Fishery Data Series No. 13-13

Kogrukluk River Salmon Studies, 2011

by

Tracy R. Hansen

and

Brittany J. Blain

April 2013

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 13-13

KOGRUKLUK RIVER SALMON STUDIES, 2011

by
Tracy R. Hansen
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage
and
Brittany J. Blain
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

April 2013

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

Tracy R. Hansen,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518-1599 USA

and

Brittany J. Blain,
Alaska Department of Fish and Game, Division of Commercial Fisheries
333 Raspberry Road, Anchorage, AK 99518-1599 USA

This document should be cited as:
Hansen, T. R., and B. J. Blain. 2013. Kogrukluk River salmon studies, 2011. Alaska Department of Fish and Game, Fishery Data Series No. 13-13, Anchorage.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The Kogrukluk River weir has been operated since 1976 to estimate the return and age, sex, and length compositions of Pacific salmon *Oncorhynchus* spp. escapements into this tributary of the Kuskokwim River. It is one of several components which form an integrated array of escapement monitoring projects in the Kuskokwim Area and provide means to monitor and assess escapement trends in accordance with the State of Alaska's *Policy for the management of sustainable salmon fisheries* (5 AAC 39.222). In 2011, a fixed-picket weir was operated in the Kogrukluk River from 21 June through 15 September. The total annual Chinook salmon *O. tshawytscha* escapement of 6,891 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 76,384 exceeded the upper boundary of the SEG range of 15,000 to 49,000 fish. The total annual sockeye salmon *O. nerka* escapement of 8,132 was within the SEG range of 4,400 to 17,000 fish. The total annual coho salmon *O. kisutch* escapement of 24,174 was within the SEG range of 13,000 to 28,000 fish. Age, sex, and 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 20.1% of the Chinook run, 42.0% of the chum run, and 51.1% of the coho salmon run. The Chinook salmon run comprised 5 age classes, dominated by age-1.2 fish (47.2%). The chum salmon run comprised four age classes, dominated by age-0.3 fish (64.2%). The coho salmon run comprised three age classes, dominated by age-2.1 fish (87.3%).

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, sockeye salmon, *O. nerka*, pink salmon, *O. gorbuscha*, Dolly Varden, *Salvelinus malma* escapement, age, sex, and length ASL, Kogrukluk River, Kuskokwim River, fixed-picket weir, mark–recapture, and stock-specific run timing

INTRODUCTION

Each year, mature Pacific salmon *Oncorhynchus* spp. return to the Kuskokwim River and its tributaries to spawn. Annually, subsistence and commercial fisheries harvest approximately 650,000 salmon within the Kuskokwim River drainage (Bavilla et al. 2010). Salmon contributing to these fisheries spawn in nearly every tributary of the river basin. The Kogrukluk River, a tributary to the Kuskokwim River, supports a relatively large number of spawning salmon when compared to other Kuskokwim River tributaries of similar size (Molyneaux and Brannian 2006). The Kogrukluk River is an index site for the Holitna River, a highly productive salmon system, and supports one of several escapement monitoring projects that assist in Kuskokwim salmon management for long-term sustainable fisheries (Figure 1).

Escapement monitoring first began on the Kogrukluk River in 1969, when a salmon counting tower was initiated upstream of the confluence of Shotgun Creek (Figure 2; Yanagawa 1972). After relocating the tower twice and one failed attempt at a counting weir, a new weir was established in 1976 downstream of the Shotgun Creek confluence (Figure 2; Yanagawa 1973; Baxter 1979). The weir has been at this location since 1976. 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 *O. kisutch* (Baxter 1982). The Kogrukluk River weir has percentile based sustainable escapement goals (SEG) for Chinook (5,300–14,000), chum (15,000–49,000), coho (13,000–28,000), and sockeye (4,400–17,000) salmon (Volk et al. 2009).

In addition to escapement monitoring, we documented habitat variables including water temperature and stream discharge (level) at the Kogrukluk River weir. The weir also served as a tag recovery site for a main river sockeye salmon tagging study and a collection site for tissue samples in a Chinook salmon disease study.

OBJECTIVES

The objectives of the Kogrukluk River escapement monitoring project in 2011 were to:

1. determine the daily and total escapement of 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. collect daily air and water temperatures, stream level measurements, and weather observations; and install automated data loggers to monitor air and stream temperatures at the Kogrukluk River weir;
4. serve as a platform to facilitate other fisheries research projects by:
    a. serving as a monitoring and recapture location for sockeye salmon equipped with anchor tags deployed as part of *Kuskokwim River sockeye salmon run reconstruction*; and
    b. serving as a sample collection site for parasite *Ichthyophonus* in Chinook salmon.

METHODS

STUDY AREA

The Kogrukluk River watershed drains approximately 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 confluence of the Chukowan and Kogrukluk Rivers forms the headwaters of the Holitna River which flows 218 rkm to join the Middle Kuskokwim River at rkm 491 (Figure 1).

The Kogrukluk River provides spawning and rearing habitat for Chinook, chum, sockeye and coho salmon (Johnson and Blanche 2012), which contribute to the subsistence, commercial, and sport fisheries of the Kuskokwim River. Smaller numbers of pink salmon *O. gorbuscha* also spawn in the Kogrukluk River. In addition to Pacific salmon, other species commonly found throughout the system include: Arctic grayling *Thymallus arcticus*, Dolly Varden *Salvelinus malma*, lampreys *Lampetra* spp., northern pike *Esox lucius*, and whitefishes *Coregonus* spp; for a complete listing of all fish species in the area, see Baxter.[1]

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,

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

and large log jams form a complex mosaic of reproductive and rearing habitat suitable for salmon (Baxter[2]; Healy 1991).

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 a remote ground-based escapement project in the Kuskokwim Area (Figure 1). Personnel and supplies were transported to and from the weir by floatplane, although occasional travel to and from the weir occurred by boat when conditions required.

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 2011 are the same as those described by Baxter (1981), with the exception of an improved fish trap (since 2001) and a tighter picket spacing (since 2005). The fish trap, which is about 2.4 m by 1.5 m, was modeled after the trap used at the George River weir since 2001 (Linderman et al. 2003). Picket spacing was narrowed after investigators observed small chum salmon passing through the pickets in 2004. Picket intervals were reduced from 76.2 mm to 63.5 mm, which narrowed the gap from 49.0 mm to 36.5 mm (R. Stewart, Commercial Fisheries Technician, ADF&G, Anchorage, personal communication). Current picket spacing now prevents Chinook, chum, coho, and sockeye salmon from passing through, while other non-targeted species can freely migrate up and downstream of the weir.

Boat traffic at the weir was uncommon, but when necessary, boats were 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. Extensive site surveys indicated that the weir location lacked the necessary 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 most of the coho salmon run. Generally, no attempt is made to estimate missed passage prior to installation or after removal of the weir.

Passage Counts

Passage counts were conducted in 4 to 8 hour long shifts per day between 0745 and 2400 hours. This schedule was adjusted as needed to accommodate variation in fish behavior and abundance. 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.

Crew members visually identified to species each fish observed passing upstream of the weir and recorded them on a tally counter. Salmon were also identified and enumerated by sex, based on the visual characteristics of advanced sexual dimorphism apparent in mature salmon at Kogrukluk River weir. Following each shift, crew members recorded total counts in a logbook

[2] Baxter, R. Holitna weir developmental project, 1976 (unpublished). Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 11, Anchorage.

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 the Alaska Department of Fish and Game (ADF&G) staff in Bethel.

Passage Estimates

Upstream salmon passage was estimated for days the weir was inoperable. Estimates were assumed to be zero if passage was likely negligible based on historical or inseason data. Otherwise, estimates for missed passage were calculated using one of the following methods:

Single Day Method

When the weir was not operational for all of one day, an estimate for the inoperable day $\hat{n}_i$ was calculated using the following formula:

$$\hat{n}_i = \left(\frac{(n_b + n_{b-1} + n_a + n_{a+1})}{4} \right). \quad (1)$$

Variables are defined as:

n_b = fish count on day before inoperable period,

n_{b-1} = fish count 2 days before inoperable period,

n_a = fish count on day after inoperable period, and

n_{a+1} = fish count 2 days after inoperable period.

The daily estimated missed passage $\hat{n}_i$ was reported unless it was less than the observed passage; in these cases, observed passage was used instead of the estimate.

Linear Method

When the weir was not operational for two or more days but later became operational again, passage estimates for the inoperable days were calculated using linear interpolation. This methodology was appropriate for short periods of inoperability when fish passage was reasonably assumed to have a linear relationship with time. Average fish counts from the two days before and two days after the inoperable period were used to estimate the counts during the period of missed passage. The estimated fish count ($\hat{n}$) on day (i) of the inoperable period was estimated as:

$$\hat{n}_i = \left(\frac{n_b + n_{b-1}}{2} \right) + i \left(\frac{(n_a + n_{a+1}) - (n_b + n_{b-1})}{2(D+1)} \right) \quad (2)$$

We denoted an inoperable period days as:

D = total number of inoperable days.

We denoted the fish counts on the days just before and just after the inoperable period as:

n_b = fish count on day before inoperable period,

n_{b-1} = fish count 2 days before inoperable period,

n_a = fish count on day after inoperable period, and

n_{a+1} = fish count 2 days after inoperable period.

Exponential Method

When the weir was not operational for the beginning or end of a run, a non-linear regression was used to fit an exponential function to existing data for each circumstance. These functions were then used to estimate fish count ($\hat{n}$) on day (i) of the inoperable period as:

$$\hat{n}_i = ae^{bp_i} \quad . \tag{3}$$

Variables are defined as:

a = y-intercept of the fitted line,

b = slope of the fitted line, and

p_i = estimated portion (p) of the run on day (i) as represented by the run curve.

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.

AGE, SEX, AND LENGTH COMPOSITION

Sample Size and Distribution

A minimum sample size was determined for each species following conventions described by Bromaghin (1993) to achieve simultaneous 95% confidence interval estimates of age composition no wider than ±10% (α=0.05 and d=0.10), assuming 10 age categories for Chinook and sockeye salmon (n=190), 8 age categories for chum salmon (n=180), and six age 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, 230 sockeye, 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 in a short period of time. Pulse sampling, which is a form of stratified random sampling, was employed to ensure adequate temporal distribution of chum and coho samples. Well-spaced pulse samples are thought to better represent temporal changes in ASL composition than other sampling methods (Geiger and Wilbur 1990), with the intent for pulses to characterize major portions of the run (i.e., early, middle, and late). Pulses were used as guidelines when stratifying postseason. The sampling strategy comprised collection of four pulses of 220 chum salmon and three pulses of 200 coho salmon. All samples were typically obtained within 3–5 days of beginning the pulse, with pulses attempted approximately every 7–10 days.

The comparatively lower numbers of Chinook and sockeye salmon running concurrently with large numbers of chum salmon at Kogrukluk River weir made pulse sampling for these species impractical. Instead, sampling efforts followed a daily collection schedule based on historical run timing information and a target sample size of 505 Chinook salmon and 231 sockeye salmon (Molyneaux et al. 2010). Daily target sample sizes were set proportional to average daily historical escapements to ensure a good distribution across the run.

At the Kogrukluk River weir, reliable aging of sockeye salmon scales is confounded by the prevalence of scale absorption (Burkey 1995; Cappiello and Burkey 1997). However, the collection of sockeye salmon ASL data, though insufficient to estimate total age or ocean years, does provide sex composition of the escapement and freshwater age.

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 while 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. (2010). 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. Mideye to fork 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 and sockeye salmon samples were often collected through "active sampling," which consisted of capturing and sampling Chinook and sockeye salmon individually while actively passing and counting all other salmon. The active sampling technique was employed when trapping Chinook or sockeye salmon proved difficult, often during times of high chum salmon passage. 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, sampling location, and gum card number was entered into a computer spreadsheet. The completed gum cards and computer file were sent to the Bethel and/or Anchorage ADF&G offices for processing. The original ASL gum cards, acetates, and data sheets were archived at the ADF&G office in Anchorage. The computer files were archived by ADF&G in the Anchorage and Bethel offices. Data was also loaded into the Arctic-Yukon-Kuskokwim (AYK) salmon database management system (Brannian et al. 2006). 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. (2010). 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.

Estimates of the ASL composition of the total escapements were generated postseason. Age and sex compositions collected were weighted proportionally to escapement occurring simultaneously—providing an estimate of ASL composition reflective for that period of time, or strata. Strata were determined based on sampling effort and run strength. ASL composition of each strata were combined to obtain an estimate of ASL composition for the entire season's escapement.

Visual Sex Determination

Sex was determined for every salmon passing upstream of the weir through observation of sexually dimorphic characteristics. Sex composition derived visually when conducting passage counts was compared to sex composition determined from handling fish during ASL sampling to assess possible biases in each method and to test the potential of visual sex determination in clear water tributaries.

WEATHER AND STREAM OBSERVATIONS

Water and air temperatures were manually measured each day at approximately 0730 and 1700 hours, along with notations about wind direction, estimated wind speed, cloud cover, and precipitation. Daily precipitation was measured using a rain gauge calibrated in millimeters.

In addition to manual techniques, air and water temperature was monitored using 2 Hobo® Water Temp Pro V2 data loggers and one Hobo® Air Temperature R/H data logger.[3] The data loggers were installed at the beginning of the field season by switching out the previous year's temperature loggers. At the end of the field season all the data loggers were downloaded using a data shuttle, then left in the field to continue monitoring temperatures over winter. The data shuttle, along with pictures and GPS coordinates of the data logger's location were returned to the ADF&G Anchorage office for data management, reporting, and storage.

Daily operations included monitoring river depth with a standardized staff gauge which consisted of a metal rod driven into the stream channel with a meter stick attached. 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. Water stage was measured at approximately 0730 and 1700 hours.

RELATED FISHERIES PROJECTS

Kuskokwim River Sockeye Salmon Run Reconstruction

The Kogrukluk River weir served as a recovery site for the ongoing, basinwide mark–recapture study entitled *Kuskokwim River sockeye salmon run reconstruction*, operated cooperatively with Kuskokwim Native Association and funded by the Alaska Sustainable Salmon Fund (Project No. 45920). Upstream passage of all salmon occurred through the weir's live trap, enabling capture of tagged sockeye salmon. Recorded data for "recovered" fish included the tag number, tag color, sex, fish color, fish condition, presence of secondary tag, and recovery date. Tagged fish that passed through the trap without being captured were recorded as "observed" along with the tag color, sex, presence of secondary tag, and passage date.

Ichthyophonus Tissue Sample Collection

In 2011, FWS Kenai Field Office received funding to sample for the parasite *Ichthyophonus* in Chinook salmon within the Kuskokwim River drainage. The Kogrukluk River weir was used as a platform to collect heart tissue from Chinook salmon to test for the presence of the parasite. The Kogrukluk River was chosen as a sample site due to its large return of Chinook salmon, relative

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

to other tributaries, along with the availability of the existing weir crew to collect samples without additional expense. Heart tissue samples were collected on an opportunistic basis from post-spawned Chinook salmon that had washed up upon the weir. Tissues were flown back to U.S. Geological Survey Marrowstone Marine Field Station, Nordland, Washington, where they were tested for *Ichthyophonus*.

RESULTS

WEIR OPERATIONS

In 2011, the Kogrukluk River weir was operated from 21 June through 15 September; daily and total passage was estimated through 25 September (Figure 4). The weir became inoperable several times during the season: 24 June through 25 June (occurrence of a hole); 12 July through 13 July (high water event); 16 July (occurrence of a hole); 4 August through 6 August (high water event); 12 August through 15 August (high water event); 20 August through 22 August (high water event); and 15 September through 25 September (early removal due to high water). To prevent structural damage during high water events that would impair future weir operation, the crew dismantled parts of the weir once water stage or debris load exceeded a safe level.

ESCAPEMENT MONITORING

Chinook Salmon

Total estimated Chinook salmon escapement upstream of the Kogrukluk River weir in 2011 was 6,891 fish. Of these, 6,354 Chinook salmon were actually counted past the weir (92.2% of the total escapement). Estimates were generated by the following methods: 24–25 June were assumed zero; 12–13 July were linear method; 16 July was single day method; 4–6, 12–15, and 20–22 August were linear method; and 15–25 September were assumed zero. The first Chinook salmon passed through the weir on 29 June, daily passage peaked at 563 fish on 22 July, and the last Chinook salmon was observed on 10 September. The median passage date was 23 July and the central 50% of the passage occurred between 18 and 27 July (Table 1).

Chum Salmon

Total estimated chum salmon escapement upstream of the Kogrukluk River weir in 2011 was 76,384 fish. Of these, 68,323 chum salmon were actually counted past the weir (89.4% of the total escapement). Estimates were generated by the following methods: 24–25 June and 12–13 July were linear method; 16 July was single day method; 4–6, 12–15, and 20–22 August were linear method; and 15–25 September were assumed zero. The first chum salmon was observed on 23 June and daily passage peaked at 4,409 fish on 22 July, and the last chum salmon was observed on 15 September. The median passage date was 23 July and the central 50% of the passage occurred between 18 and 29 July (Table 1).

Coho Salmon

Total estimated coho salmon escapement upstream of the Kogrukluk River weir in 2011 was 24,174 fish. Of these, 20,077 coho salmon were actually counted past the weir (83.1% of the total escapement). Estimates were created by the following methods: 24–25 June, 12–13 July, and16 July were assumed zero; 4–6, 12–15, and 20–22 August were linear method; and 15–25 September were with the exponential method, fitted to the exponential function (y=1564.2 $e^{-0.076pi}$) from the preceding 15 days' counts (31 August–14 September). The first coho salmon was observed on 28 July, daily passage peaked at 1,514 fish on 31 August and passage was estimated through 25 September. The median passage date was 3 September and the central 50% of the passage occurred between 29 August and 10 September (Table 1).

Sockeye Salmon

Total estimated sockeye salmon escapement upstream of the Kogrukluk River weir in 2011 was 8,132 fish. Of these, 7,608 sockeye salmon were actually counted past the weir (93.6% of the total escapement). Estimates were generated by the following methods: 24–25 June were assumed zero; 12–13 July were linear method; 16 July was single day method; 4–6, 12–15, and 20–22 August were linear method; and 15–25 September were assumed zero. The first sockeye salmon was observed on 29 June, observed daily passage peaked at 756 fish on 19 July, and the last sockeye salmon was observed on 15 September. The median passage date was 22 July and the central 50% of the passage occurred between 18 and 26 July (Table 1).

Other Species

It is assumed that small individuals such as pink salmon *O. gorbuscha* 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 2011 was 96 fish (Appendix A). Pink salmon were observed passing upstream of the weir from 15 July to 11 August. Other species observed passing upstream of the Kogrukluk River weir during the 2011 field season include 860 Dolly Varden (*Salvelinus malma*) and 105 whitefish (*Coregonus* spp.; Appendix A). Arctic grayling (*Thymallus arcticus*) and northern pike (*Esox lucius*) were also observed but total counts were not recorded.

Carcasses

A total of 12,790 salmon carcasses were recovered from the Kogrukluk River weir. Chum salmon were the most numerous (10,634), followed by Chinook salmon (1,500), sockeye (633), pink (25), and coho (1). Other fish species recovered from the weir include Arctic grayling, Dolly Varden, northern pike, and whitefish (Appendix B).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook salmon ASL sampling at the Kogrukluk River weir was conducted daily from 28 June to 2 August, resulting in a total sample of 328 fish. Of those, age was successfully determined for 268 fish (82.0% of the total sample). The ASL composition was estimated from two strata: 21 June through 20 July (n=116) and 21 July through 25 September (n=152). The Chinook salmon escapement past the weir was comprised of 5 age classes which were dominated by age-1.2 (47.2%), -1.3 (32.6%), and -1.4 (19.5%) fish. Male Chinook salmon were predominant (79.9%); however females dominated older age classes. Female Chinook salmon were larger at age than males in age classes where both sexes were identified (Table 2).

Chum Salmon

Chum salmon ASL sampling at the Kogrukluk River weir was conducted in four pulses, distributed between 5 July and 2 August, resulting in a total sample of 898 fish. Of those, age was successfully determined for 788 fish (87.8% of the total sample). The ASL composition was estimated from 3 strata: 21 June through 11 July (*n*=203), 12 July through 26 July (*n*=385), and 27 July through 25 September (*n*=200). The chum salmon escapement past the weir was largely represented by two age classes, age 0.3 (64.2%) and age 0.4 (32.7%), and was predominately male (58%). Males were larger at age than females (Table 3).

Coho Salmon

Coho salmon ASL sampling at the Kogrukluk River weir was conducted in three pulses, distributed between 24 August and 13 September, resulting in a total sample of 592 fish. Of those, age was successfully determined for 535 fish (90.4% of the total sample). The ASL composition was estimated from two strata: 21 June through 31 August (*n*=178) and 1 September through 25 September (*n*=357). The coho salmon escapement past the weir was dominated by age-2.1 individuals (87.3%) and had close to a 1:1 sex ratio (Table 4).

Sockeye Salmon

Sockeye salmon ASL sampling at the Kogrukluk River weir was conducted on a daily basis from 5 July to 1 August, resulting in a total sample of 133 fish. Of those, freshwater age was determined for 126 fish (89.5% of the total sample). The ASL samples were not stratified. The majority of the sampled fish had one year of freshwater growth (92.1%). Sockeye salmon sampled were predominately female (61.9%; Table 5).

WEATHER AND STREAM OBSERVATIONS

Water temperature at the weir ranged from 5.0 to 11.5°C, with an average water temperature of 8.6°C. Air temperature at the weir ranged from 0.5 to 24°C, with an average air temperature of 11.7°C (Appendix C1). Hobo® temperature data produced similar results, with water temperature averaging 8.5°C (range: 5.7–11.4°C) and air temperature averaging 10.3°C (range: -0.7–21.6°C) (Appendix C2 and C3). A total of 271.5 mm of precipitation was recorded throughout the season. River stage ranged from 276 to 321 cm, with an average of 292 cm (Appendix C1).

RELATED FISHERIES PROJECTS

Kuskokwim River Sockeye Salmon Run Reconstruction

The Kogrukluk River weir recovered 59 tagged sockeye salmon in 2011; of those, 58 sockeye salmon had retained the secondary tag.

Ichthyophonus Tissue Sample Collection

The Kogrukluk River weir crew collected 107 Chinook tissue samples supplied for *Ichthyophonus* testing.

DISCUSSION

OPERATIONS

In 2011, the Kogrukluk River weir operations both began and ended four days earlier than the average operational period (Figure 4). Above average water levels throughout the season and scouring contributed to the inoperable periods (Figure 5). Escapement was estimated after operations ended due to strong passage numbers of coho salmon through the weir prior to removal.

ESCAPEMENT MONITORING

Chinook Salmon

Chinook salmon escapement in 2011 fell within the SEG range of 5,300–14,000 fish (Volk et al. 2009) but 33% below the historical median (Figure 6). The Kogrukluk River weir was the only Kuskokwim River weir project to achieve its Chinook salmon escapement goal in 2011. Chinook salmon run timing at the Kogrukluk River weir was among the latest on record (Figure 7).

Visual census of females yielded a percentage that fell within the 95% confidence interval of the estimate from ASL samples (Figure 8). The similarity between these methods supports the assumption that ASL sampling methods are random and effective (Molyneaux et al. 2010).

The percentage of age-1.2 fish was above the historical median, while the other prevailing age classes were below historic median values; percent female escapement was also below the historical median. However, the percentages of all age and sex classes were within observed historical ranges (Figure 9).

Chum Salmon

Chum salmon escapement in 2011 was the fourth largest escapement on record exceeding the SEG range of 15,000–49,000 fish (Figure 10; Volk et al. 2009). Overall, chum salmon abundance was above average throughout the Kuskokwim River drainage. Run timing of chum salmon at the Kogrukluk River weir was among the latest on record (Figure 11).

Sex composition estimated from ASL samples yielded a season total female percentage of nearly identical to the visual method (Figure 8). The similarity between these methods supports the assumption that ASL sampling methods are random and effective (Molyneaux et al. 2010).

Age class percentages were similar to historical levels; females comprised a larger percentage of the escapement than the historically median yet remained within observed historical range (Figure 9). Mean lengths of age-0.3 and -0.4 chum salmon were at or near project history lows (Figure 12). A retrospective analysis of these ages of chum salmon at this project shows a general decrease in length-at-age from 1997 through 2007 (Molyneaux et al. 2010; Jasper and Molyneaux 2007). The tighter picket spacing that has been used in recent years (2005 to 2011) 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 2011. However, the chum length frequency has been decreasing since 1996, well before picket spacing was adjusted, indicating that more accurate sampling due to the decreased picket spacing may be only one of several contributing factors.

Coho Salmon

Coho salmon escapement in 2011 was within the current SEG range of 13,000–28,000 fish (Figure 13; Volk et al. 2009). Coho salmon run timing was three days later compared to the historical median (Figure 14).

Sex composition estimated from ASL samples yielded a season total female percentage of nearly identical to the visual method (Figure 8). The similarity between these methods supports the assumption that ASL sampling methods are random and effective (Molyneaux et al. 2010).

Age and sex compositions were near their historic median values (Figure 9). Mean lengths of male and female age-2.1 coho salmon at the Kogrukluk River weir were below the historical average but within the historical range observed at this project (Figure 15).

Sockeye Salmon

In 2011, Kogrukluk River sockeye escapement was similar to the historic median and fell within the escapement goal range of 4,400–17,000 fish (Figure 16; Volk et al. 2009). Run timing of sockeye salmon was the second latest on record (Figure 17).

ASL composition of sockeye salmon was estimated successfully. Visual census of females yielded a percentage that fell within the 95% confidence interval of the ASL sampling method (Figure 8). The similarity between these methods supports the assumption that ASL sampling methods are random and effective (Molyneaux et al. 2010).

Mean lengths by freshwater age class for sockeye salmon should not be used to characterize freshwater ages (Table 5). Since saltwater age could not be determined, each freshwater age class may contain various ages and thus several different size classes of fish.

Pink Salmon

Accurate enumeration of spawning pink salmon at the Kogrukluk River weir is not possible due to their small size, which allows some individuals to pass between weir pickets undetected. 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 normally make less extensive spawning migrations into freshwater than other Pacific salmon species (Heard 1991).

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). High water levels in 2011 required disassembly of the weir several times throughout the season, allowing carcasses to freely pass downstream.

WEATHER AND STREAM OBSERVATIONS

Water levels were above average for approximately three-quarters of the season but did not exceed the historical range (Figure 5). Water temperature derived from thermometer measurements was consistently below average for the entire season and exceeded historical lows (Appendix C1; Figure 18).

ACKNOWLEDGMENTS

The success of the 2011 field season is attributed to the diligence and ability of crew member Glen Lindsey, along with Derick Williams, and Rob Stewart of ADF&G. Thanks go out to Amy Brodersen who analyzed the ASL data collected at the project.

REFERENCES CITED

Bavilla, J., D. Bue, H. Carroll, T. Elison, D. Taylor, J. Estensen and C. Brazil. 2010. 2009 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 10-56, Anchorage.

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. St. Clair, and C. Lawn. 2006. 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.

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

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.

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.

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.

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

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, BC.

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, BC.

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

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.

Johnson, J. and P. Blanche. 2012. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Interior Region, Effective June 1, 2012. Alaska Department of Fish and Game, Special Publication No. 12-05, Anchorage.

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.

REFERENCES CITED (Continued)

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.

Molyneaux, D. B., A. R. Brodersen, and C. A. Shelden. 2010. Salmon age, sex, and length catalog for the Kuskokwim Area, 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A10-05, Anchorage.

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

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.

Volk, E. C., M. J. Evenson, and R. H. Clark. 2009. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 09-07, Anchorage.

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, 2011.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
6/21	0	0	0	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0	0	0	0	0
6/23	0	0	0	3	3	0	0	0	0	0	0	0
6/24	0	0	0[a]	4	7	0[b]	0	0	0[a]	0	0	0[a]
6/25	0	0	0[a]	7	15	0[b]	0	0	0[a]	0	0	0[a]
6/26	0	0	0	5	20	0	0	0	0	0	0	0
6/27	0	0	0	15	35	0	0	0	0	0	0	0
6/28	0	0	0	23	58	0	0	0	0	0	0	0
6/29	13	13	0	29	87	0	0	0	0	1	1	0
6/30	10	23	0	45	132	0	0	0	0	0	1	0
7/1	11	34	0	34	166	0	0	0	0	2	3	0
7/2	25	59	1	61	227	0	0	0	0	3	6	0
7/3	7	66	1	77	304	0	0	0	0	1	7	0
7/4	8	74	1	100	404	1	0	0	0	3	10	0
7/5	13	87	1	149	553	1	0	0	0	10	20	0
7/6	10	97	1	254	807	1	0	0	0	1	21	0
7/7	6	103	1	213	1,020	1	0	0	0	2	23	0
7/8	18	121	2	425	1,445	2	0	0	0	9	32	0
7/9	50	171	2	687	2,132	3	0	0	0	37	69	1
7/10	165	336	5	1,074	3,206	4	0	0	0	183	252	3
7/11	120	456	7	1,218	4,424	6	0	0	0	104	356	4
7/12	129	585	8[b]	1,351	5,774	8[b]	0	0	0[a]	163	519	6[b]
7/13	115	700	10[b]	1,555	7,329	10[b]	0	0	0[a]	182	700	9[b]
7/14	144	844	12	1,801	9,130	12	0	0	0	258	958	12
7/15	58	902	13	1,718	10,848	14	0	0	0	143	1,101	14
7/16	225	1,127	16[c]	2,474	13,322	17[c]	0	0	0[a]	287	1,388	17[c]
7/17	288	1,415	21	3,035	16,357	21	0	0	0	266	1,654	20
7/18	411	1,826	26	3,342	19,699	26	0	0	0	481	2,135	26
7/19	391	2,217	32	3,718	23,417	31	0	0	0	756	2,891	36
7/20	342	2,559	37	4,133	27,550	36	0	0	0	624	3,515	43
7/21	267	2,826	41	3,722	31,272	41	0	0	0	340	3,855	47
7/22	563	3,389	49	4,409	35,681	47	0	0	0	719	4,574	56
7/23	319	3,708	54	3,348	39,029	51	0	0	0	443	5,017	62
7/24	285	3,993	58	4,024	43,053	56	0	0	0	341	5,358	66
7/25	452	4,445	65	2,983	46,036	60	0	0	0	472	5,830	72
7/26	413	4,858	70	3,097	49,133	64	0	0	0	533	6,363	78
7/27	303	5,161	75	3,211	52,344	69	0	0	0	413	6,776	83
7/28	230	5,391	78	3,200	55,544	73	4	4	0	278	7,054	87
7/29	285	5,676	82	3,508	59,052	77	3	7	0	236	7,290	90
7/30	95	5,771	84	1,623	60,675	79	1	8	0	107	7,397	91
7/31	72	5,843	85	1,797	62,472	82	1	9	0	86	7,483	92
8/1	116	5,959	86	2,187	64,659	85	4	13	0	122	7,605	94
8/2	110	6,069	88	2,066	66,725	87	2	15	0	99	7,704	95
8/3	187	6,256	91	2,186	68,911	90	9	24	0	87	7,791	96
8/4	118	6,374	92[b]	1,702	70,613	92[b]	8	32	0[b]	74	7,865	97[b]
8/5	88	6,462	94[b]	1,279	71,892	94[b]	11	43	0[b]	54	7,919	97[b]
8/6	57	6,519	95[b]	855	72,747	95[b]	14	57	0[b]	35	7,953	98[b]
8/7	26	6,545	95	552	73,299	96	16	73	0	11	7,964	98
8/8	28	6,573	95	310	73,609	96	17	90	0	19	7,983	98
8/9	45	6,618	96	413	74,022	97	33	123	1	20	8,003	98

-continued-

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
8/10	44	6,662	97	450	74,472	97	22	145	1	20	8,023	99
8/11	48	6,710	97	336	74,808	98	43	188	1	23	8,046	99
8/12	40	6,750	98[b]	334	75,141	98[b]	54	242	1[b]	18	8,064	99[b]
8/13	34	6,784	98[b]	274	75,415	99[b]	76	319	1[b]	15	8,079	99[b]
8/14	28	6,813	99[b]	215	75,630	99[b]	98	417	2[b]	11	8,090	99[b]
8/15	22	6,835	99[b]	155	75,785	99[b]	120	537	2[b]	8	8,097	100[b]
8/16	13	6,848	99	75	75,860	99	165	702	3	5	8,102	100
8/17	20	6,868	100	116	75,976	99	119	821	3	3	8,105	100
8/18	8	6,876	100	89	76,065	100	117	938	4	3	8,108	100
8/19	2	6,878	100	70	76,135	100	172	1,110	5	2	8,110	100
8/20	4	6,882	100[b]	63	76,197	100[b]	173	1,283	5[b]	2	8,112	100[b]
8/21	3	6,885	100[b]	46	76,244	100[b]	201	1,483	6[b]	2	8,114	100[b]
8/22	2	6,887	100[b]	30	76,273	100[b]	229	1,712	7[b]	1	8,115	100[b]
8/23	0	6,887	100	20	76,293	100	395	2,107	9	2	8,117	100
8/24	0	6,887	100	15	76,308	100	276	2,383	10	2	8,119	100
8/25	2	6,889	100	13	76,321	100	485	2,868	12	1	8,120	100
8/26	1	6,890	100	19	76,340	100	804	3,672	15	0	8,120	100
8/27	0	6,890	100	12	76,352	100	545	4,217	17	0	8,120	100
8/28	0	6,890	100	1	76,353	100	1,051	5,268	22	2	8,122	100
8/29	0	6,890	100	4	76,357	100	883	6,151	25	0	8,122	100
8/30	0	6,890	100	1	76,358	100	876	7,027	29	0	8,122	100
8/31	0	6,890	100	2	76,360	100	1,514	8,541	35	0	8,122	100
9/1	0	6,890	100	5	76,365	100	1,433	9,974	41	0	8,122	100
9/2	0	6,890	100	0	76,365	100	1,331	11,305	47	1	8,123	100
9/3	0	6,890	100	1	76,366	100	969	12,274	51	0	8,123	100
9/4	0	6,890	100	1	76,367	100	1,156	13,430	56	1	8,124	100
9/5	0	6,890	100	0	76,367	100	1,115	14,545	60	0	8,124	100
9/6	0	6,890	100	1	76,368	100	760	15,305	63	0	8,124	100
9/7	0	6,890	100	3	76,371	100	742	16,047	66	2	8,126	100
9/8	0	6,890	100	0	76,371	100	802	16,849	70	0	8,126	100
9/9	0	6,890	100	1	76,372	100	733	17,582	73	0	8,126	100
9/10	1	6,891	100	1	76,373	100	757	18,339	76	2	8,128	100
9/11	0	6,891	100	2	76,375	100	655	18,994	79	1	8,129	100
9/12	0	6,891	100	0	76,375	100	461	19,455	80	0	8,129	100
9/13	0	6,891	100	3	76,378	100	482	19,937	82	2	8,131	100
9/14	0	6,891	100	3	76,381	100	648	20,585	85	0	8,131	100
9/15	0	6,891	100[a]	3	76,384	100[a]	464	21,048	87[d]	1	8,132	100[a]
9/16	0	6,891	100[a]	0	76,384	100[a]	430	21,478	89[d]	0	8,132	100[a]
9/17	0	6,891	100[a]	0	76,384	100[a]	398	21,876	90[d]	0	8,132	100[a]
9/18	0	6,891	100[a]	0	76,384	100[a]	369	22,245	92[d]	0	8,132	100[a]
9/19	0	6,891	100[a]	0	76,384	100[a]	342	22,587	93[d]	0	8,132	100[a]
9/20	0	6,891	100[a]	0	76,384	100[a]	317	22,904	95[d]	0	8,132	100[a]
9/21	0	6,891	100[a]	0	76,384	100[a]	294	23,198	96[d]	0	8,132	100[a]
9/22	0	6,891	100[a]	0	76,384	100[a]	272	23,471	97[d]	0	8,132	100[a]
9/23	0	6,891	100[a]	0	76,384	100[a]	252	23,723	98[d]	0	8,132	100[a]
9/24	0	6,891	100[a]	0	76,384	100[a]	234	23,957	99[d]	0	8,132	100[a]
9/25	0	6,891	100[a]	0	76,384	100[a]	217	24,174	100[d]	0	8,132	100[a]

Note: Elongated boxes delineate the central 50% of the run; bold boxes mark the median passage date.

[a] The weir was inoperable for all or part of the day; missed passage was assumed zero.

[b] The weir was inoperable for all or part of the day; missed passage was generated by the linear method.

[c] The weir was inoperable for all or part of the day; missed passage was generated by the single day method.

[d] The weir was inoperable for all or part of the day; missed passage was generated by the exponential method.

Table 2.–Age, sex, and mean length (mm) composition of Chinook salmon at the Kogrukluk River weir in 2011 based on escapement samples collected with a live trap.

			Brood Year (Age)											
			2007		2006		2006		2005		2005			
			(1.2)		(1.3)		(2.2)		(1.4)		(2.3)		Total	
	Sample Size		N	%	N	%	N	%	N	%	N	%	N	%
	268	Male	3,254	47.2	1,822	26.4	22	0.3	385	5.6	22	0.3	5,506	79.9
Season Total		Female	0	0.0	424	6.2	0	0.0	962	14.0	0	0.0	1,385	20.1
		Total	3,254	47.2	2,246	32.6	22	0.3	1,347	19.5	22	0.3	6,891	100.0
		95% C.I. (%)		±5.8		±5.4		±0.6		±4.7		±0.6		
		Male Mean Length	551		720		620		827		691			
		SE	4		9		-		28		-			
		Range	445-682		591-876		620-620		680-1006		691-691			
		n	123		75		1		16		1			
		Female Mean Length	-		816		-		861		-			
		SE	-		9		-		9		-			
		Range	-		717-869		-		760-974		-			
		n	-		16		-		36		-			

Table 3.–Age, sex, and mean length (mm) composition of chum salmon at the Kogrukluk River weir in 2011 based on escapement samples collected with a live trap.

			Brood Year (Age)									
			2008		2007		2006		2005			
			(0.2)		(0.3)		(0.4)		(0.5)		Total	
	Sample Size		N	%	N	%	N	%	N	%	N	%
	788	Male	757	1.0	27,158	35.6	15,946	20.9	436	0.6	44,296	58.0
		Female	621	0.8	21,916	28.7	9,065	11.9	486	0.6	32,088	42.0
Season Total		Total	1,378	1.8	49,074	64.2	25,010	32.7	922	1.2	76,384	100.0
		95% C.I. (%)		±1.1		±3.5		±3.4		±0.6		
		Male Mean Length	538		562		567		555			
		SE	12		2		3		11			
		Range	467-560		480-644		473-636		529-603			
		n	6		272		191		7			
		Female Mean Length	527		534		536		548			
		SE	11		2		4		13			
		Range	477-588		471-608		495-601		514-570			
		n	5		198		104		5			

Table 4.–Age, sex, and mean length (mm) composition of coho salmon at the Kogrukluk River weir in 2011 based on escapement samples collected with a live trap.

		Brood Year (Age)							
		2008		2007		2006			
		(1.1)		(2.1)		(3.1)		Total	
Sample Size		N	%	N	%	N	%	N	%
535	Male	498	2.1	10,251	42.4	1,076	4.5	11,826	48.9
	Female	590	2.4	10,857	44.9	901	3.7	12,348	51.1
Season Total	Total	1,089	4.5	21,108	87.3	1,977	8.2	24,174	100.0
	95% C.I. (%)		±1.7		±2.8		±2.3		
	Male Mean Length	538		543		544			
	SE	10		3		9			
	Range	490-590		392-620		452-604			
	n	11		225		24			
	Female Mean Length	523		547		557			
	SE	9		2		6			
	Range	464-559		430-602		476-614			
	n	13		242		20			

Table 5.–Age, sex, and mean length (mm) composition of sockeye salmon at the Kogrukluk River weir in 2011 based on escapement samples collected with a live trap.

	Sample Size		Age (0.X) N	Age (0.X) %	Age (1.X) N	Age (1.X) %	Age (2.X) N	Age (2.X) %	Total N	Total %
Season Total	126	Male	258	3.2	2,775	34.1	65	0.8	3,098	38.1
		Female	194	2.4	4,711	57.9	129	1.6	5,034	61.9
		Total	452	5.6	7,487	92.1	194	2.4	8,132	100.0
		95% C.I. (%)		±4.0		±4.7		±2.7		
		Male Mean Length	566		579		599			
		SE	14		3		-			
		Range	525-591		546-635		599-599			
		n	4		43		1			
		Female Mean Length	532		539		562			
		SE	18		3		7			
		Range	508-568		475-611		555-568			
		n	3		73		2			

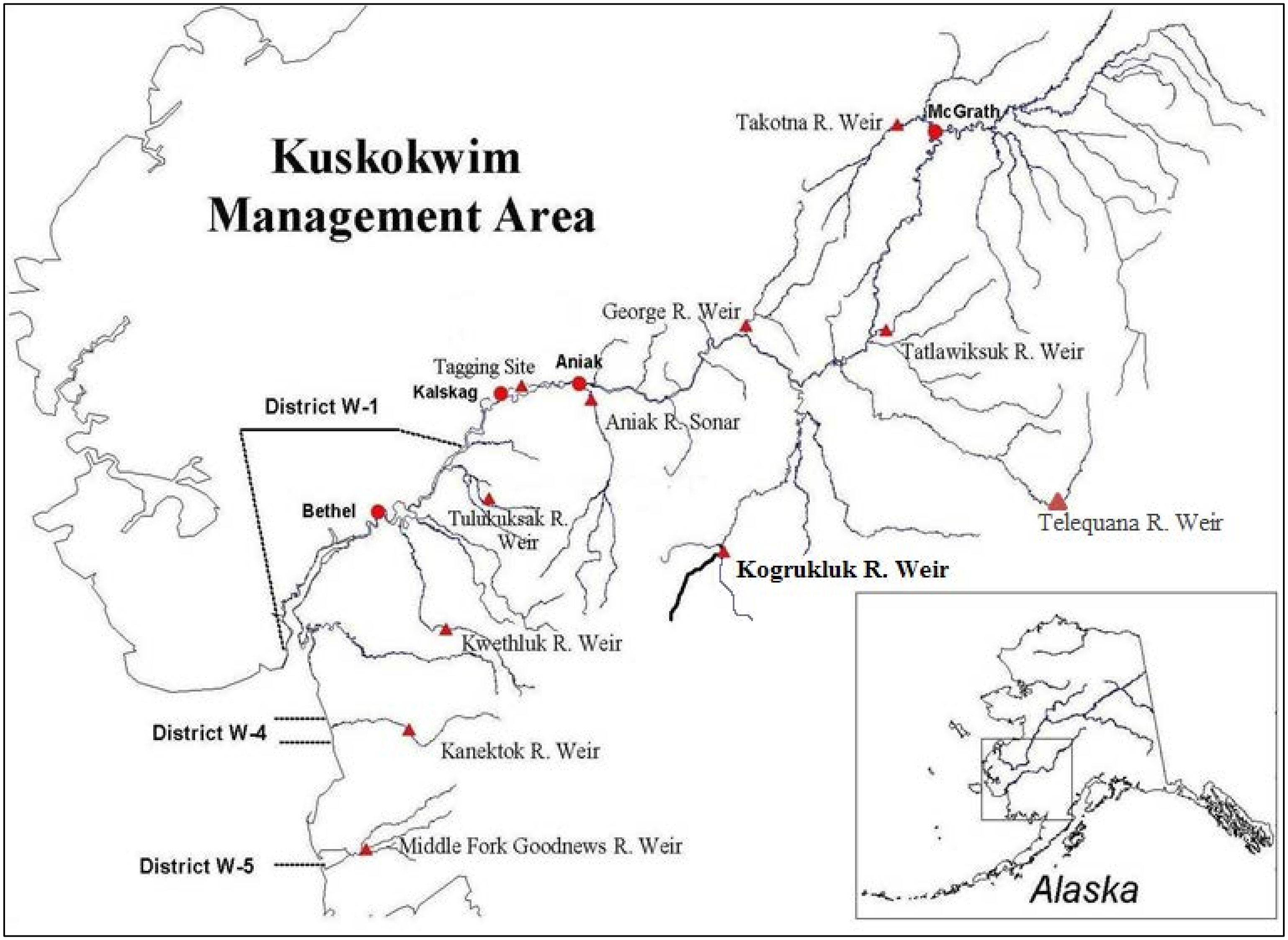


Figure 1.–Kuskokwim Area salmon management districts and escapement monitoring projects, with Kogrukluk River highlighted.

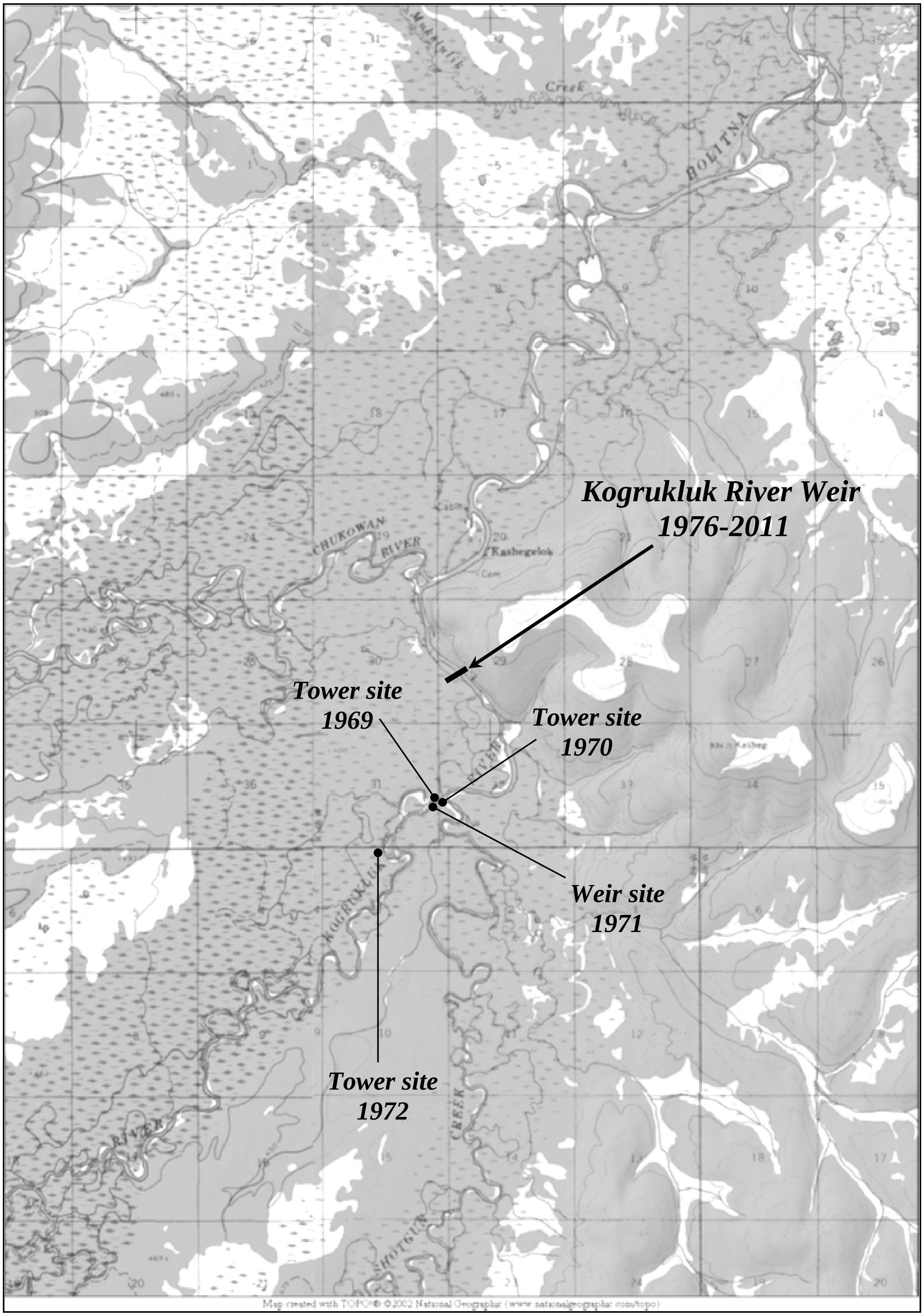
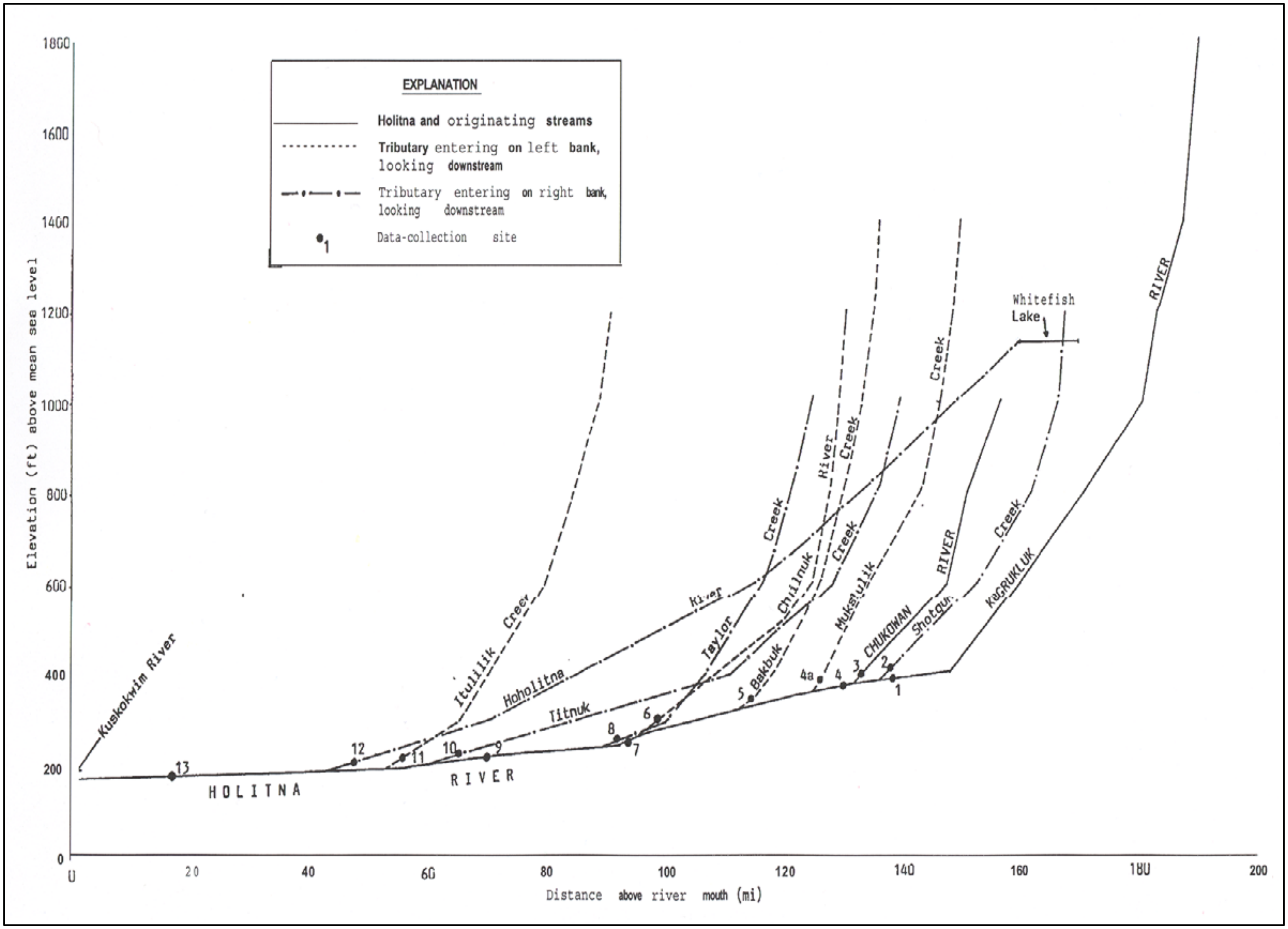


Figure 2.–The Kogrukluk River study area and location of historical escapement monitoring projects.



Source: Collazzi 1989.

Figure 3.–Profile of the Holitna River and major tributaries, Alaska.

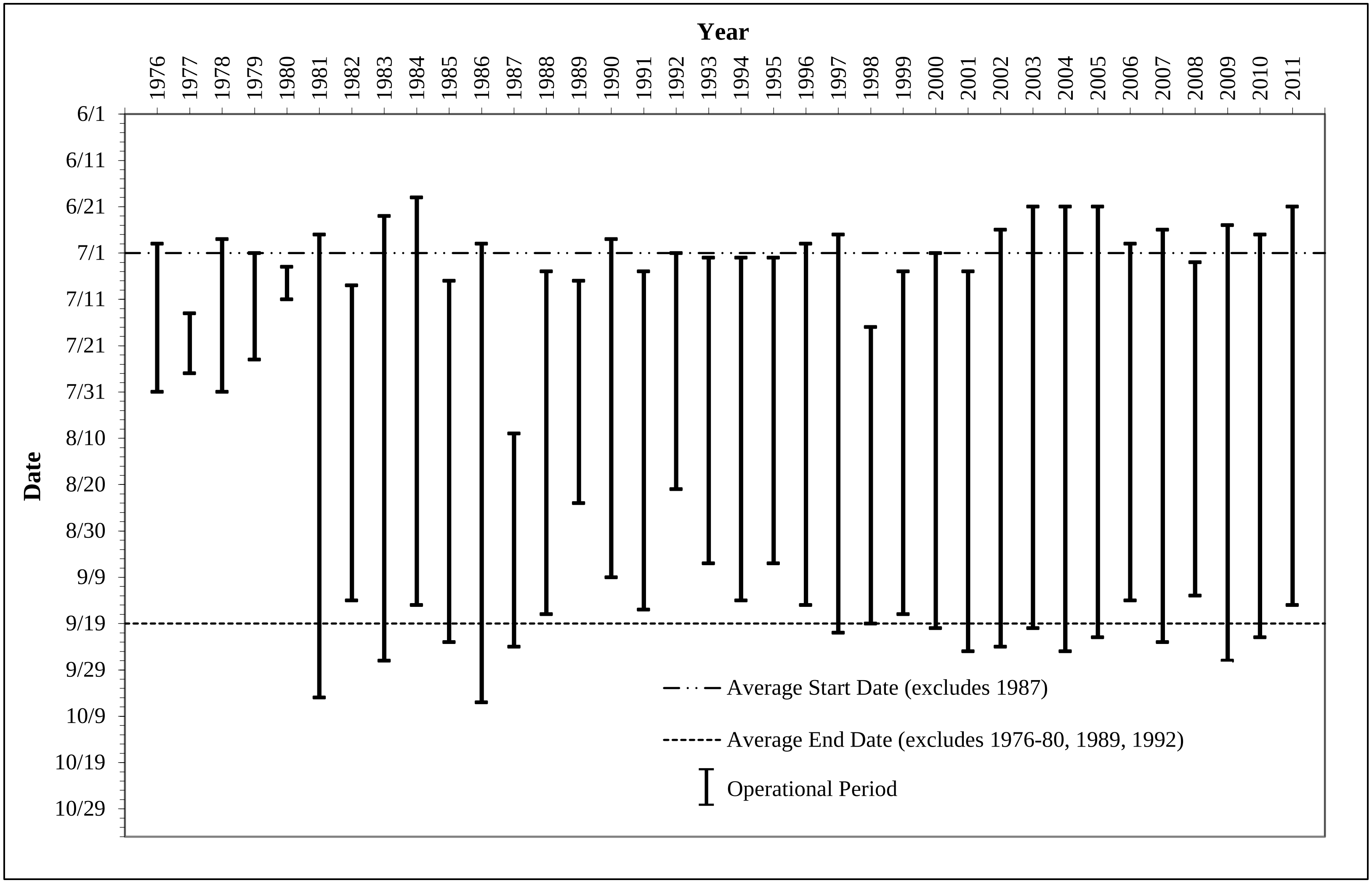


Figure 4.–Historical operational dates for the Kogrukluk River weir.

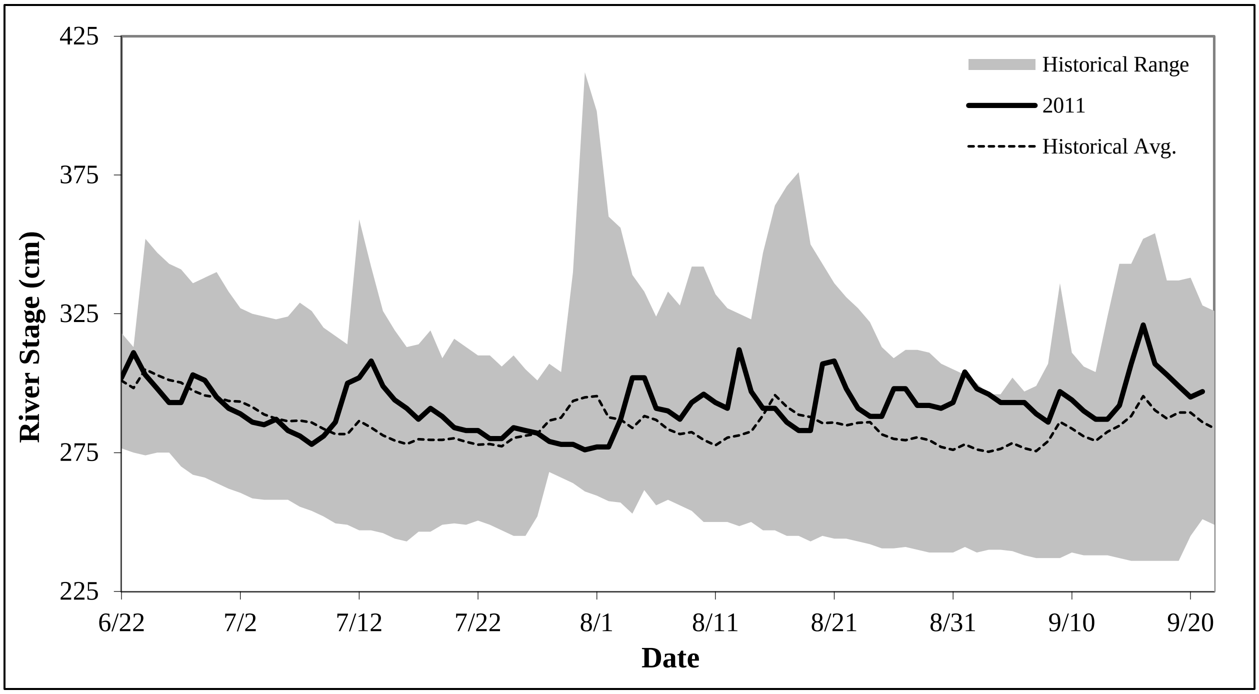
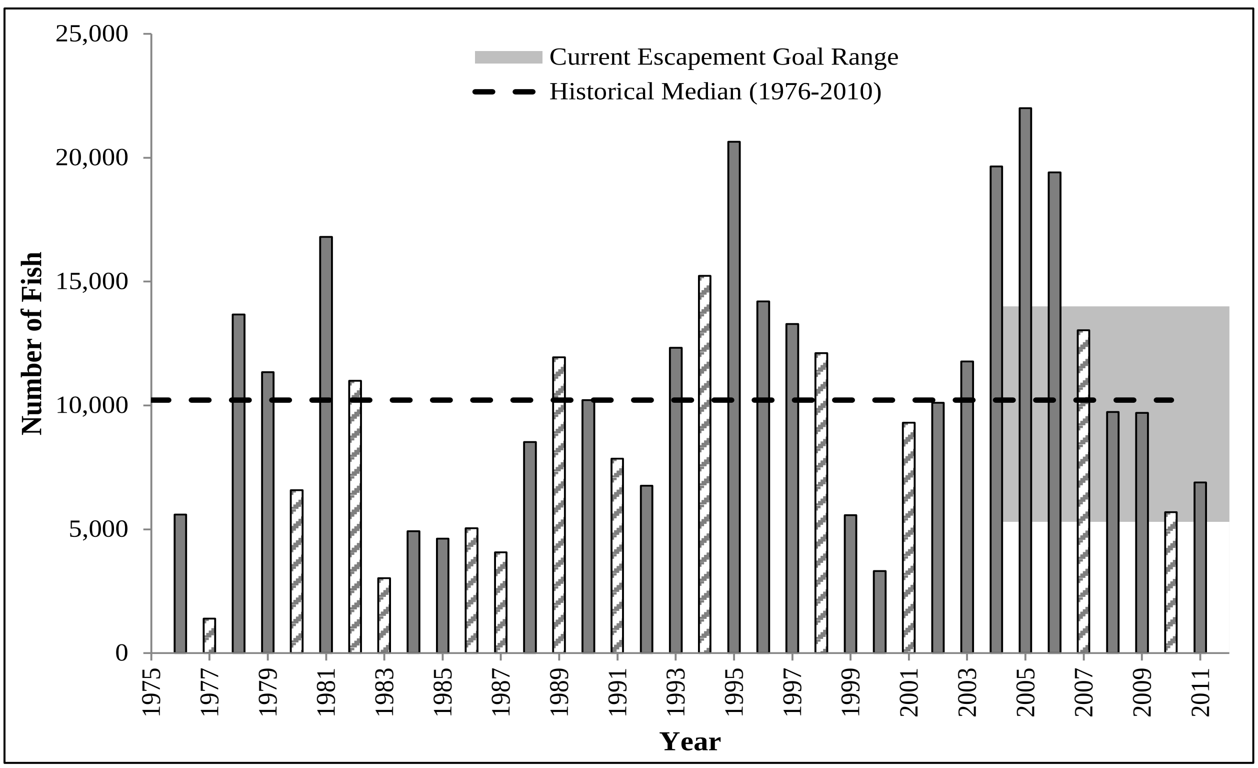
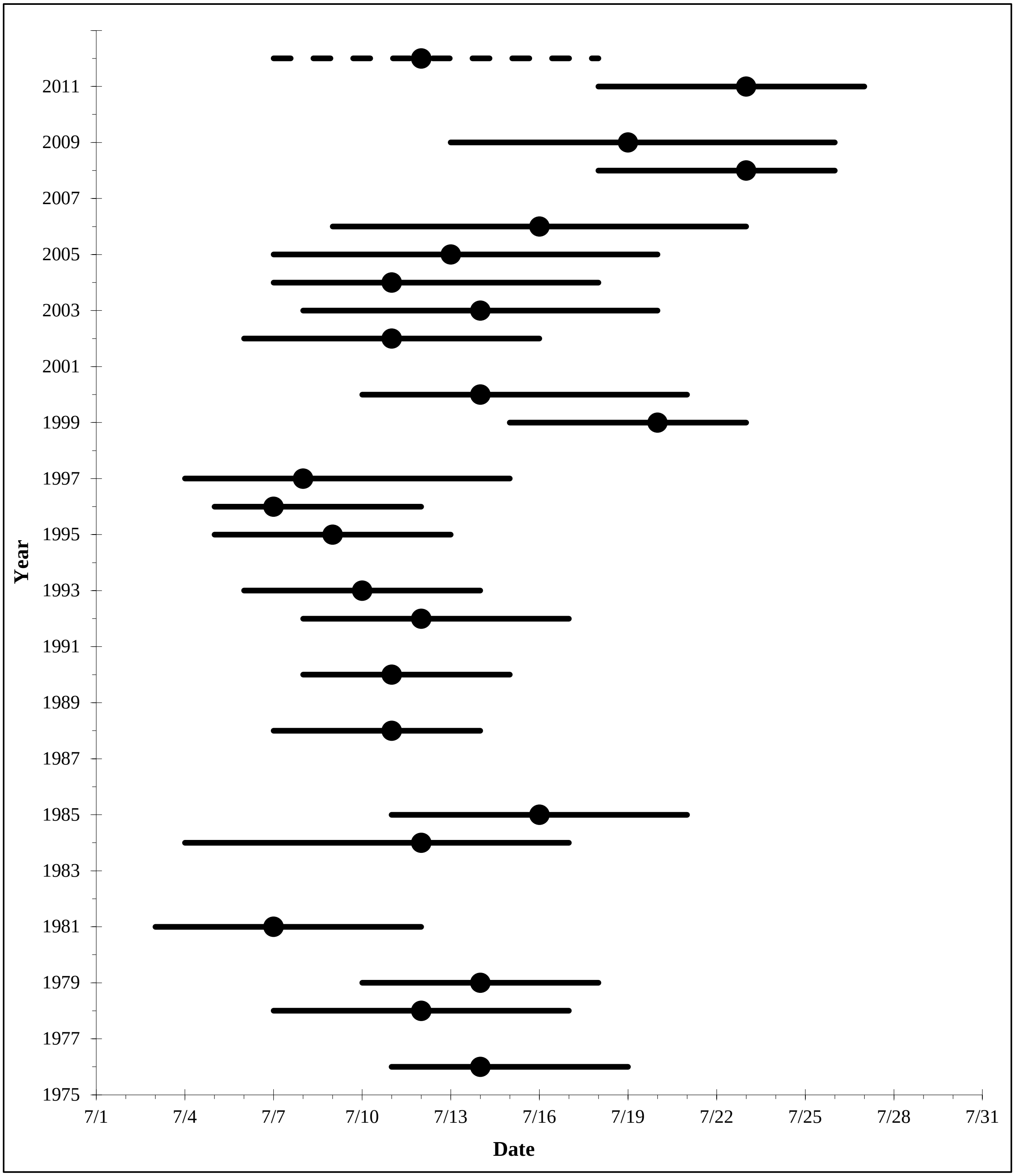


Figure 5.–Daily morning river stage at the Kogrukluk River weir in 2011 relative to historical average, minimum, and maximum morning readings, 2002–2010.



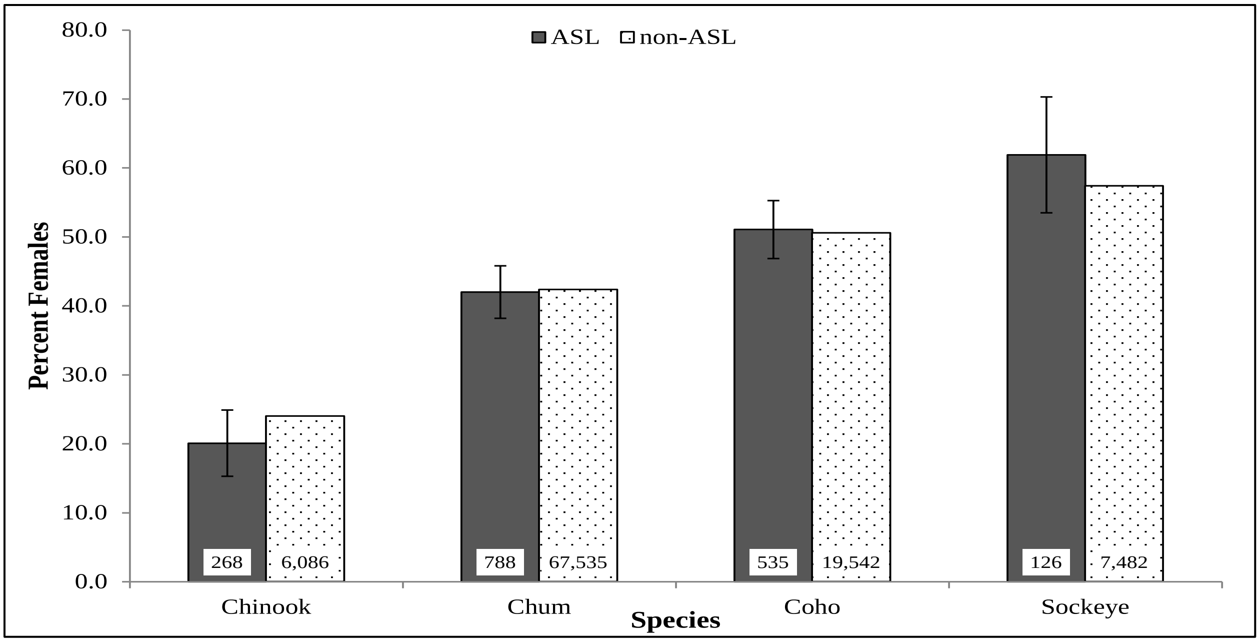
Note: Hatched bars represent years when more than 20% of the escapement was calculated through estimation methods. Historical median does not include years when more than 20% of the escapement was estimated.

Figure 6.–Historical Chinook salmon escapement with respect to the current escapement goal range and historical median escapement at the Kogrukluk River weir.



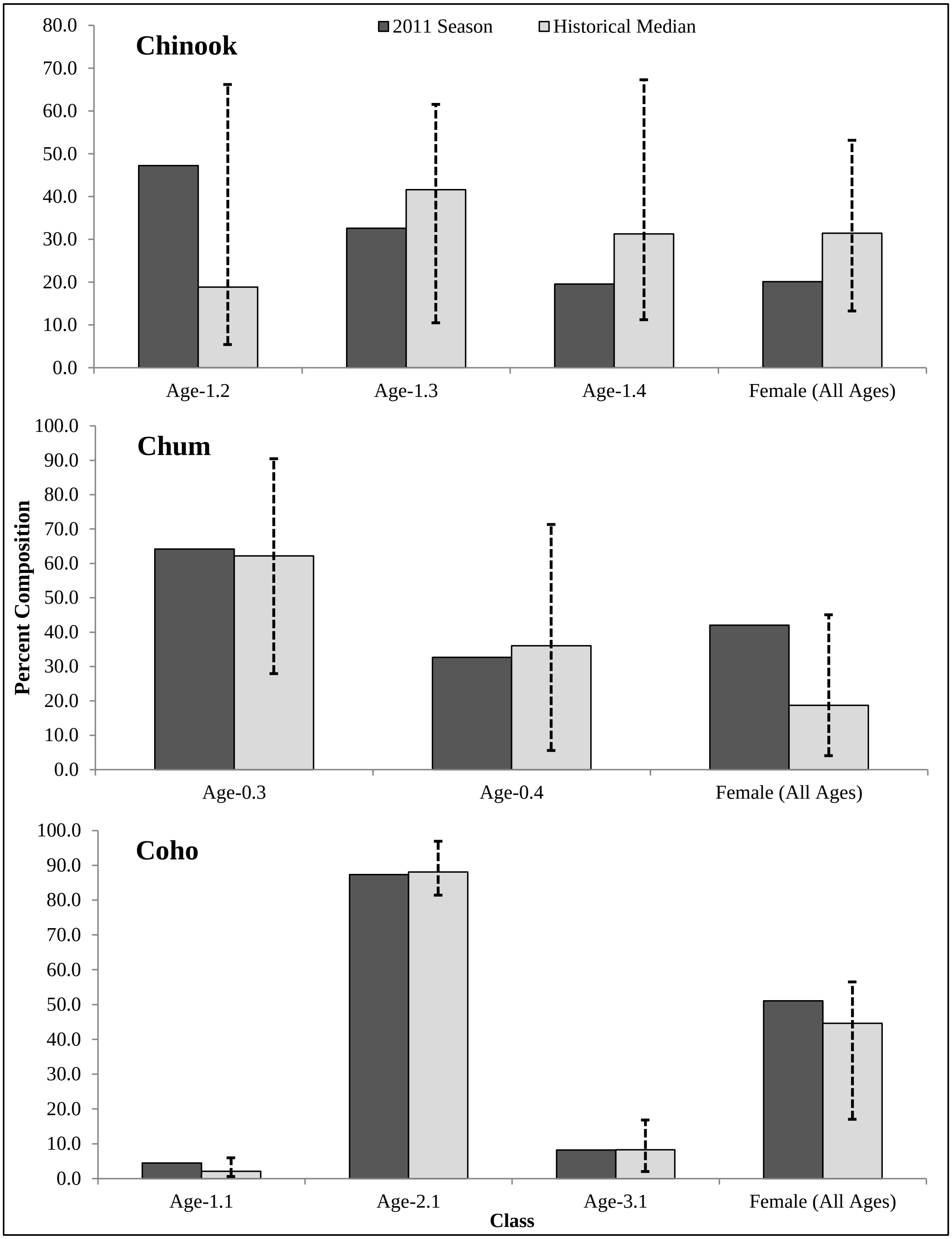
Note: Solid black lines represent the dates when the central 50% of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. The dashed line represents the median of graphed years' passage dates.

Figure 7.–Historical annual run timing of Chinook salmon based on cumulative percent passage at the Kogrukluk River weir, 1976–2011.



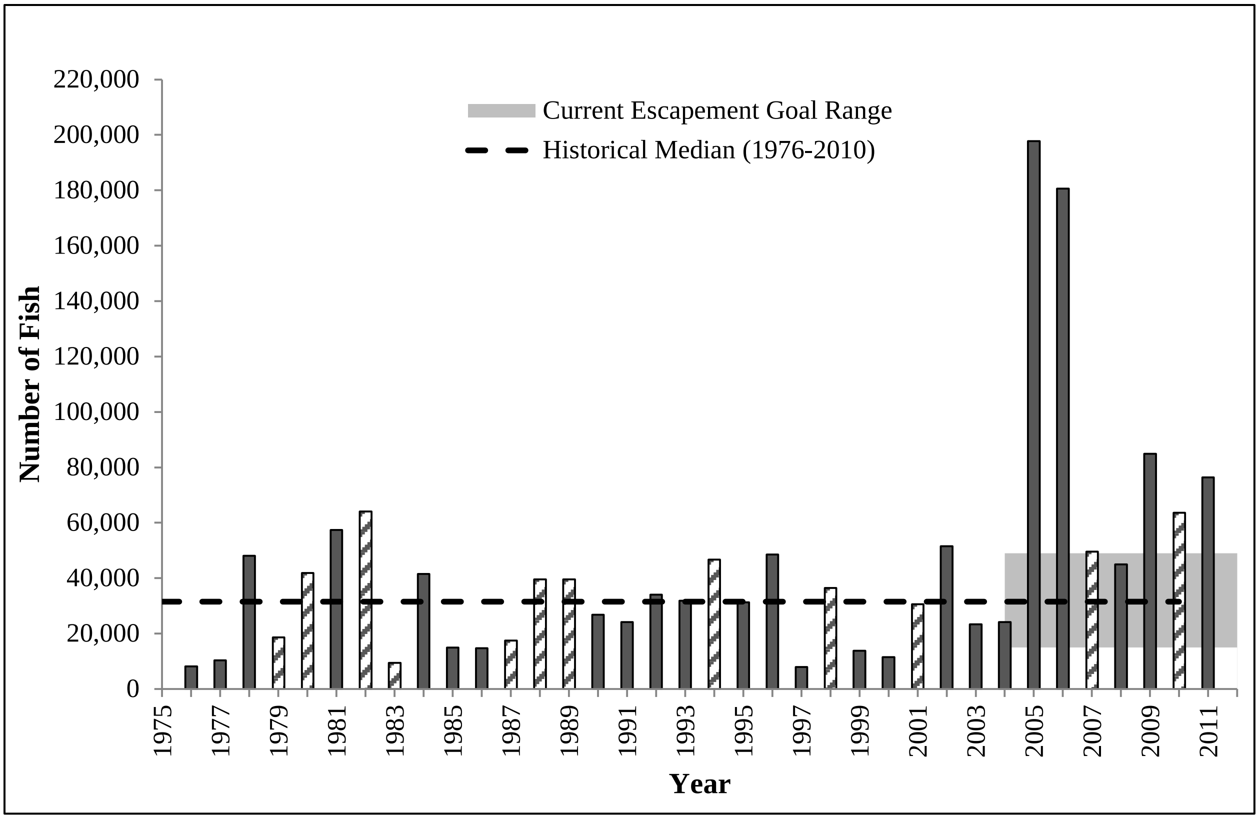
Note: The number at the base of each column is the sample size (*n*). Non-ASL sample sizes were visually counted fish. ASL determined sex rations were estimated with 95% confidence intervals; visually counted fish are considered a census.

Figure 8.–Comparison of the season total percentage of female Chinook, chum, coho, and sockeye salmon passing upstream of the Kogrukluk River weir in 2011 determined from ASL sampling and from standard fish passage procedures.



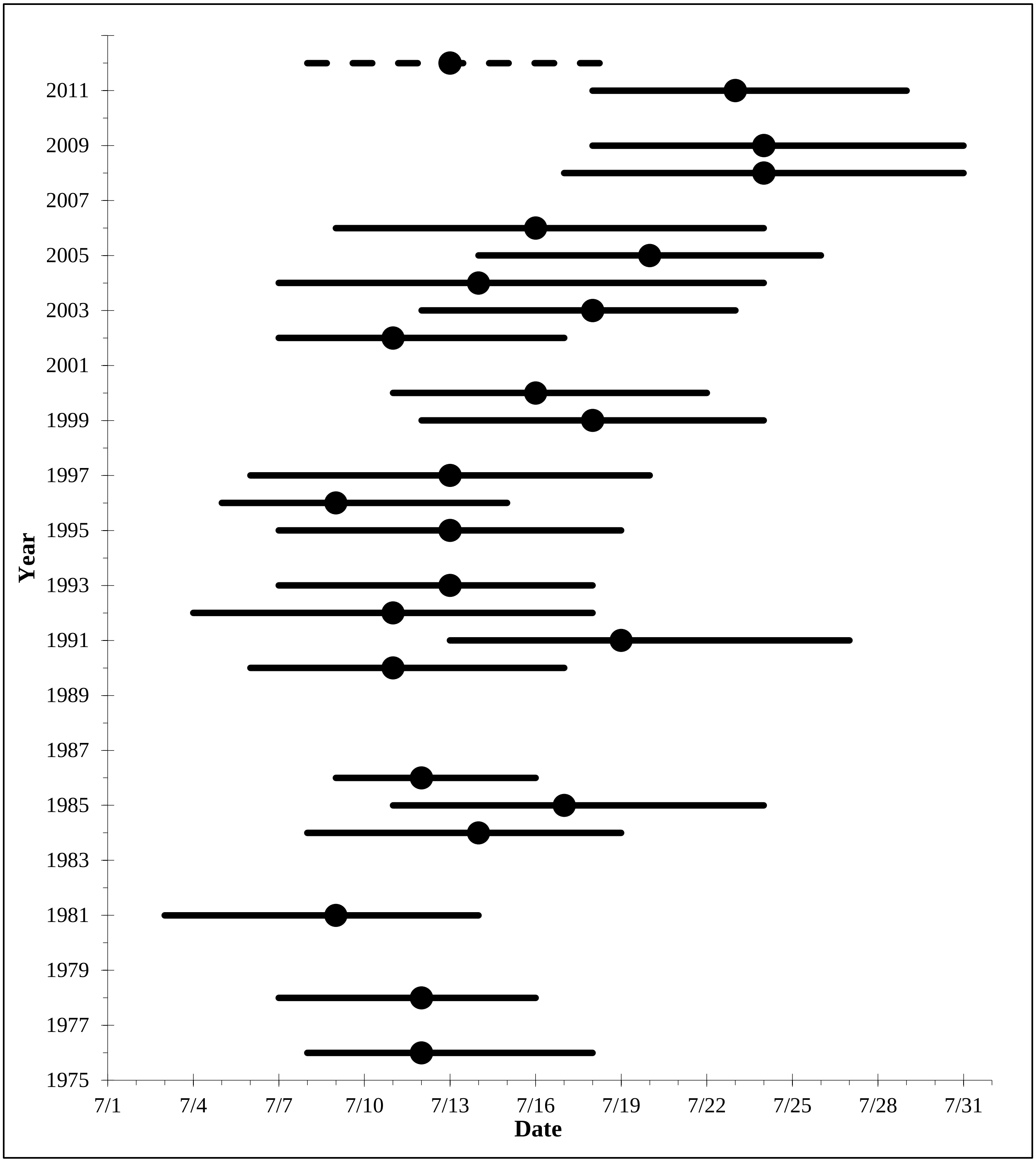
Note: Dashed vertical lines represent the historical observed range for that age or sex class. Historical medians and observed ranges exclude years when more than 20% of the escapement was estimated, or years when sampling effort was not well distributed over the run.

Figure 9.–Comparison of age class and female Chinook, chum, and coho salmon season compositions to historical values at the Kogrukluk River weir, 2011.



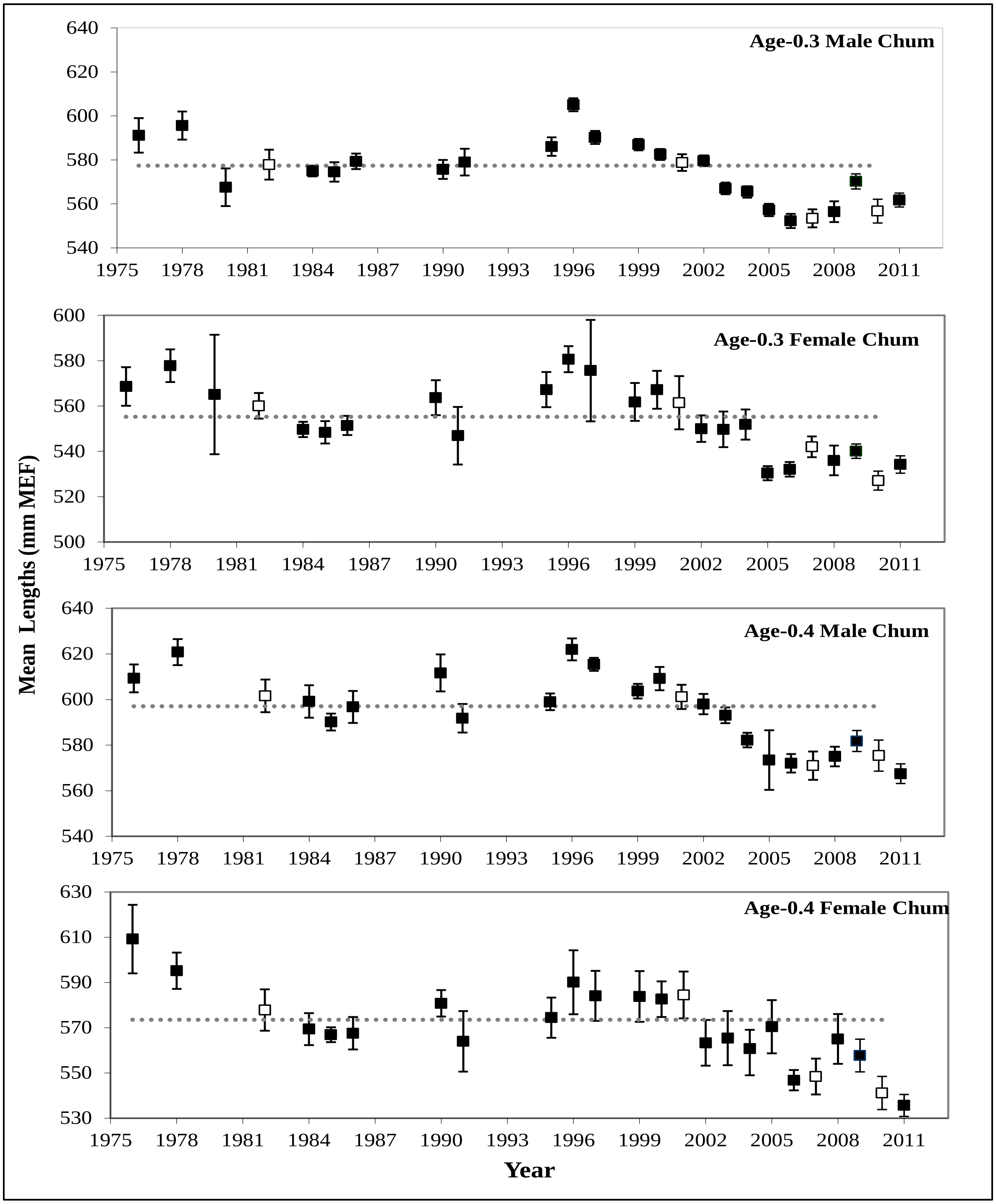
Note: Hatched bars represent years when more than 20% of the escapement was calculated through estimation methods. Historical median does not include years when more than 20% of the escapement was estimated.

Figure 10.–Historical chum salmon escapement with respect to the current escapement goal range and historical median escapement at the Kogrukluk River weir.



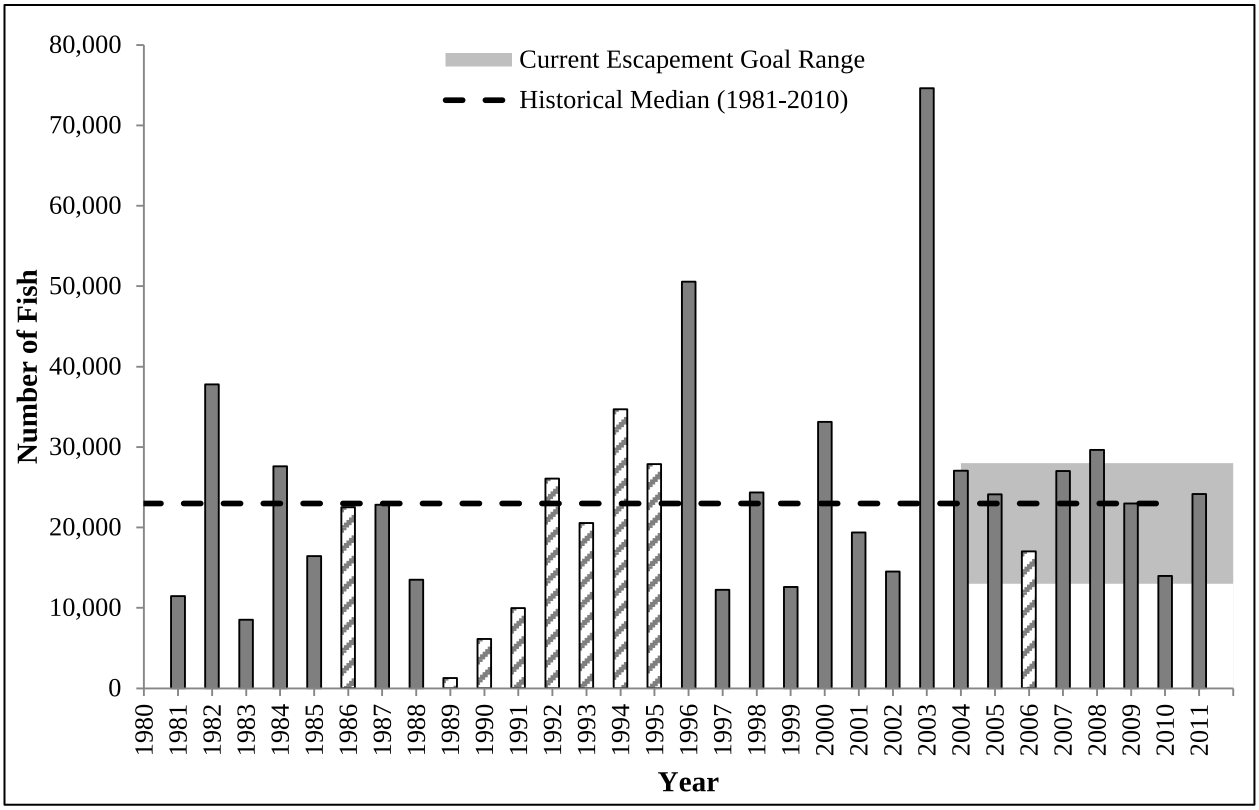
Note: Solid black lines represent the dates when the central 50% of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. The dashed line represents the median of graphed years' passage dates.

Figure 11.–Historical annual run timing of chum salmon based on cumulative percent passage at the Kogrukluk River weir, 1976–2011.



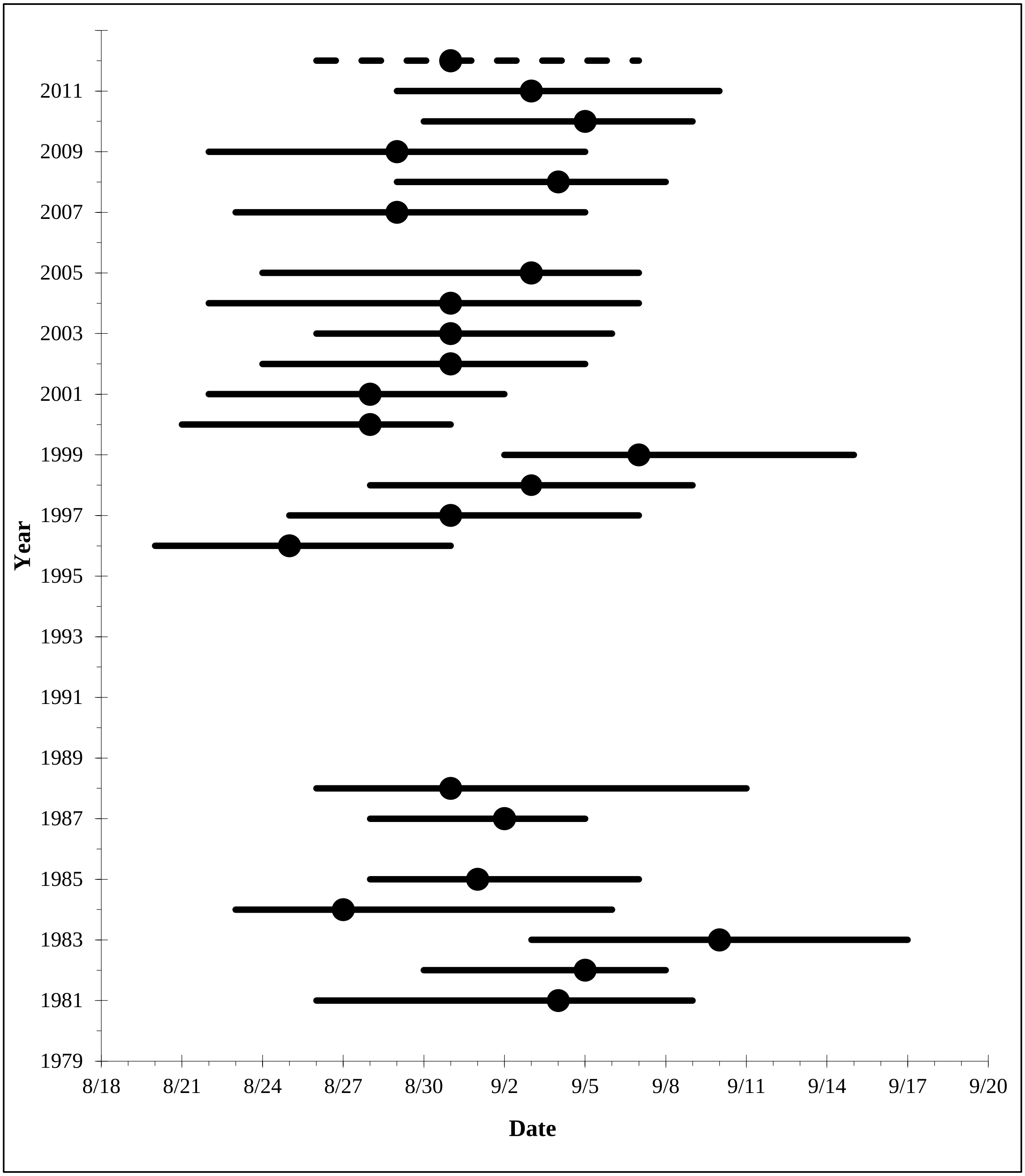
Note: Years when sampling effort was not well distributed throughout the run were omitted. Years when annual escapement consisted of greater than 20% estimated passage are delineated with white squares. The dotted line represents the average of annual lengths, excluding years when more than 20% of the escapement was estimated.

Figure 12.–Historical mean annual lengths for chum salmon with 95% confidence intervals at the Kogrukluk River weir.



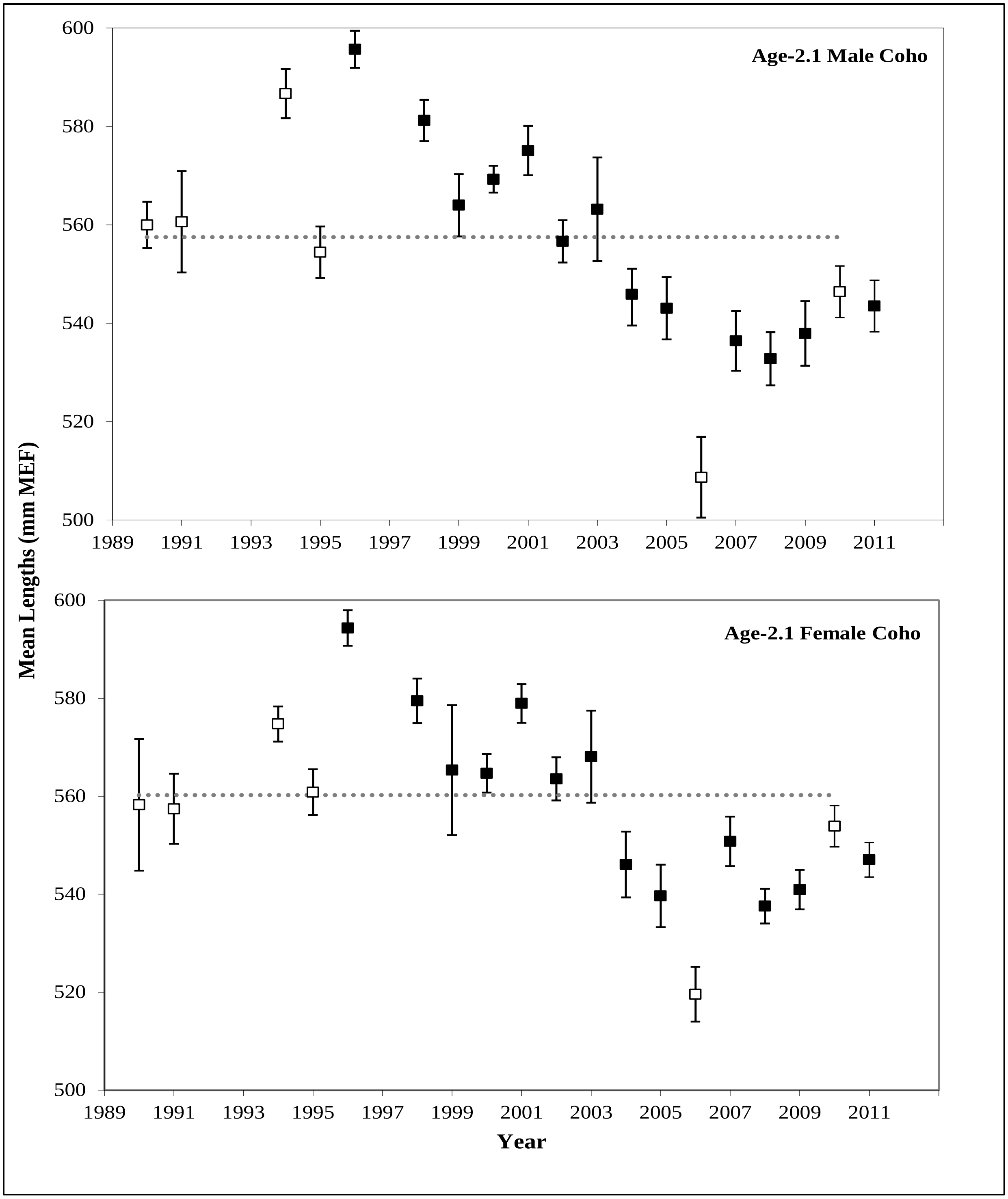
Note: Hatched bars represent years when more than 20% of the escapement was calculated through estimation methods. Historical median does not include years when more than 20% of the escapement was estimated.

Figure 13.–Historical coho salmon escapement with respect to the current escapement goal range and historical median escapement at the Kogrukluk River weir.



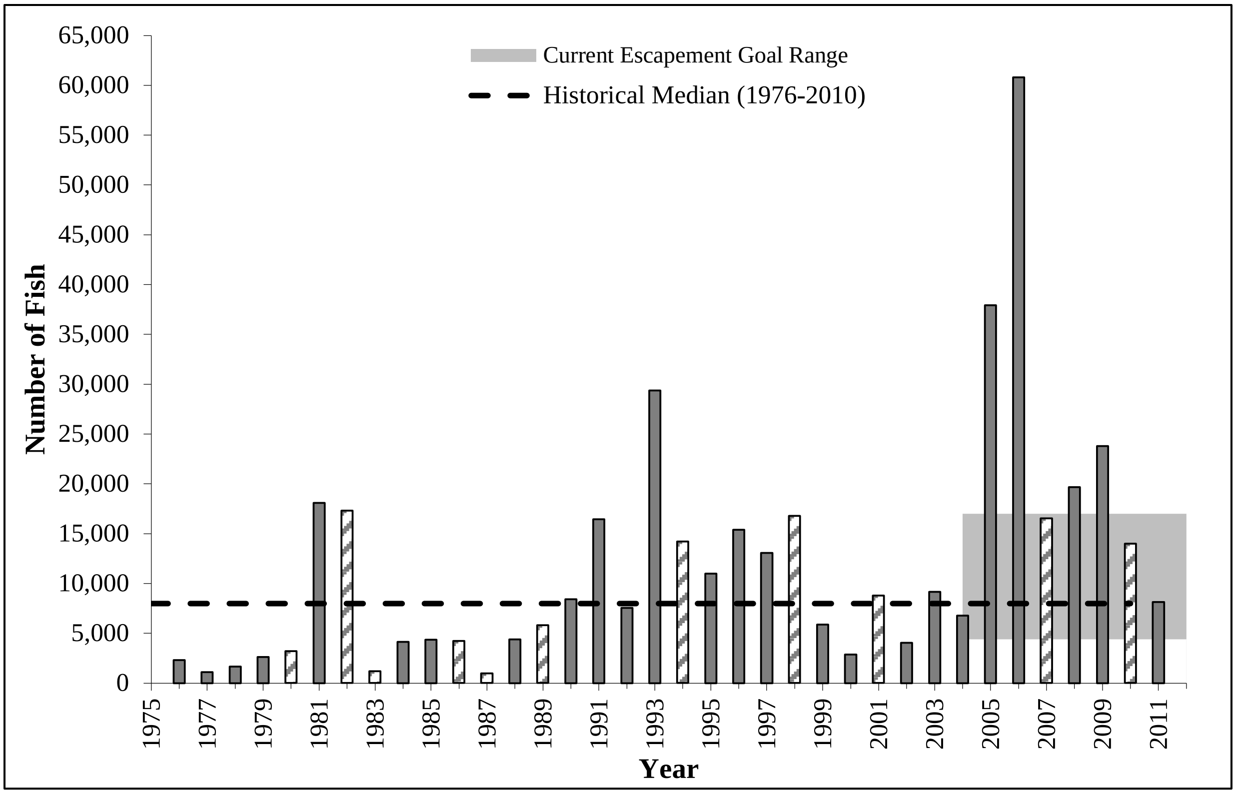
Note: Solid black lines represent the dates when the central 50% of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. The dashed line represents the median of graphed years' passage dates.

Figure 14.–Historical annual run timing of coho salmon based on cumulative percent passage the Kogrukluk River weir, 1981–2011.



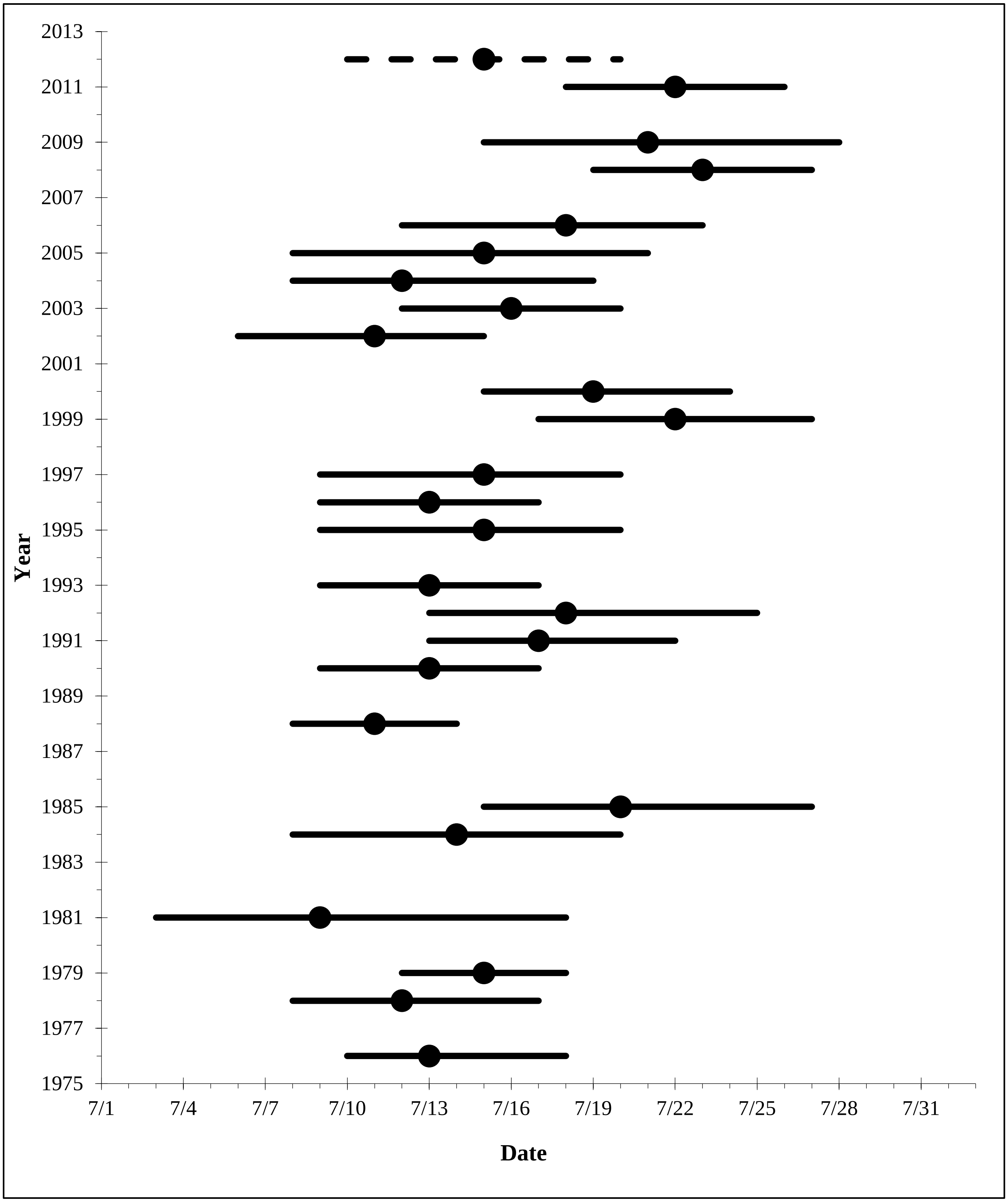
Note: Years when sampling effort was not well distributed throughout the run were omitted. Years when annual escapement consisted of greater than 20% estimated passage are delineated with white squares. The dotted line represents the average of annual lengths, excluding years when more than 20% of the escapement was estimated.

Figure 15.–Historical mean annual lengths for coho salmon with 95% confidence intervals at the Kogrukluk River weir.



Note: Hatched bars represent years when more than 20% of the escapement was calculated through estimation methods. Historical median does not include years when more than 20% of the escapement was estimated.

Figure 16.–Historical sockeye salmon escapement with respect to the current escapement goal range and historical median escapement at the Kogrukluk River weir.



Note: Solid black lines represent the dates when the central 50% of annual escapement passed in years with at least 80% observed passage. Circles represent median passage dates. The dashed line represents the median of graphed years' passage dates.

Figure 17.–Historical annual run timing of sockeye salmon based on cumulative percent passage at the Kogrukluk River weir, 1976–2011.

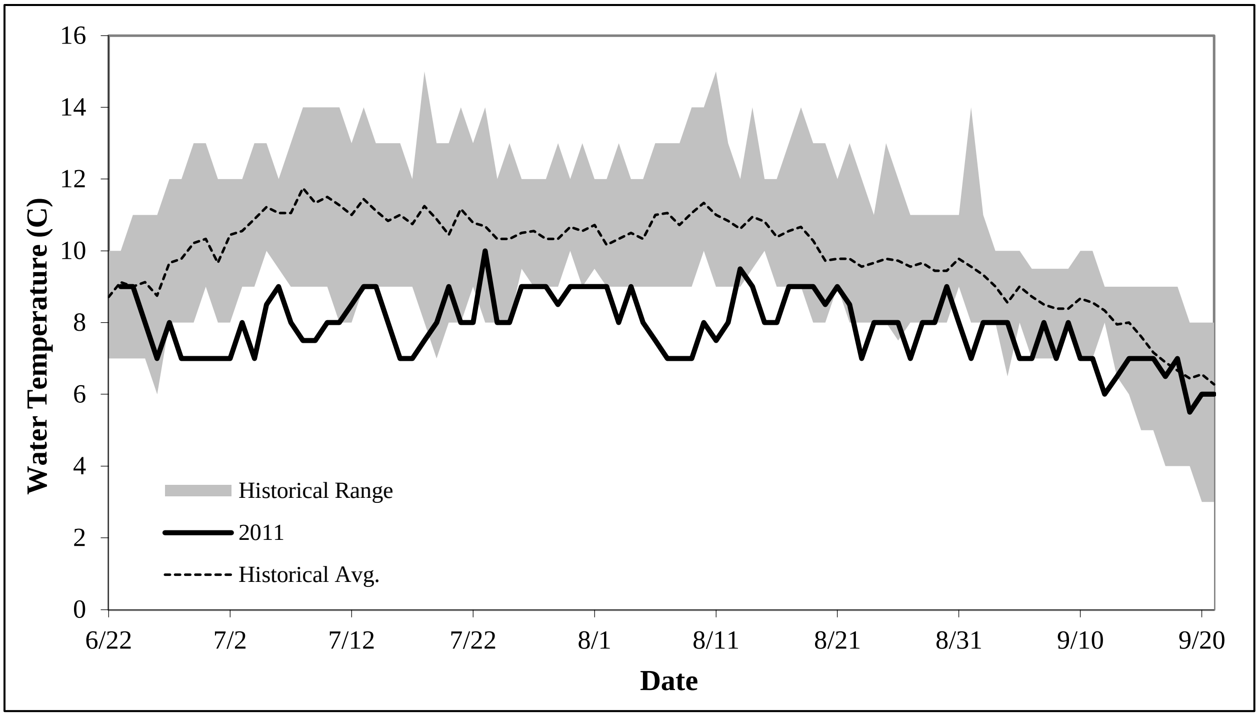


Figure 18.–Daily morning water temperature at the Kogrukluk River weir in 2011 relative to historical average, minimum, and maximum morning readings, 2002–2010.

APPENDIX A: DAILY PASSAGE COUNTS

Appendix A1.–Daily passage counts by species at the Kogrukluk River weir, 2011.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly	
Date	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Varden[a]	Other[b]
6/21	0	0	0	0	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0	0	0	1	0
6/23	0	0	0	0	3	0	0	0	0	0	0	0
6/24 [c]	0	0	0	0	0	0	0	0	0	0	0	0
6/25 [c]	0	0	0	0	1	1	0	0	0	0	0	0
6/26	0	0	0	0	2	3	0	0	0	0	2	0
6/27	0	0	0	0	7	8	0	0	0	0	1	0
6/28	0	0	0	0	11	12	0	0	0	0	1	0
6/29	6	7	1	0	11	18	0	0	0	0	0	0
6/30	4	6	0	0	19	26	0	0	0	0	0	0
7/1	8	3	1	1	14	20	0	0	0	0	0	0
7/2	19	6	0	3	35	26	0	0	0	0	0	0
7/3	5	2	0	1	38	39	0	0	0	0	2	0
7/4	7	1	1	2	58	42	0	0	0	0	0	0
7/5	11	2	3	7	87	62	0	0	0	0	1	0
7/6	6	4	1	0	151	103	0	0	0	0	2	0
7/7	6	0	1	1	141	72	0	0	0	0	0	0
7/8	15	3	3	6	270	155	0	0	0	0	2	0
7/9	30	20	9	28	460	227	0	0	0	0	1	0
7/10	138	27	51	132	669	405	0	0	0	0	1	0
7/11	102	18	33	71	765	453	0	0	0	0	4	0
7/12 [c]	37	13	27	42	309	156	0	0	0	0	0	0
7/13 [c]	12	1	16	21	195	105	0	0	0	0	0	0
7/14	126	18	98	160	1,168	633	0	0	0	0	1	0
7/15	54	4	61	82	1,086	632	1	0	0	0	0	0
7/16 [c]	134	85	87	119	755	399	0	0	0	0	1	0
7/17	234	54	114	152	1,792	1,243	0	0	0	0	2	0
7/18	332	79	214	267	1,985	1,357	1	0	0	0	1	0
7/19	276	115	330	426	2,220	1,498	2	0	0	0	0	0
7/20	269	73	270	354	2,349	1,784	3	0	0	0	3	0
7/21	189	78	146	194	2,117	1,605	4	0	0	0	0	0
7/22	451	112	291	428	2,395	2,014	9	4	0	0	1	1 WF
7/23	228	91	187	256	1,852	1,496	8	0	0	0	0	0
7/24	220	65	160	181	2,236	1,788	13	2	0	0	0	0
7/25	338	114	221	251	1,669	1,314	5	2	0	0	1	0
7/26	304	109	215	318	1,721	1,376	11	2	0	0	2	0
7/27	227	76	160	253	1,844	1,367	7	1	0	0	2	0

-continued-

Appendix A1.–Page 2 of 3.

Date	Chinook Salmon Male	Chinook Salmon Female	Sockeye Salmon Male	Sockeye Salmon Female	Chum Salmon Male	Chum Salmon Female	Pink Salmon Male	Pink Salmon Female	Coho Salmon Male	Coho Salmon Female	Dolly Varden[a]	Other[b]
7/28	178	52	130	148	1,862	1,338	2	0	2	2	7	0
7/29	200	85	99	137	1,988	1,520	5	0	2	1	1	0
7/30	74	21	49	58	928	695	3	1	1	0	5	0
7/31	61	11	44	42	1,033	764	2	0	1	0	1	0
8/1	82	34	57	65	1,210	977	3	0	3	1	5	0
8/2	70	40	48	51	1,129	937	3	0	2	0	3	0
8/3	121	66	41	46	1,217	969	0	0	8	1	0	0
8/4[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/5[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/6[c]	11	1	4	1	101	102	0	0	2	3	2	0
8/7	23	3	4	7	323	229	0	0	7	9	2	0
8/8	28	0	7	12	188	122	0	0	8	9	1	0
8/9	40	5	9	11	259	154	0	0	23	10	1	0
8/10	42	2	11	9	254	196	1	0	13	9	5	0
8/11	42	6	9	14	194	142	1	0	23	20	4	0
8/12[c]	23	1	3	1	62	63	0	0	6	5	3	0
8/13[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/14[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/15[c]	9	0	1	3	10	16	0	0	24	38	1	0
8/16	13	0	3	2	37	38	0	0	99	66	26	1 WF
8/17	20	0	1	2	44	72	0	0	74	45	20	1 WF
8/18	7	1	2	1	41	48	0	0	62	55	25	0
8/19	2	0	1	1	32	38	0	0	94	78	41	2 WF
8/20[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/21[c]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/22[c]	2	0	0	0	3	3	0	0	68	50	1	0
8/23	0	0	1	1	8	12	0	0	207	188	38	0
8/24	0	0	2	0	7	8	0	0	161	115	39	2 WF
8/25	2	0	0	1	6	7	0	0	279	206	71	11 WF
8/26	1	0	0	0	10	9	0	0	452	352	48	2 WF
8/27	0	0	0	0	5	7	0	0	311	234	43	1 WF
8/28	0	0	2	0	0	1	0	0	571	480	70	0
8/29	0	0	0	0	2	2	0	0	466	417	45	2 WF
8/30	0	0	0	0	1	0	0	0	486	390	45	2 WF
8/31	0	0	0	0	2	0	0	0	806	708	58	3 WF

-continued-

Appendix A1.–Page 3 of 3.

Date	Chinook Salmon		Sockeye Salmon		Chum Salmon		Pink Salmon		Coho Salmon		Dolly Varden[a]	Other[b]
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		
9/1	0	0	0	0	4	1	0	0	740	693	34	5 WF
9/2	0	0	0	1	0	0	0	0	694	637	25	7 WF
9/3	0	0	0	0	1	0	0	0	475	494	13	0
9/4	0	0	0	1	0	1	0	0	540	616	25	7 WF
9/5	0	0	0	0	0	0	0	0	539	576	15	3 WF
9/6	0	0	0	0	1	0	0	0	386	374	13	3 WF
9/7	0	0	1	1	0	3	0	0	343	399	14	3 WF
9/8	0	0	0	0	0	0	0	0	332	470	15	8 WF
9/9	0	0	0	0	0	1	0	0	291	442	13	6 WF
9/10	1	0	2	0	1	0	0	0	325	432	8	6 WF
9/11	0	0	1	0	1	1	0	0	284	371	11	8 WF
9/12	0	0	0	0	0	0	0	0	196	265	9	5 WF
9/13	0	0	2	0	2	1	0	0	194	288	4	3 WF
9/14	0	0	0	0	2	1	0	0	228	420	12	10 WF
9/15[c]	0	0	0	1	1	2	0	0	87	193	6	3 WF
Total	4,840	1,514	3,235	4,373	39,404	28,919	84	12	9,915	10,162	860	105

[a] Counts represent sexually mature fish only.

[b] WF = White Fish.

[c] Incomplete or partial daily count.

APPENDIX B: CARCASS COUNTS

Appendix B1.–Daily carcass counts at the Kogrukluk River weir, 2011.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Dolly Varden	White-fish	Other[a]
6/21	ND	ND	ND	ND	ND	ND	ND	ND
6/22	ND	ND	ND	ND	ND	ND	ND	ND
6/23	0	0	0	0	0	0	0	0
6/24[b]	0	0	0	0	0	0	0	0
6/25[b]	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	ND	ND	ND	ND	ND	ND	ND	ND
6/30	0	0	0	0	0	0	1	0
7/1	ND	ND	ND	ND	ND	ND	ND	ND
7/2	0	0	0	0	0	0	0	1 AG
7/3	0	0	1	0	0	0	0	0
7/4	0	0	1	0	0	0	0	0
7/5	0	0	1	0	0	0	0	0
7/6	0	0	0	0	0	0	1	0
7/7	0	0	0	0	0	0	0	0
7/8	0	0	0	0	0	0	0	0
7/9	0	0	1	0	0	0	0	0
7/10	0	0	6	0	0	0	0	0
7/11	0	0	5	0	0	0	0	0
7/12	0	0	8	0	0	0	0	0
7/13[b]	0	0	5	0	0	0	0	0
7/14[b]	0	0	5	0	0	0	0	0
7/15	ND	ND	ND	ND	ND	ND	ND	ND
7/16[b]	0	0	5	0	0	0	0	0
7/17	0	0	15	0	0	0	0	0
7/18	0	0	15	0	0	0	0	0
7/19	0	0	13	0	0	0	0	0
7/20	0	0	64	0	0	0	0	0
7/21	0	0	38	0	0	0	0	0
7/22	0	0	74	0	0	0	0	0
7/23	0	0	76	0	0	0	0	0
7/24	0	1	107	0	0	0	0	0
7/25	0	0	205	0	0	0	0	0
7/26	0	0	214	0	0	0	0	0
7/27	1	0	261	0	0	0	0	0
7/28	0	0	346	1	0	0	0	0
7/29	2	0	372	0	0	0	0	0
7/30	2	0	464	1	0	0	0	0
7/31	2	0	457	0	0	0	0	0
8/1	4	1	542	2	0	0	0	1 AG
8/2	5	0	687	1	0	0	0	0
8/3	13	6	1145	2	0	0	0	0
8/4[b]	20	3	903	1	0	1	0	0
8/5[b]	12	0	443	1	0	0	0	0

-continued-

Appendix B1.–Page 2 of 2.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Dolly Varden	White-fish	Other[a]
8/6[b]	8	0	285	2	0	0	0	0
8/7	59	9	547	2	0	1	1	1 AG
8/8	94	1	468	3	0	1	0	0
8/9	140	7	738	4	0	0	0	0
8/10	91	5	399	0	0	0	0	0
8/11	197	9	629	2	0	0	0	0
8/12[b]	178	14	581	2	0	2	1	0
8/13[b]	82	3	227	0	0	1	0	0
8/14[b]	16	3	82	0	0	0	0	0
8/15[b]	28	6	199	0	0	0	0	0
8/16	155	22	509	2	0	0	0	0
8/17	107	43	158	0	0	0	0	0
8/18	104	33	149	1	0	0	1	0
8/19	99	75	180	0	0	0	0	0
8/20	7	9	28	0	0	0	0	1 NP
8/21	ND	ND	ND	ND	ND	ND	ND	ND
8/22	ND	ND	ND	ND	ND	ND	ND	ND
8/23	12	29	38	0	0	1	0	1 AG
8/24	14	20	30	0	0	0	0	0
8/25	17	49	51	0	0	0	0	0
8/26	12	49	48	0	0	0	1	0
8/27	4	48	33	0	0	0	0	0
8/28	6	33	23	0	0	0	0	0
8/29	5	24	16	0	1	0	0	1 AG
8/30	1	15	18	0	0	0	0	0
8/31	0	18	15	0	0	0	0	0
9/1	0	19	12	0	0	1	0	0
9/2	1	17	8	0	0	0	0	1 AG
9/3	0	15	8	0	0	0	0	0
9/4	0	9	3	0	0	0	2	0
9/5	ND	ND	ND	ND	ND	ND	ND	ND
9/6	ND	ND	ND	ND	ND	ND	ND	ND
9/7	1	9	7	0	0	1	4	0
9/8	ND	ND	ND	ND	ND	ND	ND	ND
9/9	0	13	2	0	0	0	0	0
9/10	0	7	0	0	0	1	2	0
9/11	ND	ND	ND	ND	ND	ND	ND	ND
9/12	0	5	2	0	0	1	1	1 NP
9/13	ND	ND	ND	ND	ND	ND	ND	ND
9/14	ND	ND	ND	ND	ND	ND	ND	ND
9/15[b]	1	4	8	0	0	0	1	0
Total	1,500	630	10,634	25	1	10	16	6AG, 2 NP

[a] AG = Arctic grayling; NP = Northern pike.

[b] Weir inoperable for all or part of the day.

APPENDIX C: WEATHER AND STREAM OBSERVATIONS

Appendix C1.–Daily weather and stream observations at the Kogrukluk River weir, 2011.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)[b]	Water Clarity[c]
6/21	1700	4	0.0	15	ND	302	1
6/22	0730	4	11.0	8	ND	302	1
	1700	3	2.0	13	9	304	1
6/23	0730	3	0.0	10	9	311	1
	1700	4	0.0	16	9	308	1
6/24	0730	4	0.0	11	9	303	1
	1700	4	0.0	16	8	302	1
6/25	0730	3	0.0	10	8	298	1
	1700	4	0.5	16	8	295	1
6/26	0730	3	0.0	10	7	293	1
	1700	4	0.0	16	9	293	1
6/27	0730	4	0.0	10	8	293	1
	1700	4	1.2	11	8	293	1
6/28	0730	4	1.3	9	7	303	1
	1700	4	0.6	12	7	307	1
6/29	0730	3	0.8	9	7	301	1
	1700	3	0.4	16	9	300	1
6/30	0730	3	0.0	9	7	295	1
	1700	4	0.0	16.5	9	294	1
7/1	0730	4	0.8	10	7	291	1
	1700	3	0.1	24	10.5	289	1
7/2	0730	3	0.0	10	7	289	1
	1700	3	0.0	19	10.5	288	1
7/3	0730	3	0.0	11	8	286	1
	1700	4	0.0	18	10.5	284	1
7/4	0730	2	6.8	9	7	285	1
	1700	3	0.0	19	11	286	1
7/5	0730	4	0.0	10	8.5	287	1
	1700	3	0.0	20	11	285	1
7/6	0730	4	0.0	9	9	283	1
	1700	4	0.0	15	10	281	1
7/7	0730	4	0.0	10	8	281	1
	1700	4	0.0	11.5	8	281	1
7/8	0730	4	1.2	9	7.5	278	1
	1700	4	0.0	15	9	280	1
7/9	0730	4	0.0	10	7.5	281	1
	1700	4	4.0	12	9	281	1
7/10	0730	4	3.8	9	8	286	1
	1700	4	1.2	14.5	9	295	1
7/11	0730	4	2.0	10	8	300	2
	1700	4	8.0	15	9	299	2
7/12	0730	3	6.2	9	8.5	302	2
	1700	2	0.0	20	11.5	309	2
7/13	0730	4	0.0	6	9	308	2
	1700	2	0.0	18	10	305	2
7/14	0730	4	0.0	10	9	299	2
	1700	3	0.5	16	9	295	2
7/15	0730	3	0.0	9	8	294	1
	1700	4	0.0	14	9	291	1
7/16	0730	1	2.4	4	7	291	1
	1700	3	0.5	18	10	288	1

-continued-

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)[b]	Water Clarity[c]
7/17	0730	4	0.0	10	7	287	1
	1700	3	9.0	16	9	287	1
7/18	0730	4	0.5	9	7.5	291	2
	1700	2	0.0	15	9	293	2
7/19	0730	4	0.0	7	8	288	1
	1700	1	0.0	20	11	286	1
7/20	0730	1	0.0	5	9	284	1
	1700	4	0.0	18	11	282	1
7/21	0730	4	8.2	10	8	283	1
	1700	4	0.0	16	9	283	1
7/22	0730	3	0.8	10	8	283	1
7/23	0730	4	0.6	11	10	280	1
	1700	4	3.6	15	10	280	1
7/24	1000	4	4.0	11	8	280	1
	1700	4	3.2	15	10	282	1
7/25	0730	3	2.0	9	8	284	2
	1700	4	0.0	19	10	288	2
7/26	0730	4	0.5	11	9	283	1
	1700	3	0.0	20	11	283	1
7/27	0730	3	1.0	6	9	282	1
	1700	3	0.0	20	11	281	1
7/28	0730	3	0.0	9	9	279	1
	1700	4	0.0	19	10.5	281	1
7/29	0730	2	0.4	10	8.5	278	1
	1700	3	0.0	18	11	280	1
7/30	0730	4	0.0	8	9	278	1
	1700	4	0.0	13	10	279	1
7/31	0730	4	0.0	10	9	276	1
	1700	4	0.0	13	10	278	1
8/1	0730	4	4.0	10	9	277	1
	1700	4	0.7	16	10	280	1
8/2	0730	4	3.4	10	9	277	1
	1700	4	8.2	14	9	282	1
8/3	0730	5	9.4	12	8	287	2
	1700	4	0.8	15	10	291	2
8/4	0730	4	2.8	10	9	302	3
	1700	3	1.8	14	10.5	295	3
8/5	0730	2	1.6	5	8	302	3
	1700	3	0.4	14	9.5	295	2
8/6	0730	4	0.0	7	7.5	291	2
	1700	4	1.8	14	8.5	286	1
8/7	0730	2	2.8	5	7	290	2
8/8	0730	3	5.6	6	7	290	1
	1700	4	4.2	10	9	287	1
8/9	0730	4	4.0	8	7	293	2
	1700	4	1.6	15	9	292	2
8/10	0730	3	2.0	10	8	296	2
	1700	4	0.0	15	9.5	291	2

-continued-

Appendix C1.–Page 3 of 4.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)[b]	Water Clarity[c]
8/11	0730	4	0.0	10	7.5	293	1
	1700	4	0.0	16	9	285	1
8/12	0730	4	20.0	11	8	291	1
	1700	4	1.0	17	10	293	2
8/13	0730	4	0.0	14	9.5	312	3
	1700	4	0.0	15	10	304	3
8/14	0730	4	0.0	11	9	297	3
	1700	4	1.8	13	10	296	2
8/15	0730	3	1.4	9	8	291	2
	1700	3	0.0	15	10	292	1
8/16	0730	2	0.0	5	8	291	1
	1700	4	0.6	19	10	288	1
8/17	0730	4	1.8	10	9	286	1
	1700	3	0.0	18	10	285	1
8/18	0730	3	0.2	9	9	283	1
	1700	4	0.0	18	10	282	1
8/19	0730	4	12.5	9	9	283	1
	1700	4	1.6	14	9	285	1
8/20	1000	5	5.8	12	8.5	307	3
	1700	4	0.2	17	10	314	3
8/21	1000	4	2.7	11	9	308	2
	1700	2	0.3	19	11	303	1
8/22	0730	4	0.0	5	8.5	298	1
	1700	3	0.0	14	10	295	1
8/23	0730	1	0.8	0.5	7	291	1
	1700	3	0.0	14	9	290	1
8/24	0730	4	0.0	9	8	288	1
	1700	4	1.4	11	8	286	1
8/25	0730	4	1.4	8	8	288	1
	1700	3	1.0	16	9	291	1
8/26	0730	5	1.2	5	8	298	1
	1700	4	0.0	18	9	300	1
8/27	0730	2	0.0	3	7	298	1
	1700	3	1.2	16	9	293	1
8/28	1000	2	11.0	8	8	292	1
	1700	3	0.0	20	9	293	1
8/29	0730	2	0.0	4	8	292	1
	1700	4	0.5	14	10	292	1
8/30	0730	4	1.8	9	9	291	1
	1700	4	0.0	10	9	291	1
8/31	0730	4	12.0	9	8	293	1
	1700	3	1.2	13	9	298	1
9/1	0730	4	0.1	6	7	304	1
	1700	4	1.8	11	8	300	1
9/2	0730	4	3.6	7	8	298	1
	1700	4	0.6	14	9	298	1
9/3	1000	3	1.5	9	8	296	1
	1700	4	2.4	14	9	294	1
9/4	1000	4	1.7	8	8	293	1
	1700	4	0.8	16	8	293	1
9/5	0730	4	4.7	6	7	293	1
	1700	3	0.0	17	8	295	1

-continued-

Appendix C1.–Page 4 of 4.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)[b]	Water Clarity[c]
9/6	0730	2	0.0	5	7	293	1
	1700	3	0.0	16	9	292	1
9/7	0730	4	0.0	7	8	289	1
	1700	4	0.0	13	8	287	1
9/8	0730	4	1.0	9	7	286	1
	1700	4	2.2	15	8	289	1
9/9	1000	4	0.3	10	8	297	1
	1700	4	2.0	13	9	298	1
9/10	1000	4	1.8	8	7	294	1
	1700	4	0.8	11	8	293	1
9/11	1000	4	0.4	8	7	290	1
	1700	4	0.0	13	8	289	1
9/12	1000	4	0.6	7	6	287	1
9/13	1000	4	1.8	8.5	6.5	287	1
	1700	4	1.4	11	8	288	1
9/14	1000	4	1.6	9	7	292	1
	1700	4	0.0	12	8	293	1
9/15	1000	4	2.4	7	7	307	2
	1700	4	0.6	10	8	306	2
9/16	1000	5	0.4	5	7	321	3
	1700	2	0.0	15	8	318	3
9/17	1000	3	0.0	5	6.5	307	2
	1700	3	0.0	16	8	306	2
9/18	1000	4	0.7	7	7	303	2
9/19	1000	5	0.7	2	5.5	299	2
	1700	4	0.0	12	8	297	2
9/20	1000	4	3.0	7	6	295	1
	1700	4	2.0	10	7	295	1
9/21	1000	4	1.8	7	6	297	1
	1700	4	1.2	10	7	297	1
		Mode	Total	Average[d]	Average[d]	Average[d]	Mode
Season Statistics		4	271.5	11.7	8.6	292	1

[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] 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 air temperature summary from Hobo® data logger at the Kogrukluk River weir, 2011.

Date	Temperature (^oC) Avg.	Max.	Min.
6/21	10.6	13.5	7.0
6/22	9.2	13.8	5.8
6/23	11.2	15.7	6.0
6/24	12.7	16.7	9.0
6/25	11.5	15.5	8.0
6/26	11.5	15.1	7.1
6/27	9.6	10.9	8.3
6/28	8.1	10.4	6.2
6/29	10.6	15.2	5.6
6/30	11.8	15.6	6.7
7/1	13.0	20.1	8.2
7/2	13.3	18.5	8.1
7/3	12.7	18.8	6.9
7/4	11.2	16.8	6.1
7/5	11.8	16.7	6.2
7/6	10.7	13.4	8.1
7/7	9.7	12.5	7.9
7/8	10.0	14.0	7.1
7/9	10.1	11.4	9.3
7/10	10.3	12.7	8.0
7/11	11.5	15.0	9.4
7/12	12.2	17.2	6.6
7/13	9.3	15.4	3.5
7/14	10.8	16.4	7.7
7/15	9.8	14.9	4.9
7/16	9.3	16.5	1.2
7/17	10.0	13.1	7.3
7/18	10.4	14.6	7.6
7/19	10.5	17.4	3.3
7/20	11.5	21.4	3.6
7/21	10.0	12.4	7.7
7/22	14.8	21.6	8.9
7/23	11.6	15.2	9.3
7/24	9.3	12.1	7.4
7/25	11.5	16.3	7.1
7/26	12.1	16.1	9.4
7/27	12.4	18.7	5.7
7/28	12.3	17.6	7.4
7/29	13.0	17.3	8.6
7/30	10.5	13.6	6.2
7/31	11.1	14.2	8.4
8/1	11.2	14.0	9.0
8/2	10.7	12.3	9.1
8/3	12.4	14.8	10.6
8/4	10.0	14.0	7.0
8/5	8.3	12.7	4.5
8/6	7.9	13.2	4.7
8/7	7.7	11.6	4.0
8/8	7.0	8.6	5.2
8/9	8.9	13.3	5.6
8/10	11.1	14.4	8.0
8/11	11.8	15.1	8.9
8/12	13.6	16.4	11.4
8/13	13.6	14.5	12.3
8/14	10.8	12.3	8.8
8/15	11.4	16.8	6.8
8/16	12.0	18.7	4.2
8/17	13.1	19.1	9.8
8/18	12.1	16.7	7.6
8/19	11.0	12.5	9.7
8/20	11.9	15.4	9.4
8/21	12.4	18.2	7.8
8/22	8.5	14.7	5.2
8/23	7.1	13.4	0.8
8/24	9.3	10.6	7.6
8/25	10.1	13.4	8.0
8/26	10.1	16.2	5.0
8/27	10.0	20.5	3.2
8/28	12.2	18.7	6.5
8/29	9.9	14.9	4.8
8/30	9.6	10.3	8.6
8/31	9.8	13.1	7.7
9/1	7.4	9.9	5.4
9/2	9.5	14.0	6.6
9/3	10.2	12.9	8.3
9/4	8.8	12.5	6.4
9/5	9.2	16.3	3.9
9/6	10.6	15.4	5.3
9/7	9.2	12.7	5.3
9/8	10.3	12.4	9.1
9/9	9.3	12.3	7.1
9/10	8.2	11.4	5.9
9/11	8.2	12.5	5.0
9/12	7.2	12.3	2.2
9/13	9.8	13.0	7.3
9/14	8.9	11.0	7.2
9/15	8.3	10.9	5.8
9/16	8.0	14.2	2.0
9/17	8.3	15.2	4.1
9/18	7.8	11.9	3.4
9/19	4.9	12.1	-0.7
9/20	7.3	9.6	5.4
9/21	7.1	10.8	4.7
Average	10.3	14.5	6.6
Minimum	4.9	8.6	-0.7
Maximum	14.8	21.6	12.3

-continued-

Appendix C3.–Daily stream temperature summary from Hobo® data logger at the Kogrukluk River weir, 2011.

	Temperature (^{o}C)		
Date	Avg.	Min.	Max.
6/21	7.7	7.0	8.2
6/22	7.9	7.0	8.9
6/23	8.5	7.9	9.1
6/24	8.3	7.6	8.9
6/25	8.0	7.4	8.6
6/26	8.0	7.2	8.7
6/27	7.7	7.5	8.4
6/28	7.1	6.6	7.5
6/29	7.9	6.7	9.2
6/30	8.7	8.2	9.1
7/1	8.9	7.5	10.5
7/2	9.8	8.6	10.8
7/3	10.0	9.2	10.6
7/4	9.8	8.5	10.9
7/5	10.0	8.9	11.2
7/6	9.4	8.8	10.5
7/7	8.2	7.8	9.0
7/8	8.0	7.4	9.1
7/9	8.5	8.1	8.9
7/10	8.2	7.8	8.7
7/11	8.3	8.0	8.7
7/12	9.7	8.5	11.4
7/13	9.6	9.0	11.0
7/14	9.0	8.3	10.0
7/15	9.1	8.4	9.7
7/16	8.6	7.3	10.1
7/17	8.8	8.4	9.8
7/18	8.2	7.5	9.1
7/19	8.8	7.5	10.3
7/20	9.8	8.5	10.8
7/21	9.1	8.7	10.0
7/22	9.3	8.0	11.0
7/23	9.9	9.2	10.8
7/24	8.8	8.2	9.4
7/25	8.9	7.9	9.9
7/26	9.6	8.9	10.6
7/27	9.9	8.7	11.1
7/28	9.7	8.9	10.5
7/29	9.9	8.7	11.0
7/30	9.6	9.2	10.6
7/31	9.0	8.4	9.6
8/1	9.1	8.3	9.8
8/2	9.0	8.7	9.4
8/3	9.2	8.5	9.9
8/4	9.6	8.7	10.6
8/5	9.3	8.6	9.9
8/6	8.2	7.6	9.3
8/7	7.9	7.2	8.4
8/8	7.5	7.2	8.0
8/9	7.8	6.7	9.2

-continued-

	Temperature (^{o}C)		
Date	Avg.	Min.	Max.
8/10	8.8	8.2	9.4
8/11	8.8	8.3	9.2
8/12	9.1	8.6	9.7
8/13	9.5	9.4	9.8
8/14	9.1	8.8	9.5
8/15	8.6	7.9	9.4
8/16	9.1	8.0	10.1
8/17	9.6	8.8	10.5
8/18	9.3	8.6	10.1
8/19	9.0	8.7	9.5
8/20	9.1	8.4	10.0
8/21	9.8	9.0	10.9
8/22	9.3	8.6	10.1
8/23	8.2	7.1	9.0
8/24	8.0	7.7	8.4
8/25	8.1	7.6	8.7
8/26	8.4	7.7	9.0
8/27	8.2	7.4	9.0
8/28	9.0	7.9	10.3
8/29	8.9	8.0	9.8
8/30	8.3	8.0	8.8
8/31	8.1	7.5	8.7
9/1	7.8	7.5	8.4
9/2	7.7	7.1	8.3
9/3	8.2	7.7	8.8
9/4	7.9	7.5	8.5
9/5	7.7	6.9	8.4
9/6	7.9	7.2	8.7
9/7	7.8	7.4	8.3
9/8	7.8	7.4	8.3
9/9	8.0	7.5	8.3
9/10	7.7	7.3	8.1
9/11	7.3	7.0	7.6
9/12	6.7	6.3	7.0
9/13	7.0	6.5	7.5
9/14	7.4	7.1	7.9
9/15	7.4	7.0	7.8
9/16	7.5	7.0	8.0
9/17	7.2	6.6	7.8
9/18	7.1	6.8	7.6
9/19	6.3	5.7	7.1
9/20	6.4	6.1	6.9
9/21	6.6	6.3	6.9
Average	8.5	7.9	9.3
Minimum	6.3	5.7	6.9
Maximum	10.0	9.4	11.4