Fishery Data Series No. 06-42

Anvik River Sonar Chum Salmon Escapement Study, 2004

by

Malcolm S. McEwen

August 2006

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

Symbols and Abbreviations

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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

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TABLE OF CONTENTS

Page

LIST OF TABLES ii
LIST OF FIGURES ii
LIST OF APPENDICES ii
ABSTRACT 1
INTRODUCTION 1
Background Information 2
OBJECTIVES 3
METHODS 3
Study Area 3
Sonar Deployment and Operation 3
Sonar Calibration and Passage Estimation 4
Age, Sex, and Length Sampling 6
Climatological and Hydrologic Sampling 6
RESULTS 7
Sonar Assessment 7
Escapement Estimates and Run Timing 7
Spatial and Temporal Distribution 7
Age and Sex Composition 7
Hydrologic and Climatological Conditions 8
DISCUSSION 8
Escapement Estimation 8
Spatial and Temporal Distribution 9
ACKNOWLEDGEMENTS 9
REFERENCES CITED 9
TABLES AND FIGURES 13
APPENDIX A 27

LIST OF TABLES

Table **Page**

1. Summer chum and pink salmon daily and cumulative counts by bank and total, Anvik River sonar, 2004. 14
2. Annual passage estimates and associated passage timing statistics for summer chum salmon runs, Anvik River sonar, 1979–2004. 15
3. Summer chum salmon daily and cumulative proportions by bank and total, Anvik River sonar, 2004. 16
4. Age and sex composition of chum salmon, Anvik River sonar, 2004. 17
5. Hydrological and climatological observations, Anvik River sonar, 2004. 18

LIST OF FIGURES

Figure **Page**

1. Alaska portion of the Yukon River drainage showing communities and fishing districts. 20
2. Anvik River drainage with historical chum salmon escapement project locations. 21
3. Estimated passage of chum salmon by hour for each bank, Anvik River sonar, 2004. 22
4. Chum salmon daily and cumulative counts, Anvik River sonar, 2004. 22
5. Water depth, Anvik River sonar, 2004. 23
6. Hydrological and climatological observations, Anvik River sonar, 2004. 23
7. Annual age at maturity (top) and percentage females (bottom) of the Anvik River chum salmon escapement, 1972–2004. 24
8. The number of chum salmon returning to spawn, their first year as age-0.2 fish, Anvik River sonar, 1997–2001. 25

LIST OF APPENDICES

Appendix **Page**

A1. Technical specifications for the Model 241 Portable Split-Beam Digital Echo Sounder. 28

ABSTRACT

The 2004 Anvik River sonar project operated from June 22 until July 24 to estimate the passage of summer chum salmon *Oncorhynchus keta*. Data from each bank was sampled by a Hydroacoustic Technology Incorporated (HTI) sonar for 30 minutes of each hour, 24 hours a day, 7 days a week. The estimated summer chum salmon passage of 365,353 (SE 7,134) is about 9% below the minimum escapement objective for the Anvik River Biological Escapement Goal of 400,000 to 800,000 chum salmon. Based on 1979–1985 and 1987–2003 mean quartile passage dates, timing of the 2004 chum salmon run was 5 days early. A diurnal pattern of the chum salmon migration was observed with 43% of the passage occurring during the darkest hours (2100–0500 hours). Females comprised 53.6% of the catch in beach seines. The age-0.3 and -0.4 fish comprised 41.4% and 54.8%, respectively, of the chum salmon run in 2004. There was a small run of pink salmon *O. gorbuscha*, consisting of 4,500 fish, on the Anvik River this year.

Key words: chum salmon, *Oncorhynchus keta*, pink salmon, *O. gorbuscha*, HTI sonar, Anvik River

INTRODUCTION

The purpose of the Anvik River sonar project is to monitor escapement of summer chum salmon, *Oncorhynchus keta* to the Anvik River drainage, believed to be the largest producer of summer chum salmon in the Yukon River drainage (Bergstrom et al. 1999). Additional major spawning populations of summer chum salmon occur in the following tributaries of the Yukon River: Andreafsky River located at river kilometer (rkm) 167; Rodo River (rkm 719); Nulato River (rkm 777); Melozitna (rkm 938); and Tozitna rivers (rkm 1,096). Spawning tributaries in the Koyukuk River (rkm 817) are the Gisasa (rkm 907) and Hogatza (rkm 1,255) rivers. The tributaries to the Tanana River (rkm 1,118) drainage include Chena (rkm 1,480), and Salcha (rkm 1,553) rivers (Figure 1). Chinook *O. tshawytscha* and pink *O. gorbuscha* salmon spawn in the Anvik River concurrently with summer chum salmon. Fall chum, a later run of chum salmon, and coho salmon *O. kisutch* have been reported to spawn in the Anvik River drainage during the fall.

Timely and accurate reporting of information from the Anvik River sonar project allows Yukon River fishery managers to accurately assess the strength of the Anvik River summer chum salmon run to meet the established Biological Escapement Goal (BEG) (400,000 to 800,000). This information is important in the assessment of the strength of the summer chum salmon run on the Yukon River, upstream from the mouth of the Anvik River. This assessment is necessary to determine if summer chum salmon abundance will meet upstream harvest and escapement needs. A side-looking sonar, capable of detecting migrating salmon along the banks, has been in place in the Anvik River since 1980.

The Electrodynamics Division of the Bendix Corporation[1] developed the side-looking sonar and conducted a pilot study using the side-looking sonar to estimate chum salmon escapement to the Anvik River in 1979. The results indicated sonar-based estimation of chum salmon escapements to the Anvik River was superior to the counting tower method used at that time (Mauney and Buklis 1980).

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

Project results for escapement studies using sonar technology on the Anvik River, from 1979 to 2003, have been reported by Mauney and Buklis (1980), Buklis (1981-1987), Sandone (1989-1990, 1993-1996), Fair (1997), Chapell (2001), Moore and Lingnau (2002), Lingnau (2002), and Dunbar (2003).

BACKGROUND INFORMATION

Commercial and subsistence harvests of Anvik River chum salmon occur throughout the mainstem Yukon River, from the delta to the mouth of the Anvik River and within the first 19 km of the Anvik River. This section of the Yukon River includes Lower Yukon Area Districts 1, 2, and 3, and the lower portion of Subdistrict 4-A in the Upper Yukon Area (Figure 1). Most of the effort and harvest of this stock occurs in Districts 1 and 2, and in the lower portion of Subdistrict 4-A below the confluence of the Anvik and Yukon Rivers.

In the Lower Yukon Area, run timing of summer chum and Chinook salmon overlap, with runs beginning at river-ice breakup through early July. During this time, commercial fisheries in the Lower Yukon Area have traditionally targeted Chinook salmon, while Subdistrict 4-A commercial fisheries have targeted summer chum salmon. In the Lower Yukon Area, large-mesh (stretch mesh greater than 15.2 cm) gillnets were employed to harvest Chinook salmon. Although these nets were efficient for Chinook salmon, the associated harvest of summer chum salmon through 1984 was minor in relation to the size of the chum salmon run. Therefore, before the 1985 season, the Alaska Board of Fisheries (BOF), in order to allow directed harvests of summer chum salmon in the Lower Yukon, adopted regulations allowing fishing periods restricted to small-mesh (15.2 cm maximum stretch mesh) gillnets during the Chinook salmon season provided that (1) the summer chum salmon run was of sufficient size to support additional exploitation, and (2) incidental harvest of Chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species.

Increased market demand prompted allocation disputes between fishers in different districts. In February 1990, the BOF established a guideline harvest range of 400,000 to 1,200,000 summer chum salmon for the entire Yukon River, allocated by district and subdistrict based on the average harvests of the previous 15 years (ADF&G 1990). Summer chum salmon escapement to the Anvik River exceeded the lower range of the Anvik River BEG (Clark and Sandone 2001) of 400,000 salmon by an average of 233,000 salmon from 1979 to 1993.

To allow commercial exploitation of surplus chum salmon returning to the Anvik River, the BOF adopted the Anvik River chum salmon fishery management plan in March of 1994, which permits a commercial harvest of summer chum salmon in the terminal Anvik River Management Area (ARMA) (ADF&G 1994). In 1996, the BOF established a harvest limit of 100,000 pounds of chum salmon roe for the ARMA (JTC 1996). A more complete history and background information can be found in Annual Management Reports for the Yukon Area published each year by the Alaska Department of Fish and Game (ADF&G).

OBJECTIVES

Goals for the 2004 Anvik River summer chum salmon study were to estimate the timing and magnitude of adult chum salmon escapement and characterize age and sex composition. To accomplish these tasks, these specific objectives were identified:

1. Estimate timing and magnitude of chum salmon escapement using a Hydroacoustic Technology Incorporated (HTI), fixed-location, split-beam, and side-looking hydroacoustic techniques.
2. Estimate age and sex composition of the spawning population from sampled portions of the escapement using a beach seine as the capture technique, such that simultaneous 95% confidence intervals of age composition are no wider than 0.20.
3. Monitor selected climatological and hydrological parameters daily at the project site for use as baseline data.

METHODS

STUDY AREA

The Anvik River originates at an elevation of 400 m and flows in a southerly direction approximately 200 km to its mouth at rkm 512 of the Yukon River (Figure 1). This narrow runoff stream has a substrate of mainly gravel and cobble. Bedrock is exposed in some of the upper reaches. The Yellow River (Figure 2) is a major tributary of the Anvik drainage and is located approximately 100 km upstream from the mouth of the Anvik River. Downstream from the confluence of the Yellow River, the Anvik River changes from a moderate-gradient system to a low-gradient system meandering through a much broader flood plain. Turbid waters from the Yellow River greatly reduce water clarity of the Anvik River below their confluence. Numerous oxbows, old channel cutoffs, and sloughs are found throughout the lower Anvik River.

Anvik River salmon escapements were partially estimated from visual counts made at counting towers above the confluence of the Anvik and Yellow Rivers, from 1972 to 1979 (Figure 2). A site 9 km above the Yellow River, on the mainstem Anvik River, was used from 1972 to 1975 (Lebida 1973; Trasky 1974, 1976; Mauney 1977). From 1976 to 1979, a site on the mainstem Anvik River, near the confluence of Robinhood Creek and the Anvik River, was used (Figure 2; Mauney 1979, 1980; Mauney and Geiger 1977). Since 1979, the Anvik River sonar project has been located approximately 76 km upstream of the confluence of the Anvik and Yukon Rivers, 5 km below Theodore Creek (Figure 2) in Sections 34 and 35, Township 31 North, Range 61 West, Seward Meridian. The land is public, managed by Bureau of Land Management (BLM), and leased to ADF&G for public purposes until 2023. Aerial survey data indicate chum salmon spawn primarily upstream of this sonar site.

SONAR DEPLOYMENT AND OPERATION

Sonar systems operate by transmitting sound waves outward along the riverbed, from transducers located near the shore. Echoes from targets passing through the sonar beam are reflected back to the transducer and filtered and processed in the transceiver. Echoes, which satisfy criteria for strength and frequency are considered valid and are counted as fish. Echo selection criteria are designed to estimate fish passage and minimize debris counts. Echoes are counted and combined to estimate fish abundance. For the Anvik River sonar salmon counting project, all fish targets are considered salmon. Paired visual counts confirm that nearly all fish observed are salmon.

An HTI system was operated solely at the historic Anvik River sonar site in 2004. The HTI system consists of an HTI model 241 digital echo sounder (Appendix A1) and a 2° by 10° 200 kHz split-beam transducer on the right bank, and a 2.8° by 10° 200 kHz split-beam transducer on the left bank. Attached to the transducers were HTI model 662H dual-axis rotators with an HTI model 660 remote controller to facilitate aiming. The system is capable of distinguishing upstream fish from downstream fish and debris, determining fish velocity, discriminating between random reverberation and fish targets, and providing a less biased estimate of target strength (HTI 2000).

The HTI digital echo sounder is a state-of-the-art system designed for fisheries research. Accurate time-varied gains (TVG's) and stable transmit and receive sensitivities are possible. Short pulse widths can be used to improve resolution between targets. A Digital Echo Processor (DEP) is integrated into the system. A laptop computer paired with the sounder provides access to all the DEP settings and permits saving settings for future use. An oscilloscope can be linked to the sounder for diagnostic use, such as in-situ system calibration or transducer aiming. After all parameters are determined for data acquisition, the system operates 24 hours a day sampling each bank alternately for 30 minutes. Files are created by the DEP and edited to produce an estimate of fish passage.

The right bank HTI transducer and automatic rotators were mounted on an aluminum mount secured with sandbags. Aim adjustments were made using the remote control for the automatic rotators. The system configuration was set for a threshold of -42 dB with a pulse width of 0.4 milliseconds (ms) and a ping rate of 14 pulses per second. The system was verified in-situ using a 1.5-inch tungsten carbide sphere (nominal target strength of -39.5dB at 200 kHz). The target was held with monofilament line from a pole along the river bottom and in the acoustic beams at multiple distances to ensure that the full counting range of the transducer was covered. When properly aimed, the target appeared as a trace on the echogram or vertical deflection (spike) on an oscilloscope screen as it encountered the acoustic beam at a given distance. The left bank transducer was deployed in similar fashion as right bank but with the transducer and rotator cables running under the water to the right bank where the sounder for both transducers was located in a tent.

SONAR CALIBRATION AND PASSAGE ESTIMATION

At the end of each day, data collected by the DEP in 24 thirty-minute text files for each bank was transferred to another computer for tracking and editing. To facilitate tracking, echoes from stationary objects were removed using a custom program created in *C* computer language (Dunbar and Pfisterer *In prep*). The tracked data was manually edited to remove any spurious tracks such as those from any remaining bottom using Polaris, an echogram editor developed by Mr. Peter Withler through a cooperative agreement with the Department of Fisheries and Oceans Canada (DFO), ADF&G and HTI. The edited data was saved to a Microsoft Excel spreadsheet where each 30-minute file representing a sample was multiplied by 2 to account for a full hour. Linear interpolation was used when complete 30-minute periods of data were missing. If data from a complete 30 minutes was missing, counts were interpolated by averaging counts from 2 hours before and 2 hours after the missing period. If two complete 30-minute sample periods were missing, counts were interpolated by averaging counts from 3 hours before and 3 hours after the missing periods. If three 30-minute sample periods were missing, counts were interpolated by averaging counts from 4 hours before and 4 hours after the missing periods. If four or more 30-minute sample periods were missing, counts were interpolated by averaging counts from 5 hours before and 5 hours after the missing the hour. When a portion of a 30-minute sample was missing, passage was estimated by expansion based on the known portion of the 30 minutes. Thirty minutes was divided by the known number of minutes counted (if 10 minutes or more) and then multiplied by the number of fish counted in that period.

Echoes from stationary objects were removed before tracking by dividing data into range bins (0.2 meters), calculating the moving average (averaging window of 1,000 echoes) of the voltage in each range bin, and then removing the echo if the voltage was within 1.7 standard deviations of the mean and at least 100 echoes were within that range bin. The echo was not removed if the percentage of missed echoes relative to observed echoes was greater than 80. The percentage of missed relative to observed echoes was calculated by summing differences between observed ping numbers minus one and then dividing by the total number of echoes in the range bin.

After the data was cleaned up with the bottom removal program, the echoes were grouped into fish tracks that could be enumerated to produce an estimate of fish passage. Three times a day (0100, 1300, 1900 hours), a technician on each bank would manually track fish traces to determine distribution.

Final editing was accomplished with Polaris. After all editing was complete; the data was imported to an Excel spreadsheet where the final estimate of hourly and daily fish passage was produced. Since the HTI estimates were produced from 30-minute samples, a variance estimate was calculated. The daily passage for bank *z* on day *d* was calculated by summing the hourly passage rates for each hour as follows:

$$\hat{y}_{dz} = \sum_{p=1}^{24} \frac{y_{dzp}}{h_{dzp}} \tag{1}$$

where h_{dzp} is the fraction of the hour sampled on day *d*, bank *z*, period *p* and y_{dzp} is the count for period *p* on bank *z* of day *d*.

The variance for the passage estimate for bank *z* on day *d* is estimated as:

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

where n_{dz} is the number of samples in the day (24) and f_{dz} is the fraction of the day sampled (12/24=0.5) and y_{dzp} is the hourly count for day *d* on bank *z* for sample *p*.

Since the passage estimates are assumed independent between zones and among days, the total variance is estimated as the sum of the variances.

$$\hat{V}ar(\hat{y}) = \sum_{d} \sum_{z} \hat{V}ar(\hat{y}_{dz}) \tag{3}$$

During setup and at least three times a day when conditions allowed, operators attempted to visually count passing fish from counting towers. This counting helped train personnel to interpret charts and gave an estimate of the daily proportion of pink salmon since sonar counters do not distinguish between species of fish. This daily proportion of pink salmon was applied to the adjusted daily fish passage estimate to yield a daily estimate of pink salmon passage. Observers wore polarized sunglasses to reduce water surface glare. Glare, low light, wind ripples, rain, and turbid water conditions hampered tower observations at times. Aerial and carcass surveys were used to obtain a separate estimate for Chinook salmon abundance. These estimates were not subtracted from the sonar fish estimate because Chinook salmon often migrate further offshore making it difficult to visually count them and the abundance is low relative to the chum salmon run in the Anvik River.

AGE, SEX, AND LENGTH SAMPLING

Temporal strata, used to characterize the age and sex composition of the chum salmon escapement, were defined as quartiles using dates on which 25%, 50%, 75%, and 100% of the total run had passed the sonar site. These quartile-sampling strata were determined postseason based on 2004 run timing data. They represent an attempt to sample the escapement for age, sex, and length (ASL) information in relative proportion to the total run. In 2004, these strata were defined as: pre-June 29, June 30–July 5, July 6–10, and July 11 until end of the season.

As described in Bromaghin (1993) a sample size of 162 chum salmon samples is needed, assuming two major age classes with minor ages pooled. To meet region wide standards for the sample size needed to describe a salmon population and with a scale rejection rate of 15%, the initial seasonal ASL sample goal was 608 chum salmon. The beach seining goal for Chinook salmon was to sample all fish captured while pursuing the chum salmon sampling goal.

A beach seine (31 m long, 66 meshes deep, 6.35-cm mesh) was drifted, beginning approximately 10 m downstream of the sonar site to obtain ASL data from chum and Chinook salmon. All resident fresh-water fish captured were tallied by species and released. Pink salmon were counted by sex, based on external characteristics, and released. Chum salmon were placed in a holding pen and each was noted for sex, measured to the nearest 5 mm from mideye to tail fork, and 1 scale was taken for age determination. Where possible, scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish (Clutter and Whitesel 1956). The adipose fin was clipped on each sampled chum salmon to prevent resampling. If any Chinook salmon were caught, they were sampled using the same methods, except 3 scale samples were taken from each fish. A separate project to characterize age and sex composition of Anvik River Chinook salmon involved collecting ASL samples from Chinook salmon carcasses immediately after the sonar program terminated.

CLIMATOLOGICAL AND HYDROLOGIC SAMPLING

Climatological and hydrologic data were collected at approximately 1800 hours each day at the sonar site. Relative river depth was monitored using a staff gauge marked in 1 cm increments. Change in water depth was presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees Celsius (C) near shore at a depth of approximately 50 cm. Daily maximum and minimum air temperatures were recorded in degrees C. Subjective notes on wind speed and direction, cloud cover, and precipitation were recorded.

RESULTS

SONAR ASSESSMENT

Two HTI split-beam transducers, one on each riverbank, were operated in 2004. The deployment locations were the same sonar sites used in 2003. The right bank transducer was deployed on a slight inside bend, where a gravel bar slopes gently toward the thalweg. The left bank transducer was deployed from a more steeply sloping cut-bank on the outside of the same bend.

The right bank sonar began counting on 22 June and the left bank sonar was operational on 24 June. Both transducers collected data thru 26 July. It was a hot dry summer and the water level was low.

ESCAPEMENT ESTIMATES AND RUN TIMING

The 2004 summer chum salmon passage estimate is 365,353 (SE 7,137) (Table 1). This includes estimates for missing sector/hourly counts and expansions for left bank passage on 22–23 June.

Summer chum salmon run timing was slightly earlier than historically, based on 1979–1985 and 1987–2003 data (Table 2). The summer chum salmon passage quartiles were 3 to 5 days earlier then the historic mean. The central half of the run passed between 29 June and 9 July (Table 2), and the duration, 10 days, is near the historic mean of 9.9 days. The daily passage between the first and third quartile dates ranged from 10,281 (2 July) and 29,680 (7 July) with an estimated 141,637 fish passed by the sonar site during this time. The peak passage day of 29,680 summer chum salmon on 7 July accounted for .081 percent of the total escapement (Table 3). The summer chum salmon run was composed primarily of age-0.3 and -0.4 fish (Table 4). Age-0.4 chum salmon composed the majority of the run during the first half and then tapered off as the age-0.3 fish came in.

Pink salmon where first observed from the right bank tower on 5 July (Table 1). Most of the pink salmon (84%) were observed on the right bank, with a total passage of 4,500.

The 2004 chum salmon escapement estimate of 365,353 was 55.3% of the mean Anvik River escapement estimate of 660,210 fish, based on 1979–2003 data (Table 2). This year's escapement fell below the lower end of the BEG of 400,000 to 800,000 summer chum salmon.

SPATIAL AND TEMPORAL DISTRIBUTION

Temporal distribution of sonar estimates in 2004 indicates a distinct diurnal pattern with 43% of the counts recorded between the hours of 2100 and 0500 (Figure 3). Prior to 2004, passage has been associated with the right bank with the exception of 1992, 1996, and 1997 in which only 43%, 45%, and 39% of the adjusted passage occurred on the right bank, respectively (Sandone 1994a; Fair 1997; Chapell 2001). The shift to the left bank in those years was attributed to low water conditions that affected chum salmon migration patterns at the sonar site. The distribution of chum salmon in 2004 was consistent with historical trends with 74.8% of estimated chum salmon passing on the right bank (Figure 4).

AGE AND SEX COMPOSITION

From 26 June to 18 July, a total of 10 days of sampling was conducted for ASL. During the first half of the run, age-0.4 chum salmon accounted for 63.6% with slightly more females (50.6%) then males (Table 4). During the second half of the run, age-0.3 chum salmon accounted for 51%

and age-0.2 for 3.2%, with females comprising 60% of the run. In recent years, the overall trend shows females dominating the escapement (excluding 1995 and 1996) (Figure 7). In 2004, females accounted for 54% of the entire chum salmon run.

The 0.3 age class saw a record low escapement to the Anvik River and in 2003, the first year returning as age-0.2 fish, they represented 1.5% (3,800) of the run (Dunbar and Pfisterer *In prep*). This year, returning as age-0.3 fish, they represented 41.4% (151,256) of the run. The predominant age classes of age-0.3 and -0.4 salmon accounted for 96.2% of the age classes observed in 2004. In comparison to historical mean values from 1972–2003, the age-0.3 proportion of the 2004 run was 15.8% lower and the age-0.4 proportion was 15.7% higher; this represented an average age of 4.4 which is approximately the long term average (Figure 7). The age-0.4 fish continued to dominate the overall run this year. Last year, this age class saw 186,600 (72.7%) fish return (Dunbar and Pfisterer *In prep*), while this year they came back in greater numbers, over last year, at 200,213 (54.8%). So far, 390,613 chum salmon have returned from this year class.

HYDROLOGIC AND CLIMATOLOGICAL CONDITIONS

The summer of 2004 saw a warm, dry summer on the Anvik River. The water level decreased steadily throughout the summer (Table 5; Figure 5). It rained intermittently at the beginning of the season, which saw a rise in the water level, but then it only rained a couple of times the rest of the season. The minimum air temp was 7°C (7 July) and a maximum high of 29°C (28 June) with an average high and low of 22°C and 12°C (Table 5; Figure 6). The water temperature averaged 16°C with a maximum high of 19°C (22 July) and a minimum of 12°C (23 June).

DISCUSSION

ESCAPEMENT ESTIMATION

Chum salmon returns to the Anvik River continue to be depressed. The 2004 Anvik River summer chum salmon escapement estimate of 365,353 was 45% below the 1979–2003 average escapement and 9% below the BEG. In the last 5 years, the escapement to the Anvik River has exceeded the lower end of the BEG only once. Although the exact reasons for the low salmon runs are unknown, scientist speculate poor marine survival results from, or is accentuated by, localized weather conditions in the Bering Sea (Kruse 1998).

Despite the fact that we are coming off the 2000 parent year, which saw a record low escapement to the Anvik River (Figure 8), the return in 2004 was 30% higher than in 2003 and there is evidence that the run may be improving. While the average age of chum salmon in 2004 was consistent with historical estimates, the percentage of age-0.3 fish was 15.8% lower than the historical average. The large numbers of age-0.4 fish compensated for what is typically the much stronger age class and in fact, the size of chum salmon escapement observed this season was due, in large part, to the strength of the age-0.4 return. With the high numbers of age-0.2 chum salmon returning to the Anvik River in 2004, we are optimistic for higher numbers of age-0.3 fish next year and continued improvement in overall escapement in 2005.

Age and sex composition of the Anvik River chum salmon escapement passing the sonar site usually changes through the duration of the run. Typically, the trend is an increasing proportion of younger salmon and a higher proportion of female salmon as the run progresses (Fair 1997).

This trend held true this year with the older fish returning early and the younger fish returning later. Also, while the ratio of males to females was even during most of the run, the percentage of females increased towards the end of the season. This trend was also consistent with historical observations.

Spatial and Temporal Distribution

Buklis (1982) first reported a distinct diurnal salmon migration pattern during the 1981 season with a higher proportion of the migration passing the sonar site during darker hours of the day (Figure 3). Similar diurnal patterns were reported from 1985 through 2003. Temporal distribution of sonar estimates in 2004 indicates a distinct diurnal pattern (Figure 3). The chum salmon could be migrating in greater numbers at night because the water is cooler, and also to escape predation from various birds and mammals.

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REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1990. Arctic-Yukon Kuskokwim Region commercial and subsistence fishing regulations, salmon and miscellaneous finfish, 1990-1991 edition. Division of Commercial Fisheries, Juneau.

ADF&G (Alaska Department of Fish and Game). 1994. Salmon fisheries in the Yukon Area, Alaska, 1994. Division of Commercial Fisheries, Regional Information Report No. 3A94-31, Anchorage.

Bergstrom, D. J., K. C. Schultz, V. Golembeski, B. M. Borba, D. Huttunen, L. H. Barton, T. L. Lingnau, R. R. Holder, J. S. Hayes, K. R. Boeck, and W. H. Busher. 1999. Annual management report Yukon Area, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A99-26, Anchorage.

Bromaghin, J. F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician, 47(3): 203-206.

Buklis, L. S. 1981. Yukon River salmon studies. Anadromous fish conservation act completion report for period July 1, 1977 to June 30, 1981. Alaska Department of Fish and Game, Juneau.

Buklis, L. S. 1982. Anvik, Andreafsky and Tanana River salmon escapement studies, 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 15, Anchorage.

Buklis, L. S. 1983. Anvik and Andreafsky River salmon studies, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 20, Anchorage.

Buklis, L. S. 1984a. Anvik and Andreafsky River salmon studies, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 23, Anchorage.

Buklis, L. S. 1984b. Anvik and Andreafsky River salmon studies, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 24, Anchorage.

REFERENCES CITED (Continued)

Buklis, L. S. 1985. Anvik and Andreafsky River salmon studies, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 26, Anchorage.

Buklis, L. S. 1986. Anvik and Andreafsky River salmon studies, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 30, Anchorage.

Buklis, L. S. 1987. Anvik and Andreafsky River salmon studies, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Yukon Salmon Escapement Report No. 34, Anchorage.

Chapell, R. S. 2001. Anvik River chum salmon escapement studies, 1997-1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A01-12, Anchorage.

Clark, J. H., and Sandone G. J. 2001. Biological escapement goal for Anvik River chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A01-06, Anchorage.

Clutter, R. I. and L. W. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, Vancouver, British Columbia.

Dunbar, R. D. 2003. Anvik River sonar chum salmon escapement study, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A03-14, Anchorage.

Dunbar, R. D. and C. Pfisterer. *In prep*. Anvik River Sonar Chum Salmon Escapement Study, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Data Series, Anchorage.

Fair, L. F. 1997. Anvik River salmon escapement study, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A97-19, Anchorage.

HTI (Hydroacoustic Technology Incorporated). 2000. Model 241/243/244/split-beam digital echo sounder system operators manual version 1.8. Hydroacoustic Technology Incorporated, Seattle.

JTC (Joint Technical Committee). 1996. Yukon River salmon season review for 1996 and Technical Committee report. The United States/Canada Yukon River Joint Technical Committee, Whitehorse, Yukon Territory.

Kruse, G. H. 1998. Salmon run failures in 1997-1998: A link to anomalous ocean conditions? Alaska Department of Fish and Game, Division of Commercial Fisheries, Alaska Fisheries Research Bulletin 5(1): 55-63.

Lebida, R. C. Unpublished. Yukon River anadromous fish investigations, 1973. Alaska Department of Fish and Game, Juneau.

Lingnau, T. L. 2002. Anvik River sonar chum salmon escapement study, 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-25, Anchorage.

Mauney, J. L. 1977. Yukon River king and chum salmon escapement studies. Anadromous fish conservation act technical report for period July 1, 1975 to June 30, 1976. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J. L. and M. F. Geiger. 1977. Yukon River anadromous fish investigations. Anadromous fish conservation act completion report for period July 1, 1974 to June 30, 1977. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J. L. 1979. Yukon River salmon studies. Anadromous fish conservation act technical report for period July 1, 1977 to June 30, 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J. L. 1980. Yukon River salmon studies. Anadromous fish conservation act technical report for period July 1, 1978 to June 30, 1979. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Mauney, J. L. and L. S. Buklis 1980. Yukon River salmon studies. Anadromous fish conservation act technical report for period July 1, 1979 to June 30, 1980. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

REFERENCES CITED (Continued)

Moore, H. A. and T. L. Lingnau. 2002. Anvik River sonar chum salmon escapement study, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 33A02-05, Anchorage.

Sandone, G. J. 1989. Anvik and Andreafsky River salmon studies, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A89-03, Anchorage.

Sandone, G. J. 1990a. Anvik River salmon studies, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A90-26, Anchorage.

Sandone, G. J. 1990b. Anvik River salmon studies, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A90-35, Anchorage.

Sandone, G. J. 1993. Anvik River salmon escapement study, 1991. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report No. 93-08, Juneau.

Sandone, G. J. 1994a. Anvik River salmon escapement study, 1992. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report No. 94-02, Juneau.

Sandone, G. J. 1994b. Anvik River salmon escapement study, 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A9-28, Anchorage.

Sandone, G. J. 1995. Anvik River salmon escapement study, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A95-08, Anchorage.

Sandone, G. J. 1996. Anvik River salmon escapement study, 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A96-12, Anchorage.

Trasky, L. L. 1974. Yukon River anadromous fish investigations. Anadromous fish conservation act technical report for period July 1, 1973 to June 30, 1974. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

Trasky, L. L. 1976. Yukon River king and chum salmon escapement studies. Anadromous fish conservation act technical report for period July 1, 1974 to June 30, 1975. Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau.

TABLES AND FIGURES

Table 1.–Summer chum and pink salmon daily and cumulative counts by bank and total, Anvik River sonar, 2004.

	Daily						Cumulative					
	Right Bank		Left Bank		Total		Right Bank		Left Bank		Total	
Date	Chum	Pink	Chum	Pink	Chum	Pink	Chum	Pink	Chum	Pink	Chum	Pink
6/22	3,607	0[a]	637	0[b]	4,244	0	3,607	0	637	0	4,244	0
6/23	7,024	0	1,240	0[c]	8,264	0	10,631	0	1,877	0	12,508	0
6/24	8,813	0	302	0	9,115	0	19,443	0	2,179	0	21,622	0
6/25	7,699	0	936	0	8,635	0	27,142	0	3,115	0	30,257	0
6/26	13,168	0	2,011	0	15,179	0	40,310	0	5,126	0	45,436	0
6/27	16,833	0	3,359	0	20,191	0	57,143	0	8,484	0	65,627	0
6/28	11,114	0	4,770	0	15,884	0	68,257	0	13,254	0	81,511	0
6/29	9,128	0	3,755	0	12,883	0	77,385	0	17,008	0	94,393	0
6/30	8,496	0	2,516	0	11,012	0	85,881	0	19,524	0	105,405	0
7/01	10,388	0	1,630	0	12,018	0	96,269	0	21,154	0	117,423	0
7/02	9,293	0	988	0	10,281	0	105,562	0	22,142	0	127,704	0
7/03	13,256	0	1,684	0	14,940	0	118,818	0	23,826	0	142,644	0
7/04	15,799	0	2,464	0	18,263	0	134,617	0	26,290	0	160,907	0
7/05	13,999	22	4,874	0	18,873	22	148,616	22	31,164	0	179,780	22
7/06	15,363	0	5,612	0	20,975	0	163,979	22	36,776	0	200,755	22
7/07	19,344	0	10,336	0	29,680	0	183,323	22	47,112	0	230,435	22
7/08	14,719	0	9,689	4	24,408	4	198,042	22	56,801	4	254,843	25
7/09	11,768	0	6,297	0	18,065	0	209,810	22	63,097	4	272,907	25
7/10	10,395	0	5,605	0	16,000	0	220,205	22	68,703	4	288,908	25
7/11	6,881	142	4,185	29	11,066	171	227,086	164	72,888	33	299,974	196
7/12	5,803	0	3,258	68	9,061	68	232,889	164	76,146	101	309,035	265
7/13	4,833	0	2,698	51	7,532	51	237,722	164	78,844	152	316,566	316
7/14	4,081	136	1,760	44	5,841	180	241,804	300	80,604	196	322,407	496
7/15	3,048	0	1,222	80	4,269	80	244,851	300	81,826	276	326,677	576
7/16	2,508	328	1,084	0	3,592	328	247,360	628	82,909	276	330,269	904
7/17	2,572	484	869	159	3,440	643	249,931	1,112	83,778	435	333,709	1,547
7/18	3,483	273	1,083	106	4,565	379	253,414	1,385	84,861	541	338,275	1,926
7/19	3,571	467	1,150	0	4,721	467	256,985	1,852	86,011	541	342,995	2,393
7/20	3,744	348	1,332	0	5,076	348	260,729	2,200	87,343	541	348,072	2,741
7/21	3,118	515	1,399	25	4,517	540	263,847	2,715	88,741	566	352,589	3,281
7/22	2,649	237	941	0	3,590	237	266,497	2,952	89,682	566	356,179	3,517
7/23	1,945	401	729	0	2,674	401	268,441	3,352	90,411	566	358,853	3,918
7/24	2,046	0[d]	608	142	2,654	142	270,487	3,352	91,020	707	361,507	4,060
7/25	1,447	451[e]	560	0	2,007	451	271,934	3,803	91,580	707	363,514	4,511
7/26	1,467	0[e]	372	0	1,839	0	273,401	3,803	91,952	707	365,353	4,511
Total	273,401	3,803	91,952	707	365,353	4,511	273,401	3,803	91,952	707	365,353	4,511

[a] Right bank sonar counting began at 1400 hours.

[b] Calculated using relationship of right:left bank fish passage estimates from days immediately following.

[c] Left bank sonar counting began at 0000 hours.

[d] Right bank sonar counts terminated at 2400 hours due to spawners in beam.

[e] Calculated using relationship of right:left bank fish passage estimates from days immediately preceding.

Table 2.–Annual passage estimates and associated passage timing statistics for summer chum salmon runs, Anvik River sonar, 1979–2004.

Year	Sonar Passage Estimate	Day of First Salmon Counts	First Quartile Day	Median Day	Third Quartile Day	First Count & First Quartile	Days Between Quartiles		
							First & Median	Median & Third	First & Third
1979	277,712	6/23	7/02	7/08	7/12	9	6	4	10
1980	482,181	6/28	7/06	7/11	7/16	8	5	5	10
1981	1,479,582	6/20	6/27	7/02	7/07	7	5	5	10
1982	444,581	6/25	7/07	7/11	7/14	12	4	3	7
1983	362,912	6/21	6/30	7/07	7/12	9	7	5	12
1984	891,028	6/22	7/05	7/09	7/13	13	4	4	8
1985	1,080,243	7/05	7/10	7/13	7/16	5	3	3	6
1986	1,085,750	6/21	6/29	7/02	7/06	8	3	4	7
1987	455,876	6/21	7/05	7/12	7/16	14	7	4	11
1988	1,125,449	6/21	6/30	7/03	7/09	9	3	6	9
1989	636,906	6/20	7/01	7/07	7/13	11	6	6	12
1990	403,627	6/22	7/02	7/07	7/15	10	5	8	13
1991	847,772	6/21	7/01	7/10	7/16	10	9	6	15
1992	775,626	6/29	7/05	7/08	7/12	6	3	4	7
1993	517,409	6/19	7/05	7/12	7/18	16	7	6	13
1994	1,124,689	6/19	7/01	7/07	7/11	12	6	4	10
1995	1,339,418	6/19	7/01	7/06	7/11	12	5	5	10
1996	933,240	6/18	6/25	7/01	7/06	7	6	5	11
1997	605,752	6/19	6/28	7/03	7/10	9	5	7	12
1998	487,301	6/22	7/05	7/10	7/14	13	5	4	9
1999	437,356	6/27	7/06	7/10	7/16	9	4	6	10
2000	196,349	6/21	7/08	7/11	7/13	17	3	2	5
2001	224,058	6/26	7/06	7/10	7/15	10	4	5	9
2002	459,058	6/22	7/03	7/07	7/12	11	4	5	9
2003	256,920	6/21	7/05	7/10	7/15	14	5	5	10
2004	365,353	6/22	6/29	7/05	7/09	7	6	4	10
Average	**660,210**	**6/22**	**7/03**	**7/08**	**7/13**	**10.5**	**5.0**	**4.9**	**9.9**
Median	**502,355**	**6/21**	**7/04**	**7/08**	**7/13**	**10.0**	**5.0**	**5.0**	**10.0**
SD	**364,159**		**3.6**	**3.3**	**3.0**	**3.0**	**1.5**	**1.3**	**2.3**

Note: The mean and standard deviation of the timing statistics includes estimates from years 1979–1985 and 1987-2003. In 1986, sonar counting operations were terminated early, probably resulting in the incorrect calculation of the quartile statistics. Therefore, the 1986 run timing statistics were excluded from the calculation of the overall mean and timing statistic and associated standard deviation (SD).

Table 3.–Summer chum salmon daily and cumulative proportions by bank and total, Anvik River sonar, 2004.

	Daily			Cumulative		
Date	**Right Bank**	**Left Bank**	**Total**	**Right Bank**	**Left Bank**	**Total**
6/22	0.010	0.002	0.012	0.010	0.002	0.012
6/23	0.019	0.003	0.023	0.029	0.005	0.034
6/24	0.024	0.001	0.025	0.053	0.006	0.059
6/25	0.021	0.003	0.024	0.074	0.009	0.083
6/26	0.036	0.006	0.042	0.110	0.014	0.124
6/27	0.046	0.009	0.055	0.156	0.023	0.180
6/28	0.030	0.013	0.043	0.187	0.036	0.223
6/29	0.025	0.010	0.035	0.212	0.047	0.258
6/30	0.023	0.007	0.030	0.235	0.053	0.289
7/01	0.028	0.004	0.033	0.263	0.058	0.321
7/02	0.025	0.003	0.028	0.289	0.061	0.350
7/03	0.036	0.005	0.041	0.325	0.065	0.390
7/04	0.043	0.007	0.050	0.368	0.072	0.440
7/05	0.038	0.013	0.052	0.407	0.085	0.492
7/06	0.042	0.015	0.057	0.449	0.101	0.549
7/07	0.053	0.028	0.081	0.502	0.129	0.631
7/08	0.040	0.027	0.067	0.542	0.155	0.698
7/09	0.032	0.017	0.049	0.574	0.173	0.747
7/10	0.028	0.015	0.044	0.603	0.188	0.791
7/11	0.019	0.011	0.030	0.622	0.199	0.821
7/12	0.016	0.009	0.025	0.637	0.208	0.846
7/13	0.013	0.007	0.021	0.651	0.216	0.866
7/14	0.011	0.005	0.016	0.662	0.221	0.882
7/15	0.008	0.003	0.012	0.670	0.224	0.894
7/16	0.007	0.003	0.010	0.677	0.227	0.904
7/17	0.007	0.002	0.009	0.684	0.229	0.913
7/18	0.010	0.003	0.012	0.694	0.232	0.926
7/19	0.010	0.003	0.013	0.703	0.235	0.939
7/20	0.010	0.004	0.014	0.714	0.239	0.953
7/21	0.009	0.004	0.012	0.722	0.243	0.965
7/22	0.007	0.003	0.010	0.729	0.245	0.975
7/23	0.005	0.002	0.007	0.735	0.247	0.982
7/24	0.006	0.002	0.007	0.740	0.249	0.989
7/25	0.004	0.002	0.005	0.744	0.251	0.995
7/26	0.004	0.001	0.005	0.748	0.252	1.000
Total	**0.748**	**0.252**	**1.000**			

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).

Table 4.–Age and sex composition of chum salmon, Anvik River sonar, 2004.

			Age									
			0.2		0.3		0.4		0.5		Total	
2006 Sample Date (Strata)	**Sample Size**		**Est. Escapement**	**No. Sample**	**Est. Escapement**	**No. Sample**	**Est. Escapement**	**No. Sample**	**Est. Escapement**	**No. Sample**	**Est. Escapement**	**%**
6/26 6/28 6/30	189	M	0	0	14,546	26	42,900	77	1,159	2	58,605	55.6
(6/25-7/1)		F	1,159	2	13,386	24	32,359	58	0	0	46,905	44.4
		Subtotal	1,159	2	27,932	50	75,259	135	1,159	2	105,405	100
7/03 7/04 7/05	102	M	0	0	15,321	21	16,809	23	0	0	32,130	43.1
(7/2-7)		F	0	0	17,478	24	24,767	34	0	0	42,245	56.9
		Subtotal	0	0	32,799	45	41,576	57	0	0	74,375	100
7/09	147	M	4,849	5	33,945	35	33,945	35	0	0	72,740	51
(7/8-13)		F	1,997	2	37,796	39	30,094	31	0	0	69,887	49
		Subtotal	6,846	7	71,741	74	64,040	66	0	0	142,627	100
7/15 7/18	120	M	1,417	4	5,025	14	5,712	16	344	1	12,497	29.2
(7/14-26)		F	1,804	5	17,178	48	11,467	32	0	0	30,449	70.8
		Subtotal	3,221	9	22,203	62	17,178	48	344	1	42,946	100
Seasonal	558	M	5,846	9	62,841	96	98,645	151	1,827	3	169,158	46.4
		F	5,846	9	88,415	135	101,568	155	0	0	195,829	53.6
		Total	11,691	18	151,256	231	200,213	306	1,827	3	365,353	100

Table 5.–Hydrological and climatological observations, Anvik River sonar, 2004.

					Temperature (C)			Water Height			
		Wind		Sky	Air	Air		Actual	Relative	Water	
Date	**Precipitation**	**Direction**	**Velocity**	**Code**	**Min.**	**Max.**	**Water Temp.**	**(cm)**	**(cm)**	**Color**	**Comments**
6/18									0.0		Set measurement stake at ?? Cm
6/19									0.0		
6/20								50.0	50.0		set in at 50cm
6/21	I	NE	10	4	15			44.0	44.0	lt	
6/22	I	calm		4	16			50.0	50.0	lt	reset at 50cm
6/23	I	NE	5	4	12		12	54.0	4.0	lt	
6/24	I	calm		4	12	16	14	57.0	7.0	lt	
6/25	none	calm		1	10	18	13	51.0	1.0	lt	
6/26	none	calm		1	13	20	13	48.0	-2.0	cl	
6/27	none	NE	5	1	15	27	14	40.0	-10.0	lt	
6/28	none	NW	5	2	15	29	15	35.0	-15.0	cl	
6/29	none	calm		2	13	27	18	32.0	-18.0	cl	
6/30	none	calm		5	15	26	18	29.0	-21.0	cl	moved out at 1515 reset at 50cm
7/01	none	calm		5	12	25	15	46.0	-25.0	cl	
7/02	none	calm		5	10	20	15	44.0	-27.0	cl	
7/03	none	calm		4	13	19	14	41.0	-30.0	lt	moved H^2O gauge to above weir, 60 cm
7/04	none	NE	10	2	10	20	14	56.0	-34.0	lt	
7/05	none	calm		2	14	19	14	56.0	-34.0	lt	
7/06	none	N	5	2	13	22	16	51.0	-39.0	lt	
7/07	none	variable	5-10	3	7	24	16	49.0	-41.0	cl	
7/08	none	variable	5	2	14	23	16	47.0	-43.0	cl	
7/09	none	N, NE	5	1	10	22	17	46.0	-44.0	cl	
7/10	none	N	3-5	1	10	23	17	45.0	-45.0	cl	
7/11	none	calm		1	10	23	17	44.0	-46.0	cl	
7/12	none	calm		1	12	25	18	40.0	-50.0	cl	
7/13	none	calm		1	12	25	18	38.0	-52.0	cl	
7/14											
7/15	I (AM only)	S	5-7	2	12	24	17	35.0	-55.0	lt	
7/16	I	NE	5-10	3	13	19	17	34.0	-56.0	cl	
7/17	I	calm		2	12	18	17	33.0	-57.0	cl	

-continued-

Table 5.–Page 2 of 2.

					Temperature (C)			Water Height			
Date	Precipitation	Wind Direction	Velocity	Sky Code	Air Min.	Air Max.	Water Temp.	Actual (cm)	Relative (cm)	Water Color	Comments
7/18	I	calm		2	12	18	17	35.0	-55.0	lt	
7/19	none	NW	5-10	1	11	20	18	37.0	-53.0	cl	
7/20	none	NW	5	1	12	22	18	35.0	-55.0	cl	
7/21	none	NW	5	1	12	22	18	35.0	-55.0	cl	
7/22	none	NW	5-10	2	9	20	19	33.0	-57.0	cl	
7/23	some	nw	5	1	8	20	17	35.0	-55.0	lt	
7/24	none	calm		2	9	20	18	33.0	-57.0	lt	
7/25	none	gusty	5-10	3	13	19	17	30.0	-60.0	cl	
7/26	I	NW	10-15	4	12	19	17	29.0	-61.0	cl	rained hard last night
7/27											

Sky Codes:
- 0 No observation made.
- 1 Clear sky, cloud cover < 10% of sky.
- 2 Cloud cover 10% - 50% of sky.
- 3 Cloud cover > 50% of sky.
- 4 Completely overcast.
- 5 Fog or thick haze or smoke.

Precipitation Codes:
- I Intermittent rain
- R Continuous rain
- S Snow
- S&R Mixed snow and rain
- H Hail
- T Thunder showers

Water Color:
- Cl Clear
- Lt Light Brown
- Br Brown
- Dk Dark Brown
- Tr Turbid: murky or glacial

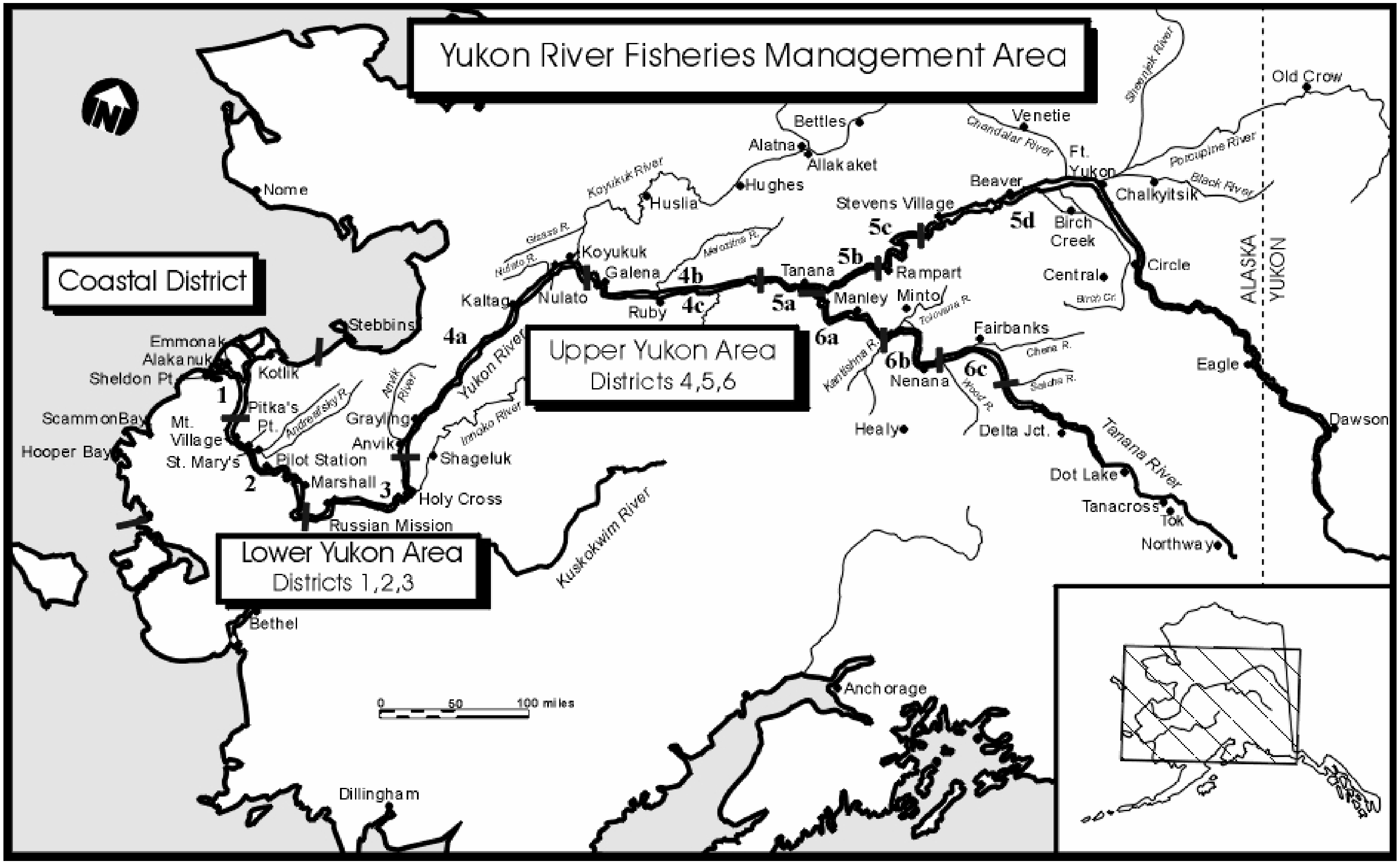


Figure 1.–Alaska portion of the Yukon River drainage showing communities and fishing districts.

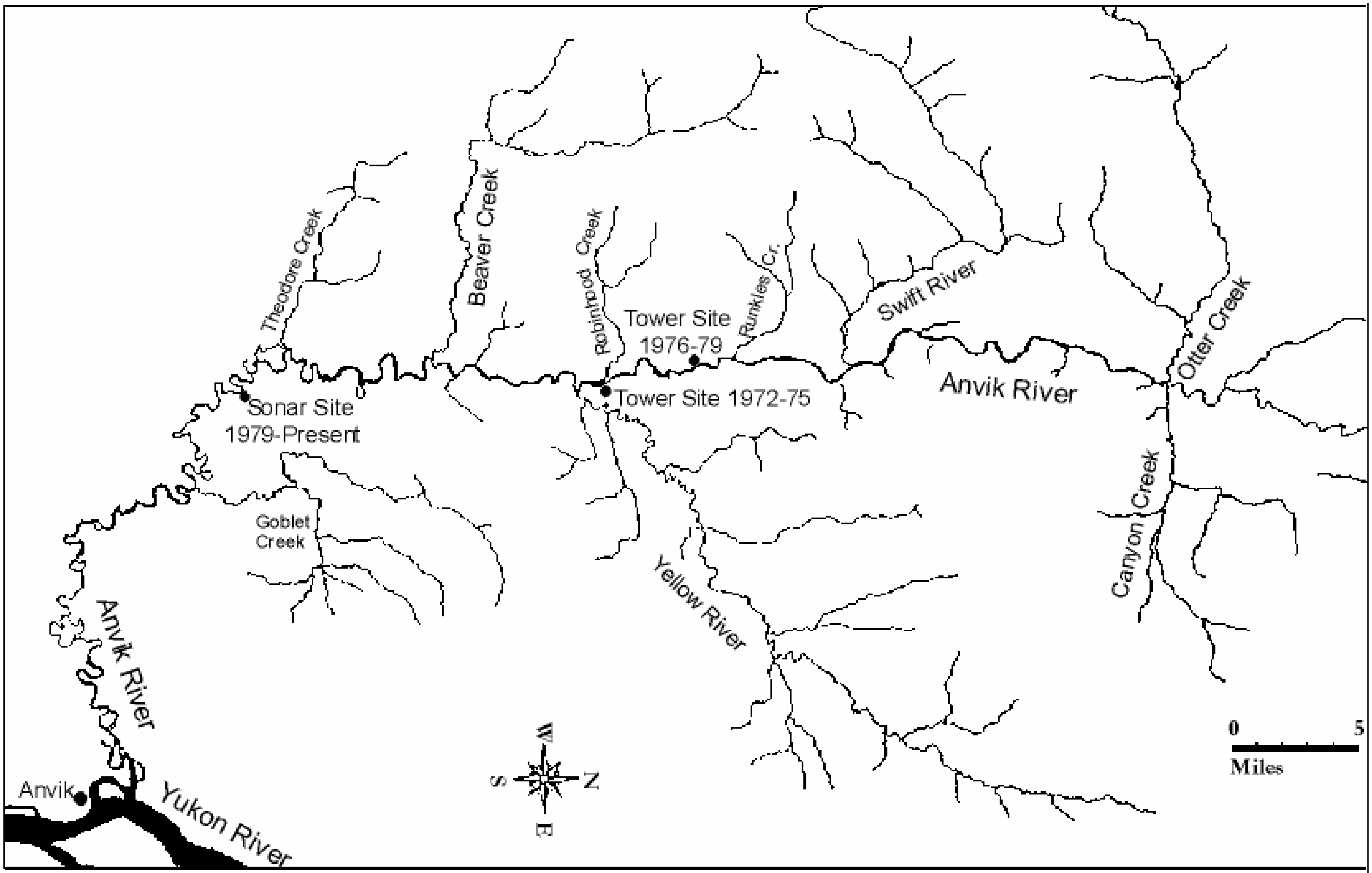


Figure 2.–Anvik River drainage with historical chum salmon escapement project locations.

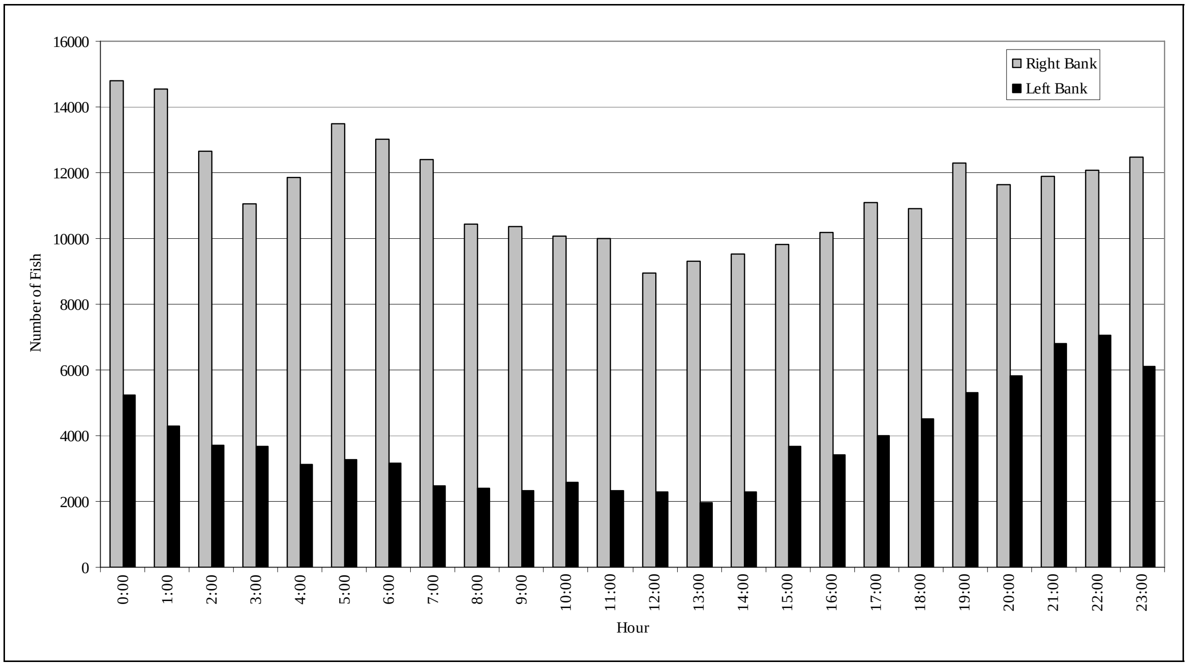


Figure 3.–Estimated passage of chum salmon by hour for each bank, Anvik River sonar, 2004.

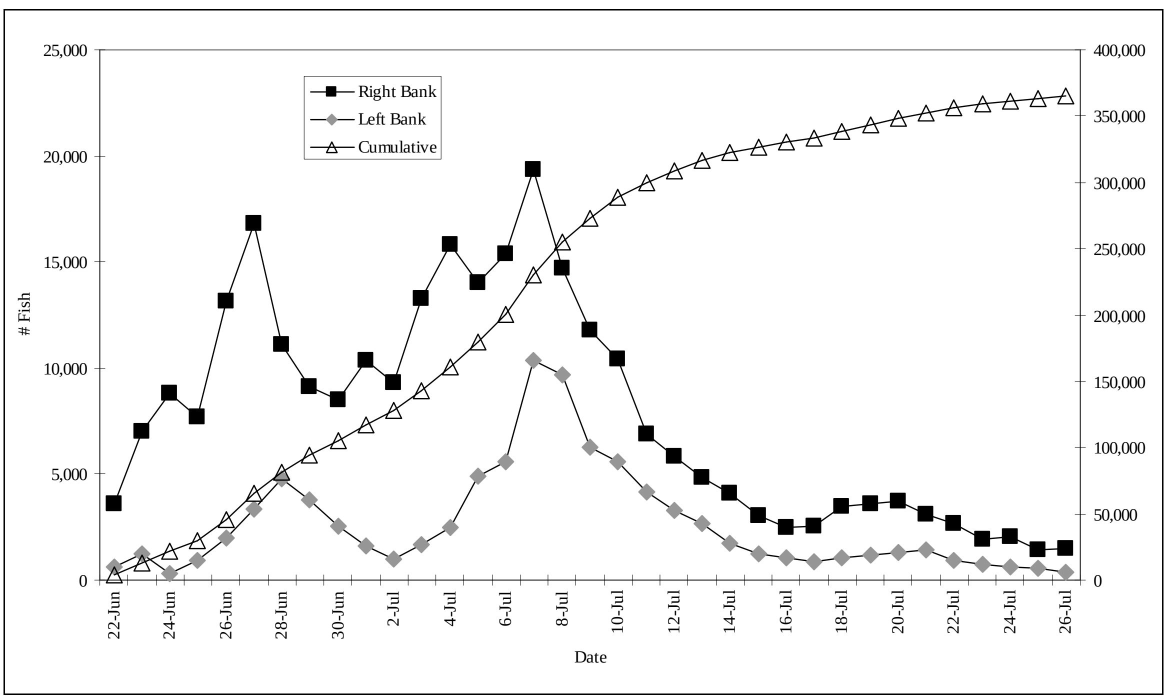
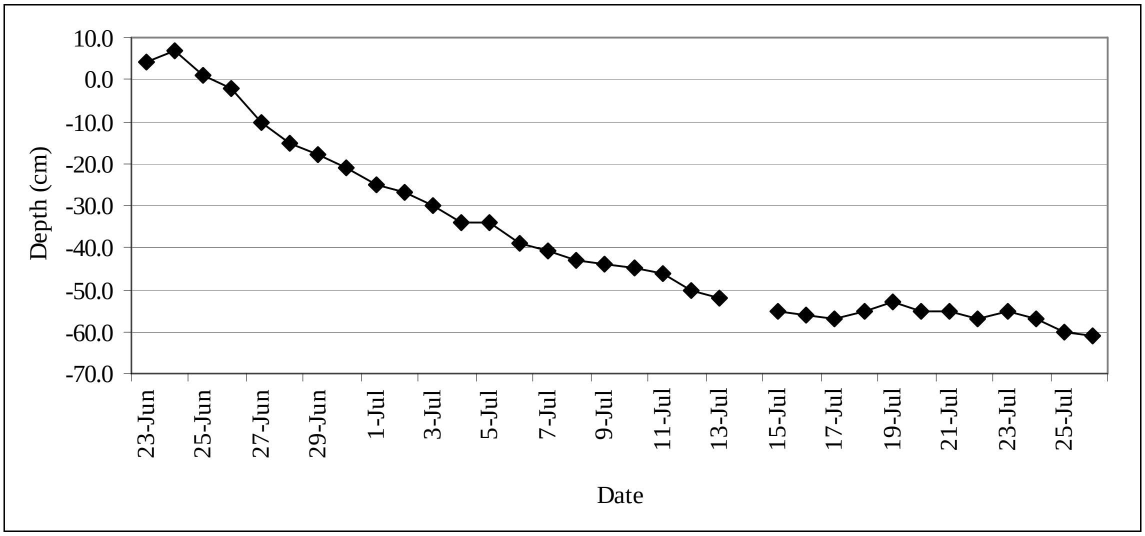
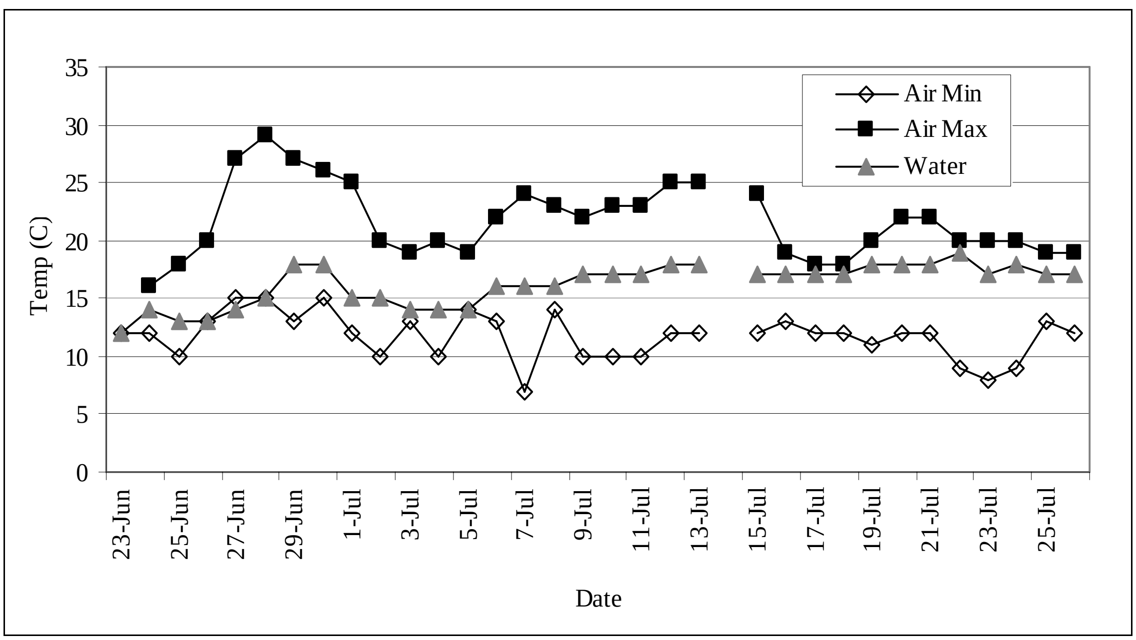


Figure 4.–Chum salmon daily and cumulative counts, Anvik River sonar, 2004.



Note: Data is missing for 7/14 due to lack of observation.

Figure 5.–Water depth, Anvik River sonar, 2004.



Note: Data is missing for 7/14 due to lack of observation.

Figure 6.–Hydrological and climatological observations, Anvik River sonar, 2004.

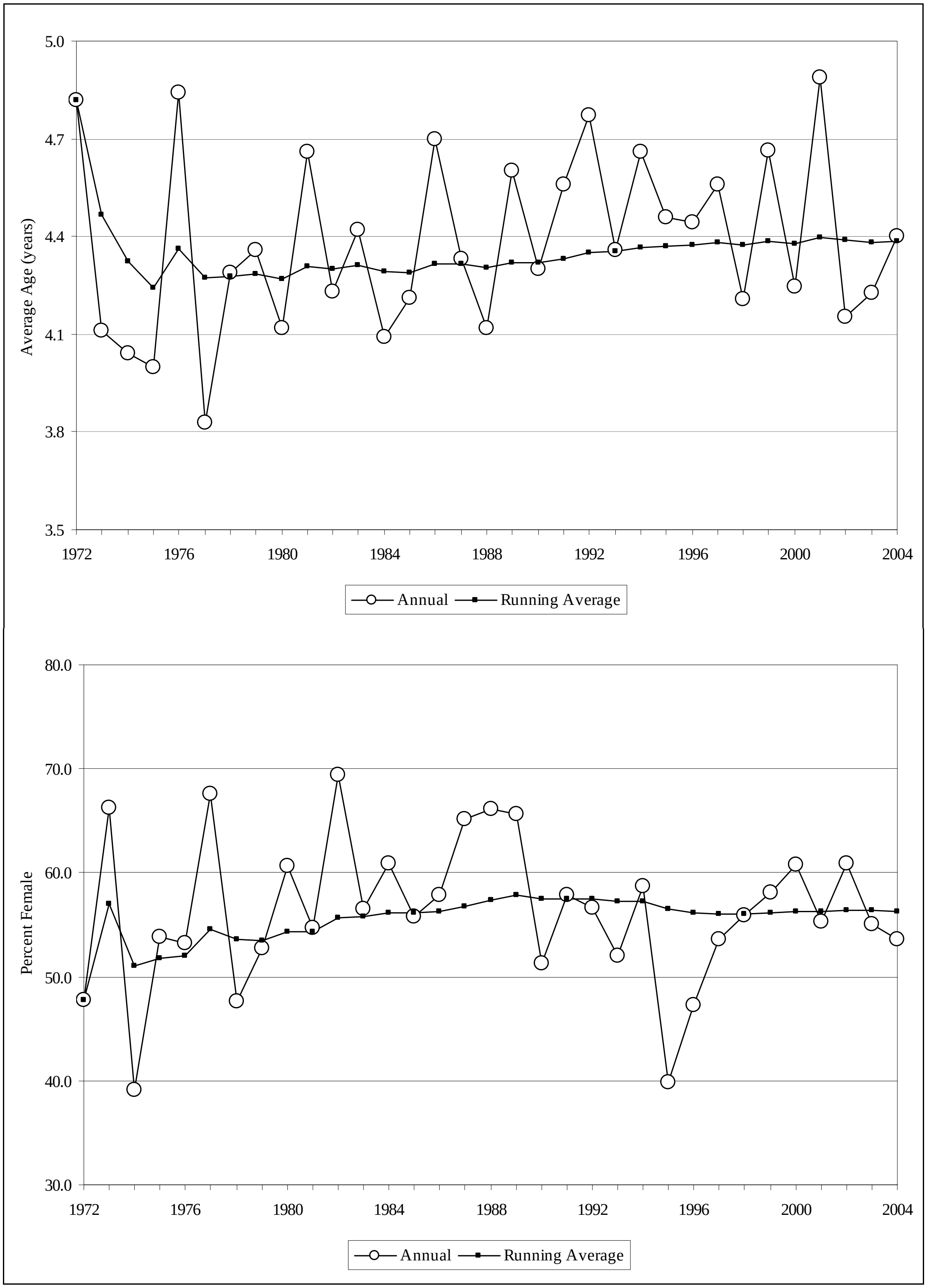


Figure 7.–Annual age at maturity (top) and percentage females (bottom) of the Anvik River chum salmon escapement, 1972–2004.

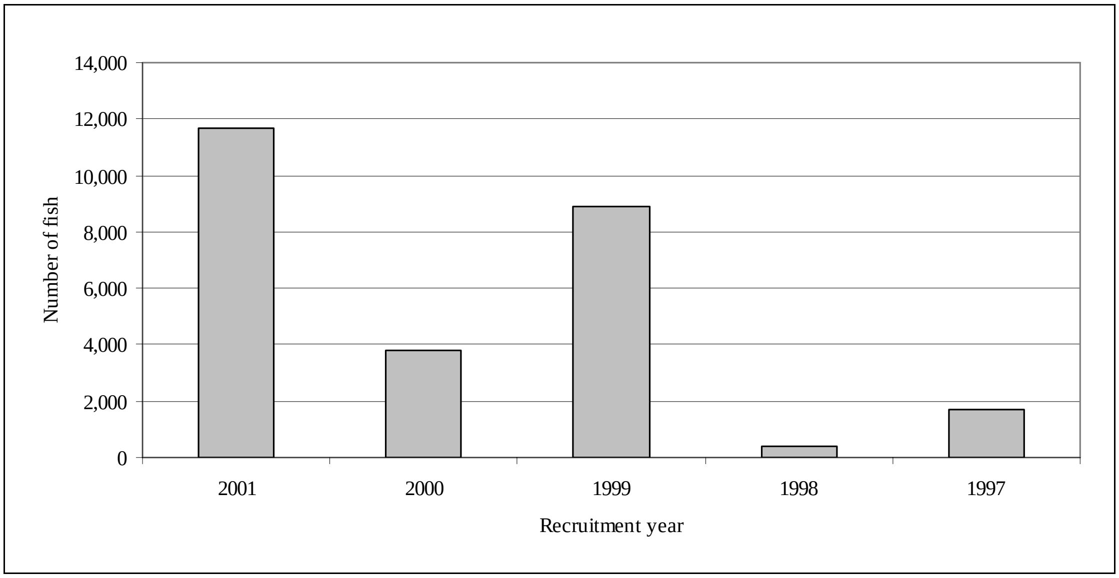


Figure 8.–The number of chum salmon returning to spawn, their first year as age-0.2 fish, Anvik River sonar, 1997–2001.

APPENDIX A

Appendix A1.–Technical specifications for the Model 241 Portable Split-Beam Digital Echo Sounder.

Size:	10 inches wide x 4.3 high x 17 long, without PC or transducer (254 mm wide x 109 high x 432 long).
Weight:	20 lb. (9 kg) without PC or transducer.
Power Supply:	Nominal 12 VDC standard (120 VAC and 240 VAC optional).
Operating Temperature:	5-50°C (41-122°F).
Power Consumption:	30 watts (120 - 200 kHz), without laptop PC.
Frequency:	200 kHz standard (120 kHz and 420 kHz optional).
Transmit Power:	100 watts standard for 120-200 kHz. 50 watts standard for 420 kHz.
Dynamic Range:	140 dB
Transmitter:	Output power is adjustable in four steps over a 20 dBw range (+2, +8, +14, and 20 dBw).
Pulse Length:	Selectable from 0.1 ms to 1.0 ms in 0.1 ms steps.
Bandwidth:	Receiver bandwidth is automatically adjusted to optimize performance for the selected pulse length.
Receiver Gain:	Overall receiver gain is adjustable in five steps over a 40 dB range (-16, -8, 0, +8, +16 dB).
TVG Functions:	Simultaneous 20 and 40 log(R)+2αr TVG. Spreading loss and alpha are programmable to nearest 0.1 dB. Total TVG range is 80 dB. TVG start is selectable in 1m increments. The minimum TVG start is 1.0 m to maximum of 200 m
Receiver Blanking:	Start and stop range blanking is selectable in 1m steps.
Undetected Output:	12 kHz, for each formed beam
Detected Output:	10 volts peak
System Synchronization:	Internal or external trigger
Ping Rate:	0.5-40.0 pings/sec
Phase Calculation:	Quadrature demodulation
Angular Resolution:	+/- <0.1° (6° beam width, 200 kHz)
Tape recording:	With Split-Beam Data Tape Interface and optional Digital Audio Tape (DAT) recorder, directly records the digitized split-beam data, permitting complete reconstruction of the raw data output.
Calibrator:	source. Pulse and CW calibration functions provided in step settings.
Positioning:	GPS positioning information (NMEA 0183 format) via serial port of computer

Source: Model 241 operators manual.