Fishery Data Series No. 08-32

Sonar Estimation of Chum Salmon Passage in the Aniak River, 2006

by

Malcolm S. McEwen

June 2008

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 08-32

SONAR ESTIMATION OF CHUM SALMON PASSAGE IN THE ANIAK RIVER, 2006

by
Malcolm S. McEwen
Alaska Department of Fish and Game, Division of Commercial Fisheries, Fairbanks

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518

June 2008

The Division of Sport Fish Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Since 2004, the Division of Commercial Fisheries has also used the Fishery Data Series. Fishery Data Series reports are intended for fishery and other technical professionals. Fishery Data Series reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Malcolm S. McEwen
Alaska Department of Fish and Game, Division of Commercial Fisheries,
1300 College Road, Fairbanks, Alaska 99701, USA

This document should be cited as:
McEwen, M. S. 2008. Sonar estimation of chum salmon passage in the Aniak River, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-32, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The Aniak River sonar project has provided daily fish passage estimates for most years since 1980. During this time, the project has undergone important modifications including changing from the original Bendix sonar to dual-beam in 1996 and to a high frequency imaging sonar (DIDSON) in 2004. In 2006, the project maintained the sampling schedule adopted in 2003 in which the sonar operated for three 4-hour blocks each day (0000–0400, 0800–1200, and 1600–2000 hours). The Aniak River sonar project was operational from June 28 through July 31, 2006. During this period, an estimated 1,108,626 fish (SE 19,795) passed through the ensonified area, the majority of which are assumed to be chum salmon *Oncorhynchus keta*. The peak passage of 61,639 fish occurred on July 17 and the 50% passage date occurred on July 14. Age-0.2, -0.3, and -0.4 chum salmon comprised 0.8%, 61.3% and 37.9% of the escapement estimate, respectively.

Key words: Aniak River, DIDSON, chum salmon, hydroacoustic, Kuskokwim River, *Oncorhynchus keta*, sonar.

INTRODUCTION

HISTORY

The Kuskokwim River subsistence and potential commercial salmon fishery in June and July is directed toward the harvest of chum salmon *Oncorhynchus keta* and Chinook salmon *O. tshawytscha*. From 1996 to 2005, an average of 54,841 chum salmon were harvested annually for subsistence purposes in the Kuskokwim area (Linderman and Bergstrom 2006). Commercial chum salmon harvests in Districts 1 (W-1) and 2 (W-2) from 1995 to 2005 averaged 56,279 fish, from 2001 to 2003 no market existed for chum salmon in the Kuskokwim River Fishery, and only modest commercial fisheries were prosecuted from 2004 to 2006 (Linderman and Bergstrom 2006).

Timely estimates of run strength and escapement are important to management of the Kuskokwim River fishery. Based on past sonar escapement estimates and aerial survey indices of abundance, the Aniak River is believed to be one of the largest producers of chum salmon in the Kuskokwim River drainage (Francisco et al. 1995). Prior tagging studies have shown that chum salmon migrate from the upper end of District 1 to the Aniak River sonar site in about 7 or 8 days (ADF&G 1961, 1962). Because of the Aniak River proximity to the Kuskokwim River commercial and subsistence fisheries (Figure 1), the Aniak River sonar project provides timely estimates of chum salmon passage.

The Aniak River sonar project began operating in 1980 and has undergone numerous changes in equipment and methodologies during this time. From 1980 to 1995, Aniak River escapement data were collected using an echo counting and processing transceiver manufactured by Bendix Corporation[1]. 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 ensonified 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 of the Aniak River, and visual observations of fish migration patterns reported for the Anvik River (Buklis 1981) lead to the supposition that approximately two-thirds of the run passed through the ensonified 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

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

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 to readjust the counts from 1980–1983. In addition to the expansion of daily totals, sonar estimates were extrapolated for salmon escapement occurring before and after the operational period.

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 throughout the chum salmon migration. A new sonar data collection site was established 1.5 km downstream from the historical site. Seasonal sonar estimates were not extrapolated for salmon escapement before or after the operational period. Sonar operations from 1997 to 2002 remained essentially unchanged. During the winter of 2002 different sonar sampling regimes were explored in order to reduce operational costs, and it was found that sampling a four on/four off schedule presented the least overall error (+/- 2.7%) with a moderate amount of daily variability. In 2003, the project implemented three 4-hour sampling periods instead of sampling 24-hours per day (Sandall and Pfisterer 2006). Preparations to transition to a dual frequency identification sonar (DIDSON) were also initiated in 2003 (Sandall and Pfisterer 2006) and in 2004, the dual-beam system was replaced with the DIDSON. Sonar operations in 2006 were consistent with the changes made in 2003 and 2004.

Examination of the past relationship of counts made using BioSonics and DIDSON equipment have shown a density dependent relationship with the BioSonics estimates approximately 70% of those derived using DIDSON (Sandall and Pfisterer 2006). Using the density dependent relationship, the fish estimates from 1980 to 2003 have been adjusted to equivalent DIDSON estimates (C. Pfisterer, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication) (Table 1). This year's estimate is well above the 10-year average (1996–2005) of 463,908, it is similar to last year's escapement of 1,171,977, and is below the 1980 adjusted estimate of 1,600,032.

In the early 1980s, sonar counts were apportioned to chum or Chinook salmon using catch information from test gillnets. Schneiderhan (1981, 1982a, b, 1984, 1985) determined that the abundance of other fish species was insufficient to compromise the utility of passage estimates for making chum salmon management decisions and because of this determination, species apportionment activities were discontinued in 1986 (Schneiderhan 1988). 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 was a lack of sufficient budgetary resources. In response to extremely poor returns of chum and coho salmon in 1997 and 1998 the federal government (Western Alaska Fisheries Disaster) made funds available for Kuskokwim River salmon fisheries research and management (Fair 2000). In 2001 and 2002, through these funds, a new species apportionment feasibility study was conducted. This study attempted to determine if test fishing with gillnets could provide an acceptable method of apportioning sonar counts to fish species. The results were similar to earlier efforts indicating that drift gillnetting was not an acceptable method and was unnecessary for apportioning sonar counts on this river system, prompting termination of the study in 2003 (McEwen 2006).

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 chum salmon ASL samples. From 1981 to 1985, attempts at beach seine test fishing and carcass sampling proved unsuccessful at obtaining adequate sample sizes for ASL determination. In 1986, ASL sampling activities were discontinued to decrease operating costs when it was noted that the Aniak River chum salmon ASL data were similar to the commercial catch results from the lower Kuskokwim River districts (Schneiderhan 1988). In 1996, beach seining procedures were reexamined and a method was devised to provide large enough samples to estimate ASL for chum salmon. ASL sampling continues to be an important component of the project.

Escapement objectives for the Aniak River have undergone a number of modifications since the project's inception. Salmon escapement objectives were tentatively set at 250,000 chum salmon 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 1980–1981 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). With the discontinuation of species apportionment in 1985, 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 in 1992, the Aniak River escapement objective was termed a biological escapement goal (BEG; Buklis 1993). During the winter of 2003 and 2004, the Arctic-Yukon-Kuskokwim (AYK) escapement goal team recommended a Sustainable Escapement Goal (SEG) of 210,000 to 370,000 chum salmon fish. In 2007, the SEG was revised upward to 220,000 to 480,000 (Brannian et al. 2006). The SEG is defined as a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5–10 year period and is used in situations where a BEG cannot be estimated due to the absence of a stock specific catch estimate (Brannian et al. 2006). A timetable of developmental changes for the sonar project is presented in Appendix A1.

OBJECTIVES

The objective of the Aniak River sonar project is to estimate the chum salmon abundance and obtain the age, sex, and length composition of the run along with collecting climatic and hydrological data. These objectives are outlined in the following list:

1. Estimate fish abundance in the Aniak River, with user-configurable sonar equipment, by sampling three 4-hour shifts per day on both banks throughout the bulk of the chum salmon migration (approximately June 21–July 31).
2. Estimate age, sex, and length (ASL) composition of the total Aniak River chum salmon escapements from a minimum of 2–3 pulse samples collected from each third of the run, such that simultaneous 95% confidence intervals of age composition in each pulse are no wider than 0.20 (α=0.05 and d=0.10).
3. Monitor selected climatic and hydrological parameters daily at the project site for use as baseline data.

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 Alaska Department of Natural Resources (DNR) permit # 13916. The main camp is situated at 61° 30.163' N, 159° 22.464' W (Figure 2). 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.

Hydroacoustic Data Acquisition

Equipment

Two DIDSON units (SN 23 and SN 161) were deployed at the Aniak sonar site, one for each bank. The sonar units operated at one of two frequencies, 700 kHz or 1.1 MHz depending on range requirements. Each DIDSON was mounted on an aluminum tripod and remotely aimed with a set of HTI rotators allowing movement in 2 axes. A Remote Ocean Systems (R.O.S.) model PTC-1 (SN 104) pan and tilt control unit connected to the rotator with 152.4 m of Belden model 9934 cable and provided horizontal and vertical positioning accurate to within ± 0.3º.

Each DIDSON was controlled by a laptop computer running either version 4.54 or 5.09 of the DIDSON software. A 152.4 m cable transferred power and data between a "breakout box" and the DIDSON unit in the water. For the right bank, a Honda model EU-2000 generator provided power for all equipment. An Ethernet cable routed data between the breakout box and a 10/100 BT hub and then to a laptop computer. A 250 gigabyte (GB) RAID (redundant array of independent drives) enclosure was connected to the laptop for storing of all data from both banks (Figure 3). The enclosure was configured as RAID 1 allowing redundant copies of the data on 2 separate hard drives within the enclosure in the event one of the mechanisms failed.

The left bank sonar electronic equipment was housed in a 3.0 by 3.7 m (10 by 12 ft) portable wall tent and the equipment was powered by a single Honda model EU-1000 generator. A wireless Ethernet router (D-Link DWL-2100AP) transferred the data from the left bank DIDSON to the controlling laptop on the right bank where the data were saved to the RAID drive (Figure 3).

Transducer Deployment

The transducers were attached to an aluminum tripod deployed on each bank, and oriented perpendicular to the current. The wide axis of each beam was oriented horizontally and positioned close to the river bottom to maximize residence time of targets in the beam. Transducers were placed offshore 4–10 m from the right bank, and 10–20 m from the left bank. Daily visual inspections confirmed proper placement and orientation of the transducers and alerted operators as to when the transducers needed to be repositioned to accommodate changing water levels. The majority of the river was ensonified by using the right bank transducer to sample outwards 20 m and the left bank transducer to sample outward 20 m.

Partial weirs were erected perpendicular to the current and extended from the shore out 1–3 m beyond the transducers. These devices moved chum salmon, Chinook salmon, and other large fish offshore and in front of the transducers to prevent them from passing undetected behind the transducers. The 4.4 cm gap between weir pickets was selected to divert large fish (primarily chum and Chinook salmon) while allowing passage of small, resident, non-target species.

Bottom Profiles and Stream Measurements

The Aniak 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. As with past years, and the stability of the site, we were able to use the same location. The river substrate at the sonar site is fine, smooth gravel, sand, and silt. The left bank slopes gradually to the thalweg at roughly 25–65 m (Figure 4), while the right bank river bottom slopes steeply to the thalweg at about 10–30 m (Figure 5), depending on water level.

Sampling Procedures

Sonar project activities commenced on June 28 and ended on July 31, 2006. Hydroacoustic sampling began at 0800 hours on June 28 on the right bank, and at 0800 hours on June 29 on the left bank and ran every day until 2000 hours on July 31. Passage estimates were available to fishery managers in Bethel at 0730 hours daily.

Acoustic sampling was conducted on both banks for three 4-hour shifts, 7 days per week, except for short periods when the generator was serviced or transducer adjustments were made. This sampling was consistent with the 2003 and 2004 field seasons but was a significant change from seasons prior to 2003 when sampling occurred 24-hours per day. All data was saved to the RAID drive in 15-minute intervals during the 4-hour shift for later review as an echogram and/or video. All counting was done manually using the echogram and marking fish traces with the computer mouse. The video was used to verify fish target and fish size. All fish were counted except for very small fish, which are assumed not to be salmon. A single fisheries technician operated and monitored equipment at the sonar site which entails identifying and tallying fish traces on echogram recordings while rotating through shifts occurring from 0000 to 0400, 0800 to 1200, and 1600 to 2000 hours. To ensure accurate data collection, crew members were trained to distinguish between fish traces and non-fish traces, such as those from debris and bottom. The number of fish traces were summed over 15-minute periods and recorded onto forms. Completed data forms were entered into a spreadsheet and checked over by the crew leader. Daily estimates were transmitted via single side-band radio or satellite phone to area managers in Bethel at 0730 hours the following morning.

The crew 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

The DIDSON is a high frequency, multi-beam sonar with a unique acoustic lens system designed to focus the beam to create high resolution images. Sound pulses are generated by the sonar at center frequencies of 1.1 MHz. DIDSON simultaneously transmits on, and then receives from, sets of 12 beams. Images or frames are built in sequences of these sets of pings. At frequencies of 1.1 MHz, 48 beams (4 sets of 12) 0.6° apart from each other on a horizontal plane are utilized to form the image. The right bank and left bank both sampled at a range from 0.83m to 20 m and the frame rate was set to 4 pings per second.

ANALYTICAL METHODS

Abundance Estimation

The estimate of daily passage $(\hat{y}_{dz})$ on day *d*, and bank *z* was calculated as follows:

$$r_{dzp} = \frac{\sum_{s=1}^{16} y_{dzps}}{4}, \tag{1}$$

where r_{dzp} is the hourly passage rate for period *p* calculated by summing the 16 individual 15-minute observations *y*, collected over the 4-hour period and dividing by the total number of hours.

The average hourly passage rate for the day ($\hat{r}_{dz}$) is estimated by summing the passage rates for the 3 periods and dividing by the number of periods (3),

$$\hat{r}_{dz} = \frac{\sum_{p=1}^{3} r_{dzp}}{3}. \tag{2}$$

Finally, the daily passage for bank *z* is estimated by multiplying the average daily passage rate by 24, the number of hours in the day by:

$$\hat{y}_{dz} = 24\hat{r}_{dz}. \tag{3}$$

The total daily passage is estimated by adding the daily passage for both banks. Note that the same result is obtained by summing the individual 15-minute samples and multiplying by the reciprocal of the fraction of the day sampled (24/12=2).

Sonar sampling periods, each 4 hours in duration, were spaced at regular (systematic) intervals. Treating the systematically sampled sonar counts as a simple random sample would overestimate the variance of the total since sonar counts were highly autocorreltated (Wolter 1985). To accommodate these data characteristics, a variance estimator based on the squared differences of successive observations was utilized. This estimator was adapted from the estimator used at the Yukon River sonar project (Pfisterer 2002). The variance for the passage estimate for bank *z* on day *d* was estimated as:

$$\hat{V}_{y_{dz}} = 24^2 \frac{1 - f_{dz}}{n_{dz}} \frac{\sum_{p=2}^{n_{dz}} \left(r_{dzp} - r_{dz,p-1}\right)^2}{2\left(n_{dz} - 1\right)}, \tag{4}$$

where n_{dz} is the number of periods sampled in the day (3) and f_{dz} is the fraction of the day sampled (12/24=0.5).

Finally, since the passage estimates are assumed independent between zones and among days, the total variance was estimated as the sum of the variances:

$$\hat{V}ar(\hat{y}) = \sum_{d}\sum_{z}\hat{V}ar(\hat{y}_{dz}). \qquad (5)$$

Missing Data

Depending on the amount of time that was missed, the crew used different methodologies to make up for incomplete or missing counts.

If more than 5 minutes were missed at the beginning of a shift, the shift was lengthened by the amount of time that was missed. If less than 5 minutes were missed at the beginning of a shift, the passage rate for the period within that interval was used to estimate passage for the un-sampled portion of the interval.

In the middle of a shift, if 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 un-sampled portion of the interval. If counts were missed for more than 10 minutes, the crew followed an ad hoc approach to estimation by initially preparing various plots of both banks passage depending on the amount of time missed. The goal of these plots was to produce a general picture of the run for that day so that an interpolation routine could be chosen that was appropriate for the real-time trends as depicted in the figures. These interpolations included averaging the passage rates for varying amounts of time before and after the missing data or performing regressions with varying start and stop points around the missing data. The crew also took into account the other bank's trends for the same time period and sometimes used this data in the regression to estimate the missing data.

On rare occasions more than 30 minutes were missed in the middle of a shift. In these instances, the crew extended the length of the shift by the amount of time missed.

ASL Sampling

Equipment and Procedures

The gravel bar just upstream and on the opposite bank from the sonar camp was used as the sampling site over the past several years. Prior to 2003, the gravel bar in front of camp was used for collecting ASL samples which became unusable due to snags. In recent years the gravel bar just upstream has been used exclusively because it has few snags, which allows the net to drift smoothly and has led to more efficient sampling. The crew fished a 3 by 46 m (10 by 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, the seine was stacked in a plastic fish tote and placed in the stern of a skiff. The crew attached the opposite end of the seine to a pulley designed to pivot from the side of the skiff from the bow to the stern. As the skiff moved offshore, orientated upstream, the end of the 30-m lead was held in place by a crew member on shore. The skiff moved straight offshore until all of the lead line was deployed and the seine started to peel out of the tote. The driver maneuvered 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 the crew 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. The crew drifted the entire seine in this formation for approximately 100 m before the lead line was pulled in to close 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, such as kype development, roundness of the belly, and the presence or absence of an ovipositor. Length was measured to the nearest 5 mm step from mideye to tail fork. Fish that were sampled had the adipose fin clipped so that they were not sampled twice if recaptured. All measurements were recorded in a "rite-in-the-rain" notebook and later transcribed to standard mark-sense forms.

The crew followed a pulse sampling design whereby intensive sampling was conducted for 1 or 2 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, which would allow us to estimate the true age composition of the escapement with simultaneous 95% confidence intervals in each pulse (Molyneaux and Dubois 1996). The goal of each sampling pulse was 210 chum salmon scales (L. Dubois, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). All ASL data were sent to the Bethel ADF&G office for analysis by research staff. Ages were reported using European notation, in which 2 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 2 digits plus one.

To estimate the age and sex composition of chum salmon escapement in the Aniak River, daily passage estimates were temporarily stratified. Each stratum consisted of several days of fish passage and 1 pulse sample. Within each stratum, estimates of 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.

ENVIRONMENTAL MEASUREMENTS

Water temperature, conductivity, and secchi visibility were measured 1 time per day between 0800–1200 hours. Water temperature was sampled in the middle of the river using an Extech model 34165 Conductivity/Temperature meter. Secchi depth was also measured at the middle of the river using a standard 20 cm radius secchi disk. A technician submerged the disk until it disappeared from sight before raising it back to the surface. As soon as the disk was visible again, the technician noted the depth before repeating this 2 more times and averaging the results to produce the recorded depth. At the main camp, the air temperature was recorded several times each day from a digital thermometer, and general wind direction was noted. The crew used a staff gauge to measure the water level. The benchmark, located at the sonar site, degraded and became unusable in 2002; consequently, readings are not comparable across years.

RESULTS

FISH PASSAGE ESTIMATES

During the 2006 season 1,108,626 (SE 19,795) fish estimated to have passed the sonar (Table 1). Of those, 47.7% passed on the left bank and 49.0% passed on the right bank (Table 2). Figure 6 shows the daily passage rates by bank along with the cumulative season estimate. The peak total daily passage of 61,639 counts occurred on July 17 (Table 2). The 25%, 50%, and 75% quartile dates of passage were July 7, July 14, and July 21 respectively (Table 2). The 2006 run timing was average compared with the historical record (Figure 7).

MISSING DATA

A total of 6.5 hours (1.7%) on the left bank and 1 hour (0.26%) on the right bank of sampling time were missed because of maintenance, system diagnostic tests, moving the tripod, or aiming the transducer to compensate for changing water levels throughout the season.

ASL SAMPLING

A total of 38 beach seine sets were completed and from these, 872 ASL samples from migrating chum salmon were obtained. Of those samples, 742 scales were analyzed post season with 61.3% falling in the 0.3 age class, 37.9% comprising the 0.4 age class, 0.8% in the 0.2 age class (Table 3). Age-0.3 chum salmon remained constant throughout the first half of the run accounting for 53.8% to 64.6%. Age-0.4 chum salmon came in strong at the beginning of the run (46.2%) and decreased to 35% during the middle of the run. During the 5th strata (July 20–26) the number of age-0.3 fish decreased by 11% (53.9%) when compared to the 4th strata, age-0.2 fish arrived accounting for 3.1% of the run and age-0.4 fish increased by 8% (42.9%). During the 6th strata (July 27–31) the age-0.2 fish accounted for 1.9%, the age-0.3 fish increased by 22% (75.2%) and the age-0.4 fish decreased 20% (22.9%). Female chum salmon accounted for 40.1% of the overall run. During the 4th and 6th strata females accounted for 51% and 60.0% respectively, and during the 1, 2, 3, and 5th strata accounted for between 26.3% to 46.6% of the run.

ENVIRONMENTAL INFORMATION

Climate and River Measurements

Water levels steadily went down throughout the summer except for a brief period in the middle of July when it rained; otherwise it was a hot and dry summer with the lowest water levels coming at the end of July (Figure 8). Water temperatures varied from 8ºC (July 15) to 13ºC (July 22) over the operational period of the project (Figure 9). Data was only collected with the secchi disk for the first 16 days and ranged from 25 cm to 73 cm. Daily air temperatures fluctuated between a minimum of 8ºC (June 28) and 20ºC (July 15) over the project operational period (Figure 9).

DISCUSSION

When we arrived at the sonar site in mid June the water level was very high, this caused a delay in getting the sonar in the water and conducting the ASL sampling. The water went down enough that we were able to get sonar in the water on June 28 which is 2 days later then anticipated. We back calculated the fish passage estimate at the end of the season for these 2 days based on average run timing. The ASL sampling started at the beginning of July.

FISH PASSAGE ESTIMATES

We were able to meet objective one of collecting fish abundance data using sonar. The estimated passage for 2006 was the third highest since the projects inception in 1980 (Figure 10). The fish count was slightly higher through the first half (July 15) when compared with the previous 2 years (Figure 11), and then started to taper off during the second half of the run. Similar to 2002–2005, the 2006 daily passages followed a roughly sinusoidal pattern with peaks separated in time by 4 or 5 days (Figure 6). Fish were distributed fairly evenly between left and right bank. In previous years, passage has been biased to one bank or the other, and often this bias changed as water levels changed. When the water level is low a gravel bar becomes exposed down stream of the sonar on right bank. Fair (2000) noted that when this gravel bar becomes exposed during low water a high percentage of the fish are diverted over to left bank.

ASL Sampling

We were able to meet objective two of estimating the age, sex, and length composition of the Aniak River chum salmon escapement. The age distribution of the catch in 2006 didn't exhibit any anomalies. As in past years the 2006 chum salmon run was predominantly age-0.3 and -0.4 fish at 99.2% (61.3% and 37.9% respectively). The age-0.3 fish were the dominant age class for the entire run. Male fish dominated the run during the first half and then during the second half female fish dominated 2 out of the three sampling periods. Females accounted for 40% of the entire run.

Environmental Information

We were able to meet objective three, of monitoring selected climatic and hydrological parameters daily at the project site. Due to preseason rain and snow melt, the water level was very high which prevented installation of the sonar until late June, 2 days later then anticipated. Air and water temperatures were moderate, and with low rain fall, the water level steadily decreased throughout the season prompting frequent movement of the left bank sonar. The right bank sonar was moved less frequently due to the steeper bank which allowed for a deeper deployment closer to shore.

ACKNOWLEDGEMENTS

The author wishes to thank seasonal ADF&G staff including Elizabeth Smith, Samuel Roy, Zach Tomco and Garis Kinegak for the collection of hydroacoustic and ASL data. The Kuskokwim Native Association and David Orabutt provided invaluable logistical assistance in Aniak. Carl Pfisterer, AYK Sonar Biologist, provided project oversight, technical support, and review of this report. This project was operated using State of Alaska General Funds.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1961. Kuskokwim River salmon tagging studies, 1961. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Stock Separation Report No. 1, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1962. Kuskokwim River salmon tagging studies, 1962. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Stock Separation Report No. 2, Anchorage.

Brannian, L. K., M. J. Evenson, and J. R. Hilsinger. 2006. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim region salmon stocks, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 06-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms06-07.pdf

Buklis, L. S. 1981. Yukon River salmon studies. Project No. AFC-63-4, Anadromous Fish Conservation Act. NOAA, National Marine Fisheries Service. Technical report for period July 1, 1980 to June 30, 1981, Anchorage.

Buklis, L. S. 1993. Documentation of Arctic-Yukon-Kuskokwim region salmon escapement goals in effect as of the 1992 fishing season. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A93-03, Anchorage.

Fair, L. 2000. Aniak River sonar project report 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-10, Anchorage.

Francisco, K. R., C. A. Anderson, C. Burkey Jr., M. Fogarty, D. B. Molyneaux, C. Utermohle, and K. Vaught. 1995. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A95-15, Anchorage.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report, 1961. Vancouver, British Columbia.

Knuepfer, G. 1995. Aniak River sonar test fishing feasibility report. Alaska Department of Fish and Game,Commercial Fisheries Management and Development Division, Regional Information Report 3A95-34, Anchorage.

Linderman Jr., J. C., and D. J. Bergstrom. 2006. Kuskokwim River Chinook and chum salmon stock status and Kuskokwim area fisheries; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/sp06-35.pdf

McEwen, M. S. 2006. Sonar estimation of chum salmon passage in the Aniak River, 2002. Alaska Department of Fish and Game, Fishery Data Series No. 06-33, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-33.pdf

Molyneaux, D., and L. Dubois. 1996. Salmon age, sex and length catalog for the Kuskokwim area, 1995 progress report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A96-31, Anchorage.

Pfisterer, C. T. 2002. Estimation of Yukon River salmon passage in 2001 using hydroacoustic methodologies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-24, Anchorage.

Sandall, H. D., and C. T. Pfisterer. 2006. Sonar estimation of chum salmon passage in the Aniak River, 2003. Alaska Department of Fish and Game, Fishery Data Series No. 06-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-32.pdf

Schneiderhan, D. J. 1981. 1980 Aniak River sonar studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Escapement Report No. 19, Anchorage.

Schneiderhan, D. J. 1982a. 1981 Aniak River sonar studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Escapement Report No. 22, Anchorage.

REFERENCES CITED (Continued)

Schneiderhan, D. J. 1982b. 1982 Aniak River sonar studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Escapement Report No. 26, Anchorage.

Schneiderhan, D. J. 1984. 1983 Aniak River sonar studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Kuskokwim Escapement Report No. 32, Anchorage.

Schneiderhan, D. J. 1985. 1984 Aniak River sonar studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Escapement Report No. 36, Anchorage.

Schneiderhan, D. J. 1988. Aniak River salmon escapement study, 1985-1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A88-17, Anchorage.

Schneiderhan, D. J. 1989. Aniak River salmon escapement studies, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A89-23, Anchorage.

Wolter, K. M. 1985. Introduction to Variance Estimation. Springer-Verlag, New York.

TABLES AND FIGURES

Table 1.–Density dependent relationship between BioSonics and DIDSON counts between 1980 and 2006.

Year	BioSonics Passage	DIDSON Passage	Percent of DIDSON
1980	1,094,094	1,600,032 [a]	68.38%
1981	500,348	649,849 [a]	76.99%
1982	408,397	529,758 [a]	77.09%
1983	135,442	166,452 [a]	81.37%
1984	251,771	317,688 [a]	79.25%
1985	217,376	273,306 [a]	79.54%
1986	177,808	219,770 [a]	80.91%
1987	165,523	204,834 [a]	80.81%
1988	380,094	485,077 [a]	78.36%
1989	236,998	295,993 [a]	80.07%
1990	198,939	246,813 [a]	80.60%
1991	287,816	366,687 [a]	78.49%
1992	71,439	87,467 [a]	81.68%
1993	12,708	15,278 [a]	83.18%
1994	366,276	474,356 [a]	77.22%
1995	No Data	No Data	No Data
1996	316,767	402,195 [a]	78.76%
1997	231,807	289,654 [a]	80.03%
1998	278,534	351,792 [a]	79.18%
1999	173,363	214,429 [a]	80.85%
2000	144,157	177,384 [a]	81.27%
2001	323,076	408,830 [a]	79.02%
2002	370,272	472,346 [a]	78.39%
2003	372,559	477,544 [a]	78.02%
2004	518,117 [b]	672,931	76.99%
2005	828,257 [b]	1,151,505	71.93%
2006	770,931 [b]	1,108,625	69.54%

[a] 1980–2003 DIDSON Passage values estimated using daily relationship from 1997–2003.

[b] 2004–2006 BioSonics Passage estimates based on hourly count relationship established in 2003.

Table 2.–Daily and cumulative fish passage estimates for left and right banks, and percent passage for left and right banks and cumulative passage, Aniak River Sonar, 2006.

Date	Left Bank	Right Bank	Daily Total	Cumulative Total	LB % Passage	RB % Passage	Cumulative % passage
26-Jun	No Data	No Data	9,562[a]	9,562	0.0%	0.0%	0.9%
27-Jun	No Data	No Data	27,037[a]	36,599	0.0%	0.0%	3.3%
28-Jun	4,236	2,510	6,746	43,345	0.8%	0.5%	3.9%
29-Jun	4,860	8,612	13,472	56,817	0.9%	1.6%	5.1%
30-Jun	3,245	8,693	11,938	68,755	0.6%	1.6%	6.2%
1-Jul	10,274	16,566	26,840	95,595	1.9%	3.0%	8.6%
2-Jul	9,623	23,135	32,758	128,353	1.8%	4.3%	11.6%
3-Jul	5,973	14,418	20,391	148,744	1.1%	2.7%	13.4%
4-Jul	10,514	22,026	32,540	181,283	2.0%	4.1%	16.4%
5-Jul	20,445	25,452	45,896	227,180	3.9%	4.7%	20.5%
6-Jul	19,378	24,576	43,954	271,134	3.7%	4.5%	24.5%
7-Jul	20,278	27,420	47,699	318,832	3.8%	5.0%	28.8%
8-Jul	14,091	16,934	31,025	349,857	2.7%	3.1%	31.6%
9-Jul	21,130	27,388	48,518	398,376	4.0%	5.0%	35.9%
10-Jul	25,158	23,731	48,889	447,265	4.8%	4.4%	40.3%
11-Jul	10,732	16,294	27,026	474,291	2.0%	3.0%	42.8%
12-Jul	14,240	17,908	32,148	506,439	2.7%	3.3%	45.7%
13-Jul	16,728	19,790	36,518	542,957	3.2%	3.6%	49.0%
14-Jul	10,664	9,152	19,815	562,772	2.0%	1.7%	50.8%
15-Jul	9,253	9,251	18,504	581,276	1.8%	1.7%	52.4%
16-Jul	24,490	18,578	43,068	624,344	4.6%	3.4%	56.3%
17-Jul	38,795	22,844	61,639	685,983	7.3%	4.2%	61.9%
18-Jul	29,949	22,674	52,623	738,606	5.7%	4.2%	66.6%
19-Jul	24,656	18,403	43,059	781,665	4.7%	3.4%	70.5%
20-Jul	21,224	15,911	37,135	818,800	4.0%	2.9%	73.9%
21-Jul	28,452	21,258	49,710	868,510	5.4%	3.9%	78.3%
22-Jul	22,102	17,400	39,502	908,012	4.2%	3.2%	81.9%
23-Jul	16,124	13,224	29,348	937,360	3.0%	2.4%	84.6%
24-Jul	11,918	11,008	22,926	960,286	2.3%	2.0%	86.6%
25-Jul	10,282	9,546	19,828	980,114	1.9%	1.8%	88.4%
26-Jul	15,738	11,494	27,232	1,007,346	3.0%	2.1%	90.9%
27-Jul	13,579	10,250	23,829	1,031,175	2.6%	1.9%	93.0%
28-Jul	12,872	11,792	24,664	1,055,839	2.4%	2.2%	95.2%
29-Jul	8,925	8,482	17,407	1,073,246	1.7%	1.6%	96.8%
30-Jul	8,812	8,942	17,754	1,091,000	1.7%	1.6%	98.4%
31-Jul	9,956	7,670	17,626	1,108,626	1.9%	1.4%	100.0%
Season Totals	528,696	543,331	1,108,626		47.7%	49.0%	

Note: The large box indicates the central 50% of the run (second and third quartiles). The small box indicates the median passage date (mean quartile).

[a] Extrapolated daily count, at end of season, due to high water.

Table 3.–Age and sex composition of chum salmon for 6 sampling strata, Aniak River Sonar, 2006.

2006 Sample			Age									Total		
			0.2			0.3			0.4					
Date (Strata)	Sample size		Number fish	Sample count	%	Number fish	Sample count	%	Number fish	Sample count	%	Number fish	Sample count	%
7/1–3		M	0	0	0.0	48,807	7	26.9	76,697	11	42.3	125,504	18	69.2
(6/26–7/4)		F	0	0	0.0	48,807	7	26.9	6,972	1	3.9	55,779	8	30.8
	26	Subtotal	0	0	0.0	97,614	14	53.8	83,669	12	46.2	181,283	26	100.0
7/6		M	0	0	0.0	62,119	28	45.2	33,278	15	24.2	95,397	43	69.4
(7/5–7)		F	0	0	0.0	24,404	11	17.7	17,748	8	12.9	42,152	19	30.6
	62	Subtotal	0	0	0.0	86,523	39	62.9	51,026	23	37.1	137,549	62	100.0
7/8–11		M	0	0	0.0	107,752	75	48.1	57,468	40	25.6	165,220	115	73.7
(7/8–13)		F	0	0	0.0	35,917	25	16.0	22,987	16	10.3	58,904	41	26.3
	156	Subtotal	0	0	0.0	143,669	100	64.1	80,455	56	35.9	224,124	156	100.0
7/15–16		M	0	0	0.0	68,368	59	28.7	48,669	42	20.4	117,036	101	49.0
(7/14–19)		F	0	0	0.0	85,749	74	35.9	35,922	31	15.0	121,672	105	51.0
	206	Subtotal	0	0	0.0	154,117	133	64.6	84,591	73	35.4	238,708	206	100.0
7/23–24		M	2,363	2	1.0	67,350	57	29.8	50,808	43	22.5	120,521	102	53.4
(7/20–26)		F	4,726	4	2.1	54,352	46	24.1	46,081	39	20.4	105,160	89	46.6
	191	Subtotal	7,089	6	3.1	121,702	103	53.9	96,889	82	42.9	225,681	191	100.0
7/28		M	0	0	0.0	28,937	30	28.6	11,575	12	11.5	40,512	42	40.0
(7/27–31)		F	1,929	2	1.9	47,264	49	46.6	11,575	12	11.4	60,768	63	60.0
	105	Subtotal	1,929	2	1.9	76,201	79	75.2	23,150	24	22.9	101,280	105	100.0
Season		M	2,363	2	0.2	383,333	258	34.6	278,494	187	25.1	664,189	447	59.9
		F	6,656	4	0.6	296,494	199	26.7	141,286	95	12.8	444,436	299	40.1
	746	Total	9,019	6	0.8	679,827	457	61.3	419,780	283	37.9	1,108,625	746	100.0

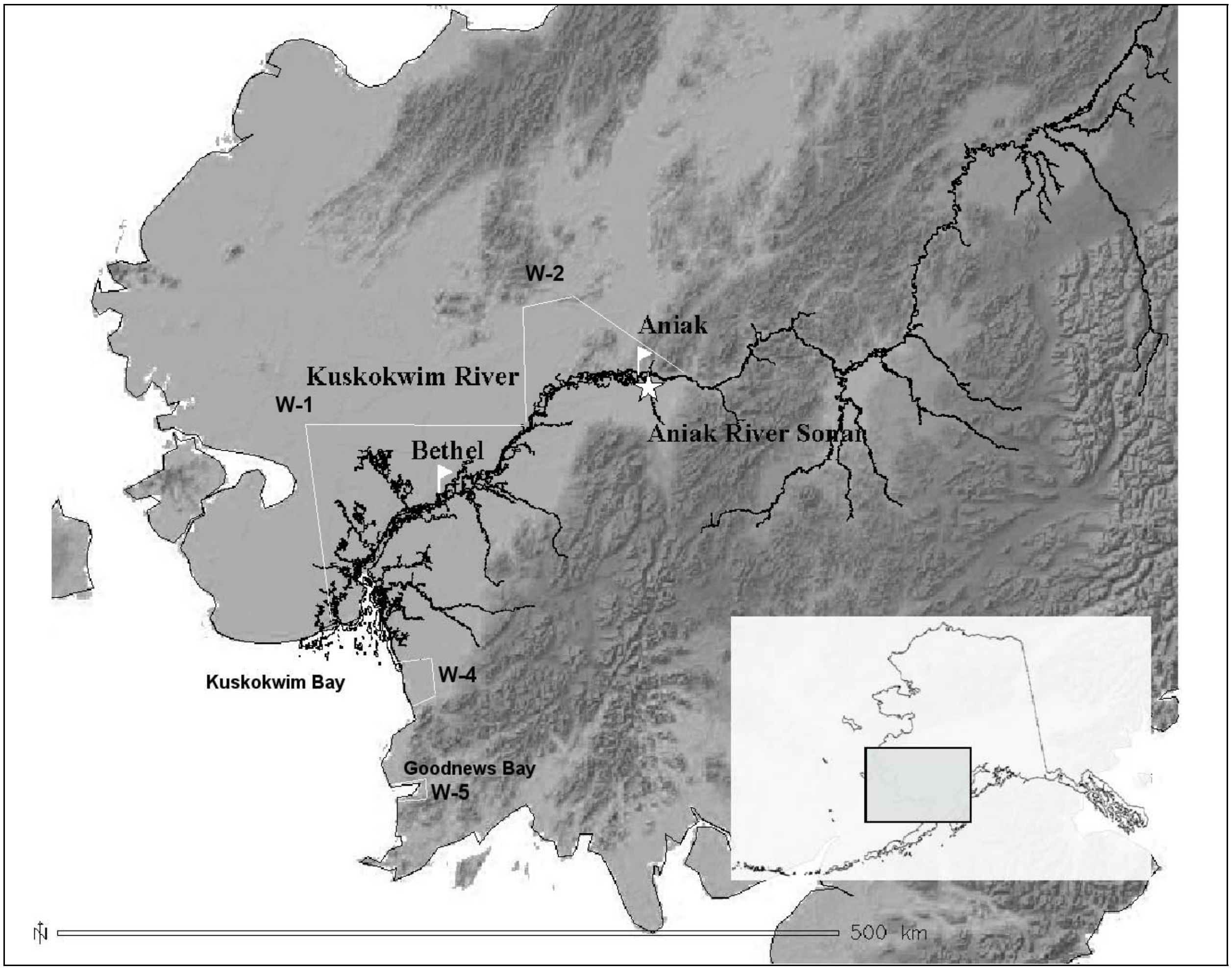


Figure 1.–Kuskokwim River Area, with lower river fishing districts (W-1, W-2, W-4, W-5) delineated.

Figure 2.–Location of Aniak River Sonar site, 2006.

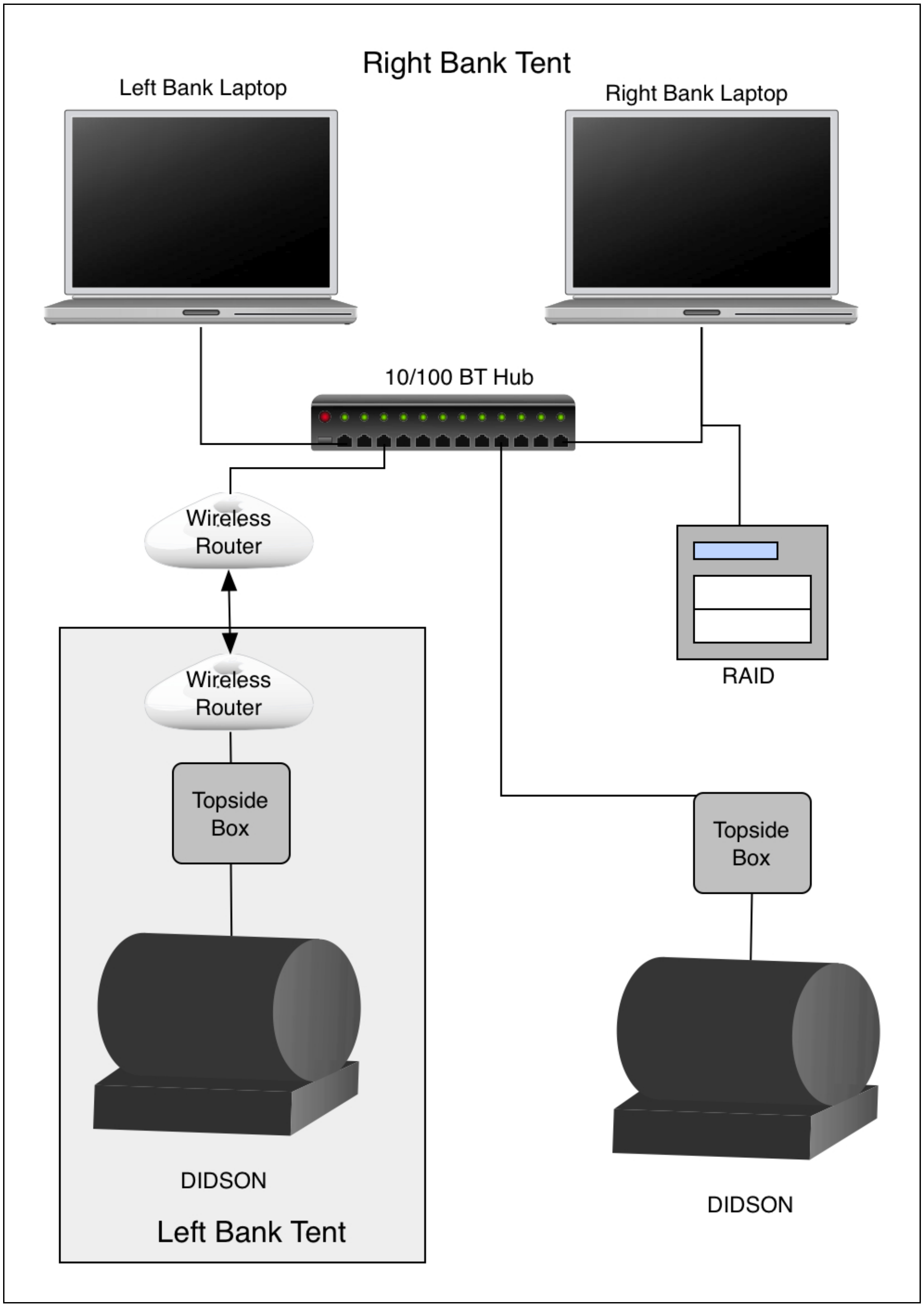


Figure 3.–DIDSON Sonar equipment schematic, Aniak River Sonar, 2006.

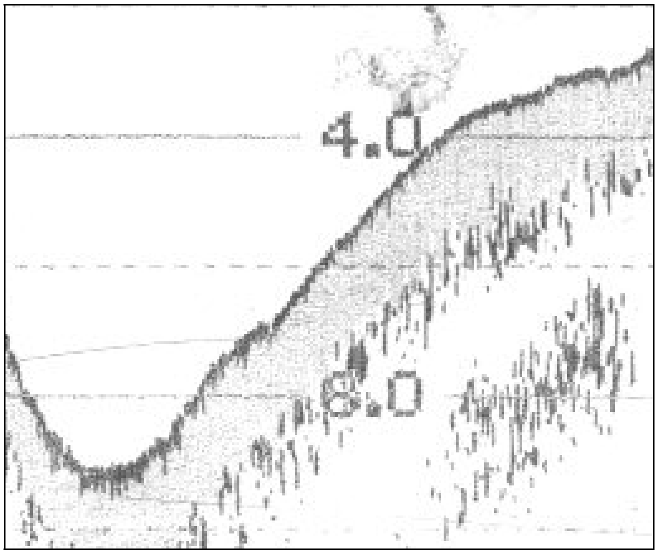


Figure 4.–Left bank bottom profile, Aniak River Sonar, 2006.

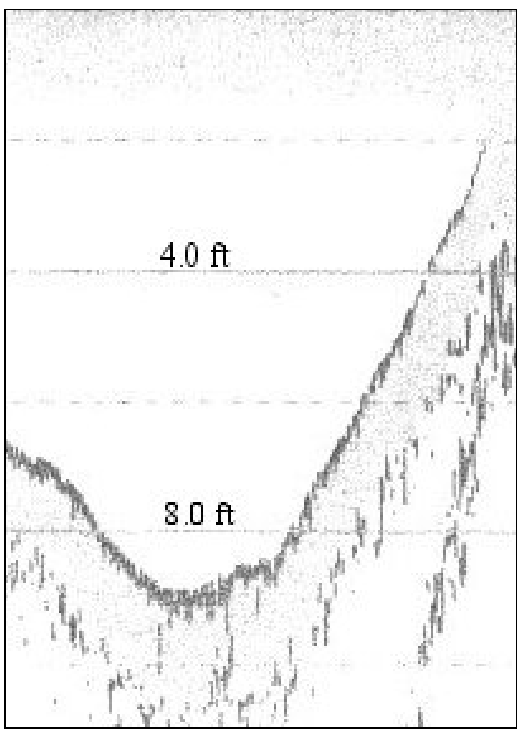


Figure 5.–Right bank bottom profile, Aniak River Sonar, 2006.

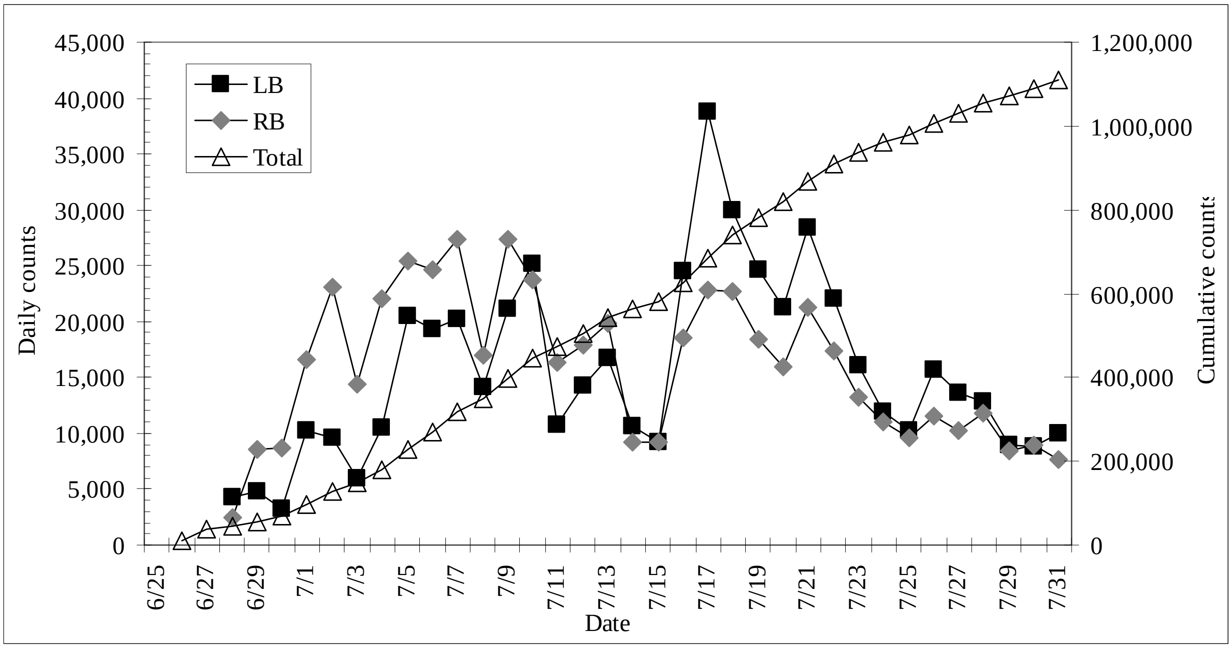
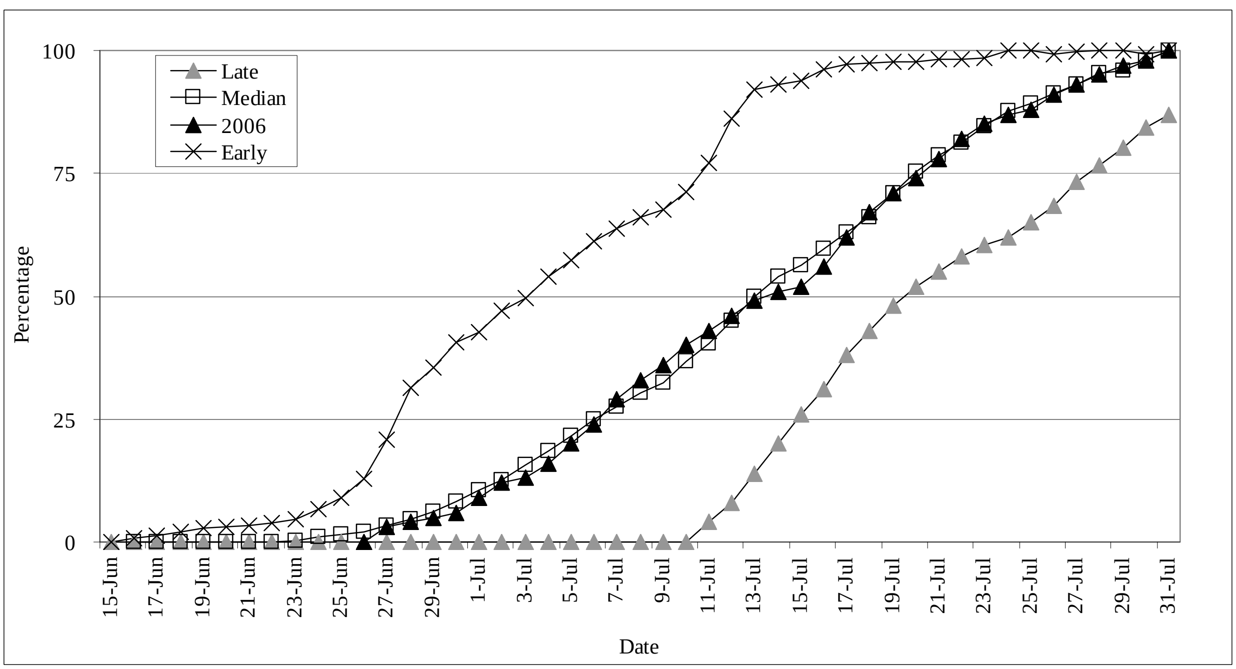


Figure 6.–Daily and cumulative passage estimates at Aniak River Sonar, 2006.



Note: Early, late, and median values were derived from the maximum, minimum and median cumulative percentages across all years, respectively.

Figure 7.–Historical run timing, 1980–2006, Aniak River Sonar.

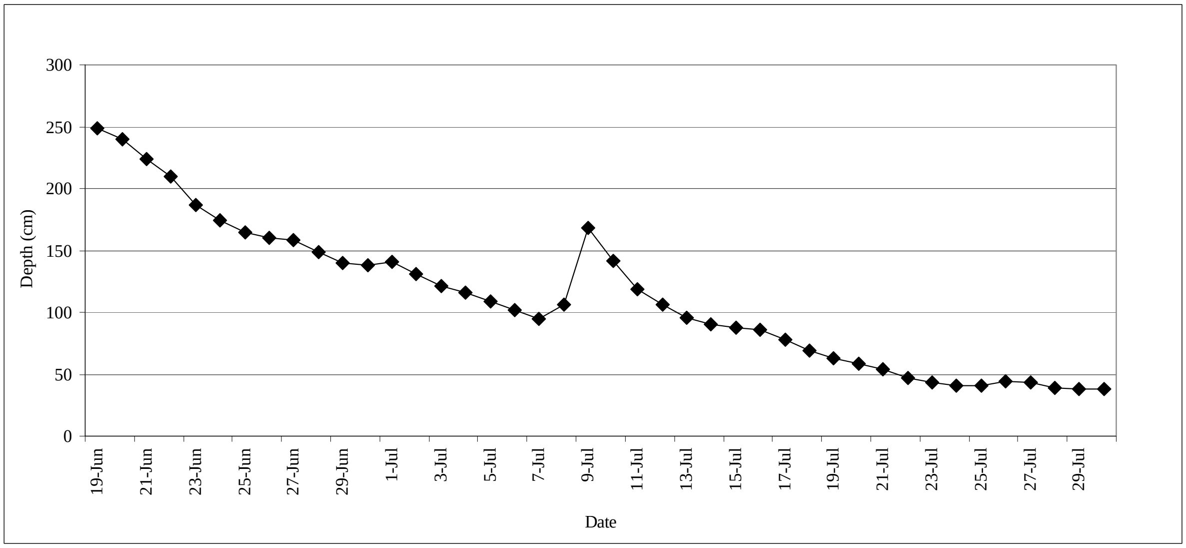


Figure 8.–Water level, Aniak River Sonar, 2006.

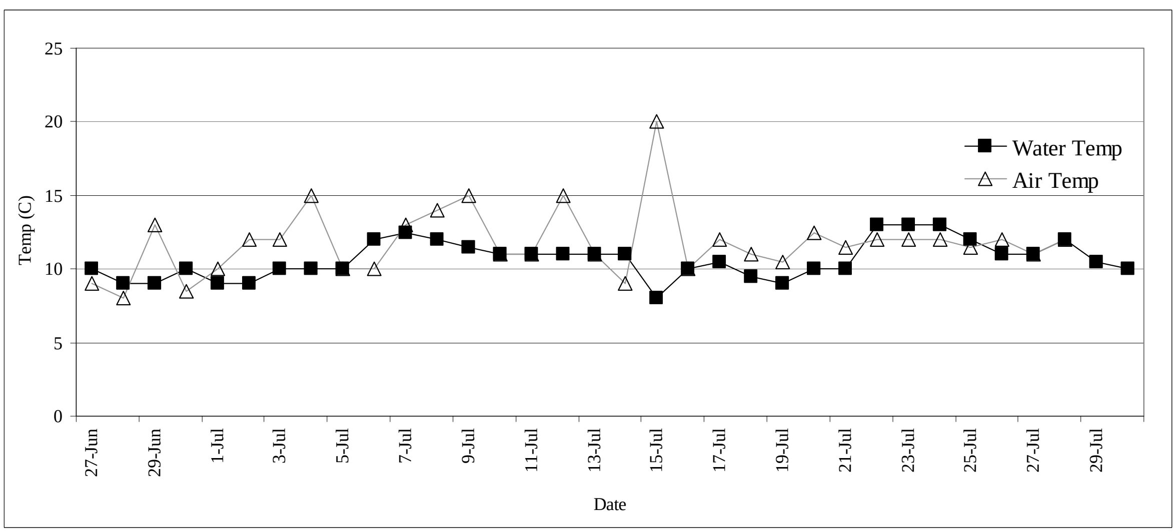


Figure 9.–Air and water temperatures, Aniak River Sonar, 2006.

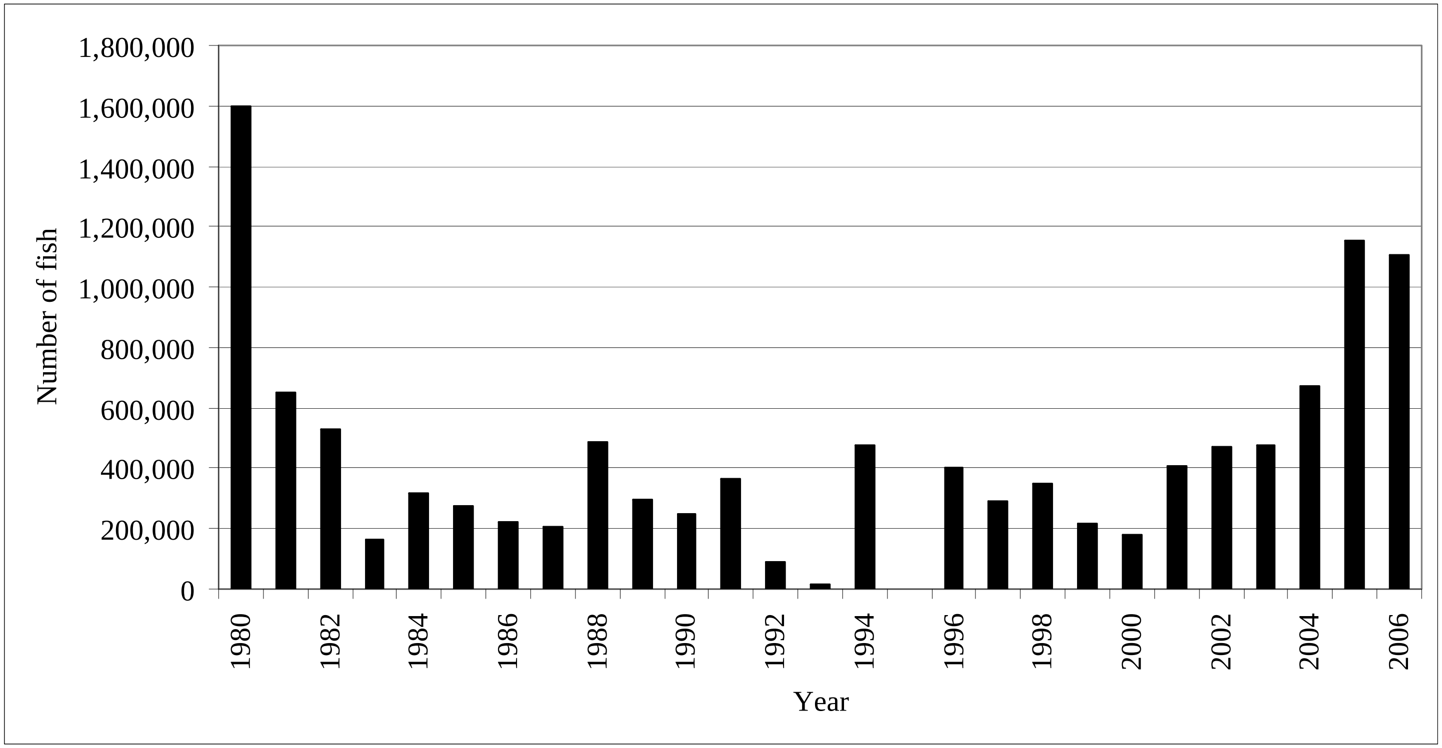


Figure 10.–Corrected historical passage at the Aniak River Sonar project, 1980–2006.

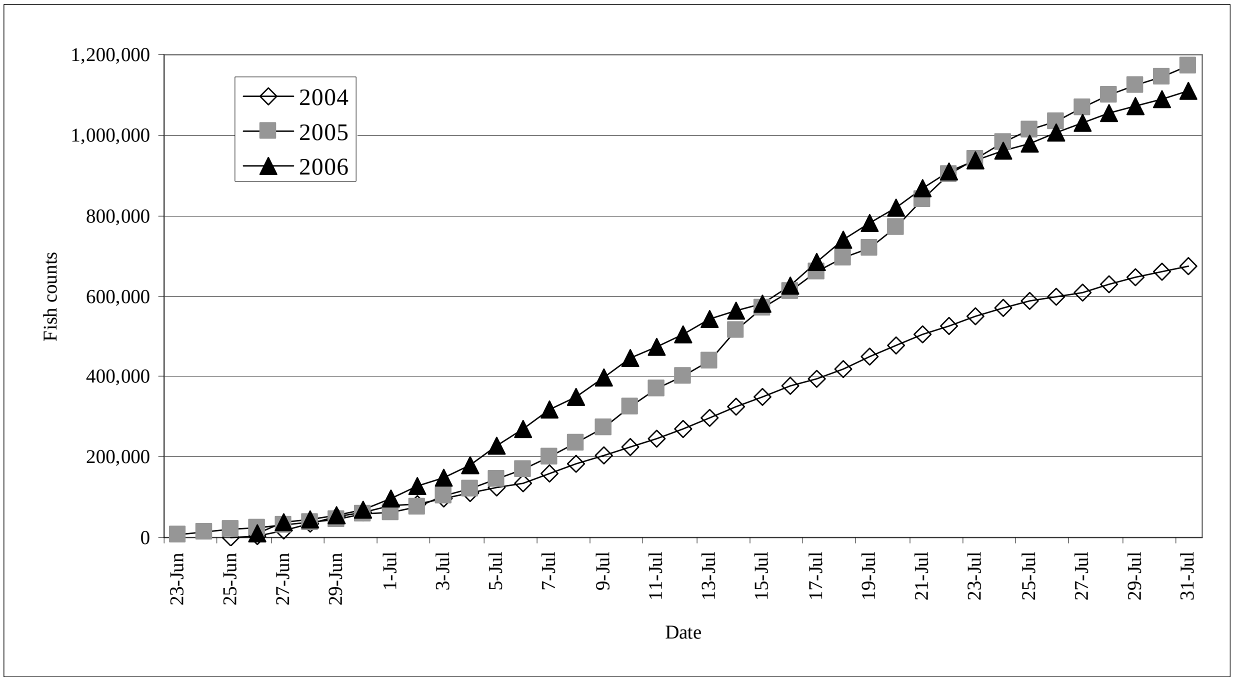


Figure 11.–Cumulative fish passage estimates, Aniak River Sonar, 2004–2006.

APPENDIX A. PROJECT HISTORY

Appendix A1.–Timetable of developmental changes of the Aniak River sonar project, 1980–2006.

Year	Event
1980	• Aniak River sonar project established • 1978 model, non-configurable Bendix sonar counter used with 60 ft artificial substrate • Single bank operation (1980–1995) • 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 (1980–1982, 1985–1989, and 1991–1996) • 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 Chinook 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 Chinook 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 1980–1981 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 Chinook salmon • Sonar estimates are not extrapolated for preseason and postseason salmon escapement (1983–1984, 1990, 1996–1997)
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 • 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

-continued-

Appendix A1.–Page 2 of 2.

Year	Event
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 (1990–1995)
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 1980–1983 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 insonification 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 preseason and postseason salmon escapement (1996–1997) • Regional Information Report documents project operations and data collection activities
1997–2000	• Project operations remain the same as 1996 for years 1997 through 2000
2001	• 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 the crew size
2002	• Sonar operations remain the same as years 1996–2001 • Species apportionment program operates for last season with similar methodology to 2001.
2003	• Sampled three 4-hour periods on each bank instead of operating 24-hours/day. • Species apportionment discontinued • DIDSON sonar was tested at the site in preparation to migrate from BioSonics to DIDSON • Escapement goal updated: SEG to provide a range of 210,000 – 370,000 fish
2004-2006	• Operated DIDSON exclusively on both banks