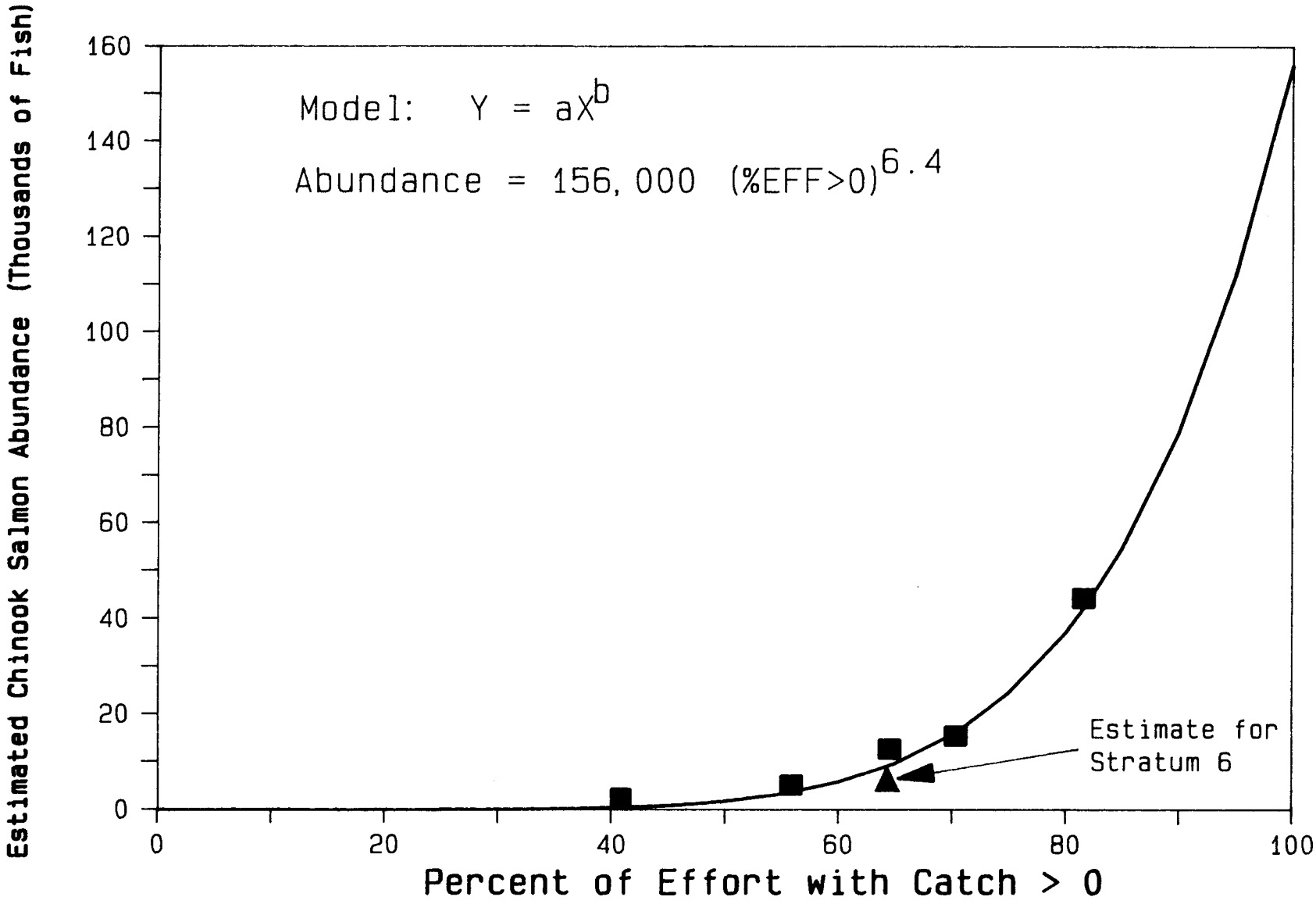

Figure 7. Effort and catch statistic %EFF>0 versus the estimate of chinook salmon abundance for strata 1 to 5 and the model used to estimate abundance for stratum 6 (29 July to 14 August).

Summary

The estimated numbers of chinook salmon entering the Kenai River were 27,080 fish (SE = 6,860) during the early run and 57,563 fish (SE = 11,782) during the late run (Table 9). From 17 May through 14 August, 84,643 chinook salmon (SE = 10,602) were estimated to have entered the Kenai River.

Biological Data

Gillnet Samples:

The age compositions of both male and female chinook salmon sampled by the tagging crews changed significantly ($P < 0.001$) during the early and late runs. For males, the percentages of age 1.3[2] and age 1.2 fish increased during the early run and decreased during the late run (Figure 8 and Appendix Table 4). The 1.3 age group was the most abundant age group for male chinook salmon in every stratum except the first (17 May to 31 May) and the last (29 July to 14 August), when the 1.2 age group was the most abundant. For females, the percentage of the 1.2 age group increased during the early run and decreased during the late run; conversely, the percentage of age 1.4 females decreased during the early run and increased during the late run (Figure 8 and Appendix Table 4). The 1.4 age group was the most abundant female age group during the early run. During the late run, age 1.3 females were most abundant during strata 4 and 5 and age 1.4 females during stratum 6.

Age 1.3 and age 1.4 chinook salmon were the most abundant in both runs (Table 10). Age 1.3 and age 1.4 chinook salmon composed 43.2% and 32.8% of the early run, respectively, and 47.5% and 37.0% of the late run, respectively. The most abundant sex-age group in the early run was age 1.3 males (26.9%) and the most abundant sex-age group in the late run was age 1.3 females (24.2%)

There were temporal changes in the mean lengths of the major sex-age groups, also. Generally, the mean lengths of the chinook salmon sampled by the tagging crews increased as the season progressed (Figure 9 and Appendix Table 6). Age 1.3 females were larger than age 1.3 males in every stratum but the first. Conversely, age 1.4 males were larger than age 1.4 females in every stratum.

Recreational Harvest Samples:

The age compositions of the samples from the recreational harvest were more similar among strata than the samples from the gillnets (Appendix Table 5). Only the age composition of late run males changed significantly within a run ($P < 0.001$). The temporal changes in the percentages of ages 1.3 and 1.4 male chinook salmon in the harvest were similar

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[2] European formula: Numeral preceding the decimal is the number of freshwater annuli, numeral following the decimal is the number of marine annuli. Total age from brood year is the sum of these two numbers plus one (Koo 1962).

Table 9. Estimated numbers of chinook salmon, by stratum and run, entering the Kenai River, 1986.

Stratum	Point Estimate	Standard Error[1]	95% Confidence Interval[2]
1. 17 May - 31 May	592	1,208	204 - 2,961
2. 1 June - 15 June	14,691	5,928	3,072 - 26,310
3. 16 June - 30 June	11,797	7,708	581 - 26,905
Early Run Total	27,080	6,860	13,633 - 40,527
4. 1 July - 15 July	4,249	14,522	760 - 32,712
5. 16 July - 28 July	43,508	12,906	18,211 - 68,804
6. 29 July - 14 August	9,806	1,067	7,715 - 11,898
Late Run Total	57,563	11,782	34,469 - 80,656
SEASON TOTAL	84,643	10,602	63,863 - 105,423

[1] Standard errors for run totals and season total include covariance terms for the abundance estimates from the mark-recapture estimate and, therefore, are not simply the sum of the variances of the stratum estimates.

[2] If the lower limit of the 95% confidence interval was equal to zero, it was adjusted to the total number of chinook salmon captured by the drift gillnets during the stratum (not including any recaptures of previously tagged fish).

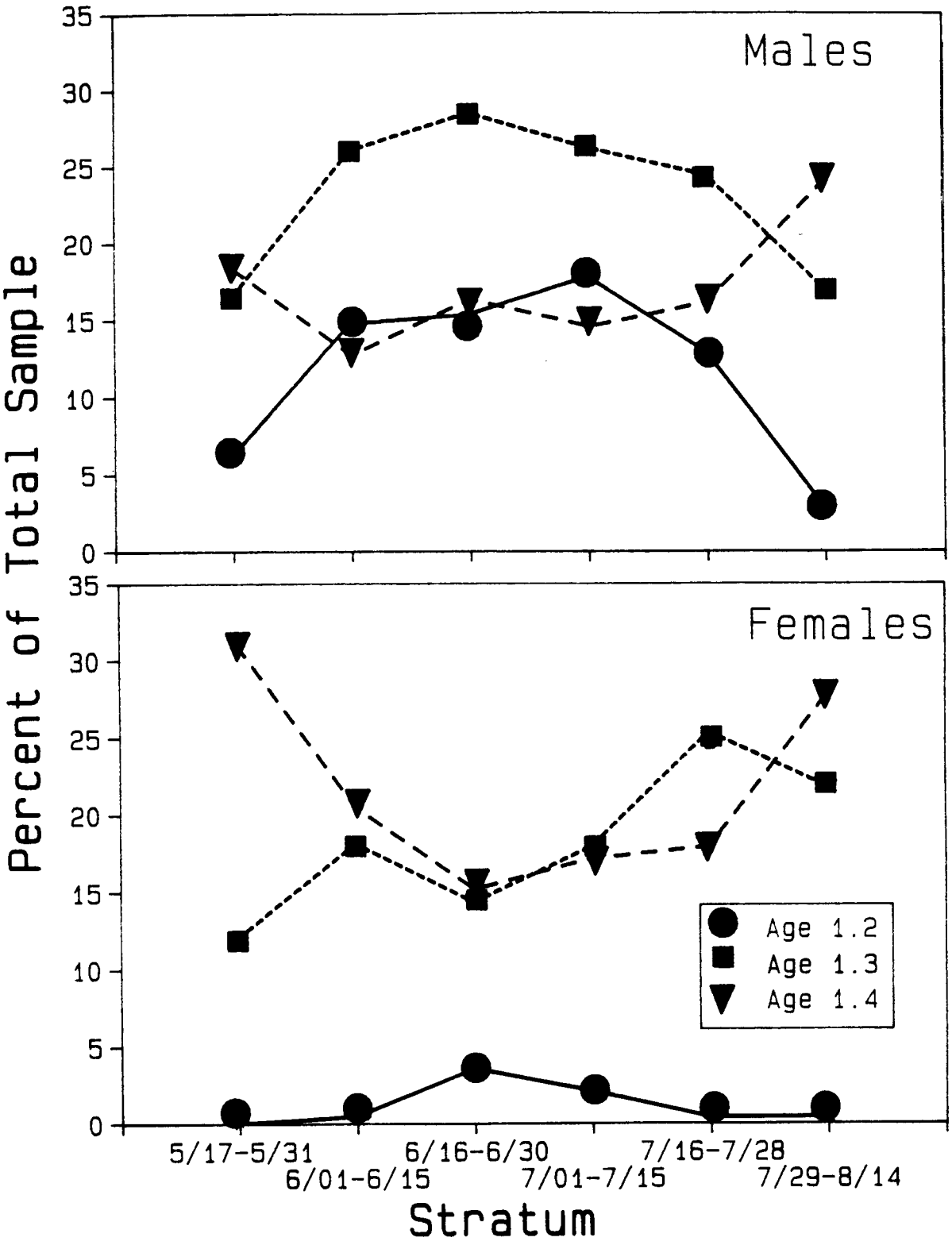

Figure 8. Age composition, by stratum, of chinook salmon sampled by gillnets in the Kenai River, 1986.

Table 10. Estimated numbers of chinook salmon, by sex and age group, entering the Kenai River during the early and late runs and the season total, 1986.

Component	Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	2.4	Total
EARLY RUN	Male	Percent	14.9	26.9	14.4	3.4	Tr[1]	59.6
		Estimated Number	4,028	7,294	3,910	908	3	16,143
		Standard Error	1,496	2,710	1,505	348	3	
	Female	Percent	1.9	16.3	18.4	3.8	Tr	40.3
		Estimated Number	498	4,417	4,989	1,030	3	10,937
		Standard Error	293	1,564	1,747	380	3	
	Combined	Percent	16.7	43.2	32.8	7.2	Tr	99.9
		Estimated Number	4,526	11,711	8,899	1,938	6	27,080
		Standard Error	1,525	3,129	2,306	515	5	
LATE RUN	Male	Percent	11.5	23.3	17.4	1.8	0	54.0
		Estimated Number	6,649	13,396	10,031	1,012	0	31,088
		Standard Error	3,147	5,101	3,375	500	0	
	Female	Percent	0.5	24.2	19.6	1.7	0	46.0
		Estimated Number	302	13,907	11,288	978	0	26,475
		Standard Error	322	4,443	3,858	411	0	
	Combined	Percent	12.0	47.5	37.0	3.5	0.0	100.0
		Estimated Number	6,951	27,303	21,319	1,990	0	57,563
		Standard Error	3,163	6,765	5,126	647	0	
SEASON TOTAL	Male	Percent	12.6	24.4	16.5	2.3	Tr	55.8
		Estimated Number	10,677	20,690	13,941	1,920	3	47,231
		Standard Error	3,485	5,776	3,695	609	3	
	Female	Percent	0.9	21.6	19.2	2.4	Tr	44.1
		Estimated Number	800	18,324	16,277	2,008	3	37,412
		Standard Error	435	4,710	4,235	560	3	
	Combined	Percent	13.5	46.0	35.7	4.7	Tr	99.9
		Estimated Number	11,477	39,014	30,218	3,928	6	84,643
		Standard Error	3,512	7,453	5,621	827	5	

[1] Trace, less than 0.05%.

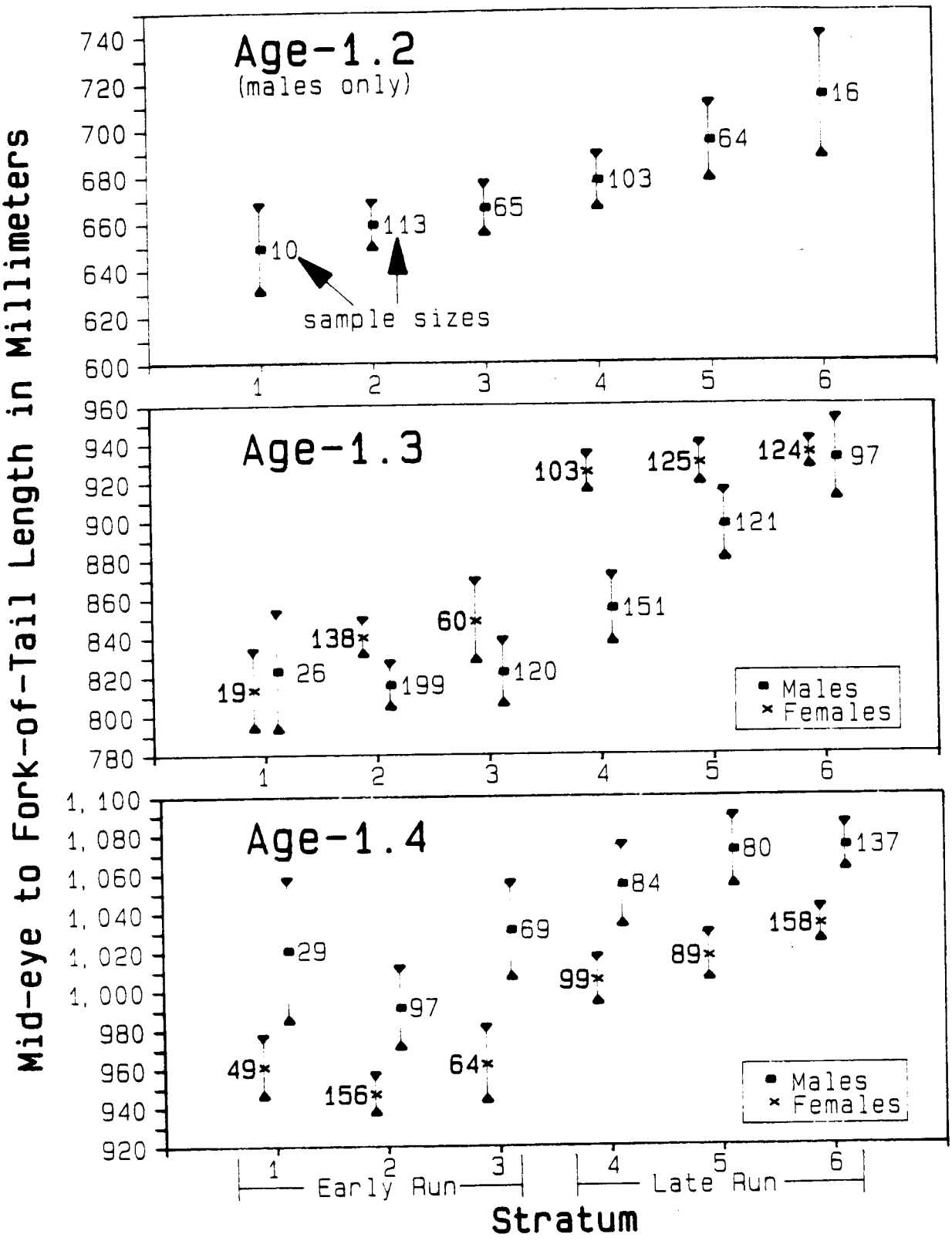

Figure 9. Mean length by sex, 95% confidence interval, and sample size, by stratum, for chinook salmon aged 1.2, 1.3, and 1.4 sampled by gillnets in the Kenai River, 1986.

to that observed in the gillnet samples (Figures 8 and 10). The percentage of age 1.2 males in the harvest did not show the gradual increase followed by a decline seen in the gillnet samples. Females in the harvest had temporal changes in the percentages of ages 1.2 and 1.3 similar to that observed in the gillnet samples, also. The percentage of age 1.4 females in the harvest increased during the early run but, in the gillnet samples, this same group declined. The 1.4 age group was the most abundant age group for females in all strata.

Age 1.3 and age 1.4 chinook salmon were the most abundant in both the early and late run harvests (Table 11). Age groups 1.3 and 1.4 composed 35.6% and 48.8% of the early run, respectively, and 39.2% and 44.2% of the late run, respectively. Age 1.4 male chinook salmon were the most abundant sex-age group in both the early-run and late-run harvests (31.0% and 23.0%, respectively).

There were temporal changes in the mean lengths of the major sex-age groups in the harvest, also. Similar to the gillnet samples, the mean lengths of the chinook salmon in the harvest generally increased as the season progressed (Figure 11 and Appendix Table 7). The mean lengths of age 1.3 females were nearly the same as age 1.3 males in every stratum. For comparison, age 1.3 females were larger than males for all strata but one in the gillnet samples. Identically to the gillnet samples, age 1.4 males were larger than age 1.4 females in every stratum.

Comparison of Gillnet and Harvest Samples:

There were significant ($P < 0.025$) differences between the age compositions of male chinook salmon sampled by the gillnets and the sport fishery samples in strata 2, 3, and 5. For females, the only significant ($P < 0.01$) difference between the two sets of samples was in stratum 3. One sex-age group present in the samples from the sport fishery was not present in the gillnet samples, age 1.1 male chinook salmon. Apparently, these fish are too small to be caught by the gillnets, therefore, their abundance is not estimated by the tag release-and-recovery data. Fortunately, the 1.1 age group appears to be a very small component of the chinook salmon runs to the Kenai River since none were found during the surveys of the mainstem spawning grounds and only 2 (0.2%) age 1.1 males were found in the 1,046 samples collected from the sport harvest during the creel surveys.

The mean lengths of ages 1.3 and 1.4 chinook salmon from the gillnet samples were compared to the samples from the creel survey in strata 2, 3, 4, and 5. Age 1.3 males sampled by the creel surveys were significantly larger ($P < 0.05$) than those sampled by the tagging crews in all strata examined. The only other significant differences were for age 1.4 males and females in stratum 4 ($P < 0.05$).

Spawning Escapement:

Only two chinook salmon carcasses were observed during the spawning ground surveys of the Funny and Killey Rivers because of high water conditions. Chinook salmon carcasses were much more abundant during the spawning ground surveys of the mainstem Kenai River. The majority

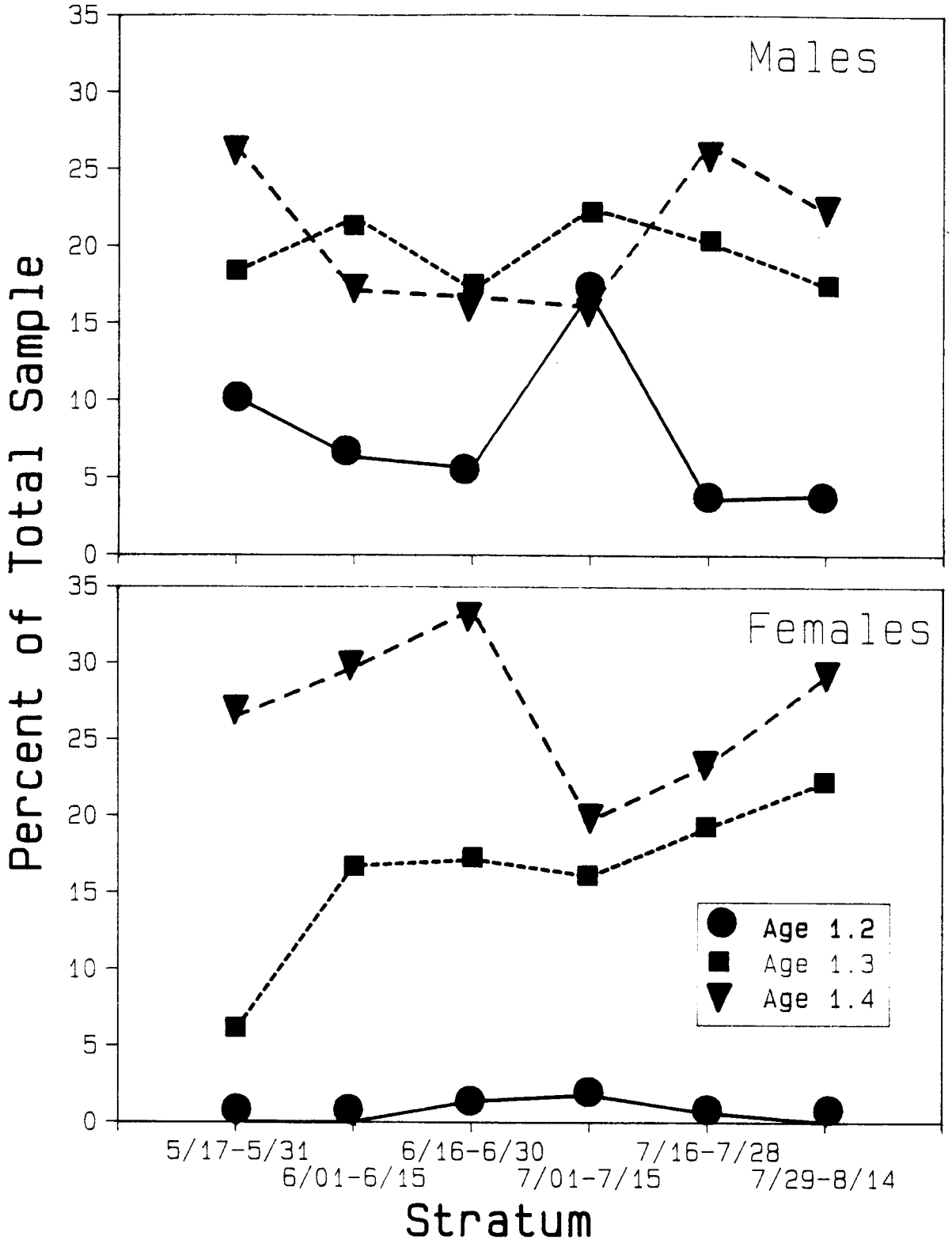

Figure 10. Age composition, by stratum, of chinook salmon sampled during creel surveys of the sport fishery in the Kenai River, 1986.

Table 11. Estimated numbers of chinook salmon, by sex and age group, harvested by the recreational fishery in the Kenai River during the early and late runs, 1986.

Component	Sex	Statistic	Age Group 1.1	1.2	1.3	1.4	1.5	Total
EARLY RUN (n = 533)[1]	Male	Percent	0.2	6.4	19.7	17.8	4.5	48.6
		Estimated Number	15	484	1,490	1,346	340	3,675
		Standard Error	15	86	160	151	71	
	Female	Percent	0.0	0.6	15.9	31.0	3.9	51.4
		Estimated Number	0	45	1,202	2,344	295	3,886
		Standard Error	0	25	141	210	66	
	Combined	Percent	0.2	7.0	35.6	48.8	8.4	100.0
		Estimated Number	15	529	2,692	3,690	635	7,561[2]
		Standard Error	15	89	213	259	97	
LATE RUN (n = 513)[1]	Male	Percent	0.2	9.4	20.7	21.2	2.9	54.4
		Estimated Number	18	846	1,864	1,909	261	4,898
		Standard Error	18	124	187	189	68	
	Female	Percent	0.0	1.0	18.5	23.0	3.1	45.6
		Estimated Number	0	90	1,666	2,071	279	4,106
		Standard Error	0	40	176	198	70	
	Combined	Percent	0.2	10.4	39.2	44.2	6.0	100.0
		Estimated Number	18	936	3,530	3,980	540	9,004[2]
		Standard Error	18	130	257	274	98	

[1] n = sample size.

[2] From Conrad and Hammarstrom (1987).

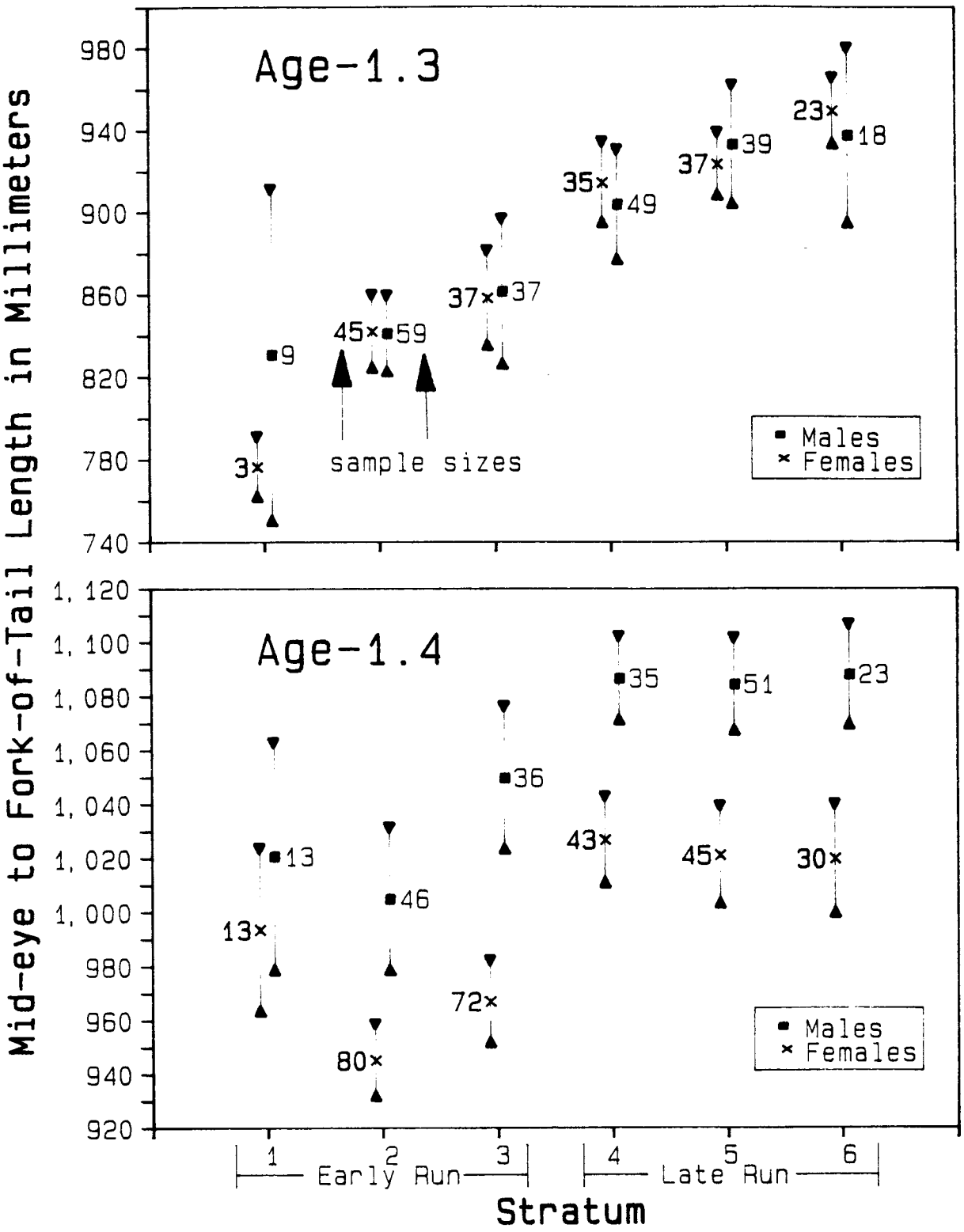

Figure 11. Mean length by sex, 95% confidence interval, and sample size, by stratum, for chinook salmon aged 1.3 and 1.4 sampled during creel surveys of the sport fishery in the Kenai River, 1986.

(52.4%) of the spawning ground samples were age 1.4 (Appendix Table 8). Next most abundant were fish aged 1.3 (36.5%). Age 1.3 females were larger than age 1.3 males, while age 1.4 males were larger than females of the same age (Appendix Table 9).

The estimated number of chinook salmon in the early run available for spawning was 19,534 fish (Table 12). Males were much more abundant than females; they composed 63.8% of the total for the early run. The most abundant age groups were 1.3 (46.2%) and 1.4 (26.6%). The estimated number of chinook salmon in the late run available for spawning was 48,577 fish (Table 12). Males and females were nearly equally abundant; they composed 54.0% and 46.0% of the total for the late run, respectively. The most abundant age groups were 1.3 (48.9%) and 1.4 (35.7%).

DISCUSSION

The definitions of the early run (17 May to 30 June) and the late run (1 July to 14 August) are idealistic representations of the timing of the runs and, in reality, there is overlap of their timing. Evidence for the gradual change in the mixture of early- and late- run fish in the return is the increasing mean length for all sex-age groups throughout the season in the gillnet and recreational harvest samples (Figures 9 and 11). The larger mean size-at-age of late-run fish compared to early-run fish has been documented previously (Burger et al. 1985, McBride et al. 1985). Linear discriminant function analysis using length-at-age was demonstrated as a feasible method of estimating the proportion of late-run chinook salmon from the Kenai River present in mixtures of other stocks by McBride et al. (1985). This technique could be used to better define the timing of the early and late chinook salmon runs into the Kenai River. This would require that length samples representing the early run and late run be collected to establish standards for the discriminant analysis. This may be difficult as the samples need to be a random sample from each run. The only samples which are composed entirely of either early-run or late-run fish are the spawning grounds samples. While samples from late-run fish from the Kenai River mainstem spawning areas are usually readily available, early-run samples from Kenai River tributary systems are often difficult to obtain (as was the case in 1986). The earliest and latest samples collected by the gillnets are not viable alternatives for the standards because they are not random samples.

Abundance Estimate using Tagging Data

Some of the sources of error which could potentially affect the estimate of chinook salmon abundance from the tagging data are:

The hypothesis that the probability of capture by the sport fishery was equal for chinook salmon of different lengths was not accepted. Small chinook salmon composed about 11% of both the tagging sample and the creel survey sample.

Table 12. Estimated numbers of chinook salmon, by sex and age group, in the spawning escapement to the Kenai River during the early and late runs, 1986.

Component	Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	2.4	Total
EARLY RUN	Male	Percent	18.1	29.7	13.1	2.9	Tr[1]	63.8
		Estimated Number	3,544	5,804	2,564	568	3	12,483
		Standard Error	1,498	2,715	1,513	355	3	
	Female	Percent	2.3	16.5	13.5	3.8	Tr	36.1
		Estimated Number	453	3,215	2,645	735	3	7,051
		Standard Error	294	1,570	1,760	386	3	
	Combined	Percent	20.4	46.2	26.6	6.7	Tr	99.9
		Estimated Number	3,997	9,019	5,209	1,303	6	19,534[2]
		Standard Error	1,527	3,136	2,320	524	4	
LATE RUN	Male	Percent	12.0	23.7	16.7	1.6	0.0	54.0
		Estimated Number	5,803	11,532	8,122	751	0	26,208
		Standard Error	3,149	5,104	3,380	505	0	
	Female	Percent	0.4	25.2	19.0	1.4	0.0	46.0
		Estimated Number	212	12,241	9,217	699	0	22,369
		Standard Error	324	4,446	3,863	417	0	
	Combined	Percent	12.4	48.9	35.7	3.0	0.0	100.0
		Estimated Number	6,015	23,773	17,339	1,450	0	48,577[2]
		Standard Error	3,166	6,770	5,133	655	0	

[1] Trace, less than 0.05%.

[2] Does not include escapement of age-1.1 chinook salmon which could not be estimated from the tagging data.

Of 81 chinook salmon with freshly clipped adipose fins observed during the creel surveys, only one fish did not have a tag attached. Additionally, 234 previously tagged chinook salmon were recaptured by the tagging crews after being at-large from 1 to 25 days and no fish with a fresh adipose finclip but no attached tag were observed. The maximum tag loss rate is estimated to be 0.3% in 1986. Tag loss (either naturally or by anglers removing tags and releasing fish) was not a major problem in 1986.

There were small numbers of chinook salmon tagged in the lower Kenai River and recovered in other systems in 1985 and 1986. The largest number of out-of-system recoveries were from the Kasilof River (11 recoveries in 1985, 5 recoveries in 1986). Tags have been recovered from the Susitna River (1 in 1985, 2 in 1986) and Deep Creek (1 in 1985), also. Four adipose finclipped and coded-wire tagged chinook salmon released as smolts from Crooked Creek hatchery (on the Kasilof River) were captured by the tagging crews in 1986. These fish were used to estimate the number of fish from Crooked Creek hatchery in the lower Kenai River (Appendix B). Only 676 (SE = 392) chinook salmon from Crooked Creek hatchery were estimated to be present in the lower Kenai River from 17 May to 30 June (Appendix B). Because of the proximity of the Kasilof River to the Kenai River, we expect that more fish from this stock are present in the lower Kenai River than any other stock. Since only 676 chinook salmon from Crooked Creek were estimated to be present in the river, the numbers of other stocks present are probably much smaller. We conclude that the presence of chinook salmon stocks from outside the Kenai River was not a major source of error.

Abundance Estimate using Gillnet Effort and Catch Data

The negative correlation between estimated chinook salmon abundance and MNDUR=0, indicating that as abundance increased the mean duration of sets which caught no chinook salmon decreased, is interesting. We feel this is because that as the abundance of chinook salmon increased, the frequency of sets which we term "false alarms" increased. These are sets when a chinook salmon strikes the gillnet and sinks the corkline but does not actually become entangled in the net. The crew, however, interprets this as a capture and retrieves the net, prematurely ending the set. During periods of high abundance these "false alarms" are more frequent and cause the mean duration of zero catch sets to decrease.

The obvious limitation of the estimate of chinook salmon abundance from 29 July to 14 August is that it is based on only five data points. Other linear and nonlinear models using the selected statistic (%EFF>0) or the other two statistics selected for final evaluation (MNDUR=0 and CPUE) produced estimates in the same range, therefore, we are confident that the point estimate (9,806 chinook salmon) is not grossly in error. Hopefully, the analysis of gillnet effort and catch data collected during 1987 will help better define these relationships.

RECOMMENDATIONS

1. If tag recovery rates are significantly different between chinook salmon of different lengths in the future, the present method of collecting data in the creel surveys will not allow separate estimates to be produced, as should be done. This is because the lengths of all fish examined during the creel surveys are not recorded, only a subsample of fish are actually measured. One solution to this problem is to compare examined fish to a standard template so that they can be visually classified as either small, medium, or large. This eliminates the need to measure each fish.

2. The sample design for collecting biological data (sex, age, and length data) from chinook salmon by the tagging crews and creel surveys should be temporally stratified as there are significant changes during the return. The approximate 15-day periods used in 1986 are recommended.

3. Chinook salmon with adipose finclips caught by the tagging crews should continue to be sacrificed so that coded-wire tag data can be analyzed.

4. If length-at-age standards for the early run and late run can be collected, methods similar to McBride et al. (1985) should be used to estimate the proportion of each run in the gillnet samples and sport fishery samples.

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LITERATURE CITED

Burger, C. V., R. L. Wilmont, and D. B. Wangaard. 1985. Comparison of spawning areas and times for two runs of chinook salmon (*Oncorhynchus tshawytscha*) in the Kenai River, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 42:693-700.

Clark, J. E. and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 261. 113 pp.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9. 159 pp.

Conover, W. J. 1971. Practical nonparametric statistics. John Wiley and Sons, New York. 493 pp.

Conrad, R. H. and S. L. Hammarstrom. in press. Harvest of chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) and angler-effort by the lower Kenai River recreational fisheries, 1986. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Data Series Report. 124 pp.

Conrad, R. H., S. Sonnichsen, E. T. McHenry, and D. S. Vincent-Lang. in press. Evaluation of coho salmon (*Oncorhynchus kisutch*) enhancement in Resurrection Bay, Alaska, 1986. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Data Series Report. 35 pp.

Darroch, J. N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-260.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 66:708-713.

Hammarstrom, S. L. 1980. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21(G-II-L):59-90.

Hammarstrom, S. L. and L. L. Larson. 1982. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23(G-II-L):1-47.

_____. 1983. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24(G-II-L):36-67.

_____. 1984. Evaluation of chinook salmon fisheries of the Kenai Peninsula. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25(G-II-L):1-39.

_____. 1986. Cook Inlet chinook and coho salmon studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, 1985-1986, Project F-10-1, 27(S-32):40-88.

Hammarstrom, S. L., L. L. Larson, and D. T. Balland. in press. Fisheries statistics for selected sport fisheries on the Lower Kenai Peninsula, Alaska, 1986, with emphasis on chinook salmon. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Data Series Report.

Hammarstrom, S. L., L. L. Larson, M. Wenger, and J. Carlon. 1985. Kenai River chinook and coho salmon studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, 1984-1985, Project F-9-17, 26(G-II-L):60-149.

Kleinbaum, D. G. and L. L. Kupper. 1978. Applied regression analysis and other multivariate methods. Duxbury Press, North Scituate, Mass. 556 pp.

Koo, T. S. Y. 1962. Age designation in salmon. Pages 37-48 *in* T. S. Y. Koo, editor. Studies of Alaska red salmon. University of Washington Publications in Fisheries, New Series, Volume 1.

McBride, D. N., R. D. Harding, B. A. Cross, and R. H. Conrad. 1985. Origins of chinook salmon (*Oncorhynchus tshawytscha*) in the commercial catches from the central district eastside set gillnet fishery in Upper Cook Inlet, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 251. 68 pp.

Mills, M. 1986. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration and Anadromous Fish Studies, Annual Performance Report, 1985-1986, Project F-10-1, 27(RT-2):137 pp.

Norusis, M. J. 1983. Introductory statistics guide: SPSSx. McGraw-Hill Book Co., New York. 276 pp.

Rubinstein, R. Y. 1981. Simulation and the Monte Carlo method. John Wiley and Sons, New York. 278 pp.

SAS. 1982. SAS user's guide: statistics, 1982 edition. SAS Institute, Inc. Cary, North Carolina. 584 pp.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1979. Elementary survey sampling. Duxbury Press, North Scituate, Massachusetts. 278 pp.

Seber, G. A. F. 1982. The estimation of animal abundance. MacMillan Publishing Co., Inc. New York. 654 pp.

Sukhatme, P. V., B. V. Sukhatme, S. Sukhatme, and C. Asok. 1984. Sampling theory of surveys with applications. Iowa State University Press, Ames, Iowa. 526 pp.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 620 pp.

Appendix Table 1. Detailed release and recovery information for the 80 tags recovered from chinook salmon during the creel surveys of the Kenai River in 1986.

Tag Number	Date Recov.	Date Tagged	Days Out	Recov. Source[1]	Mile Recov.	Mile Tagged	Miles Between
2742	20 May	19 May	1	DRS	14	7.8	6
4107	22 May	19 May	3	DRS	14	8.2	6
4110	22 May	21 May	1	DRS	13	7.3	6
4127	30 May	24 May	6	ASS	18	7.2	11
4049	28 May	26 May	2	DRS	17	8.2	9
4461	22 June	28 May	25	URS	44	7.5	36
4476	31 May	29 May	2	DRS	14	7.7	6
3966	01 June	29 May	3	DRS	14	9.2	5
4467	01 June	29 May	3	DRS	14	7.5	6
3980	15 June	30 May	16	ASS	14	6.9	7
3990	07 June	31 May	7	ASS	11	8.4	3
4514	13 June	02 June	11	ASS	35	7.0	28
4560	05 June	03 June	2	ASS	15	7.3	8
4426	05 June	04 June	1	ASS	14	9.1	5
4428	28 June	04 June	24	ASS	16	7.2	9
4619	07 June	06 June	1	DRS	10	8.7	1
4606	07 June	06 June	1	DRS	10	7.2	3
4610	07 June	06 June	1	ASS	15	7.8	7
4617	07 June	06 June	1	ASS	14	8.5	6
4639	08 June	07 June	1	DRS	12	9.1	3
4880	11 June	08 June	3	DRS	11	7.3	4
4656	03 July	08 June	25	URS	46	9.2	37
4951	10 June	09 June	1	DRS	15	7.8	7
4673	13 June	09 June	4	DRS	10	7.2	3
4894	21 June	09 June	12	DRS	12	7.9	4
4911	15 June	10 June	5	ASS	17	9.1	8
4574	15 June	10 June	5	ASS	10	8.0	2
5014	05 July	10 June	25	URS	44	9.2	35
4921	12 June	11 June	1	ASS	11	8.2	3
4937	13 June	11 June	2	DRS	18	8.9	9
5188	22 June	12 June	10	DRS	14	8.9	5
5051	05 July	12 June	23	ASS	19	7.9	11
5218	24 June	13 June	11	DRS	19	9.0	10
5234	24 June	13 June	11	ASS	28	7.1	21
5235	26 June	13 June	13	ASS	10	7.2	3
5256	15 June	14 June	1	ASS	15	7.6	7
5267	24 June	14 June	10	DRS	12	7.0	5
5375	17 June	15 June	2	DRS	14	9.0	5
5328	21 June	15 June	6	DRS	15	7.3	8
5510	21 June	19 June	2	ASS	18	7.6	10
5512	25 June	19 June	6	DRS	18	7.0	11
5529	28 June	21 June	7	DRS	19	7.1	12

-continued-

Appendix Table 1. Detailed release and recovery information for the 80 tags recovered from chinook salmon during the creel surveys of the Kenai River in 1986 (continued).

Tag Number	Date Recov.	Date Tagged	Days Out	Recov. Source[1]	Mile Recov.	Mile Tagged	Miles Between
4992	25 June	22 June	3	DRS	12	7.7	4
5574	24 June	23 June	1	DRS	15	7.2	8
5659	24 June	23 June	1	DRS	15	7.5	7
5657	28 June	23 June	5	DRS	14	8.1	6
5576	12 July	23 June	19	ASS	12	7.2	5
5673	28 June	24 June	4	ASS	16	9.2	7
5583	23 July	24 June	29	ASS	21	6.9	14
5882	28 June	27 June	1	DRS	14	9.0	5
5866	29 June	27 June	2	DRS	18	7.9	10
5801	02 July	27 June	5	ASS	18	9.2	9
5880	19 July	27 June	22	URS	47	8.9	38
5982	01 July	30 June	1	DRS	14	8.3	6
5993	03 July	30 June	3	DRS	15	7.7	7
5718	03 July	02 July	1	DRS	11	8.9	2
6018	10 July	05 July	5	DRS	12	7.5	4
6088	11 July	10 July	1	DRS	12	8.9	3
6093	18 July	10 July	8	DRS	12	8.3	4
6089	19 July	10 July	9	DRS	12	8.9	3
6050	12 July	11 July	1	DRS	10	8.8	1
6259	16 July	12 July	4	ASS	17	9.1	8
6105	15 July	13 July	2	DRS	12	9.0	3
6345	15 July	13 July	2	DRS	12	9.1	3
4846	27 July	13 July	14	DRS	18	9.3	9
6177	22 July	14 July	8	DRS	12	7.4	7
6554	29 July	14 July	15	DRS	15	8.0	7
6605	24 July	15 July	9	DRS	15	8.8	6
6466	29 July	15 July	14	ASS	10	7.7	2
6364	18 July	16 July	2	ASS	19	9.0	10
6380	19 July	16 July	3	DRS	10	9.0	1
6786	20 July	18 July	2	DRS	12	9.1	3
6776	25 July	18 July	7	DRS	15	9.2	6
6783	30 July	18 July	12	ASS		9.2	
5134	27 July	21 July	6	DRS	15	7.5	8
6889	22 July	22 July	0	DRS	8	9.0	-1
7026	25 July	22 July	3	ASS	12	7.3	5
6886	29 July	22 July	7	DRS	18	8.6	9
6948	25 July	23 July	2	DRS	12	7.4	5
7176	26 July	24 July	2	DRS	10	8.9	1

[1] Recovery sources: DRS = downstream roving creel survey,
URS = upstream roving creel survey, and
ASS = access-site creel survey.

Appendix Table 2a. Summary of the drift gillnet effort and chinook salmon catch statistics for crew A of the Kenai River tagging project, 1986.

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
517	5	186	37.2	11.89	0	0.00	0.000	0.0000	186	37.2	11.89			0	0.0%	0	0.0%		
518	5	198	39.6	8.20	1	0.20	0.200	0.0051	137	34.3	8.01	61.0		1	30.8%	1	20.0%	61.0	
519	7	155	22.1	9.36	5	0.71	0.184	0.0323	45	22.5	17.50	22.0	12.39	5	71.0%	5	71.4%	22.0	12.39
520	3	161	53.7	6.33	1	0.33	0.333	0.0062	101	50.5	9.50	60.0		1	37.3%	1	33.3%	60.0	
521	0													0		0			
522	0													0		0			
523	10	210	21.0	5.62	5	0.50	0.224	0.0238	130	21.7	8.67	46.5	26.50	4	38.1%	4	40.0%	20.0	6.92
524	14	157	11.2	1.71	13	0.93	0.245	0.0828	55	11.0	2.39	15.1	2.74	9	65.0%	9	64.3%	11.3	2.42
525	11	143	13.0	2.32	11	1.00	0.270	0.0769	29	9.7	1.76	17.9	3.30	8	79.7%	8	72.7%	14.3	3.06
526	10	123	12.3	4.51	7	0.70	0.153	0.0569	59	19.7	11.78	17.6	9.90	7	52.0%	7	70.0%	9.1	4.27
527	0													0		0			
528	0													0		0			
529	0													0		0			
530	9	94	10.4	3.94	10	1.11	0.200	0.1064	9	9.0		11.8	4.37	8	90.4%	8	88.9%	10.6	4.46
531	15	99	6.6	1.83	15	1.00	0.169	0.1515	25	8.3	3.84	8.3	2.37	12	74.7%	12	80.0%	6.2	2.14
601	8	56	7.0	1.99	6	0.75	0.250	0.1071	8	2.7	1.67	9.8	2.33	5	85.7%	5	62.5%	9.6	2.40
602	0													0		0			
603	7	83	11.9	5.78	5	0.71	0.286	0.0602	27	9.0	3.51	20.8	13.50	4	67.5%	4	57.1%	14.0	10.35
604	0													0		0			
605	0													0		0			
606	24	88	3.7	0.72	33	1.38	0.179	0.3750	12	6.0	3.00	3.6	0.80	22	86.4%	22	91.7%	3.5	0.74
607	25	89	3.6	0.66	32	1.28	0.187	0.3596	20	5.0	0.91	4.0	0.88	21	77.5%	21	84.0%	3.3	0.75
608	28	100	3.6	0.57	34	1.21	0.173	0.3400	33	5.5	1.98	4.5	0.78	22	67.0%	22	78.6%	3.0	0.46
609	0													0		0			
610	23	56	2.4	0.37	40	1.74	0.201	0.7143	1	1.0		2.5	0.40	22	98.2%	22	95.7%	2.5	0.38
611	0													0		0			

-continued-

Appendix Table 2a. Summary of the drift gillnet effort and chinook salmon catch statistics for crew A of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
612	0													0		0			
613	27	67	2.5	0.28	33	1.22	0.154	0.4925	3	1.0	0.00	2.8	0.28	24	95.5%	24	88.9%	2.7	0.29
614	5	23	4.6	1.83	12	2.40	0.510	0.5217				4.6	1.83	5	100.0%	5	100.0%	4.6	1.83
615	20	94	4.7	0.81	23	1.15	0.131	0.2447	14	7.0	0.00	5.2	0.99	18	85.1%	18	90.0%	4.4	0.88
616	21	89	4.2	0.90	26	1.24	0.217	0.2921	7	2.3	1.33	4.9	1.00	18	92.1%	18	85.7%	4.6	1.02
617	17	107	6.3	1.52	14	0.82	0.231	0.1308	42	7.0	2.74	6.5	1.86	11	60.7%	11	64.7%	5.9	1.90
618	0													0		0			
619	0													0		0			
620	15	157	10.5	2.95	9	0.60	0.131	0.0573	112	18.7	5.63	14.1	4.27	9	28.7%	9	60.0%	5.0	1.70
621	9	143	15.9	3.99	10	1.11	0.309	0.0699	53	26.5	11.50	20.4	6.73	7	62.9%	7	77.8%	12.9	3.75
622	9	184	20.4	7.73	8	0.89	0.200	0.0435	53	26.5	3.50	26.3	13.82	7	71.2%	7	77.8%	18.7	9.98
623	16	144	9.0	1.95	18	1.13	0.239	0.1250	41	13.7	8.41	11.1	2.76	13	71.5%	13	81.3%	7.9	1.61
624	3	35	11.7	4.91	2	0.67	0.333	0.0571	12	12.0		11.5	8.50	2	65.7%	2	66.7%	11.5	8.50
625	0													0		0			
626	0													0		0			
627	0													0		0			
628	0													0		0			
629	0													0		0			
630	15	160	10.7	2.17	13	0.87	0.165	0.0813	63	15.8	3.75	14.5	4.14	11	60.6%	11	73.3%	8.8	2.48
701	11	139	12.6	4.03	14	1.27	0.237	0.1007	2	2.0		13.9	4.36	10	98.6%	10	90.9%	13.7	4.29
702	0													0		0			
703	18	99	5.5	1.33	24	1.33	0.229	0.2424	32	10.7	6.69	6.6	1.69	15	67.7%	15	83.3%	4.5	0.91
704	0													0		0			
705	8	128	16.0	6.08	5	0.63	0.183	0.0391	81	27.0	14.57	23.6	9.87	5	36.7%	5	62.5%	9.4	3.30
706	13	153	11.8	2.87	9	0.69	0.237	0.0588	65	10.8	3.81	21.9	9.78	7	57.5%	7	53.8%	12.6	4.48
707	0													0		0			

-continued-

Appendix Table 2a. Summary of the drift gillnet effort and chinook salmon catch statistics for crew A of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
708	8	197	24.6	5.41	4	0.50	0.189	0.0203	69	17.3	4.33	43.8	11.18	4	65.0%	4	50.0%	32.0	9.03
709	0													0		0			
710	0													0		0			
711	15	89	5.9	1.35	10	0.67	0.159	0.1124	52	8.7	2.32	7.8	2.38	9	41.6%	9	60.0%	4.1	1.44
712	19	154	8.1	1.60	17	0.89	0.201	0.1104	65	10.8	2.87	10.2	2.20	13	57.8%	13	68.4%	6.8	1.91
713	35	60	1.7	0.16	54	1.54	0.185	0.9000	7	1.8	0.25	1.9	0.22	31	88.3%	31	88.6%	1.7	0.18
714	31	78	2.5	0.28	32	1.03	0.127	0.4103	15	2.5	0.67	3.1	0.44	25	80.8%	25	80.6%	2.5	0.31
715	27	94	3.5	0.50	35	1.30	0.158	0.3723	12	4.0	1.53	3.8	0.67	24	87.2%	24	88.9%	3.4	0.54
716	0													0		0			
717	0													0		0			
718	19	78	4.1	0.78	18	0.95	0.179	0.2308	23	3.8	1.80	6.0	1.41	13	70.5%	13	68.4%	4.2	0.85
719	0			0.00										0		0			
720	13	150	11.5	2.57	15	1.15	0.274	0.1000	38	19.0	1.00	13.6	4.33	11	74.7%	11	84.6%	10.2	2.85
721	23	142	6.2	1.20	28	1.22	0.166	0.1972	13	3.3	2.25	7.5	1.34	19	90.8%	19	82.6%	6.8	1.36
722	9	45	5.0	1.85	11	1.22	0.324	0.2444	4	2.0	1.00	6.4	2.72	7	91.1%	7	77.8%	5.9	2.29
723	0													0		0			
724	0													0		0			
725	14	134	9.6	3.18	13	0.93	0.286	0.0970	22	4.4	1.57	14.9	4.99	9	83.6%	9	64.3%	12.4	4.68
726	21	86	4.1	1.09	28	1.33	0.159	0.3256	10	5.0	0.00	4.5	1.29	19	88.4%	19	90.5%	4.0	1.20
727	20	74	3.7	0.88	29	1.45	0.198	0.3919	1	1.0		3.9	0.91	19	98.6%	19	95.0%	3.8	0.91
728	19	140	7.4	1.80	20	1.05	0.179	0.1429	18	4.5	1.50	8.6	2.18	15	87.1%	15	78.9%	8.1	2.22
729	24	113	4.7	0.72	22	0.92	0.190	0.1947	64	6.4	1.39	8.1	2.53	14	43.4%	14	58.3%	3.5	0.58
730	0													0		0			
731	0													0		0			
801	21	92	4.4	0.71	24	1.14	0.186	0.2609	12	4.0	2.52	5.1	0.99	18	87.0%	18	85.7%	4.4	0.76
802	16	61	3.8	1.08	21	1.31	0.237	0.3443	15	3.8	2.75	5.0	1.42	12	75.4%	12	75.0%	3.8	1.20

-continued-

Appendix Table 2a. Summary of the drift gillnet effort and chinook salmon catch statistics for crew A of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
803	31	93	3.0	0.51	32	1.03	0.170	0.3441	23	2.9	0.74	4.0	0.73	23	75.3%	23	74.2%	3.0	0.64
804	28	76	2.7	0.45	26	0.93	0.114	0.3421	17	2.8	1.01	3.4	0.72	22	77.6%	22	78.6%	2.7	0.52
805	18	75	4.2	0.85	19	1.06	0.127	0.2533	10	5.0	1.00	4.7	1.14	16	86.7%	16	88.9%	4.1	0.95
806	0													0		0			
807	0													0		0			
808	18	127	7.1	1.33	20	1.11	0.196	0.1575	12	3.0	0.41	9.1	1.59	14	90.6%	14	77.8%	8.2	1.58
809	22	85	3.9	0.53	20	0.91	0.185	0.2353	14	2.3	0.33	5.3	0.71	16	83.5%	16	72.7%	4.4	0.67
810	0													0		0			
811	9	193	21.4	6.88	4	0.44	0.176	0.0207	142	28.4	10.39	37.3	21.99	4	26.4%	4	44.4%	12.8	7.69
812	12	159	13.3	3.25	9	0.75	0.329	0.0566	120	20.0	4.84	16.0	7.60	6	24.5%	6	50.0%	6.5	2.17
813	0													0		0			
814	12	92	7.7	1.62	10	0.83	0.167	0.1087	14	4.7	1.76	10.2	2.45	9	84.8%	9	75.0%	8.7	2.01
TOT	895	6,407	7.2	0.33	959	1.07	0.029	0.1497	2,249	10.7	9.75	8.2	0.48	685	64.9%	685	76.5%	6.1	6.05

[1] SE = standard error of estimate.

[2] SS = sample size.

Appendix Table 2b. Summary of the drift gillnet effort and chinook salmon catch statistics for crew B of the Kenai River tagging project, 1986.

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
517	0													0		0			
518	0													0		0			
519	6	142	23.7	6.75	3	0.50	0.342	0.0211	68	17.0	8.07	37.0	5.00	2	52.1%	2	33.3%	37.0	5.00
520	9	167	18.6	4.09	1	0.11	0.111	0.0060	151	18.9	4.63	135.0		1	9.6%	1	11.1%	16.0	
521	12	201	16.8	3.18	1	0.08	0.083	0.0050	176	16.0	3.38	182.0		1	12.4%	1	8.3%	25.0	
522	10	230	23.0	4.03	1	0.10	0.100	0.0043	224	24.9	3.98	79.0		1	2.6%	1	10.0%	6.0	
523	0													0		0			
524	0													0		0			
525	0													0		0			
526	0													0		0			
527	11	155	14.1	2.18	7	0.64	0.152	0.0452	56	14.0	4.22	20.7	6.42	7	63.9%	7	63.6%	14.1	2.72
528	16	156	9.8	1.56	7	0.44	0.128	0.0449	95	10.6	1.45	20.3	2.47	7	39.1%	7	43.8%	8.7	3.17
529	19	133	7.0	1.34	20	1.05	0.223	0.1504	44	7.3	2.08	8.6	1.94	13	66.9%	13	68.4%	6.8	1.76
530	0													0		0			
531	0													0		0			
601	8	91	11.4	3.76	5	0.63	0.183	0.0549	40	13.3	5.78	18.2	9.97	5	56.0%	5	62.5%	10.2	5.34
602	18	183	10.2	1.91	8	0.44	0.121	0.0437	144	14.4	2.56	15.4	4.87	8	21.3%	8	44.4%	4.9	1.48
603	5	70	14.0	4.75	4	0.80	0.374	0.0571	24	12.0	7.00	21.7	5.61	3	65.7%	3	60.0%	15.3	7.54
604	15	155	10.3	2.39	9	0.60	0.190	0.0581	122	15.3	3.59	15.7	6.53	7	21.3%	7	46.7%	4.7	1.27
605	18	155	8.6	2.12	14	0.78	0.191	0.0903	96	13.7	4.63	14.4	5.74	11	38.1%	11	61.1%	5.4	1.27
606	0													0		0			
607	0													0		0			
608	14	57	4.1	0.88	26	1.86	0.294	0.4561	5	5.0		4.4	1.02	13	91.2%	13	92.9%	4.0	0.95
609	15	123	8.2	1.18	18	1.20	0.262	0.1463	32	10.7	2.40	9.3	2.89	12	74.0%	12	80.0%	7.6	1.34
610	15	54	3.6	0.67	27	1.80	0.341	0.5000	5	2.5	0.50	4.2	0.80	13	90.7%	13	86.7%	3.8	0.76
611	21	85	4.0	0.57	49	2.33	0.319	0.5765	12	6.0	4.00	3.9	0.52	19	85.9%	19	90.5%	3.8	0.53

-continued-

Appendix Table 2b. Summary of the drift gillnet effort and chinook salmon catch statistics for crew B of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
612	20	95	4.8	0.70	38	1.90	0.270	0.4000				4.8	0.70	20	100.0%	20	100.0%	4.8	0.70
613	0													0		0			
614	0													0		0			
615	11	84	7.6	1.21	6	0.55	0.207	0.0714	47	7.8	1.78	14.4	5.00	5	44.0%	5	45.5%	7.4	1.81
616	18	164	9.1	1.37	12	0.67	0.140	0.0732	92	13.1	2.35	14.9	2.95	11	43.9%	11	61.1%	6.5	1.18
617	17	159	9.4	1.49	10	0.59	0.193	0.0629	86	9.6	2.34	19.9	4.10	8	45.9%	8	47.1%	9.1	1.91
618	19	205	10.8	1.16	7	0.37	0.137	0.0341	138	10.6	1.07	34.2	11.59	6	32.7%	6	31.6%	11.2	3.05
619	17	139	8.2	1.07	16	0.94	0.264	0.1151	57	8.1	1.32	13.3	3.06	10	59.0%	10	58.8%	8.2	1.62
620	0													0		0			
621	0													0		0			
622	17	135	7.9	0.82	16	0.94	0.160	0.1185	38	9.5	0.96	10.4	2.27	13	71.9%	13	76.5%	7.5	1.01
623	0													0		0			
624	13	123	9.5	1.67	17	1.31	0.237	0.1382	19	19.0		10.3	2.14	12	84.6%	12	92.3%	8.7	1.59
625	19	147	7.7	1.07	20	1.05	0.209	0.1361	61	10.2	2.06	8.2	1.80	13	58.5%	13	68.4%	6.6	1.17
626	22	157	7.1	0.94	21	0.95	0.154	0.1338	48	9.6	2.01	9.2	1.90	17	69.4%	17	77.3%	6.4	1.03
627	27	105	3.9	0.56	31	1.15	0.148	0.2952	19	4.8	1.11	4.6	0.72	23	81.9%	23	85.2%	3.7	0.63
628	30	107	3.6	0.45	30	1.00	0.117	0.2804	25	4.2	1.45	4.5	0.80	24	76.6%	24	80.0%	3.4	0.45
629	21	168	8.0	1.06	15	0.71	0.140	0.0893	88	11.0	1.90	11.0	2.03	13	47.6%	13	61.9%	6.2	1.01
630	16	149	9.3	1.84	12	0.75	0.171	0.0805	69	11.5	3.33	14.9	3.09	10	53.7%	10	62.5%	8.0	2.20
701	0													0		0			
702	0													0		0			
703	0													0		0			
704	18	182	10.1	2.17	17	0.94	0.098	0.0934	25	12.5	2.50	11.4	2.36	16	86.3%	16	88.9%	9.8	2.43
705	0													0		0			
706	13	147	11.3	2.05	8	0.62	0.140	0.0544	91	18.2	3.28	18.4	10.32	8	38.1%	8	61.5%	7.0	1.02
707	11	187	17.0	3.66	5	0.45	0.157	0.0267	127	21.2	5.87	31.8	11.75	5	32.1%	5	45.5%	12.0	3.22

-continued-

Appendix Table 2b. Summary of the drift gillnet effort and chinook salmon catch statistics for crew B of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
708	0													0		0			
709	11	169	15.4	3.31	6	0.55	0.157	0.0355	106	21.2	4.91	22.7	5.81	6	37.3%	6	54.5%	10.5	3.71
710	17	192	11.3	1.72	8	0.47	0.194	0.0417	141	12.8	2.40	32.0	7.60	6	26.6%	6	35.3%	8.5	1.84
711	0													0		0			
712	0													0		0			
713	19	121	6.4	1.44	21	1.11	0.151	0.1736	33	11.0	3.79	7.6	2.02	16	72.7%	16	84.2%	5.5	1.51
714	22	114	5.2	1.39	31	1.41	0.182	0.2719	32	10.7	5.21	4.9	1.39	19	71.9%	19	86.4%	4.3	1.35
715	19	114	6.0	1.68	29	1.53	0.234	0.2544	7	3.5	2.50	6.7	1.82	17	93.9%	17	89.5%	6.3	1.86
716	41	137	3.3	0.42	53	1.29	0.145	0.3869	32	5.3	1.36	3.4	0.57	35	76.6%	35	85.4%	3.0	0.42
717	28	111	4.0	0.70	47	1.68	0.252	0.4234	26	6.5	2.90	4.0	0.86	24	76.6%	24	85.7%	3.5	0.66
718	0													0		0			
719	21	91	4.3	1.03	26	1.24	0.217	0.2857	34	6.8	2.97	4.6	1.46	16	62.6%	16	76.2%	3.6	0.97
720	14	110	7.9	1.56	17	1.21	0.281	0.1545	49	12.3	2.50	9.5	3.08	10	55.5%	10	71.4%	6.1	1.70
721	25	123	4.9	0.54	22	0.88	0.176	0.1789	39	3.9	0.77	8.2	1.48	15	68.3%	15	60.0%	5.6	0.70
722	25	122	4.9	0.65	29	1.16	0.125	0.2377	16	5.3	2.33	5.5	0.83	22	86.9%	22	88.0%	4.8	0.69
723	24	101	4.2	0.45	37	1.54	0.190	0.3663	8	4.0	1.00	4.6	0.57	22	92.1%	22	91.7%	4.2	0.49
724	0													0		0			
725	0													0		0			
726	0													0		0			
727	17	76	4.5	0.90	28	1.65	0.226	0.3684	4	4.0		4.8	0.96	16	94.7%	16	94.1%	4.5	0.96
728	30	130	4.3	0.67	41	1.37	0.148	0.3154	25	8.3	4.37	4.8	1.27	27	80.8%	27	90.0%	3.9	0.56
729	19	94	4.9	1.00	23	1.21	0.211	0.2447	12	4.0	1.15	5.9	1.15	16	87.2%	16	84.2%	5.1	1.17
730	18	114	6.3	1.04	36	2.00	0.291	0.3158	7	7.0		6.7	1.23	17	93.9%	17	94.4%	6.3	1.10
731	19	101	5.3	0.94	26	1.37	0.288	0.2574	34	5.7	2.60	7.8	1.62	13	66.3%	13	68.4%	5.2	0.78
801	0													0		0			
802	0													0		0			

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Appendix Table 2b. Summary of the drift gillnet effort and chinook salmon catch statistics for crew B of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
803	15	95	6.3	0.83	36	2.40	0.321	0.3789				6.3	0.83	15	100.0%	15	100.0%	6.3	0.83
804	17	78	4.6	0.67	31	1.82	0.312	0.3974	15	7.5	1.50	5.2	1.14	15	80.8%	15	88.2%	4.2	0.68
805	9	54	6.0	1.65	14	1.56	0.338	0.2593	7	7.0		6.8	2.13	8	87.0%	8	88.9%	5.9	1.87
806	17	103	6.1	0.77	27	1.59	0.364	0.2621	26	6.5	0.96	7.9	1.40	13	74.8%	13	76.5%	5.9	0.98
807	15	112	7.5	1.20	29	1.93	0.300	0.2589	14	7.0	3.00	7.5	1.35	13	87.5%	13	86.7%	7.5	1.35
808	0													0		0			
809	0													0		0			
810	15	130	8.7	1.74	16	1.07	0.284	0.1231	43	7.2	1.66	14.3	3.80	9	66.9%	9	60.0%	9.7	2.72
811	0													0		0			
812	0													0		0			
813	13	157	12.1	3.25	7	0.54	0.144	0.0446	109	18.2	6.28	12.6	4.02	7	30.6%	7	53.8%	6.9	1.14
814	0													0		0			
TOT	991	7,359	7.4	0.22	1,121	1.13	0.033	0.1523	3,143	11.3	6.78	9.2	0.50	714	57.3%	714	72.0%	5.9	3.87

[1] SE = standard error of estimate.

[2] SS = sample size.

Appendix Table 2c. Summary of the drift gillnet effort and chinook salmon catch statistics for crew C of the Kenai River tagging project, 1986.

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
517	0													0		0			
518	0													0		0			
519	10	226	22.6	5.04	1	0.10	0.100	0.0044	214	23.8	5.47	125.0		1	5.3%	1	10.0%	12.0	
520	9	189	21.0	4.29	3	0.33	0.167	0.0159	118	19.7	4.92	45.0	17.67	3	37.6%	3	33.3%	23.7	9.74
521	10	216	21.6	5.00	2	0.20	0.133	0.0093	187	23.4	5.99	98.5	45.50	2	13.4%	2	20.0%	14.5	7.50
522	7	255	36.4	6.86	2	0.29	0.184	0.0078	223	44.6	5.51	127.5	48.50	2	12.5%	2	28.6%	16.0	10.00
523	0													0		0			
524	0													0		0			
525	0													0		0			
526	0													0		0			
527	12	192	16.0	4.26	8	0.67	0.142	0.0417	80	20.0	9.08	22.9	6.89	8	58.3%	8	66.7%	14.0	4.84
528	11	218	19.8	2.82	7	0.64	0.152	0.0321	95	23.8	1.49	4.9	6.35	7	56.4%	7	63.6%	17.6	4.22
529	18	179	9.9	1.33	18	1.00	0.081	0.1006	12	12.0		0.5	1.57	17	93.3%	17	94.4%	9.8	1.40
530	0													0		0			
531	0													0		0			
601	11	157	14.3	3.27	9	0.82	0.182	0.0573	47	15.7	3.71	19.6	7.25	8	70.1%	8	72.7%	13.8	4.40
602	16	159	9.9	1.55	16	1.00	0.183	0.1006	36	12.0	4.04	0.8	1.82	13	77.4%	13	81.3%	9.5	1.73
603	4	76	19.0	6.86	3	0.75	0.250	0.0395	14	14.0		5.3	12.02	3	81.6%	3	75.0%	20.7	9.40
604	20	149	7.5	1.49	29	1.45	0.198	0.1946	9	4.5	3.50	0.2	1.60	18	94.0%	18	90.0%	7.8	1.61
605	19	186	9.8	1.88	17	0.89	0.130	0.0914	64	16.0	5.79	10.2	2.05	15	65.6%	15	78.9%	8.1	1.70
606	0													0		0			
607	0													0		0			
608	14	53	3.8	0.67	15	1.07	0.245	0.2830	22	5.5	1.55	5.3	1.63	10	58.5%	10	71.4%	3.1	0.64
609	22	92	4.2	0.73	30	1.36	0.242	0.3261	20	4.0	1.10	0.9	0.95	17	78.3%	17	77.3%	4.2	0.91
610	29	88	3.0	0.47	42	1.45	0.231	0.4773	16	2.7	0.67	0.8	0.64	23	81.8%	23	79.3%	3.1	0.57
611	29	130	4.5	0.46	30	1.03	0.093	0.2308	15	5.0	1.15	0.8	0.69	26	88.5%	26	89.7%	4.4	0.50

-continued-

Appendix Table 2c. Summary of the drift gillnet effort and chinook salmon catch statistics for crew C of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
612	32	142	4.4	0.59	39	1.22	0.189	0.2746	33	6.6	1.81	0.1	0.84	27	76.8%	27	84.4%	4.0	0.60
613	0													0		0			
614	0													0		0			
615	21	151	7.2	1.02	19	0.90	0.118	0.1258	39	9.8	3.42	0.5	1.61	17	74.2%	17	81.0%	6.6	0.99
616	23	188	8.2	1.18	17	0.74	0.129	0.0904	95	11.9	2.34	9.8	1.90	15	49.5%	15	65.2%	6.2	1.04
617	21	185	8.8	1.83	18	0.86	0.143	0.0973	45	7.5	1.77	2.3	2.88	15	75.7%	15	71.4%	9.3	2.49
618	20	213	10.7	1.36	13	0.65	0.150	0.0610	101	11.2	1.56	7.5	3.95	11	52.6%	11	55.0%	10.2	2.17
619	15	192	12.8	2.53	10	0.67	0.159	0.0521	96	16.0	4.99	0.2	8.00	9	50.0%	9	60.0%	10.7	2.62
620	0													0		0			
621	0													0		0			
622	17	181	10.6	1.61	10	0.59	0.123	0.0552	86	12.3	1.97	15.4	3.30	10	52.5%	10	58.8%	9.5	2.37
623	16	181	11.3	1.75	14	0.88	0.125	0.0773	31	10.3	2.33	3.9	2.81	13	82.9%	13	81.3%	11.5	2.12
624	17	181	10.6	2.16	18	1.06	0.160	0.0994	28	9.3	3.18	2.9	2.63	14	84.5%	14	82.4%	10.9	2.57
625	24	151	6.3	1.14	28	1.17	0.115	0.1854	6	3.0	0.00	0.9	1.29	22	96.0%	22	91.7%	6.6	1.23
626	22	173	7.9	1.38	20	0.91	0.112	0.1156	37	9.3	2.56	0.6	1.70	18	78.6%	18	81.8%	7.6	1.61
627	0													0		0			
628	0													0		0			
629	0													0		0			
630	13	179	13.8	2.93	10	0.77	0.166	0.0559	87	21.8	3.20	9.9	7.78	9	51.4%	9	69.2%	10.2	3.43
701	14	146	10.4	2.21	16	1.14	0.097	0.1096				0.4	2.21	14	100.0%	14	100.0%	10.4	2.21
702	41	261	6.4	0.85	60	1.46	0.121	0.2299	13	4.3	1.45	0.9	0.88	38	95.0%	38	92.7%	6.5	0.91
703	27	104	3.9	0.69	32	1.19	0.107	0.3077	4	4.0		4.0	0.74	26	96.2%	26	96.3%	3.8	0.71
704	0													0		0			
705	0													0		0			
706	8	133	16.6	6.70	4	0.50	0.189	0.0301	79	19.8	11.56	30.0	12.89	4	40.6%	4	50.0%	13.5	8.33
707	12	198	16.5	5.66	8	0.67	0.188	0.0404	147	29.4	10.74	0.6	10.72	7	25.8%	7	58.3%	7.3	3.42

-continued-

Appendix Table 2c. Summary of the drift gillnet effort and chinook salmon catch statistics for crew C of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
708	10	200	20.0	5.87	6	0.60	0.221	0.0300	135	27.0	9.42	25.8	12.54	5	32.5%	5	50.0%	13.0	6.46
709	20	173	8.7	1.38	18	0.90	0.143	0.1040	58	11.6	3.44	0.1	1.93	15	66.5%	15	75.0%	7.7	1.43
710	18	153	8.5	2.03	18	1.00	0.229	0.1176	90	15.0	4.37	1.1	2.87	12	41.2%	12	66.7%	5.3	1.51
711	0													0		0			
712	0													0		0			
713	18	123	6.8	1.67	18	1.00	0.114	0.1463	16	8.0	5.00	7.5	1.95	16	87.0%	16	88.9%	6.7	1.82
714	30	120	4.0	0.81	46	1.53	0.213	0.3833	26	6.5	2.02	0.6	0.94	26	78.3%	26	86.7%	3.6	0.87
715	28	127	4.5	0.87	38	1.36	0.237	0.2992	23	3.8	0.60	0.3	1.24	22	81.9%	22	78.6%	4.7	1.10
716	41	129	3.1	0.31	55	1.34	0.129	0.4264	19	4.8	1.25	0.4	0.43	37	85.3%	37	90.2%	3.0	0.30
717	37	147	4.0	0.53	47	1.27	0.143	0.3197	26	4.3	1.50	0.5	0.72	31	82.3%	31	83.8%	3.9	0.57
718	0													0		0			
719	0													0		0			
720	21	131	6.2	1.42	28	1.33	0.187	0.2137	13	6.5	3.50	0.2	1.55	19	90.1%	19	90.5%	6.2	1.55
721	25	148	5.9	1.23	28	1.12	0.105	0.1892	9	4.5	2.50	0.4	1.33	23	93.9%	23	92.0%	6.0	1.33
722	27	158	5.9	0.82	38	1.41	0.153	0.2405	3	3.0		0.1	0.86	26	98.1%	26	96.3%	6.0	0.84
723	26	121	4.7	0.78	42	1.62	0.229	0.3471	17	5.7	1.76	0.3	1.06	23	86.0%	23	88.5%	4.5	0.86
724	48	234	4.9	0.53	67	1.40	0.129	0.2863	47	5.9	1.80	5.9	0.95	40	79.9%	40	83.3%	4.7	0.54
725	0													0		0			
726	0													0		0			
727	0													0		0			
728	0													0		0			
729	0													0		0			
730	25	85	3.4	0.32	25	1.00	0.191	0.2941	27	3.9	0.51	0.7	0.42	18	68.2%	18	72.0%	3.2	0.40
731	22	112	5.1	0.83	31	1.41	0.182	0.2768	10	10.0		0.3	0.99	21	91.1%	21	95.5%	4.9	0.84
801	0													0		0			
802	0													0		0			

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Appendix Table 2c. Summary of the drift gillnet effort and chinook salmon catch statistics for crew C of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
803	23	124	5.4	0.97	28	1.22	0.153	0.2258	16	5.3	0.88	6.3	1.15	20	87.1%	20	87.0%	5.4	1.11
804	18	80	4.4	0.75	28	1.56	0.232	0.3500	13	6.5	1.50	5.0	1.15	16	83.8%	16	88.9%	4.2	0.81
805	18	87	4.8	1.02	23	1.28	0.253	0.2644	34	8.5	3.57	0.2	1.69	14	60.9%	14	77.8%	3.8	0.72
806	23	127	5.5	0.95	19	0.83	0.136	0.1496	67	9.6	1.86	6.9	1.72	16	47.2%	16	69.6%	3.8	0.77
807	17	127	7.5	1.48	18	1.06	0.181	0.1417	25	6.3	1.25	0.1	2.01	13	80.3%	13	76.5%	7.8	1.91
808	0													0		0			
809	0													0		0			
810	10	57	5.7	1.99	9	0.90	0.180	0.1579	9	4.5	0.50	7.1	2.33	8	84.2%	8	80.0%	6.0	2.51
811	0													0		0			
812	0													0		0			
813	14	159	11.4	3.43	10	0.71	0.125	0.0629	61	15.3	4.77	15.9	6.44	10	61.6%	10	71.4%	9.8	4.45
814	0													0		0			
TOT	1,103	8,446	7.7	0.25	1,208	1.10	0.025	0.1430	2,843	12.4	4.93	0.9	0.45	873	66.3%	873	79.1%	6.4	4.91

[1] SE = standard error of estimate.

[2] SS = sample size.

Appendix Table 2d. Summary of the drift gillnet effort and chinook salmon catch statistics for crew D of the Kenai River tagging project, 1986.

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
517	9	183	20.3	9.76	1	0.11	0.111	0.0055	179	22.4	10.82	55.0		1	2.2%	1	11.1%	4.0	
518	7	214	30.6	6.41	0	0.00	0.000	0.0000	214	30.6	6.41			0	0.0%	0	0.0%		
519	11	137	12.5	2.71	7	0.64	0.279	0.0511	54	9.0	2.38	24.6	6.47	5	60.6%	5	45.5%	16.6	4.92
520	6	157	26.2	9.47	1	0.17	0.167	0.0064	149	29.8	10.71	29.0		1	5.1%	1	16.7%	8.0	
521	0													0		0			
522	0													0		0			
523	13	211	16.2	3.23	9	0.69	0.208	0.0427	126	21.0	4.87	27.4	14.90	7	40.3%	7	53.8%	12.1	3.97
524	18	161	8.9	1.68	12	0.67	0.114	0.0745	63	10.5	3.49	11.7	4.03	12	60.9%	12	66.7%	8.2	1.91
525	13	114	8.8	1.96	10	0.77	0.201	0.0877	41	8.2	3.48	12.0	2.26	8	64.0%	8	61.5%	9.1	2.52
526	12	133	11.1	1.99	10	0.83	0.207	0.0752	38	9.5	1.50	16.0	6.41	8	71.4%	8	66.7%	11.9	2.93
527	0													0		0			
528	0													0		0			
529	0													0		0			
530	10	124	12.4	2.79	3	0.30	0.153	0.0242	71	10.1	2.33	19.3	8.99	3	42.7%	3	30.0%	17.7	7.69
531	13	152	11.7	2.09	9	0.69	0.133	0.0592	54	13.5	0.50	13.8	2.80	9	64.5%	9	69.2%	10.9	3.03
601	14	133	9.5	1.77	15	1.07	0.221	0.1128	36	12.0	1.53	12.1	3.06	11	72.9%	11	78.6%	8.8	2.20
602	15	160	10.7	2.71	14	0.93	0.153	0.0875	32	10.7	4.37	13.8	4.56	12	80.0%	12	80.0%	10.7	3.29
603	6	84	14.0	4.15	3	0.50	0.224	0.0357	50	16.7	5.67	28.0	2.08	3	40.5%	3	50.0%	11.3	6.84
604	0													0		0			
605	0													0		0			
606	16	96	6.0	0.84	23	1.44	0.316	0.2396	28	7.0	1.58	6.5	1.43	12	70.8%	12	75.0%	5.7	1.00
607	22	71	3.2	0.46	35	1.59	0.215	0.4930	6	6.0		3.1	0.46	21	91.5%	21	95.5%	3.1	0.46
608	21	127	6.0	0.83	24	1.14	0.173	0.1890	29	7.3	1.65	7.5	1.18	17	77.2%	17	81.0%	5.8	0.95
609	20	76	3.8	0.73	21	1.05	0.170	0.2763	17	3.4	1.03	4.7	1.11	15	77.6%	15	75.0%	3.9	0.92
610	27	59	2.2	0.28	37	1.37	0.186	0.6271	11	2.8	1.11	2.6	0.42	23	81.4%	23	85.2%	2.1	0.27
611	0													0		0			

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Appendix Table 2d. Summary of the drift gillnet effort and chinook salmon catch statistics for crew D of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
612	0													0		0			
613	26	74	2.8	0.40	36	1.38	0.167	0.4865	5	1.7	0.67	3.2	0.49	23	93.2%	23	88.5%	3.0	0.44
614	23	56	2.4	0.33	37	1.61	0.233	0.6607	11	2.8	1.11	2.9	0.44	19	80.4%	19	82.6%	2.4	0.34
615	23	91	4.0	0.59	30	1.30	0.213	0.3297	13	4.3	2.03	4.2	0.68	20	85.7%	20	87.0%	3.9	0.63
616	17	78	4.6	0.91	18	1.06	0.218	0.2308	35	7.0	1.92	6.5	2.05	12	55.1%	12	70.6%	3.6	0.00
617	19	82	4.3	0.94	15	0.79	0.123	0.1829	15	3.0	1.30	5.3	1.32	14	81.7%	14	73.7%	4.8	1.18
618	0													0		0			
619	0													0		0			
620	12	226	18.8	5.26	5	0.42	0.149	0.0221	147	21.0	8.10	35.6	15.17	5	35.0%	5	41.7%	15.8	6.41
621	11	142	12.9	5.02	9	0.82	0.182	0.0634	40	13.3	4.98	15.1	6.73	8	71.8%	8	72.7%	12.8	6.84
622	0													0		0			
623	11	140	12.7	3.06	16	1.45	0.247	0.1143	4	4.0		13.6	3.24	10	97.1%	10	90.9%	13.6	3.24
624	13	129	9.9	2.11	20	1.54	0.183	0.1550				9.9	2.11	13	100.0%	13	100.0%	9.9	2.11
625	0													0		0			
626	0													0		0			
627	23	90	3.9	0.88	26	1.13	0.145	0.2889	10	3.3	2.33	4.5	1.01	20	88.9%	20	87.0%	4.0	0.97
628	24	92	3.8	0.42	28	1.17	0.130	0.3043	9	3.0	0.58	4.4	0.57	21	90.2%	21	87.5%	4.0	0.47
629	16	150	9.4	1.76	14	0.88	0.125	0.0933	7	2.3	0.88	11.2	1.94	13	95.3%	13	81.3%	11.0	1.89
630	17	135	7.9	2.60	12	0.71	0.143	0.0889	51	8.5	3.35	12.0	5.04	11	62.2%	11	64.7%	7.6	3.69
701	0													0		0			
702	0													0		0			
703	0													0		0			
704	19	131	6.9	1.17	17	0.89	0.130	0.1298	17	4.3	1.97	8.7	2.05	15	87.0%	15	78.9%	7.6	1.36
705	0													0		0			
706	8	175	21.9	6.81	4	0.50	0.189	0.0229	120	30.0	11.32	25.0	9.87	4	31.4%	4	50.0%	13.8	6.64
707	11	226	20.5	5.70	5	0.45	0.157	0.0221	147	24.5	8.40	36.6	18.71	5	35.0%	5	45.5%	15.8	7.92

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Appendix Table 2d. Summary of the drift gillnet effort and chinook salmon catch statistics for crew D of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
708	7	214	30.6	8.00	2	0.29	0.184	0.0093	210	42.0	4.47	70.5	69.50	2	1.9%	2	28.6%	2.0	1.00
709	0													0		0			
710	0													0		0			
711	18	110	6.1	1.54	16	0.89	0.137	0.1455	21	5.3	2.66	7.4	2.04	14	80.9%	14	77.8%	6.4	1.87
712	16	130	8.1	1.26	15	0.94	0.170	0.1154	28	7.0	2.74	10.4	2.46	12	78.5%	12	75.0%	8.5	1.46
713	44	80	1.8	0.25	72	1.64	0.126	0.9000				1.8	0.25	44	100.0%	44	100.0%	1.8	0.25
714	26	89	3.4	0.45	24	0.92	0.146	0.2697	26	3.7	0.68	4.4	0.72	19	70.8%	19	73.1%	3.3	0.57
715	34	89	2.6	0.38	41	1.21	0.125	0.4607	16	4.0	1.78	3.0	0.47	30	82.0%	30	88.2%	2.4	0.36
716	0													0		0			
717	0													0		0			
718	24	107	4.5	0.91	26	1.08	0.158	0.2430	28	5.6	1.40	5.6	1.42	19	73.8%	19	79.2%	4.2	1.10
719	19	136	7.2	2.52	25	1.32	0.242	0.1838	11	2.8	1.18	9.1	3.14	15	91.9%	15	78.9%	8.3	3.13
720	25	144	5.8	1.04	29	1.16	0.197	0.2014	31	6.2	2.40	7.2	1.36	20	78.5%	20	80.0%	5.7	1.19
721	23	134	5.8	0.95	28	1.22	0.188	0.2090	9	3.0	2.00	6.4	1.05	20	93.3%	20	87.0%	6.3	1.03
722	24	123	5.1	1.35	27	1.13	0.211	0.2195	55	7.9	4.30	7.2	2.05	17	55.3%	17	70.8%	4.0	0.74
723	0													0		0			
724	0													0		0			
725	16	105	6.6	1.72	17	1.06	0.213	0.1619	23	5.8	2.87	8.8	2.14	12	78.1%	12	75.0%	6.8	2.15
726	22	124	5.6	1.46	27	1.23	0.173	0.2177	24	8.0	4.04	6.1	1.72	19	80.6%	19	86.4%	5.3	1.60
727	22	88	4.0	0.69	24	1.09	0.207	0.2727	23	3.3	0.92	5.6	1.11	15	73.9%	15	68.2%	4.3	0.93
728	20	114	5.7	0.99	19	0.95	0.153	0.1667	24	4.8	1.93	7.5	1.66	15	78.9%	15	75.0%	6.0	1.18
729	22	102	4.6	0.99	24	1.09	0.173	0.2353	38	7.6	3.99	6.0	1.42	17	62.7%	17	77.3%	3.8	0.55
730	0													0		0			
731	0													0		0			
801	25	110	4.4	0.72	28	1.12	0.194	0.2545	28	4.7	1.23	5.8	1.63	19	74.5%	19	76.0%	4.3	0.88
802	21	97	4.6	0.92	23	1.10	0.248	0.2371	27	4.5	1.28	5.3	1.53	15	72.2%	15	71.4%	4.7	1.20

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Appendix Table 2d. Summary of the drift gillnet effort and chinook salmon catch statistics for crew D of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
803	31	85	2.7	0.26	35	1.13	0.137	0.4118	14	2.3	0.80	3.3	0.45	25	83.5%	25	80.6%	2.8	0.27
804	29	119	4.1	0.50	26	0.90	0.115	0.2185	33	4.7	0.78	5.4	0.82	22	72.3%	22	75.9%	3.9	0.61
805	16	78	4.9	0.68	25	1.56	0.223	0.3205				4.9	0.68	16	100.0%	16	100.0%	4.9	0.68
806	0													0		0			
807	0													0		0			
808	20	125	6.3	1.11	19	0.95	0.153	0.1520	26	5.2	2.08	7.5	1.79	15	79.2%	15	75.0%	6.6	1.34
809	22	118	5.4	0.70	25	1.14	0.178	0.2119	36	7.2	2.06	6.4	1.11	17	69.5%	17	77.3%	4.8	0.67
810	16	109	6.8	1.28	15	0.94	0.193	0.1376	31	7.8	2.17	8.3	2.05	12	71.6%	12	75.0%	6.5	1.58
811	11	167	15.2	3.19	10	0.91	0.211	0.0599	59	19.7	10.27	15.9	3.54	8	64.7%	8	72.7%	13.5	2.69
812	13	194	14.9	3.42	12	0.92	0.239	0.0619	73	18.3	5.94	22.8	7.10	9	62.4%	9	69.2%	13.4	4.31
813	0													0		0			
814	14	129	9.2	2.48	7	0.50	0.174	0.0543	93	11.6	3.84	19.0	13.18	6	27.9%	6	42.9%	6.0	2.52
TOT	1,106	7,629	6.9	0.27	1,167	1.06	0.025	0.1530	2,816	10.4	7.36	7.8	0.41	835	63.1%	835	75.5%	5.8	5.74

[1] SE = standard error of estimate.

[2] SS = sample size.

Appendix Table 2e. Summary of the drift gillnet effort and chinook salmon catch statistics for all crews combined of the Kenai River tagging project, 1986.

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
517	14	369	26.4	7.63	1	0.07	0.071	0.0027	365	28.1	8.03	55.0		1	1.1%	1	7.1%	4.0	
518	12	412	34.3	5.00	1	0.08	0.083	0.0024	351	31.9	4.79	61.0		1	14.8%	1	8.3%	61.0	
519	34	660	19.4	2.82	16	0.47	0.121	0.0242	381	18.1	3.29	33.2	9.27	13	42.3%	13	38.2%	21.5	5.25
520	27	674	25.0	3.47	6	0.22	0.082	0.0089	519	24.7	3.87	59.8	17.45	6	23.0%	6	22.2%	25.8	8.49
521	22	417	19.0	2.83	3	0.14	0.075	0.0072	363	19.1	3.21	126.3	38.27	3	12.9%	3	13.6%	18.0	5.57
522	17	485	28.5	3.92	3	0.18	0.095	0.0062	447	31.9	4.06	111.3	32.33	3	7.8%	3	17.6%	12.7	6.67
523	23	421	18.3	3.01	14	0.61	0.151	0.0333	256	21.3	4.74	34.4	13.03	11	39.2%	11	47.8%	15.0	3.56
524	32	318	9.9	1.21	25	0.78	0.125	0.0786	118	10.7	2.09	13.1	2.55	21	62.9%	21	65.6%	9.5	1.50
525	24	257	10.7	1.53	21	0.88	0.163	0.0817	70	8.8	2.18	14.9	2.07	16	72.8%	16	66.7%	11.7	2.03
526	22	256	11.6	2.26	17	0.77	0.130	0.0664	97	13.9	4.97	16.7	5.53	15	62.1%	15	68.2%	10.6	2.46
527	23	347	15.1	2.41	15	0.65	0.102	0.0432	136	17.0	4.77	21.9	4.58	15	60.8%	15	65.2%	14.1	2.78
528	27	374	13.9	1.74	14	0.52	0.098	0.0374	190	14.6	2.06	22.6	3.33	14	49.2%	14	51.9%	13.1	2.82
529	37	312	8.4	0.96	38	1.03	0.119	0.1218	56	8.0	1.88	9.7	1.22	30	82.1%	30	81.1%	8.5	1.11
530	19	218	11.5	2.32	13	0.68	0.154	0.0596	80	10.0	2.03	13.8	3.91	11	63.3%	11	57.9%	12.5	3.79
531	28	251	9.0	1.44	24	0.86	0.112	0.0956	79	11.3	1.81	10.6	1.87	21	68.5%	21	75.0%	8.2	1.81
601	41	437	10.7	1.36	35	0.85	0.108	0.0801	131	10.9	2.14	14.8	2.83	29	70.0%	29	70.7%	10.6	1.73
602	49	502	10.2	1.17	38	0.78	0.093	0.0757	212	13.3	1.87	13.0	2.11	33	57.8%	33	67.3%	8.8	1.44
603	22	313	14.2	2.58	15	0.68	0.138	0.0479	115	12.8	2.52	23.7	4.65	13	63.3%	13	59.1%	15.2	4.07
604	35	304	8.7	1.33	38	1.09	0.155	0.1250	131	13.1	3.22	10.3	2.18	25	56.9%	25	71.4%	6.9	1.23
605	37	341	9.2	1.40	31	0.84	0.113	0.0909	160	14.5	3.46	12.0	2.66	26	53.1%	26	70.3%	7.0	1.13
606	40	184	4.6	0.57	56	1.40	0.163	0.3043	40	6.7	1.28	4.6	0.75	34	78.3%	34	85.0%	4.2	0.62
607	47	160	3.4	0.41	67	1.43	0.142	0.4188	26	5.2	0.73	3.6	0.50	42	83.8%	42	89.4%	3.2	0.44
608	77	337	4.4	0.38	99	1.29	0.108	0.2938	89	5.9	0.95	5.4	0.56	62	73.6%	62	80.5%	4.0	0.40
609	57	291	5.1	0.54	69	1.21	0.129	0.2371	69	5.3	1.11	6.0	0.97	44	76.3%	44	77.2%	5.0	0.63
610	94	257	2.7	0.22	146	1.55	0.115	0.5681	33	2.5	0.45	3.2	0.28	81	87.2%	81	86.2%	2.8	0.24
611	50	215	4.3	0.35	79	1.58	0.169	0.3674	27	5.4	1.44	4.4	0.46	45	87.4%	45	90.0%	4.2	0.36

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Appendix Table 2e. Summary of the drift gillnet effort and chinook salmon catch statistics for all crews combined of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
612	52	237	4.6	0.45	77	1.48	0.161	0.3249	33	6.6	1.81	4.9	0.56	47	86.1%	47	90.4%	4.3	0.45
613	53	141	2.7	0.24	69	1.30	0.113	0.4894	8	1.3	0.33	3.0	0.28	47	94.3%	47	88.7%	2.8	0.26
614	28	79	2.8	0.43	49	1.75	0.216	0.6203	11	2.8	1.11	3.3	0.51	24	86.1%	24	85.7%	2.8	0.48
615	75	420	5.6	0.46	78	1.04	0.090	0.1857	113	7.5	1.22	6.6	0.79	60	73.1%	60	80.0%	5.1	0.48
616	79	519	6.6	0.60	73	0.92	0.091	0.1407	229	10.0	1.37	8.5	1.04	56	55.9%	56	70.9%	5.2	0.00
617	74	533	7.2	0.77	57	0.77	0.085	0.1069	188	7.2	1.17	10.2	1.44	48	64.7%	48	64.9%	7.2	0.00
618	39	418	10.7	0.88	20	0.51	0.103	0.0478	239	10.9	0.88	23.4	5.01	17	42.8%	17	43.6%	10.5	1.72
619	32	331	10.3	1.36	26	0.81	0.158	0.0785	153	11.8	2.56	16.6	4.08	19	53.8%	19	59.4%	9.4	1.49
620	27	383	14.2	2.91	14	0.52	0.098	0.0366	259	19.9	4.89	21.8	6.38	14	32.4%	14	51.9%	8.9	2.78
621	20	285	14.3	3.23	19	0.95	0.170	0.0667	93	18.6	5.57	17.6	4.65	15	67.4%	15	75.0%	12.8	3.91
622	43	500	11.6	1.84	34	0.79	0.091	0.0680	177	13.6	1.98	15.8	3.55	30	64.6%	30	69.8%	10.8	2.50
623	43	465	10.8	1.24	48	1.12	0.121	0.1032	76	10.9	3.55	12.8	1.65	36	83.7%	36	83.7%	10.8	1.33
624	46	468	10.2	1.11	57	1.24	0.109	0.1218	59	11.8	2.56	11.1	1.30	41	87.4%	41	89.1%	10.0	1.21
625	43	298	6.9	0.79	48	1.12	0.111	0.1611	67	8.4	1.91	7.4	1.04	35	77.5%	35	81.4%	6.6	0.87
626	44	330	7.5	0.83	41	0.93	0.094	0.1242	85	9.4	1.49	9.4	1.25	35	74.2%	35	79.5%	7.0	0.96
627	50	195	3.9	0.50	57	1.14	0.103	0.2923	29	4.1	1.10	4.5	0.60	43	85.1%	43	86.0%	3.9	0.56
628	54	199	3.7	0.31	58	1.07	0.087	0.2915	34	3.8	0.97	4.4	0.50	45	82.9%	45	83.3%	3.7	0.33
629	37	318	8.6	0.96	29	0.78	0.096	0.0912	95	8.6	1.84	11.1	1.37	26	70.1%	26	70.3%	8.6	1.15
630	61	623	10.2	1.20	47	0.77	0.079	0.0754	270	13.5	1.94	15.1	2.50	41	56.7%	41	67.2%	8.6	1.46
701	25	285	11.4	2.12	30	1.20	0.115	0.1053	2	2.0		11.9	2.20	24	99.3%	24	96.0%	11.8	2.18
702	41	261	6.4	0.85	60	1.46	0.121	0.2299	13	4.3	1.45	6.9	0.88	38	95.0%	38	92.7%	6.5	0.91
703	45	203	4.5	0.67	56	1.24	0.111	0.2759	36	9.0	5.02	5.0	0.79	41	82.3%	41	91.1%	4.1	0.56
704	37	313	8.5	1.23	34	0.92	0.081	0.1086	42	7.0	2.24	10.1	1.56	31	86.6%	31	83.8%	8.7	1.41
705	8	128	16.0	6.08	5	0.63	0.183	0.0391	81	27.0	14.57	23.6	9.87	5	36.7%	5	62.5%	9.4	3.30
706	42	608	14.5	2.12	25	0.60	0.097	0.0411	355	18.7	3.70	22.6	5.17	23	41.6%	23	54.8%	11.0	2.21
707	34	611	18.0	2.89	18	0.53	0.097	0.0295	421	24.8	4.55	28.6	7.53	17	31.1%	17	50.0%	11.2	2.82

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Appendix Table 2e. Summary of the drift gillnet effort and chinook salmon catch statistics for all crews combined of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
708	25	611	24.4	3.63	12	0.48	0.117	0.0196	414	29.6	4.58	40.5	12.51	11	32.2%	11	44.0%	17.9	5.42
709	31	342	11.0	1.56	24	0.77	0.111	0.0702	164	16.4	3.25	13.7	2.43	21	52.0%	21	67.7%	8.5	1.45
710	35	345	9.9	1.34	26	0.74	0.155	0.0754	231	13.6	2.12	18.1	3.86	18	33.0%	18	51.4%	6.3	1.21
711	33	199	6.0	1.03	26	0.79	0.104	0.1307	73	7.3	1.75	7.5	1.52	23	63.3%	23	69.7%	5.5	1.27
712	35	284	8.1	1.03	32	0.91	0.132	0.1127	93	9.3	2.03	10.3	1.61	25	67.3%	25	71.4%	7.6	1.20
713	116	384	3.3	0.41	165	1.42	0.082	0.4297	56	6.2	2.01	3.6	0.49	107	85.4%	107	92.2%	3.1	0.41
714	109	401	3.7	0.39	133	1.22	0.088	0.3317	99	5.0	1.02	4.2	0.45	89	75.3%	89	81.7%	3.4	0.41
715	108	424	3.9	0.42	143	1.32	0.092	0.3373	58	3.9	0.60	4.4	0.51	93	86.3%	93	86.1%	3.9	0.48
716	82	266	3.2	0.26	108	1.32	0.096	0.4060	51	5.1	0.91	3.4	0.35	72	80.8%	72	87.8%	3.0	0.00
717	65	258	4.0	0.42	94	1.45	0.137	0.3643	52	5.2	1.41	4.3	0.55	55	79.8%	55	84.6%	3.7	0.43
718	43	185	4.3	0.61	44	1.02	0.118	0.2378	51	4.6	1.15	5.8	1.00	32	72.4%	32	74.4%	4.2	0.73
719	40	227	5.7	1.32	51	1.28	0.160	0.2247	45	5.0	1.79	6.8	1.71	31	80.2%	31	77.5%	5.9	1.63
720	73	535	7.3	0.79	89	1.22	0.111	0.1664	131	10.1	1.78	8.5	1.17	60	75.5%	60	82.2%	6.7	0.87
721	96	547	5.7	0.50	106	1.10	0.080	0.1938	70	3.7	0.67	7.0	0.64	77	87.2%	77	80.2%	6.2	0.59
722	85	448	5.3	0.53	105	1.24	0.091	0.2344	78	6.0	2.37	6.2	0.67	72	82.6%	72	84.7%	5.1	0.46
723	50	222	4.4	0.46	79	1.58	0.149	0.3559	25	5.0	1.10	4.9	0.60	45	88.7%	45	90.0%	4.4	0.50
724	48	234	4.9	0.53	67	1.40	0.129	0.2863	47	5.9	1.80	5.9	0.95	40	79.9%	40	83.3%	4.7	0.54
725	30	239	8.0	1.73	30	1.00	0.173	0.1255	45	5.0	1.45	11.4	2.48	21	81.2%	21	70.0%	9.2	2.37
726	43	210	4.9	0.91	55	1.28	0.117	0.2619	34	6.8	2.33	5.3	1.07	38	83.8%	38	88.4%	4.6	0.99
727	59	238	4.0	0.46	81	1.37	0.123	0.3403	28	3.1	0.75	4.7	0.57	50	88.2%	50	84.7%	4.2	0.53
728	69	384	5.6	0.65	80	1.16	0.094	0.2083	67	5.6	1.37	6.5	0.95	57	82.6%	57	82.6%	5.6	0.74
729	65	309	4.8	0.51	69	1.06	0.109	0.2233	114	6.3	1.31	6.6	0.98	47	63.1%	47	72.3%	4.1	0.48
730	43	199	4.6	0.52	61	1.42	0.180	0.3065	34	4.3	0.59	5.2	0.68	35	82.9%	35	81.4%	4.7	0.62
731	41	213	5.2	0.62	57	1.39	0.163	0.2676	44	6.3	2.29	6.3	0.88	34	79.3%	34	82.9%	5.0	0.59
801	46	202	4.4	0.50	52	1.13	0.134	0.2574	40	4.4	1.08	5.5	0.95	37	80.2%	37	80.4%	4.4	0.58
802	37	158	4.3	0.69	44	1.19	0.173	0.2785	42	4.2	1.25	5.2	1.04	27	73.4%	27	73.0%	4.3	0.84

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Appendix Table 2e. Summary of the drift gillnet effort and chinook salmon catch statistics for all crews combined of the Kenai River tagging project, 1986 (continued).

Date	1. TS	2. TE	3. MD	SE[1] MD	4. TC	5. MC	SE[1] MC	6. CPUE	9. TE=0	10. MD=0	SE[1] MD=0	11. MEB	SE[1] MEB	SS[2] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[1] MD>0
803	100	397	4.0	0.34	131	1.31	0.100	0.3300	53	3.1	0.52	4.8	0.42	83	86.6%	83	83.0%	4.1	0.39
804	92	353	3.8	0.29	111	1.21	0.096	0.3144	78	4.6	0.63	4.7	0.46	75	77.9%	75	81.5%	3.7	0.32
805	61	294	4.8	0.49	81	1.33	0.114	0.2755	51	7.3	2.02	5.4	0.66	54	82.7%	54	88.5%	4.5	0.47
806	40	230	5.8	0.63	46	1.15	0.181	0.2000	93	8.5	1.28	7.4	1.12	29	59.6%	29	72.5%	4.7	0.64
807	32	239	7.5	0.95	47	1.47	0.185	0.1967	39	6.5	1.12	8.3	1.20	26	83.7%	26	81.3%	7.7	1.15
808	38	252	6.6	0.85	39	1.03	0.122	0.1548	38	4.2	1.18	8.2	1.19	29	84.9%	29	76.3%	7.4	1.02
809	44	203	4.6	0.45	45	1.02	0.128	0.2217	50	4.5	1.18	5.8	0.66	33	75.4%	33	75.0%	4.6	0.47
810	41	296	7.2	0.94	40	0.98	0.133	0.1351	83	6.9	1.08	9.9	1.63	29	72.0%	29	70.7%	7.3	1.26
811	20	360	18.0	3.53	14	0.70	0.147	0.0389	201	25.1	7.24	23.0	7.65	12	44.2%	12	60.0%	13.3	2.91
812	25	353	14.1	2.32	21	0.84	0.197	0.0595	193	19.3	3.55	20.1	5.13	15	45.3%	15	60.0%	10.7	2.80
813	27	316	11.7	2.32	17	0.63	0.095	0.0538	170	17.0	4.05	14.5	4.05	17	46.2%	17	63.0%	8.6	2.62
814	26	221	8.5	1.51	17	0.65	0.123	0.0769	107	9.7	2.94	13.7	5.31	15	51.6%	15	57.7%	7.6	1.55
TOT	4,095	29,841	7.3	0.13	4,455	1.09	0.014	0.1493	11,051	11.2	7.58	8.5	0.23	3107	63.0%	3,107	75.9%	6.0	5.19

[1] SE = standard error of estimate.

[2] SS = sample size.

Appendix Table 3. Summary of the drift gillnet effort and chinook salmon catch statistics, by stratum, using data from days when three or fewer crews operated, 1986.

Stratum	Statistic: d[1]	D[2]	1. TS	2. TE	3. MD	SE[3] MD	4. TC	5. MC	SE[3] MC	6. CPUE	9. TE=0	10. MD=0	SE[3] MD=0	11. MEB	SE[3] MEB	12. %E>0	13. TS>0	14. %S>0	15. MD>0	SE[3] MD>0
5/17-5/31	13	15	300	4,437	14.8	1.21	189	0.63	0.046	0.0426	2,608	18.9	1.36	20.3	5.82	41.2%	162	54.0%	11.3	1.71
6/01-6/15	10	15	448	2,454	5.5	0.55	573	1.28	0.069	0.2335	717	8.9	1.01	6.1	0.78	70.8%	367	81.9%	4.7	0.42
6/16-6/30	11	15	432	3,722	8.6	0.71	394	0.91	0.046	0.1059	1,307	11.2	1.08	11.1	1.37	64.9%	315	72.9%	7.7	0.68
7/01-7/15	11	15	349	3,582	10.3	1.15	323	0.93	0.058	0.0902	1,570	16.5	2.07	12.4	2.30	56.2%	254	72.8%	7.9	0.87
7/16-7/28	10	13	529	2,463	4.7	0.31	689	1.30	0.046	0.2797	445	5.1	0.43	5.4	0.47	81.9%	441	83.4%	4.6	0.40
7/29-8/14	14	17	525	3,551	6.8	0.60	569	1.08	0.048	0.1602	1,248	8.9	1.00	8.4	1.02	64.9%	385	73.3%	6.0	0.49

[1] Number of days sampled.

[2] Number of days in stratum.

[3] Standard error of estimate.

Appendix Table 4. Estimated numbers, by sex and age group, of chinook salmon in each stratum of the Kenai River abundance estimate, 1986.

Stratum	Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	2.4	Total
5/17 - 5/31	Male	Percent	6.3	16.5	18.4	5.7	0.6	47.5
(n = 158)[1]		Estimated Number	37	98	109	34	3	281
		Standard Error	73	197	220	66	3	
	Female	Percent	0.0	12.0	31.0	8.9	0.6	52.5
		Estimated Number	0	71	184	53	3	311
		Standard Error	0	142	373	105	3	
	Combined	Percent	6.3	28.5	49.4	14.6	1.2	100.0
		Estimated Number	37	169	293	87	8	592
		Standard Error	73	243	433	124	5	
6/01 - 6/15	Male	Percent	14.8	26.1	12.7	3.3	0.0	56.9
(n = 762)		Estimated Number	2,174	3,834	1,866	485	0	8,359
		Standard Error	894	1,562	770	214	0	
	Female	Percent	0.5	18.1	20.5	4.0	0.0	43.1
		Estimated Number	73	2,659	3,012	588	0	6,332
		Standard Error	45	1,089	1,231	250	0	
	Combined	Percent	15.3	44.2	33.2	7.2	0.0	100.0
		Estimated Number	2,247	6,493	4,878	1,073	0	14,691
		Standard Error	895	1,904	1,452	329	0	
6/16 - 6/30	Male	Percent	15.4	28.5	16.4	3.3	0.0	63.6
(n = 421)		Estimated Number	1,817	3,362	1,935	389	0	7,503
		Standard Error	1,197	2,206	1,274	266	0	
	Female	Percent	3.6	14.3	15.2	3.3	0.0	36.4
		Estimated Number	425	1,687	1,793	389	0	4,294
		Standard Error	289	1,113	1,182	266	0	
	Combined	Percent	19.0	42.8	31.6	6.6	0.0	100.0
		Estimated Number	2,242	5,049	3,728	778	0	11,797
		Standard Error	1,232	2,470	1,738	376	0	

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Appendix Table 4. Estimated numbers, by sex and age group, of chinook salmon in each stratum of the Kenai River abundance estimate, 1986 (continued).

Stratum	Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	2.4	Total
7/01 - 7/15	Male	Percent	17.9	26.2	14.6	2.6	0.0	61.3
(n = 576)		Estimated Number	761	1,113	620	110	0	2,604
		Standard Error	2,590	3,796	2,110	366	0	
	Female	Percent	2.1	17.9	17.2	1.5	0.0	38.7
		Estimated Number	89	761	731	64	0	1,645
		Standard Error	293	2,590	2,488	206	0	
	Combined	Percent	20.0	44.1	31.8	4.1	0.0	100.0
		Estimated Number	850	1,874	1,351	174	0	4,249
		Standard Error	2,606	4,595	3,263	420	0	
7/16 - 7/28	Male	Percent	12.9	24.4	16.2	1.6	0.0	55.1
(n = 495)		Estimated Number	5,613	10,616	7,048	696	0	23,973
		Standard Error	1,779	3,250	2,201	313	0	
	Female	Percent	0.4	25.3	18.0	1.2	0.0	44.9
		Estimated Number	174	11,008	7,831	522	0	19,535
		Standard Error	129	3,365	2,432	256	0	
	Combined	Percent	13.3	49.7	34.2	2.8	0.0	100.0
		Estimated Number	5,787	21,624	14,879	1,218	0	43,508
		Standard Error	1,784	4,678	3,280	404	0	
7/29 - 8/14	Male	Percent	2.8	17.0	24.1	2.1	0.0	46.0
(n = 569)		Estimated Number	275	1,667	2,363	206	0	4,511
		Standard Error	176	1,023	1,446	134	0	
	Female	Percent	0.4	21.8	27.8	4.0	0.0	54.0
		Estimated Number	39	2,138	2,726	392	0	5,295
		Standard Error	32	1,309	1,667	247	0	
	Combined	Percent	3.2	38.8	51.9	6.1	0.0	100.0
		Estimated Number	314	3,805	5,089	598	0	9,806
		Standard Error	179	1,661	2,207	281	0	

[1] n = sample size.

Appendix Table 5. Estimated age composition, by stratum, of chinook salmon harvested by the recreational fishery in the Kenai River, 1986.

Stratum	Sex	Statistic	Age Group 1.1	1.2	1.3	1.4	1.5	Total
5/20 - 5/31 (n = 49)[1]	Male	Percent	0.0	10.2	18.4	26.5	4.1	59.2
		Standard Error[2]	0.0	4.4	5.6	6.4	2.9	
	Female	Percent	0.0	0.0	6.1	26.5	8.2	40.8
		Standard Error	0.0	0.0	3.5	6.4	4.0	
	Combined	Percent	0.0	10.2	24.5	53.0	12.3	100.0
		Standard Error	0.0	4.4	6.6	9.0	4.9	
6/01 - 6/15 (n = 269)	Male	Percent	0.0	6.3	21.9	17.1	5.2	50.5
		Standard Error	0.0	1.5	2.5	2.3	1.4	
	Female	Percent	0.0	0.0	16.8	29.7	3.0	49.5
		Standard Error	0.0	0.0	2.3	2.8	1.0	
	Combined	Percent	0.0	6.3	38.7	46.8	8.2	100.0
		Standard Error	0.0	1.5	3.4	3.6	1.7	
6/16 - 6/30 (n = 215)	Male	Percent	0.5	5.6	17.2	16.7	3.7	43.7
		Standard Error	0.5	1.6	2.6	2.5	1.3	
	Female	Percent	0.0	1.4	17.2	33.5	4.2	56.3
		Standard Error	0.0	0.8	2.6	3.2	1.4	
	Combined	Percent	0.5	7.0	34.4	50.2	7.9	100.0
		Standard Error	0.5	1.8	3.6	4.1	1.9	

-continued-

Appendix Table 5. Estimated age composition, by stratum, of chinook salmon harvested by the recreational fishery in the Kenai River, 1986 (continued).

Stratum	Sex	Statistic	Age Group 1.1	1.2	1.3	1.4	1.5	Total
7/01 - 7/15 (n = 218)	Male	Percent	0.4	17.0	22.5	16.1	1.8	57.8
		Standard Error	0.4	2.5	2.8	2.5	0.9	
	Female	Percent	0.0	1.8	16.1	19.7	4.6	42.2
		Standard Error	0.0	0.9	2.5	2.7	1.4	
	Combined	Percent	0.4	18.8	38.6	35.8	6.4	100.0
		Standard Error	0.4	2.7	3.8	3.7	1.7	
7/16 - 7/28 (n = 192)	Male	Percent	0.0	3.6	20.3	26.6	3.6	54.1
		Standard Error	0.0	1.3	2.9	3.2	1.3	
	Female	Percent	0.0	0.6	19.3	23.4	2.6	45.9
		Standard Error	0.0	0.6	2.9	3.1	1.2	
	Combined	Percent	0.0	4.2	39.6	50.0	6.2	100.0
		Standard Error	0.0	1.5	4.1	4.4	1.8	
7/29 - 7/31 (n = 103)	Male	Percent	0.0	3.9	17.5	22.3	3.9	47.6
		Standard Error	0.0	1.9	3.8	4.1	1.9	
	Female	Percent	0.0	0.0	22.3	29.1	1.0	52.4
		Standard Error	0.0	0.0	4.1	4.5	1.0	
	Combined	Percent	0.0	3.9	39.8	51.4	4.9	100.0
		Standard Error	0.0	1.9	5.6	6.1	2.2	

[1] n = sample size.

[2] Standard error of proportional estimate of age composition x 100.

Appendix Table 6. Mean length (mm), by sex and age group, of chinook salmon sampled by gillnets in the Kenai River, 1986.

Stratum / Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	2.4
5/17 - 5/31						
Male	Mean Length	649.5	822.7	1,020.9	1,080.0	925.0
	Sample Size	10	26	29	9	1
	Standard Error	7.8	14.2	17.3	16.7	
Female	Mean Length		814.2	961.8	1,008.9	945.0
	Sample Size	0	19	49	14	1
	Standard Error		9.0	7.2	13.7	
6/01 - 6/15						
Male	Mean Length	659.7	816.0	991.3	1,080.2	
	Sample Size	113	199	97	25	0
	Standard Error	4.6	5.3	9.9	10.7	
Female	Mean Length	665.0	840.8	947.6	1,016.3	
	Sample Size	4	138	156	30	0
	Standard Error	21.0	4.2	4.6	8.1	
6/16 - 6/30						
Male	Mean Length	666.4	822.3	1,030.9	1,094.6	
	Sample Size	65	120	69	14	0
	Standard Error	5.1	7.9	11.7	13.7	
Female	Mean Length	677.0	848.6	962.9	1,049.3	
	Sample Size	15	60	64	14	0
	Standard Error	15.6	9.9	9.1	15.5	
7/01 - 7/15						
Male	Mean Length	677.8	854.4	1,054.0	1,124.1	
	Sample Size	103	151	84	15	0
	Standard Error	5.4	8.3	9.9	15.9	
Female	Mean Length	680.8	924.9	1,006.1	1,067.2	
	Sample Size	12	103	99	9	0
	Standard Error	14.3	4.3	5.5	13.5	
7/16 - 7/28						
Male	Mean Length	694.5	898.2	1,071.4	1,088.1	
	Sample Size	64	121	80	8	0
	Standard Error	7.7	8.4	8.5	15.0	
Female	Mean Length	695.0	929.5	1,017.6	1,046.7	
	Sample Size	2	125	89	6	0
	Standard Error	45.0	4.7	5.5	25.2	
7/29 - 8/14						
Male	Mean Length	713.8	931.3	1,073.4	1,131.3	
	Sample Size	16	97	137	12	0
	Standard Error	11.9	9.9	5.5	18.8	
Female	Mean Length	680.0	935.0	1,034.3	1,077.2	
	Sample Size	2	124	158	23	0
	Standard Error	40.0	3.1	3.9	14.1	

Appendix Table 7. Mean length (mm), by sex and age group, of chinook salmon sampled during creel surveys of the sport fishery in the Kenai River, 1986.

Stratum / Sex	Statistic	Age Group 1.1	1.2	1.3	1.4	1.5
5/20 - 5/31						
Male	Mean Length		675.0	831.0	1,020.9	1,055.0
	Sample Size	0	5	9	13	2
	Standard Error		14.3	34.8	19.3	5.0
Female	Mean Length			776.7	993.8	1,003.0
	Sample Size	0	0	3	13	4
	Standard Error			3.3	13.8	14.5
6/01 - 6/15						
Male	Mean Length		649.5	841.3	1,005.1	1,104.6
	Sample Size	0	17	59	46	14
	Standard Error		8.7	9.2	13.0	19.2
Female	Mean Length			842.4	945.5	1,039.5
	Sample Size	0	0	45	80	8
	Standard Error			8.8	6.7	16.2
6/16 - 6/30						
Male	Mean Length	380.0	647.4	861.8	1,050.0	1,070.0
	Sample Size	1	12	37	36	8
	Standard Error		27.7	17.4	13.0	41.8
Female	Mean Length		733.3	858.8	967.4	1,027.4
	Sample Size	0	3	37	72	9
	Standard Error		43.7	11.3	7.6	36.5
7/01 - 7/15						
Male	Mean Length	345.0	678.3	904.4	1,086.9	1,117.5
	Sample Size	1	37	49	35	4
	Standard Error		11.0	13.2	7.5	30.4
Female	Mean Length		680.0	915.2	1,027.2	1,060.5
	Sample Size	0	4	35	43	10
	Standard Error		40.3	9.6	7.8	24.7
7/16 - 7/28						
Male	Mean Length		654.0	933.4	1,084.6	1,136.4
	Sample Size	0	7	39	51	7
	Standard Error		34.1	14.2	8.5	27.5
Female	Mean Length		750.0	923.9	1,021.5	1,072.0
	Sample Size	0	1	37	45	5
	Standard Error			7.5	8.9	22.8
7/29 - 8/14						
Male	Mean Length		662.3	937.9	1,088.3	1,116.3
	Sample Size	0	4	18	23	4
	Standard Error		10.5	20.1	8.8	35.6
Female	Mean Length			949.9	1,020.1	1,065.0
	Sample Size	0	0	23	30	1
	Standard Error			7.7	9.8	

Appendix Table 8. Estimated age composition of chinook salmon sampled during surveys of spawning grounds on the mainstem Kenai River, 1986.

Dates	Sex	Statistic	Age Group 1.2	1.3	1.4	1.5	Total
9/08 - 9/12 (n = 614)[1]	Male	Percent	4.1	19.7	26.7	2.6	53.1
		Standard Error[2]	0.8	1.6	1.8	0.6	
	Female	Percent	0.2	16.8	25.7	4.2	46.9
		Standard Error	0.2	1.5	1.8	0.8	
	Combined	Percent	4.3	36.5	52.4	6.8	100.0
		Standard Error	0.8	2.2	2.5	1.0	

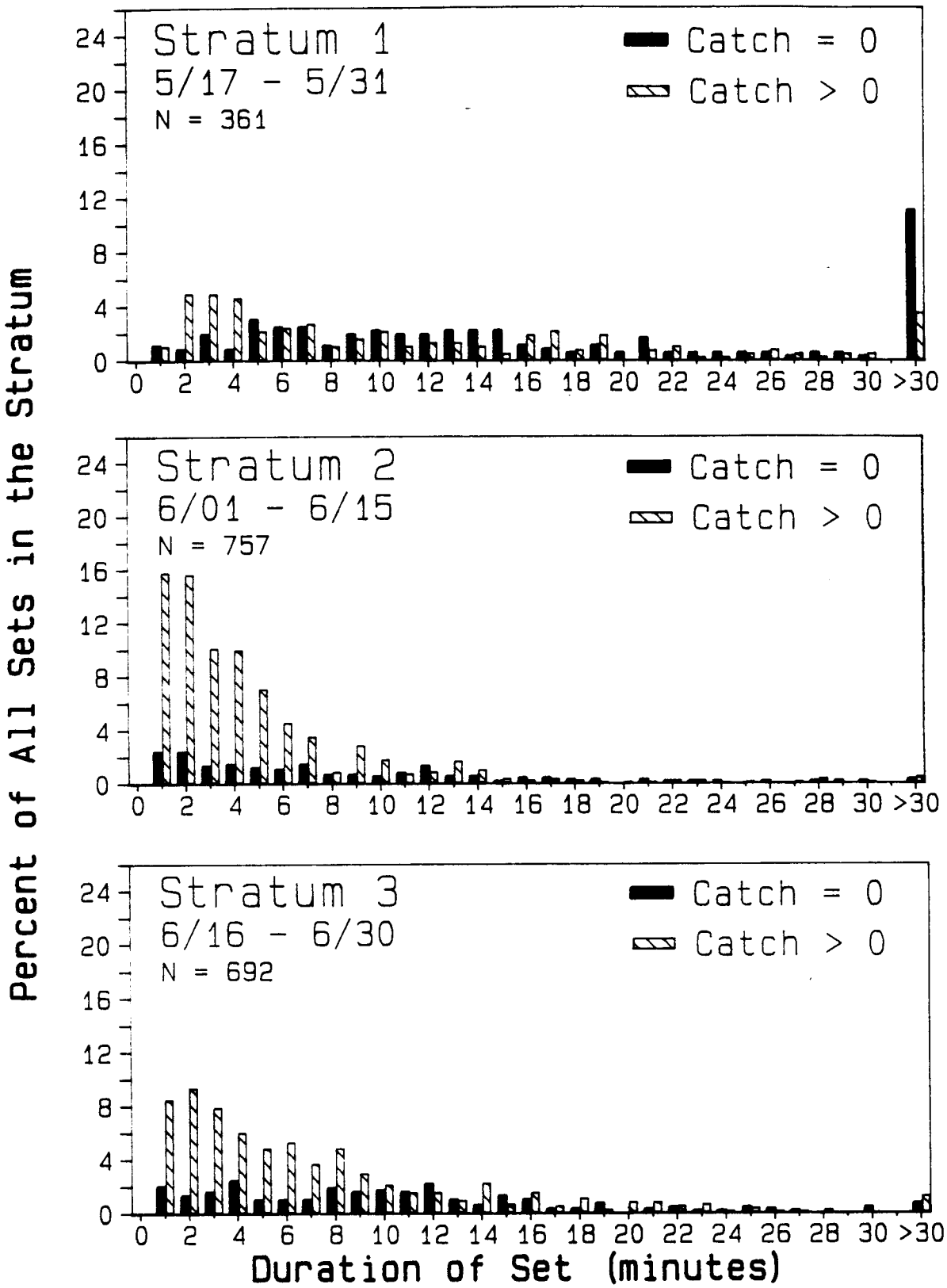
[1] n = sample size.

[2] Standard error of proportional estimate of age composition x 100.

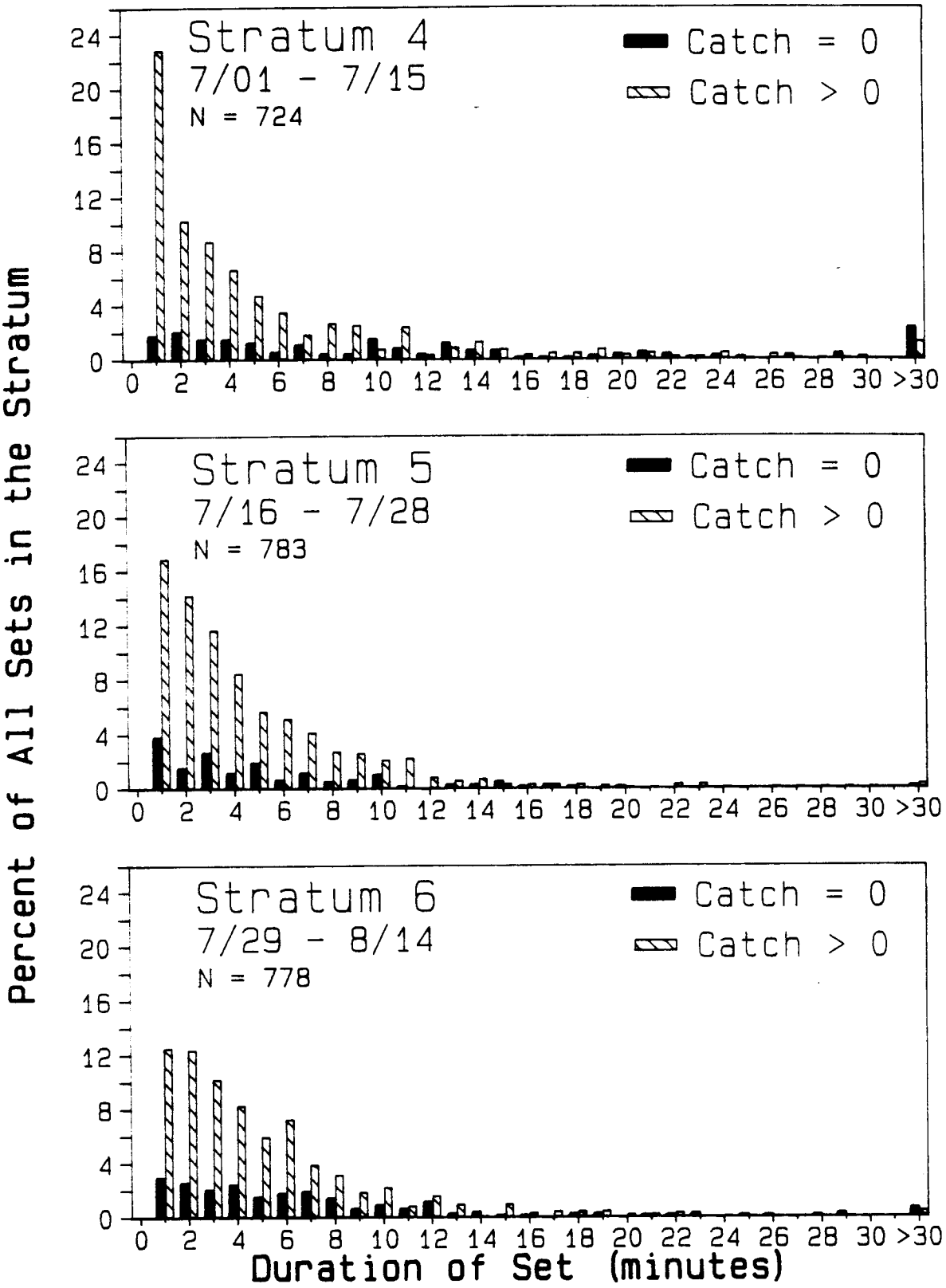
Appendix Table 9. Mean length (mm), by sex and age group, of chinook salmon sampled during surveys of spawning grounds on the mainstem Kenai River, 1986.

Dates / Sex	Statistic	Age Group 1.2	1.3	1.4	1.5
9/08 - 9/12					
Male	Mean Length	707.0	901.2	1,053.8	1,085.3
	Sample Size	25	121	164	16
	Standard Error	19.2	9.0	6.3	11.8
Female	Mean Length	630.0	912.6	1,004.8	1,023.7
	Sample Size	1	103	158	26
	Standard Error		6.0	4.9	13.3

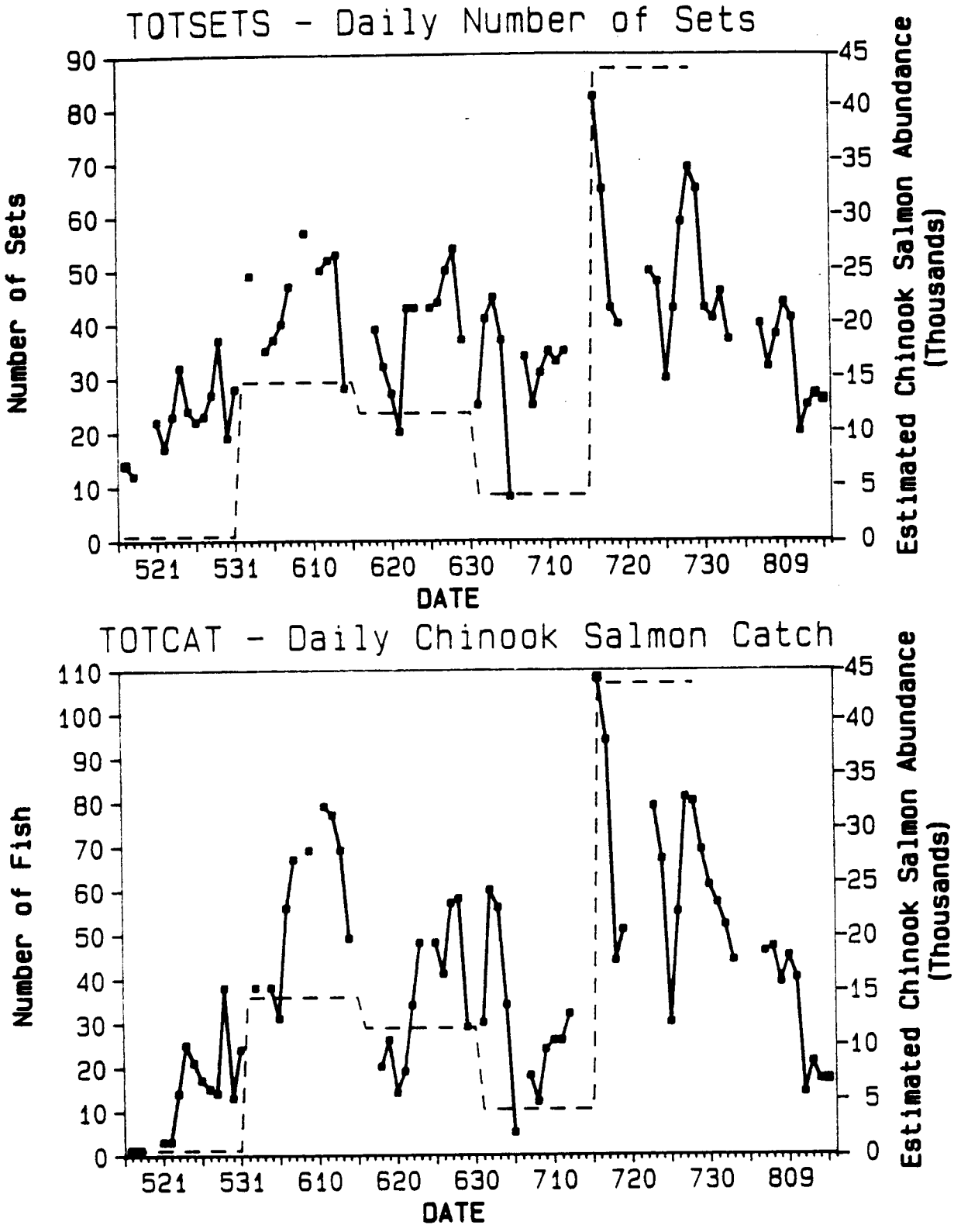
APPENDIX FIGURES



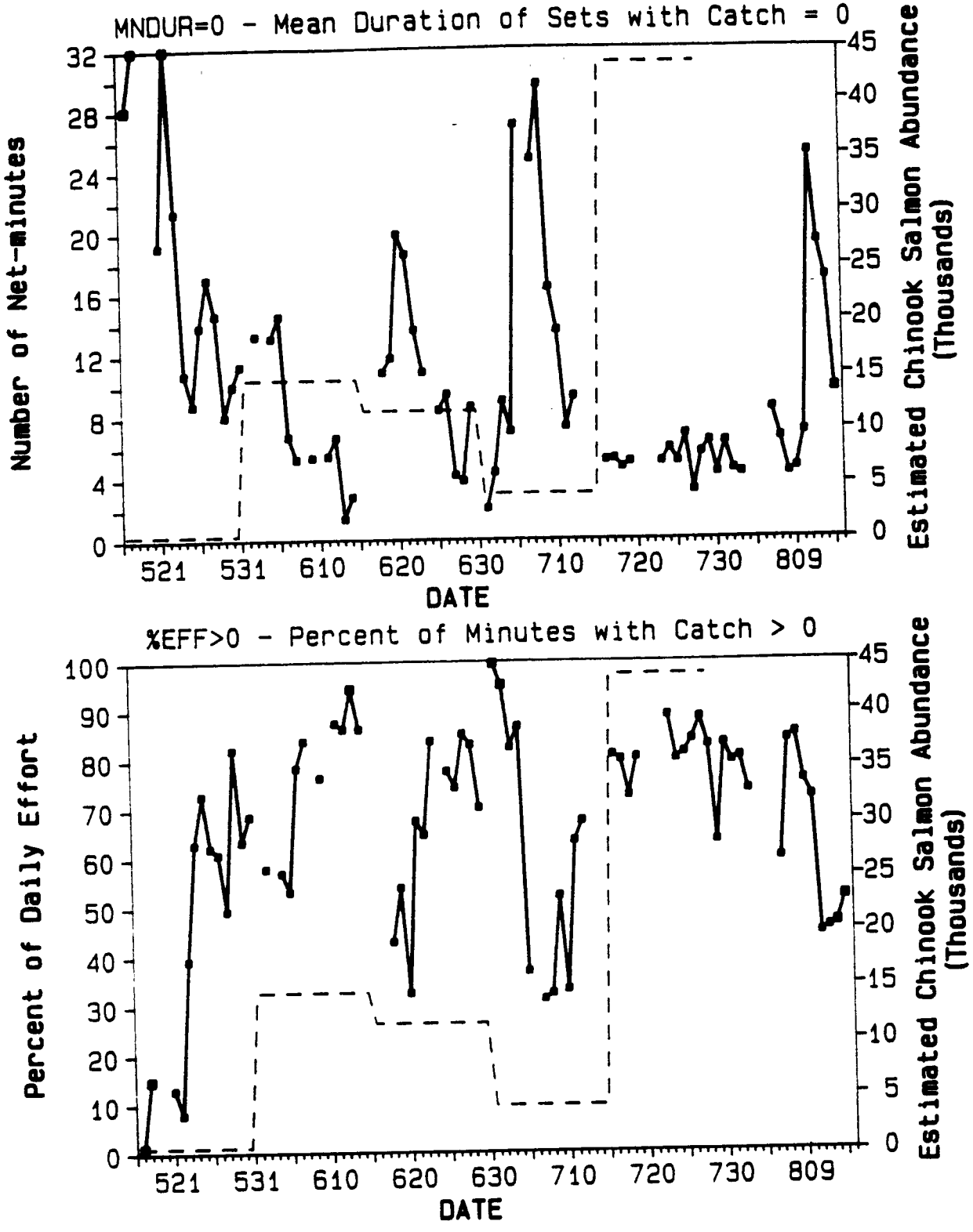
Appendix Figure 1. Frequency histograms of the duration of drift gillnet sets which caught no chinook salmon and of sets which caught at least one chinook salmon, by stratum.



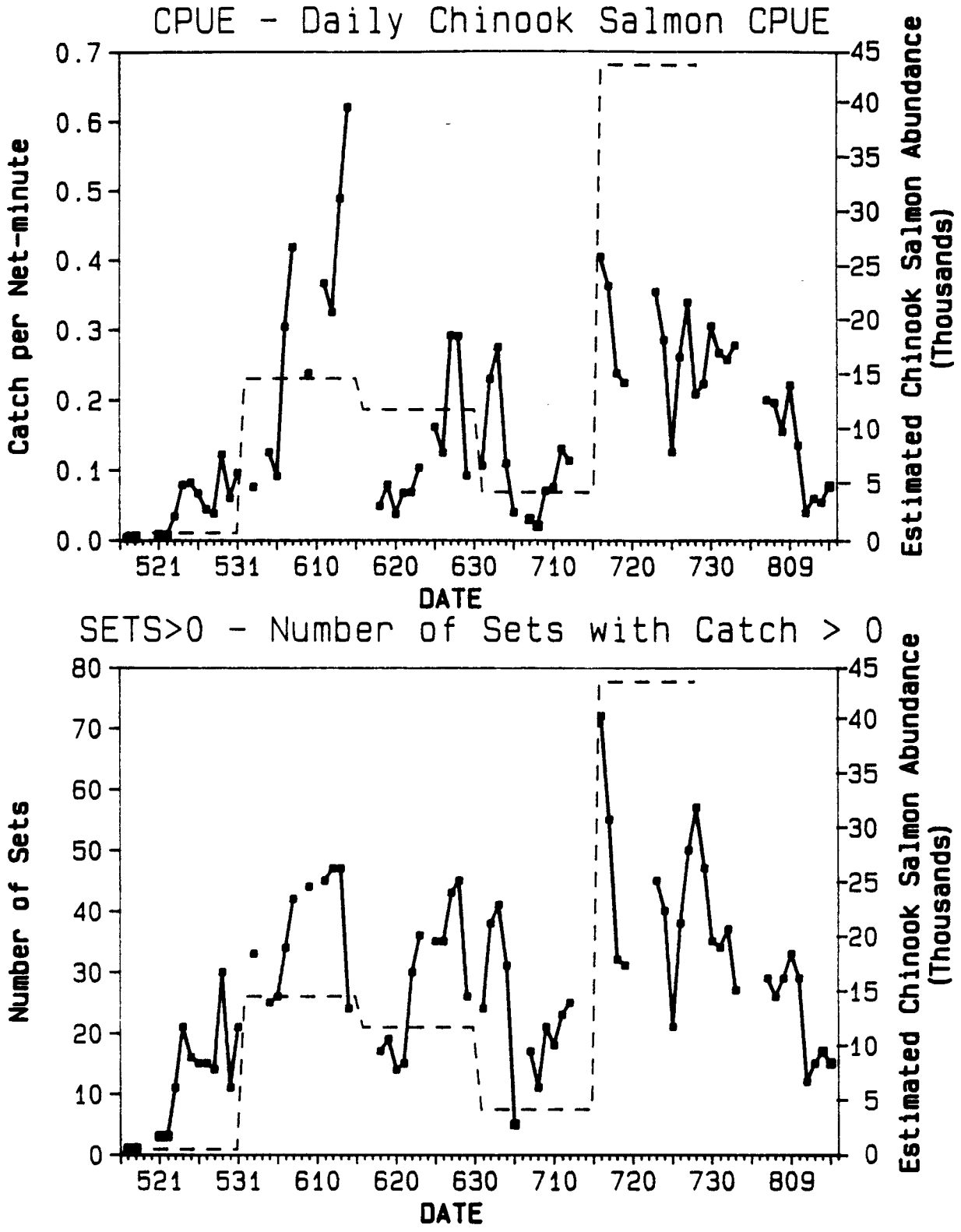
Appendix Figure 1. Frequency histograms of the duration of drift gillnet sets which caught no chinook salmon and of sets which caught at least one chinook salmon, by stratum (continued).



Appendix Figure 2. Daily values of the six effort and catch statistics for gillnets which had the highest correlations with the estimated abundance of chinook salmon entering the Kenai River, 1986. The estimated abundance is indicated by the dotted line.



Appendix Figure 2. Daily values of the six effort and catch statistics for gillnets which had the highest correlations with the estimated abundance of chinook salmon entering the Kenai River, 1986. The estimated abundance is indicated by the dotted line (continued).



Appendix Figure 2. Daily values of the six effort and catch statistics for gillnets which had the highest correlations with the estimated abundance of chinook salmon entering the Kenai River, 1986. The estimated abundance is indicated by the dotted line (continued).

APPENDIX A

APPENDIX A

Three possible sources of variation for each of the 15 effort and catch statistics were investigated: (1) between-set variation for sets made on the same day by the same crew; (2) between-crew variation; and (3) between-day variation. The possible sources of variation contributing to each of the statistics are summarized in Appendix Table A1.

Methods

Two-factor analysis of variance (ANOVA) was used to analyze those variables which had between-set variation. Two-factor ANOVA for unequal number of observations in each cell was conducted using a regression approach to test the significance of interaction of the factors and the main-effects as described on pages 362-367 in Kleinbaum and Kupper (1978). Separate analyses of the gillnet effort and chinook salmon catch statistics were conducted for tides when only two crews fished, tides when only three crews fished, and tides when all four crews fished so that a complete-block design could be used. All ANOVA were conducted with SPSS (Norusis 1983).

Those variables in Appendix Table A1 with only crew and day as sources of variation were tested to determine if there were significant differences among crews on days when multiple crews operated. On days when only two crews operated, the Wilcoxon signed-rank test (Conover 1980) for two related samples was used. The *k* sample extension of the Wilcoxon signed-rank test, the Quade test (Conover 1980), was used for days when three or four crews operated. For these tests, crews corresponded to the treatments and days the blocks in the experimental design.

Based on the results of the previous analyses, variances of the statistics measured by set (those variables in Appendix Table A1 with three sources of variation) were estimated using a two-stage sample design. Days were considered the primary sample units (with a finite number available) and sets the secondary sample units (with an unknown number of sample units available). Variance of effort or catch statistic x for tagging stratum j was estimated by (Sukhatme et al. 1984):

$$V(\bar{x}_j) = [1 - (d_j/D_j)]\ s^2_{Bj}/d_j + (\sum_{i=1}^{D} s^2_{ij}/m_{ij})/d_j D_j$$

where; d_j = number of days sampled during tagging stratum j,

D_j = number of days during tagging stratum j,

s^2_{ij} = sample variance for sets on day i of tagging stratum j,

s^2_{Bj} = between-day variance for sets during tagging stratum j, and

m_{ij} = number of sets made on day i of tagging stratum j.

Appendix Table A1. Possible sources of variation for the fifteen effort and catch statistics investigated.

Statistic[1]	Sources of Variation
TOTSETS	crew, day
TOTEFF	crew, day
MNDUR	set, crew, day
TOTCAT	crew, day
MNCAT	set, crew, day
CPUE	set, crew, day
MNCPUE	set, crew, day
MNLNCPUE	set, crew, day
TOTEFF=0	crew, day
MNDUR=0	set, crew, day
MNEFFBET	set, crew, day
%EFF>0	crew, day
SETS>0	crew, day
%SETS>0	crew, day
MNDUR>0	set, crew, day

[1] Statistics defined in Table 1.

Between-day variance, s^2_{Bj}, was estimated as follows:

$$s^2_{Bj} = [\sum_{i=1}^{D_j}(\bar{x}_{ij} - \bar{x}_j)^2]/(d_j - 1).$$

Results

The majority of the crew-day interactions were not significant for tides when two or three crews operated (Appendix Table A2). For all the two-crew and three-crew analyses where the interaction effect was not significant ($P > 0.05$), the day effect was significant ($P < 0.01$) while the crew effect was not ($P > 0.05$). There was only one non-significant crew-day interaction when four crews worked a tide (Appendix Table A2). Interaction terms are difficult to interpret and the presence of significant interaction nullifies any tests of the main-effects (Kleinbaum and Kupper 1978). Both the day and crew effects were significant ($P < 0.05$) for the single instance of a non-significant crew-day interaction in the four-crew data.

The results of the nonparametric tests for differences among-crews for the eight statistics having two sources of variation were similar to those of the two-factor ANOVA. No significant differences ($P > 0.05$) were found for the comparison of data collected during two-crew and three-crew tides (Appendix Table A3). However, 4 of the 8 statistics had significant ($P < 0.05$) among-crew differences for tides when four crews operated.

Since there were no significant among-crew differences for the effort and catch statistics from tides when three or fewer crews worked (Appendix Table A3), data were pooled for all crews. Because crews were not a significant source of variation, a two-stage sample design was used to estimate the variance of the statistics measured by set reported in Appendix Table 3.

Discussion

We interpreted these analyses as indicating gear competition or gear interference among crews when all four crews operated during a tide. Gear competition would cause the relationship between the effort and catch statistics and chinook salmon abundance to be different during the four-crew tides than for tides when three or fewer crews operated. The correlations between the temporal estimates of chinook salmon abundance and the effort and catch statistics calculated using all the data, and calculated using data from days when only three or fewer crews worked, support this hypothesis. For 13 of the 15 statistics, the correlation coefficient calculated from the three-or-fewer-crew data was greater than the correlation coefficient calculated from all data (Table 6). Therefore, we only used effort and catch data from the days when three or fewer crews worked and omitted the data from days when all four crews worked the same tide in the regression analyses.

Appendix Table A2. Results of the two-factor analyses of variance for the effort and catch statistics having three sources of variation: set, crew, and day. Analyses performed for tides when only two crews worked, tides when only three crews worked, and tides when all four crews worked. (** = significant $P \leq 0.01$, * = significant $0.01 < P \leq 0.05$, and NS = not significant $P > 0.05$).

	Two Crews			Three Crews			Four Crews		
Statistic[1]	Int[2]	Day	Crew	Int[2]	Day	Crew	Int[2]	Day	Crew
MNDUR[3]	NS	**	NS	NS	**	NS	**	**	**
MNCAT[3]	**	**	NS	NS	**	NS	**	**	NS
CPUE	NS	**	NS	NS	**	NS	**	**	*
MNLNCPUE[3]	NS	**	NS	NS	**	NS	**	**	**
MNDUR=0[3]	NS	**	NS	NS	**	NS	NS	**	**
MNEFFBET[3]	NS	**	NS	NS	**	NS	**	**	**
MNDUR>0[3]	*	**	NS	**	**	NS	**	**	**

[1] Statistics defined in Table 1.

[2] Day-crew interaction.

[3] Transformed by natural logarithm to equalize variances.

Appendix Table A3. Results of the non-parametric tests for related samples of effort and catch statistics having two sources of variation: crew and day. Analyses performed for tides when only two crews worked, tides when only three crews worked, and tides when all four crews worked. (** = significant $P \leq 0.01$, * = significant $0.01 < P \leq 0.05$, and NS = not significant $P > 0.05$).

Statistic[1]	Two Crews	Three Crews	Four Crews
TOTSETS	NS	NS	*
TOTEFF	NS	NS	**
TOTCAT	NS	NS	NS
LNCPUE	NS	NS	NS
TOTEFF=0	NS	NS	**
%EFF>0	NS	NS	NS
SETS>0	NS	NS	**
%SETS>0	NS	NS	NS

[1] Statistics defined in Table 1.

APPENDIX B

APPENDIX B

The four chinook salmon with coded-wire tags recovered by the tagging crews were from three different smolt releases by Crooked Creek Hatchery in 1983 and 1984 (Appendix Table B1). The number of chinook salmon from Crooked Creek Hatchery present in the lower Kenai River during the early run was estimated using the procedures of Clark and Bernard (1987). The number of fish from release group r (N_r) was estimated by:

$$\hat{N}_r = (m_1/m_2)\ (a_1/a_2)\ (\hat{N}_E/n_2)\ (\hat{m}_c/p_r)$$

where; m_1 = number of heads from fish with adipose finclips collected and sent to the lab for processing that have a CWT present,
m_2 = number of heads from fish with adipose finclips collected and sent to the lab for processing that have a decodeable CWT,
a_1 = number of heads from fish with adipose finclips collected and sent to lab for processing,
a_2 = number of heads from fish with adipose finclips collected and sent to lab for processing that arrive at the lab,
$\hat{N}_E$ = estimated abundance of early run chinook salmon,
n_2 = number of chinook salmon examined for adipose finclips by the tagging crews during the early run,
$\hat{m}_c$ = number of heads with a decodeable CWT from a unique tag code, and
p_r = for each tag code, the proportion of the number released that were marked with a CWT at the time of release.

The variance of $\hat{N}_r$ has two components, variance due to $\hat{N}_E$ and variance due to $\hat{m}_c$. The variance of $\hat{N}_r$ can be equated to that for the product of two independent random variables divided by a constant (Conrad et al. in press). It is assumed that the variance of p_r is negligible. The variance of $\hat{N}_r$ was calculated as follows:

$$V(\hat{N}_r) = [N_E^2\ V(\hat{m}_c) + \hat{m}_c^2\ V(\hat{N}_E) - V(\hat{N}_E)V(\hat{m}_c)]\ [(m_1\ a_1)/(m_2\ a_2\ n_2\ p_r)]^2.$$

The variance of $\hat{m}_c$ was calculated as follows (Clark and Bernard 1987):

$$V(\hat{m}_c) = \left[\frac{m_2\ [m_2\text{-}1]\ a_2\ [a_2\text{-}1]\ n_2\ [n_2 - 1]\ \hat{N}_r\ [\hat{N}_r - 1] p_r^2}{m_1\ [m_1\text{-}1]\ a_1\ [a_1\text{-}1]\ \hat{N}_E\ [\hat{N}_E\text{-}1]} \right] +$$

$$\left[\frac{m_2\ a_2\ n_2\ \hat{N}_r\ p_r}{m_1\ a_1\ \hat{N}_E} \right] - \left[\frac{(m_2\ a_2\ n_2\ \hat{N}_r\ p_r)^2}{(m_1\ a_1\ \hat{N}_E)^2} \right].$$

Appendix Table B1. Release information for the three groups of chinook salmon smolts from Crooked Creek Hatchery that were captured as adults in the lower Kenai River by the drift gillnet crews, 1986.

Tag Code	Release Date	Number Released	Number Tagged	Percent Tagged	Number Recovered[1]
31 16/13	1983	211,180	14,650	6.9	2
B4 09/04 B4 09/05	1983	53,741	10,942	20.4	1
31 16/02	1984	67,800	20,300	29.9	1

[1] Recovered by the tagging crews between 17 May through 30 June.

The estimates for the three releases were summed to estimate the total number of chinook salmon from Crooked Creek present in the lower Kenai River during the early run. The variance of the total was the sum of the variances for the individual estimates plus the covariances for the three combinations of two-releases possible. The equation used to estimate the covariance between releases N_{r1} and N_{r2} was (Clark and Bernard 1987):

$$\text{Cov}\ (\hat{N}_{r1};\hat{N}_{r2}) = \hat{N}_{r1}\hat{N}_{r2}\left[\frac{m_1\ (m_2\text{-}1)\ a_1\ (a_2\text{-}1)\ \hat{N}_E\ (n_2\text{-}1)}{m_2\ (m_1\text{-}1)\ a_2\ (a_1\text{-}1)\ n_2\ (\hat{N}_E\text{-}1)} - 1\right].$$