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ANIAK RIVER SALMON ESCAPEMENT STUDY,

1985 - 1987

By

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The total sonar-based estimates of chum salmon escapements for the Aniak River in 1985-87 were 253,048, 209,080, and 193,464, respectively. The relationship (R^2=.93, P<0.05, df=6) for all years (n=8) between Aniak River chum salmon escapement estimates and chum salmon CPUE in District 1 of the Kuskokwim River was significant (.05). Mean dates of chum salmon passage were similar to historic dates in 1986 (12.82 July, s=8.4 days) and 1987 (12.00 July, s=9.5) and were later than historic dates in 1985 (16.63 July, s=8.6). The average sector count distribution was atypically uniform in 1985 and typical in 1986 and 1987. Average diel count distributions were typical in all three years.

Test fishing in 1985 yielded a total catch of seven (7) chinook, 98 chum, three (3) sockeye, and two (2) pink salmon. Test fishing was discontinued after 1985 due to the small catches of chinook salmon and the failure of the program to provide species apportionment indices for the sonar estimates.

A carcass survey in 1985 yielded SLA data from 56 chinook (55.4% age 1.4 and 43% female), 450 chum (56.4% age 0.4 and 52.0% female). The carcass survey was discontinued after 1985 due to the small sample size of chinook and the similarity in age and sex composition between Aniak River and District 1 chum salmon.

The three years, 1985-87, were characterized by higher than usual stream levels which were sustained through the sonar operating period. Flooding which occurred in 1987 suspended sonar operation for the period 3-6 July.

INTRODUCTION

Description of the Area

The Aniak River originates in the Aniak Lake basin about 90 miles east and 20 miles south of Bethel, Alaska. It flows north for nearly 80 miles where it joins the Kuskokwim River one mile above the village of Aniak. The uppermost portion of the river is characterized by swift, clear water which descends from Aniak Lake at about 800 feet elevation to about 450 feet elevation in the vicinity of the confluence of Atsaksovluk Creek, a distance of about 35 miles. The character of the river and its substrate begins to change in that area. The swift, clear water becomes increasingly turbid as it flows in the shallower gradients of the middle and lower river valley where the substrate grades into finer gravels, sands, and silts. The main features of the river from this area to the mouth are the broad meanders with large gravel bars on the inside bend and cutbanks with exposed soil, tree roots and snags on the outside bend. Downstream navigation in the middle and lower reaches of the Aniak River can be hazardous due to the numerous snags and sweepers found there.

The Aniak River sonar project is located in section 5 of T16N, R56W (Seward Meridian) approximately 12 miles upstream from the mouth of the Aniak River (Figure 1).

Project History

The Kuskokwim River produces abundant quantities of Pacific salmon (Oncorhynchus spp.). Subsistence and commercial fishermen who live along the Kuskokwim River place major cultural and economic importance upon harvests of chum (O. keta) and chinook salmon (O. tschawytscha). The population of the Kuskokwim area is rapidly expanding. This results in increasing pressure on the salmon resource to provide cash and subsistence food and to maintain the accustomed lifestyle of the native people. Increasing demand for the resource is accompanied by growing interest in more efficient harvest technique and equipment. The combination of growing demand and increasing harvest efficiency in other fisheries has proven to be a forewarning of the potential for resource overexploitation. It is one of the primary aims of fishery management to protect fishery stocks from overexploitation while optimizing their potential value and limiting the adverse political, economic and cultural effects caused by stock depletion.

Obtaining timely chum salmon escapement data from Kuskokwim River tributaries is needed for the evaluation of regulatory actions taken in the fishery. In 1978 and 1979, the Kwethluk and Kasigluk Rivers were chosen to evaluate the feasibility of using Bendix side scan sonar for providing estimates of chinook and chum salmon escapements. These rivers were chosen for their proximity to the important commercial fishery near Bethel, e.g. District 1 (Figure 2).

The Kwethluk and Kasigluk Rivers proved to be unsuitable for sonar operation. The Kwethluk contained large quantities of debris which caused an unacceptable amount of indeterminant false counts (Schneiderhan 1979). The Kasigluk salmon escapements were too small to allow accurate sonar calibration (Schneiderhan 1980).

Evidence of the importance of Aniak River salmon production has accumulated since 1954 (Schneiderhan 1983) when the first efforts were made by biologists to quantify the extent of salmon spawning in Kuskokwim River tributaries. Because of its record of higher than usual counts of spawning salmon among other Kuskokwim tributaries, the Aniak was chosen in 1980 for a sonar feasibility study (site A in Figure 3). The purpose of the study was to assess the implementation of the Bendix side scan sonar to index adult salmon escapements. After three years of operation (1980-82) demonstrated that the sonar results agreed with trends in commercial chum salmon CPUE, the project emerged from the feasibility stage to become fully operational. The earlier reports (Schneiderhan 1981, 1982, 1982a, 1984, 1985) should be consulted for further information about the project history.

Description of the Resource

Since 1980, sonar-based escapement estimates have ranged from 115 thousand to over one million salmon of which 5 to 10 percent are thought to be chinook, and the remainder mostly chum salmon. These and other observationsdata suggest that in the Kuskokwim drainage the Aniak River is one of the two most important producers of chum and chinook salmon. Although the contribution of Aniak River chum salmon to total Kuskokwim River chum salmon production is not known, it is believed that it may be as much as 10% to 25% of the drainage-wide total.

Quantitatively, little is known about Aniak salmon species other than chum, although in many years aerial surveys provide an index of chinook salmon abundance in the clearwater areas. Early attempts to apportion sonar counts using test fishing techniques indicate that probably less than 10% of the sonar count may be attributed to chinook salmon (Schneiderhan 1981, 1982a, 1982b). Coho salmon (*O. kisutch*) spawn and rear (Schneiderhan 1981, Sundberg pers. comm.) in relative abundance in the Aniak River drainage. Sockeye salmon (*O. nerka*) have been sighted in small schools by experienced aerial observers (Schneiderhan 1983,

1987), while pink salmon (O. gorbuscha) have been infrequently captured in gill nets or beach seines in the Aniak (Schneiderhan 1981).

Management of the commercial and subsistence chum salmon fisheries benefits from timely knowledge of spawning escapement performance. The Kuskokwim chum salmon resource has traditionally been the major fisheries resource in the Kuskokwim River. It provides a significant cash income to most Kuskokwim River commercial fishermen and is a resource of major importance to the Kuskokwim subsistence economy. Currently, there is only one other intensive escapement monitoring activity in the drainage. A major strength of the Aniak Sonar project is its established database consisting of eight consecutive years of comparable sonar data. The database provides a migration timing model consisting of cumulative daily proportions which are used on a daily basis during the migration to forecast total season escapement.

The Aniak sonar project is the closest of the two upriver escapement monitoring projects to the lower river commercial and subsistence fisheries. Because of its proximity to the main Kuskokwim River fisheries, the project is able to provide a timely indication of chum salmon escapement magnitudes while the fishery is still in progress. It also provides an index of relative annual chum salmon escapement abundance upon which escapement index objectives are based.

Project Objectives

The primary objective of the Aniak River sonar project is to acquire daily and seasonal indexes of adult chum salmon passage at the sonar site. Supplemental to this is the objective of using the chum indexes to provide analytical tools for the in-season management of the chum salmon commercial fishery on the lower Kuskokwim River. These objectives are accomplished by:

1. Estimating daily chum salmon migrations in the Aniak River using Bendix side scan sonar equipment.

2. Estimating timing statistics of the chum salmon passage at the sonar site.

3. Examining sites and techniques which have the potential for improving the accuracy or precision of the project results.

In 1985 the project also had the objective of determining the age, sex and size composition of chinook and chum salmon from drift gill net and carcass samples. Previous work of this nature determined that the chum salmon escapement composition was similar to that of the commercial catch sampled at Bethel. This

objective was deleted from the project operation in 1986 in order to decrease operating costs.

The early work also had the objective of indexing chinook salmon escapements by apportioning counts using the results of test fishing at the project site. That objective was also dropped in 1986 after it was evident that test fishing techniques were incapable of providing adequate sample sizes.

METHODS

Types of Data Collected

The primary data recording form was the sonar data sheet. Each form accepted a day of sonar data from a single sonar counter. Daily sonar counts were automatically output on the built-in printer. These data were then transferred to the sonar data sheet on a daily basis. The sonar data sheet served as a worksheet for estimating the daily chum salmon escapement. The estimates were usually calculated after the last of the daily counts were made at 2400 hours. The estimate was relayed to the area management biologist in Bethel via single side band radio at 0730 hours following the day the counts were made.

The field calibration log was used to maintain a record of sonar calibration data. The result of each calibration was an agreement ratio (AR) which was transferred to the sonar data sheet and used as a factor in estimating the daily chum salmon escapement.

The side scan counter log was used to record changes to the physical or electronic settings of the sonar equipment which may have affected performance.

Data which was regularly relayed to the Department of Fish and Game office in Bethel was recorded on the radio data log. This included the date, adjusted daily site A sonar count, and the daily estimated end-of-season escapement.

Test fish data obtained in 1985 was maintained in a "Rite in the Rain" (TM J.L. Darling Corp., Tacoma) book. Data included date, time of day, duration of drift, gear type, and salmon catch by species and sex. Sex, length and age (SLA) data was collected using the techniques and materials recommended by the Statewide Stock Biology Group (1984).

Data from the carcass survey performed in 1985 was recorded in "Rite in the Rain" (TM) books. The following data were included:

1. River name
2. Date

3. River miles

4. Daily number of chinook carcasses by sample, count and total

5. Daily number of chum carcasses by sample, count and total

6. Daily number of "other" species carcasses by sample, count and total

7. Remarks

SLA data taken from each sampled carcass was recorded and the scale cards cross referenced on ADF&G Adult Salmon Age-Length Forms. These forms were readable by optical scanning machines which produced computer files of the data for later analysis.

Gummed cards with data blanks on the ungummed side and scale positions printed on the gummed side were used to collect and label scale specimens from carcass samples (Statewide Stock Biology Group 1984). The cards with scales attached were used to imprint scale patterns on acetate cards which were then examined with a microfiche reader to determine the age of the specimens.

Weather and hydrologic conditions were recorded on the climatological and stream observations form. The data was recorded daily at noon.

Sonar Operation

A three person crew in 1985 and a two person crew in 1986 and 1987 installed and operated a Bendix side scan sonar counter at the primary sonar location, e.g. site A (Figure 1). Sonar operating periods for the three years began on June 22, June 25 and June 21, respectively. Sonar operation concluded in the three years on July 31, July 25 and July 31, respectively. Daily salmon magnitude indexes were obtained from sonar counts which had been adjusted using standardized calibration procedures. Comparable site A sonar data exists for all years of sonar operation, e.g. 1980 through 1987.

Operation of two additional sonar counters was attempted at sites B and C in all three years. The objective of those experiments was to provide a more accurate expansion factor for use with site A data as was done in limited fashion in 1984 (Schneiderhan 1985).

The sonar counters were operated continuously except for short periods when the equipment was moved or malfunctioning. Sonar counters were calibrated at 0600, 1200, 1800, and 2400 hours each day, or more often if necessary.

In each year, a 1981 model Bendix side scan sonar was installed with its substrate and operated at site A as it had in all previous years. The equipment was operated continuously during the operational period to count salmon migrating up the east bank of the Aniak River.

Sonar calibration was performed by a practiced observer using an oscilloscope to visually display real time echo-generated electronic patterns from the sonar receiver. The observer applied criteria developed through experience and training to discern and count the oscilloscope patterns which were generated by migrating salmon during a minimum fifteen minute time period. The sonar count during the same period of time was compared to the oscilloscope count as:

$$\text{AR (adjustment ratio)} = \frac{\text{OSCILLOSCOPE COUNT}}{\text{SONAR COUNT}}$$

where AR > 1 indicated that the sonar was proportionally undercounting and AR < 1 indicated that it was proportionally overcounting.

The fish velocity control, which sets the sonar ping rate, was initially set at 0.571 s/ft when the sonar was installed (Bendix 1981). After the daily 2400 hours calibration, the sonar ping rate was adjusted if the daily average AR value was less than 0.8 or greater than 1.2. The ping rate adjustment was proportional to the deviation of the average AR from 1.0.

The sonar counts were subtotaled for each six hour period The subtotals were multiplied by the end-of-period AR value to adjust for the period's observed sonar error during that period. The sum of adjusted six hour sonar counts was the daily adjusted count which was the essential product of the sonar operation and represented the best estimate of daily salmon passage through the sonar counting range.

Inseason estimation of total escapement was conducted in the field by the project crewleader using an electronic calculator. The daily estimate of the total-season escapement magnitude was calculated as the most recent cumulative adjusted daily count multiplied by an expansion factor of 1.62 to account for salmon which passed outside of the sonar counting range. The result of that operation was then divided by the corresponding cumulative proportion from the inseason forecast model. The accuracy of these daily estimates depended on how well the current year escapement time series matched that of the model chosen as the most probable representative type. In practice, three models representing early, normal (mean) and late migration timing were followed simultaneously, and the estimates from the one which demonstrated the best fit with current season data was used by the

management biologist along with other catch and escapement indicators for regulating the chum salmon harvest in District 1.

At the end of the season, daily proportions were calculated as the daily adjusted count divided by the sum of all daily adjusted counts. These data were then used as a basis for calculating the mean date of migration and its standard deviation using techniques presented by Mundy (1982) for Yukon River chinook salmon.

Final post season data analysis involved entry of the data into spreadsheets where all adjustment and estimation calculations were examined and repeated. Counts on days when the sonar was not operated but for which historic data existed were estimated as

$$x = \frac{a\ b}{c}$$

where x represented the expanded count to be estimated, a was the sum of the known expanded counts, b was the historic daily proportion on the day of the count to be estimated, and c was the sum of historic daily proportions on days with known expanded counts. This process resulted in an estimated count for at least each day for which historic data existed.

The estimated total escapement and the commercial chum salmon CPUE in Kuskokwim District 1 was regressed for all years of sonar operation.

Sonar sector distribution was calculated as the average by sector of the daily sonar counts for the season. The average sector count was used to graphically illustrate the average sonar sector distributions. A similar procedure was used to analyze hourly sonar count distributions.

Most analyses of the sonar data were performed after the completion of the field season in either the Bethel or Anchorage office. Analyses were performed using the Lotus 1-2-3 (copyright Lotus Developement Corp.) software running on a Compaq Deskpro 286 (TM Compaq Computer Corp.) microcomputer or other IBM (TM International Business Machines) compatible computer.

1985 Test Fishing

A drift gill net test fishing program was used to provide information on the species, age, sex, and size composition of the salmon escapement. Timed drifts were conducted several times during the day. The drifts were conducted in the stream area immediately downstream from the site A sonar substrate. The

primary objective of the program was to obtain data to apportion the sonar-based salmon escapement estimate for species.

The sampling design (Schneiderhan 1982) required three or four fishing periods per day. In each period three or four gill nets of different mesh size were fished in rotating order on alternate days according to the following pattern:

Day 1	Period	A	5-1/2", 7-1/4", 8-1/2"
		B	5-1/2", 8-1/2", 7-1/4"
		C	7-1/4", 5-1/2", 8-1/2"
		D	7-1/4", 8-1/2", 5-1/2"
Day 2		A	7-1/4", 5-1/2", 8-1/2"
		B	7-1/4", 8-1/2", 5-1/2"
		C	5-1/2", 7-1/4", 8-1/2"
		D	5-1/2", 8-1/2", 7-1/4".

The 5-1/2" and 7-1/4" gill nets were most effective for catching chinook and chum salmon (Schneiderhan 1984). To increase the probability of catching salmon in the drift area, those nets were always fished first in a given period.

The fourth mesh size (4-1/4") was drifted once a day to detect the presence of pink salmon. All drifts were made in the area about 30-60 feet offshore beginning about 50 feet and ending about 300 feet downstream from the sonar substrate (Schneiderhan 1984).

1985 Carcass Survey

Beginning August 5, after termination of sonar operation in 1985, a carcass sampling trip was conducted on the Aniak River. Two Department employees used an inflatable raft and small outboard motor to descend from Aniak Lake to the river's mouth near the village of Aniak. All available salmon carcasses were sampled for age, sex and length composition until objectives were met or the sampling trip ended. The sample size objective was 580 chinook and 450 chum salmon. Additionally, all unsampled carcasses were counted where species and sex could be determined.

After the scales were analyzed at the end of the season, the resulting data base was used to calculate the mean length by sex and age class and its standard error, percent age composition by sex, and the associated standard errors.

Age, sex and length data files were created using the OPSCAN form reader and various Basic language programs to produce ASCII (American Standard Code for Information Interchange) files which were read and edited using an IBM compatible microcomputer running WordStar (copyright Micropro International Corp.) The data in the WordStar files was analyzed using SLA programs written by Conrad (1985).

Meteorologic and Hydrologic

Environmental factors were measured daily at noon. Measurements were made of air and water temperatures, and relative stream levels. Type of precipitation, amount of cloud cover, wind direction and velocity, and water color were subjectively estimated and coded using instructions printed on the form. Water color was coded in accordance with instructions from the record form.

RESULTS

Site A Sonar

1985

Sonar site A provided uninterrupted daily adjusted salmon counts during the operating period in 1985. The cumulative adjusted count was 136,337 (Table 1). Adjustment ratios used to correct these counts averaged 1.1 for the season (Table 2). The late migration timing model was selected to provide proportions for nonoperating days. Expansion to account for salmon swimming outside of the sonar range (EF = 1.62), and expansion for nonoperating days resulted in an estimated total escapement of 253,048 (Table 3).

1986

Sonar site A provided uninterrupted daily adjusted salmon counts during the operating period in 1986. The cumulative adjusted count was 93,007 (Table 4). Adjustment ratios used to correct these counts averaged 1.0 for the season (Table 5). The late migration timing model was selected to provide proportions for nonoperating days. Expansion to account for salmon swimming outside of the sonar range (EF = 1.62), and expansion for nonoperating days resulted in an estimated total escapement of 209,080 (Table 6).

1987

Sonar site A operation was interrupted on July 3 and 4 due to flood conditions in the Aniak River. Including estimates for the missed days, the cumulative adjusted count was 107,798 (Table 7). Adjustment ratios used to correct these counts averaged 1.1 for the season (Table 8). The late migration timing model was selected to provide proportions for nonoperating days. Expansion to account for salmon swimming outside of the sonar range (EF = 1.62), and expansion for nonoperating days resulted in an estimated total escapement of 193,464 (Table 9). The annual trend of chum salmon abundance in the Aniak River continued to decrease from the record escapement of 1.17 million in 1980 (Figure 4).

Relationship with W-1 CPUE

The relationship (R^2 = .93, P< 0.05, df = 6) between Aniak River chum salmon escapement estimates and chum salmon CPUE in District 1 (Figure 5), the lower Kuskokwim River, was significant (.05). Annual data and regression statistics appear in Appendix A.

Daily Count Magnitude and Timing

The distribution of daily counts followed patterns typical of previous years (Figure 6). Counts in 1985 and 1986 began low and built relatively steadily until around the middle of the migration, then steadily decreased until the end of operation. Counts in 1987 followed a similar pattern except for the pulse of relatively large counts at the very beginning of the operating period. Characteristically, counts leveled out at an intermediate level near the end of the operating period. This was thought to be an artifact caused by the difficulty of properly calibrating the sonar as salmon behavior changed and swimming speeds slowed near the end of the spawning period. The mean date of passage was 16.63 July (s = 8.6 days) in 1985, 12.82 July (s = 8.4) in 1986, and 12.00 July (s = 9.5) in 1987. Peak daily escapement estimates were 20,274 fish on July 23 in 1985, 11,025 fish on July 22 in 1986, and 12,721 fish on July 12 in 1987.

Sector Distribution

The nearly uniform sector distribution in 1985, though similar to that of 1983 (Schneiderhan 1984), was atypical for the project (Figure 7, Appendix B). Distributions in 1986 and 1987 appear to be more typical, with the majority of the fish crossing the inshore sectors. The distribution in 1984 (Schneiderhan 1985) was uniquely characterized by relatively large counts in the outermost sectors, e.g. sectors 12 through 16.

Diel Distribution

The hourly pattern of sonar count fluctuations followed the same pattern in 1985 through 1987 (Figure 8, Appendix C) as it has in all previous years. The diel distribution of counts was characterized by relatively low counts around noon gradually increasing to relatively high counts at midnight and the early morning hours, and then declining to low counts by the following noon.

Sites B and C Sonar

High water levels in the three years covered by this report made sonar operation at sites B and C ineffective in accomplishing the program objective of further documenting a more accurate expansion factor for the site A estimates. Successful operation at sites B and C would also have provided the basis for future decisions regarding the relocation of the project and changes in pro-

ject operation to include sonar counters on each bank of the river.

1985 Test Fishing

Drift Gill Nets

The length of the drift for the gill net test fishing program was about 220 feet in 1985. The total drift gill net effort was 9 hours, 21 minutes of soak time. The total catch was 7 chinook, 98 chum, 3 sockeye, and 2 pink salmon. Season catch per unit of effort (CPUE) for chinook, all gill nets combined, was 0.15 fish per fathom per hour. The chum salmon CPUE, all gill nets combined, was 2.10 fish per fathom per hour (Table 10). Daily CPUE ranged from zero to 9.0 for chum salmon.

Beach Seine

Seventy beach seine hauls resulted in a catch of 4 chinook, 1 sockeye, 4 pink and 103 chum salmon. The beach seine appeared to be less efficient for catching chinook than the combination of gill nets used. The beach seine yielded a 3.6 percent catch of chinook salmon while the gill nets yielded a catch composed of 8.7 percent chinook salmon.

The small catches from the beach seine and gill nets made it desirable to combine the samples for sex, length and age (SLA) analysis. The combined ageable chinook salmon sample (n = 13) was insufficient for meaningful analysis. The combined chum salmon sample (n = 168) failed to meet the minimum sample size objective (n = 450); however, the age and sex composition of the combined samples compared closely to the larger sample obtained by the later carcass survey. The chum salmon sample from all nets combined was composed of 58.3 percent age 0.4 fish and was 47.6 percent female (Table 11).

1985 Carcass Sample

The chinook sample (n = 56) was composed of 55.4 percent age 1.4 and was 43 percent female. The chum salmon sample (n = 450) was composed of 56.4 percent age 0.4 and was 52.0 percent female (Table 12). One sockeye salmon and 31 pink salmon carcasses were counted.

The carcass survey was discontinued after 1985 primarily because it, even when conditions are good, appears to be unable to accomplish the objective of providing a representative sample for species apportionment of the sonar count. Severe budget reductions occurred in 1986 and the survey planned for that year was cancelled. The rationale for abandoning the chum salmon SLA data was that the age and sex composition appeared to be very similar to that for the commercial catch in District 1. There is

also some uncertainty regarding the significance to be placed on carcass sample data.

Meteorologic and Hydrologic

1985

High stream levels and flow rates predominated in 1985. Relative stream levels, daily water temperatures and weather conditions appear in Table 13.

1986

High stream levels and flow rates also occurred in 1986. Relative stream levels, daily water temperatures and weather conditions appear in Table 14.

1987

The highest stream levels on record occurred during flood conditions which suspended sonar operations on 3 - 6 July. Unusually high stream levels and flow rates occurred throughout the operating period in 1987. Relative stream levels, daily water temperatures and weather conditions appear in Table 15.

DISCUSSION

Sonar

Inseason Escapement Estimates

The site A average chum salmon migration timing is represented as a time series of cumulative proportions in Figure 9. The average cumulative proportion series was calculated as the average cumulative proportion for each date for the years 1980 through 1984. The late cumulative proportion series represents the minimum cumulative proportion for each date from the baseline data, while the early cumulative proportion series represents the maximum cumulative proportion for each date from the baseline data.

Inseason estimates of total season escapement were made using cumulative adjusted sonar counts to date and the baseline (1980-84) time series of cumulative proportions. The trends of those estimates is closely monitored, as the one which was most consistent most closely represented the current season's progression of cumulative counts. It was that baseline data which was relied upon for the most reasonable estimate of the final season chum salmon escapement in the Aniak River.

The most stable series of estimates for 1985 was derived from the late baseline model (Figure 10). Therefore, the results from

this model provided the best estimate of final season escapement. In 1986 (Figure 11) and 1987 (Figure 12), the mean baseline model provided the best inseason estimates of total season escapement.

Fish Velocity Setting

The sonar ping rate is set under the assumption of a static salmon swimming speed when in reality swimming speed varies with time of day and other factors. The six hour calibration intervals (0600, 1200, 1800, 2400 hours) were chosen for operational expediency as well as considerations of daily migration rate fluctuations. Calibrations (AR values), which vary from 1.0, are used to weight (adjust) the previous six hour total count when intraday variations occur. Swimming speed may also vary on a longer term with the stage of the migration. The average AR, when less than 0.8 or greater than 1.2, is used to reset the sonar ping rate to compensate for a multiday trend in swimming speed.

Relationship with W-1 CPUE

The table of critical values for correlation coefficients (Rohlf and Sokol 1969) indicates that there was a significant (.05) relationship of type $y = 31{,}768x - 251{,}177$ between estimated chum salmon escapement and district 1 CPUE ($R^2 = .93$, $P<0.05$, $df = 6$). Until 1985 the relationship was much better ($R^2 = .98$, $P<0.05$, $df = 4$). The fact that Aniak chum salmon escapement and commercial CPUE show nearly identical trends suggests that each is limited by the same factor, e.g. return strength. The deterioration that has been seen in the relationship may be due to a change in gear regulations that went into effect in 1986. At that time, commercial use of gill net mesh larger than 6 inches stretch measure was prohibited in the Kuskokwim Area. This may have caused an increase in catchability of chum salmon which may have increased the catch relative to total return and relative to the Aniak chum salmon escapement.

1985 Carcass Survey

Carcass sample objectives have been established through region wide standards for the sample size needed to describe the age composition of a salmon population. These would apply to the time period or stratum in which the sample is collected. The sample size goals are based on a one-in-ten chance (the precision of the sample) of not having the true age proportion (p_i) within the interval $p_i+/-.05$ for all i ages (the accuracy of the sample). A sample size of 584 fish per stratum is needed for chinook salmon assuming 3 major age classes with minor ages pooled and a 14% regeneration rate when 3 scales per fish are collected. A sample size of 473 fish per stratum is needed for chum salmon assuming 2 major age classes with minor ones pooled and 5% unreadable scales when one scale per fish is collected (Brannian, pers. comm.).

Chinook Sampling

The sample size required to accurately estimate chinook salmon age and sex composition in any year is 584 fish assuming periodic random samples are obtained which represent the escapement in both magnitude and time. The largest sample of chinook salmon achieved by test fishing in the Aniak River was 61 fish captured in drift gill nets in 1982 (Schneiderhan 1983). All attempts to increase the catch of chinook salmon have failed. Changes in location of fishing and inclusion of beach seining as well as experimentation with various techniques for using the gear have all been tried. Chinook salmon appear to be very difficult to catch. The wide variation in the size of chinook also introduces large catchability biases which cannot be quantified at this time.

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Table 1. Adjusted daily site A sonar counts, Aniak River, 1985.

Date	DAILY COUNT BY PERIOD 0600	1200	1800	2400	ADJUSTMENT RATIO 0600	1200	1800	2400	ADJUSTED COUNT
15-Jun									
16-Jun									
17-Jun									
18-Jun									
19-Jun									
20-Jun									
21-Jun									
22-Jun	80	113	82	55	1.00	1.00	1.00	1.00	330.0
23-Jun	80	113	112	147	1.00	1.33	0.95	1.00	483.8
24-Jun	98	135	169	173	2.00	1.43	1.86	0.77	835.8
25-Jun	100	163	146	144	1.25	0.71	0.83	1.00	507.1
26-Jun	141	98	54	107	1.33	1.00	0.50	1.00	420.0
27-Jun	117	74	127	182	0.80	1.00	1.50	1.40	612.9
28-Jun	279	247	270	466	0.74	1.00	0.63	1.00	1087.3
29-Jun	418	275	154	231	1.00	1.00	0.78	0.86	1010.8
30-Jun	253	129	212	435	1.33	0.75	1.63	0.56	1020.3
01-Jul	308	211	189	248	0.78	1.25	1.50	2.00	1282.8
02-Jul	120	287	325	504	0.80	0.93	1.04	0.70	1050.6
03-Jul	641	533	669	369	0.90	1.40	1.67	0.44	2602.1
04-Jul	517	393	729	569	1.10	0.68	0.90	1.15	2148.6
05-Jul	627	520	458	888	0.67	0.63	0.73	1.00	1964.1
06-Jul	1506	678	627	730	0.66	2.00	1.07	0.71	3531.7
07-Jul	1238	635	370	1071	0.85	1.00	1.17	0.71	2883.6
08-Jul	1230	1184	1065	1347	0.55	0.86	1.02	1.25	4478.2
09-Jul	769	880	670	903	1.06	1.27	1.18	0.90	3536.4
10-Jul	1109	598	466	717	1.35	1.64	1.53	0.69	3675.8
11-Jul	811	352	955	1551	1.00	1.83	1.03	0.80	3676.0
12-Jul	963	383	453	2578	2.00	1.14	1.00	0.78	4837.3
13-Jul	1980	858	950	879	0.54	0.68	0.50	0.98	2993.2
14-Jul	1154	482	540	723	1.14	1.00	0.81	0.87	2860.9
15-Jul	1064	592	1221	2302	1.00	0.80	0.75	0.92	4575.5
16-Jul	2722	3790	3400	1177	0.85	0.79	0.98	0.37	9078.1
17-Jul	2737	845	2036	1702	2.10	0.36	0.23	0.65	7616.2
18-Jul	1979	506	566	1081	1.33	0.53	1.07	1.07	4668.4
19-Jul	1885	811	660	1488	0.73	0.34	0.73	1.05	3682.5
20-Jul	1291	634	1251	1527	1.11	1.00	0.76	0.86	4333.7
21-Jul	1243	584	1137	1616	0.78	1.00	0.74	1.22	4369.0
22-Jul	1230	2538	3694	3034	1.18	0.63	1.54	0.88	11429.1
23-Jul	4252	5892	889	864	0.78	1.32	0.97	0.62	12514.9
24-Jul	1414	553	776	889	1.03	0.80	1.05	0.59	3233.3
25-Jul	1575	618	465	1210	1.02	1.00	0.84	0.80	3591.4
26-Jul	1526	966	449	874	0.83	0.73	0.94	0.58	2908.7
27-Jul	2647	697	518	808	1.00	1.00	0.86	0.70	4357.3
28-Jul	1349	1169	408	768	0.70	0.86	0.74	0.52	2655.1
29-Jul	1750	579	656	1271	0.78	1.00	1.13	0.89	3810.3
30-Jul	1198	656	575	1141	0.47	1.09	0.63	0.53	2250.6
31-Jul	1193	651	575	1141	0.89	1.00	1.00	1.00	3434.4
01-Aug									
02-Aug									
03-Aug									
04-Aug									
05-Aug									
06-Aug									
								TOTAL	136,337

Table 2. Scheduled daily sonar calibration data, site A, Aniak River, 1985.

Date	0600 Counts Scope	0600 Counts Sonar	0600 a A.R.	1200 Counts Scope	1200 Counts Sonar	1200 a A.R.	1800 Counts Scope	1800 Counts Sonar	1800 a A.R.	2400 Counts Scope	2400 Counts Sonar	2400 a A.R.	Daily Average A.R.
15-Jun													
16-Jun													
17-Jun													
18-Jun													
19-Jun													
20-Jun													
21-Jun													
22-Jun	0	0	1.00	0	0	1.00	0	0	1.00	0	0	1.00	1.00
23-Jun	0	0	1.00	8	6	1.33	36	38	0.95	0	0	1.00	1.70
24-Jun	6	3	2.00	10	7	1.43	13	7	1.86	40	52	0.77	1.36
25-Jun	10	8	1.25	5	7	0.71	5	6	0.83	0	0	1.00	1.95
26-Jun	4	3	1.33	0	3	1.00	1	2	0.50	0	0	1.00	4.00
27-Jun	4	5	0.80	0	2	1.00	3	2	1.50	7	5	1.40	2.93
28-Jun	14	19	0.74	10	0	1.00	10	16	0.63	16	0	1.00	1.91
29-Jun	0	0	1.00	4	4	1.00	7	9	0.78	18	21	0.86	1.76
30-Jun	4	3	1.33	12	16	0.75	13	8	1.63	15	27	0.56	1.31
01-Jul	7	9	0.78	10	8	1.25	24	16	1.50	6	3	2.00	1.97
02-Jul	4	5	0.80	13	14	0.93	27	26	1.04	16	23	0.70	1.28
03-Jul	18	20	0.90	7	5	1.40	5	3	1.67	16	36	0.44	0.92
04-Jul	11	10	1.10	21	31	0.68	28	31	0.90	38	33	1.15	1.12
05-Jul	12	18	0.67	5	8	0.63	40	55	0.73	36	36	1.00	0.96
06-Jul	48	73	0.66	4	2	2.00	48	45	1.07	46	65	0.71	0.70
07-Jul	41	48	0.85	21	21	1.00	14	12	1.17	39	55	0.71	0.77
08-Jul	36	65	0.55	32	37	0.86	45	44	1.02	60	48	1.25	0.87
09-Jul	55	52	1.06	56	44	1.27	45	38	1.18	52	58	0.90	0.96
10-Jul	35	26	1.35	36	22	1.64	26	17	1.53	24	35	0.69	1.17
11-Jul	15	15	1.00	11	6	1.83	41	40	1.03	24	30	0.80	1.18
12-Jul	10	5	2.00	8	7	1.14	15	15	1.00	58	74	0.78	1.11
13-Jul	58	107	0.54	15	22	0.68	41	82	0.50	45	46	0.98	0.51
14-Jul	25	22	1.14	15	15	1.00	22	27	0.81	46	53	0.87	0.97
15-Jul	25	25	1.00	16	20	0.80	93	124	0.75	59	64	0.92	0.85
16-Jul	294	347	0.85	77	97	0.79	45	46	0.98	26	70	0.37	0.32
17-Jul	21	10	2.10	10	28	0.36	27	119	0.23	74	114	0.65	0.52
18-Jul	16	12	1.33	38	72	0.53	29	27	1.07	47	44	1.07	0.94
19-Jul	37	51	0.73	15	44	0.34	35	48	0.73	45	43	1.05	0.68
20-Jul	31	28	1.11	22	22	1.00	19	25	0.76	70	81	0.86	0.91
21-Jul	25	32	0.78	8	0	1.00	45	61	0.74	44	36	1.22	0.88
22-Jul	39	33	1.18	34	54	0.63	105	68	1.54	89	101	0.88	0.96
23-Jul	72	92	0.78	41	31	1.32	56	58	0.97	72	116	0.62	0.63
24-Jul	34	33	1.03	35	44	0.80	23	22	1.05	65	110	0.59	0.67
25-Jul	44	43	1.02	12	12	1.00	16	19	0.84	89	111	0.80	0.72
26-Jul	35	42	0.83	22	30	0.73	16	17	0.94	44	76	0.58	0.60
27-Jul	12	0	1.00	15	15	1.00	30	35	0.86	62	88	0.70	0.90
28-Jul	19	27	0.70	18	21	0.86	26	35	0.74	48	92	0.52	0.62
29-Jul	38	49	0.78	33	0	1.00	18	16	1.13	59	66	0.89	0.97
30-Jul	18	38	0.47	24	22	1.09	17	27	0.63	52	98	0.53	0.59
31-Jul	17	19	0.89	0	0	1.00	0	0	1.00	0	0	1.00	0.89
01-Aug													
02-Aug													
03-Aug													
04-Aug													
05-Aug													
06-Aug													
AVERAGE	29.9	34.9	1.0	18.1	20.0	1.0	27.7	32.2	1.0	38.7	50.3	0.9	1.1

a Adjustment ratio is the scope count divided by the sonar count.

Table 3. Chum salmon escapement estimation for 1985 using side scan sonar migration timing data from the years 1980-1984, Aniak River, Alaska.

Date	Normal Timing Daily Prop.	Normal Timing Cum. Prop.	Late Timing Daily Prop.	Late Timing Cum. Prop.	Early Timing Daily Prop.	Early Timing Cum. Prop.	Expanded Adjusted Count	Estimated Daily Escapem't [a]
15-Jun	0.00021	0.00021	0.00000	0.00000	0.00105	0.00105		
16-Jun	0.00151	0.00172	0.00000	0.00000	0.00604	0.00709		
17-Jun	0.00150	0.00322	0.00000	0.00000	0.00698	0.01407		
18-Jun	0.00137	0.00459	0.00000	0.00000	0.00586	0.01993		
19-Jun	0.00244	0.00703	0.00000	0.00000	0.00730	0.02723		
20-Jun	0.00184	0.00887	0.00000	0.00000	0.00460	0.03183		
21-Jun	0.00327	0.01214	0.00000	0.00000	0.00240	0.03423		
22-Jun	0.00426	0.01640	0.00048	0.00048	0.00494	0.03917	330.0	534.6
23-Jun	0.00579	0.02219	0.00035	0.00083	0.00533	0.04450	483.8	783.7
24-Jun	0.00623	0.02842	0.00028	0.00111	0.00744	0.05194	835.8	1354.0
25-Jun	0.00761	0.03603	0.00026	0.00137	0.00704	0.05898	507.1	821.5
26-Jun	0.01223	0.04826	0.00065	0.00202	0.01875	0.07773	420.0	680.4
27-Jun	0.01480	0.06306	0.00168	0.00370	0.03390	0.11163	612.9	992.9
28-Jun	0.01534	0.07840	0.00126	0.00496	0.02971	0.14134	1087.3	1761.5
29-Jun	0.01660	0.09500	0.00207	0.00703	0.01421	0.15555	1010.8	1637.5
30-Jun	0.01491	0.10991	0.00677	0.01380	0.00967	0.16522	1020.3	1652.8
01-Jul	0.02119	0.13110	0.01131	0.02511	0.02875	0.19397	1282.8	2078.1
02-Jul	0.02853	0.15963	0.01489	0.04000	0.02403	0.21800	1050.6	1702.0
03-Jul	0.03569	0.19532	0.02961	0.06961	0.06474	0.28274	2602.1	4215.4
04-Jul	0.04857	0.24389	0.04150	0.11111	0.07010	0.35284	2148.6	3480.7
05-Jul	0.03364	0.27753	0.02119	0.13230	0.01399	0.36683	1964.1	3181.8
06-Jul	0.03669	0.31422	0.03881	0.17111	0.01153	0.37836	3531.7	5721.3
07-Jul	0.02961	0.34383	0.02077	0.19188	0.02029	0.39865	2883.6	4671.4
08-Jul	0.02909	0.37292	0.01405	0.20593	0.03133	0.42998	4478.2	7254.7
09-Jul	0.03818	0.41110	0.03165	0.23758	0.06977	0.49975	3536.4	5728.9
10-Jul	0.03585	0.44695	0.03264	0.27022	0.03690	0.53665	3675.8	5954.8
11-Jul	0.03775	0.48470	0.03572	0.30594	0.03852	0.57517	3676.0	5955.1
12-Jul	0.03615	0.52085	0.03783	0.34377	0.03744	0.61261	4837.3	7836.4
13-Jul	0.03807	0.55892	0.04551	0.38928	0.04124	0.65385	2993.2	4848.9
14-Jul	0.03778	0.59670	0.02560	0.41488	0.04707	0.70092	2860.9	4634.6
15-Jul	0.03647	0.63317	0.02472	0.43960	0.03687	0.73779	4575.5	7412.3
16-Jul	0.03237	0.66554	0.03526	0.47486	0.02454	0.76233	9078.1	14706.5
17-Jul	0.03123	0.69677	0.04363	0.51849	0.03126	0.79359	7616.2	12338.3
18-Jul	0.03494	0.73171	0.07171	0.59020	0.03505	0.82864	4668.4	7562.7
19-Jul	0.02975	0.76146	0.05634	0.64654	0.02031	0.84895	3682.5	5965.6
20-Jul	0.02654	0.78800	0.02057	0.66711	0.01847	0.86742	4333.7	7020.6
21-Jul	0.02256	0.81056	0.02385	0.69096	0.01557	0.88299	4369.0	7077.7
22-Jul	0.02634	0.83690	0.02918	0.72014	0.02517	0.90816	11429.1	18515.2
23-Jul	0.02288	0.85978	0.03165	0.75179	0.01676	0.92492	12514.9	20274.2
24-Jul	0.02393	0.88371	0.03344	0.78523	0.02004	0.94496	3233.3	5238.0
25-Jul	0.02137	0.90508	0.02279	0.80802	0.01571	0.96067	3591.4	5818.0
26-Jul	0.01745	0.92253	0.02438	0.83240	0.01411	0.97478	2908.7	4712.0
27-Jul	0.01553	0.93806	0.02220	0.85460	0.01384	0.98862	4357.3	7058.8
28-Jul	0.01572	0.95378	0.02030	0.87490	0.01138	1.00000	2655.1	4301.2
29-Jul	0.01153	0.96531	0.01578	0.89068			3810.3	6172.8
30-Jul	0.00986	0.97517	0.01198	0.90266			2250.6	3645.9
31-Jul	0.00677	0.98194	0.01482	0.91748			3434.4	5563.8
01-Aug	0.00442	0.98636	0.01434	0.93182				5592.4
02-Aug	0.00279	0.98915	0.01394	0.94576				5436.4
03-Aug	0.00381	0.99296	0.01902	0.96478				7417.5
04-Aug	0.00326	0.99622	0.01644	0.98122				6411.4
05-Aug	0.00378	1.00000	0.01878	1.00000				7323.9
Escapement Objective = 250,000					Estimated Total Escapement =>			253,048

a Daily escapements for the period 1 - 5 August were estimated from historic daily proportions for a late migration. All other daily estimates were determined from adjusted daily counts as listed in Table 1. Daily escapement estimates represent adjusted sonar counts which have been expanded by a factor of 1.62 to account for salmon which swim outside of the ensonified water column.

Table 4. Adjusted daily site A sonar counts, Aniak River, 1986.

Date	DAILY COUNT BY PERIOD 0600	1200	1800	2400	ADJUSTMENT RATIO 0600	1200	1800	2400	ADJUSTED COUNT
15-Jun									
16-Jun									
17-Jun									
18-Jun									
19-Jun									
20-Jun									
21-Jun									
22-Jun									
23-Jun									
24-Jun									
25-Jun				84				1.00	702.0
26-Jun	28	84	156	160	1.57	0.00	0.00	0.00	439.0
27-Jun	81	209	347	517	0.00	2.20	3.40	2.21	2782.4
28-Jun	560	1621	1179	741	1.56	0.77	0.50	1.75	3999.0
29-Jun	439	557	375	228	0.31	0.00	1.00	2.57	1095.4
30-Jun	403	397	691	559	1.00	0.45	1.00	0.68	1654.6
01-Jul	619	293	184	488	0.53	1.25	1.75	0.50	1262.4
02-Jul	749	280	248	341	0.86	0.92	0.46	1.36	1479.9
03-Jul	587	1160	792	467	0.27	1.00	U	2.53	2498.5
04-Jul	366	351	482	606	1.27	1.28	3.14	1.25	3186.7
05-Jul	481	365	356	401	1.19	1.78	1.56	0.95	2157.3
06-Jul	232	186	244	232	1.33	2.00	1.29	3.00	1691.0
07-Jul	158	262	653	698	1.50	1.00	2.00	0.82	2374.0
08-Jul	1102	580	446	863	1.33	2.33	0.89	0.13	3333.7
09-Jul	348	233	842	2362	U	1.00	0.71	0.56	2146.8
10-Jul	2019	982	895	1279	0.70	0.82	0.76	1.11	4302.8
11-Jul	1153	701	562	841	0.71	0.80	1.18	1.22	3060.8
12-Jul	1259	725	1194	1008	0.75	1.46	0.71	1.33	4200.7
13-Jul	1330	629	637	1086	0.34	0.69	1.03	1.35	3016.4
14-Jul	1077	550	1005	1337	1.05	0.93	0.98	1.04	4005.7
15-Jul	1396	691	209	754	0.82	1.57	1.67	1.14	3438.1
16-Jul	1256	712	798	1339	1.13	1.21	0.83	1.33	4727.2
17-Jul	1331	584	495	944	0.95	0.83	0.85	0.93	3040.8
18-Jul	1015	897	950	584	0.72	0.49	0.87	1.30	2756.2
19-Jul	1519	468	933	458	0.46	0.00	1.17	1.44	2443.1
20-Jul	992	600	866	804	1.53	0.09	1.45	0.73	3414.3
21-Jul	1635	1343	778	2151	0.76	1.17	1.03	0.83	5413.2
22-Jul	3241	1349	983	1127	1.10	1.00	0.95	0.84	6805.6
23-Jul	1561	555	520	640	1.00	0.27	1.08	0.67	2700.6
24-Jul	1265	1217	1274	1341	0.48	0.70	0.62	2.80	6005.3
25-Jul	0	0			1.50				2873.0
26-Jul									
27-Jul									
28-Jul									
29-Jul									
30-Jul									
31-Jul									
01-Aug									
02-Aug									
03-Aug									
04-Aug									
05-Aug									
06-Aug									
								TOTAL	93,007

Table 5. Scheduled daily sonar calibration data, site A, Aniak River, 1986.

Date	0600 Counts Scope	0600 Counts Sonar	0600 a A.R.	1200 Counts Scope	1200 Counts Sonar	1200 a A.R.	1800 Counts Scope	1800 Counts Sonar	1800 a A.R.	2400 Counts Scope	2400 Counts Sonar	2400 a A.R.	Daily Average A.R.
15-Jun													
16-Jun													
17-Jun													
18-Jun													
19-Jun													
20-Jun													
21-Jun													
22-Jun													
23-Jun													
24-Jun													
25-Jun													
26-Jun	11	7	1.57										1.57
27-Jun	0	0	0.00	22	10	2.20	17	5	3.40	42	19	2.21	2.38
28-Jun	14	9	1.56	36	47	0.77	7	14	0.50	14	8	1.75	0.91
29-Jun	11	36	0.31	0	0	0.00	6	6	1.00	18	7	2.57	0.71
30-Jun	9	9	1.00	10	22	0.45	8	8	1.00	17	25	0.68	0.69
01-Jul	8	15	0.53	5	4	1.25	7	4	1.75	25	50	0.50	0.62
02-Jul	12	14	0.86	12	13	0.92	6	13	0.46	15	11	1.36	0.88
03-Jul	15	56	0.27	26	26	1.00	27	0	U	43	17	2.53	1.12
04-Jul	28	22	1.27	23	18	1.28	22	7	3.14	45	36	1.25	1.42
05-Jul	19	16	1.19	16	9	1.78	25	16	1.56	19	20	0.95	1.30
06-Jul	4	3	1.33	4	2	2.00	9	7	1.29	6	2	3.00	1.64
07-Jul	6	4	1.50	10	10	1.00	18	9	2.00	97	119	0.82	0.92
08-Jul	8	6	1.33	7	3	2.33	16	18	0.89	53	399	0.13	0.20
09-Jul	3	0	U	9	9	1.00	22	31	0.71	73	131	0.56	0.63
10-Jul	48	69	0.70	23	28	0.82	25	33	0.76	63	57	1.11	0.85
11-Jul	24	34	0.71	28	35	0.80	20	17	1.18	39	32	1.22	0.94
12-Jul	24	32	0.75	38	26	1.46	25	35	0.71	44	33	1.33	1.04
13-Jul	32	93	0.34	11	16	0.69	35	34	1.03	65	48	1.35	0.75
14-Jul	23	22	1.05	42	45	0.93	41	42	0.98	86	83	1.04	1.00
15-Jul	36	44	0.82	11	7	1.57	15	9	1.67	80	70	1.14	1.09
16-Jul	26	23	1.13	29	24	1.21	34	41	0.83	60	45	1.33	1.12
17-Jul	18	19	0.95	15	18	0.83	28	33	0.85	37	40	0.93	0.89
18-Jul	23	32	0.72	45	91	0.49	20	23	0.87	35	27	1.30	0.71
19-Jul	11	24	0.46	0	0	0.00	14	12	1.17	69	48	1.44	1.12
20-Jul	29	19	1.53	20	225	0.09	16	11	1.45	65	89	0.73	0.38
21-Jul	54	71	0.76	41	35	1.17	31	30	1.03	145	174	0.83	0.87
22-Jul	65	59	1.10	43	43	1.00	42	44	0.95	74	88	0.84	0.96
23-Jul	30	30	1.00	18	67	0.27	14	13	1.08	37	55	0.67	0.60
24-Jul	55	115	0.48	21	30	0.70	38	61	0.62	14	5	2.80	0.61
25-Jul	27	18	1.50										1.50
26-Jul													
27-Jul													
28-Jul													
29-Jul													
30-Jul													
31-Jul													
01-Aug													
02-Aug													
03-Aug													
04-Aug													
05-Aug													
06-Aug													
AVERAGE	22.4	30.0	0.9	20.2	30.8	1.0	21.0	20.6	1.2	49.3	62.1	1.3	1.0

a Adjustment ratio is the scope count divided by the sonar count.

Table 6. Chum salmon escapement estimation for 1986 using side scan sonar migration timing data from the years 1980-1984, Aniak River, Alaska.

Date	Normal Timing Daily Prop.	Normal Timing Cum. Prop.	Late Timing Daily Prop.	Late Timing Cum. Prop.	Early Timing Daily Prop.	Early Timing Cum. Prop.	Expanded Adjusted Count	Estimated Daily Escapem't [a]
15-Jun	0.00021	0.00021	0.00000	0.00000	0.00105	0.00105		
16-Jun	0.00151	0.00172	0.00000	0.00000	0.00604	0.00709		
17-Jun	0.00150	0.00322	0.00000	0.00000	0.00698	0.01407		
18-Jun	0.00137	0.00459	0.00000	0.00000	0.00586	0.01993		
19-Jun	0.00244	0.00703	0.00000	0.00000	0.00730	0.02723		
20-Jun	0.00184	0.00887	0.00000	0.00000	0.00460	0.03183		
21-Jun	0.00327	0.01214	0.00000	0.00000	0.00240	0.03423		
22-Jun	0.00426	0.01640	0.00048	0.00048	0.00494	0.03917		145.2
23-Jun	0.00579	0.02219	0.00035	0.00083	0.00533	0.04450		105.9
24-Jun	0.00623	0.02842	0.00028	0.00111	0.00744	0.05194		84.7
25-Jun	0.00761	0.03603	0.00026	0.00137	0.00704	0.05898		1137.2
26-Jun	0.01223	0.04826	0.00065	0.00202	0.01875	0.07773	439.0	711.2
27-Jun	0.01480	0.06306	0.00168	0.00370	0.03390	0.11163	2782.4	4507.6
28-Jun	0.01534	0.07840	0.00126	0.00496	0.02971	0.14134	3999.0	6478.3
29-Jun	0.01660	0.09500	0.00207	0.00703	0.01421	0.15555	1095.4	1774.6
30-Jun	0.01491	0.10991	0.00677	0.01380	0.00967	0.16522	1654.6	2680.4
01-Jul	0.02119	0.13110	0.01131	0.02511	0.02875	0.19397	1262.4	2045.1
02-Jul	0.02853	0.15963	0.01489	0.04000	0.02403	0.21800	1479.9	2397.5
03-Jul	0.03569	0.19532	0.02961	0.06961	0.06474	0.28274	2498.5	4047.5
04-Jul	0.04857	0.24389	0.04150	0.11111	0.07010	0.35284	3186.7	5162.4
05-Jul	0.03364	0.27753	0.02119	0.13230	0.01399	0.36683	2157.3	3494.8
06-Jul	0.03669	0.31422	0.03881	0.17111	0.01153	0.37836	1691.0	2739.5
07-Jul	0.02961	0.34383	0.02077	0.19188	0.02029	0.39865	2374.0	3845.8
08-Jul	0.02909	0.37292	0.01405	0.20593	0.03133	0.42998	3333.7	5400.7
09-Jul	0.03818	0.41110	0.03165	0.23758	0.06977	0.49975	2146.8	3477.8
10-Jul	0.03585	0.44695	0.03264	0.27022	0.03690	0.53665	4302.8	6970.6
11-Jul	0.03775	0.48470	0.03572	0.30594	0.03852	0.57517	3060.8	4958.5
12-Jul	0.03615	0.52085	0.03783	0.34377	0.03744	0.61261	4200.7	6805.2
13-Jul	0.03807	0.55892	0.04551	0.38928	0.04124	0.65385	3016.4	4886.6
14-Jul	0.03778	0.59670	0.02560	0.41488	0.04707	0.70092	4005.7	6489.2
15-Jul	0.03647	0.63317	0.02472	0.43960	0.03687	0.73779	3438.1	5569.7
16-Jul	0.03237	0.66554	0.03526	0.47486	0.02454	0.76233	4727.2	7658.1
17-Jul	0.03123	0.69677	0.04363	0.51849	0.03126	0.79359	3040.8	4926.1
18-Jul	0.03494	0.73171	0.07171	0.59020	0.03505	0.82864	2756.2	4465.1
19-Jul	0.02975	0.76146	0.05634	0.64654	0.02031	0.84895	2443.1	3957.8
20-Jul	0.02654	0.78800	0.02057	0.66711	0.01847	0.86742	3414.3	5531.1
21-Jul	0.02256	0.81056	0.02385	0.69096	0.01557	0.88299	5413.2	8769.4
22-Jul	0.02634	0.83690	0.02918	0.72014	0.02517	0.90816	6805.6	11025.1
23-Jul	0.02288	0.85978	0.03165	0.75179	0.01676	0.92492	2700.6	4375.1
24-Jul	0.02393	0.88371	0.03344	0.78523	0.02004	0.94496	6005.3	9728.6
25-Jul	0.02137	0.90508	0.02279	0.80802	0.01571	0.96067	2873.0	4654.3
26-Jul	0.01745	0.92253	0.02438	0.83240	0.01411	0.97478		7374.8
27-Jul	0.01553	0.93806	0.02220	0.85460	0.01384	0.98862		6715.4
28-Jul	0.01572	0.95378	0.02030	0.87490	0.01138	1.00000		6140.7
29-Jul	0.01153	0.96531	0.01578	0.89068				4773.4
30-Jul	0.00986	0.97517	0.01198	0.90266				3623.9
31-Jul	0.00677	0.98194	0.01482	0.91748				4483.0
01-Aug	0.00442	0.98636	0.01434	0.93182				4337.8
02-Aug	0.00279	0.98915	0.01394	0.94576				4216.8
03-Aug	0.00381	0.99296	0.01902	0.96478				5753.5
04-Aug	0.00326	0.99622	0.01644	0.98122				4973.0
05-Aug	0.00378	1.00000	0.01878	1.00000				5680.9
Escapement Objective = 250,000					Estimated Total Escapement =>			209,080

a Daily escapements for the period 15-25 June and 26 July - 5 August were estimated from historic daily proportions for a late migration. All other daily estimates were determined from adjusted daily counts as listed in Table 4. Daily escapement estimates represent adjusted sonar counts which have been expanded by a factor of 1.62 to account for salmon which swim outside of the ensonified water column.

Table 7. Adjusted daily site A sonar counts, Aniak River, 1987.

Date	DAILY COUNT BY PERIOD 0600	1200	1800	2400	ADJUSTMENT RATIO 0600	1200	1800	2400	ADJUSTED COUNT
15-Jun									
16-Jun									
17-Jun									
18-Jun									
19-Jun									
20-Jun									
21-Jun	52	119	58	90	1.00	0.67	7.00	1.00	628.0
22-Jun	52	125	146	299	1.56	1.50	2.83	1.29	1066.5
23-Jun	134	154	94	143	2.75	3.50	2.75	2.33	1499.7
24-Jun	178	310	545	504	1.00	0.90	0.74	6.50	4137.0
25-Jun	74	149	134	185	0.60	0.29	1.50	0.53	385.9
26-Jun	216	183	278	552	0.67	0.67	0.78	0.86	955.4
27-Jun	504	433	359	421	1.21	1.20	0.76	1.30	1951.7
28-Jun	533	578	404	420	0.95	1.18	1.22	0.60	1936.1
29-Jun	168	190	233	193	0.85	1.27	2.25	3.00	1487.2
30-Jun	210	236	201	154	1.00	1.00	0.32	0.36	564.7
01-Jul	151	61	110	97	4.00	0.91	1.00	0.67	834.1
02-Jul	73	75	101	97	0.50	0.50	1.00	1.00	272.0
03-Jul	540	504.6	641.2	544.6	1.00	1.00	1.00	1.00	2230.4
04-Jul	702.4	629.8	693.4	668	1.00	1.00	1.00	1.00	2693.6
05-Jul	1021	1406	2140	1631	1.00	1.00	1.00	1.00	6198.0
06-Jul	1245	745	654	744	1.00	1.00	1.00	1.00	3388.0
07-Jul	1022	862	462	771	1.00	1.35	1.18	1.35	3771.9
08-Jul	935	878	699	1063	0.71	0.69	0.58	0.64	2358.3
09-Jul	573	441	561	704	1.31	1.10	1.09	1.24	2719.6
10-Jul	763	740	790	1358	1.05	1.13	1.12	0.88	3719.8
11-Jul	1106	1060	1874	2258	1.23	1.21	1.11	0.88	6711.6
12-Jul	2009	1222	1236	2041	0.88	1.89	1.36	1.02	7852.6
13-Jul	1806	830	482	815	0.79	0.39	1.05	0.66	2798.6
14-Jul	801	438	565	732	1.00	1.40	1.75	3.45	4928.4
15-Jul	648	806	581	749	1.04	1.30	1.48	1.19	3468.8
16-Jul	1298	794	871	929	1.00	0.38	0.98	1.28	3645.6
17-Jul	1277	1254	2707	1031	0.62	0.67	0.64	1.02	4425.0
18-Jul	988	632	705	670	1.60	0.92	0.89	1.13	3553.0
19-Jul	575	785	821	1191	0.97	0.44	1.12	0.70	2655.9
20-Jul	1756	1364	1195	1464	0.58	0.45	1.20	0.55	3875.9
21-Jul	931	503	571	917	0.85	1.60	1.08	0.64	2799.1
22-Jul	496	274	210	593	0.63	1.00	1.00	1.56	1721.2
23-Jul	628	479	1267	384	1.38	0.20	0.49	1.35	2101.3
24-Jul	417	190	236	418	5.25	1.00	0.51	1.83	3266.6
25-Jul	392	266	253	300	1.04	0.94	0.57	1.04	1117.9
26-Jul	560	236	305	507	1.57	1.14	1.00	1.91	2423.4
27-Jul	832	513	166	228	0.97	0.69	2.17	1.94	1962.6
28-Jul	4107	512	391	374	0.17	0.72	0.83	0.73	1664.0
29-Jul	738	234	189	355	2.14	1.00	0.57	1.07	2302.9
30-Jul	571	311	314	435	1.43	0.50	0.73	1.21	1726.2
31-Jul									
01-Aug									
02-Aug									
03-Aug									
04-Aug									
05-Aug									
06-Aug									
								TOTAL	107,798

Table 8. Scheduled daily sonar calibration data, site A, Aniak River, 1987.

Date	0600 Counts Scope	0600 Counts Sonar	0600 a A.R.	1200 Counts Scope	1200 Counts Sonar	1200 a A.R.	1800 Counts Scope	1800 Counts Sonar	1800 a A.R.	2400 Counts Scope	2400 Counts Sonar	2400 a A.R.	Daily Average A.R.
15-Jun													
16-Jun													
17-Jun													
18-Jun													
19-Jun													
20-Jun													
21-Jun	0	0	1.00	2	3	0.67	7	1	7.00	3	0	1.00	3.00
22-Jun	14	9	1.56	9	6	1.50	17	6	2.83	9	7	1.29	1.75
23-Jun	11	4	2.75	7	2	3.50	11	4	2.75	7	3	2.33	2.77
24-Jun	0	0	1.00	46	51	0.90	57	77	0.74	13	2	6.50	0.89
25-Jun	3	5	0.60	2	7	0.29	3	2	1.50	9	17	0.53	0.55
26-Jun	2	3	0.67	6	9	0.67	7	9	0.78	12	14	0.86	0.77
27-Jun	17	14	1.21	18	15	1.20	19	25	0.76	13	10	1.30	1.05
28-Jun	59	62	0.95	39	33	1.18	11	9	1.22	15	25	0.60	0.96
29-Jun	11	13	0.85	14	11	1.27	18	8	2.25	18	6	3.00	1.61
30-Jun	9	9	1.00	4	4	1.00	7	22	0.32	65	183	0.36	0.39
01-Jul	4	1	4.00	10	11	0.91	4	4	1.00	2	3	0.67	1.05
02-Jul	2	4	0.50	2	4	0.50	0	0	1.00	0	0	1.00	0.50
03-Jul			1.00			1.00			1.00			1.00	1.00
04-Jul			1.00			1.00			1.00			1.00	1.00
05-Jul			1.00			1.00			1.00			1.00	1.00
06-Jul			1.00			1.00			1.00			1.00	1.00
07-Jul	0	0	1.00	23	17	1.35	33	28	1.18	31	23	1.35	1.28
08-Jul	29	41	0.71	25	36	0.69	26	45	0.58	27	42	0.64	0.65
09-Jul	17	13	1.31	33	30	1.10	37	34	1.09	41	33	1.24	1.16
10-Jul	39	37	1.05	36	32	1.13	56	50	1.12	45	51	0.88	1.04
11-Jul	53	43	1.23	52	43	1.21	107	96	1.11	120	137	0.88	1.04
12-Jul	67	76	0.88	51	27	1.89	64	47	1.36	85	83	1.02	1.15
13-Jul	34	43	0.79	11	28	0.39	20	19	1.05	29	44	0.66	0.70
14-Jul	12	12	1.00	14	10	1.40	21	12	1.75	69	20	3.45	2.15
15-Jul	26	25	1.04	26	20	1.30	31	21	1.48	38	32	1.19	1.23
16-Jul	31	31	1.00	25	65	0.38	43	44	0.98	100	78	1.28	0.91
17-Jul	42	68	0.62	50	75	0.67	49	76	0.64	44	43	1.02	0.71
18-Jul	16	10	1.60	24	26	0.92	25	28	0.89	34	30	1.13	1.05
19-Jul	33	34	0.97	36	82	0.44	29	26	1.12	45	64	0.70	0.69
20-Jul	74	128	0.58	38	84	0.45	42	35	1.20	73	132	0.55	0.60
21-Jul	23	27	0.85	24	15	1.60	26	24	1.08	61	96	0.64	0.83
22-Jul	15	24	0.63	9	9	1.00	5	5	1.00	86	55	1.56	1.24
23-Jul	11	8	1.38	11	54	0.20	133	271	0.49	27	20	1.35	0.52
24-Jul	21	4	5.25	13	13	1.00	20	39	0.51	33	18	1.83	1.18
25-Jul	24	23	1.04	17	18	0.94	8	14	0.57	48	46	1.04	0.96
26-Jul	22	14	1.57	8	7	1.14	8	8	1.00	107	56	1.91	1.71
27-Jul	30	31	0.97	9	13	0.69	13	6	2.17	33	17	1.94	1.27
28-Jul	32	189	0.17	13	18	0.72	5	6	0.83	73	100	0.73	0.39
29-Jul	15	7	2.14	1	1	1.00	4	7	0.57	31	29	1.07	1.16
30-Jul	10	7	1.43	4	8	0.50	8	11	0.73	23	19	1.21	1.00
31-Jul	5	15	0.33	12	87	0.14							
01-Aug													
02-Aug													
03-Aug													
04-Aug													
05-Aug													
06-Aug													
AVERAGE	22.0	27.9	1.2	19.6	26.3	1.0	27.1	31.1	1.3	40.8	42.7	1.3	1.1

a Adjustment ratio is the scope count divided by the sonar count.

Table 9. Chum salmon escapement estimation for 1987 using side scan sonar migration timing data from the years 1980-1984, Aniak River, Alaska.

Date	Normal Timing Daily Prop.	Normal Timing Cum. Prop.	Late Timing Daily Prop.	Late Timing Cum. Prop.	Early Timing Daily Prop.	Early Timing Cum. Prop.	Expanded Adjusted Count	Estimated Daily Escapem't [a]
15-Jun	0.00021	0.00021	0.00000	0.00000	0.00105	0.00105		
16-Jun	0.00151	0.00172	0.00000	0.00000	0.00604	0.00709		
17-Jun	0.00150	0.00322	0.00000	0.00000	0.00698	0.01407		
18-Jun	0.00137	0.00459	0.00000	0.00000	0.00586	0.01993		
19-Jun	0.00244	0.00703	0.00000	0.00000	0.00730	0.02723		
20-Jun	0.00184	0.00887	0.00000	0.00000	0.00460	0.03183		
21-Jun	0.00327	0.01214	0.00000	0.00000	0.00240	0.03423	627.0	1015.7
22-Jun	0.00426	0.01640	0.00048	0.00048	0.00494	0.03917	1066.5	1727.7
23-Jun	0.00579	0.02219	0.00035	0.00083	0.00533	0.04450	1499.7	2429.5
24-Jun	0.00623	0.02842	0.00028	0.00111	0.00744	0.05194	4137.0	6702.0
25-Jun	0.00761	0.03603	0.00026	0.00137	0.00704	0.05898	385.9	625.2
26-Jun	0.01223	0.04826	0.00065	0.00202	0.01875	0.07773	955.4	1547.7
27-Jun	0.01480	0.06306	0.00168	0.00370	0.03390	0.11163	1951.7	3161.8
28-Jun	0.01534	0.07840	0.00126	0.00496	0.02971	0.14134	1936.1	3136.4
29-Jun	0.01660	0.09500	0.00207	0.00703	0.01421	0.15555	1487.2	2409.3
30-Jun	0.01491	0.10991	0.00677	0.01380	0.00967	0.16522	564.7	914.7
01-Jul	0.02119	0.13110	0.01131	0.02511	0.02875	0.19397	834.1	1351.3
02-Jul	0.02853	0.15963	0.01489	0.04000	0.02403	0.21800	272.0	440.6
03-Jul	0.03569	0.19532	0.02961	0.06961	0.06474	0.28274	2230.4	3613.2
04-Jul	0.04857	0.24389	0.04150	0.11111	0.07010	0.35284	2693.6	4363.6
05-Jul	0.03364	0.27753	0.02119	0.13230	0.01399	0.36683	6198.0	10040.8
06-Jul	0.03669	0.31422	0.03881	0.17111	0.01153	0.37836	3388.0	5488.6
07-Jul	0.02961	0.34383	0.02077	0.19188	0.02029	0.39865	3771.9	6110.5
08-Jul	0.02909	0.37292	0.01405	0.20593	0.03133	0.42998	2358.3	3820.4
09-Jul	0.03818	0.41110	0.03165	0.23758	0.06977	0.49975	2719.6	4405.7
10-Jul	0.03585	0.44695	0.03264	0.27022	0.03690	0.53665	3719.8	6026.0
11-Jul	0.03775	0.48470	0.03572	0.30594	0.03852	0.57517	6711.6	10872.8
12-Jul	0.03615	0.52085	0.03783	0.34377	0.03744	0.61261	7852.6	12721.1
13-Jul	0.03807	0.55892	0.04551	0.38928	0.04124	0.65385	2798.6	4533.7
14-Jul	0.03778	0.59670	0.02560	0.41488	0.04707	0.70092	4928.4	7983.9
15-Jul	0.03647	0.63317	0.02472	0.43960	0.03687	0.73779	3468.8	5619.5
16-Jul	0.03237	0.66554	0.03526	0.47486	0.02454	0.76233	3645.6	5905.9
17-Jul	0.03123	0.69677	0.04363	0.51849	0.03126	0.79359	4425.0	7168.5
18-Jul	0.03494	0.73171	0.07171	0.59020	0.03505	0.82864	3553.0	5755.8
19-Jul	0.02975	0.76146	0.05634	0.64654	0.02031	0.84895	2655.9	4302.5
20-Jul	0.02654	0.78800	0.02057	0.66711	0.01847	0.86742	3875.9	6278.9
21-Jul	0.02256	0.81056	0.02385	0.69096	0.01557	0.88299	2799.1	4534.6
22-Jul	0.02634	0.83690	0.02918	0.72014	0.02517	0.90816	1721.2	2788.4
23-Jul	0.02288	0.85978	0.03165	0.75179	0.01676	0.92492	2101.3	3404.1
24-Jul	0.02393	0.88371	0.03344	0.78523	0.02004	0.94496	3266.6	5291.9
25-Jul	0.02137	0.90508	0.02279	0.80802	0.01571	0.96067	1117.9	1811.0
26-Jul	0.01745	0.92253	0.02438	0.83240	0.01411	0.97478	2423.4	3926.0
27-Jul	0.01553	0.93806	0.02220	0.85460	0.01384	0.98862	1962.6	3179.4
28-Jul	0.01572	0.95378	0.02030	0.87490	0.01138	1.00000	1664.0	2695.7
29-Jul	0.01153	0.96531	0.01578	0.89068			2302.9	3730.7
30-Jul	0.00986	0.97517	0.01198	0.90266			1726.2	2796.4
31-Jul	0.00677	0.98194	0.01482	0.91748				2867.1
01-Aug	0.00442	0.98636	0.01434	0.93182				2774.3
02-Aug	0.00279	0.98915	0.01394	0.94576				2696.9
03-Aug	0.00381	0.99296	0.01902	0.96478				3679.7
04-Aug	0.00326	0.99622	0.01644	0.98122				3180.5
05-Aug	0.00378	1.00000	0.01878	1.00000				3633.3
Escapement Objective = 250,000					Estimated Total Escapement =>			193,464

a Daily escapements for the period 31 July - 5 August were estimated from historic daily proportions for a late migration. All other daily estimates were determined from adjusted daily counts as listed in Table 7. Daily escapement estimates represent adjusted sonar counts which have been expanded by a factor of 1.62 to account for salmon which swim outside of the ensonified water column.

Table 10. Daily CPUE data for chinook and chum salmon from all gear, Aniak Sonar Project, 1985.

Date	Chinook n	Chinook Soak Time (Hr)	Chinook a CPUE	Chum n	Chum Soak Time (Hr)	Chum a CPUE	Total n	Total Soak Time (Hr)	Total a CPUE
20-Jun b									
21-Jun b									
22-Jun	0	0.29	0.000		0.29	0.000	0	0.29	0.000
23-Jun	0	0.34	0.000		0.34	0.000	0	0.34	0.000
24-Jun	0	0.32	0.000		0.32	0.000	0	0.32	0.000
25-Jun b									
26-Jun	0	0.32	0.000	1	0.32	0.625	1	0.32	0.625
27-Jun b									
28-Jun b									
29-Jun	0	0.29	0.000	2	0.29	1.379	2	0.29	1.379
30-Jun	0	0.28	0.000		0.28	0.000	0	0.28	0.000
01-Jul b									
02-Jul	0	0.32	0.000	1	0.32	0.625	1	0.32	0.625
03-Jul	0	0.32	0.000	1	0.32	0.625	1	0.32	0.625
04-Jul	0	0.29	0.000	3	0.29	2.069	3	0.29	2.069
05-Jul	0	0.29	0.000	7	0.29	4.828	7	0.29	4.828
06-Jul b									
07-Jul	0	0.27	0.000	5	0.27	3.704	5	0.27	3.704
08-Jul b									
09-Jul	0	0.29	0.000	13	0.29	8.966	13	0.29	8.966
10-Jul	0	0.27	0.000	4	0.27	2.963	4	0.27	2.963
11-Jul	0	0.27	0.000	5	0.27	3.704	5	0.27	3.704
12-Jul	0	0.28	0.000	2	0.28	1.429	2	0.28	1.429
13-Jul	0	0.28	0.000	1	0.28	0.714	1	0.28	0.714
14-Jul	1	0.28	0.714	4	0.28	2.857	5	0.28	3.571
15-Jul b									
16-Jul	1	0.28	0.714	2	0.28	1.429	3	0.28	2.143
17-Jul	1	0.30	0.667	4	0.30	2.667	5	0.30	3.333
18-Jul	0	0.32	0.000	7	0.32	4.375	7	0.32	4.375
19-Jul	0	0.32	0.000	3	0.32	1.875	3	0.32	1.875
20-Jul	1	0.32	0.625	2	0.32	1.250	3	0.32	1.875
21-Jul	0	0.32	0.000	4	0.32	2.500	4	0.32	2.500
22-Jul b									
23-Jul	0	0.32	0.000	8	0.32	5.000	8	0.32	5.000
24-Jul	0	0.36	0.000	3	0.36	1.667	3	0.36	1.667
25-Jul	2	0.36	1.111	7	0.36	3.889	9	0.36	5.000
26-Jul	0	0.37	0.000	4	0.37	2.162	4	0.37	2.162
27-Jul	1	0.36	0.556	2	0.36	1.111	3	0.36	1.667
28-Jul	0	0.36	0.000	2	0.36	1.111	2	0.36	1.111
29-Jul b									
30-Jul	0	0.36	0.000	1	0.36	0.556	1	0.36	0.556
31-Jul b									
Total	7	9.35	0.150	98	9.35	2.096	105	9.35	2.246

a Catch per fathom length of gill net per hour.

b CPUEs interpolated for days not fished.

Table 11. Chum salmon age, and sex composition from beach seine and gill net catches, Aniak River, Alaska, 1985.

	Age 0.3		Age 0.4		Age 0.5		TOTAL	
	No.	%	No.	%	No.	%	No.	%
MALE	30	17.9	56	33.3	2	1.2	88	52.4
FEMALE	38	22.6	42	25.0	0	0.0	80	47.6
TOTAL	68	40.5	98	58.3	2	1.2	168	100.0

Table 12. Salmon carcass species, age, and sex composition, Aniak River, Alaska, 1985.

Species	Sampled	Counted	Total	% Female
Chinook	56	7	63	36.5
Sockeye	1	0	1	0.0
Pink	0	31	31	70.0
Chum	450	1735	2185	50.5
Total	507	1773	2280	

CHINOOK

	Age 1.2		Age 1.3		Age 1.4		Age 1.5		Total	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
MALE	2	3.6	16	28.6	13	23.2	1	1.8	32	57.1
FEMALE		0.0	6	10.7	18	32.1		0.0	24	42.9
TOTAL	2	3.6	22	39.3	31	55.4	1	1.8	56	100.0

CHUM

	Age 0.3		Age 0.4		Age 0.5		TOTAL	
	NO.	%	NO.	%	NO.	%	NO.	%
MALE	70	15.6	143	31.8	3	0.7	216	48.0
FEMALE	122	27.1	111	24.7	1	0.2	234	52.0
TOTAL	191	42.4	254	56.4	5	1.1	450	100.0

Table 13. Site A meteorologic and hydrologic observations, 1985.

Date	Time[a]	Cloud Cover (%)	Precipitation[b]	Wind (Dir/mph)[b]	Air Temperature (Fahrenheit)	Water Temperature (Fahrenheit)	Relative Stream Level (mm)
15-Jun							
16-Jun							
17-Jun							
18-Jun							
19-Jun							
20-Jun							
21-Jun							
22-Jun	1410	50	0	V<4			4085
23-Jun	1200	10	0	N/10	67	47	4030
24-Jun	1200	10	0	W/13	66	49	4055
25-Jun	1210	100	0	WNW/5	50	47	4060
26-Jun	1300	60	0	V<4	58	46	4040
27-Jun	1220	75	0	V<4	70	48	3995
28-Jun	1200	90	0	V<4	57	50	3970
29-Jun	1220	100	A	W/8	60	50	3925
30-Jun	1230	60	A	NE<4	54	49	3900
01-Jul	1230	100	A	SW/15	54	49	3910
02-Jul	1300	100	0	SW/5	54	49	3940
03-Jul	1250	75	0	W<4	51	46	3905
04-Jul	1220	60	0	V<4	59	48	3870
05-Jul	1150	10	0	V<4	66	48	3845
06-Jul	1220	60	B	SSW/15	69	50	3820
07-Jul	1200	100	B	SW/15	53	50	3790
08-Jul	1250	60	A	W/4	56	49	3750
09-Jul	1300	90	0	NW<4	58	50	3770
10-Jul	1200	100	A	V<4	56	50	3775
11-Jul	1210	75	0	N<4	56	49	3790
12-Jul	1200	10	0	V<4	62	51	3780
13-Jul	1230	10	0	S/10	72	54	3745
14-Jul	1200	75	0	S/4	66	53	3700
15-Jul	1310	60	0	SW/10	72	51	3630
16-Jul	1200	60	A	SSE/10	66	52	3585
17-Jul	1200	90	A	S/4	59	52	3530
18-Jul	1220	60	0	S/10	72	52	3510
19-Jul	1200	75	0	NE<4	75	52	3460
20-Jul	1330	75	A	N<4	66	53	3400
21-Jul	1200	30	0	S/12	62	53	3345
22-Jul	1330	90	A	S/5	64	51	3295
23-Jul	1200	100	A	V<4	66	50	3250
24-Jul	1200	30	0	WSW/10	61	51	3220
25-Jul	1300	10	0	S/5	64	53	3240
26-Jul	1200	50	A	V<4	70	54	3255
27-Jul	1250	60	A	NW<4	68	54	3230
28-Jul	1200	60	A	V<4	64	54	3200
29-Jul	1220	75	A	SW/4	67	54	3185
30-Jul	1240	75	A	V<4	63	54	3130
31-Jul							

a Using the 24 hour clock.

b Codes: A = intermittent rain; F = thunderstorms; N, S, E, W, etc. = compass points; V = variable; < = less than.

Table 14. Site A meteorologic and hydrologic observations, 1986.

R Date	a Time	Cloud Cover (%)	b Precipitation	Wind b (Dir/mph)	Air Temperature (Fahrenheit)	Water Temperature (Fahrenheit)	Relative Stream Level (mm)
15-Jun							
16-Jun							
17-Jun							
18-Jun							
19-Jun							
20-Jun							
21-Jun							
22-Jun							
23-Jun							
24-Jun							
25-Jun							
26-Jun							
27-Jun							
28-Jun							
29-Jun							
30-Jun							
01-Jul	1310	80	0	N/5	70	54	3990
02-Jul	1414	10	0	N/6	81	59	3950
03-Jul	1415	15	0	SW<4	88	55	4005
04-Jul	1150	95	0	SE/8	73	55	4030
05-Jul							
06-Jul	1520	100	0	S/5	61	50	4000
07-Jul	1220	90	0	S/6	64	50	3925
08-Jul	1300	80	0	SE<4	68	50	3890
09-Jul	1340	80	0	V<4	73	50	3875
10-Jul	1635	75	A	S<4	70	52	3850
11-Jul	1215	100	A	SW<4	61	50	3790
12-Jul	1520	100	0	SW<4	61	48	3820
13-Jul	1450	100	0	V<4	72	48	3810
14-Jul	1345	10	0	SE/12	66	50	3765
15-Jul							
16-Jul	1315	100	0	S<4	59	52	3760
17-Jul	1840	100	0	S<4	57	52	3720
18-Jul	1150	100	A	SE<4	59	50	3705
19-Jul	1440	100	A	SW/5	61	52	3640
20-Jul	1340	100	A	SW/5	50	50	3605
21-Jul	1340	25	0	NE<4	66	52	3550
22-Jul	1330	100	A	SE<4	59	52	3510
23-Jul	1425	100	A	S/15	52	50	3480
24-Jul	1520	100	0	V<4	54	48	3465
25-Jul	900	100	A	V<4			
26-Jul							
27-Jul							
28-Jul							
29-Jul							
30-Jul							
31-Jul							

a Using the 24 hour clock.

b Codes: A = intermittent rain; F = thunderstorms; N, S, E, W, etc. = compass points; V = variable; < = less than.

Table 15. Site A meteorologic and hydrologic observations, 1987.

Date	Time [a]	Cloud Cover (%)	Precipitation [b]	Wind (Dir/mph) [b]	Air Temperature (Fahrenheit)	Water Temperature (Fahrenheit)	Relative Stream Level (mm)
15-Jun							
16-Jun							
17-Jun							
18-Jun							
19-Jun							
20-Jun							
21-Jun	1315	75	0	NW/5	70	48	4610
22-Jun	1225	100	B	V<4	54	48	4520
23-Jun	1227	100	0	SE/7	63	46	4540
24-Jun	1340	75	0	SE/7	66	46	4710
25-Jun	1505	50	0	SE/7	55	48	4910
26-Jun	1420	100	0	SE/10	54	48	4910
27-Jun	1230	100	0	S/10	54	46	4730
28-Jun	1500	100	A	S/15	54	46	4690
29-Jun	1410	100	0	S/30	59	48	4830
30-Jun	1511	100	A	SE/15	50	46	5000
01-Jul	1617	100	A	SE<4	52	46	
02-Jul	1225	50	A	SE/5	57	46	
03-Jul [c]							
04-Jul [c]							
05-Jul	1300	50	A	NW/5	64	48	4590
06-Jul	1430	100	B	W<4	61	50	4350
07-Jul	1525	100	A	W<4	55	48	4300
08-Jul	1230	100	B	V<4	54	48	4400
09-Jul	1148	75	A	V<4	63	48	4430
10-Jul	1130	50	0	V<4	63	50	4630
11-Jul	1330	100	0	W<4	54	50	4470
12-Jul	1229	75	0	V<4	57	48	4330
13-Jul	1300	75	0	V<4	64	50	4200
14-Jul	1200	100	A	V<4	55	48	4090
15-Jul	1240	50	A	V<4	68	50	4110
16-Jul	1155	100	A	SE/7	55	50	4090
17-Jul	1300	100	A	SSE<4	57	52	4060
18-Jul	1545	100	A	SE<4	63	51	4170
19-Jul	1302	100	A	V<4	64	52	4250
20-Jul	1240	100	A	S/12	55	52	4240
21-Jul	1218	75	A	V<4	61	51	4250
22-Jul	1220	75	A	S/12	64	51	4180
23-Jul	1300	100	A	NW<4	59	52	4040
24-Jul	1250	100		S<4	54	51	4090
25-Jul	1925	50	0	W<4	61	52	4030
26-Jul	1240	50	0	V<4	64	50	3980
27-Jul	1230	21	-	V<4	75	54	3890
28-Jul	1315	10	0	V<4	79	55	3790
29-Jul	1229	75	0	W/8	66	57	3720
30-Jul	1230	100	A	NW/8	59	55	3630
31-Jul	1140	75	0	W<4	61	55	3660

a Using the 24 hour clock.

b Codes: A = intermittent rain; F = thunderstorms; N, S, E, W, etc. = compass points; V = variable; < = less than.

c Flood waters rendered the project inoperable.

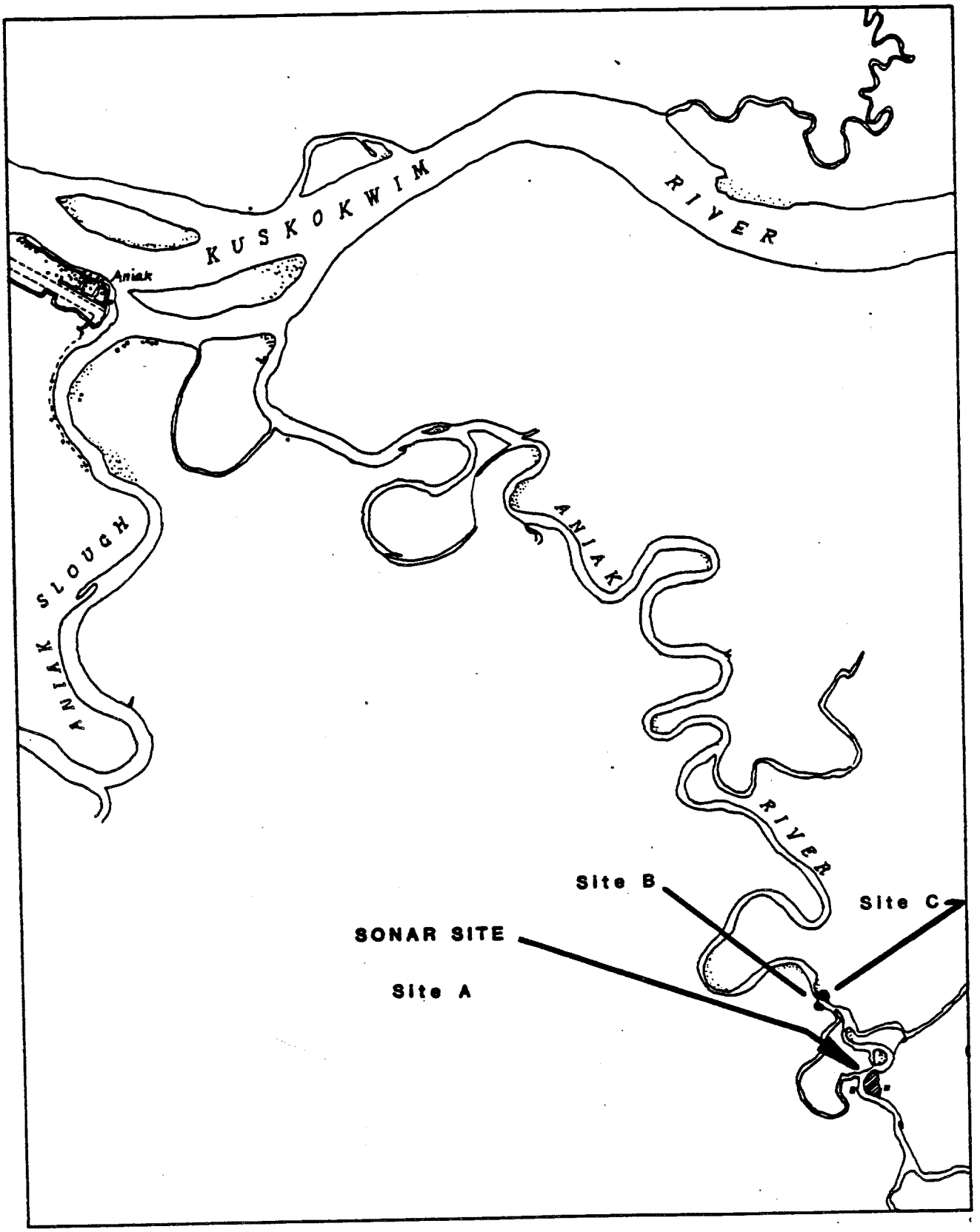

Figure 1. Map of the Aniak Sonar site and vicinity, 1985-87.

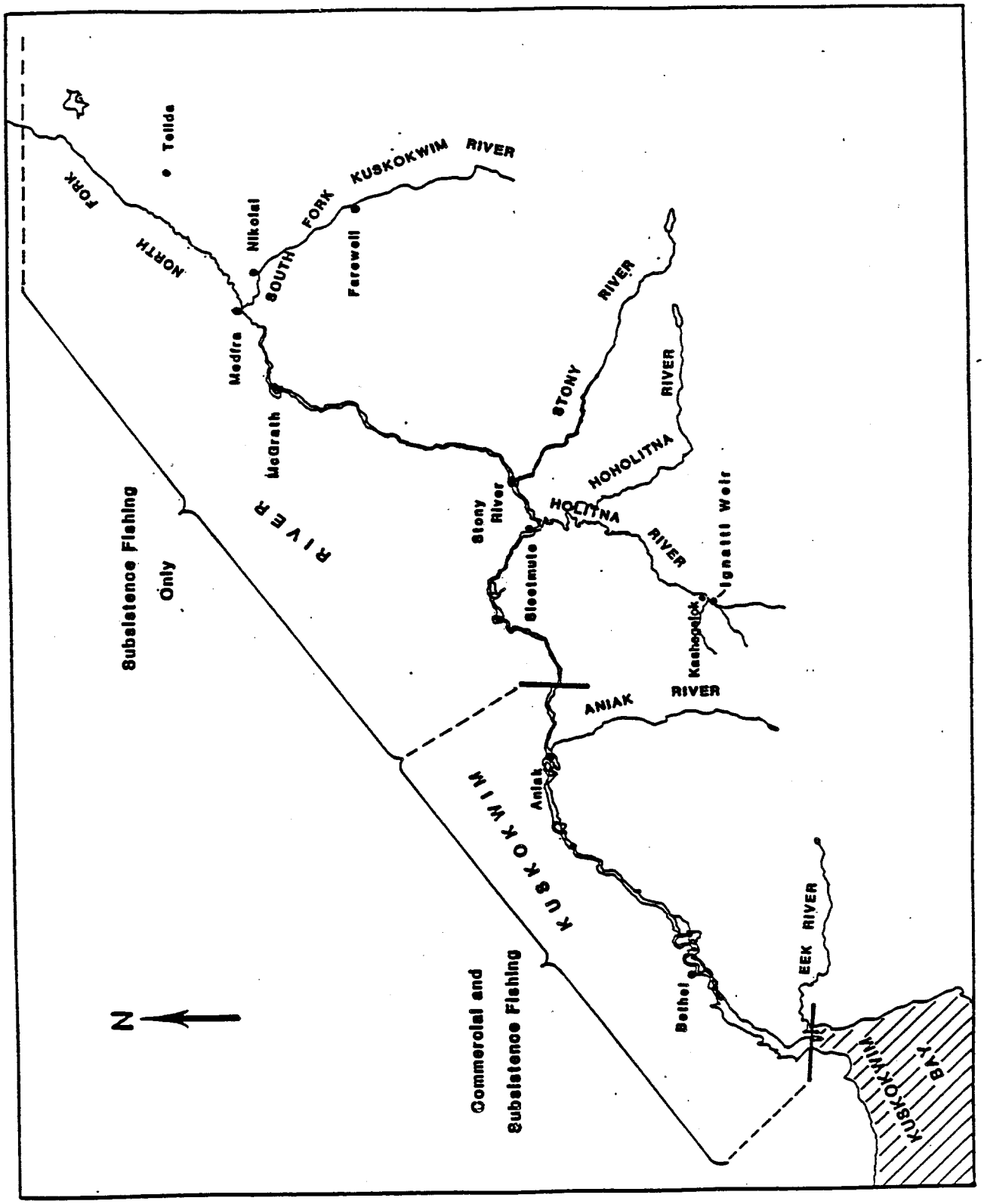

Figure 2. Map of the Kuskokwim area.

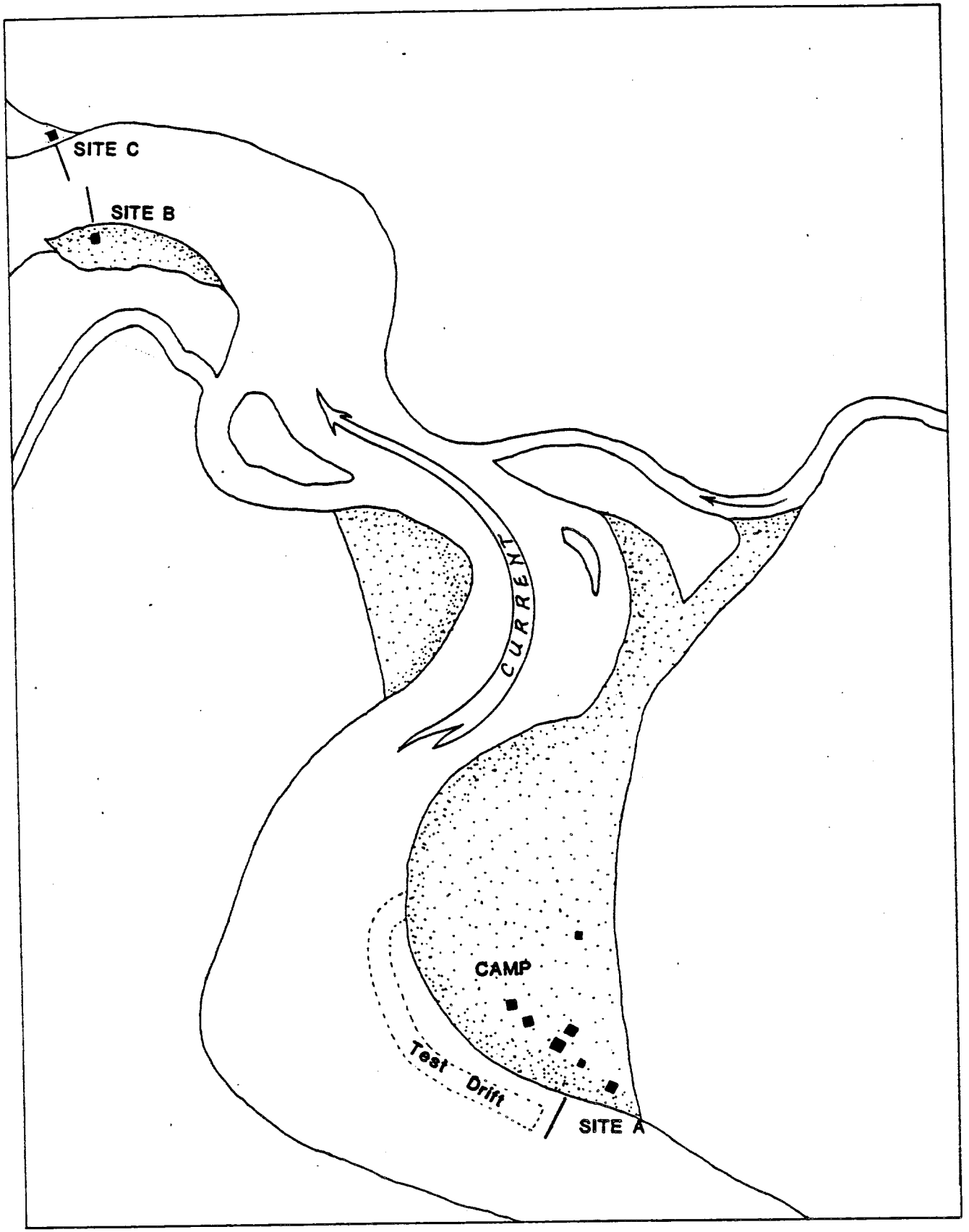

Figure 3. Map of the Aniak Sonar site, 1985-87.

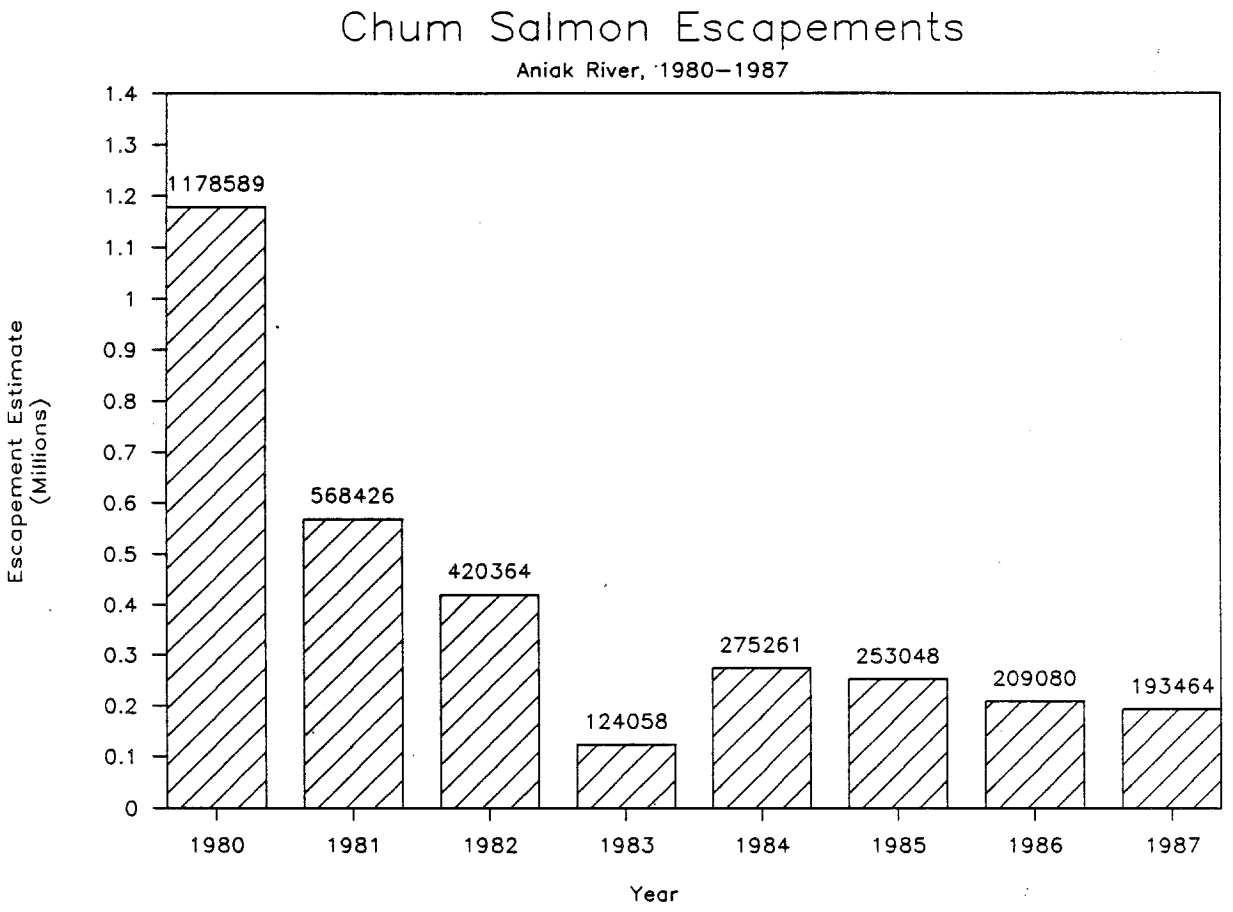

Figure 4. Annual Aniak River chum salmon escapement estimates, 1980-1987.

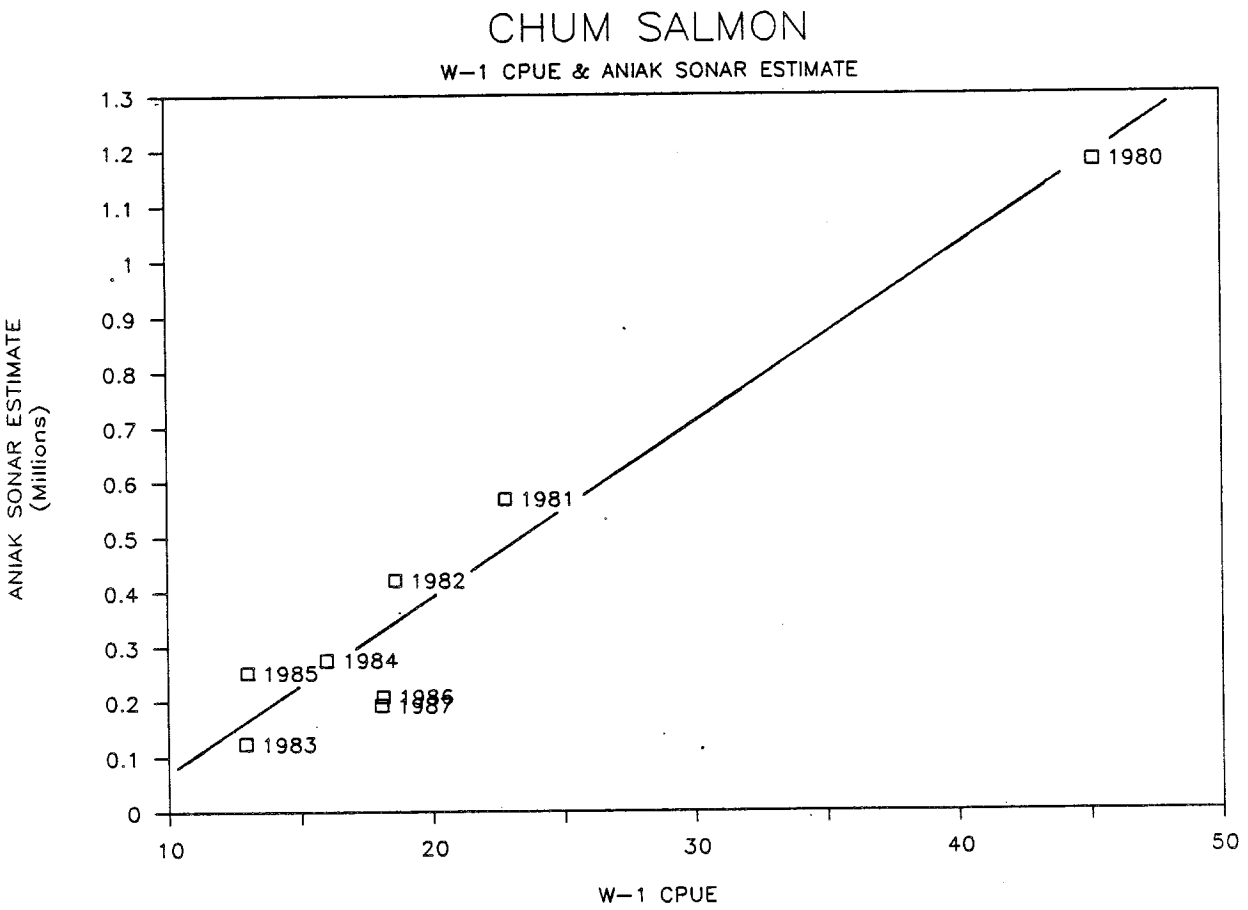

Figure 5. Relationship between annual Aniak sonar escapement estimates and District 1 commercial chum salmon catch per unit effort, 1980-1987.

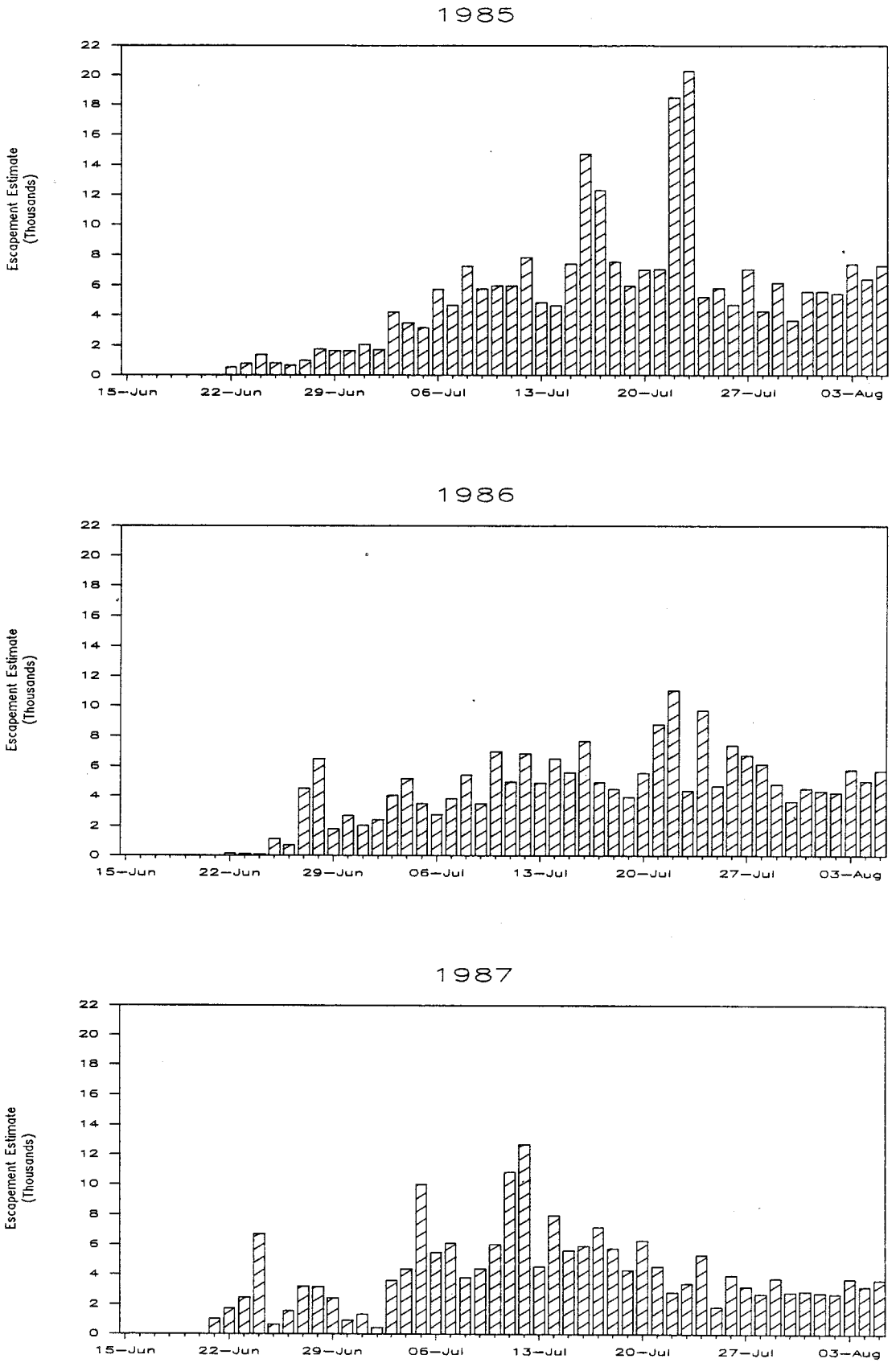

Figure 6. Daily chum salmon escapement estimates in the Aniak River, 1985-1987.

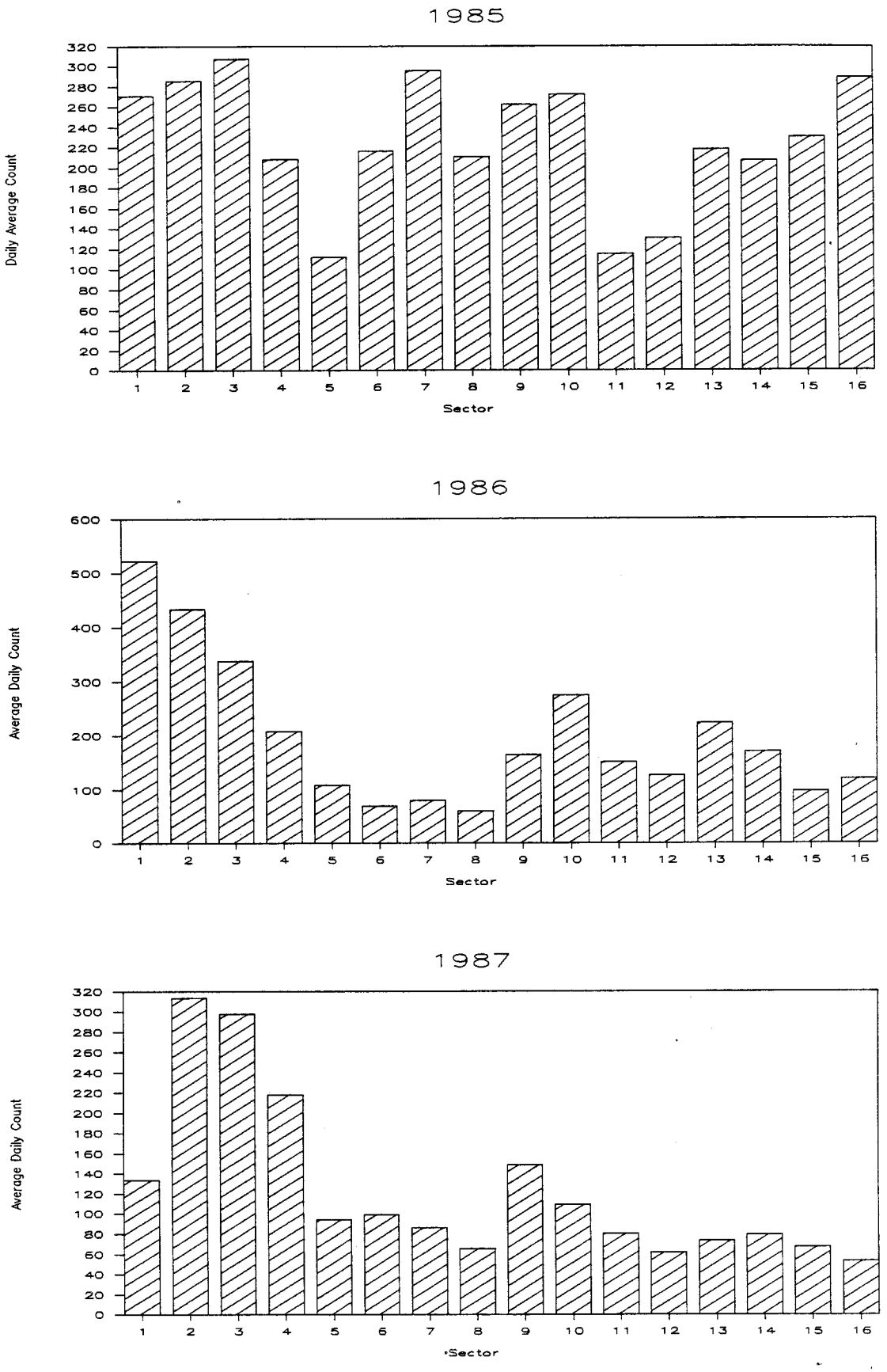

Figure 7. Average daily sonar sector count distributions, Aniak Sonar project, 1985-1987.

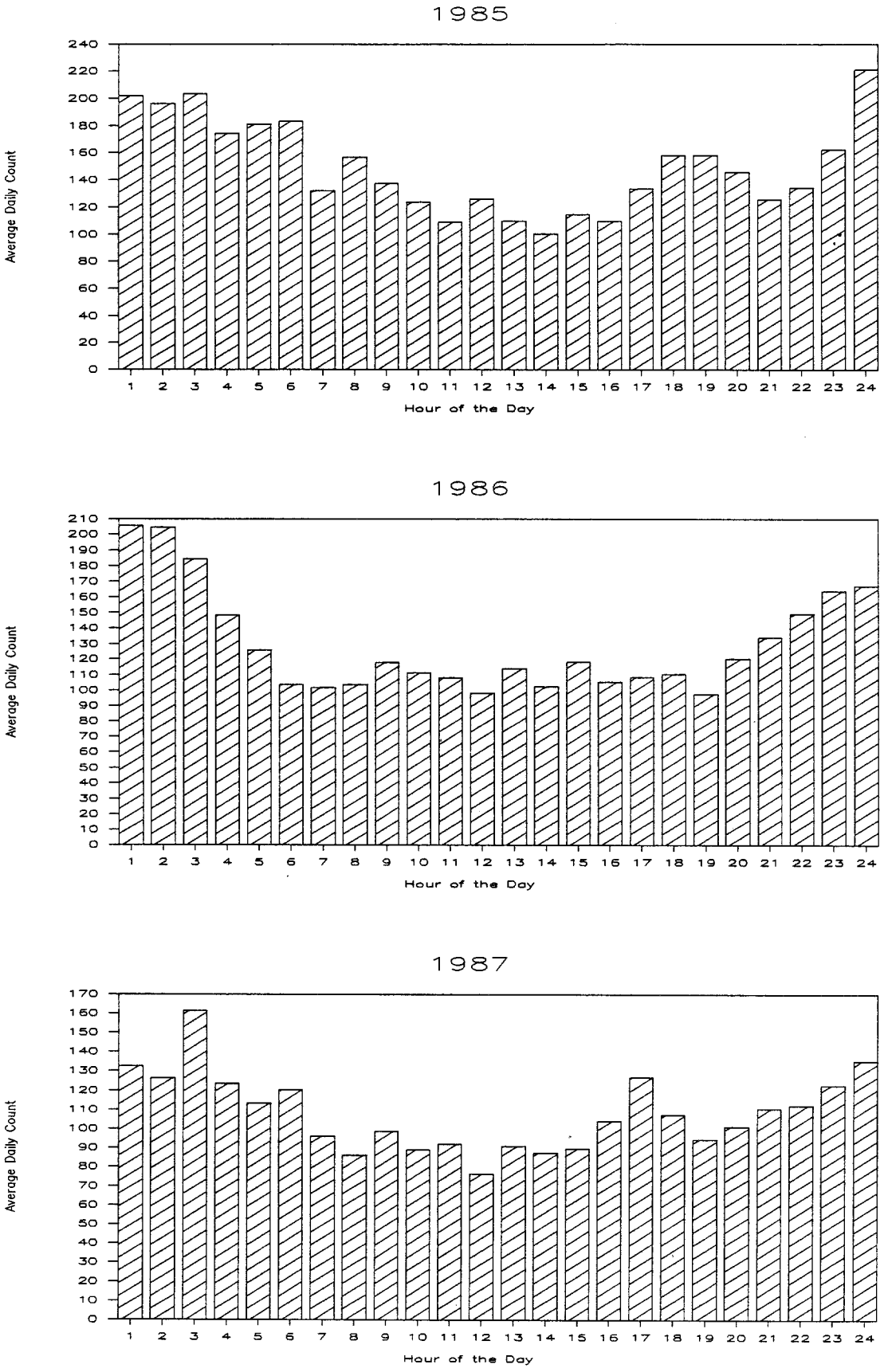

Figure 8. Average daily diel count distributions, Aniak Sonar project, 1985-1987.

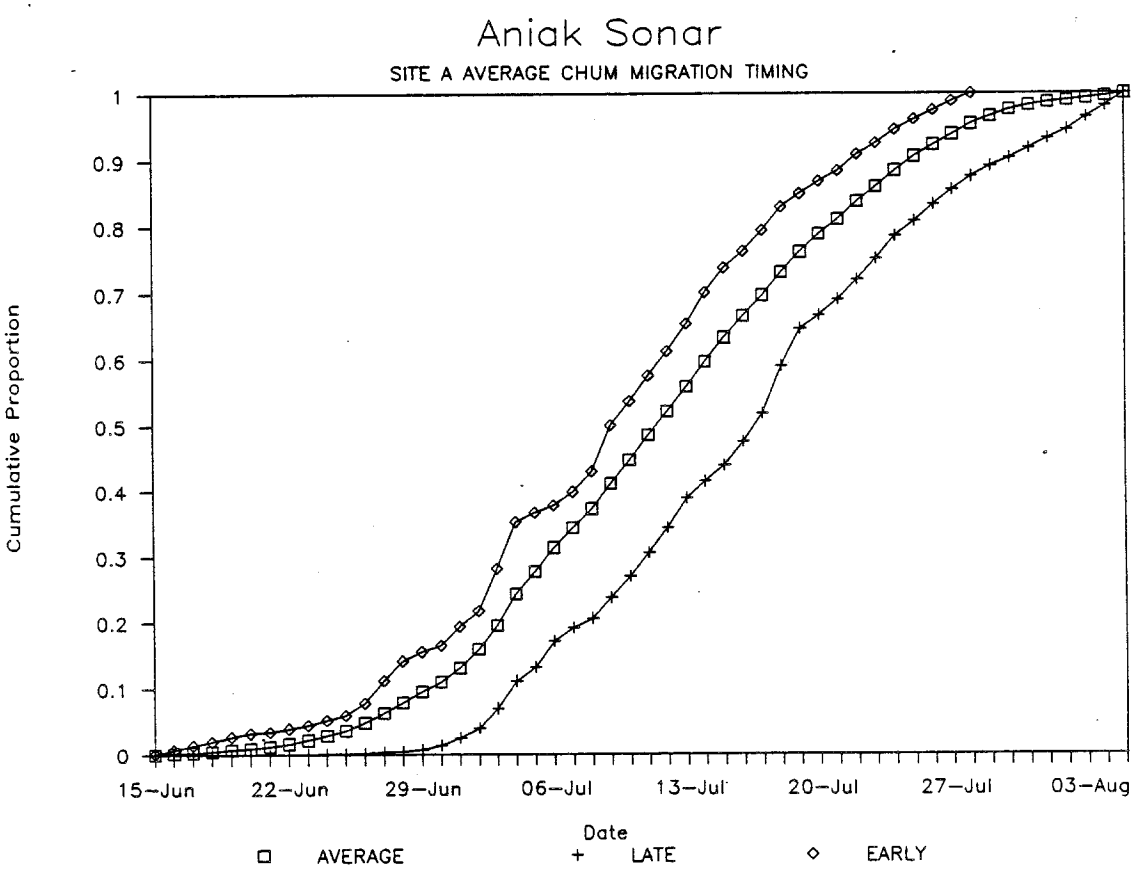

Figure 9. Average, late and early chum salmon migration timing based on historic data, Aniak Sonar project, 1980-1984.

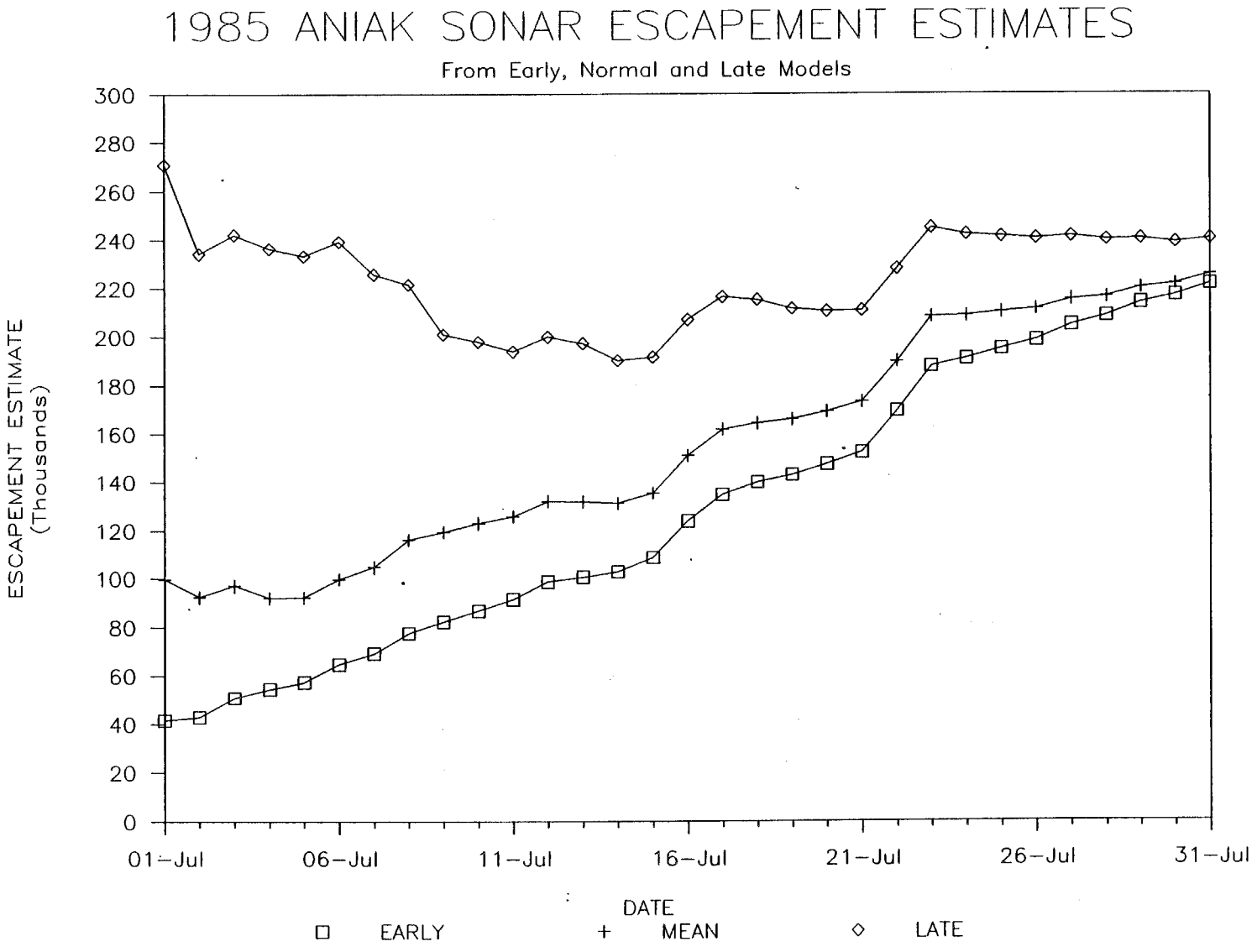

Figure 10. Daily inseason sonar-based total season chum salmon escapement estimates, Aniak Sonar project, 1985.

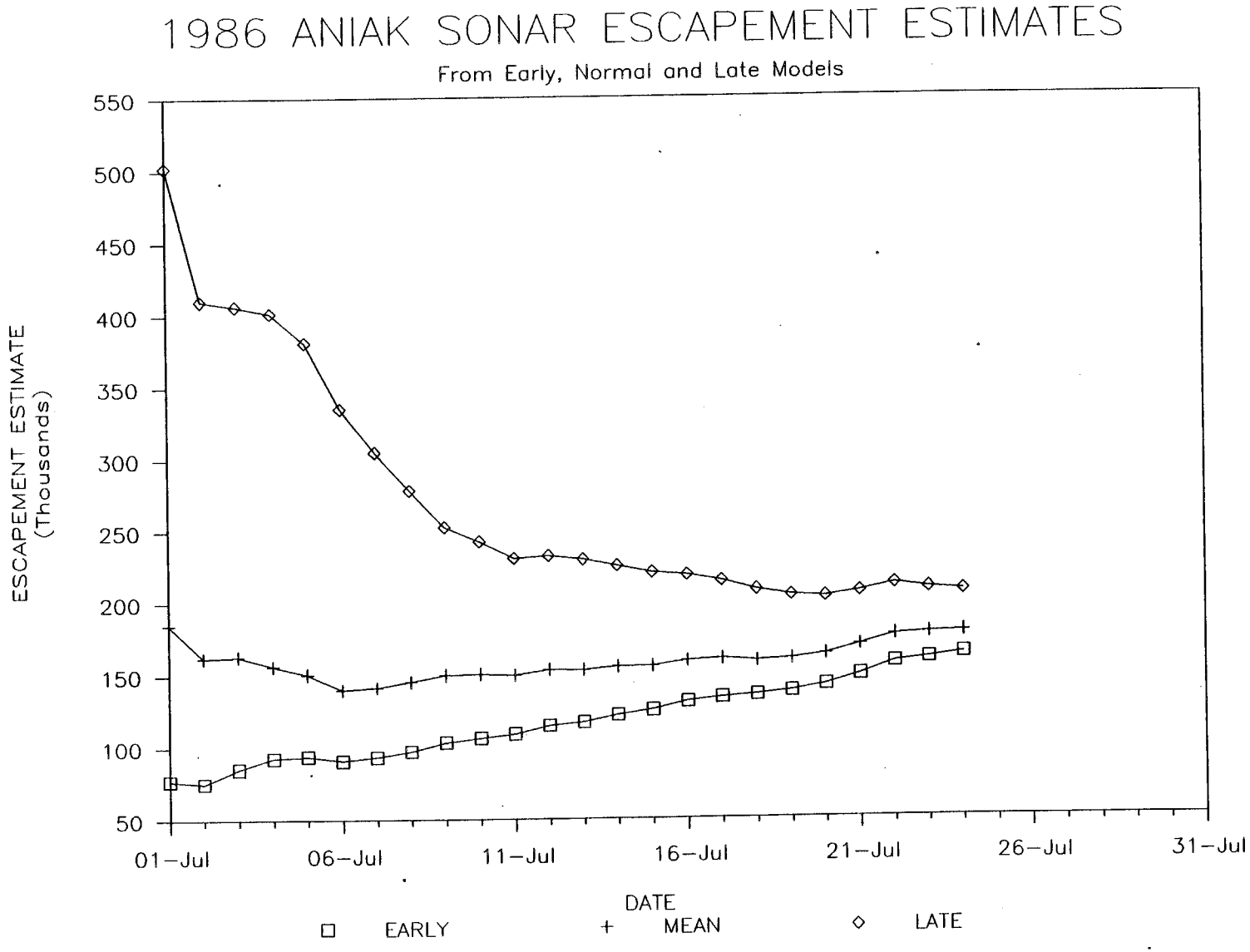

Figure 11. Daily inseason sonar-based total season chum salmon escapement estimates, Aniak Sonar project, 1986.

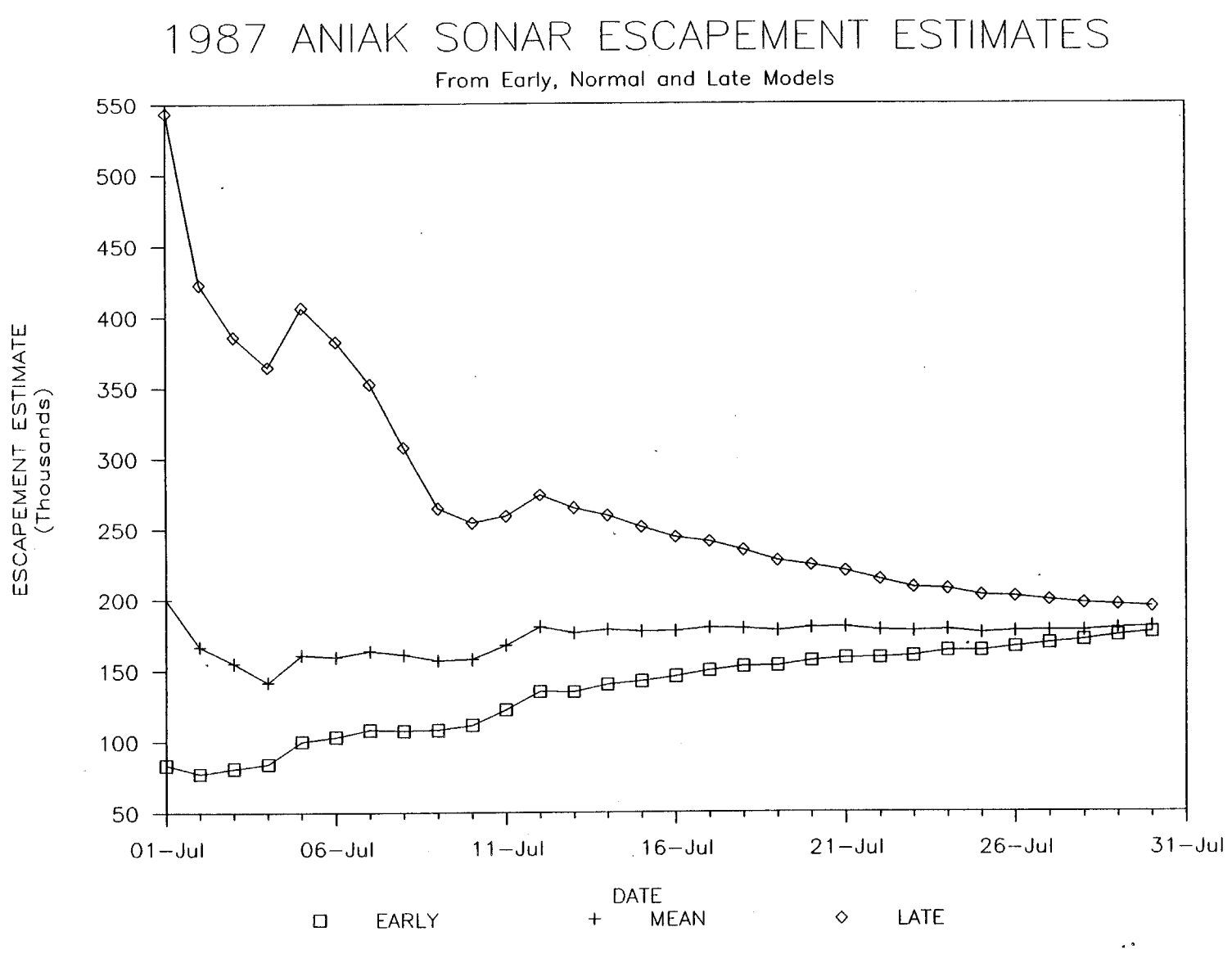

Figure 12. Daily inseason sonar-based total season chum salmon escapement estimates, Aniak Sonar project, 1987.

Appendix A. Historic progression of linear regression computations using sonar generated chum salmon escapement estimates for the Aniak River and chum salmon cumulative season commercial catch per unit effort for District 1 of the Kuskokwim River.

DATA

YEAR	ANIAK ESC. EST. (Y)	W-1 CPUE (X)
1980	1178589	45.2
1981	568426	22.8
1982	420364	18.6
1983	124058	12.9
1984	275261	16.0
1985	253048	13.0
1986	209080	18.1
1987	193464	18.1

REGRESSION OUTPUT[a]

Year	Constant	Std Err of Y Est	R Squared	N	D.F.	X Coef.	Std Err of Coef.
1982	-81952.3	19864.12	0.999	3	1	26002.96	982.2333
1983	-185305.6	71400.76	0.980	4	2	28766.05	2914.4687
1984	-194229.8	59116.62	0.982	5	3	28979.64	2295.5532
1985	-185061.4	52101.06	0.983	6	4	28726.60	1904.7383
1986	-212991.0	69829.69	0.964	7	5	29198.04	2537.1256
1987	-251177.6	96156.14	0.933	8	6	31768.34	3477.0005

a Regression output was generated using the built-in regression function in the Lotus 1-2-3 (copyright Lotus Developement Corporation) spreadsheet software.

Appendix B-1. Daily site A sonar counts by sector, Aniak River, 1985.

	Sonar Sector															
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
15-Jun																
16-Jun																
17-Jun																
18-Jun																
19-Jun																
20-Jun																
21-Jun																
22-Jun	56	1	5	5	2	4	2	3	11	23	13	13	55	64	37	27
23-Jun	83	1	5	11	4	8	5	21	33	36	30	19	61	57	36	29
24-Jun	71	14	24	27	24	24	37	44	68	84	81	34	25	19	4	6
25-Jun	134	74	68	51	17	13	19	12	30	8	11	16	44	29	21	8
26-Jun	141	94	40	23	10	13	16	3	14	11	14	17	7	6	2	0
27-Jun	90	77	55	43	7	8	7	17	27	45	21	30	49	28	16	12
28-Jun	132	119	112	100	39	43	58	63	67	163	85	117	65	30	43	22
29-Jun	172	95	96	92	38	32	29	101	107	71	59	34	81	9	22	31
30-Jun	192	147	89	101	38	17	28	40	101	75	60	41	59	25	11	10
01-Jul	168	148	172	83	20	14	10	7	15	85	64	36	62	30	24	18
02-Jul	344	248	166	82	24	13	10	5	24	71	50	33	60	41	28	37
03-Jul	502	423	243	157	40	25	64	69	131	122	102	66	99	53	56	66
04-Jul	168	191	151	137	44	25	61	91	191	195	93	159	245	131	128	177
05-Jul	84	27	81	70	43	43	49	33	231	374	214	219	362	172	298	220
06-Jul	168	137	213	281	155	90	83	99	435	414	235	197	259	228	318	245
07-Jul	690	619	492	256	55	35	37	47	263	189	83	84	131	85	93	207
08-Jul	928	1672	1350	497	52	17	13	7	51	54	40	14	33	37	27	35
09-Jul	255	841	1353	459	37	13	4	3	43	40	31	20	36	13	53	20
10-Jul	306	689	826	338	62	63	28	34	146	162	65	28	31	20	50	47
11-Jul	121	161	242	188	88	138	198	178	569	592	251	168	140	130	241	299
12-Jul	74	85	139	206	71	98	78	95	410	434	135	116	195	229	315	1720
13-Jul	261	104	175	229	87	124	129	184	559	644	289	273	429	364	463	382
14-Jul	269	46	162	257	137	152	89	127	330	476	132	194	193	90	174	90
15-Jul	250	39	94	132	148	226	267	387	487	596	231	576	585	326	353	496
16-Jul	303	177	240	438	448	916	1190	1944	976	1028	325	336	439	298	568	1505
17-Jul	452	305	214	151	111	491	805	609	723	516	255	205	385	527	597	1047
18-Jul	381	285	267	158	105	260	382	245	494	320	204	188	276	268	197	144
19-Jul	204	145	208	161	71	208	438	285	613	676	158	234	514	310	361	287
20-Jul	262	315	230	101	93	295	481	255	418	398	118	203	348	161	175	870
21-Jul	258	202	241	80	61	360	482	352	521	571	289	355	397	195	183	92
22-Jul	167	123	291	379	589	1830	2249	945	681	863	433	295	448	514	511	252
23-Jul	315	444	1060	691	594	1285	2710	874	332	604	175	234	547	1129	570	816
24-Jul	367	379	457	379	161	212	256	220	213	136	8	68	201	152	292	134
25-Jul	188	343	412	361	139	220	236	137	267	163	12	104	337	382	419	151
26-Jul	120	126	264	274	180	263	282	163	300	149	33	122	393	423	498	243
27-Jul	359	395	333	270	151	276	307	241	163	78	34	71	507	476	747	283
28-Jul	282	406	312	235	104	182	122	91	73	83	27	64	161	153	431	974
29-Jul	592	820	633	332	205	266	170	142	60	40	11	52	86	313	393	118
30-Jul	659	608	469	276	109	120	89	45	45	36	18	57	137	549	215	145
31-Jul																
01-Aug																
02-Aug																
03-Aug																
04-Aug																
05-Aug																
06-Aug																
Average	271	285	307	208	112	216	295	211	262	272	115	131	217	207	230	289

Appendix B-2. Daily site A sonar counts by sector, Aniak River, 1986.

	Sonar Sector															
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
15-Jun																
16-Jun																
17-Jun																
18-Jun																
19-Jun																
20-Jun																
21-Jun																
22-Jun																
23-Jun																
24-Jun																
25-Jun	64	3	2	2	0	2	0	0	0	2	1	2	3	4	0	0
26-Jun	111	77	66	25	8	10	12	9	19	12	13	14	21	29	4	9
27-Jun	158	146	223	100	40	33	20	14	67	36	46	67	188	92	12	9
28-Jun	790	439	532	430	131	76	84	124	154	221	275	291	306	195	19	34
29-Jun	682	196	193	106	24	89	62	93	55	32	14	24	4	2	7	16
30-Jun	647	258	94	19	4	3	45	63	36	486	242	153				
01-Jul	881	447	135	25	0	0	11	7	14	22	25	17				
02-Jul	887	398	65	8	2	0	0	9	17	51	59	125				
03-Jul	457	767	580	268	135	99	93	105	107	92	108	104	21	20	25	25
04-Jul	161	588	555	212	49	21	2	0	37	26	24	11	35	33	29	23
05-Jul	131	499	493	224	70	18	8	4	25	16	15	15	16	35	14	25
06-Jul	64	168	182	111	52	5	4	8	28	36	24	25	50	26	41	70
07-Jul	8	56	106	222	198	96	29	41	110	111	76	71	244	81	57	267
08-Jul	10	94	207	323	153	102	66	25	225	230	182	199	366	218	113	478
09-Jul	215	528	706	392	238	94	147	112	103	105	83	148	300	264	151	209
10-Jul	494	909	694	392	284	173	266	144	164	141	65	165	466	282	219	317
11-Jul	179	495	538	327	240	174	155	78	106	119	39	167	227	171	146	127
12-Jul	205	410	481	374	391	271	327	86	311	237	50	170	309	203	187	174
13-Jul	81	369	292	203	171	145	237	110	261	272	108	254	503	287	213	176
14-Jul	51	115	146	133	113	101	133	73	250	315	146	224	890	515	465	308
15-Jul	27	129	198	212	150	126	177	57	189	255	155	164	453	285	159	314
16-Jul	265	500	723	269	97	84	141	132	373	445	369	286	209	235	98	189
17-Jul	149	199	220	154	72	65	62	53	368	582	391	224	339	214	154	118
18-Jul	53	121	371	541	181	59	59	91	295	413	308	177	286	260	147	94
19-Jul	56	123	114	127	155	106	107	128	351	550	231	138	173	724	178	117
20-Jul	66	107	181	153	104	49	78	117	482	889	356	164	211	190	68	47
21-Jul	1851	1142	383	213	66	28	25	54	341	1015	347	159	138	88	35	22
22-Jul	2074	1094	554	312	78	48	44	39	348	1133	539	161	161	69	19	27
23-Jul	1202	1544	932	297	54	11	12	12	104	331	221	58	71	58	61	39
24-Jul	3632	1094	171	51	7	3	3	0	8	60	29	20	26	14	8	4
25-Jul																
26-Jul																
27-Jul																
28-Jul																
29-Jul																
30-Jul																
31-Jul																
01-Aug																
02-Aug																
03-Aug																
04-Aug																
05-Aug																
06-Aug																
Average	522	434	338	208	109	70	80	60	165	275	151	127	223	170	97	120

Appendix B-3. Daily site A sonar counts by sector, Aniak River, 1987.

	Sector															
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
15-Jun																
16-Jun																
17-Jun																
18-Jun																
19-Jun																
20-Jun																
21-Jun	21	21	26	26	4	9	12	7	23	19	36	46	42	11	4	12
22-Jun	19	55	70	57	14	13	23	15	34	43	69	81	67	37	10	13
23-Jun	63	72	58	40	26	12	3	5	12	20	52	40	37	28	30	25
24-Jun	121	114	63	93	35	22	118	41	133	175	84	77	114	142	136	109
25-Jun	92	63	52	42	30	15	18	11	10	19	9	12	12	33	78	48
26-Jun	107	167	91	73	56	62	87	28	58	88	78	155	89	45	32	41
27-Jun	109	141	97	121	74	84	133	64	129	210	183	138	78	66	44	46
28-Jun	345	221	168	191	79	50	45	165	157	125	71	89	46	48	45	59
29-Jun	185	124	151	72	40	30	13	13	29	24	12	7	3	18	30	33
30-Jun	187	98	88	77	29	21	26	17	17	11	34	23	17	39	47	67
01-Jul	71	36	41	9	39	8	5	6	10	9	11	13	45	63	19	37
02-Jul	46	42	14	25	26	5	5	4	15	8	8	2	29	52	25	41
03-Jul	131	250	491	268	92	113	54	30	127	98	45	25	28	42	24	33
04-Jul	119	289	610	361	135	149	80	56	166	130	61	33	37	42	22	25
05-Jul	336	978	1814	958	206	439	177	92	481	378	144	70	42	45	23	17
06-Jul	13	98	496	273	161	92	57	32	111	86	28	16	8	11	4	3
07-Jul	130	290	685	538	242	202	154	148	213	170	113	63	61	40	38	29
08-Jul	495	1289	454	309	176	149	110	97	133	45	35	46	69	51	36	77
09-Jul	411	776	270	151	83	77	47	37	196	131	20	18	17	14	19	14
10-Jul	539	1630	519	225	109	108	64	29	62	127	48	32	62	36	32	33
11-Jul	156	1732	1284	1952	593	197	281	453	770	178	31	45	40	16	13	23
12-Jul	70	742	923	1014	400	386	441	511	1072	530	131	112	91	33	19	33
13-Jul	79	246	568	562	211	162	144	208	469	329	209	116	139	161	154	176
14-Jul	301	261	129	81	53	76	109	93	141	138	151	204	251	192	218	173
15-Jul	113	166	228	280	175	174	222	281	222	134	48	158	173	192	118	97
16-Jul	342	523	551	393	235	179	198	212	244	110	98	160	224	174	113	133
17-Jul	167	413	625	513	368	1034	599	150	275	215	841	165	222	195	344	248
18-Jul	301	533	704	364	153	86	213	50	177	87	30	37	72	63	35	58
19-Jul	315	677	679	373	134	56	130	36	168	170	112	86	136	140	135	26
20-Jul	626	2162	1220	533	156	98	42	121	213	198	44	92	125	62	71	15
21-Jul	404	684	635	299	123	110	94	23	108	73	57	49	78	64	73	48
22-Jul	120	187	210	127	66	34	45	27	119	105	72	91	146	136	62	28
23-Jul	68	58	55	128	153	590	187	159	330	270	131	148	228	138	87	35
24-Jul	132	123	82	115	40	27	40	18	127	252	156	58	40	19	17	11
25-Jul	87	104	72	92	60	38	53	27	111	228	170	44	34	34	16	42
26-Jul	36	91	116	92	54	29	73	23	129	168	263	226	106	91	36	75
27-Jul	29	77	85	136	96	98	75	44	152	194	191	113	159	122	76	89
28-Jul	39	715	1018	310	36	62	118	14	422	118	73	110	261	918	824	282
29-Jul	53	142	127	99	16	23	109	10	179	87	30	44	114	178	134	172
30-Jul	72	123	93	61	45	29	34	27	121	152	118	84	124	205	179	164
31-Jul	34	75	118	123	157	114	128	76	221	149	163	145	224	234	154	125
01-Aug																
02-Aug																
03-Aug																
04-Aug																
05-Aug																
06-Aug																
Average	134	313	298	218	94	99	86	65	149	109	80	62	73	80	67	53

Appendix C-1. Daily site A sonar counts by hour, Aniak River, 1985.

	Hour of the Day																							
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15-Jun																								
16-Jun																								
17-Jun																								
18-Jun																								
19-Jun																								
20-Jun																								
21-Jun																								
22-Jun	11	17	10	15	16	11	9	18	24	28	11	23	16	14	16	8	14	14	11	9	13	12	4	6
23-Jun	11	17	10	15	16	11	9	18	24	28	11	23	16	14	16	21	24	21	33	31	32	16	17	18
24-Jun	10	16	15	10	27	20	19	33	17	38	18	10	18	12	22	41	43	33	39	37	27	22	16	32
25-Jun	16	12	11	12	20	29	27	28	23	17	22	46	23	23	13	34	28	25	20	20	26	14	40	24
26-Jun	37	23	18	19	19	25	17	21	12	26	9	13	6	4	12	11	10	11	9	5	18	6	27	42
27-Jun	23	13	21	24	21	15	16	9	8	6	15	20	16	19	12	22	34	24	13	47	11	29	38	44
28-Jun	30	51	43	40	70	45	45	68	27	37	26	44	43	47	42	52	59	27	13	47	44	158	90	114
29-Jun	110	87	55	41	62	63	54	35	72	32	46	36	35	36	14	14	30	25	22	30	41	28	55	55
30-Jun	59	65	37	27	42	23	25	13	27	23	16	25	35	45	25	21	44	42	45	58	82	84	82	84
01-Jul	71	48	55	37	50	47	27	27	38	25	43	51	35	25	30	26	40	33	54	49	34	39	29	43
02-Jul	23	25	23	20	5	24	24	26	76	53	57	51	35	25	30	26	93	116	108	95	74	50	70	107
03-Jul	115	120	124	80	82	120	105	118	90	68	84	68	147	96	76	270	46	34	46	40	60	30	76	117
04-Jul	105	75	123	95	65	54	61	47	89	57	50	89	117	137	125	270	46	34	46	63	112	95	130	123
05-Jul	120	153	101	88	92	73	122	80	71	83	89	75	33	68	80	97	64	116	170	171	145	165	119	118
06-Jul	183	295	202	184	329	313	226	286	58	48	35	25	18	35	176	179	127	92	113	106	193	60	131	127
07-Jul	279	216	269	170	152	152	159	77	105	74	64	156	71	10	53	59	82	95	81	195	131	92	248	324
08-Jul	314	196	170	177	161	212	245	260	179	210	142	148	159	173	147	151	215	220	192	218	223	260	242	212
09-Jul	196	102	99	79	108	185	196	166	148	125	95	150	111	103	121	93	103	139	156	171	156	106	152	162
10-Jul	246	184	243	144	151	141	140	120	156	42	77	63	77	65	50	80	68	126	145	117	135	97	124	99
11-Jul	123	118	199	137	80	154	145	35	66	36	28	42	46	77	72	277	249	234	552	173	148	199	305	174
12-Jul	178	272	169	162	130	52	39	83	41	79	55	86	50	95	61	55	72	120	104	261	194	135	176	1708
13-Jul	379	301	369	214	309	408	313	195	41	79	99	131	114	223	175	82	140	216	207	118	93	93	125	243
14-Jul	206	192	256	167	155	178	94	104	93	56	62	73	71	74	79	88	85	143	93	113	106	125	137	149
15-Jul	163	204	168	118	119	292	130	67	80	105	101	109	170	208	290	244	146	163	660	355	162	245	523	357
16-Jul	282	434	561	318	695	432	711	202	329	456	1168	924	297	564	715	248	1107	469	89	116	273	221	245	233
17-Jul	347	670	709	483	387	141	136	169	123	73	80	264	307	228	563	275	280	383	677	297	99	180	145	304
18-Jul	284	280	623	323	132	337	85	131	106	47	43	94	233	49	87	34	67	96	289	43	136	170	248	195
19-Jul	226	269	305	602	279	204	237	142	103	128	82	119	95	147	85	82	133	118	165	277	318	246	210	272
20-Jul	235	211	246	211	226	162	109	123	136	91	85	90	111	151	122	200	269	398	104	183	194	329	362	355
21-Jul	264	202	233	178	190	176	122	97	97	88	72	108	274	50	80	262	244	227	345	174	260	257	281	299
22-Jul	240	207	207	134	323	119	164	363	616	751	395	249	357	375	550	388	628	1396	519	792	359	369	400	595
23-Jul	555	612	481	465	943	1196	445	1676	1278	1107	395	991	237	68	80	143	104	257	154	162	139	98	158	153
24-Jul	223	292	290	264	232	113	108	122	132	53	63	75	300	149	29	52	73	173	100	109	100	154	193	233
25-Jul	367	273	340	254	183	158	118	162	118	105	73	42	45	75	58	38	116	133	71	175	164	193	262	345
26-Jul	400	242	227	229	227	201	163	195	145	81	196	186	102	53	113	53	72	56	70	58	109	191	179	267
27-Jul	362	373	358	397	332	825	219	290	54	72	20	42	41	52	74	59	173	119	121	115	90	133	165	184
28-Jul	309	224	181	221	229	185	111	221	308	239	243	47	41	44	78	70	66	109	80	88	105	167	136	192
29-Jul	391	310	240	439	219	151	94	92	113	113	38	129	78	64	55	200	90	169	322	254	127	177	123	268
30-Jul	303	256	143	184	182	130	105	179	170	77	64	61	204	161	81	35	30	64	143	229	150	164	219	236
31-Jul	279	190	202	184	182	156	116	178	99	100	91	67	204	161	81	35	30	64	143	229	150	164	219	236
01-Aug																								
02-Aug																								
03-Aug																								
04-Aug																								
05-Aug																								
06-Aug																								
Average	202	196	203	174	181	183	132	157	137	124	109	126	110	100	115	110	134	158	158	146	126	134	163	221

Appendix C-2. Daily site A sonar counts by hour, Aniak River, 1986.

	Hour of the Day																							
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15-Jun																								
16-Jun																								
17-Jun																								
18-Jun																								
19-Jun																								
20-Jun																								
21-Jun																								
22-Jun																								
23-Jun																								
24-Jun																								
25-Jun																							44	40
26-Jun	15	1	1	3	8	0	7	14	13	13	25	12	11	14	20	26	28	57	34	23	24	40	27	12
27-Jun	24	7	4	13	12	21	32	28	25	57	14	53	29	62	78	62	62	54	39	67	99	80	92	140
28-Jun	117	106	88	53	85	111	139	182	182	259	420	439	203	322	329	116	128	81	84	119	107	119	171	141
29-Jun	94	69	82	52	70	72	127	119	74	69	90	78	103	80	67	87	18	20	21	28	58	34	25	62
30-Jun	110	78	83	67	33	32	27	44	69	79	73	105	106	110	107	155	123	90	93	129	72	45	115	105
01-Jul	125	160	135	84	75	40	91	64	62	37	15	24	25	55	24	36	23	21	35	38	86	77	98	154
02-Jul	185	210	151	62	73	68	69	38	31	52	31	59	57	40	38	26	33	54	46	47	83	57	61	47
03-Jul	34	41	151	109	142	110	72	233	229	260	192	174	95	65	142	191	183	116	83	70	66	73	65	110
04-Jul	74	67	66	55	50	54	52	60	57	58	61	63	71	93	91	76	77	74	60	67	76	102	174	127
05-Jul	141	55	74	89	78	44	54	72	71	81	38	49	37	57	41	75	86	60	48	49	63	41	108	92
06-Jul	53	48	35	37	37	22	21	60	24	53	9	19	41	31	54	42	30	46	62	27	51	19	45	28
07-Jul	10	12	28	20	37	51	38	44	81	48	18	33	59	112	112	174	107	89	52	80	113	111	192	150
08-Jul	403	153	152	131	176	87	58	83	38	104	229	68	30	79	78	55	74	130	136	182	111	204	136	94
09-Jul	184	73	41	12	37	1	0	0	226	0	0	7	78	58	122	122	232	230	193	225	507	459	440	538
10-Jul	420	399	375	452	188	185	201	194	176	171	112	128	118	101	120	148	198	210	140	242	204	204	199	290
11-Jul	261	294	195	158	139	106	125	145	139	118	86	88	107	91	78	78	138	70	64	66	200	183	200	128
12-Jul	168	231	364	168	133	195	171	104	155	96	72	127	189	159	372	180	175	119	139	192	155	179	192	151
13-Jul	271	325	313	179	152	90	113	122	98	120	89	87	74	91	126	87	126	133	136	141	116	123	230	340
14-Jul	219	246	229	175	118	90	108	86	77	85	81	113	157	161	154	185	194	154	282	219	241	169	204	222
15-Jul	252	343	268	196	163	174	125	110	168	104	91	93	42	64	24	30	12	37	51	99	120	122	173	189
16-Jul	276	338	232	165	155	90	89	105	88	81	169	180	134	90	121	132	184	137	70	101	113	507	401	147
17-Jul	289	320	195	209	174	144	106	100	86	135	95	62	75	65	82	56	89	128	180	150	101	203	155	155
18-Jul	159	206	218	157	120	155	125	91	176	264	118	123	274	124	172	79	175	126	84	86	115	105	103	91
19-Jul	162	377	274	416	148	142	159	55	55	71	67	61	128	161	194	149	45	256	43	51	73	77	86	128
20-Jul	153	242	220	165	106	106	83	119	151	84	96	67	409	126	81	82	103	65	72	121	100	164	151	196
21-Jul	333	303	251	225	225	298	249	249	249	260	186	150	136	111	131	119	140	141	118	271	375	343	468	576
22-Jul	717	620	638	417	567	282	191	224	252	194	324	164	192	147	214	175	114	141	124	162	163	183	228	267
23-Jul	454	397	230	194	183	103	114	72	117	68	98	86	153	111	74	88	39	55	78	69	74	87	154	178
24-Jul	262	210	253	243	162	135	200	193	257	205	229	133	173	189	184	225	203	300	260	369	213	219	171	109
25-Jul																								
26-Jul																								
27-Jul																								
28-Jul																								
29-Jul																								
30-Jul																								
31-Jul																								
01-Aug																								
02-Aug																								
03-Aug																								
04-Aug																								
05-Aug																								
06-Aug																								
Average	206	205	184	148	126	104	102	104	118	111	108	98	114	102	118	105	108	110	97	120	134	149	164	167

Appendix C-3. Daily site A sonar counts by hour, Aniak River, 1987.

	Hour of the Day																							
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15-Jun																								
16-Jun																								
17-Jun																								
18-Jun																								
19-Jun																								
20-Jun																								
21-Jun	2	7	15	11	5	12	36	19	34	2	19	9	8	7	8	17	11	7	2	17	18	19	15	19
22-Jun	2	7	15	11	5	12	36	13	34	23	9	10	35	17	23	12	40	19	57	41	48	46	50	57
23-Jun	33	24	16	16	14	31	54	10	19	33	31	7	19	22	12	11	18	12	24	14	32	38	21	14
24-Jun	24	24	30	22	30	48	38	29	5	68	77	93	87	134	61	99	66	98	168	167	83	50	23	13
25-Jun	8	17	21	7	13	8	20	19	23	33	34	20	8	38	23	16	28	21	27	17	36	21	35	49
26-Jun	41	32	43	52	17	31	29	23	32	14	50	35	31	49	48	45	35	70	60	103	81	115	97	96
27-Jun	69	97	86	82	88	82	66	56	76	64	91	80	48	59	66	58	80	48	61	56	51	71	86	96
28-Jun	77	96	118	80	68	94	128	72	85	89	105	99	63	70	61	83	71	56	49	88	60	80	55	88
29-Jun	58	18	19	10	27	36	40	24	33	27	30	36	29	41	36	36	44	47	12	35	47	44	38	17
30-Jun	22	16	56	45	35	36	41	56	46	46	22	25	46	37	6	28	42	42	55	24	19	16	21	19
01-Jul	43	27	47	8	16	10	14	16	1	1	10	19	19	17	11	8	27	28	35	9	9	20	23	1
02-Jul	4	23	4	22	6	14	11	2	12	24	13	13	13	14	11	8	27	28	35	9	9	20	23	1
03-Jul	114	81	91	84	70	101	61	74	95	114	104	56	135	82	103	98	152	71	83	90	105	84	99	84
04-Jul	151	111	116	112	85	127	89	92	127	134	121	66	137	83	116	110	166	81	95	103	130	106	128	105
05-Jul	206	164	185	186	114	166	182	148	208	359	373	136	468	284	392	355	502	139	210	272	326	197	265	361
06-Jul	294	174	161	159	177	280	58	148	208	142	104	85	131	58	93	93	162	117	82	134	161	165	162	40
07-Jul	206	165	185	186	114	166	182	148	208	142	104	78	55	44	73	84	113	93	114	93	147	128	169	120
08-Jul	132	174	179	165	122	163	184	132	144	123	145	150	135	134	129	87	131	83	175	165	179	190	177	177
09-Jul	82	131	103	95	77	85	59	85	87	65	57	88	86	110	91	89	87	98	55	171	118	85	130	145
10-Jul	143	107	118	127	139	129	122	115	121	119	122	141	108	115	162	119	152	134	179	161	265	305	248	200
11-Jul	186	201	175	178	189	177	159	148	208	165	179	201	218	256	275	327	309	489	313	358	436	302	418	431
12-Jul	511	382	343	261	231	281	295	209	227	189	164	138	159	190	139	355	166	227	199	221	319	397	411	494
13-Jul	361	335	351	237	229	293	164	148	205	149	49	115	62	52	58	167	82	61	47	86	78	167	256	181
14-Jul	151	233	193	117	59	48	54	48	89	46	120	81	160	118	63	73	73	78	103	40	73	114	130	272
15-Jul	101	45	125	110	128	139	135	129	146	171	122	103	69	90	109	123	96	94	117	150	119	106	119	138
16-Jul	224	274	238	183	249	130	128	132	123	106	176	129	240	171	112	128	103	117	134	117	107	160	213	198
17-Jul	255	178	160	309	278	97	174	163	170	218	230	299	199	224	395	533	1050	306	180	200	163	168	146	174
18-Jul	266	185	36	200	178	123	70	107	127	136	100	92	94	95	177	96	120	123	132	98	81	97	126	136
19-Jul	94	149	31	98	78	125	123	130	142	176	103	111	190	91	145	147	119	129	132	156	114	233	205	351
20-Jul	79	359	163	416	392	347	424	385	297	60	158	40	190	222	124	165	249	245	207	214	264	233	279	267
21-Jul	270	155	48	170	174	114	102	75	105	55	97	69	68	109	65	68	143	118	114	245	98	119	96	245
22-Jul	116	96	46	88	82	68	79	53	26	24	58	34	38	34	33	21	37	47	60	51	136	129	72	145
23-Jul	141	96	52	104	121	114	96	93	80	20	100	90	110	84	75	206	187	605	93	82	47	46	58	58
24-Jul	60	88	55	91	94	29	19	23	36	45	43	24	21	27	24	31	82	51	76	48	47	102	67	78
25-Jul	68	79	91	94	27	33	51	62	42	28	35	48	30	51	23	57	44	48	32	22	38	55	73	80
26-Jul	136	101	85	91	103	44	39	53	43	37	31	33	21	56	48	74	48	58	67	57	40	56	116	171
27-Jul	179	185	141	126	111	90	96	62	86	99	158	12	30	60	18	14	20	24	24	13	56	44	38	53
28-Jul	102	123	2299	377	438	768	70	47	88	84	92	131	49	74	76	36	66	90	28	26	60	64	79	117
29-Jul	184	155	106	108	79	106	78	31	37	35	30	23	13	43	34	20	41	38	72	55	78	24	86	40
30-Jul	106	141	106	103	66	49	38	59	71	92	15	36	15	30	69	66	85	49	68	32	138	65	50	82
31-Jul																								
01-Aug																								
02-Aug																								
03-Aug																								
04-Aug																								
05-Aug																								
06-Aug																								
Average	133	126	161	124	113	120	96	86	99	89	92	76	91	87	90	104	127	107	94	101	110	112	123	135