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George River Salmon Studies, 2008

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

by

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December 2009

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

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 09-70

GEORGE RIVER SALMON STUDIES, 2008

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ABSTRACT

The George River is a major tributary of the Kuskokwim River and produces Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, and coho salmon *O. kisutch* that contribute to intensive subsistence and commercial salmon fisheries downstream of its confluence. 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 in accordance with the State of Alaska Sustainable Fishery Policy (5 AAC 39.222). Salmon were enumerated by species as they migrated upstream through the weir to determine daily and annual escapements. Samples were collected from fish as they migrated upstream through the weir to estimate the age, sex, and length composition of escapements.

Operations were successful in 2008 and escapements of 2,698 Chinook, 29,978 chum, 94 sockeye *O. nerka*, and 21,931 coho salmon were determined at George River weir. Chinook salmon escapement was below the historical average in 2008, while chum and coho salmon escapements were well above their historical averages. Age, sex, and length sampling in 2008 indicated the Chinook salmon escapement consisted of 49% age-1.3, 27% age-1.4, and 20% age-1.2 fish, with 28% females. The chum escapement consisted of 79% age-0.4 and 17% age-0.3 fish. The coho salmon escapement consisted of 63% age-2.1 and 36% age-3.1 fish. Relative to previous years determined at George River weir, the abundances of age-1.2 and -1.4 Chinook salmon were below average in 2008, and the abundance of age-1.3 Chinook salmon was near average. The number of female Chinook salmon was low. The abundance of age-0.3 chum salmon was below average, while the abundance of age-0.4 chum salmon was record high. The abundance of age-1.2 coho salmon was above average while the abundance of age 3.1 coho salmon was also record high in 2008.

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; Brown 1983). Each year mature Pacific salmon *Oncorhynchus* spp. return to the river and its tributaries to spawn, supporting an annual average subsistence and commercial harvest of nearly 1 million salmon (Whitmore et al. 2008). The subsistence salmon fishery in the Kuskokwim Area is one of the largest in the state and remains a fundamental component of local culture (Coffing 1991; Coffing Unpublished a-b[1]; Coffing et al. 2000; Smith et al. 2008; Whitmore et al. 2008). The commercial salmon fishery, though modest in value compared to other areas of Alaska, has been an important component of the market economy of lower Kuskokwim River communities (Buklis 1999; Whitmore et al. 2008). Salmon contributing to these fisheries spawn and rear in nearly every tributary of the Kuskokwim River basin.

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

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[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.

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 provides for sustainable fisheries by ensuring that adequate numbers of salmon escape to the spawning grounds each year. 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, only 2 Kuskokwim River tributaries received rigorous escapement monitoring.

Reliable data from just 2 tributaries was inadequate to provide escapement information for the entire Kuskokwim River basin. 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 (Holmes and Burtkett 1996; Molyneaux and Brannian 2006; Mundy 1998). 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; Mundy 1998).

In recent years Kuskokwim River Chinook and chum *O. keta* salmon have received considerable attention due to erratic run abundance patterns. In 2000, the Alaska Board of Fish (BOF) designated Kuskokwim River Chinook and chum salmon as "stocks of yield concern" after several years of lower than expected harvest levels (Burkey et al. 2000a, b). This "stock of yield concern" designation was upheld during the 2004 BOF meeting (Bergstrom and Whitmore 2004) but was cancelled during the 2007 BOF meeting at the recommendation of ADF&G following several years of expected harvest levels and relatively strong escapements (Linderman and Bergstrom 2006; Molyneaux and Brannian 2006). Between 2001 and 2006 subsistence and commercial fisheries were managed conservatively and in accordance with the BOF "stocks of yield concern" designations. Efforts were focused on enumerating abundance of these species and obtaining enough data for escapement goal development. Several main-river and regional projects were initiated that utilized existing weir infrastructure for data collection. Such projects have since become deeply integrated components of Kuskokwim River salmon research.

The utility of weirs extends beyond providing annual escapement estimates. Escapement projects, such as the George River weir, commonly serve as platforms for collecting other types of information useful for management and other research initiatives. Collection of age, sex, and length (ASL) data is typically included in most escapement monitoring projects (Molyneaux et al. 2008), such as George River weir. Knowledge of ASL composition can improve understanding of fluctuations in salmon abundance and is essential for developing spawner-recruit relationships that are investigated when formulating escapement goals (Molyneaux and Brannian 2006).

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, 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*.

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 George River as an angling and hunting destination for their clients. In 2000, 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 annual 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 annual 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 and 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 instream 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. Collecting juvenile salmon samples as part of the *Productivity of Kuskokwim Juvenile Coho* project;
    e. Collecting otolith samples from chum and Chinook salmon as part of 2 pilot studies looking at the *Investigation of Stable Isotope and Otolith Elemental Analyses as Tools for Salmon Stock Assessment*, and;
    f. Hosting local area high school students as part of a *Natural Resources Internship Program*.

The primary goal of this report is to summarize and present results for the 2008 field season at the George River weir. In addition, we intend to enhance the utility of this report by discussing results within the context of broader temporal and spatial trends. To do so, we draw on historical project data and data from other escapement monitoring projects, related research projects, and the commercial and subsistence fisheries. Effort was made to ensure that all preliminary data was reported as such. In addition, many of the referenced documents are currently being developed. Consequently, most of the reported trends for other projects were determined by the authors of this report based on finalized data sets generously provided by other researchers. At the time of publication of this document all reported estimates and trends are as accurate as possible. However, readers should consult the original documents prior to referencing results from other projects, especially those listed as "*In prep*". Furthermore, unless stated, the statistical significance of the trends discussed for this and other escapement monitoring projects have not been determined. Many of these trends are subjective and based on low sample sizes with high variance. It is important to remember that sampling methodologies may differ across projects and over time leading to difficulty in comparisons. Throughout this report every effort was made to ensure sound comparisons; however, the reader should be aware of these potential issues and view broader spatial and temporal trends with caution.

METHODS

STUDY AREA

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.

WEIR DESIGN

Project Site

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.

Construction

A resistance board weir was installed at the site from 21:00 hours on 16 June until nightfall on 22 September, 2008. 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 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 incorporated into the weir once these fish were observed congregating just upstream. At locations where downstream migrants were most concentrated, chutes were created by releasing the resistance boards on 1 or 2 adjacent weir panels so the distal

ends dipped slightly below the stream surface. The chute's shallow profile guides downstream migrants while preventing upstream salmon passage. The chutes were monitored and adjusted to ensure salmon were not passing upstream. Downstream passage was not enumerated; however, few salmon have been observed passing downstream over these chutes, and there numbers are considered negligible.

Maintenance

The weir was cleaned several times each day, typically at the end of a counting shift. A technician walked across the weir partially submerging each panel, thereby allowing the current to wash any debris downstream. A rake was used to push larger debris loads off the weir. Each time the weir was cleaned, a visual inspection was made of weir panels, substrate rail, fish trap, and fixed weir sections to ensure no breaches would allow fish to pass upstream uncounted. If conditions prevented an adequate visual inspection, technicians used snorkel gear to complete their inspection.

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.

The live trap was used as the primary means of upstream fish passage allowing crew members to capture and recover information from fish tagged in the mainstem Kuskokwim River. A clear plastic viewing window was placed on the stream surface to improve visual identification of fish entering the trap. This allowed passage counts to be conducted from the downstream entrance of the trap, and enabled crew members to capture tagged fish once they entered the trap. Alternatively, a secondary passage gate was employed if fish were reluctant to pass through the live trap (Hildebrand et al. 2007), a behavior observed during extreme low water conditions.

Estimating Missed Passage

Upstream salmon passage was estimated for days the weir was inoperable if adequate supporting data existed. Inoperable periods may have resulted from a breach in the weir, a delayed start

date, or a premature end date. 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 part or all of one day, an estimate for the inoperable day would be calculated using the following formula:

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

where:

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

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

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

Linear Method

When the weir is not operational for 2 or more days and later becomes operational, passage estimates for the inoperable days are calculated using the following formula:

$$\hat{n}_{d_i} = (\alpha + \beta \cdot i) - n_{o_i} \tag{2}$$

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

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

where:

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

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

Proportion Method

In circumstances when the weir does not first become operational until well into the one or more salmon runs, or when the weir ceases operating before data suggest salmon runs are nearing completion, daily passage for inoperable days is estimated using passage data from another year at the Kogrukluk River weir or from a neighboring project. The dataset used to model escapement for a particular situation is selected because it exhibits similar passage patterns to the incomplete dataset. With this method, daily passage estimates are calculated using the following formula:

$$\hat{n}_{d_i} = \left(\frac{\left(n_{md_i} \times \sum n_{d_i} \right)}{\sum n_{md_i}} \right) - n_{o_i} \tag{3}$$

where:

n_{md_i} = passage for the ith day in the model data;

$\sum n_{d_i}$ = cumulative passage;

$\sum n_{md_i}$ = cumulative passage of the model data for the corresponding time period; and,

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

Exponential Method

When model data sets are not adequate to use the "proportion method" the "exponential method" can be used. This method uses non-linear regression to fit an exponential function to existing data. For estimating the beginning of a run, use the rising limb of the run curve to fit an exponential trend line. For estimating the end of a run, use the falling limb of the run curve to fit an exponential trend line. Using this method the trendline is fitted to the data using the exponential function:

$$\hat{n}_{d_i} = ae^{bi} \tag{4}$$

where:

a = y-intercept of the fitted line,

b = slope of the fitted line,

i = day of the estimated portion of the run.

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. The term "pulse" is used to describe an instantaneous sample, though in practice a pulse sample is typically collected over the period of a few days. 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 sample size was selected because it was similar to what had been collected for Chinook salmon in previous years at George River weir, and exceeded the minimum sample size necessary to meet precision and accuracy criteria.

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.

After sampling was completed, relevant information such as sex, length, sampling date, and sampling location was copied to computer mark–sense forms that correspond to numbered gum cards. The completed gum cards and mark–sense forms were sent to the Bethel and/or Anchorage ADF&G offices for processing. The original ASL gum cards, acetates, and mark–sense forms were archived at the ADF&G office in Anchorage. The computer files were archived by ADF&G in the Anchorage and Bethel offices. Data were also loaded into the Arctic-Yukon-Kuskokwim (AYK) salmon database management system (Brannian et al. 2006a). Further details of sampling procedures can be found in Molyneaux et al. (2008).

Data Processing and Reporting

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

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

WEATHER AND STREAM OBSERVATIONS

Water and air temperatures were manually measured each day at approximately 0730 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 2005–2007, water temperature readings were also obtained using a Hobo® Water Temp Pro V1[2] 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 0730 and 1700 hours. The staff gauge consisted of a metal rod driven into the stream channel with a meter stick attached. The staff gauge was located near the bank just downstream of the weir. 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. To provide for historical consistency, the staff gauge was calibrated to the datum plane by a semi-permanent benchmark (Appendix A1). The steel pipes installed on the river bank in 2000 and that served as benchmarks in subsequent years were vulnerable to damage and distortion during spring break-up and proved unreliable. A much-improved benchmark was established in 2005 and continues to be used for initial and periodic calibration of the staff gauge. The newest benchmark consists of a small rectangular aluminum plate fixed to the top of a tree stump located

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

in the middle of the field camp approximately 10 m inland from the riverbank. This benchmark represents a river stage of 300 cm and is directly comparable with benchmarks and stage measurements maintained since 2000. The new benchmark requires the use of a surveyor's rod and level to calibrate the staff gauge.

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

The George River weir served as a recovery site for the first season of a two season basin wide mark–recapture and radiotelemetry study entitled *Kuskokwim River Coho Salmon Investigations* funded under Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK SSI) Project No. 803. The project was designed to estimate coho salmon abundance, distribution, and run timing above the upper Kalskag tagging site (rkm 270), as well as produce a statistical model that would compute historical annual abundance estimates from known escapement data. Coho salmon were captured at Kalskag and tagged using individually numbered Floy® anchor tags. A subset of tagged coho salmon received an individually coded radio tag. Adipose fin clips were used as a secondary mark. Tagging methods are described by (Stuby 2007).

Whenever possible, tagged coho salmon observed passing through the weir's live trap were captured to recover tag information. 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.

This project built on an established network of telemetry tracking stations set up in support of Stuby (2007), with additional stations to increase the resolution of coho salmon distribution. The George River weir crew helped set-up and maintain the George River weir station, Red Devil station, lower Holitna River station, Hoholitna River station, and (Rocky's) Holitna River station. All data collected by the George River weir crew was transferred to the principal investigator.

Hydrologic Data for the George River

This project was developed to better understand relationships among aquatic species and their freshwater habitats by collecting baseline hydrologic data for the George River under the direction of the Statewide Aquatic Resources Coordination Unit (SARCU). The objective of this project was to install a stream gage on the George River and collect accurate hydrologic data during annual salmon spawning migration. This data is necessary to assess relationships between fish populations and flow dynamics. In addition, baseline hydrologic data is critical for the establishment of water reservations: the legal basis for maintaining a specific flow rate or level in a body of water for purposes of: 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). Coordinating the installation and operation of the stream gage with the operations of the George River weir allow comparison of hydrologic dynamics with salmon fish migration rates. The 2008 season marked the third year of a 5-year study aimed at addressing temporal flow dynamics.

George River weir crew installed an Aquistar stream gage (Instrumentation Northwest, Inc.) approximately 200 meters downstream of the weir (river right) on 15 June in 2008. The station was monitored throughout the season and removed on 25 September. Stream discharge was

measured on 14 August, 1 September, and 25 September in 2008, 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 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.

Juvenile Coho Salmon Collection

Juvenile coho salmon were collected throughout the Kuskokwim River watershed in support of a *Productivity of Kuskokwim Juvenile Coho* study, in an effort to develop scale radius-fish length relationships. Baited minnow traps were used to collect juvenile coho salmon. Traps were baited with cured salmon eggs and soaked for variable lengths of time (typically 0.5 to 1 hour) to maximize trapping efficiency. Traps were placed in pools, backwater areas, and along river and creek banks. Captured coho salmon juveniles were measured to determine size class. Fish of a given size class were placed in Whirlpacks® with buffered 10% formalin. A log book was used to record soak time, number of each species captured, and approximate size of juvenile coho salmon collected. Fish were collected throughout the summer or until a sample size of 100 juvenile coho salmon was collected with fish evenly distributed across the range of available size classes. Collected samples were sent to the principle investigator at the end of the season (Greg Ruggerone, Natural Resources Consultants, Inc, Seattle WA).

Otolith Collections

Otoliths were collected from chum and Chinook salmon carcasses in support of 2 pilot investigations into the utility of microchemical analysis for stock identification. Crews collected carcasses from the weir on an opportunistic basis. Carcasses were examined to ensure that the fish had spawned above the weir, and these were assumed to belong to George River stocks. A goal was set to collect otoliths from 20 male and 20 female chum and Chinook salmon carcasses. Carcasses were rated 1 to 4 based on gill color, with red gills rated 1 and no color rated four. Saggital otoliths were collected only from fish with a rating of one or two. Plastic forceps were used to extract the samples to prevent contamination from foreign metals. Fresh forceps were used on each sample and then discarded to prevent contamination between samples. Otoliths from each fish were placed in separate envelopes with location, length, and sex information recorded on the outside. Samples were sent to study investigators Frank Harris, USFWS, Kenai Fisheries Resource Office, and Trent Sutton, University of Alaska, Fairbanks.

High School Internship Program

Kuskokwim Native Association 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

ESCAPEMENT MONITORING

The George River weir operated from 21:00 hours on 16 June until nightfall on 22 September. All escapement was counted except during 3 inoperable periods within the target operational dates 15 June through 20 September (Table 1). The first inoperable period occurred on 15 and 16 June prior to completion of the weir installation. Salmon passage was assumed to be zero for these days based on subsequent passage counts. The second inoperable period occurred from 28 June to 7 July when the weir became inoperable due to high water. The "linear method" was used to estimate passage of Chinook, sockeye, and chum salmon. Coho salmon passage was assumed to be zero based on historical information for these dates. Finally, counts on 20 and 21 July were considered partial due to the occurrence of a hole in the weir. The "linear method" was used to estimate Chinook, sockeye, and chum salmon for these dates, and coho salmon passage was assumed to be zero.

Chinook Salmon

A total annual escapement of 2,698 Chinook salmon to George River was determined for the target operational period in 2008 (Table 1). Estimates for missed passage accounted for 142, or 5.3% of the total. The first Chinook salmon was observed on 20 June, daily passage peaked at 424 fish on 21 July, and the last Chinook salmon was observed on 30 August. The median passage date was 18 July and the central 50% of the passage occurred between 14 July and 21 July (Table 1).

Chum Salmon

A total annual escapement of 29,978 chum salmon to George River was determined for the target operational period in 2008 (Table 1). Estimates for missed passage accounted for 4,246, or 14.2% of the total. The first chum salmon was observed on 20 June, daily passage peaked at 2,265 fish on 14 July, and the last chum salmon was observed on 19 September. The median passage date was 16 July and the central 50% of the passage occurred between 12 and 24 July (Table 1).

Coho Salmon

A total annual escapement of 21,931 coho salmon to George River was determined for the target operational period in 2008 (Table 1). The first coho salmon was observed on 26 July, daily

passage peaked at 1,201 fish on 22 August, and the last coho salmon was observed on 22 September, the last day of operation. The median passage date was 25 August and the central 50% of the run occurred between 18 August and 22 August (Table 1).

Sockeye Salmon

A total annual escapement of 94 sockeye salmon to George River was determined for the target operational period in 2008 (Table 1). Estimates for missed passage accounted for 2, or 2.1% of the total. The first sockeye salmon was observed on 13 July and the last was observed on 17 September. Peak daily passage of 8 fish occurred on 4 August. The median passage date was 3 August and the central 50% of the run occurred between 29 July and 15 August (Table 1).

Other Species

It is assumed that small individuals in spawning 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 2008, 2,444 pink salmon were observed passing upstream of the George River weir during the target operational period (Appendix B1). The first pink salmon was observed on 9 July, daily counts peaked at 370 on 26 July, and the last fish was observed on 29 August. Other species observed passing upstream of the George River weir included 9,221 longnose suckers, 218 Arctic grayling, 19 Dolly Varden, 15 whitefish, and 8 northern pike in 2008(Appendix B1). No estimates of missed passage were made for these species during inoperable periods.

Carcass Counts

A total of 5,143 salmon carcasses were recovered on the George River weir in 2008 (Appendix C1). Pink salmon were the most numerous (2,515), followed by chum salmon (2,230), Chinook salmon (349), coho salmon (48), and sockeye salmon (1). Females comprised 29% of pink salmon carcasses, 29.9% of chum salmon carcasses, 5.4% of Chinook salmon carcasses, and 31% of coho salmon carcasses. Non-salmon carcasses consisted of longnose sucker (130), whitefish (59), northern pike (9), arctic grayling (5), and Dolly Varden (1).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Samples were collected from 330 Chinook salmon between 26 June and 10 August at George River weir in 2008. Of those, age was determined for 288 (87% of the total sample), or 10.7% of annual Chinook salmon escapement (Tables 2 and 3). The escapement was partitioned into 3 temporal strata based on sampling dates, with sample sizes of 88, 81, and 119 in the first, second, and third strata, respectively (Table 2). Sample size and distribution was adequate for estimating total annual age composition of the Chinook salmon escapement to the George River weir given that the 95% confidence intervals ranged no wider than ±5.4% (Table 2).

The sample was composed of age-1.2, -1.3, -1.4, -2.3, and -1.5 Chinook salmon in 2008 (Table 2). The annual escapement was predominately age-1.3 (48.7%), -1.4 (27.3%), and -1.2 (19.8%). Age-1.2 fish were all males, age-1.3 fish were predominately males (86.0%), and age-1.4 fish were predominately females (69.7%). Females composed 27.9% of the total (Table 2). Length samples ranged between 390 mm and 990 mm in 2008 and sample sizes ranged from 20 to 118 fish among predominant age-sex categories (Table 3). Mean lengths of female Chinook salmon were 780 mm at age-1.3, and 833 mm at age-1.4. Mean lengths of male age-1.2, -1.3, and -1.4

fish were 513, 686, and 794 mm, respectively. Female Chinook salmon were consistently larger at age than males, and mean length generally increased with age for both females and males (Figure 3).

Chum Salmon

Samples were collected from 886 chum salmon between 8 July and 9 August at George River weir in 2008. Of those, age was determined for 787 (89% of the total sample), or 2.6% of annual chum salmon escapement (Tables 4 and 5). The escapement was partitioned into 4 temporal strata which contained between 192 to 203 samples each (Table 4). Sample size and distribution was adequate for estimating total annual age composition of the chum salmon escapement to the George River weir given that the 95% confidence intervals ranged no wider than ±3.1% (Table 4).

The sample was composed of age-0.2, -0.3, -0.4, and -0.5 chum salmon (Table 4). Escapement was predominately age-0.4 (78.8%) and age-0.3 (17.4%). Females composed 48.4% of the chum salmon escapement (Table 4), and the ratio of females was higher at age-0.3 than at age-0.4 (Figure 4). Length samples ranged between 440 mm and 650 mm in 2008 (Table 5). Sample sizes for annual mean length ranged from 64 to 291 fish among predominant age-sex categories. Mean lengths of male chum salmon were 525 mm at age-0.3, and 570 mm at age-0.4. Mean lengths of females were 525 mm and 539 mm at age-0.3 and -0.4 respectively. Among predominant age-sex classes, mean length at age was greater in males (Figure 3), with mean length of age-0.3 males exceeding that of -0.4 females.

Coho Salmon

Samples were collected from 600 coho salmon between 14 August and 10 September at George River weir in 2008. Of those, age was determined for 429 (72% of the total sample), or 2.0% of annual coho salmon escapement (Tables 6 and 7). The escapement was partitioned into 3 temporal strata containing 148, 140, and 141 samples respectively. Sample size and distribution was adequate for estimating total annual age composition of the coho salmon escapement to the George River weir given that the 95% confidence intervals ranged no wider than ±4.5% (Table 6).

The sample was composed of age-1.1, -2.1, and 3.1 coho salmon in 2008 (Table 6). Escapement was predominately age-2.1 (63.4%), and age-3.1 (36.2%). Females composed 52.3% of the coho salmon escapement (Table 6), and the ratio of females was higher at age-3.1 than at age-2.1 (Figure 4). Length samples ranged between 387 mm and 672 mm in 2008 (Table 7). Mean lengths of male coho salmon were 539 mm at age-2.1, and 542 mm at age-3.1. Mean lengths of females were 544 mm and 549 mm at age-2.1 and -3.1 respectively. Annual mean lengths did not vary considerably between dominant age-sex classes (Figure 3).

WEATHER AND STREAM OBSERVATIONS

A total of 108 complete weather and stream observations were recorded between 10 June and 25 September, 2008 (Appendix D1). Based on twice-daily thermometer observations water temperature at the weir ranged from 5°C to 15°C, with an average of 10.0°C. Based on hourly data logger readings, daily average water temperature ranged from 6.2°C to 14.1°C, with an average daily temperature of 10.3°C (Appendix D2). Air temperature at the weir ranged from -2°C to 27°C, with an average of 11.6°C (Appendix D1). A total of 221.2 mm of precipitation

was recorded throughout the season. River stage ranged from 24 cm to 146 cm, with an average of 48.1 cm (Appendix D1).

RELATED FISHERIES PROJECTS

Kuskokwim River Coho Salmon Investigations

From 18 July to 8 September 3,324 coho salmon were caught at the Kalskag fish wheels. Of those, 2,517 received anchor tags and 308 received radio tags. The George River weir crew observed and recovered 111 tagged fish (3.9%), of those 97 fish had anchor tags and 14 had radio tags. The fixed tracking station at George River weir detected 16 coho salmon equipped with radio tags that passed upstream of the weir. Additionally, 843 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

The stream gage was deployed between 15 June and 25 September 2008. Stream discharge was measured at 3 varying water levels during the 2008 season (Appendix D3–D5) 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 5-year 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.

JUVENILE COHO SALMON COLLECTION

Approximately 70 juvenile coho salmon of varying lengths were collected from the George River in 2008, preserved in the field, and sent to the project investigator at the end of the season. Results of the *Productivity of Kuskokwim Juvenile Coho* study will be reported under AYKSSI project 808 (Greg Ruggerone, Natural Resources Consultants, Inc.; Principal Investigator).

DISCUSSION

ESCAPEMENT MONITORING

Daily and total annual escapements were successfully determined for each of the objective species at George River weir in 2008, despite an early season flood resulting in the inoperable period 28 June to 7 July (Table 1). The flood's impact on escapement monitoring was minimized by the late migration of Chinook and chum salmon to tributaries monitored throughout the Kuskokwim Drainage in 2008 (Elison et al. *In prep* a, b; McEwen *In prep*; Miller and Harper *In prep* a, b; Williams and Shelden *In prep*). Late run timing at George River was also evident from the initially low daily passage counts observed once weir operation resumed (Table 1). Successful operation of the weir during coho salmon migration in 2008 required no estimates for missed passage during the target operational period. Determination of annual escapements at George River weir were considered reliable because estimates for missed passage accounted for less than 20% of total annual escapements: 5.3% of Chinook, 2.1% of sockeye, 14.2% of chum, and 0% of coho salmon escapements.

Chinook Salmon

Abundance

The escapement of 2,698 Chinook salmon in 2008 was below the historical average of 4,617 at George River weir (Figure 5), however, overall Kuskokwim Area Chinook salmon escapement was characterized as average to below average in 2008 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). Though Chinook salmon fell below the minimum escapement goal of 3,100 fish at George River, escapement goals were met or exceeded in 5 of 10 other Kuskokwim River tributaries monitored for Chinook salmon in 2008. Escapement trends vary from year to year among projects, but broad trends are similar (Figure 5). Escapement in 2008 represents a general decline from the historically high levels of recent years.

The commercial and subsistence harvest of Kuskokwim River Chinook salmon has historically been considerable. Though the commercial catch has diminished since the late 1990s, the subsistence fishery has remained intensive for Chinook salmon in the Kuskokwim River (Molyneaux and Brannian 2006). The 2008 subsistence harvest estimate is not yet available, but is likely within 63,177 and 81,577 Chinook salmon, which is the range of annual estimates since 1996 (Smith and Dull 2008). The 2008 commercial harvest of 8,865 Chinook salmon represents an increase from recent years (J. C. Linderman, Jr. Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), but remains a small fraction of annual Chinook salmon harvest, and likely had little impact on escapement.

Run-timing at the Weir

Based on the median passage date and central 50% of escapement, Chinook salmon run timing in 2008 was comparable only to the record late run of 1999 (Figure 6). Late to record late run timing was reported throughout Kuskokwim River escapement projects for Chinook salmon in 2008 (Elison et al. *In prep* a, b; Miller and Harper *In prep* a, b; Williams and Shelden *In prep*). To account for the early season inoperable period at George River weir, run timing was assessed in comparison with Tuluksak and Takotna River weirs, which remained operational throughout their Chinook salmon escapements in 2008, and provided the most reliable data among projects. Similar to George River weir, record late run timing was also observed during the first 25% of Chinook salmon escapement at each of these projects in 2008 (Elison et al. *In prep* b; Miller and Harper *In prep* b). This further suggests the estimate for missed passage during this portion of the run was reliable.

Chum Salmon

Abundance

The escapement of 29,978 chum salmon in 2008 was above the historical average of 20,089 at George River weir (Figure 7). Overall, chum salmon escapements monitored in the Kuskokwim Drainage ranged from below average to above average in 2008 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), and escapement goals were met or exceeded at both projects with rigorous monitoring (Figure 7).

Escapement trends vary from year to year among projects, but broad trends are similar (Figure 7). Though 2008 escapements were lower than in most recent years, they were high relative to historical norms. Reduced market demand for chum salmon in the Kuskokwim River

commercial fishery since the late 1990s likely contributed to the high level of escapement in recent years (Molyneaux and Brannian 2006).

Chum salmon are harvested both commercially and for subsistence use in the Kuskokwim River and harvest has varied historically. The commercial chum salmon harvest over the past 10 years in the Kuskokwim River has averaged about 22,000 fish annually, with a maximum of 69,000 harvested in 2005 (Smith and Dull 2008). In contrast, commercial chum salmon harvest averaged about 335,000 fish annually between 1989 and 1998, with a maximum 750,000 harvested in 1989 (Whitmore et al. 2008). In 2008, 30,516 chum salmon were harvested commercially in the Kuskokwim River (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). A subsistence harvest estimate is not yet available for 2008, but estimates have remained near 50,000 chum salmon in recent years. A total harvest of about 80,000 chum salmon in 2008 is small relative to overall run size, and likely had little impact to escapement.

Run timing at the Weir

Chum salmon run timing at George River weir in 2008 might be considered moderately late overall, with the median passage date intermediate to previous years and the central 50% of passage generally later and more compacted than most previous years (Figure 6). To account for an early season inoperable period, run timing at George River weir was assessed in comparison with Tuluksak and Takotna River weirs and Aniak sonar, which remained operational throughout their chum salmon runs in 2008 and, therefore, provided the best run timing data among projects. Similar to George River weir, late run timing was observed for the first 25% of chum salmon escapement at each of these projects in 2008 (Elison et al. *In prep* b; McEwen *In prep*; Miller and Harper *In prep* b). This supports the reliability of the early season estimate for missed chum salmon passage at George River weir.

Coho Salmon

Abundance

The escapement of 21,931 coho salmon in 2008 was above the historical average of 14,514 at George River weir (Figure 8), and coho salmon escapements monitored in the Kuskokwim Drainage were generally above average in 2008 (Elison et al. *In prep* a, b; Miller and Harper *In prep a*, b; Williams and Shelden *In prep*). The only escapement goal currently established for coho salmon in the Kuskokwim Drainage (Kogrukluk River weir) was exceeded in 2008 (Figure 8).

Commercial harvest pressure on Kuskokwim River coho salmon has historically been considerable. Though the commercial harvest of 142,862 coho salmon in 2008 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) was probably sufficient to noticeably detract from observed escapements at tributary weirs, the harvest probably represents a relatively low exploitation rate considering the escapements observed in 2008. In contrast, the effect of subsistence fishing on individual Kuskokwim River coho salmon stocks was probably negligible in 2008. A subsistence harvest estimate is not yet available for coho salmon in 2008, but estimates have remained near 30,000 fish in recent years (Smith and Dull 2008).

Run timing at the Weir

The timing of the 2008 coho salmon run at the George River weir was earlier and more protracted than most years on record (Figure 6). Coho salmon run timing was dissimilar among Kuskokwim River escapement monitoring projects in 2008 (Elison et al. *In prep* a, b; Miller and Harper *In prep* a, b; Williams and Shelden *In prep*).

Sockeye Salmon

Though sockeye salmon are not a major component of salmon runs to the George River, counts of this species represent a census of their escapement past the weir, and provide a convenient opportunity to monitor their abundance. The escapement of 94 sockeye salmon in 2008 is near the average of 90 fish for years since 1999 (Thalhauser et al. 2008). Escapements have ranged from 16 to 276 fish over these years. Sockeye salmon data prior to 1999 is not considered reliable because the occurrence of this species at George River weir was not anticipated when the project began in 1996. It is unclear to what extent these fish represent a distinct George River spawning population or stray from nearby populations. Most of the George River sockeye salmon passage occurred in the first half of August (Table 1), which is similar to previous years at George River weir (Thalhauser et al. 2008). This is much later than in the more substantial sockeye salmon escapements monitored at Kogrukluk and Kwethluk River weirs, where run timing is concentrated toward the early half of July (Miller and Harper *In prep* a; Williams and Shelden *In prep*).

Other Species

Accurate enumeration of spawning pink salmon at the weirs is confounded by their small size, which allows some individuals to pass between pickets undetected. Though incomplete, weir counts are currently the only index of pink salmon abundance in the Kuskokwim River drainage. Pink salmon are regularly observed at George River weir, but their abundance has historically been low. Annual passage counts have averaged 520 among even years, and 117 among odd years. The total passage count of 2,444 pink salmon in 2008 was a record high at George River weir. Relatively high abundance of pink salmon was also observed at the other escapement monitoring projects in 2008 (Elison et al. *In prep* a, b; McEwen *In prep*; Miller and Harper *In prep* a, b; Williams and Shelden *In prep*). It appears that the contribution of pink salmon to this and other Kuskokwim River systems is greater than previously believed. 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 is needed to improve understanding of this species' run dynamics and importance to the 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 9,221 counted in 2008. 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. Of the monitored tributaries, longnose suckers are also common in the Aniak, Tatlawiksuk, and Takotna rivers, but they appear to be uncommon in or absent from the Kwethluk, Tuluksak, and Kogrukluk rivers (Elison et al. *In prep* a, b; McEwen *In prep*; Miller and Harper *In prep* a, b; Williams and Shelden *In prep*). The numbers of non-salmon species counted through the weir in 2008 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 C1). 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 noticeably decrease following chute installation (Appendix C1). No attempt was made to estimate the number of carcasses that passed undetected over the sucker chutes, or during the July flood event. 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 largely underestimates the number of post-spawners that drifted past the weir site. Regardless of these confounding factors, observations indicated that many more fish passed upstream than could be accounted for from carcass counts. This would indicate a majority of carcasses likely remained near the spawning grounds long enough to contribute to the productivity of the system through the addition of marine-derived nutrients as described by Cederholm et al. (1999; 2000).

Estimating the sex composition of upstream passage from carcass counts is not reliable. The method of counting carcass by sex overestimated the percentage of females in the Chinook and coho salmon escapements. In contrast, for chum salmon the method of estimating sex composition from carcasses severely underestimated the percentage of females derived from ASL sampling. Generally, sexing the carcasses yields female salmon percentages that are considerably lower than the percentage determined from ASL sampling. Regardless of whether its biased high or low, the method of sexing carcasses does not provide reliable sex composition estimates of upstream escapement.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

The objective for estimating the ASL composition of annual Chinook salmon escapement to George River was achieved in 2008. Samples were well distributed throughout the migration, and 95% confidence intervals for age composition in the annual escapement ranged no wider than ±5.4% (Table 2), which was within the ±10% objective.

Age Composition

George River Chinook salmon return primarily as age-1.2, -1.3, and -1.4 fish, which is common among Kuskokwim Area stocks (Molyneaux et al. 2008). Relative to previous years at George River weir, age-1.2 and -1.4 were below average abundance in 2008, and age-1.3 was near average abundance (Figure 9). Age-1.4 abundance was below average at each of the Kuskokwim River escapement projects in 2008, indicating this was a widespread occurrence (Elison et al. *In prep* a, b; McEwen *In prep*; Miller and Harper *In prep* a, b; Molyneaux et al. *In prep*; Williams and Shelden *In prep*). Age-1.3 abundance was near or above average among these samples, and age-1.2 abundance was mixed. Appendix E1 provides a brood table of available George River data. Too few years are yet complete to assess spawner-recruit relationships, and these data do not account for the fraction of George River fish taken in the harvest that occurs downstream of the weir. Without stock-specific exploitation information, the utility of this table is limited. However, as more escapement data become available, this brood table will provide perspectives on abundance of parent years vs. abundance of surviving offspring.

Although sample sizes within strata are generally too small at the George River weir to depict significant variations in age composition over the Chinook salmon run, compiling these data with past years may indicate the presence of general trends (Figure 10). Patterns are unclear for age-1.2 and -1.3 fish, however, age-1.4 fish appear to migrate later in proportion to the other age classes.

Sex Composition

The abundance estimate of 751 female Chinook salmon in the 2008 was below previous years at George River weir (Figure 11). Previous estimates have ranged from 838 to 3,419 females and averaged 1,760. Since female Chinook salmon typically return at age-1.4 to the Kuskokwim Area (Molyneaux et al. 2008), their low abundance correlated to a poor return of this age class in 2008. The temporal variation in sex composition across strata in 2008 is consistent with the historical pattern at George River weir, which suggests the ratio of female Chinook salmon tends to increase over the run (Figure 12). The significance of this pattern is unknown and may be investigated in future years.

Length Composition

Mean lengths for each age-sex category in 2008 were generally similar to those of recent years (Figure 13). Mean length increased with age, and females tended to be longer than males of the same age, which is a pattern commonly observed in Chinook salmon throughout the Kuskokwim River drainage (Molyneaux et al. 2008). There appear to be no discernable trends in the variation of mean lengths across strata at George River weir (Figure 14). Kuskokwim Area Chinook salmon rarely show an obvious intra-seasonal trend in lengths by age-sex class over the course of the season, and apparent trends tend to be weak and their significance is unknown (Molyneaux et al. 2008).

Management Implications

Salmon are harvested in both subsistence and commercial fisheries that occur in the main stem Kuskokwim River far downstream from George River and other spawning areas (Whitmore et al. 2008). Most harvest is taken with gillnets that are size selective for discreet components of the returning salmon population (Molyneaux and Brannian 2006). The potential impact of the size selective harvest is perhaps most consequential to Chinook salmon because of their wide range of size at maturity.

Subsistence fishermen tend to favor using gillnets hung with large mesh web (e.g., 6 to 8-inch stretch mesh; Smith and Dull 2008), so their harvest is selective for the larger and older Chinook salmon (Molyneaux et al. 2008). This is the same segment of the population where females are most common. The low abundance of age-1.4 Chinook salmon in 2008 was likely compounded by the subsistence fishery, given its size selectivity.

In contrast, commercial fishermen were limited to using 6-inch or smaller mesh sizes in 2008 (J. C. Linderman, Jr. Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), so their harvest was selective for smaller Chinook salmon in a size range dominated more by males (Molyneaux et al. 2008). The low abundance of age-1.2 in 2008 was likely compounded by the commercial fishery, but only to a small degree given this catch was small relative to the total run.

Chum Salmon

The objective for estimating the ASL composition of annual chum salmon escapement to George River was achieved in 2008. Pulse samples were well distributed throughout the migration, and 95% confidence intervals for the proportions of age composition in the annual escapement ranged no wider than ±3.1% (Table 4), which was within the ±10% objective.

Age Composition

George River chum salmon return primarily as age-0.3, and -0.4 fish, which is common among Kuskokwim Area stocks (Molyneaux et al. 2008). Relative to previous years at George River weir, age-0.3 abundance was below average, and age-0.4 abundance was high in 2008 (Figure 9). Age-0.4 fish were the majority in 7 of the 8 chum salmon escapements monitored in the Kuskokwim drainage in 2008, indicating a widespread occurrence (Molyneaux et al. *In prep*).

Appendix E2 provides a brood table of available George River data. Too few years are yet complete to assess spawner-recruit relationships, and these data do not account for the fraction of George River fish taken in the harvest that occurs downstream of the weir. Without stock-specific exploitation information, the utility of this table is limited. However, as more escapement data become available, this brood table will provide perspectives on abundance of parent years vs. abundance of surviving offspring.

Although sample sizes within strata are generally too small at the George River weir to depict significant temporal variations in age composition, compiling these data with past years may indicate the presence of general trends (Figure 15). Though noisy, the data indicate younger age-0.2 and -0.3 fish tend to increase over the run in proportion to older age-0.4 fish. This suggests that age tends to decrease over the chum salmon run at George River weir.

Sex Composition

The relatively high abundance of chum salmon resulted in an above average abundance of female chum salmon in 2008 (Figure 11). The 48% female ratio in 2008 was similar to most previous years which tend to approximate 50%. The temporal variation in sex composition across strata in 2008 is consistent with the historical pattern at George River weir, which suggests the ratio of female chum salmon tends to increase over the run (Figure 12). The significance of this pattern is unknown and may be investigated in future years.

Length Composition

Mean lengths for each age-sex category in 2008 were generally similar to those of recent years, but generally less than those in years prior to 2003 (Figure 16). Mean length increased slightly with age, and was greater in males than females of the same age, which is a pattern broadly observed in Kuskokwim River chum salmon spawning populations (Molyneaux et al. 2008). There appears to be a tendency for length at age to decrease slightly over the run at George River weir (Figure 17), which is also broadly observed in Kuskokwim River chum salmon spawning populations (Molyneaux et al. 2008). Again, small sample sizes decrease the certainty surrounding any one point, however strong commonality of patterns between 2008 and most pervious years do suggest actual trends.

Coho Salmon

The objective for estimating the ASL composition of annual coho salmon escapement to George River was achieved in 2008. Pulse samples were distributed evenly over the run, and 95%

confidence intervals for age composition in the annual escapement ranged no wider than ±4.5% (Table 6), which was within the ±10% objective.

Age Composition

George River coho salmon return primarily as age-2.1 fish, which is common among Kuskokwim Area stocks (Molyneaux et al. 2008). Relative to previous years at George River weir, age-2.1 abundance was average, and age-3.1 abundance was high in 2008 (Figure 9). The high abundance of age-3.1 fish shows a strong correlation with the cohort strength observed in 2007, and record high escapement observed in the parent year 2003. Above average age-3.1 abundance was also observed in other Kuskokwim River coho salmon spawning populations in 2008 (Molyneaux et al. *In prep*). Appendix E3 provides a brood table of available George River data. Too few years are yet complete to assess spawner-recruit relationships, and these data do not account for the fraction of George River fish taken in the harvest that occurs downstream of the weir. Without stock-specific exploitation information, the utility of this table is limited. However, as more escapement data become available, this brood table will provide perspectives on abundance of parent years vs. abundance of surviving offspring.

Although sample sizes within strata are generally too small at the George River weir to depict significant variations in age composition over the coho salmon run, compiling these data with past years may indicate the presence of general trends (Figure 18). Although age appeared to have increased over the run in 2008, there is no clear pattern among years.

Sex Composition

Both the abundance and proportion of females in the 2008 coho salmon escapement at George River weir were above average (Figure 11). This is partly the result a high proportion of females (63%) apparent among age-3.1 fish (Figure 4). The temporal variation sex composition across strata in 2008 is consistent with the historical pattern at George River weir, which suggests the ratio of female coho salmon tends to increase over the run (Figure 12). The significance of this pattern is unknown and may be investigated in future years

Length Composition

Mean length at age-2.1 in 2008 was near the average of previous years determined at George River weir (Figure 19). In some years mean length-at-age has been greater in females, but confidence intervals overlapped broadly between age-sex classes in 2008 (Figure 3). Similar to previous years at George River weir, mean length at age-2.1 varied little over the run in 2008 (Figure 20). A slight tendency for length-at-age to increase over the run has been observed at other Kuskokwim Area escapement projects (Molyneaux et al. 2008).

WEATHER AND STREAM OBSERVATIONS

Water temperature was well below its historical average at George River weir during the first half of the 2008 season, and near or above average during the latter half of the season (Figure 21). Cooler temperatures were observed throughout Kuskokwim River escapement projects in June and July (Elison et al. *In prep* a, b; Miller and Harper *In prep* a, b; Williams and Shelden. *In prep*) which may have contributed to the delayed run timing of salmon during this period. After the early season flood, water level remained well below the historical average (Figure 22). The low water condition that persisted during coho salmon migration at George River weir may have contributed to protracted run timing in 2008.

CONCLUSIONS

- Daily and total annual escapements were successfully determined for each of the objective species at George River weir in 2008.
- The impact of an early season flood to escapement monitoring at George River weir was minimized by the late migration of Chinook and chum salmon in 2008.
- Chinook salmon escapement was below the historical average at George River weir in 2008, while chum and coho salmon escapements were well above their historical averages.
- Late run timing of Chinook and chum salmon was observed at George River weir and across Kuskokwim River escapement projects in 2008.
- The abundances of age-1.2 and -1.4 Chinook salmon in 2008 were below their historical average at George River weir, while the abundance of age-1.3 Chinook salmon was near average.
- The low abundance of age-1.4 Chinook salmon correlated to low abundance of female Chinook salmon to George River in the 2008.
- The abundance of age-0.3 chum salmon in 2008 was below its historical average at George River weir, while the abundance of age-0.4 chum salmon was high.
- The high abundance of age-3.1 fish in 2008 shows a strong correlation with the cohort strength observed in 2007, and record high escapement observed in the parent year 2003.

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TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at George River weir, 2008.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
6/15	0 [a]	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	0
6/16	0 [a]	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	0	0 [a]	0 [a]	0
6/17	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
6/19	0	0	0	0	0	0	0	0	0	0	0	0
6/20	2	2	0	1	1	0	0	0	0	0	0	0
6/21	0	2	0	0	1	0	0	0	0	0	0	0
6/22	2	4	0	18	19	0	0	0	0	0	0	0
6/23	1	5	0	12	31	0	0	0	0	0	0	0
6/24	1	6	0	22	53	0	0	0	0	0	0	0
6/25	1	7	0	51	104	0	0	0	0	0	0	0
6/26	2	9	0	26	130	0	0	0	0	0	0	0
6/27	2	11	0	136	266	1	0	0	0	0	0	0
6/28	4 [b]	15 [b]	1	134 [b]	400 [b]	1	0 [b]	0 [b]	0	0 [b]	0 [b]	0
6/29	7 [a]	22 [a]	1	187 [a]	587 [a]	2	0 [a]	0 [a]	0	0 [a]	0 [a]	0
6/30	9 [a]	32 [a]	1	240 [a]	828 [a]	3	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/01	12 [a]	44 [a]	2	294 [a]	1,121 [a]	4	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/02	14 [a]	58 [a]	2	347 [a]	1,468 [a]	5	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/03	17 [a]	75 [a]	3	400 [a]	1,868 [a]	6	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/04	19 [a]	94 [a]	3	453 [a]	2,321 [a]	8	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/05	22 [a]	115 [a]	4	506 [a]	2,827 [a]	9	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/06	24 [a]	139 [a]	5	559 [a]	3,386 [a]	11	0 [a]	0 [a]	0	0 [a]	0 [a]	0
7/07	27 [b]	166 [b]	6	635 [b]	4,021 [b]	13	0 [b]	0 [b]	0	0 [b]	0 [b]	0
7/08	50	216	8	757	4,778	16	0	0	0	0	0	0
7/09	8	224	8	574	5,352	18	0	0	0	0	0	0
7/10	13	237	9	843	6,195	21	0	0	0	0	0	0
7/11	10	247	9	1,063	7,258	24	0	0	0	0	0	0
7/12	41	288	11	1,827	9,085	30	0	0	0	0	0	0
7/13	231	519	19	1,764	10,849	36	0	0	0	1	1	1
7/14	157	676	25	2,265	13,114	44	0	0	0	0	1	1
7/15	247	923	34	1,358	14,472	48	0	0	0	1	2	2
7/16	122	1,045	39	955	15,427	**51**	0	0	0	1	3	3
7/17	267	1,312	49	1,101	16,528	55	0	0	0	0	3	3
7/18	34	1,346	**50**	696	17,224	57	0	0	0	0	3	3
7/19	134	1,480	55	1,221	18,445	62	0	0	0	1	4	4
7/20	175 [c]	1,655 [c]	61	942 [c]	19,387 [c]	65	0 [c]	0 [c]	0	1 [c]	5 [c]	5
7/21	424 [c]	2,079 [c]	77	925 [c]	20,311 [c]	68	0 [c]	0 [c]	0	2 [c]	7 [c]	7
7/22	72	2,151	80	970	21,281	71	0	0	0	3	10	10
7/23	106	2,257	84	845	22,126	74	0	0	0	1	11	11
7/24	37	2,294	85	872	22,998	77	0	0	0	0	11	11
7/25	87	2,381	88	933	23,931	80	0	0	0	0	11	11
7/26	70	2,451	91	1,037	24,968	83	4	4	0	3	14	14
7/27	56	2,507	93	613	25,581	85	4	8	0	3	17	18
7/28	20	2,527	94	432	26,013	87	2	10	0	4	21	22
7/29	14	2,541	94	427	26,440	88	3	13	0	5	26	27
7/30	13	2,554	95	535	26,975	90	7	20	0	4	30	32
7/31	18	2,572	95	363	27,338	91	13	33	0	3	33	35
8/01	35	2,607	97	605	27,943	93	18	51	0	6	39	41
8/02	14	2,621	97	278	28,221	94	27	78	0	4	43	45
8/03	7	2,628	97	159	28,380	95	18	96	0	4	47	**50**
8/04	14	2,642	98	298	28,678	96	51	147	1	8	55	58

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Table 1.–Page 2 of 2.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
8/05	15	2,657	98	161	28,839	96	52	199	1	2	57	60
8/06	7	2,664	99	207	29,046	97	66	265	1	2	59	63
8/07	4	2,668	99	136	29,182	97	42	307	1	0	59	63
8/08	3	2,671	99	132	29,314	98	223	530	2	5	64	68
8/09	7	2,678	99	126	29,440	98	206	736	3	1	65	69
8/10	3	2,681	99	84	29,524	98	316	1,052	5	0	65	69
8/11	5	2,686	100	56	29,580	99	408	1,460	7	2	67	71
8/12	2	2,688	100	39	29,619	99	225	1,685	8	0	67	71
8/13	0	2,688	100	30	29,649	99	324	2,009	9	1	68	72
8/14	1	2,689	100	29	29,678	99	203	2,212	10	2	70	74
8/15	1	2,690	100	18	29,696	99	578	2,790	13	1	71	75
8/16	1	2,691	100	17	29,713	99	966	3,756	17	1	72	76
8/17	1	2,692	100	30	29,743	99	1,097	4,853	22	2	74	79
8/18	0	2,692	100	24	29,767	99	898	5,751	26	0	74	79
8/19	0	2,692	100	18	29,785	99	634	6,385	29	2	76	81
8/20	1	2,693	100	19	29,804	99	407	6,792	31	2	78	83
8/21	2	2,695	100	10	29,814	99	1,029	7,821	36	1	79	84
8/22	0	2,695	100	27	29,841	100	1,201	9,022	41	2	81	86
8/23	1	2,696	100	27	29,868	100	1,172	10,194	46	0	81	86
8/24	0	2,696	100	16	29,884	100	530	10,724	49	2	83	88
8/25	0	2,696	100	10	29,894	100	383	11,107	**51**	2	85	90
8/26	0	2,696	100	3	29,897	100	149	11,256	51	0	85	90
8/27	1	2,697	100	17	29,914	100	1,167	12,423	57	0	85	90
8/28	0	2,697	100	1	29,915	100	954	13,377	61	5	90	96
8/29	0	2,697	100	3	29,918	100	662	14,039	64	0	90	96
8/30	1	2,698	100	5	29,923	100	207	14,246	65	0	90	96
8/31	0	2,698	100	1	29,924	100	667	14,913	68	0	90	96
9/01	0	2,698	100	2	29,926	100	984	15,897	72	1	91	97
9/02	0	2,698	100	0	29,926	100	699	16,596	76	0	91	97
9/03	0	2,698	100	3	29,929	100	787	17,383	79	2	93	99
9/04	0	2,698	100	3	29,932	100	827	18,210	83	0	93	99
9/05	0	2,698	100	0	29,932	100	68	18,278	83	0	93	99
9/06	0	2,698	100	2	29,934	100	22	18,300	83	0	93	99
9/07	0	2,698	100	3	29,937	100	474	18,774	86	0	93	99
9/08	0	2,698	100	1	29,938	100	793	19,567	89	0	93	99
9/09	0	2,698	100	4	29,942	100	174	19,741	90	0	93	99
9/10	0	2,698	100	7	29,949	100	124	19,865	91	0	93	99
9/11	0	2,698	100	4	29,953	100	304	20,169	92	0	93	99
9/12	0	2,698	100	3	29,956	100	119	20,288	93	0	93	99
9/13	0	2,698	100	2	29,958	100	320	20,608	94	0	93	99
9/14	0	2,698	100	0	29,958	100	311	20,919	95	0	93	99
9/15	0	2,698	100	3	29,961	100	138	21,057	96	0	93	99
9/16	0	2,698	100	5	29,966	100	89	21,146	96	0	93	99
9/17	0	2,698	100	5	29,971	100	241	21,387	98	1	94	100
9/18	0	2,698	100	4	29,975	100	102	21,489	98	0	94	100
9/19	0	2,698	100	3	29,978	100	115	21,604	99	0	94	100
9/20	0	2,698	100	0	29,978	100	327	21,931	100	0	94	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 2008 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.	%
6/26-27;7/8-14	88	M	0	0.0	126	13.6	0	0.0	524	56.8	63	6.8	10	1.1	31	3.4	0	0.0	755	81.8
(6/15-7/15)		F	0	0.0	0	0.0	0	0.0	42	4.6	115	12.5	0	0.0	11	1.1	0	0.0	168	18.2
		Subtotal[a]	0	0.0	126	13.6	0	0.0	566	61.4	178	19.3	10	1.1	42	4.5	0	0.0	923	100.0
7/16-19	81	M	0	0.0	154	21.0	0	0.0	325	44.5	81	11.1	0	0.0	0	0.0	0	0.0	560	76.5
(7/16-20)		F	0	0.0	0	0.0	0	0.0	36	4.9	118	16.1	0	0.0	18	2.5	0	0.0	172	23.5
		Subtotal[a]	0	0.0	154	21.0	0	0.0	361	49.4	199	27.2	0	0.0	18	2.5	0	0.0	732	100.0
07/22-26,28-	119	M	0	0.0	254	24.4	0	0.0	281	26.9	79	7.6	9	0.9	9	0.8	0	0.0	631	60.5
8/5,7-8,10		F	0	0.0	0	0.0	0	0.0	105	10.1	280	26.9	9	0.8	17	1.7	0	0.0	412	39.5
(7/21-9/20)		Subtotal[a]	0	0.0	254	24.4	0	0.0	386	37.0	359	34.5	18	1.7	26	2.5	0	0.0	1,043	100.0
Season[b]	288	M	0	0.0	534	19.8	0	0.0	1,130	41.9	223	8.3	19	0.7	40	1.5	0	0.0	1,947	72.1
		F	0	0.0	0	0.0	0	0.0	184	6.8	513	19.0	9	0.3	46	1.7	0	0.0	751	27.9
		Total	0	0.0	534	19.8	0	0.0	1,314	48.7	736	27.3	28	1.0	86	3.2	0	0.0	2,698	100.0
		95% C.I. (%)				(±4.3)				(±5.4)		(±4.8)		(±1.1)		(±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 3.–Mean length (mm) of Chinook salmon at the George River weir in 2008 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
6/26-27,7/8-14 (6/15-7/15)	M	Mean Length	558	695	746	685	870
		SE[b]	12	9	36		51
		Range	470-620	560-870	650-905	685-685	785-960
		Sample Size	12	50	6	1	3
	F	Mean Length		789	837		740
		SE[b]		10	23		-
		Range		760-805	650-920		740-740
		Sample Size	0	4	11	0	1
7/16-19 (7/16-20)	M	Mean Length	487	667	770		
		SE[b]	12	13	31		
		Range	390-575	500-850	595-940		
		Sample Size	17	36	9	0	0
	F	Mean Length		764	841		820
		SE[b]		24	19		40
		Range		710-820	680-980		780-860
		Sample Size	0	4	13	0	2
07/22-26,28-8/5,7-8,10 (7/21-9/20)	M	Mean Length	506	689	857	670	805
		SE[b]	12	15	24		
		Range	415-625	440-820	740-945	670-670	805-805
		Sample Size	29	32	9	1	1
	F	Mean Length		781	827	750	770
		SE[b]		12	11		
		Range		695-840	710-990	750-750	770-770
		Sample Size	0	12	32	1	2
Season[a]	M	Mean Length	513	686	794	678	856
		SE[b]	7	6	16		
		Range	390-625	440-870	595-945	670-685	785-960
		Sample Size	58	118	24	2	4
	F	Mean Length		780	833	750	783
		SE[b]		8	9		
		Range		695-840	650-990	750-750	740-860
		Sample Size	0	20	56	1	5

[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 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %
7/8-11	192	M	0	0.0	452	3.1	7,613	52.6	226	1.6	8,291	57.3
(6/15-7/15)		F	75	0.5	528	3.7	5,352	37.0	226	1.5	6,181	42.7
		Subtotal[a]	75	0.5	980	6.8	12,965	89.6	452	3.1	14,472	100.0
7/18-20,22	196	M	0	0.0	1,158	12.3	3,571	37.8	290	3.1	5,019	53.1
(7/16-25)		F	0	0.0	1,448	15.3	2,944	31.1	48	0.5	4,440	46.9
		Subtotal[a]	0	0.0	2,606	27.6	6,515	68.9	338	3.6	9,459	100.0
7/28-30	196	M	22	0.5	263	6.1	1,160	27.0	44	1.0	1,488	34.7
(7/26-8/2)		F	22	0.5	788	18.4	1,926	44.9	65	1.6	2,802	65.3
		Subtotal[a]	44	1.0	1,051	24.5	3,086	71.9	109	2.6	4,290	100.0
8/7-9	203	M	17	1.0	190	10.8	442	25.1	26	1.5	675	38.4
(8/3-9/20)		F	52	2.9	381	21.7	623	35.5	26	1.5	1,082	61.6
		Subtotal[a]	69	3.9	571	32.5	1,065	60.6	52	3.0	1,757	100.0
Season[b]	787	M	39	0.1	2,064	6.9	12,785	42.6	585	2.0	15,474	51.6
		F	149	0.5	3,144	10.5	10,845	36.2	366	1.2	14,504	48.4
		Total	188	0.6	5,208	17.4	23,630	78.8	951	3.2	29,978	100.0
		95% C.I. (%)		(±0.5)		(±2.8)		(±3.1)		(±1.5)	-	-

[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 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
7/8-11 (6/15-7/15)	M	Mean Length		582	580	560
		SE[b]		6	3	29
		Range		560-605	515-645	510-610
		Sample Size	0	6	101	3
	F	Mean Length	545	530	551	570
		SE[b]		6	3	6
		Range	545-545	500-550	490-620	560-580
		Sample Size	1	7	71	3
7/18-20,22 (7/16-25)	M	Mean Length		552	552	568
		SE[b]		6	4	13
		Range		500-620	440-650	525-610
		Sample Size	0	24	74	6
	F	Mean Length		531	530	585
		SE[b]		6	4	-
		Range		440-575	445-620	585-585
		Sample Size	0	30	61	1
7/28-30 (7/26-8/2)	M	Mean Length	490	561	567	603
		SE[b]		9	5	23
		Range	490-490	500-610	465-650	580-625
		Sample Size	1	12	53	2
	F	Mean Length	540	520	530	567
		SE[b]		5	4	2
		Range	540-540	470-610	450-600	565-570
		Sample Size	1	36	87	3
8/7-9 (8/3-9/20)	M	Mean Length	525	546	556	577
		SE[b]	15	8	5	19
		Range	510-540	440-600	485-635	540-605
		Sample Size	2	22	51	3
	F	Mean Length	498	507	514	523
		SE[b]	9	4	4	22
		Range	475-530	465-570	445-580	490-565
		Sample Size	6	44	72	3
Season[a]	M	Mean Length	505	559	570	568
		SE[b]		4	2	
		Range	490-540	440-620	440-650	510-625
		Sample Size	3	64	279	14
	F	Mean Length	528	525	539	568
		SE[b]		3	2	
		Range	475-545	440-610	445-620	490-585
		Sample Size	8	117	291	10

[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 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 1.1 Esc.	1.1 %	2.1 Esc.	2.1 %	3.1 Esc.	3.1 %	Total Esc.	Total %
8/14-18	148	M	0	0.0	3,223	41.2	898	11.5	4,122	52.7
(6/25-8/21)		F	0	0.0	2,537	32.4	1,163	14.9	3,699	47.3
		Subtotal[a]	0	0.0	5,760	73.6	2,061	26.4	7,821	100.0
8/25-28,30	140	M	101	1.4	2,584	36.4	1,064	15.0	3,749	52.9
(8/22-31)		F	0	0.0	1,722	24.3	1,621	22.9	3,343	47.1
		Subtotal[a]	101	1.4	4,306	60.7	2,685	37.9	7,092	100.0
9/5,8-10	141	M	0	0.0	1,593	22.7	995	14.2	2,588	36.9
(9/1-20)		F	0	0.0	2,240	31.9	2,190	31.2	4,430	63.1
		Subtotal[a]	0	0.0	3,833	54.6	3,185	45.4	7,018	100.0
Season[b]	429	M	101	0.5	7,400	33.8	2,957	13.5	10,459	47.7
		F	0	0.0	6,498	29.6	4,974	22.7	11,472	52.3
		Total	101	0.5	13,898	63.4	7,931	36.2	21,931	100.0
		95% C.I. (%)		(±0.6)		(±4.5)		(±4.5)	-	-

[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 2008 based on escapement samples collected with a live trap.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/14-18 (6/25-8/21)	M	Mean Length		534	533
		SE[b]		5	10
		Range		445-625	450-585
		Sample Size	0	61	17
	F	Mean Length		547	547
		SE[b]		4	5
		Range		485-600	485-600
		Sample Size	0	48	22
8/25-28,30 (8/22-31)	M	Mean Length	509	539	536
		SE[b]	4	7	11
		Range	505-513	387-623	412-595
		Sample Size	2	51	21
	F	Mean Length		539	547
		SE[b]		6	6
		Range		472-607	444-615
		Sample Size	0	34	32
9/5,8-10 (9/1-20)	M	Mean Length		548	557
		SE[b]		8	9
		Range		466-672	447-627
		Sample Size	0	32	20
	F	Mean Length		544	551
		SE[b]		5	5
		Range		480-622	479-606
		Sample Size	0	45	44
Season[a]	M	Mean Length	509	539	542
		SE[b]	-	4	6
		Range	505-513	387-672	412-627
		Sample Size	2	144	58
	F	Mean Length		544	549
		SE[b]		3	4
		Range		472-622	444-615
		Sample Size	0	127	98

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

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

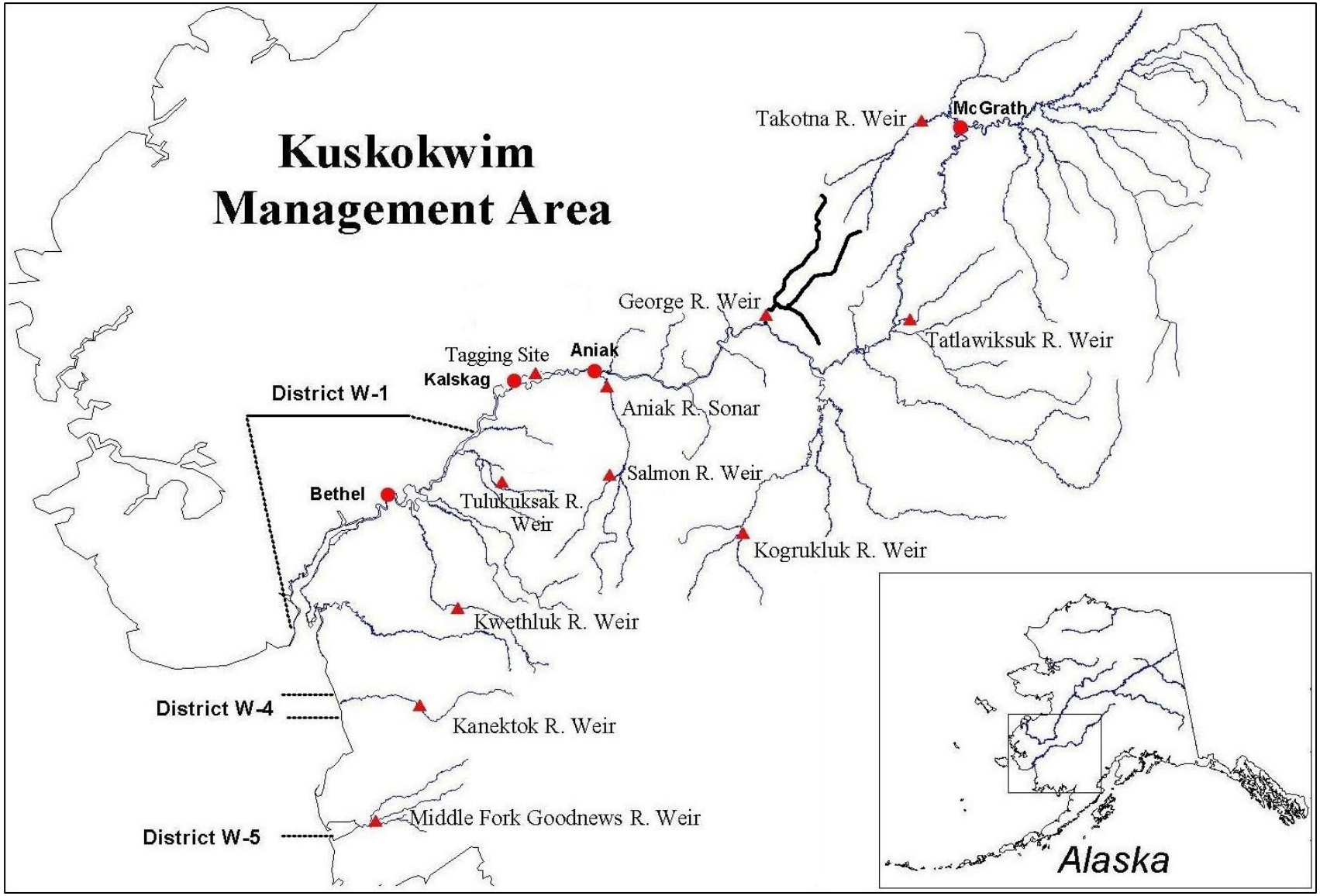


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the George River.

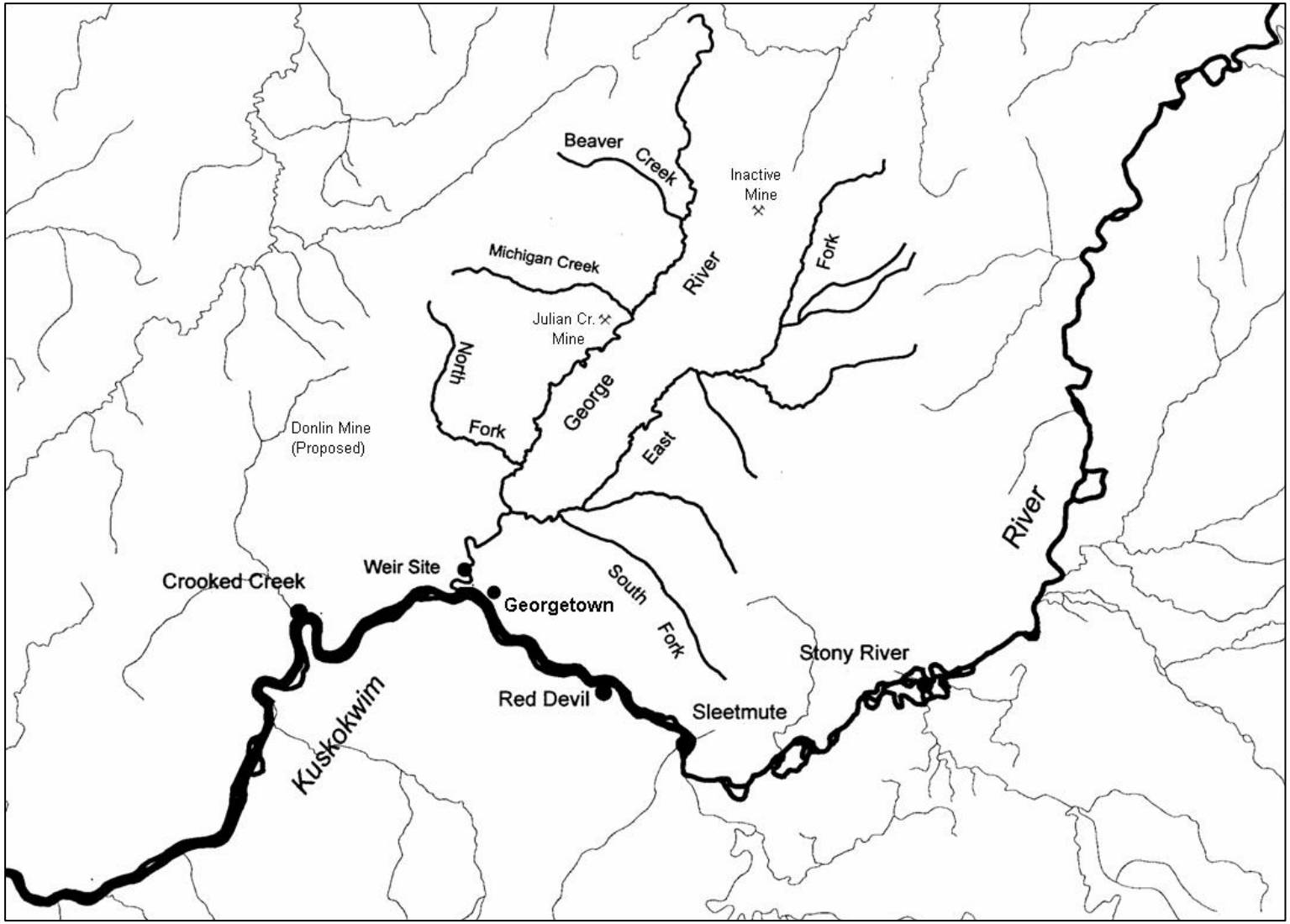


Figure 2.–George River, middle Kuskokwim River basin.

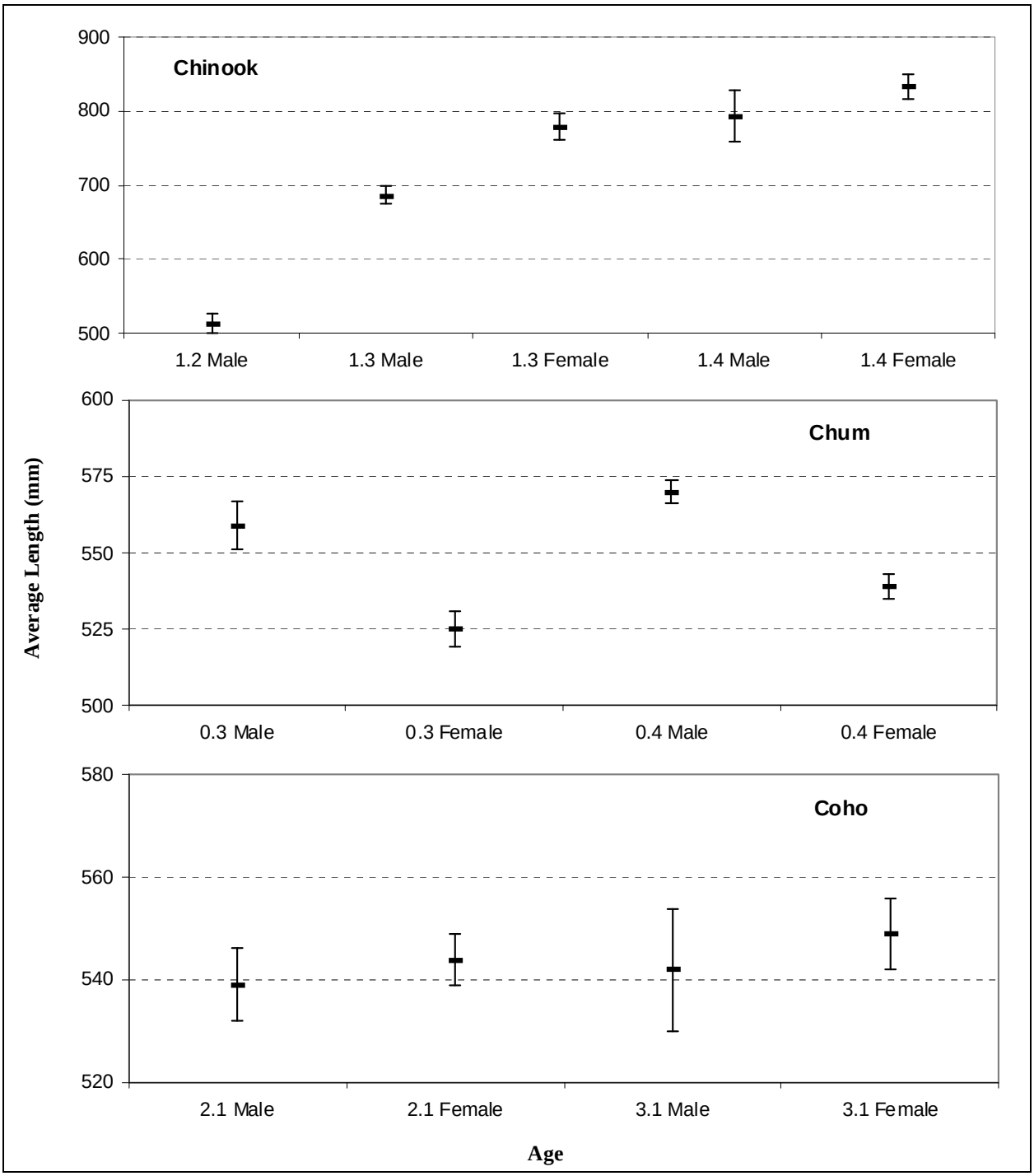


Figure 3.–Mean length at age of male and female Chinook, chum, and coho salmon escapements at George River weir in 2008, with 95% confidence intervals.

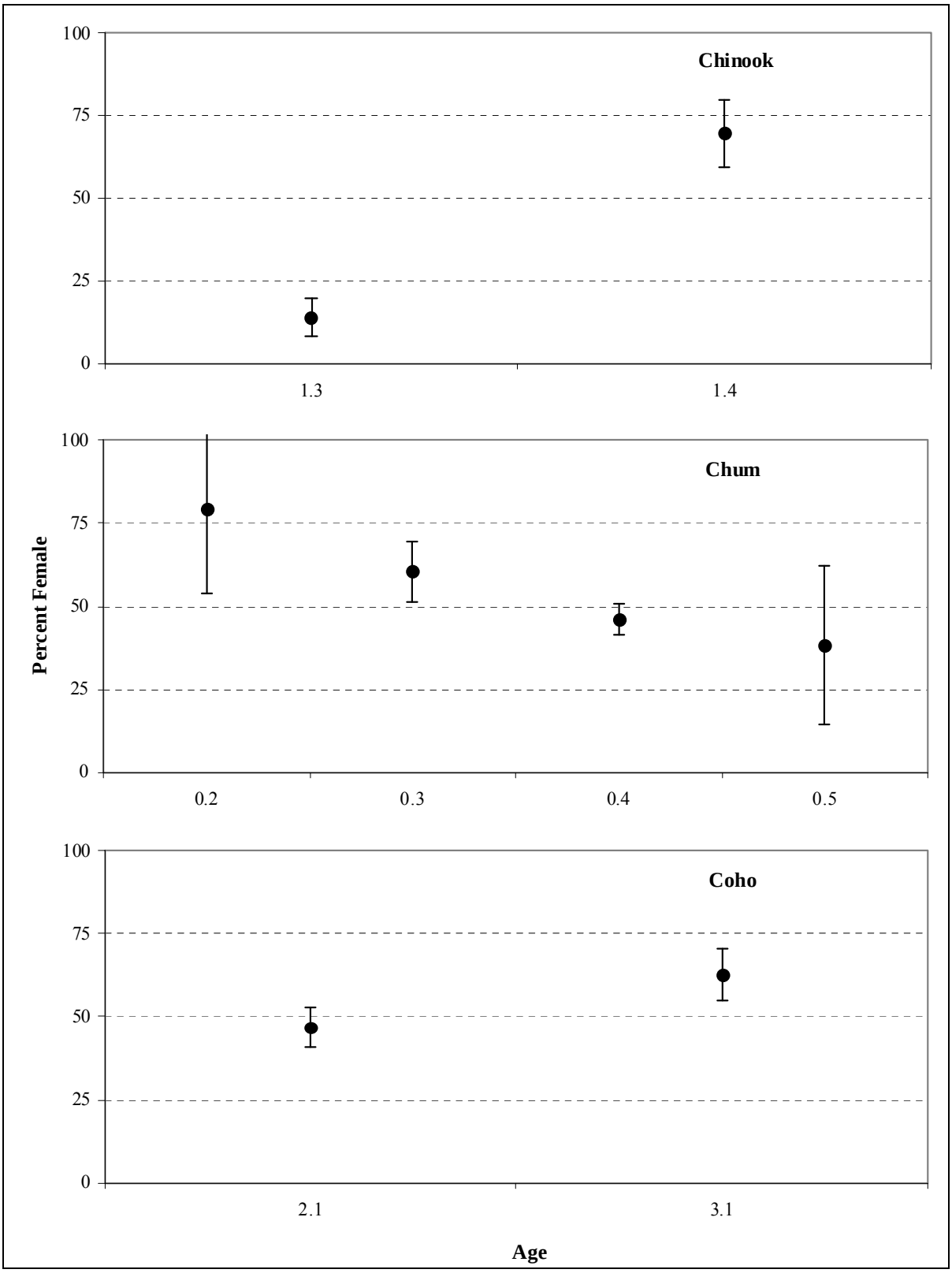


Figure 4.–Percent female at age in annual escapements of Chinook, chum, and coho salmon at George River weir in 2008, with 95% confidence intervals.

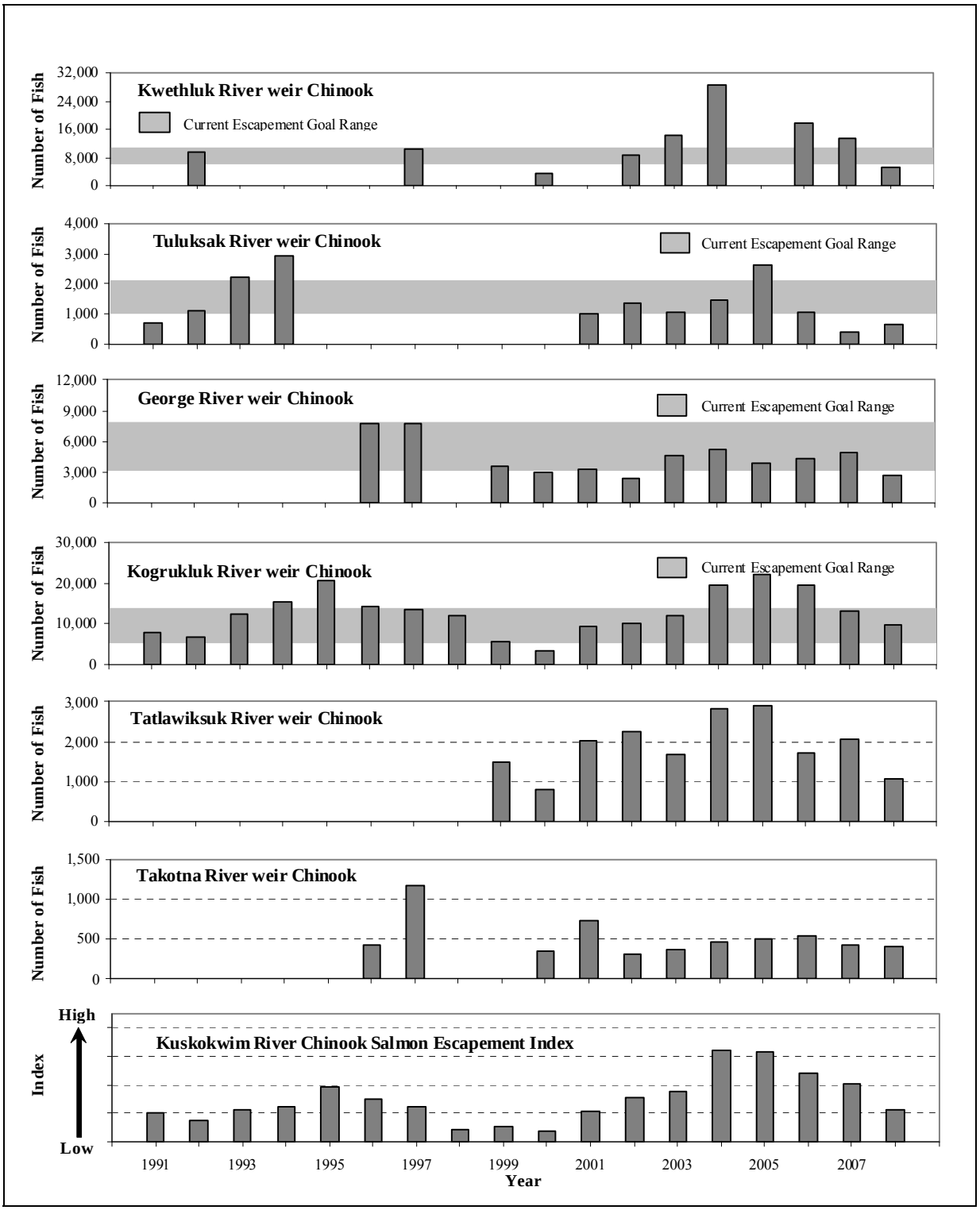
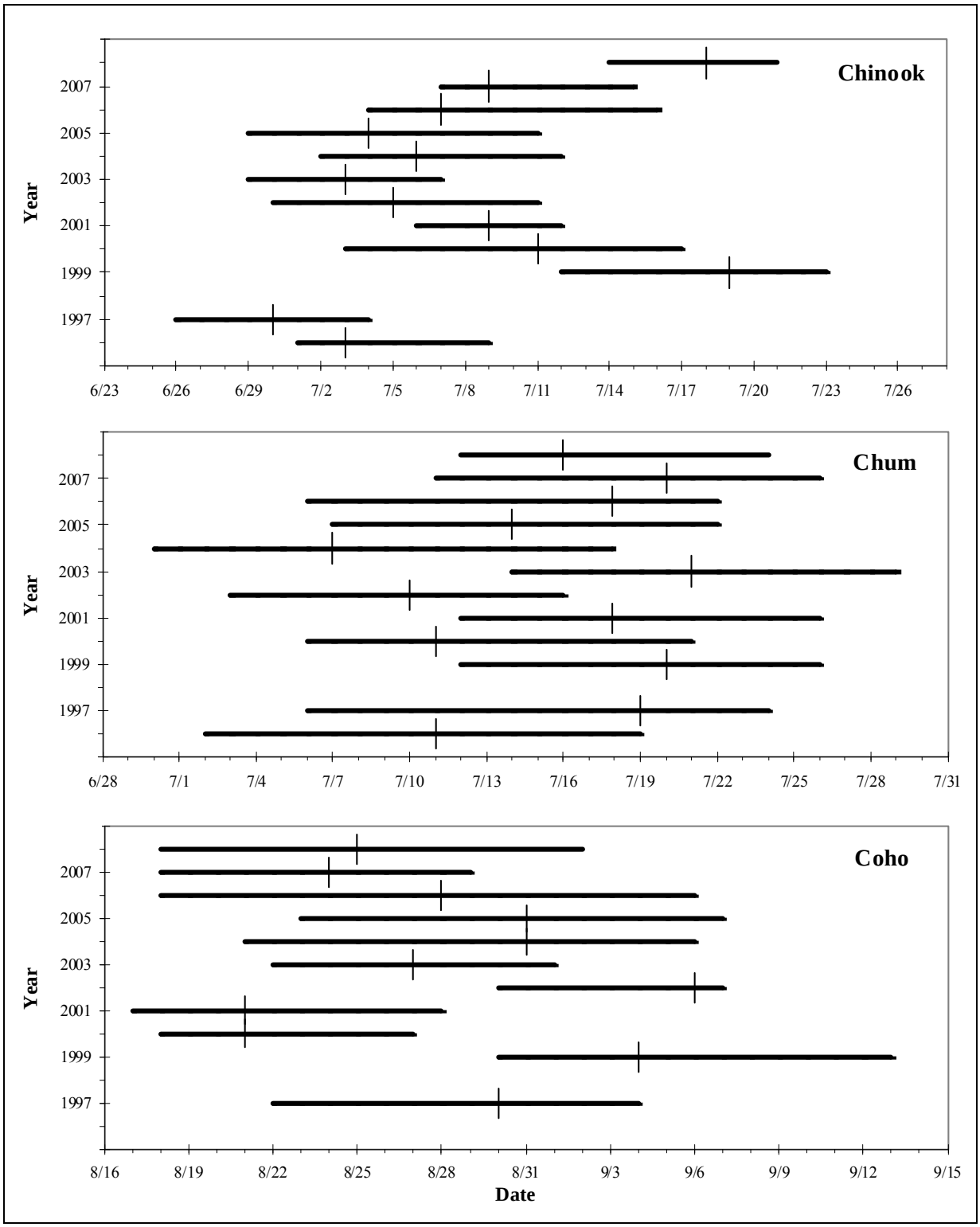


Figure 5.–Annual Chinook salmon escapement into 6 Kuskokwim River tributaries and the Kuskokwim River Chinook salmon escapement indices, 1991–2008.



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

Figure 6.–Annual run timing of Chinook, chum, and coho salmon based on cumulative percent passage at George River weir, 1996–2008.

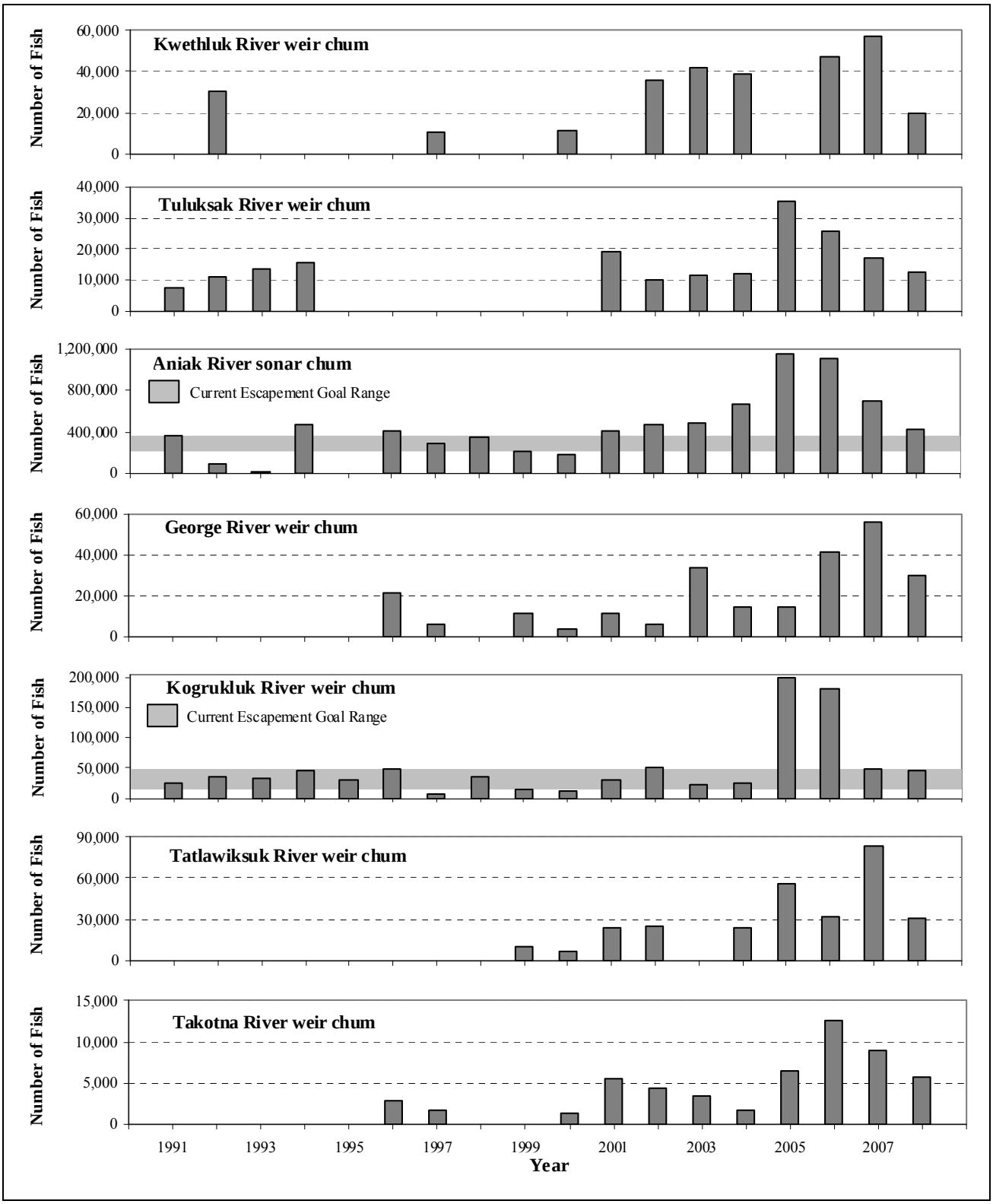


Figure 7.–Annual chum salmon escapement into 7 Kuskokwim River tributaries, 1991–2008.

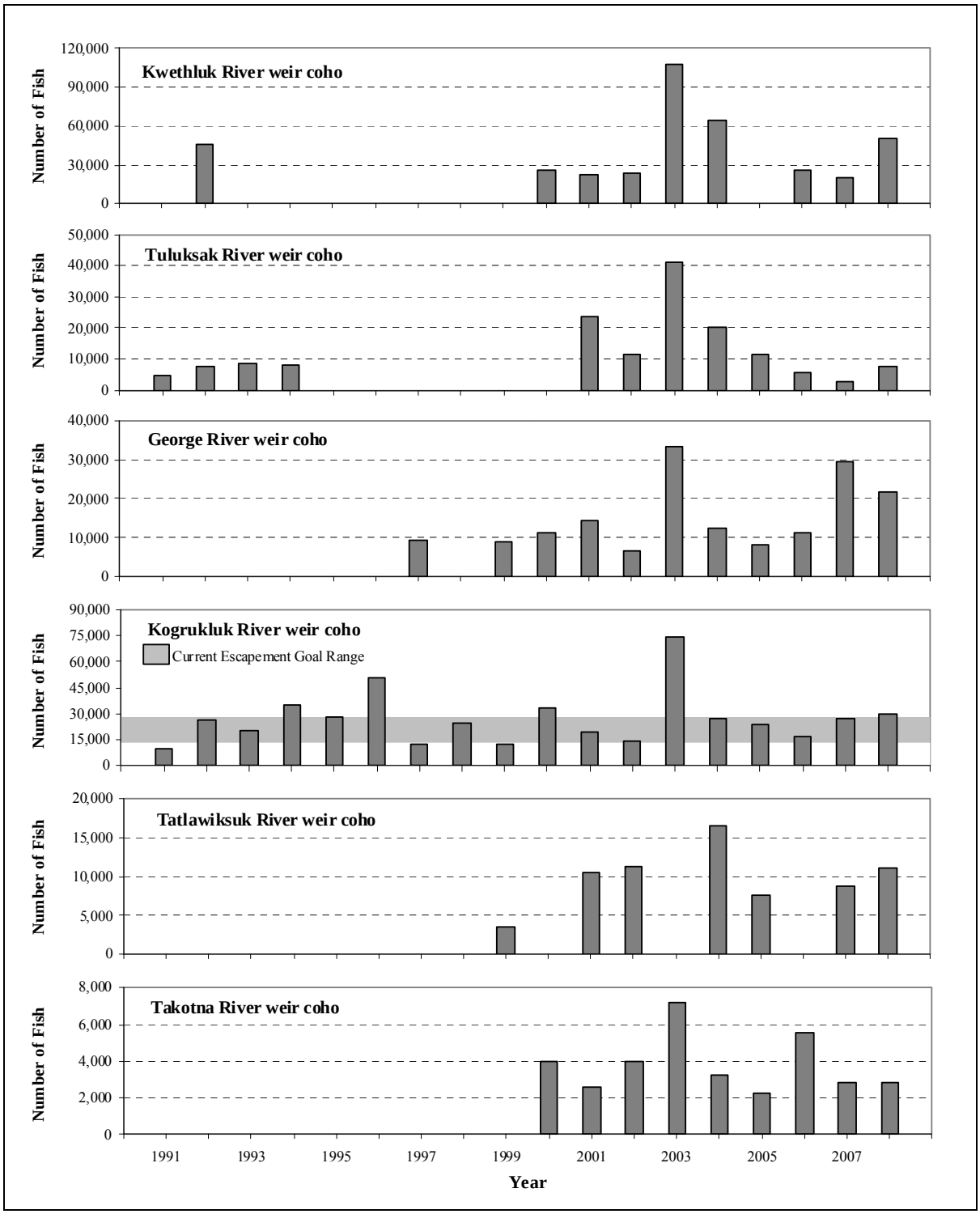
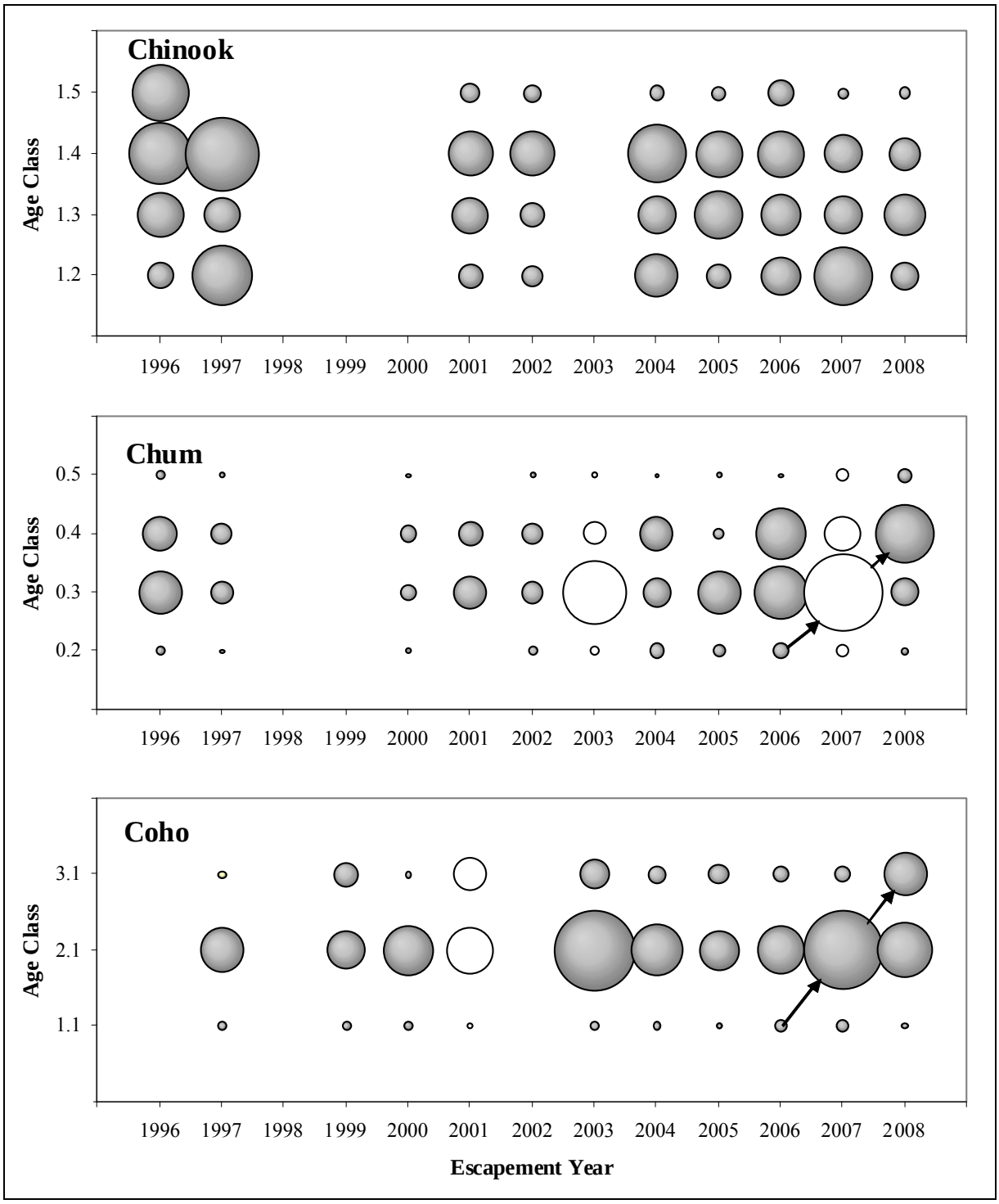


Figure 8.–Annual coho salmon escapement into 6 Kuskokwim River tributaries, 1991–2008.



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

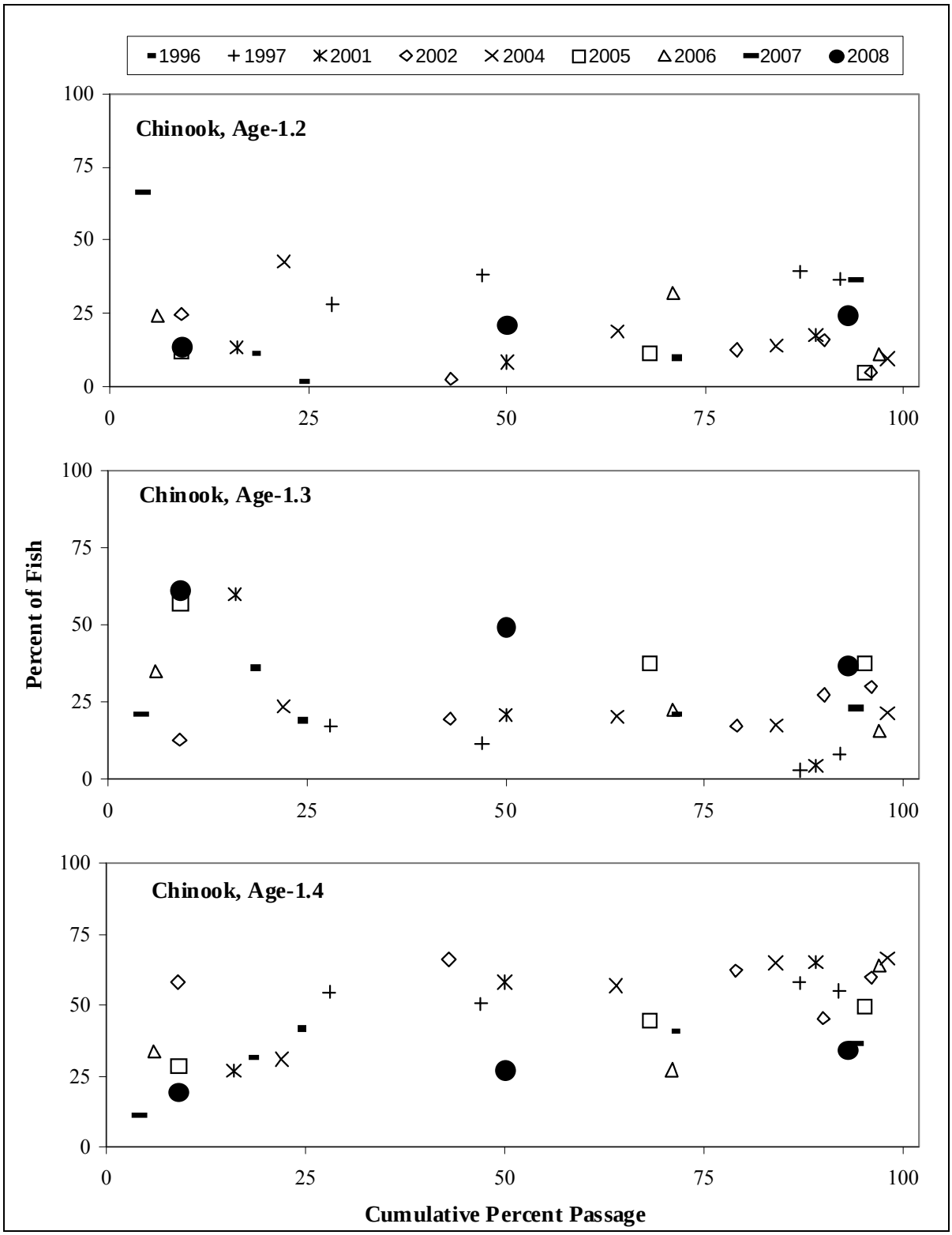
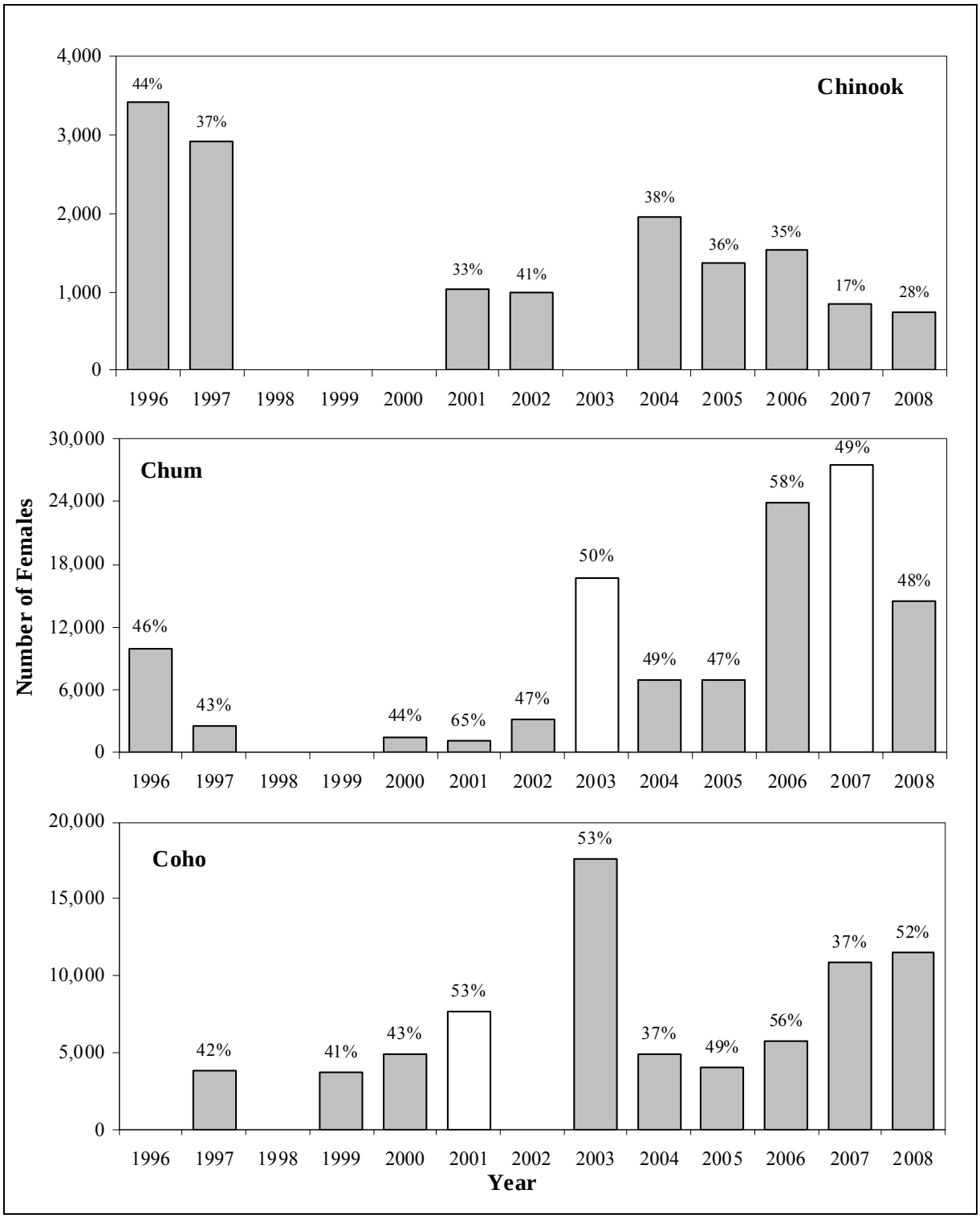


Figure 10.–Historical age composition by cumulative percent passage for Chinook salmon at George River weir.



Note: Empty bars (white) indicate years when estimates for missed passage total more than 20% of annual escapement determined. Sampling objectives were not achieved in years with no data.

Figure 11.–Historical escapement of female salmon by species at George River weir, with labels indicating the percentage of females in annual escapement.

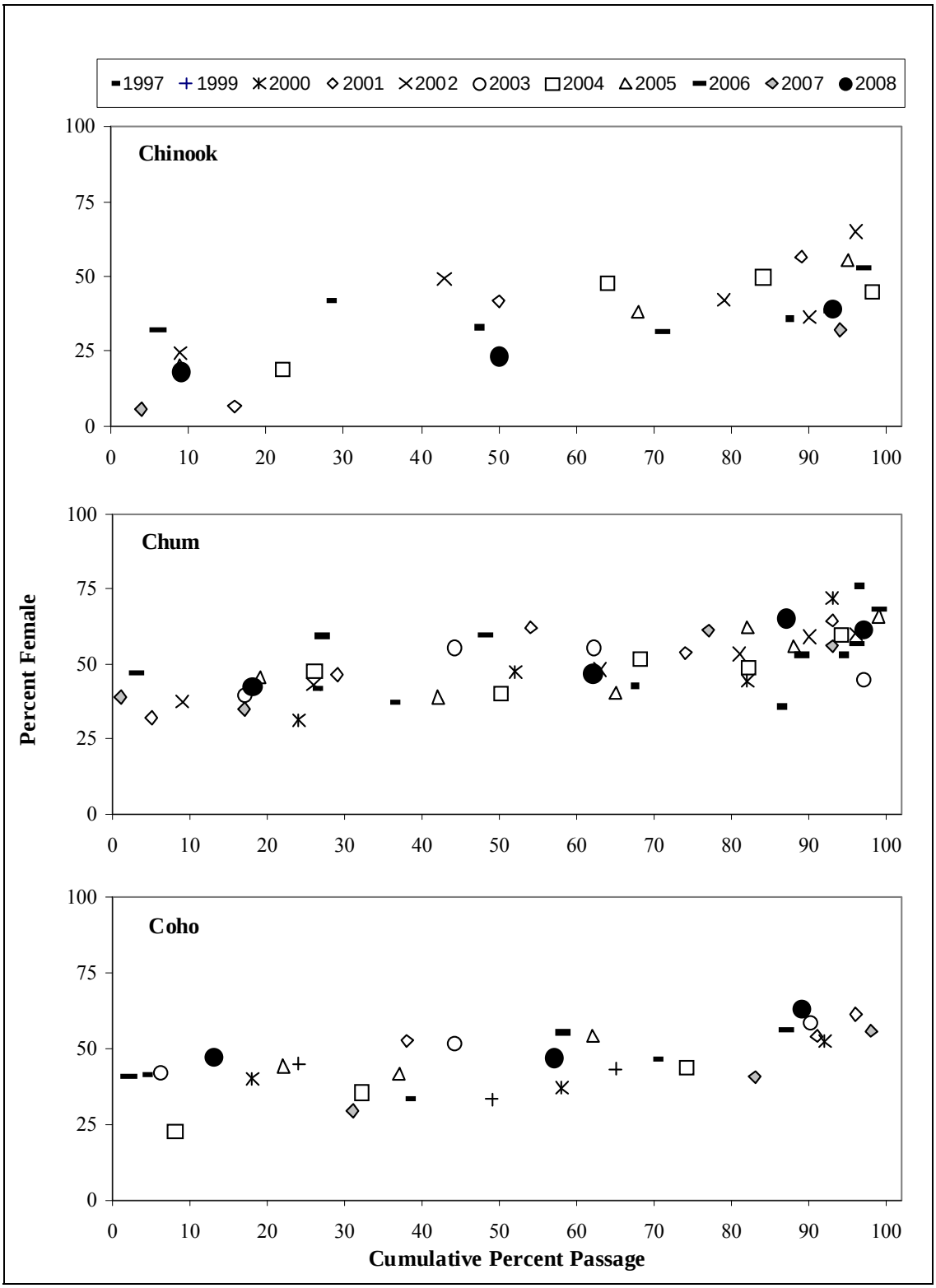


Figure 12.–Percentage of female Chinook, chum, and coho salmon by cumulative percent passage at George River weir, 1997–2007.

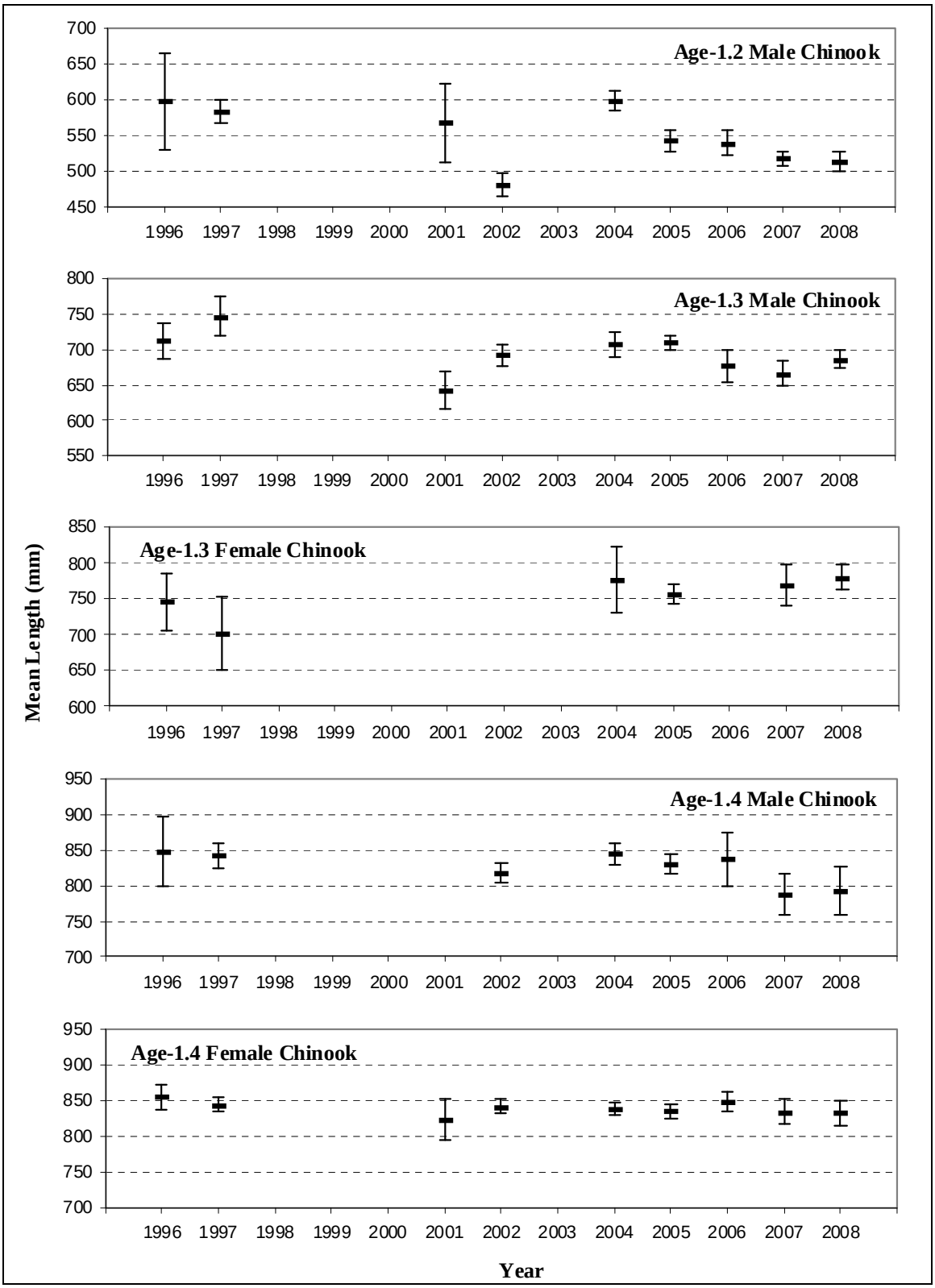
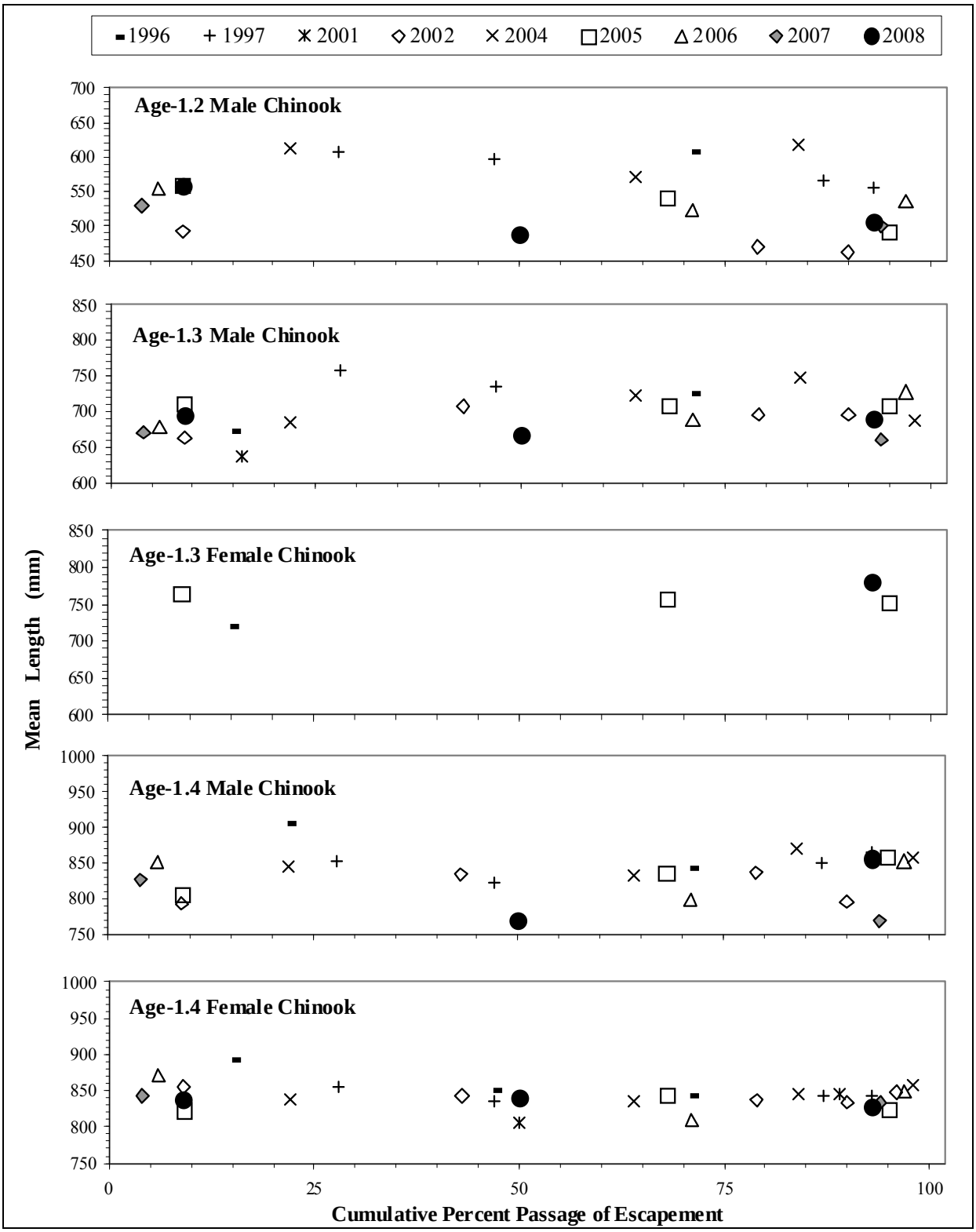


Figure 13.–Historical average annual length with 95% confidence intervals for Chinook salmon at the George River weir.



Note: Only samples of greater than 6 fish are included in figure.

Figure 14.–Historical intra-annual mean length-at-age of male and female Chinook salmon by cumulative percent passage at George River weir.

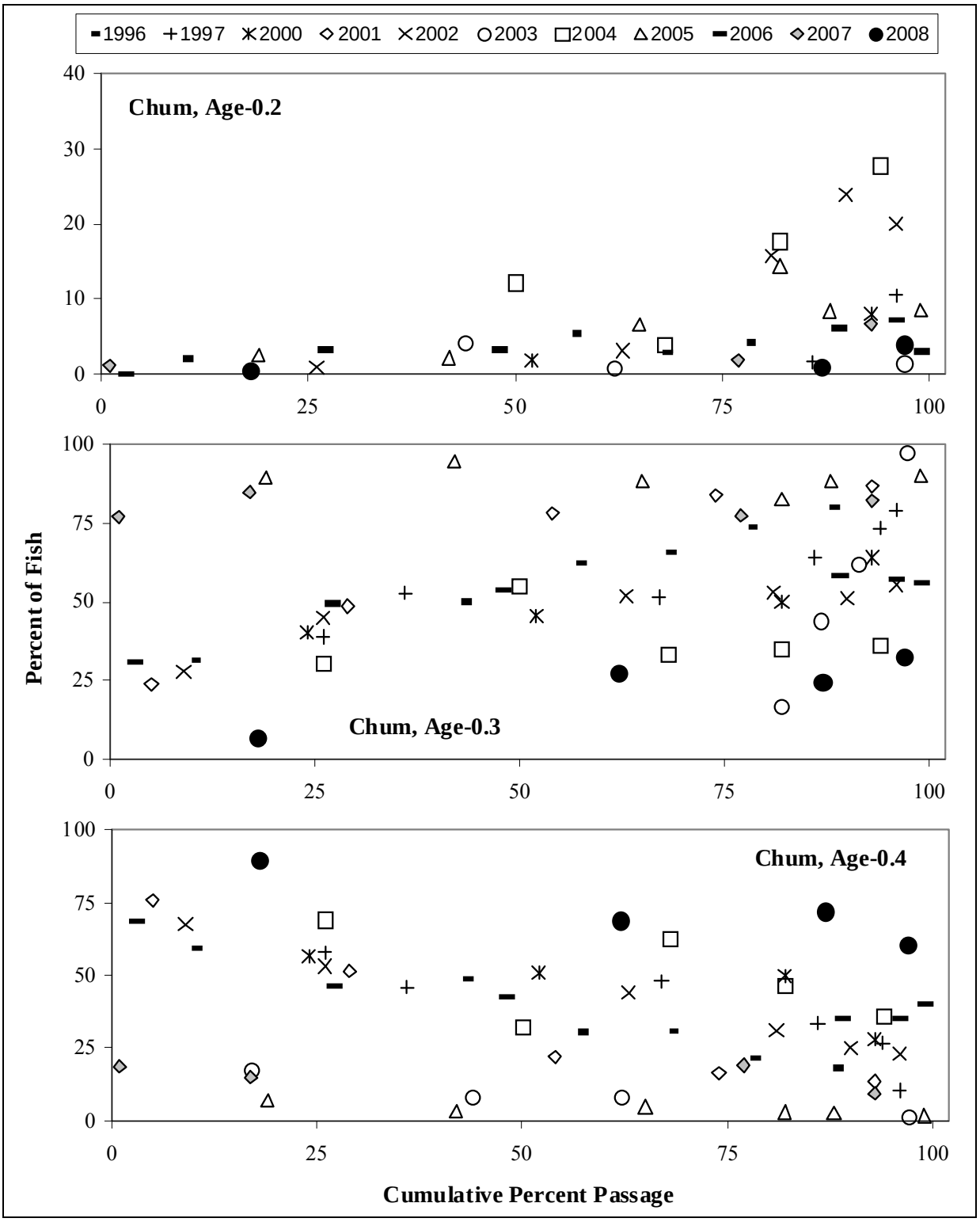


Figure 15.–Historical age composition by cumulative percent passage for chum salmon at George River weir.

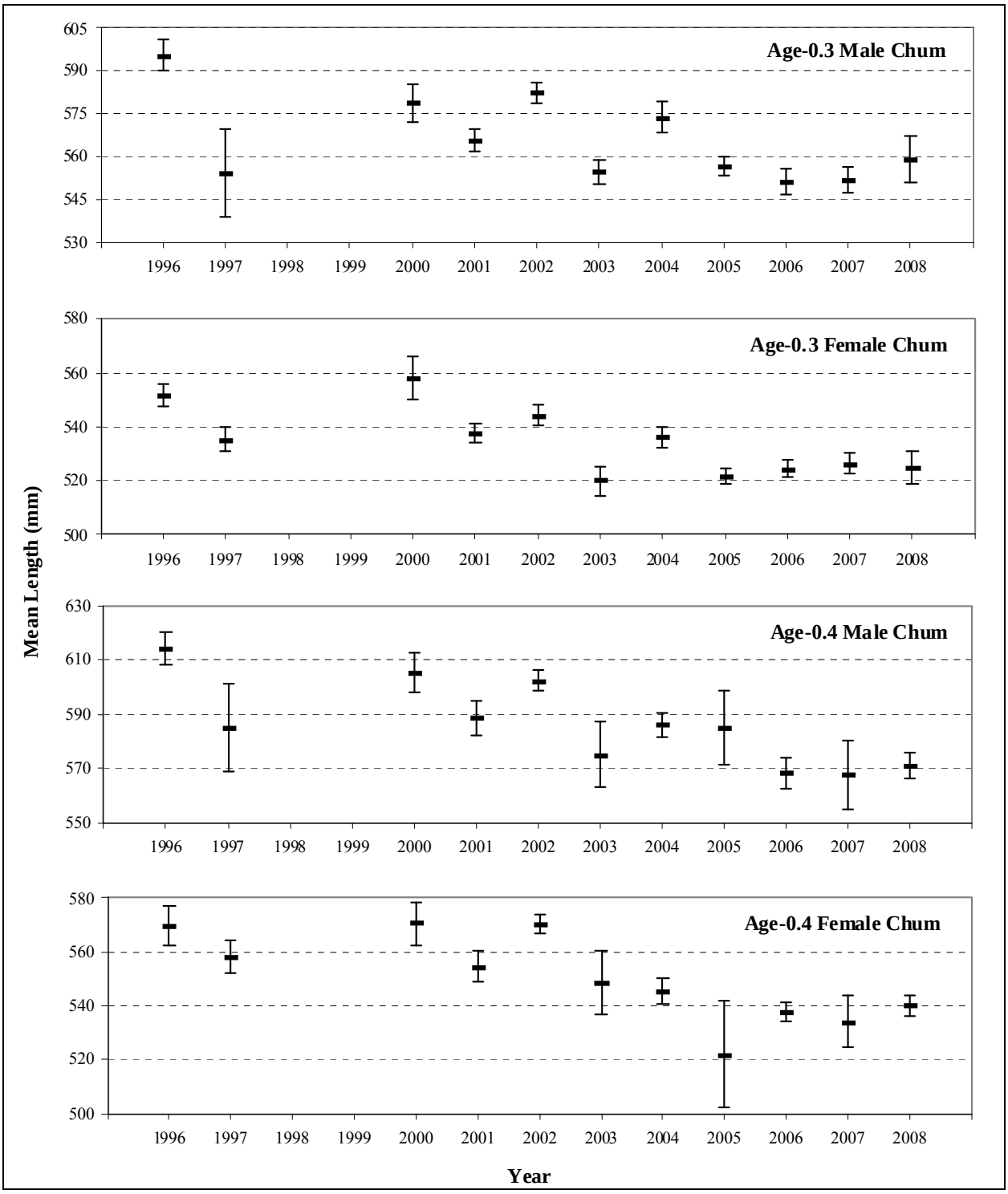


Figure 16.–Historical average annual length with 95% confidence intervals for male chum salmon at George River weir.

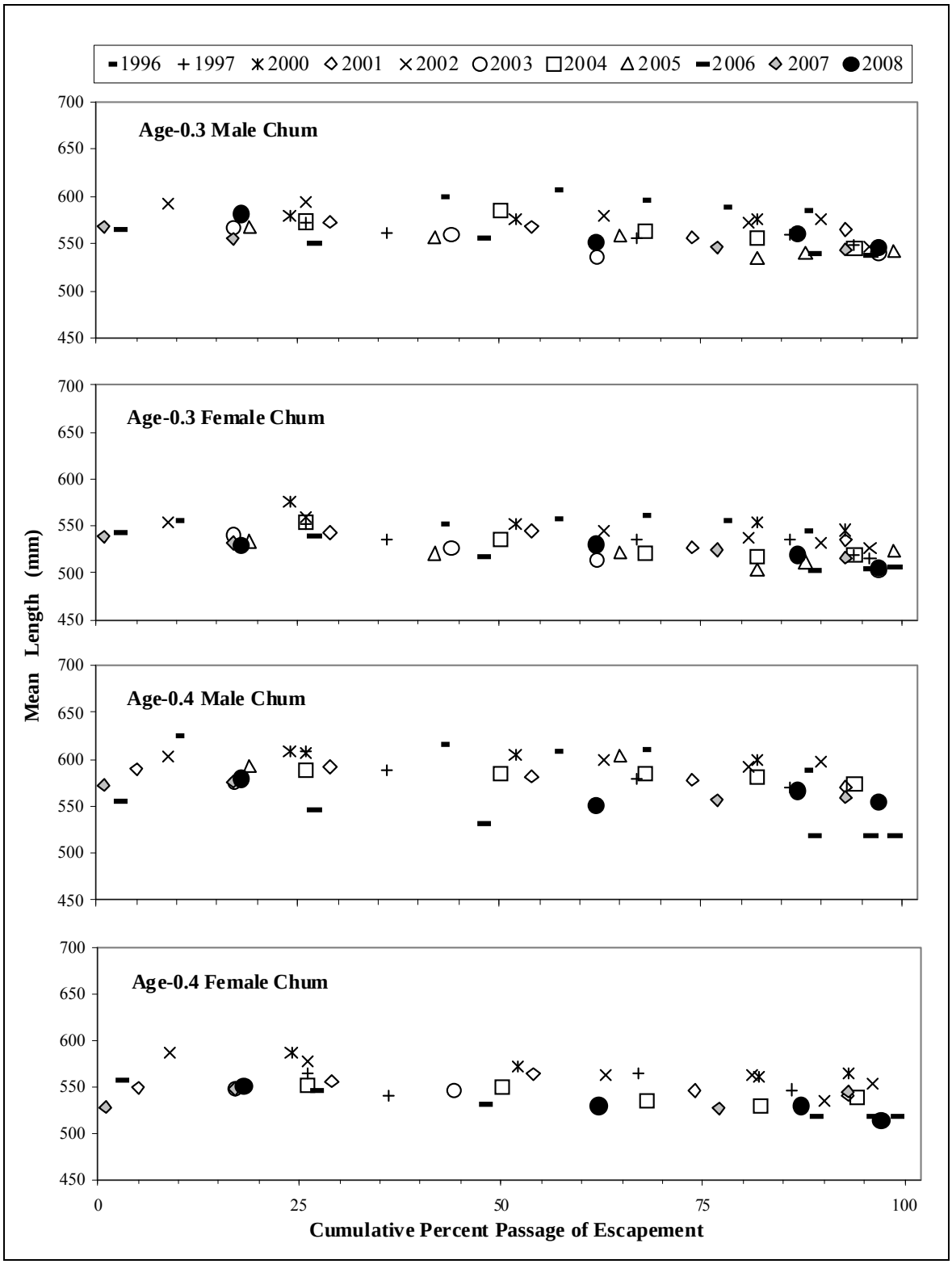


Figure 17.–Historical mean length at age of male and female chum salmon by cumulative percent passage at George River weir.

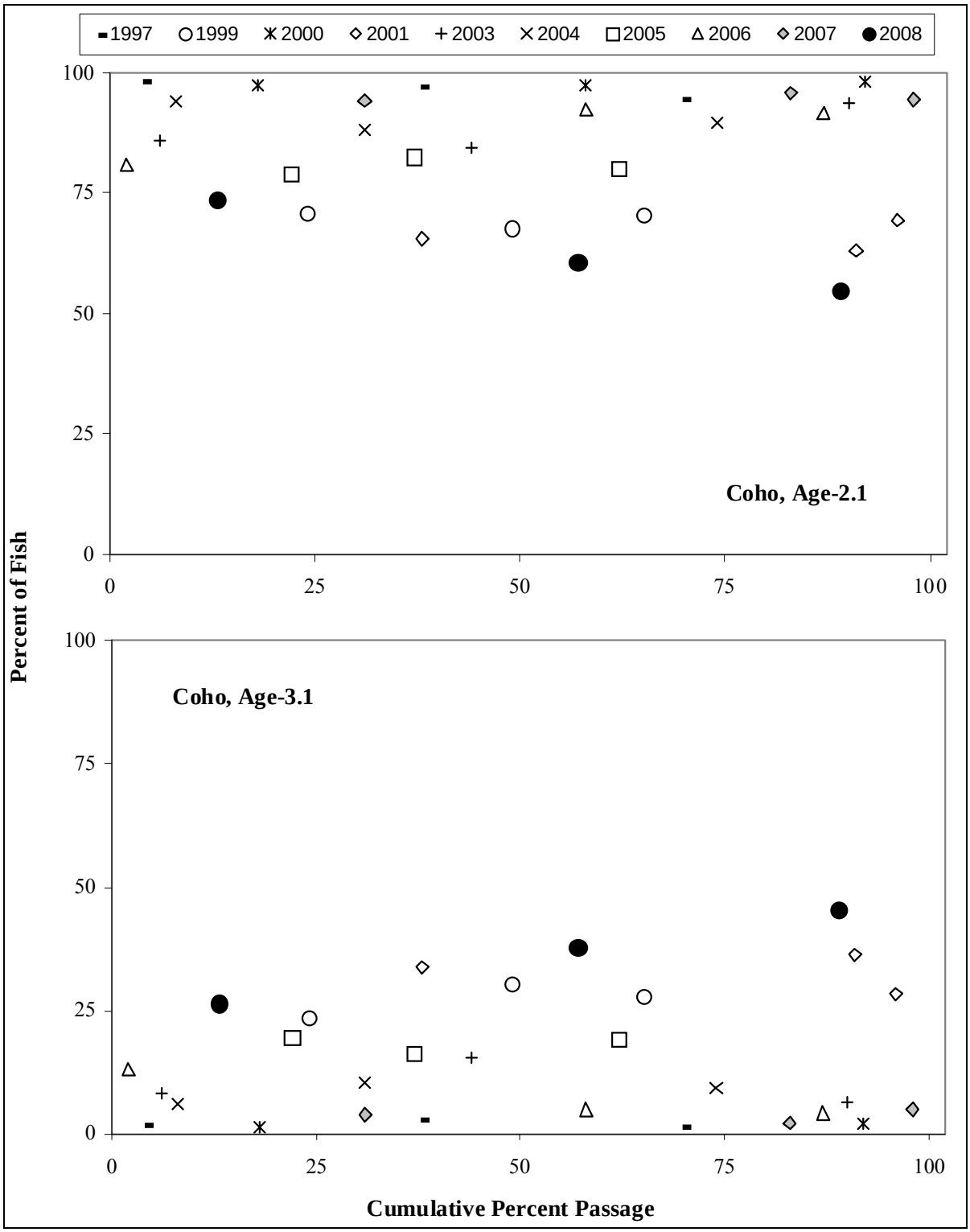


Figure 18.–Historical age composition by cumulative percent passage for coho salmon at George River weir.

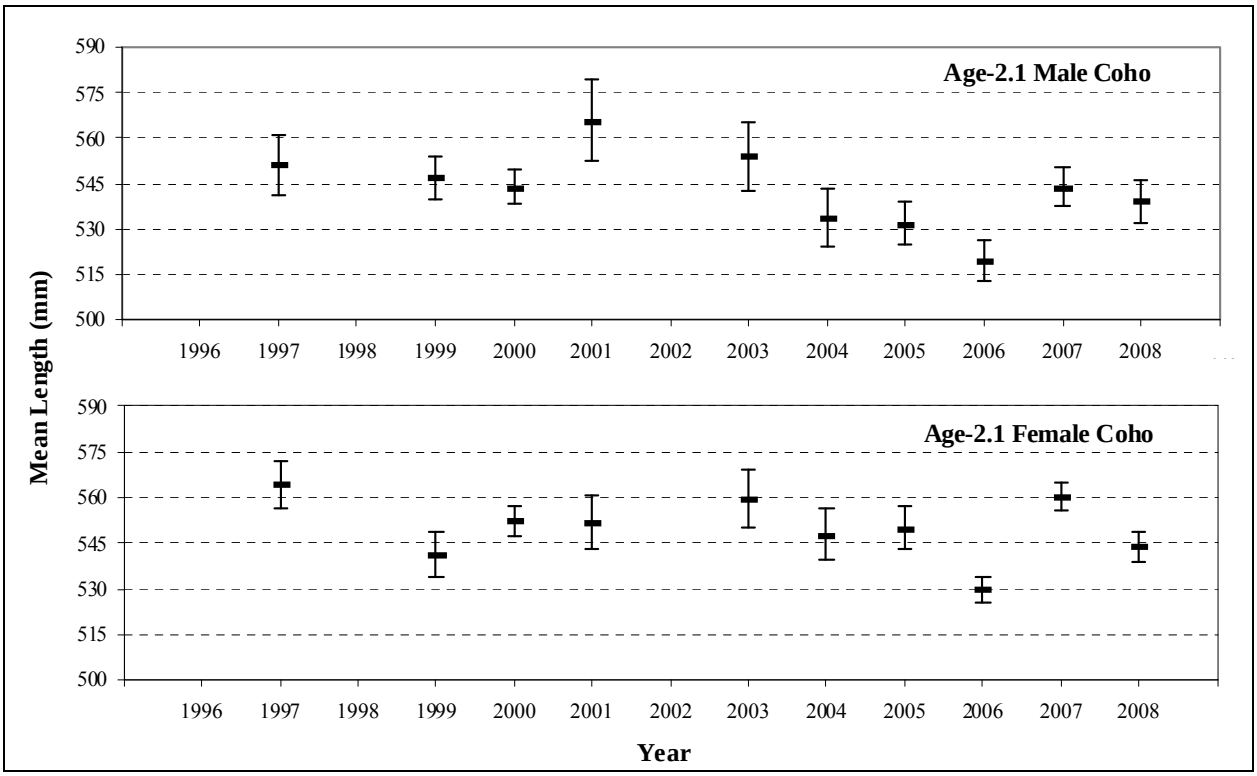


Figure 19.–Historical mean length of age-2.1 male and female coho salmon at George River weir, with 95% confidence intervals.

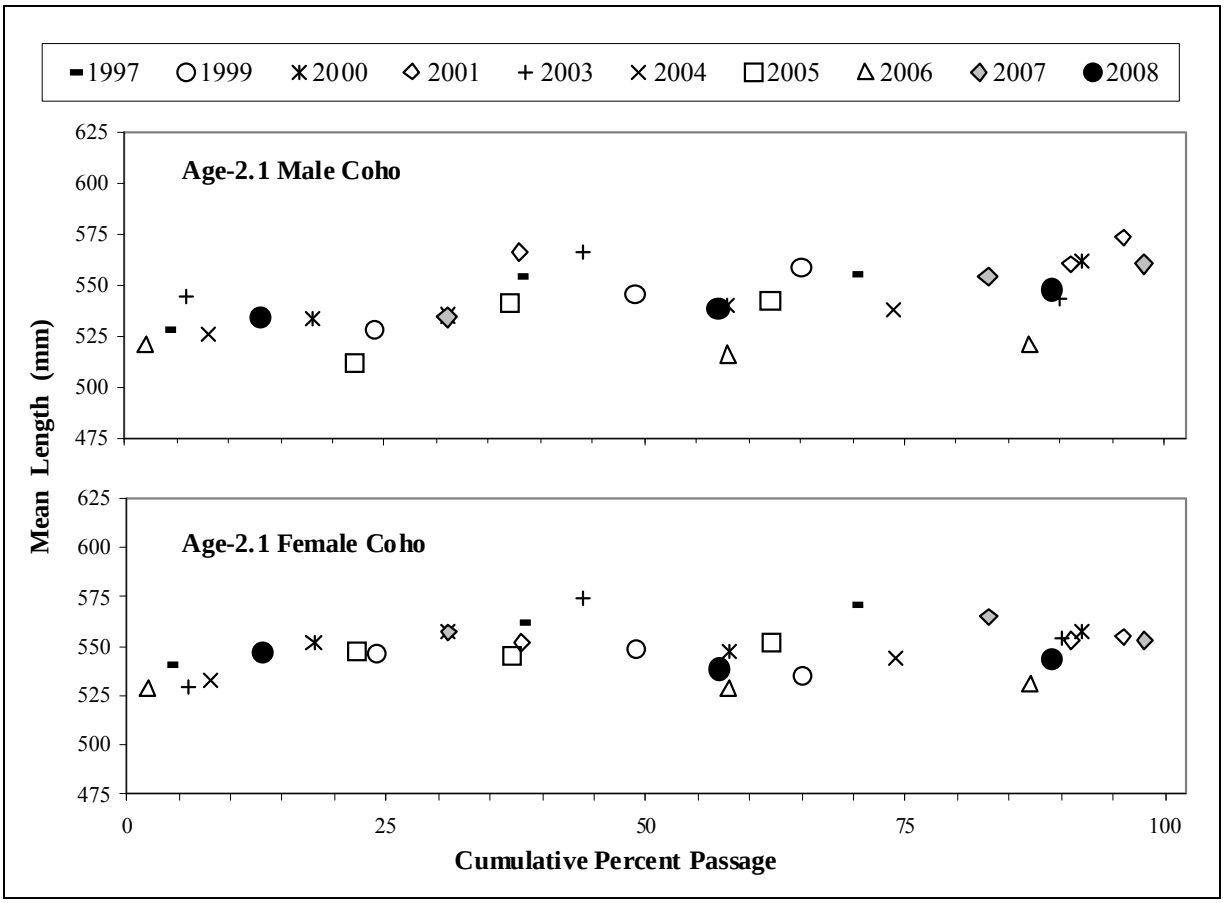


Figure 20.–Historical mean length-at-age by cumulative percent passage for male and female coho salmon at George River weir.

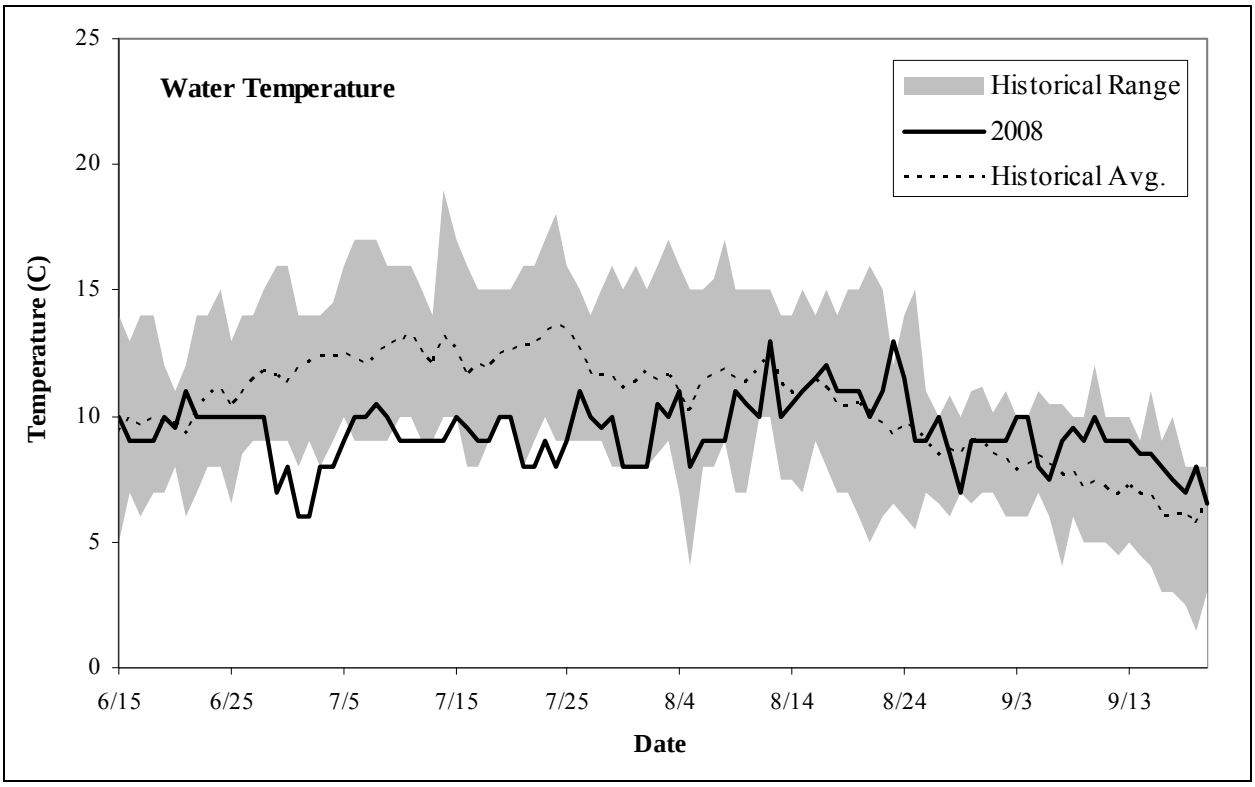


Figure 21.–Daily morning water temperature at George River weir in 2008 relative to historical average, minimum, and maximum morning readings from 1996–2007.

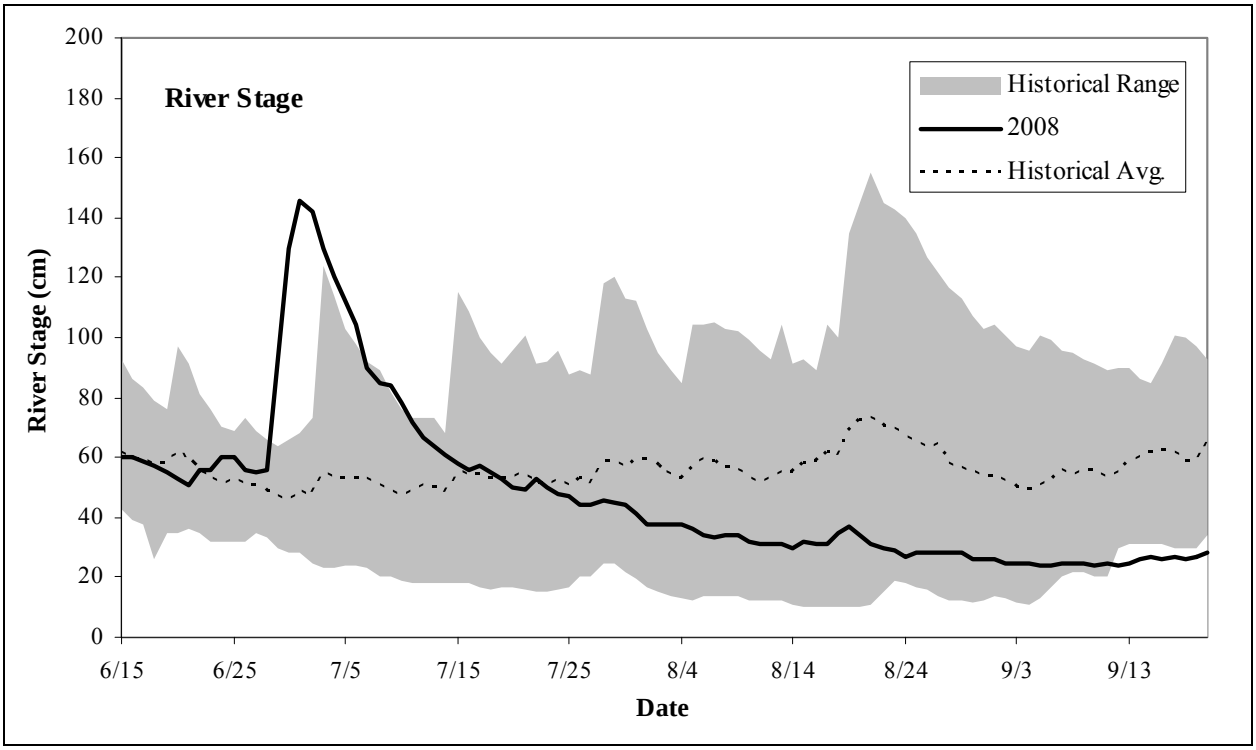
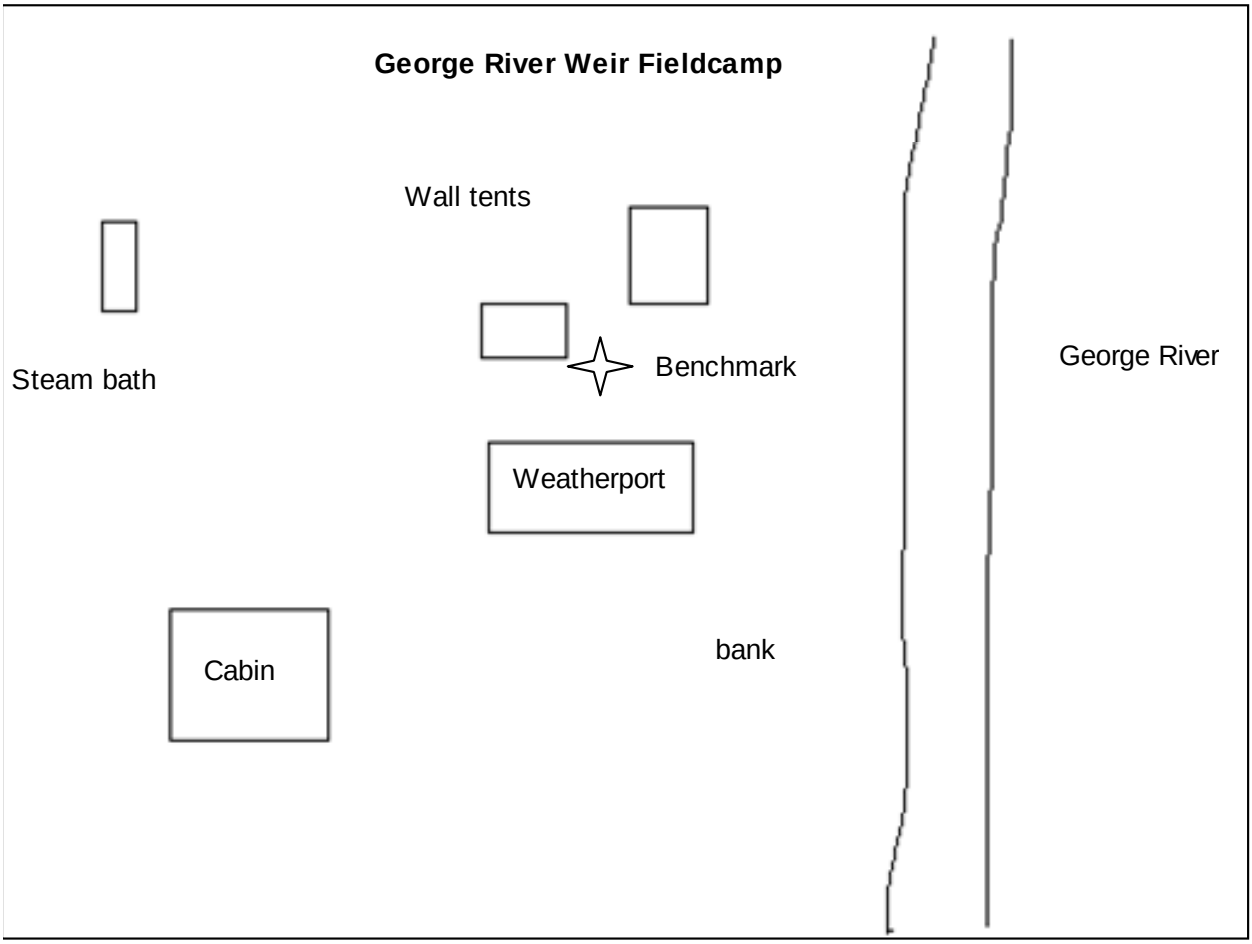


Figure 22.–Daily morning river stage at George River weir in 2008 relative to historical average, minimum, and maximum morning readings from 2000–2007.

APPENDIX A: BENCHMARKS

Appendix A1.–Location and description of a stable river stage benchmark established at George River weir in 2005.



Note: This benchmark consists of a 5 by 8 cm aluminum plate mounted on top of a tree stump approximately 20 cm in diameter, and represents a river stage of 300 cm. This Benchmark was established in 2005 as a stable alternative to benchmarks located along the river ban subject to ice damage, and correlates to benchmarks and river stage measurements maintained since 2000.

APPENDIX B: DAILY PASSAGE

Appendix B1.–Daily passage counts by species at George River weir, 2008.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Arctic Grayling	Other[a]
6/15 [b]	ND	ND	ND	ND	ND	ND	ND	ND
6/16 [b]	ND	ND	ND	ND	ND	ND	ND	ND
6/17	0	0	0	0	0	35	3	0
6/18	0	0	0	0	0	145	4	0
6/19	0	0	0	0	0	356	47	0
6/20	2	0	1	0	0	1,307	0	0
6/21	0	0	0	0	0	636	0	0
6/22	2	0	18	0	0	2,139	8	2;2 P;W
6/23	1	0	12	0	0	89	4	2 W
6/24	1	0	22	0	0	205	10	1 W
6/25	1	0	51	0	0	122	7	0
6/26	2	0	26	0	0	919	14	9 D
6/27	2	0	136	0	0	779	2	0
6/28 [b]	0 [c]	0 [c]	86 [c]	0 [c]	0 [c]	174 [c]	2 [c]	1;1 W;P
6/29 [b]	ND	ND	ND	ND	ND	ND	ND	ND
6/30 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/01 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/02 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/03 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/04 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/05 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/06 [b]	ND	ND	ND	ND	ND	ND	ND	ND
7/07 [b]	13 [c]	0 [c]	635 [c]	9 [c]	0 [c]	207 [c]	0 [c]	0
7/08	50	0	757	21	0	103	43	0
7/09	8	0	574	11	0	19	0	0
7/10	13	0	843	5	0	17	1	1 D
7/11	10	0	1,063	12	0	3	1	1 W
7/12	41	0	1,827	29	0	13	4	0
7/13	231	1	1,764	43	0	21	26	0
7/14	157	0	2,265	47	0	22	4	0
7/15	247	1	1,358	53	0	17	2	0
7/16	122	1	955	42	0	131	3	1;5 W;D
7/17	267	0	1,101	59	0	32	4	1 D
7/18	34	0	696	35	0	18	1	0
7/19	134	1	1,221	88	0	23	2	1 D
7/20 [c]	175 [c]	1 [c]	341 [c]	52 [c]	0 [c]	2 [c]	1 [c]	0
7/21 [c]	424 [c]	0 [c]	313 [c]	77 [c]	0 [c]	3 [c]	0 [c]	0
7/22	72	3	970	153	0	114	2	0
7/23	106	1	845	105	0	49	0	0
7/24	37	0	872	110	0	63	0	0
7/25	87	0	933	174	0	289	0	0
7/26	70	3	1,037	370	4	552	0	0
7/27	56	3	613	168	4	277	0	0
7/28	20	4	432	113	2	108	0	0
7/29	14	5	427	99	3	20	2	0
7/30	13	4	535	134	7	11	0	0
7/31	18	3	363	61	13	3	4	1 D
8/01	35	6	605	107	18	26	1	0
8/02	14	4	278	59	27	21	0	0
8/03	7	4	159	33	18	3	0	1 W
8/04	14	8	298	60	51	12	1	1 W
8/05	15	2	161	23	52	6	1	0
8/06	7	2	207	21	66	5	1	0
8/07	4	0	136	12	42	0	1	0
8/08	3	5	132	15	223	1	2	0

-continued-

Appendix B1.–Page 2 of 2.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Arctic Grayling	Other[a]	
8/09	7	1	126	5	206	2	0	0	
8/10	3	0	84	2	316	3	2	0	
8/11	5	2	56	9	408	1	1	0	
8/12	2	0	39	3	225	3	2	0	
8/13	0	1	30	1	324	28	0	0	
8/14	1	2	29	1	203	13	0	0	
8/15	1	1	18	1	578	13	0	0	
8/16	1	1	17	6	966	6	0	0	
8/17	1	2	30	2	1,097	9	0	2	P
8/18	0	0	24	3	898	9	0	2	W
8/19	0	2	18	5	634	4	0	0	
8/20	1	2	19	0	407	3	0	0	
8/21	2	1	10	1	1,029	11	1	0	
8/22	0	2	27	2	1,201	5	0	0	
8/23	1	0	27	0	1,172	1	1	0	
8/24	0	2	16	0	530	3	0	0	
8/25	0	2	10	0	383	4	0	0	
8/26	0	0	3	0	149	3	0	1	P
8/27	1	0	17	1	1,167	0	0	0	
8/28	0	5	1	0	954	1	2	0	
8/29	0	0	3	2	662	0	0	0	
8/30	1	0	5	0	207	0	0	1	W
8/31	0	0	1	0	667	0	0	0	
9/01	0	1	2	0	984	1	0	1	P
9/02	0	0	0	0	699	0	0	1	P
9/03	0	2	3	0	787	0	0	0	
9/04	0	0	3	0	827	0	1	0	
9/05	0	0	0	0	68	0	0	1	W
9/06	0	0	2	0	22	1	0	0	
9/07	0	0	3	0	474	0	0	0	
9/08	0	0	1	0	793	0	0	0	
9/09	0	0	4	0	174	0	0	0	
9/10	0	0	7	0	124	0	0	0	
9/11	0	0	4	0	304	0	0	0	
9/12	0	0	3	0	119	0	0	0	
9/13	0	0	2	0	320	0	0	0	
9/14	0	0	0	0	311	0	0	0	
9/15	0	0	3	0	138	0	0	0	
9/16	0	0	5	0	89	0	0	0	
9/17	0	1	5	0	241	0	0	0	
9/18	0	0	4	0	102	0	0	0	
9/19	0	0	3	0	115	0	0	1	D
9/20	0	0	0	0	327	0	0	0	
9/21	0	0	0	0	21	0	0	0	
9/22	0	0	0	0	4	0	0	1	W

[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 C: DAILY CARCASS COUNT

Appendix C1.–Daily carcass counts at George River weir, 2008.

	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]
6/15	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
6/16	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
6/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 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	0	0	1 P
6/21	0	0	0	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	2	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 P
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	2 G
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 P
6/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
6/29 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
6/30 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/01 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/02 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/03 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/04 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/05 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/06 [b]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/07 [c]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	4	5	9	0	0	0	0	0	0	2	0	0
7/09	0	0	0	0	0	0	2	1	3	0	0	0	0	0	0	1	0	0
7/10	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
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	12	5	17	0	0	0	0	0	0	1	0	0
7/13	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	1	0	0
7/14	0	0	0	0	0	0	12	4	16	0	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	10	5	15	0	0	0	0	0	0	0	1	1 P
7/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/18	0	0	0	0	0	0	11	2	13	0	0	0	0	0	0	0	0	0

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	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]
7/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	46	36	82	1	0	1	0	0	0	0	0	0
7/21	0	0	0	0	0	0	21	6	27	0	0	0	0	0	0	2	0	0
7/22	0	0	0	0	0	0	41	10	51	0	0	0	0	0	0	0	1	0
7/23	0	1	1	0	0	0	54	10	64	1	2	3	0	0	0	1	1	1 P
7/24	0	0	0	0	0	0	46	12	58	2	1	3	0	1	1	1	0	0
7/25	0	0	0	0	0	0	47	13	60	6	0	6	0	0	0	0	1	0
7/26	0	0	0	0	0	0	60	22	82	9	6	15	0	0	0	0	1	1 G
7/27	0	1	1	0	0	0	63	19	82	15	2	17	0	0	0	0	0	0
7/28	0	0	0	0	0	0	2	3	5	5	0	5	0	0	0	0	0	0
7/29	1	1	2	0	0	0	172	63	235	66	11	77	2	0	2	1	0	0
7/30	3	0	3	0	0	0	37	22	59	62	22	84	0	1	1	0	0	0
7/31	5	3	8	0	0	0	50	18	68	52	6	58	0	0	0	2	0	0
8/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/02	37	1	38	0	0	0	111	44	155	141	48	189	0	0	0	3	0	0
8/03	23	1	24	0	0	0	56	16	72	58	18	76	0	0	0	3	0	0
8/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/05	26	0	26	0	0	0	117	42	159	212	45	257	0	0	0	1	2	2 P
8/06	26	0	26	0	0	0	79	26	105	148	62	210	1	0	1	2	1	0
8/07	18	0	18	0	0	0	83	36	119	139	38	177	0	0	0	3	6	0
8/08	30	0	30	0	0	0	47	19	66	122	42	164	0	0	0	5	0	0
8/09	26	1	27	0	0	0	61	19	80	157	72	229	0	1	1	2	1	1 G
8/10	30	1	31	0	0	0	38	28	66	113	49	162	1	0	1	1	0	0
8/11	16	1	17	0	0	0	62	39	101	124	79	203	0	0	0	4	2	0
8/12	16	1	17	0	0	0	41	16	57	84	45	129	0	0	0	3	1	0
8/13	12	0	12	0	0	0	25	10	35	63	30	93	0	0	0	0	2	0
8/14	15	2	17	0	0	0	44	18	62	71	38	109	0	0	0	3	0	0
8/15	15	2	17	0	0	0	31	27	58	68	29	97	0	0	0	4	0	0
8/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	8	2	10	0	0	0	34	21	55	43	32	75	0	0	0	16	2	0
8/18	3	1	4	0	0	0	15	21	36	15	21	36	1	0	1	6	0	2 G
8/19 [d]	4	0	4	0	0	0	5	11	16	8	7	15	0	0	0	6	0	0
8/20 [d]	2	0	2	0	0	0	6	5	11	1	2	3	1	0	1	4	1	0
8/21 [d]	2	0	2	1	0	1	3	2	5	1	2	3	1	0	1	0	0	0

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	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]
8/22 [d]	1	0	1	0	0	0	4	1	5	3	1	4	0	0	0	2	0	0
8/23 [d]	2	0	2	0	0	0	3	1	4	2	4	6	0	0	0	6	0	0
8/24 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/25 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/26 [d]	0	0	0	0	0	0	0	1	1	0	2	2	0	0	0	4	0	0
8/27 [d]	0	0	0	0	0	0	0	1	1	0	2	2	0	0	0	3	0	0
8/28 [d]	0	0	0	0	0	0	0	1	1	1	1	2	0	0	0	1	0	0
8/29 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/30 [d]	1	0	1	0	0	0	0	0	0	1	0	1	0	1	1	0	5	0
8/31 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9/01 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/02 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/03 [d]	0	0	0	0	0	0	1	1	2	1	1	2	1	0	1	2	0	0
9/04 [d]	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
9/05 [d]	0	0	0	0	0	0	0	1	1	0	0	0	2	1	3	5	0	0
9/06 [d]	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0
9/07 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
9/08 [d]	1	0	1	0	0	0	1	0	1	0	0	0	1	0	1	4	6	0
9/09 [d]	1	0	1	0	0	0	0	0	0	0	0	0	1	1	2	2	3	0
9/10 [d]	0	0	0	0	0	0	1	0	1	0	0	0	1	1	2	0	5	0
9/11 [d]	2	0	2	0	0	0	0	1	1	0	0	0	1	2	3	1	3	0
9/12 [d]	2	0	2	0	0	0	1	0	1	0	0	0	0	0	0	1	3	1 D
9/13 [d]	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0
9/14 [d]	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0
9/15 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/16 [d]	1	0	1	0	0	0	0	0	0	0	0	0	4	4	8	1	0	0
9/17 [d]	0	0	0	0	0	0	0	0	0	0	0	0	5	1	6	1	4	0
9/18 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/19 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/20 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/21 [d]	0	0	0	0	0	0	0	0	0	0	0	0	7	1	8	2	4	1 P
9/22 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

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

[c] Partial daily count.

[d] Downstream passage chutes installed; counts are incomplete.

APPENDIX D: WEATHER AND STREAM OBSERVATIONS

Appendix D1.–Daily weather and stream observations at George River weir, 2008.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/10	10:30	4	0.0	9	7	65	2
	17:00	4	0.0	16	8	64	2
6/11	07:30	4	1.0	7	7	63	2
	17:00	4	3.0	11	8	62	1
6/12	07:30	4	0.8	7	7	61	1
	17:00	3	3.0	13	9	61	1
6/13	07:30	4	7.7	10	8	63	2
	17:00	2	0.5	16	9	66	2
6/14	10:30	1	0.0	19	10	64	2
	17:00	3	12.5	13	11	62	2
6/15	10:30	4	4.8	12	10	60	1
	17:00	4	0.5	11	10	60	1
6/16	10:30	4	1.5	11	9	60	1
	17:00	4	0.1	14	10	60	1
6/17	07:30	4	0.0	10	9	59	1
6/18	07:30	3	0.0	7.5	9	57	1
6/19	07:30	4	0.7	10	10	55	1
	17:00	3	0.0	17	11	54	1
6/20	07:30	1	0.0	7.5	9.5	53	1
6/21	10:00	1	0.0	15	11	51	1
	17:00	4	7.0	13.5	11.5	52	1
6/22	07:30	2	3.0	13.5	10	56	1
	17:00	2	0.0	20	12	57	1
6/23	07:30	4	0.0	10.5	10	56	1
	17:00	4	5.6	12.5	10.5	56	1
6/24	07:30	5	0.0	5	10	60	1
	17:00	3	0.0	16	11	62	1
6/25	07:30	4	0.0	8.5	10	60	1
	17:00	3	0.0	19	12	59	1
6/26	07:30	4	0.0	7.5	10	56	1
	17:00	2	0.0	20	12.5	55	1
6/27	07:30	3	1.7	10	10	55	1
	17:00	3	0.0	18	13	55	1
6/28	10:30	4	17.5	11	10	56	1
	17:00	4	5.0	12	10.5	65	3
6/29	10:30	4	2.6	10	7	ND	3
	17:00	4	11.5	11	8	110	3
6/30	07:30	4	22.5	10	8	130	3
	17:00	4	0.0	15	7	136	3
7/01	07:30	5	0.0	7	6	146	3
	17:00	3	0.0	17	8	146	3
7/02	07:30	3	0.0	7	6	142	3
	16:40	3	0.0	18	7.5	138	3
7/03	07:30	2	0.0	9	8	130	3
	17:00	3	0.0	16	8	126	3
7/04	10:30	1	0.7	15	8	120	3
	17:00	1	0.0	22.5	12.5	117	3

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Appendix D1.–Page 2 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/05	10:30	2	0.4	16.5	9	112	3
	17:00	2	0.0	27	12.5	108	3
7/06	10:30	1	0.1	18	10	104	2
	17:00	2	0.0	25.5	11.5	98	2
7/07	07:30	1	0.0	10	10	90	2
	17:00	2	0.0	22	12	88	1
7/08	07:30	4	0.0	12	10.5	85	1
	17:00	3	0.0	18	11	88	2
7/09	07:30	3	0.0	13	10	84	2
	17:00	3	0.0	16	10	82	1
7/10	07:30	3	0.0	11	9	78	1
	17:00	3	0.0	14	9	75	1
7/11	07:30	4	0.0	9	9	72	1
	17:00	3	0.0	16	10	70	1
7/12	10:30	4	0.0	11.5	9	67	1
	17:00	4	0.0	14.5	9.5	66	1
7/13	10:30	4	0.7	12	9	64	1
	17:00	3	0.0	17	10.5	63	1
7/14	07:30	3	0.0	6.5	9	61	1
	17:00	2	0.0	19.5	12	60	1
7/15	07:30	4	0.0	12	10	58	1
	17:00	4	0.0	14	10	56	1
7/16	07:30	4	0.8	12.5	9.5	56	1
	17:00	4	1.2	14	10	57	1
7/17	07:30	3	3.0	7	9	57	1
	17:00	4	0.5	11	10	56	1
7/18	07:30	5	0.2	5	9	55	1
	17:00	2	0.0	16.5	12	55	1
7/19	10:30	4	0.7	10.5	10	53	1
	17:00	4	0.3	15	11	53	1
7/20	10:30	4	0.0	12	10	50	1
	17:00	4	0.3	14	10	49	1
7/21	07:30	4	11.0	9	8	49	1
	17:00	3	0.0	13	11	50	1
7/22	07:30	1	0.0	2	8	53	1
	17:00	4	0.0	9	11	52	1
7/23	07:30	4	0.0	7.5	9	50	1
	17:00	4	5.3	11.5	10	49	1
7/24	07:30	5	0.4	3	8	48	1
7/25	07:30	1	0.0	3	9	47	1
7/26	07:30	4	2.3	9.5	11	44	1
	17:00	3	0.2	14	12	44	1
7/27	07:30	4	1.6	9	10	44	1
	10:30	4	0.1	11	10.5	46	1
7/28	07:30	1	0.3	5	9.5	46	1
	17:00	2	0.0	17	12	46	1
7/29	07:30	3	0.0	9	10	45	1

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Appendix D1.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
	17:00	3	0.0	14.5	12	45	1
7/30	07:30	3	0.0	9	8	44	1
	17:00	3	0.0	12.5	9	44	1
7/31	07:30	1	0.0	3	8	41	1
	17:00	1	0.0	19.5	12	39	1
8/01	07:30	2	0.0	7	8	38	1
	17:00	2	0.0	18	13	39	1
8/02	10:30	4	0.0	12	10.5	38	1
	17:00	3	0.0	15	12	38	1
8/03	10:30	1	0.0	14	10	38	1
	17:00	1	0.0	18	13	38	1
8/04	07:30	3	0.0	8	11	38	1
	17:00	4	0.0	14	11.5	38	1
8/05	07:30	3	0.0	7	8	36	1
	17:00	1	0.0	16	14	36	1
8/06	07:30	2	0.0	2	9	34	1
	17:00	4	0.0	14	11	34	1
8/07	07:30	4	0.0	8.5	9	33	1
	17:00	3	0.0	17	13	34	1
8/08	07:30	5	0.0	2	9	34	1
	17:00	2	0.0	19	14	34	1
8/09	10:30	1	0.0	10	11	34	1
	17:00	3	0.0	18	13	32	1
8/10	10:30	4	0.0	10	10.5	32	1
	17:00	3	1.0	17	13	31	1
8/11	07:30	3	0.0	5	10	31	1
	17:00	2	0.0	21	13.5	30	1
8/12	17:00	3	0.2	15	13	31	1
8/13	07:30	5	2.0	6	10	31	1
	17:00	3	0.2	20	13	30	1
8/14	07:30	4	3.9	9	10.5	30	1
	17:00	4	1.1	16	13	30	1
8/15	07:30	4	0.5	10	11	32	1
8/16	10:30	4	0.0	10	11.5	31	1
	17:00	3	0.0	18	15	31	1
8/17	10:30	4	0.8	11	12	31	1
	17:00	3	0.3	17	15	33	1
8/18	07:30	5	0.2	5	11	35	1
	17:00	3	0.1	17	13.5	36	1
8/19	07:30	5	0.8	7	11	37	1
	17:00	4	0.0	18	14	35	1
8/20	07:30	3	0.0	7	11	34	1
	17:00	2	0.0	18	13	33	1
8/21	07:30	5	0.0	3	10	31	1
8/22	07:30	4	0.0	8	11	30	1
	17:00	4	0.4	18	14	30	1
8/23	10:00	1	0.0	9.5	13	29	1

-continued-

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
	17:00	2	0.0	21	15	29	1
8/24	10:00	1	0.0	8	11.5	27	1
	17:00	1	0.0	19.5	13.5	27	1
8/25	07:30	5	0.0	-2	9	28	1
	17:00	2	0.0	19	13	28	1
8/26	07:30	3	0.0	2	9	28	1
	17:00	3	0.0	17	12	28	1
8/27	07:30	5	1.8	9	10	28	1
	17:00	4	1.0	12.5	11	29	1
8/28	07:30	1	0.0	4.5	8.5	28	1
	17:00	3	0.0	13	13	29	1
8/29	07:30	5	0.0	-1	7	28	1
	17:00	2	0.0	15	11	27	1
8/30	10:30	4	0.0	6.5	9	26	1
	17:00	4	0.0	14	10	26	1
8/31	10:30	4	0.1	10	9	26	1
	17:00	4	0.0	15	11	26	1
9/01	10:30	1	0.0	8	9	26	1
	17:00	1	0.0	17	11	26	1
9/02	10:30	3	0.0	8	9	25	1
	17:00	3	0.0	17	11	25	1
9/03	10:30	4	1.5	9	10	25	1
	17:00	4	0.3	14	11	25	1
9/04	10:30	4	1.8	11	10	25	1
	17:00	3	0.3	15	13	25	1
9/05	10:30	5	0.0	3	8	24	1
	17:00	3	0.0	16	11	24	1
9/06	10:30	5	0.0	2	7.5	24	1
	17:00	4	0.0	15	10	24	1
9/07	10:30	4	3.4	9.5	9	25	1
	17:00	4	0.3	14	10	25	1
9/08	10:30	4	1.6	11	9.5	25	1
	17:00	2	0.0	15	12	25	1
9/09	10:30	4	0.0	10	9	25	1
	17:00	4	0.2	14	10	25	1
9/10	10:30	3	0.8	10	10	24	1
	17:00	3	0.0	15	11	24	1
9/11	10:30	5	2.0	7	9	25	1
	17:00	3	0.0	14.5	11.5	25	1
9/12	10:30	4	0.6	7	9	24	1
	17:00	4	1.4	14	11.5	24	1
9/13	10:30	4	3.0	10	9	25	1
	17:00	4	0.8	12	10	25	1
9/14	10:30	4	1.6	8	8.5	26	1
	18:00	4	0.2	9.5	9	26	1
9/15	10:30	3	0.0	8.5	8.5	27	1
	17:00	4	0.0	13	9	26	1

-continued-

Appendix D1.–Page 5 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
9/16	10:30	4	1.2	6	8	26	1
	17:00	3	0.5	11	9	26	1
9/17	10:30	5	7.9	4	7.5	27	1
	17:00	3	0.6	11	9	26	1
9/18	10:30	4	0.2	6.5	7	26	1
9/19	10:30	3	5.7	6	8	27	1
	17:00	3	0.7	9	7.5	27	1
9/20	07:30	3	4.0	4.5	6.5	28	1
	17:00	4	0.4	7	8	28	1
9/21	10:30	4	0.4	3.5	6	27	1
	17:00	3	0.6	6	8	26	1
9/22	10:30	5	0.0	-1.5	5	26	1
	17:00	4	0.0	6	5.5	26	1
9/23	10:30	4	15.1	6	5.5	28	1
	17:00	4	5.5	8	6	30	1
9/24	10:00	4	0.4	5.5	6	43	2
	17:00	2	0.0	8.5	6.5	47	2
9/25	10:30	5	1.2	3	5.5	50	2

[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

Appendix D2.–Daily stream temperature summary at George River weir from hourly readings logged by Hobo® Water Temp Pro tethered to the stream bottom, 2008.

	Temperature (°C)		
Date	Min.	Max.	Avg.
6/17	9.0	10.1	9.6
6/18	8.9	11.2	10.0
6/19	9.6	11.2	10.4
6/20	9.6	11.9	10.6
6/21	10.2	11.6	11.0
6/22	9.7	12.4	10.8
6/23	10.3	11.2	10.7
6/24	8.7	11.1	9.9
6/25	9.7	11.9	10.6
6/26	9.8	12.4	11.1
6/27	10.8	12.7	11.8
6/28	9.6	12.4	10.8
6/29	7.6	9.4	8.2
6/30	6.5	7.5	6.9
7/01	6.2	7.4	6.7
7/02	6.8	8.0	7.3
7/03	7.2	7.9	7.4
7/04	6.6	9.2	7.7
7/05	8.3	10.6	9.3
7/06	9.3	11.5	10.4
7/07	10.0	12.0	11.0
7/08	10.4	11.8	10.9
7/09	9.5	10.7	10.0
7/10	8.9	10.1	9.3
7/11	8.6	9.9	9.2
7/12	8.7	9.6	9.2
7/13	8.7	11.2	9.6
7/14	9.1	11.7	10.3
7/15	9.8	11.3	10.3
7/16	9.3	9.8	9.6
7/17	8.9	10.4	9.6
7/18	8.9	10.9	9.7
7/19	9.2	10.8	10.1
7/20	9.4	10.5	9.8
7/21	8.7	10.3	9.5
7/22	8.6	10.1	9.4
7/23	9.0	10.1	9.5
7/24	8.5	12.0	10.0
7/25	9.8	13.3	11.4
7/26	11.0	12.6	11.7
7/27	10.4	12.0	11.2
7/28	9.9	12.8	11.3
7/29	10.6	12.1	11.3
7/30	9.9	11.2	10.2
7/31	8.6	12.5	10.3
8/01	10.6	12.8	11.6
8/02	11.3	12.6	11.8
8/03	9.5	12.9	11.2
8/04	11.0	12.5	11.6
8/05	10.1	13.4	11.6
8/06	10.1	12.6	10.9
8/07	9.4	11.9	10.5

-continued, next column-

	Temperature (°C)		
Date	Min.	Max.	Avg.
8/08	9.8	12.6	11.2
8/09	10.0	12.4	11.3
8/10	10.5	13.0	11.5
8/11	10.5	13.2	11.9
8/12	10.6	12.7	11.8
8/13	10.9	12.6	11.8
8/14	11.2	13.3	12.2
8/15	11.5	13.8	12.5
8/16	11.8	14.1	12.9
8/17	12.1	14.0	13.0
8/18	11.2	13.3	12.4
8/19	11.5	13.1	12.4
8/20	11.1	13.0	12.1
8/21	10.3	13.4	11.9
8/22	11.4	13.2	12.3
8/23	10.9	13.9	12.3
8/24	10.7	13.4	12.2
8/25	9.7	12.5	11.1
8/26	10.0	11.6	10.9
8/27	10.5	11.2	10.9
8/28	9.4	11.5	10.5
8/29	9.0	11.2	10.2
8/30	8.9	10.6	9.9
8/31	9.4	10.5	9.9
9/01	8.7	11.2	10.0
9/02	9.1	10.9	10.1
9/03	9.7	11.2	10.4
9/04	10.0	11.7	10.7
9/05	8.8	10.7	9.8
9/06	8.1	10.0	9.2
9/07	8.9	10.1	9.5
9/08	9.2	11.4	10.1
9/09	9.3	10.5	10.0
9/10	9.6	11.0	10.3
9/11	9.3	10.9	10.1
9/12	9.3	10.6	10.0
9/13	9.6	10.2	9.9
9/14	9.0	10.3	9.6
9/15	8.5	9.7	9.1
9/16	8.3	9.2	8.8
9/17	7.8	8.9	8.4
9/18	7.8	8.5	8.1
9/19	7.3	8.4	7.8
9/20	6.8	7.8	7.3
Average:	9.5	11.3	10.3
Minimum:	6.2	7.4	6.7
Maximum:	12.1	14.1	13.0

Appendix D3.–Stream Discharge Measurement at George River weir on 14 August, 2008.

Location: George River Weir

Date: 8/14/08

Description: 50 meters upstream from weir

Time: 21:00

Crew: R. Stewart, S. Warnament

River Stage: 32 cm

Comments: Measured from right bank

Meter Type: AA

Station Distance (m)	Stream Depth (m)	Meter Height (m)	Number of Revolutions Measured	Duration of Measurment (sec)	Point Velocity (m/sec)	Mean Cell Velocity (m/sec)	Mean Cell Depth (m)	Cell Width (m)	Cell Area (m^2)	Cell Flow (m^3/sec)
0	0.00	-	-	-	0.000					
1	0.28	0.11	17	42.2	0.274	0.14	0.14	1.00	0.14	0.02
5	0.52	0.21	18	40.5	0.301	0.29	0.40	4.00	1.60	0.46
10	0.65	0.26	20	40.4	0.335	0.32	0.59	5.00	2.93	0.93
15	0.74	0.30	25	41.7	0.404	0.37	0.70	5.00	3.48	1.28
20	0.85	0.34	28	40.5	0.464	0.43	0.80	5.00	3.98	1.73
25	0.94	0.38	26	40.8	0.430	0.45	0.90	5.00	4.48	2.00
30	1.00	0.40	29	40.4	0.483	0.46	0.97	5.00	4.85	2.21
35	1.02	0.41	29	40.2	0.485	0.48	1.01	5.00	5.05	2.44
40	0.99	0.40	29	40.5	0.482	0.48	1.01	5.00	5.03	2.43
45	0.92	0.37	31	40.9	0.510	0.50	0.96	5.00	4.78	2.37
50	0.87	0.35	30	40.7	0.496	0.50	0.90	5.00	4.48	2.25
55	0.81	0.32	25	41.5	0.406	0.45	0.84	5.00	4.20	1.89
60	0.75	0.30	24	40.0	0.404	0.41	0.78	5.00	3.90	1.58
65	0.69	0.28	25	41.4	0.407	0.41	0.72	5.00	3.60	1.46
70	0.62	0.25	20	40.1	0.337	0.37	0.66	5.00	3.28	1.22
75	0.55	0.22	21	40.9	0.347	0.34	0.59	5.00	2.93	1.00
80	0.48	0.19	21	41.2	0.345	0.35	0.52	5.00	2.58	0.89
85	0.36	0.14	17	41.1	0.281	0.31	0.42	5.00	2.10	0.66
90	0.34	0.14	17	40.9	0.282	0.28	0.35	5.00	1.75	0.49
95	0.21	0.08	10	43.3	0.160	0.22	0.28	5.00	1.38	0.30
101	0.00	-	-	-	0.000	0.08	0.11	6.00	0.63	0.05

Avg. Depth: 0.65 m

Avg. Velocity 0.35 m/sec

Max. Depth: 1.02 m

Max. Velocity 0.51 m/sec

Total Discharge: 27.7 m^3/sec

Appendix D4.–Stream Discharge Measurement at George River weir on 1 September, 2008.

Location: George River Weir

Date: 9/1/08

Description: 50 meters upstream from weir

Time: 14:00

Crew: S. Warnament, M. Sanguinetti

River Stage: 24 cm

Comments: Measured from right bank
Near seasonal low water

Meter Type: AA

Station Distance (m)	Stream Depth (m)	Meter Height (m)	Number of Revolutions Measured	Duration of Measurment (sec)	Point Velocity (m/sec)	Mean Cell Velocity (m/sec)	Mean Cell Depth (m)	Cell Width (m)	Cell Area (m^2)	Cell Flow (m^3/sec)
0	0.00	-	-	-	0.000					
2	0.34	0.14	9	44.0	0.142	0.07	0.17	2.00	0.34	0.02
5	0.48	0.19	11	40.2	0.188	0.17	0.41	3.00	1.23	0.20
10	0.58	0.23	18	41.4	0.295	0.24	0.53	5.00	2.65	0.64
15	0.68	0.27	19	40.5	0.318	0.31	0.63	5.00	3.15	0.97
20	0.76	0.30	21	41.0	0.346	0.33	0.72	5.00	3.60	1.20
25	0.88	0.35	20	40.0	0.338	0.34	0.82	5.00	4.10	1.40
30	0.92	0.37	20	40.7	0.349	0.34	0.90	5.00	4.50	1.55
35	0.98	0.39	24	40.1	0.404	0.38	0.95	5.00	4.75	1.79
40	0.90	0.36	24	41.6	0.389	0.40	0.94	5.00	4.70	1.86
45	0.85	0.34	22	40.0	0.372	0.38	0.88	5.00	4.38	1.66
50	0.79	0.32	22	40.6	0.366	0.37	0.82	5.00	4.10	1.51
55	0.72	0.29	24	40.2	0.403	0.38	0.76	5.00	3.78	1.45
60	0.66	0.26	20	41.5	0.326	0.36	0.69	5.00	3.45	1.26
65	0.61	0.24	20	41.5	0.326	0.33	0.64	5.00	3.18	1.04
70	0.52	0.21	18	40.3	0.303	0.31	0.57	5.00	2.83	0.89
75	0.47	0.19	14	41.5	0.230	0.27	0.50	5.00	2.48	0.66
80	0.37	0.15	17	42.2	0.273	0.25	0.42	5.00	2.10	0.53
85	0.30	0.12	14	41.0	0.233	0.25	0.34	5.00	1.68	0.42
90	0.24	0.10	12	42.2	0.195	0.21	0.27	5.00	1.35	0.29
95	0.12	0.05	8	43.5	0.128	0.16	0.18	5.00	0.90	0.15
99	0.00	-	-	-	0.000	0.06	0.06	4.00	0.24	0.02

Avg. Depth: 0.58 m

Avg. Velocity 0.27 m/sec

Max. Depth: 0.98 m

Max. Velocity 0.40 m/sec

Total Discharge: 19.5 m^3/sec

Appendix D5.–Stream Discharge Measurement at George River weir on 25 September, 2008.

Location: George River Weir

Date: 9/25/08

Description: 50 meters upstream from weir site

Time: 18:00

Crew: R. Stewart, M. Sanguinetti

River Stage: 46 cm

Comments: Measured from right bank
Weir removed on 8/23

Meter Type: AA

Station Distance (m)	Stream Depth (m)	Meter Height (m)	Number of Revolutions Measured	Duration of Measurment (sec)	Point Velocity (m/sec)	Mean Cell Velocity (m/sec)	Mean Cell Depth (m)	Cell Width (m)	Cell Area (m^2)	Cell Flow (m^3/sec)
0	0.00	-	-	-	0.000					
2	0.45	0.18	20	41.4	0.327	0.16	0.23	2.00	0.45	0.07
5	0.64	0.26	26	41.7	0.420	0.37	0.55	3.00	1.64	0.61
10	0.77	0.31	29	40.0	0.488	0.45	0.71	5.00	3.53	1.60
15	0.85	0.34	36	41.3	0.585	0.54	0.81	5.00	4.05	2.17
20	0.96	0.38	42	40.6	0.693	0.64	0.91	5.00	4.53	2.89
25	1.06	0.42	41	40.7	0.674	0.68	1.01	5.00	5.05	3.45
30	1.12	0.45	44	40.6	0.726	0.70	1.09	5.00	5.45	3.82
35	1.12	0.45	42	40.6	0.613	0.67	1.12	5.00	5.60	3.75
40	1.10	0.44	42	40.3	0.698	0.66	1.11	5.00	5.55	3.64
45	1.05	0.42	40	40.6	0.661	0.68	1.08	5.00	5.38	3.65
50	0.99	0.40	43	40.2	0.717	0.69	1.02	5.00	5.10	3.51
55	0.92	0.37	41	40.5	0.693	0.71	0.96	5.00	4.78	3.37
60	0.86	0.34	41	40.0	0.685	0.69	0.89	5.00	4.45	3.07
65	0.80	0.32	35	40.2	0.585	0.64	0.83	5.00	4.15	2.64
70	0.74	0.30	36	40.5	0.597	0.59	0.77	5.00	3.85	2.28
75	0.66	0.26	34	41.2	0.554	0.58	0.70	5.00	3.50	2.01
80	0.62	0.25	32	41.2	0.522	0.54	0.64	5.00	3.20	1.72
85	0.48	0.19	28	40.2	0.468	0.50	0.55	5.00	2.75	1.36
90	0.45	0.18	24	41.7	0.389	0.43	0.47	5.00	2.33	1.00
95	0.35	0.14	21	40.2	0.353	0.37	0.40	5.00	2.00	0.74
100	0.14	0.06	15	42.1	0.243	0.30	0.25	5.00	1.23	0.37
102	0.00	-	-	-	0.000	0.12	0.07	2.00	0.14	0.02

Avg. Depth: 0.73 m

Avg. Velocity 0.51 m/sec

Max. Depth: 1.12 m

Max. Velocity 0.73 m/sec

Total Discharge: 47.7 m^3/sec

APPENDIX E: GEORGE RIVER BROOD TABLES

Appendix E1.–Brood table for George River Chinook salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year						Returns[a]	Return per Spawner[a]
		3	4	5	6	7	8		
1988	ND	ND	ND	ND	ND	ND	0	-	-
1989	ND	ND	ND	ND	ND	2,271	0	-	-
1990	ND	ND	ND	ND	3,070	0	-	-	-
1991	ND	ND	ND	1,793	4,198	-	-	-	-
1992	ND	ND	551	913	-	-	-	-	-
1993	ND	0	2,709	-	-	-	0	-	-
1994	ND	0	-	-	-	257	0	-	-
1995	ND	-	-	-	1,537	201	-	-	-
1996	7,716	-	-	962	1,488	-	0	-	-
1997	7,834	-	395	448	-	130	12	-	-
1998	2,505 [bc]	0	307	-	2,580	127	0	-	-
1999	3,548 [b]	0	-	1,103	1,563	472	0	-	-
2000	2,960 [b]	-	1,349	1,689	1,561	87	0	4,686	1.58
2001	3,309	27	409	1,230	1,089	86	ND	-	-
2002	2,444	0	1,087	1,085	764	ND	ND	-	-
2003	4,693 [b]	7	2,621	1,314	ND	ND	ND	-	-
2004	5,207	0	534	ND	ND	ND	ND	-	-
2005	3,845	0	ND	ND	ND	ND	ND	ND	ND
2006	4,357	ND	ND	ND	ND	ND	ND	ND	ND
2007	4,883	ND	ND	ND	ND	ND	ND	ND	ND
2008	2,698	ND	ND	ND	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.
[b] Insufficient age data.
[c] Incomplete escapement data.

Appendix E2.–Brood table for George River chum salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year				Returns[a]	Return per Spawner[a]
		3	4	5	6		
1990	ND	ND	ND	ND	367	-	-
1991	ND	ND	ND	7,969	95	-	-
1992	ND	ND	12,990	2,732	-	-	-
1993	ND	344	3,037	-	-	-	-
1994	ND	42	-	-	55	-	-
1995	ND	-	-	1,756	0	-	-
1996	19,393	-	1,630	3,905	96	-	-
1997	5,907	47	7,696	2,999	104	10,846	1.84
1998	6,391 [bc]	0	3,032	3,381	29	6,442	-
1999	11,558 [b]	416	29,678	7,498	88	37,680	3.26
2000	3,492	502	5,559	664	67	6,792	1.95
2001	11,601	1,325	13,309	18,867	828	34,329	2.96
2002	6,543	767	21,070	8,940	951	31,728	4.85
2003	33,666	1,463	45,091	23,630	ND	-	-
2004	14,411	985	5,208	ND	ND	-	-
2005	14,828	188	ND	ND	ND	ND	ND
2006	41,467	ND	ND	ND	ND	ND	ND
2007	55,843	ND	ND	ND	ND	ND	ND
2008	29,978	ND	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.
[b] Insufficient age data.
[c] Incomplete escapement data.

Appendix E3.–Brood table for George River coho salmon.

Brood Years	Escapement (spawners)	Number by Age in Return Year			Returns[a]	Return per Spawner[a]
		3	4	5		
1991	ND	ND	ND	-	-	
1992	ND	ND	-	166	-	
1993	ND	-	8,575	-	-	
1994	ND	196	-	2,451	-	
1995	ND	-	6,236	122	-	-
1996	173 [b]	243	10,984	4,851	16,078	-
1997	9,210	150	9,457	-	-	-
1998	52 [bc]	111	-	3,673	-	-
1999	8,930	-	29,292	1,181	-	-
2000	11,262	316	11,897	1,541	13,754	1.22
2001	14,415	171	6,579	864	7,614	0.53
2002	6,759 [c]	80	9,934	944	10,958	1.62
2003	33,280	496	27,825	7,931	36,252	1.09
2004	13,248	548	13,898	ND	ND	ND
2005	8,200	101	ND	ND	ND	ND
2006	11,296	ND	ND	ND	ND	ND
2007	29,317	ND	ND	ND	ND	ND
2008	21,931	ND	ND	ND	ND	ND

[a] Returns do not include downstream harvest.
[b] Incomplete escapement count.
[c] Insufficient age data.