Fishery Data Series No. 08-63

George River Salmon Studies, 2007

Final Report for Study 05-304
USFWS Office of Subsistence Management
Fisheries Information Services Division

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

Symbols and Abbreviations

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Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm
Weights and measures (English)	
cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd
Time and temperature	
day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s
Physics and chemistry	
all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

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

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

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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. The George River weir is one of several projects operated in the Kuskokwim Area that form an integrated geographic array of escapement monitoring projects. Collectively, and in accordance with the State of Alaska Sustainable Fishery Policy (5 AAC 39.222), this array of projects is a tool to ensure adequate geographic and temporal distribution of spawning salmon, and provides a means to assess trends in escapement that should be monitored and considered in harvest management decisions. Towards this end, George River weir has been operated annually since 1996 to determine daily and total salmon escapements for the target operational period of 15 June through 20 September; to estimate age, sex, and length compositions of Chinook, chum, and coho salmon escapement; to monitor environmental variables that influence salmon productivity; and to provide part of an integrated platform in support of other Kuskokwim Area fisheries projects.

In 2007, a resistance board weir was operated on the George River from 14 June through 17 September. Escapements for the target operational period were estimated as 4,883 Chinook, 55,842 chum, 74 sockeye, and 29,317 coho salmon. Chinook and sockeye salmon escapements in 2007 were near average while escapements of chum and coho salmon were exceptionally high. Of the species that occur in the George River only Chinook salmon have been assigned an escapement goal and 2007 escapement was well within the escapement goal range. Age, sex, and length data indicated a relatively strong return of age-1.2 Chinook salmon and age-0.3 chum salmon. Information collected at the weir from fish tagged in the mainstem Kuskokwim River suggest that in 2007 George River Chinook salmon were an intermediate component of runs migrating past the tagging site located near the village of Kalskag.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, longnose suckers, *Catostomus catostomus*, escapement, ASL, age-sex-length, salmon age composition, salmon sex composition, salmon length composition, George River, Kuskokwim River, resistance board weir, radiotelemetry, mark–recapture, genetic stock identification, stock specific run-timing.

INTRODUCTION

Draining an area approximately 130,000 km^2 (11% of the total area of the state), the Kuskokwim River is the second largest river in 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*[1]; Coffing et al. 2000; Smith et al. *In prep*; 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 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

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

within the Kuskokwim Area. In addition, numerous tribal groups are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. For years, these and other groups have combined their resources in an effort to achieve long-term sustainability of Kuskokwim River salmon.

Proper salmon management provides for long-term 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. For much of the ADF&G management history, escapement monitoring has been limited to aerial surveys and 2 ground-based escapement-monitoring projects. The operation of escapement-monitoring projects on only 2 tributaries clearly does not provide adequate escapement information for the entire Kuskokwim River basin. This deficiency was improved when several additional projects were initiated in the mid to late 1990s, one of which was the George River weir. The data provided by the current array of projects have much greater utility for fisheries managers and reliance on aerial surveys has decreased (Whitmore et al. 2008). Over time and with sufficient data, escapement goals can be developed as a means to gauge annual escapement. The George River weir is 1 of 3 that currently boast an escapement goal for Chinook salmon. Annual escapement monitoring in the George River provides escapement and abundance information required for effective management (Holmes and Burkett 1996; Mundy 1998).

During recent Alaska Board of Fisheries (BOF) meetings, Kuskokwim River Chinook *O. tshawytscha* and chum *O. keta* salmon have received considerable attention due to erratic run abundance patterns. In 2000, the 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 the existing weir infrastructure for data collection. Such projects have since become deeply integrated components of field operations.

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 are typically included in most escapement monitoring projects (Molyneaux et al. *In prep*), and the George River weir is no exception. 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 (level), which are fundamental variables of the stream environment that directly or indirectly influence salmon productivity and timing of salmon migrations (Hauer and Hill 1996; Kruse 1998; Quinn 2005). Since these variables can be affected by human activities (i.e., mining, timber harvesting, man-made impoundments, etc.; NRC 1996), climatic variability (e.g., El Nino and La Nina events), and / or climate change (e.g. global warming), data collection for such variables are included in the project operational plan.

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 salmon *O. nerka* and pink salmon *O. gorbuscha* also spawn and rear in the George River. In addition to Pacific salmon, several resident fish species are found throughout the system: Arctic grayling *Thymallus arcticus*, various whitefishes *Coregonus spp.*, *Stenodus leucichthys*, *Prosopium cylindraceum*, Dolly Varden *Salvelinus malma*, northern pike *Esox lucius*, longnose suckers *Catostomus catostomus*, lampreys *Lampetra spp.*, slimy sculpin *Cottus cognatus*, burbot *Lota lota*, blackfish *Dallia pectoralis*, and nine-spine stickleback *Pungitius pungitius*. The production of both Pacific salmon and resident species contributes to the diversity of Kuskokwim River fish populations.

George River is popular for sport fishing, and the river is an access route for recreational and subsistence fishers 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). A small tributary of George River named Julian Creek has received intermittent mining activity since the early 1900s, and this activity continues at a recreational level today. Mining interest in the northern region of the Kuskokwim Mountains expanded in recent years with a proposed large-scale open-pit gold mining operation centered around Donlin Creek of the Crooked Creek drainage, which borders the George River drainage. Expected 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 cause an increase in the human population, which may increase the level of recreational and subsistence fishing activity in the George River. In the presence of a human population influx, 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 escapement monitoring project has been operated cooperatively by ADF&G and the Kuskokwim Native Association (KNA) since its inception in 1996. Project responsibilities are shared between KNA and ADF&G and both organizations make use of weir data. George River weir has developed into a useful tool for sustainable salmon management. Generally, ADF&G leads efforts in data management, data analysis, and reporting while KNA takes the lead in field operations and community outreach. The primary objective of this project is to accurately monitor size and quality (age, sex, and length) of Pacific salmon escapement to the George River system. Secondary to this is the goal to promote local education and involvement in fisheries monitoring and develop the capacity of KNA to engage effectively in salmon resource management. To this end, the George River weir crew annually comprises 1 locally hired KNA technician, 1 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, and coho salmon to George River from 15 June through 20 September.
2. Estimate the age, sex, and length (ASL) composition of total Chinook, chum, sockeye, and coho salmon escapements to George River from a minimum of 3 pulse samples, 1 collected from each third of the run, such that simultaneous 95% confidence intervals of age composition in each pulse are no wider than 0.20 ($\alpha = 0.05$ and $d = 0.10$).
3. Monitor habitat variables including daily water temperature and daily water level.
4. Provide for collaborative, efficient research in the Kuskokwim River system by:
   a. Serving as a monitoring and recapture location for Chinook salmon equipped with radio transmitters and anchor tags deployed as part of *Kuskokwim River Chinook Salmon Run Reconstruction*;
   b. Serving as a monitoring and recapture location for sockeye salmon equipped with radio transmitters deployed as part of *Kuskokwim River Sockeye Salmon Investigations*; and,
   c. Installation of a stream gage at the George River to begin collecting hydrologic data as part of the *Hydrologic Data for the George River Project* (SWG).

The primary goal of this report is to summarize and present the results for the 2007 field season at the George River weir. Secondary to this, we intend to provide a more holistic perspective of Kuskokwim Area fisheries by placing the 2007 findings into the broader spatial and temporal context. To do this we draw heavily on data from past years at this project to highlight between-year trends and we draw on data from other escapement monitoring projects, related research projects, and the commercial and subsistence fishery in order to highlight spatial trends. These goals are intended to enhance the utility of this report beyond simply archiving data. It is important to note that some of the data used to make these broader comparisons are preliminary. 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, the final results and conclusions for "*In prep*" documents may change. Therefore, 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 often differ across projects and over time leading to difficulty in comparisons. Throughout this document 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

The George River drains a watershed of about 3,558 km^2 that is formed by surface runoff from the northern Kuskokwim Mountains within the middle Kuskokwim River basin. Major tributaries of the George River include Beaver Creek, Michigan Creeks, North Fork George River, South Fork George River, and East Fork George River (Figure 2). From its headwaters the George River flows southerly for approximately 120 river kilometers (rkm) to its confluence with the Kuskokwim River (Figure 1). The mouth of the George River is located near the community of Georgetown, which is 446 rkm upstream of the mouth of the Kuskokwim River, 340 rkm upstream of Bethel, and 139 rkm upstream of Aniak.

Over its course the George River flows through a poorly-drained moderately-confined floodplain consisting of soft sediments that erode easily. The substrate is composed primarily of gravels and cobbles, with some sand. At normal flow the George River is considerably stained due to organic leaching, limiting visibility to approximately 0.5 m. Oxbows, sloughs, and large log jams are common throughout the drainage, creating a complex mosaic of habitats of varying suitability for salmon and resident fish species. Riparian areas consist predominantly of upland spruce-hardwood forests. White spruce *Picea glauca* and scattered birch *Betula spp.* and/or aspen *Populus trenuloides* are common on south-facing slopes. Black spruce *P. mariana* is characteristic of 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 willows *Salix spp.*, and/or alders *Alnus spp.* in open forest near timberline.

The George River weir is located 7 rkm upstream of the mouth of the George River (N61° 55.4' Latitude and W157° 41.9' Longitude) and captures nearly the entire salmon spawning habitat within the drainage (Figure 2). The weir has operated at this location since the project began in 1996. At the weir site the channel is approximately 110 m wide with a depth of about 1 m during normal summer operations. Discharge measurements taken at the site over the years have ranged between 16.0 and 149.0 m^3/s, with velocities ranging from 0.6 and 1.3 m/s in the thalweg (the line of fastest flow). Discharge measurements have not been attempted during flood conditions and therefore discharge data do not represent the full potential range of flows.

WEIR DESIGN

Construction

The George River weir is termed "floating panel" resistance board weir. Tobin (1994) describes details of the design and construction and Stewart (2002) describes the changes implemented for the George River weir. Each year the weir is installed across the entire 110 m channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels cover the middle 100 m portion of the channel, and fixed weir materials extend the weir 5 m to each bank. The pickets are 3.33 cm (1-5/16 in) in diameter and spaced at intervals of 6.67 cm (2-5/8 in) to leave a gap of 3.33 cm (1-5/16 in) between each picket.

Most fish passage intentionally occurs through the fish trap, which is installed within the deeper portion of the stream channel each year. The fish trap is about 2.5 m long (parallel to channel) and 1.5 m wide (perpendicular to channel) and has 2 gates: 1 facing downstream and 1 facing upstream. After all the panels are installed across the river, 1 is removed where the trap is to be installed and modified weir panels are fastened to the side of each panel adjacent the gap. The trap is lowered into the river just upstream of the rail with its downstream gate centered on the gap. The modified panels are butted against the trap frame and maintain the weir's integrity. The trap can be easily configured to pass fish freely upstream or to capture individuals for sampling.

A skiff gate is installed within a deeper section of the river to facilitate both jet-driven and propeller-driven boat traffic. The skiff gate consists of panels modified to submerge under the weight of passing boats. Generally, boat operators can pass with little or no involvement by the weir crew. Boats with jet-drive engines are the most common and can pass up or downstream over the skiff gate after reducing speed to 5 miles per hour or less. A submerged tow rope with a buoy attached to the downstream end was installed in 2007 to allow propeller driven boats to pass upstream without the aide of the weir crew.

To accommodate downstream migration of longnose suckers and other resident species, downstream passage chutes are incorporated into the weir once resident species are observed congregating upstream. At locations where downstream migrants are most concentrated, chutes are 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, but prevents upstream salmon passage. The chutes are monitored and adjusted to ensure salmon are not passing upstream. Downstream salmon passage is not enumerated; however, few salmon have been observed passing downstream over these chutes and their numbers are not considered significant.

Maintenance

The weir is cleaned several times each day, typically at the end of a counting shift. To clean the weir, a technician walks along the floating end. This added weight on the distal end partially submerges each panel and allows the current to wash debris downstream. A rake is used to push larger debris off the weir. Each time the weir is cleaned panels and other weir components are inspected for damage. Periodically, a more thorough inspection is performed by snorkeling along the rail.

ESCAPEMENT MONITORING

The George River weir operates according to a "target operational period" that encompasses virtually the entire runs of Chinook, chum, and coho salmon. Having a target operational period provides for consistent comparisons among years. The target operational period for George River weir has been established as 15 June through 20 September. Annual operational dates may vary due to stream conditions and anomalies in run timing and/or abundance. Reported daily and annual Chinook, chum, coho, and sockeye salmon escapements consist of observed plus any estimated passage. Counts of all other species, including pink salmon, are reported as observed passage; expected missed passage is not estimated.

Passage Counts

Passage counts are conducted periodically during daylight hours. Substantial delays in fish passage occur only at night or during ASL sampling. Crew members visually identify each fish as it passes upstream and records it by species on a multiple tally counter. Counting continues for a minimum of 1 hour or until passage substantially decreases. Counting effort is 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 record the total upstream fish count in a designated notebook and zero the tally counter after each counting session. At the end of each day, total daily and cumulative seasonal counts are copied to logbook forms. These counts are reported each morning to ADF&G staff in Bethel via single side band radio or satellite telephone.

The live trap is used as the primary means of upstream fish passage. Fish are counted as they enter the downstream end of the trap. Proper identification is enhanced by use of a clear-bottom viewing box that reduces glare and water turbulence. In addition to aiding in species identification, this tool allows observers to see and thus trap tagged fish in support of tagging projects, such as *Kuskokwim River Chinook Salmon Run Reconstruction* and *Kuskokwim River Sockeye Salmon Investigations* in 2007. Other methods are occasionally used when salmon are reluctant to enter the fish trap, such as during periods of extreme low water. Hildebrand et al. (2007) describes other methods.

Estimating Missed Passage

To better assess annual run size of each species of salmon and to facilitate comparison among years, upstream salmon passage is estimated for days when the weir is not operational within the target operational period. When historical data indicate that passage of a particular species on an inoperable day is probably negligible, passage is assumed to be zero without performing any calculations. However, when historical records indicate that passage of a particular species is probably considerable, 1 of the 3 formulas listed below are used to calculate potential missed passage. The method used depends on the duration and timing of the inoperable periods.

Single Day Method

When the weir is not operational for part or all of 1 day, an estimate for the inoperable day is calculated using the following formula:

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

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:

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

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

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

where

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

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

Proportion Method

In circumstances when the weir does not first become operational until after the target start date (15 June) or when the weir ceases operating long before the target end date (20 September) daily passage for inoperable days is estimated using passage data from another year at the George River weir or from the present year at 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:

$$\hat{n}_{d_i} = \left(\frac{\left(n_{md_i} \times \sum n_{d_1}\right)}{\sum n_{md_1}} \right) - n_{o_i} \qquad (3)$$

where

$n_{md_i} =$ passage for the i^{th} day in the model data;

$\sum n_{d_1} =$ cumulative passage;

$\sum n_{md_1} =$ 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.

Estimates Required in 2007

Presented here in chronological order, the "linear method" was used to estimate missed Chinook, chum, coho, and sockeye salmon passage during the inoperable period that occurred between 14 and 21 July and again when the weir became inoperable between 6 and 8 August. The final inoperable period in 2007 (18–20 September) was the result of a planned early termination of seasonal weir operation and estimates were necessary only for coho salmon; passage of Chinook, chum, and sockeye salmon was assumed to be zero during this period. The "proportion method" was not used in this case because the sources of error associated with using a model dataset were thought to be greater than those of other methods. Instead, coho salmon passage on 18, 19, and 20 September was extrapolated (exponentially) using daily passages on the 11 preceding days.

Carcass Counts

In 2007 the weir was cleaned several times each day, typically at the beginning and end of counting shifts. Spawned out salmon and carcasses of dead salmon (both hereafter referred to as carcasses) that wash up on the weir were counted by species and sex and passed downstream. Daily and cumulative carcass counts were copied to logbook forms.

AGE, SEX, AND LENGTH COMPOSITION

The ASL composition of the total Chinook, chum, and coho salmon escapements were estimated by sampling a fraction of the fish passage and applying the ASL composition of those samples to the total escapement as described in DuBois and Molyneaux (2000).

Sample Collection

The field crew at the George River weir employed standard sampling techniques as described by DuBois and Molyneaux (2000). For chum and coho salmon, a pulse sampling design was used, in which moderate sampling was conducted for 3 days followed by a few days without sampling. The goal of each pulse was to sample 200 chum and 170 coho salmon. The pulse sample design was not strictly followed with Chinook salmon such that the goal to sample a minimum of 210 Chinook salmon from each third of the run preceded the goal to sample in pulses. This method results in a near daily Chinook salmon sample collection throughout most of the target operational period. Sample sizes were selected so the simultaneous 95% confidence interval estimates of age and sex composition proportions would be no wider than 0.20 (Bromaghin 1993) per pulse (or per third of the run in the case of Chinook salmon) for Chinook salmon assuming 10 age/sex categories, for chum salmon assuming 8 age/sex categories, and for coho salmon assuming 6 age/sex categories. Target sample sizes for all species were increased by about 10% from that recommended by Bromaghin (1993) to account for sampled individuals that could not be aged. The minimum acceptable number of sampling events was 3 per species, 1 event from each third of the run, to account for temporal dynamics in the ASL composition.

To facilitate sampling, salmon were trapped by opening the entrance gate while the exit gate remained closed. Fish were allowed to swim freely into the holding box but the V-shape positioning of the entrance gate prevented them 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”. Three scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards (DuBois and Molyneaux 2000). 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. Length was measured to the nearest millimeter from mid eye to tail fork (METF) 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.

When necessary, additional samples were collected through active sampling for difficult species (i.e. Chinook and sockeye salmon). Active sampling required that a crew member be positioned above the downstream end of the trap to observe fish passing upstream. Both the entrance and exit gates remained open, which allowed most species to pass unimpeded and increased current flow through the structure. Increased current flow seems to encourage fish to enter the trap. When the targeted species entered the trap, the crew member would immediately close both the entrance and exit gates, thereby actively trapping the fish for sampling. This method was useful in isolating the relatively few Chinook salmon from larger volumes of chum passing at the same time and improved ASL sampling success.

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

Estimating Age, Sex, and Length Composition

ADF&G staff in Bethel and Anchorage aged scales, processed ASL data, and generated data summaries. DuBois and Molyneaux (2000) describe details. For each sampled species, 2 types of summary tables were generated from this process: 1 described the age and sex composition and the other described length statistics. These summary tables illustrated changes in the ASL composition throughout the season by first partitioning the season into temporal strata based on pulse sample dates and/or sample size requirements, and then applying the ASL composition of individual temporal samples to the corresponding temporal stratum, and finally summing the strata to generate the estimated ASL composition for the season. This procedure ensured that the ASL composition of the total annual escapement was weighted by the abundance of fish in the escapement rather than the abundance of fish in the samples. For example, if 6 pulse samples of chum salmon were collected, the season would be partitioned into 6 temporal strata whose dates were selected such that each stratum encompassed 1 pulse sample. Hence, a hypothetical sample of 200 chum salmon collected from 3 to 4 July would be used to estimate the ASL composition of the hypothetical escapement of 2,000 chum salmon that passed the weir during the temporal stratum that might extend from 1 to 7 July. This procedure would be repeated for each temporal stratum, and the estimated age and sex composition for the total annual escapement would be calculated as the sum of chum salmon in each stratum. In similar fashion, the estimated mean length composition for the total annual escapement would be calculated by weighting the mean lengths in each temporal stratum by the escapement of chum salmon that passed the weir during that stratum. Confidence intervals for estimates of length composition were constructed based on the method set forth by Thompson (1992, p.105).

Often in this document fish ages are reported using European notation. European notation is composed of 2 numerals separated by a decimal. The first numeral is the number of winters the juvenile has spent in freshwater and the second numeral is the number of winters it spent in the ocean (Groot and Margolis 1991). Total age of a fish is equal to the sum of these 2 numerals, plus 1 year to account for the winter when the egg was incubating in gravel. For example, a Chinook salmon described as age-1.4 is actually 6 years of age.

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. In 2005–2007, water temperature was also measured with a remote temperature logger located near mid-channel just upstream from the weir. 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 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 river gauge.

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

The overall cost to initiate *Kuskokwim River Chinook Salmon Run Reconstruction* project (henceforth referred to as the "run reconstruction project") was relatively little because most of the infrastructure required to operate the project was already installed. The presence of weirs and other escapement monitoring projects was a critical component that satisfied the requirement for reliable escapement data. Nearly the entire network of stationary tracking stations and much of the tagging equipment was installed for previous and concurrent radiotelemetry-based projects, including *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (Stuby 2007), *Kuskokwim River Sockeye Salmon Investigations* (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), and *Assessment of Chinook, Chum, and Coho Salmon Escapements in the Holitna River Drainage Using Radiotelemetry* (Stroka and Brase 2004). Most of the tagging equipment was provided by these and a former project entitled *Kuskokwim River Salmon Mark-Recapture Project* (Pawluk et al. 2006). In subsequent text, these project names will be truncated to the following: "inriver abundance project", "sockeye salmon investigations project", "Holitna River telemetry project", and "mark-recapture project".

Objectives of the run reconstruction project included investigating the relationship between drainage-wide abundance estimates and known tributary escapements to derive a statistical model that would compute historical annual abundance estimates based on known tributary escapements. The run reconstruction project utilized data obtained from the inriver abundance project and most of the methods used by the latter were implemented into the experimental design of the former. The former inriver abundance project provided abundance estimates for each year between 2002 and 2006. In an effort to increase the power of the model and since the infrastructure was already in place investigators decided to continue radio-tagging and anchor-tagging Chinook salmon in 2007 to achieve another annual abundance estimate. As with the inriver abundance project, radio transmitters were inserted into select Chinook salmon with lengths greater than 450 mm caught near Kalskag (rkm 270) following methods described by Stuby (2007; Figure 1). Radio-tagged fish were detected by several tracking stations spread throughout the drainage and every weir upstream of the tagging locations was accompanied by a tracking station. Radio-tags are not visible when fish are viewed from the top, so every radio-tagged fish was fitted with an anchor tag that allowed weir crews to identify and trap radio-tagged fish for tag number recovery. Tag data recovered by weir crews supplemented, and sometimes verified, tracking station recovery information. This system of weirs and tracking stations allowed for: (1) the development of tagged-to-untagged ratios, (2) a means to test potential tagging bias, and (3) the development of annual abundance estimates for most of the drainage.

With the run reconstruction project, additional attention was given to the Aniak River drainage for which an annual abundance estimate had remained elusive. In 2006 and 2007, a weir and tracking station were installed together on an upper-river tributary of the Aniak River (specifically, the Salmon River) to generate a tagged-to-untagged ratio assumed to be representative of the entire Aniak River drainage. Consequently, Aniak River abundance estimates are available for 2006 and 2007.

The location of the tracking station relative to the weir differed slightly at each weir project. At the George River weir site, the receiver station was placed about 100 m upstream of the weir. The known Chinook salmon passage at the weir, coupled with data collected from the receiver station, were used with similar data collected at other weir projects to develop estimates of the total Chinook salmon abundance upstream from the Kalskag tagging site.

Kuskokwim River Sockeye Salmon Investigations

The George River weir was used as a platform for the project entitled *Kuskokwim River Sockeye Salmon Investigations*. This project was designed to address critical knowledge gaps in the biology and ecology of Kuskokwim River sockeye salmon. Specifically, this project aimed to describe the location and relative abundance of sockeye salmon spawning aggregates, estimate stock-specific run-timing in the main stem of the Kuskokwim River, describe and compare habitat use and seasonal migration patterns of river-type and lake-type juveniles, and describe and compare smolt size and growth among tributaries and habitat types. These goals were addressed by conducting a two-sample mark–recapture study within the upper Kuskokwim River drainage above Kalskag and conducting juvenile studies within various habitat types throughout the Holitna River drainage and Telaquana Lake.

Similar to Chinook salmon radio-tagging efforts, radio transmitters were inserted into sockeye salmon caught near Kalskag. Radio-tagged fish were also equipped with an anchor tag to assess incidences of tag loss. A combination of radio receiver stations located throughout the upper Kuskokwim River drainage (the same receiver stations used for the Chinook project) and aerial surveys was used to monitor the movements of tagged fish. In 2006, juvenile salmon were sampled from various habitat types throughout the Holitna River drainage using standard seining techniques. The known sockeye salmon passage at the weir projects located throughout the upper drainage, coupled with data collected from tracking efforts, was used to address distribution, abundance, and run-timing of spawning aggregates. Data from seining efforts were used to address habitat use, out migration timing, and variation in size and growth of juvenile sockeye salmon.

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. The objective of this project was to install a stream gage on the George River and collect accurate hydrologic data. This data is required to assess relationships between fish population dynamics and flow characteristics throughout freshwater stages of their life cycle. In addition, baseline hydrologic data is critical for the establishment of water reservations: the legal right (or appropriation of water) to maintain a specific flow rate or level in a given body of water for 1 or a combination of purposes: 1) protection of fish and wildlife habitat, migration, and propagation; 2) recreation and parks purposes; 3) navigation and transportation purposes; and 4) sanitary and water quality purposes (Estes 1996). The coordination of the installation and operation of the stream gage with the operations of the George River weir will allow comparison of hydrologic dynamics with salmon fish migration rates. The 2007 season marked the second year of a 5 year study aimed at addressing temporal flow dynamics.

The George River weir and crew facilitated this effort by installing an Aquistar stream gage (Instrumentation Northwest, Inc.) approximately 200 yards downstream of the weir (river right) on 21 June, 2006. The stream gage was installed at a water level of 69 cm. The station was monitored throughout the season under the direction of the Statewide Aquatic Resources Coordination Unit (SARCU). The stream gage was calibrated from stream discharge measurements representing 3 contrasting water levels, “stages”, during the season following methods described by the U.S. Geological Survey (Rantz 1982). Discharge was measured using a Price AA current-meter and top-setting wading rod. Information collected for calculating discharge was recorded in the camp logbook. Stream discharge was calculated using standard area velocity methods.

RESULTS

ESCAPEMENT MONITORING

The George River weir operated from 0000 hours on 15 June until nightfall on 17 August. The weir was inoperable for 14 days throughout the 2007 season. The most consequential inoperable periods (14–21 July and 6–8 August) resulted from high water and heavy debris load. Operations were stopped 3 days prior to the end of the target operational period, resulting in another inoperable period from 18–20 September. This action was taken due to anticipation of another high water event at the end of the project season and low daily passages of coho salmon during the previous 3 days.

Chinook Salmon

Total annual Chinook salmon escapement upstream of the George River weir during the target operational period in 2007 was 4,883 fish, which includes an estimated 873 fish (17.9% of the total run) that passed during the inoperable periods (Table 1). The first Chinook salmon was observed on 23 June, daily passage peaked at 915 fish on 8 July, and the last Chinook salmon was observed on 23 August. The median passage date was 9 July and the central 50% of the passage occurred between 7 July and 15 July (Figure 3).

Chum Salmon

Total annual chum salmon escapement upstream of the George River weir during the target operational period in 2007 was 55,842 fish, which includes an estimated 12,410 fish (22.2% of the total run) that passed during the inoperable periods (Table 1). The first chum salmon was observed on 16 June, daily passage peaked at 3,334 fish on 24 July, and the last chum salmon was observed on 17 September, the last day of operation. The median passage date was 20 July and the central 50% of the passage occurred between 11 and 26 July (Figure 3).

Coho Salmon

Total annual coho salmon escapement upstream of the George River weir during the target operational period in 2007 was 29,317 fish, which includes an estimated 1,360 fish (4.6% of the total run) that passed during the inoperable periods (Table 1). The first coho salmon was observed on 15 July, daily passage peaked at 2,219 fish on 14 August, and the last coho salmon was observed on 17 September, the last day of operation. The median passage date was 24 August and the central 50% of the run occurred between 18 August and 29 August (Figure 3).

Sockeye Salmon

Total annual sockeye salmon escapement upstream of the George River weir during the target operational period in 2007 was 74 fish, which includes an estimated 9 fish (12.2% of the total run) that passed during the inoperable periods (Table 1). The first sockeye salmon was observed on 10 July and the last fish was observed on 2 September. Peak daily passage of 7 fish occurred on 3 August. The median passage date was 4 August and the central 50% of the run occurred between 29 July and 13 August (Table 1).

Other Species

Pink Salmon

Total annual observed pink salmon escapement upstream of the George River weir during the target operational period in 2007 was 325 fish, which includes an estimated 41 fish (12.6% of the total run) that passed during the inoperable periods (Appendix B). The first pink salmon was observed on 5 July, passage peaked at 106 on 26 July, and the last fish was observed on 13 September. The median passage date was 26 July and the central 50% of the passage occurred from 23 July through 27 July.

Resident Species

Several other species were routinely observed passing upstream and downstream over the weir by crew members during normal salmon enumeration routines. Other species observed passing upstream of the George River weir during the 2007 field season include 3,813 longnose suckers, 504 Arctic grayling, 47 whitefish, and 1 northern pike (Appendix B). No estimates of missed passage were made for these species during the inoperable periods.

Carcass Counts

A total of 2,486 salmon carcasses were recovered from the George River weir in 2007 (Appendix C). A total of 250 male and 86 female (total = 336) Chinook salmon carcasses were recovered (6.9% of the observed annual escapement) from 30 July through 29 August. A total of 1,367 male and 710 female (total = 1,367) chum salmon carcasses were recovered (2.4% of the observed annual escapement) from 1 July through 14 September. A total of 2 male and 2 female (total = 4) coho salmon carcasses were recovered (<0.1% of the observed annual escapement) from 9 September through 17 September. A total of 8 male and 0 female (total = 8) sockeye salmon carcasses were recovered (10.8% of the observed annual escapement) from 29 July through 1 September. A total of 46 male and 15 female (total = 61) pink salmon carcasses were recovered (18.8% of the observed annual escapement) from 28 July through 23 August.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Chinook salmon ASL sampling at the George River weir was conducted opportunistically (i.e. when the weir was operational and water levels allowed) from 29 June to 5 August, resulting in a total sample of 304 fish. Of those, age was determined for 249 fish (82% of the total sample), or 5.1% of the total annual Chinook salmon escapement (Table 2). As written, the ASL sampling objective was not achieved for 2 reasons. First, when the total annual escapement was divided into 3 temporal strata postseason (with dates corresponding to each third of the run) it was revealed that the central one-third of the run was not represented in the sample; authors of this report decided to divide the sample and escapement into 2 temporal strata, with sample sizes of 159 and 90 fish, rather than 3 (Table 2). Second, neither of the 2 stratum samples was sufficiently large to achieve the objective confidence interval range of 0.20. Despite these limitations, the total sample size and temporal distribution was considered adequate to estimate annual age composition in this report. Given that the utility of 2 strata samples is limited, per-stratum ASL composition data from 2007 can simply corroborate or contradict historical trends when plotted among historical data. It is for that reason that per-stratum Chinook salmon ASL composition data from 2007 have been graphed along with other years.

Age Composition

Most Chinook salmon age *groups* were comprised of only 1 age *class*; that is, all 4 year old fish were of the 1.2 age class, all 5 year old fish were of the 1.3 age class, and all 6 year old fish were of the 1.4 age class (Table 2). In contrast, the 7 year old component consisted both of age-1.5 and age-2.4 fish (Table 2). The Chinook salmon run was almost completely represented by the 3 most common age classes that, combined, comprised over 98% of the total Chinook salmon escapement at the George River weir. Age-1.2 was the most abundant age class (53.7%), followed by age-1.3 (22.2%), age-1.4 (22.3%), age-1.5 (1.3%), and age-2.4 (0.5%) (Table 2). No other age classes were sampled although they are known to occur in some systems. Data were largely inadequate to investigate intra-annual changes in age composition; however, comparisons can be made between the 2 existing pulse samples. One considerable conclusion is that age-1.2 fish were predominant during the first stratum whereas age-1.2 and age-1.4 fish were similar but of higher proportion than other age classes during the second (Table 2; Figure 4). The percentage of age-1.3 fish varied little between the first and last strata and they were less abundant than age-1.2 fish in both (Table 2; Figure 4).

Sex Composition

The Chinook salmon escapement past the weir was approximately 5:1 males to females. Females comprised 17.2% of the total escapement based on weighted ASL samples (Table 2). The female escapement was dominated (78.3%) by older, age-1.4, individuals while the male escapement was largely composed of younger, age-1.2 and -1.3, individuals (64.8% and 22.9%, respectively) (Table 2). Data were largely inadequate to investigate intra-annual changes in sex composition;

however, comparisons can be made between the 2 existing pulse samples. One reasonable conclusion is that females were far more abundant during the last stratum than during the first (Table 2; Figure 5).

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female Chinook salmon ranged from 700 to 940 mm, and males ranged from 395 to 990 mm (Table 3). In the 2 age classes that contained considerable numbers of both males and females (age-1.3 and -1.4), female Chinook salmon were larger at age than males and average length increased with age for both females and males (Figure 6). Average length of age-1.3 females was 764 mm while the average length of age-1.4 females was 835 mm. Average lengths for male age-1.2, -1.3, and -1.4 Chinook salmon were 518 mm, 666 mm, and 787 mm, respectively. Two male Chinook salmon of the 1.5 age class were sampled and had lengths of 825 and 990 mm. One male age-2.4 Chinook salmon was sampled with a length of 835 mm and one female age-1.5 Chinook salmon was sampled with a length of 940 mm. For all age and sex categories, mean lengths changed little between the first and last pulse sample (Figure 7).

Chum Salmon

Sampling goals for chum salmon were achieved in 2007. Intensive sampling was conducted during 4 sampling pulses that were fairly well-distributed throughout the chum salmon run. A total of 800 chum salmon were sampled. Of those, age was determined for 705 fish (88% of the total sample), or 1.3% of the total annual chum salmon escapement in 2007 (Table 4). The chum salmon run was partitioned into 4 temporal strata based the temporal distribution of the sampling effort, with sample sizes ranging between 163 and 183 aged fish per stratum (Table 4). Generally, sample sizes were adequate for estimating total and per-strata age, sex, and length composition of chum salmon escapement to the George River weir in 2007.

The temporal gap between the end of the second pulse sample and the beginning of the third was longer than anticipated due to continuous high water levels that inhibited sampling. Thus, when annual escapement was divided into 4 temporal strata postseason it was revealed that the central one-third of the run was not well represented in the sample. Nevertheless, the distribution of the existing strata are probably sufficient to reasonably estimate total annual age, sex, and length composition as well as to investigate intra-annual changes of these parameters.

Age Composition

The chum salmon escapement past the weir was largely represented by 4 year old and 5 year old individuals; 80.7% of annual escapement was composed of 4 year old individuals and 16.0% was composed of 5 year old individuals (Table 4). Combined, fish of these 2 ages comprised over 95% of annual escapement. 3 year old and 6 year old individuals comprised 1.8% and 1.5% of annual escapement, respectively (Table 4). Since virtually all chum salmon out-migrate the first spring or summer after emergence, all 3 year old individuals were of the 0.2 age class, all 4 year old individuals were of the 0.3 age class, all 5 year old individuals were of the 0.4 age class, and all 6 year old individuals were of the 0.5 age class. Age composition varied over the course of the run but there existed no consistent pattern of increase or decrease for any age class (Table 4; Figure 8).

Sex Composition

The chum salmon escapement past the weir was approximately 1:1 males to females. Females comprised 49.3% of the total escapement based on weighted ASL samples (Table 4). Sex composition was fairly consistent, although the proportion of females increased in the later half of the run (Table 4; Figure 5). The female escapement was mostly age-0.3 fish (79.3%); although age-0.4 fish also comprised a considerable component of the total return (17.4%). Similarly, the male escapement was comprised predominantly of age-0.3 and age-0.4 individuals, which represented 82.1% and 14.6% of male chum salmon escapement (Table 4).

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female chum salmon ranged from 450 to 675 mm, and males ranged from 455 to 695 mm (Table 5). Male chum salmon were generally larger at age than females (Figure 6). However, average length did not vary significantly with age (Figure 6). Average lengths for female age-0.2, -0.3, -0.4 and -0.5 chum salmon were 509, 527, 534, and 540 mm, respectively (Table 5). Average lengths for male age-0.2, -0.3, -0.4, and -0.5 fish were 517, 552, 568, and 573 mm, respectively (Table 5). For both males and females, average length-at-age varied little during the run (Table 5; Figure 9).

Coho Salmon

Coho salmon ASL sampling at the George River weir was conducted in 3 sampling pulses distributed evenly throughout the coho salmon run, for a total of 515 fish. Of those, age was determined for 442 coho salmon (86% of the total sample), or 1.5% of the total annual coho salmon escapement (Table 6). The total sample size and temporal distribution was more than adequate to estimate annual age composition. The coho salmon run was partitioned into 3 temporal strata based on the temporal distribution of sampling effort. Sample sizes were 156 fish in the first stratum and 143 fish in each of the last 2 strata (Table 6). These sample sizes were below the inseason goal of 170 fish per pulse outputted by Bromaghin's method and, as such, are not sufficient to satisfy the requirement that confidence intervals be no wider than 0.20. Despite this shortfall, actual sample sizes are sufficiently large to reasonably investigate intra-annual ASL dynamics.

Age Composition

The coho salmon escapement past the weir was dominated by 4 year old individuals, which comprised 94.9% of the total escapement (Table 6). Of the escapement, 3 year old fish comprised 1.9% and 5 year old fish comprised 3.2% (Table 6). Since virtually all coho salmon spend only 1 winter at sea before returning to spawn, all 3 year old fish were of the 1.1 age class, all 4 year old fish were of the 2.1 age class, and all 5 year old fish were of the 3.1 age class (Table 6). No individuals from other age classes were sampled. Some intra-annual variation in age composition was observed, but variations tended to be slight and inconsistent (Figure 10).

Sex Composition

The ratio of males to females in the coho salmon escapement past the weir was slightly less than 2:1. Male coho salmon composed 63.1% of the total annual escapement based on weighted ASL samples (Table 6). The proportional contribution of females increased steadily over the course of the run, comprising 29.5%, 40.6%, and 55.9% of escapement during the first, second, and third strata, respectively (Figure 5). Both the male and female escapement was dominated by age-2.1 individuals, representing 95.6% and 93.7% of the total male and female escapement, respectively (Table 6).

Length Composition

Analysis of length composition suggested partitioning by sex and age class. The length of female coho salmon ranged from 445 to 630 mm, and males ranged from 400 to 635 (Table 7). Female coho salmon were generally larger at age than males (Figure 6). Considering small sample sizes, there is no evidence that length increases with age among George River coho salmon in 2007 (Table 7). Average lengths for female age-1.1, -2.1, and -3.1 fish were 588, 560, and 555, respectively. Average lengths for male age-1.1, -2.1, and -3.1 fish were 558, 544, and 570 mm, respectively. Average length of male coho salmon increased continuously during the run (Figure 11); however, no discernible pattern occurred among females

WEATHER AND STREAM OBSERVATIONS

A total of 190 complete weather and stream observations were recorded between 15 June and 20 September, 2007 (Appendix D1). Based on twice-daily thermometer observations water temperature at the weir ranged from 5°C to 16°C, with an average of 10.4°C. Based on hourly data logger readings, daily average water temperature ranged from 5.9°C to 16.6°C, with an average daily temperature of 10.1°C (Appendix D2). Air temperature at the weir ranged from 3°C to 26°C, with an average of 13.6°C (Appendix D1). A total of 239.2 mm of precipitation was recorded throughout the season. River stage ranged from 34 cm to 120 cm, with an average of 63.7 cm (Appendix D1).

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

A total of 10 radio-tagged Chinook salmon were detected by the receiver station located near the George River weir in 2007. Telemetry data from the tracking station along with telemetry data from aerial tracking efforts and tag passage data through the weir revealed that these fish passed the weir site.

The 2007 estimates of Chinook salmon abundance provided by this study are preliminary at the time of writing; however, they are probably near the final values and sufficient for discussion here. Estimates resulting from this study indicate that 121,370 Chinook salmon greater than 450 mm in length (SE = 13,027; 95% CI = 95,837–146,904) migrated upstream of Kalskag and a total of 105,832 Chinook salmon greater than 450 mm in length (SE = 12,288; 95% CI = 81,747–129,916) migrated upstream of the Aniak River confluence (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). According to these estimates, the George River stock represented 4.0% of total abundance upstream of Kalskag and 4.6% of the abundance upstream of the Aniak River confluence.

Kuskokwim River Sockeye Salmon Investigations

In 2007, one radio-tagged sockeye salmon was observed passing the George River weir; however, it could not be confirmed whether or not it passed the receiver station. This uncertainty may be due to the fact that the receiver station is located upstream of the weir because it is possible, although unlikely, that the radio-tagged sockeye salmon passed the weir and turned around before passing the tracking station. In addition, 2 anchor-tagged sockeye salmon were observed passing the George River weir. Tagged sockeye salmon were tracked to tributaries throughout the Kuskokwim River basin using 18 ground-based tracking stations and aerial tracking surveys conducted in July and August. Of 488 tags deployed, 398 (81%) successfully resumed upstream migration and 378 (77%) were successfully tracked to tributary streams. Radio-tagged sockeye salmon were identified in most major drainages between Kalskag and the Stony River. Large aggregates were observed in the Aniak, Holitna, Hoholitna, and Stony river drainages, and 4 were observed in the Holokuk River. The highest concentrations were observed in the Holitna River. Complete results of this project can be obtained from Gilk (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

DISCUSSION

ESCAPEMENT MONITORING

The 2007 field season at George River weir was successful in providing reliable estimates of Chinook, chum, and coho salmon escapements. Escapement monitoring was conducted throughout the target operational period of 15 June to 17 September and was consistent with past years. Salmon passage was low for several days following weir installation (Table 1), so the likelihood that salmon passed upstream of the weir site before installation is low. Additional evidence for this statement is provided by the neighboring radiotelemetry tracking station; no radio-tagged fish were detected prior to weir installation even though tag deployment had begun 2 weeks prior to that time. Favorable river conditions allowed accurate and efficient escapement monitoring for most of the season. However, the weir suffered 3 inoperable periods within the target operational period. Historical run-timing data for the George River suggest that the inoperable period occurring in July was the only period for which sizeable estimates were necessary. The other inoperable periods occurred on dates that salmon passage is generally low, based on historical information, and estimation methods yielded low values for these days. Run timing data from the several years of weir operation indicate the target operational period established for George River weir is sufficient for reliable measure of total annual escapement. Future weir operation, if successful, will provide an important reference for constructing future estimates and models for these species.

Escapement monitoring at the George River weir in 2007 revealed escapements of Chinook and sockeye salmon that were near average, an escapement of coho salmon that was above average, and an escapement of chum salmon that exceeded all prior years (Figures 12–15). Relatively high salmon escapements have been observed at this project and throughout the Kuskokwim River drainage over the past 3 to 4 years for all salmon species except coho, which declined steadily from 2003 to 2006 (Figure 14; Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Williams et al. 2008). This spatially consistent increase in escapement follows a period of low escapement in 1999 and 2000 which lead to the BOF classification of Kuskokwim River Chinook and chum salmon as “stocks of yield concern” (5 AAC 39.222, 2001) due to the chronic inability of these stocks to maintain expected harvest levels despite the use of specific management measures (Burkey et al. 2000a, b). The 2007 season represents the fourth consecutive year of higher-than-average salmon escapement to the Kuskokwim River, which supports the BOF decision to rescind the “stocks of yield concern” designation in February 2007 as anticipated by Linderman and Bergstrom (2006).

The increased escapement of most Pacific salmon species throughout the Kuskokwim River drainage may be partially explained by more conservative management of the commercial fishery. After the BOF initially classified Kuskokwim River Chinook and chum salmon as “stocks of yield concern” in 2000, fishery managers implemented several changes to mitigate effects of commercial fishing on these stocks (Bergstrom and Whitmore 2004). The prohibition of commercial fishing in districts W-1 and W-2 in June and July (or until managers had sufficient evidence that escapement goals would be achieved) was one initiative to curb harvest pressure. However, improved abundances of Chinook and chum salmon in recent years led to the rescission of the stocks of yield concern designation in February 2007 (Linderman and Bergstrom 2006). Managing authorities are now more amenable to June and July District W-1 openings, but there are no plans to open District W-2 because processors have shown little interest in buying from fishers in this district. In 2007, managers planned to open District W-1 for commercial fishing in June and July; however, processors chose not to participate because of the high cost of transporting low value chum salmon, which are the principle portion of the harvest in those months. Therefore, all Chinook salmon harvested commercially were captured incidentally to coho salmon during commercial openings in August, and low harvest numbers were not an indication of low abundance. Low commercial harvest pressure in 2007 likely contributed to desirable escapements.

Generally, species-specific commercial fishing pressure varies due to variation in fish abundance, market value, and processing capabilities. For example, in 2007 District W-1 remained closed until 1 August due to a lack of a commercial market. These prolonged closures restricted the commercial harvest of Chinook and chum salmon but had no effect on subsistence harvest. Coho salmon endured moderate commercial fishing pressure in 2007 during 12 coho salmon-directed commercial openings that occurred in District W-1 between 1 and 24 August (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Chinook Salmon

Abundance

The early installation date and the timing of inoperable periods confirms that annual Chinook salmon escapement to the George River was reasonably determined in 2007; the reported escapement of 4,883 fish is considered a reliable estimate of the total annual Chinook salmon escapement upstream of the weir. The 2007 season was characterized by a 12% increase in total annual Chinook salmon escapement to this system compared to 2006, which itself was a 13% increase over 2005 (Figure 12; Hildebrand et al. 2007). The Kuskokwim River Chinook salmon escapement index values developed to summarize total annual escapement to the Kuskokwim River (Figure 12) reveal considerable variation. Of particular interest is the contrast between the relatively low escapements of 1999 and 2000 and the relatively high escapements of 2004 through 2007 (Figure 12). This contrast is apparent, to varying degrees, at all weir projects; however, the George River has not exhibited the extremes witnessed elsewhere. The George River has been unique in that annual escapements have been relatively stable over the past 5–10 years compared to other monitoring projects operating in the Kuskokwim drainage (Figure 12). Chinook salmon escapement to the George River weir in 2007 was well within the newly adopted escapement goal range (Brannian et al. 2006b).

The decrease between the 2007 abundance estimate provided by *Kuskokwim River Chinook Salmon Run Reconstruction* (K. L. Schaberg, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) and earlier estimates of abundance provided by *Inriver Abundance of Chinook Salmon in the Kuskokwim River* (Stuby 2007) is reflected by the lower escapement numbers at all of the weir projects with the exception of the George and Tatlawiksuk river weirs which observed increased Chinook salmon escapement from 2006 to 2007 (Figure 12; Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008). The annual proportion of the total run above Aniak monitored by each upriver weir project has been fairly consistent over time. The Kogrukluk River weir represents the highest proportion (between 10.0 and 15.1%) followed by the George River weir (between 2.4 and 4.6%), Tatlawiksuk River weir (between 1.0 and 2.2%), and Takotna River weir (between 0.3 and 0.4%). Consistency in the proportional contribution of each weir project suggests the Kogrukluk, George, Tatlawiksuk, and Takotna river weirs, singly and in concert, provide a reasonable index of inriver abundance of Chinook salmon within the upper Kuskokwim drainage.

By limiting exploitation, the closure of the commercial fishery in District W-1 until 1 August probably increased 2007 escapements of George River and other Kuskokwim River Chinook salmon stocks. Though no commercial fishing effort in the Kuskokwim River was directed at Chinook salmon, a modest level of incidental harvest did occur during coho salmon-directed openings in August. The actual effect of the combined pressure of subsistence and commercial harvest on George River Chinook salmon is unknown because stock-specific exploitation cannot be calculated. Furthermore, the total subsistence harvest for 2007 has not yet been estimated. Annual Chinook salmon harvest has remained relatively constant through history, despite varying abundance and escapement. Though the most recent 10 year average (1997–2006) of 72,277 fish (Smith et al. *In prep*) is still preliminary, it probably reasonably approximates the 2007 harvest. The subsistence harvest combined with the relatively small incidental commercial harvest of 179 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) add to an approximate harvest of less than 73,000 in 2007. When compared to the estimated inriver abundance of 121,370 Chinook salmon above Kalskag and the 105,832 fish above the Aniak River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication), it is obvious that, in terms of size, the subsistence harvest is a significant component of the total run. The region of the Kuskokwim River above Aniak experiences relatively limited harvest of Chinook salmon (Smith et al. *In prep*); consequently, estimations of abundance above this point are a reasonable estimate of total escapement to this region of the Kuskokwim drainage. These comparisons suggest a reasonable harvestable surplus was available to Kuskokwim Area users, but this cannot be verified by escapement goals since they do not exist for most of the Kuskokwim River tributaries. In the few tributaries where they do exist escapement goals were met or exceeded in 2007. The determination that escapement goals were met or exceeded in 2007 was corroborated by near or above average escapements in most other monitored tributaries both with and without formal escapement goals (Figure 12).

Sustainable salmon management improved significantly in the early 1980s when fisheries management shifted from a strategy emphasizing guideline harvest levels to a strategy focused on escapement. Consequently, ADF&G established species-specific escapement goals for streams that had sufficient historical baseline information (Buklis 1993). Though the first formal escapement goals were expressed as thresholds, more recent escapement goals have been expressed as ranges to better address variability in annual escapement (Brannian et al. 2006b).

To date, stock-specific exploitation rates, critical for the establishment of biological escapement goals (BEG), are not available for Kuskokwim River stocks. However sustainable escapement goals (SEG) have been established for 3 tributaries throughout the drainage (Brannian et al. 2006b). SEGs are levels of escapement, indicated by an index or an escapement estimate, which are known to provide for sustained yield over a 5–10 year period. Because the commonly used Bue and Hasbrouck method[2] requires 10 years of escapement data, early deliberations on establishing sustainable escapement goals at the George River resulted in inaction because of inadequate historical escapement information which emphasized the need for uninterrupted continuation of this and other projects (ADF&G 2004). In preparation for the 2007 BOF meeting, Molyneaux and Brannian (2006) suggested an escapement goal based on 10 years of weir escapement data (1996–2005), with one being an expansion of an aerial survey count that used 5 years of paired aerial survey and weir escapement data. Based on these data, Molyneaux and Brannian (2006) suggested an SEG range of 3,100 to 7,900 for George River Chinook salmon. The BOF formally adopted this SEG range in February 2007. This SEG range encompasses the estimate (5,309) for the number of spawners at maximum sustained yield (S_{msy}) and is well below the estimated spawners at carrying capacity (S_c) derived using the habitat-based model developed by Parken et al. (2004). With the addition of the 2006 and 2007 field seasons to the historical data set, an SEG can be calculated for George River Chinook salmon in the future that is not reliant on aerial survey data.

Run-timing at the Weir

Based on median passage dates, the timing of the 2007 Chinook salmon run at the George River weir was approximately 2 days later than average but well within the historical range (Figure 3). With the exception of 1999, which was characterized by an extraordinarily late median passage date (19 July; Linderman et al. 2003) that is of dubious comparative value, median passage dates of Chinook salmon at the George River weir have ranged between 3 and 11 July (Figure 3). Similar late run timing was observed throughout the Kuskokwim River drainage for Chinook salmon in 2007 (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008).

Chum Salmon

Abundance

The early installation date and the timing of inoperable periods confirms that annual chum salmon escapement to the George River was reasonably determined in 2007; the reported escapement of 55,842 fish is considered a reliable estimate of the total annual chum salmon escapement upstream of the weir (Table 1). For the second consecutive year, the 2007 chum salmon escapement was the highest on record for this project (Figure 13). Also for the second consecutive year, relatively high chum salmon escapements were recorded by all weir projects throughout the Kuskokwim drainage (Figure 13; Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008). In fact, the 2007 season exhibited a 35% increase in total annual escapement to the George River compared to 2006, which itself was the previous recorded high (Figure 13; Hildebrand et al. 2007). Of particular importance is the fact that all escapement monitoring projects reported considerably higher

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[2] Methods for setting escapement goals from Bue, B. G., and J. J. Hasbrouck. *Unpublished*, *Escapement goal review of salmon stocks of Upper Cook Inlet*. Alaska Department of Fish and Game, Report to the Board of Fisheries, Anchorage, 2001.

escapements in 2007 than the critically low years of 1999 and 2000 which contributed to the stocks of concern designations (Figure 13; Burkey et al. 2000b).

There currently is no escapement goal for George River chum salmon, which precludes confident assessment of relative escapement strength. Based on the Bue and Hasbrouck method for establishing SEGs and a combination of 10 years of weir- and aerial survey-determined escapement data collected through 2005, a reasonable escapement goal for George River chum salmon would be a range between 6,100 and 15,000 fish (Molyneaux and Brannian 2006). Currently, only the Kogrukluk and Aniak rivers bear a formal escapement goal for chum salmon.

By limiting exploitation, the closure of the commercial fishery in District W-1 until 1 August likely increased annual escapements of George River and other Kuskokwim River chum salmon stocks. Though no commercial fishing effort in the Kuskokwim River was directed at chum salmon, a modest level of incidental harvest did occur during coho salmon-directed openings in August. In recent years chum salmon harvest has been relatively low (Whitmore et al. 2008) and the harvest of 10,763 chum salmon in 2007 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) probably had negligible impact on individual chum salmon stocks. In fact, the 2007 Kuskokwim River commercial harvest of chum salmon was over 29,000 fewer fish than both the 2006 harvest, and the recent 10 year average of about 40,000. Furthermore, the 2007 harvest continues a trend of dramatic decrease in harvest from the pre-2001 10 year average of 216,406 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). Thus, the commercial chum salmon harvest in 2007 did not greatly impact tributary escapements.

As with the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River chum salmon stocks was probably not significant. Estimates are not yet available for 2007, but the preliminary 1997–2006 average harvest estimate of 52,439 fish (Smith et al. *In prep*) is probably a reasonable approximation because annual subsistence harvests have not varied greatly in the past 10 years of available data. Compared to the number of chum salmon counted past tributary weirs and into the Aniak River in 2007 (Figure 13), a subsistence harvest of around 50,000 chum salmon probably did not significantly impact escapements of individual stocks. In recent years, chum salmon have generally not been targeted for subsistence use, and the numbers annually harvested since the early 1990s have generally been far less than annual harvests in the 1960s–1980s (Smith et al. *In prep*). In fact, annual subsistence harvests of Chinook salmon, despite lower abundance, have exceeded chum salmon harvests nearly every year since 1993. Historical data regarding the effectiveness of subsistence fishing schedules imposed between 2001–2006 was examined for the BOF in 2007 and indicated that schedules were not effective at improving the temporal distribution of harvest effort; thus a subsistence fishing schedule was not implemented in 2007 (Toshihide Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication; J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication).

Run-timing at the Weir

Based on median passage dates, the timing of the 2007 chum salmon run at the George River weir was equal to 1999 (Linderman et al. 2003) and, as such, was considerably later than average (Figure 3). 2003 was the only year in which chum salmon run timing was later (median passage date was 1 day later) (Linderman et al. 2004). With the central 50% occurring over a 16 day period and the central 80% occurring over a 28 day period, the chum salmon run in 2007 was similar in duration to previous years (Figure 3). All Kuskokwim River escapement monitoring projects observed later-than-average run timing based on median passage dates (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008).

Coho Salmon

Abundance

The early installation date and the timing of inoperable periods confirms that annual coho salmon escapement to the George River was reasonably determined in 2007; the reported escapement of 29,317 fish is considered a reliable estimate of the total annual coho salmon escapement upstream of the weir. Coho salmon escapement in 2007 represented an increase of 159% from that of 2006, which was considered an average year for coho salmon escapement (Hildebrand et al. 2007) (Figure 14). Of all projects for which escapement was determined in 2007, only the George and the Kogrukluk River weirs reported an increase in the abundance of coho salmon between 2006 and 2007 (Figure 14; Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008). Such disparities between projects exemplify the considerable inseason and intra tributary variation observed in coho salmon abundance throughout the history of escapement monitoring in the Kuskokwim River drainage (Figure 14). Of particular concern is the continual decrease in coho salmon escapement between 2003 and 2007 at Kwethluk and Tuluksak river weirs (Figure 14; Miller and Harper 2008; Plumb and Harper 2008). This trend is unique to these 2 locations (which, incidentally, are the furthest downstream) and has not been observed at other locations further upstream (Costello et al. 2008; Stewart et al. 2008; Williams et al. 2008).

Unfortunately, an escapement goal on which to judge relative escapement strength does not exist for George River coho salmon (Brannian et al. 2006b). The Kogrukluk River weir is the only Kuskokwim River project to bear an escapement goal for this species, a fact that limits managers' assessments of escapement adequacy for much of the drainage. At the Kogrukluk River weir coho salmon escapement in 2007 nearly reached the upper limit of the escapement goal range (Figure 14; Williams et al. 2008), so it is reasonable to state that escapement was satisfactory at least for that location. Managing authorities expect that an escapement goal will be developed for George River coho salmon before the next BOF cycle, contingent upon continued successful weir operation and escapement determination. The Bue and Hasbrouck method for establishing SEGs requires 10 years of reliable escapement data, which should be achieved following successful 2008 weir operations. Based on data collected through 2005, a reasonable escapement goal for George River coho salmon would be a range between 8,300 and 15,000 fish (Molyneaux and Brannian 2006). While coho salmon escapements in 2007 and 2003 would greatly exceed the upper boundary of this range, escapements most other years would fall within it (Figure 14).

Commercial harvest pressure on Kuskokwim River coho salmon has always been considerable. Though the commercial harvest of 141,049 coho salmon in 2007 (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 2007. Total inriver abundance estimates are not available for 2007, but results from the *Kuskokwim River Salmon Mark–Recapture Project* indicated that between 2001 and 2005, inriver abundance of coho salmon ranged from 386,743 (2004) to 928,075 (2003) fish (Pawluk et al. 2006). When compared to the number of coho salmon commercially harvested during these same years, it is obvious that a significant portion of the annual coho salmon spawning population is removed during the commercial fishery. Investigators are not fully confident in these estimates, however, and a forthcoming study entitled *Kuskokwim River Coho Salmon Investigation* will be addressing that concern and generating annual inriver abundance estimates (Toshihide Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage; personal communication).

Kuskokwim River coho salmon were never identified as a stock of concern by the Alaska BOF (Bergstrom and Whitmore 2004) and they have not been the focus of conservation measures. Coho salmon-directed commercial fishing has been permitted annually since statehood. However, the numbers harvested in recent years have generally remained below harvests in the 1980s and 1990s (Smith et al. *In prep*). The recent 10 year average of 194,851 coho salmon in the commercial harvest is lower than all annual harvests between 1977 and 1996 (Smith et al. *In prep*). The small harvests in recent years may be partially attributable to relatively low permit utilization and depressed commercial markets for chum salmon.

In contrast with the commercial fishery, the effect of the subsistence fishery on individual Kuskokwim River coho salmon stocks was probably not significant. Estimates are not yet available for 2007 but the preliminary 1997–2006 average harvest estimate of 30,427 fish (Smith et al. *In prep*) is probably a reasonable approximation because annual subsistence harvests have not varied greatly in the past 10 years of available data. Compared to the number of coho salmon captured in the commercial fishery, and recognizing that escapements at most projects were near average to high, a subsistence harvest of approximately 30,000 coho salmon probably did not significantly affect escapements of individual stocks. Indeed, the exploitation rate of coho salmon for subsistence use is undoubtedly much lower than that for Chinook salmon. The subsistence fishing schedule that was implemented annually from 2001 to 2006 had no effect on coho salmon subsistence harvest practices because, in each year, the schedule was lifted for the season long before coho salmon were passing through the lower river in significant numbers.

Run-timing at the Weir

Based on median passage dates, the timing of the 2007 coho salmon run at the George River weir was earlier than most years on record (Figure 3). The only years in which coho salmon run timing was earlier were 2000 and 2001 (Linderman et al. 2003). With the central 50% occurring over a 12 day period and the central 80% occurring over a 23 day period, the coho salmon run in 2007 was similar in duration to previous years (Figure 3). All Kuskokwim River escapement monitoring projects exhibited relatively early coho salmon run timing in 2007, based on median passage dates (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008).

Sockeye Salmon

Abundance

The early installation date and the timing of inoperable periods confirms that annual sockeye salmon escapement to the George River was reasonably determined in 2007; the reported escapement of 74 fish is considered a reliable estimate of the total annual sockeye salmon escapement upstream of the weir. Sockeye salmon are regularly observed returning to spawn each year at the George River weir, but annual escapement has always been low compared to other projects (Figure 15). The George River is not a primary spawning tributary for sockeye salmon (Burkey and Salomone 1999); therefore, the relatively low annual escapements to this system are not surprising. The 2007 escapement of 74 sockeye salmon to the George River was 64% less than the average return for the 3 previous years (Figure 15). Interestingly, the escapements for the last 3 years were some of the largest recorded returns to this system and considerably greater than most years for this project (Figure 15). Higher-than-average escapements of sockeye salmon in recent years have been spatially consistent throughout much of the Kuskokwim River drainage, as was the decrease in sockeye salmon returns between 2006 and 2007 (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008).

Compared to other species, little is known about the distribution and abundance of Kuskokwim River sockeye salmon. Sockeye salmon have been observed in several tributaries throughout the drainage (Burkey and Salomone 1999), but only the Kogrukluk River has a historical record sockeye runs of any size (Williams et al. 2008). A recent investigation aimed at improving understanding of the biology and ecology of Kuskokwim River sockeye salmon shows substantial and previously unknown spawning aggregates in the upper reaches of several Kuskokwim tributaries. Of these, the largest concentrations of sockeye occur in the Holitna River system (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). These findings are significant in that they indicate sockeye salmon are utilizing a watershed that lacks the lentic habitat most commonly used by sockeye salmon for spawning and rearing (Burgner 1991). Preliminary results of this study suggest the ecological contribution of these less well known “river type” sockeye salmon to the Kuskokwim drainage may be larger than previously believed.

Sockeye salmon in the Kuskokwim River have not been identified as a stock of concern, although escapements may have benefited from the conservation measures imposed on Chinook and chum salmon because of the concurrent run timing of these 3 species. The actual effect of the combined pressure of subsistence and commercial harvest on George River sockeye salmon is unknown. There are currently no subsistence harvest estimates for sockeye salmon in the Kuskokwim River for 2007; however, the most recent and preliminary 10 year average (1997–2006) of 37,077 fish (Smith et al. *In prep*) probably is a reasonable estimate. What was probably a modest subsistence harvest combined with the low 2007 commercial harvest of 703 (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication) adds to a total harvest estimate of approximately 40,000. Considering that the total observed escapement (sum of all projects) was just over 22,000 fish, a harvest of 40,000 is probably significant (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al. 2008).

Run-timing at the Weir

Historical run timing comparisons are limited by low abundances, but higher abundances between 2004 and 2007 make comparisons among these years possible (Figure 15). Though low abundances reduce the utility of such assessment, the timing of the sockeye salmon run in 2007 was earlier than all previous years based on median passage dates. Other measures of run timing (i.e. central 50% and 80% of passage) were not compared because low run abundances artificially influence run duration.

Other Species

Pink salmon

Pink salmon are regularly observed in the George River, but annual escapements have historically been low. Because the George River is not a primary spawning tributary for this species, the relatively low annual escapements to this system are not surprising. Historically, average pink salmon escapement upstream of the George River weir is 266 fish per year, which is a value that was raised significantly in 2006 with a record 1,232 pink salmon returning to spawn (Hildebrand et al. 2007). The 2007 escapement of 325 fish at the George River weir was above average and higher than all but 3 years, but significantly lower than the 2006 record escapement of 1,232 pink salmon (Hildebrand et al. 2007).

No monitored tributary system in the middle to upper Kuskokwim River drainage has a history of large escapements of pink salmon. Generally, pink salmon make less extensive spawning migrations into freshwater than other Pacific salmon species (Heard 1991). Given the spatial orientation of the George River and other upper river tributaries, the small escapements observed at these sites is not surprising. The reasons for the increased abundance in upper river tributaries are not known, but low exploitation rates, favorable oceanic conditions, and increased incidences of straying may have been contributing factors. Accurate enumeration of pink salmon runs using weirs is difficult because of the species' small size, which probably enables them to pass between weir pickets. However, it does appear that the contribution of pink salmon to this and other Kuskokwim River systems is greater than previously believed. To date, the relatively few pink salmon that return to spawn 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.

Resident Species

Of the non-salmon species that occur in the George River, longnose suckers are historically the most abundant. The highest recorded passage of this species was 15,840 in 2001 (Linderman et al. 2003), which is much higher than the 3,813 counted in 2007. 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 common in the Aniak, Tatlawiksuk, and Takotna rivers (Costello et al. 2008; McEwen *In prep*; Stewart et al. 2008), but they appear to be uncommon in or absent from the Kwethluk, Tuluksak, and Kogrukluk rivers (Miller and Harper 2008; Plumb and Harper 2008; Williams et al. 2008). The numbers of other species counted through the weir in 2007 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 resident species provide a pathway for postspawning salmon (postspawners) to pass downstream. Weak or dead salmon are commonly observed washing over these chutes and daily carcass counts noticeably decrease following their installation (Appendix C). Second, carcass deposition was not estimated for the period when the weir was not operational, so no carcass counts are available for the inoperable periods in July and August. Third, 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 significantly underestimates the number of postspawners 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. Therefore, we concluded that most of the spawned-out fish were likely retained in or near the river upstream of the weir site for a protracted period of time, thereby contributing 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

Predetermined sample goals were not achieved in 2007, but postseason analysis revealed that actual sample sizes were sufficient to estimate age class proportion with the objective confidence interval width for the total season. This was the eighth year out of 12 operational years that the annual Chinook salmon ASL sample was considered adequate for describing the annual escapement composition. However, this was not possible for the individual pulses. Assessment of intra-annual patterns in age composition is limited by our failure to obtain 3 full strata samples and most discussion here is limited to differences between the 2 strata. The sample from the first stratum was collected within the first 10% of total annual Chinook salmon passage (referred to as sampling pulse 1) and the sample from the second stratum was collected during the last 30% of the run (referred to as sampling pulse 2). The contrast between the position of the first and last pulse sample allows for some meaningful comparisons.

The current sample design is based on a recommendation by Bromaghin (1993) that assumes the sample is being drawn from a population of unknown size. However, the current ASL sampling goal of 630 fish (three 210-fish pulse samples) is poorly suited for the George River because sample sizes of this magnitude have proven impractical to obtain. Annual abundances of Chinook salmon in the George River are modest and greatly overshadowed by chum salmon abundances, making it difficult to sample large numbers of Chinook salmon without significantly impeding chum salmon passage. In the future, investigators may abandon the pulse sample design goal of obtaining 3 pulse samples of 210 fish each. Possible alternatives to this method include setting weekly sampling goals proportional to the run stage, reducing sampling sizes, and removing the requirement that sample sizes be sufficient to satisfy a 95% confidence interval.

Age Composition

The assortment of age classes seen at the George River weir in 2007 (age 1.2, 1.3, 1.4, 1.5 and 2.4) are similar to past years, and similar to what has been observed elsewhere in the Kuskokwim Area (Molyneaux et al. *In prep*). The percentage of age-1.2 fish in the total escapement reached a record high in 2007 while the percentage of age-1.3 fish was about average and the percentage of age-1.4 fish was considerably below average (Molyneaux et al. *In prep*). The percentage of age-1.5 fish was the lowest on record with the exception of 1997 when none were found in the sample (Molyneaux et al. *In prep*). The high percentage of age-1.2 fish equated to a near record-high abundance of this age class, while the average percentage of age-1.3 fish equated to average abundance and the low percentages of age-1.4 and -1.5 fish equated to record low abundances (Figure 16). With few exceptions, investigators observed a similar pattern of abundant age-1.2 and / or age-1.3 Chinook salmon accompanied by relatively few age-1.4 fish at most other escapement monitoring projects in the Kuskokwim River drainage (Molyneaux et al. *In prep*).

The most abundant age class for 2007 (age-1.2) was the first age class to return to the George River from the 2003 brood year. Their high abundance in 2007 was not surprising considering that Chinook salmon escapement in 2003 was higher than the 4 preceding years (Figure 12; Linderman et al. 2004), but we could not quantify the spawner-recruit relationship. Annual weir operation has not been consistent enough or ASL sampling always sufficient enough to construct a comprehensive brood table (Appendix E1) with which to illustrate changes or anomalies in return rate. Furthermore, the stock-specific return data presented in Appendix E1 do not include the portion of the George River stock harvested downstream. Still, even a modest rate of survival can yield a high return when parent abundance is high. By this reasoning and assuming survival rates between the 2003 and 2004 cohorts have been similar, it is reasonable to expect a relatively large return of age-1.2 Chinook salmon again in 2008 because escapement in 2004 was also high and actually exceeded that of 2003 (Figure 12; Stewart et al. 2005). The anticipated high abundance of age-1.2 Chinook salmon in 2008 may provide the impetus for relatively high overall (all age classes combined) escapement in 2008.

Additional forecasting value comes from the relatively strong sibling relationship that Kuskokwim River Chinook salmon tend to show, wherein the relative strength of each age class produced from a given brood year is often mirrored in subsequent year escapements of sibling age classes (Figure 16; Appendix E1). By this relationship, it is possible to make limited predictions about age-specific run strength in subsequent years based on past sibling returns (Molyneaux et al. *In prep*). For instance, the relatively high abundance of age-1.2 Chinook salmon that occurred in the George River in 2007 suggests a relatively high return of that generation’s age-1.3 siblings in 2008; however, the abundance of age-1.4 Chinook salmon in 2008 is not expected to be high following a year in which abundance of age-1.3 was near average (2007). Likewise, the abundance of age-1.5 fish will probably be relatively low again in 2008 following a year with low abundance of age-1.4 fish; however, the 1.5 age class historically comprises only a very small fraction of annual escapement, so deviations in relative abundance of this age class does not greatly influence relative strength of total escapement. Conversely, a relatively high abundance of age-1.3 Chinook salmon alone can result in high overall escapement. In this case, however, the concurrent high abundance of age-1.2 and -1.3 fish expected in 2008 will increase the likelihood of high overall escapement to the George River. In general, the widespread occurrence of relatively high abundances of age-1.2 and/or -1.3 Chinook salmon at most projects in 2007 (Molyneaux et al. *In prep*) may provide the impetus for expected large returns (and escapements) of Chinook salmon drainage-wide in 2008.

Despite only 2 strata samples being collected, differences in age composition between the two can be reasonably investigated due to the contrast in time and cumulative percent passage between the two. Initially, differences between these 2 strata samples may seem profound, but when placed into a historical context (Figure 4) it is clear that the differences observed in 2007 are probably only incidental. Historical data for the George River weir do not show that changes in age composition during the run adhere to an obvious trend; nor do they corroborate the age composition changes observed in 2007. Though results from 2007 are not supported by historical data, the dominance of younger fish near the beginning of the run and dominance of older fish towards the end of the run was consistent with most other projects in 2007 (Molyneaux et al. *In prep*). This pattern is fairly common in the Kuskokwim River drainage, and it is probably explained by the later migration timing of female Chinook salmon. Most female Chinook salmon are age-1.4 fish, their later migration timing translates into an increased number of age-1.4 fish in the later stages of the annual run (Molyneaux et al. *In prep*).

Sex Composition

At 17.2% of the total 2007 escapement (Table 2), the percentage of female Chinook salmon at George River weir was far below the historical range of 33.0% to 44.3% (Figure 17). The record-low percentage value equated to record-low abundance of female Chinook salmon in 2007 (Figure 17). Their lesser occurrence may be attributed to the low abundance of the more female-dominated 1.4 age class, coupled with the relatively high abundance of the male-dominated 1.2 and 1.3 age classes (Table 2; Figure 16). The significance of the low female ratio is amplified by the modest overall Chinook salmon escapement to the George River in 2007. Elsewhere in the Kuskokwim River drainage, percentages and abundances of female Chinook salmon were generally low (Molyneaux et al. *In prep*).

Despite only 2 strata samples being collected, differences in sex composition between the 2 can be reasonably investigated due to the contrast in time and cumulative percent passage between the two. The observation that the percentage of female Chinook salmon was considerably higher in the second stratum (32.2%) than in the first (5.7%) (Table 2; Figure 5) is corroborated by historical ASL data from George River weir (Figure 5) and 2007 data from elsewhere in the Kuskokwim River drainage (Molyneaux et al. *In prep*).

Length Composition

Mean lengths for each age-sex category in 2007 were within the historical range (Figure 18), but differed slightly from average. Mean lengths of males in each age class (1.2, 1.3 and 1.4) tended to be below the historical average while age-1.4 females tended to be near average and age-1.3 females were considerably above average (Figure 18). The observation that female Chinook salmon tended to be longer than males of the same age (Figure 6) was a common pattern throughout the Kuskokwim River drainage in 2007 (Molyneaux et al. *In prep*). Mean length increased with age, and the length range of female age-1.3 and male age-1.4 fish overlapped broadly (Figure 6). Chinook salmon rarely show an obvious intra-annual trend in length by age class over the course of the season, and apparent trends tend to be weak and their significance is unknown (Figure 7; Molyneaux et al. *In prep*). The length of fish in each age-sex category did not change appreciably between the 2 temporal strata in 2007 (Figure 7), which is typical for Chinook salmon at George River weir and elsewhere in the Kuskokwim River drainage (Molyneaux et al. *In prep*).

Management Implications

Salmon are harvested in both subsistence and commercial fisheries that occur in the mainstem Kuskokwim River far downstream from the George River and other spawning areas (Smith et al.

In prep; Whitmore et al. 2008). Most harvest is taken with gillnets that are size-selective for discrete components of the returning salmon population. The potential impact of the size-selective harvest is perhaps most consequential to Chinook salmon because of their wide range of sizes at maturity (Molyneaux et al. *In prep*).

Subsistence fishers tend to favor using gillnets composed of large-mesh web (e.g., 8 in stretch mesh; Smith et al. *In prep*), so their harvest is selective for larger and older Chinook salmon (Figure 19). This is the same segment of the population in which females are most common (Molyneaux et al. *In prep*). The exploitation rate of the subsistence fishery was estimated to range between 22% and 32% of the total Kuskokwim River Chinook salmon runs in the years 2002, 2003, 2004, and 2005 (Molyneaux and Brannian 2006).

In contrast, commercial fishers are limited to using 6 in or smaller mesh sizes (Whitmore et al. 2008), so their harvest is selective for smaller Chinook salmon in a size range dominated by males (Figure 19). The timing of the commercial fishery tends to be more towards the second half of the Chinook salmon run; however, in recent years low market interest has resulted in very limited commercial harvest (Whitmore et al. 2008). Exploitation rates from the commercial fishery are estimated to have been no more than 1.6% in the 2002 to 2005 run reconstructions (Molyneaux and Brannian 2006).

The Chinook salmon seen at the George River weir and within spawning areas elsewhere in the Kuskokwim River consist of the fraction of fish that escape harvest. The selectivity of that harvest influences the resulting age, sex, and length composition in the escapement (Figure 19). In 2007, the subsistence fishery had a much greater impact on tributary escapement composition than the commercial fishery since nearly the entire harvest of Chinook salmon occurred in the subsistence fishery. Since subsistence fishers tend to favor large-mesh gillnets (e.g., 8 in stretch mesh; Smith et al. *In prep*), their fishing efforts are selective for larger fish. This size selectivity coupled with the relatively high exploitation rate increased the incidence of smaller Chinook salmon, which are usually male, and decreased the incidence of larger fish, which are usually female (Figure 19). Furthermore, this occurrence seemed more amplified in the George River escapement in which younger and smaller male Chinook salmon were more prevalent that at other escapement monitoring projects (Figure 19). A similar pattern was seen at George River weir in 2006 (Hildebrand et al. 2007).

Chum Salmon

The ASL data collected from chum salmon in 2007 were adequate for describing annual age, sex, and length composition for the total escapement as well as for each of 4 individual temporal strata. Sampling pulses were fairly well-distributed throughout the run and the actual sample size met or exceeded the minimum goal for each pulse. Annual chum salmon ASL composition has been estimated for 8 out of the 12 years the project has operated.

Samples sizes were large enough that the proportions resulting from the pulse samples are considered representative of the escapement that occurred during the assigned stratum dates; however, the escapement values (total and per pulse) calculated from these proportions have an additional source of error that reduce their reliability. Error inherent in the formulas used to calculate missed passage during inoperable periods persists in the escapement value assigned to each age-sex category both for the season total and in each stratum. Despite this caveat, authors are confident that estimates of escapement within each age-sex category are reasonable.

Age Composition

The assortment of age classes seen at the George River weir in 2007 (age 0.2, 0.3, 0.4, and 0.5) are similar to past years and to observed escapements elsewhere in the Kuskokwim Area (Molyneaux et al. *In prep*). The record-high escapement of chum salmon at the George River weir in 2007 is mostly attributable to a record-high abundance of age-0.3 (4 year old) fish, which comprised 80.7% of total annual escapement (Figure 16). Most of the remaining fish were age-0.4 (16.0%); the percentages of the remaining age-0.2 and age-0.5 individuals were relatively low. These percentages differ considerably from those in 2006 but are not unprecedented; chum salmon escapements in both 2003 and 2005 exhibited an age composition similar to 2007 in that the great majority of annual escapement was age-0.3 fish (Linderman et al. 2004; Stewart et al. 2006). Despite the modest percentages of age-0.2, age-0.4, and age-0.5 fish, the abundance of each age class was relatively high (Figure 16).

The unusually high abundance of age-0.3 chum salmon that migrated through the George River weir in 2007 was a common trend throughout the Kuskokwim River drainage (Molyneaux et al. *In prep*). The significance of age-0.3 high abundance is that it suggests a relatively strong return of their age-0.4 siblings in 2008. Likewise, the relatively high abundance of age-0.2 chum salmon in the George River weir and most other projects in 2007 indicates the potential for a high return of age-0.3 fish in 2008. Unfortunately, sibling relationships for chum salmon are not as reliable as with Chinook salmon, even with the relatively low and stable harvest that has occurred since 1999 (Appendix E2; Smith et al. *In prep*). High abundances of age-0.3 and age-0.4 chum salmon in 2008 at George River weir and other projects will probably equate to high overall escapement.

Age composition of the chum salmon escapement varied only slightly as the 2007 run progressed past the George River weir and not one age class adhered to a consistent increasing or decreasing trend (Table 4; Figure 8). Furthermore, the relative contribution of the 0.3 and 0.4 age classes that was determined for the total season (that age-0.3 fish were dominant) was reflected in every stratum (Table 4). Between-strata fluctuations did occur in the relative contribution of the 0.2 and 0.5 age classes, but their combined contribution never exceed that of age-0.4. This intra-annual consistency in age class percentages does not substantiate the trend that commonly occurs in the George River in which the percentage of age-0.3 fish tends to increase while the percentage of age-0.4 fish tends to decrease during the run (Figure 8). In 2007 this inverse relationship between the percentage of age-0.3 and -0.4 chum salmon, which is a common occurrence in some years, was not widely observed (Molyneaux et al. *In prep*). Though distinct trends were not observed elsewhere, some projects reported patterns similar to the George River weir in that the proportions of age-0.3 and age-0.4 remained similar throughout the run (Molyneaux et al. *In prep*).

Brood tables provide the tools to investigate potential cohort survival and assess the number of returns per spawner (Appendix E2). For chum salmon, total return is calculated as the sum of all individuals between 3 and 6 years of age returning from a specific brood year. The most recent return number available in any given year is from the brood year 6 years before (2001 in this case). As with other projects in the Kuskokwim River drainage, return data for the George River do not include the fraction of George River chum salmon harvested in downstream fisheries. For chum salmon, the number of fish harvested in the subsistence fishery may be large enough to noticeably detract from escapement, so the return values presented in Appendix E2 underestimate actual returns. However, since subsistence harvests of chum salmon tend to vary with abundance, the values presented in this report are probably reasonable indexes of total returns to the George River. Consistent ASL sampling effort has allowed calculation of return for all brood years between 1997 and 2001 and return per spawner can be calculated for all but 1998 (Appendix E2). Return-per-spawner values have ranged from 1.84 for the 1997 brood year to 3.26 for the 1999 brood year. The 2.96 returns per spawner determined for the 2001 brood year, the most recent for which it can be calculated, fits comfortably within the range of other years already calculated. However, there are only a few years available from which to draw comparisons, and this limits the validity of conclusions and makes it difficult to determine with confidence whether total returns in subsequent years were higher or lower than expected. Despite this shortfall, a return-per-spawner value of 2.96 indicates that the total number of surviving offspring from the 2001 brood year amounted to nearly 3 times the escapement of their parents.

Sex Composition

While the percentage of female chum salmon at the George River weir was near average in 2007 (49.3%), the abundance of females exceeded all previous years (Figure 17). Historically, the percentage of female chum salmon has been near 50% in most Kuskokwim area data sets (Molyneaux et al. *In prep*). In 2007, female percentage varied considerably among projects, but nearly every project reported percentages near their respective historical averages (Molyneaux et al. *In prep*). Compared to Chinook salmon, sex composition among chum salmon tends to vary little historically or among tributaries (Molyneaux et al. *In prep*).

Stratified sampling at the George River weir revealed considerable changes in sex composition during the run. The relatively long interval between the second and third pulse samples obscures changes in sex composition that may have occurred during the middle of the run. Furthermore, the intervals between the first and the second and between the third and the fourth pulse samples, measured both in time and cumulative percent passage, are relatively short, decreasing the likelihood that differences within each pair is an effect of time and/or run progression (Figure 5). Thus, probably the only worthwhile comparisons are those between the first pair and last pair of pulse samples. Between these, female percentage was considerably higher in the last 2 pulse samples (61.3% and 56.0%) than during the first 2 (39.0% and 35.0%) (Table 4). When viewed this way, intra-annual estimates of sex composition in 2007 corroborate the trend suggested by historical data: the percentage of female chum salmon tends to increase as the run progresses (Figure 5). Though not always true, it is common throughout the Kuskokwim River drainage for the percentage of female chum salmon to increase during the run (Molyneaux et al. *In prep*).

Length Composition

In 2007, length of chum salmon in each age and sex category was considered below average and among the lowest recorded thus far (Figures 20 and 21). Over the past 3 years, mean lengths in each age and sex category have remained similar and below most previous years. The most extreme dissimilarity has occurred among age-0.4 females whose mean lengths in recent years have been significantly below those from years prior to 2005 (Figures 20 and 21). Continued low mean lengths for every age and sex category in 2007 perpetuate an indistinct decreasing trend that has been occurring since about 2000 (Molyneaux et al. *In prep*). Data prior to 2000 are lacking.

George River chum salmon exhibited length partitioning by age and sex. Males of an age class tended to be significantly longer than females and age-0.4 fish tended to be longer than age-0.3 fish (Figure 6), though the latter conclusion is not statistically significant. One implication of the phenomenon that length varies between sexes is that annual mean length of a certain age class will be influenced by the number of females. Logically, more females will equate to lower mean lengths. The similarity between females of different ages (Figure 6) is a valuable conclusion as well and confirms that age can not be deduced from length.

Typically length trends have exhibited a high degree of spatial variability in the Kuskokwim River drainage, but historical trends involving only recent years are notably consistent. Over the past few years, most other projects have reported declines in annual mean lengths in every age and sex category (Molyneaux et al. *In prep*). Throughout the Kuskokwim River, mean lengths among males tended to increase with age, males tended to be larger than females at a given age, and mean length-at-age tended to decrease during the run (Costello et al. 2008; Molyneaux et al. *In prep*; Stewart et al. 2008; Williams et al. 2008). These patterns tend to be common at the George River weir and other locations where ASL samples have been collected (Molyneaux et al. *In prep*).

Coho Salmon

Predetermined sample goals were achieved in 2007 and the total sample size and temporal distribution was more than adequate to estimate the age composition of the total coho salmon run. This was the ninth out of 12 operational years that the annual coho salmon ASL sample was considered adequate for describing the annual escapement composition. However, the number of fish sampled in each pulse for which age could be determined (i.e. post-aging sample) was not sufficient to achieve the desired confidence interval width for any stratum (Table 6). In short, more fish were removed from the sample(s) due to aging difficulties than was anticipated and accounted for by the sampling goal. Though actual per-pulse samples sizes result in confidence intervals slightly wider than desired, intra-annual changes in ASL composition can be reasonably investigated, especially considering the fair distribution of sampling effort.

Sample sizes were sufficiently large for the proportions resulting from the pulse samples to be considered representative of the escapement that occurred during the assigned stratum dates. Unfortunately, the escapement values (total and per pulse) calculated from these proportions have an additional source of error that reduce their reliability. Error inherent in the formulas used to calculate missed passage during inoperable periods persists in the escapement value assigned to each age-sex category both for the season total and in each stratum. Despite this caveat, authors are confident that estimates of escapement within each age-sex category are reasonable.

Age Composition

Kuskokwim River coho salmon are predominantly age-2.1 (4 year old) fish. At the George River weir in 2007 age-2.1 coho salmon comprised 94.8% of the total run whereas age-3.1 comprised 3.2% and age-1.1 comprised 1.9% (Table 6). At the George River weir, like other projects, age-2.1 coho salmon typically comprise about 90% of annual escapement (Molyneaux et al. *In prep*). Historically, the relative contributions of other age classes have fluctuated in terms of relative contribution, but their percentages are always low compared to age-2.1 fish (Molyneaux et al. *In prep*). The exceptional escapement of coho salmon to the George River weir in 2007 was primarily driven by a high abundance of age-2.1 fish in 2003, the year that boasted the highest recorded escapement for this location (Linderman et al. 2004; Figures 14 and 16). Similarly, age-1.1 fish returned in record-high abundance in 2007, but the abundance of age-3.1 fish was considerably below the historical average (Figure 16).

The concept of sibling relationships that suggests that the abundance of an age class in 1 year can predict the abundance of that cohort's siblings the next year (1 year older) has limited utility when applied to coho salmon. First, nearly all Kuskokwim River coho return as age-2.1 individuals, so deviations in the abundance of other age classes will have little effect on total annual escapement. Second, historical data do not show that such predictions are reliable (Figure 16). Applied to 2007 escapement data, the exceptional abundance of age-2.1 coho salmon does not guarantee a high abundance of age-3.1 fish in 2008, nor does the relatively high abundance of age-1.1 fish predict an unusually high abundance of age-2.1 fish. As always, such speculation is marred by unknown stock-specific harvest that occurs downstream of the weir.

Age composition of the coho salmon escapement varied little as the 2007 run progressed past the George River weir (Figure 10). Furthermore, the relative contribution determined for the whole escapement (i.e. age-2.1 dominant, followed by age-3.1 and then age-1.1) was reflected in all 3 sampling strata (Table 6). Coho salmon do not usually exhibit consistent trends in the George River or in other tributaries of the Kuskokwim River (Molyneaux et al. *In prep*). In fact, the temporal consistency of this species mitigates difficulties that arise when sampling distribution is poor.

Brood tables provide the tools necessary to investigate potential cohort survival and the number of returns per spawner (Appendix E3). For coho salmon, total return is calculated as the sum of all individuals between 3 and 5 years of age returning from a specific brood year. The most recent return number available in any given year is from the brood year 5 years before (2002 in this case). As with other projects in the Kuskokwim River drainage, return data for the George River do not include the number of George River coho salmon harvested annually in downstream fisheries. For coho salmon, the number of fish harvested in the commercial and subsistence fisheries may be large enough to noticeably detract from escapement, so the return values presented in Appendix E3 underestimate actual returns. However, the values presented in this report are probably reasonable indexes of total returns to the George River. Consistent ASL sampling effort has allowed calculation of return for brood years 1996, 2000, 2001, and 2002 (Appendix E3). Of these brood years, return per spawner can be calculated for all but 1996 (Linderman et al. 2003). Return-per-spawner values have ranged from 0.53 for the 2001 brood year to 1.62 for the 2002 brood year. Unfortunately, there are only a couple years available from which to draw comparisons limits the validity of conclusions, which makes it difficult to determine with confidence whether total returns in subsequent years were higher or lower than expected. Despite this shortfall, a return-per-spawner value of 1.62 indicates that the total number of surviving offspring from the 2002 brood year were 62% more abundant than their parents.

Sex Composition

At 36.9% of the total 2007 escapement (Table 6), the percentage of female coho salmon at George River weir was near the lowest on record for this project, with the lowest being 36.6% in 2004 (Figure 17). Despite being record-low, this percentage equated to a high abundance of female coho salmon in 2007 (Figure 17). Female percentage varied considerably among Kuskokwim Area monitoring projects and no widespread trend was apparent (Molyneaux et al. *In prep*). Half of Kuskokwim River escapement projects reported an above-average percentage of female coho salmon and the other half reported a below-average percentage (Costello et al. 2008; Miller and Harper 2008; Plumb and Harper 2008; Stewart et al. 2008; Williams et al.

2008). Compared to Chinook salmon, sex composition among coho salmon tends to vary little spatially and historically.

Stratified sampling at the George River weir in 2007 revealed considerable changes in sex composition during the coho salmon run. In 2007, the percentage of female coho salmon increased continually from the first stratum to the last (Figure 5), a trend that is historically consistent at the George River weir and consistent with most other projects in 2007 (Molyneaux et al. *In prep*). However, this trend has not occurred often enough throughout the Kuskokwim River drainage to be considered the norm. More often than not the percentage of female coho salmon is higher in the last stratum than in the first, but percentages tend to vary widely between.

Length Composition

Annual mean lengths of male and female age-2.1 coho salmon at the George River weir have varied considerably from year to year (Figure 22). Mean lengths for both female and male coho salmon in 2007 were near or slightly above their historical averages and, as such, well within the range reported in previous years (Figure 22). The most significant deviation from average occurred among age-2.1 females; their mean length in 2007 was the highest since 2003 and significantly above most other years (Figure 22; Molyneaux et al. *In prep*). In 2007 females were significantly longer than males, which was true of most years at the George River weir (Figure 6; Molyneaux et al. *In prep*). In 2007 the mean length of female age-2.1 coho salmon exceeded that of males at most projects, and for some locations the difference between them was significant (Costello et al. 2008; Stewart et al. 2008; Williams et al. 2008). However, for most escapement projects this occurrence has not been common. Where mean lengths in 2007 fall in relation to past years varies among projects, but most reported mean lengths near their respective historical averages and an increase from 2006 (Molyneaux et al. *In prep*).

WEATHER AND STREAM OBSERVATIONS

Measured against date-dependent historical environmental data, water temperature at the George River weir was above-average early and late in the season and below average during the middle of the season (Figure 23). River stage was above average during the bulk of Chinook and chum migrations and near average during the bulk of the coho migration (Figure 24). Stream discharge measurements were taken 3 times during the season and ranged from 75.6 to 149.0m^3/sec (Appendices D3–D5).

Any relationship between water level (or water temperature) and passage strength or timing is not easily discernible by the available data. Daily weir operation and ASL sampling effort are not consistent and salmon passage can be influenced by the timing and duration of counting sessions, the level of ASL sampling activity, and cleaning and repairing efforts. If the study was designed such that these activities were consistent, the effect of water level on salmon passage may be better revealed. Nevertheless, increases in coho salmon escapement did coincide with an increase in water level, which is a relationship that has been observed in past years at this project (Stewart et al. 2005, 2006) and a behavior that has been observed in other stocks of coho salmon throughout their range (Sandercock 1991). In fact, the unusually high water levels reported during the first half of August (Figure 24) may have inspired the relatively early run timing of coho salmon through the George River weir in 2007 (Figure 3). However, considering the presence of uncontrolled factors and that data are limited, it would be inappropriate to assert any firm conclusions in this report.

RELATED FISHERIES PROJECTS

Kuskokwim River Chinook Salmon Run Reconstruction

Tag deployment efforts were successful in 2007. The Chinook salmon abundance estimates generated as 1 component of the project mark the sixth year that an abundance estimate was determined for the Kuskokwim River drainage upstream of the Aniak River confluence, and the second year that an abundance estimate could be calculated that included the Aniak River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication; Stuby 2007). The deployment of anchor tags in addition to radio-tags provided a tag sample large enough to investigate travel speed and run timing, thereby providing an additional year for historical comparisons of these measures.

At the time of publication, development of the model required for a comprehensive run reconstruction was still ongoing. Until the model is completed, historical abundance estimates cannot be computed. Results and discussion of success will be reported in a separate publication that will be written upon completion of historical run abundance estimates.

Abundance Estimate

Project investigators in 2007 worked closely with investigators from the former *Inriver Abundance of Chinook Salmon in the Kuskokwim River* project to ensure that methods remain consistent (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication; Stuby 2007). Generally, the same limitations and assumptions of the former project persist in the current. For example, Chinook salmon smaller than 450 mm MEF were not radio-tagged, so abundance estimates generated then and now do not include the fraction of the Kuskokwim River Chinook salmon run below this threshold. The annual abundance estimates generated without this component likely do not greatly underestimate the total abundance inclusive of fish less than 450 mm MEF because such small Chinook salmon are not common in the Kuskokwim River (Molyneaux et al. *In prep*). At the George River weir, for example, these small Chinook salmon only comprise about 1% of total escapement annually. Other weirs have reported even lower percentages.

Run Timing and Travel Speed

The run timing information derived from pooling the radio-tag and anchor-tag samples from *Kuskokwim River Chinook Salmon Run Reconstruction* indicates slight variation in stock-specific run timing. In 2007, as in most past years, there was a noticeable inverse relationship between natal stream distance and time of passage past the Kalskag tagging sites (Figure 25). Based on median passage dates, stocks with the furthest to travel tended to arrive earlier than stocks bound for tributaries nearer the tagging sites. The earliest arriving stocks for which run timing was assessed were bound for Takotna and Tatlawiksuk; both had a median passage date (at the Kalskag tagging sites) of 24 June. Consistent with this pattern, George River and Salmon River fish tended to arrive later (29 and 30 June, respectively), but, contrary to this pattern, the median passage date for fish bound for the Kogrukluk River occurred after that for the Tatlawiksuk stock (28 June) despite the latter being further from the tagging sites. The median passage dates past the tagging sites of tagged Chinook salmon bound for the George River have been the latest of any stock in 3 of the 5 years with comparable data (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). In the remaining years only the Salmon River stock arrived later.

Travel speed and run timing indicators provided by the Chinook salmon radiotelemetry and anchor tagging projects are valuable tools for fisheries management. The timing of commercial fishery openings is considered with respect to the stock-specific run timing evident through the tagging and tracking of Chinook salmon. Relatively low subsistence and Bethel Test Fishery catches during a period when Chinook salmon should have been abundant based on tagging data contributed to the 2007 management decision to postpone the first commercial opening (J. C. Linderman, Jr., Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). In retrospect, what was interpreted as low abundance was actually the consequence of relatively late run timing. Regardless, very few Chinook salmon were harvested in the August coho-directed fishing openings and run timing and travel speed data obtained from tagging studies verify that virtually no George River Chinook salmon were harvested in the commercial fishery. Though irrelevant in 2007, the commercial fishing periods that usually occur in late June probably affect stocks bound for the George River. However, because of fewer restrictions and greater annual harvest, the subsistence fishery likely has a much greater impact on George River Chinook salmon (Smith et al. *In prep*).

Kuskokwim River Sockeye Salmon Investigations

For the third consecutive year, sockeye salmon radio tag deployment efforts were successful. The deployment of anchor tags in addition to radio tags provided a tag sample large enough to investigate travel speed and run timing, thereby providing an additional year for historical comparisons of these measures.

Run Timing and Travel Speed

Historically, sockeye salmon escapement at the George River weir has been low compared to other projects in the Kuskokwim River drainage, such as the Kogrukluk and Kwethluk river weirs (Figure 15). However, the proportion of tagged to the total observed sockeye salmon has been relatively high and is probably adequate for investigating migration characteristics for George River sockeye salmon. Over the past 6 years, 41 tagged sockeye salmon have been observed passing upstream of the George River weir representing 5.7% of the escapement for the same years (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). In 2007, three (4.1%) of the total sockeye salmon that passed upstream of the George River weir were tagged fish.

The tagged sockeye salmon detected and/or recovered at the George River weir in 2007 exhibited relatively early run timing both at the tagging sites and passed the weir (Figure 26). In fact, the passage date of the first 2 tagged sockeye salmon at the George River weir occurred on the very same day that sockeye salmon were first observed in 2007 and the third tagged sockeye salmon was observed passing after only 20% of the total annual escapement had passed (Table 1). Plotting their dates of tagging along with data from other weirs confirms that they were among the earliest to be captured and tagged at the tagging sites (Figure 26). This early run timing is inconsistent with historical data that suggested George River sockeye salmon are among the latest to migrate through the lower Kuskokwim River (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). This historical incongruity substantiates the possibility that the tagged sockeye salmon observed in the George River were not returning members of a natal population in the George River but perhaps strays destined for other tributaries. Unfortunately, the time they remained in the George River and whether they spawned there is unknown because they may have exited the system any time after being detected and/or observed. With enough momentum, healthy salmon can travel downstream over the weir during normal operations, and the inoperable periods that occurred in July and August would have eased downstream passage. Aerial tracking data revealed these fish were later detected in the mainstem Kuskokwim River much farther downstream from the George River confluence (S. E. Gilk, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication), so these tagged sockeye salmon could have exited the George River any time after being observed. The timing of and interval between aerial tracking surveys provided a window when these could have spawned elsewhere before being rediscovered in the mainstem Kuskokwim River. Furthermore, stationary tracking stations were not spaced frequently enough to determine whether any or all of these tagged sockeye salmon later migrated into tributaries known to support spawning populations. Therefore, investigators are not confident that run timing and travel speed exhibited by these tagged sockeye is representative of all George River sockeye salmon and they will not be included in further discussion in this report.

Information obtained from tagged sockeye salmon throughout the Kuskokwim River drainage reveals a consistency in average travel speed (about 25 km/day) regardless of tributary location. Assuming that sockeye salmon bound for the George River travel near this speed, fish migrating from the Kalskag tagging site would require about 7–8 days to travel to the weir. Of the tagged sockeye salmon captured at the George River weir over the years, average travel speed has generally been below this 25 km/day average. In 2007 average travel speed was approximately 18 km/day. These results suggest that fish migrating shorter distances travel slower.

From an area-wide perspective, the run timing information derived from pooling the tag samples from *Kuskokwim River Salmon Mark–Recapture Project* and *Sockeye Salmon Investigations* indicates some variation in stock-specific run timing in 2007 (Figure 26). Though not the case in 2007, in each year between 2004 and 2006, the tagged sockeye observed in the George River were tagged during the later half of the tagging effort, after most of the tagged fish bound for the Kogrukluk River weir and Telaquana Lake (a feeder of the Stony River) were tagged (K. L. Schaberg, Fishery Biologist, ADF&G, Anchorage; personal communication). Unfortunately, only the Kogrukluk River weir has consistently received an adequate tag sample for confident assessment of run timing and travel speed; however, run timing trends in other locations tend to be historically consistent despite small sample sizes. Among the stocks investigated, sockeye salmon stocks bound for locations farthest upriver tend to migrate past the tagging sites earlier than stocks bound for tributaries nearer the tagging sites (Figure 26). In each year with comparable data, fish bound for Telaquana Lake were generally the first captured and tagged, followed in order of timing by fish bound for the Kogrukluk, Tatlawiksuk, and George rivers. Incidentally, this trend has been commonly observed in Kuskokwim River chum salmon during years they were tagged.

CONCLUSIONS

ESCAPEMENT MONITORING

- The weir operated from 15 June through 17 September, which was nearly the entire target operational period of 15 June to 20 September.
- The weir was inoperable due to high water once from 14 to 21 July and again from 6 to 8 August.

- The Chinook salmon escapement of 4,883 fish to the George River in 2007 represented an increase of about 12% from 2006, which was a trend not widely observed in 2007.
- The steady increase in annual Chinook escapement between 2005 and 2007 was not observed in any other tributary, nor was it reflected in the composite index or in the inriver abundance estimates provided through the radio tagging effort.
- The chum salmon escapement of 55,842 fish to the George River in 2007 represented an increase of about 35% from 2006 and was the highest recorded at the George River weir.
- The steady increase in annual chum salmon escapement between 2004 and 2007 was not observed in any other tributary, but chum salmon escapements throughout the drainage have been relatively high in recent years.
- The coho salmon escapement of 29,317 fish to the George River in 2007 represented nearly a three-fold increase from 2006 and was near the highest recorded at the George River weir.
- The exceptional abundance of coho salmon observed at the George River weir in 2007 did not occur elsewhere; most other projects reported near-average or below-average coho salmon escapements.
- The sockeye salmon escapement of 74 fish to the George River in 2007 represented a decrease of about 55% from 2006.
- Throughout the drainage, annual sockeye salmon escapements declined between 2006 and 2007; however, sockeye salmon escapements in 2007 were still considered high.

AGE, SEX, AND LENGTH COMPOSITION

- The Chinook salmon run was primarily represented by age-1.2, -1.3, and -1.4 fish. The percentage of age-1.2 was highest early in the run while the percentages of age-1.3 and -1.4 were highest near the end of the run.
- Female Chinook salmon made up approximately 17.2% of the total annual run, which was far below the historical range. The percentage of females was highest near the end of the run.
- The Chinook salmon run showed length partitioning by age and sex; length increased with age and females were generally longer than males of the same age.
- Healthy escapements of all Chinook salmon age classes suggests continued high ocean survival compared to the conditions that led to the low runs to the Kuskokwim River in 1998, 1999, and 2000.
- Assuming consistency in ocean survival, the relatively high abundance of age-1.2 Chinook salmon in 2007 may indicate a healthy return of age-1.3 fish to the George River in 2008.
- The chum salmon run was primarily represented by age-0.3 and age-0.4 fish. Percentages of neither age class were found to increase or decrease during the run.
- Female chum salmon made up approximately 47.8% of the total annual run. The percentage of females did not change consistently during the run.

- The chum salmon run showed length partitioning by sex but not by age; average length of males was than females but length did not increase with age among males or females.
- Healthy escapements of all chum salmon age classes suggests continued ocean survival compared to the conditions that led to the low runs to the Kuskokwim River in 1998, 1999, and 2000.
- Assuming consistency in ocean survival, the high abundance of age-0.2 and -0.3 chum salmon in 2007 may indicate a healthy return of age-0.3 and -0.4 fish to the George River in 2008.
- Mean length-at-age of male and female chum salmon were some of the smallest on record for this project.
- The chum salmon run was primarily represented by age-2.1 fish. Percentages of this or any other age class were not found to change greatly during the run.
- Female coho salmon made up approximately 36.9% of the total annual run. The percentage of females increased continually as the run progressed.
- The coho salmon run showed length partitioning by sex; females were larger at age than males.
- Mean length-at-age of male and female coho salmon were similar to past years.

Weather and Stream Observations

- Compared to previous years at the George River weir, water temperatures in 2007 were above average early and late in the season and below average during the middle of the season.
- Compared to previous years at the George River weir, river levels in 2007 were lower than average early in the season, above average during the middle of the season, and nearly average late in the season.
- No obvious relationships were observed between water temperature or river level and salmon passage.

Related Projects

- The George River weir served as an important platform for several projects conducted in the Kuskokwim River drainage in 2007, including *Kuskokwim River Chinook Salmon Run Reconstruction* (AYKSSI), *Kuskokwim River Sockeye Salmon Investigations* (AYKSSI), and *Hydrologic Data for the George River Project* (SWG).

RECOMMENDATIONS

Project Operation

- Annual operation of the George River weir should continue indefinitely. The George River weir project has been a valuable addition to the array of well-distributed escapement monitoring projects throughout the Kuskokwim River drainage. Adequate monitoring of Kuskokwim River salmon escapements is 1 of many requirements needed for long-term sustainable management of Kuskokwim River salmon stocks. Discontinuation of the

George River weir, or any other escapement monitoring project, would be a step backward from progress made in recent years toward fulfilling salmon stock assessment and information needs in the Kuskokwim River drainage. Additionally, the George River weir project serves as 1 of several data collection platforms critical to other Kuskokwim River salmon research initiatives aimed at narrowing critical knowledge gaps toward the goal of sustainable salmon management. Without the existing array of escapement monitoring projects, such as the George River weir, these research initiatives would not be logistically or financially possible.

- Sustainable escapement goals (SEG) should be established for George River chum and coho salmon. SEGs require a 5 to 10 year data series of reliable escapement estimates that demonstrate sustainable yields. Previous deliberations regarding establishing escapement goals at the George River resulted in inaction because of inadequate historical escapement information (ADF&G 2004), which heightens the need for uninterrupted continuation of the project. With the 2007 field season complete, historical datasets are now sufficient for establishing SEGs for George River chum and coho salmon. Using escapement data collected through 2005, the SEGs derived from the Bue and Hasbrouck method would range between 6,100 and 15,000 for chum salmon and 8,300 and 15,000 for coho salmon. Uninterrupted continuation of this project will serve to further refine SEGs for this system, thereby improving managers' ability to assess escapement adequacy.

PROJECT MANAGEMENT

- The George River weir should continue to be operated jointly by KNA and ADF&G. The partnership developed between KNA and ADF&G in the operation of fisheries research projects, including the George River weir, has proven to be a successful strategy. Each organization complements the partnership by providing an element the other cannot.

  KNA provides a communication link to help its constituents be more informed and less prone to the distrust that can result when local organizations and their constituents are not directly involved. Active involvement of KNA adds an element of trust and acceptance toward the projects and ADF&G, which would not exist if ADF&G operated these projects alone. KNA is more effective at hiring technicians for these projects from the local area, and makes these jobs more acceptable and accessible for potential applicants. Additionally, the proximity of KNA facilities to these cooperatively managed projects provides logistical benefits for staging and responding to various inseason project needs.

  Despite these attributes, KNA would have difficulty managing the George River weir and other jointly operated fisheries projects without ADF&G involvement. The fisheries staff of ADF&G has more experience in managing fisheries research projects, including on-site field experience, logistical planning, data management, data analysis, and report writing. The addition of a Partners Fishery Biologist to the KNA staff has shifted some of these responsibilities to KNA, which is evident with the inclusion of a KNA biologist as a co-author of this report since 2003 and the lead author in 2007 and 2008. Ultimately, however, the transfer of responsibility has been slow. Currently, KNA employs 2 full-time fisheries biologists: a Fisheries Director and a Partners Fishery Biologist. However, the addition of these 2 fisheries biologists to the KNA staff is not sufficient to replace all ADF&G personnel involved and the many years of fisheries management experience and scientific expertise they contribute. Additionally, KNA's fisheries biologists have a myriad of other responsibilities including involvement in multiple projects with multiple cooperative partners. Specifically, the Fisheries Director oversees all aspects of KNA's Fisheries Program while the Partners Fishery Biologist dedicates a majority of time to community outreach and internship programs. Such priorities limit the attention KNA staff can devote to individual projects.

Partnership between KNA and ADF&G is a major contributing factor to the success of the many fisheries projects for which these organizations are responsible. Dissolution of this partnership would result in a detrimental loss of continuity and support to both inseason and postseason project requirements, and increases the possibility of misunderstanding and mistrust between ADF&G, KNA, and the public. Continued joint operation will help to ensure the success of these projects in the future.

AGE, SEX, AND LENGTH COMPOSITION

- Current pulse sampling goals represent only a 10% increase from those recommended by Bromaghin (1993) to account for illegible or lost scales ("scale loss"). History has proven that scale loss is usually higher. Instead, actual goals should represent a 20% increase over those Bromaghin recommended. Revised goals should be 230 for Chinook salmon, 220 for chum salmon, and 200 for coho salmon (rather than the 210, 200, and 170, respectively, currently in place).
- Objective 2 should be simplified to: "Estimate the age, sex, and length composition of annual Chinook, chum, and coho salmon escapements to the George River weir such that simultaneous 95% confidence intervals of age composition are no wider than 0.20 (α = 0.05, d = 0.10)." As it is currently written, there are 2 clauses that have proven nearly impossible to achieve. First, Chinook salmon should not be among the 3 species for which pulse sampling is required. Second, requirements for *per-pulse* confidence interval width should be omitted from the objective.
- Sampling goals should be revised for Chinook salmon. The goal to sample in 3 pulse samples each composed of 230 fish is impractical in tributaries such as the George River where chum salmon escapement greatly exceeds that of Chinook salmon. In such tributaries it is impossible to sample 230 fish in 3 distinct pulses without greatly inhibiting chum salmon passage. Therefore, sampling goals should be reduced such that the desired confidence interval width of 0.20 would apply to the entire annual escapement but not to individual strata. Consequently, instead of trying to sample a total of 690 fish over 3 pulse samples, investigators should sample a minimum of 230 fish for the entire season. Though 1 purpose of the pulse sampling design was to ensure fair distribution of the sampling effort, pulse sampling is not necessary to estimate total annual ASL composition as long as sampling effort is fairly well distributed and is conducted in proportion to the run. The annual run can still be stratified and intra-annual changes can still be investigated, but confidence intervals for age composition per strata will generally be broader than what is required by the current Objective 2. Historically, the Chinook salmon confidence interval requirement of Objective 2 has rarely been achieved. Thus, if recommendations described in this paragraph are implemented, it will have little effect on the comparability of historical data.
- In addition to the changes recommended above for Chinook salmon, Objective 2 should be amended as it pertains to all species. As currently worded, the objective requires that

confidence intervals for age composition in each pulse be no wider than 0.20. Thus, this objective is not achieved when confidence interval width exceeds 0.20. Since these confidence intervals depend on the size of the sample(s) after ages have been determined, which is a variable that cannot be controlled when sampling, it should not be a requirement of the objective. Desired confidence interval width should be one criterion on which to base sample size goals but it should not influence the success or failure at meeting the objective. In practice, chum and coho sampling can be conducted following the pulse sampling design; large pulse samples increase the resolution

- Future project reports for the George River weir should continue to include detailed figures depicting trends in age, sex, and length composition. Inclusion of detailed figures such as these allows other researchers and fishery managers to easily compare ASL trends between projects and across years.

WEATHER AND STREAM OBSERVATIONS

- Continue monitoring environmental conditions indefinitely. It is clear that environmental stimuli can and do influence migration of Pacific salmon (Quinn 2005). Kuskokwim Area escapement monitoring projects are not specifically designed to evaluate environmental cues to upstream migration, but knowledge of environmental conditions and a commitment to long-term monitoring is valuable to understanding migration and survival of Pacific salmon (Quinn 2005). Even though annual relationships between environmental conditions and salmon migration and abundance are not always clear, long-term data sets may prove valuable to understanding the biology and ecology of these species. We cannot begin to assess the effects of changing environmental conditions on Kuskokwim River salmon without sufficient baseline data consisting of complete and accurate measures of environmental variables. Escapement projects must continue to be diligent in the collection of weather and stream data. Perhaps with sufficient data, researchers and managers will be able to assess relationships between migration and environmental factors relevant in the broader spatial-temporal context.

- Continue the use of a water temperature data logger in the river channel to enable the determination of high, low, and mean daily measurements. This will provide more complete temperature documentation and enable better comparisons between years.

- Conduct additional stream discharge surveys to supplement those conducted in previous years at George River weir.

- Continue operating a stream gaging station near the weir site to determine baseline flow characteristics, which is required before establishing water reservations for the George River system. Additional stream gauging stations should be installed on the following tributaries of the Kuskokwim River mainstem: Holitna, Kogrukluk, Hoholitna, Tatlawiksuk, Aniak, and Takotna rivers. Installation of these stations is critical to documenting baseline conditions as well as providing managers with the tools necessary to ensure the continued productivity of these rivers.

- Cooperate with USFWS OSM in their effort to collect reliable, consistent, and scientifically-defensible baseline data on weather and stream conditions at weir sites. A thermograph has been installed annually in the George River since 2005 and will continue to be installed annually for the foreseeable future. If the George River weir crew is selected to assist in this effort, project managers' are willing to add this thermograph to a pool of equipment that is shared among all projects involved.

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TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at the George River weir, 2007.

	Chinook			Chum			Coho			Sockeye		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
6/15	0	0	0	0	0	0	0	0	0	0	0	0
6/16	0	0	0	1	1	0	0	0	0	0	0	0
6/17	0	0	0	0	1	0	0	0	0	0	0	0
6/18	0	0	0	0	1	0	0	0	0	0	0	0
6/19	0	0	0	3	4	0	0	0	0	0	0	0
6/20	1	1	0	2	6	0	0	0	0	0	0	0
6/21	0	1	0	0	6	0	0	0	0	0	0	0
6/22	0	1	0	1	7	0	0	0	0	0	0	0
6/23	1	2	0	19	26	0	0	0	0	0	0	0
6/24	1	3	0	21	47	0	0	0	0	0	0	0
6/25	0	3	0	6	53	0	0	0	0	0	0	0
6/26	0	3	0	15	68	0	0	0	0	0	0	0
6/27	10	13	0	176	244	0	0	0	0	0	0	0
6/28	0	13	0	69	313	1	0	0	0	0	0	0
6/29	36	49	1	162	475	1	0	0	0	0	0	0
6/30	61	110	2	358	833	1	0	0	0	0	0	0
7/1	13	123	3	241	1,074	2	0	0	0	0	0	0
7/2	81	204	4	527	1,601	3	0	0	0	0	0	0
7/3	79	283	6	537	2,138	4	0	0	0	0	0	0
7/4	119	402	8	982	3,120	6	0	0	0	0	0	0
7/5	93	495	10	904	4,024	7	0	0	0	0	0	0
7/6	450	945	19	1,515	5,539	10	0	0	0	0	0	0
7/7	464	1,409	29	1,007	6,546	12	0	0	0	0	0	0
7/8	915	2,324	48	3,011	9,557	17	0	0	0	0	0	0
7/9	445	2,769	57	2,254	11,811	21	0	0	0	0	0	0
7/10	268	3,037	62	1,341	13,152	24	0	0	0	6	6	8
7/11	183	3,220	66	909	14,061	25	0	0	0	1	7	9
7/12	176	3,396	70	1,263	15,324	27	0	0	0	0	7	9
7/13	90	3,486	71	1,366	16,690	30	0	0	0	0	7	9
7/14 [a]	128 [b]	3,614	74	1,396 [b]	18,086	32	0 [b]	0	0	0 [b]	7	9
7/15 [a]	123 [b]	3,738	77	1,477 [b]	19,563	35	1 [b]	1	0	0 [b]	7	9
7/16 [a]	119 [b]	3,856	79	1,559 [b]	21,122	38	1 [b]	2	0	0 [b]	7	9
7/17 [a]	114 [b]	3,970	81	1,640 [b]	22,761	41	2 [b]	4	0	0 [b]	7	9
7/18 [a]	109 [b]	4,079	84	1,721 [b]	24,483	44	2 [b]	6	0	0 [b]	7	9
7/19 [a]	104 [b]	4,183	86	1,803 [b]	26,285	47	2 [b]	8	0	0 [b]	7	9
7/20 [a]	99 [b]	4,282	88	1,884 [b]	28,169	50	3 [b]	11	0	0 [b]	7	9
7/21 [a]	94 [b]	4,376	90	1,965 [b]	30,134	54	3 [b]	14	0	0 [b]	7	9
7/22	27	4,403	90	929	31,063	56	5	19	0	0	7	9
7/23	152	4,555	93	3,164	34,227	61	2	21	0	0	7	9
7/24	56	4,611	94	3,334	37,561	67	3	24	0	2	9	12
7/25	51	4,662	95	3,178	40,739	73	10	34	0	3	12	16
7/26	22	4,684	96	2,401	43,140	77	14	48	0	3	15	20
7/27	14	4,698	96	1,722	44,862	80	11	59	0	2	17	23
7/28	21	4,719	97	1,110	45,972	82	3	62	0	0	17	23
7/29	11	4,730	97	1,176	47,148	84	4	66	0	2	19	26
7/30	6	4,736	97	864	48,012	86	7	73	0	2	21	28
7/31	4	4,740	97	849	48,861	87	12	85	0	1	22	30
8/1	6	4,746	97	838	49,699	89	28	113	0	3	25	34
8/2	13	4,759	97	770	50,469	90	39	152	1	1	26	35
8/3	11	4,770	98	721	51,190	92	45	197	1	7	33	45
8/4	8	4,778	98	546	51,736	93	81	278	1	4	37	50
8/5	25	4,803	98	598	52,334	94	383	661	2	0	37	50

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Table 1.–Page 2 of 2.

Date	Chinook			Chum			Coho			Sockeye		
	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
8/6[a]	14[b]	4,817	99	476[b]	52,810	95	334[b]	995	3	3[b]	40	53
8/7[a]	11[b]	4,828	99	381[b]	53,191	95	436[b]	1,430	5	3[b]	43	57
8/8[a]	8[b]	4,836	99	285[b]	53,476	96	537[b]	1,968	7	4[b]	46	62
8/9	0	4,836	99	28	53,504	96	9	1,977	7	0	46	62
8/10	11	4,847	99	524	54,028	97	308	2,285	8	0	46	62
8/11	7	4,854	99	352	54,380	97	144	2,429	8	5	51	69
8/12	6	4,860	100	275	54,655	98	333	2,762	9	4	55	74
8/13	0	4,860	100	104	54,759	98	945	3,707	13	4	59	80
8/14	7	4,867	100	250	55,009	99	2,219	5,926	20	5	64	86
8/15	1	4,868	100	85	55,094	99	196	6,122	21	3	67	91
8/16	6	4,874	100	116	55,210	99	421	6,543	22	0	67	91
8/17	1	4,875	100	92	55,302	99	593	7,136	24	3	70	95
8/18	3	4,878	100	97	55,399	99	1,363	8,499	29	2	72	97
8/19	2	4,880	100	67	55,466	99	697	9,196	31	0	72	97
8/20	0	4,880	100	65	55,531	99	1,241	10,437	36	0	72	97
8/21	1	4,881	100	25	55,556	99	1,035	11,472	39	0	72	97
8/22	1	4,882	100	41	55,597	100	1,331	12,803	44	0	72	97
8/23	1	4,883	100	32	55,629	100	1,118	13,921	47	0	72	97
8/24	0	4,883	100	24	55,653	100	990	14,911	51	0	72	97
8/25	0	4,883	100	16	55,669	100	1,802	16,713	57	0	72	97
8/26	0	4,883	100	15	55,684	100	924	17,637	60	0	72	97
8/27	0	4,883	100	16	55,700	100	2,128	19,765	67	0	72	97
8/28	0	4,883	100	21	55,721	100	1,489	21,254	72	0	72	97
8/29	0	4,883	100	11	55,732	100	2,099	23,353	80	0	72	97
8/30	0	4,883	100	4	55,736	100	1,023	24,376	83	0	72	97
8/31	0	4,883	100	10	55,746	100	339	24,715	84	0	72	97
9/1	0	4,883	100	4	55,750	100	488	25,203	86	1	73	99
9/2	0	4,883	100	4	55,754	100	148	25,351	86	1	74	100
9/3	0	4,883	100	7	55,761	100	173	25,524	87	0	74	100
9/4	0	4,883	100	4	55,765	100	726	26,250	90	0	74	100
9/5	0	4,883	100	4	55,769	100	452	26,702	91	0	74	100
9/6	0	4,883	100	2	55,771	100	249	26,951	92	0	74	100
9/7	0	4,883	100	4	55,775	100	316	27,267	93	0	74	100
9/8	0	4,883	100	6	55,781	100	722	27,989	95	0	74	100
9/9	0	4,883	100	6	55,787	100	548	28,537	97	0	74	100
9/10	0	4,883	100	8	55,795	100	69	28,606	98	0	74	100
9/11	0	4,883	100	2	55,797	100	95	28,701	98	0	74	100
9/12	0	4,883	100	6	55,803	100	164	28,865	98	0	74	100
9/13	0	4,883	100	21	55,824	100	163	29,028	99	0	74	100
9/14	0	4,883	100	8	55,832	100	163	29,191	100	0	74	100
9/15	0	4,883	100	7	55,839	100	35	29,226	100	0	74	100
9/16	0	4,883	100	2	55,841	100	7	29,233	100	0	74	100
9/17	0	4,883	100	1	55,842	100	45	29,278	100	0	74	100
9/18[c]	0[d]	4,883	100	0[d]	55,842	100	17[e]	29,295	100	0[d]	74	100
9/19[c]	0[d]	4,883	100	0[d]	55,842	100	13[e]	29,308	100	0[d]	74	100
9/20[c]	0[d]	4,883	100	0[d]	55,842	100	9[e]	29,317	100	0[d]	74	100

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

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

[b] Daily passage was estimated using the "linear interpolation" method described in *Methods.*

[c] Operations were terminated early.

[d] Daily passage was assumed to be zero based on historical passage data.

[e] Daily passage was estimated using the "proportional" method described in *Methods*.

Table 2.–Age and sex composition of George River Chinook salmon in 2007 based on escapement samples collected at the weir.

			Age Class																	
Sample Dates	Sample		1.1		1.2		1.3		2.2		1.4		2.3		1.5		2.4		Total	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
6/29-7/5	159	M	0	0.0	1,846	66.7	575	20.8	0	0.0	174	6.3	0	0.0	17	0.6	0	0.0	2,612	94.3
(6/15-7/9)		F	0	0.0	0	0.0	17	0.6	0	0.0	139	5.0	0	0.0	0	0.0	0	0.0	157	5.7
		Subtotal[a]	0	0.0	1,846	66.7	592	21.4	0	0.0	313	11.3	0	0.0	17	0.6	0	0.0	2,769	100.0
7/13- 14, 7/26- 8/5	90	M	0	0.0	775	36.7	352	16.7	0	0.0	258	12.2	0	0.0	24	1.1	23	1.1	1,433	67.8
(7/10-9/20)		F	0	0.0	0	0.0	141	6.6	0	0.0	517	24.5	0	0.0	23	1.1	0	0.0	681	32.2
		Subtotal[a]	0	0.0	775	36.7	493	23.3	0	0.0	775	36.7	0	0.0	47	2.2	23	1.1	2,114	100.0
Season [b]	249	M	0	0.0	2,621	53.7	927	19.0	0	0.0	433	8.9	0	0.0	41	0.8	23	0.5	4,045	82.8
		F	0	0.0	0	0.0	158	3.2	0	0.0	656	13.4	0	0.0	23	0.5	0	0.0	838	17.2
		Subtotal[a]	0	0.0	2,621	53.7	1,085	22.2	0	0.0	1,089	22.3	0	0.0	64	1.3	23	0.5	4,883	100.0

Note: This table differs from that published in *Salmon Age, Sex, and Length Catalog for the Kuskokwim Area, 2007* (Molyneaux et al. *In prep*) because the authors of this report decided to divide the total sample and escapement into 2 strata rather than 3 to allow for calculation of total season ASL composition estimates.

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are due 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.–Length composition of George River Chinook salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4
6/29-7/5 (6/15-7/9)	M	Mean Length		530	671		827		990	
		SE		5	12		23		-	
		Range		405- 645	520- 820		630- 870		990- 990	
		Sample Size	0	106	33	0	10	0	1	0
	F	Mean Length			700		843			
		SE			-		17			
		Range			700- 700		775- 900			
		Sample Size	0	0	1	0	8	0	0	0
7/13- 14, 7/26- 8/5 (7/10-9/20)	M	Mean Length		500	661		770		825	835
		SE		11	14		18		-	-
		Range		395- 650	590- 750		710- 915		825- 825	835- 835
		Sample Size	0	33	15	0	11	0	1	1
	F	Mean Length			769		834		940	
		SE			11		10		-	
		Range			720- 795		760- 915		940- 940	
		Sample Size	0	0	6	0	22	0	1	0
Season[a]	M	Mean Length		518	666		787		878	835
		Range		395- 650	520- 820		630- 915		825- 990	835- 835
		Sample Size	0	139	48	0	21	0	2	1
	F	Mean Length			764		835		940	
		Range			700- 795		760- 915		940- 940	
		Sample Size	0	0	7	0	30	0	1	0

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

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

Table 4.–Age and sex composition George River chum salmon in 2007 based on escapement samples collected at the weir.

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 %
6/28-30	177	M	35	1.1	1,340	42.9	458	14.7	71	2.3	1,904	61.0
(6/15-7/4)		F	0	0.0	1,057	33.9	124	3.9	35	1.1	1,216	39.0
		Subtotal [a]	35	1.1	2,397	76.8	582	18.6	106	3.4	3,120	100.0
7/8-9	183	M	0	0.0	11,790	55.2	1,985	9.3	117	0.5	13,892	65.0
(7/5-18)		F	0	0.0	6,304	29.5	1,167	5.5	0	0.0	7,471	35.0
		Subtotal [a]	0	0.0	18,094	84.7	3,152	14.8	117	0.5	21,363	100.0
7/26-27	163	M	144	0.6	7,218	30.7	1,444	6.1	289	1.2	9,094	38.7
(7/19-30)		F	289	1.2	10,971	46.6	3,031	12.9	144	0.6	14,436	61.3
		Subtotal [a]	433	1.8	18,189	77.3	4,475	19.0	433	1.8	23,530	100.0
8/4-5	182	M	172	2.2	2,925	37.4	258	3.3	86	1.1	3,442	44.0
(7/31-9/20)		F	344	4.4	3,485	44.5	473	6.0	86	1.1	4,388	56.0
		Subtotal [a]	516	6.6	6,410	81.9	731	9.3	172	2.2	7,830	100.0
Season [b]	705	M	352	0.6	23,274	41.7	4,145	7.4	562	1.0	28,332	50.7
		F	633	1.2	21,817	39.0	4,795	8.6	266	0.5	27,511	49.3
		Total	985	1.8	45,091	80.7	8,940	16.0	828	1.5	55,843	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are due 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.–Length composition of George River chum salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
6/28-29	M	Mean Length	548	568	573	585
(6/15-7/4)		Std. Error	23	3	6	18
		Range	525- 570	505- 625	520- 615	550- 620
		Sample Size	2	76	26	4
	F	Mean Length		539	528	544
		Std. Error		3	7	19
		Range		480- 585	500- 545	525- 562
		Sample Size	0	60	7	2
7/8-9	M	Mean Length		555	576	580
(7/5-18)		Std. Error		3	11	-
		Range		500- 610	510- 695	580- 580
		Sample Size	0	101	17	1
	F	Mean Length		532	548	
		Std. Error		4	8	
		Range		480- 675	515- 590	
		Sample Size	0	54	10	0
7/26-27	M	Mean Length	525	546	557	558
(7/19-28)		Std. Error	-	5	7	8
		Range	525- 525	480- 635	535- 605	550- 565
		Sample Size	1	50	10	2
	F	Mean Length	510	525	527	570
		Std. Error	15	3	7	-
		Range	495- 525	480- 590	485- 600	570- 570
		Sample Size	2	76	21	1
7/29-30,8/4-5	M	Mean Length	505	544	560	605
(7/29-9/20)		Std. Error	20	4	20	15
		Range	455- 545	470- 645	520- 630	590- 620
		Sample Size	4	68	6	2
	F	Mean Length	508	516	545	495
		Std. Error	8	3	7	5
		Range	470- 530	450- 590	505- 585	490- 500
		Sample Size	8	81	11	2
Season[a]	M	Mean Length	517	552	568	573
		Range	455- 570	470- 645	510- 695	550- 620
		Sample Size	7	295	59	9
	F	Mean Length	509	527	534	540
		Range	470- 530	450- 675	485- 600	490- 570
		Sample Size	10	271	49	5

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

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

Table 6.–Age and sex composition of George River coho salmon in 2007 based on escapement samples collected at the weir.

			Age Class							
			1.1		2.1		3.1		Total	
Sample Dates (Stratum Dates)	Sample Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%
8/18-21	156	M	89	0.6	9,459	67.9	268	1.9	9,816	70.5
(6/15-8/23)		F	179	1.3	3,659	26.3	267	1.9	4,105	29.5
		Subtotal[a]	268	1.9	13,118	94.2	535	3.8	13,921	100.0
8/29-9/1	143	M	173	1.4	6,984	56.6	173	1.4	7,328	59.4
(8/24-9/4)		F	86	0.7	4,828	39.2	86	0.7	5,001	40.6
		Subtotal[a]	259	2.1	11,812	95.8	259	2.1	12,329	100.0
9/10-13	143	M	21	0.7	1,244	40.6	86	2.8	1,351	44.1
(9/5-20)		F	0	0.0	1,651	53.8	64	2.1	1,716	55.9
		Subtotal[a]	21	0.7	2,895	94.4	150	4.9	3,067	100.0
Season[b]	442	M	283	1.0	17,687	60.3	526	1.8	18,496	63.1
		F	265	0.9	10,138	34.6	418	1.4	10,821	36.9
		Total	548	1.9	27,825	94.9	944	3.2	29,317	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are due 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.–Length composition of George River coho salmon in 2007 based on escapement samples collected at the weir.

Sample Dates (Stratum Dates)	Sex		Age Class 1.1	2.1	3.1
8/18-21 (6/15-8/23)	M	Mean Length	515	534	567
		SE	-	5	22
		Range	515- 515	400- 635	525- 600
		Sample Size	1	106	3
	F	Mean Length	578	557	557
		SE	13	4	7
		Range	565- 590	445- 605	550- 570
		Sample Size	2	41	3
8/29-9/1 (8/24-9/4)	M	Mean Length	583	554	590
		SE	5	5	20
		Range	578- 588	440- 624	570- 610
		Sample Size	2	81	2
	F	Mean Length	610	565	550
		SE	-	4	-
		Range	610- 610	465- 630	550- 550
		Sample Size	1	56	1
9/10-13 (9/5-20)	M	Mean Length	540	560	538
		SE	-	5	22
		Range	540- 540	470- 625	475- 580
		Sample Size	1	58	4
	F	Mean Length		553	555
		SE		4	31
		Range		465- 625	515- 615
		Sample Size	0	77	3
Season[a]	M	Mean Length	558	544	570
		Range	515- 588	400- 635	475- 610
		Sample Size	4	245	9
	F	Mean Length	588	560	555
		Range	565- 610	445- 630	515- 615
		Sample Size	3	174	7

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

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

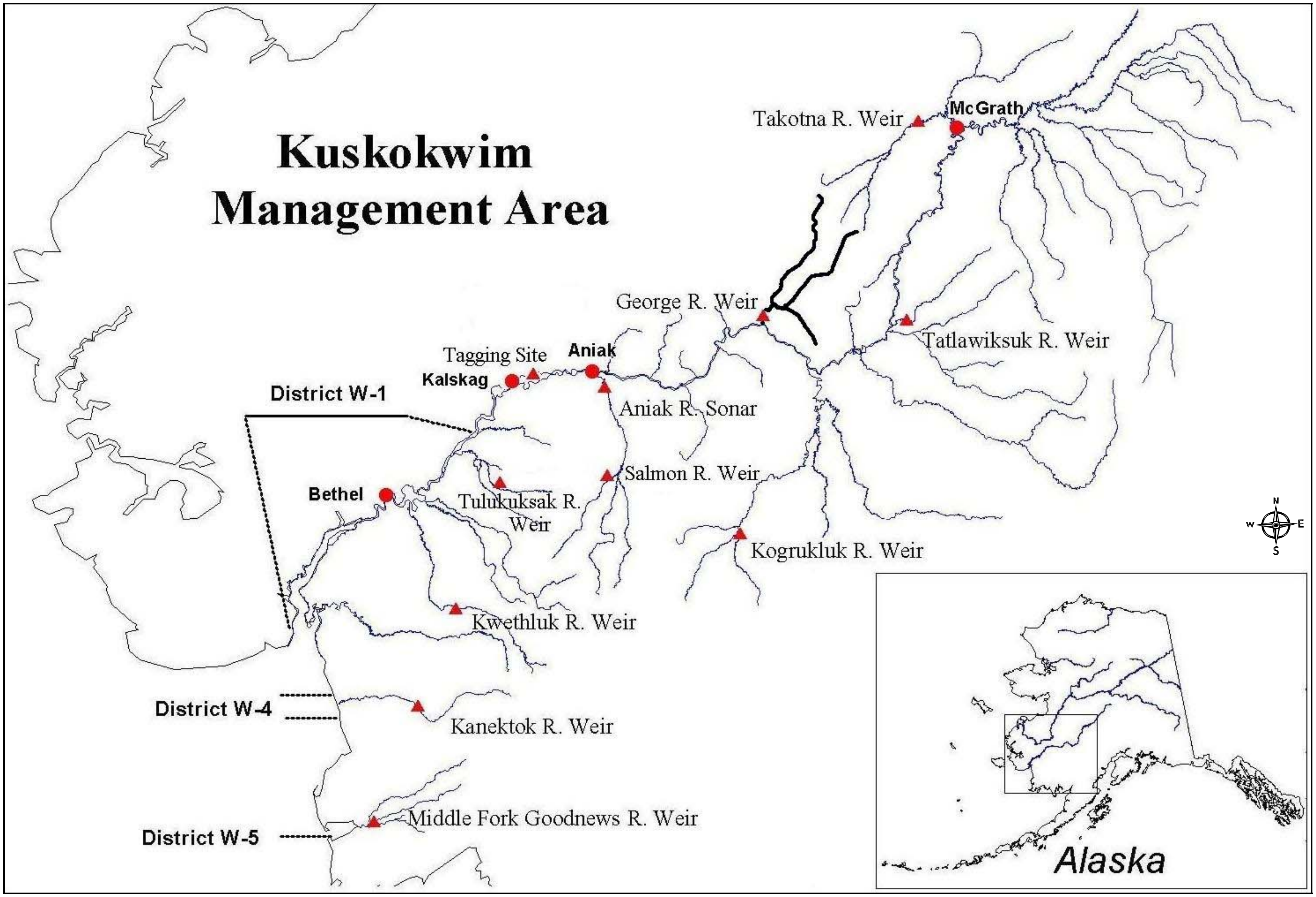


Figure 1.–Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the George River.

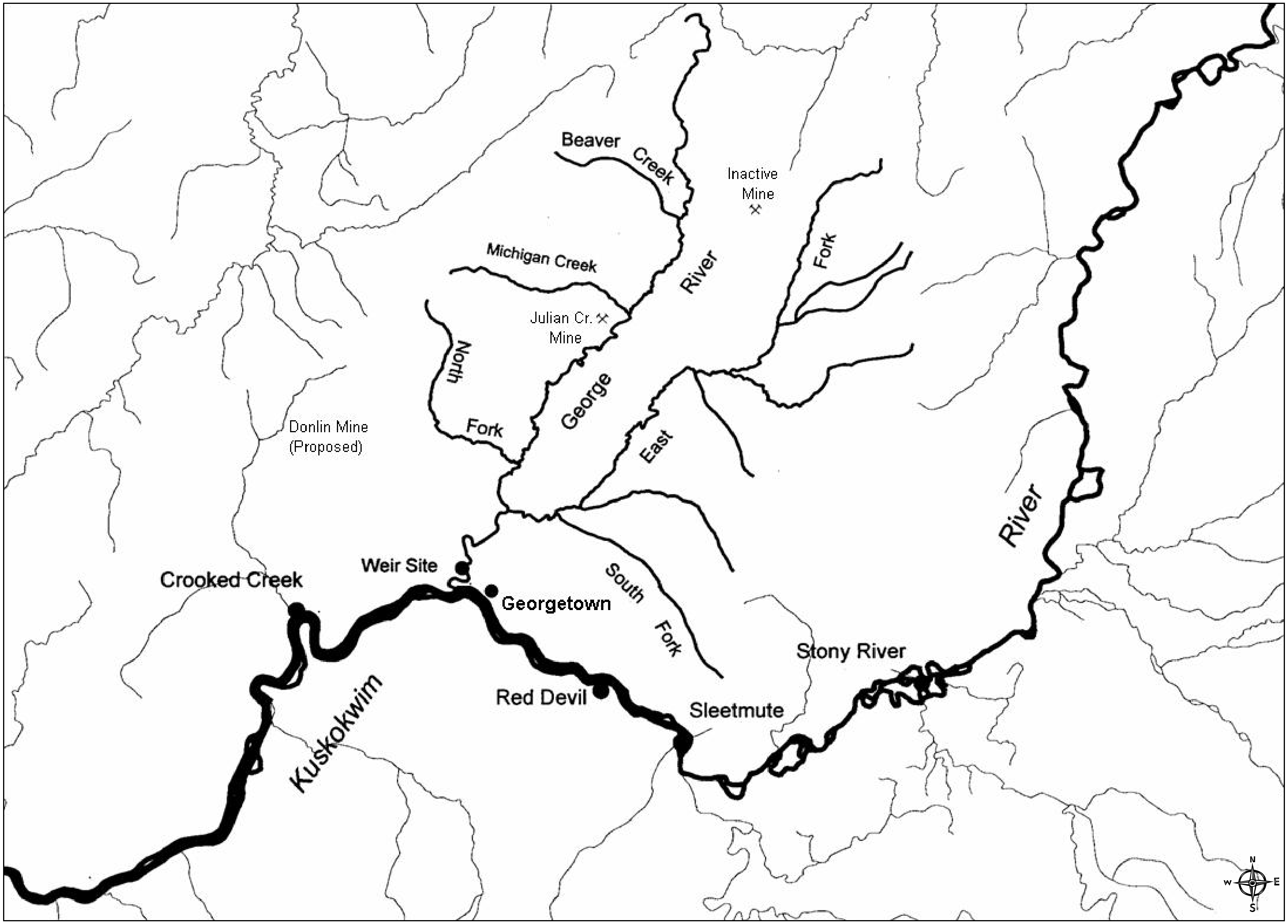
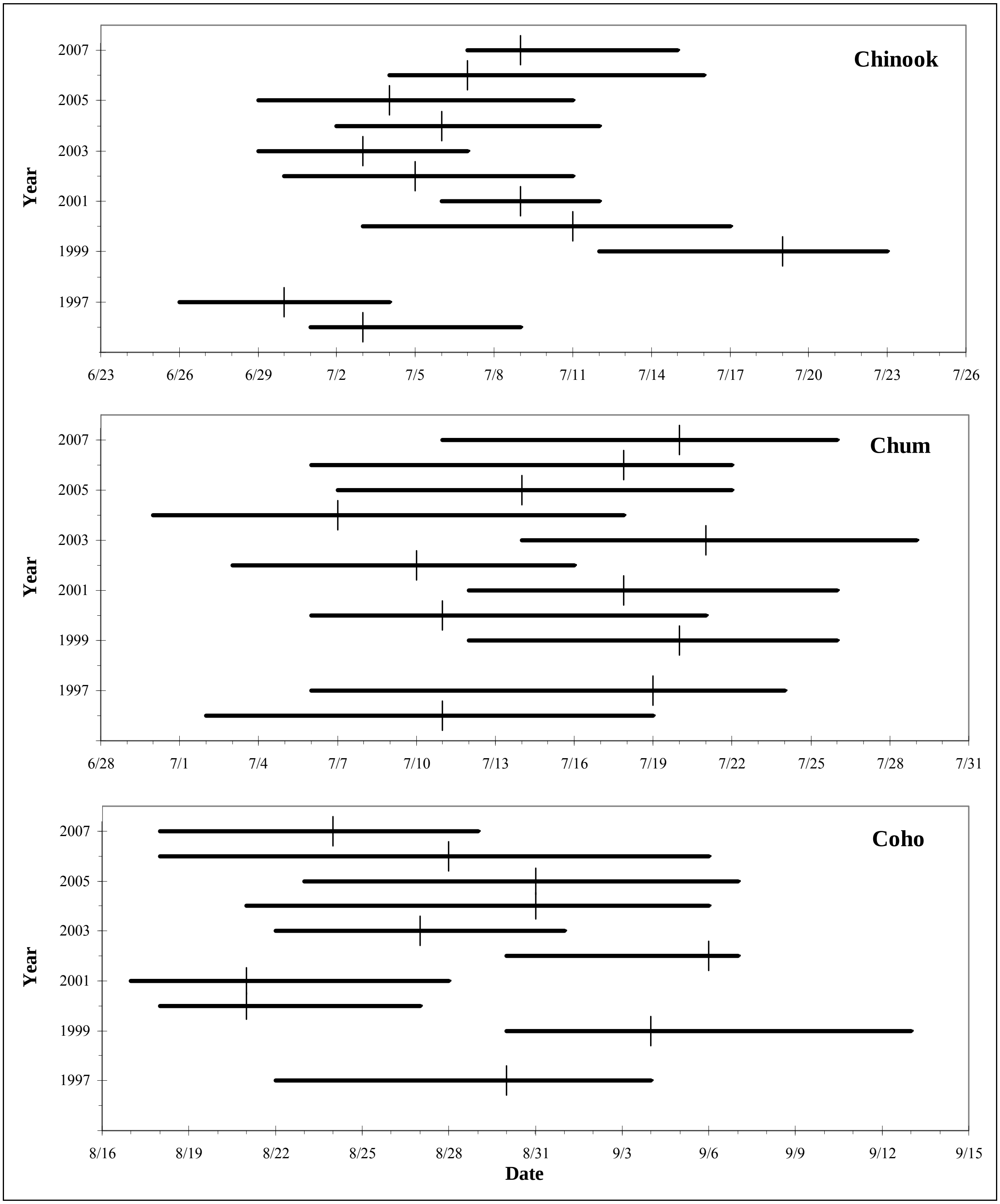


Figure 2.–Detailed map of the George River.



Note: Solid lines represent the dates when the central 50% of the run passed (elongated box in Table 1) and cross-bars represent the median passage date (bold box in Table 1).

Figure 3.–Annual run timing of Chinook, chum, and coho salmon through the George River weir based on cumulative percent passage.

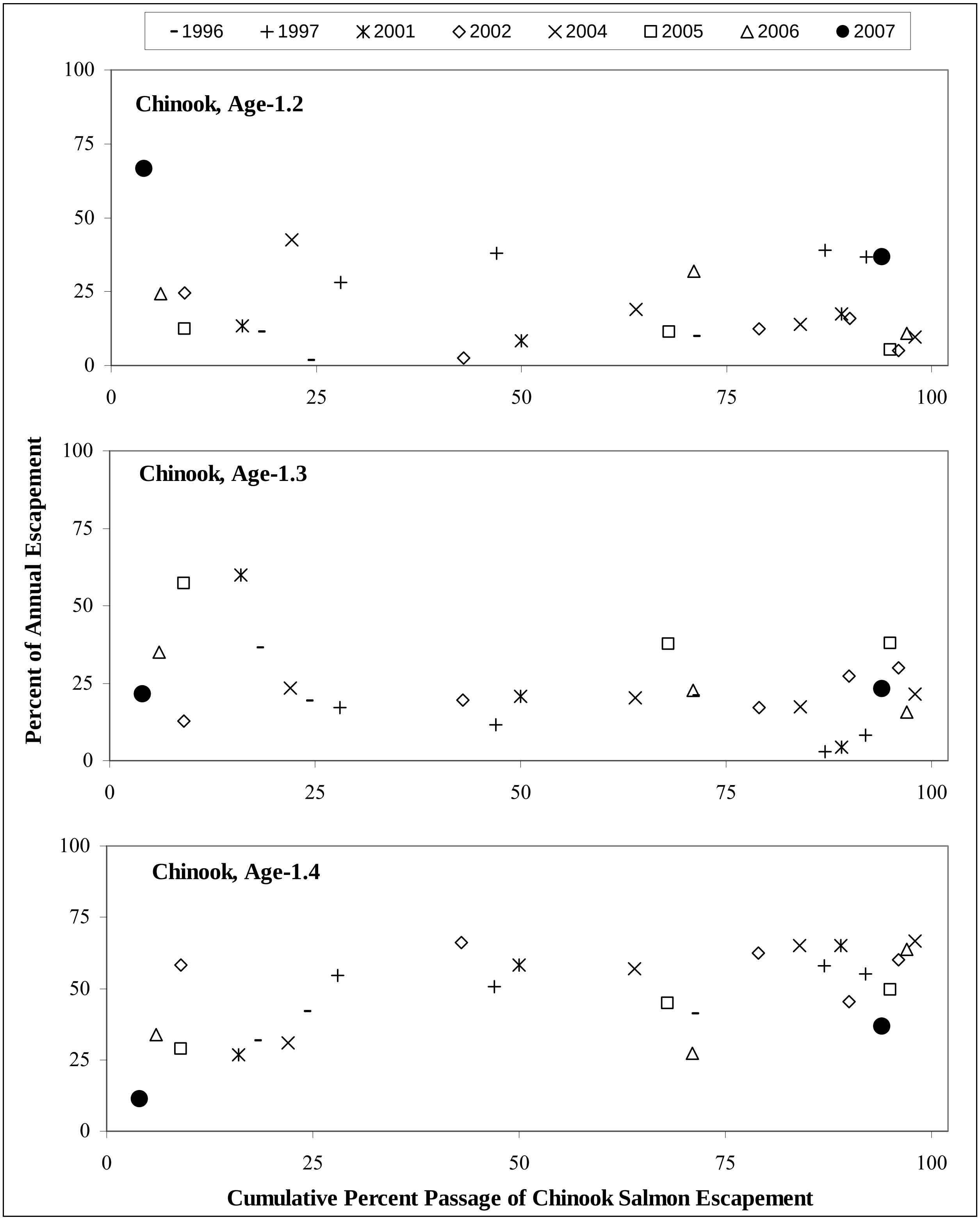


Figure 4.–Age composition of George River Chinook salmon by cumulative percent passage through the weir, 1996–2007.

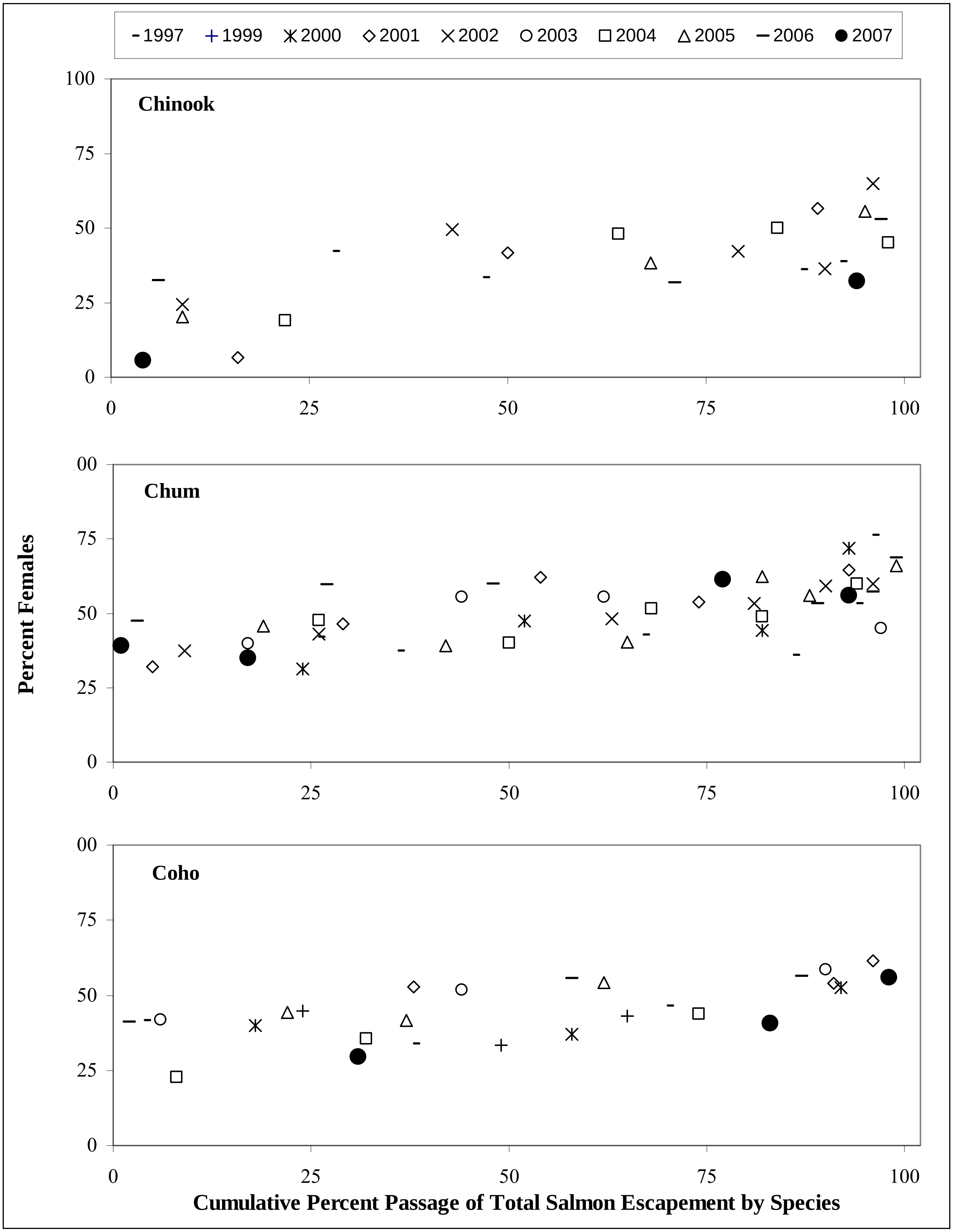
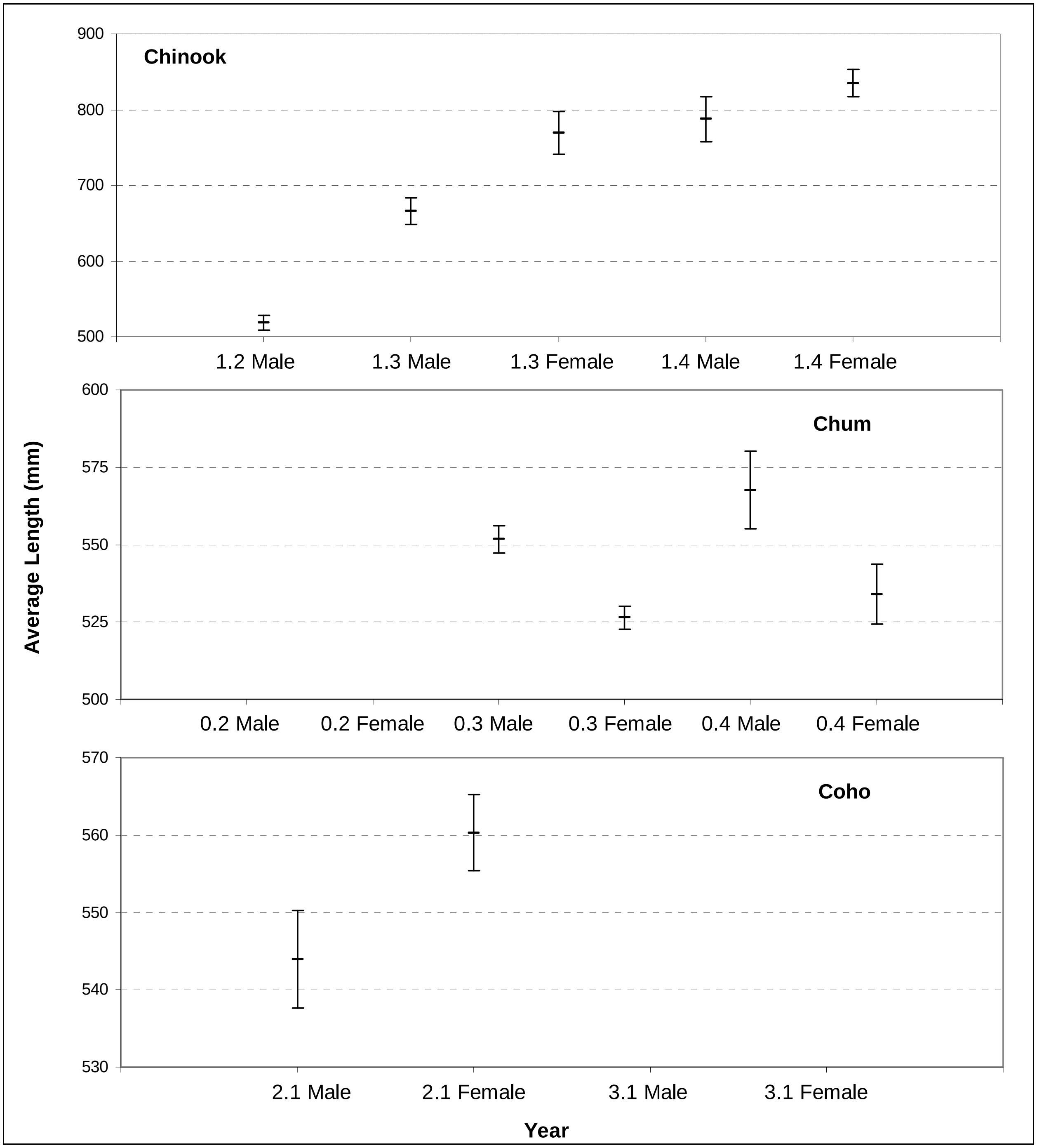
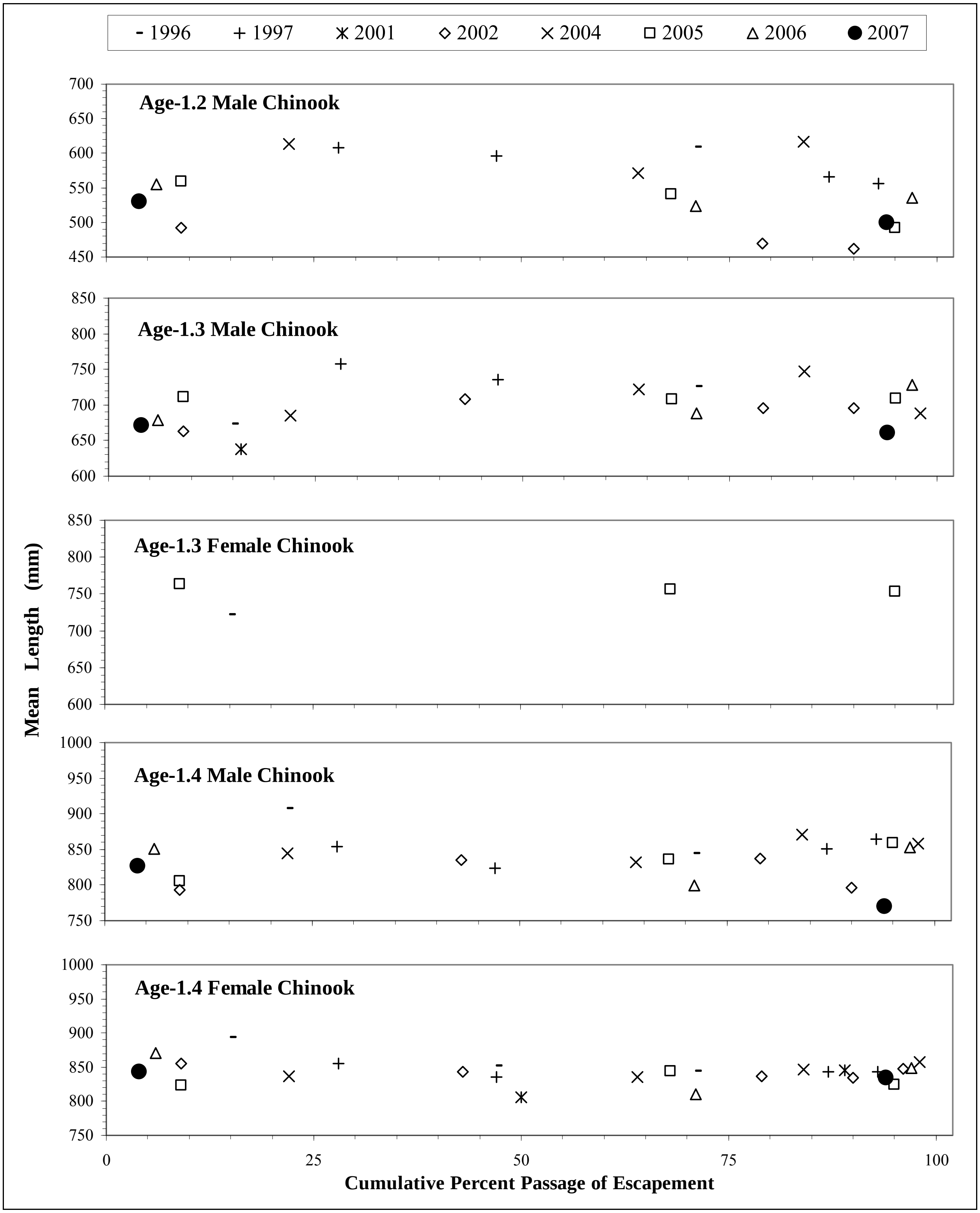


Figure 5.–Percentage of female Chinook, chum, and coho salmon by cumulative percent passage at the George River weir, 1996–2007.



Note: Age-0.2 chum salmon (both males and females) were excluded from this figure because confidence intervals were so broad they skewed the vertical axis.

Figure 6.–Average length of George River Chinook, chum, and coho salmon by age/sex category in 2007 with 95% confidence intervals.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 7.–Average length of common George River Chinook salmon age/sex categories by cumulative percent passage, 1996–2007.

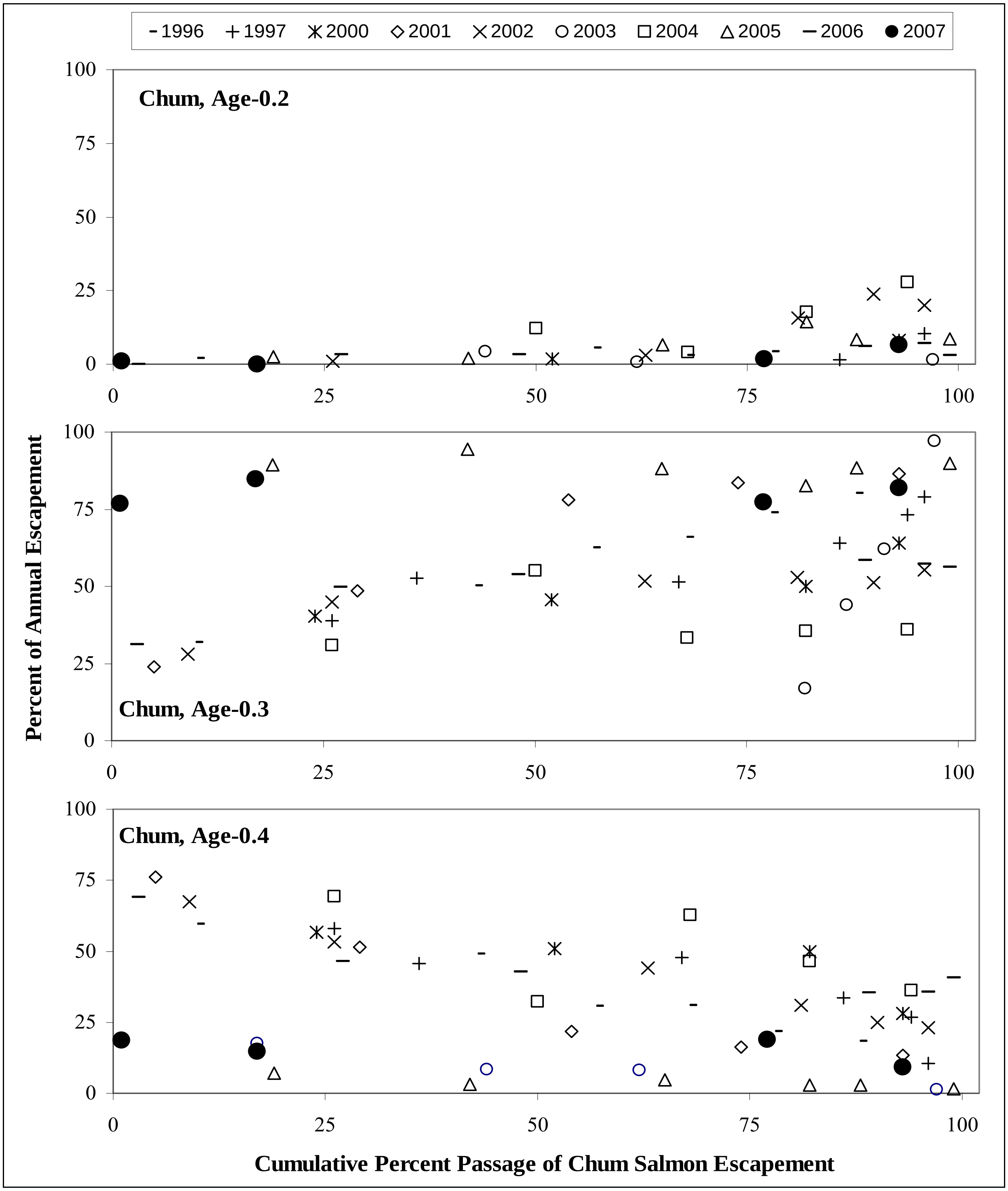
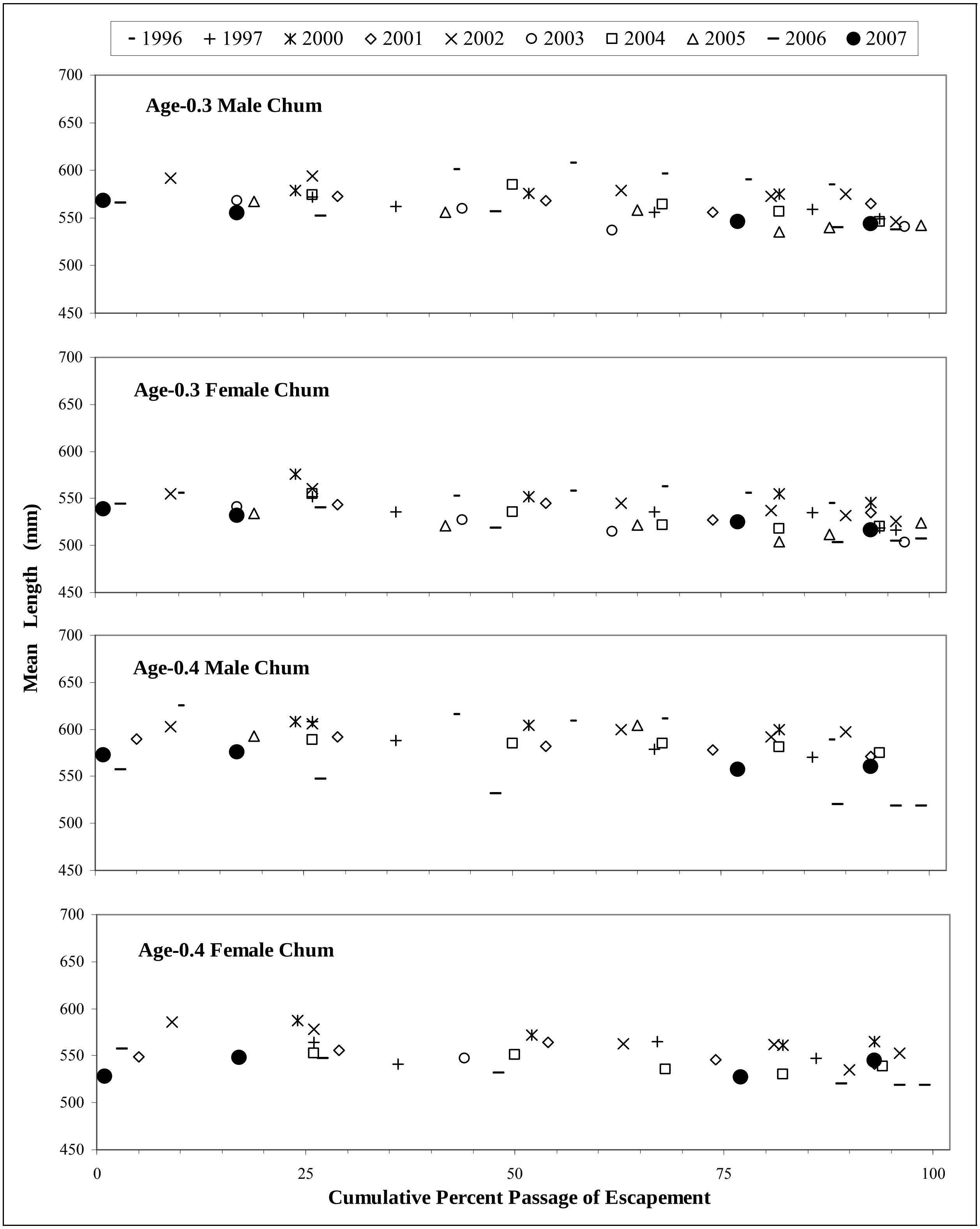


Figure 8.–Age composition of George River chum salmon by cumulative percent passage through the weir, 1996–2007.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 9.–Average length of common George River chum salmon age/sex categories by cumulative percent passage, 1996–2007.

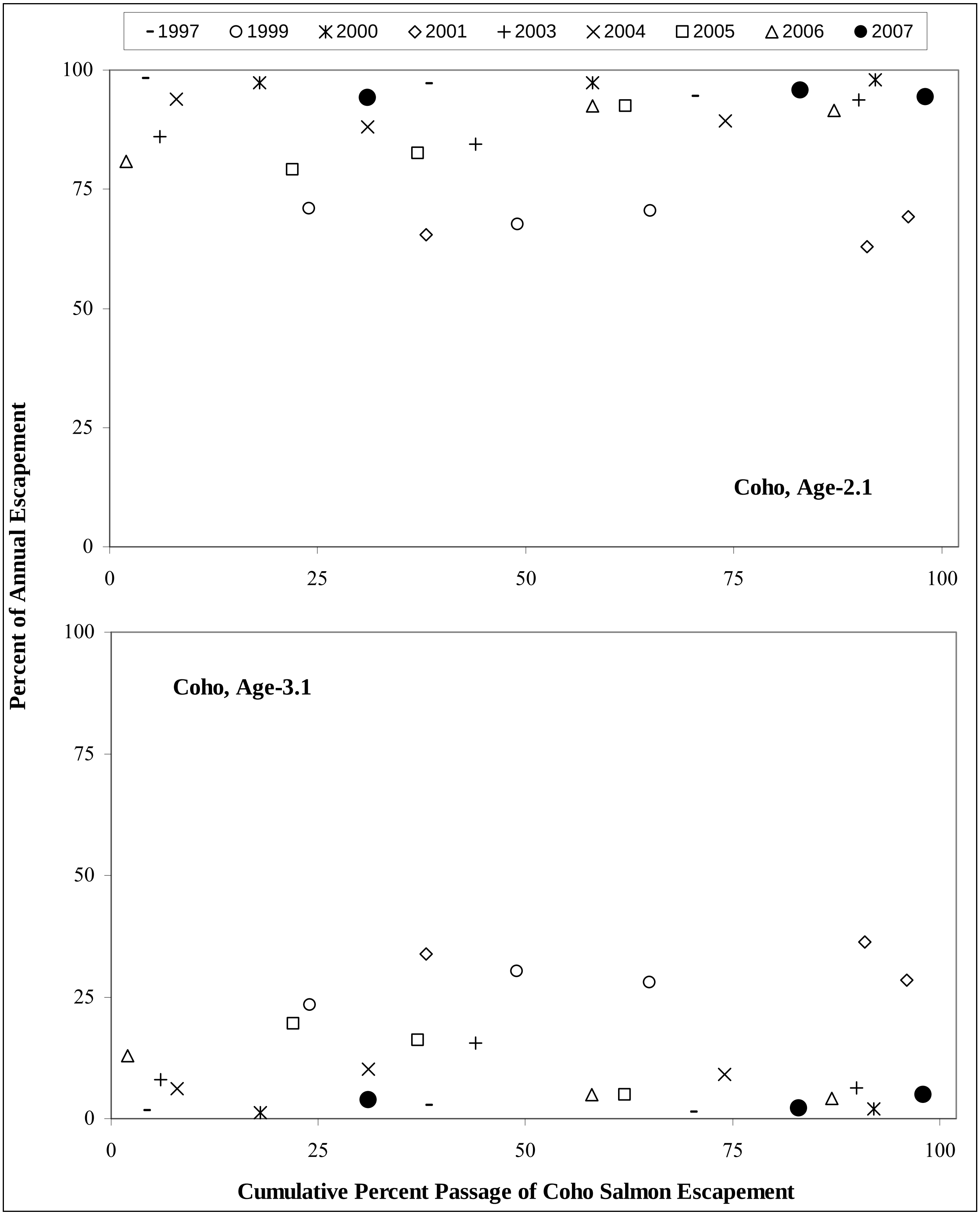
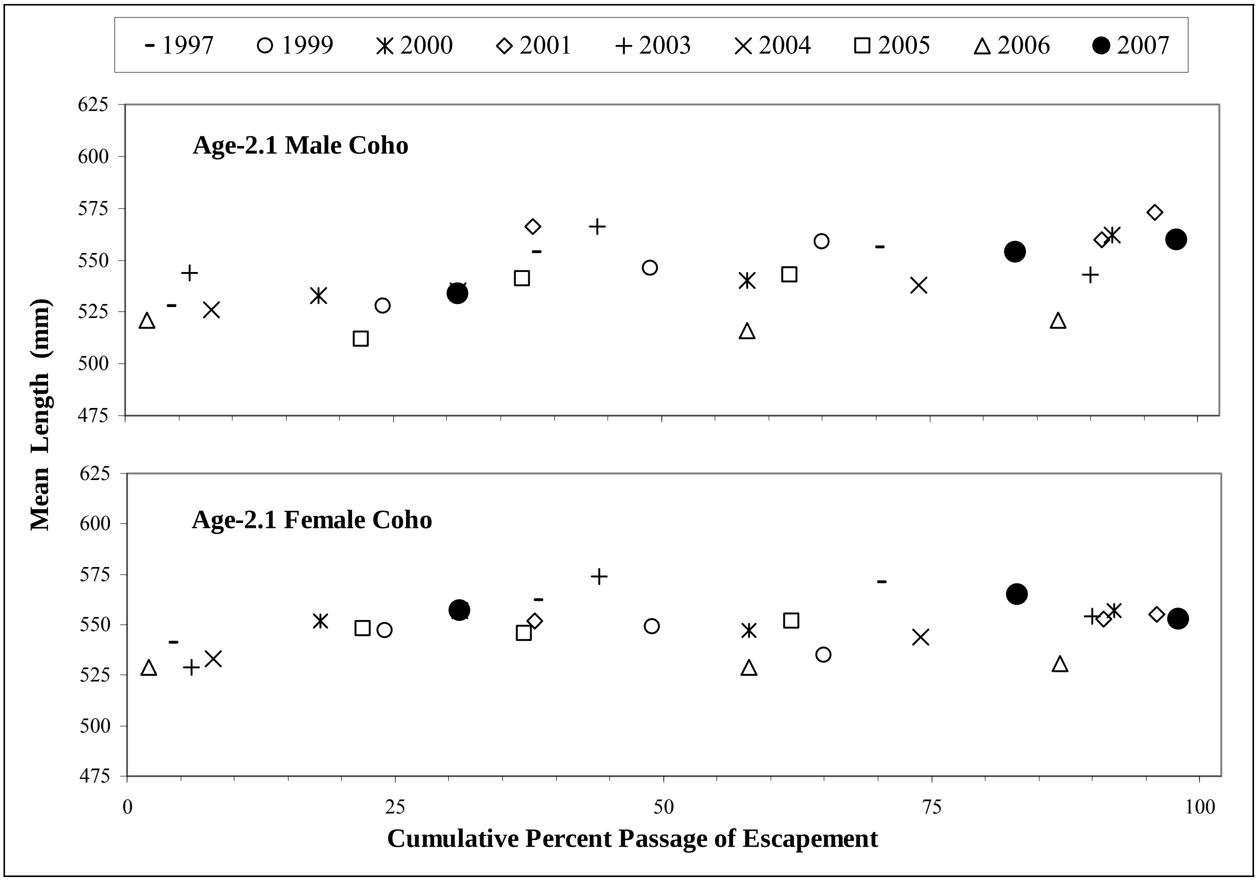


Figure 10.–Age composition of George River coho salmon by cumulative percent passage through the weir, 1996–2007.



Note: Only samples consisting of more than 6 fish are included in this figure.

Figure 11.–Average length of common George River coho salmon age/sex categories by cumulative percent passage, 1996–2007.

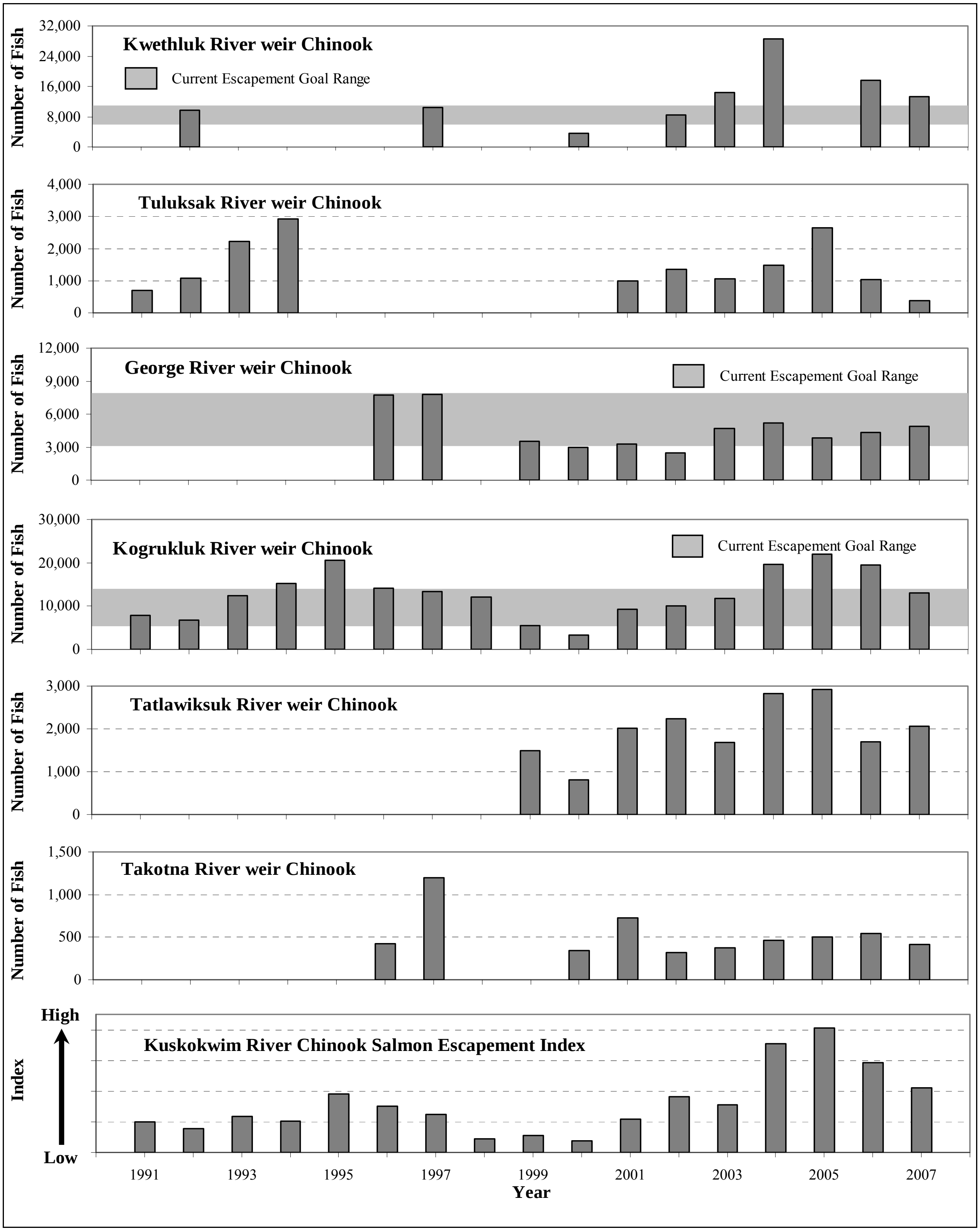


Figure 12.–Annual Chinook salmon escapements into 6 Kuskokwim River tributaries graphed in comparison to each other and to the drainage-wide Kuskokwim River Chinook Salmon Escapement Index.

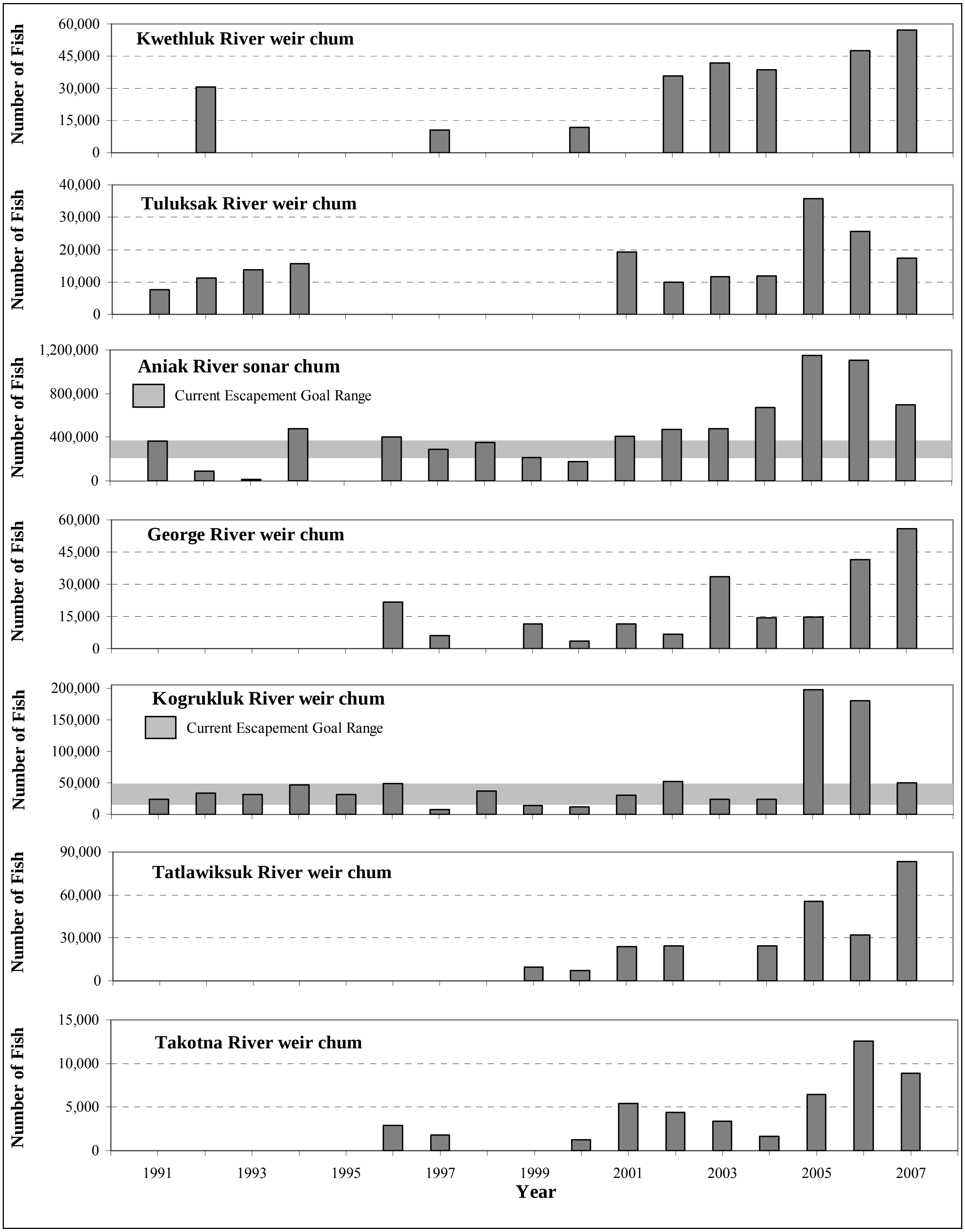


Figure 13.–Annual chum salmon escapements into 7 Kuskokwim River tributaries.

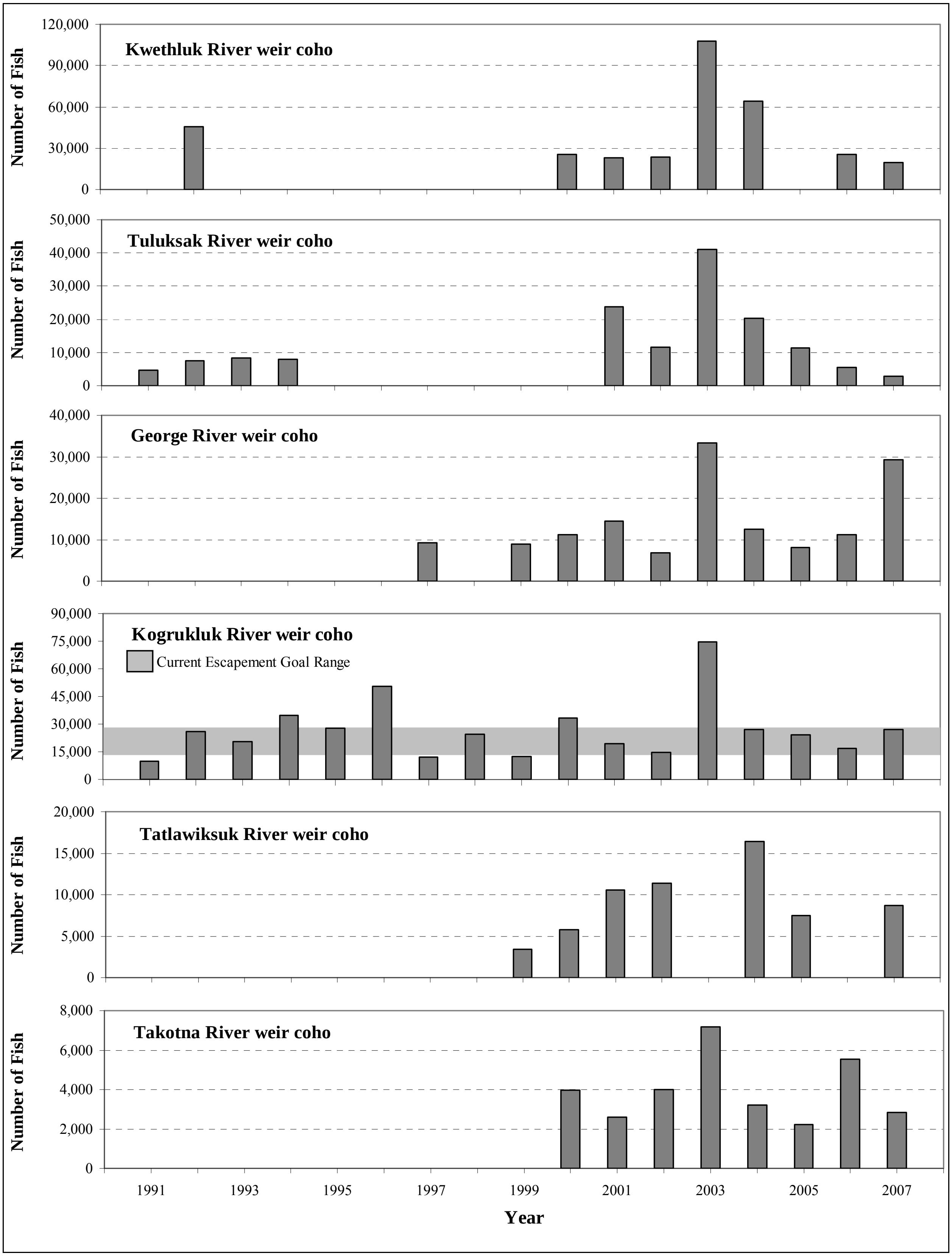
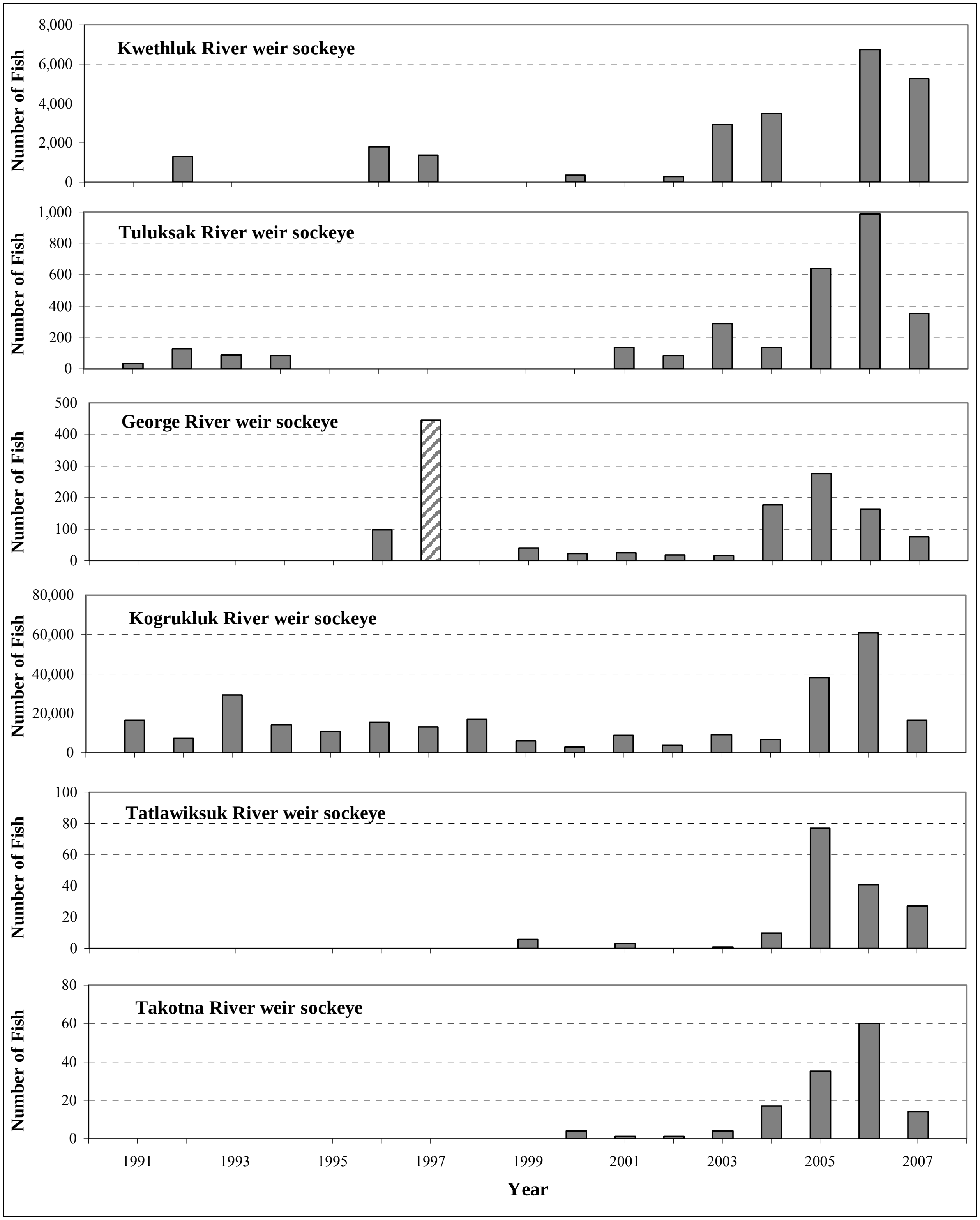
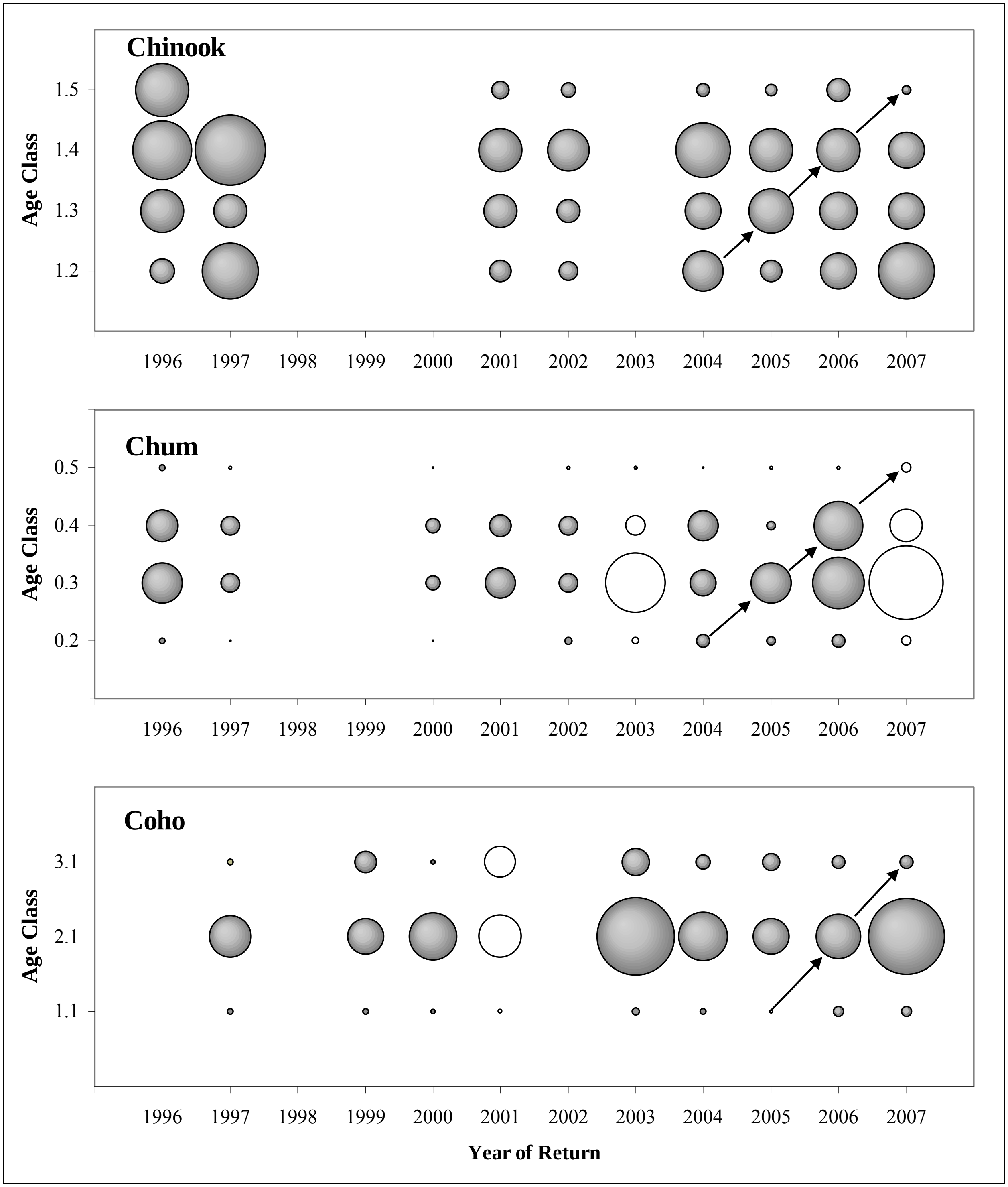


Figure 14.–Annual coho salmon escapements into 6 Kuskokwim River tributaries.



Note: 1997 escapement for George River is hatched because investigators suspect it may be incorrect.

Figure 15.–Annual sockeye salmon escapements into 6 Kuskokwim River tributaries.



Note: Size of circles represents abundance and arrows illustrate a cohort group. Plots that appear empty correspond to years when greater than 20% of reported escapement was derived through calculations for missed passage. Years when sample objectives were not achieved contain no data plots.

Figure 16.–Relative age class abundance by return year of Chinook, chum, and coho salmon at the George River weir.

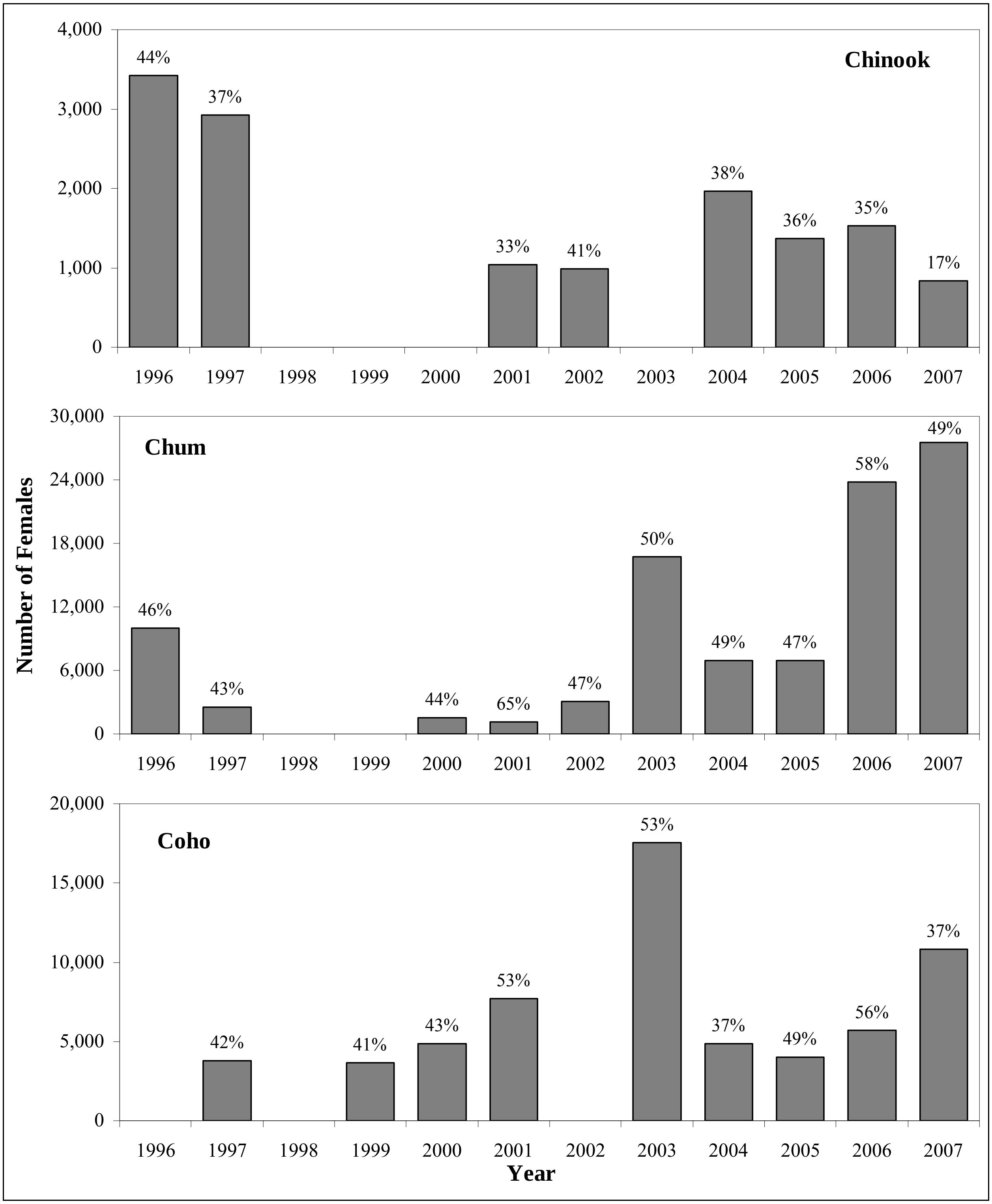
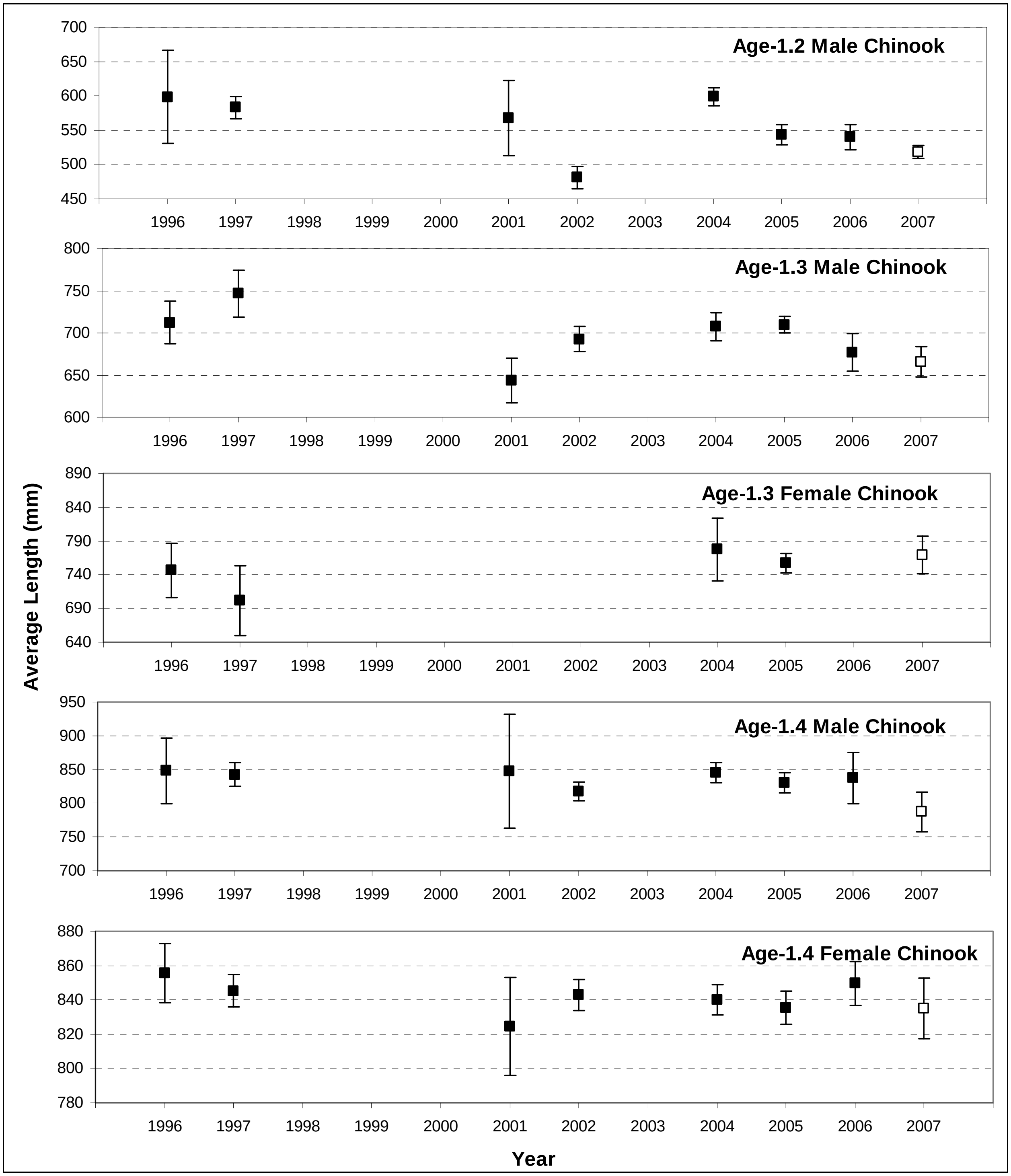
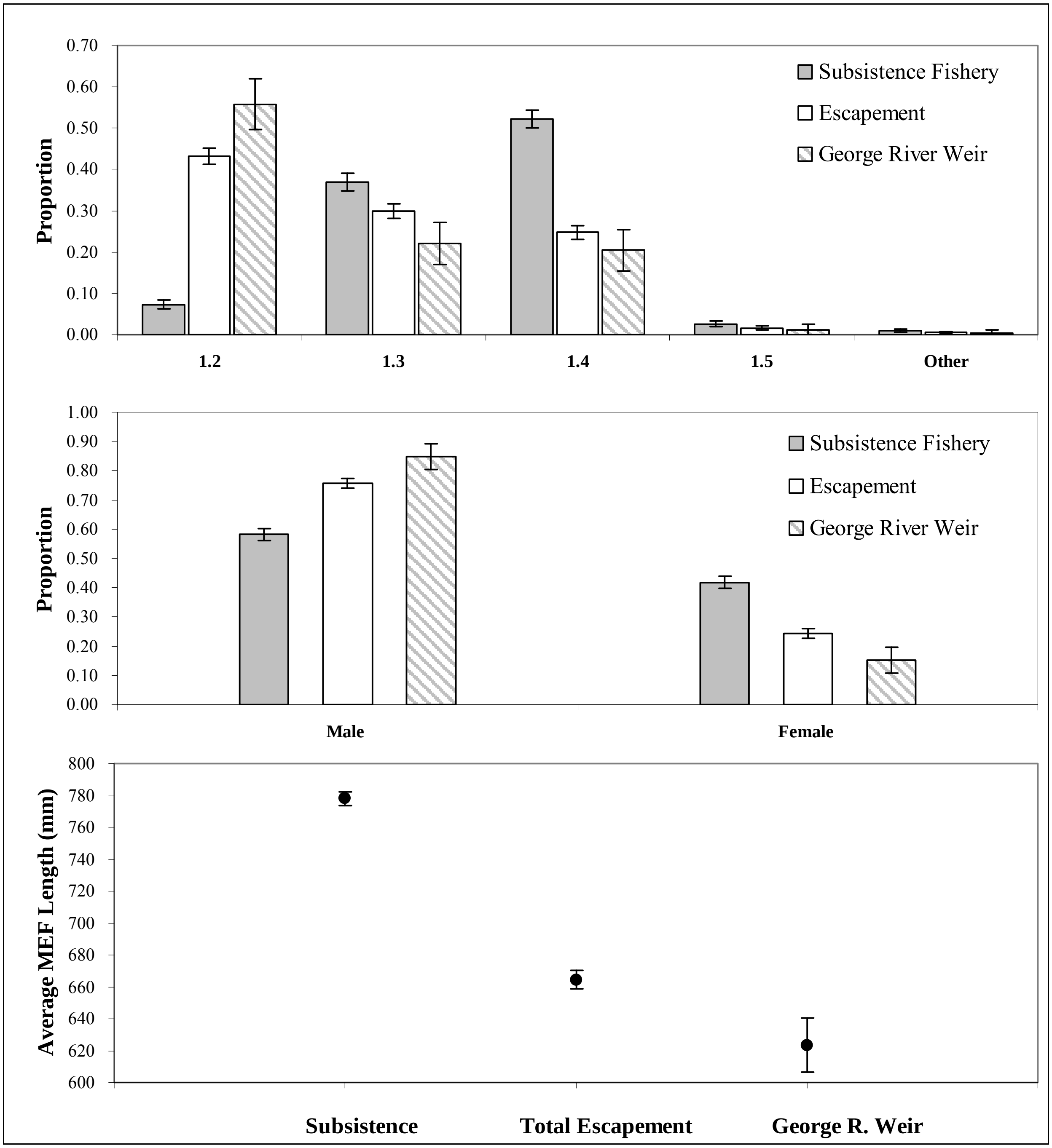


Figure 17.–Annual escapement of female Chinook, chum, and coho salmon at the George River weir with labels indicating the percentage of total escapement consisting of females.



Note: Blank plots indicate that though sampling goals were not achieved mean lengths could be calculated from one or more sampling pulses. Years without plots indicate that either sampling was insufficient for ASL analysis or confidence intervals were so broad they would skew the scale of the vertical axis.

Figure 18.–Average annual length of common Chinook salmon age/sex categories at the George River weir with 95% confidence intervals.



Note: Few Chinook salmon were harvested in the coho salmon-directed commercial fishery in 2007 and none of the incidental harvest was sampled for ASL analysis.

Figure 19.–ASL composition of the 2007 Kuskokwim River Chinook salmon subsistence harvest of Chinook salmon compared to total Kuskokwim River escapement and George River escapement, with 95% confidence intervals.

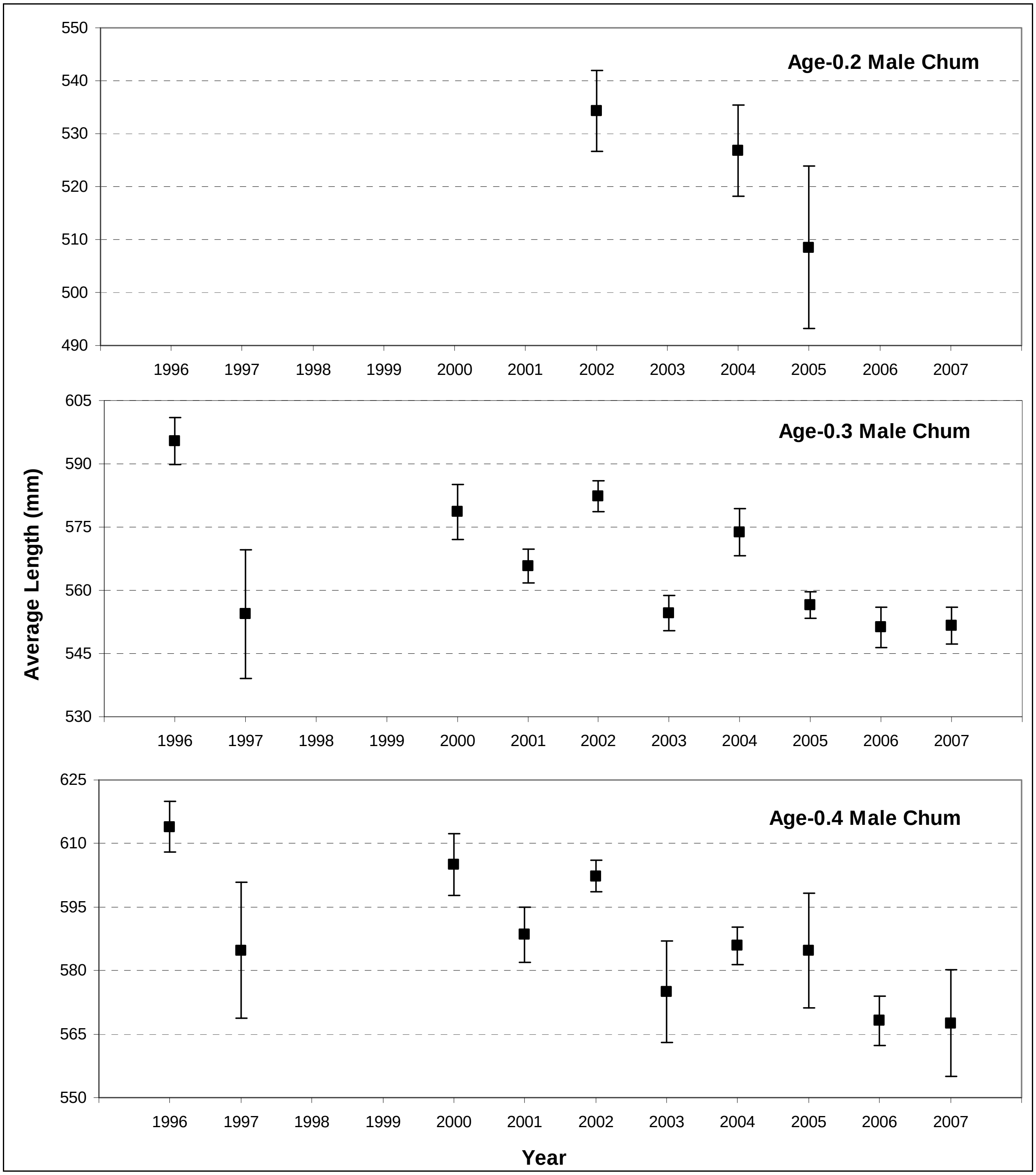


Figure 20.–Average annual length of common age classes of male chum salmon at the George River weir with 95% confidence intervals.

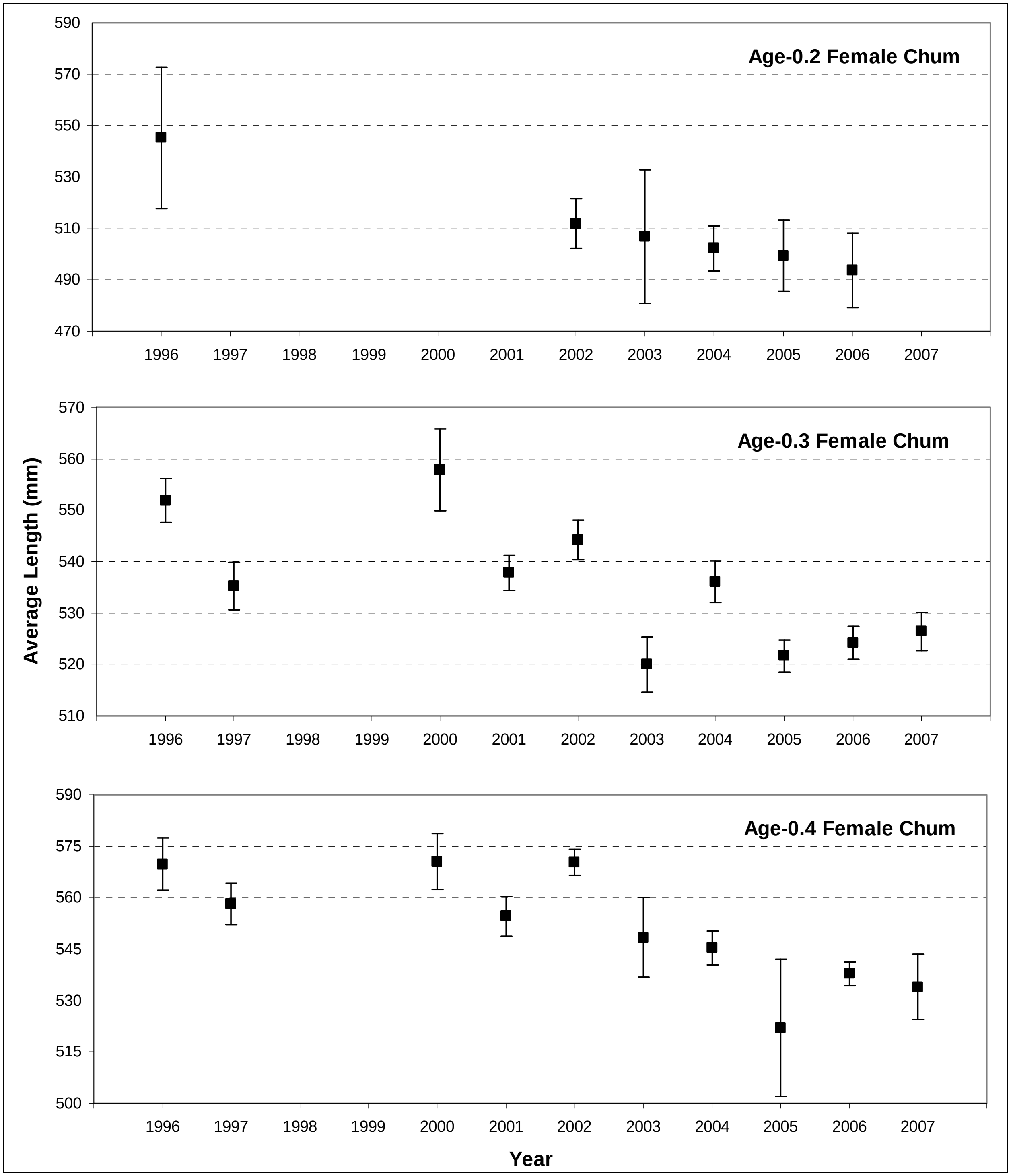


Figure 21.–Average annual length of common age classes of female chum salmon at the George River weir with 95% confidence intervals.

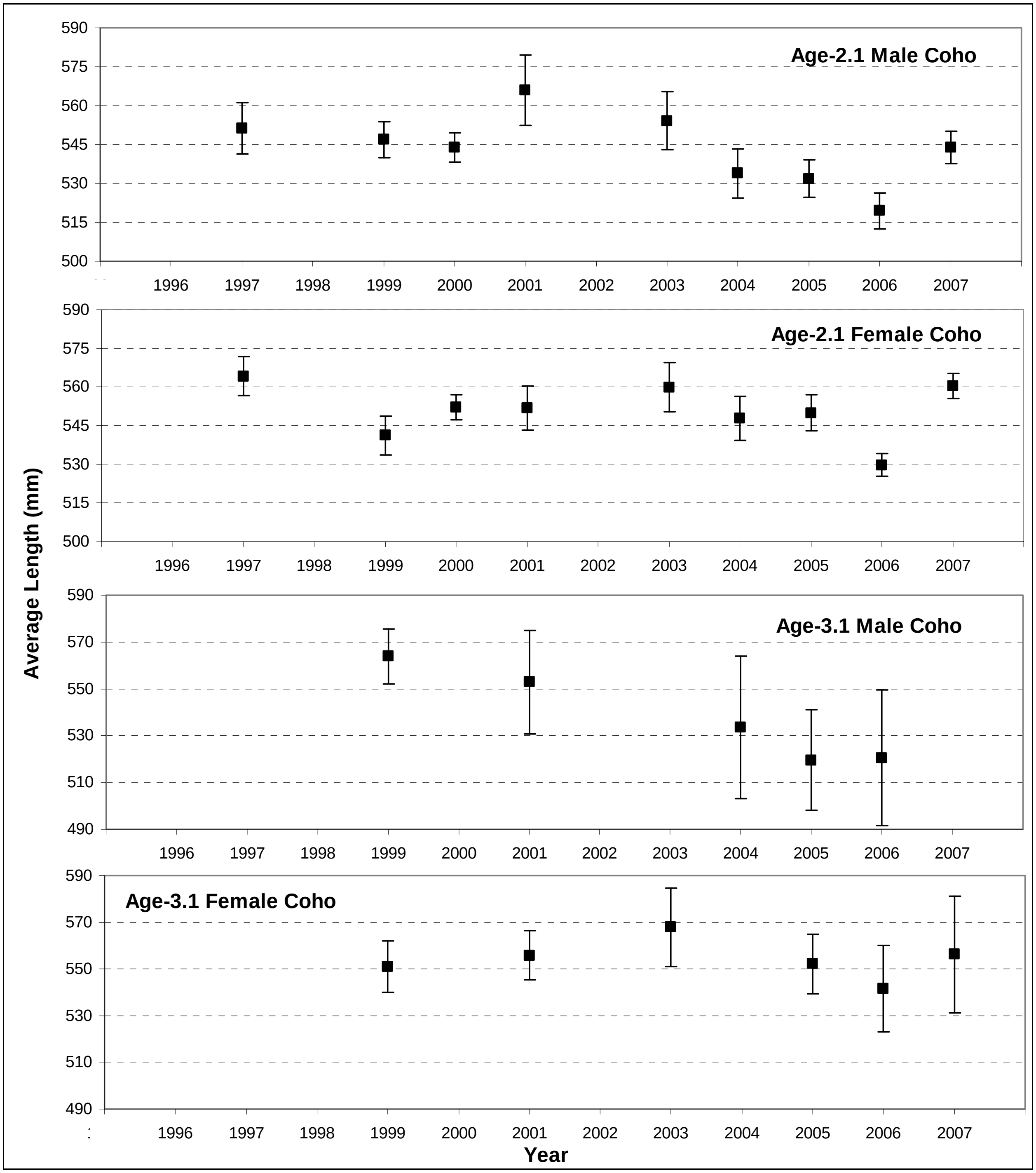


Figure 22.–Average annual length of common coho salmon age/sex categories at the George River weir with 95% confidence intervals.

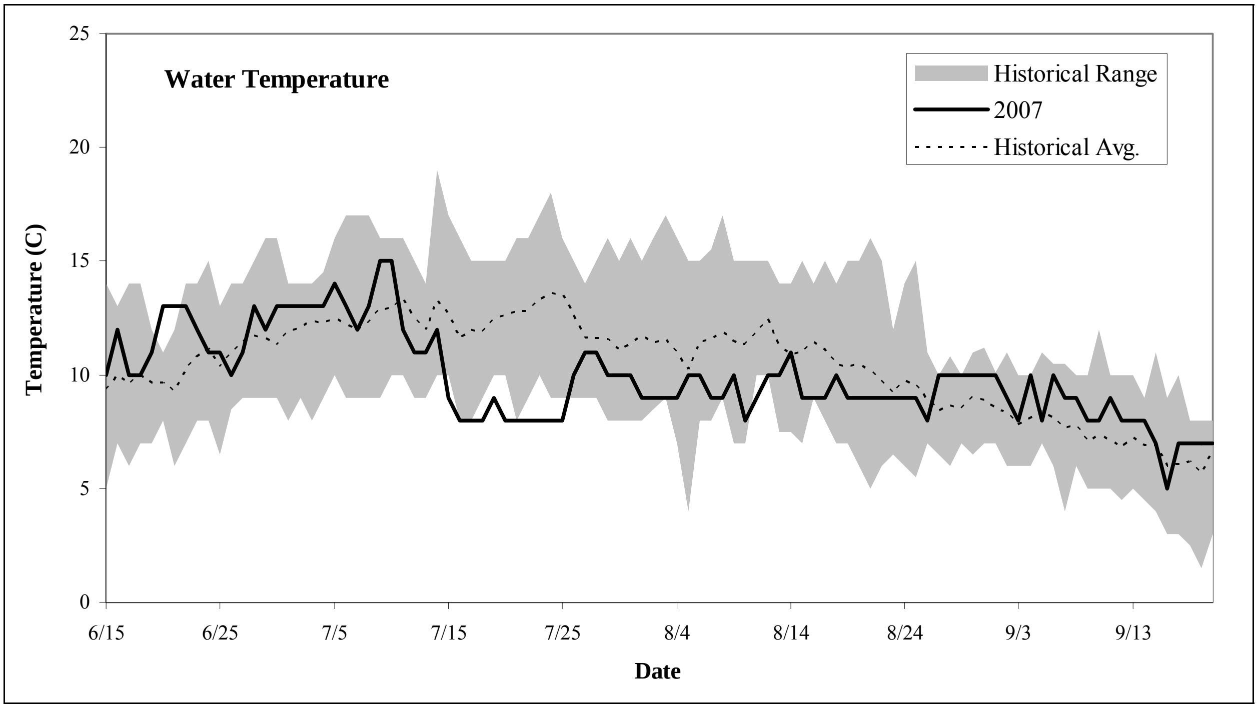


Figure 23.–Daily morning water temperature at the George River weir in 2007 (bold line) relative to the historical average (dotted line) and the historical (1996–2006) range.

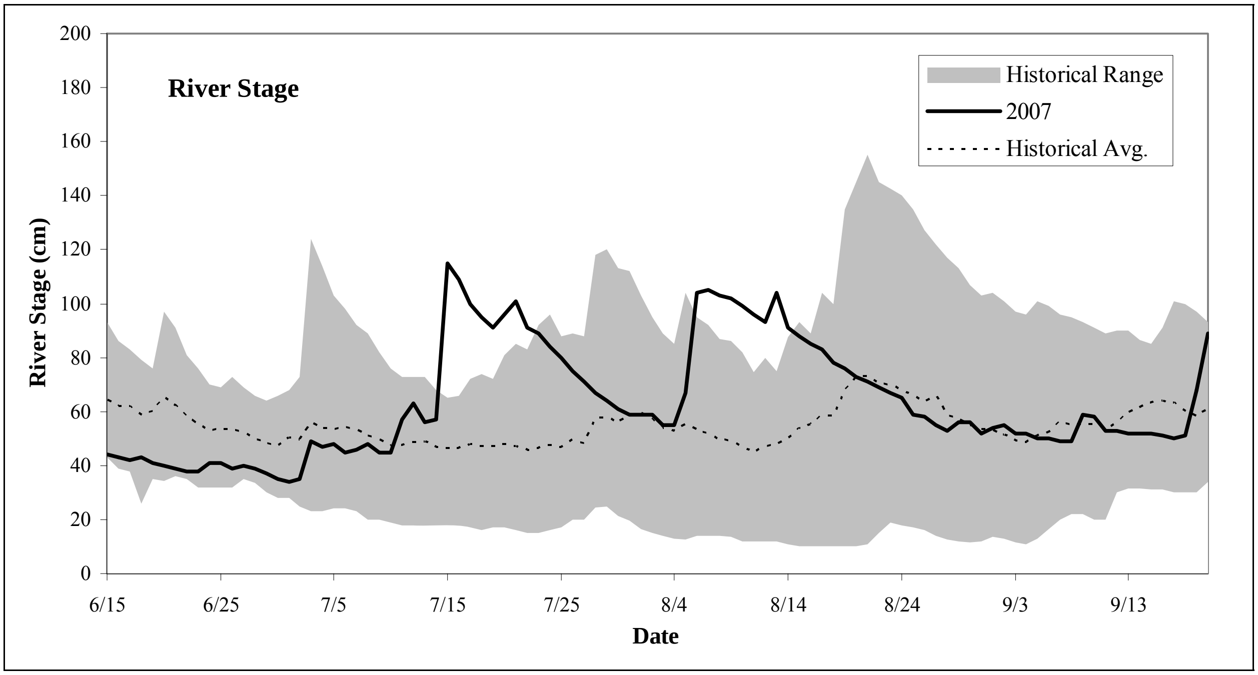
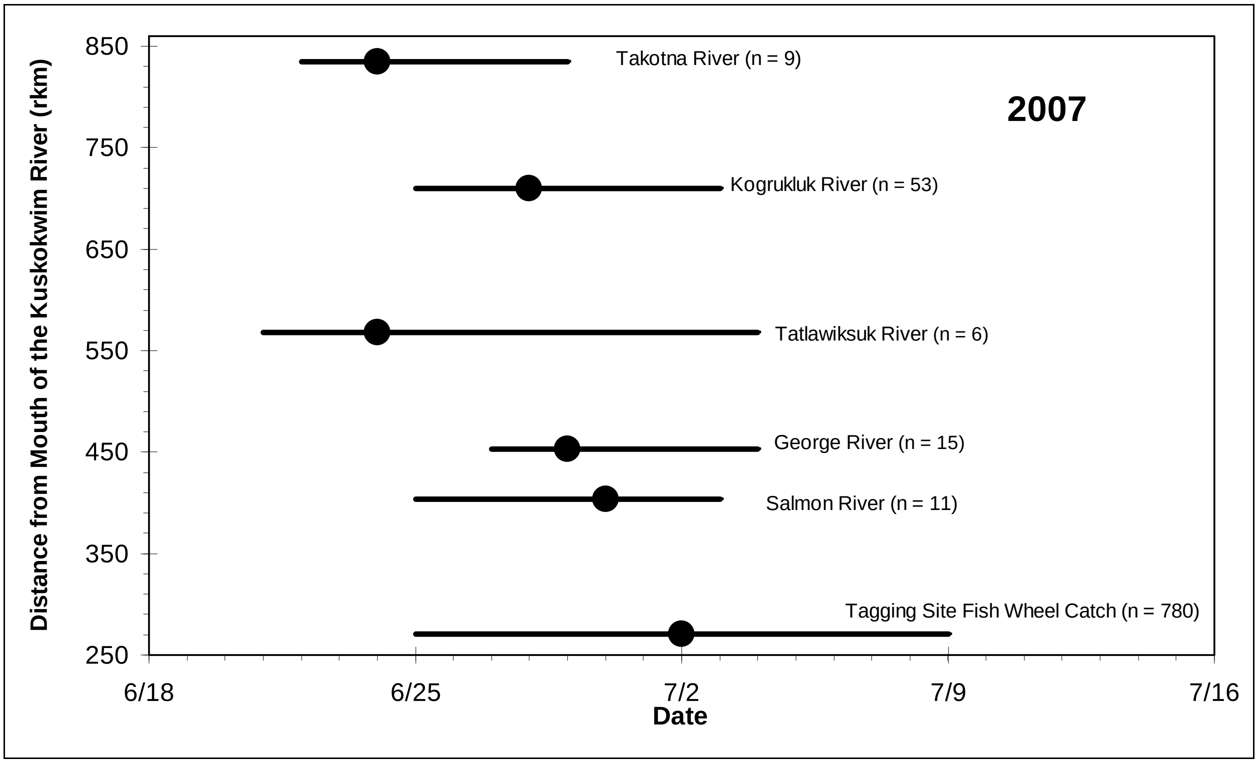
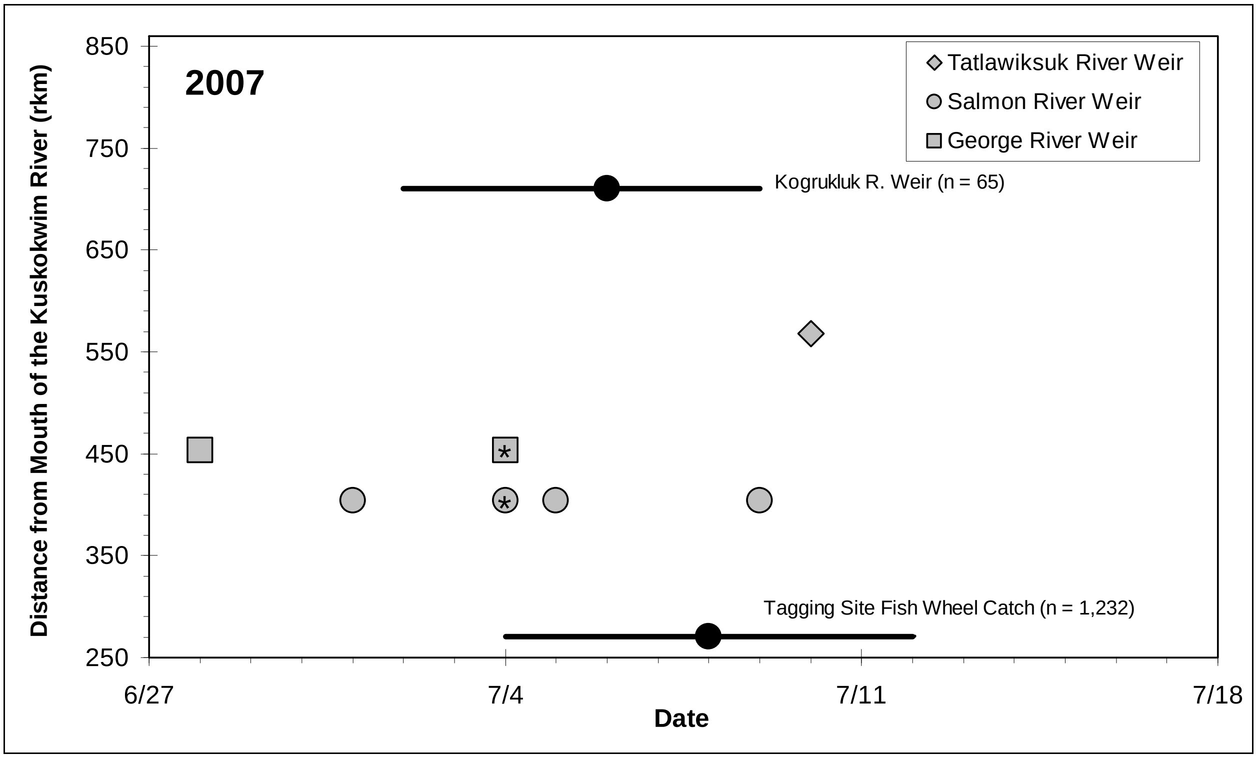


Figure 24.–Daily morning river stage at the George River weir in 2007 (bold line) relative to the historical average (dotted line) and the historical (2000–2006) range.



Note: Horizontal lines represent the central 50% and circles represent the median passage date. Results are confounded by inconsistent weir operational dates (resulting from high water levels) that affected tag recovery success.

Figure 25.–Date ranges when individual Chinook salmon stocks passed through the Kalskag tagging sites (rkm 271) in 2007 based on anchor- and radio-tagging efforts.

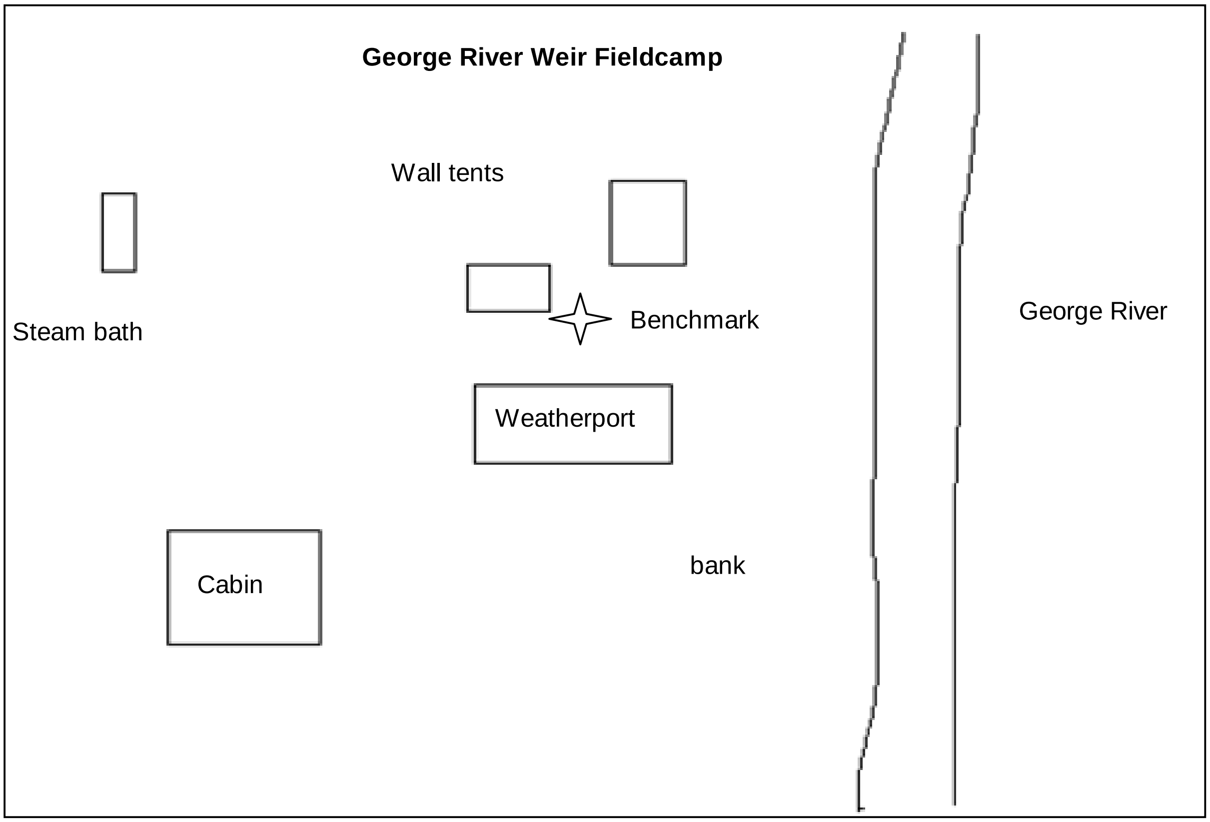


Note: Horizontal lines represent the central 50% and circles represent the median passage date. Results are confounded by inconsistent weir operational dates (resulting from high water levels) that affected tag recovery success. An asterisk (*) denotes 2 fish.

Figure 26.–Date ranges when individual sockeye salmon stocks passed through the Kalskag tagging sites (rkm 271) in 2007 based on anchor- and radio-tagging efforts.

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 5X8 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 bank 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 the George River weir in 2007 excluding estimates calculated for inoperable days.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Sucker	Arctic Grayling	Other[a]
6/14[b]	0[c]	0[c]	0[c]	0[c]	0[c]	73[c]	2[c]	0[c]
6/15	0	0	0	0	0	86	23	0
6/16	0	0	1	0	0	22	11	0
6/17	0	0	0	0	0	19	2	0
6/18	0	0	0	0	0	25	12	0
6/19	0	0	3	0	0	572	28	0
6/20	1	0	2	0	0	305	213	0
6/21	0	0	0	0	0	58	48	0
6/22	0	0	1	0	0	6	67	0
6/23	1	0	19	0	0	45	6	0
6/24	1	0	21	0	0	7	18	0
6/25	0	0	6	0	0	2	2	0
6/26	0	0	15	0	0	1	3	0
6/27	10	0	176	0	0	325	7	1 P
6/28	0	0	69	0	0	41	0	0
6/29	36	0	162	0	0	79	0	0
6/30	61	0	358	0	0	104	2	0
7/1	13	0	241	0	0	95	0	0
7/2	81	0	527	0	0	250	2	0
7/3	79	0	537	0	0	373	2	0
7/4	119	0	982	0	0	182	0	0
7/5	93	0	904	2	0	173	0	0
7/6	450	0	1,515	0	0	434	1	0
7/7	464	0	1,007	1	0	79	1	0
7/8	915	0	3,011	1	0	134	0	0
7/9	445	0	2,254	1	0	66	0	0
7/10	268	6	1,341	11	0	149	14	0
7/11	183	1	909	1	0	8	0	0
7/12	176	0	1,263	7	0	7	0	0
7/13	90	0	1,366	4	0	16	0	0
7/14	22[c]	0[c]	739[c]	2[c]	0[c]	2[c]	0[c]	0[c]
7/15[b]	ND	ND	ND	ND	ND	ND	ND	ND
7/16[b]	ND	ND	ND	ND	ND	ND	ND	ND
7/17[b]	ND	ND	ND	ND	ND	ND	ND	ND
7/18[b]	ND	ND	ND	ND	ND	ND	ND	ND
7/19	14[c]	0[c]	651[c]	0[c]	0[c]	0[c]	0[c]	0[c]
7/20	5[c]	0[c]	397[c]	0[c]	0[c]	0[c]	0[c]	0[c]
7/21	9[c]	0[c]	377[c]	0[c]	0[c]	0[c]	0[c]	0[c]
7/22	27	0	929	3	5	1	1	0
7/23	152	0	3,164	6	2	0	0	0
7/24	56	2	3,334	13	3	1	0	0
7/25	51	3	3,178	36	10	1	1	0
7/26	22	3	2,401	106	14	1	2	0
7/27	14	2	1,722	21	11	1	0	0
7/28	21	0	1,110	15	3	2	1	0
7/29	11	2	1,176	10	4	0	0	0
7/30	6	2	864	2	7	2	0	0
7/31	4	1	849	10	12	0	0	0
8/1	6	3	838	2	28	0	0	0
8/2	13	1	770	4	39	0	0	0
8/3	11	7	721	8	45	0	0	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]
8/4	8	4	546	2	81	0	0	0
8/5	25	0	598	1	383	0	0	0
8/6[b]	ND	ND	ND	ND	ND	ND	ND	ND
8/7[b]	ND	ND	ND	ND	ND	ND	ND	ND
8/8	0[c]	0[c]	12[c]	0[c]	0[c]	0[c]	0[c]	0[c]
8/9	0	0	28	0	9	0	0	0
8/10	11	0	524	2	308	0	0	0
8/11	7	5	352	0	144	0	0	0
8/12	6	4	275	0	333	0	0	0
8/13	0	4	104	1	945	0	0	0
8/14	7	5	250	4	2,219	0	0	0
8/15	1	3	85	1	196	0	0	0
8/16	6	0	116	2	421	0	0	0
8/17	1	3	92	2	593	2	0	0
8/18	3	2	97	1	1,363	3	0	0
8/19	2	0	67	0	697	0	0	0
8/20	0	0	65	0	1,241	0	0	0
8/21	1	0	25	0	1,035	0	0	0
8/22	1	0	41	0	1,331	0	0	0
8/23	1	0	32	0	1,118	0	0	0
8/24	0	0	24	1	990	2	0	0
8/25	0	0	16	0	1,802	4	0	0
8/26	0	0	15	0	924	0	0	0
8/27	0	0	16	0	2,128	1	0	0
8/28	0	0	21	0	1,489	1	0	5 W
8/29	0	0	11	0	2,099	9	0	2 W
8/30	0	0	4	0	1,023	4	8	4 W
8/31	0	0	10	0	339	4	2	2 W
9/1	0	1	4	0	488	0	0	0
9/2	0	1	4	0	148	0	6	6 W
9/3	0	0	7	0	173	3	3	1 W
9/4	0	0	4	0	726	9	0	2 W
9/5	0	0	4	0	452	1	1	7 W
9/6	0	0	2	0	249	4	4	4 W
9/7	0	0	4	0	316	4	0	0
9/8	0	0	6	0	722	0	0	3 W
9/9	0	0	6	0	548	5	3	4 W
9/10	0	0	8	0	69	2	4	0
9/11	0	0	2	0	95	2	0	0
9/12	0	0	6	0	164	4	0	1 W
9/13	0	0	21	1	163	2	2	0
9/14	0	0	8	0	163	0	1	0
9/15	0	0	7	0	35	0	1	2 W
9/16	0	0	2	0	7	0	0	2 W
9/17	0	0	1	0	45	0	0	2 W
9/18[d]	ND	ND	ND	ND	ND	ND	ND	ND
9/19[d]	ND	ND	ND	ND	ND	ND	ND	ND
9/20[d]	ND	ND	ND	ND	ND	ND	ND	ND

[a] P = Northern pike and W = whitefish; count may not correspond to actual day observed.
[b] The weir was inoperable for all or part of a day.
[c] Incomplete or partial day count.
[d] Seasonal weir operation was terminated early.

APPENDIX C: DAILY CARCASS COUNTS

Appendix C1.–Daily carcass counts at the George River weir in 2007.

	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0
6/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
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	0	0	0
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
6/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
7/1	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	0	1 G
7/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1 G
7/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2 P
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/5	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	7	0	1 G
7/6	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2	0	1 P
7/7	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	3	0	0
7/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/9	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	2	2	1 P
7/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0	0	12	1	13	0	0	0	0	0	0	19	0	1 P
7/12	0	0	0	0	0	0	13	7	20	0	0	0	0	0	0	22	0	0
7/13	0	0	0	0	0	0	8	4	12	0	0	0	0	0	0	12	0	0
7/14 [b]	0	0	0	0	0	0	11	5	16	0	0	0	0	0	0	1	0	0
7/15 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/16 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/17 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/18 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND

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Date	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
7/19 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/20 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
7/21 [b]	0	0	0	0	0	0	6	2	8	0	0	0	0	0	0	12	0	0
7/22	0	0	0	0	0	0	13	2	15	0	0	0	0	0	0	1	0	0
7/23	0	0	0	0	0	0	13	2	15	0	0	0	0	0	0	12	0	0
7/24	0	0	0	0	0	0	23	8	31	0	0	0	0	0	0	0	0	0
7/25	0	0	0	0	0	0	32	2	34	0	0	0	0	0	0	0	0	0
7/26	0	0	0	0	0	0	40	6	46	0	0	0	0	0	0	8	1	1 G
7/27	0	0	0	0	0	0	40	7	47	0	0	0	0	0	0	7	1	0
7/28	0	0	0	0	0	0	31	14	45	1	1	2	0	0	0	2	1	0
7/29	0	0	0	1	0	1	32	12	44	0	0	0	0	0	0	0	0	0
7/30	2	0	2	0	0	0	22	5	27	0	0	0	0	0	0	3	3	0
7/31	0	0	0	0	0	0	28	12	40	2	2	4	0	0	0	2	1	0
8/1	1	0	1	2	0	2	36	7	43	0	0	0	0	0	0	4	0	0
8/2	14	2	16	0	0	0	40	9	49	6	0	6	0	0	0	3	2	1 P
8/3	13	2	15	0	0	0	49	8	57	1	0	1	0	0	0	1	0	1 G
8/4	15	2	17	0	0	0	63	15	78	2	0	2	0	0	0	3	4	1 P
8/5	15	2	17	0	0	0	91	33	124	3	0	3	0	0	0	4	1	0
8/6 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
8/7 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
8/8 [c]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
8/9	5	4	9	0	0	0	28	17	45	2	0	2	0	0	0	6	0	0
8/10	5	4	9	0	0	0	42	38	80	3	0	3	0	0	0	15	0	0
8/11	16	12	28	0	0	0	43	35	78	1	1	2	0	0	0	6	0	1 P
8/12	20	14	34	0	0	0	59	38	97	3	1	4	0	0	0	8	0	0
8/13	7	4	11	0	0	0	25	20	45	1	0	1	0	0	0	13	0	0
8/14	12	7	19	0	0	0	34	32	66	1	0	1	0	0	0	0	0	0
8/15	10	3	13	0	0	0	34	33	67	3	0	3	0	0	0	0	0	0
8/16	22	1	23	0	0	0	42	34	76	2	0	2	0	0	0	5	0	0
8/17	31	0	31	0	0	0	50	35	85	4	0	4	0	0	0	6	0	0
8/18	15	10	25	0	0	0	54	48	102	2	1	3	0	0	0	6	1	0
8/19	11	7	18	0	0	0	61	44	105	2	1	3	0	0	0	2	1	0
8/20	13	1	14	0	0	0	54	30	84	4	0	4	0	0	0	4	0	0
8/21 [d]	8	1	9	0	0	0	48	22	70	1	1	2	0	0	0	25	6	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]	9	2	11	0	0	0	46	25	71	1	0	1	0	0	0	1	0	1 P
8/23 [d]	3	0	3	0	0	0	21	16	37	1	0	1	0	0	0	2	0	0
8/24 [d]	2	4	6	0	0	0	23	17	40	0	0	0	0	0	0	1	0	0
8/25 [d]	0	0	0	0	0	0	24	4	28	0	5	5	0	0	0	1	0	0
8/26 [d]	0	2	2	0	0	0	13	7	20	0	0	0	0	0	0	2	1	0
8/27 [d]	0	1	1	1	0	1	11	15	26	0	0	0	0	0	0	2	1	0
8/28 [d]	1	0	1	0	0	0	13	1	14	0	1	1	0	0	0	1	0	0
8/29 [d]	0	1	1	0	0	0	5	7	12	0	0	0	0	0	0	1	1	1 P
8/30 [d]	0	0	0	0	0	0	5	4	9	0	0	0	0	0	0	0	0	0
8/31 [d]	0	0	0	1	0	1	5	5	10	0	0	0	0	0	0	2	0	0
9/1 [d]	0	0	0	1	0	1	3	3	6	0	0	0	0	0	0	0	0	0
9/2 [d]	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	5	0	0
9/3 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/4 [d]	0	0	0	0	0	0	1	4	5	0	0	0	0	0	0	0	0	0
9/5 [d]	0	0	0	1	0	1	6	4	10	0	0	0	0	0	0	1	0	0
9/6 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/7 [d]	0	0	0	0	0	0	2	0	2	0	1	1	0	0	0	0	0	0
9/8 [d]	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3	2	0
9/9 [d]	0	0	0	0	0	0	1	3	4	0	0	0	0	1	1	0	0	1 P
9/10 [d]	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0
9/11 [d]	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	0
9/12 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/13 [d]	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
9/14 [d]	0	0	0	0	0	0	2	1	3	0	0	0	0	0	0	0	1	1 B
9/15 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
9/16 [d]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/17 [d]	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	5	2	0
9/18 [e]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
9/19 [e]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND
9/20 [e]	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	--	ND	ND	ND

[a] B = burbot; G = Arctic Grayling; P = Northern pike
[b] Partial day count.
[c] Weir was inoperable due to a high water event.
[d] Downstream passage chutes installed; counts are incomplete.
[e] Seasonal weir operations were terminated early.

APPENDIX D: WEATHER AND STREAM OBSERVATIONS

Appendix D1.–Daily weather and stream observations at the George River weir in 2007.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/15	7:30	1	0.0	9	10	44	1
	17:00	1	0.0	15	13	44	1
6/16	10:00	4	0.0	11	12	43	1
6/17	10:00	3	5.5	9	10	42	1
	17:00	4	0.0	15	11	42	1
6/18	10:00	4	0.0	11	10	43	1
	17:00	3	0.0	16	12	43	1
6/19	7:30	3	0.5	10	11	41	1
	17:00	2	0.0	23	15	41	1
6/20	7:30	4	0.0	14	13	40	1
	17:00	4	0.0	22	16	40	1
6/21	7:30	3	0.0	10	13	39	1
	17:00	3	0.0	18	15	39	1
6/22	7:30	4	1.5	10	13	38	1
	17:00	3	0.0	14	13	38	1
6/23	10:00	4	4.7	11	12	38	1
	17:00	4	0.5	12	12	38	1
6/24	10:00	4	0.0	11	11	41	1
	17:00	3	0.0	15	13	42	1
6/25	7:30	4	0.5	9	11	41	1
	17:00	4	0.5	14	12	40	1
6/26	7:30	4	0.0	10	10	39	1
	17:00	3	0.1	16	12	39	1
6/27	7:30	5	0.7	10	11	40	1
	17:00	3	0.0	20	15	39	1
6/28	7:30	4	0.0	10	13	39	1
	17:00	4	0.0	15	12	38	1
6/29	7:30	3	0.0	11	12	37	1
	17:00	4	0.0	19	14	37	1
6/30	10:00	4	0.0	14	13	35	1
	17:00	3	0.0	19	15	34	1
7/1	10:00	3	0.1	14	13	34	1
	17:00	4	0.0	16	14	34	1
7/2	7:30	5	8.0	13	13	35	1
	17:00	3	0.0	19	14	39	1
7/3	7:30	4	0.0	14	13	49	1
	17:00	3	0.0	25	15	50	1
7/4	7:30	3	4.8	14	13	47	2
	17:00	3	0.4	24	16	46	2
7/5	7:30	3	0.0	14	14	48	2
7/6	7:30	4	0.1	15	13	45	2
	17:00	4	0.0	18	13	42	2
7/7	7:30	3	2.0	16	12	46	2
	17:00	2	0.0	22	14	47	2
7/8	10:00	1	0.0	18	13	48	2
	17:00	1	0.0	24	14	47	2
7/9	7:30	4	2.0	13	15	45	1
	17:00	2	0.0	22	16	45	1
7/10	7:30	4	0.0	13	15	45	1
	17:00	4	0.0	20	15	44	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/11	7:30	4	12.5	13	12	57	3
	17:00	4	9.0	15	11	60	3
7/12	7:30	4	0.1	10	11	63	3
	17:00	3	0.0	20	12	60	2
7/13	7:30	4	0.0	10	11	56	2
	17:00	3	0.0	19	14	54	2
7/14	7:30	4	21.0	12	12	57	2
	17:00	4	6.0	14	12	72	3
7/15	7:30	4	9.0	10	9	115	3
	17:00	4	0.0	15	9	120	3
7/16	7:30	4	0.0	10	8	109	3
	17:00	3	0.0	11	9	105	3
7/17	7:30	3	0.1	10	8	100	3
	19:00	3	0.3	17	10	97	3
7/18	7:30	5	0.1	9	8	95	3
	17:00	3	0.0	20	10	93	3
7/19	7:30	5	4.8	9	9	91	2
	17:00	4	7.5	17	9	91	2
7/20	7:30	4	10.5	10	8	96	2
	17:00	4	1.5	15	9	109	3
7/21	10:00	4	0.0	8	8	101	3
	17:00	4	0.0	13	9	97	3
7/22	10:00	4	4.0	10	8	91	3
	17:00	4	0.0	13	8	90	3
7/23	7:30	4	0.5	10	8	89	3
	17:00	4	0.0	15	9	87	2
7/24	7:30	4	0.1	11	8	84	2
	17:00	3	0.0	19	10	82	2
7/25	7:30	5	0.5	9	8	80	2
	17:00	2	0.0	22	11	77	2
7/26	7:30	4	0.0	12	10	75	2
	17:00	3	0.0	24	12	73	2
7/27	7:30	4	0.0	15	11	71	1
7/28	10:00	4	0.0	14	11	67	1
	17:00	4	0.0	17	12	66	1
7/29	10:00	4	0.0	12	10	64	1
	17:00	4	0.0	17	11	61	1
7/30	7:00	4	1.5	12	10	61	1
	17:00	4	0.0	15	10	59	1
7/31	7:00	4	0.0	11	10	59	1
	17:00	4	1.5	14	10	58	1
8/1	7:00	4	2.0	12	9	59	1
	17:00	4	0.0	13	10	59	1
8/2	7:30	4	0.6	11	9	59	1
	19:00	4	0.1	13	10	58	1
8/3	7:30	4	0.5	12	9	55	1
	17:00	4	0.0	15	10	56	1
8/4	7:30	4	1.2	12	9	55	1
	17:00	4	3.0	14	10	55	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/5	10:00	3	14.5	15	10	67	1
	17:00	4	2.2	17	10	82	2
8/6	7:30	4	2.5	10	10	104	3
	17:00	3	0.0	15	10	106	3
8/7	7:30	3	0.2	10	9	105	3
	17:00	4	0.0	16	9	104	3
8/8	7:30	4	0.0	13	9	103	3
	17:00	3	0.0	19	10	103	3
8/9	7:30	5	0.0	9	10	102	3
	17:00	1	0.0	23	13	100	3
8/10	7:30	1	0.0	3	8	99	3
	17:00	1	0.0	23	14	97	3
8/11	10:00	1	0.0	10	9	96	3
	17:00	4	0.0	20	10	95	3
8/12	10:00	4	14.0	15	10	93	3
	17:00	3	0.5	26	13	96	3
8/13	7:30	5	0.5	10	10	104	3
	17:00	2	0.0	25	12	99	3
8/14	7:30	2	6.0	10	11	91	3
	17:00	4	0.3	15	11	89	2
8/15	7:30	4	0.3	10	9	88	2
	17:00	4	0.0	15	10	87	2
8/16	7:30	5	0.5	11	9	85	2
	17:00	2	0.0	19	10	84	2
8/17	7:30	5	0.0	7	9	83	2
	17:00	1	0.0	24	12	82	2
8/18	7:30	1	0.3	12	10	78	2
	17:00	4	0.0	19	11	77	1
8/19	10:00	4	0.2	13	9	76	1
8/20	7:30	4	0.2	10	9	73	1
	17:00	4	0.2	18	10	73	1
8/21	7:30	3	0.0	8	9	71	1
8/22	7:30	4	0.8	9	9	69	1
	17:00	4	0.1	14	10	68	1
8/23	7:30	5	0.0	8	9	67	1
	17:00	3	0.0	19	10	66	1
8/24	7:30	1	0.0	5	9	65	1
	17:00	2	0.0	22	10	60	1
8/25	7:30	4	6.1	10	9	59	1
	17:00	3	0.0	21	11	59	1
8/26	9:30	5	0.0	7	8	58	1
	17:00	3	0.2	20	10	57	1
8/27	10:00	1	2.0	13	10	55	1
	16:00	3	0.0	23	13	54	1
8/28	9:00	4	8.0	10	10	53	1
	16:00	3	0.0	18	13	52	1
8/29	9:30	4	0.0	13	10	56	1
	17:00	4	0.0	11	11	60	1
8/30	9:30	4	0.0	11	10	56	1
	17:00	4	0.0	16	11	55	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[b]
8/31	9:00	4	0.8	13	10	52	1
	16:00	4	0.0	11	11	52	1
9/1	10:00	4	0.0	13	10	54	1
	17:00	4	0.0	14	10	56	1
9/2	10:00	4	0.0	9	9	55	1
	17:00	3	2.2	14	9	54	1
9/3	10:00	4	0.5	8	8	52	1
	17:00	4	1.3	13	10	52	1
9/4	10:00	3	0.2	11	10	52	1
	17:00	1	0.0	20	11	52	1
9/5	10:00	1	0.0	10	8	50	1
9/6	10:00	4	0.0	8	10	50	1
	17:00	4	0.0	15	10	50	1
9/7	10:00	3	0.3	11	9	49	1
	17:00	4	0.0	15	10	49	1
9/8	10:00	4	8.5	12	9	49	1
	17:00	3	0.9	13	10	50	1
9/9	10:00	4	0.3	13	8	59	1
	17:00	3	0.6	12	10	60	1
9/10	10:00	1	1.4	9	8	58	1
	17:00	4	0.0	12	10	56	1
9/11	10:00	4	0.3	12	9	53	1
	17:00	4	0.0	10	8	53	1
9/12	10:00	1	0.8	8	8	53	1
	17:00	4	0.0	13	9	53	1
9/13	10:00	4	1.8	8	8	52	1
	17:00	4	1.0	10	8	52	1
9/14	10:00	4	0.4	7	8	52	1
	17:00	3	0.2	11	8	53	1
9/15	10:00	4	0.0	5	7	52	1
	17:00	3	1.2	9	8	52	1
9/16	10:00	5	2.0	4	5	51	1
	17:00	3	0.3	11	7	51	1
9/17	10:00	4	6.2	6	7	50	1
	17:00	4	1.9	11	7	49	1
9/18	10:00	4	2.4	9	7	51	1
	17:00	4	5.8	11	7	54	1
9/19	10:00	4	5.1	9	7	68	2
	17:00	3	1.2	12	7	80	3
9/20	10:00	4	0.1	9	7	89	3
	17:00	4	2.2	11	7	91	3

[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 the George River weir from hourly readings logged by Hobo® Water Temp Pro tethered to the stream bottom, 2007.

Location: George River Weir — **Date:** 7/16/07

Description: 50 meters upstream from weir — **Time:** 22:30

Crew: R. Stewart, P. Branson, C. John — **River Stage:** 103.5 cm

Comments: Weir is mostly sunk, top of trap is a few cm above surface. 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					
5	1.20	0.48	51	40.3	0.846	0.42	0.60	5.00	3.00	1.27
10	1.45	0.58	51	40.5	0.842	0.84	1.33	5.00	6.63	5.59
15	1.50	0.60	59	40.5	0.973	0.91	1.48	5.00	7.38	6.69
20	1.60	0.64	68	40.0	1.130	1.05	1.55	5.00	7.75	8.15
25	1.72	0.69	67	40.0	1.120	1.13	1.66	5.00	8.30	9.34
30	1.79	0.72	69	40.5	1.140	1.13	1.76	5.00	8.78	9.92
35	1.80	0.72	64	40.4	1.060	1.10	1.80	5.00	8.98	9.87
40	1.75	0.70	72	40.6	1.170	1.12	1.78	5.00	8.88	9.90
45	1.75	0.70	69	40.5	1.140	1.16	1.75	5.00	8.75	10.11
50	1.70	0.68	76	40.1	1.260	1.20	1.73	5.00	8.63	10.35
55	1.61	0.64	73	40.0	1.210	1.24	1.66	5.00	8.28	10.22
60	1.55	0.62	66	40.4	1.090	1.15	1.58	5.00	7.90	9.09
65	1.48	0.59	69	40.2	1.130	1.11	1.52	5.00	7.58	8.41
70	1.42	0.57	62	40.4	1.010	1.07	1.45	5.00	7.25	7.76
75	1.35	0.54	60	40.2	0.994	1.00	1.39	5.00	6.93	6.94
80	1.28	0.51	59	40.2	0.980	0.99	1.32	5.00	6.58	6.49
85	1.25	0.50	50	40.3	0.830	0.91	1.27	5.00	6.33	5.72
90	1.15	0.46	48	40.0	0.803	0.82	1.20	5.00	6.00	4.90
95	1.10	0.44	43	40.5	0.711	0.76	1.13	5.00	5.63	4.26
100	0.89	0.36	37	40.6	0.610	0.66	1.00	5.00	4.98	3.29
103	0.86	-	-	-	0.000	0.31	0.88	3.00	2.63	0.80

Avg. Depth: 1.44 m — Avg. Velocity 0.91 m/sec

Max. Depth: 1.80 m — Max. Velocity 1.26 m/sec

Total Discharge: 149.0 m^3/sec

Appendix D3.–Summary of the stream discharge survey conducted at the George River weir on 16 July, 2007.

Location: George River Weir | **Date:** 8/24/07

Description: 50 meters upstream from weir | **Time:** 12:35

Crew: R. Stewart, J. Beaver, A. Thrasher | **River Stage:** 60 cm

Comments: Measured from right bank | **Meter Type:** AA

Station	Stream	Meter	Number of	Duration of	Point	Mean Cell		Cell		
Distance (m)	Depth (m)	Height (m)	Revolutions Measured	Measurment (sec)	Velocity (m/sec)	Velocity (m/sec)	Depth (m)	Width (m)	Area (m^2)	Flow (m^3/sec)
0	0.00	-	-	-	0.000					
2	0.58	0.23	29	41.2	0.474	0.24	0.29	2.00	0.58	0.14
5	0.85	0.34	36	41.1	0.588	0.53	0.72	3.00	2.15	1.14
10	1.04	0.41	43	40.5	0.710	0.65	0.95	5.00	4.73	3.07
15	1.10	0.44	44	40.0	0.737	0.72	1.07	5.00	5.35	3.87
20	1.20	0.48	49	40.7	0.805	0.77	1.15	5.00	5.75	4.43
25	1.30	0.52	50	40.0	0.836	0.82	1.25	5.00	6.25	5.13
30	1.34	0.54	52	40.2	0.865	0.85	1.32	5.00	6.60	5.61
35	1.35	0.54	52	40.7	0.854	0.86	1.35	5.00	6.73	5.78
40	1.35	0.54	52	40.4	0.860	0.86	1.35	5.00	6.75	5.78
45	1.30	0.52	49	40.6	0.807	0.83	1.33	5.00	6.63	5.52
50	1.22	0.49	54	40.5	0.891	0.85	1.26	5.00	6.30	5.35
55	1.16	0.46	50	40.5	0.826	0.86	1.19	5.00	5.95	5.11
60	1.08	0.43	47	40.7	0.773	0.80	1.12	5.00	5.60	4.48
65	1.00	0.40	47	40.5	0.777	0.78	1.04	5.00	5.20	4.03
70	0.96	0.38	44	40.7	0.722	0.75	0.98	5.00	4.90	3.67
75	0.89	0.35	41	40.5	0.679	0.70	0.93	5.00	4.63	3.24
80	0.78	0.31	39	40.4	0.648	0.66	0.84	5.00	4.18	2.77
85	0.70	0.28	46	40.3	0.600	0.62	0.74	5.00	3.70	2.31
90	0.61	0.24	35	41.0	0.572	0.59	0.66	5.00	3.28	1.92
95	0.50	0.20	26	40.0	0.438	0.51	0.56	5.00	2.78	1.40
98	0.46	0.18	25	40.2	0.419	0.43	0.48	3.00	1.44	0.62
100	0.42	-	-	-	0.000	0.21	0.44	2.00	0.88	0.18

Avg. Depth: 0.96 m | Avg. Velocity 0.65 m/sec

Max. Depth: 1.35 m | Max. Velocity 0.89 m/sec

Total Discharge: 75.6 m^3/sec

Appendix D4.–Summary of the stream discharge survey conducted at the George River weir on 24 August, 2007.

Location:	George River Weir	**Date:**	8/24/07
Description:	50 meters upstream from weir	**Time:**	12:35
Crew:	R. Stewart, J. Beaver, A. Thrasher	**River Stage:**	60 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					
2	0.58	0.23	29	41.2	0.474	0.24	0.29	2.00	0.58	0.14
5	0.85	0.34	36	41.1	0.588	0.53	0.72	3.00	2.15	1.14
10	1.04	0.41	43	40.5	0.710	0.65	0.95	5.00	4.73	3.07
15	1.10	0.44	44	40.0	0.737	0.72	1.07	5.00	5.35	3.87
20	1.20	0.48	49	40.7	0.805	0.77	1.15	5.00	5.75	4.43
25	1.30	0.52	50	40.0	0.836	0.82	1.25	5.00	6.25	5.13
30	1.34	0.54	52	40.2	0.865	0.85	1.32	5.00	6.60	5.61
35	1.35	0.54	52	40.7	0.854	0.86	1.35	5.00	6.73	5.78
40	1.35	0.54	52	40.4	0.860	0.86	1.35	5.00	6.75	5.78
45	1.30	0.52	49	40.6	0.807	0.83	1.33	5.00	6.63	5.52
50	1.22	0.49	54	40.5	0.891	0.85	1.26	5.00	6.30	5.35
55	1.16	0.46	50	40.5	0.826	0.86	1.19	5.00	5.95	5.11
60	1.08	0.43	47	40.7	0.773	0.80	1.12	5.00	5.60	4.48
65	1.00	0.40	47	40.5	0.777	0.78	1.04	5.00	5.20	4.03
70	0.96	0.38	44	40.7	0.722	0.75	0.98	5.00	4.90	3.67
75	0.89	0.35	41	40.5	0.679	0.70	0.93	5.00	4.63	3.24
80	0.78	0.31	39	40.4	0.648	0.66	0.84	5.00	4.18	2.77
85	0.70	0.28	46	40.3	0.600	0.62	0.74	5.00	3.70	2.31
90	0.61	0.24	35	41.0	0.572	0.59	0.66	5.00	3.28	1.92
95	0.50	0.20	26	40.0	0.438	0.51	0.56	5.00	2.78	1.40
98	0.46	0.18	25	40.2	0.419	0.43	0.48	3.00	1.44	0.62
100	0.42	-	-	-	0.000	0.21	0.44	2.00	0.88	0.18

Avg. Depth:	0.96 m	Avg. Velocity	0.65 m/sec
Max. Depth:	1.35 m	Max. Velocity	0.89 m/sec

Total Discharge: 75.6 m^3/sec

Appendix D5.–Summary of the stream discharge survey conducted at the George River weir on 24 September, 2007.

Location:	George River Weir	**Date:**	9/24/07
Description:	50 meters upstream from weir site	**Time:**	14:00
Crew:	R. Stewart, J. Durende	**River Stage:**	90 cm
Comments:	Measured from right bank Weir has been removed	**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					
5	1.00	0.40	42	40.0	0.704	0.35	0.50	5.00	2.50	0.88
10	1.25	0.50	60	40.2	0.994	0.85	1.13	5.00	5.63	4.78
15	1.30	0.52	63	40.0	1.050	1.02	1.28	5.00	6.38	6.52
20	1.38	0.55	66	40.5	1.090	1.07	1.34	5.00	6.70	7.17
25	1.48	0.59	66	40.5	1.090	1.09	1.43	5.00	7.15	7.79
30	1.55	0.62	71	40.6	1.170	1.13	1.52	5.00	7.58	8.56
35	1.53	0.61	66	40.6	1.080	1.13	1.54	5.00	7.70	8.66
40	1.56	0.62	69	40.2	1.130	1.11	1.55	5.00	7.73	8.54
45	1.52	0.61	73	40.0	1.220	1.18	1.54	5.00	7.70	9.05
50	1.45	0.58	73	40.2	1.210	1.22	1.49	5.00	7.43	9.02
55	1.37	0.55	68	40.2	1.130	1.17	1.41	5.00	7.05	8.25
60	1.30	0.52	65	40.5	1.070	1.10	1.34	5.00	6.68	7.34
65	1.28	0.51	64	40.3	1.060	1.07	1.29	5.00	6.45	6.87
70	1.20	0.48	65	40.5	1.070	1.07	1.24	5.00	6.20	6.60
75	1.11	0.44	62	40.0	1.020	1.05	1.16	5.00	5.78	6.03
80	1.05	0.42	56	40.5	0.924	0.97	1.08	5.00	5.40	5.25
85	0.95	0.38	50	40.0	0.836	0.88	1.00	5.00	5.00	4.40
90	0.94	0.38	50	40.6	0.824	0.83	0.95	5.00	4.73	3.92
95	0.84	0.34	45	40.5	0.744	0.78	0.89	5.00	4.45	3.49
100	0.62	0.25	34	40.4	0.565	0.65	0.73	5.00	3.65	2.39
103	0.57	-	-	-	0.000	0.28	0.60	3.00	1.79	0.50

Avg. Depth:	1.20 m	Avg. Velocity	0.91 m/sec
Max. Depth:	1.56 m	Max. Velocity	1.22 m/sec

Total Discharge: 126.0 m^3/sec

APPENDIX E: GEORGE RIVER BROOD TABLES

Appendix E1.–Ad hoc 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	ND	-	-
2001	3,309	27	409	1,230	1,089	ND	ND	-	-
2002	2,444	0	1,087	1,085	ND	ND	ND	-	-
2003	4,693 [b]	7	2,621	ND	ND	ND	ND	-	-
2004	5,207	0	ND	ND	ND	ND	ND	-	-
2005	3,845	ND	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

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

Appendix E2.–Ad hoc 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	ND	-	-
2003	33,666	1,463	45,091	ND	ND	-	-
2004	14,411	985	ND	ND	ND	-	-
2005	14,828	ND	ND	ND	ND	ND	ND
2006	41,467	ND	ND	ND	ND	ND	ND
2007	55,843	ND	ND	ND	ND	ND	ND

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

Appendix E3.–Ad hoc 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	ND	-	-
2004	13,248	548	ND	ND	-	-
2005	8,200	ND	ND	ND	ND	ND
2006	11,296	ND	ND	ND	ND	ND
2007	29,317	ND	ND	ND	ND	ND

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