ANIAK RIVER SONAR PROJECT REPORT
1998

by

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ABSTRACT

The Aniak River sonar project provided daily estimates of fish passage from 24 June through 31 July, 1998. User-configurable sonar continuously sampled the entire width of the river between the transducers, except for five days during a high water event and short periods when equipment was moved or serviced. An estimated 279,430 fish passed through the ensonified area during the period of operation. The peak daily passage of 16,409 fish occurred on 21 July, and the 50% passage date occurred on 19 July. The four and five year age classes of Aniak River chum salmon comprised an estimated 87.3% and 12.0% of the escapement estimate, respectively. High water conditions and a relatively poor return of five year age class chum salmon to the Kuskokwim Area characterized the 1998 season.

INTRODUCTION

The Kuskokwim River commercial salmon fishery in June and July is directed toward the harvest of chum salmon *Oncorhynchus keta*. Commercial harvests from 1988-1997 averaged 450,658 chum salmon (Appendix A.1). The 1998 commercial harvest for chum salmon was 207,809 fish. Exvessel value from in-river harvests of chum salmon during the same period averaged nearly $900 thousand (Francisco et al. 1989, 1990, 1991, 1992, 1993, 1994, 1995; Burkey et al. 1997, 1998, 1999). The 1998 season chum salmon harvest was valued at $183 thousand. Also during that time, an average 93,595 chum salmon were estimated to have been 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 that the Aniak River is one of the largest producers of chum salmon in the Kuskokwim drainage (Francisco et al. 1995). Prior tagging studies suggest that travel time of chum salmon migrating from the upper end of District 1 to the Aniak River sonar site is about 7 or 8 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 the number of chum salmon escaping the fisheries to spawn in that river.

Aniak River escapement data were collected using an echo counting and processing transceiver manufactured by Bendix Corporation[1] beginning in 1980. 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 using a variety of techniques (Schneiderhan 1989). Initially, cumulative adjusted daily totals were subjectively expanded by 150% to compensate for salmon passing beyond the ensonified range. 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 ensonified portion of the river.

A second sonar counter was operated 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%. In addition to the expansion of daily totals, season sonar estimates were also extrapolated for salmon escapement estimated to have occurred before and after the operational period.

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

Gillnet test fishing provided species apportionment and age, sex, and length (ASL) information of chum and chinook salmon. Early 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 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 sonar estimates likely represented record escapements, and much smaller escapements would probably provide adequate future spawning stocks as well as for sustained harvest (Schneiderhan 1984).

Species apportionment activities were discontinued in 1986 due to inadequate sample sizes (Schneiderhan 1988). Early gillnet and beach seine test fishing investigations indicated that 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). With 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 ensonification, with user-configurable sonar equipment operating 24 hours per day on both banks. A new sonar data collection site was established 1.5 km downstream from the historical site. 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. The project was intended to operate throughout the duration of the chum salmon migration and season sonar estimates were not extrapolated for salmon escapement that occurred before and after the operational period.

Project operations in 1998 remained the same as in 1997 and 1996. The BEG of 250,000 estimated fish counts has been 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 A.3.

The objectives of the 1998 Aniak River sonar project were:

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 22 June through 31 July.
2) Provide daily fish passage estimates in the Aniak River to fishery managers in Bethel.
3) Periodically drift a suite of gillnets to qualitatively monitor general trends in species composition, and to corroborate acoustically detected fish abundance trends.
4) Collect and archive ASL samples from chum salmon migrating near the sonar site from beach seine catches.

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 (Figure 1). 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.

In order to accomplish our objective of full river ensonification, we relocated the sonar site approximately 1.5 km downstream from the historical site in 1996 (Figure 2). The river at the sonar site is characterized by broad meanders, with large gravel bars on inside bends and cutbanks with exposed soil, tree roots and snags on outside bends. Numerous transects were conducted in the immediate vicinity of the sonar site, using a Lowrance model X-16 chart recording portable 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 102 (SN 89-020) 120/420 kHz echosounder configured to transmit and receive at 120 kHz; 2) an International Transducer Co. (I.T.C.) model 5398 (SN 008) user-configurable 120 kHz elliptical beam transducer configured for dual beam use as Case II (4°x9° narrow, 12°x22° wide beam); 3) two 152.4 m (500 ft) Belden model 8412 transducer

cables (SN 703A, 704A); and 4) a Biosonics model 111 (SN 053) thermal chart recorder. A Nicolet model 310 (SN 4865) digital storage oscilloscope was used to examine signals from both the left and right bank systems.

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 215) oil 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 9934 pan and tilt cable. A set of digital panel meters provided readings, accurate to within ± 0.3 degrees, for the horizontal and vertical axes positions.

Left bank sonar equipment included: 1) a Biosonics model 102 (SN 89-021) 120/420 kHz echosounder configured to transmit and receive at 120 kHz; 2) an I.T.C. model 5398 (SN 009) user-configurable 120 kHz elliptical beam transducer configured for dual beam use as Case I (2°x5° narrow, 4°x9° wide beam); 3) two 304.8 m (1000 ft) Belden model 8412 transducer cables (SN 701A, 702A); and 4) a Biosonics model 111 (SN 041) 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 1064) air 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 m x 3.7 m (10 ft x 12 ft) portable wall tent on the right bank and powered by a single Honda model EM-3500 independently grounded generator. Transducer and rotator cables for the left bank were attached to a 6.4 mm (1/4 in) steel cable suspended 3 m above the river. The cable bundle was marked with orange flagging to allow safe boat passage.

Sampling Procedures

We conducted single beam acoustic sampling on both banks continuously 24 h per day, seven days per week, except for short periods of time in which 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 rotated through shifts of 0000-0800, 0800-1600, and 1600-2400 h. During those shifts, crewmembers identified and tallied fish traces on chart recordings. 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. Range intervals were 5 m wide on the right bank and 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 h 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 then catalogued for storage.

We recorded project activities in a project logbook. The logbook was used to document daily events of sonar activities and system diagnostics. During each shift, crewmembers were required to: 1) read the log from the previous shift; 2) sign the log book, including date and time; 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 120 kHz. We used a 40 log(R) time-varied gain (TVG) and a 5 kHz frequency bandwidth filter for both banks. We set the right and left bank transmit pulse width at 0.4 ms, and later changed the right bank transmit pulse width to 0.3 ms on 29 June and then to 0.2 ms on 23 July to minimize cross-talk between transducers and increase resolution of fish traces. Maximum sampling range was 35 m on the right bank and 76 m on the left bank. The right bank chart recorder threshold was set at 0.27 Volts (-42.2 dB) during all sampling activities. The left bank threshold was set at 0.2 Volts (-43.7 dB). Three printer thresholds, corresponding to intensities of gray-line, on the Biosonics MDL 111 thermal printer were factory set at 6 dB intervals. Right bank printer thresholds corresponded to target strengths of -42.2 dB, -36.2 dB, and –30.2 dB (gray scale 1, 2, and 3 respectively). Left bank printer thresholds were –43.7 dB, -37.7 dB, and –31.7 dB. We altered the left bank chart recorder threshold to 0.25 Volts on 8 July (-41.8 dB, -35.8 dB, and -29.8 dB) in response to aim changes associated with transducer relocation as water levels rose.

Threshold levels and target strength levels were calculated as follows:

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

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
$2B\theta$ = 2-way beam pattern factor in dB

Transmission loss was assumed to be negligible at the ensonification ranges sampled, and was therefore compensated by TVG.

Transducer Deployment

The transducers were positioned in the river as nearly perpendicular to the current as possible. The wide axis of each elliptical beam was oriented as close to the horizontal position and as near the bottom of the river as possible to maximize target residence time in the beam. Transducers were placed offshore 5 m to 9 m from the right bank, and 12 m to 19 m from the left bank. Daily visual inspections confirmed proper placement and orientation of the transducers.

Weirs extended from shore 3 m to 8 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 but allow passage of small, resident fish we did not want to include in the passage estimate.

Hydroacoustic Equipment Checks

Both sonar systems were bench calibrated in May, 1998. We estimated noise levels in the field at three range intervals for the right bank sonar system and at five intervals for the left bank sonar system. For our purposes, we defined noise as any unwanted signal including boundary and volume reverberation, electronic noise, and ambient background noise in our measurements. Noise levels were estimated by measuring the average peak voltage in four separate range intervals on the oscilloscope. Structure reverberation peaks separated the selected range intervals.

Bottom Profiles and Stream Measurements

We recorded numerous bottom profiles outward from both banks using a Lowrance X-16 chart recording fathometer prior to choosing exact deployment sites. On 27 June and 27 July, we made paired depth at range measurements on both banks using the Lowrance fathometer and a Laser Atlanta model Advantage (SN 10365) optical laser range finder. Measurements were made at 2 m to 3 m intervals, from each transducer to the opposite shore.

Climatological and Hydrologic Measurements

We measured ambient air temperature, and 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.

We established a benchmark to reference daily water level measurements. The benchmark at the southeast corner of the sonar tent platform is indicated by a black rectangular mark. We used the laser range finder to measure distance and angle from the benchmark to the staff gauge.

Analytical Methods

Missing Data

Generator maintenance, sonar equipment adjustments and malfunctions occasionally resulted in missing sonar data. When less than 10 minutes of a 15 minute interval were missed, the passage rate for the period within the interval that was sampled was used to estimate passage for the unsampled portion of the interval. Data missing from more than 10 minutes of a 15 minute interval 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 data were missed on both banks, the average proportions of passage rates were pooled from 6 hours before and after the missing block of data on that bank respectively. A right bank/left bank average proportion of passage rates was used to estimate fish passage when one of the sonar systems remained operational while the other was down for more than one hour.

Fish Passage Estimates

Fish traces were tallied in 5 m range intervals for the right bank and 10 m intervals for the left bank in 15 minute intervals directly from the chart recordings. Data were collected on both banks 24 hours per day, 7 days per week, except for brief and infrequent periods when the sonar equipment was not operational. The full width of the river between transducers was ensonified. The number of fish traces tallied for both banks was summed with estimates for missing data to provide daily total fish passage estimates. No attempts were made to determine direction of travel. Passage estimates were not apportioned to species.

Species Composition Verification

Equipment and Procedures

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 traces. We used a 13.6 cm (5-3/8") mesh multifilament net measuring 18.3 m (10 fathoms) long by 3.1 m (10 feet) deep and a 7.0 cm (2-3/4") mesh multifilament net measuring 18.3 m (10 fathoms) long by 1.5 m (5 feet) deep. Each net was drifted at least once at two stations, one on each bank, during the sampling period (Figure 3). Most drifts were approximately 2-3 minutes in duration. 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, and unharmed fish were released back into the river.

ASL Sampling

Equipment and Procedures

The sampling site was relocated downstream from the 1997 location due to high water conditions. The gravel bar in front of the sonar camp was used as the sampling site. A 46 m x 3 m (150 ft x 10 ft) green 7.0 cm mesh beach seine was used to obtain ASL samples of chum salmon. We attached a long line, approximately 30 m, to one end of the seine. The seine was stacked in a plastic fish tote and placed 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, 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 the tail. All data were recorded in a "rite-in-the-rain" notebook and later transcribed to standard mark-sense forms.

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). A pulse sampling design was followed in which intensive sampling was conducted for one or two days followed by several days without sampling. The goal of each 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 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 by age and sex.

RESULTS

Hydroacoustic Data Acquisition

Sampling Procedures

Sonar project activities commenced on 16 June and ended on 4 August 1998. Hydroacoustic sampling began on 24 June on both banks. With few exceptions, the equipment ran continuously, 24 hours per day, 7 days per week, until sampling ended at midnight on 31 July. Passage estimates were available to fishery managers in Bethel at 0730 h and 1700 h daily.

Data acquisition was suspended from 10 July through 14 July during a high water event. In addition to regular maintenance, a total of 10 hours (less than 2%) of sampling time were missed on the left bank due to paper jams, system diagnostic tests, moving the tripod, or aiming the transducer to compensate for changing water levels throughout the season. Moving the tripod, aiming the transducer, and damaged transducer cables caused 15 hours (less than 2%) of sampling time to be missed on the right bank over the course of the season.

Typical noise levels measured -64 dB over most of the counting range on the right bank and –60 dB on the left bank. Signal to noise ratios (SNR's) of approximately 21 dB on the right bank and 17 dB on the left bank were common. Higher noise levels, -43 dB and –38 dB, occurred on the right and left bank over narrow range intervals where the beam grazed high points in the river bottom. Lower SNR's (0.6 dB and 4.2 dB) at these points did not unduly corrupt data collection since the goal of the acoustic sampling was only fish detection. SNR's usually remained above 17 dB during sampling.

Bottom Profiles and Stream Measurements

Stream measurements were calculated using a laser range finder with paired magnetic direction output capacity and a chart recording fathometer on 27 June and 27 July. The river width at the sonar site on 27 June was 95 m and the maximum depth was 4.2 m (Figure 5). The right bank transducer was positioned at a 194° magnetic heading (20° East declination) and the left bank transducer was aimed at a 9° magnetic heading. Total diagonal distance between the transducers measured 92 m. Total ensonification range between transducers, as measured perpendicular from the face of the transducers, was 100 m and there was approximately a 52 m lateral separation between effective beam widths. When we conducted stream measurements again on 27 July, the river width was 79 m and the maximum depth was 3.4 m. The right bank transducer position had changed to a 180° magnetic heading and the left bank transducer to a 15° magnetic heading. Total diagonal distance between transducers measured 98 m. Total ensonification range between transducers was 80 m. With respect to the left bank transducer, the right bank transducer was positioned approximately 56 m downstream. 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 ensonified range was adjusted accordingly.

Fish Passage Estimates

Total passage during project sampling activities was estimated at 279,430 fish, with 61 percent passing on the right bank and 39 percent passing on the left bank (Table 1). A comparison of daily estimated passage between banks is presented in Figure 6. The peak daily passage of 16,409 fish occurred on 21 July (Figure 7). The 25%, 50%, and 75% quartile dates of passage were 11 July, 19 July and 23 July (Table 1).

We examined the hourly fish count data for evidence of daily patterns of movement during 5- and 6-day periods of data collection. Five of the six time periods displayed fish passage increasing at night and declining during the day (Figure 8). This tendency was not as pronounced when compared to the 1996 and 1997 passage estimates (Vania and Huttunen 1997, Vania 1998). Overall, seasonal range distributions of targets that passed the site peaked at 5-10 m from the right bank transducer (Figure 9) and at 0-10 m from the left bank transducer (Figure 10). Less than 2% of the right bank targets passed through the outer 15 meters of the right bank sampling range (Table 2). The outer 10 meter sampling range on the left bank accounted for less than 2% of the left bank passage estimates (Table 3). As the season progressed, the fish passage distribution on the left bank demonstrated an inshore movement.

Species Composition Verification

We conducted gillnet drifts during nine sampling periods to verify dominant species presence (Table 4). Drift duration averaged two to three minutes and fish passage rates varied from 61 – 669 fish per hour. We made a total of 40 drifts, 21 with 13.6 cm mesh gillnets and 19 with 7.0 cm mesh gillnets. The total catch consisted of 139 chum salmon, 18 chinook salmon (*O. tshawytscha*), 7 sockeye salmon (*O. nerka*), 1 coho salmon (*O. kisutch*), 7 pink salmon (*O. gorbuscha*), 14 longnose sucker (*Catostomus catostomus*), 14 humpback whitefish (*Coregonus clupeaformis*), 4 Dolly Varden (*Salvelinus malma*), and 2 sheefish (*Stenodus leucichthys*).

ASL Sampling

We made a total of 74 beach seine sets and obtained 1,120 ASL samples from migrating chum salmon (Table 5) for later analysis. The 0.3 and 0.4 age classes for chum salmon comprised an estimated 87.3% and 12.0% of the Aniak River escapement estimate in 1998, respectively (Table 6). The percentage of 0.4 age class fish was much lower than

usual (Appendix A.4). Age 0.4 fish were from the 1993 brood year that also produced low numbers of age 0.3 chum salmon in 1997 (Molyneaux and DuBois 1999).

DISCUSSION

Hydroacoustic Data Acquisition

Sampling Procedures

Using an operating frequency of 420 kHz at the Aniak site has been discussed as a means of improving project operations. The transducers currently used are very large due to their narrow beam width and low frequency (120 kHz). To submerge the left bank transducer, it was necessary to deploy it approximately 12-18 m offshore. Constructing and maintaining a weir to prevent fish passing undetected behind the transducer was difficult and time consuming. The use of a higher (i.e. 420 kHz) sampling frequency will minimize this difficulty by allowing us to place a smaller transducer closer to shore. The short sampling ranges employed at the site minimize the effect of transmission loss at this higher frequency.

Chart recordings displayed some evidence of fish occasionally passing in the near field of both transducers. Swift current and deep water prevented us from extending the weirs further than 3 – 5 m beyond the face of the transducers. The 420 kHz transducer would substantially reduce the near-field range and the likelihood of fish passing in this zone.

We deployed a 420 kHz transducer with a 2° circular beam on the right bank to determine if the higher operating frequency and smaller transducer size could improve project operations. The three-hour study occurred after we ended normal project operations for the season. An examination of chart recordings showed slightly clearer fish traces and no evidence of fish passing in the near field.

Project operations for the 1999 field season will include the use of 420 kHz transducers for all sampling procedures. As the opportunity arises, a 120 kHz transducer will be deployed to compare with the 420 kHz transducer.

Fish Passage Estimates

A comparison of daily left bank percent passage rates for 1996, 1997 and 1998 indicate 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 and cannot be directly compared between years. An analysis of each season

indicates an inverse relationship between left bank percent passage and water level (Figures 12-14). 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 ensonified range.

Large seasonal changes in the percent of estimated fish passage by bank occurred during the past three years. In 1998, 39% of the estimated fish passed through the left bank ensonified area while in 1996 and 1997 the left bank accounted for 37% and 53% of the total passage (Appendix A.5).

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 that 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 has included significant numbers of several non-target resident and anadromous species that are 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 that 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 has made available funds for Kuskokwim River salmon fisheries research and management. Federal Disaster Relief Funds have been requested to develop a species apportionment study to complement the Aniak River sonar project. Development requires a multi-year commitment and funding has been requested for three field seasons starting in 2000. Estimates of passage by species are not expected to be available until after the final year of data collection. Coupled with the main river sonar project, the apportioned Aniak River sonar escapement would provide fishery managers information on the contribution of Aniak River chum salmon stocks to the total Kuskokwim River chum salmon escapement.

A secondary consideration to implementing a species apportionment program has been the potential for unacceptable levels of collateral fish mortality due to additional netting and fish handling. Fish mortality issues were not included in the 1995 Aniak River sonar test fish feasibility study.

In 1998, we retained fish captured from two drift gillnet operations in a live box to observe the effects of netting and handling. Extraordinary care was given in handling the

first catch, which was retained for six hours. All of the salmon (18 chum, 2 sockeye, and 1 coho) appeared healthy and swam away when released. The remaining fish, 2 whitefish and one sheefish, were dead. These fish appeared healthy when placed into the live box and may have sustained fatal injury while in the live box.

The second catch was handled in a manner more consistent with a typical test fishing operation with less care given to the fish and speed of operation increased. This catch, which was retained for 5 hours, consisted of 24 chum salmon, 2 king salmon, 2 pink salmon, and one sucker. All but 2 chum salmon survived and swam away when released.

It appears that some mortality can be expected, but with short drift periods and careful handling, we may be able to keep the mortality of fish to a minimum.

ASL Sampling

The techniques used to obtain ASL samples were designed to maximize the capture of chum salmon with the equipment on hand. The beach seine sampling area was located 1.5 km upstream of the sonar site and only the extreme nearshore portion of the river was fished. While these data provide valuable biological ASL 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 back to 1980. Estimates prior to 1996 are difficult to substantiate due to a lack of project documentation and the inability of the Bendix equipment 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 traditional 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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TABLES

Table 1. Daily and cumulative estimates of fish passage at the Aniak River sonar site, 1998.

Date	Left Bank	Right Bank	Daily Total	Cumulative Total	LB % Passage	RB % Passage	Percent Passage	Water Level [a]
24-Jun	231	169	400	400	0.58	0.42	0	161.5
25-Jun	227	270	497	897	0.46	0.54	0	166.0
26-Jun	292	884	1,176	2,073	0.25	0.75	1	175.5
27-Jun	470	1,360	1,830	3,903	0.26	0.74	1	184.5
28-Jun	447	1,689	2,136	6,039	0.21	0.79	2	190.0
29-Jun	520	2,106	2,626	8,665	0.20	0.80	3	188.5
30-Jun	841	2,626	3,467	12,132	0.24	0.76	4	186.0
1-Jul	1,209	3,992	5,201	17,333	0.23	0.77	6	179.5
2-Jul	1,353	3,864	5,217	22,550	0.26	0.74	8	174.5
3-Jul	1,008	3,702	4,710	27,260	0.21	0.79	10	164.5
4-Jul	1,072	3,576	4,648	31,908	0.23	0.77	11	175.5
5-Jul	839	2,451	3,290	35,198	0.26	0.74	13	181.5
6-Jul	885	3,103	3,988	39,186	0.22	0.78	14	190.5
7-Jul	1,409	4,059	5,468	44,654	0.26	0.74	16	196.5
8-Jul	1,622	5,560	7,182	51,836	0.23	0.77	19	198.0
9-Jul	1,798	5,939	7,737	59,573	0.23	0.77	21	162.0
10-Jul [b]	1,609	5,370	6,979	66,552	0.23	0.77	24	100.5
11-Jul [b]	1,609	5,370	6,979	73,531	0.23	0.77	26	67.5
12-Jul [b]	1,609	5,370	6,979	80,509	0.23	0.77	29	54.5
13-Jul [b]	1,609	5,370	6,979	87,488	0.23	0.77	31	109.5
14-Jul [b]	1,609	5,370	6,979	94,467	0.23	0.77	34	151.5
15-Jul	1,410	4,509	5,919	100,386	0.24	0.76	36	162.5
16-Jul	1,604	5,473	7,077	107,463	0.23	0.77	38	181.5
17-Jul	2,021	7,773	9,794	117,257	0.21	0.79	42	197.5
18-Jul	5,163	10,363	15,526	132,783	0.33	0.67	48	209.5
19-Jul	5,466	9,485	14,951	147,734	0.37	0.63	53	221.5
20-Jul	7,151	8,035	15,186	162,920	0.47	0.53	58	228.5
21-Jul	7,560	8,849	16,409	179,329	0.46	0.54	64	235.5
22-Jul	7,997	8,274	16,271	195,600	0.49	0.51	70	245.5
23-Jul	7,120	7,151	14,271	209,871	0.50	0.50	75	253.5
24-Jul	6,285	6,195	12,480	222,351	0.50	0.50	80	259.0
25-Jul	5,572	3,466	9,038	231,389	0.62	0.38	83	264.5
26-Jul	5,244	3,003	8,247	239,636	0.64	0.36	86	267.5
27-Jul	6,177	3,473	9,650	249,286	0.64	0.36	89	263.5
28-Jul	4,842	3,392	8,234	257,520	0.59	0.41	92	266.5
29-Jul	4,263	2,892	7,155	264,675	0.60	0.40	95	273.5
30-Jul	4,465	3,361	7,826	272,501	0.57	0.43	98	280.5
31-Jul	4,616	2,313	6,929	279,430	0.67	0.33	100	284.5
TOTAL	109,222	170,208	279,430	279,430	0.39	0.61		

[a] Measured centimeters below benchmark

[b] Sonar not operational, passage estimated using the average passage from 8-9 July & 15-16 July.

Table 2. Estimated right bank daily fish passage per range strata, Aniak River sonar, 1998.

	Right Bank Strata					
	1	2	3	4	5	6
	Distance from right bank transducer (m)					
	0-5	5-10	10-15	15-20	20-25	25-30
24-Jun	8	22	7	1	1	1
25-Jun	69	182	10	1	3	0
26-Jun	164	687	31	1	5	0
27-Jun	249	1041	42	2	6	0
28-Jun	642	643	5	4	5	1
Week Total	1132	2575	95	9	20	2
Passage (%)	29.53	67.18	2.48	0.23	0.52	0.05
29-Jun	1215	846	21	10	3	1
30-Jun	1455	1042	18	6	7	0
1-Jul	2340	1600	20	19	13	0
2-Jul	2192	1583	21	23	8	0
3-Jul	929	2648	25	4	1	0
Week Total	8131	7719	105	62	32	1
Passage (%)	50.66	48.09	0.65	0.39	0.20	0.01
4-Jul	373	3102	50	17	31	3
5-Jul	979	1257	53	26	34	7
6-Jul	1604	1279	96	57	59	8
7-Jul	2217	1618	71	34	60	7
8-Jul	3725	1652	54	6	10	1
9-Jul	945	4296	231	36	38	15
Week Total	9843	13204	555	176	232	41
Passage (%)	40.93	54.90	2.31	0.73	0.96	0.17
15-Jul	495	1989	60	14	13	1
16-Jul	1017	4295	103	11	12	15
17-Jul	3568	3938	94	32	39	4
18-Jul	5708	4433	52	78	92	
19-Jul	4413	4487	220	154	56	
20-Jul	3103	4256	466	210	0	
Week Total	18304	23398	995	499	212	20
Passage (%)	42.15	53.88	2.29	1.15	0.49	0.05
21-Jul	3275	4594	504	168	0	
22-Jul	3970	3887	342	45		
23-Jul	2986	3785	329	51		
24-Jul	2984	2651	319	73		
25-Jul	1780	1438	197	15		
26-Jul	1597	1214	169	23		
Week Total	16592	17569	1860	375	0	0
Passage (%)	45.59	48.27	5.11	1.03	0.00	0.00
27-Jul	1646	1455	237	42		
28-Jul	1868	1135	317	46		
29-Jul	1849	897	134	12		
30-Jul	2287	969	90	15		
31-Jul	1739	475	20	5		
Week Total	9389	4931	798	120	0	0
Passage (%)	61.62	32.36	5.24	0.79	0.00	0.00
Season Total	**63391**	**69396**	**4408**	**1241**	**496**	**64**
Passage (%)	**45.61**	**49.93**	**3.17**	**0.89**	**0.36**	**0.05**

Table 3. Estimated left bank daily fish passage per range strata, Aniak River sonar, 1998.

	Left Bank Strata						
	1	2	3	4	5	6	7
	Distance from left bank transducer (m)						
	0-10	10-20	20-30	30-40	40-50	50-60	60-70
24-Jun	2	58	27	15	54	29	43
25-Jun	1	83	41	17	44	14	25
26-Jun	2	90	58	19	72	16	35
27-Jun	11	136	96	32	112	31	49
28-Jun	1	120	105	21	138	22	40
Week Total	17	487	327	104	420	112	192
Passage (%)	1.02	29.36	19.71	6.27	25.32	6.75	11.57
29-Jun	8	129	96	55	136	37	59
30-Jun	3	236	143	77	220	71	63
1-Jul	7	326	192	134	304	95	113
2-Jul	10	359	244	119	336	148	133
3-Jul	6	253	167	81	274	87	140
Week Total	34	1303	842	466	1270	438	508
Passage (%)	0.70	26.81	17.32	9.59	26.13	9.01	10.45
4-Jul	28	324	198	84	237	87	114
5-Jul	46	256	138	64	178	67	88
6-Jul	34	332	121	69	164	89	76
7-Jul	146	435	137	91	240	160	76
8-Jul	400	471	54	210	352	95	12
9-Jul	68	651	258	95	299	222	141
Week Total	722	2469	906	613	1470	720	507
Passage (%)	9.75	33.33	12.23	8.28	19.85	9.72	6.84
15-Jul	79	615	174	133	269	100	40
16-Jul	125	702	222	150	294	72	33
17-Jul	924	607	148	113	164	24	17
18-Jul	4434	451	16	179	8	24	10
19-Jul	4877	349	14	152	15	13	13
20-Jul	6499	486	13	124	10	9	10
Week Total	16938	3210	587	851	760	242	123
Passage (%)	74.58	14.13	2.58	3.75	3.35	1.07	0.54
21-Jul	5735	1706	8	91	13	1	6
22-Jul	3825	3813	96	90	14	9	0
23-Jul	6179	782	136	18	5	0	
24-Jul	5369	738	144	28	3	3	63
25-Jul	4675	729	109	17	7	2	138
26-Jul	4015	727	51	7	2	3	116
Week Total	29798	8495	544	251	44	18	323
Passage (%)	75.49	21.52	1.38	0.64	0.11	0.05	0.82
27-Jul	5205	868	86	12	0	6	126
28-Jul	3526	1156	92	12	10	7	60
29-Jul	3318	684	43	4	3	1	33
30-Jul	4197	218	33	10	7	49	0
31-Jul	4146	380	31	12	12	24	0
Week Total	20392	3306	285	50	32	87	219
Passage (%)	83.67	13.57	1.17	0.21	0.13	0.36	0.90
Season Total	**67901**	**19270**	**3491**	**2335**	**3996**	**1617**	**1872**
Passage (%)	**67.58**	**19.18**	**3.47**	**2.32**	**3.98**	**1.61**	**1.86**

Table 4. Aniak River sonar catch results using drift gillnets, 1998.

Date	Time of Day	# of Drifts	Mesh (cm)	Chum	King	Sockeye	Coho	Pink	Sucker	Whitefish	Dolly Varden	Sheefish
6/30/98	1435-1446	3	13.6	1	1	0	0	0	0	0	0	0
Fish Passage – 61/h.												
6/30/98	1510-1517	2	7.0	0	3	0	0	0	0	0	0	0
Fish Passage – 61/h.												
7/02/98	1405-1432	4	13.6	12	7	1	0	0	0	0	0	0
Fish Passage – 151/h.												
7/02/98	1447-1509	4	7.0	5	0	1	0	0	0	0	0	0
Fish Passage – 151/h.												
7/18/98	2215-2315	2	13.6	9	0	1	0	0	0	0	0	0
Fish Passage – 669/h.												
7/18/98	2330-2342	2	7.0	7	1	1	0	0	6	4	1	0
Fish Passage – 669/h.												
7/20/98	0300-0420	5	7.0	17	2	1	0	2	3	7	2	1
Fish Passage – 511/h.												
7/23/98	1430-1527	4	13.6	40	2	0	0	2	0	0	1	0
Fish Passage – 367/h.												
7/23/98	1550-1602	2	7.0	4	0	0	0	0	0	1	0	0
Fish Passage – 367h.												
7/27/98	0953-1054	4	13.6	9	0	1	0	0	0	0	0	1
Fish Passage – 309/h.												
7/27/98	1120-1142	2	7.0	11	0	1	1	0	0	2	0	0
Fish Passage – 309/h.												
7/28/98	2200-2245	4	13.6	21	2	0	0	2	0	0	0	0
Fish Passage – 331/h.												
7/28/98	2135-2150	2	7.0	3	0	0	0	1	1	0	0	0
Fish Passage – 331/h.												

Table 5. Aniak River sonar catch results using beach seine gear, 1998.

Date	Time of Day	# of Sets	Chum	King	Pink	Sockeye	Coho	WF[a]	Sucker	Pike	DV[a]	RB[a]	Sheefish	Total Catch
7/01/98	0100-0330	5	12	0	0	0	0	1	7	0	1	0	0	**21**
Avg. Fish Passage – 184/h.														
7/02/98	0030-0230	6	32	7	0	2	0	1	8	0	0	0	0	**50**
Avg. Fish Passage – 271/h.														
7/03/98	0030-0315	8	38	9	0	1	0	2	8	1		0	0	**59**
Avg. Fish Passage – 157/h.														
7/06/98	2300-0230	8	116	14	0	6	0	11	34	0	1	1	0	**183**
Avg. Fish Passage – 183/h.														
7/07/98	2130-0030	7	71	15	0	2	0	12	25	1	1	0	0	**127**
Avg. Fish Passage – 291/h.														
7/15/98	2145-2345	6	120	1	7	5	0	5	12	0	2	0	1	**153**
Avg. Fish Passage – 374/h.														
7/16/98	2140-2300	4	111	5	5	4	0	11	2	0	3	0	0	**141**
Avg. Fish Passage – 525/h.				(1 recap)										
7/20/98	2100-2300	7	218	4	23	3	0	17	2	0	12	0	0	**279**
Avg. Fish Passage – 761/h.														
7/24/98	2130-2350	7	119	4	37	9	1	35	5	1	6	0	0	**217**
Avg. Fish Passage – 467/h.														
7/25/98	2115-2330	5	99	0	15	2	0	8	1	0	7	0	0	**132**
Avg. Fish Passage – 542/h.														
7/29/98	2300-0045	6	121	0	11	0	0	58	8	3	3	0	1	**205**
Avg. Fish Passage – 435/h.														
7/30/98	2315-0035	5	63	2	7	0	0	40	5	1	1	2	2	**123**
Avg. Fish Passage – 399/h.									(1 recap)					

[a] WF = Whitefish DV = Dolly Varden RB = Rainbow Trout

Table 6. 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 1998.

Sample Dates (Stratum Dates	Sample Size	Sex	Age Class									
			0.2		0.3		0.4		0.5		Total	
			Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
7/1 - 7/3	72	M	0	0.0	15,644	44.4	3,422	9.7	0	0.0	19,066	54.2
(6/24 - 7/5)		F	0	0.0	13,688	38.9	1,955	5.6	489	1.4	16,132	45.8
		Subtotal	0	0.0	29,332	83.3	5,377	15.3	489	1.4	35,198	100.0
7/7 - 7/8	165	M	0	0.0	20,871	46.1	5,492	12.1	275	0.6	26,637	58.8
(7/6- 7/12)		F	0	0.0	14,554	32.1	4,119	9.1	0	0.0	18,674	41.2
		Subtotal	0	0.0	35,425	78.2	9,611	21.2	275	0.6	45,311	100.0
7/15 - 7/16	220	M	0	0.0	23,999	45.9	5,465	10.4	0	0.0	29,464	56.4
(7/13 - 7/18)		F	0	0.0	20,672	39.6	2,138	4.1	0	0.0	22,810	43.6
		Subtotal	0	0.0	44,671	85.5	7,603	14.5	0	0.0	52,274	100.0
7/20	204	M	0	0.0	25,866	41.2	1,232	1.9	308	0.5	27,405	43.6
(7/19 - 7/22)		F	308	0.5	31,100	49.5	4,003	6.4	0	0.0	35,412	56.4
		Subtotal	0	0.5	56,966	90.7	5,235	8.3	308	0.5	62,817	100.0
7/24 - 7/25	210	M	511	1.0	18,918	35.2	2,301	4.3	0	0.0	21,730	40.5
(7/23 - 7/27)		F	0	0.0	30,422	56.7	1,534	2.8	0	0.0	31,956	59.5
		Subtotal	511	1.0	49,340	91.9	3,835	7.1	0	0.0	53,686	100.0
7/29 - 7/30	173	M	0	0.0	9,757	32.3	523	1.8	0	0.0	10,280	34.1
(7/28 - 7/31)		F	0	0.0	18,470	61.3	1,394	4.6	0	0.0	19,864	65.9
		Subtotal	0	0.0	28,227	93.6	1,917	6.4	0	0.0	30,144	100.0
Season	1,044	M	511	0.2	115,054	41.2	18,423	6.6	582	0.2	134,582	48.2
		F	308	0.1	128,907	46.1	15,144	5.4	489	0.2	144,848	51.8
		Total	819	0.3	243,961	87.3	33,579	12.0	1,071	0.4	279,430	100.0

FIGURES

Figure 1. Map of the Kuskokwim Area.

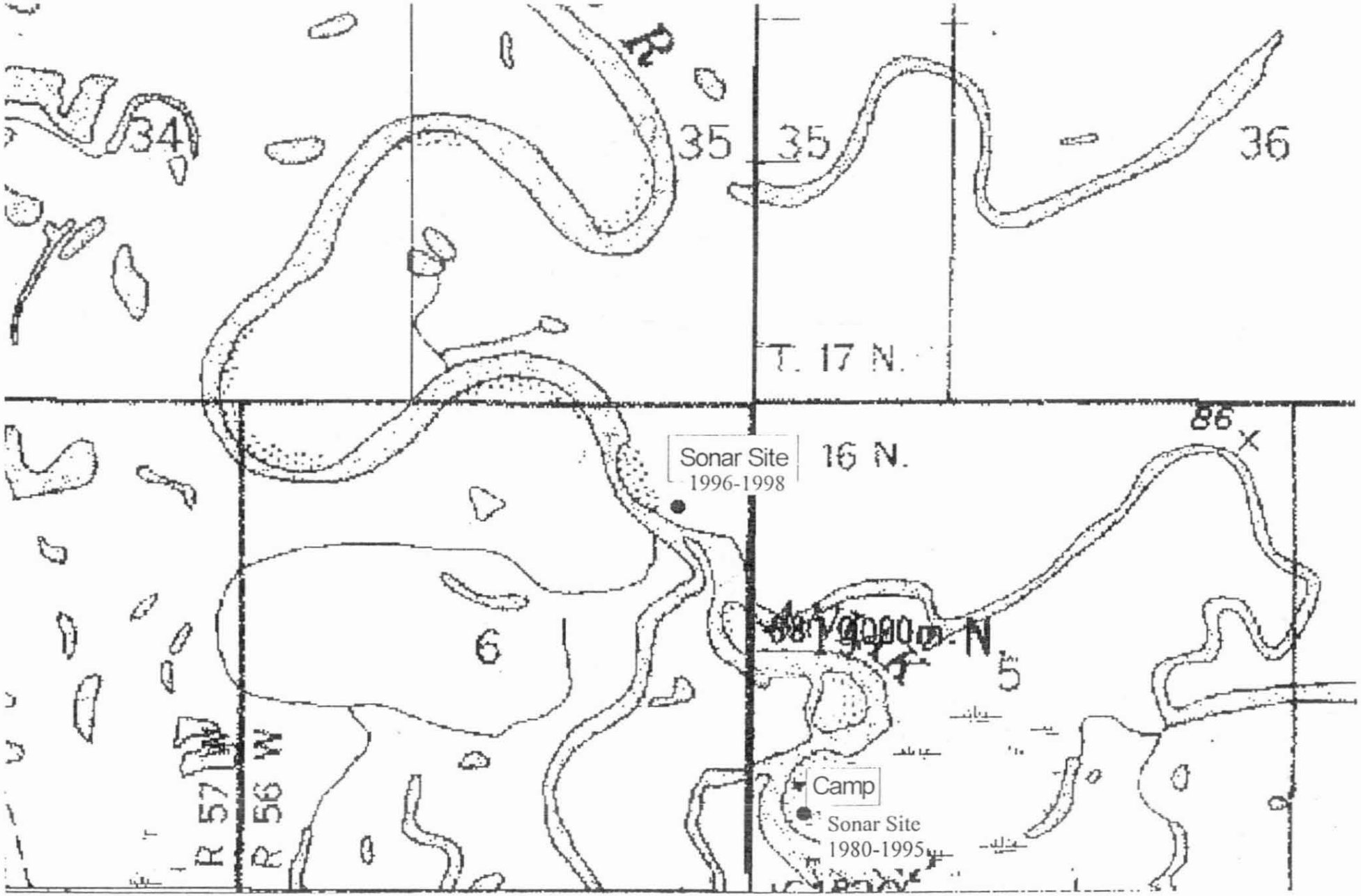


Figure 2. Aniak River sonar site map, 1998.

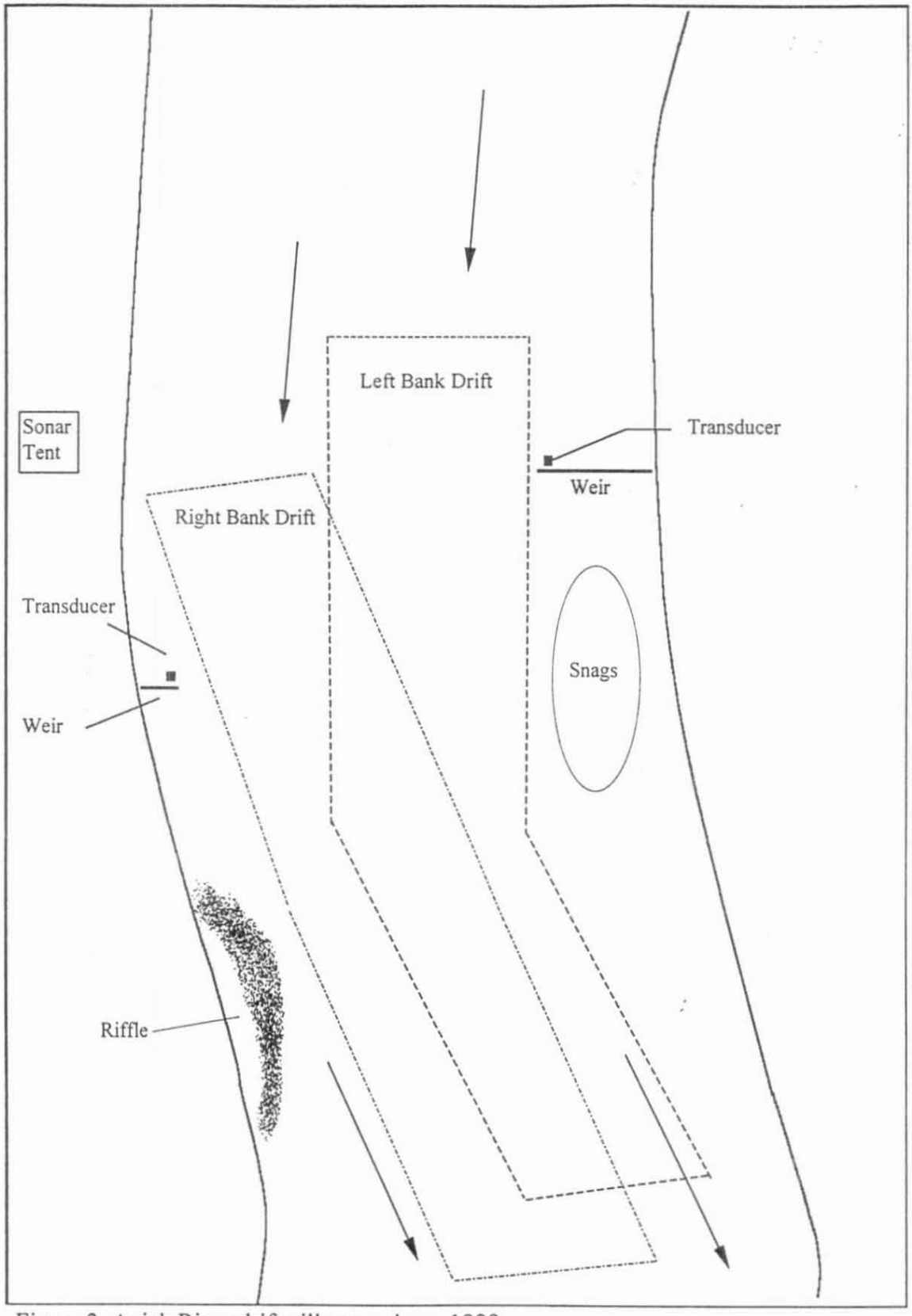


Figure 3. Aniak River drift gillnet stations, 1998.

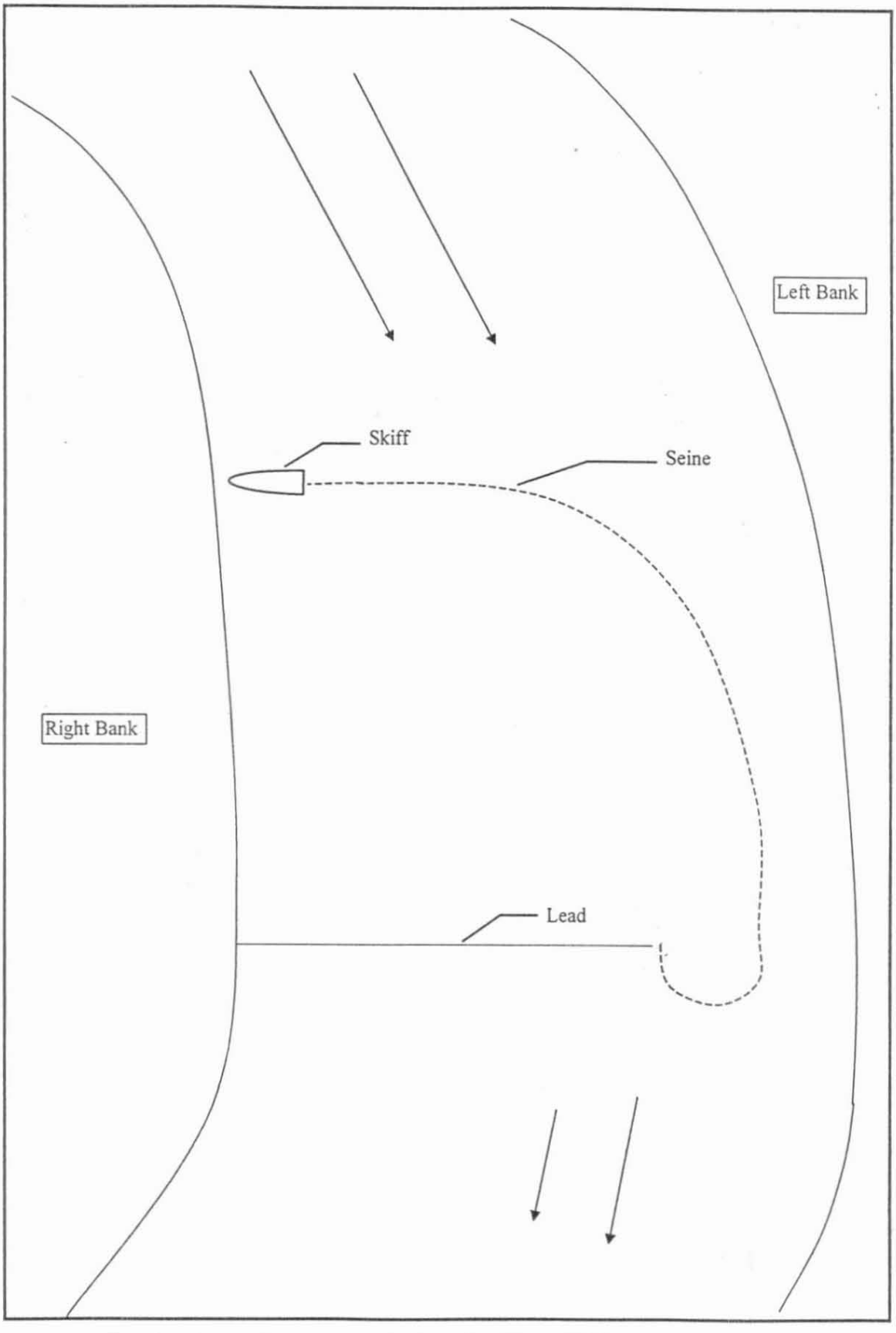


Figure 4. Beach seine deployment method, Aniak River, 1998.

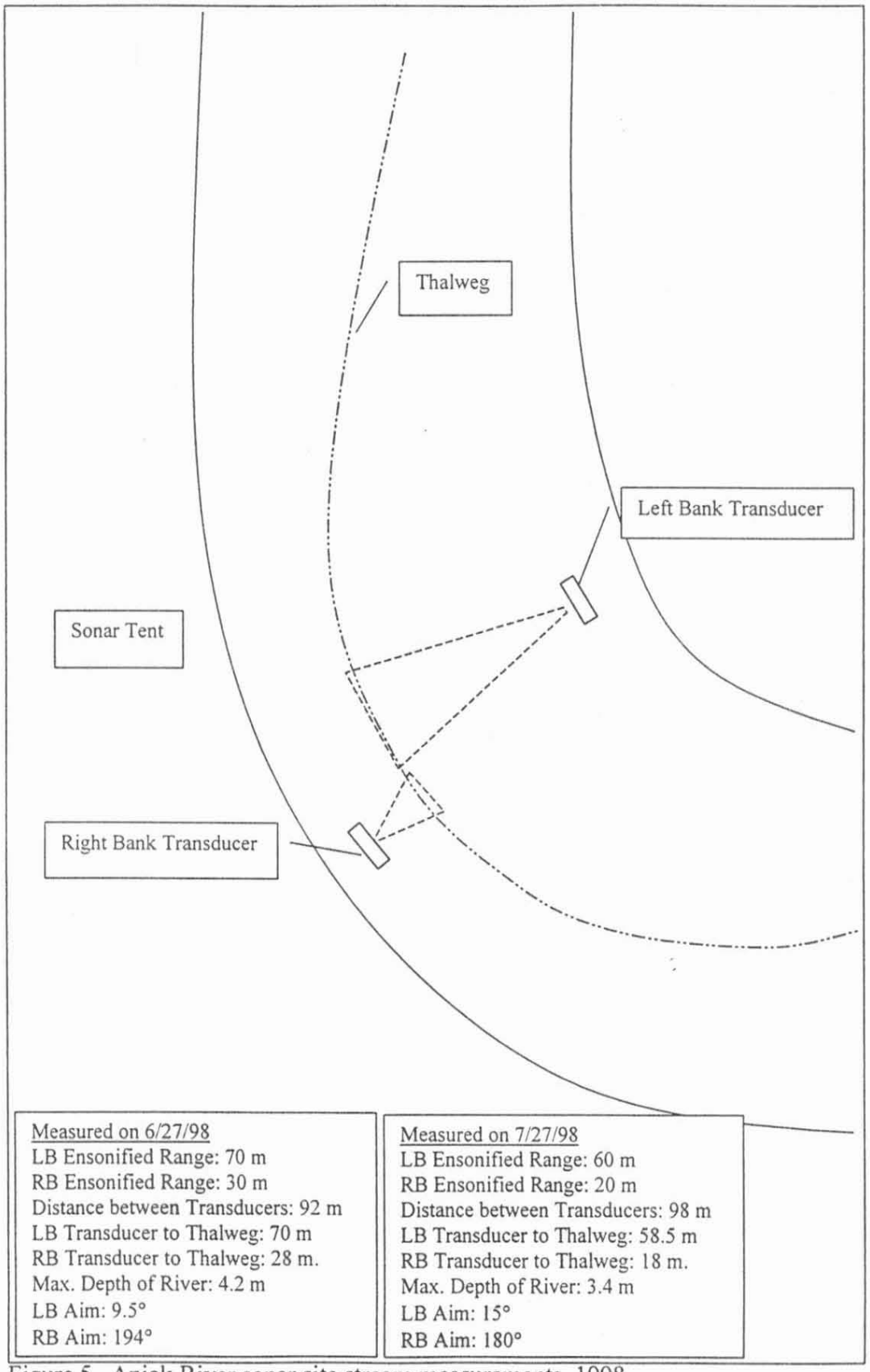


Figure 5. Aniak River sonar site stream measurements, 1998.

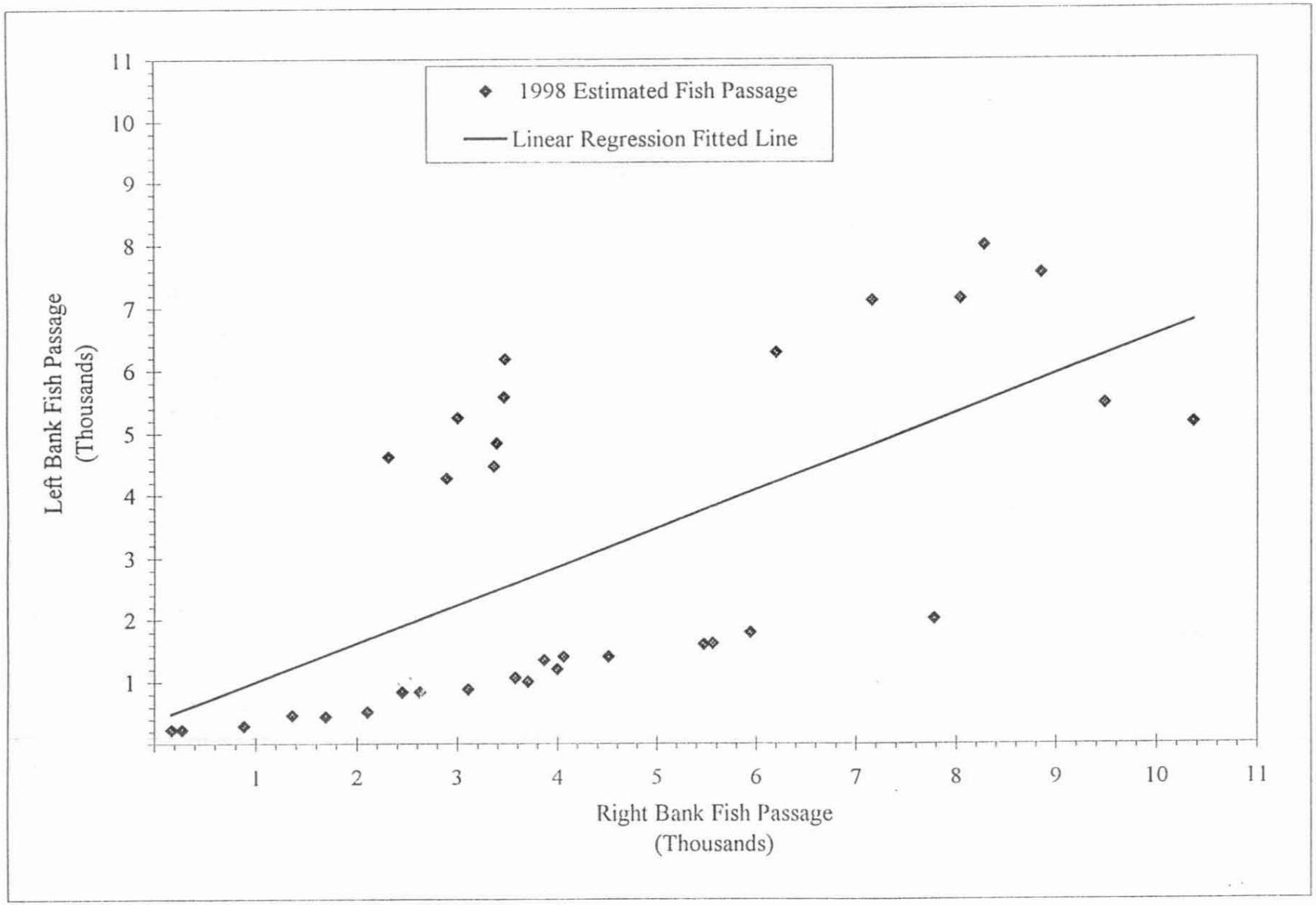


Figure 6. A comparison of daily estimated fish passage between banks, Aniak River sonar, 1998.

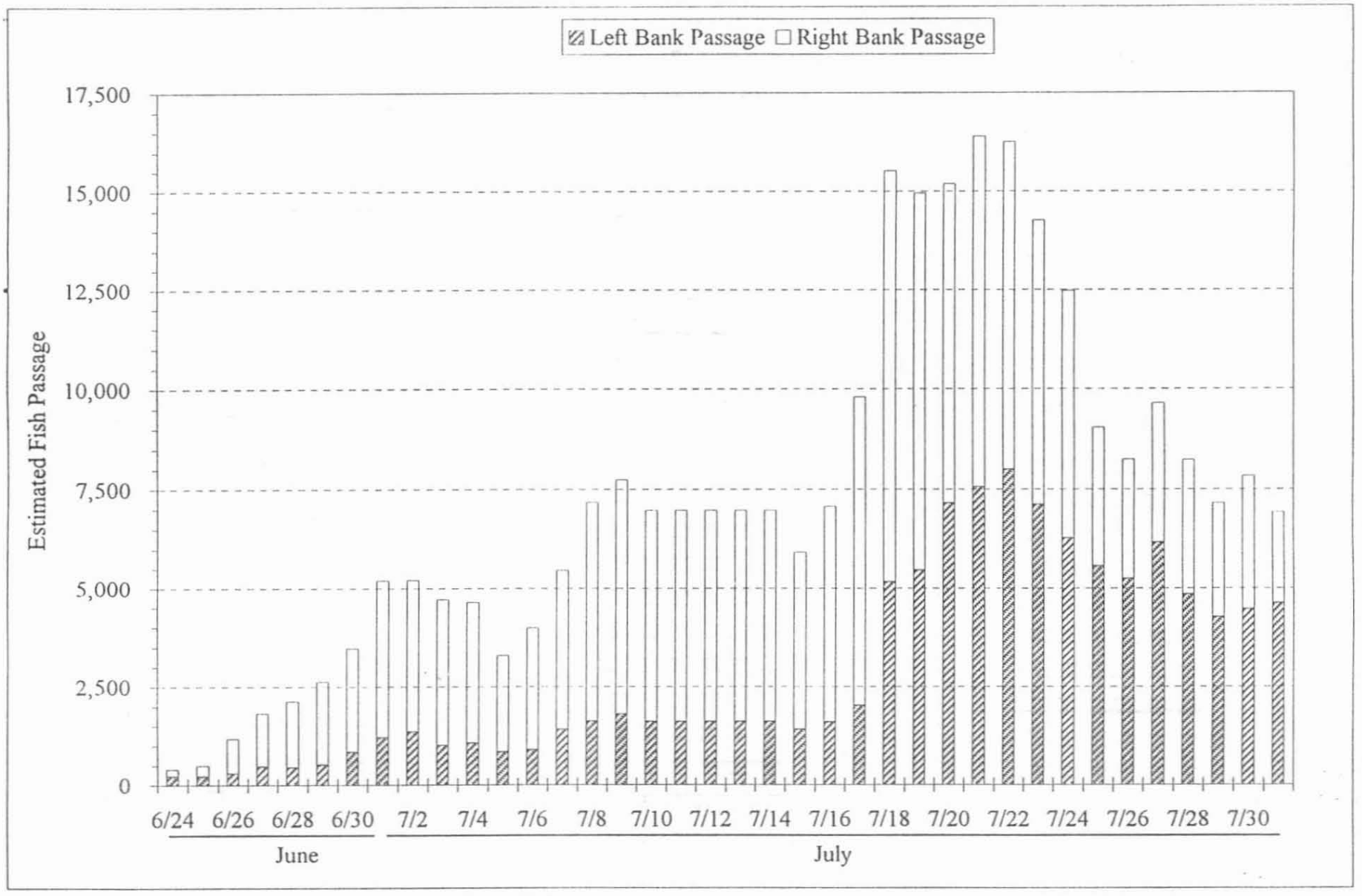


Figure 7. Estimated daily fish passage, Aniak River, 1998.

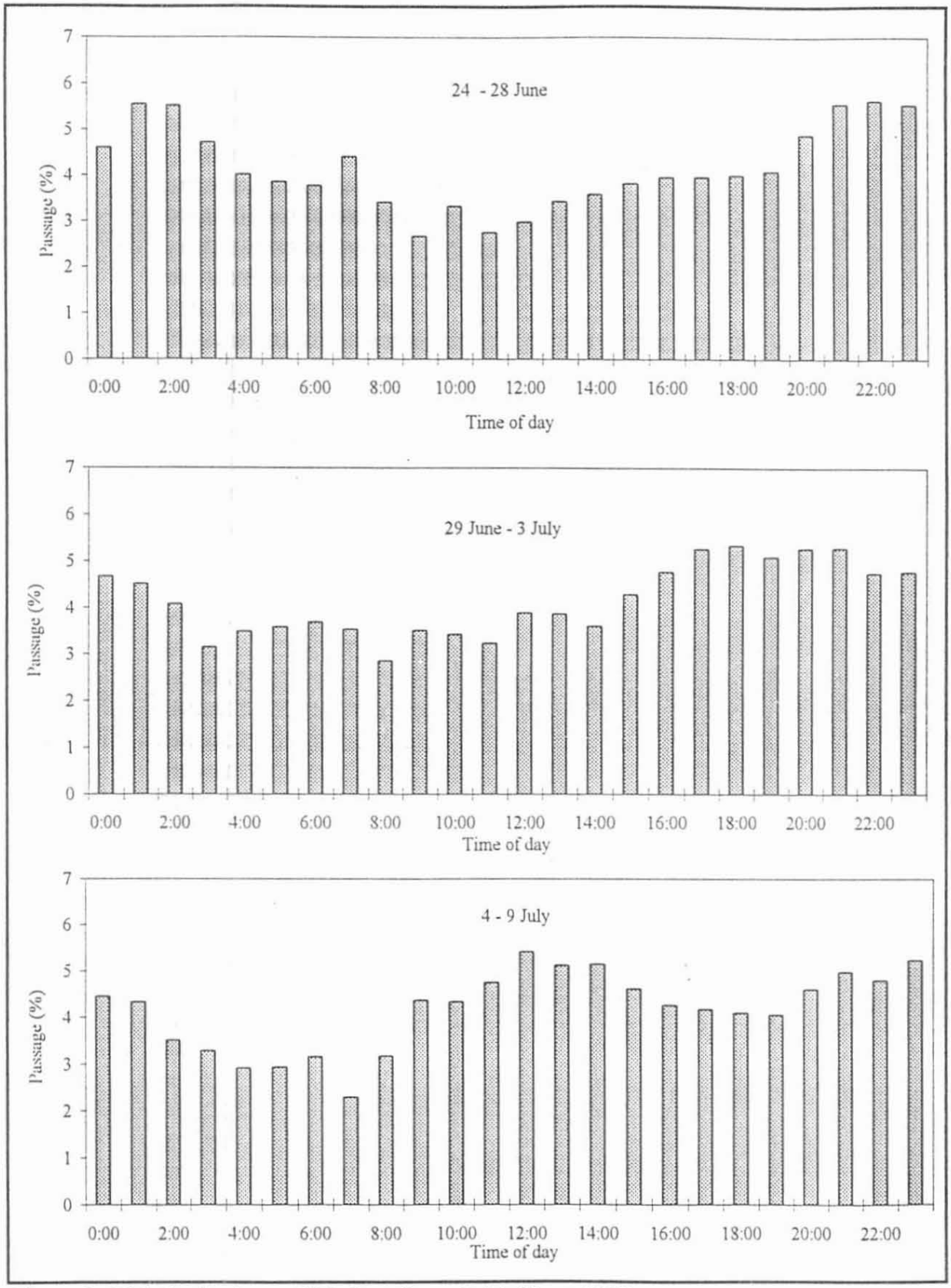


Figure 8. Diel distributions of fish detections, Aniak River, 1998.

(continued)

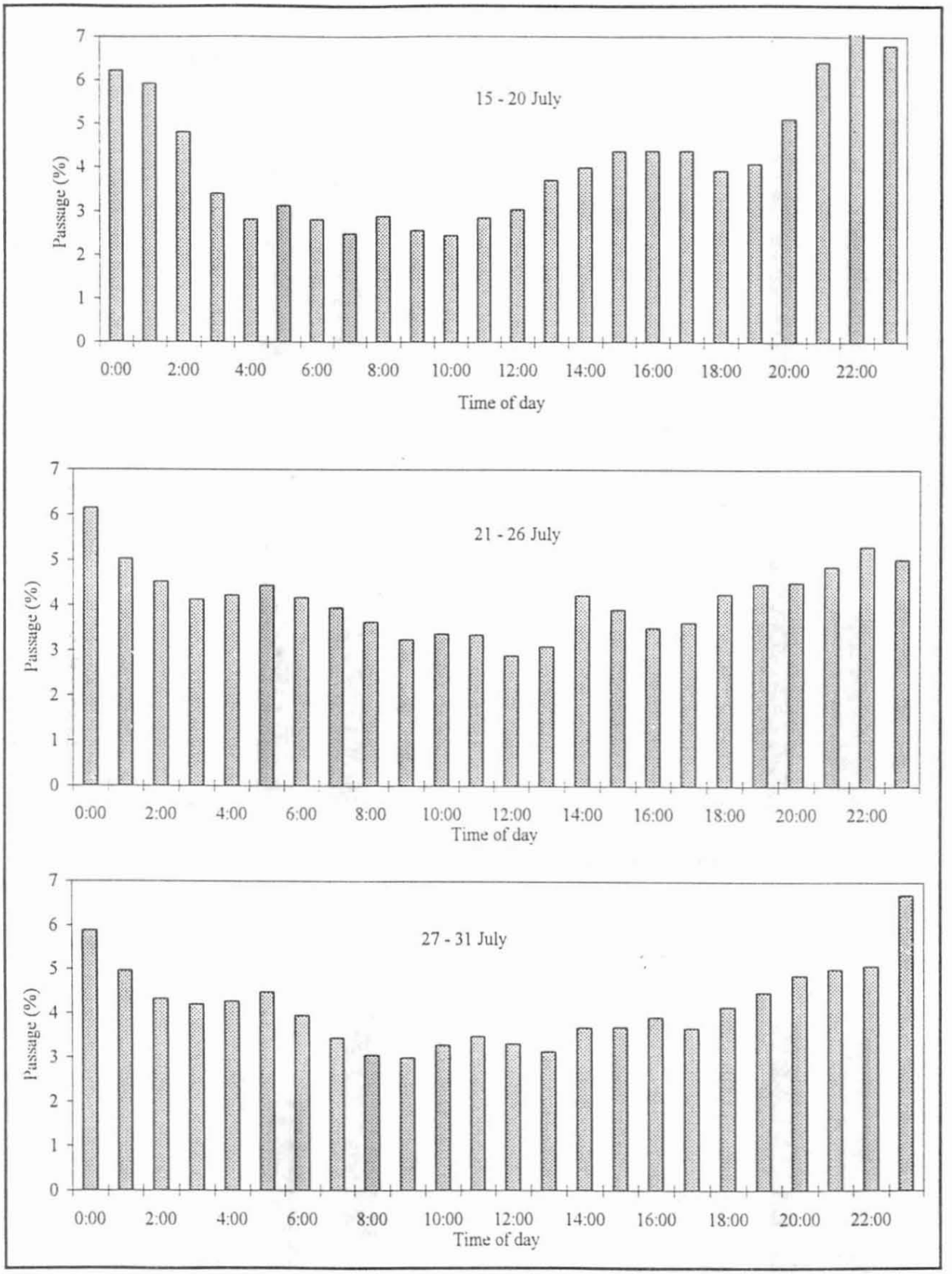


Figure 8. (page 2 of 2)

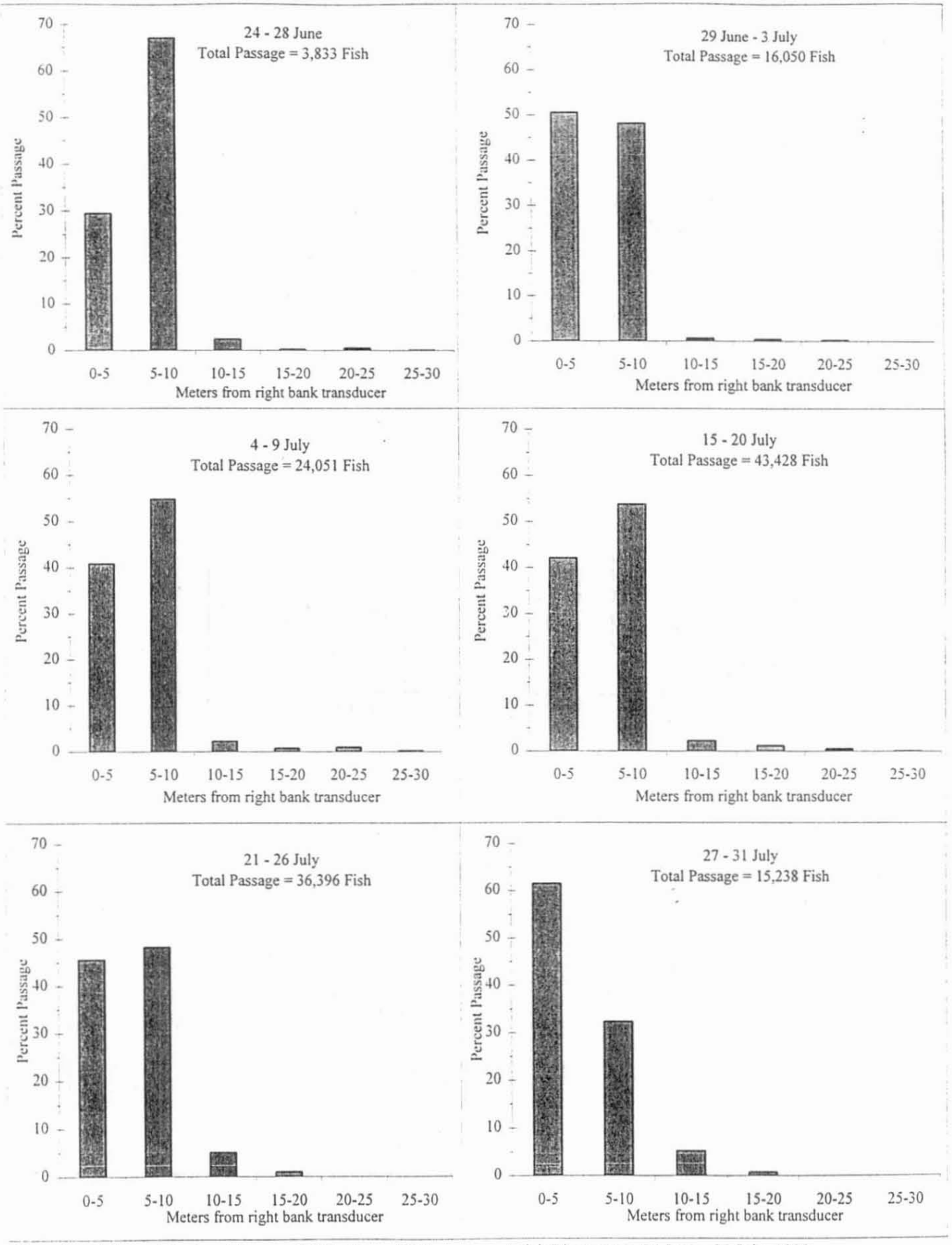


Figure 9. Right bank horizontal range distributions of fish passage, Aniak River sonar, 24 June - 31 July, 1998.

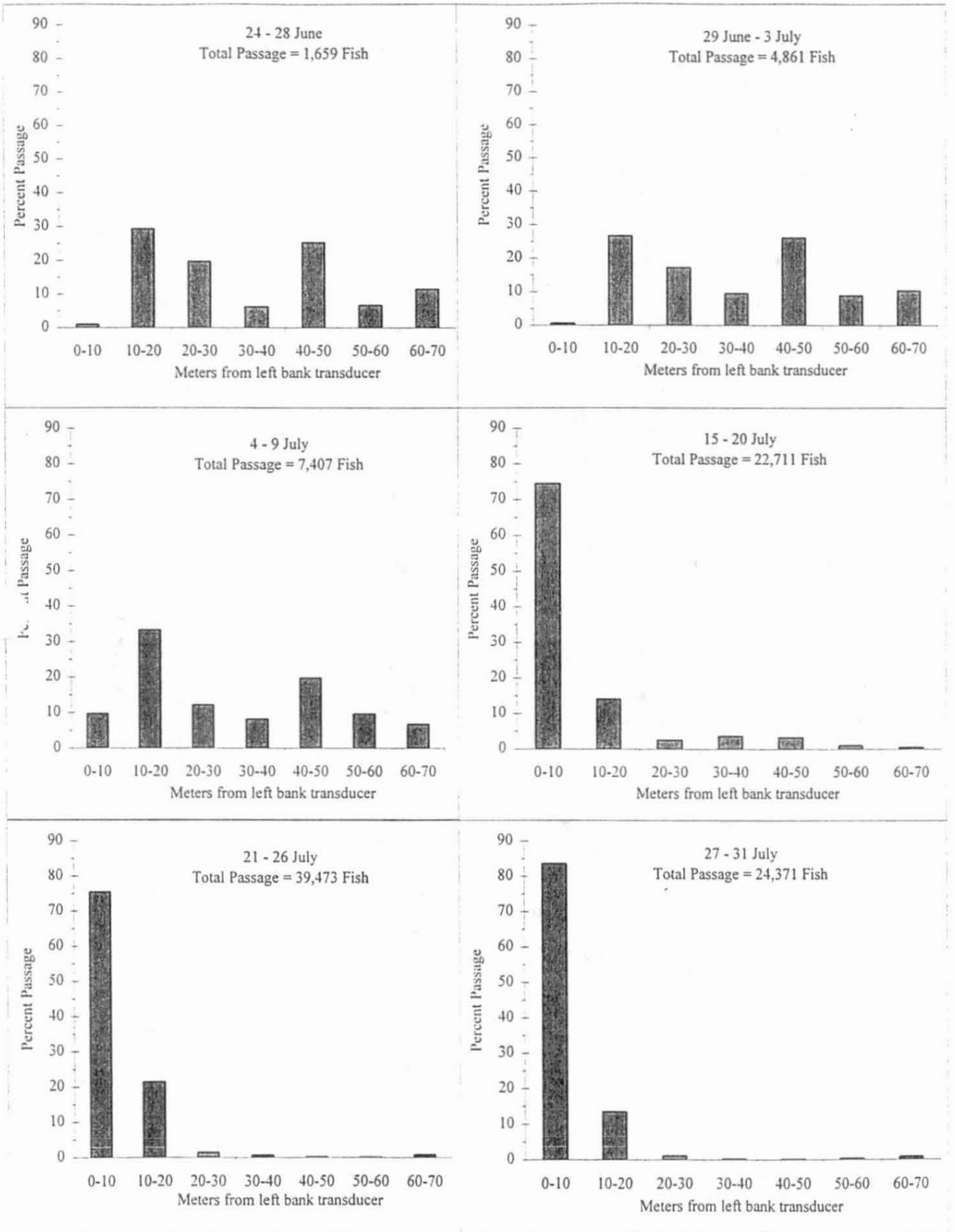


Figure 10. Left bank horizontal range distributions of fish passage, Aniak River sonar, 24 June - 31 July, 1998.

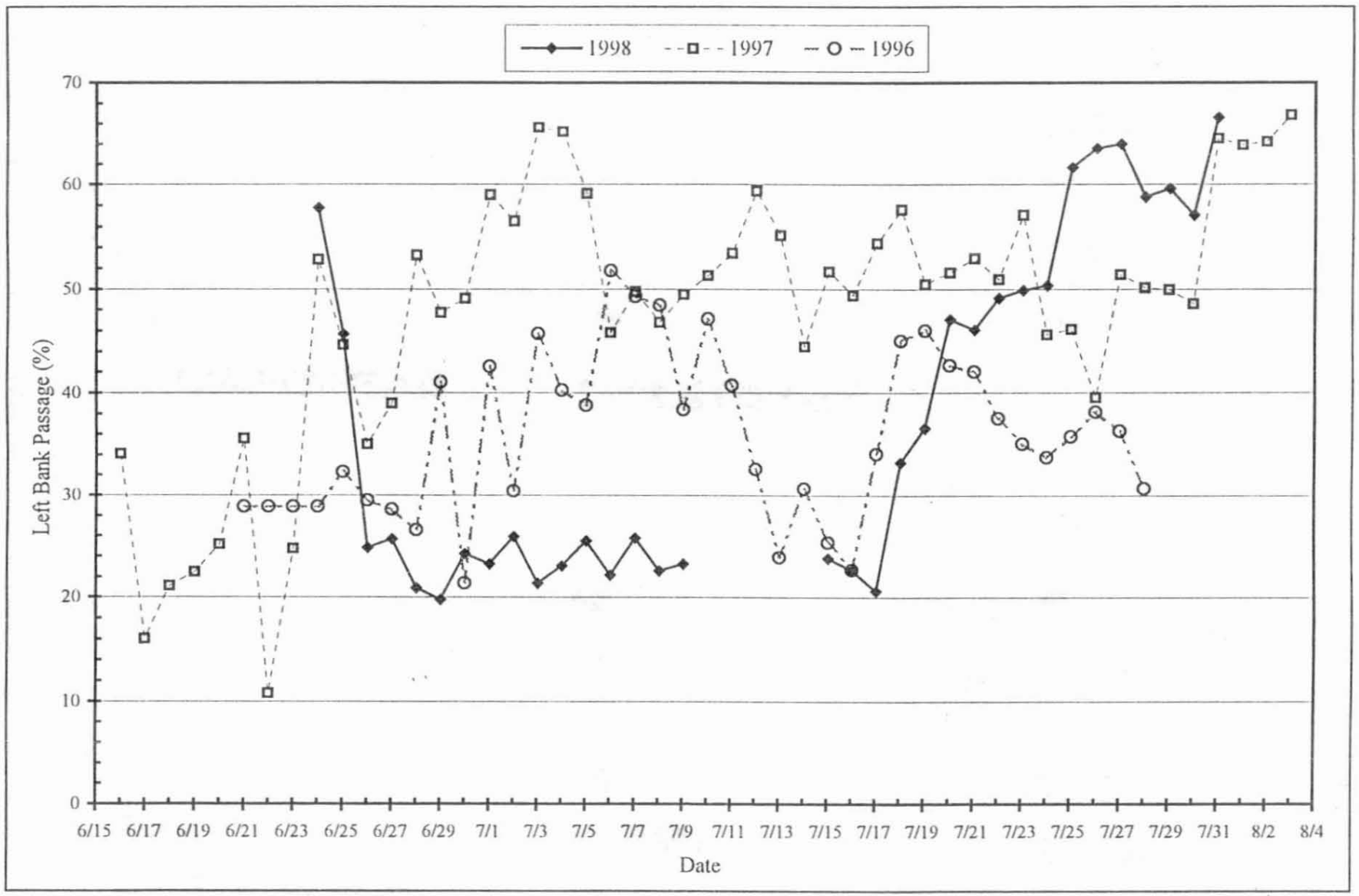


Figure 11. Daily left bank percent passage rates for Aniak River sonar, 1996-1998.

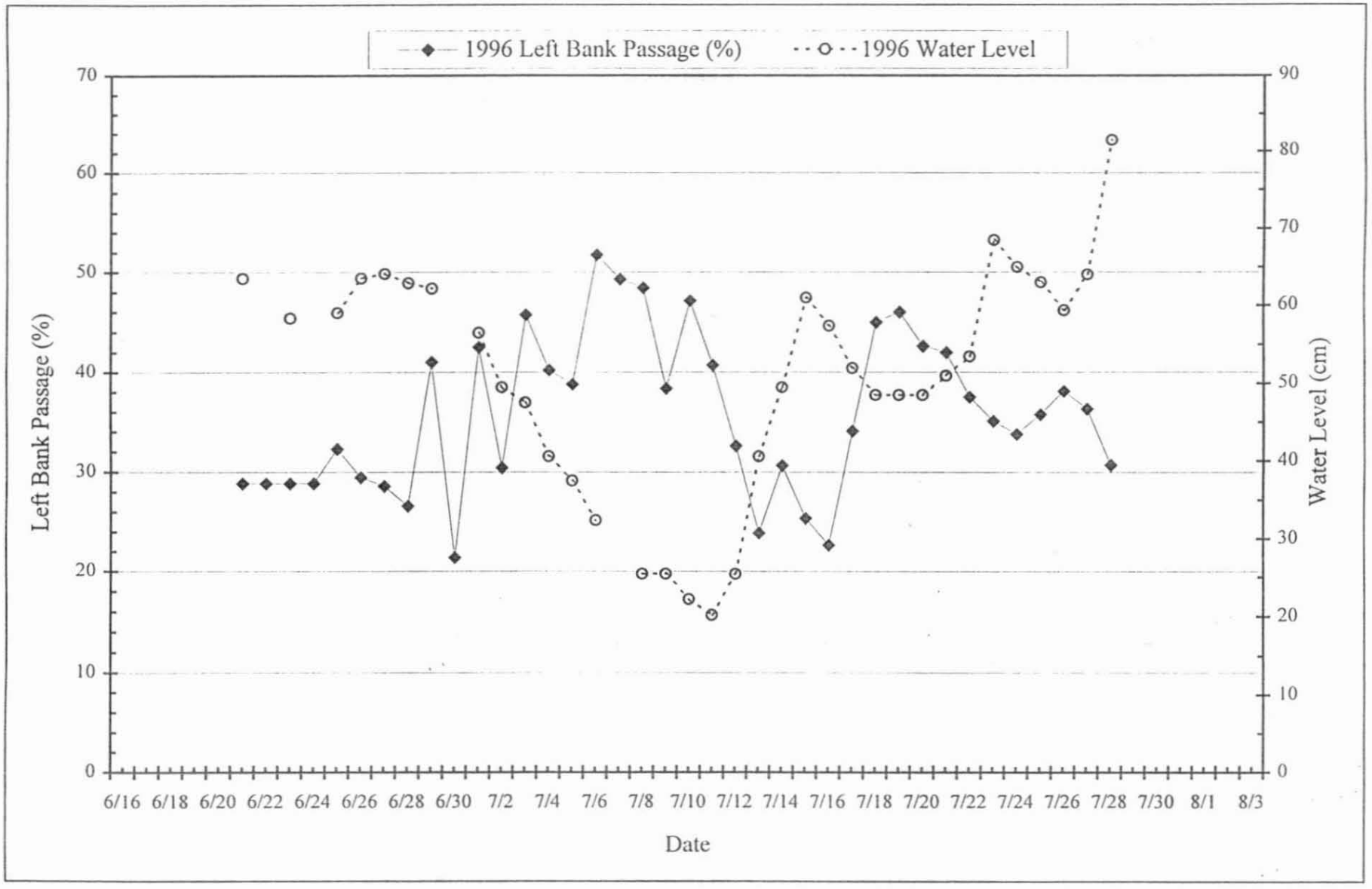


Figure 12. Daily left bank percent passage rate and water level for Aniak River sonar, 1996

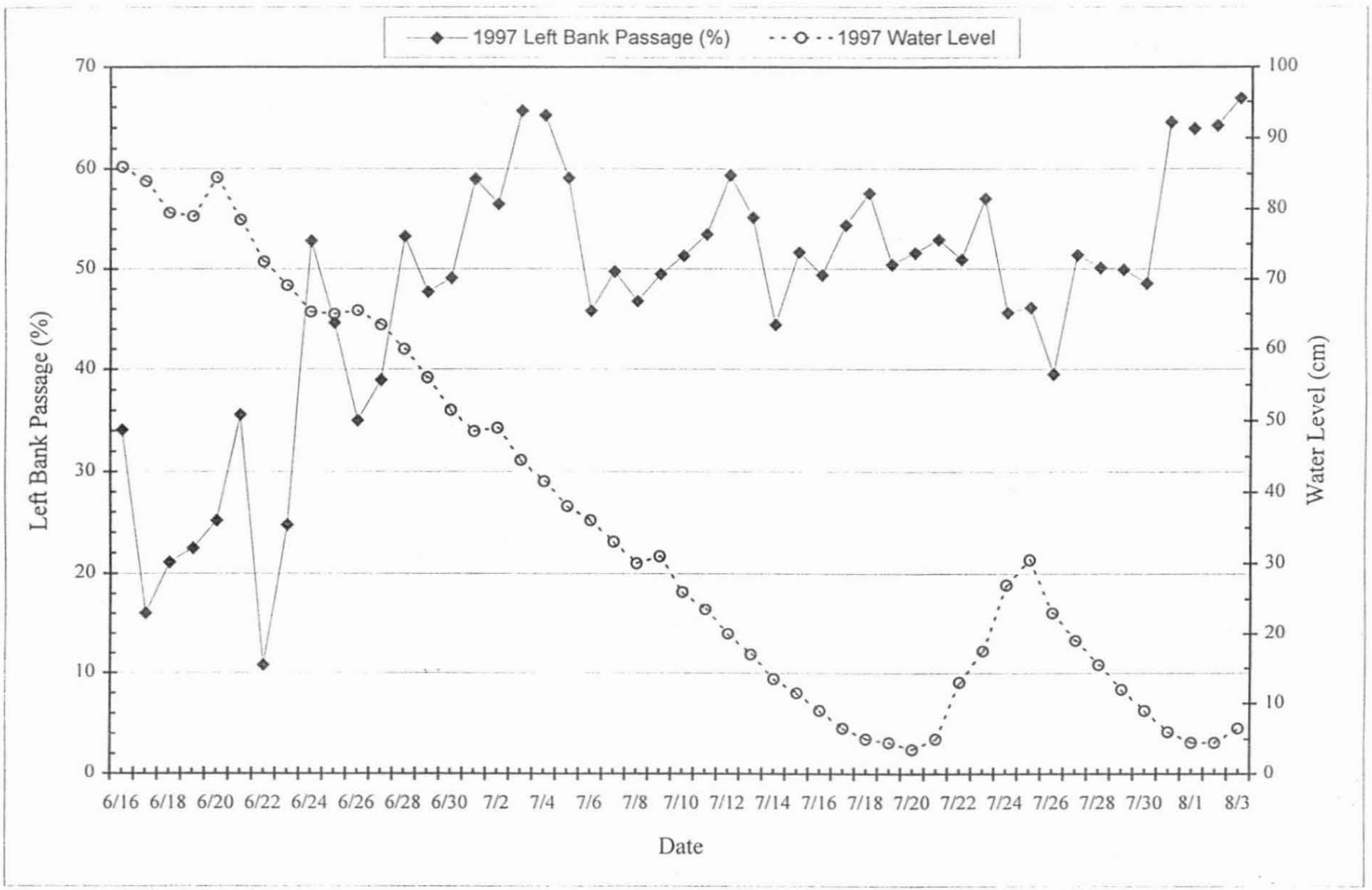


Figure 13. Daily left bank percent passage rate and water level for Aniak River sonar, 1997

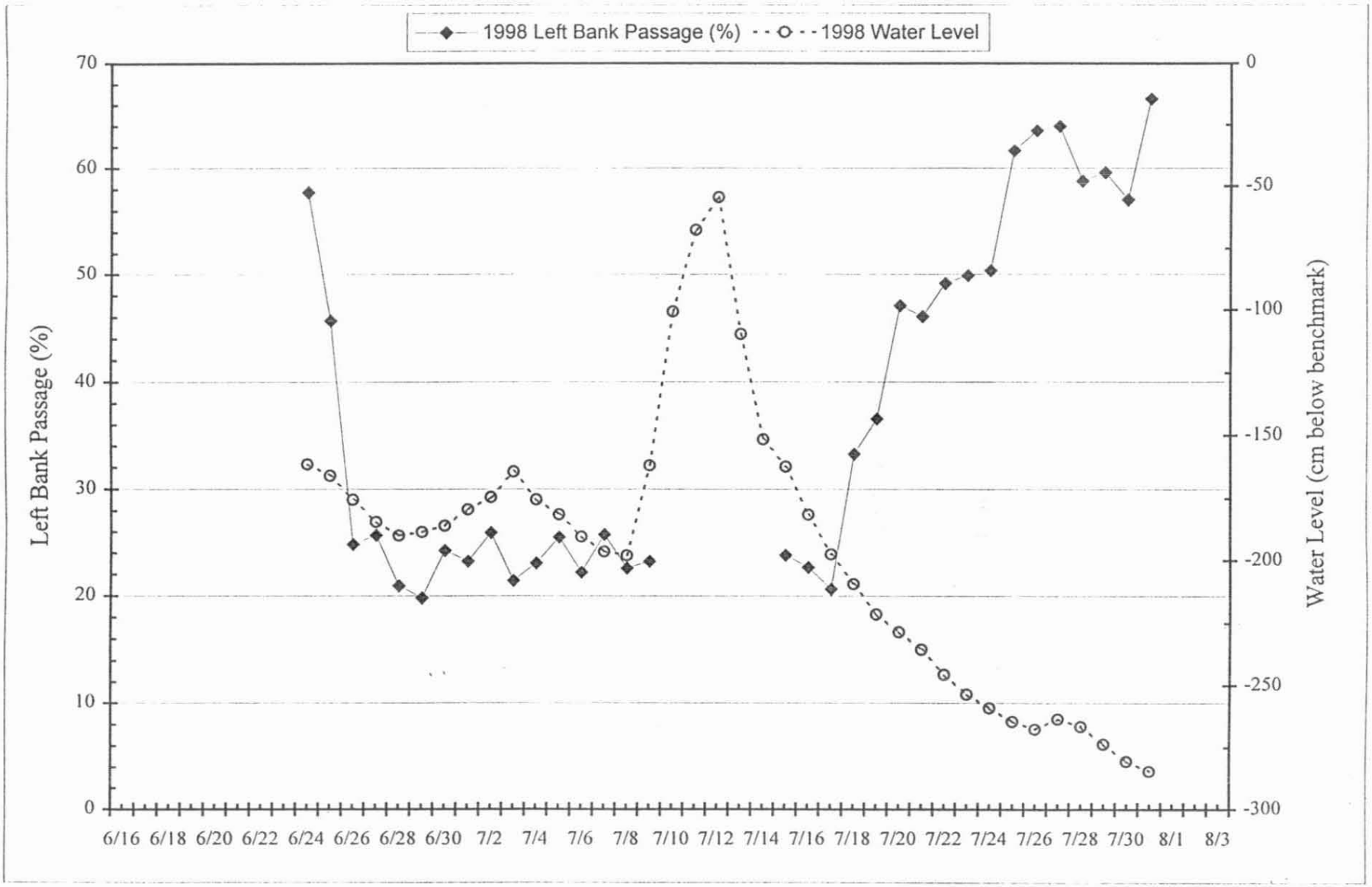


Figure 14. Daily left bank percent passage rate and water level for Aniak River sonar, 1998

APPENDICES

APPENDIX A

Appendix A.1. Lower Kuskokwim River, District 1 and the middle Kuskokwim River, District 2, combined commercial salmon harvest and estimated exvessel value, 1988-1998.[a]

Kuskokwim In-River Commercial Salmon Harvest

(Source: 1988-98 Kuskokwim Area Management Reports)

Year		Chinook	Sockeye	Coho	Pink	Chum	Total
1988	Fish	55,716	92,025	524,296	10,825	1,381,674	2,064,536
	Value	$974,664	$950,181	$4,570,505	$5,495	$3,781,449	$10,282,296
1989	Fish	43,217	42,712	479,856	464	749,182	1,315,431
	Value	$490,410	$376,775	$1,875,097	$80	$1,305,284	$4,047,646
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	$2,128,234
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
Average	Fish	31,055	64,515	545,484	5,525	450,658	1,097,235
(1988-1997)	Value	$318,817	$400,261	$2,047,672	$1,883	$894,262	$3,662,896

[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, 1988-1997.

Kuskokwim In-River Subsistence Salmon Harvest
(Source: 1988-97 Kuskokwim Area Annual Management Reports)

Year	Chinook	Chum	Sockeye	Coho	Total
1988[a]	70,943	151,967	30,775	38,387	292,072
1989	81,176	139,687	35,224	52,918	309,005
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
Average (1988-1997)	82,528	93,595	37,592	38,947	252,661

[a] Beginning in 1988, estimate based on new formula, data not comparable to previous years.

Appendix A.3. Timetable of developmental changes at the Aniak River Sonar Project, 1980-1998.

YEAR	EVENT
1980	• Aniak 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 ensonified 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 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 gillnet catches. In the absence of sufficient species apportionment data, the sonar based escapement objective would be 250,000 estimated salmon counts. • Cumulative adjusted daily sonar estimates expanded by 162% to account for salmon passing outside the ensonified area.

-Continued-

Appendix A.3. (Page 2 of 2)

YEAR	EVENT
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	• First change in project leadership • 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
1997	• Project operations remain the same as 1996
1998	• Project operations remain the same as 1997 & 1996

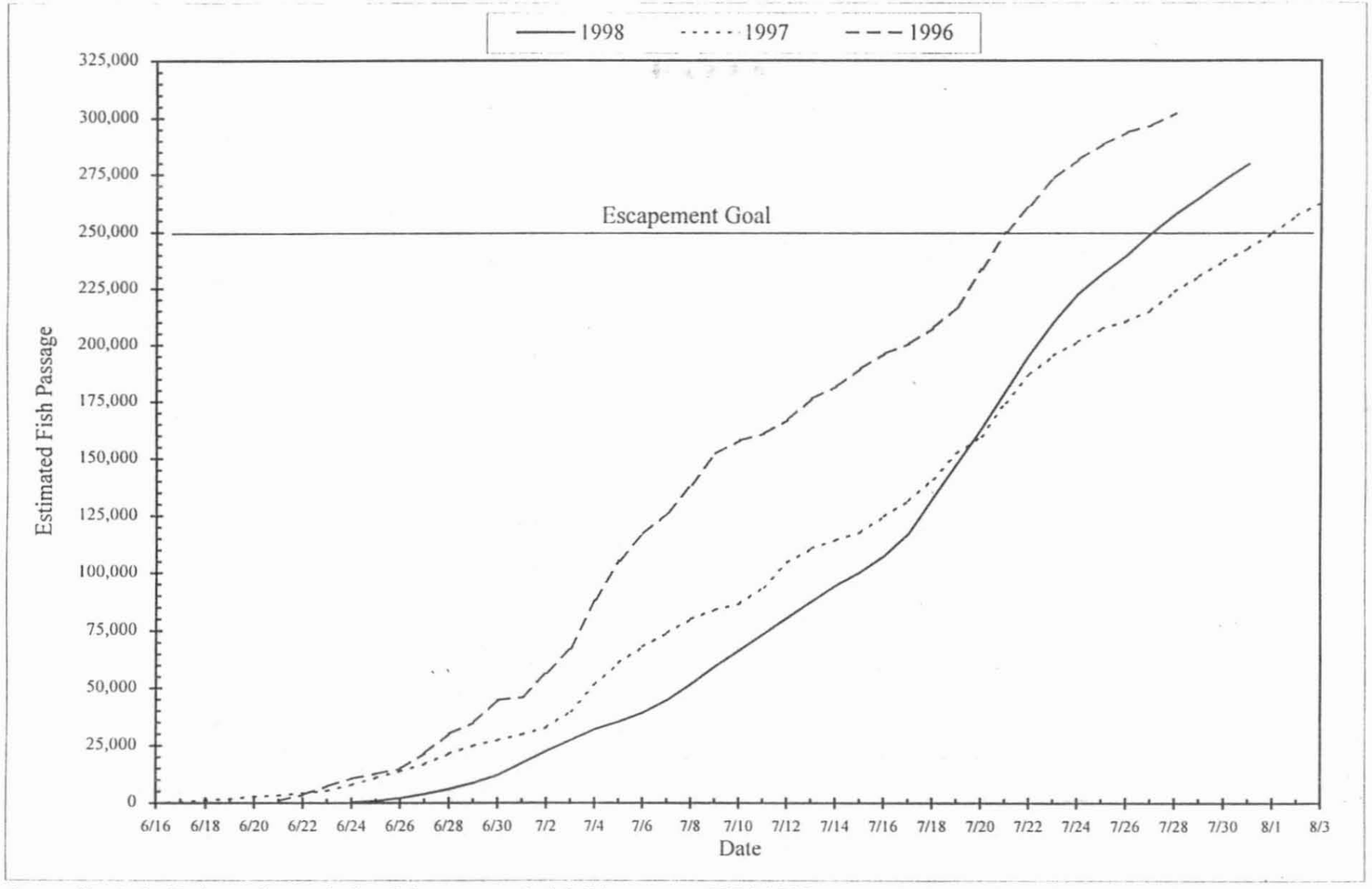
Appendix A.4. Historic age class of beach seine caught chum salmon from Aniak River escapement samples, collected near the sonar site and applied to passage estimates by time stratum, 1996 - 1998.

Year	Stratum Dates	Sample Size	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.
1998	6/24 - 7/05	72	0	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	0.0	48,595	55.1	37,294	42.3	2,260	2.6	88,149
1998	7/06 - 7/12	165	0	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	0.0	59,429	63.6	34,034	36.4	0	0.0	93,463
1998	7/13 - 7/18	220	0	0.0	44,671	85.5	7,603	14.5	0	0.0	52,274
1997	7/14 - 7/17	138	610	2.9	11,896	56.5	8,540	40.6	0	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
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
1998	7/23 - 7/27	210	511	1.0	49,340	91.9	3,835	7.1	0	0.0	53,686
1997	7/23 - 7/26	156	598	2.6	16,883	72.4	5,827	25.0	0	0.0	23,308
1996	7/18 - 7/28	167	4,866	4.8	74,813	73.7	19,463	19.2	2,433	2.4	101,575
1998	7/28 - 7/31	173	0	0.0	28,227	93.6	1,917	6.4	0	0.0	30,144
1997	7/27 - 8/03	127	1,231	2.4	43,505	83.5	7,388	14.2	0	0.0	52,124
1998	Season	1,044	819	0.3	243,961	87.3	33,579	12.0	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	1.8	197,657	65.4	94,260	31.2	4,851	1.6	302,106

Appendix A.5. Daily and cumulative estimates of fish passage at the Aniak River sonar site, 1996-98.

	1998 Season Estimates					1997 Season Estimates					1996 Season Estimates				
Date	Left Bank	Right Bank	Daily Total	Cumulative Total	Passage (%)	Left Bank	Right Bank	Daily Total	Cumulative Total	Passage (%)	Left Bank	Right Bank	Daily Total	Cumulative Total	P. (%)
16-Jun						74	143	217	217	0					0
17-Jun						52	272	324	541	0					0
18-Jun						119	445	564	1,105	0					0
19-Jun						155	535	690	1,795	1					0
20-Jun						248	737	985	2,780	1					0
21-Jun						205	371	576	3,356	1	261	643	904	904	0
22-Jun						92	760	852	4,208	2	770	1,898	2,668	3,572	1
23-Jun						270	821	1,091	5,299	2	1,034	2,549	3,583	7,155	2
24-Jun	231	169	400	400	0	1,412	1,261	2,673	7,972	3	1,001	2,467	3,468	10,623	4
25-Jun	227	270	497	897	0	1,344	1,667	3,011	10,983	4	696	1,459	2,155	12,778	4
26-Jun	292	884	1,176	2,073	1	964	1,789	2,753	13,736	5	606	1,450	2,056	14,834	5
27-Jun	470	1,360	1,830	3,903	1	1,238	1,940	3,178	16,914	6	1,941	4,843	6,784	21,618	7
28-Jun	447	1,689	2,136	6,039	2	2,445	2,145	4,590	21,504	8	2,252	6,216	8,468	30,086	10
29-Jun	520	2,106	2,626	8,665	3	1,663	1,822	3,485	24,989	10	1,868	2,684	4,552	34,638	11
30-Jun	841	2,626	3,467	12,132	4	1,151	1,193	2,344	27,333	10	2,169	7,973	10,142	44,780	15
1-Jul	1,209	3,992	5,201	17,333	6	1,455	1,011	2,466	29,799	11	508	687	1,195	45,975	15
2-Jul	1,353	3,864	5,217	22,550	8	1,650	1,270	2,920	32,719	12	3,307	7,559	10,866	56,841	19
3-Jul	1,008	3,702	4,710	27,260	10	4,621	2,420	7,041	39,760	15	4,697	5,576	10,273	67,114	22
4-Jul	1,072	3,576	4,648	31,908	11	7,628	4,070	11,698	51,458	20	8,462	12,573	21,035	88,149	29
5-Jul	839	2,451	3,290	35,198	13	5,760	3,986	9,746	61,204	23	6,633	10,469	17,102	105,251	35
6-Jul	885	3,103	3,988	39,186	14	3,199	3,783	6,982	68,186	26	6,213	5,788	12,001	117,252	39
7-Jul	1,409	4,059	5,468	44,654	16	2,984	3,014	5,998	74,184	28	4,507	4,640	9,147	126,399	42
8-Jul	1,622	5,560	7,182	51,836	19	2,770	3,152	5,922	80,106	31	5,920	6,307	12,227	138,626	46
9-Jul	1,798	5,939	7,737	59,573	21	1,975	2,016	3,991	84,097	32	5,247	8,433	13,680	152,306	**50**
10-Jul	1,609 [a]	5,370 [a]	6,979	66,552	24	1,272	1,207	2,479	86,576	33	2,669	2,995	5,664	157,970	52
11-Jul	1,609 [a]	5,370 [a]	6,979	73,531	26	3,849	3,350	7,199	93,775	36	1,210	1,762	2,972	160,942	5
12-Jul	1,609 [a]	5,370 [a]	6,979	80,509	29	6,466	4,429	10,895	104,670	40	1,987	4,109	6,096	167,038	
13-Jul	1,609 [a]	5,370 [a]	6,979	87,488	31	3,366	2,738	6,104	110,774	42	2,233	7,108	9,341	176,379	5
14-Jul	1,609 [a]	5,370 [a]	6,979	94,467	34	1,632	2,040	3,672	114,446	44	1,604	3,629	5,233	181,612	60
15-Jul	1,410	4,509	5,919	100,386	36	1,779	1,665	3,444	117,890	45	2,007	5,901	7,908	189,520	63
16-Jul	1,604	5,473	7,077	107,463	38	3,515	3,602	7,117	125,007	48	1,496	5,099	6,595	196,115	65
17-Jul	2,021	7,773	9,794	117,257	42	3,704	3,109	6,813	131,820	**50**	1,505	2,911	4,416	200,531	66
18-Jul	5,163	10,363	15,526	132,783	48	5,392	3,977	9,369	141,189	54	3,083	3,770	6,853	207,384	69
19-Jul	5,466	9,485	14,951	147,734	**53**	5,668	5,568	11,236	152,425	58	4,253	4,992	9,245	216,629	72
20-Jul	7,151	8,035	15,186	162,920	58	3,826	3,591	7,417	159,842	61	7,244	9,758	17,002	233,631	77
21-Jul	7,560	8,849	16,409	179,329	64	7,833	6,971	14,804	174,646	67	6,777	9,360	16,137	249,768	83
22-Jul	7,997	8,274	16,271	195,600	70	6,339	6,105	12,444	187,090	71	4,404	7,338	11,742	261,510	87
23-Jul	7,120	7,151	14,271	209,871	75	4,760	3,584	8,344	195,434	74	4,149	7,681	11,830	273,340	90
24-Jul	6,285	6,195	12,480	222,351	80	2,714	3,234	5,948	201,382	77	2,758	5,408	8,166	281,506	93
25-Jul	5,572	3,466	9,038	231,389	83	2,654	3,098	5,752	207,134	79	2,458	4,415	6,873	288,379	95
26-Jul	5,244	3,003	8,247	239,636	86	1,290	1,974	3,264	210,398	80	2,042	3,317	5,359	293,738	97
27-Jul	6,177	3,473	9,650	249,286	89	2,428	2,296	4,724	215,122	82	1,095	1,922	3,017	296,755	98
28-Jul	4,842	3,392	8,234	257,520	92	4,251	4,231	8,482	223,604	85	1,643	3,708	5,351	302,106	100
29-Jul	4,263	2,892	7,155	264,675	95	3,457	3,464	6,921	230,525	88					
30-Jul	4,465	3,361	7,826	272,501	98	3,273	3,465	6,738	237,263	90					
31-Jul	4,616	2,313	6,929	279,430	100	3,568	1,959	5,527	242,790	92					
1-Aug						4,340	2,451	6,791	249,581	95					
2-Aug						4,750	2,646	7,396	256,977	98					
3-Aug						3,707	1,838	5,545	262,522	100					
Total	109,222	170,208	279,430	279,430		139,307	123,215	262,522	262,522		112,709	189,397	302,106	302,106	

[a] Sonar not operational, passage estimated using the average passage from 8-9 July & 15-16 July



Appendix A.6. Estimated cumulative fish passage, Aniak River sonar, 1996-1998.

Appendix A.7. Climatological and hydrologic measurements, Aniak River sonar site, 1998.

Date	Time	Water (C)	Air (C)	Secchi (m)	H_2O Level (cm)	Rain (mm)	Wind Vel/Dir.	Conductivity (microsiemens)	Air (C) (Min/Max)	General Conditions (sunny, overcast, intermittent rain, heavy rain, etc....)
24-Jun	0820	9.2	8.3	0.30	161.50	0	5/SE	74.1	N/A	Broken overcast
25-Jun	0810	9.4	8.8	0.40	166.0	0	0-3/SE	74.7	6.6 / 17.7	Solid overcast
26-Jun	0835	10.6	11.6	0.45	175.5	0	0	74.6	3.3 / 23.3	Slightly cloudy
27-Jun	0800	11.2	11.1	0.45	184.5	0	0	79.6	-1.1 / 26.6	Broken overcast
28-Jun	0800	11.2	12.5	0.40	190.0	0	1-3/NW	77.6	10.0 / 22.7	Broken overcast
29-Jun	0816	11.6	12.2	0.40	188.5	0	0-3/SE	76.8	8.3 / 21.6	Mostly sunny
30-Jun	0830	12.0	13.1	0.40	186.0	0	1-2/SW	75.4	11.1 / 23.8	Solid overcast
1-Jul	0835	13.0	15.2	0.35	179.5	18	1-2/SW	76.5	13.3 / 28.8	Steady rain, solid overcast
2-Jul	0810	12.3	12.4	0.40	174.5	0	3/SE	76.3	10.0 / 20.0	Broken, mostly sunny
3-Jul	0810	12.1	12.2	0.35	164.5	1	5-7/SE	74.7	11.1 / 20.0	Solid overcast
4-Jul	0810	11.7	13.6	0.45	175.5	1	0	77.5	8.8 / 20.5	Solid overcast, intermittent rain
5-Jul	0810	11.5	13.3	0.45	181.5	1	0	74.8	10.0 / 21.1	Solid overcast
6-Jul	0810	11.1	13.4	0.40	190.5	1	0	78.8	13.3 / 21.6	Solid overcast
7-Jul	0804	11.7	13.5	0.50	196.5	1	0	77.8	13.4 / 22.2	Intermittent rain
8-Jul	0803	11.1	11.8	0.50	198.0	15	15/SE	78.5	10.0 / 16.1	Intermittent rain
9-Jul	0800	9.7	8.5	0.25	162.0	8	0	72.8	8.2 / 13.8	Intermittent rain
10-Jul	1000	9.9	11.6	0.15	100.5	0	0	68.7	11.1 / 14.4	Broken skies
11-Jul					67.5					(Sonar not operational due to
12-Jul					54.5					flood water conditions)
13-Jul					109.5					" "
14-Jul					151.5					" "
15-Jul	0814	13.0	13.6	0.48	162.5	0	0	78.0	5.0 / 25.0	Solid overcast
16-Jul	0820	13.0	13.3	0.60	181.5	0	5/SE	79.5	5.5 / 23.3	Broken skies
17-Jul	0800	12.9	13.2	0.50	197.5	1	0	83.2	6.6 / 23.3	Solid overcast
18-Jul	0825	12.4	12.1	0.50	209.5	0	0	82.3	2.2 / 23.3	Clear skies
19-Jul	0840	12.3	11.1	0.60	221.5	1	0	87.3	3.3 / 15.5	Solid overcast
20-Jul	0806	12.4	12.0	0.65	228.5	1	0	86.1	8.8 / 22.2	Clear skies, morning fog
21-Jul	0758	12.5	11.7	0.65	235.5	0	0	72.8	10.0 / 24.2	Partly cloudy
22-Jul	0800	12.8	14.7	0.65	245.5	1	1-2/S	81.2	10.5 / 29.4	Partly cloudy
23-Jul	0810	13.7	12.8	0.70	253.5	0	5/SE	80.4	11.1 / 25.5	High overcast
24-Jul	0810	13.4	9.8	0.70	259.0	0	1-2/N	79.7	7.7 / 22.7	Mostly sunny
25-Jul	0820	12.5	12.2	0.70	264.5	1	5/SE	80.2	8.3 / 20.0	Solid overcast
26-Jul	0805	12.5	12.1	0.75	267.5	10	1-3/SE	82.3	10.0 / 17.2	Solid overcast
27-Jul	0805	12.1	12.0	0.70	263.5	9	0	81.4	10.0 / 20.0	Solid overcast
28-Jul	0810	11.9	13.0	0.70	266.5	0	0	80.5	10.0 / 25.5	Solid overcast
29-Jul	0815	11.6	12.3	0.75	273.5	0	1-6/NW	84.6	11.1 / 20.0	Solid overcast
30-Jul	0750	11.9	12.7	0.80	280.5	1	0	83.3	8.8 / 18.8	Solid overcast, light rain
31-Jul	0830	11.4	11.5	0.80	284.5	0	0	80.5	10.0 / 17.7	Broken skies
	Median	12.0	12.2	0.5	189.3			78.7		
	Max	13.7	15.2	0.8	284.5			87.3		
	Min	9.2	8.3	0.2	54.5			68.7		

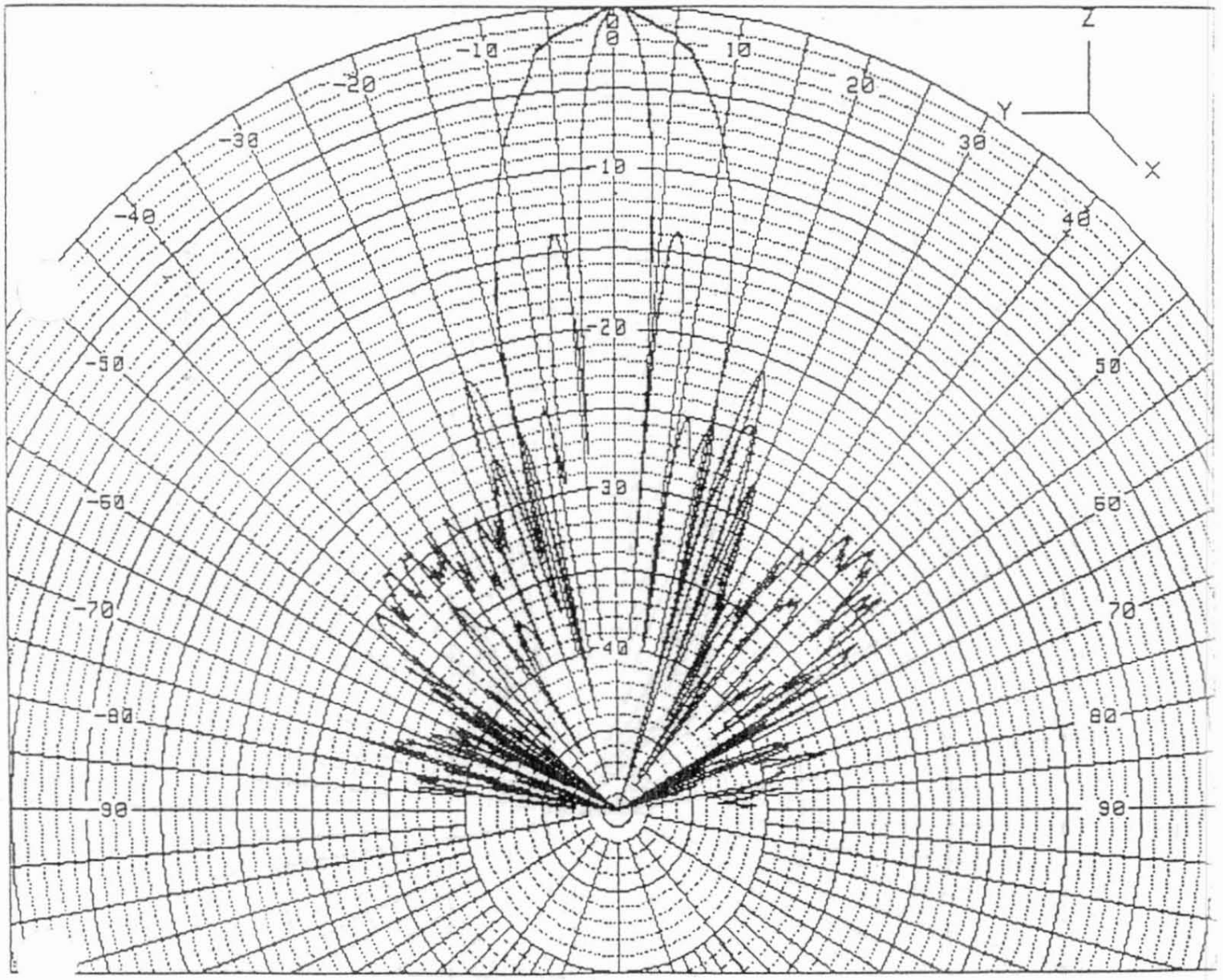
APPENDIX B

Appendix B.1. BioSonics bench calibration data. Calibrated 14 May, 1998.

Sounder: Cables: (S/N): Transducer:	102-021 1000' Belden 702A/701A ITC 009 Case I	102-021 1000' Belden 702A/701A ITC 009 Case II	102-020 500' Belden 704A/703A ITC 008 Case I	102-020 500' Belden 704A/703A ITC 008 Case II
Receiver Gain L	0	0	0	0
Standard Volts In	3	3	3	3
Vdet NB 40	0.850	0.775	0.885	1.250
G1 NB 40	-169.222	-170.025	-168.872	-165.873
Vdet WB 40	0.945	0.910	1.270	1.210
G1 WB 40	-168.302	-168.630	-165.735	-166.155
-13 dB Vrms	0.08132	0.05445	0.12728	0.06293
-13 dB SL	214.153	210.669	218.044	211.927
-10 dB Vrms	0.11243	0.07354	0.17678	0.08627
-10 dB SL	216.967	213.280	220.898	214.666
-6 dB Vrms	0.17324	0.11172	0.27047	0.13364
-6 dB SL	220.722	216.912	224.592	218.468
-3 dB Vrms	0.24395	0.15486	0.37653	0.18668
-3 dB SL	223.695	219.748	227.465	221.371
0 dB Vrms	0.35002	0.22274	0.57276	0.27224
0 dB SL	226.831	222.905	231.109	224.648

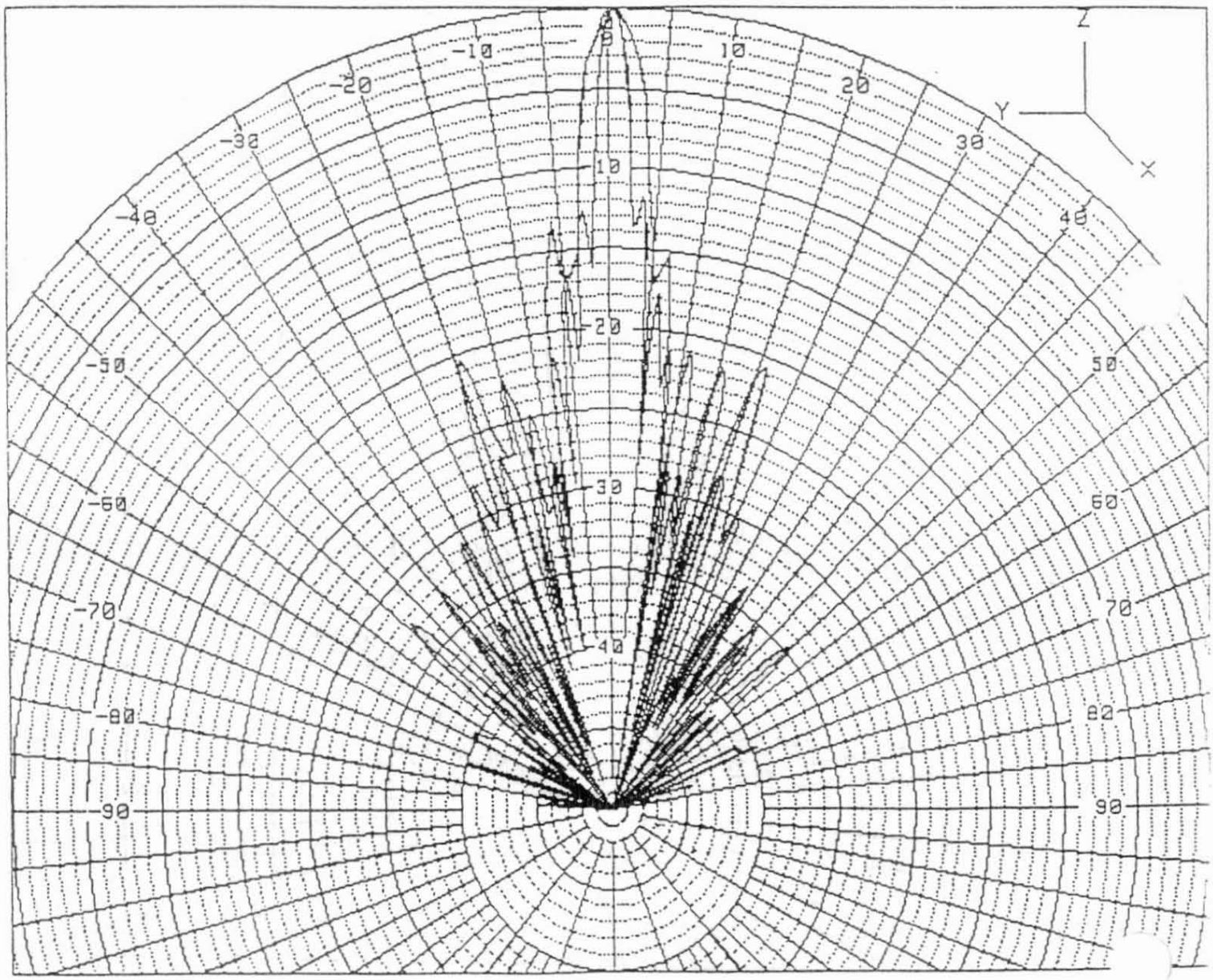
Appendix B.2. Polar Plot for ITC model 5398 transducer (S/N 008) configured as case II (4°X9° narrow beam).

```
RECEIVE BEAM PATTERN                          DATE May 14 1998   TIME  22:27:37
ITC-5398-08          S/N 008                DRIVE CABLE
REF PROJ E-27        S/N 233                  R 0 OHMS
T#E2782AAA01         SEP DIST. 20.1 FT        C 0 nF
TR/WO NO.            DEPTH 15 FEET            L 0 uH
TESTED BY RJ         FREQ SPAN 200 kHz      REF UNIT CAL EXP    BASICC 02/24/97
LOC. 36 FT TANK      DRIVE 0 Vrms           15 AUG 1998         ENGR TEST ONLY
WATER TEMP 63.5°F    SPEC.COND.  10 kHz     NARROW BEAM OUTPUT  CASE 2
WIDE/NARROW BEAM CASE 2
```



Appendix B.3. Polar Plot for ITC model 5398 transducer (S/N 009) configured as case I (2°X5° narrow beam).

```
RECEIVE BEAM PATTERN                          DATE May 14 1998   TIME  21:07:17
ITC-5398-09          S/N 009                DRIVE CABLE
REF PROJ E-27        S/N 233                  R 0 OHMS
T#E2782AAA01         SEP DIST. 20.1 FT        C 0 nF
TR/WO NO.            DEPTH 15 FEET            L 0 uH
TESTED BY RJ         FREQ SPAN 200 kHz      REF UNIT CAL EXP    BASICC 02/24/97
LOC. 36 FT TANK      DRIVE 0 Vrms           15 AUG 1998         ENGR TEST ONLY
WATER TEMP 63.5°F    SPEC.COND.  10 kHz     NARROW BEAM OUTPUT CASE 1
WIDE/NARROW BEAM CASE 1
```



APPENDIX C

Appendix C.1. State of Alaska, Department of Natural Resources Land Use Permit for the Aniak River sonar project.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF LAND, SOUTHCENTRAL REGION
3601 C STREET, SUITE 1080
ANCHORAGE, AK 99503-5937
PHONE: (907) 269-8554; FAX (907) 269-8913

1998 MULTI-YEAR LAND USE PERMIT VALIDATION

Under AS 38.05.850

PERMIT # LAS 13916

ALASKA DEPARTMENT OF FISH & GAME, COMMERCIAL FISHERIES MANAGEMENT & DEVELOPMENT DIVISION, ANIAK SONAR PROJECT LEADER is issued this 1998 multi-year (seasonal) land use permit validation authorizing the permittee's activity and use of the following described land:

NW1/4SW1/4 of Section: 05, Township: 16 North, Range: 56 West, Seward Meridian

This multi-year (seasonal) land use permit validation authorizes:

(a) the 1998 establishment and use of a temporary camp, per the attached site utilization plan, from June 1, 1998 through August 10, 1998, to support a fish monitoring project.

DIVISION OF LAND
NOV 18 1997
ISSUE DATE IS RED

Mike Sullivan
Natural Resource Manager

11/18/97
Date

*The permittee is responsible for conducting the permitted activities in accordance with original, amended and/or new land use permit stipulations attached to the multi-year (seasonal) land use permit and applicable guidelines set forth in 11 AAC 96.140.

*The permittee is responsible for obtaining authorizations required by other agencies for the permitted activity.

*The permittee is responsible for maintaining a current address with the division during the term of the multi-year (seasonal) land use permit.

LAND USE PERMIT

PERMIT NUMBER : LAS 13916

ALASKA DEPT. OF FISH & GAME

PERMITTEE : Division of Commercial Fisheries

Aniak Sonar Project Leader, (907) 267-2131

1998 TERM : 06/01/98 through 08/10/98

Alaska Department of
NATURAL
RESOURCES

Max Hall 11/18/97

DNR AUTHORIZED SIGNATURE

This permit must be posted in a conspicuous location visible from the most common access route. Only permit posters with tan or green backgrounds are valid.

Township	Range	Section/Other
16 North	56West	NW1/4SW1/4 Sec. 05 Seward Meridian

Division of Land and Water
Southcentral Region
3601 C Street, Suite 1080
Anchorage, Alaska 99503-5937
269-8554.

Appendix C.2. State of Alaska, Department of Natural Resources Caching Permit for the Aniak River sonar project.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF LAND, SOUTHCENTRAL REGION
3601 C STREET, SUITE 1080
ANCHORAGE, AK 99503-5937
PHONE: (907) 269-8554; FAX (907) 269-8913

ALASKA DIVISION OF LAND

1998/99
CACHING PERMIT VALIDATION

Under AS 38.05.850

PERMIT # LAS 13916(S)

ALASKA DEPARTMENT OF FISH & GAME, COMMERCIAL FISHERIS MANAGEMENT & DEVELOPMENT DIVISION, ANIAK SONAR PROJECT LEADER is issued this 1998/99 multi-year permit validation authorizing the permittee's caching of: 100 feet of aluminum weir material, 4' x 8' plywood table (2), 4'x8'x4' frame for fish sampling live box, stainless steel kitchen sink, stove pipe and one 4'x 6'x 8' outhouse. This cache is to be positioned in a wooded area and located on a parcel of state owned land located within:

NW1/4 SW1/4 of Section: 05, Township: 16 North, Range: 56 West, Seward Meridian

The authorized 1997/98 term is August 11, 1998 through May 30, 1999 unless earlier terminated at the state's discretion.

DIVISION OF LAND
NOV 18 1997
ISSUE DATE IS RED

Mike Sullivan
Natural Resource Manager

11/18/97
Date

*The permittee is responsible for conducting the permitted activities in accordance with any original, amended and/or new land use permit stipulations attached to the multi-year permit and applicable guidelines set forth in 11 AAC 96.140.

*The permittee is responsible for obtaining authorizations required by other agencies for the permitted activity.

*The permittee is responsible for maintaining a current address with the division during the term of the permit.

LAND USE PERMIT

PERMIT # : LAS 13916(S) - CACHING

ALASKA DEPT. OF FISH & GAME

PERMITTEE : Division of Commercial Fisheries

Aniak Sonar Project Leader, (907) 267-2131

1998/99 TERM : 08/11/98 through 05/30/99

Alaska Department of
NATURAL
RESOURCES

Mike Hull 11/18/97

DNR AUTHORIZED SIGNATURE

This permit must be posted in a conspicuous location visible from the most common access route. Only permit posters with tan or green backgrounds are valid.

Township	Range	Section/Other
16 North	56West	NW1/4SW1/4 Sec. 05 Seward Meridian

Division of Land and Water
Southcentral Region
3601 C Street, Suite 1080
Anchorage, Alaska 99503-5937
269-8554.