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Kogrukluk River Salmon Studies, 2009

by

Derick L. Williams

and

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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)

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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KOGRUKLUK RIVER SALMON STUDIES, 2009

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TABLE OF CONTENTS

Page

LIST OF TABLES ... iii

LIST OF FIGURES ... iii

LIST OF APPENDICES ... iv

ABSTRACT ... 1

INTRODUCTION ... 1

Background ... 2

Regional ... 2

Kogrukluk River Escapement Monitoring ... 3

Objectives ... 3

METHODS ... 4

Study Area ... 4

Weir Design ... 4

Escapement Monitoring ... 5

Passage Counts ... 5

Passage Estimates ... 5

Single Day ... 6

Linear Method ... 6

Carcass Counts ... 6

Age, Sex, and Length Composition ... 6

Sample Size and Distribution ... 7

Sample Collection Procedures ... 7

Data Processing and Reporting ... 8

Visual Sex Determination ... 9

Weather and Stream Observations ... 9

Related Fisheries Projects ... 9

Kuskokwim River Coho Salmon Run Reconstruction ... 9

Baseline Genetic Sample Collections ... 9

RESULTS ... 10

Weir Operations ... 10

Escapement Monitoring ... 10

Chinook Salmon ... 10

Chum Salmon ... 10

Coho Salmon ... 10

Sockeye Salmon ... 10

Other Species ... 10

Carcasses ... 11

Age, Sex, and Length Composition ... 11

Chinook Salmon ... 11

Chum Salmon ... 11

Coho Salmon ... 12

Sockeye Salmon ... 12

Weather and Stream Observations ... 12

Related Fisheries Projects ... 13

Kuskokwim River Coho Salmon Run Reconstruction ... 13

TABLE OF CONTENTS (Continued)

Page

DISCUSSION....13

Operations....13

Escapement Monitoring....13

- Chinook Salmon....13
- Chum Salmon....14
- Coho Salmon....14
- Sockeye Salmon....15
- Pink Salmon....15
- Carcass Counts....15

Weather and Stream Observations....15

CONCLUSIONS....16

ACKNOWLEDGMENTS....16

REFERENCES CITED....17

TABLES AND FIGURES....21

APPENDIX A....49

APPENDIX B....55

APPENDIX C....59

LIST OF TABLES

Table **Page**

1. Daily, cumulative, and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at the Kogrukluk River weir, 2009. 22
2. Age and sex composition of Chinook salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 24
3. Mean length (mm) of Chinook salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 25
4. Age and sex composition of chum salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 26
5. Mean length (mm) of chum salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 27
6. Age and sex composition of coho salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 28
7. Mean length (mm) of coho salmon at the Kogrukluk River weir in 2009 based one escapement samples collected with a live trap. 29
8. Age and sex composition of sockeye salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 30
9. Mean length (mm) of Sockeye salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap. 31

LIST OF FIGURES

Figure **Page**

1. Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Kogrukluk River weir. 32
2. Kogrukluk River study area and location of historical escapement monitoring projects. 33
3. Profile of the Holitna River and major tributaries, Alaska (Collazzi 1989). 34
4. Comparison of the percentage of female salmon passing upstream of the Kogrukluk River weir in 2009 as determined from standard ASL sampling using a fish trap, and from visual inspection of non-ASL sampled fish using standard fish passage procedures. 35
5. Historical operational dates for the Kogrukluk River weir. 36
6. Historical Chinook and chum salmon escapement with the pre-2004 minimum escapement goal and the current escapement goal range at the Kogrukluk River weir. 37
7. Historical run timing of Chinook salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009. 38
8. Historical female escapement of Chinook, chum, and coho salmon with percent composition of female salmon. 39
9. Historical average length for Chinook salmon with 95% confidence intervals at the Kogrukluk River weir. 40
10. Historical run timing of chum salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009. 41
11. Relative age-class abundance of chum salmon by return year at Kogrukluk River weir. 42
12. Historical average length for chum salmon with 95% confidence intervals at the Kogrukluk River weir. 43
13. Historical sockeye and coho salmon escapement with the pre-2004 minimum escapement goal and the current escapement goal range at the Kogrukluk River weir. 44
14. Historical run timing of coho salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009. 45
15. Historical average length for coho salmon with 95% confidence intervals at Kogrukluk River weir. 46
16. Historical run timing of sockeye salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009. 47

LIST OF FIGURES (Continued)

Figure **Page**

17. Daily morning water temperature at Kogrukluk River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2002–2008. 48
18. Daily morning river stage at Kogrukluk River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2002–2008. 48

LIST OF APPENDICES

Appendix **Page**

A1. Daily passage counts by species at Kogrukluk River weir, 2009. 50
B1. Daily carcass counts at Kogrukluk River weir, 2009. 56
C1. Daily weather and stream observations at Kogrukluk River weir, 2009. 60
C2. Daily weather and stream observations at Kogrukluk River weir, 2009. 65

ABSTRACT

The Kogrukluk River weir has been operated since 1976 to estimate the return and age-sex-length compositions of salmon escapements, monitor environmental variables, and contribute to other Kuskokwim Area fisheries projects. In 2009, a fixed-picket weir was operated in the Kogrukluk River from 25 June through 27 September to estimate escapements of 4 species of pacific salmon *Oncorhynchus* spp. The total annual Chinook salmon *O. tshawytscha* escapement of 9,702 fish fell within the sustainable escapement goal (SEG) range of 5,300 to 14,000 fish. The total annual chum salmon *O. keta* escapement of 84,940 exceeded the upper boundary of the SEG range of 15,000 to 49,000 fish. The total annual sockeye salmon *O. nerka* escapement of 23,785 was above the SEG range of 4,400 to 17,000 fish. The total annual coho salmon *O. kisutch* escapement of 22,981 was in the center of the SEG range of 13,000 to 28,000 fish. Age-sex-length samples taken from weir trapped fish were used to describe the age-sex structure of the Chinook, chum and coho salmon runs. Females comprised 28.2% of the Chinook salmon run, 44.6% of the chum salmon run, and 56.5% of the coho salmon run. The Chinook salmon run was comprised of 6 age classes, dominated by age-1.3 fish (52.4%). The chum salmon run was comprised of 4 age classes, dominated by age-0.3 fish (75.1%). The coho salmon run was comprised of 3 age classes, dominated by age-2.1 fish (90.2%).

The Kogrukluk River weir is one of several components which form an integrated array of escapement monitoring projects in the Kuskokwim Area. This array of projects provides a means to monitor and assess escapement trends that must be considered in harvest management decisions in accordance with the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222).

Key words: Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, coho *O. kisutch*, sockeye *O. nerka*, and pink salmon, *O. gorbuscha*, longnose suckers, *Catostomus catostomus*, escapement, age-sex-length, Kogrukluk River, Kuskokwim River, resistance board weir, radiotelemetry, mark–recapture, genetic stock identification, stock-specific run-timing, Dolly Varden, *Salvelinus malma*

INTRODUCTION

The Kuskokwim River is the second largest river in Alaska, draining an area approximately 130,000 km^2, or 11% of the total area of Alaska (Figure 1; Brown 1983). Each year mature Pacific salmon *Oncorhynchus* spp. return to the river and its tributaries to spawn, supporting an annual average subsistence and commercial harvest of nearly 1 million salmon (Whitmore et al. 2008). The subsistence salmon fishery in the Kuskokwim Area is one of the largest in the state and remains a fundamental component of local culture (Coffing[1] 1991;Coffing et al. 2000; Carroll and Patton 2010; Whitmore et al. 2008). The commercial salmon fishery, though modest in value compared to other areas of Alaska, has been an important component of the market economy of lower Kuskokwim River communities (Buklis 1999; Whitmore et al. 2008). Salmon contributing to these fisheries spawn and rear in most tributaries of the Kuskokwim River basin (Whitmore et al. 2008).

In the State of Alaska, salmon management seeks to provide for long-term sustainable fisheries by ensuring that adequate numbers of salmon escape to the spawning grounds each year (5 AAC 39.222). This goal requires an array of long-term escapement monitoring projects that reliably measure annual escapement to key spawning systems as well as track temporal and spatial patterns in abundance, which influence management decisions. Over time and with sufficient data, escapement goals can be developed as a means to gauge escapement adequacy, but current models for escapement goal development require many years of data. For much of the Alaska

[1] Coffing, M. *Unpublished* a. Kuskokwim area subsistence salmon harvest summary, 1996; prepared for the Alaska Board of Fisheries, Fairbanks, Alaska, December 2, 1997. Alaska Department of Fish and Game, Division of Subsistence, Bethel.
Coffing, M. *Unpublished* b. Kuskokwim area subsistence salmon fishery; prepared for the Alaska Board of Fisheries, Fairbanks, Alaska, December 2, 1997. Alaska Department of Fish and Game, Division of Subsistence, Bethel.

Department of Fish and Game (ADF&G) management history in the Kuskokwim Area, escapement monitoring has been limited to aerial surveys and two ground-based escapement monitoring projects.

Salmon spawn in dozens of tributaries in the Kuskokwim drainage and the operation of only 2 escapement monitoring projects was not an adequate measure of the entire Kuskokwim River basin. This problem was answered with the addition of several escapement monitoring projects in the mid to late 1990s. The data provided by the current array of projects have much greater utility for fishery managers and have decreased their reliance on aerial stream surveys, which are known to be imprecise (Holmes and Burkett 1996; Molyneaux and Brannian 2006; Mundy 1998). In addition, mainriver tagging studies rely on the expanded weir infrastructure to estimate inriver abundance and develop run reconstruction models for Kuskokwim River salmon. Run reconstruction models that result from these studies will be an important tool in answering questions of exploitation, distribution, abundance and travel time for Kuskokwim River salmon and may eventually lead to the development of escapement goals for the entire Kuskokwim River drainage. Such projects have since become deeply integrated components of Kuskokwim River salmon management.

The Kogrukluk River weir also serves as a platform for collecting information on habitat variables including water temperature, water chemistry, and stream discharge (level), which may directly or indirectly influence salmon productivity and timing of salmon migrations but do not yet figure prominently into management strategies (Hauer and Hill 1996; Kruse 1998; Quinn 2005). These variables can be affected by human activities (i.e., mining, timber harvesting, man-made impoundments, etc.; NRC 1996) or broader climatic variability (e.g., El Nino and La Nina events, climate change).

BACKGROUND

Regional

In the dialect of the upper Kuskokwim River Yupik people, Kogrukluk means “middle fork” (Evan Ignatti, elder, Kashegelok; personal communication). In the early 1800s, the Holitna River, along with the Nushagak River, formed a fur trade corridor between Bristol Bay and the Kuskokwim River (Oswalt 1990). Twice each year, Russian traders traveled this route, completing a 5-day portage between Shotgun Creek and the Chichitnok River (Brown 1983; Oswalt 1990). Until 1845, this route served as the primary supply conduit for the first Russian station on the Kuskokwim River, located at the mouth of the Holitna River. A number of communities were established along the Holitna River to service this route, including Kashegelok, Nogamut, and Itulilik. Residents of Holitna River communities relied heavily on the abundant Holitna River salmon runs, and supplemented their livelihoods through the fur trade.

As the fur trade declined and other opportunities arose, such as the opening of the Red Devil mercury mine in the 1930s, the Holitna River villages were slowly abandoned. Kashegelok, located just downstream from the Kogrukluk/Chukowan confluence, was the longest surviving Native community along the Holitna River. Kashegelok harbored a sizable community until most of the dwellings were destroyed when the Holitna River shifted course to the east sometime between 1940 and 1960 (Evan Ignatti, elder, Kashegelok; personal communication). The last two individuals claiming ties to Kashegelok, Evan Ignatti and Ignatti Ignatti, relocated to Red Devil when a gravel bar formed across a portion of the channel favored as a floatplane landing site after the Chukowan River shifted course during the spring flood of 2003.

Today, most inhabitants of the Holitna River reside in a number of commercial lodges and private, homesteads along the lower Holitna River. Only one inhabitant, Elder Nastacia Nick, remains year round (Evan Ignatti, elder, Kashegelok; personal communication). The Holitna River drainage continues to draw users from throughout the Kuskokwim River drainage and beyond, and remains an important area for subsistence fishing, sport fishing, and hunting.

Kogrukluk River Escapement Monitoring

Since the first aerial survey was flown in 1961, state managers have recognized the importance of the Holitna River drainage as a salmon spawning system (Burkey 1994; Schneiderhan[2]). Escapement monitoring began in 1969 when a salmon counting tower project was initiated on the Kogrukluk River upstream of the confluence of Shotgun Creek (Figure 2; Yanagawa 1972). The tower was relocated twice between 1970 and 1978 because of shifting river channels, but always remained upstream of the mouth of Shotgun Creek. In order to more accurately assess salmon escapements, installation of a counting weir was attempted in 1971 near the counting tower site. This first weir was destroyed by high water early in the season (Yanagawa 1973). In 1976, a new weir was established not far downstream of the original weir and tower sites (Baxter 1979). Since the project's establishment, the Kogrukluk River weir has operated annually to monitor Chinook *O. tshawytscha*, chum *O. keta*, and sockeye *O. nerka* salmon escapement to this system; and beginning in 1981, the weir operations were extended to include coho salmon (Baxter 1982).

Kogrukluk River salmon escapements are a relatively small percentage of overall salmon escapements in the Kuskokwim River drainage; however, this tributary appears to support a relatively large number of spawning Chinook, chum, sockeye, and coho salmon *O. kisutch* when compared to other Kuskokwim River tributaries of similar size (Molyneaux and Brannian 2006). The Kogrukluk River weir is 1 of 3 ground-based projects in the Kuskokwim River drainage with a formal escapement goal for Chinook salmon, 1 of 2 projects with a formal escapement goal for chum salmon, and the only project with a formal escapement goal for coho salmon (Figure 1; Brannian et al. 2006b).

OBJECTIVES

The objectives of the Kogrukluk River escapement monitoring project in 2009 were to:

1. Determine the daily and total escapement of male and female Chinook, chum, sockeye, and coho salmon to the Kogrukluk River;
2. Estimate the age, sex, and length (ASL) composition of Chinook, chum, and coho salmon escapements to the Kogrukluk River such that 95% confidence intervals for the age composition are no wider than ±10% (α=0.05 and d=0.10);
3. Serve as a platform to facilitate current and future fisheries research projects (in 2008) by:
    a. Serving as a monitoring and recapture location for coho salmon equipped with radio transmitters and anchor tags deployed as part of *Kuskokwim River Coho Salmon Run Reconstruction*; and
    b. Serving as a collection site for pink salmon *O. gorbuscha,* genetic tissue.

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[2] Schneiderhan, D. J., editor. *Unpublished.* Kuskokwim stream catalog, 1954 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

METHODS

STUDY AREA

The Kogrukluk River watershed drains about 2,073 km^2, formed by a low plateau that divides the Tikchik Lakes system and Nushagak River basin to the south from the Holitna River basin to the north. From its headwaters near Nishlik Lake, the Kogrukluk River flows northerly for approximately 80 river kilometers (rkm). The Kogrukluk River weir is located near the abandoned village site of Kashegelok at the headwaters of the Holitna River (Figure 2). The confluence of the Chukowan and Kogrukluk Rivers forms the headwaters of the Holitna River which flows 218 rkm to its own ending in the Kuskokwim River. The Holitna River joins the Kuskokwim River at rkm 491.

The Kogrukluk River flood plain is poorly drained and is composed of soft sediments that erode easily. Over its course, the river descends approximately 250 m with an average drop of 3.2 m per km across a 1–5 km wide flood plain (Figure 3; Collazzi 1989). The river substrate is mostly gravel and cobble of assorted sizes. At normal flow, the Kogrukluk River has a nominal load of suspended materials and the water is clear; however, water clarity is reduced during periods of high flow when it can become stained from organic leaching. The Kogrukluk River and its tributaries are dynamic in that they can change course quickly. The resulting oxbows, sloughs, and large log jams form a complex mosaic of reproductive and rearing habitat suitable for salmon (Baxter[3]; Healy 1991).

Riparian areas consist of low-lying mixed spruce (*Picea* spp.), cottonwood (*Populus* sp.), willows (*Salix* spp.), and alders (*Alnus* spp.), interspersed with wet tundra. Uplands are typically spruce-hardwood forest, and terrain above 200 m is typically alpine tundra. White spruce (*P. glauca*), birch (*Betula* spp.), and aspen (*P. trenuloides*) are common on moderate south-facing slopes and black spruce (*P. mariana*) are common on north-facing slopes, in poorly drained areas, and within pockets of permafrost. On cool moist slopes the understory consists of spongy moss and low brush, whereas on dry slopes the understory is mostly grasses and near timberline most understories consist of willows, alders, and dwarf birch (*B. nana*).

Located approximately 220 rkm from the village of Sleetmute, 710 rkm from the mouth of the Kuskokwim River, and 212 km by air from the city of Bethel; the Kogrukluk River weir is the most remote ground-based escapement project in the Kuskokwim Area (Figure 1). Personnel and supplies are transported to and from the weir by floatplane. The weir has been at this location since 1976 (Figure 2; Baxter[4]).

WEIR DESIGN

The Kogrukluk River weir is a fixed-picket design, spans a 70-m channel and incorporates a fish trap and narrow boardwalk. The design and materials used to construct the Kogrukluk River weir in 2009 are the same as those described by Baxter (1981), with the exception of an improved fish trap and a tighter picket spacing. The use of the new fish trap began in 1999 and the new picket spacing was first used in 2005. The fish trap, which is about 2.4 m by 1.5 m, was modeled after

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[3] Baxter, R. *Unpublished*. Hoholitna River reconnaissance survey, 1977. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Resource Report No. 3, Anchorage.

[4] Baxter, R. *Unpublished*. Holitna Weir developmental project, 1976. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 11, Anchorage.

the trap used at the George River weir since 2001 (Linderman et al. 2003). The picket spacing was narrowed after investigators observed small chum salmon passing through the pickets in 2004, a year that was characterized by an unusually high abundance of small, 3-year-old chum salmon. Picket intervals were reduced from 76.2 mm to 63.5 mm, which narrowed the gap from 49.0 to 36.5 mm (R. Stewart, Commercial Fisheries Technician, ADF&G, Anchorage; personal communication).

Boat traffic at the weir is uncommon, but when necessary, boats can be passed by removing weir pickets and pulling the boat through the opening (Baxter 1981). The use of a floating resistance board weir, which is generally better at accommodating debris and boat traffic, was considered for this site. But extensive site surveys indicated that the weir location lacked the necessary homogenous riverbed profile and substrate stability for proper installation and operation of a floating weir (Shelden et al. 2005).

ESCAPEMENT MONITORING

Annually, the weir is installed in late June, prior to the onset of the Chinook and chum salmon runs, and is operated into late September to encompass the bulk of the coho salmon run. Generally, no attempt is made to estimate missed passage prior to installation and/or after removal of the weir. High water events or damage to the weir occasionally result in inoperable periods, however estimates of salmon passage for inoperable periods help to provide consistent comparisons of escapements among years. Total annual escapement is determined from the total observed and estimated fish passage.

Passage Counts

Passage counts were conducted in four to eight 1-hour shifts per day between 0730 and 2400 hours. This schedule was adjusted as needed to accommodate variation in fish behavior and abundance. Crew members visually identified the species and sex of each fish observed passing upstream of the weir and recorded them on a tally counter. Following each shift, crew members recorded total counts in a logbook and zeroed the tally counter. At the end of each day, total daily and cumulative seasonal counts were recorded in a designated logbook. These counts were reported each morning to ADF&G staff in Bethel via single side band radio or satellite phone.

The live trap was used as the primary means of upstream fish passage. A clear plastic viewing window was placed on the stream surface to improve visual identification of fish entering the trap. Other methods were occasionally used when salmon were reluctant to enter the fish trap, such as during periods of extreme low water. Liller et al. (2008) describes other methods.

Salmon were also enumerated by sex, from the visual characteristics of advanced sexual dimorphism apparent in adult salmon at Kogrukluk River weir. This data is not considered a conclusive determination of sex, but instead may serve as a means of assessing bias in ASL sampling.

Passage Estimates

Passage missed during the occurrence of a hole in the weir was estimated by linear interpolation using the following formulas:

Single Day

When the weir is not operational for part or all of one day, an estimate for the inoperable day is calculated using the following formula:

$$\hat{n}_{d_i} = \left(\frac{\left(n_{d_i-2} + n_{d_i-1} + n_{d_i+1} + n_{d_i+2} \right)}{4} \right) - n_{o_i} \qquad (1)$$

where

n_{d_i-1}, n_{d_i-2} = observed passage of 1, 2 days before the weir was washed out;

n_{d_i+1}, n_{d_i+2} = observed passage of 1, 2 days after the weir was reinstalled; and,

n_{o_i} = observed passage (if any) from the given day (i) being estimated.

Linear Method

When the weir is not operational for two or more days within the season, passage estimates for the inoperable days are calculated using the following formula:

$$\hat{n}_{d_i} = (\alpha + \beta \cdot i) - n_{o_i}$$

$$\alpha = \frac{n_{d_1-1} + n_{d_1-2}}{2}$$

$$\beta = \frac{\left(n_{d_I+I} + n_{d_I+I+1} \right) - \left(n_{d_1-1} + n_{d_1-2} \right)}{2\left(I + 1 \right)}$$

where

I = number of inoperative days ($I > 2$), and

n_{o_i} = observed passage (if any) from the given day (i) being estimated.

n_{d_I+I}, n_{d_I+I+1} = observed passage the first day after the weir was reinstalled.

n_{d_I-1}, n_{d_I-2} = observed passage of 1, 2 days before the weir was washed out;

Carcass Counts

Each time the weir was cleaned, spawned-out salmon, or carcasses, that washed up on the weir were counted by species and discarded downstream. Daily and cumulative carcass counts were copied to a logbook. In some years, sex and species of all carcasses was determined however, this practice has been discontinued.

AGE, SEX, AND LENGTH COMPOSITION

To estimate the age, sex, and length composition of Chinook, chum, and coho salmon escapements, live sampling was conducted as fish migrated upstream through the weir. Samples were collected throughout the season to account for temporal dynamics in ASL characteristics. Samples were stratified postseason to develop weighted estimates.

Sample Size and Distribution

A minimum sample size was determined for each species following conventions described by Bromaghin (1993) to achieve simultaneous 95% confidence intervals of age-sex composition no wider than ±10% (α=0.05 and d=0.10), assuming 10 age-sex categories for Chinook salmon (*n*=190), 8 age-sex categories for chum salmon (*n*=180), and 6 age-sex categories for coho salmon (*n*=168). These sample sizes were then increased by about 20% to account for unreadable scales or collection errors. This yielded a minimum collection goal for each sample of 230 Chinook, 220 chum, and 200 coho salmon.

The abundance of chum and coho salmon at the Kogrukluk River weir is high enough to collect a large sample size in a short period of time. A pulse sampling strategy was therefore employed to ensure adequate temporal distribution of chum and coho samples. The term "pulse" is used to describe a sample that is collected over a short period of time and then used to characterize a longer time interval. Well spaced pulse samples are thought to have greater power for detecting temporal changes in ASL composition than other sampling methods (Geiger and Wilbur 1990). Pulse sampling was conducted approximately every 7 to 10 days. The goal was to collect a minimum of one pulse sample from each third of the run.

The comparatively lower numbers of Chinook salmon running concurrently with large numbers of chum salmon and sockeye salmon at Kogrukluk River weir makes pulse sampling impractical. In 2009 sampling efforts followed a daily collection schedule based on historical run timing information using a sample size of 350 fish (Molyneaux et al. *In prep*). Daily sample sizes were proportional to average historical escapements by day to ensure a good distribution across the run. The overall sample size was selected to exceed the minimum necessary to meet precision and accuracy criteria for this location and was similar to average historical sampling success.

Sample Collection Procedures

Salmon were sampled from the fish trap installed in the weir. Salmon were trapped by opening the entrance gate while the exit gate remained closed. Fish were allowed to swim freely into the live trap, and the V-shape positioning of the entrance gate prevented them from easily escaping. The live trap was allowed to fill with fish until a reasonable number were inside. Crew members used a short-handled dip net to capture fish within the live trap. To obtain length data and aid in scale collection, fish were removed from the dip net and placed into a partially submerged fish "cradle." Scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards as described in Molyneaux et al. (2008). Sex was determined through visual examination of the external morphology, focusing on the prominence of a kype, roundness of the belly, and the presence or absence of an ovipositor. Mid eye to fork (MEF) length was measured to the nearest millimeter using a straight-edged meter stick. Sex and length data were recorded on standardized numbered data sheets that correspond with numbers on the gum cards used for scale preservation. After sampling, each fish was released upstream of the weir. The procedure was repeated until the live trap was emptied to ensure no bias was introduced.

Chinook salmon samples were often collected through "active sampling," which consisted of capturing and sampling fish individually while actively passing and counting all salmon. Further details of the active sampling procedures are described in Linderman et al. (2003). This method was also used for tag recoveries.

After sampling was completed, relevant information such as sex, length, sampling date, and sampling location was copied to computer mark-sense forms that correspond to numbered gum cards. The completed gum cards and mark-sense forms were sent to the Bethel and/or Anchorage ADF&G offices for processing. The original ASL gum cards, acetates, and mark-sense forms were archived at the ADF&G office in Anchorage. The computer files were archived by ADF&G in the Anchorage and Bethel offices. Data were also loaded into the Arctic-Yukon-Kuskokwim (AYK) salmon database management system (Brannian et al. 2006a). Further details of sampling procedures can be found in DuBois and Molyneaux (2000) and Linderman et al. (2003).

Data Processing and Reporting

Samples were aged and processed by ADF&G staff in Bethel and Anchorage following procedures describe by Molyneaux et al. (2008). Samples were partitioned into a minimum of 3 temporal strata, based on overall distribution within the run. The escapement in each stratum was divided into age-sex classes proportionately with strata sample composition. Mean length by age-sex class was determined for each stratum as well. Annual estimates were calculated as strata sums, weighted by the abundance in each stratum. When sample size or distribution was not considered adequate to estimate annual ASL composition, results were reported but not applied to annual escapements.

Two summary tables were generated for each species. The first table provides the escapement and percentage of each age-sex class by stratum, with season totals weighted by escapement in each stratum. The second table provides a summary of mean length-at-age by sex for each stratum, with season totals weighted by escapement in each stratum. Sample sizes and dates are included for each stratum. Age is reported in the European notation, composed of two numerals separated by a decimal. The first numeral represents the number of winters the juvenile spent in freshwater excluding the first winter spent incubating in the gravel, and the second numeral is the number of winters it spent in the ocean (Groot and Margolis 1991). The total age is therefore one year greater than the sum of these two numerals.

The practice of collecting complete ASL data from sockeye salmon was discontinued at Kogrukluk River weir in 1995 because of the prevalence of scale absorption, which confounds reliable aging (Burkey 1995; Cappiello and Burkey 1997). Crews continue to visually estimate sex composition during daily enumeration routines. Annual sex composition was determined by comparing the total annual escapement of males to the total annual escapement of females. ASL sampling of sockeye salmon was reinitiated at the Kogrukluk River weir in 2006 in support of *Kuskokwim River Sockeye Salmon Investigations*, although the project was completed in 2007 the practice of sampling has continued. The collected sockeye ASL data, though insufficient to estimate total age or ocean life history, provides perspectives on juvenile life history strategies of riverine sockeye salmon populations in Western Alaska, which have previously been poorly understood (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Visual Sex Determination

Sex was determined for every salmon passing upstream of the weir through observation of sexually dimorphic characteristics. Sex compositions derived visually and through ASL were compared to assess possible biases in each method and to test the potential of visual sex determination in clear water tributaries. Each ASL stratum was considered independently, with the sex composition determined by ASL compared to the sex composition determined visually for the same time period.

WEATHER AND STREAM OBSERVATIONS

Water and air temperatures were manually measured each day at approximately 1000 and 1700 hours. Water temperature was determined by submerging a calibrated thermometer below the water surface until the temperature reading stabilized. Air temperature was obtained from a thermometer attached to an outside wall of the cabin in a shaded location. Temperature readings were recorded in a designated logbook, along with notations about wind direction, estimated wind speed, cloud cover, and precipitation. Daily precipitation was measured using a rain gauge calibrated in millimeters. These manual techniques are consistent with past years at this project.

Daily operations included monitoring river depth with a standardized staff gauge. The staff gauge consisted of a metal rod driven into the stream channel with a meter stick attached. The height of the water surface, as measured from the meter stick, represented the "stage" of the river in centimeters above an established datum plane. The staff gauge was calibrated (using a surveyor's level) to the datum plane with a semi-permanent benchmark to provide for consistent stage measurements between years. The benchmark consisted of a nail driven into the second step of a wooden staircase leading from the riverbank to the utility shed, which represents a measurement of 5 m above baseline and corresponds to the highest water level observed at the Kogrukluk River weir. Water stage was measured at approximately 1000 and 1700 hours.

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Run Reconstruction

The Kogrukluk River weir served as a recovery site for a basinwide mark–recapture and radiotelemetry study entitled *Kuskokwim River Coho Salmon Investigations* (Project No. 565) any questions regarding this study can be directed to the project investigator Kevin Schaberg, ADF&G. Whenever possible, tagged coho salmon passing through the weir's live trap were captured to recover tag information. Data recorded for "recovered" fish included the tag number, tag color, condition, presence of secondary mark, and recovery date. When a tagged fish was not captured it was recorded as "observed" along with the tag color and passage date. Tag loss was assessed at the weir by inspecting for secondary marks during routine ASL sampling. The Kogrukluk River weir crew maintained the Kogrukluk River weir receiver station, including periodic downloads of data. All data collected by the crew was transferred to the principal investigator on an opportunistic basis.

Baseline Genetic Sample Collections

In 2009, the Kogrukluk River weir was used as a platform to collect genetic tissue from pink salmon. Pink salmon samples were collected on an opportunistic basis to contribute to existing baseline collections. These were sent to the ADF&G genetics lab in Anchorage for storage and processing.

RESULTS

Weir Operations

In 2009, the Kogrukluk River weir was operated from 25 June through 27 September. The weir became inoperable during 3 separate high water events during the operational period (Table 1). To prevent structural damage that would impair future weir operation, the crew dismantled parts of the weir once water stage or debris load exceeded a safe level. Estimates of missed salmon passage were generated using the linear interpolation methods described above.

Escapement Monitoring

Chinook Salmon

Total Chinook salmon escapement upstream of the Kogrukluk River weir in 2009 was 9,702 fish, including an estimated 996 fish (10.3% of the total escapement) that passed during inoperable periods. The first Chinook salmon passed through the weir on 28 June, daily passage peaked at 575 fish on 13 July, and the last Chinook salmon was observed on 8 September. The median passage date was 19 July and the central 50% of the passage occurred between 13 and 26 July (Table 1).

Chum Salmon

Total chum salmon escapement upstream of the Kogrukluk River weir in 2009 was 84,940 fish, of which 15,245 (17.9%) fish were estimated. The first chum salmon was observed on 26 June and daily passage peaked at 4,234 fish on 28 July, and the last chum salmon was observed on 24 September. The median passage date was 24 July and the central 50% of the passage occurred between 18 and 31 July (Table 1).

Coho Salmon

Total coho salmon escapement upstream of the Kogrukluk River weir in 2009 was 22,981 fish, which includes an estimated 1,644 (7.2%) fish that passed during inoperable periods. The first coho salmon was observed on 29 July, daily passage peaked at 1,556 fish on 3 September and on the last day of operations 56 coho salmon were observed. The median passage date was 29 August and the central 50% of the passage occurred between 22 August and 5 September (Table 1).

Sockeye Salmon

Total sockeye salmon escapement upstream of the Kogrukluk River weir in 2009 was 23,785 fish, of which 3,420 (14.4%) fish were estimated. The first sockeye salmon was observed on 27 June, daily passage peaked at 1,611 fish on 16 July, and the last sockeye salmon was observed on 17 September. The median passage date was 21 July and the central 50% of the passage occurred between 15 and 28 July (Table 1).

Other Species

It is assumed that small individuals such as pink salmon and non-salmon species may pass freely between weir pickets. Counts of these fish are therefore not considered a census of passage, but are reported here as anecdotal information. Observed pink salmon escapement upstream of the Kogrukluk River weir in 2009 was 46 fish (Appendix A1). Pink salmon were observed passing upstream of the weir from 7 July to 28 July. Other species observed passing upstream of the

Kogrukluk River weir during the 2009 field season include 522 char (*Salvelinus* spp.) and 13 whitefish (*Coregonus* sp.; Appendix A1). Arctic grayling (*Thymallus arcticus*) and northern pike (*Esox lucius*) were also observed but total counts were not recorded. For a complete listing of fish species in the area, see Baxter[5].

Carcasses

A total of 12,512 salmon carcasses were recovered from the Kogrukluk River weir. Chum salmon were the most numerous (9,629), followed by sockeye (1,467), Chinook (1,371), coho (27), and pink salmon (18). Other fish species recovered from the weir include Arctic grayling, char, northern pike, and whitefish (Appendix B).

Age, Sex, and Length Composition

Chinook Salmon

Chinook salmon ASL sampling at the Kogrukluk River weir was conducted on a near daily basis from 2 July to 8 August, resulting in a total sample of 318 fish. Of those, age was successfully determined for 245 fish (77.0% of the total sample), or 2.5% of the escapement (Table 2). The total escapement was partitioned into 3 temporal strata based on sample size and the temporal distribution of the sampling effort, which effectively encompassed each third of the run. Sample sizes were 80, 115, and 50 fish, respectively (Table 2). Overall, 95% confidence intervals for age composition proportions were no wider than ±7% (Table 2).

The Chinook salmon escapement past the weir was dominated by 3 age classes: -1.2, -1.3, and -1.4 (Table 2). Age-1.3 fish were the most abundant (52.4%), followed by age-1.4 (22.9%) fish, and age-1.2 (22.2%). Female Chinook salmon composed 28.2% of the total escapement (Table 2), and the method of visually identifying the sex of passing Chinook salmon yielded a sex ratio similar to that derived from ASL sampling (Figure 4). The length of female Chinook salmon ranged from 625 to 958 mm, and the length of males ranged from 475 to 945 mm. Average length of age-1.3 females was 827 mm, while the average length of age-1.4 females was 856 mm. Average lengths for male Chinook salmon age-1.2, -1.3, and -1.4 were 582, 718, and 846 mm, respectively (Table 3). Female Chinook salmon were consistently larger at age than males (Table 3).

Chum Salmon

Chum salmon ASL sampling at the Kogrukluk River weir was conducted in 3 pulses, distributed between 8 July and 9 August, resulting in a total sample of 877 fish. Of those, age was successfully determined for 806 fish (91.9% of the total sample) or 0.9% of the total escapement. The total annual escapement was partitioned into 3 temporal strata based on the temporal distribution of sampling effort. Sample sizes were 408, 203 and 195 aged fish for the first, second, and third strata, respectively. Overall, 95% confidence intervals for age composition were no wider than ±3.1% (Table 4).

The chum salmon escapement past the weir was largely represented by 2 age classes, age-0.3, and age-0.4 fish. Age-0.3 was the most abundant age class (75.1%), followed by age-0.4 (21.4%), age-0.2 (2.6%), and age-0.5 (0.8%). Female chum salmon comprised 44.6% (37,854

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[5] Baxter, R. *Unpublished*. Holitna River salmon studies, 1977. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 13, Anchorage.

fish) of the total annual escapement, and the method of visually identifying the sex of every passing chum salmon yielded a sex ratio similar to that derived through ASL sampling (Table 4, Figure 4). The length of female chum salmon ranged from 456 to 618 mm and the length of males ranged from 502 to 657 mm, males were generally larger at age than females, and average length generally increased with age for both males and females. Average lengths for female chum salmon age-0.2, -0.3, -0.4, and -0.5 were 526, 541, 558, and 557 mm, respectively. Average length for male age-0.2, -0.3, -0.4, and -0.5 chum salmon was 549, 571, 581, and 589 mm, respectively (Table 5).

Coho Salmon

Coho salmon ASL sampling at the Kogrukluk River weir was conducted in 3 pulses, distributed between 20 August and 11 September, resulting in a total sample of 602 fish. Of those, age was successfully determined for 520 fish (86.4% of the total sample) or 2.3% of the escapement. The run was partitioned into 3 temporal strata based on the temporal distribution of sampling effort, which effectively encompassed each third of the run, sample sizes were 175, 172, and 173 aged fish, respectively. Overall, 95% confidence intervals for age composition were no wider than ±2.6% (Table 6).

The coho salmon escapement past the weir was dominated by age-2.1 individuals, which comprised 90.2% of total escapement. Age-3.1 fish comprised 8.2% of the escapement and age-1.1 fish comprised 1.5% of the escapement. Females comprised 56.5% (12,990 fish) of the escapement and the method of visually identifying the sex of every passing coho salmon yielded a sex ratio that was similar to that derived through ASL sampling. The length of female coho salmon ranged from 418 to 616 mm, and males ranged from 363 to 635 mm. Average lengths for age-1.1, -2.1, and -3.1 female fish were 505, 541, and 553 mm, respectively. Male fish had average lengths of 495, 538, and 565 mm for age-1.1, -2.1, and -3.1 fish, respectively (Tables 6 and Table 7).

Sockeye Salmon

Sockeye salmon ASL sampling at the Kogrukluk River weir was conducted on an opportunistic basis from 10 July to 26 July, resulting in a total sample of 124 fish. Of those, age was determined for 82 fish (66.1% of the total sample) or 0.3% of the total escapement (Table 8). Despite the collection of this data, complete analysis is confounded by the fact that Kogrukluk River sockeye salmon scales are highly reabsorbed by the time they reach the weir site making determination of salt water ages unreliable. Some insight into the life history type of Kogrukluk River sockeye salmon can still be obtained, the majority of the scales collected were age-1.X, however some age-0.X fish were also sampled (Table 8). The method of visually identifying the sex of every passing sockeye salmon indicated that female sockeye salmon comprised 61.6% of the run (Appendix A). The length of female sockeye salmon ranged from 477 to 614 mm, and males ranged from 501 to 606 mm (Table 9).

WEATHER AND STREAM OBSERVATIONS

A total of 193 complete observations of weather and stream conditions were recorded between 20 June and 28 September (Appendix C1). Based on twice-daily thermometer observations, water temperature at the weir ranged from 4.0° to 16.0°C, with an average water temperature of 9.9°C. Based on twice-daily thermometer observations, air temperature at the weir ranged from -5° to 31°C, with an average air temperature of 13.0°C (Appendix C1). Based on hourly data logger readings, daily average air temperature ranged from -0.1°C to 21.3°C, with an average daily temperature of 11.4°C (Appendix C2). A total of 142.2 mm of precipitation was recorded throughout the season. River stage ranged from 265 to 332 cm, with an average of 284.2 cm (Appendix C1).

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Run Reconstruction

In support of the *Kuskokwim River Coho Salmon Run Reconstruction* project, the crew recorded 28 tagged coho salmon passed the Kogrukluk River weir in 2009, of those 21 were radio tags of which 16 were hand recovered. In addition to the radio tags, 7 anchor tags were seen at the weir and 6 were hand recovered. Information regarding this study is preliminary and can be obtained from Schaberg (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; Principle Investigator). Tag information was recorded and sent to the project investigators postseason.

DISCUSSION

OPERATIONS

In 2009, the Kogrukluk River weir operated from 25 June to 27 September. Operations were similar in duration and timing to the historical average (Figure 5). Despite 3 periods of inoperability, daily and total annual escapements of Chinook, chum, sockeye, and coho salmon reported at Kogrukluk River weir were considered accurate. Based on historical run timing, inoperable periods had limited effects on Kogrukluk salmon enumeration and sampling events (Table 1). Missed passage during inoperable periods accounted for approximately 10%, 14%, 18%, and 7% of the Chinook, chum, sockeye, and coho salmon escapements respectively. The most substantial inoperable period (29 July to 3 August) occurred at a time when runs of Chinook, chum, and sockeye salmon were declining, and near the very beginning of the coho salmon run. The subsequent inoperable periods were of short duration and late enough in the year that coho salmon were the only species affected.

ESCAPEMENT MONITORING

Chinook Salmon

Chinook salmon escapements have exhibited a distinct sinusoidal pattern of increase and decrease throughout most of the 34-year history of escapement monitoring at the Kogrukluk River. The regularity of this pattern has predictive potential and suggests 2010 escapement may be similar to that of 2009. The 2009 escapement fell near the midpoint of the current sustainable escapement goal (SEG) range of 5,300 to 14,000 fish (Figure 6). The 2009 Chinook salmon run at the Kogrukluk River weir was the third latest on record, while the duration was just above average, and the median passage date was the third latest on record for the Kogrukluk River weir (Figure 7).

In 2009, Chinook salmon ASL samples were well distributed temporally, and sampling goals and objectives for precision and accuracy were achieved. Age-1.4 fish abundance in 2009 was nearly half the historical average, and below average in proportion by 13%. The percentage of female Chinook salmon was slightly below the historical average that corresponded to both a relatively high abundance of age-1.3 fish, which are predominantly male, and a relatively low abundance of age-1.4 fish that are predominantly female (Figure 8, Table 2). The ASL sampling method yielded a female percentage similar to the visual method (Figure 4). The similarity between these methods supports the assumption that ASL sampling methods are random and effective.

Mean lengths for each age-sex category in 2009 were within the historical range (Figure 9). Age-1.3 and age-1.4 Chinook salmon average lengths for both males and females were near the historical averages and have shown little variation since 2002. Female Chinook salmon tended to be longer than males of the same age, consistent with observations from past project years.

Chum Salmon

Chum salmon escapement in 2009 was far below the unprecedented high escapements in 2005 and 2006 (Jasper and Molyneaux 2007; Liller et al. 2008), it was however the third largest escapement in the project's 34-year history, exceeding the SEG range of 15,000–49,000 fish (Figure 6). The central 50% of the 2009 chum salmon run at the Kogrukluk River weir was the latest on record. The median passage date was also the latest on record, however the run duration was of average length (Figure 10).

In 2009, chum salmon ASL sample were temporally well distributed, and sampling goals and objectives for precision and accuracy were achieved. The 2009 escapement past the Kogrukluk River weir was typical in terms of age structure proportions with age-0.3 fish dominating the run followed by age-0.4 fish. The unusually high escapement of the age-0.3 class observed in 2009 follows the record high escapement observed 4 years prior in 2005 (Figure 11). The percentage of female chum salmon at the Kogrukluk River weir in 2009 was above the historical average (Figure 8). Beginning in 2005, the percent female rose to a record high for the project and since 2005 has remained high. The continuation of the above average proportion of female chum salmon in 2009 was supported by the visual sex determination, which produced values almost identical to those of the ASL determined sex ratios supporting the validity of the ASL sampling methods (Figure 4). Possible reasons for the observed changes in sex ratios are detailed in Williams and Shelden (2010).

Mean lengths of chum salmon for all age-sex categories were below the historical averages, but above project history lows in 2006 (Figure 12). A retrospective analysis of age-0.3 and-0.4 chum salmon at this project shows a general decrease in length-at-age from 1997 through 2007 (Molyneaux et al 2008; Jasper and Molyneaux 2007). This decrease is most obvious among age-0.3 and -0.4 males. The 2009 mean lengths have increased from the project lows observed in 2006–2007. The tighter picket spacing that has been used in recent years (2005 to 2009) may be partially responsible for the lower mean lengths-at-age in recent years; prior to 2005 smaller fish were occasionally observed passing between the pickets, but there have been no reports of this occurring between 2005 and 2009. However, the decreasing length frequency has been occurring since 1996, well before picket spacing was adjusted, indicating that the decreased picket spacing may not be the reason, or only one of several contributing factors.

Coho Salmon

Coho salmon escapement in 2009 was below the historical average, but well within the current SEG range (13,000–28,000) (Figure 13). The run exhibited slightly earlier than average run timing and a slightly longer than average duration for this project (Figure 14). The median passage date was 29 August, several days earlier than the historical median date. Kogrukluk River coho salmon are predominantly age-2.1 (4-year-old) fish; 2009 was no exception. The proportion of female coho salmon at the weir was above the historical average this was corroborated by an abundance of females in 2009 that was the third largest on record (Figure 8). The ASL sampling method yielded a female percentage similar to the visual method (Figure 4).

Mean lengths of male and female age-2.1 coho salmon at the Kogrukluk River weir have generally been declining since the late 1990s (Figure 15). Mean lengths in 2009 were considerably below those in most years between 1990 and 2003. Female fish tended to be slightly larger than males of the same age.

Sockeye Salmon

In 2009, Kogrukluk River sockeye escapement was the fourth highest in the 34-year escapement monitoring history (Figure 13). In recent years, sockeye salmon escapements have been unusually high this comes after consecutively low escapements that occurred between 1999 and 2003. An SEG range of 4,400 to 17,000 fish was recently established for Kogrukluk River sockeye, which the escapement far surpassed. The timing of the 2009 sockeye salmon run at the Kogrukluk River weir was later than average, although not the latest for this project (Figure 16). The duration of the run was one of the most protracted runs on record.

Pink Salmon

Accurate enumeration of spawning pink salmon at the Kuskokwim Area weirs is confounded by their small size, which allows some individuals to pass between weir pickets undetected. Pink salmon are regularly observed at Kogrukluk River weir, but their abundance has historically been low and counts are incomplete. Historically, the contribution of pink salmon to the overall salmon escapement at the Kogrukluk River weir has been negligible, often contributing less than 10 individuals per year. The passage of 46 pink salmon in 2009 was neither the largest or smallest return in the history of monitoring at the Kogrukluk River weir. Annual passage counts are higher in even years than in odd years. It appears that the contribution of pink salmon to this and other Kuskokwim River systems is greater than previously believed with the presence of a distinct population and recurring run timing events. It is notable that the pink salmon spawning in upper Kuskokwim River tributaries are among the farthest known migrating pink salmon in the world (Morrow 1980; Heard 1991). Pink salmon make less extensive spawning migrations into freshwater than other Pacific salmon species (Heard 1991) and, given the spatial orientation of the Kogrukluk River weir (approximately 710 rkm from the mouth of the Kuskokwim River), the small escapements observed at this site are not surprising.

Carcass Counts

The number of salmon carcasses found on the weir is not a complete census of the number of carcasses that drifted downstream of the weir site (Appendix B). Water levels in 2009 steadily declined throughout late July, when carcass deposition was beginning to increase. Carcass washout rates are closely tied to water level, making it impossible to standardize the data, and analysis among years is unreliable. Some remainder of the spawned-out fish were invariably retained in or near the river upstream of the weir for a protracted period of time, possibly contributing to the productivity of the system through the introduction of marine derived nutrients as described by Cederholm et al. (1999).

WEATHER AND STREAM OBSERVATIONS

Water levels and water temperatures were near average throughout the operational period (Figures 17 and 18). Overall, water level was average, except in August when water levels rose to the upper boundary of historical data (2002–2008). Water temperature derived from thermometer measurements was near average and within the historical range (Appendix C1, Figure 17). It is unclear whether water temperature affected salmon passage, because changes in water temperature at Kogrukluk River weir usually occur concurrently with fluctuations in water level.

Peak coho salmon escapement dates did seem to coincide with an increase in water level. This behavior has been observed in other stocks of coho salmon throughout their range (Sandercock 1991) (Table 1; Figure 18). No obvious relationship was observed between Chinook, chum, sockeye or coho salmon passage through the weir and local weather conditions.

CONCLUSIONS

- Total escapements of Chinook, chum, sockeye and coho salmon in 2009 were 9,702, 84,940, 23,785, 22,981 fish respectively.
- Run timing of Chinook, chum, and sockeye salmon at the Kogrukluk River weir was later than average while coho salmon had earlier than average run timing.
- Female Chinook salmon made up approximately 28% of the total annual run.
- Average length increased with age and females were longer than males at age for all species.
- Female chum salmon made up approximately 45% of the total annual run. The percentage of female chum salmon observed in the last 3 years is considerably higher than that observed since the late 1980s.
- Female coho salmon made up approximately 57% of the total annual run.
- Female sockeye salmon made up approximately 61.6% of the total annual run based on the non-ASL sex-determination method.

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REFERENCES CITED

Baxter, R. 1979. Holitna River salmon studies, 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 15, Anchorage.

Baxter, R. 1981. Ignatti weir construction manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 28, Anchorage.

Baxter, R. 1982. 1981 Ignatti weir study. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 25, Anchorage.

Brannian, L. K., K. R. Kamletz, H. A. Krenz, S. StClair, and C. Lawn. 2006a. Development of the Arctic-Yukon-Kuskokwim salmon database management system through June 30, 2006. Alaska Department of Fish and Game, Special Publication No. 06-21, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp06-21.pdf

Brannian, L. K., M. J. Evenson, and J. R. Hilsinger. 2006b. 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/fm06-07.pdf

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

Brown, C. M. 1983. Alaska's Kuskokwim River region: a history. Bureau of Land Management, Anchorage.

Buklis, L. S. 1999. A description of economic changes in commercial salmon fisheries in a region of mixed subsistence and market economies. Arctic 52 (1):40-48.

Burkey, C. E. Jr., editor. 1994. Kuskokwim Area salmon escapement observation catalog, 1984-1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A94-36, Anchorage.

Burkey, C. E. Jr. 1995. Kogrukluk River weir salmon escapement report, 1991-1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A95-24, Anchorage.

Cappiello, T. and C. E. Burkey, Jr. 1997. Kogrukluk River weir salmon escapement report, 1995-1996. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 3A97-18, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.1997.18.pdf

Carroll, H. C., and E. Patton. 2010. Lower Kuskokwim River inseason subsistence salmon catch monitoring, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 10-09, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/FMR10-09.pdf

Cederholm, C. J., M. D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24:6-15.

Coffing, M. 1991. Kwethluk subsistence: contemporary land use patterns, wild resource harvest and use, and the subsistence economy of a lower Kuskokwim River area community. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 157, Bethel.

Coffing, M., L. Brown, G. Jennings, and C. Utermohle. 2000. The subsistence harvest and use of wild resources in Akiachak, Alaska, 1998. Alaska Department of Fish and Game, Division of Subsistence, FIS 00-009, Juneau.

Collazzi, E. J. 1989. Results of a summer reconnaissance of the Holitna River Basin, Alaska, August 1985. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Public-data File 89-15, Fairbanks.

DuBois, L. and D. B. Molyneaux. 2000. Salmon age, sex, and length catalog for the Kuskokwim area, 1999 Progress Report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report 3A00-18, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2000.18.pdf

Geiger, H. J. and R. L. Wilbur. 1990. Proceedings of the 1990 Alaska Stock separation workshop, Anchorage, Alaska, February 14-16, 1990. Alaska Department of Fish and Game, Division of Commercial Fisheries, Special Publication No. 2, Juneau.

REFERENCES CITED (Continued)

Groot, C. and L. Margolis, editors. 1991. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Hauer, F. R., and W. R. Hill. 1996. Temperature, light and oxygen. Pages 93- 106 [*In*]: F. R. Hauer and G. A. Lambert (editors) Methods in Stream Ecology. Academic Press, San Diego.

Healy, M. C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha).* [*In*]: Groot, C., and L. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Heard, W. R. 1991. Life history of pink salmon (*Oncorhynchus gorbuscha*). [*In*]: Groot, C., and L. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Holmes, R. A., and R. D. Burkett. 1996. Salmon stewardship: Alaska's perspective. Fisheries 21 (10):36-38.

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

Jasper, J. R., and D. B. Molyneaux. 2007. Kogrukluk River weir salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-12, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-12.pdf

Kruse, G. H. 1998. Salmon run failures 1997-1998: a link to anomalous ocean conditions? Alaska Fishery Research Bulletin 5 (1):55-63.

Liller, Z. W., D. J. Costello, and D. B. Molyneaux. 2008. Kogrukluk River weir salmon studies, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 08-26, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-26.pdf

Linderman, J. C. Jr., D. B. Molyneaux, L. DuBois and D. J. Cannon. 2003. George River salmon studies, 1996 to 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2003.17.pdf

Molyneaux, D. B., D. L. Folletti, and A. R. Brodersen. 2008. Salmon age, sex, and length catalog for the Kuskokwim Area, 2007. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A08-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2008.05.pdf.

Molyneaux, D. B., A. R. Brodersen, and C. A. Shelden. *In prep*. Salmon age, sex, and length catalog for the Kuskokwim Area, 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, Anchorage.

Molyneaux, D. B., and L. K. Brannian. 2006. Review of escapement and abundance information for Kuskokwim area salmon stocks. Alaska Department of Fish and Game, Fishery Manuscript No. 06-08, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms06-08.pdf

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska.

Mundy, P. R. 1998. Principles and criteria for sustainable salmon management, a contribution to the development of a salmon fishery evaluation framework for the State of Alaska. Alaska Department of Fish and Game, Contract No. IHP-98-045, Anchorage.

NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest, Committee on the Protection and Management of Pacific Northwest Salmonids. National Academy Press, Washington, D.C.

Oswalt, W. H. 1990. Bashful no longer: an Alaskan Eskimo ethnohistory, 1778-1988 (Civilization of the American Indian, Vol 199). University of Oklahoma Press, Norman, Oklahoma.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle, WA.

Sandercock, F. K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 395-446 [In]: C Groot and L Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

REFERENCES CITED (Continued)

Shelden, C. A., D. J. Costello, and D. B. Molyneaux. 2005. Kogrukluk River salmon studies, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-58, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-58.pdf

Whitmore, C., M. Martz, J. C. Linderman, R. L. Fisher and D. G. Bue. 2008. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2004. Alaska Department of Fish and Game, Fishery Management Report No. 08-25, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-25.pdf

Williams, D.L., and C. A. Shelden. 2010. Kogrukluk River weir salmon studies, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 10-24, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds10-24.pdf

Yanagawa, C. M. 1972. Kogrukluk River counting tower project, 1969-1970. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Kuskokwim Escapement Report No. 4, Anchorage.

Yanagawa, C. M. 1973. Kogrukluk River counting tower project, 1972. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Kuskokwim Escapement Report No. 6, Anchorage.

TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at the Kogrukluk River weir, 2009.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
6/25	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	10	10	0	0	0	0	0	0	0
6/27	0	0	0	15	25	0	0	0	0	1	1	0
6/28	5	5	0	33	58	0	0	0	0	1	2	0
6/29	4	9	0	60	118	0	0	0	0	5	7	0
6/30	6	15	0	40	158	0	0	0	0	0	7	0
7/1	13	28	0	65	223	0	0	0	0	6	13	0
7/2	29	57	1	86	309	0	0	0	0	4	17	0
7/3	39	96	1	115	424	0	0	0	0	7	24	0
7/4	34	130	1	91	515	1	0	0	0	10	34	0
7/5	183	313	3	276	791	1	0	0	0	38	72	0
7/6	95	408	4	180	971	1	0	0	0	58	130	1
7/7	134	542	6	270	1,241	1	0	0	0	70	200	1
7/8	273	815	8	672	1,913	2	0	0	0	112	312	1
7/9	225	1,040	11	831	2,744	3	0	0	0	320	632	3
7/10	202	1,242	13	1,300	4,044	5	0	0	0	499	1,131	5
7/11	434	1,676	17	1,691	5,735	7	0	0	0	985	2,116	9
7/12	533	2,209	23	2,187	7,922	9	0	0	0	1,265	3,381	14
7/13	575	2,784	29	2,484	10,406	12	0	0	0	949	4,330	18
7/14	392	3,176	33	1,880	12,286	14	0	0	0	710	5,040	21
7/15	308	3,484	36	2,206	14,492	17	0	0	0	1,201	6,241	26
7/16	535	4,019	41	3,115	17,607	21	0	0	0	1,611	7,852	33
7/17	334	4,353	45	2,440	20,047	24	0	0	0	671	8,523	36
7/18	331	4,684	48	2,325	22,372	26	0	0	0	486	9,009	38
7/19	573	5,257	**54**	3,035	25,407	30	0	0	0	1,399	10,408	44
7/20	382	5,639	58	3,507	28,914	34	0	0	0	1,061	11,469	48
7/21	435	6,074	63	3,268	32,182	38	0	0	0	1,093	12,562	**53**
7/22	292	6,366	66	3,505	35,687	42	0	0	0	789	13,351	56
7/23	283	6,649	69	3,396	39,083	46	0	0	0	804	14,155	60
7/24	227	6,876	71	3,655	42,738	**50**	0	0	0	568	14,723	62
7/25	203	7,079	73	3,646	46,384	55	0	0	0	320	15,043	63
7/26	461	7,540	78	3,021	49,405	58	0	0	0	847	15,890	67
7/27	416	7,956	82	2,454	51,859	61	0	0	0	1,230	17,120	72
7/28	237	8,193	84	4,234	56,093	66	0	0	0	953	18,073	76
7/29 [a]	288	[b] 8,481	87	3,125	[b] 59,218	70	10	[b] 10	0	970	[b] 19,043	80
7/30 [a]	250	[b] 8,731	90	2,906	[b] 62,124	73	21	[b] 31	0	848	[b] 19,891	84
7/31 [a]	212	[b] 8,944	92	2,688	[b] 64,812	76	31	[b] 62	0	726	[b] 20,617	87
8/1 [a]	174	[b] 9,118	94	2,469	[b] 67,281	79	41	[b] 103	0	604	[b] 21,221	89
8/2 [a]	136	[b] 9,254	95	2,250	[b] 69,531	82	52	[b] 155	1	483	[b] 21,704	91
8/3 [a]	98	[b] 9,352	96	2,031	[b] 71,562	84	62	[b] 217	1	361	[b] 22,065	93
8/4	53	9,405	97	1,762	73,324	86	41	258	1	187	22,252	94
8/5	67	9,472	98	1,863	75,187	89	104	362	2	291	22,543	95
8/6 [a]	41	[c] 9,513	98	1,410	[c] 76,597	90	102	[c] 464	2	184	[c] 22,727	96
8/7	22	9,535	98	1,075	77,672	91	127	591	3	125	22,852	96
8/8	21	9,556	98	939	78,611	93	134	725	3	131	22,983	97
8/9	23	9,579	99	1,077	79,688	94	150	875	4	114	23,097	97
8/10	22	9,601	99	1,010	80,698	95	222	1,097	5	119	23,216	98

-continued-

Table 1.–Page 2 of 2.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
8/11	11	9,612	99	763	81,461	96	145	1,242	5	104	23,320	98
8/12	17	9,629	99	591	82,052	97	184	1,426	6	67	23,387	98
8/13	5	9,634	99	341	82,393	97	18	1,444	6	27	23,414	98
8/14	8	9,642	99	432	82,825	98	255	1,699	7	58	23,472	99
8/15	6	9,648	99	467	83,292	98	680	2,379	10	88	23,560	99
8/16 [a]	7	[b] 9,655	100	369	[b] 83,661	98	491	[b] 2,870	12	60	[b] 23,620	99
8/17 [a]	6	[b] 9,661	100	289	[b] 83,950	99	515	[b] 3,385	15	47	[b] 23,667	100
8/18 [a]	6	[b] 9,667	100	208	[b] 84,158	99	538	[b] 3,923	17	34	[b] 23,701	100
8/19	4	9,671	100	172	84,330	99	610	4,533	20	30	23,731	100
8/20	7	9,678	100	83	84,413	99	514	5,047	22	13	23,744	100
8/21	2	9,680	100	87	84,500	99	338	5,385	23	6	23,750	100
8/22	1	9,681	100	81	84,581	100	256	5,641	25	8	23,758	100
8/23	7	9,688	100	60	84,641	100	456	6,097	27	6	23,764	100
8/24	0	9,688	100	33	84,674	100	442	6,539	28	2	23,766	100
8/25	3	9,691	100	68	84,742	100	1,025	7,564	33	3	23,769	100
8/26	0	9,691	100	38	84,780	100	780	8,344	36	8	23,777	100
8/27	1	9,692	100	35	84,815	100	1,177	9,521	41	1	23,778	100
8/28	0	9,692	100	16	84,831	100	1,195	10,716	47	1	23,779	100
8/29	0	9,692	100	26	84,857	100	778	11,494	**50**	0	23,779	100
8/30	1	9,693	100	19	84,876	100	1,477	12,971	56	1	23,780	100
8/31	2	9,695	100	13	84,889	100	133	13,104	57	0	23,780	100
9/1	0	9,695	100	9	84,898	100	53	13,157	57	2	23,782	100
9/2	3	9,698	100	9	84,907	100	345	13,502	59	1	23,783	100
9/3	2	9,700	100	8	84,915	100	1,556	15,058	66	0	23,783	100
9/4	1	9,701	100	4	84,919	100	1,367	16,425	71	0	23,783	100
9/5	0	9,701	100	3	84,922	100	1,339	17,764	77	0	23,783	100
9/6	0	9,701	100	4	84,926	100	216	17,980	78	0	23,783	100
9/7	0	9,701	100	5	84,931	100	321	18,301	80	0	23,783	100
9/8	1	9,702	100	3	84,934	100	313	18,614	81	0	23,783	100
9/9	0	9,702	100	2	84,936	100	194	18,808	82	0	23,783	100
9/10	0	9,702	100	1	84,937	100	119	18,927	82	0	23,783	100
9/11	0	9,702	100	0	84,937	100	112	19,039	83	0	23,783	100
9/12	0	9,702	100	0	84,937	100	277	19,316	84	0	23,783	100
9/13	0	9,702	100	1	84,938	100	426	19,742	86	0	23,783	100
9/14	0	9,702	100	0	84,938	100	193	19,935	87	0	23,783	100
9/15	0	9,702	100	0	84,938	100	571	20,506	89	1	23,784	100
9/16	0	9,702	100	0	84,938	100	350	20,856	91	0	23,784	100
9/17	0	9,702	100	0	84,938	100	183	21,039	92	1	23,785	100
9/18	0	9,702	100	1	84,939	100	668	21,707	94	0	23,785	100
9/19	0	9,702	100	0	84,939	100	375	22,082	96	0	23,785	100
9/20	0	9,702	100	0	84,939	100	135	22,217	97	0	23,785	100
9/21	0	9,702	100	0	84,939	100	365	22,582	98	0	23,785	100
9/22	0	9,702	100	0	84,939	100	131	22,713	99	0	23,785	100
9/23	0	9,702	100	0	84,939	100	129	22,842	99	0	23,785	100
9/24	0	9,702	100	1	84,940	100	33	22,875	100	0	23,785	100
9/25	0	9,702	100	0	84,940	100	39	22,914	100	0	23,785	100
9/26	0	9,702	100	0	84,940	100	11	22,925	100	0	23,785	100
9/27 [a]	0	9,702	100	0	84,940	100	56	22,981	100	0	23,785	100

Note: Boxes represent the central 50% of the run and bold represents the median date of passage.

[a] The weir was inoperable for all or part of the day.

[b] Daily passage was estimated using the "Linear" method.

[c] Daily passage was estimated using the "single day" method.

Table 2.–Age and sex composition of Chinook salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

			Age Class																	
Sample Dates	Sample		1.1		1.2		1.3		2.2		1.4		2.3		1.5		2.4		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
7/2-7/14	80	M	0	0.0	913	28.8	1,548	48.8	40	1.3	278	8.8	0	0.0	0	0.0	0	0.0	2,779	87.5
(6/25-7/14)		F	0	0.0	80	2.5	0	0.0	0	0.0	238	7.5	40	1.3	40	1.3	0	0.0	397	12.5
		Subtotal[a]	0	0.0	993	31.3	1,548	48.8	40	1.3	516	16.3	40	1.3	40	1.3	0	0.0	3,176	100.0
7/15-7/22	115	M	0	0.0	693	21.7	1,026	32.2	28	0.9	305	9.5	0	0.0	0	0.0	0	0.0	2,053	64.3
(7/15-7/22)		F	0	0.0	0	0.0	444	13.9	0	0.0	666	20.9	0	0.0	28	0.9	0	0.0	1,137	35.7
		Subtotal[a]	0	0.0	693	21.7	1,470	46.1	28	0.9	971	30.4	0	0.0	28	0.9	0	0.0	3,190	100.0
7/23-8/8	50	M	0	0.0	400	12.0	1,734	52.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2,134	64.0
(7/23-9/27)		F	0	0.0	67	2.0	334	10.0	0	0.0	734	22.0	0	0.0	67	2.0	0	0.0	1,201	36.0
		Subtotal[a]	0	0.0	467	14.0	2,068	62.0	0	0.0	734	22.0	0	0.0	67	2.0	0	0.0	3,335	100.0
Season[b]	245	M	0	0.0	2,007	20.7	4,309	44.4	67	0.7	583	6.0	0	0.0	0	0.0	0	0.0	6,966	71.8
		F	0	0.0	146	1.5	777	8.0	0	0.0	1,638	16.9	40	0.4	134	1.4	0	0.0	2,735	28.2
		Total	0	0.0	2,153	22.2	5,086	52.4	67	0.7	2,221	22.9	40	0.4	134	1.4	0	0.0	9,701	100.0
		95% C.I. (%)				(±5.3)		(±6.6)		(±1.0)		(±5.5)		(±0.8)		(±1.7)				

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 3.–Mean length (mm) of Chinook salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	1.2	1.3	2.2	1.4	2.3	1.5
7/2-7/14 (6/25-7/14)	M	Mean Length		588	686	557	848		
		Std. Error		13	9	-	35		
		Range		496-781	593-851	557-557	736-931		
		Sample Size	0	23	39	1	6	0	0
	F	Mean Length		625			883	807	851
		Std. Error		-			16	-	-
		Range		625-625			852-958	807-807	851-851
		Sample Size	0	1	0	0	6	1	1
7/15-7/22 (7/15-7/22)	M	Mean Length		587	713	522	844		
		Std. Error		11	10	-	14		
		Range		478-693	605-863	522-522	783-945		
		Sample Size	0	24	37	1	11	0	0
	F	Mean Length			815		851		773
		Std. Error			12		11		-
		Range			717-893		761-956		773-773
		Sample Size	0	0	16	0	24	0	1
7/23-8/8 (7/23-9/27)	M	Mean Length		558	749				
		Std. Error		26	12				
		Range		475-623	618-850				
		Sample Size	0	6	26	0	0	0	0
	F	Mean Length		680	842		851		920
		Std. Error		-	34		20		-
		Range		680-680	734-946		732-940		920-920
		Sample Size	0	1	5	0	11	0	1
Season[a]	M	Mean Length		582	718	543	846		
		Std. Error[b]		9	6	-	18		
		Range		475-781	593-863	522-557	736-945		
		Sample Size	0	53	102	2	17	0	0
	F	Mean Length		650	827		856	807	869
		Std. Error[b]		.	16		10	-	-
		Range		625-680	717-946		732-958	807-807	773-920
		Sample Size	0	2	21	0	41	1	3

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 2.

[a] "Season" mean lengths are weighted by the escapement passage in each stratum.

[b] Standard error was not calculated for small samples.

Table 4.–Age and sex composition of chum salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
7/8-7/18	408	M	425	1.5	10,488	36.3	4,677	16.2	283	1.0	15,874	54.9
(6/25-7/20)		F	496	1.7	9,780	33.8	2,622	9.0	142	0.5	13,040	45.1
		Subtotal[a]	921	3.2	20,268	70.1	7,299	25.2	425	1.5	28,914	100.0
7/22-7/25	203	M	134	0.5	11,648	42.9	3,749	13.8	0	0.0	15,531	57.1
(7/21-7/28)		F	134	0.5	9,104	33.5	2,410	8.9	0	0.0	11,648	42.9
		Subtotal[a]	268	1.0	20,752	76.4	6,159	22.7	0	0.0	27,179	100.0
8/4,8/7-8/9	195	M	444	1.5	11,391	39.5	3,698	12.8	148	0.5	15,681	54.4
(7/29-9/27)		F	592	2.1	11,391	39.5	1,036	3.6	148	0.5	13,166	45.6
		Subtotal[a]	1,036	3.6	22,782	79.0	4,734	16.4	296	1.0	28,847	100.0
Season[b]	806	M	1,003	1.2	33,527	39.5	12,124	14.3	431	0.5	47,086	55.4
		F	1,222	1.4	30,275	35.6	6,068	7.1	290	0.3	37,854	44.6
		Total	2,225	2.6	63,802	75.1	18,192	21.4	721	0.8	84,940	100.0
		95% C.I. (%)		(±1.1)		(±3.1)		(±2.9)		(±0.6)	-	-

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 5.–Mean length (mm) of chum salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
7/8-7/18	M	Mean Length	549	572	588	587
(6/25-7/20)		SE	13	2	4	10
		Range	502-575	510-647	504-657	567-616
		Sample Size	6	148	66	4
	F	Mean Length	544	549	558	538
		SE	8	2	4	8
		Range	521-571	494-618	502-606	530-545
		Sample Size	7	138	37	2
7/22-7/25	M	Mean Length	512	574	580	
7/21-7/28		SE	-	3	5	
		Range	512-512	504-655	523-649	
		Sample Size	1	87	28	0
	F	Mean Length	575	543	559	
		SE	-	3	5	
		Range	575-575	482-597	515-591	
		Sample Size	1	68	18	0
8/4, 8/7-8/9	M	Mean Length	560	568	574	591
(7/29-9/27)		SE	10	3	4	-
		Range	545-579	504-646	543-599	591-591
		Sample Size	3	77	25	1
	F	Mean Length	500	533	553	575
		SE	12	3	13	-
		Range	471-525	456-609	497-589	575-575
		Sample Size	4	77	7	1
Season[a]	M	Mean Length	549	571	581	589
		Std. Error[b]	8	2	2	10
		Range	502-579	504-655	504-657	567-616
		Sample Size	10	312	119	5
	F	Mean Length	526	541	558	557
		Std. Error[b]	8	2	4	8
		Range	471-575	456-618	497-606	530-575
		Sample Size	12	283	62	3

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 4.

[a] "Season" mean lengths are weighted by the escapement passage in each stratum.

Table 6.–Age and sex composition of coho salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

			Age Class							
			1.1		2.1		3.1		Total	
Sample Dates (Stratum Dates)	Sample Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%
8/20-23	175	M	0	0.0	4,148	49.7	429	5.2	4,577	54.9
(6/25-8/26)		F	0	0.0	3,338	40.0	429	5.1	3,767	45.1
		Subtotal[a]	0	0.0	7,486	89.7	858	10.3	8,344	100.0
8/31-9/3	172	M	141	1.7	2,490	30.8	282	3.5	2,913	36.0
(8/27-9/4)		F	94	1.2	4,698	58.2	376	4.6	5,168	64.0
		Subtotal[a]	235	2.9	7,188	89.0	658	8.1	8,081	100.0
9/7-11	173	M	76	1.1	2,311	35.3	114	1.7	2,501	38.2
(9/5-27)		F	38	0.6	3,752	57.2	265	4.1	4,055	61.8
		Subtotal[a]	114	1.7	6,063	92.5	379	5.8	6,556	100.0
Season[b]	520	M	217	0.9	8,950	38.9	825	3.6	9,991	43.5
		F	132	0.6	11,787	51.3	1,070	4.6	12,990	56.5
		Total	349	1.5	20,737	90.2	1,895	8.2	22,981	100.0
		95% C.I. (%)		(±1.0)		(±2.6)		(±2.4)	-	-

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 7.–Mean length (mm) of coho salmon at the Kogrukluk River weir in 2009 based one escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/20-23 (6/25-8/26)	M	Mean Length		544	576
		SE		5	19
		Range		363-635	457-614
		Sample Size	0	87	9
	F	Mean Length		548	556
		SE		4	12
		Range		472-616	494-608
		Sample Size	0	70	9
8/31-9/3 (8/27-9/4)	M	Mean Length	485	536	551
		SE	15	6	15
		Range	460-513	424-608	498-596
		Sample Size	3	53	6
	F	Mean Length	494	538	554
		SE	11	3	10
		Range	483-504	458-616	518-592
		Sample Size	2	100	8
9/7-11 (9/5-27)	M	Mean Length	515	530	556
		SE	12	6	15
		Range	503-527	433-630	526-577
		Sample Size	2	61	3
	F	Mean Length	535	538	547
		SE	-	4	11
		Range	535-535	418-609	505-591
		Sample Size	1	99	7
Season[a]	M	Mean Length	495	538	565
		SE	11	3	11
		Range	460-527	363-635	457-614
		Sample Size	5	201	18
	F	Mean Length	505	541	553
		SE	-	2	7
		Range	483-535	418-616	494-608
		Sample Size	3	269	24

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 6.

[a] "Season" mean lengths are weighted by the escapement passage in each stratum.

Table 8.–Age and sex composition of sockeye salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

			Age Class																	
Sample Dates	Sample		0.2		0.3		1.2		0.4		1.3		2.2		1.4		2.3		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
7/10-18	40	M	0	0.0	0	0.0	1,545	15.0	0	0.0	515	5.0	0	0.0	0	0.0	0	0.0	2,060	20.0
(6/25-7/19)		F	0	0.0	257	2.5	5,921	57.5	0	0.0	2,060	20.0	0	0.0	0	0.0	0	0.0	8,238	80.0
		Subtotal[a]	0	0.0	257	2.5	7,466	72.5	0	0.0	2,575	25.0	0	0.0	0	0.0	0	0.0	10,298	100.0
7/20-26	42	M	0	0.0	0	0.0	3,870	28.6	0	0.0	322	2.4	0	0.0	0	0.0	0	0.0	4,193	31.0
(7/20-9/27)		F	0	0.0	0	0.0	7,418	54.7	0	0.0	1,935	14.3	0	0.0	0	0.0	0	0.0	9,352	69.0
		Subtotal[a]	0	0.0	0	0.0	11,288	83.3	0	0.0	2,257	16.7	0	0.0	0	0.0	0	0.0	13,545	100.0
Season[b]	82	M	0	0.0	0	0.0	5,415	22.7	0	0.0	837	3.5	0	0.0	0	0.0	0	0.0	6,252	26.2
		F	0	0.0	257	1.1	13,339	56.0	0	0.0	3,995	16.8	0	0.0	0	0.0	0	0.0	17,591	73.8
		Total	0	0.0	257	1.1	18,754	78.7	0	0.0	4,832	20.3	0	0.0	0	0.0	0	0.0	23,843	100.0
		95% C.I. (%)				(±2.1)		(±8.9)				(±8.7)								

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in "Season" summaries are the strata sums; "Season" percentages are derived from the sums of the estimated escapement that occurred in each stratum.

Table 9.–Mean length (mm) of Sockeye salmon at the Kogrukluk River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	1.2	0.4	1.3	2.2	1.4
7/10-18 (6/25-7/19)	M	Mean Length			561		606		
		Std. Error			10		1		
		Range			536-604		605-606		
		Sample Size	0	0	6	0	2	0	0
	F	Mean Length		536	540		552		
		Std. Error		-	5		12		
		Range		536-536	492-578		521-614		
		Sample Size	0	1	23	0	8	0	0
7/20-26 (7/20-9/27)	M	Mean Length			571		605		
		Std. Error			7		-		
		Range			501-599		605-605		
		Sample Size	0	0	12	0	1	0	0
	F	Mean Length			529		541		
		Std. Error			4		15		
		Range			492-563		477-574		
		Sample Size	0	0	23	0	6	0	0
Season[a]	M	Mean Length			568		605		
		Std. Error[b]		-	6	-	-		
		Range			501-604		605-606		
		Sample Size	0	0	18	0	3	0	0
	F	Mean Length		536	534		546		
		Std. Error[b]		-	3		10		
		Range		536-536	492-578		477-614		
		Sample Size	0	1	46	0	14	0	0

Note: The sum of the sample sizes in each stratum equal the total sample size reported for that stratum in Table 2.

[a] "Season" mean lengths are weighted by the escapement passage in each stratum.

[b] Standard error was not calculated for small samples.

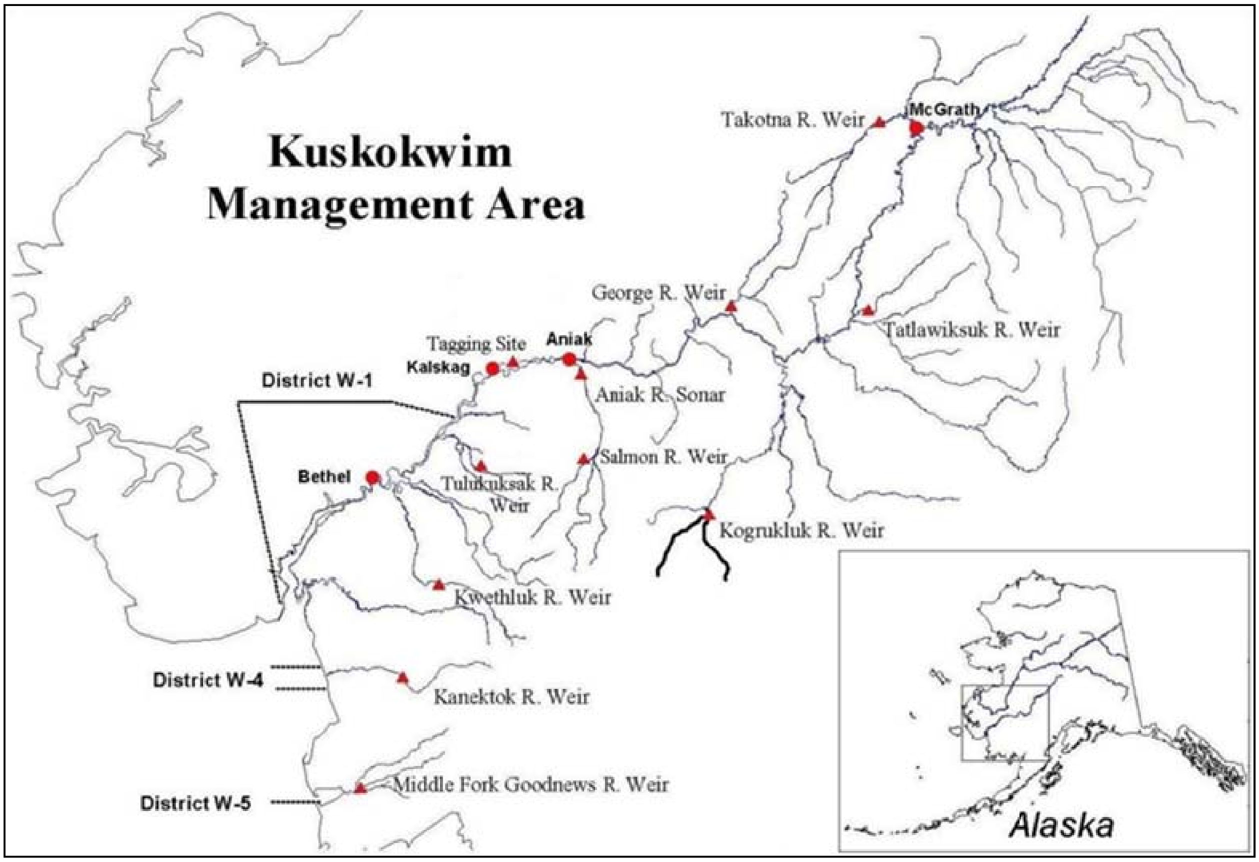


Figure 1.–Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Kogrukluk River weir.

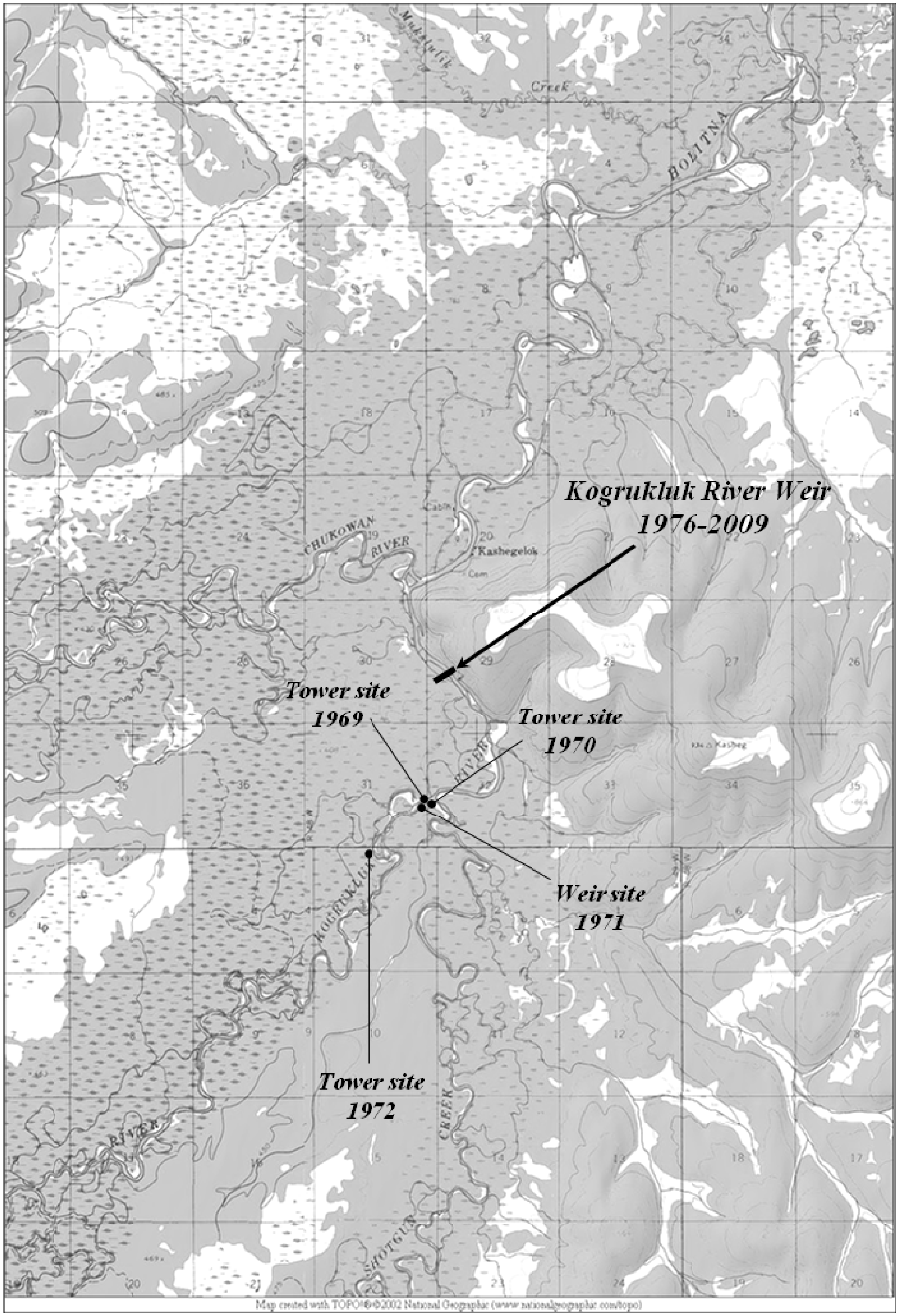


Figure 2.–Kogrukluk River study area and location of historical escapement monitoring projects.

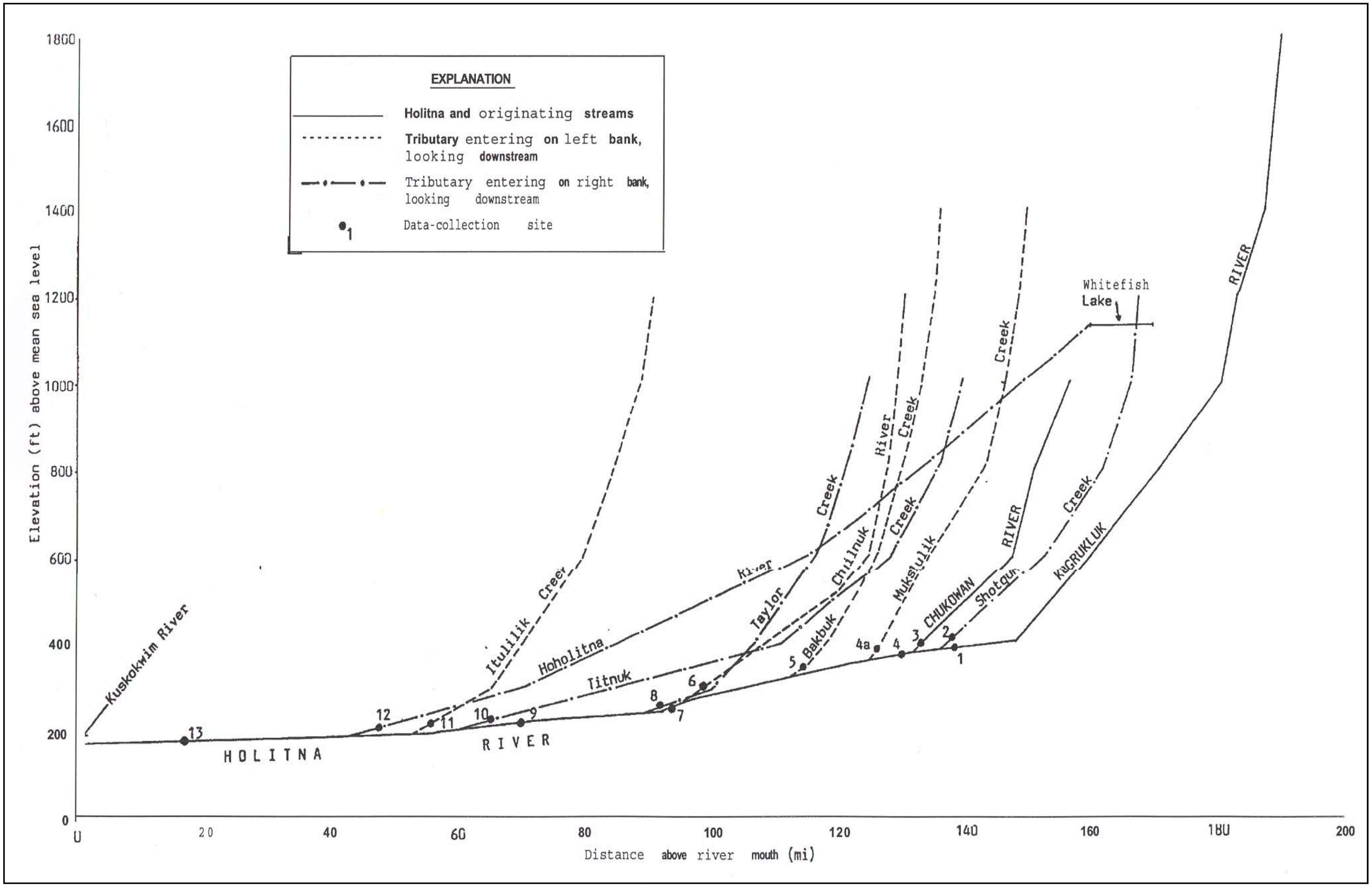


Figure 3.–Profile of the Holitna River and major tributaries, Alaska (Collazzi 1989).

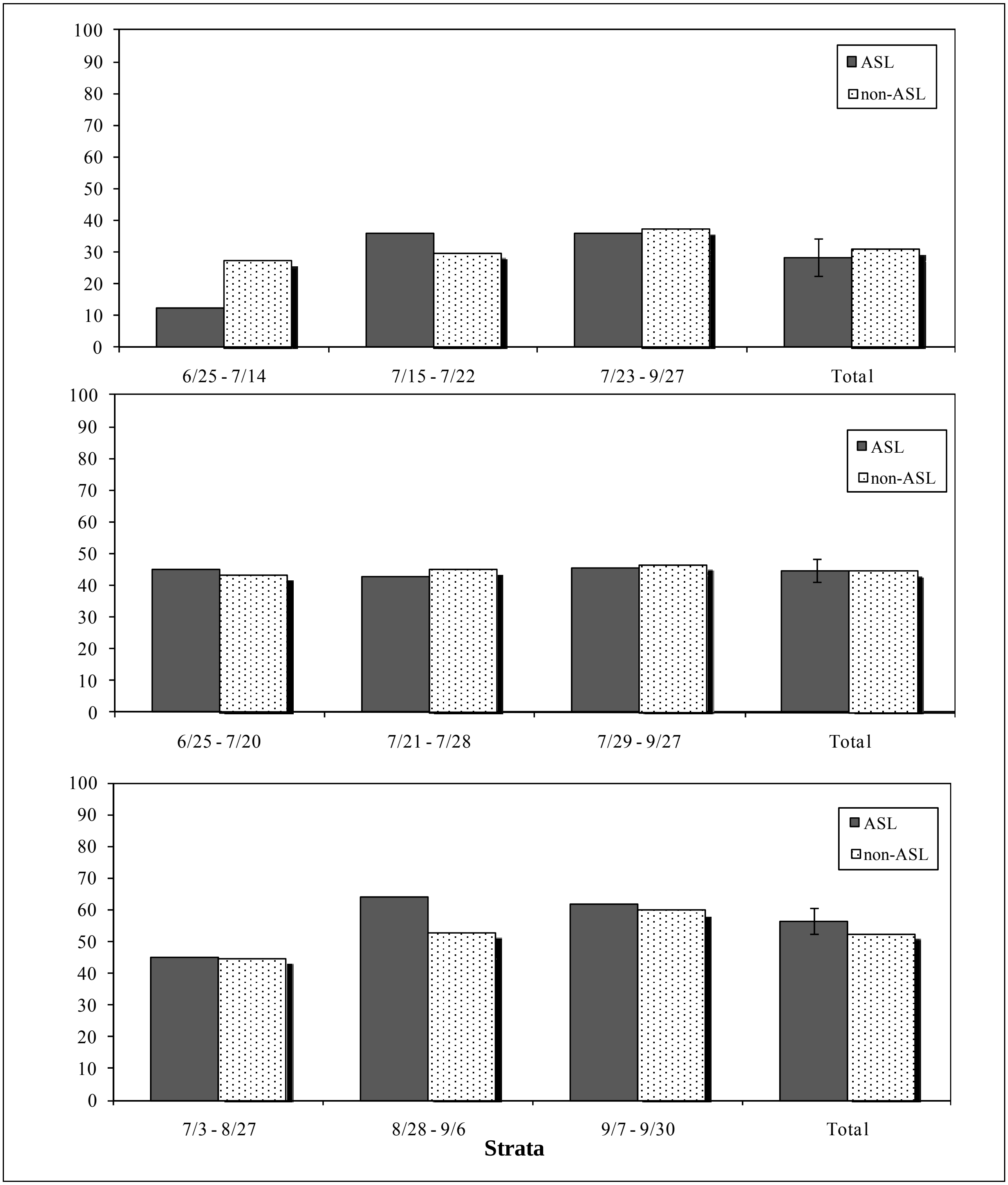


Figure 4.–Comparison of the percentage of female salmon passing upstream of the Kogrukluk River weir in 2009 as determined from standard ASL sampling using a fish trap, and from visual inspection of non-ASL sampled fish using standard fish passage procedures.

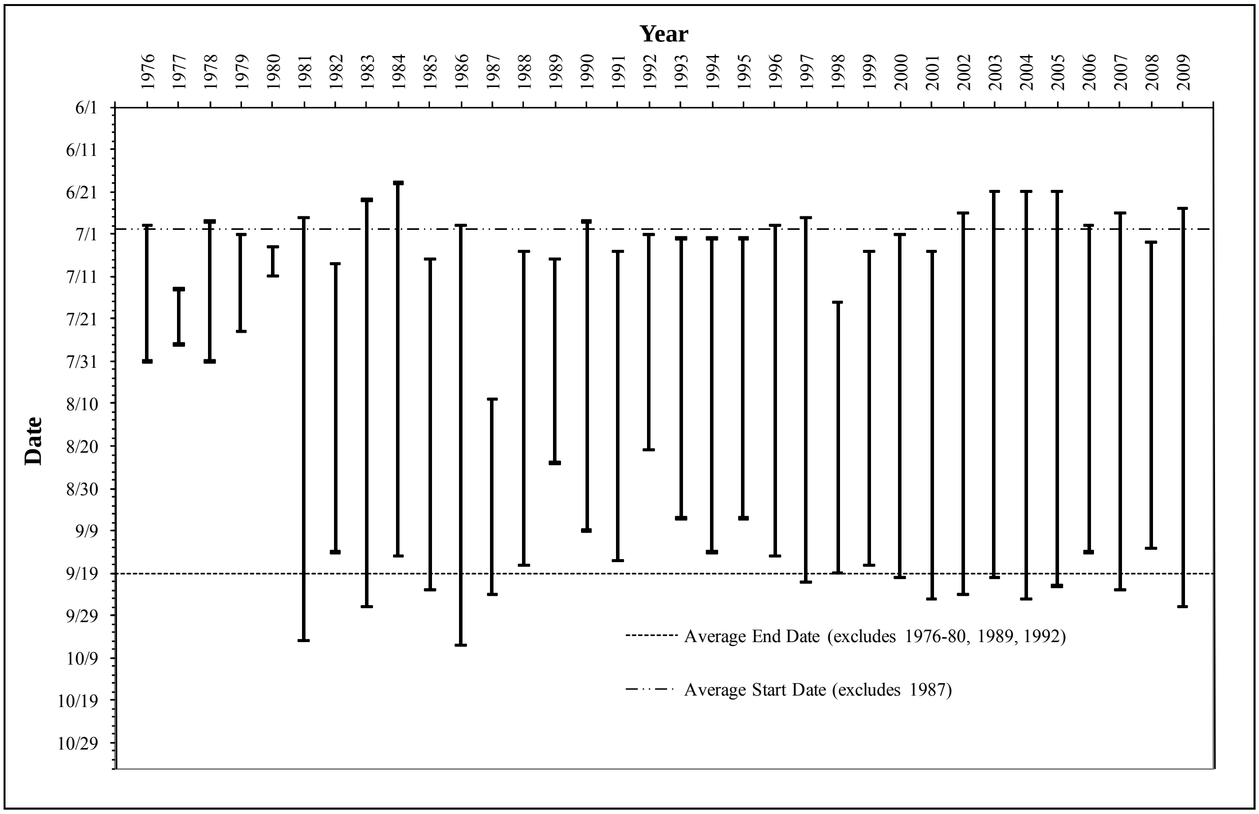


Figure 5.–Historical operational dates for the Kogrukluk River weir.

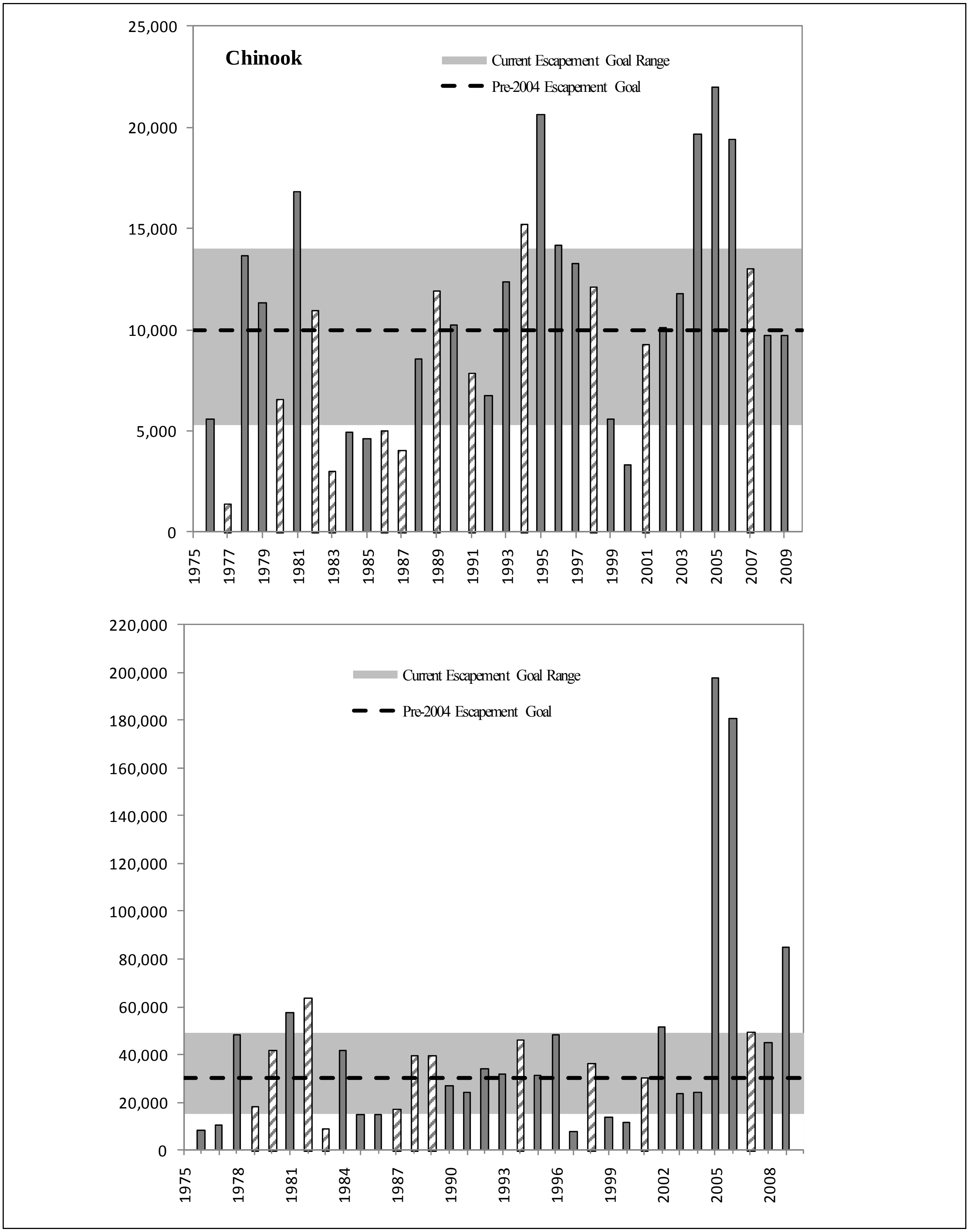
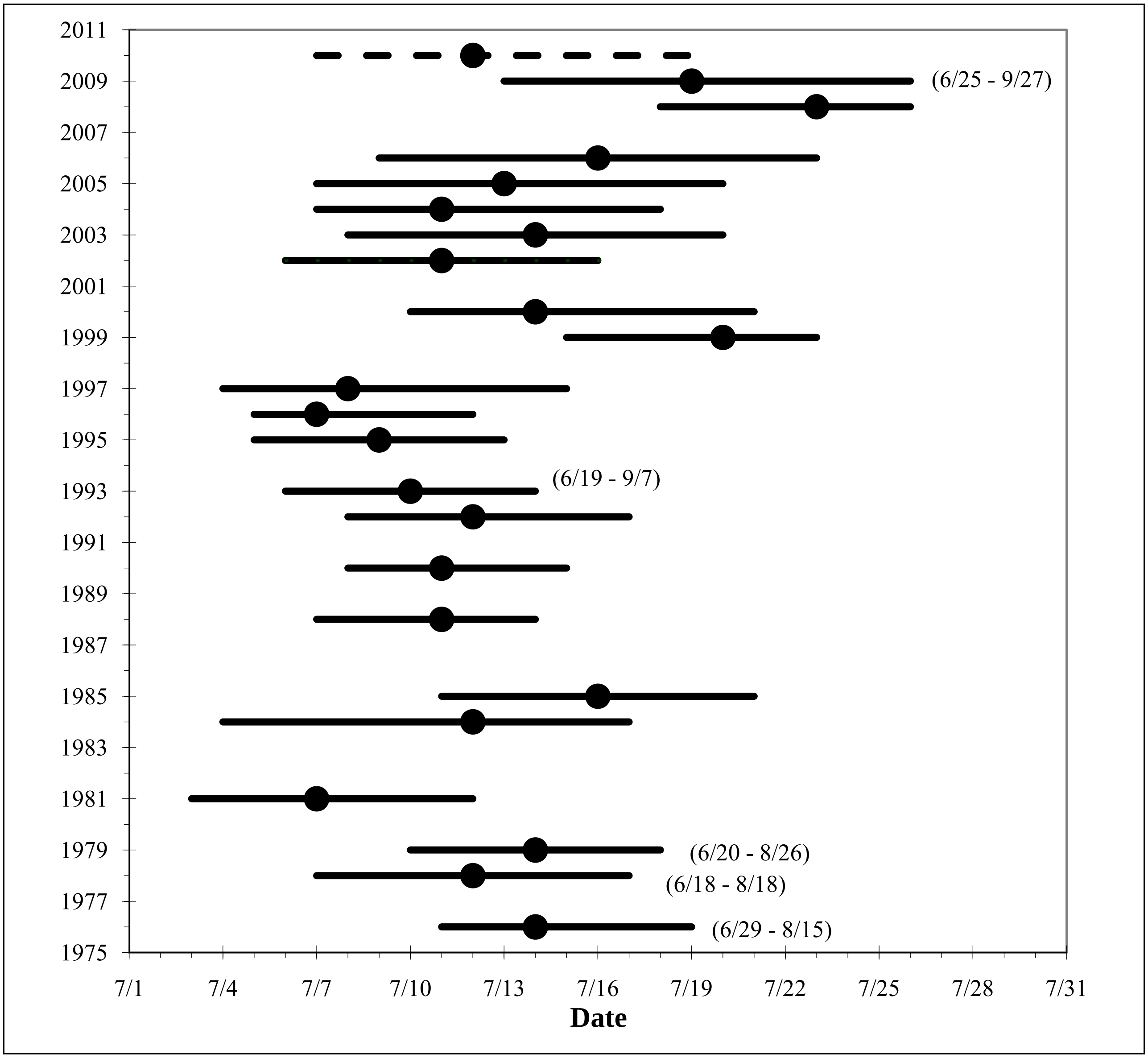


Figure 6.–Historical Chinook and chum salmon escapement with the pre-2004 minimum escapement goal and the current escapement goal range at the Kogrukluk River weir.



Note: Solid black lines represent dates the central 50% of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. As a means to gauge the comparability of the run timing estimates, operational date ranges are in parentheses beside each annual line. The dashed line represents the average passage dates of the graphed years.

Figure 7.–Historical run timing of Chinook salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009.

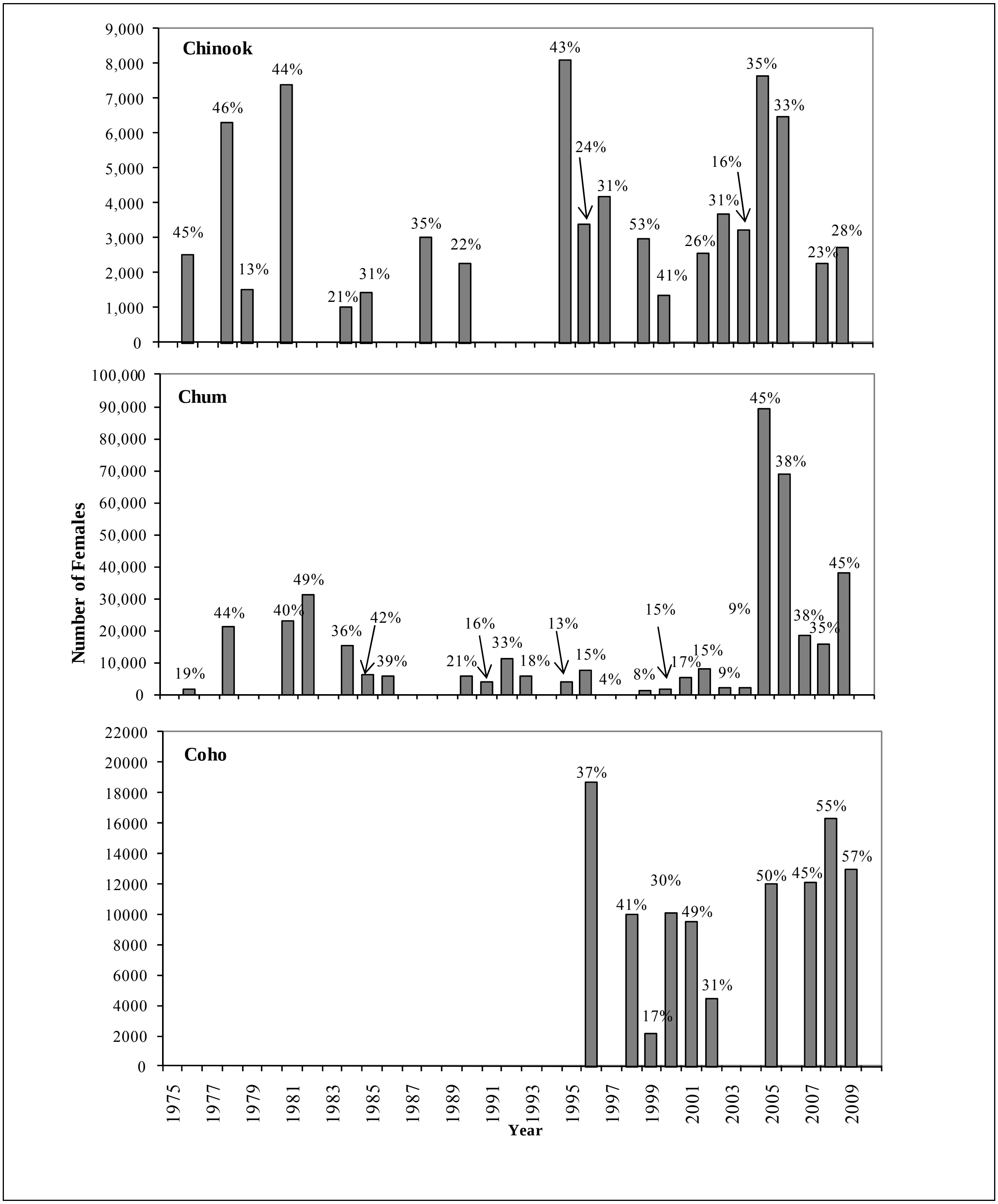


Figure 8.–Historical female escapement of Chinook, chum, and coho salmon with percent composition of female salmon.

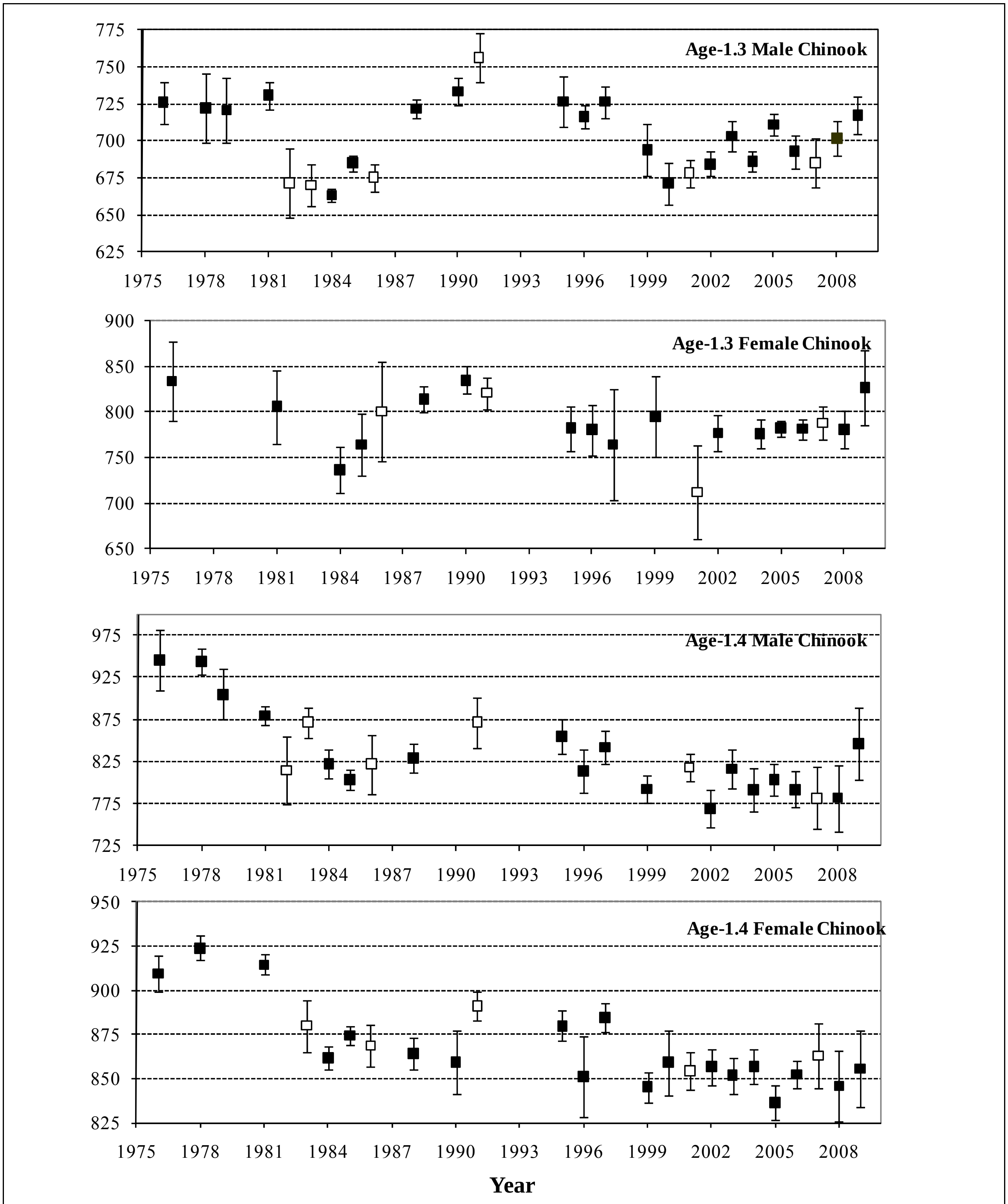


Figure 9.–Historical average length for Chinook salmon with 95% confidence intervals at the Kogrukluk River weir.

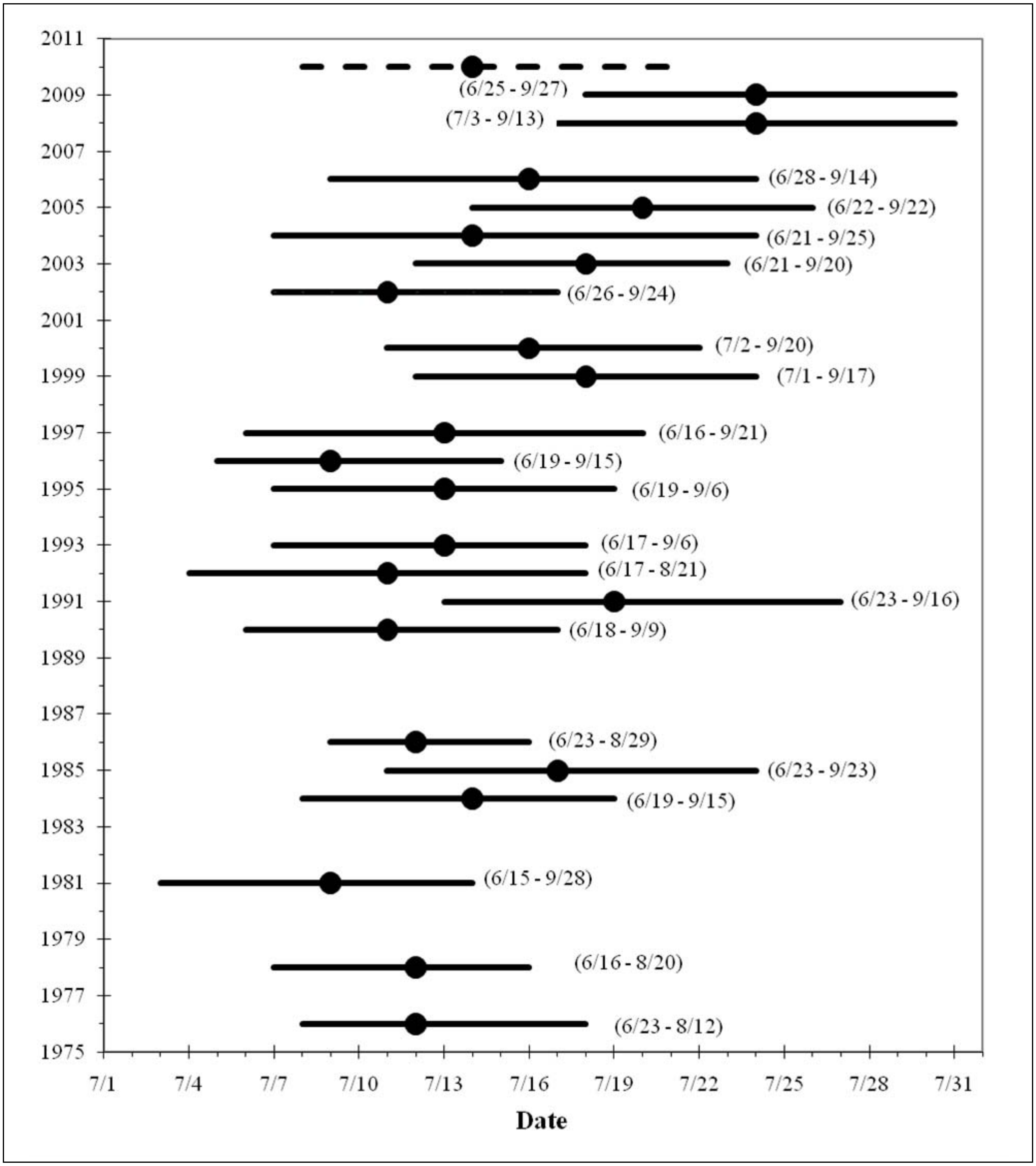


Figure 10.–Historical run timing of chum salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009.

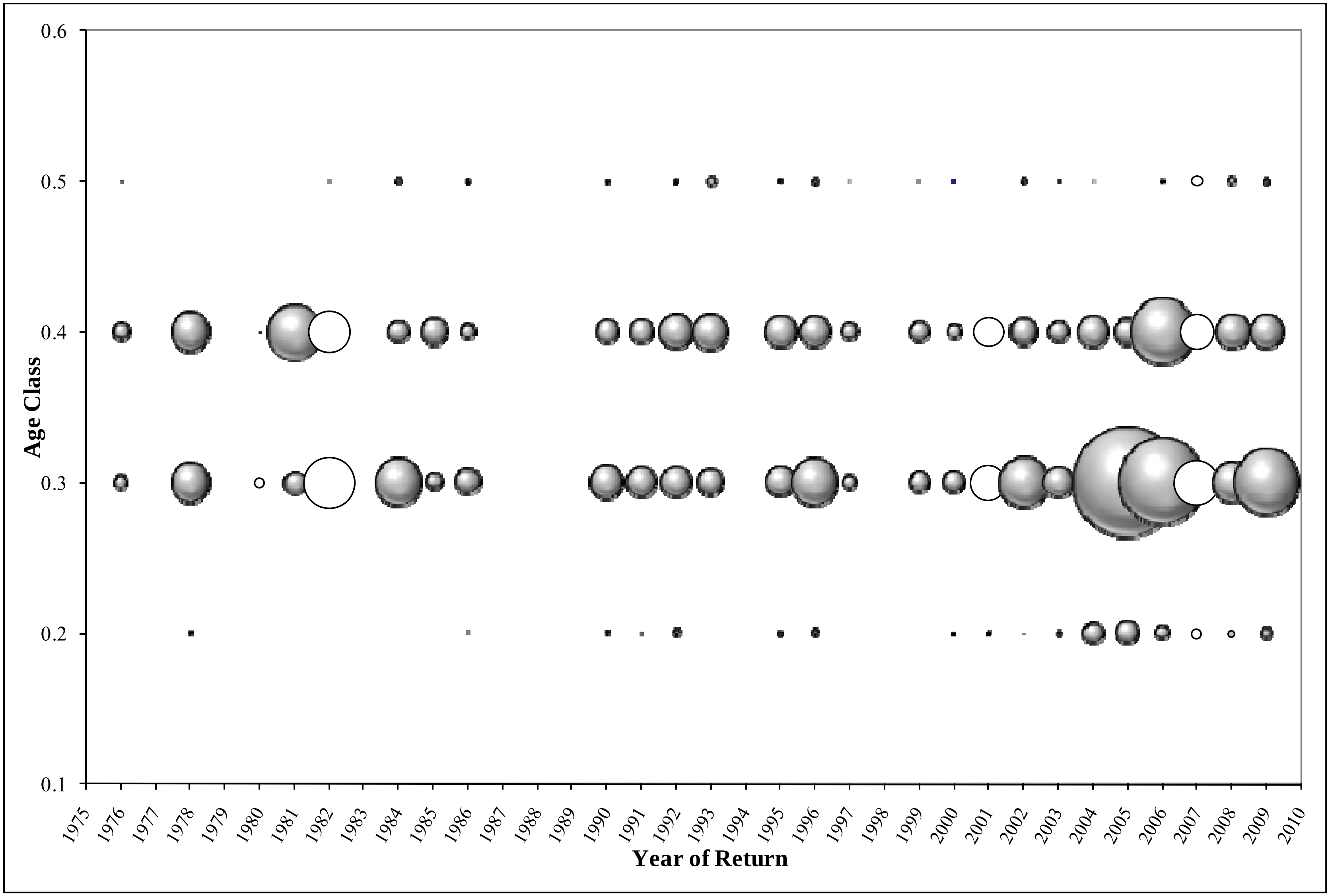


Figure 11.–Relative age-class abundance of chum salmon by return year at Kogrukluk River weir.

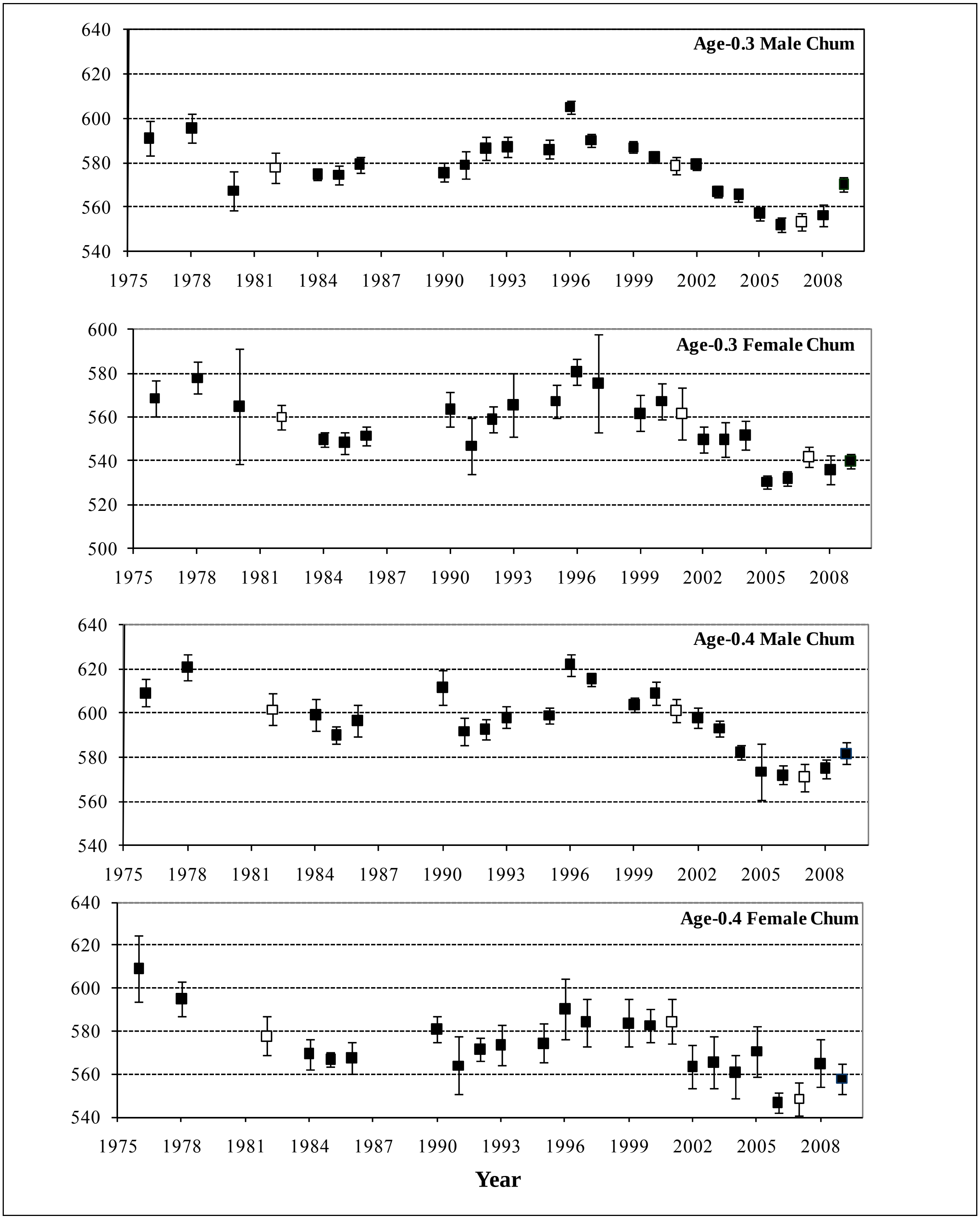


Figure 12.–Historical average length for chum salmon with 95% confidence intervals at the Kogrukluk River weir.

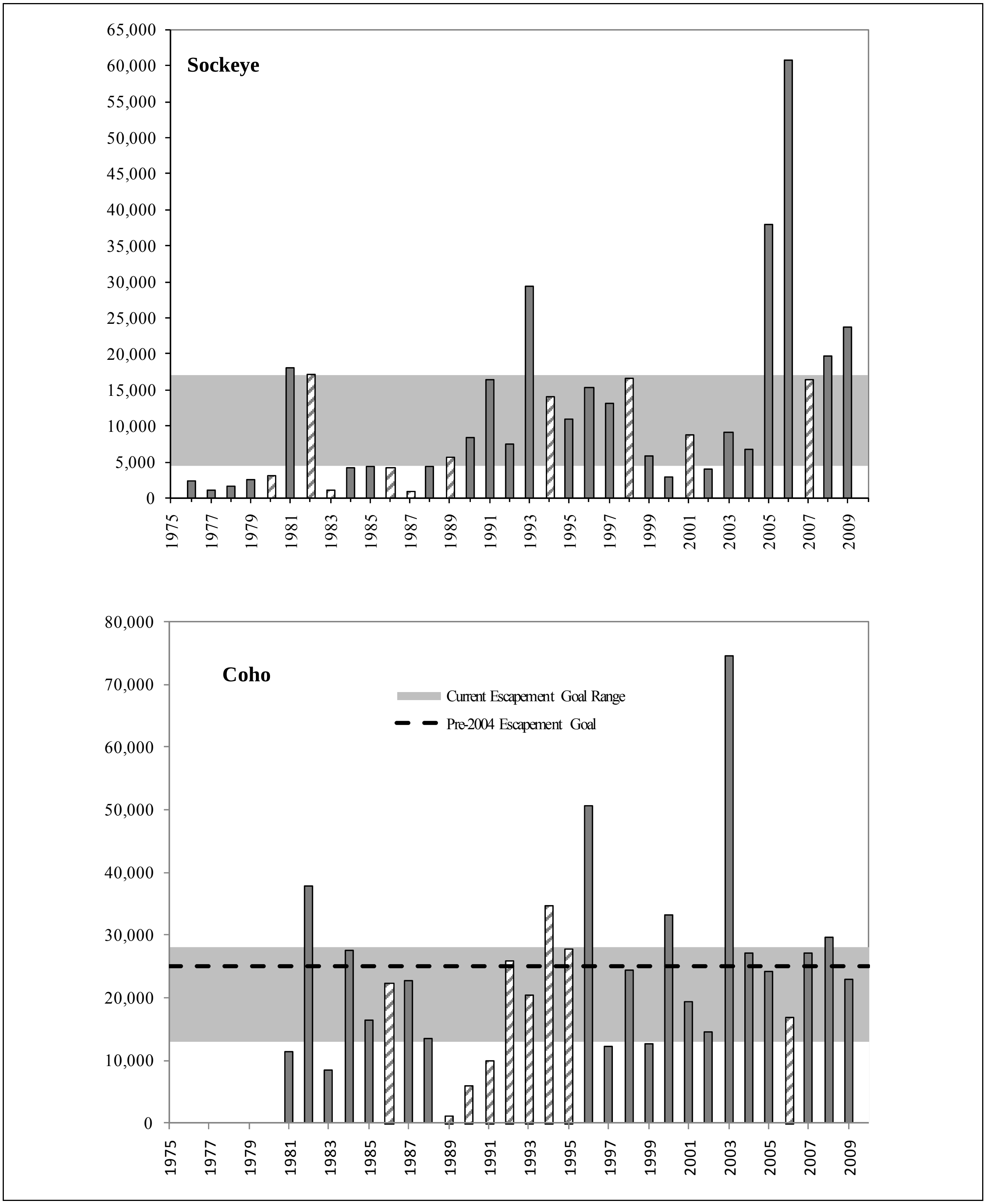
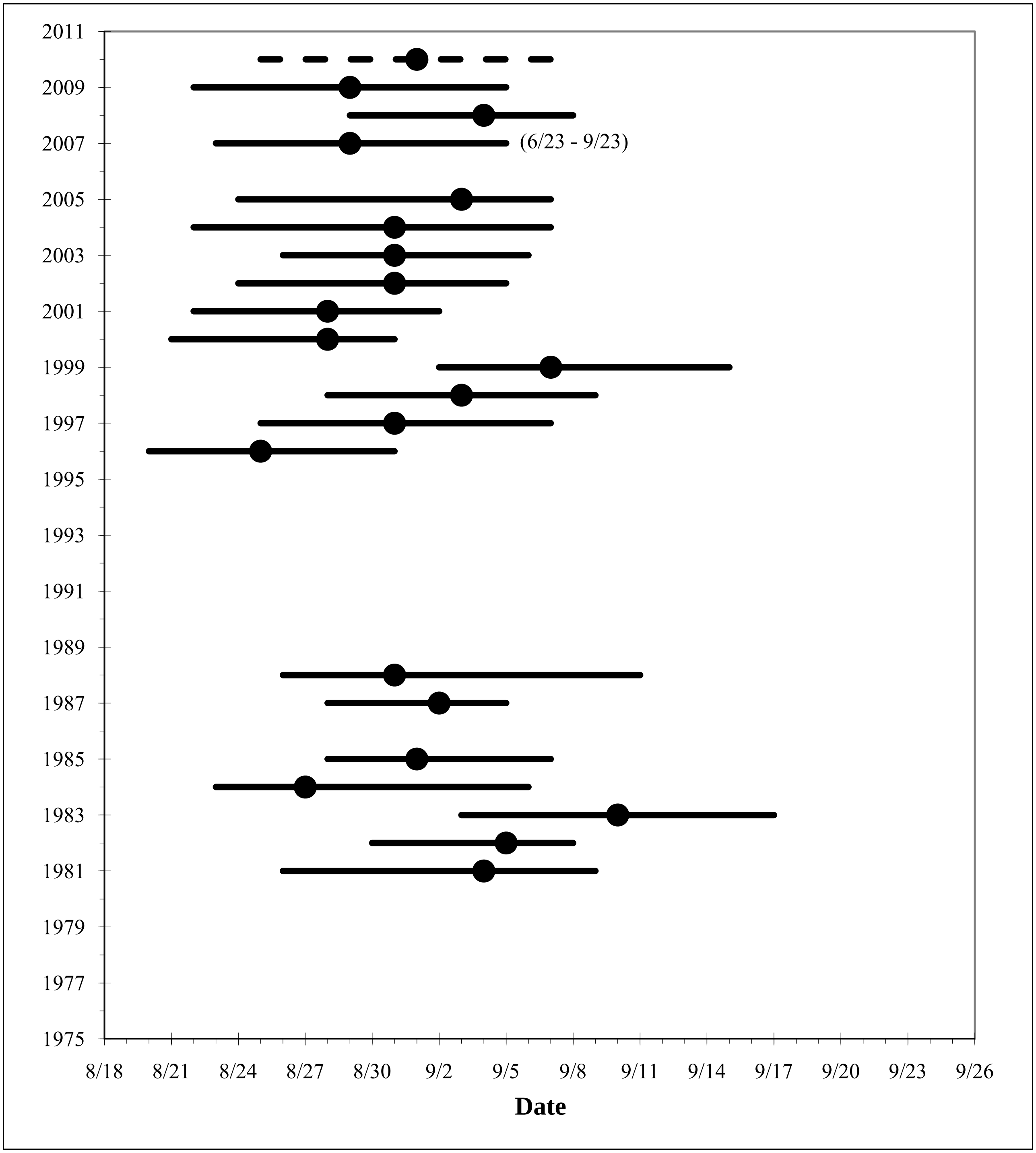


Figure 13.–Historical sockeye and coho salmon escapement with the pre-2004 minimum escapement goal and the current escapement goal range at the Kogrukluk River weir.



Note: Solid black lines represent dates the central fifty percent of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. As a means to gauge the comparability of the run timing estimates, operational date ranges are in parentheses beside each annual line. The dashed line represents the average passage dates of the graphed years.

Figure 14.–Historical run timing of coho salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009.

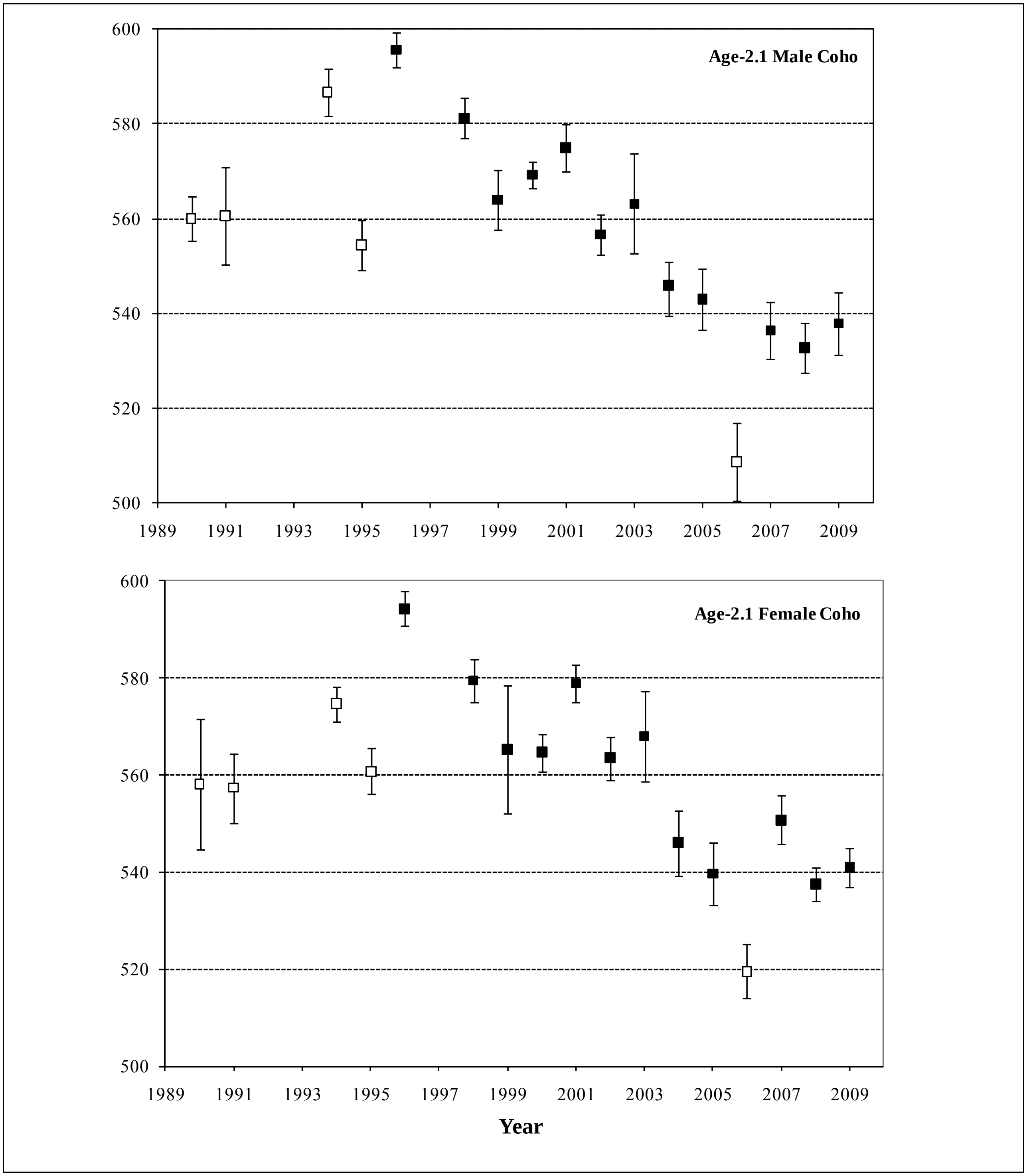


Figure 15.–Historical average length for coho salmon with 95% confidence intervals at Kogrukluk River weir.

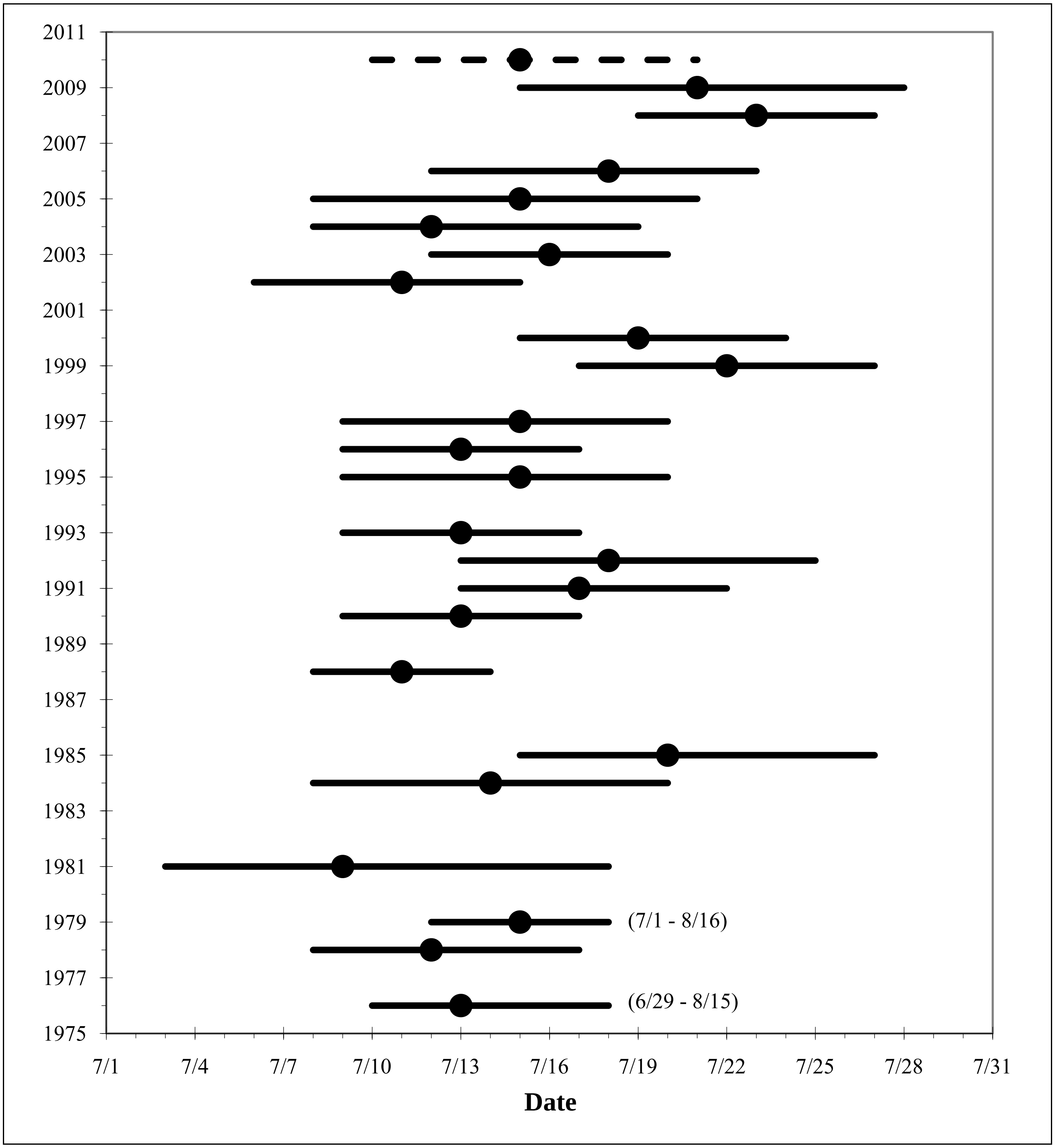


Figure 16.–Historical run timing of sockeye salmon based on cumulative percent passage at Kogrukluk River weir, 1976–2009.

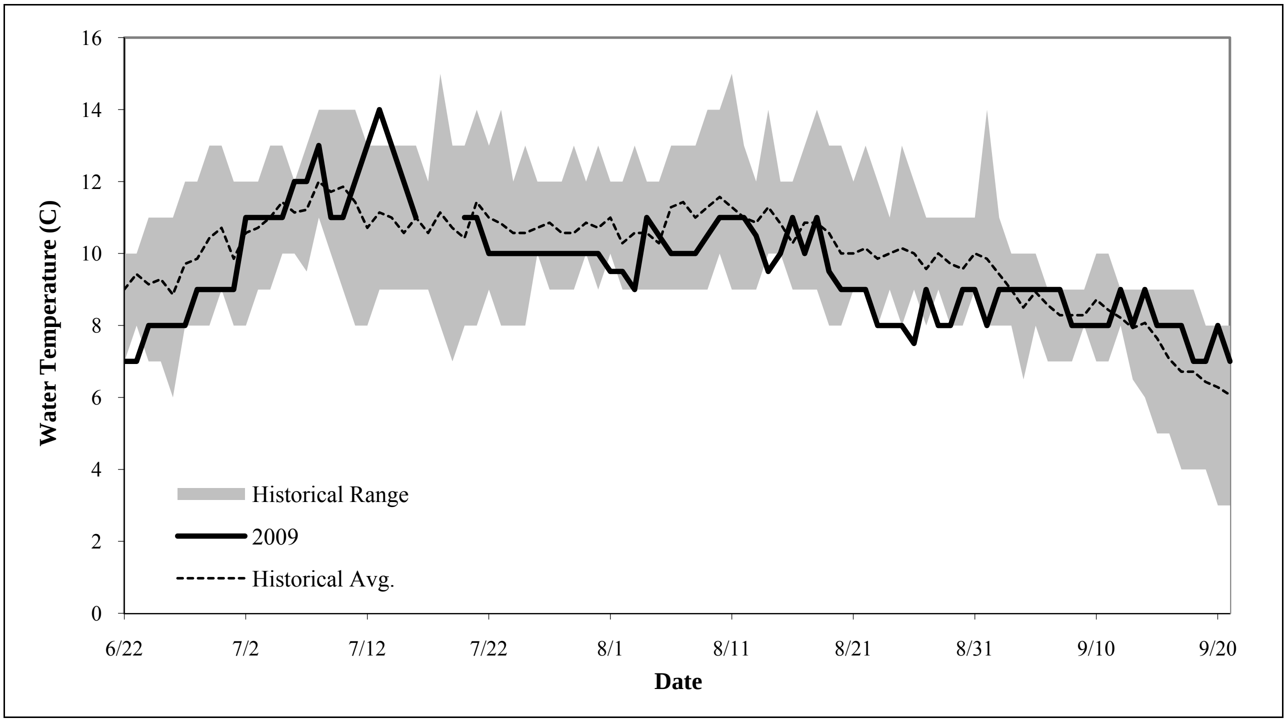


Figure 17.–Daily morning water temperature at Kogrukluk River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2002–2008.

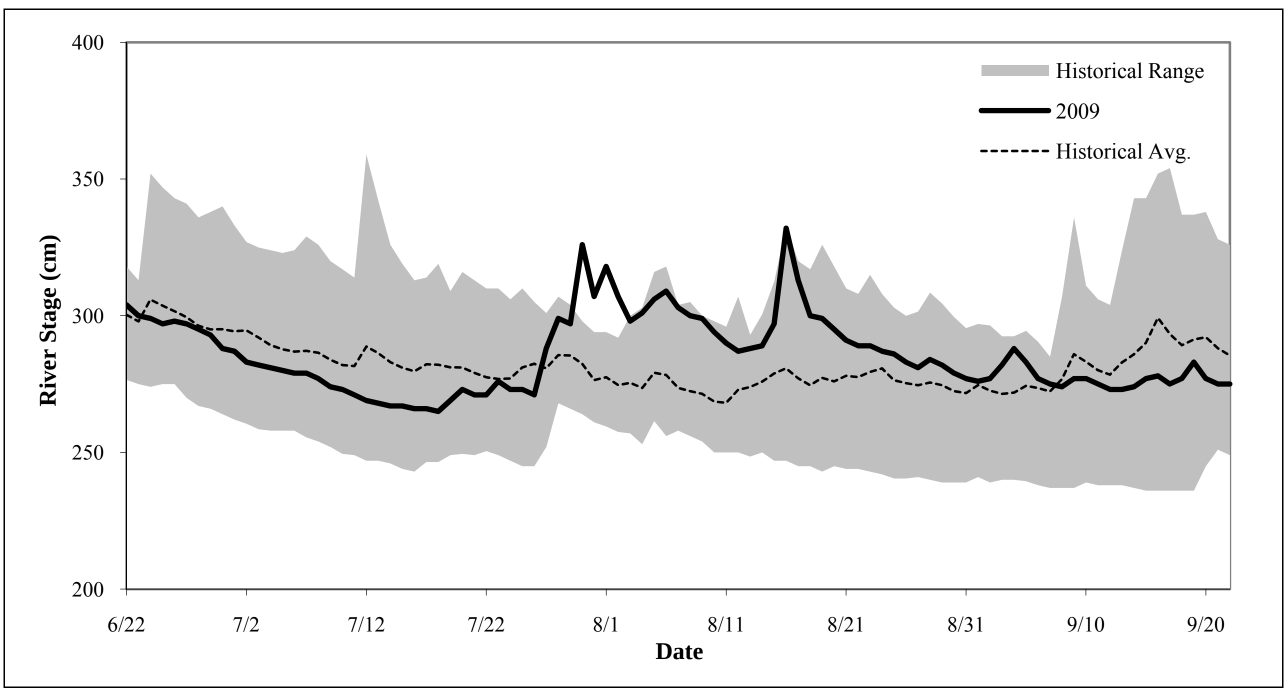


Figure 18.–Daily morning river stage at Kogrukluk River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2002–2008.

APPENDIX A

Appendix A1.–Daily passage counts by species at Kogrukluk River weir, 2009.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly	White-	
Date	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Varden[a]	fish	Other[b]
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	0	7	3	0	0	0	0	0	0	0
6/27	0	0	1	0	9	6	0	0	0	0	1	0	0
6/28	2	3	0	1	22	11	0	0	0	0	0	0	0
6/29	1	3	4	1	34	26	0	0	0	0	0	1	0
6/30	3	3	0	0	21	19	0	0	0	0	0	0	0
7/1	6	7	3	3	34	31	0	0	0	0	0	0	0
7/2	15	14	1	3	54	32	0	0	0	0	0	0	0
7/3	21	18	2	5	66	49	0	0	0	0	0	0	0
7/4	23	11	5	5	48	43	0	0	0	0	1	0	0
7/5	136	57	13	25	154	122	0	0	0	0	2	0	0
7/6	72	23	19	39	108	72	0	0	0	0	1	0	0
7/7	104	30	24	46	148	122	0	1	0	0	1	2	0
7/8	217	56	35	77	403	269	0	0	0	0	1	0	0
7/9	173	52	107	213	500	331	0	1	0	0	1	0	0
7/10	163	39	174	325	737	563	0	1	0	0	1	0	0
7/11	330	104	333	652	970	721	1	2	0	0	0	0	0
7/12	368	165	427	838	1,227	960	1	0	0	0	1	0	0
7/13	418	157	340	609	1,380	1,104	0	0	0	0	0	0	0
7/14	286	106	275	435	1,075	805	2	0	0	0	0	0	0
7/15	226	82	459	742	1,334	872	2	0	0	0	0	0	0
7/16	383	152	660	951	1,745	1,370	1	0	0	0	0	0	0
7/17	258	76	241	430	1,312	1,128	1	0	0	0	1	0	0
7/18	241	90	175	311	1,317	1,008	2	0	0	0	1	0	0
7/19	382	191	507	892	1,720	1,315	4	0	0	0	0	0	0
7/20	263	119	390	671	1,931	1,576	4	1	0	0	0	0	0
7/21	304	131	405	688	1,766	1,502	1	1	0	0	2	0	0
7/22	197	95	288	501	1,922	1,583	1	0	0	0	2	0	0
7/23	196	87	309	495	1,886	1,510	2	0	0	0	22	0	0

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Appendix A1.–Page 2 of 4.

Date	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly	White-	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Varden[a]	fish	Other[b]
7/24	158	69	191	377	1,970	1,685	0	0	0	0	1	0	0
7/25	140	53	135	185	1,987	1,659	3	0	0	0	0	0	0
7/26	273	188	359	488	1,730	1,291	4	1	0	0	0	0	0
7/27	227	189	546	684	1,407	1,047	6	2	0	0	0	1	0
7/28 [c]	159	78	390	563	2,273	1,961	1	0	0	0	0	0	0
7/29	124	79	383	486	1,133	992	0	0	4	1	2	0	0
7/30	0	0	0	0	0	0	0	0	0	0	0	0	0
7/31	0	0	0	0	0	0	0	0	0	0	0	0	0
8/1	0	0	0	0	0	0	0	0	0	0	0	0	0
8/2	0	0	0	0	0	0	0	0	0	0	0	0	0
8/3	5	10	7	19	174	150	0	0	3	10	2	0	0
8/4	21	32	82	105	1,001	761	0	0	16	25	1	0	0
8/5	37	30	131	160	1,051	812	0	0	35	69	0	0	0
8/6	0	0	0	0	0	0	0	0	0	0	0	0	0
8/7	15	7	65	60	573	502	0	0	56	71	15	0	0
8/8	15	6	59	72	503	436	0	0	64	70	2	0	0
8/9	14	9	50	64	574	503	0	0	78	72	2	0	0
8/10	13	9	63	56	517	493	0	0	109	113	3	0	0
8/11	10	1	41	63	423	340	0	0	72	73	6	0	0
8/12	13	4	24	43	307	284	0	0	98	86	14	0	0
8/13	4	1	11	16	183	158	0	0	11	7	5	0	0
8/14	5	3	23	35	237	195	0	0	145	110	9	0	0
8/15	3	3	35	53	277	190	0	0	376	304	22	2	0
8/16	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	5	0	1	1	33	18	0	0	106	95	6	0	0
8/19	4	0	9	21	74	98	0	0	369	241	17	0	0
8/20	5	2	3	10	29	54	0	0	292	222	29	0	0
8/21	2	0	4	2	29	58	0	0	183	155	22	1	0
8/22	0	1	2	6	24	57	0	0	144	112	0	0	0

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Appendix A1.–Page 3 of 4.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly	White-	
Date	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Varden[a]	fish	Other[b]
8/23	6	1	1	5	33	27	0	0	269	187	22	0	0
8/24	0	0	1	1	13	20	0	0	277	165	28	0	0
8/25	2	1	0	3	30	38	0	0	563	462	21	0	0
8/26	0	0	5	3	17	21	0	0	444	336	7	0	0
8/27	0	1	0	1	14	21	0	0	626	551	30	0	0
8/28	0	0	1	0	6	10	0	0	566	629	19	0	0
8/29	0	0	0	0	13	13	0	0	381	397	26	0	0
8/30	0	1	0	1	9	10	0	0	722	755	17	0	0
8/31	2	0	0	0	8	5	0	0	48	85	6	0	0
9/1	0	0	1	1	1	8	0	0	21	32	5	0	0
9/2	3	0	0	1	5	4	0	0	146	199	21	0	0
9/3	2	0	0	0	4	4	0	0	673	883	20	0	0
9/4	0	1	0	0	1	3	0	0	636	731	17	0	0
9/5	0	0	0	0	2	1	0	0	598	741	14	0	0
9/6	0	0	0	0	0	4	0	0	83	133	4	0	0
9/7	0	0	0	0	1	4	0	0	150	171	9	0	0
9/8	1	0	0	0	2	1	0	0	135	178	8	0	0
9/9	0	0	0	0	2	0	0	0	81	113	3	0	0
9/10	0	0	0	0	0	1	0	0	46	73	0	1	0
9/11	0	0	0	0	0	0	0	0	44	68	0	0	0
9/12	0	0	0	0	0	0	0	0	93	184	2	0	0
9/13	0	0	0	0	0	1	0	0	139	287	2	0	0
9/14	0	0	0	0	0	0	0	0	63	130	2	0	0
9/15	0	0	0	1	0	0	0	0	199	372	2	0	0
9/16	0	0	0	0	0	0	0	0	126	224	5	0	0
9/17	0	0	0	1	0	0	0	0	56	127	4	0	0
9/18	0	0	0	0	1	0	0	0	314	354	2	0	0
9/19	0	0	0	0	0	0	0	0	152	223	5	0	0
9/20	0	0	0	0	0	0	0	0	38	97	2	0	0
9/21	0	0	0	0	0	0	0	0	142	223	6	0	0

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Appendix A1.–Page 4 of 4.

Date	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly	White-	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Varden[a]	fish	Other[b]
9/22	0	0	0	0	0	0	0	0	53	78	11	0	0
9/23	0	0	0	0	0	0	0	0	71	58	1	0	0
9/24	0	0	0	0	1	0	0	0	18	15	3	1	0
9/25	0	0	0	0	0	0	0	0	19	20	1	0	0
9/26	0	0	0	0	0	0	0	0	3	8	1	0	0
9/27	0	0	0	0	0	0	0	0	21	35	0	4	0
Total	6,056	2,650	7,820	12,545	38,602	31,093	36	10	10,177	11,160	522	13	0

[a] Counts represent sexually mature fish only.

[b] G = Arctic grayling; P = Northern pike: Counts may not correspond to actual day observed.

[c] Incomplete or partial daily count.

APPENDIX B

Appendix B1.–Daily carcass counts at Kogrukluk River weir, 2009.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Dolly Varden	White-fish	Other[a]
6/24	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0
7/1	0	0	0	0	0	0	0	0
7/2	0	0	0	0	0	0	0	0
7/3	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0
7/5	0	0	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0
7/8	0	0	16	0	0	1	2	1 P
7/9	0	0	0	0	0	0	0	0
7/10	0	0	7	0	0	2	1	0
7/11	0	0	23	0	0	0	0	0
7/12	0	0	0	0	0	0	0	0
7/13	0	0	0	0	0	0	0	0
7/14	0	0	9	0	0	0	0	0
7/15	0	0	0	0	0	0	0	0
7/16	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	0	0
7/19	0	0	69	0	0	0	0	0
7/20	0	0	108	0	0	0	0	0
7/21	0	0	114	0	0	0	0	0
7/22	0	0	201	0	0	0	0	0
7/23	0	0	249	0	0	0	0	0
7/24	0	0	304	0	0	0	0	0
7/25	0	0	364	0	0	0	0	0
7/26	0	0	540	1	0	0	0	0
7/27	0	0	776	0	0	0	0	0
7/28	0	0	789	1	0	0	0	0
7/29	0	5	801	1	0	0	0	0
7/30	0	0	0	0	0	0	0	0
7/31	0	0	0	0	0	0	0	0
8/1	0	0	0	0	0	0	0	0
8/2	0	0	0	0	0	0	0	0
8/3	0	0	0	0	0	0	0	0
8/4	26	4	360	2	0	0	0	0
8/5	43	19	647	8	0	0	0	0
8/6	0	0	0	0	0	0	0	0

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Appendix B1.–Page 2 of 3.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Dolly Varden	White-fish	Other[a]	
8/7	49	6	247	1	0	0	0	1	P
8/8	129	27	398	1	0	0	0	0	
8/9	179	47	606	0	0	0	0	0	
8/10	190	28	436	1	0	2	0	0	
8/11	172	49	293	0	0	0	0	0	
8/12	96	43	239	0	0	1	0	0	
8/13	148	64	249	0	0	0	0	0	
8/14	78	46	306	1	0	0	0	0	
8/15	136	98	459	0	1	0	0	0	
8/16	0	0	0	0	0	0	0	0	
8/17	0	0	0	0	0	0	0	0	
8/18	0	0	0	0	0	0	0	0	
8/19	20	26	105	0	0	0	0	0	
8/20	19	70	106	0	0	0	0	0	
8/21	32	89	119	0	0	1	0	0	
8/22	6	75	90	0	0	1	1	0	
8/23	16	79	98	0	0	0	0	0	
8/24	9	95	69	0	0	0	0	0	
8/25	3	52	59	0	0	0	0	0	
8/26	0	0	0	0	0	0	0	0	
8/27	3	59	53	0	0	0	0	0	
8/28	0	47	46	0	0	0	0	0	
8/29	1	62	57	0	0	0	0	1	P
8/30	1	71	45	0	0	0	0	0	
8/31	0	0	0	0	0	0	0	0	
9/1	0	60	32	0	0	0	0	0	
9/2	0	53	32	0	0	1	1	0	
9/3	1	37	18	0	0	0	0	0	
9/4	0	0	0	0	0	0	0	0	
9/5	1	58	41	0	1	0	1	1	G
9/6	0	11	7	0	0	0	0	0	
9/7	0	0	0	0	0	0	0	0	
9/8	3	18	7	1	1	0	0	0	
9/9	1	18	11	0	2	0	1	0	
9/10	6	16	4	0	0	0	1	0	
9/11	0	17	8	0	1	0	0	0	
9/12	0	0	0	0	0	0	0	0	
9/13	0	0	0	0	0	0	0	0	
9/14	0	0	0	0	0	0	0	0	
9/15	0	0	0	0	0	0	0	0	
9/16	3	18	12	0	21	3	1	3	P
9/17	0	0	0	0	0	0	0	0	
9/18	0	0	0	0	0	0	0	0	
9/19	0	0	0	0	0	0	0	0	

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Appendix B1.–Page 3 of 3.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Dolly Varden	White-fish	Other[a]
9/20	0	0	0	0	0	0	0	0
9/21	0	0	0	0	0	0	0	0
9/22	0	0	0	0	0	0	0	0
9/23	0	0	0	0	0	0	0	0
9/24	0	0	0	0	0	0	0	0
9/25	0	0	0	0	0	0	0	0
9/26	0	0	0	0	0	0	0	0
9/27	0	0	0	0	0	0	0	0
Total	1,371	1,467	9,629	18	27	12	9	6P, 1G

[a] G = Arctic grayling; P = Northern pike.

APPENDIX C

Appendix C1.–Daily weather and stream observations at Kogrukluk River weir, 2009.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)[b]	Water Clarity[c]
6/20	10:00	3	0.0	9	ND	ND	1
	17:00	3	0.5	16	9	ND	1
6/21	10:00	4	0.0	8	8	ND	1
	21:00	4	10.0	13	9	302	2
6/22	10:00	3	0.0	9	7	304	2
6/23	10:00	2	0.0	11	7	300	2
	17:00	3	3.5	13	8	300	2
6/24	10:00	2	0.5	10	8	299	2
	17:00	2	0.0	13	9	299	2
6/25	10:00	4	1.0	9	8	297	1
	17:00	3	6.0	13	9	298	1
6/26	10:00	4	0.0	10	8	298	1
	17:00	4	0.0	15	10	298	1
6/27	10:00	2	0.0	11	8	297	1
	17:00	1	0.0	19	10	297	1
6/28	10:00	4	0.0	10	9	295	1
	17:00	3	0.0	16	10	295	1
6/29	10:00	1	0.0	8	9	293	1
	17:00	2	0.0	18	11	289	1
6/30	10:00	1	0.0	11	9	288	1
	17:00	1	0.0	25	12	287	1
7/1	10:00	1	0.0	11	9	287	1
	17:00	1	0.0	28	13	284	1
7/2	10:00	1	0.0	15	11	283	1
	17:00	1	0.0	27	14	283	1
7/3	10:00	1	0.0	13	11	282	1
	17:00	2	0.0	23	14	281	1
7/4	10:00	2	0.0	14	11	281	1
	17:00	1	0.0	28	14	281	1
7/5	10:00	1	0.0	14	11	280	1
	17:00	4	0.0	27	14	280	1
7/6	10:00	1	0.0	15	12	279	1
	17:00	1	0.0	30	15	279	1
7/7	10:00	1	0.0	15	12	279	1
	17:00	1	0.0	31	14	278	1
7/8	10:00	4	0.0	15	13	277	1
	17:00	1	0.0	17	13	275	1
7/9	10:00	2	0.0	13	11	274	1
	17:00	1	0.0	23	14	274	1
7/10	7:30	1	0.0	8	11	273	1
	17:00	1	0.0	25	15	272	1
7/11	10:00	1	0.0	19	12	271	1
	17:00	1	0.0	30	16	271	1

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Appendix C1.–Page 2 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)[b]	Water Clarity[c]
7/12	10:00	1	0.0	15	13	269	1
	17:00	1	0.0	31	16	269	1
7/13	7:30	1	0.0	13	14	268	1
	17:00	1	0.0	22	15	267	1
7/14	10:00	3	0.0	16	13	267	1
	17:00	3	0.0	19	13	267	1
7/15	10:00	4	0.0	15	12	267	1
	17:00	3	0.0	19	14	266	1
7/16	10:00	1	0.0	9	11	266	1
	18:00	2	0.0	22	ND	266	1
7/17	10:00	4	0.0	15	ND	266	1
	18:30	4	2.0	15	ND	265	1
7/18	10:00	4	7.0	12	ND	265	1
	18:00	4	4.0	15	ND	266	1
7/19	8:00	4	0.0	13	ND	269	1
	17:00	4	3.0	15	11	271	1
7/20	10:00	3	2.5	13	11	273	1
	17:00	3	0.0	18	12	272	1
7/21	10:00	4	0.0	13	11	271	1
	17:00	4	0.0	15	11.5	269	1
7/22	10:00	4	1.5	13	10	271	1
	17:30	4	0.0	16	11.5	271	1
7/23	10:00	4	0.0	11	10	276	1
	17:00	4	3.0	14	12	272	1
7/24	10:00	4	1.0	13	10	273	1
	17:30	4	0.0	15	11	271	1
7/25	10:00	4	0.0	13	10	273	1
	17:00	4	1.0	13	10	271	1
7/26	7:30	4	4.9	12	10	271	1
	17:00	4	0.0	15	10.5	280	2
7/27	7:30	4	0.0	12	10	288	2
	21:00	3	0.0	16	11	288	3
7/28	10:00	4	0.0	13	10	299	3
	17:00	4	0.0	14	10	293	3
7/29	10:00	3	4.5	14	10	297	3
	17:00	2	0.0	18	12	299	3
7/30	10:00	1	0.0	ND	10	326	3
	17:00	4	0.0	14	11	310	3
7/31	7:30	4	22.5	8	10	307	3
	17:00	3	2.0	13	10.5	311	3
8/1	10:00	4	0.0	11	9.5	318	3
	17:00	2	0.0	18	10	310	2
8/2	10:00	4	0.0	11	9.5	307	2
	17:00	4	0.0	13	10	301	1

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Appendix C1.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)[b]	Water Clarity[c]
8/3	10:00	2	0.0	12	9	298	1
	17:00	3	0.0	22	12	298	1
8/4	10:00	4	2.7	14	11	301	1
	17:00	4	0.8	16	11	297	1
8/5	10:00	4	0.5	13	10.5	306	1
	17:00	3	0.0	20	11	308	1
8/6	10:00	3	0.0	11	10	309	1
	17:00	3	0.0	17	10.5	307	1
8/7	7:30	2	0.0	7	10	303	1
	17:00	2	0.0	21	12	298	1
8/8	10:00	1	0.0	10	10	300	1
	17:00	1	0.0	19	11.5	295	1
8/9	10:00	2	0.0	15	10.5	299	1
	17:30	2	0.0	22	12	293	1
8/10	10:00	1	0.0	12	11	294	1
	17:00	1	0.0	23	14	291	1
8/11	10:00	1	0.0	9	11	290	1
	17:00	1	0.0	22	13	287	1
8/12	10:00	3	0.0	12	11	287	1
	17:00	4	0.0	15	12	285	1
8/13	10:00	4	4.1	12	10.5	288	1
	17:00	4	1.6	12	10	284	1
8/14	10:00	4	7.0	13	9.5	289	1
	17:00	4	0.5	17	10	287	1
8/15	10:00	4	13.5	13	10	297	1
	17:00	3	0.7	19	11.5	295	1
8/16	10:00	4	1.1	14	11	332	3
	17:00	3	0.0	20	12	318	3
8/17	10:00	1	0.0	8	10	313	2
	17:00	3	0.4	18	10	306	1
8/18	9:30	2	0.0	12	11	300	1
	17:00	4	0.0	16	11	300	1
8/19	10:00	3	0.0	10	9.5	299	1
	17:00	3	0.0	15	11	297	1
8/20	10:00	3	0.0	9	9	295	1
	17:00	3	0.0	15	10	293	1
8/21	10:00	1	0.0	11	9	291	1
	17:00	3	0.0	16	11	290	1
8/22	10:00	4	0.0	9	9	289	1
	17:00	3	0.0	12	10	288	1
8/23	10:00	3	0.0	5	8	289	1
	17:00	2	0.0	13	10	287	1
8/24	10:00	2	0.0	3	8	287	1
	17:30	4	0.0	11	9	287	1

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Appendix C2.–Page 4 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)[b]	Water Clarity[c]
8/25	10:00	1	0.0	5	8	286	1
	17:00	2	0.0	14	10	284	1
8/26	10:00	1	0.0	2	7.5	283	1
	17:00	1	0.0	16	10	282	1
8/27	10:00	4	1.1	8	9	281	1
	17:00	3	2.6	13	10	281	1
8/28	10:00	1	0.0	6	8	284	1
	17:00	1	0.0	17	11	284	1
8/29	10:00	1	0.0	5	8	282	1
	18:00	1	0.0	17	11	281	1
8/30	10:00	3	0.0	11	9	279	1
	17:00	2	0.0	17	11	278	1
8/31	10:00	4	0.0	8	9	277	1
	17:00	4	0.6	13	8	277	1
9/1	10:00	4	0.0	10	8	276	1
	18:00	4	0.6	13	9	276	1
9/2	10:00	4	7.0	9	9	277	1
	18:00	4	4.0	13	9	277	1
9/3	10:00	4	3.0	9	9	282	1
	18:00	1	0.0	18	10	286	1
9/4	10:00	1	0.0	5	9	288	1
	17:00	1	0.0	21	11	287	1
9/5	10:00	1	0.0	5	9	283	1
	17:00	1	0.0	22	11	282	1
9/6	10:00	1	0.0	5	9	277	1
	18:00	1	0.0	21	11	276	1
9/7	10:00	4	0.0	5	9	275	1
	17:00	4	0.0	12	9	275	1
9/8	10:00	4	0.0	7	8	274	1
	17:00	4	0.0	14	9	275	1
9/9	10:00	4	3.0	9	8	277	1
	18:00	4	0.0	13	9	277	1
9/10	10:00	5	0.0	4	8	277	1
	18:00	1	0.0	18	9	277	1
9/11	10:00	1	0.0	9	8	275	1
	17:00	2	0.0	18	10	275	1
9/12	10:00	4	0.0	9	9	273	1
	17:00	4	0.0	11	9	273	1
9/13	10:00	5	1.0	7	8	273	1
	17:00	3	0.0	15	9	273	1
9/14	10:00	5	0.5	5	9	274	1
	17:00	4	0.0	14	9	274	1
9/15	10:00	4	2.0	9	8	277	1
	18:00	4	1.0	16	9	277	1
9/16	10:00	4	0.0	5	8	278	1
	18:00	4	0.5	13	8	275	1

-continued-

Appendix C1.–Page 5 of 5.

		Sky	Precipitation	Temperature (°C)		River	Water
Date	Time	Conditions[a]	(mm)	Air	Water	Stage (cm)[b]	Clarity[c]
9/17	10:00	4	0.5	5	8	275	1
	18:30	4	1.0	13	8	276	1
9/18	10:00	2	0.5	5	7	277	1
	17:00	2	0.0	14	8	280	1
9/19	10:00	5	0.0	4	7	283	1
	17:00	3	0.0	16	9	283	1
9/21	10:00	2	0.0	5	7	275	1
	17:00	3	0.0	8	8	275	1
9/22	10:00	1	0.0	0.5	6	275	1
	17:00	3	0.0	8	7	275	1
9/23	10:00	3	0.0	0	5	274	1
	17:00	4	0.0	7	6	273	1
9/24	10:00	2	0.0	-5	4	273	1
	19:00	3	0.0	5	6	273	1
9/25	10:00	4	0.0	0	4	273	1
	17:00	4	0.0	5	5	273	1
9/26	10:00	2	0.0	-3	4	273	1
	17:00	4	0.0	6	5	273	1
9/27	10:00	4	0.0	1	4	272	1
	17:00	4	0.0	5	5	272	1
9/28	10:00	4	0.0	3	4	268	1
Seasonal mode[d]:		4	-	-	-	-	1
Seasonal average[e]:		-	0.75638	13.65	9.90	284.903	-

[a] Sky condition codes are: 0 = no observation; 1 = mostly clear (< 10% cloud cover); 2 = partly cloudy (< 50% cloud cover); 3 = mostly cloudy (> 50% cloud cover); 4 = complete overcast (100% cloud cover); 5 = thick fog.

[b] In previous reports water level was reported in millimeters. Note this distinction when comparing to past years.

[c] Water clarity codes are: 1 = visibility is greater than 1.0 m; 2 = visibility is 0.5 to 1.0 m; 3 = visibility is less than 0.5 m.

[d] The most frequent occurrence.

[e] Calculated from days in which two observations were made: one between 0730 and 1100 hours and one between 1700 and 1900 hours.

Appendix C2.–Daily weather and stream observations at Kogrukluk River weir, 2009.

	Temperature (^oC)		
Date	Avg.	Min.	Max.
6/24	8.3	7.3	9.3
6/25	8.4	7.7	9.3
6/26	8.9	7.7	10.1
6/27	9.6	8.1	11.4
6/28	9.8	9.2	10.6
6/29	12.2	8.3	19.4
6/30	16.9	12.7	21.9
7/1	18.7	13.2	25.1
7/2	19.5	14.0	24.7
7/3	17.3	12.2	23.0
7/4	18.3	13.1	25.9
7/5	19.6	13.3	24.9
7/6	20.7	14.0	28.2
7/7	21.8	14.9	28.0
7/8	19.1	16.5	25.7
7/9	17.5	12.0	24.5
7/10	18.0	10.7	26.8
7/11	20.4	12.7	29.3
7/12	22.5	15.7	29.3
7/13	20.0	16.1	26.8
7/14	17.7	15.4	20.5
7/15	18.2	15.2	22.7
7/16	16.6	9.8	24.0
7/17	17.1	15.0	22.0
7/18	16.2	14.7	17.9
7/19	18.9	15.0	24.7
7/20	20.5	17.7	25.1
7/21	20.1	17.2	22.4
7/22	19.9	17.5	24.6
7/23	19.9	17.1	24.5
7/24	19.4	18.2	21.5
7/25	20.3	16.6	24.3
7/26	22.5	18.4	29.4
7/27	21.5	18.7	28.8
7/28	19.9	17.1	22.6
7/29	20.8	18.8	23.1
7/30	18.4	15.4	21.6
7/31	19.0	15.7	23.3
8/1	17.4	12.4	23.0
8/2	19.8	17.7	23.3
8/3	20.5	16.9	23.3
8/4	20.6	18.6	22.7
8/5	20.3	18.3	23.7
8/6	20.4	15.9	25.6
8/7	21.4	17.2	24.8
8/8	21.2	17.3	25.8
8/9	23.1	20.8	26.5
8/10	21.8	17.1	26.7
8/11	22.1	17.1	27.5
8/12	22.0	18.0	27.7
8/13	22.9	17.9	30.9
8/14	22.7	20.0	28.0
8/15	22.0	19.1	25.2
8/16	22.9	20.4	25.6
8/17	20.9	17.3	24.6
8/18	20.4	18.6	23.2
8/19	18.8	16.0	23.3
8/20	19.3	14.8	24.4
8/21	19.9	16.6	24.6
8/22	18.8	14.0	23.8
8/23	19.6	14.6	23.9
8/24	16.8	12.3	23.3
8/25	8.7	7.6	10.1
8/26	8.8	7.4	10.2
8/27	9.3	8.7	10.0
8/28	9.3	8.0	10.8
8/29	9.6	8.2	11.0
8/30	10.2	9.3	11.5
8/31	9.5	9.1	10.5
9/1	8.8	8.4	9.2
9/2	9.0	8.6	9.5
9/3	9.4	8.6	10.6
9/4	10.0	8.6	11.4
9/5	10.1	8.9	11.4
9/6	10.0	8.6	11.2
9/7	9.3	8.5	10.3
9/8	8.8	8.3	9.4
9/9	9.0	8.3	9.7
9/10	9.1	7.9	10.5
9/11	9.5	8.3	10.9
9/12	9.1	8.8	9.9
9/13	8.7	8.1	9.5
9/14	8.6	8.0	9.0
9/15	8.6	8.2	9.2
9/16	7.8	7.3	8.5
9/17	7.4	6.8	7.8
9/18	7.5	6.8	8.3
9/19	7.8	6.7	8.9
9/20	8.2	7.5	9.0
9/21	7.6	6.9	8.3
9/22	6.2	5.5	6.9
9/23	5.6	5.1	6.1
9/24	4.5	3.7	5.2
9/25	4.3	4.0	4.7
9/26	4.1	3.3	4.6
9/27	4.3	3.8	4.8
Average:	15.1	12.4	18.4
Minimum	4.1	3.3	4.6
Maximum	23.1	20.8	30.9