ESTIMATION OF ANIAK RIVER CHUM SALMON PASSAGE IN 2001 USING HYDROACOUSTIC METHODOLOGIES

By

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ABSTRACT

The Aniak River sonar project provided daily estimates of fish passage from 11 July through 31 July, 2001. User-configurable sonar continuously sampled the entire width of the river between the transducers, except for short periods when equipment was moved or serviced. An estimated 222,231 fish passed through the insonified area during the period of operation. The peak daily passage of 14,488 fish occurred on 21 July, and the 50% passage date occurred on 9 July. The four and five-year age classes of Aniak River chum salmon comprised an estimated 81.1% and 18.3% of the escapement estimate, respectively. A species apportionment program began this season examines the feasibility of producing passage estimates by species.

KEY WORDS: Aniak River, chum salmon, species apportionment, sonar, transducers

INTRODUCTION

The Kuskokwim River commercial salmon fishery in June and July is directed toward the harvest of chum salmon *Oncorhynchus keta*. Commercial chum salmon harvests from 1990-2001 averaged 221,450 fish and the exvessel value from inriver harvests averaged approximately $341,233 (Burkey et al. 2000). The 2001 commercial harvest for chum salmon was 1,291 fish valued at $827 (Appendix A.1). From 1990 to 2000, an average 73,387 chum salmon were harvested annually for subsistence purposes (Appendix A.2).

Management of the fishery resource requires timely estimates of run strength and escapement. Past sonar escapement estimates and aerial survey indices of abundance suggest the Aniak River is one of the largest producers of chum salmon in the Kuskokwim drainage (Francisco et al. 1995; Figure 1). Prior tagging studies suggest travel time of chum salmon migrating from the upper end of District 1 to the Aniak River sonar site is about seven or eight days (ADF&G 1961 and 1962). Because of its proximity to the Kuskokwim River commercial and subsistence fisheries, the Aniak River sonar project can provide management with timely estimates of fish passage.

Aniak River escapement data were collected using an echo counting and processing transceiver manufactured by Bendix Corporation[1] from 1980 to 1995. Data were collected with a single transceiver mounted on an 18.3 m artificial substrate located on the right bank and expanded to estimate total fish passage beyond the insonified range (Schneiderhan 1989). Cumulative adjusted daily totals were subjectively estimated to be 150% of the actual count for the initial years of operation. Behavior of chum salmon observed during aerial spawning surveys on the Aniak River, and visual observations of fish migration patterns reported for the Anvik River (Buklis, 1981) lead to the supposition that on the order of two-thirds of the run passed through the insonified portion of the river.

A second sonar counter was temporarily operated for a few days in 1984 to refine the expansion factor applied to the daily counts (Schneiderhan 1985). The second counter was deployed 1.5 km downstream from the existing counter and alternately operated on each bank. The proportions between daily counts at the historical site and each bank of the downstream site over a 16-day period resulted in a new expansion factor of 162%. This expansion factor was used from 1984 through 1995. In addition to the expansion of daily totals, sonar estimates were extrapolated for salmon escapement occurring before and after the operational period.

In the early 1980s, gillnet test fishing provided species apportionment and age, sex, and length (ASL) information of chum and chinook salmon *O. tshawytscha*. From 1981 to 1985, attempts at beach seine test fishing and carcass sampling proved unsuccessful at obtaining adequate sample sizes for ASL data. In 1986, ASL sampling activities were discontinued to decrease operating costs. Supporting the decision to abandon chum salmon ASL data collection was previous age

[1] Use of vendor names does not constitute product endorsement by ADF&G.

and sex composition data that indicated Aniak River chum salmon results were similar to commercial catch results from the lower Kuskokwim River districts (Schneiderhan 1988).

Salmon escapement objectives for the Aniak River were tentatively set at 250,000 chum and 25,000 chinook salmon in 1981, and formally established in 1982. The chum salmon objective was derived subjectively by relating historical sonar passage estimates to trends in harvest and aerial survey indices (Schneiderhan 1982b). In 1983, a review of the escapement objective based upon sonar estimates and other escapement indices suggested that the 1980-81 Aniak River sonar estimates likely represented record escapements, and much smaller escapements would probably provide adequate future spawning stocks and a sustainable harvest (Schneiderhan 1984).

Species apportionment activities were discontinued in 1986 because of inadequate sample sizes (Schneiderhan 1988). Early gillnet and beach seine test fishing investigations indicated the abundance of fish species other than chum salmon was insufficient to compromise the utility of passage estimates for making chum salmon management decisions (Schneiderhan 1981, 1982a, 1982b, 1984, 1985). In the absence of species apportionment data, the sonar-based escapement objective was changed from species-specific objectives to 250,000 estimated fish counts (Schneiderhan 1985). After the implementation of the Salmon Escapement Goal Policy, the Aniak River escapement objective was termed a biological escapement goal (BEG) (Buklis 1993).

In 1996, the Aniak River sonar project was redesigned to provide full river insonification, with user-configurable sonar equipment operating 24 hours per day on both banks throughout the chum salmon migration. Seasonal sonar estimates were not extrapolated for salmon escapement before and after the operational period. A new sonar data collection site was established 1.5 km downstream from the historical site (Figure 2). Although fish passage estimates were not apportioned by species, periodic net sampling was employed to monitor broad changes in species composition, corroborate acoustically detected abundance trends, and obtain ASL samples of chum salmon.

Sonar operations in 2001 remained essentially unchanged since 1996. The BEG of 250,000 estimated fish counts was carried forward to the redesigned sonar project, but will be reassessed as more information is gathered. A timetable of developmental changes for the sonar project is presented in Appendix B.

A species apportionment program was added to the project in 2001. The goal of the species apportionment program at the Aniak River sonar project is to estimate the proportion of each species passing the sonar site. These catches will be used in developing net selectivity curves and ultimately allow us to estimate the actual passage of chum salmon up the Aniak River.

The 2001 Aniak River sonar project objectives are outlined in the following list:

1) Collect fish abundance data with user-configurable sonar equipment 24 hours per day on both banks throughout the bulk of the chum salmon migration, from approximately 21 June through 31 July.

2) Provide daily fish passage estimates to fishery managers in Bethel.

3) Collect and archive ASL samples from chum salmon captured with a beach seine.

4) Twice daily drift gillnets to collect types of species present and in what quantities to be used in the newly started species apportionment program will allow in the future a more accurate estimate of fish passage per species through insonified areas of the Aniak River.

METHODS

Site Description

The Aniak River sonar project site is located in Section 5 of T16N, R56W (Seward Meridian), approximately 19 km upstream from the mouth of the Aniak River on state land and permitted by DNR permit # 13916 (Appendix C). The Aniak River originates in the Aniak Lake basin about 145 km east and 32 km south of Bethel, Alaska. It flows north for nearly 129 km, where it joins the Kuskokwim River 1.6 km upstream from the community of Aniak.

The river at the sonar site is characterized by broad meanders, with large gravel bars on the inside bends and cut banks with exposed soil, tree roots and snags on the outside bends. Numerous transects were conducted in the immediate vicinity of the sonar site, using a Lowrance model X-16 chart recording fathometer to determine the best location to deploy the sonar transducers. The river substrate at the sonar site is fine smooth gravel, sand, and silt. The right bank river bottom slopes steeply to the thalweg at about 10-30 m, while the left bank slopes gradually to the thalweg at roughly 25-65 m depending on water level.

Hydroacoustic Data Acquisition

Equipment

Sonar equipment for the right bank of the Aniak River included: 1) a Biosonics model 101 (SN 101-034) 120/420 kHz echosounder configured to transmit and receive at 420 kHz; 2) a 4 °x15 ° Biosonics single beam 420 kHz elliptical transducer (SN 16-420-4x15-006); 3) a 152.4 m (500 ft) Belden model 8412 cable (SN 703A); and 4) a Biosonics model 111 (SN 111-88-041) thermal chart recorder. A Hewlett Packard model 54501A (SN 2842A04372) digital storage oscilloscope (DSO) and a Nicolet 310 (SN 88DO4365) were used to examine signals from both the left and right bank systems. System calibration information is contained in Appendix D.

We mounted the right bank transducer on an aluminum tripod and remotely aimed it with a Remote Oceans Systems (R.O.S.) model PT-25 (SN 1064) air filled, dual axis rotator. We

controlled rotator movements with a R.O.S. model PTC-1 pan and tilt control unit connected to the rotator with 152.4 m of Belden model 9934 cable. A set of digital panel meters provided horizontal and vertical position readings, accurate to within ± 0.3 degrees.

Left bank sonar equipment included: 1) a Biosonics model 102 (SN 102-89-020) 120/420 kHz echosounder configured to transmit and receive at 420 kHz; 2) a 3^{o}x10^{o} (S/N 09-420-4x15-004) Biosonics dual beam 420 kHz elliptical transducer; 3) two 304.8 m (1000 ft) Belden model 8412 cables (SN 601K, 602K); and 4) a Biosonics model 111 (SN 111-89-053) thermal chart recorder.

We mounted the left bank transducer on an aluminum tripod and remotely aimed it with a R.O.S. model PT-25 (SN 214) oil filled, dual axis rotator. We controlled left bank rotator movements with the same R.O.S. PTC-1 controller used for the right bank. All electronic equipment was housed in a 3.0 x 3.7 m (10 x 12 ft) portable wall tent on the right bank and powered by a single Honda model EM-3500 independently grounded generator. Left bank cables were attached to a 6.4 mm (1/4 in) steel cable suspended 3 m above the river. The cable bundle was marked with pink and blue flagging to allow safe boat passage.

Sampling Procedures

We conducted single beam acoustic sampling on both banks continuously 24 h per day, 7 days per week, except for short periods the generator was serviced and transducer adjustments were made. Inseason analysis consisted of visually scanning the echograms for fish traces and anomalous detections to verify consistent aim. A single fisheries technician operated and monitored equipment at the sonar site. Crewmembers identified and tallied fish traces on chart recordings while rotating through shifts of 0000-0800, 0800-1600, and 1600-2400 h. For consistency, crewmembers were trained to distinguish between fish traces and non-fish traces, such as those from debris and bottom. The number of fish traces was summed within range intervals and 15-minute periods and recorded onto forms. Range intervals were 2-5 m wide on the right bank and 5-10 m wide on the left bank. Completed data forms were transported to the main camp throughout the day and entered into Excel97 electronic spreadsheets by the project leader. Daily estimates were transmitted via single side band radio to area managers at 0730 hours the following morning. Chart recorder output constituted the only record of detected echoes and fish passage. Chart recordings were annotated for date, time, and bank, and subsequently catalogued for storage.

We recorded all project activities in a project logbook. The logbook was used to document daily events of sonar activities and system diagnostics. During each shift, crew members were required to: 1) read the log from the previous shift; 2) sign the log book, including date and time of arrival and departure; 3) record equipment problems, factors contributing to problems, and resolution of problems; 4) record equipment setting adjustments and their purpose; 5) record observations concerning weather, wildlife, boat traffic, etc.; and 6) record visitors to the site, including their arrival and departure times.

Equipment Settings and Thresholds

Sound pulses were generated by the echosounders at a center frequency of 420 kHz. We applied a 40 log (R) time-varied gain (TVG) function and a 5 kHz frequency bandwidth filter for all data on both banks. We set the right bank transmit pulse width at 0.2 ms and the left bank transmit pulse width at 0.4 ms. Maximum sampling range was 20 m on the right bank and 75 m on the left bank. Minimum sampling range was 20 m on the right bank and 50 m on the left bank. Three printer thresholds, corresponding to intensities of gray-line were factory set at 6 dB intervals. Right bank chart recorder thresholds were set at -40, -34, and -28 dB during all sampling activities. The left bank thresholds were set at -40, -34, and -28 dB during all sampling activities. Both banks thresholds remained unchanged throughout the season.

Thresholds were calculated as follows:

$$TS_{dB} = V_o - SL - G_X - G_R - 2B\theta \quad (1)$$

Where:

TS_{dB} = target strength in dB
V_o = Volts out in dB
SL = transmitted source level in dB
G_X = through-system gain in dB
G_R = receiver gain in dB
$2B\theta$ = two-way beam pattern factor in dB

Attenuation ($\propto$) was assumed to be negligible at the insonification ranges sampled.

Transducer Deployment

The transducers were positioned in the river perpendicular to current flow. The wide axis of each elliptical beam was oriented horizontally and positioned close to the river bottom to maximize target residence time in the beam. Transducers were placed offshore 4 to 10 m from the right bank, and 10 to 20 m from the left bank. Daily visual inspections confirmed proper placement and orientation of the transducers.

Weirs extended from shore 3 to 10 m beyond the transducers to prevent chum salmon from passing undetected behind the transducers and to minimize detections in the near field (MacLennan and Simmonds 1992). The gap between weir pickets, 4.4 cm (1 ¾ in), was selected to divert chum salmon while allowing passage of small, resident, non-target species.

Hydroacoustic Equipment Checks

Both sonar systems were bench calibrated in April 2001 (Appendix D). We estimated noise levels in situ at three range intervals for the right bank sonar system and at five intervals for the left bank sonar system by measuring the average peak voltage on the DSO. For our purposes, we

defined noise as any unwanted signal including boundary and volume reverberation, electronic noise and ambient background noise. Structure reverberation peaks separated the range intervals.

Bottom Profiles and Stream Measurements

We recorded numerous bottom profiles outward from both banks using the chart recording fathometer before choosing exact deployment sites. On 8 July, we made depth measurements in 3 to 5 m intervals from each transducer to the opposite shore on both banks using the fathometer. Precise range measurements were not made because of the unexpected loss of an optical laser range finder.

Climatologic and Hydrologic Measurements

In 2001, we measured ambient air temperature, water conductivity, and temperature once per day using an Extech model 34165 Conductivity/Temperature meter. Standard secchi disk readings were taken daily. Water level was recorded daily on the right bank at the site using a staff gauge.

In 1998, we established a benchmark to reference daily water level measurements and to be able to make valid comparisons between years. The benchmark at the southeast corner of the sonar tent platform is indicated by a black rectangular mark. This season we were not able to reference the benchmark because the laser range finder was lost. Water levels were recorded via the meter stick installed in a location used in prior seasons. Postseason analyses were done by referencing to a benchmark water level of zero for simplicity in the calculations.

Analytical Methods

Abundance Estimation

Actual sonar counts in a spreadsheet are computed by time/space and summed for each bank. Counts are assumed to represent all fish passing the sonar site.

Missing Data

Generator maintenance, sonar equipment adjustments, and malfunctions occasionally resulted in missing sonar counts. When less than 10 minutes of a 15 minute interval were missed, the passage rate for the period within that interval was used to estimate passage for the unsampled portion of the interval. Counts missing from more than 10 minutes were estimated from the average relative distribution (proportions) of passage rates 45 minutes before and after the missing block of data on that bank. When more than one hour of sonar counts were missed on both banks, the average proportions of passage rates were pooled from six hours before and after

the missing block of time on that bank respectively. A right bank/left bank average proportion of passage rates were used to estimate fish passage when one of the sonar systems remained operational while the other was down for more than an hour. The number of fish traces tallied for both banks was summed to provide daily total fish passage estimates.

Species Composition Verification

Equipment and Procedures

In past seasons we fished two gillnets periodically at times determined inseason to qualitatively monitor general trends in species composition and corroborate the presence or absence of fish as a reference to observed trends in the number of fish. In the 2001 season we did not perform this monitoring because of the start of the species apportionment program.

Species Apportionment

Equipment and Procedures

The species apportionment program involved drifting five different gillnet mesh sizes twice daily once at 1000 hours and then at 2000 hours. An 18.4 cm (7-1/4"), 16.5 cm (6-1/2"), 13.6 cm (5-3/8"), 10.2 cm (4.0"), and a 7.0 cm (2-3/4") net sizes were fished. All gillnets were constructed using multifilament mesh and measured 18.3 m (10 fathoms) long by 3.1 m (10 feet) deep. Each net was drifted for approximately 2-3 minutes on each bank during the sampling period (Figure 3). The procedure for gillnet fishing was to deploy the net off the bow of a skiff moving from midstream toward shore, then drift downstream with the net perpendicular to shore. The net was pulled into the boat at the end of the drift, and the fish were removed, identified, sexed, length measured and unharmed fish were then released back into the river. For each drift we recorded the start out (SO), full out (FO), start in (SI), and full in (FI) times. The duration of each drift was then calculated as: duration = [(FO – SO)/2] + (SI-FO) + [(FI – SI)/2].

ASL Sampling

Equipment and Procedures

The gravel bar in front of the sonar camp was used as the sampling site for the third consecutive year. We used a 3 x 46 m (10 x 150 ft) green 7.0 cm mesh beach seine to obtain ASL samples of chum salmon. After attaching a 30 m line to one end of the seine, we stacked the seine in a plastic fish tote and placed it in the stern of a skiff. We attached the opposite end of the seine to a pulley designed to pivot from the side of the skiff to the stern. As the skiff moved offshore, orientated upstream, the end of the 30 m lead was held in place by a crewmember on shore. We moved the skiff straight offshore until all of the lead line was deployed and the seine started to peel out of the tote. We then drove the skiff upstream and inshore, deploying the entire length of the seine. When the skiff reached the shore, the seine was released from the pulley and allowed to drift downstream while we guided it next to the shore. The lead was pulled in just enough to form a hook shape to the offshore end of the seine (Figure 4). We drifted the entire seine in this formation for approximately 100 m before we pulled in the lead line and closed the set.

All captured fish except chum salmon were tallied by species, fin clipped, recorded and released. Chum salmon were placed in a live box for sampling. One scale was taken from the preferred area of each chum salmon for use in age determination (INPFC 1963). Scales were wiped clean and mounted on gum cards. Sex was determined by visually examining external morphological characteristics, keying on the development of the kype, roundness of the belly and the presence or absence of an ovipositor. Length was measured to the nearest millimeter from mid-eye to the fork-of-tail. All measurements were recorded in a "rite-in-the-rain" notebook and later transcribed to standard mark-sense forms.

We followed a pulse sampling design whereby intensive sampling was conducted for one or two days followed by several days without sampling. The sampling goal was to obtain data from a sufficient number of fish within a given period of time to precisely estimate the true age composition of the escapement during that time (Molyneaux and DuBois 1996). The goal of each sampling pulse was 200 chum salmon scales (Bromaghin 1993). All ASL data were sent to the Bethel ADF&G office for analysis by research staff. Ages were reported using European notation, in which two digits, separated by a decimal, refer to the number of freshwater and marine annuli. The total age from the time of egg deposition is the sum of the two digits plus one.

To estimate the age and sex composition of the chum salmon escapement in the Aniak River, daily passage estimates were temporarily stratified. Each stratum consisted of several days of fish passage and one pulse sample. Within each stratum, estimates of the age and sex composition were applied to the sum of the chum salmon passage to generate an estimate of the number of fish in each age-sex category. The numbers of fish were summed by age-sex category over all strata to estimate the total season passage.

RESULTS

Hydroacoustic Data Acquisition

Sampling Procedures

Sonar project activities commenced on 11 June and ended on 3 August 2000. Hydroacoustic sampling began at 0001 on 11 July on both banks with the first full 24-hour period occurring on the same date. The water level was sufficiently high to hinder camp set up and hydroacoustic deployment causing the late sampling starting date. With few exceptions, the equipment ran continuously until sampling ended at midnight on 31 July. Passage estimates were available to fishery managers in Bethel at 0730 hours and 1700 hours daily. A total of 2.5 hours (0.5%) on the left bank and 2.7 hours (0.54%) on the right bank of sampling time were missed because of regular maintenance, paper jams, system diagnostic tests, moving the tripod, or aiming the transducer to compensate for changing water levels throughout the season.

Relatively low signal to noise ratios (SNR) occurred on the right and left bank over narrow range intervals where the beam grazed high points in the river bottom. The SNR in those instances were about 3dB. Sonar counts at these points were not unduly corrupted since only a small range was affected.

Bottom Profiles, Stream Measurements, and Climatologic Measurements

The river width on 8 July at the sonar site was estimated at 97 m based on the previous year and the maximum depth was 4.0 m (Figure 5). The thalweg was located 29 m from the right bank and 68 m from the left bank. Cross talk between transducers was observed on the chart recordings, but did not interfere with data acquisition. When transducers were repositioned to compensate for changing water levels, the insonified range was adjusted accordingly.

Other climate and stream measurements are outlined in Table 1.

Fish Passage Estimates

Total passage during project sampling activities was estimated at 222,231 fish, with 65% passing on the right bank and 35% passing on the left bank (Table 2). A comparison of daily estimated passage between banks is presented in Figure 6 with a linear regression fit line. The significant ($p<0.01$) relationship indicates that left and right bank passages are correlated to one another. The peak daily passage of 14,488 fish occurred on 21 July (Figure 7). The 25%, 50%, and 75% quartile dates of passage were 15 July, 19 July, and 24 July (Table 2).

We examined the hourly fish count data for evidence of daily patterns of movement during 7-day periods of data collection. All time periods displayed fish passage increasing at night and declining during the day (Figure 8). This tendency is similar to 2000, 1999, 1997 and 1996 and not as pronounced in 1998 (Palmer 2001, Vania and Huttunen 1997, Vania 1998, Vania 1999).

Seasonal range distributions of targets that passed the site peaked at 0-5 m from the right bank transducer (Figure 9) and at 0-10 m from the left bank transducer (Figure 10). The outer 5-meter sampling range on the right bank accounted for 0.1% of the right bank passage estimates (Table 3). The outer 10-meter sampling range on the left bank accounted for 10% of the left bank passage estimates (Table 4). As the season progressed, the fish passage distribution on the left bank demonstrated an increasingly inshore movement.

Species Apportionment Program

Five different gillnet drifts were conducted twice daily once at 1000 hours and then at 2000 hours from July 4 to July 31. Sonar fish passage rates during these testfish periods ranged from 139 to 796 fish per hour. A total of 559 drifts were performed over a total fishing time of 21 hours 19 minutes resulting in a total catch of 1400 chum salmon, 121 chinook salmon, 63 sockeye salmon *O. nerka*, 6 coho salmon *O. kisutch*, 14 pink salmon *O. gorbuscha*, 71 humpback whitefish *Coregonus pidschian*, 12 Dolly Varden *Salvelinus malma*, 5 sheefish *Stenodus leucichthys*, 5 longnose suckers *Catostomus catostomus* (Table 5).

ASL Sampling

We made a total of 66 beach seine sets and obtained 681 ASL samples from migrating chum salmon (Table 6 & 7). The 0.3 and 0.4 age classes for chum salmon comprised an estimated 81.1% and 18.3% of the Aniak River escapement in 2001, respectively (Table 7). The percentages of 0.3 and 0.4 age class chum salmon were similar to the 2000, 1998 seasons but differed from the 1999, 1997 and 1996 seasons that demonstrated higher percentages of 0.4 fish (Table 8).

DISCUSSION

Hydroacoustic Data Acquisition

Sampling Procedures

For the 2001 season, we employed the 420 kHz transducer instead of the 120 kHz model that was used before 1999. One continued benefit was that the 420 kHz transducers are much smaller in size, allowing technicians greater flexibility with changing water levels. This meant less sampling time lost from moving weirs and tripods, and re-aiming. In addition, the smaller transducers can be placed in shallower water and because of a shorter near field, they can accommodate a relatively short weir length, beneficial in the fast Aniak River waters.

The Aniak River sonar site is approximately 97 meters from left bank to right bank where the hydroacoustic data acquisition occurs. Higher frequencies such as 420kHz experience greater attenuation than lower frequencies. Because of the short ranges insonified at this site, we do not think the higher frequency compromised our ability to detect fish, and any potential for decreased detection is likely more than offset by the shorter nearfield of the 420kHz transducer.

Fish Passage Estimates

A comparison of daily left bank percent passage rates for 1996-2001 displays the daily and seasonal changes in fish migration patterns at the sonar site (Figure 11). A comparison between water level and percent passage by bank may explain some of this variation. Water level measurements were relative only to the year in which they were taken for 1996, 1997 and 2001 and thus cannot be directly compared across years. For years 1998-2000 however, water levels were set to a permanent benchmark. An analysis of each season indicates an inverse relationship between left bank percent passage and water level (Figures 12-17). A large gravel bar below the right bank transducer becomes exposed at lower water levels and appears to divert a higher percentage of fish through the left bank insonified range. Five of the past six seasons have experienced left bank passage percentages between 35% and 41% including 2001. The only exception was a passage for left bank of 53% in 1997. This can be attributed to a dry summer in the Kuskokwim Area, with water levels notably low on the Aniak River.

Species Composition Verification

Although the Aniak River supports anadromous and resident fish populations of several different species, the sonar estimates are not apportioned to species. Gillnet and beach seine test fishing investigations in the early 1980's indicated the abundance of fish other than chum salmon was insufficient to compromise the utility of passage estimates for making chum salmon management

decisions. However, recent beach seine sampling conducted near the sonar site to obtain ASL samples of chum salmon included significant numbers of several non-target resident and anadromous species that were detectable by the sonar. The degree to which these non-target species compromise the effectiveness of the sonar project is unknown.

A 1995 Aniak River sonar test fish feasibility study indicated a species apportionment program is logistically feasible at the current site (Knuepfer 1995). The primary impediment to implementing such a program has been a lack of sufficient budgetary resources. In response to extremely poor returns of chum and coho salmon in 1997 and 1998, the Federal government made funds available for Kuskokwim River salmon fisheries research and management. This funding source supported the development of a species apportionment study to complement the Aniak River sonar project.

Species Apportionment

The species apportionment program is a multi-year commitment. At present no estimates based on the CPUE of the test fishery can be applied to passage estimates by species. This information will be available the year following the final year of the program. The newly apportioned Aniak River sonar escapement would provide fishery managers information on the proportionate contribution of Aniak River chum salmon stocks to the total Kuskokwim River chum salmon escapement. The first year of the three-year species apportionment program operated on the Aniak River was 2001. This operation was made possible by funding from the federal government because of the low return of chum and coho in 1997 and 1998 for salmon fisheries research and management.

The start of the season had substantially high waters that delayed the start of test fishing. During the interim between arriving and the start of test fishing, the crew worked on pulling snags from the drift areas and any other camp projects possible with the high water. Test fishing began before sonar deployment. When sonar was placed in the water on July 8, drifting was shifted further offshore to accommodate the transducer tripod and weirs that extended into the drift path, minimal loss of net efficiency was noted. The technique used for drifting had been tested at several other projects for species composition verification on the Aniak River and was expected to be functional for this Aniak site. Drifting proceeded unimpeded throughout the remainder of the season with only a few minor problems involving snags surfacing as water dropped.

Staff determined that the nets used at the beginning of the season should be rehung to optimize their fishing capabilities for the bottom fish namely the sucker, whitefish, and Dolly Varden. These fish were caught in the bottom four meshes of the net. Technicians hypothesized the nets would fish better if the hanging distance between the leadline and mesh was reduced to minimal length from the present 4 inches. The 4" and 2.5" nets were rehung with a maximum of 1½" hanging distance. The efficiency of these two nets increased as demonstrated by an increase in the catches of non-salmon species. All nets for the 2002 season will be rehung with the minimal hanging distance to ensure optimal efficiency.

A concern of the species apportionment program was possible increased mortality of fish caught in gillnets used in the test fishery. Twice in 1998, catches from drift gillnets were kept for five and six hours in a live box at the sonar site. The fish in good condition at the start were all released except two chum salmon, two whitefish, and one inconnu (sheefish) that possibly suffered fatal injury while in the live box. From this observation it was determined that with careful handling and short drift periods, fish mortality in the species apportionment program could be kept to a minimum.

In 2001 the previous concern with the survival rate of gilled fish from the test fishery was addressed. To address this issue, six gilled and bleeding chum salmon and one gilled bleeding whitefish were placed in a live box. All the fish were alive and swimming in a normal fashion. After a 24-hour period in the live box, all but one chum salmon were alive and released. The one whitefish did not survive. The whitefish could have suffered fatal injuries in the live box, or it may have been less physically equipped for surviving being gilled.

This test demonstrated that most of the fish caught in the gillnet, while receiving no special handling in removal from the net and transport to the live box, are still capable of surviving a minimum of 24 hours.

For the 2002 season, continued dragging of the drift zone will be needed to remove new snags deposited during the winter. With the experience gained from the 2001 season, the test fish crew leader will utilize a grappling hook to increase effectiveness at removing snags. The experience from the 2001 season and continuing efforts to improve fishing techniques will help to minimize fish loss caused by damage from gillnets and provide for a successful species apportionment program.

ASL Sampling

The techniques used to obtain ASL samples were designed to maximize the capture of chum salmon with the equipment available. The beach seine sampling areas are located 1.5 km and 2.5 km upstream of the sonar site. Although ASL determination provides valuable biological information on the chum salmon escapement, they are insufficient to provide quantitative species apportionment information.

Historical Data

In 1996, the Aniak River sonar project was redesigned and operations were significantly altered from past operations dating to 1980. Estimates before 1996 are difficult to substantiate because project documentation is lacking and the Bendix equipment is unable to verify aim. Comparisons between escapement estimates generated from these two very different types of project operations could lead to misinterpretation and should not be made. The established BEG of

250,000 fish for the Aniak River sonar project should be considered as interim under the redesigned sonar project. The goal will need to be reassessed as more information is gathered.

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Table 1. Climatologic and hydrologic measurements, Aniak River sonar site 2001.

Date	Time	Water (°C)	Air (°C)	Secchi (cm)	H_2O Level (cm)	Conductivity	Air (°C) min	Air (°C) max	General Conditions
12-Jul	0837	9.4	9.5	50	30	80.6	10	48	overcast, rain, winds SW @ 0-5
13-Jul	0623	8.8	12	48	20	82	12	22	overcast, light drizzle, no wind
14-Jul	0822	9.7	11	50	15.5	82.1	10	35	overcast, sprinkles, wind S @ 0-5
15-Jul	0837	10.9	14.5	49	14	84.4	10	35	overcast, no wind
16-Jul	0600	10.1	12.1	48	15	81.3	10	34	overcast, light drizzle, wind SW @ 0-5
17-Jul	0600	10.4	13.2	48	14.5	82.7	10	24	overcast, light sprinkles, wind W @ 5-10
18-Jul	0600	10.3	11.8	48	16	85.6	12	36	partly sunny, no wind
19-Jul	0600	10.4	12.1	50	10.5	83.2	13	39	sunny, no wind
20-Jul	0618	10.4	13.7	48	9	80.6	14	41	overcast, no wind
21-Jul	0624	10.2	13.1	40	22	84.5	15	42	overcast, rain, no wind
22-Jul	0941	11.3	13.1	48	75	74.4	8	40	scattered clouds, no wind
23-Jul	0606	12.2	12.8	50	71	80.5	15	42	overcast, no wind
24-Jul	0625	12	12	50	57	84.1	15	50	overcast, wind E @15
25-Jul	0619	12.1	13	50	46	82.5	15	40	overcast, light sprinkles, no wind
26-Jul	0610	12.1	14	50	35	83	15	48	scattered clouds, no wind
27-Jul	0628	12	13.8	50	35	88.5	19	48	scattered clouds, no wind
28-Jul	0655	11.4	11.8	50	42	88	19	47	overcast, no wind
29-Jul	0941	12.2	11.2	50	35	86.2	18	56	scattered clouds, partly sunny, no wind
30-Jul	0634	12.2	11	50	50	87.4	14	50	overcast, no wind
31-Jul	0613	11.6	11.2	50	47	89.4	17	50	overcast, wind E @ 0-5

Table 2. Daily and cumulative estimates of fish passage at the Aniak River sonar site, 2001.

2001 Season Estimates								
Date	Left Bank	Right Bank	Daily Total	Cumulative Total	LB % Passage	RB % Passage	Percent Passage (%)	Water Level*
11-Jul	1654	6522	8,175	8,175	0.20	0.80	4	6
12-Jul	2463	6650	9,113	17,288	0.27	0.73	8	16
13-Jul	4055	10072	14,127	31,415	0.29	0.71	14	21
14-Jul	4455	9361	13,816	45,231	0.32	0.68	20	22
15-Jul	3578	8688	12,266	57,497	0.29	0.71	26	21
16-Jul	3470	8816	12,286	69,783	0.28	0.72	31	22
17-Jul	4053	10284	14,337	84,120	0.28	0.72	38	20
18-Jul	3608	8535	12,143	96,263	0.30	0.70	43	26
19-Jul	3439	6680	10,119	106,383	0.34	0.66	48	24
20-Jul	5756	10769	16,525	122,908	0.35	0.65	55	14
21-Jul	5476	9012	14,488	137,396	0.38	0.62	62	31
22-Jul	4783	7129	11,912	149,308	0.40	0.60	67	35
23-Jul	4083	6485	10,568	159,876	0.39	0.61	72	49
24-Jul	3753	5675	9,428	169,304	0.40	0.60	76	60
25-Jul	3805	4991	8,796	178,099	0.43	0.57	80	71
26-Jul	3676	5899	9,575	187,674	0.38	0.62	84	71
27-Jul	4081	4677	8,758	196,432	0.47	0.53	88	64
28-Jul	3788	4649	8,437	204,869	0.45	0.55	92	71
29-Jul	3611	3654	7,266	212,135	0.50	0.50	95	56
30-Jul	2412	2817	5,229	217,364	0.46	0.54	98	59
31-Jul	2169	2698	4,867	222,231	0.45	0.55	100	61
TOTAL	**78168**	**144063**	**222,231**	**222,231**	**35%**	**65%**		

* Measured centimeters below arbitrary benchmark of zero.

Table 3. Estimated right bank daily fish passage per range strata, Aniak River sonar, 2001.

		Right Bank Strata			
		1	2	3	4
		Distance From Right Bank Transducer			
		0-5	6-10	11-15	16 - 20
	11-Jul	5558	931	25	2
	12-Jul	5645	885	22	94
	13-Jul	8562	1138	42	22
	14-Jul	8506	776	33	34
	15-Jul	7945	664	27	3
Week Total		36216	4394	149	155
Passage		88.5%	10.7%	0.4%	0.4%
	16-Jul	8140	620	24	0
	17-Jul	9533	633	18	18
	18-Jul	7755	638	35	4
	19-Jul	6101	566	12	1
	20-Jul	9758	783	4	0
	21-Jul	7990	998	24	0
	22-Jul	6462	659	8	0
Week Total		55739	4897	125	23
Passage		91.7%	8.1%	0.2%	0.04%
	23-Jul	5870	605	7	0
	24-Jul	4925	709	16	0
	25-Jul	4129	849	13	0
	26-Jul	3413	1197	11	0
	27-Jul	3270	1293	14	0
	28-Jul	3383	1258	8	0
	29-Jul	2711	912	3	0
Week Total		27701	6823	72	0
Passage		80.1%	19.7%	0.2%	0.0%
	30-Jul	2213	571	3	0
	31-Jul	2117	536	2	0
Week Total		4330	1107	5	0
Passage		79.6%	20.3%	0.1%	0.0%
Season Total		**123986**	**17221**	**351**	**178**
Passage		**87.5%**	**12.2%**	**0.2%**	**0.1%**

Table 4. Estimated left bank daily fish passage per range strata, Aniak River sonar, 2001.

		Left Bank Strata				
		1	2	3	4	5
		Distance from Left Bank Transducer(m)				
		0-10	11-20	21-30	31-40	41-50
	11-Jul	776	248	131	205	291
	12-Jul	1489	258	143	164	403
	13-Jul	2374	419	226	293	717
	14-Jul	2976	382	215	229	668
	15-Jul	2517	290	132	166	473
Week Total		10132	1597	847	1057	2552
Passage		62.6%	9.9%	5.2%	6.5%	15.8%
	16-Jul	2325	424	158	161	396
	17-Jul	2865	409	178	216	375
	18-Jul	2394	442	167	195	365
	19-Jul	2479	338	129	152	335
	20-Jul	3903	546	264	319	656
	21-Jul	3846	531	233	285	581
	22-Jul	3469	369	135	157	351
Week Total		21281	3059	1264	1485	3059
Passage		70.6%	10.1%	4.2%	4.9%	10.1%
	23-Jul	2954	400	138	176	376
	24-Jul	2518	578	147	171	339
	25-Jul	2532	620	153	154	330
	26-Jul	2683	436	108	119	294
	27-Jul	2899	457	86	141	238
	28-Jul	2720	611	100	114	243
	29-Jul	2693	515	76	70	170
Week Total		18999	3617	808	945	1990
Passage		72.1%	13.7%	3.1%	3.6%	7.5%
	30-Jul	1737	435	74	53	109
	31-Jul	1568	429	55	49	51
Week Total		3305	864	129	102	160
Passage		72.5%	18.9%	2.8%	2.2%	3.5%
Season Total		**53717**	**9137**	**3048**	**3589**	**7761**
Passage		**69.5%**	**11.8%**	**3.9%**	**4.6%**	**10.0%**

Table 5. Aniak River sonar gillnet catch data by species and drift, 2001.

Date	Fishing Time(Hrs)[a]	Chinook	Sockeye	Coho	Pink	S. Chum[b]	F. Chum[c]	Cisco	B. Whitefish[d]	H. Whitefish[e]	Burbot	Sheefish	Char/Dolly Varden	Smelt	Pike	Sucker
7/4/2001		9	0	0	0	2	0	0	0	0	0	0	0	0	0	0
7/5/2001	1:37	6	0	0	0	33	0	0	0	0	0	0	0	0	0	0
7/6/2001	1:42	5	1	0	0	23	0	0	0	0	0	0	0	0	0	0
7/7/2001	1:47	14	3	0	0	51	0	0	0	0	0	1	0	0	0	0
7/8/2001	2:19	17	12	0	0	56	0	0	0	1	0	0	0	0	0	0
7/9/2001	1:44	10	2	0	0	41	0	0	0	0	0	0	0	0	0	2
7/10/2001	0:51	0	1	0	0	21	0	0	0	0	0	3	2	0	0	0
7/11/2001	1:34	2	1	0	0	16	0	0	0	0	0	0	0	0	0	2
7/12/2001	2:11	3	3	0	0	44	0	0	0	0	0	0	0	0	0	1
7/13/2001	2:04	7	9	0	0	81	0	0	0	0	0	0	0	0	0	0
7/14/2001	1:43	4	5	0	0	80	0	0	0	0	0	1	0	0	0	0
7/15/2001	0:51	1	3	0	2	36	0	0	0	2	0	0	1	0	0	0
7/16/2001	1:47	7	5	0	0	91	0	0	0	0	0	0	0	0	0	0
7/17/2001	1:52	3	4	0	0	76	0	0	0	4	0	0	2	0	0	0
7/18/2001	0:57	2	4	0	0	40	0	0	0	1	0	0	0	0	0	0
7/19/2001	1:29	1	3	0	0	86	0	0	0	8	0	0	2	0	0	0
7/20/2001	1:39	4	1	0	2	64	0	0	0	1	0	0	0	0	0	0
7/21/2001	1:31	3	2	0	1	45	0	0	0	2	0	0	0	0	0	0
7/22/2001	1:57	6	1	0	2	59	0	0	0	5	0	0	1	0	0	0
7/23/2001	2:08	3	0	0	0	74	0	0	0	1	0	0	0	0	0	0
7/24/2001	1:52	3	1	0	1	52	0	0	0	4	0	0	0	0	0	0
7/25/2001	1:35	2	0	1	0	35	0	0	0	5	0	0	1	0	0	0
7/26/2001	1:58	2	0	1	4	61	0	0	0	8	0	0	0	0	0	0
7/27/2001	1:52	3	0	1	1	79	0	0	0	4	0	0	0	0	0	0
7/28/2001	1:42	2	1	0	1	56	0	0	0	9	0	0	0	0	0	0
7/29/2001	0:45	1	0	1	0	23	0	0	0	5	0	0	0	0	0	0
7/30/2001	1:49	1	1	1	0	31	0	0	0	8	0	0	2	0	0	0
7/31/2001	1:48	0	0	1	0	44	0	0	0	3	0	0	1	0	0	0
Season Totals	21:19	121	63	6	14	1400	0	0	0	71	0	5	12	0	0	5

[a] Blank cells equal times not recorded in field

[b] S.Chum = Summer Chum

[c] F.Chum = Fall Chum

[d] B. Whitefish = Broad Whitefish

[e] H. Whitefish = Humpback Whitefish

Table 6. Aniak River sonar catch results using beach seine gear, 2001.

Date	Time of Day	# of Sets	Chum	King	Pink	SK	Coho	WF	Sucker	Pike	DV	RB	GL	IN	Total Catch	Chum %
6-Jul	22:40 0:35	8	19	5	0	3	0	4	20	0	0	0	0	0	**51**	**37.3%**
7-Jul	22:15 1:13	8	102	13	3	6	0	8	22	0	0	1	0	0	**155**	**65.8%**
8-Jul	22:29 0:55	8	93	11	3	11	0	5	25	0	2	0	0	0	**150**	**62.0%**
12-Jul	22:48 1:20	6	73	1	0	7	0	1	14	0	0	0	0	0	**96**	**76.0%**
13-Jul	22:44 0:40	6	90	2	0	7	0	2	2	0	1	0	0	0	**104**	**86.5%**
14-Jul	22:50 0:15	4	76	1	1	2	0	3	7	0	0	0	0	0	**90**	**84.4%**
20-Jul	21:51 0:45	6	152	1	0	3	0	3	7	0	2	0	0	0	**168**	**90.5%**
21-Jul	21:58 23:39	5	86	0	1	0	0	0	9	0	1	0	0	0	**97**	**88.7%**
25-Jul	21:23 0:05	7	61	0	1	2	0	20	9	0	4	0	0	0	**97**	**62.9%**
26-Jul	0:00 0:29	8	67	0	0	0	0	8	10	0	0	1	0	0	**86**	**77.9%**
	Total	**66**	**819**	**34**	**9**	**41**	**0**	**54**	**125**	**0**	**10**	**2**	**0**	**0**	**1094**	
	% catch		**74.9%**	**3.1%**	**0.8%**	**3.7%**	**0.0%**	**4.9%**	**11.4%**	**0.0%**	**0.9%**	**0.2%**	**0.0%**	**0.0%**	**100.0%**	

WF = Whitefish DV = Dolly Varden RB = Rainbow Trout GL = Grayling IN = Inconnu SK = Sockeye

Table 7. Age and sex of beach seine caught chum salmon from Aniak River escapement samples collected near the sonar site and applied to passage estimates by time stratum in 2001.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
7/6-7/8	160	Male	0	0	0	31.9	0	20.6	0	0	0	52.5
No counts		Female	0	0	0	28.7	0	18.8	0	0	0	47.5
		Subtotal	0	0	0	60.6	0	39.4	0	0	0	100.0
7/12 - 7/14	179	Male	0	0	33,366	39.7	12,219	14.5	0	0	45,585	54.2
(7/12 - 7/17)		Female	940	1.1	24,907	29.6	12,688	15.1	0	0	38,535	45.8
		Subtotal	940	1.1	58,273	69.3	24,907	29.6	0	0	84,120	100.0
7/20-7/21	174	Male	0	0	39,620	52.3	6,531	8.6	0	0	46,150	60.9
(7/18 - 7/23)		Female	435	0.6	24,381	32.2	4,789	6.3	0	0	29,606	39.1
		Subtotal	435	0.6	64,001	84.5	11,320	14.9	0	0	75,756	100.0
7/25 - 7/28	168	Male	0	0	27,465	44.1	2,598	4.1	0	0	30,064	48.2
(7/24 – 7/31)		Female	0	0	30,435	48.8	1,856	3.0	0	0	32,290	51.8
		Subtotal	0	0	57,900	92.9	4,454	7.1	0	0	62,354	100.0
Season	681	Male	0	0	100,451	45.2	21,347	9.6	0	0	121,798	54.8
		Female	1,375	0.6	79,723	35.9	19,334	8.7	0	0	100,432	45.2
		Total	1,375	0.6	180,174	81.1	40,681	18.3	0	0	222,230	100.0

[d] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums.

Table 8. Historic age class of beach seine caught chum salmon from Aniak River escapement samples collected near the site and applied to passage estimates by time stratum, 1996-2001.

	Stratum	Sample	0.2		0.3		0.4		0.5		Total Esc.
Year	Dates	Size	Esc.	%	Esc.	%	Esc.	%	Esc.	%	
2000	6/26-7/7	102	318	1	18,466	56.9	13,372	41.2	318	1	32,473
1999	7/1-7/8	151	0	0	8,347	37.7	13,618	61.6	146	0.7	22,111
1998	6/24-705	72	0	0	29,332	83.3	5,377	15.3	489	1.4	35,198
1997	6/16-7/06	139	491	0.7	31,886	46.8	35,319	51.8	491	0.7	68,186
1996	6/21-7/04	78	0	0	48,595	55.1	37,294	42.3	2,260	2.6	88,149
2000	7/8-7/13	109	0	0	30,134	73.4	10,547	25.7	377	0.9	41,057
1999	7/9-7/14	182	0	0	15,401	48.9	16,094	51.1	0	0	31,495
1998	7/06-7/12	165	0	0	35,425	78.2	9,611	21.2	275	0.6	45,311
1997	7/07-7/13	169	252	0.6	28,224	66.3	13,356	31.4	756	1.8	42,588
1996	7/06-7/14	94	0	0	59,429	63.6	34,034	36.4	0	0	93,463
2001	7/12-7/17	179	940	1.1	58,273	69.3	24,907	29.6	0	0	84,120
2000	7/14-7/19	149	315	1.3	19,233	81.9	3,941	16.8	0	0	23,490
1999	7/15-7/20	175	213	0.6	22,612	60.6	14,292	38.3	213	0.6	37,331
1998	7/13-7/18	220	0	0	44,671	85.5	7,603	14.5	0	0	52,274
1997	7/14-7/17	138	610	2.9	11,896	56.5	8,540	40.6	0	0	21,046
1996	7/15-7/17	120	473	2.5	14,820	78.3	3,468	18.3	158	0.8	18,919
)1	7/18-7/23	174	435	0.6	64,001	84.5	11,320	14.9	0	0	75,756
,00	7/20-7/23	182	561	2.7	17,405	85.2	2,470	12.1	0	0	20,437
1999	7/21-7/25	187	0	0	27,752	70.6	11,563	29.4	0	0	39,315
1998	7/19-7/22	204	308	0.5	56,966	90.7	5,235	8.3	308	0.5	62,817
1997	7/18-7/22	124	446	0.8	39,669	71.8	14,709	26.6	446	0.8	55,270
2001	7/24-7/31	168	0	0	57,900	92.9	4,454	7.1	0	0	62,354
2000	7/24-7/31	189	1,413	5.3	21,190	79.4	4,097	15.3	0	0	26,700
1998	7/23-7/27	210	511	1	49,340	91.9	3,835	7.1	0	0	53,686
1997	7/23-7/26	156	598	2.6	16,883	72.4	5,827	25	0	0	23,308
1996	7/18-728	167	4,866	4.8	74,813	73.7	19,463	19.2	2,433	2.4	101,575
1999	7/26-8/3	192	0	0	31,926	67.2	15,344	32.3	247	0.5	47,518
1998	7/28-7/31	173	0	0	28,227	93.6	1,917	6.4	0	0	30,144
1997	7/27-8/03	127	1,231	2.4	43,505	83.5	7,388	14.2	0	0	52,124
2001	Season	681	1,375	0.6	180,174	81.1	40,681	18.3	0	0	222,230
2000	Season	731	2,608	1.8	106,428	73.8	34,427	23.9	695	0.5	144,157
1999	Season	1003	213	0.1	106,038	59.6	70,912	39.9	607	0.3	177,771
1998	Season	1044	819	0.3	243,961	87.3	33,579	12	1,071	0.4	279,430
1997	Season	853	3,628	1.4	172,063	65.5	85,138	32.4	1,693	0.6	262,522
1996	Season	459	5,339	2	197,657	65	94,260	31	4,851	2	302,106

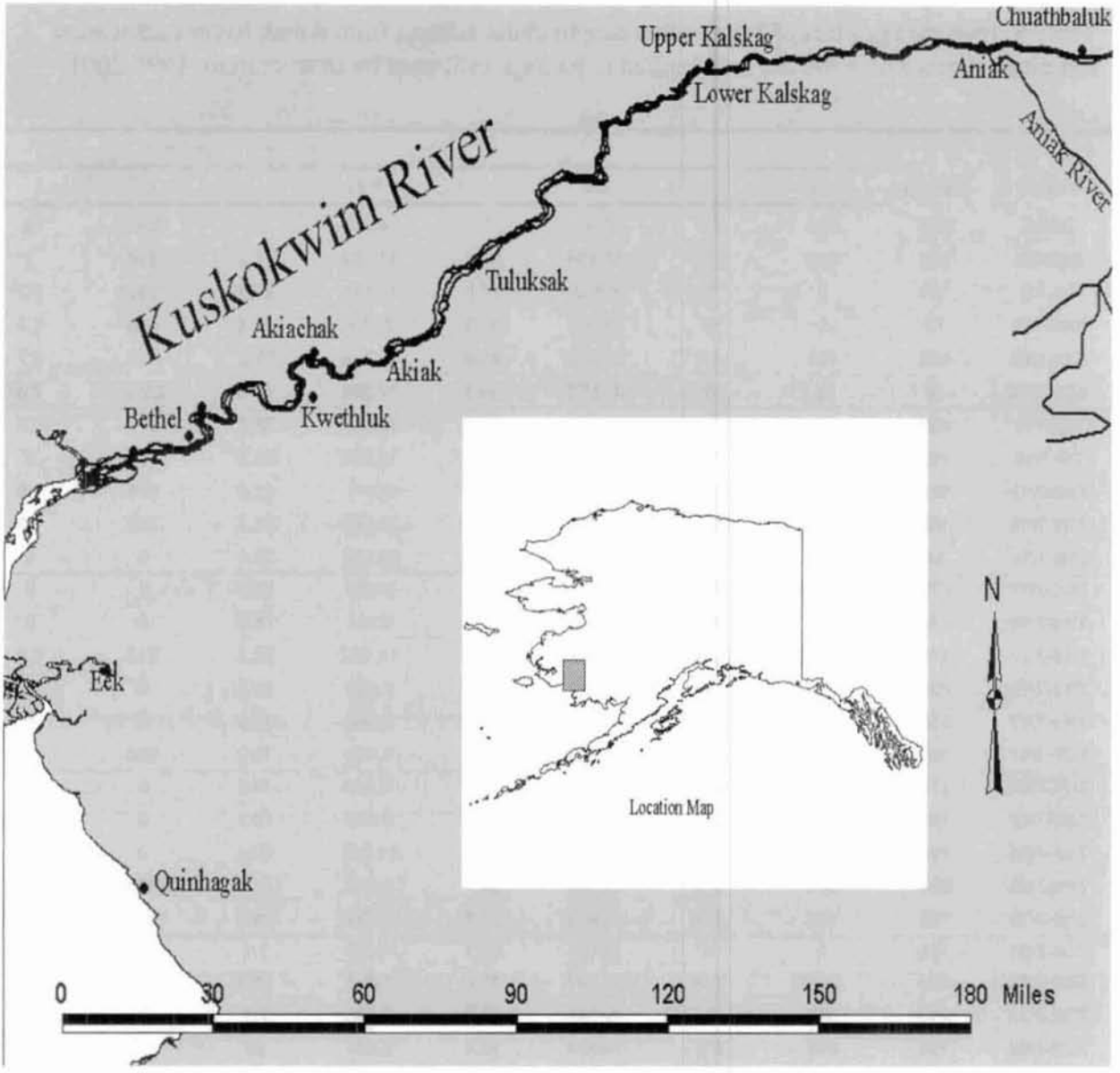


Figure 1. Map of the Kuskokwim Area.

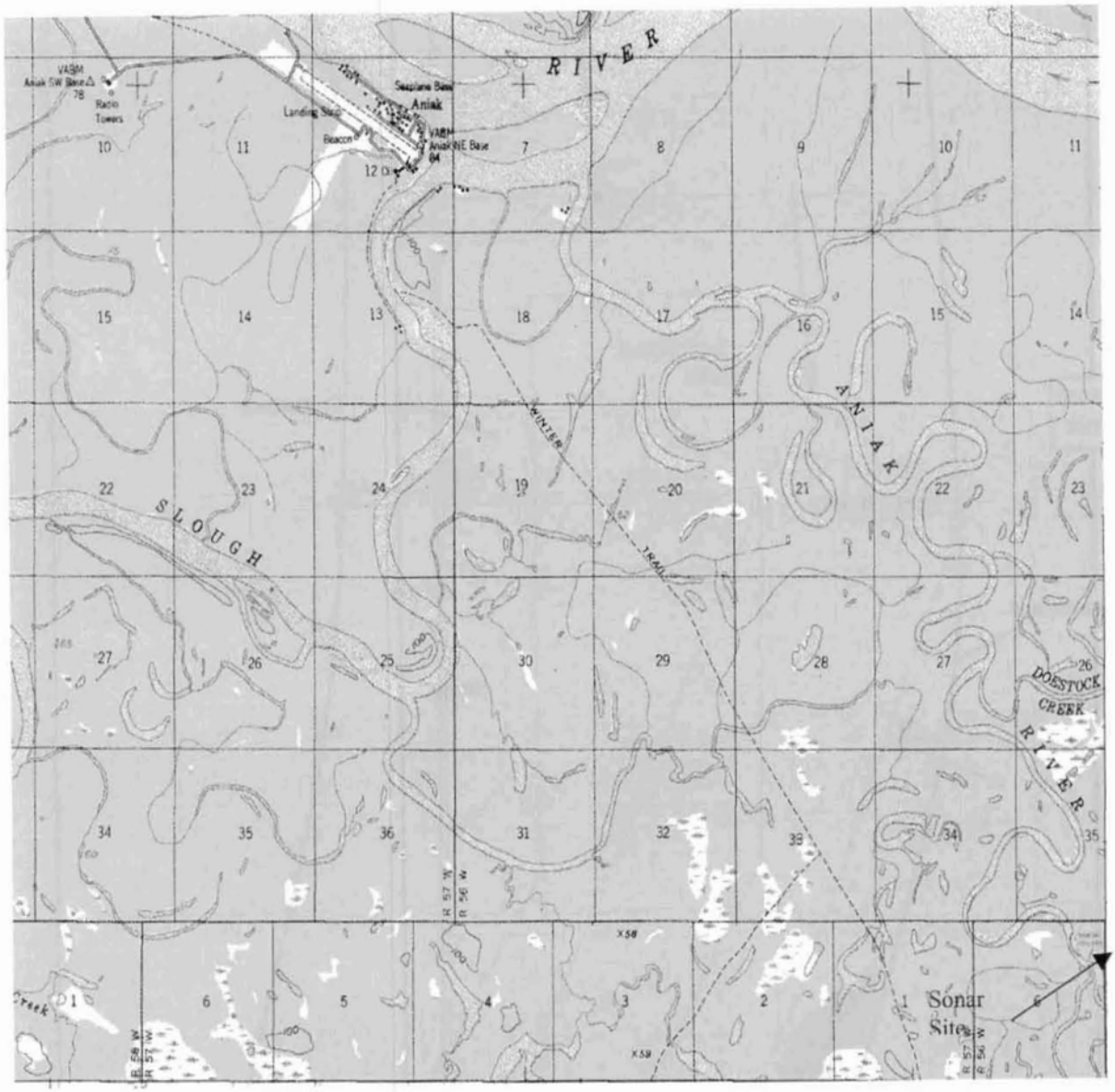


Figure 2. Aniak River sonar site map, 2001.

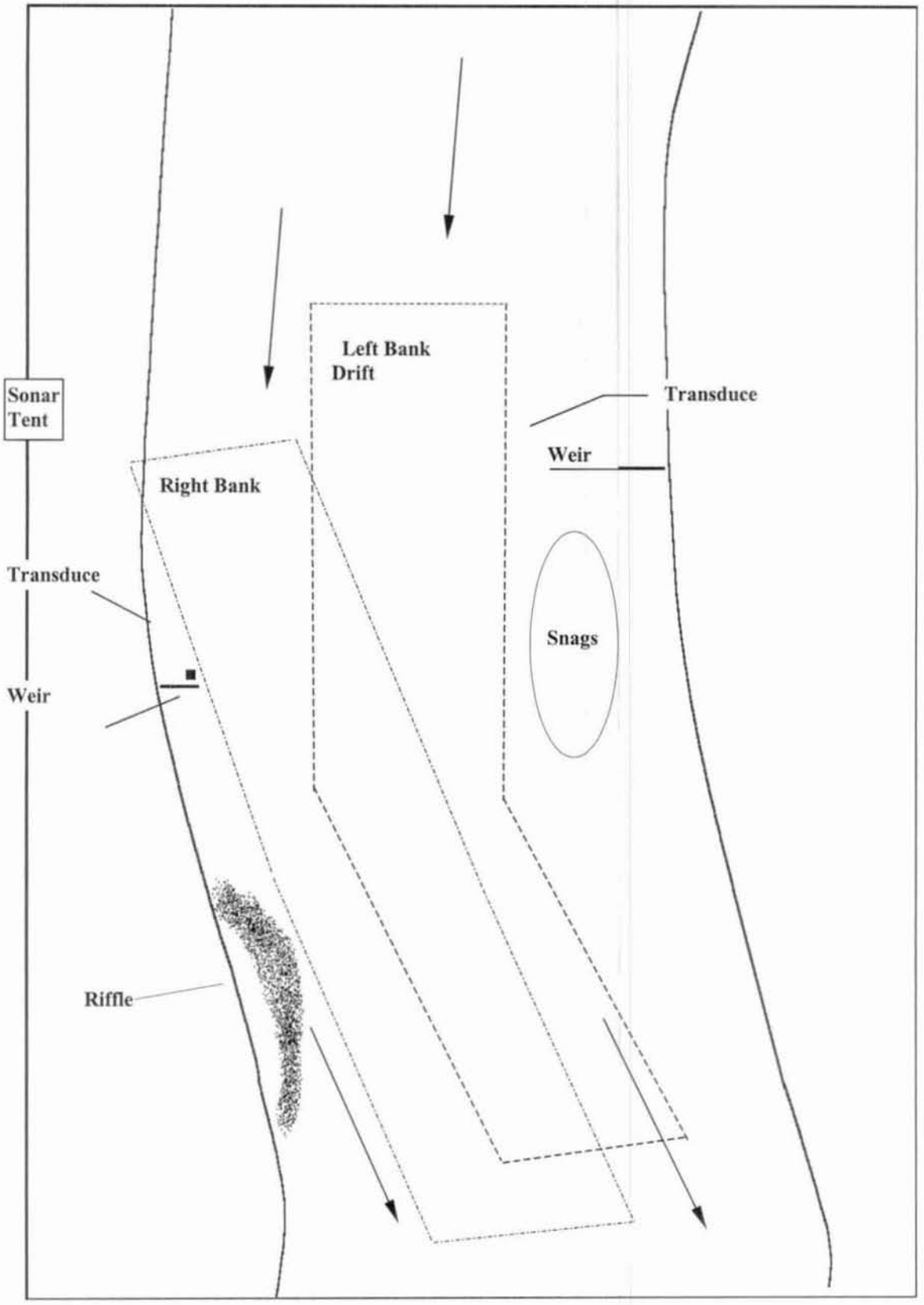


Figure 3. Aniak River drift gillnet stations, 2001.

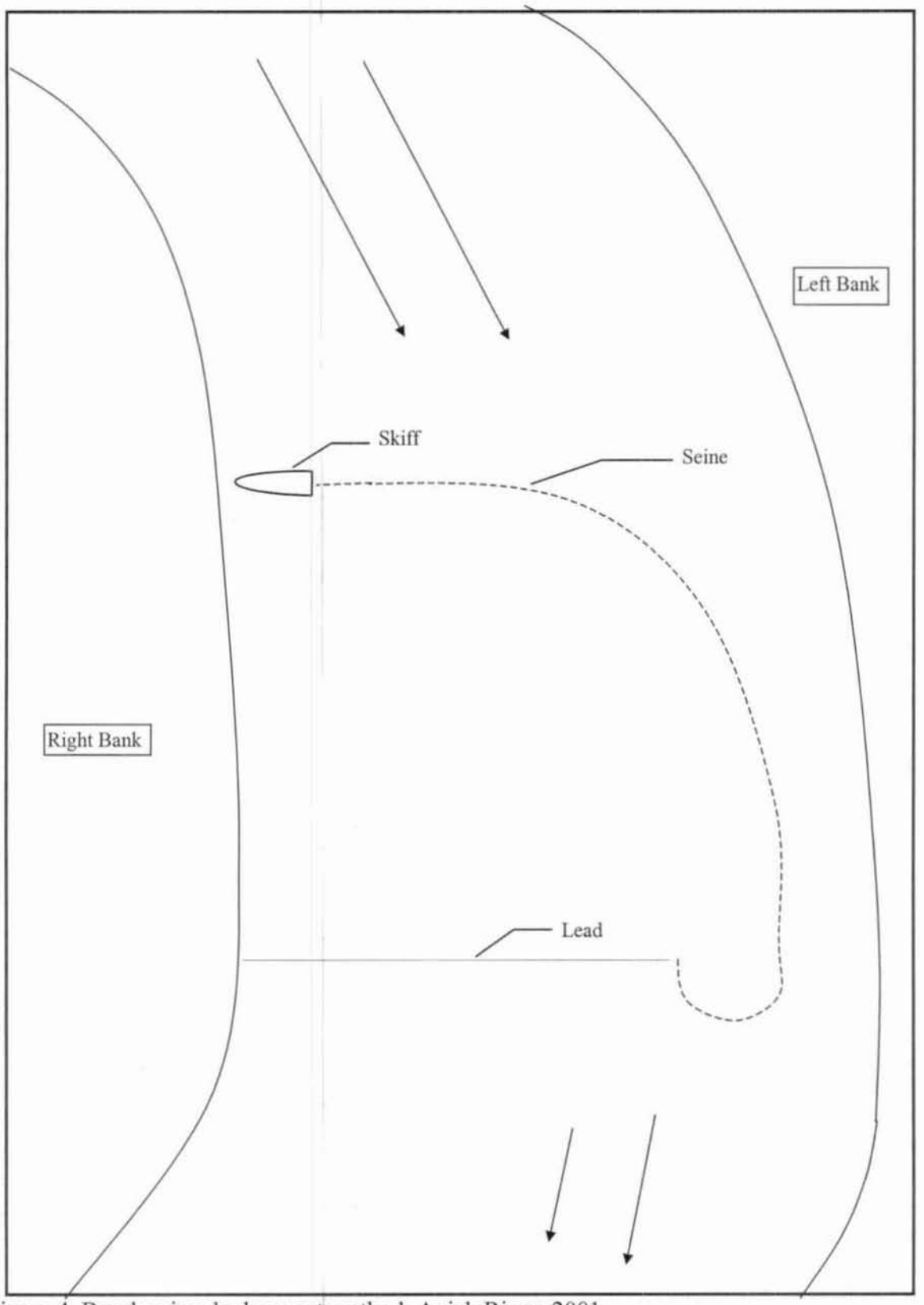


Figure 4. Beach seine deployment method, Aniak River, 2001.

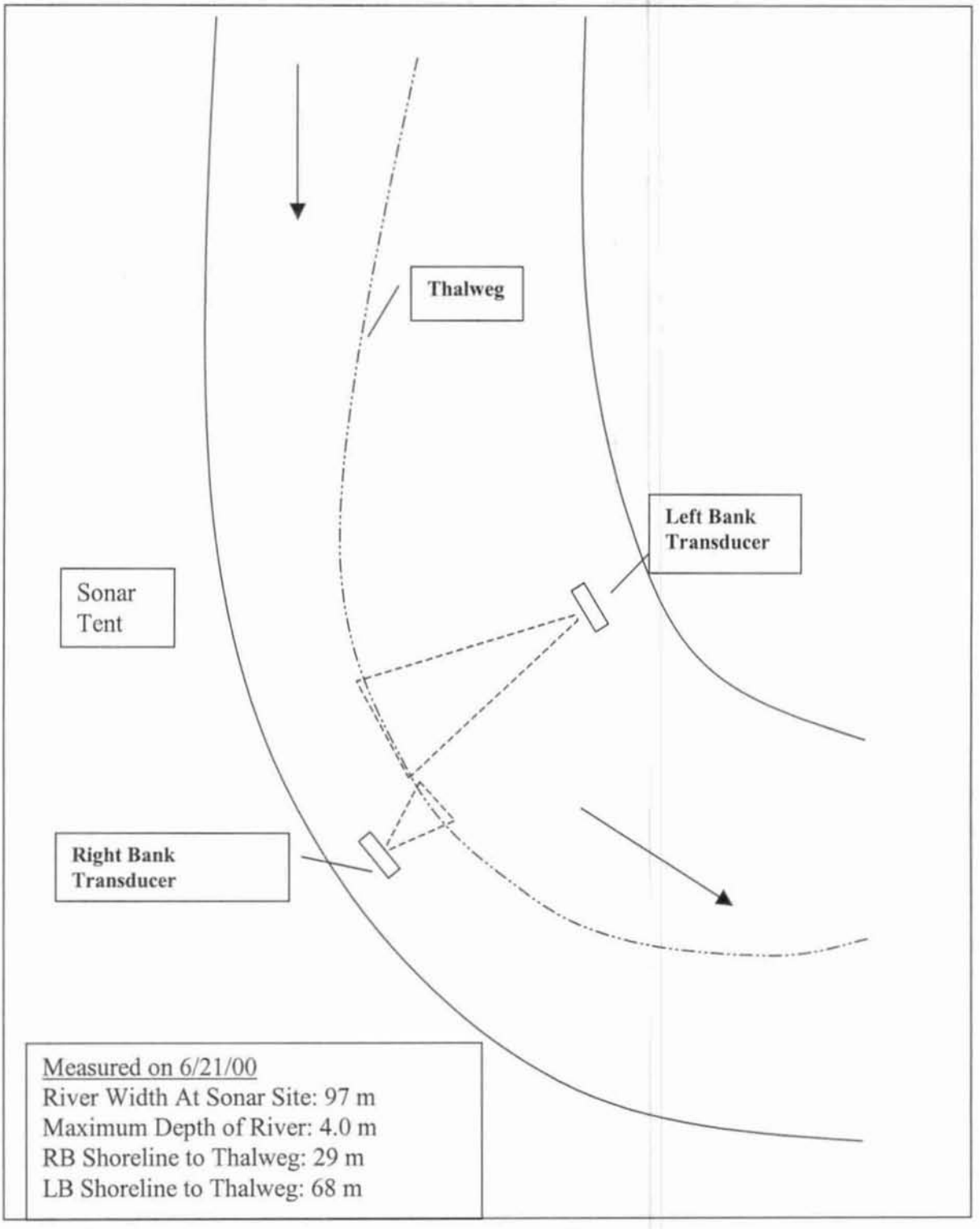


Figure 5. Aniak River sonar site stream measurements, 2001.

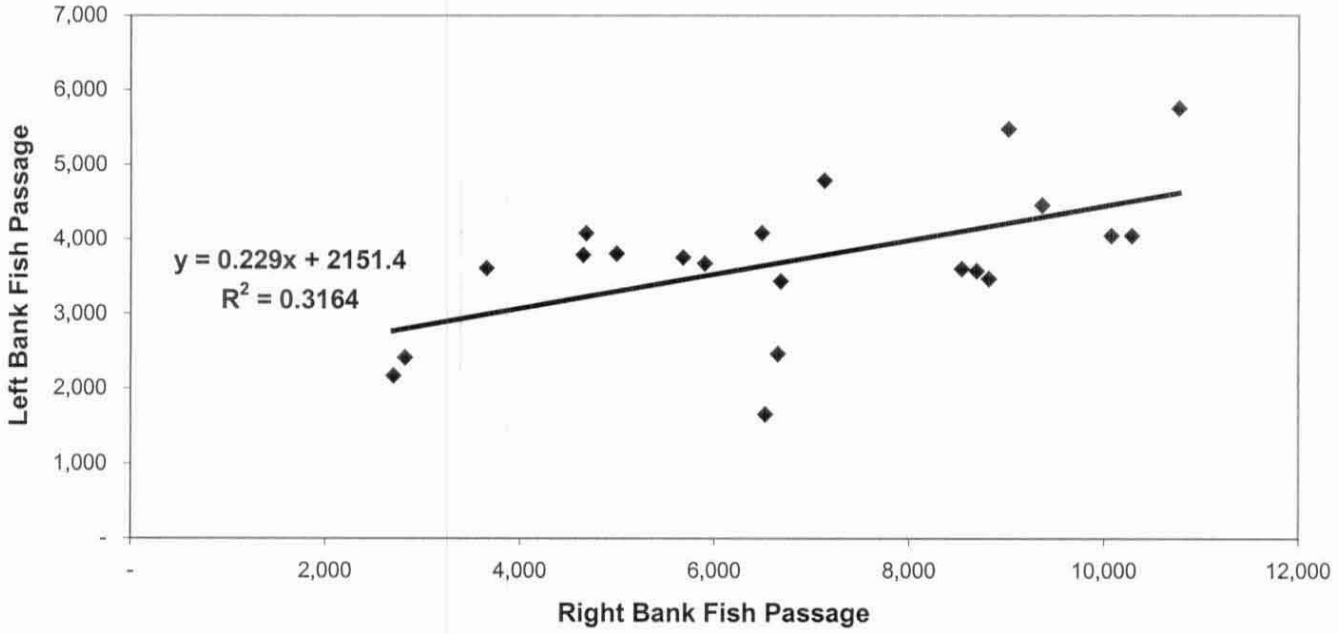


Figure 6. A comparison of daily estimated fish passage between banks, Aniak River, 2001.

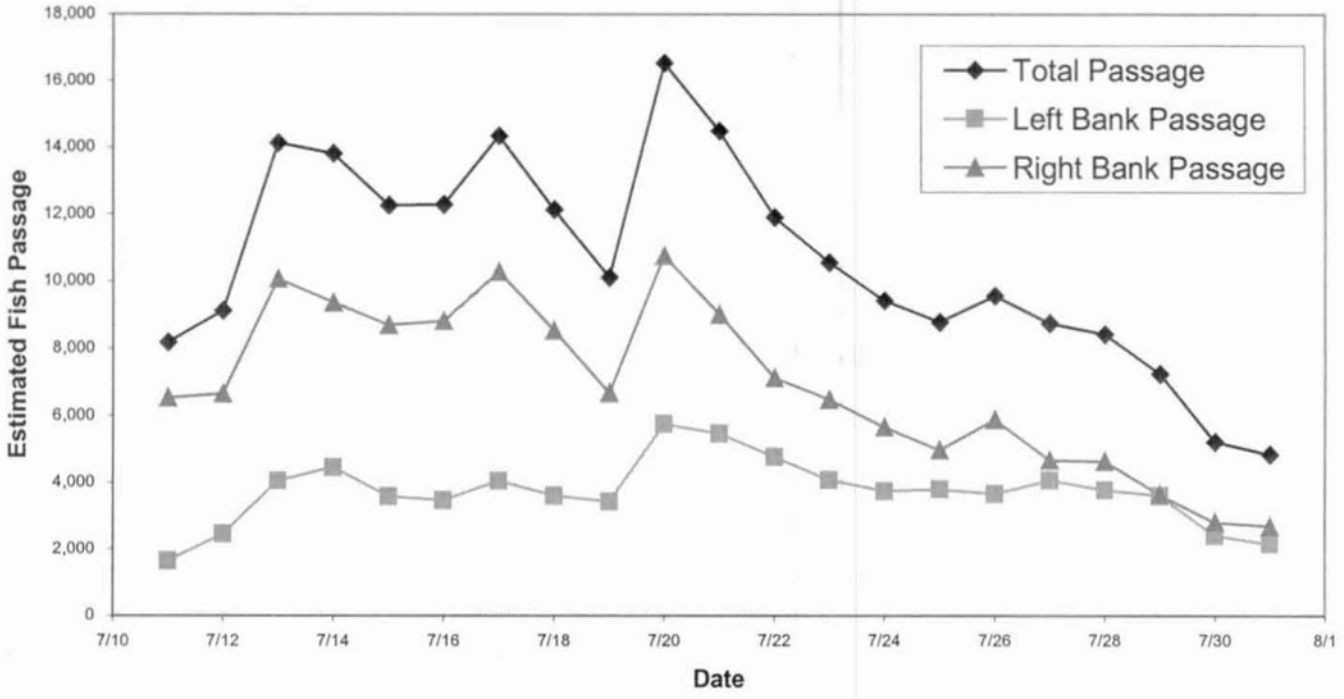


Figure 7. Estimated daily fish passage, Aniak River, 2001.

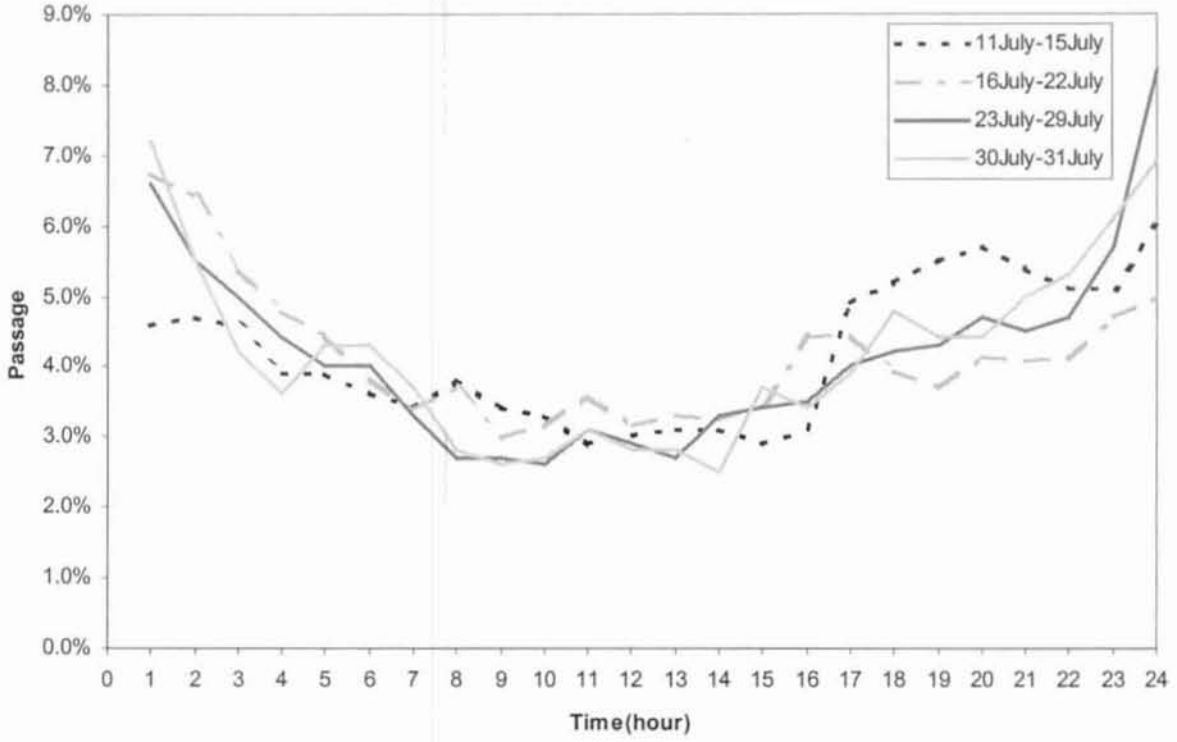


Figure 8. Diel distributions of fish detections, Aniak River, 2001.

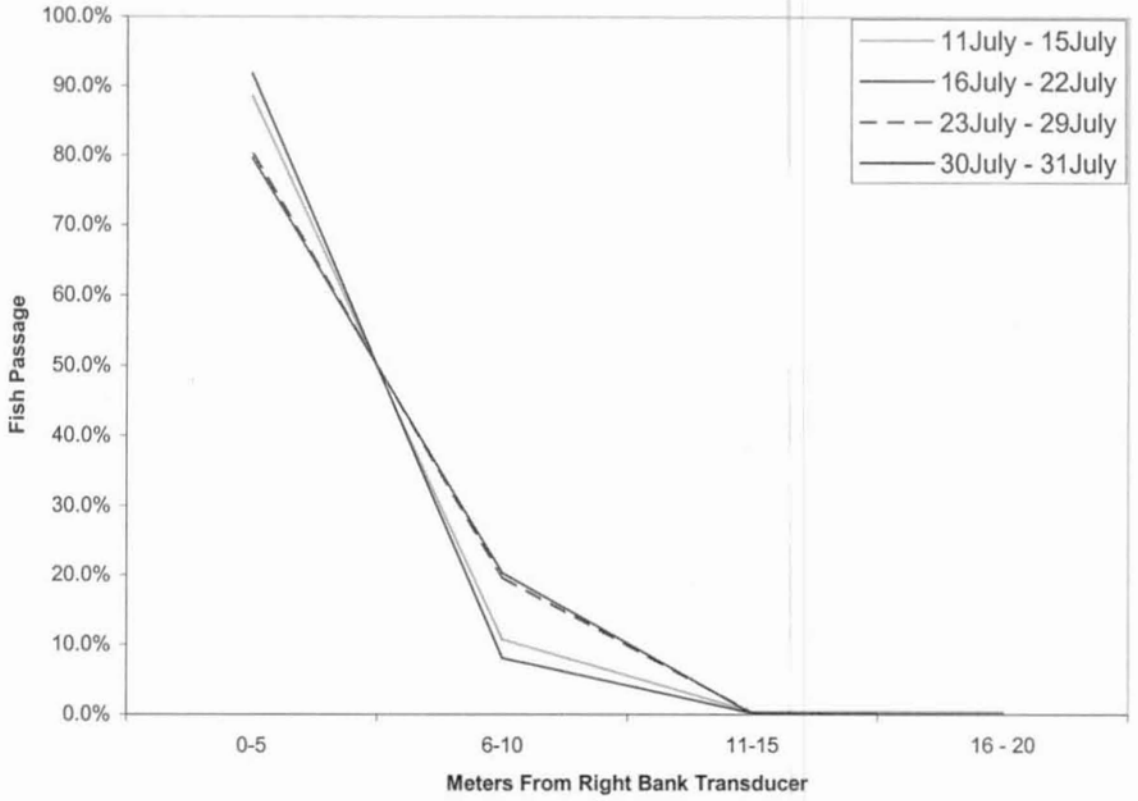


Figure 9. Right bank horizontal range distributions of fish passage, Aniak River sonar, 11 July – 31 July, 2001.

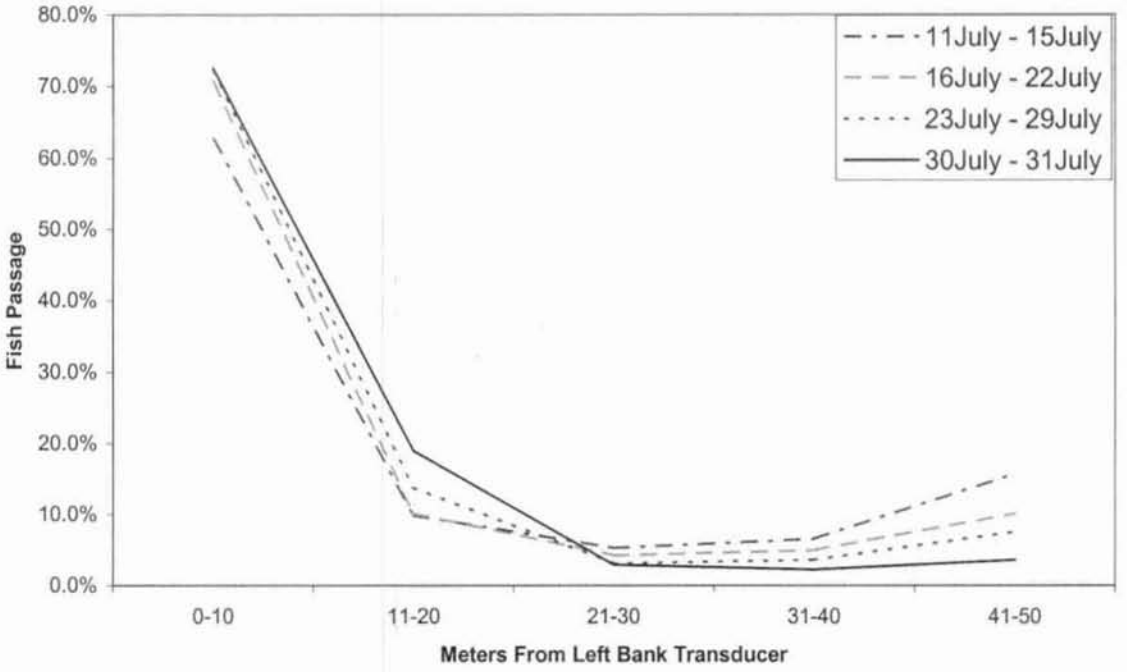


Figure 10. Left bank horizontal range distributions of fish passage, Aniak River sonar, 11 July – 31 July, 2001.

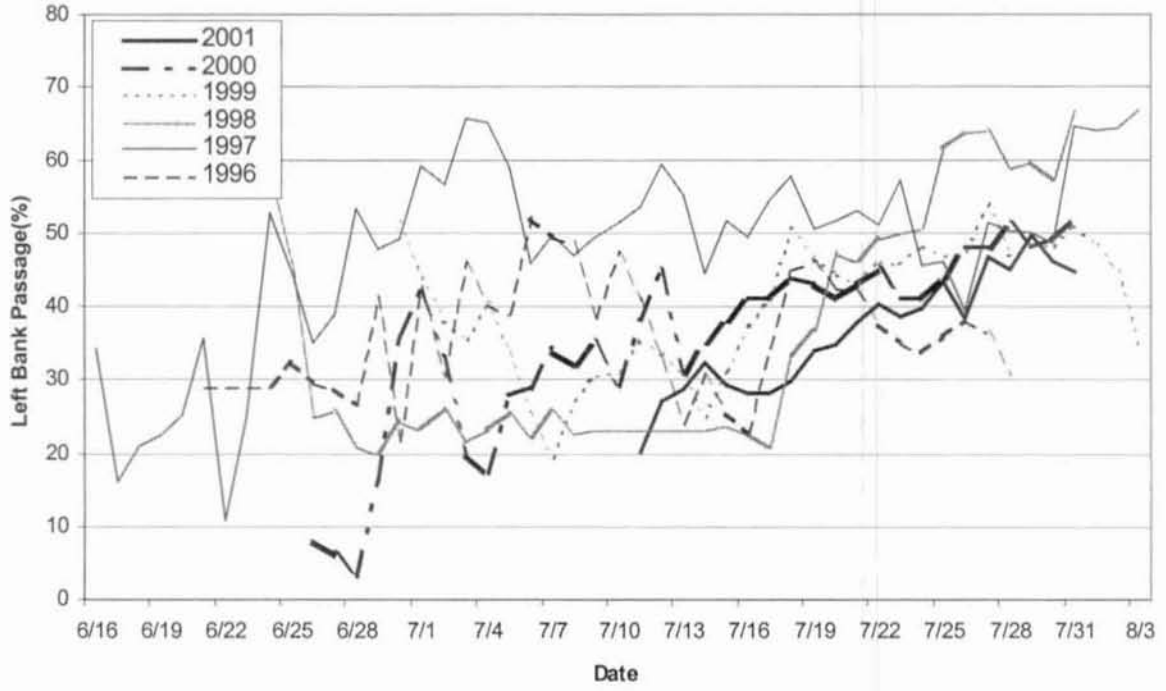


Figure 11. Daily left bank percent passage rates for Aniak River sonar, 1996-2001.

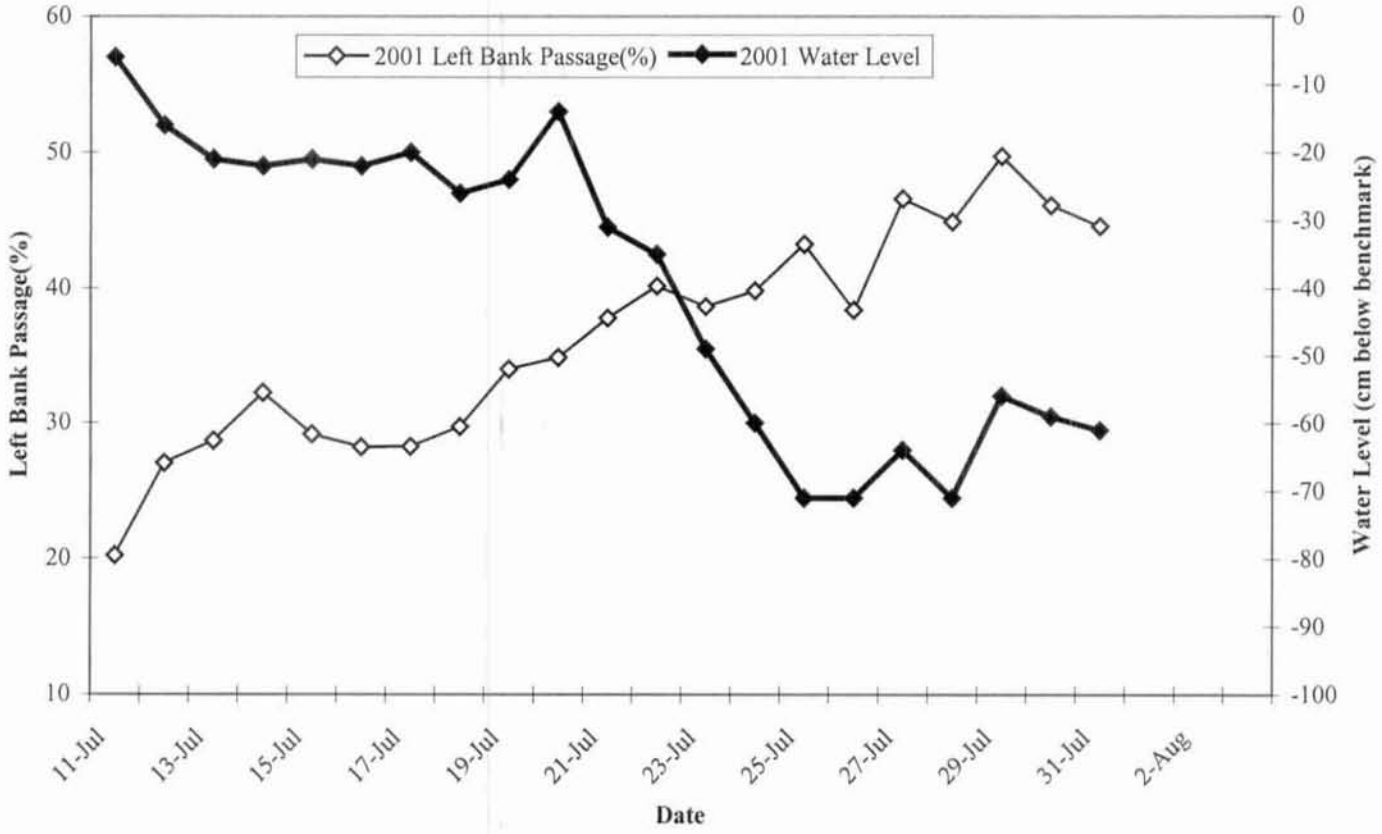


Figure 12. Daily left bank percent passage rate and water level for the Aniak River sonar, 2001.

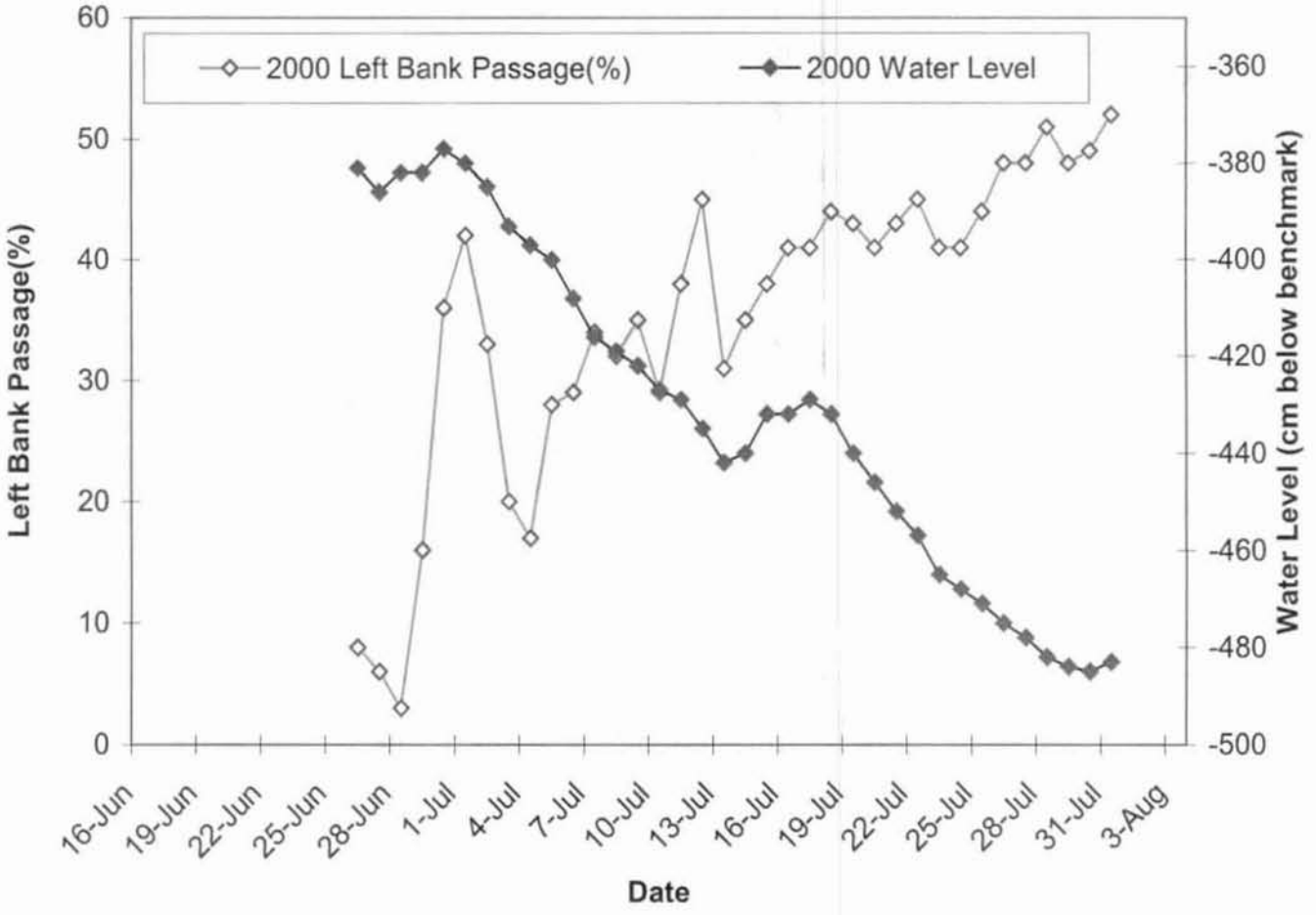


Figure 13. Daily left bank percent passage rate and water level for the Aniak River sonar, 2000.

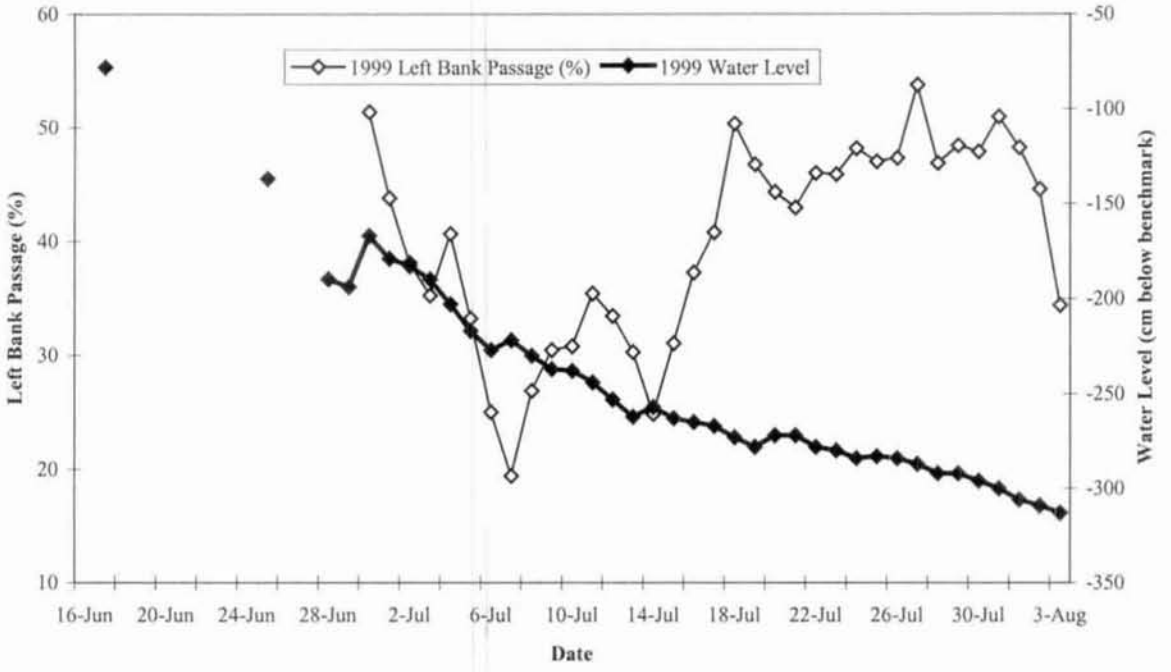


Figure 14. Daily left bank percent passage rate and water level for Aniak River sonar, 1999.

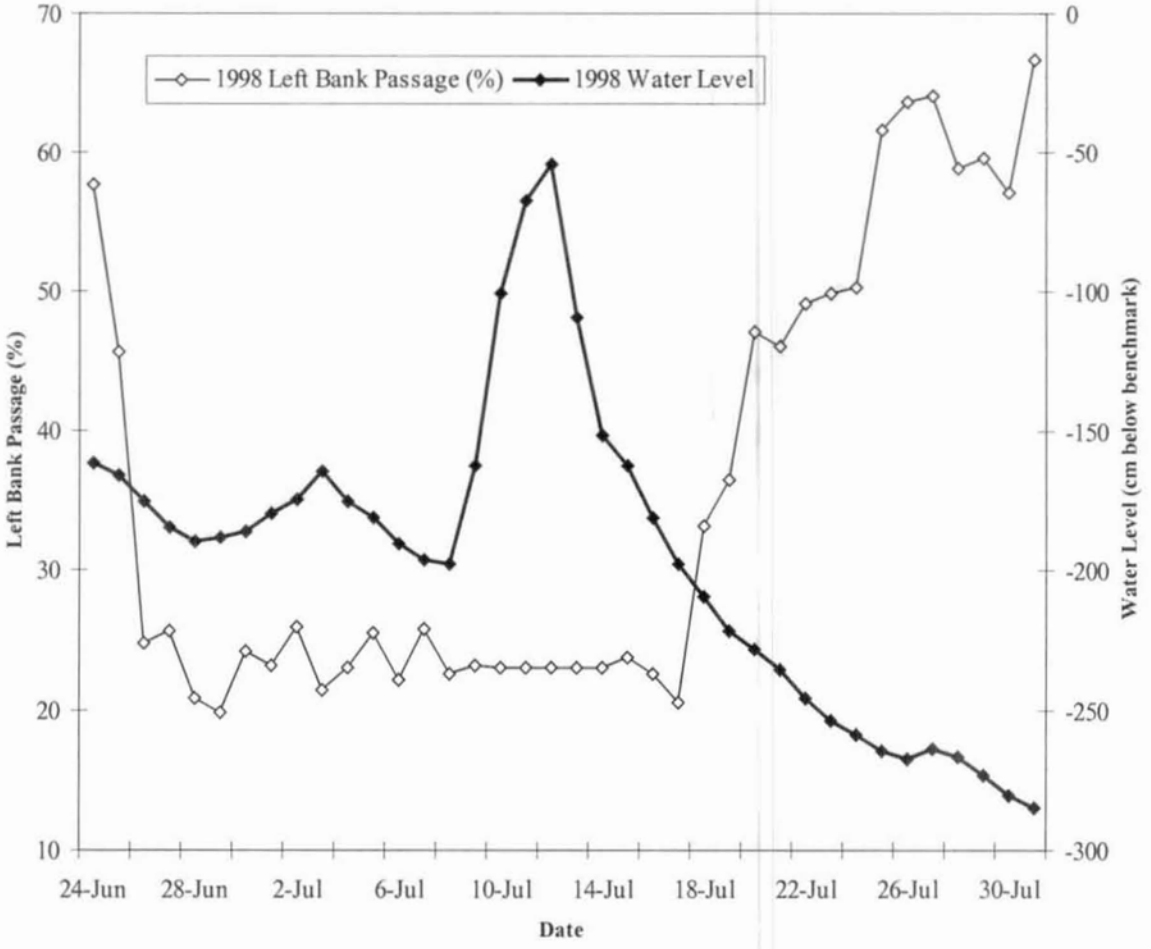


Figure 15. Daily left bank percent passage rate and water level for Aniak River sonar, 1998.

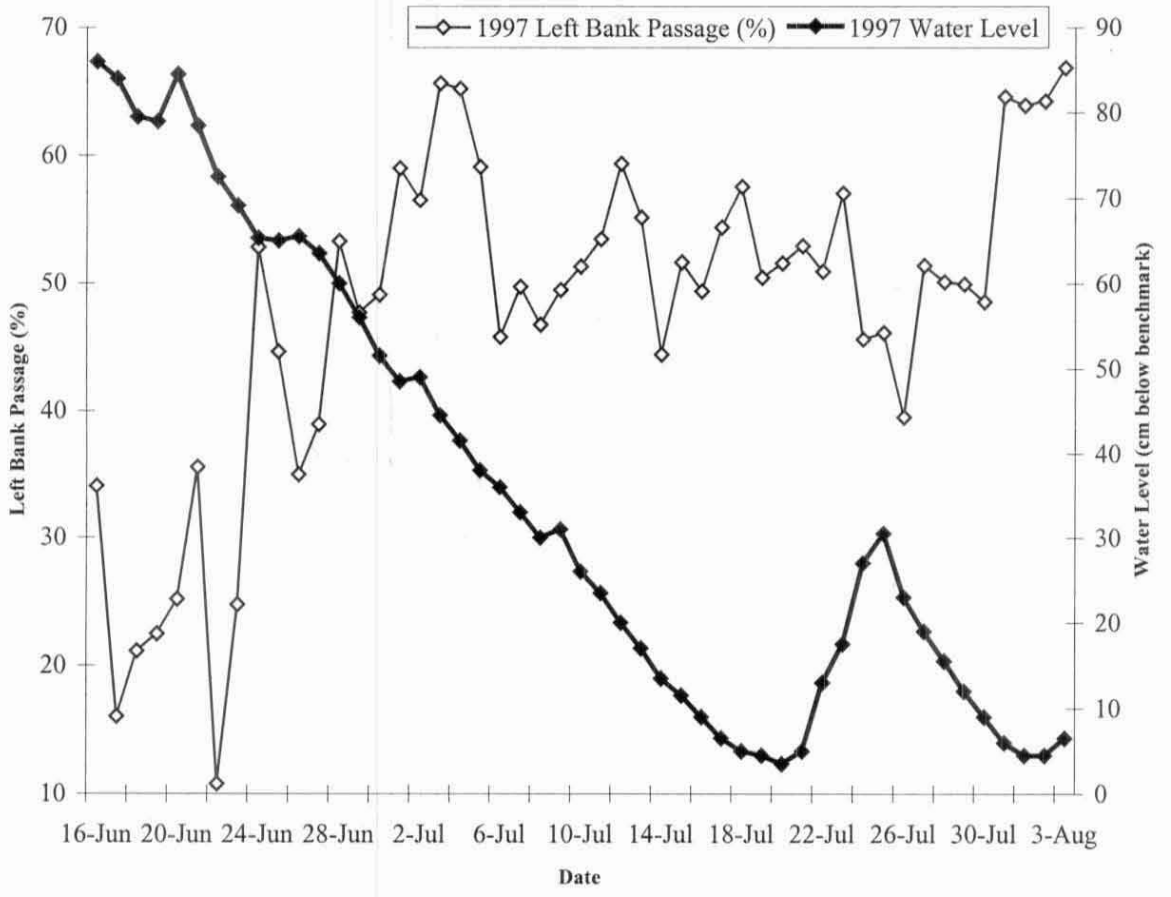


Figure 16. Daily left bank percent passage rate and water level for Aniak River sonar, 1997.

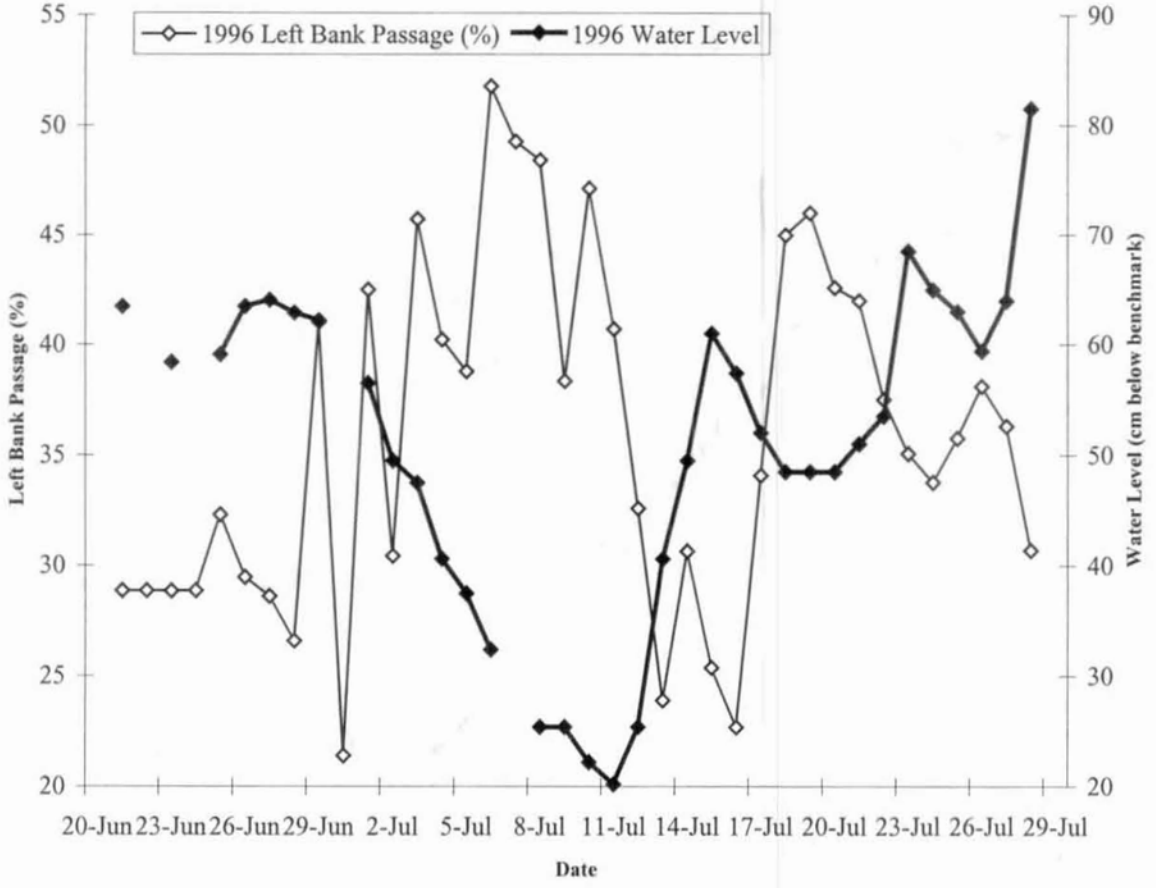


Figure 17. Daily left bank percent passage rate and water level for Aniak River sonar, 1996.

APPENDIX A. HISTORICAL KUSKOKWIM SUBSISTENCE AND COMMERCIAL HARVESTS

Appendix A.1. Lower Kuskokwim River, District 1 and the middle Kuskokwim River, District 2, combined commercial salmon harvest and estimated exvessel value, 1990-2001[a].

Kuskokwim In-River Commercial Salmon Harvest

(Source: 1990-00 Kuskokwim Area Management Reports)

Year		Chinook	Sockeye	Coho	Pink	Chum	Total
1990	Fish	53,759	84,870	410,332	3,397	461,624	1,013,982
	Value	$435,052	$619,442	$1,639,224	$1,893	$824,067	$3,519,678
1991	Fish	37,778	108,946	500,935	378	431,802	1,079,839
	Value	$320,733	$512,858	$1,431,976	$157	$836,144	$3,101,868
1992	Fish	46,872	92,218	666,170	7,451	344,603	1,157,314
	Value	$397,894	$590,293	$2,150,242	$1,381	$760,934	$3,900,744
1993	Fish	8,735	27,008	610,786	64	43,337	689,930
	Value	$72,812	$140,824	$2,297,772	$59	$114,127	$2,625,594
1994	Fish	16,211	49,365	724,689	30,949	271,115	1,092,329
	Value	$126,961	$188,704	$3,002,387	$8,973	$383,630	$3,710,655
1995	Fish	30,846	92,500	471,461	93	605,918	1,200,818
	Value	$309,088	$460,982	$1,358,656	$50	$746,478	$2,875,254
1996[b]	Fish	6,973	33,512	935,510	1,621	200,298	1,177,914
	Value	$23,672	$97,622	$1,835,208	$744	$170,988	$2,128,2
1997	Fish	10,441	21,989	130,803	2	17,026	180,261
	Value	$36,888	$64,926	$315,650	$1	$19,522	$436,987
1998	Fish	17,359	60,906	210,481	92	207,809	496,647
	Value	$74,396	$209,870	$516,552	$55	$183,386	$984,259
1999	Fish	4,705	16,976	25,593	2	23,006	70,282
	Value	$23,337	$64,000	$54,052	$0.15	$16,794	$158,183
2000	Fish	26,115	109,939	307,439	17	49,574	493,084
	Value	$159, 695	$410,454	$589,135	$6	$37,897	$1,037,492
2001	Fish	90	84	192,298	0	1291	193,763
	Value	$535	$264	$427,496	$0	$827	$429,122
Avg. (1990-2001)	Fish	21,657	58,193	432,208	3,672	221,450	737,180
	Value	$165,089	$280,020	$1,301,529	$1,110	$341,233	$2,075,673

[a] Does not include test fish sales.

[b] Does not include roe sales

Appendix A. 2. Lower Kuskokwim River, District 1 and the middle Kuskokwim River, District 2 and the Upper Kuskokwim River combined subsistence salmon harvest, 1990-2000.

Kuskokwim In-River Subsistence Salmon Harvest					
(Source: 1990-2000 Kuskokwim Area Annual Management Reports)					
Year	**Chinook**	**Chum**	**Sockeye**	**Coho**	**Total**
1990	85,979	126,508	36,276	44,791	293,554
1991	85,554	93,075	52,984	50,370	281,983
1992	64,795	96,491	32,067	40,168	233,521
1993	87,512	59,396	49,349	31,737	227,994
1994	93,242	72,025	37,159	33,050	235,476
1995	96,436	67,862	27,791	36,277	228,366
1996	78,063	88,965	34,213	32,741	233,982
1997	81,577	39,970	40,077	29,032	190,656
1998	86,115	67,665	37,578	27,239	218,597
1999	73,194	43,601	46,677	25,004	188,476
2000	64,893	51,696	41,783	33,786	192,158
Average (1990-2000)	81,578	73,387	39,632	34,927	229,524

APPENDIX B. TIMETABLE OF THE ANIAK RIVER SONAR PROJECT

Appendix B.1. Timetable of developmental changes at the Aniak River sonar project, 1980-2001.

YEAR	EVENT
1980	• Aniak River sonar project established • 1978 model, non-configurable Bendix sonar counter used with 60 ft artificial substrate • Single bank operation (1980-95) • Cumulative adjusted daily sonar estimates expanded by 150% to account for salmon passing outside the insonified area • Sonar estimates are extrapolated for pre and post season salmon escapement (1980-82, 85-89, 91-96) • Gillnet test fishing to provide species apportionment and ASL information • Three correction factor calibrations per day averaged to adjust daily estimates
1981	• 1981 model, non-configurable Bendix sonar counter used with 60 ft artificial substrate • A tentative escapement goal of 250,000 chum and 25,000 king salmon is established for the Aniak River • Gillnet and beach seine test fishing to provide species apportionment and ASL information
1982	• Sonar equipment unchanged • Escapement goals for AYK Region updated; 250,000 chum and 25,000 king salmon escapement goal is established for the Aniak River • Gillnet test fishing to provide species apportionment and ASL information • Four correction factor calibrations applied to 6 hour time periods to adjust daily estimates
1983	• Sonar equipment unchanged • Review of escapement goal based upon sonar estimates indicated 1980-81 Aniak River • Sonar estimates likely represented unusual record escapements, and much smaller escapements would probably provide adequate future spawning stocks as well as catches for user groups. Goal remains 250,000 chum and 25,000 king salmon. • Sonar estimates are not extrapolated for pre- and post-season salmon escapement (1983-84, 90, 96-97)
1984	• Sonar equipment unchanged • No apportionment of estimates made due to insufficient test gillnets catches. In the absence of sufficient species apportionment data, the sonar based escapement objective would be 250,000 estimated salmon counts.

-Continued-

Appendix B.1. (Page 2 of 3)

YEAR	EVENT
	• Cumulative adjusted daily sonar estimates expanded by 162% to account for salmon passing outside the insonified area.
1985	• Sonar equipment unchanged • Gillnet test fishing and carcass samples provide ASL information
1986	• Sonar equipment unchanged • ASL sampling activities are discontinued to decrease operating costs. • Species apportionment activities are discontinued due to inadequate sample sizes.
1988	• Sonar operations eliminated use of the 60 ft artificial substrate. Sampling range unknown
1989	• Sonar operations same as 1988
1990	• No formal project documentation (1990-95)
1993	• Fire destroys 1981 model Bendix sonar counter. Replaced with a 1978 model Bendix sonar counter • Historic data in Kuskokwim Area Management Report is adjusted to reflect 162% expansion factor applied to 1980-83 season estimates.
1994	• Sonar operations continue with 1978 model counter
1995	• Sonar operations continue with 1978 model counter • Reliable escapement estimates are not generated
1996	• Established a new sonar data collection site 1.5 km downstream from the historical site • Project operations redesigned to provide full river ensonification, with user-configurable sonar equipment 24 hours per day on both banks. • Periodic net sampling to monitor broad changes in species composition, corroborate acoustically detected abundance trends, and obtain ASL samples of chum salmon • Sonar estimates are not extrapolated for pre- and post-season salmon escapement (1996-97) • Regional Information Report documents project operations and data collection activities

-Continued-

Appendix B.1. (Page 3 of 3)

YEAR	EVENT
2000 2001	• Project operations remain the same as 1996 for years 1997 through 2000. • Sonar operations remain the same as 1996 for years 1997 through 2001. • Species Apportionment Program is added to the project, which involved test fishing twice daily and expanding crew.

APPENDIX C. DNR LAND USE PERMIT

Appendix C.1. State of Alaska, Department of Natural Resources land use and cache permit for the Aniak River sonar project.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MINING, LAND AND WATER

TONY KNOWLES, GOVERNOR

550 W. 7th AVENUE, SUITE 900C
ANCHORAGE, ALASKA 99501-3577
PHONE: (907) 269-8552
FAX: (907) 269-8913

February 2, 2000

Lowell Fair
Alaska Department of Fish and Game
Commercial Fisheries Division
333 Raspberry Road
Anchorage, AK 99518

Re: Land Use Permit: LAS 13916

Dear Mr. Fair:

The Southcentral Region, Land Office, Division of Mining, Land and Water has received your annual report for land use permit LAS 13916. We found the written report to be satisfactory. However, we would appreciate receiving the during and after use photographs required in the second paragraph of Stipulation #11.

In an attempt to streamline the administrative portion of the land use permit program, the division is discontinuing the permit validation program. With its elimination, permits are being amended to specifically define the permit term and the authorized use periods.

LAS 13916 was initially issued with terms allowing it to be validated on an annual basis through 2002. With this letter, **the remaining term of the subject land use permit is amended to February 1, 2000 through May 31, 2002. Within this permit term, you are authorized to do the following:**

(i) **establish and use a temporary camp per the attached site development plan each 06/01 – 08/10 term covered under the remaining term of the subject permit and**

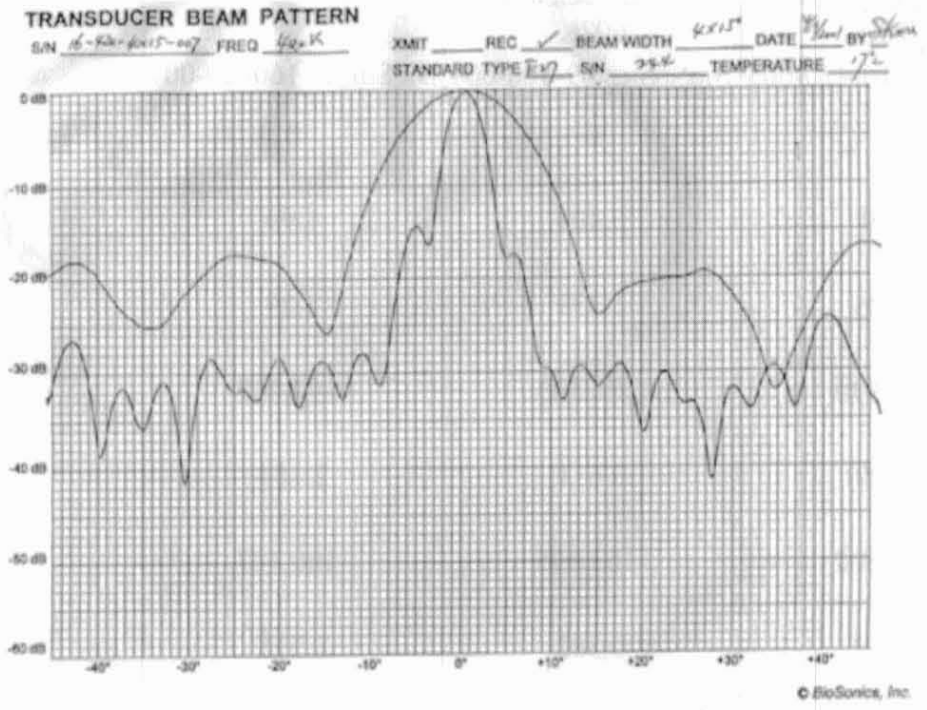
(ii) **cache a disassembled weir, plywood table, frame, kitchen sink, stovepipe and out-house each 08/11 – 05/31 term covered under the remaining term of the subject permit.**

APPENDIX D. SONAR EQUIPMENT CALIBRATIONS

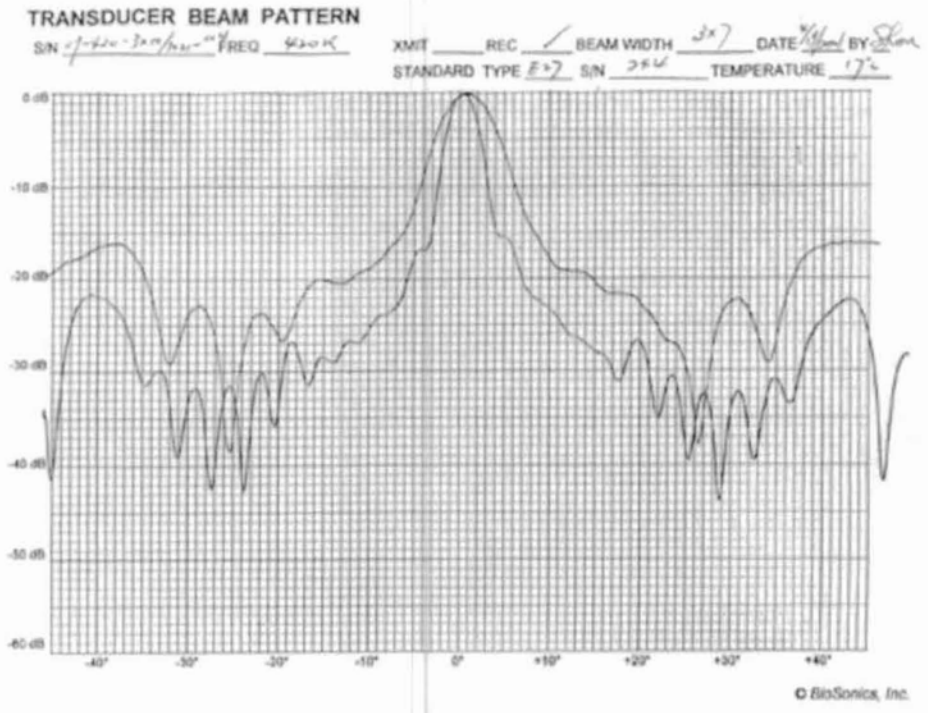
Appendix D.1. BioSonics bench calibration data; calibrated 19 April, 2001.

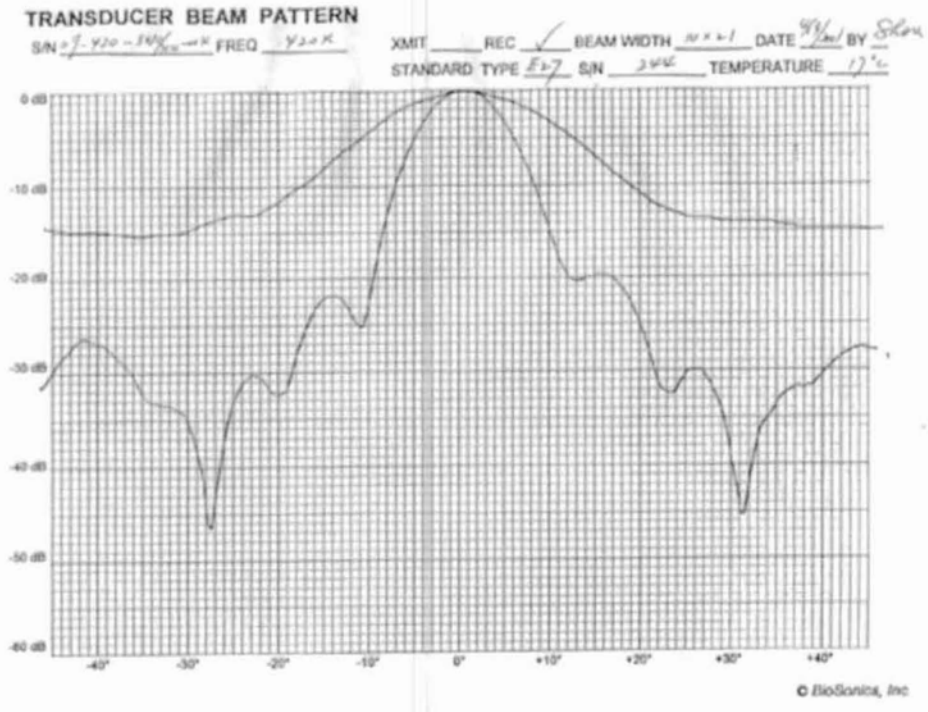
Sounder Cables (S/N):	101-034 1000' Belden 701A, 703A	102-020 1000' Belden 601K, 602K	102-21 500' Belden 503K
Transducer:	BioSonics 16-420-006	BioSonics 09-420-004	BioSonics 160420-007
Receiver Gain L	0	0	0
Standard Volts In	1.99	0.409	1.99
Vdet 40 Log	3.125	1.339	3.29
G1 40 Log	-190.914	-184.533	-190.467
Vdet 20 Log	10.058	0.611	2.154
G1 20 Log	-152.802	-163.395	-166.187
-13 dB Vrms	0.262	0.382	0.315
-13 dB SL	208.337	211.621	209.941
-10 dB Vrms	0.361	0.52	0.438
-10 dB SL	211.125	214.299	212.821
-6 dB Vrms	0.566	0.742	0.654
-6 dB SL	215.035	217.397	216.296
-3 dB Vrms	0.778	1.078	0.902
-3 dB SL	217.801	220.639	219.084
0 dB Vrms	1.061	1.414	1.209
0 dB SL	220.495	222.994	221.633

Appendix D.2. Polar Plot for BioSonics transducer (S/N 16-420-007)



Appendix D.3. Polar plots for BioSonics transducer (S/N 09-420-004)





Appendix D.4. Polar plot for BioSonics transducer (S/N 16-420-006)