Fishery Data Series No. 10-51

George River Salmon Studies, 2009

Annual Report for Study 08-303
USFWS Office of Subsistence Management
Fisheries Resource Monitoring Program

by

Joshua Clark,

J. Michael Thalhauser,

and

Christopher A. Shelden

July 2010

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 10-51

GEORGE RIVER SALMON STUDIES, 2009

by
Joshua Clark,
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

J. Michael Thalhauser
Kuskokwim Native Association, Aniak

and

Christopher A. Shelden
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

July 2010

Development and publication of this manuscript was partially financed by the USFWS Office of Subsistence Management (Project 08-303) Fisheries Resource Monitoring Program under FWS Agreement Number 701818J689. Matching funds were provided by the State of Alaska.

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.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Joshua Clark
joshua.clark@alaska.gov
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

J. Michael Thalhauser
mthalhauser@kuskokwim.org
Kuskokwim Native Association, P. O. Box 127, Aniak, AK 99557

Christopher A. Shelden
chris.shelden@alaska.gov
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

This document should be cited as:
Clark, J., J. M. Thalhauser, and C. A. Shelden. 2010. George River salmon studies, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 10-51, Anchorage.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

The George River is a major tributary of the Kuskokwim River and produces Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, sockeye *O. nerka,* and coho salmon *O. kisutch* which contribute to subsistence and commercial salmon fisheries of the Kuskokwim River. A weir has been operated annually on the George River since 1996, and is part of an array of projects used to monitor salmon escapement in the Kuskokwim River drainage. Salmon were enumerated by species as they migrated through the weir to determine daily and annual escapements. Samples were collected from fish as they migrated through the weir to estimate the age, sex, and length composition of escapements.

Operations were successful in 2009 and escapements of 3,663 Chinook, 7,941 chum, 54 sockeye, and 12,464 coho salmon were estimated at George River weir. Chinook salmon met the escapement goal range in 2009; chum salmon were below the historical median; and coho salmon escapements were above the historical median. Age and sex sampling in 2009 indicated the Chinook salmon escapement consisted of 52.0% age-1.4, 25.0% age-1.3, 21.1% age-1.2, 1.0% age-1.5, and 0.9% age-2.4 fish with 41.9% female fish. The chum salmon escapement consisted of 52.7% age-0.3, 30.6% age-0.4, 10.6% age- 0.2, and 6.1% age-0.5 fish. The coho salmon escapement consisted of 92.8% age-2.1, 5.6% age-3.1, and 1.6% age- 1.1 fish.

Key words: Escapement, George River, Kuskokwim River, Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, longnose suckers, *Catostomus catostomus*, ASL, age-sex-length, salmon age composition, salmon sex composition, salmon length composition, resistance board weir.

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). 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. The subsistence salmon fishery in the Kuskokwim Area is one of the largest in the state and remains a fundamental component of local culture. 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. Salmon contributing to these fisheries spawn and rear in nearly every tributary of the Kuskokwim River basin (Brown 1983; Buklis 1999; Coffing[1], 1991; Coffing et al. 2000; Smith and Dull 2008; Whitmore et al. 2008).

Since 1960, management of Kuskokwim River subsistence, commercial, and sport fisheries has been the responsibility of the Alaska Department of Fish and Game (ADF&G), though other agencies contribute to the process. Management authority for the subsistence fishery was broadened in October 1999 to include the federal government under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA). The U.S. Fish and Wildlife Service (USFWS) is the federal agency most involved within the Kuskokwim Area. In addition, numerous tribal groups are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. For years, these and other groups have combined their resources in an effort to achieve long-term sustainability of Kuskokwim River salmon.

In the state of Alaska, salmon management seeks to provide for sustainable fisheries by ensuring that adequate numbers of salmon escape to the spawning grounds each year (5 AAC 39.222).

---

[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.

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 that influence management decisions. Over time and with sufficient data, escapement goals can be developed as a means to gauge annual escapement. For much of ADF&G management history in the Kuskokwim Area, escapement monitoring has been limited to aerial surveys and two ground-based escapement monitoring projects.

This situation was improved when several additional projects were initiated in the mid to late 1990s, one of which was the George River weir. These data provided by the current array of projects have much greater utility for fisheries managers and have decreased their reliance on less precise aerial survey data. The George River weir is 1 of 3 that currently have escapement goals for Chinook salmon *O. tshawytscha*. Annual escapement monitoring in the George River provides escapement and abundance information required for effective management (Holmes and Burkett 1996; Molyneaux and Brannian 2006; Mundy 1998).

Salmon spawn in dozens of tributaries in the Kuskokwim drainage and the operation of only two 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, including the George River weir. 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, main-river 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 George River weir also serves as a platform for collecting information on habitat variables including water temperature, water chemistry, and stream discharge (water level), which may directly or indirectly influence salmon productivity and timing of salmon migrations (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

The George River drainage is located in the middle Kuskokwim River basin (Figure 1) and provides spawning and rearing habitat for Chinook, chum *O. keta*, and coho salmon *O. kisutch* (ADF&G 1998), which contribute to the subsistence, commercial, and sport fisheries of the Kuskokwim River. Smaller numbers of sockeye *O. nerka* and pink salmon *O. gorbuscha* also spawn in the George River. In addition to Pacific salmon, other species found throughout the system include: Arctic grayling *Thymallus arcticus*, various whitefishes *Coregonus* spp., *Stenodus leucichthys*, *Prosopium cylindraceum*, Dolly Varden *Salvelinus malma*, northern pike *Esox lucius*, longnose suckers *Catostomus catostomus*, lampreys *Lampetra* spp., slimy sculpin *Cottus cognatus*, burbot *Lota lota*, blackfish *Dallia pectoralis*, and nine-spine stickleback *Pungitius pungitius*.

The George River is popular for sport fishing, and the river is an access route for recreational and subsistence fishermen and hunters. Professional guide operations based within and outside the Kuskokwim Area use the George River as an angling and hunting destination for their clients. In 2000, the George River received some of the highest Chinook salmon sport fishing effort in the Middle Kuskokwim River area (Burr 2002).

Historically, the George River drainage has supported a relatively high level of mining activity. Since the early 1900s, several small to moderate size mining camps have operated intermittently in the middle and upper George River drainage (Brown 1983). Julian Creek, a small tributary of George River, has been the site of intermittent placer gold mining activity since the early 1900s. Mineral exploration continues at Julian Creek in association with the Donlin Creek project. Located in the Crooked Creek drainage adjacent to the George River, the Donlin Creek project is a proposed large-scale open-pit gold mine. If approved for development, construction could begin in the next few years. Anticipated development of the Donlin Creek Mine increases interest in local aquatic systems and highlights the need for baseline data collection specific to salmon population dynamics and habitat quality (such as water chemistry and hydrology). Development of the proposed Donlin Creek Mine will increase the local human population, which may increase the level of recreational and subsistence fishing activity in the George River. Therefore, escapement monitoring on the George River must continue to provide managers with the information necessary to maintain sustainable escapement levels while ensuring that all user groups have reasonable harvest opportunity.

The George River weir has been operated cooperatively by ADF&G and the Kuskokwim Native Association (KNA) staff since its inception in 1996. Project responsibilities are shared between ADF&G and KNA and both organizations make use of weir data. Generally, ADF&G leads efforts in data management, data analysis, and reporting while KNA leads in field operations and community outreach. The project also serves to promote local education and involvement in fisheries monitoring and to develop the capacity of KNA staff to engage effectively in salmon resource management. To this end, the George River weir crew annually comprises one locally hired KNA technician, one ADF&G technician, and several student interns from surrounding communities for a "hands-on" work experience.

OBJECTIVES

1. Determine daily and total escapements of Chinook, chum, sockeye, and coho salmon to George River from 15 June through 20 September.
2. Estimate the age, sex, and length (ASL) composition of Chinook, chum, and coho salmon escapements to George River such that 95% confidence intervals for age composition are no wider than ±10% (α=0.05 and d=0.10).
3. Monitor stream variables including daily water temperature and daily water level.
4. Facilitate other fisheries related projects in the Kuskokwim Area 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 Investigations*;
    b. Maintaining a stream gage and collecting discharge measurements to establish an in-stream flow reservation for the George River;

c. Installing and monitoring air and stream thermographs at George River weir as part of a broader *Temperature Monitoring* project;

d. Hosting local area high school students as part of a *Natural Resources Internship Program*.

METHODS

STUDY SITE

The George River originates in the northern Kuskokwim Mountains within the middle Kuskokwim River basin and flows south for approximately 120 km to its confluence with the Kuskokwim River (Figures 1 and 2). The river drains an area of approximately 3,558 km² of mostly upland spruce-hardwood forest. Major tributaries include the East, South, and North Forks, and Michigan and Beaver Creeks. White spruce and scattered birch or aspen are common on south-facing slopes, and black spruce is characteristic on northern exposures and poorly drained areas. The understory consists of spongy moss and low brush in poorly drained areas, grasses in well-drained areas, and willow and alder in open forest near timberline. At normal flow, the George River is stained due to organic leaching, limiting visibility to less than one meter.

The weir site is located at N61° 55.4' Latitude and W157° 41.9' Longitude, approximately 7 river kilometers (rkm) up the George River from its confluence with the Kuskokwim River and captures nearly all the salmon spawning habitat within the drainage (Figure 2). The weir has operated at this location since the project began in 1996. The river channel at this site is about 110 m wide and has a depth of about 1 m during normal summer flow. The substrate is composed mostly of gravel, with some sand and cobble. Discharge measurements taken at the site over the years have ranged between 16 and 149 m^3/s, with velocities reaching 0.6 and 1.3 m/s respectively in the thalweg. Discharge measurements have not been attempted during flood conditions.

WEIR DESIGN

Details of design and materials used to construct the weir are described in Tobin (1994) with panel modifications described by Stewart (2002). The George River resistance board weir was designed with a gap of 3.33 cm (1-5/16 in) between each picket. The weir was installed across the entire 110 m channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels covered the middle 100 m portion of the channel, and fixed weir materials extended the weir 5 m to each bank.

A live trap and skiff gate were installed within the deeper portion of the channel. The live trap was designed as the primary means of upstream fish passage. The trap could be easily configured to pass fish freely upstream, capture individual fish for tag recovery, or trap numerous fish for collection of ASL or genetic samples. The skiff gate allowed boat operators to pass with little or no involvement by the weir crew as the weight of a boat submerged the passage panels and allowed boats to pass over the weir. Boats with jet-drive engines were the most common and could pass up or downstream over the skiff gate after reducing their speed to 5 miles per hour or less. To accommodate downstream migration of longnose suckers and other non-salmon species, downstream passage chutes were installed into the weir.

ESCAPEMENT MONITORING

A target operational period, spanning most of the salmon runs, was used to provide for consistent comparisons of annual escapements among years. The target operational period for George River weir has been established as 15 June through 20 September, although actual operational dates may vary with stream conditions. Daily and total annual escapements consisted of the observed passage plus any estimated passage of Chinook, sockeye, chum, or coho salmon missed during the target operational period. Counts of all other species were reported simply as observed passage.

Passage Counts

Passage counts were conducted periodically during daylight hours. Substantial delays in fish passage occurred only at night or during ASL sampling. Crew members visually identified each fish as it passed upstream and recorded it by species on a multiple tally counter. Counting continued for a minimum of 1 hour, or until passage waned. This schedule was adjusted as needed to accommodate the migratory behavior and abundance of fish, or operational constraints such as reduced visibility in evening hours late in the season. Crew members recorded the total upstream fish count in a designated notebook and zeroed the tally counter after each counting session. At the end of each day, total daily and cumulative seasonal counts were copied to logbook forms. These counts were reported each morning to ADF&G staff in Bethel via single side band radio or satellite telephone.

Passage Estimates

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

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

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.

Carcass Counts

The weir was cleaned several times each day, typically after morning and late evening counts. Dead or spawned out live salmon that washed up on the weir, both referred to hereafter as carcasses, were counted by species and sex and passed downstream. Daily and cumulative carcass counts were copied to logbook forms.

AGE, SEX, AND LENGTH COMPOSITION

To estimate the age, sex, and length composition of annual 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 for age 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 George River weir is generally 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 salmon samples. A pulse sample is essentially random stratified sampling, where each instantaneous sample characterizes a large portion of the run (i.e., early, middle, and late). 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 7–10 days. The goal was to collect a minimum of one pulse sample from each third of the run.

The relatively low abundance of Chinook salmon at George River weir makes pulse sampling impractical. Instead, Chinook salmon sampling followed a daily collection schedule to distribute a sample size of 350 fish in proportion to expected run abundance. The daily sample collection schedule was based on historical passage data. 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. The trap included an entrance gate, holding pen and exit gate. Salmon were trapped by opening the entrance gate while the exit gate remained closed. The entrance doors to the trap could be arranged in a V-shape, or fyke, to prevent fish from easily escaping. The holding box was allowed to fill with fish until a reasonable number was inside. Crew members used a dip net to capture fish within the holding box. 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. 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 of tail (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 holding box was emptied.

Chinook salmon samples were often collected through "active sampling," which consisted of capturing and sampling Chinook salmon 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.

The completed gum cards and corresponding mark–sense forms were sent to the Bethel and/or Anchorage ADF&G offices for processing. Data were 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 Molyneaux et al. (2009).

Data Processing and Reporting

Samples were aged and processed by ADF&G staff in Bethel and Anchorage following procedures described by Molyneaux et al. (2009). 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.

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 (°C) below the water surface until the temperature reading stabilized. Air temperature was obtained by placing the thermometer in a shaded location until the temperature reading stabilized. 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. As in 2005–2008, water temperature readings were also obtained using a Hobo® Water Temp Pro V1[1] data logger installed at mid channel near the stream bottom. The data logger was programmed to record temperature every hour during the operational period. Records were retrieved at the end of the season and compared to temperatures measured manually using a thermometer.

Daily operations included recording river depth (stage height) as determined by a standardized staff gauge at approximately 1000 and 1700 hours. 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 to the datum plane by a semi-permanent benchmark (Stewart et. al. 2006).

---

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

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

The George River weir served as a recovery site for a basin-wide mark–recapture and radiotelemetry study entitled *Kuskokwim River Coho Salmon Investigations* funded by the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative. The live trap was used as the primary means of upstream fish passage. Whenever possible, tagged coho salmon observed passing through the weir's live trap were captured to recover tag information. A clear plastic viewing window was placed on the stream surface to improve visual identification of fish entering the trap. Recorded data 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. A secondary passage gate described in Costello et al. (2007) was employed during extreme low water conditions when fish showed reluctance to pass through the live trap.

Hydrologic Data for the George River

Statewide Aquatic Resources Coordination Unit (SARCU) initiated this project to collect accurate hydrologic data during annual salmon spawning migration in order to assess relationships between fish populations and flow dynamics, and provide baseline hydrologic data. Data may eventually be used to establish water rights for: 1) protecting fish and wildlife habitat, migration, and propagation; 2) recreation and parks; 3) navigation and transportation; and 4) sanitary and water quality (Estes 1996). The 2009 season was the fourth year of a 5-year study aimed at addressing temporal flow dynamics.

The George River weir crew installed an Aquistar stream gage (Instrumentation Northwest, Inc.) approximately 200 meters downstream of the weir (river right) on 17 June in 2009. The station was monitored throughout the season and removed on 28 September. Stream discharge was measured on 25 June, 30 July, and 22 September in 2009, representing 3 different water levels. A Price AA current-meter and top-setting wading rod were used following methods described by the U.S. Geological Survey (Rantz et al. 1982). Information collected for calculating discharge was recorded in the camp logbook. This data was transferred to SARCU along with the stream gage after the season.

Temperature Monitoring

The George River weir served as a monitoring site for the temperature monitoring project (USFWS, Office of Subsistence Management, Project No. 08-701). An OSM contractor provided the monitoring equipment for installation at the weir site. Two Hobo® Water Temp Pro V2 data loggers and two Hobo® Air Temperature R/H data loggers were installed at the beginning of the field season. The water temperature loggers were anchored to the stream bed near mid-channel using a number 68 Duckbill® anchor. The air temperature loggers were installed using a solar shield attached to a small spruce tree approximately 2 meters above ground level and 50 meters from the river. At the end of the field season, one water temperature logger and one air temperature logger were removed and the remaining temperature loggers were downloaded using the provided data shuttle and left to continue monitoring temperature. The removed temperature loggers and data shuttle were returned to the contractor for data management and reporting and logger maintenance, calibration, and storage.

High School Internship Program

Kuskokwim Native Association (KNA) recruited local area high school students to spend 1 or 2 weeks at various KNA fisheries projects including the George River weir. Students participated in passage counts, ASL sample collections, and weather and stream measurements under the supervision of project crew members. In addition, crew helped administer a curriculum of daily educational assignments and field activities. The curriculum was developed in consultation with Kuspuk School District (KSD) teachers and is a melding of the Alaska state high school science and math standards with lessons about fish biology and ecology, fisheries research, subsistence living, and fisheries management. Students were paid $250 per week if they successfully completed the internship. Detailed methods of the KNA Natural Resources Internship Program are described in Orabutt and Diehl (2006).

RESULTS

WEIR OPERATIONS

The George River weir operated from 15:30 hours on 17 June until 24:00 on 25 September in 2009, which spanned the majority of the target operational period (15 June until 20 September). The crew completed escapement passage counts for all but 4 days in 2009: June 15–16 (prior to installation), June 17 (partial day prior to installation), and August 20 (partial day count resulting from a hole in the weir). Missed escapement was estimated using the linear interpolation method previously detailed.

ESCAPEMENT MONITORING

Chinook Salmon

A total escapement of 3,663 Chinook salmon was estimated to have passed George River weir during the target operational period. Estimated passage during inoperable periods in 2009 was 0 fish. The first Chinook salmon was observed on 19 June, daily passage peaked at 421 fish on 7 July, and the last Chinook salmon was observed on 4 September. The median passage date was 11 July, with the central 50% of the passage occurring between 7 July and 14 July (Table 1).

Chum Salmon

A total escapement of 7,941 chum salmon was estimated to have passed George River weir during the target operational period. Estimated passage during inoperable periods in 2009 was 2 fish. The first chum salmon was observed on 17 June, daily passage peaked at 540 fish on 11 July, and the last chum salmon was observed on 15 September. The median passage date was 17 July, with the central 50% of the passage occurring between 11 and 24 July (Table 1).

Coho Salmon

A total escapement of 12,464 coho salmon to George River was estimated to have passed George River weir during target operational period. Estimated passage during inoperable periods in 2009 was 257 fish. The first coho salmon was observed on 26 July with daily passage peaking at 3,030 fish on 2 September, and the last coho salmon was observed on 25 September (the last day of operation). The median passage date was 28 August, with the central 50% of the run occurring between 19 August and 2 September (Table 1). An additional 109 coho salmon were counted after the end of the target operational period, 21 to 25 September (Appendix A1).

Other Species

A total escapement of 54 sockeye salmon was estimated to have passed George River weir during the target operational period in 2009. Peak daily passage of 5 fish occurred on 11 July. The median passage date was 23 July, with the central 50% of the run occurring between 17 July and 4 August (Table 1).

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. In 2009, 318 pink salmon were observed passing upstream of the George River weir. Passage peaked with 21 pink salmon on 11 and 29 July. The last fish was observed on 28 August. Other species observed passing upstream of the George River weir included 9,546 longnose suckers, 66 Arctic grayling, 3 Dolly Varden, 21 whitefish, and 4 northern pike in 2009 (Appendix A1). No estimates of missed passage were made for these species with the exception of sockeye salmon during inoperable periods.

Carcass Counts

A total of 769 salmon carcasses were recovered at the George River weir in 2009. Chum salmon were the most numerous (541) followed by Chinook salmon (111), pink salmon (105), coho salmon (10), and sockeye salmon (2). Females comprised 30.9% of chum salmon carcasses, 27.9% of Chinook salmon carcasses, 23.8% of pink salmon carcasses, and 20.0% of coho salmon carcasses. Non-salmon carcasses consisted of longnose sucker (130), whitefish (59), northern pike (9), arctic grayling (5), and Dolly Varden (1) (Appendix B1).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Samples were collected from 191 Chinook salmon between 30 June and 6 August. Of those, age was determined for 152 (80% of the total sample), or 4.2% of annual Chinook salmon escapement. Sample size and distribution resulted in 95% confidence intervals for age composition no wider than ±8.1% (within minimum sample size CI=±10.0%). The escapement was partitioned into 3 temporal strata based on sampling dates, with sample sizes of 38, 37, and 77 in the first, second, and third strata, respectively. The annual escapement was predominately age-1.4 (52.0%), -1.3 (25.0%), and -1.2 (21.1%), however, age-1.5 (1.0%) and age-2.4 (0.9%) individuals also contributed to the run. Age-1.2 fish were all males, age-1.3 fish were predominately males (82.0%), and age-1.4 fish were predominately females (68.2%). Females composed 41.9% of the total sample (Table 2). Length samples ranged between 406 mm and 949 mm and sample sizes ranged from 7 to 57 fish among predominant age-sex categories. Mean lengths of female Chinook salmon were 831 mm at age-1.3, and 842 mm at age-1.4. Mean lengths of male age-1.2, -1.3, and -1.4 fish were 529, 721, and 843 mm, respectively (Table 3).

Chum Salmon

Samples were collected from 732 chum salmon between 4 July and 16 August. Of those, age was determined for 690 (94% of the total sample), or 8.6% of chum salmon escapement (Tables 4 and 5). The escapement was partitioned into 4 temporal strata which contained sample sizes of 63, 115, 332, and 180, respectively (Table 4). Sample size and distribution was adequate to estimate annual age composition of the chum salmon escapement to the George River weir such that the 95% confidence intervals ranged no wider than ±5.2% (Table 4).

Escapement was predominately age-0.3 (52.7%) and age-0.4 (30.6%) fish. Minimal escapement occurred for age-0.2 (10.6%) and age-0.5 (6.1%) individuals. Females composed 50.0% of the chum salmon escapement (Table 4). Sampled fish ranged between 416 mm and 700 mm in length (Table 5).

Coho Salmon

Samples were collected from 608 coho salmon between 16 and 17 August. Of those, age was determined for 524 (86% of the total sample), or 4.2% of annual coho salmon escapement (Tables 6 and 7). The escapement was partitioned into 3 temporal strata containing 135, 209, and 180 samples respectively. Sample size and distribution was adequate for estimating annual age composition of the coho salmon escapement to the George River weir such that the 95% confidence intervals ranged no wider than ±2.2% (Table 6).

Escapement was predominately age-2.1 (92.8%). Minimal escapement occurred for age-1.1 (1.6%) and age-3.1 (5.6%) individuals. Females composed 44.7% of the coho salmon escapement (Table 6), and the ratio of females was higher at age-3.1 than at age-2.1. Sampled fish ranged between 413 mm and 659 mm in 2009 (Table 7).

Weather and Stream Observations

A total of 199 complete weather and stream observations were recorded between 15 June and 26 September. Based on twice-daily thermometer observations, water temperature at the weir ranged from 3°C to 18°C, with an average of 11.4°C. Air temperature at the weir ranged from 3°C to 28°C, with an average of 12.8°C (Appendix C1).

Related Fisheries Projects

Kuskokwim River Coho Salmon Investigations

The George River weir crew recovered 11 of 14 tags observed at the weir. Of those fish, 7 had anchor tags and 4 had radio tags. The fixed tracking station at the George River weir detected 6 coho salmon equipped with radio tags that passed upstream of the weir. 628 coho salmon were examined for adipose fin clips to determine tag retention. Final results of this study are anticipated by 2011 (Kevin Schaberg, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Hydrologic Data for the George River Project

A stream gage was deployed between 17 June and 28 September 2009 for the fourth year of a 5-year study. Stream discharge was measured at 3 varying water levels during the 2009 season in support of the George River stream gage project. Preliminary data are available from the SARCU. Results will be applied to an instream flow reservation once the study has been completed after 2010 (Jason Mouw, Wildlife Biologist, ADF&G, Anchorage; personal communication).

Temperature Monitoring

Results for temperature monitoring will be reported under USFWS, Office of Subsistence Management, Project No. 08-701.

DISCUSSION

OPERATIONS

Daily and total annual escapements were successfully determined for each of the target species at George River weir in 2009 (Table 1). Normal to low water contributed to successful weir operation throughout the season resulting in a minimal reliance on passage estimates (Figure 3). ASL composition was estimated successfully for each of the target species.

Chinook salmon ASL sampling was problematic due to a relatively low escapement throughout the season. Early in the season, Chinook were often hesitant to pass through the weir's live trap for long periods after sampling activity. This may have been due to conditions of high water clarity and fluctuating temperatures and water stage. Sampling was suspended on several occasions to facilitate passage through the weir's live trap (Table 2).

ESCAPEMENTS

Chinook Salmon

The escapement of Chinook salmon was within the escapement goal range of 3,100 to 7,900 fish for 2009 (Figure 4). Escapement goals were also met on the majority of other rivers within the Kuskokwim River drainage (Jeff Estensen, Area Management Biologist, Personal Communication, 2009). Escapement in 2009 represents a slight increase from 2008, but a general decline from the historically high levels of recent years. The run timing of 2009 Chinook salmon was similar to the historical median run timing; however 50% passage of the run occurred somewhat later than the historical median 50% of the passage (Figure 5).

Precision and accuracy objectives in estimating the ASL composition of total annual Chinook salmon escapement to George River were achieved in 2009. Although, optimal sample sizes were not obtained, ASL compositions for the George River are considered representative of a run with ideally obtained sample sizes. Samples were well distributed throughout the migration, and the 95% confidence interval for age composition in the total escapement was within ±10% (Table 2).

Relative to previous years at George River weir, age-1.3 and -1.5 were below historical median abundance. Age-1.2 was near typical historical median abundance, and age-1.4 was above historical median abundance (Figure 6). The estimated abundance of female Chinook salmon in 2009 was similar to previous years (Figure 7), while the overall abundance fell within the lower limits of the escapement goal range (Figure 4). A historical average sex ratio of 34% exists for female Chinook salmon. However, a strong predominantly female 1.4-age class and a weak 1.3-age class in which males were well below the age-1.3 historical median male abundance (1,008 fish) were contributors to a high female sex ratio of 42% in 2009 (Table 2). Positive effects on reproductive potential could occur, where the reproductive capacity of the 2009 escapement may have been greater than that of other years with similar total abundance.

Chum Salmon

The escapement of chum salmon in 2009 was below the historical median at George River weir (Figure 4). Tributary escapements throughout the Kuskokwim River drainage were lower in 2009 than most recent years. The chum salmon run timing at George River weir in 2009 showed a later than median arrival. The run was generally compressed, but mostly within the historical median passage period (Figure 5).

The objectives for estimating the ASL composition of annual chum salmon escapement to George River was achieved in 2009, and pulse samples were well distributed throughout the migration (Table 4). The percent of females in 2009 was similar to most of the previous years, which approximates 50%. Relative to previous years at George River weir, age-0.3 and age-0.4 abundance were below the historical median, while age-0.2 and age-0.5 approximated stronger escapements (Figure 6).

Coho Salmon

The escapement of coho salmon in 2009 was above the historical median at George River weir (Figure 4). Despite the low water levels present in 2009, coho salmon run timing was similar to historical median run timing (Figure 5).

The objective for estimating the ASL composition of annual coho salmon escapement to George River was achieved in 2009. Samples were well distributed and objectives for accuracy and precision were achieved (Table 6). The percent of females in 2009 was similar to most of the previous years, which approximates 50%.

Relative to previous years at George River weir, age-2.1 abundance was similar to the historical median and age-3.1 abundance was low in 2009 (Figure 6). Occasionally, age-3.1 will make up a sizeable proportion of the run; this however was not the case in 2009.

Other Species

The escapement of sockeye salmon in 2009 is near the average for all years since 1999. Most of the George River sockeye salmon passage occurred in the last half of July in 2009 (Table 1), which is earlier than most years (Stewart et al. 2009).

Sockeye salmon are not a major component of salmon runs to the George River, but our project provides a convenient opportunity to monitor their abundance. The weir was operable the entire season, thus counts of this species represent a census of their escapement past the weir. It is unclear to what extent these fish represent a distinct George River spawning population or stray from nearby populations.

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 George River weir, but their abundance has historically been low and counts are incomplete. 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). Continued monitoring would improve understanding of this species' run dynamics and importance to the George River ecosystem.

Of the non-salmon species that occur in the George River, longnose suckers are historically the most abundant. As many as 15,808 have been counted passing upstream in previous years, with 9,546 counted in 2009. However, annual enumeration of longnose suckers is incomplete because smaller individuals may be able to pass freely between pickets and upstream migration appears to start before weir operations typically begin. The numbers of non-salmon species counted through the weir in 2009 were not unusual.

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 B1). The "sucker chutes" that are installed to facilitate downstream passage of non-salmon species provide a pathway for post-spawning salmon (post-spawners) to pass downstream. Weak or dead salmon are commonly observed washing over these chutes and daily carcass counts have historically shown a noticeable decrease following chute installation. No attempt was made to estimate the number of carcasses that passed undetected over the sucker chutes. Additionally, the weir was removed long before most of the coho salmon had completed spawning, so the number of coho salmon carcasses counted on the weir greatly underestimates the number of post-spawners that drifted past the weir site.

WEATHER AND STREAM OBSERVATIONS

Water temperature was generally above the historical average at George River weir in 2009 (Figure 8). Run timing seemed unaffected by temperature, except during the short cold spell during June followed by a jump to higher temperatures in early July. This period of cooler temperatures may have been responsible for the later than median start of Chinook escapement, though it is difficult to estimate with certainty (Figure 5). River stage was below the historical average for the vast majority of the season, with record lows present in mid September (Figure 3); this did not appear to affect run timing.

CONCLUSIONS

- Daily and total annual escapements were successfully estimated for each of the target species at George River weir in 2009.
- Estimates were calculated for two full days and one partial day prior to weir installation, and for one partial day within the normal operation of the weir in 2009.
- Chinook salmon escapement was within the escapement goal range for 2009, while chum salmon were below the historical median, and coho salmon were above the historical median escapement level.
- The abundance of Chinook salmon for age-1.3 and -1.5 were below historical median abundance, age-1.2 was near the historical median abundance, and age- 1.4 was above the historical median abundance in 2009.
- The high abundance of age-1.4 Chinook salmon corresponded to high abundance of females for George River.
- The overall escapement of Chinook salmon was slightly lower than many previous years, however the female sex ratio was higher than average. This suggests a higher reproductive potential.
- The abundances of age-0.3 and age-0.4 chum salmon in 2009 were below their historical medians at George River Weir.
- Record low river stage in the George River was observed in September of 2009.

ACKNOWLEDGEMENTS

The salmon escapement monitoring program on the George River is a cooperative project operated by the Kuskokwim Native Association (KNA) and the Alaska Department of Fish and Game (ADF&G), Division of Commercial Fisheries. The USFWS Office of Subsistence Management (OSM) provided $158,982 in funding support for this project through the Fisheries Resource Monitoring Program under FWS Agreement Number 701818J689. Matching support for this grant was provided by the State of Alaska. Additional funding was provided by Coastal Villages Region Fund. In addition, other groups such as the Kuskokwim Corporation and the Sport Fish Division of ADF&G have provided in-kind support to the project in the form of free land-use for camp facilities, weir fabrication, and welding services. General Fund support from ADF&G included assistance from staff biologists, fish and wildlife technicians who served as crew, and some operational costs. USFWS OSM Resource Monitoring Program under FWS Agreement Number 701817J646 funded project FIS 07-303 which supported salmon age, sex, and length data analysis for this project among others.

Many individuals contributed to the operation of the George River weir in 2009. Thanks to Doug Molyneaux and Ashley Fairbanks of ADF&G, Melissa Smith, Carrie Hackett, Seraphim Ukatish, and Tamara Sakar of KNA deserve credit for assisting with administrative needs and logistical support. Our greatest appreciation goes to crew members Stephanie Warnement, Glen Lindsey, and Micah Sanguinetti who performed the bulk of the field work. We especially thank the Vanderpool family of Georgetown for sharing their facilities in support of this project and providing the weir crew with many hours of Alaskan hospitality.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1998. Catalog of waters important for spawning, rearing or migration of anadromous fishes. Alaska Department of Fish and Game, Habitat Division, Juneau.

Brannian, L. K., M. J. Evenson, and J. R. Hilsinger. 2006a. 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, draft. 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.

Burr, J. M. 2002. Middle Kuskokwim Chinook angler survey, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 02-15, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds02-15.pdf

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, Juneau.

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, Final Project Report to U.S. Fish and Wildlife Service, Office of Subsistence Management, FIS 00-009, Juneau.

Costello, D. J., R. Stewart, D. B. Molyneaux, and D. E. Orabutt. 2007. Tatlawiksuk River salmon studies, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-56, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-56.pdf

Estes, C. C. 1996. Annual summary of instream flow reservations and protection in Alaska. Alaska Department of Fish and Game, Fishery Data Series No. 96-45, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds96-45.pdf

Geiger, G. J., and R. L. Wilbur. 1990. Proceedings of the 1990 Alaska stock separation workshop. 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. University of British Columbia Press, Vancouver, BC.

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.

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.

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, BC.

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

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., 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

REFERENCES CITED (Continued)

Molyneaux, D. B., A. R. Brodersen, and C. A. Shelden. 2009. Salmon age, sex, and length catalog for the Kuskokwim Area, 2008. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 09-06, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2009.06.pdf

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

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.

Orabutt, D., and D. A. Diehl. 2006. Natural Resource Internship Program. Federal Subsistence Fishery Monitoring Program, Annual Project Report No. FIS 04-309. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Information Services Division, Anchorage.

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

Rantz, S. E. and others 1982. Measurements and computation of streamflow: volume 1, measurements of stage and discharge. U.S. Geological Survey. Geological Survey Water-supply Paper 2175. Washington, D.C.

Smith, E. A., and B. S. Dull. 2008. Lower Kuskokwim River inseason subsistence salmon catch monitoring, 2007. Alaska Department of Fish and Game, Fishery Management Report No. 08-75, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fmr08-75.pdf

Stewart, R. 2002. Resistance board weir panel construction manual, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-21, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2002.21.pdf

Stewart, R. 2003. Techniques for installing a resistance board fish weir. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-26, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2003.26.pdf

Stewart, R., D. B. Molyneaux, D. J. Costello, and D. Orabutt. 2006. George River salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-29, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds06-29.pdf

Stewart, R., J. M. Thalhauser, and C. A. Shelden. 2009. George River salmon studies, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-70, Anchorage.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.

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/fmr08-25.pdf

TABLES AND FIGURES

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

	Chinook		Chum		Coho		Sockeye	
Date	Daily	%	Daily	%	Daily	%	Daily	%
6/15	0 [a]	0	0 [a]	0	0 [a]	0	0 [a]	0
6/16	0 [a]	0	0 [a]	0	0 [a]	0	0 [a]	0
6/17	0 [b]	0	1 [b]	0	0 [b]	0	0 [b]	0
6/18	0	0	1	0	0	0	0	0
6/19	2	0	5	0	0	0	0	0
6/20	3	0	4	0	0	0	0	0
6/21	1	0	11	0	0	0	0	0
6/22	0	0	1	0	0	0	0	0
6/23	0	0	1	0	0	0	0	0
6/24	3	0	4	0	0	0	0	0
6/25	1	0	6	0	0	0	0	0
6/26	6	0	25	1	0	0	0	0
6/27	3	1	1	1	0	0	0	0
6/28	1	1	8	1	0	0	0	0
6/29	3	1	20	1	0	0	0	0
6/30	31	1	27	1	0	0	0	0
7/1	140	5	76	2	0	0	0	0
7/2	22	6	66	3	0	0	0	0
7/3	45	7	103	5	0	0	0	0
7/4	55	9	217	7	0	0	0	0
7/5	310	17	240	10	0	0	0	0
7/6	209	23	237	13	0	0	0	0
7/7	421	34	165	15	0	0	0	0
7/8	118	38	131	17	0	0	0	0
7/9	203	43	262	20	0	0	0	0
7/10	116	46	255	24	0	0	0	0
7/11	252	**53**	540	30	0	0	5	9
7/12	317	62	365	35	0	0	2	13
7/13	358	72	223	38	0	0	0	13
7/14	248	78	533	44	0	0	5	22
7/15	95	81	151	46	0	0	0	22
7/16	57	82	239	49	0	0	1	24
7/17	87	85	220	**52**	0	0	3	30
7/18	75	87	286	56	0	0	2	33
7/19	86	89	285	59	0	0	0	33
7/20	44	90	396	64	0	0	1	35
7/21	24	91	268	68	0	0	2	39
7/22	43	92	249	71	0	0	2	43
7/23	62	94	233	74	0	0	4	**50**
7/24	15	94	153	76	0	0	0	50
7/25	12	95	149	78	0	0	0	50
7/26	34	96	205	80	1	0	2	54
7/27	6	96	146	82	1	0	1	56
7/28	31	97	187	84	1	0	0	56
7/29	40	98	243	87	5	0	3	61
7/30	3	98	92	89	6	0	1	63

-continued-

Table 1.–Page 2 of 3.

	Chinook		Chum		Coho		Sockeye	
Date	Daily	%	Daily	%	Daily	%	Daily	%
7/31	21	98	165	91	15	0	2	67
8/1	13	99	86	92	18	0	0	67
8/2	6	99	101	93	7	0	1	69
8/3	5	99	113	94	11	1	3	74
8/4	2	99	35	95	7	1	1	76
8/5	1	99	36	95	4	1	0	76
8/6	4	99	62	96	16	1	2	80
8/7	0	99	37	97	11	1	0	80
8/8	5	99	33	97	15	1	0	80
8/9	0	99	24	97	32	1	1	81
8/10	5	99	35	98	80	2	3	87
8/11	3	100	15	98	104	3	0	87
8/12	1	100	15	98	58	3	0	87
8/13	4	100	20	98	219	5	0	87
8/14	2	100	11	98	127	6	1	89
8/15	2	100	31	99	953	14	0	89
8/16	2	100	15	99	325	16	1	91
8/17	0	100	10	99	429	20	0	91
8/18	1	100	7	99	602	24	0	91
8/19	0	100	16	99	296	27	1	93
8/20	0 [c]	100	9 [c]	100	386 [c]	30	0 [c]	93
8/21	0	100	11	100	524	34	0	93
8/22	0	100	2	100	123	35	0	93
8/23	0	100	1	100	224	37	0	93
8/24	2	100	4	100	149	38	0	93
8/25	1	100	2	100	184	40	0	93
8/26	0	100	0	100	160	41	0	93
8/27	0	100	2	100	84	42	1	94
8/28	0	100	3	100	1,307	**52**	1	96
8/29	0	100	1	100	817	59	0	96
8/30	0	100	1	100	155	60	0	96
8/31	0	100	2	100	223	62	0	96
9/1	0	100	0	100	110	62	0	96
9/2	0	100	1	100	3,030	87	0	96
9/3	0	100	1	100	822	93	0	96
9/4	1	100	1	100	154	95	0	96
9/5	0	100	0	100	30	95	0	96
9/6	0	100	0	100	68	95	1	98
9/7	0	100	0	100	30	96	0	98
9/8	0	100	2	100	14	96	0	98
9/9	0	100	0	100	54	96	0	98
9/10	0	100	0	100	72	97	0	98
9/11	0	100	0	100	34	97	0	98
9/12	0	100	0	100	53	97	0	98
9/13	0	100	0	100	91	98	0	98
9/14	0	100	0	100	36	98	0	98
9/15	0	100	1	100	40	99	0	98

-continued-

Table 1.–Page 3 of 3.

Date	Chinook		Chum		Coho		Sockeye	
	Daily	%	Daily	%	Daily	%	Daily	%
9/16	0	100	0	100	28	99	0	98
9/17	0	100	0	100	31	99	0	98
9/18	0	100	0	100	32	100	0	98
9/19	0	100	0	100	19	100	1	100
9/20	0	100	0	100	37	100	0	100
Totals	3,663	100	7,941	100	12,464	100	54	100

Note: Elongated boxes delineate the central 50% of the run and the bold box delineates the median passage date.

[a] The weir was not operational; daily passage was estimated.

[b] Partial day count, passage was estimated.

[c] Daily passage was estimated due to the occurrence of a hole in the weir.

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

			Age Class																	
Sample Dates	Sample		1.1		1.2		2.2		1.3		1.4		2.3		1.5		2.4		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
6/30–7/3, 7/6	38	M	0	0.0	529	42.1	0	0.0	331	26.3	99	7.9	0	0.0	0	0.0	0	0.0	959	76.3
(6/15–7/7)		F	0	0.0	0	0.0	0	0.0	0	0.0	265	21.0	0	0.0	0	0.0	33	2.6	297	23.7
		Subtotal[a]	0	0.0	529	42.1	0	0.0	331	26.3	364	28.9	0	0.0	0	0.0	33	2.6	1,256	100.0
7/8–7/10, 7/13	37	M	0	0.0	147	10.8	0	0.0	258	18.9	221	16.2	0	0.0	0	0.0	0	0.0	627	45.9
(7/8–7/13)		F	0	0.0	0	0.0	0	0.0	111	8.1	590	43.3	0	0.0	37	2.7	0	0.0	737	54.1
		Subtotal[a]	0	0.0	147	10.8	0	0.0	369	27.0	811	59.5	0	0.0	37	2.7	0	0.0	1,364	100.0
7/14–8/6	77	M	0	0.0	95	9.1	0	0.0	163	15.6	284	27.3	0	0.0	0	0.0	0	0.0	542	51.9
(7/14–9/20)		F	0	0.0	0	0.0	0	0.0	54	5.2	447	42.8	0	0.0	0	0.0	0	0.0	501	48.1
		Subtotal[a]	0	0.0	95	9.1	0	0.0	217	20.8	731	70.1	0	0.0	0	0.0	0	0.0	1,043	100.0
Season[b]	152	M	0	0.0	771	21.1	0	0.0	751	20.5	605	16.5	0	0.0	0	0.0	0	0.0	2,127	58.1
		F	0	0.0	0	0.0	0	0.0	165	4.5	1,301	35.5	0	0.0	37	1.0	33	0.9	1,536	41.9
		Total	0	0.0	771	21.1	0	0.0	916	25.0	1,906	52.0	0	0.0	37	1.0	33	0.9	3,663	100.0
		95% C.I. (%)				(±6.8)				(±7.6)		(±8.1)				(±1.9)		(±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 George River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.2	1.3	1.4	2.3	1.5	2.4
6/30–7/3, 7/6 (6/15–7/7)	M	Mean Length	521	685	901			
		SE	20	17	27			
		Range	406–640	610–770	874–928			
		Sample Size	16	10	2	0	0	0
	F	Mean Length			844			865
		SE			27			-
		Range			710–949			865–865
		Sample Size	0	0	8	0	0	1
7/8, 7/10, 7/13 (7/8–7/13)	M	Mean Length	538	771	805			
		SE	31	35	15			
		Range	456–592	628–929	748–850			
		Sample Size	4	7	6	0	0	0
	F	Mean Length		824	842		906	
		SE		22	12		-	
		Range		783–857	768–941		906–906	
		Sample Size	0	3	16	0	1	0
7/14–8/6 (7/14–9/20)	M	Mean Length	558	716	852			
		SE	28	25	16			
		Range	465–664	582–842	705–961			
		Sample Size	7	12	19	0	0	0
	F	Mean Length		844	839			
		Std. Error		24	9			
		Range		790–901	724–940			
		Sample Size	0	4	33	0	0	0
Season[a]	M	Mean Length	529	721	843			
		SE[b]	14.87	14.94	10.08			
		Range	406–664	582–929	705–961			
		Sample Size	27	29	27	0	0	0
	F	Mean Length		831	842		906	865
		SE[b]			8.33		-	-
		Range		783–901	710–949		906–906	865–865
		Sample Size	0	7	57	0	1	1

[a] "Season" mean lengths are weighted by the escapement in each stratum.
[b] Standard error was not calculated for small samples.

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

			Age Class									
Sample Dates	Sample		0.2		0.3		0.4		0.5		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
7/4, 7/6, 7/10	63	M	88	3.2	484	17.4	660	23.8	220	7.9	1,452	52.4
(6/15–7/12)		F	44	1.6	748	27.0	484	17.5	44	1.6	1,320	47.6
		Subtotal[a]	132	4.8	1,232	44.4	1,144	41.3	264	9.5	2,772	100.0
7/13–7/15 7/17 7/20	115	M	163	7.0	507	21.8	365	15.6	122	5.2	1,156	49.6
(7/13-7/20)		F	162	6.9	710	30.4	284	12.2	20	0.9	1,177	50.4
		Subtotal[a]	325	13.9	1,217	52.2	649	27.8	142	6.1	2,333	100.0
7/21–7/28	332	M	122	6.3	609	31.6	215	11.1	29	1.5	974	50.6
(7/21–7/30)		F	151	7.9	539	28.0	226	11.8	35	1.8	951	49.4
		Subtotal[a]	273	14.2	1,148	59.6	441	22.9	64	3.3	1,925	100.0
8/1–8/16	180	M	50	5.6	228	25.0	96	10.6	15	1.7	390	42.8
(7/31–9/20)		F	66	7.2	359	39.4	96	10.5	0	0.0	521	57.2
		Subtotal[a]	116	12.8	587	64.4	192	21.1	15	1.7	911	100.0
Season[b]	690	M	423	5.3	1,828	23.0	1,336	16.8	386	4.9	3,972	50.0
		F	423	5.3	2,356	29.7	1,090	13.8	99	1.2	3,969	50.0
		Total	846	10.6	4,184	52.7	2,426	30.6	485	6.1	7,941	100.0
		95% C.I. (%)		(±2.7)		(±5.2)		(±5.0)		(±3.2)	-	-

[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 George 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
7/4, 7/6, 7/10 (6/15–7/12)	M	Mean Length	557	570	591	596
		SE	22	11	9	13
		Range	535-578	516-622	554-700	570-645
		Sample Size	2	11	15	5
	F	Mean Length	555	546	559	590
		SE	-	5	7	-
		Range	555-555	519-595	505-590	590-590
		Sample Size	1	17	11	1
7/13–7/15, 7/17, 7/20 (7/13–7/20)	M	Mean Length	510	559	551	572
		SE	11	6	7	13
		Range	473-557	494-633	511-605	515-603
		Sample Size	8	25	18	6
	F	Mean Length	511	526	516	614
		SE	9	5	7	
		Range	466-550	439-591	461-558	614-614
		Sample Size	8	35	14	1
7/21–7/28 (7/21–7/30)	M	Mean Length	525	550	562	552
		SE	7	4	4	10
		Range	454-597	431-653	505-611	517-573
		Sample Size	21	105	37	5
	F	Mean Length	487	526	528	535
		SE	5	3	5	9
		Range	428-548	416-626	442-593	510-566
		Sample Size	26	93	39	6
8/1–8/16 (7/31–9/20)	M	Mean Length	518	561	569	616
		SE	9	5	9	14
		Range	486-566	487-640	513-669	601-644
		Sample Size	10	45	19	3
	F	Mean Length	497	527	520	
		SE	7	3	6	
		Range	463-545	444-602	478-585	
		Sample Size	13	71	19	0
Season[a]	M	Mean Length	525	559	574	586
		SE[b]	6.36	3.47	4.98	8.22
		Range	454-597	431-653	505-700	515-645
		Sample Size	41	186	89	19
	F	Mean Length	505	533	538	576
		SE[b]	3.99	2.41	3.8	–
		Range	428-555	416-626	442-593	510-614
		Sample Size	48	216	83	8

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

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

Table 6.–Age and sex composition of coho salmon at the George 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.	%
8/16–17,8/20–22	135	M	33	0.8	2,950	67.4	97	2.2	3,079	70.4
(6/15–8/22)		F	32	0.7	1,167	26.7	97	2.2	1,297	29.6
		Subtotal[a]	65	1.5	4,117	94.1	194	4.4	4,376	100.0
8/27–9/1	209	M	33	1.0	1,584	46.4	65	1.9	1,682	49.3
(8/23–9/1)		F	49	1.4	1,584	46.4	98	2.9	1,731	50.7
		Subtotal[a]	82	2.4	3,168	92.8	163	4.8	3,413	100.0
9/9–17	180	M	0	0.0	1,974	42.2	156	3.3	2,130	45.6
(9/2–20)		F	52	1.1	2,311	49.5	182	3.9	2,545	54.4
		Subtotal[a]	52	1.1	4,285	91.7	338	7.2	4,675	100.0
Season[b]	524	M	65	0.5	6,508	52.2	318	2.6	6,891	55.3
		F	133	1.1	5,062	40.6	377	3.0	5,573	44.7
		Total	198	1.6	11,570	92.8	695	5.6	12,464	100.0
		95% C.I. (%)		(±1.1)		(±2.2)		(±2.0)		-

[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 George River weir in 2009 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/16–17, 8/20–22	M	Mean Length	538	533	576
(6/15–8/22)		SE	-	4	6
		Range	538-538	413-610	565-583
		Sample Size	1	91	3
	F	Mean Length	530	542	572
		SE	-	6	15
		Range	530-530	457-602	543-593
		Sample Size	1	36	3
8/27–9/1	M	Mean Length	536	544	518
(8/23–9/1)		SE	42	5	45
		Range	494-578	415-621	422-613
		Sample Size	2	97	4
	F	Mean Length	523	546	555
		SE	9	4	14
		Range	512-541	433-605	500-595
		Sample Size	3	97	6
9/9–9/17	M	Mean Length		574	571
(9/2–9/20)		SE		4	25
		Range		443-659	466-647
		Sample Size	0	76	6
	F	Mean Length	576	572	577
		SE	36	3	6
		Range	540-611	471-635	543-593
		Sample Size	2	89	7
Season[a]	M	Mean Length	537	548	562
		SE[b]		2.49	15.08
		Range	494-578	413-659	422-647
		Sample Size	3	264	13
	F	Mean Length	545	557	570
		SE[b]	13.99	2.58	6.03
		Range	512-611	433-635	500-595
		Sample Size	6	222	16

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

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

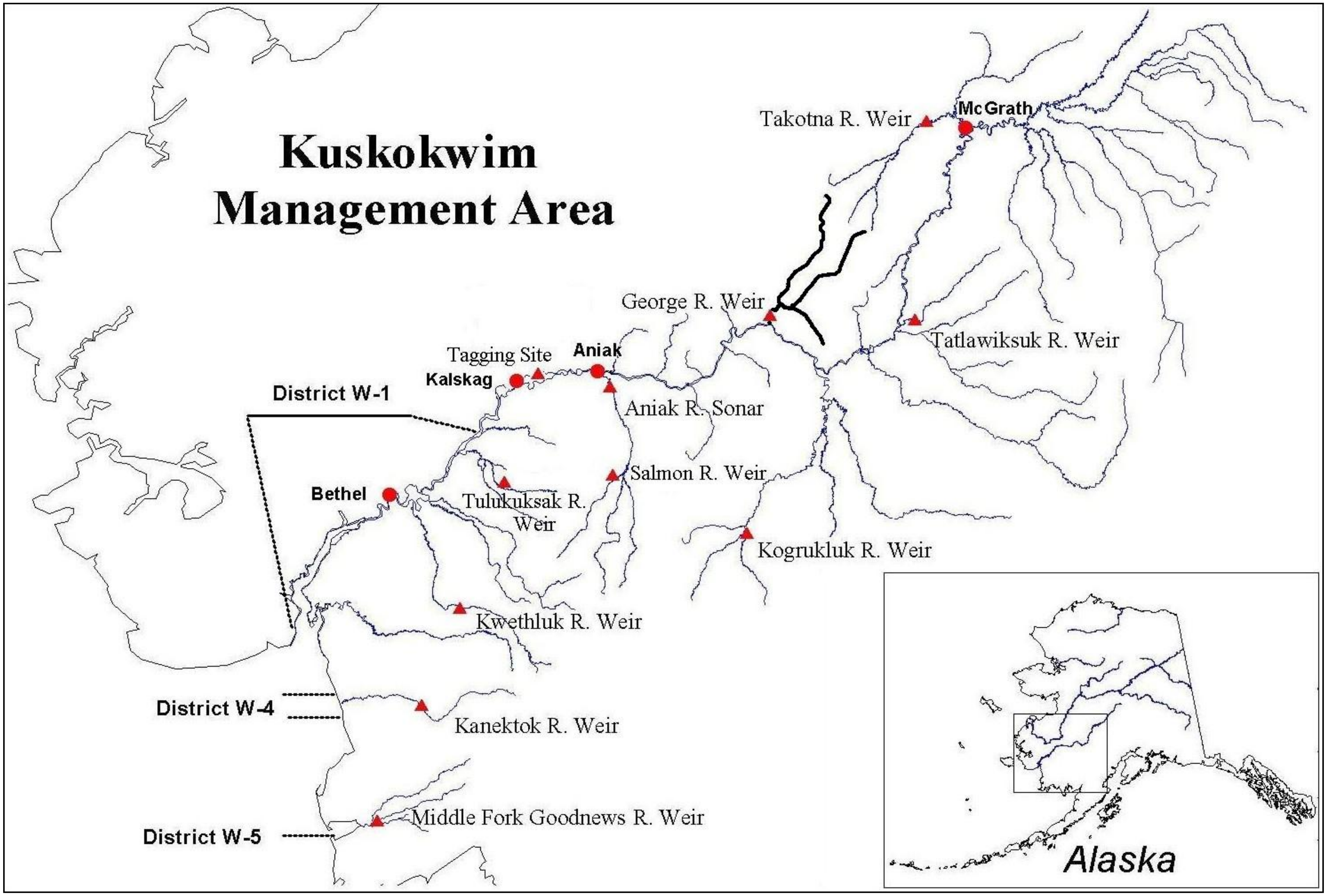


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the George River.

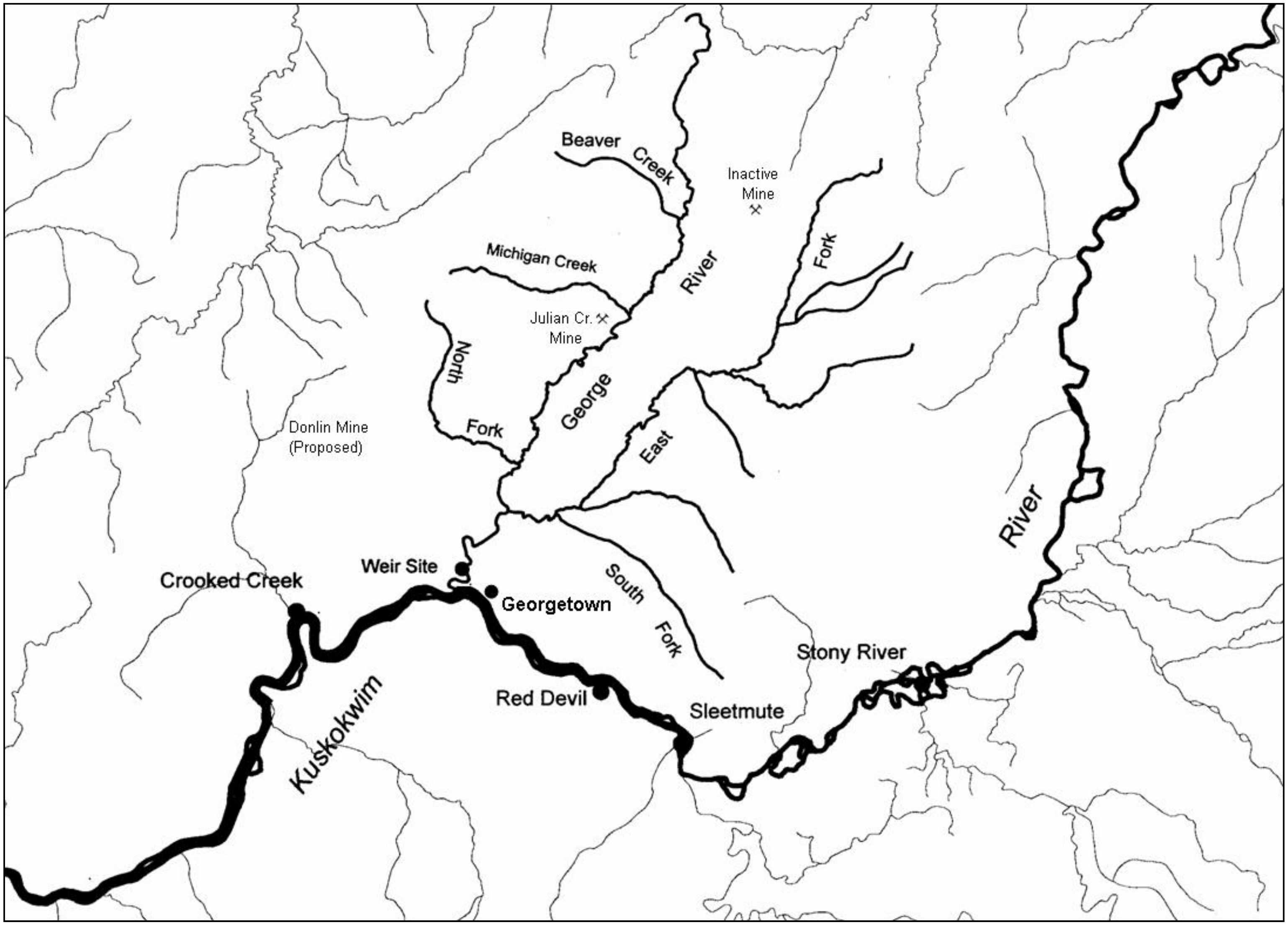


Figure 2.–George River, middle Kuskokwim River basin.

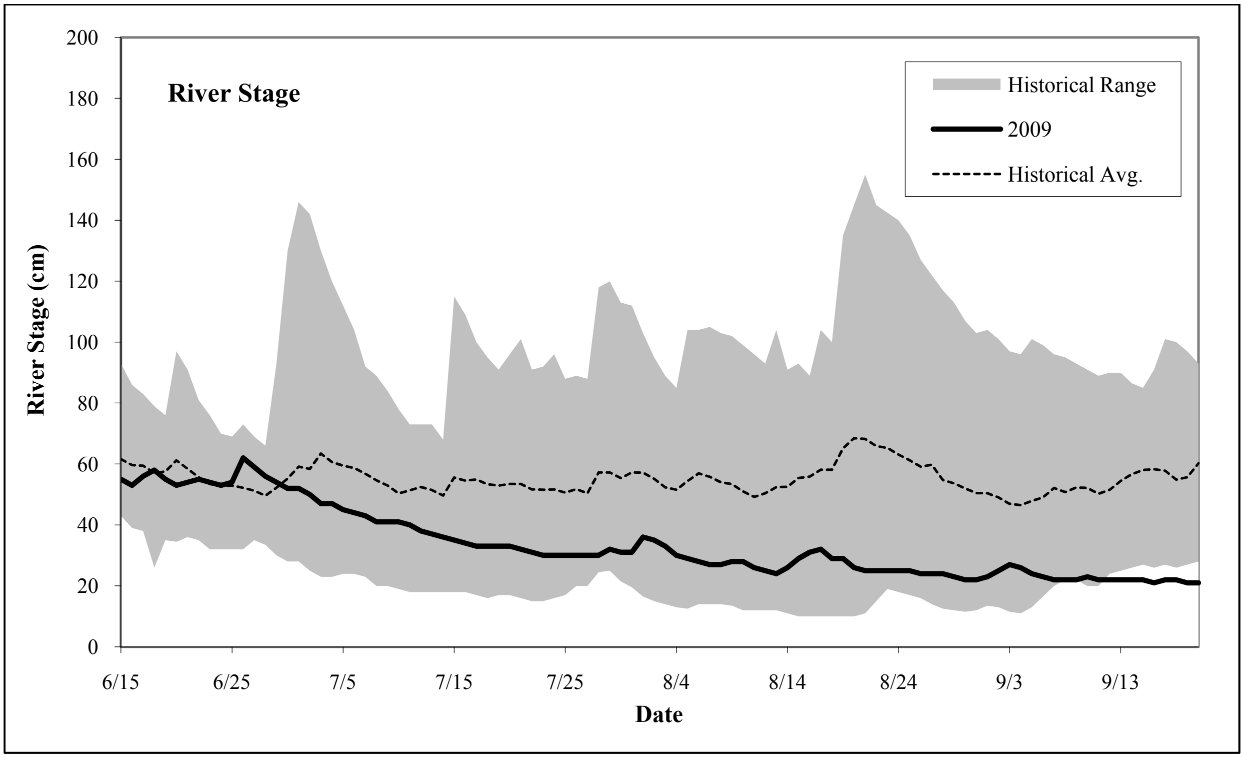
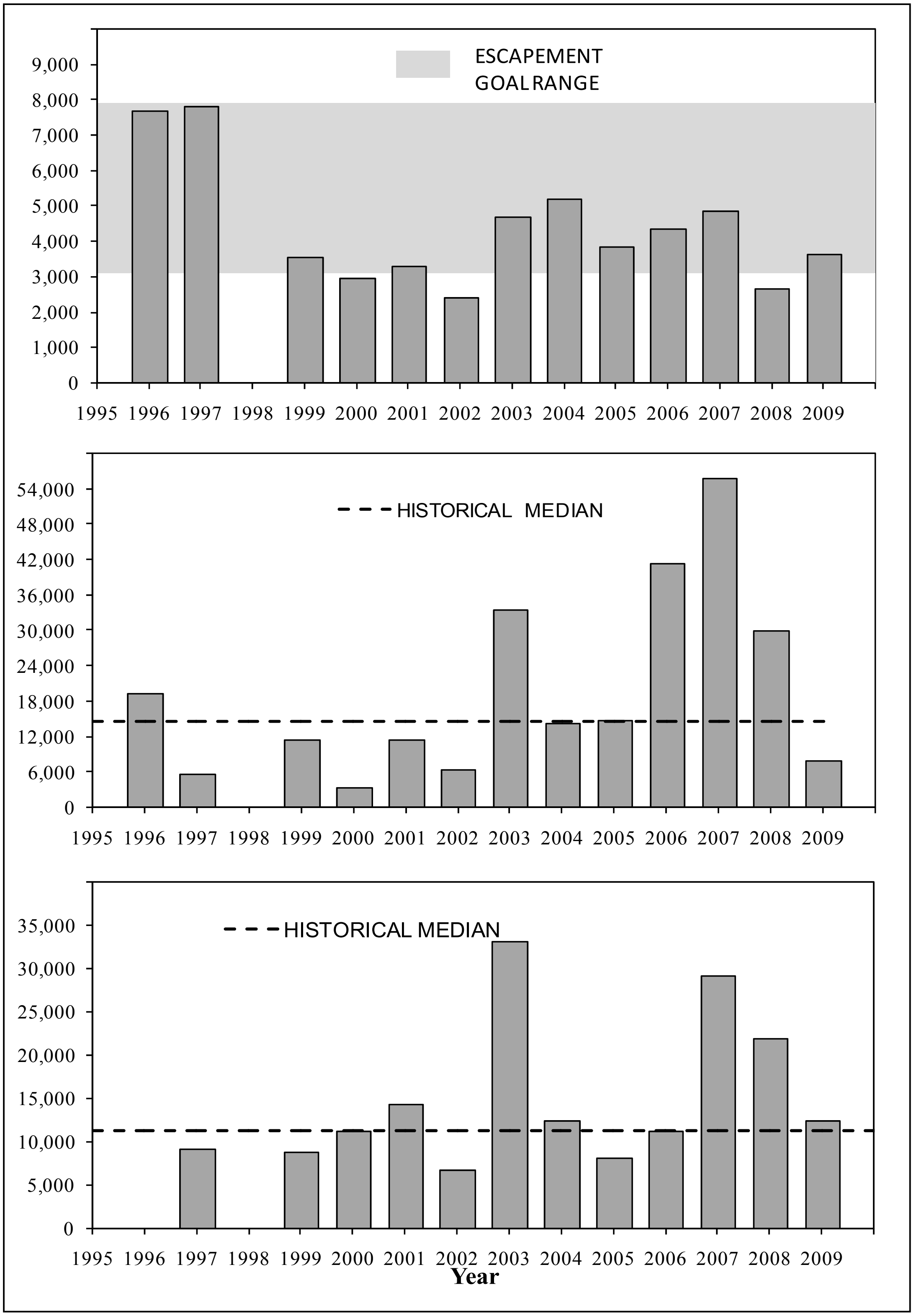
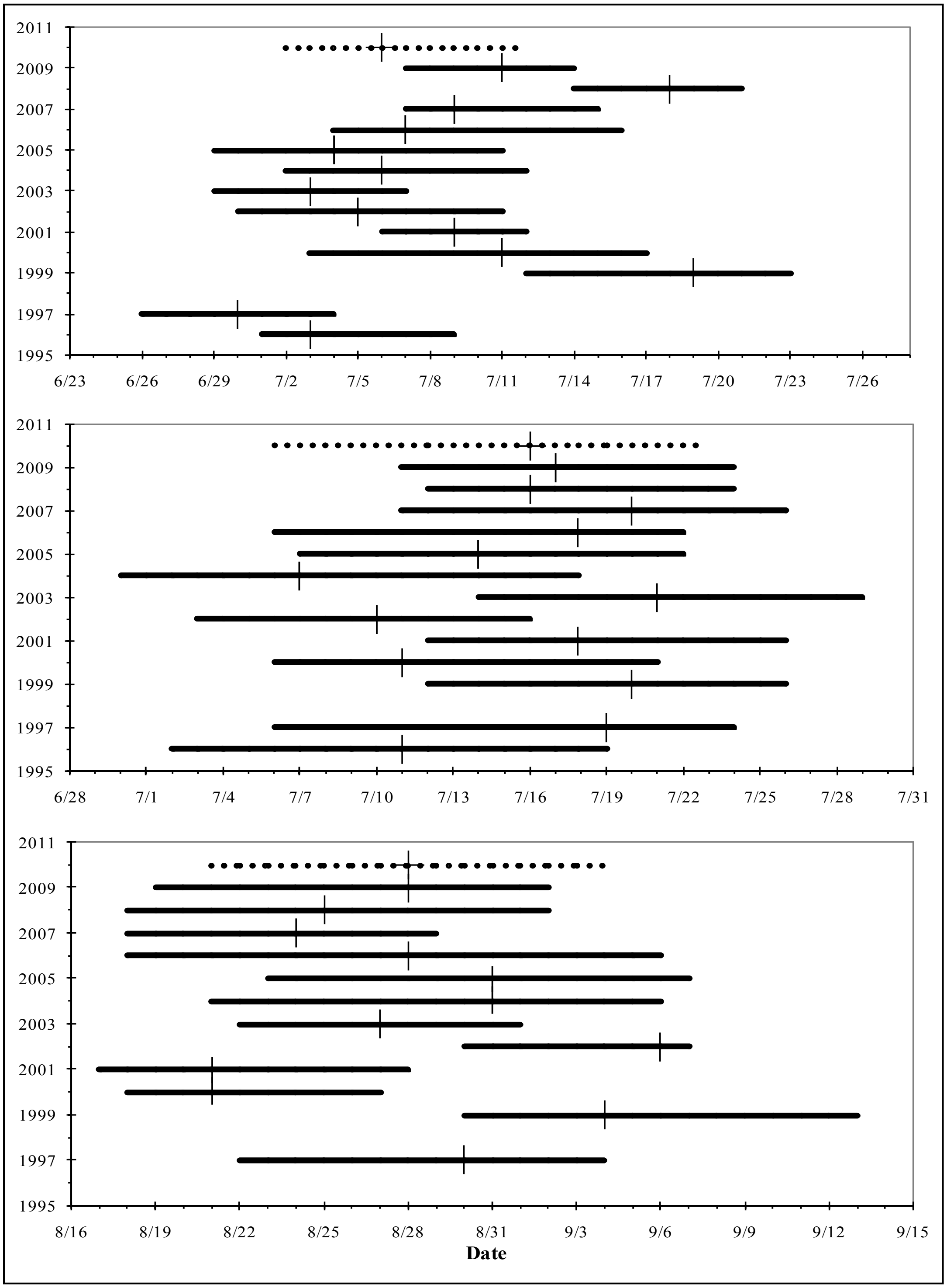


Figure 3.–Daily morning river stage at George River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2000 to 2008.



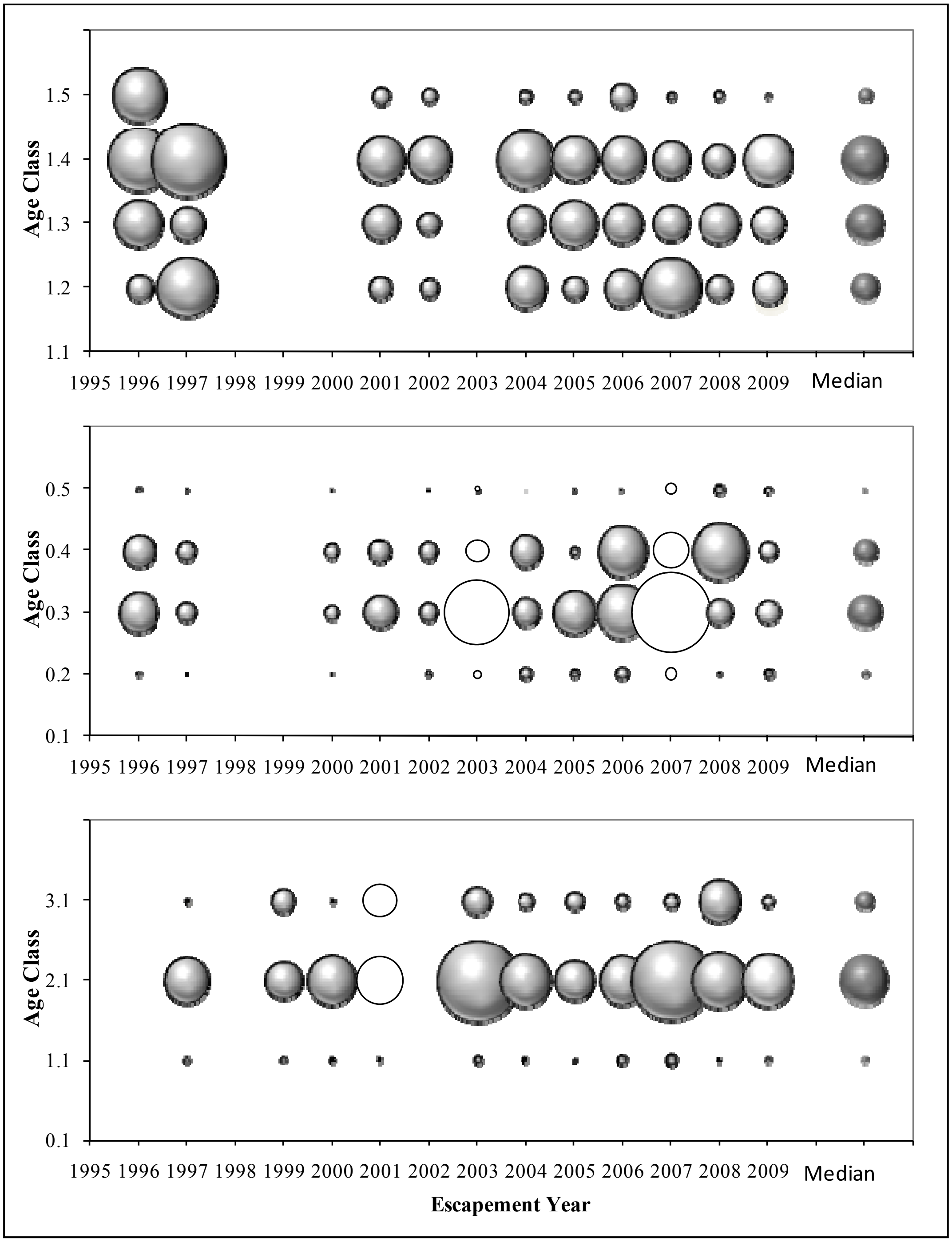
Note: Escapement goals given for Chinook salmon, historical median given for chum and coho salmon.

Figure 4.–Historical escapement of salmon by species at George River weir.



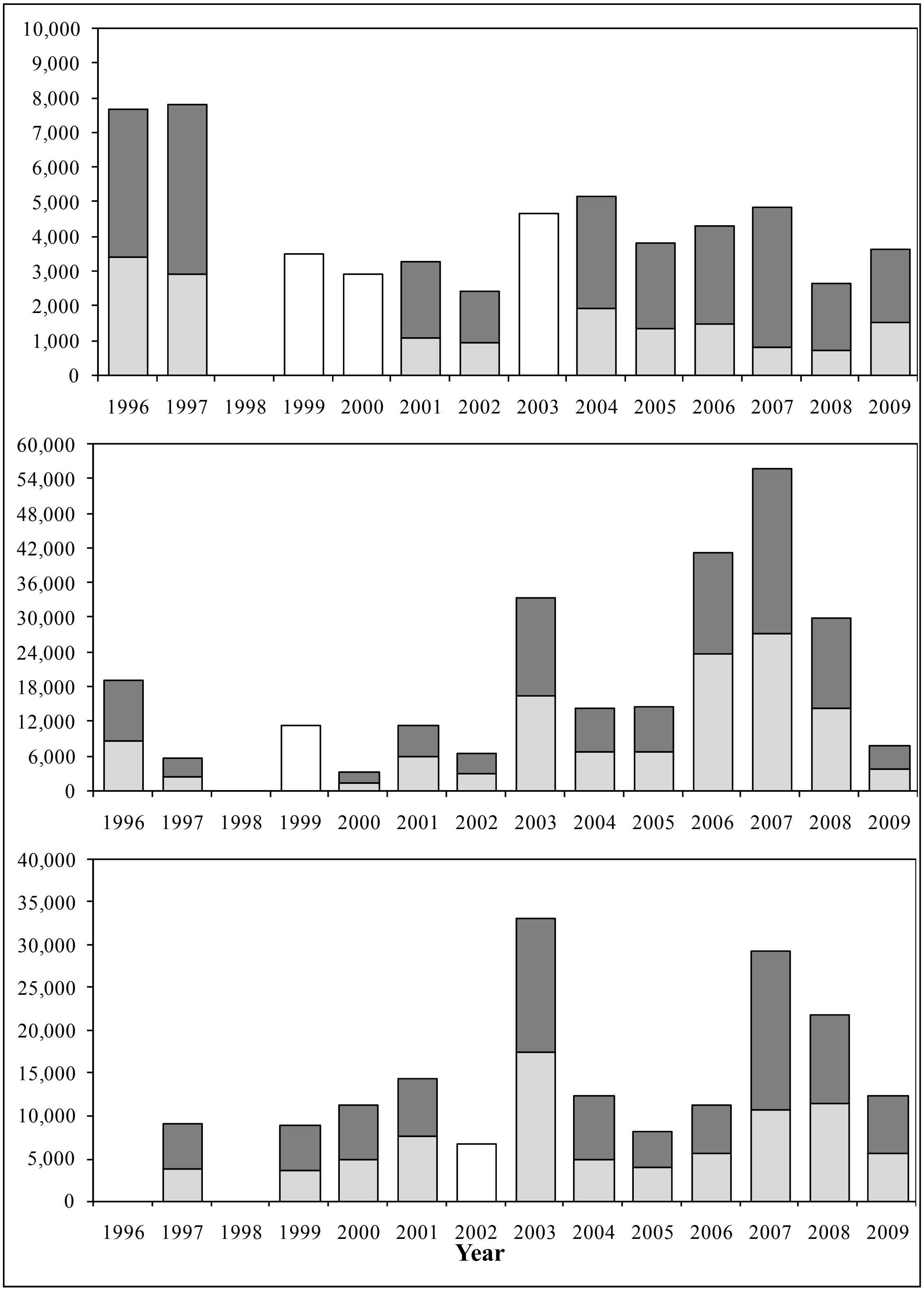
Note: Horizontal bars represent the central 50% of the run and cross-marks represent the median passage date.

Figure 5.–Annual run timing of Chinook, chum, and coho salmon based on cumulative percent passage at George River weir, 1996–2009.



Note: Size of circles represents escapement and arrows illustrate tracking a cohort group. Empty (white) circles correspond to years when greater than 20% of reported escapement was derived from daily passage estimates. Sampling objectives were not achieved in years with no data.

Figure 6.–Relative age-class abundance of Chinook, chum, and coho salmon by escapement year at George River weir.



Note: Empty bars (white) indicate years when sex ratio goals were not achieved. Black bars indicate males, and grey bars indicate females.

Figure 7.–Historical escapement of salmon by species at George River weir.

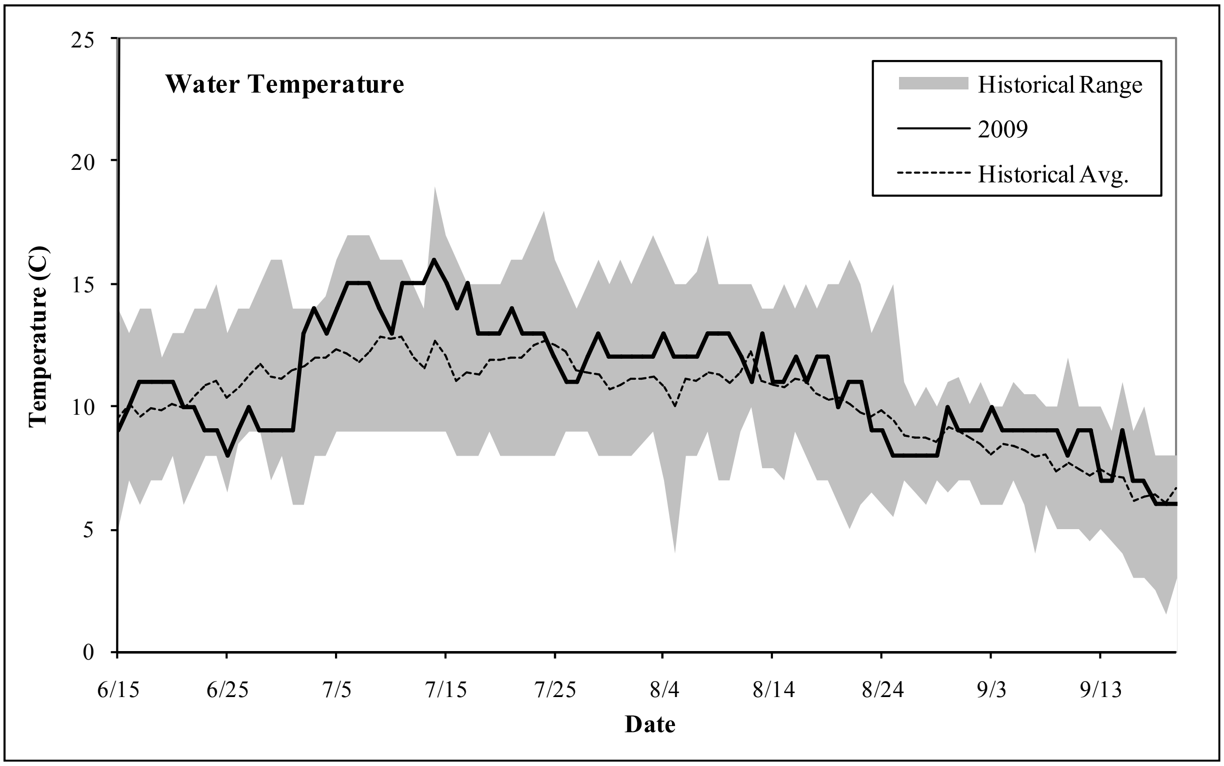


Figure 8.–Daily morning river stage at George River weir in 2009 relative to historical average, minimum, and maximum morning readings from 2000 to 2008.

APPENDIX A: DAILY PASSAGE

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

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Whitefish	Other[a]
6/17	0	0	1	0	0	50	0	
6/18	0	0	1	0	0	358	5	[b] 13G
6/19	2	0	5	0	0	423	3	[b] 4G
6/20	3	0	4	0	0	103	1	
6/21	1	0	11	0	0	245	2	[b] 4G
6/22	0	0	1	0	0	8	0	
6/23	0	0	1	0	0	47	0	
6/24	3	0	4	0	0	146	0	
6/25	1	0	6	0	0	115	0	[b] 9G
6/26	6	0	25	0	0	391	0	
6/27	3	0	1	0	0	50	0	
6/28	1	0	8	0	0	154	0	
6/29	3	0	20	0	0	164	0	[b] 1G
6/30	31	0	27	0	0	474	0	[b] 3G
7/1	140	0	76	0	0	960	0	
7/2	22	0	66	0	0	653	0	
7/3	45	0	103	0	0	512	0	[b] 3G,2P
7/4	55	0	217	0	0	322	0	
7/5	310	0	240	0	0	247	1	
7/6	209	0	237	4	0	148	0	
7/7	421	0	165	6	0	166	0	[b] 1D
7/8	118	0	131	1	0	81	0	[b] 1G
7/9	203	0	262	0	0	64	0	[b] 1D,1G
7/10	116	0	255	5	0	199	0	
7/11	252	5	540	21	0	226	0	[b] 15G,1P
7/12	317	2	365	18	0	793	2	
7/13	358	0	223	6	0	464	0	
7/14	248	5	533	18	0	683	0	[b] 8G
7/15	95	0	151	1	0	227	0	
7/16	57	1	239	5	0	193	0	
7/17	87	3	220	8	0	236	0	
7/18	75	2	286	6	0	157	1	
7/19	86	0	285	8	0	72	0	
7/20	44	1	396	13	0	70	0	1G
7/21	24	2	268	8	0	52	1	
7/22	43	2	249	13	0	56	0	[b] 1D, 1G
7/23	62	4	233	15	0	81	0	
7/24	15	0	153	8	0	22	0	
7/25	12	0	149	13	0	27	0	
7/26	34	2	205	17	1	12	0	
7/27	6	1	146	13	1	0	0	
7/28	31	0	187	17	1	8	0	[b] 1G
7/29	40	3	243	21	5	18	0	
7/30	3	1	92	11	6	14	0	
7/31	21	2	165	16	15	0	0	
8/1	13	0	86	4	18	8	0	
8/2	6	1	101	20	7	2	0	
8/3	5	3	113	7	11	5	0	
8/4	2	1	35	1	7	0	0	

-continued-

Appendix A1.–Page 2 of 3.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Whitefish	Other[a]
8/5	1	0	36	1	4	2	0	
8/6	4	2	62	6	16	1	0	
8/7	0	0	37	1	11	7	0	
8/8	5	0	33	0	15	6	0	
8/9	0	1	24	0	32	3	0	
8/10	5	3	35	0	80	1	0	
8/11	3	0	15	1	104	1	1	
8/12	1	0	15	0	58	0	0	
8/13	4	0	20	2	219	1	0	
8/14	2	1	11	0	127	3	0	
8/15	2	0	31	2	953	3	0	[b] 2G
8/16	2	1	15	0	325	1	0	
8/17	0	0	10	0	429	0	0	
8/18	1	0	7	0	602	2	0	
8/19	0	1	16	0	296	0	0	
8/20 [c]	0	0	7	0	129	0	0	
8/21	0	0	11	0	524	0	0	
8/22	0	0	2	0	123	0	0	
8/23	0	0	1	0	224	0	0	
8/24	2	0	4	0	149	0	0	
8/25	1	0	2	0	184	0	0	
8/26	0	0	0	0	160	0	0	
8/27	0	1	2	0	84	0	0	
8/28	0	1	3	1	1,307	0	0	
8/29	0	0	1	0	817	0	0	
8/30	0	0	1	0	155	0	0	
8/31	0	0	2	0	223	0	0	
9/1	0	0	0	0	110	0	0	
9/2	0	0	1	0	3,030	0	0	
9/3	0	0	1	0	822	0	0	
9/4	1	0	1	0	154	0	0	
9/5	0	0	0	0	30	1	0	[b] 1P
9/6	0	1	0	0	68	0	0	
9/7	0	0	0	0	30	0	0	
9/8	0	0	2	0	14	2	0	[b] 1G
9/9	0	0	0	0	54	2	0	
9/10	0	0	0	0	72	1	1	
9/11	0	0	0	0	34	0	0	
9/12	0	0	0	0	53	0	0	
9/13	0	0	0	0	91	0	0	
9/14	0	0	0	0	36	0	1	
9/15	0	0	1	0	40	0	0	
9/16	0	0	0	0	28	0	0	
9/17	0	0	0	0	31	0	0	
9/18	0	0	0	0	32	0	0	
9/19	0	1	0	0	19	0	0	
9/20	0	0	0	0	37	1	0	
9/21	0	0	0	0	32	0	0	
9/22	0	0	0	0	30	1	0	

-continued-

Appendix A1.–Page 3 of 3.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Whitefish	Other[a]
9/23	0	0	0	0	14	0	2	
9/24	0	0	0	0	14	1	0[b]	1P
9/25	0	0	0	0	19	0	0	
							2	
Totals	3,663	54	7,939	318	12,316	9,546	1	

[a] P = Northern pike; W = whitefish; D = Dolly Varden: count may not correspond to actual day observed.
[b] The weir was inoperable for all or part of the day.
[c] Incomplete or partial daily count.

APPENDIX B: DAILY CARCASS COUNT

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

	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
6/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[b] P
6/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
6/21	1	0	1	0	0	0	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	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	[b] H
6/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0
7/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
7/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/5	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0
7/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7	1	0	1	0	0	0	2	0	2	0	0	0	0	0	0	0	1	0
7/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	1	0
7/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	[b] G
7/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	7	3	10	0	0	0	0	0	0	4	0	[b] G
7/13	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0	1	0	0
7/14	0	0	0	0	0	0	6	2	8	0	1	1	0	0	0	3	0	0
7/15	0	0	0	0	0	0	7	3	10	1	0	1	0	0	0	3	0	0
7/16	0	0	0	0	0	0	10	6	16	0	0	0	0	0	0	3	0	0
7/17	1	0	1	0	0	0	6	3	9	0	0	0	0	0	0	5	1	[b] G
7/18	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	3	1	0
7/19	0	0	1	0	0	0	7	5	12	0	0	0	0	0	0	6	1	[b] D
7/20	0	0	0	0	0	0	5	4	9	0	0	0	0	0	0	3	1	0
7/21	0	0	0	0	0	0	6	4	10	0	0	0	0	0	0	4	0	b G, P
7/22	0	0	0	0	0	0	5	3	8	0	0	0	0	0	0	4	0	b P

-continued-

	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
7/23	0	1	1	0	0	0	7	6	13	0	0	0	0	0	0	12	1	[b] G
7/24	0	0	0	0	0	0	17	5	22	0	0	0	0	0	0	8	1	[b] G
7/25	0	0	0	0	0	0	3	4	7	0	0	0	0	0	0	8	1	[b] G
7/26	0	0	2	0	0	0	9	4	13	0	0	0	0	0	0	8	0	[b] D
7/27	0	0	0	0	0	0	8	4	12	2	0	2	0	0	0	7	0	[b] G, M
7/28	0	0	0	0	0	0	13	4	17	0	0	0	0	0	0	11	0	0
7/29	0	0	0	0	0	0	4	8	12	1	0	1	0	0	0	10	1	0
7/30	1	2	3	1	0	1	8	3	11	1	0	1	0	0	0	2	0	0
7/31	1	1	2	0	0	0	10	3	13	1	0	1	0	0	0	12	0	0
8/1	3	2	5	0	0	0	17	6	23	3	1	4	0	0	0	15	0	0
8/2	0	0	0	0	0	0	17	4	21	2	1	3	0	0	0	15	1	0
8/3	1	0	1	0	0	0	19	10	29	10	1	11	0	0	0	15	0	[b] G
8/4	3	2	5	0	0	0	23	12	35	4	2	6	0	0	0	7	0	0
8/5	1	0	1	0	0	0	28	11	39	6	3	9	0	0	0	15	2	[b] 2G
8/6	1	1	2	0	0	0	16	11	27	7	3	10	0	0	0	4	3	0
8/7	2	1	3	0	0	0	24	8	32	5	3	8	0	0	0	20	0	0
8/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/9	7	0	7	0	0	0	18	2	20	11	3	14	0	0	0	22	3	0
8/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	8	3	11	0	0	0	13	4	17	11	3	14	0	0	0	24	3	0
8/12	3	5	8	0	0	0	18	7	25	4	0	4	0	0	0	17	1	[b] 2G
8/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/14	8	3	11	0	0	0	8	2	10	3	1	4	0	0	0	28	10	[b] G
8/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	23	7	30	0	0	0	18	9	27	7	3	10	0	0	0	57	3	0
8/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/20 [c]	10	2	12	0	0	0	2	2	4	0	0	0	0	0	0	50	2	[b] 5G
8/21	1	1	2	1	0	1	1	0	1	0	0	0	0	0	0	33	1	[b] 2G
8/22	1	0	1	0	0	0	0	0	0	1	0	1	0	1	1	30	0	0
8/23	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	30	0	0
8/24	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	26	0	0
8/25	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	10	1	b G
8/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	3	0

-continued-

Appendix B1.–Page 3 of 3.

	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
8/27	0	0	0	0	0	0	1	2	3	0	0	0	0	0	0	23	1	0
8/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
8/29	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	6	0	0
8/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0
9/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
9/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
9/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	[b] D
9/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
9/8	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
9/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/10	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
9/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	[b] P
9/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
9/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[b] P
9/17	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	[b] G
9/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/19	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0
9/20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0
9/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/22	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	4	0	0
9/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[b] P
9/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	77	31	111	2	0	2	374	167	541	80	25	105	8	2	10	641	52	

[a] B = Burbot; G = Arctic Grayling; P = Northern pike.

[b] Weir was inoperable due to a high water event.

[c] Partial daily count.

APPENDIX C: WEATHER AND STREAM OBSERVATIONS

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

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/15	10:00	2	0.0	12	9	55	1
	17:00	2	0.0	18	11	54	1
6/16	10:00	1	0.0	12	10	53	1
	17:00	3	0.5	17	12	53	1
6/17	10:00	4	0.6	11	11	56	1
	17:00	2	0.0	17	13	58	1
6/18	10:00	2	0.0	14	11	58	1
	17:00	2	0.0	20	14	58	1
6/19	10:00	21	0.0	14	11	55	1
	17:00	3	0.0	20	14	54	1
6/20	10:00	4	5.0	10	11	53	2
	17:00	3	1.0	15	12	54	1
6/21	10:00	4	0.9	7	10	54	1
	17:00	4	4.2	13	11	55	1
6/22	10:00	3	5.0	9	10	55	1
	17:00	2	0.0	14	12	55	1
6/23	7:30	4	6.0	8	9	54	1
	10:00	4	0.5	9	9	54	1
	17:00	4	0.0	11	9	54	1
6/24	10:00	3	0.5	10	9	53	1
	17:00	4	0.0	14	10	53	1
6/25	10:00	4	6.5	8	8	54	1
	17:00	4	1.2	12	10	55	1
6/26	10:00	3	0.1	10	9	62	1
	16:30	2	0.8	15	11	62	1
6/27	10:00	3	1.4	13	10	59	1
6/28	10:00	4	0.2	11	9	56	1
6/29	10:00	1	0.0	10	9	54	1
	17:00	2	0.0	19	12	54	1
6/30	10:00	2	0.0	10	9	52	1
	16:30	2	0.0	21	13	51	1
7/1	9:00	2	0.0	10	9	52	1
	17:00	2	0.0	25	14	52	1
7/2	10:00	1	0.0	16	13	50	1
	17:00	2	0.0	26	16	48	1
7/3	10:00	1	0.0	15	14	47	1
7/4	10:00	2	0.0	15	13	47	1
7/5	10:00	1	0.0	15	14	45	1
7/6	10:00	3	0.0	18	15	44	1
7/7	10:00	1	0.0	19	15	43	1
	16:50	1	0.0	26	17	43	1
7/8	10:00	4	0.0	13	15	41	1
	17:00	4	0.0	16	14	41	1
7/9	10:00	3	0.0	13	14	41	1
	17:00	3	0.0	14	15	42	1

-continued-

Appendix C1.–Page 2 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[b]
7/10	7:30	1	0.0	7	13	41	1
	17:00	1	0.0	23	16	41	1
7/11	10:00	1	0.0	16	15	40	1
7/12	10:00	1	0.0	20	15	38	1
	17:00	2	0.0	28	18	38	1
7/13	7:30	1	0.0	13	15	37	1
	17:00	3	0.0	23	17	37	1
7/14	10:00	3	0.0	18	16	36	1
	17:00	4	0.0	21	17	36	1
7/15	10:00	4	0.0	13	15	35	1
	17:00	1	0.0	18	15	35	1
7/16	10:00	1	0.0	14	14	34	1
	17:00	3	0.0	22	16	34	1
7/17	10:00	4	0.0	15	15	33	1
	17:00	4	0.0	15	15	33	1
7/18	10:00	4	1.0	12	13	33	1
	17:00	4	0.4	15	14	33	1
7/19	10:00	4	2.0	14	13	33	1
	17:00	4	0.5	17	14	33	1
7/20	10:00	4	0.2	13	13	33	1
	17:00	2	0.0	17	16	32	1
7/21	10:00	3	0.0	15	14	32	1
	17:00	4	0.0	17	14	31	1
7/22	10:00	2	0.0	17	13	31	1
	17:00	4	0.0	18	14	31	1
7/23	10:00	3	0.0	12	13	30	1
7/24	10:00	4	0.6	11	13	30	1
	17:00	3	0.0	14	13	30	1
7/25	10:00	3	0.0	13	12	30	1
	17:00	4	0.0	15	13	30	1
7/26	10:00	4	0.3	12	11	30	1
	17:00	4	0.0	14	12	30	1
7/27	10:00	3	0.2	11	11	30	1
	17:00	4	1.6	15	12	30	1
7/28	10:00	4	0.0	13	12	30	1
	17:00	4	0.0	17	13	31	1
7/29	10:00	3	3.0	18	13	32	1
	17:00	3	0.0	17	14	32	1
7/30	10:00	1	0.0	11	12	31	1
	17:00	4	0.0	16	14	30	1
7/31	10:00	4	19.5	8	12	31	1
	17:00	4	1.2	13	14	32	1
8/1	10:00	4	0.4	9	12	36	1
	17:00	2	0.0	14	13	35	1

-continued-

Appendix C1.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[b]
8/2	10:00	3	0.0	14	12	35	1
	17:00	4	0.8	13	12	35	1
8/3	10:00	1	1.0	16	12	33	1
	17:00	1	0.0	24	14	32	1
8/4	10:00	4	0.0	14	13	30	1
	17:00	4	0.0	19	14	30	1
8/5	10:00	4	0.4	13	12	29	1
	17:00	4	0.0	19	14	29	1
8/6	10:00	4	0.0	13	12	28	1
	17:00	2	0.0	20	14	28	1
8/7	7:30	1	0.0	13	12	27	1
	17:00	3	0.0	18	14	27	1
8/8	10:00	4	0.0	12	13	27	1
	17:00	4	0.0	17	14	28	1
8/9	10:00	3	0.0	15	13	28	1
	17:00	2	0.0	19	15	28	1
8/10	10:00	1	0.0	16	13	28	1
	17:00	1	0.0	20	15	27	1
8/11	10:00	1	0.0	13	12	26	1
	17:00	1	0.0	19	14	26	1
8/12	10:00	3	0.0	9	11	25	1
	17:00	4	0.0	18	14	24	1
8/13	10:00	4	2.5	11	13	24	1
	17:00	4	0.5	12	13	25	1
8/14	10:00	4	2.8	13	11	26	1
	17:00	4	0.0	16	13	27	1
8/15	10:00	4	9.6	12	11	29	1
	17:00	4	1.5	15	13	30	1
8/16	10:00	3	0.0	12	12	31	1
	17:00	2	0.0	19	14	31	1
8/17	10:00	1	0.0	9	11	32	1
	17:30	2	0.0	19	14	32	1
8/18	10:00	4	0.0	10	12	29	1
	17:00	4	0.0	12	11	29	1
8/19	10:00	2	0.0	13	12	29	1
	17:00	2	0.0	17	14	28	1
8/20	10:00	4	0.0	6	10	26	1
	17:00	3	0.0	16	13	26	1
8/21	10:00	4	0.0	11	11	25	1
	17:00	4	0.0	14	13	26	1
8/22	10:00	4	0.5	10	11	25	1
	17:30	3	0.0	ND	ND	25	1
8/23	10:00	3	0.2	5	9	25	1
	17:00	2	0.0	12	11	25	1

-continued-

Appendix C1.–Page 4 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/24	10:00	5	5.2	3	9	25	1
	17:00	3	0.0	12	12	25	1
8/25	10:00	2	0.0	4	8	25	1
	17:00	3	0.0	13	11	25	1
8/26	10:00	1	0.0	5	8	24	1
	17:00	1	0.0	14	11	24	1
8/27	10:00	4	0.0	6	8	24	1
	17:00	4	0.5	13	9	24	1
8/28	10:00	1	0.0	8	8	24	1
8/29	10:00	1	0.0	7	8	23	1
	17:00	1	0.0	16	11	23	1
8/30	10:00	4	0.0	10	10	22	1
	17:00	4	0.0	14	11	22	1
8/31	10:00	4	0.4	8	9	22	1
	17:00	4	4.4	10	10	22	1
9/1	10:00	3	0.7	9	9	23	1
	17:00	3	0.0	12	10	23	1
9/2	10:00	4	3.4	10	9	25	1
	17:00	4	0.3	14	11	25	1
9/3	10:00	4	0.0	8	10	27	1
	17:00	3	0.0	19	12	27	1
9/4	10:00	1	0.0	11	9	26	1
	17:00	1	0.0	20	12	25	1
9/5	10:00	5	0.0	4	9	24	1
	17:00	1	0.0	21	13	23	1
9/6	10:00	5	0.0	4	9	23	1
	17:00	2	0.0	20	13	23	1
9/7	10:00	1	0.0	6	9	22	1
	17:00	4	0.0	17	11	22	1
9/8	10:00	4	0.0	6	9	22	1
	17:00	3	0.5	14	10	22	1
9/9	10:00	3	0.0	5	9	22	1
	17:00	3	0.0	15	11	23	1
9/10	10:00	2	0.0	7	8	23	1
	17:00	2	0.0	18	12	23	1
9/11	10:00	4	0.0	9	9	22	1
	17:00	4	0.0	11	10	22	1
9/12	10:00	4	0.3	7	9	22	1
	17:00	4	0.0	11	10	22	1
9/13	10:00	5	0.0	2	7	22	1
	17:00	3	0.0	16	10	22	1
9/14	10:00	5	0.0	2	7	22	1
	17:00	3	0.0	17	11	22	1
9/15	10:00	3	0.0	8	9	22	1
	17:00	3	0.0	13	10	21	1

-continued-

Appendix C1.–Page 5 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[b]
9/16	10:00	5	0.0	2	7	21	1
	17:00	2	0.0	ND	ND	ND	1
9/17	10:00	5	0.0	3	7	22	1
	17:00	3	0.0	15	9	22	1
9/18	10:00	5	0.0	-1	6	22	1
	17:00	2	0.0	15	9	21	1
9/19	10:00	3	0.0	3	6	21	1
	17:00	3	0.0	15	9	21	1
9/20	10:00	3	0.0	2	6	21	1
9/20	17:00	2	0.0	12	8	21	1
9/21	10:00	3	0.0	5	6	21	1
	17:00	3	0.0	8	7	21	1
9/22	10:00	4	0.0	1	5	21	1
	17:00	4	0.0	5	6	21	1
9/23	10:00	4	0.0	1	5	20	1
	17:00	3	2.0	5	6	21	1
9/24	10:00	5	0.0	-3	3	21	1
	17:00	2	0.5	5	5	21	1
9/25	10:00	4	0.0	0	3	21	1
9/26	10:00	4	0.0	0	3	21	1
	17:00	4	0.0	5	5	21	1

[a] Sky condition codes:
- 0 = no observation
- 1 = < 1/10 cloud cover
- 2 = partly cloudy; < 1/2 cloud cover
- 3 = mostly cloudy; > 1/2 cloud cover
- 4 = complete overcast
- 5 = thick fog

[b] Water clarity codes:
- 1 = visibility greater than 1 meter
- 2 = visibility 0.5 to 1 meter
- 3 = visibility less than 0.5 meter