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Tatlawiksuk River Salmon Studies, 2010

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USFWS Office of Subsistence Management
Fisheries Resource Monitoring Program

by

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

FISHERY DATA SERIES NO. 11-47

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ABSTRACT

The Tatlawiksuk River is a major tributary of the Kuskokwim River and produces Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, and coho salmon *O. kisutch*, which contribute to subsistence and commercial salmon fisheries of the Kuskokwim River. The Tatlawiksuk River weir has operated since 1998 to estimate the return and age-sex-length compositions of salmon escapements, monitor environmental variables, and facilitate other Kuskokwim Area fisheries projects. In 2010, a resistance board weir was operated from 17 June to 17 September to estimate escapements of 3 species of Pacific salmon. Chinook escapement (562 fish) was below the historical median, chum escapement (36,701 fish) was above the historical median, and coho salmon escapement (3,520 fish) was below the historical median. Samples were collected from fish caught in a live trap and used to describe the age and sex structure of the Chinook, chum, and coho salmon escapements. Age and sex sampling in 2010 indicated the Chinook salmon escapement consisted of 43.2% age-1.3, 29.4% age-1.2, 23.3% age-1.4, 2.0% age-1.5, 1.1% age-2.4, and 1.0% age 1.1 fish with 39.4% female fish overall. The chum salmon escapement consisted of 82.7% age-0.3, 8.9% age-0.2, 7.9% age- 0.4, and 0.5% age-0.5 fish. The coho salmon escapement consisted of 90.4% age-2.1, 5.0% age-3.1, and 4.6% age- 1.1 fish.

The Tatlawiksuk River weir is one of several components which form an integrated array of escapement monitoring projects in the Kuskokwim Area. This array of projects provides a means to monitor and assess escapement trends that must be considered in harvest management.

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

INTRODUCTION

The Kuskokwim River is the second largest river in Alaska, draining an area of approximately 130,000 km^2, or 11% of the total area of Alaska (Figure 1). Each year mature salmon *Oncorhynchus* spp. return to the river to spawn, supporting an annual average subsistence and commercial harvest of nearly one million salmon. The subsistence salmon fishery in the Kuskokwim Area is one of the largest and most important in the state and remains a fundamental component of local culture. The commercial salmon fishery, though modest in value compared to other areas of Alaska, has been an important component of the market economy of lower Kuskokwim River communities. Salmon that contribute to these fisheries spawn and rear in nearly every tributary of the Kuskokwim River basin (Brown 1983; Buklis 1999; Coffing 1991; Coffing et al. 2001; Bavilla et al. 2010).

Since 1960, management of Kuskokwim River subsistence, commercial, and sport fisheries has been the responsibility of the Alaska Department of Fish and Game (ADF&G), though other agencies contribute to the decision making process. Management authority for the subsistence fishery was broadened in October 1999 to include the federal government under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA). The U.S. Fish and Wildlife Service (USFWS) is the federal agency most involved within the Kuskokwim Area and tribal groups such as the Kuskokwim Native Association (KNA) are charged by their constituency to actively promote a healthy and sustainable subsistence salmon fishery. These and other groups have combined their resources to develop projects such as the Tatlawiksuk River weir to better achieve the common goal of providing for sustainable salmon fisheries in the Kuskokwim River.

In the State of Alaska, the goal of salmon management is to provide for sustainable fisheries by ensuring that adequate numbers of salmon escape to the spawning grounds each year in accordance with the State of Alaska's *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222). Achievement of this goal requires an array of long-term escapement monitoring projects that 1) reliably measure annual escapement to key spawning systems, and 2) track temporal and spatial patterns in abundance which influence management decisions. Over time and with sufficient data, escapement goals can be developed as a means to gauge escapement adequacy, but current spawner-recruit models for escapement goal development require many years of data. For much of ADF&G management history in the Kuskokwim Area, escapement monitoring has been limited to aerial surveys and 2 ground-based escapement monitoring projects.

With dozens of tributaries known to support spawning populations of salmon, the presence of escapement monitoring projects on 2 tributaries was not adequate with respect to the entire Kuskokwim River basin. This deficiency was addressed with the establishment of several additional projects in the mid-to-late 1990s, including the Tatlawiksuk River weir in 1998 (Molyneaux and Brannian 2006). The data provided by the current array of projects have much greater utility for fishery managers (Holmes and Burkett 1996; Mundy 1998) and have decreased reliance on aerial stream surveys, which are known to be imprecise (Bavilla et al. 2010). In addition, main-river tagging studies rely on the expanded weir infrastructure to estimate inriver abundance and develop run reconstruction models for Kuskokwim River salmon. Run reconstruction models that result from these studies will be an important tool in answering questions of exploitation, distribution, abundance and travel time for Kuskokwim River salmon and may eventually lead to the development of escapement goals for the entire Kuskokwim River drainage. Such projects have since become deeply integrated components of Kuskokwim River salmon management.

The Tatlawiksuk River weir also serves as a platform for collecting information on habitat variables including water temperature and stream discharge (stage), which may directly or indirectly influence salmon productivity and timing of migrations (Hauer and Hill 1996; Kruse 1998; Quinn 2005). These variables can be affected by human activities (i.e., mining, timber harvesting, man-made impoundments, etc.; NRC 1996) or broader climatic variability (e.g., El Niño and La Niña events).

BACKGROUND

The Tatlawiksuk River is a tributary of the middle Kuskokwim River basin that provides spawning and rearing habitat for Chinook (*O. tshawytscha*), chum (*O. keta*), and coho salmon (*O. kisutch*) (ADF&G 1998) and has a history of subsistence use (Figure 2). According to Elders of nearby communities, Athabaskan groups routinely harvested salmon from the Tatlawiksuk River until the mid-1900s (Andrew Gusty Sr., Resident, Stony River village; personal communication). Periodically during the last 40 years, ADF&G biologists have observed adult salmon in the mainstem Tatlawiksuk River during aerial surveys (Burkey and Salomone 1999; D. J. Schneiderhan, Kuskokwim stream catalog, 1954–1983, Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage).

Salmon escapement monitoring began at the Tatlawiksuk River in 1998 through the joint effort of KNA and ADF&G (Linderman et al. 2002). Operations in 1998 were incomplete and the fixed-panel weir design was replaced with a resistance board weir in 1999, which improved performance. Since then, the Tatlawiksuk River weir has been collecting escapement and age, sex, length (ASL) composition information on Chinook, chum, and coho salmon. Additionally, information on habitat and climatic variables has been collected while the project has also served as a platform for other collaborative research efforts.

Tatlawiksuk River originates in the foothills of the Alaska Range and flows southwesterly for 113 km, draining an area of approximately 2,106 km^2 before joining the Kuskokwim River at river kilometer (rkm) 553 (Figure 1). Throughout most of the river's course, it meanders across wide, flat valleys vegetated with white spruce and scattered birch or aspen. Black spruce is more characteristic in poorly drained areas of the basin and dense stands of willow and alder occur on sand and gravel bars. Unnamed streams that join the Tatlawiksuk River from the southeast and northeast drain extensive bog flats and swampy lowlands in the lower reaches of the basin. The channel gradient of the lower 80 km is approximately 1.5 m per km (Brown 1983).

OBJECTIVES

1. Determine daily and total Chinook, chum, and coho salmon escapements to Tatlawiksuk River from 15 June to 20 September.
2. Estimate the age, sex, and length composition of Chinook, chum, and coho salmon escapements to the Tatlawiksuk River such that 95% confidence intervals of age composition are no wider than ±10% (α=0.05 and d=0.10).
3. Monitor habitat variables including daily water temperature and water level.
4. Serve as a platform to facilitate current and future fisheries research projects by:
    a. Collection of escapement and ASL data for development and maintenance of salmon run reconstruction models and other management tools for the entire Kuskokwim River.
    b. Operating and maintaining four radiotelemetry fixed receiver stations located between Stony River and Vinasale on the mainstem Kuskokwim River for the study *Kuskokwim Chum Tagging Effects*.
    c. Installing and monitoring air and stream thermographs at Tatlawiksuk River weir as part of a broader *Temperature Monitoring* project.
    d. Hosting local area high school students as part of KNA's High School Internship Program.

METHODS

STUDY SITE

In 2010, the Tatlawiksuk River weir site was located approximately 4.5 rkm upstream from the confluence with the mainstem Kuskokwim River, and 557 rkm from the mouth of the Kuskokwim River (Figure 1): the same site that has been utilized for the past 12 years. Salmon spawning in the Tatlawiksuk River downstream of the weir site was assumed to be negligible due to historic observations (Figure 2). At the weir site, the river measured 64 m wide and 1 m deep during normal summer operations. The weir was positioned in the center of a wide bend, adjacent to a high-cut bank to the east and a small floodplain to the west. Dense patches of willow suggest that the floodplain was at an intermediate stage of succession and terracing of the floodplain indicated that the stream channel has shifted course many times. The floodplain is interspersed with small channels that remain isolated except in periods of extreme high water. Substantial fine sediments in the area contribute to large amounts of erosion and sediment load in the water during high water events.

WEIR DESIGN

Details of design and materials used to construct the resistance board weir are described in Tobin (1994) with panel modifications described by Stewart (2002). The Tatlawiksuk River weir was designed with a gap of 3.33 cm (1-5/16 in) between each picket. The weir was installed across the entire 64 m channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels covered the middle 58 m portion of the channel, and fixed weir materials extended the weir 3 m to each bank.

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

To accommodate downstream migration of longnose suckers (*Catostomus catostomus*) and other non-salmon species, downstream passage chutes were installed into the weir mid-season. At locations where downstream migrants were most concentrated (typically lower velocity areas in the river), chutes were created by releasing the resistance boards on 1 or 2 adjacent weir panels so the distal ends dipped slightly below the stream surface. The chute's shallow profile guides downstream migrants while preventing upstream salmon passage. The chutes were monitored and adjusted to ensure salmon were not passing upstream. Few salmon have been observed passing downstream over these chutes, and their numbers are considered negligible.

ESCAPEMENT MONITORING

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

Passage Counts

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

Passage Estimates

A variety of situations were encountered in which passage was missed. Several methods have been used to most appropriately estimate passage for the given type of inoperable period. These periods may have resulted from a breach in the weir, a delayed start date, or a premature end date. Estimates were assumed to be zero if passage was likely negligible based on historical or inseason data. Otherwise, estimates for missed passage were calculated using one of the following methods:

Single Day Method

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

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

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.

If any passage was observed on a day when the weir was not fully operational, those fish were subtracted from the daily passage to convey what proportion was actually estimated. The proportion of estimated missed passage provides insight on accuracy. Since error is associated with any estimation method, years with greater proportions of estimated passage can be considered less accurate compared to years with smaller proportions.

The daily estimated missed passage $\hat{n}_{d_i}$ will always be reported except for when it is less than the observed passage, as the estimate will be disregarded and observed passage will then be considered the daily passage.

Linear Method

When the weir was not operational for 2 or more days but later became operational again, passage estimates for the inoperable days ($d_1,\ldots,d_i$) were calculated using the following formula:

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

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

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

where:

$n_{d_1-I,} n_{d_1-2} =$ observed passage for the first and second days before the inoperable period,

$n_{d_i+1,} n_{d_i+2} =$ observed passage the first and second day after the weir was reinstalled.

Exponential Method

This method used non-linear regression to fit an exponential function to existing data. For estimating the end of a run, we used the falling limb of the run curve to fit an exponential trend line. Using this method the trendline was fitted to the data using the exponential function:

$$\hat{n}_{d_i} = ae^{bi} \tag{3}$$

where:

a = y-intercept of the fitted line,

b = slope of the fitted line,

i = day of the estimated portion of the run as represented by the curve.

Carcass Counts

The weir was cleaned several times each day, typically after morning and late evening counts. Dead or spawned out live salmon that washed up on the weir, both referred to hereafter as carcasses, were counted by species, visually identified by sex, and passed downstream. Daily and cumulative carcass counts were copied to logbook forms. These counts are not considered a census, as both skiff gate and downstream passage chutes are installed to facilitate migration of non-salmon species, which additionally provide a pathway for dead and dying salmon to pass downstream uncounted.

AGE, SEX, AND LENGTH COMPOSITION

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

Sample Size and Distribution

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

The abundance of chum and coho salmon at Tatlawiksuk River weir was generally high enough to collect a large sample size in a short period of time. A pulse sampling strategy was employed to ensure adequate temporal distribution of chum and coho salmon samples. A pulse sample is essentially random stratified sampling, where each instantaneous sample characterizes a large portion of the run (i.e., early, middle, and late). Well spaced pulse samples are thought to have greater power for detecting temporal changes in ASL composition than other sampling methods (Geiger and Wilbur 1990). Pulse sampling was conducted approximately every 7–10 days. The goal was to collect a minimum of one pulse sample from each third of the run.

In 2010, the relatively low abundance of Chinook salmon at Tatlawiksuk River weir made pulse sampling impractical. Instead, Chinook salmon sampling followed a daily collection schedule to distribute a sample size of 234 fish in proportion to expected run abundance. The daily sample collection schedule was based on historical passage data. The overall sample size was selected to exceed the minimum necessary to meet precision and accuracy criteria for this location and was similar to average historical sampling success.

Sample Collection Procedures

Salmon were sampled from the fish trap installed in the weir. The trap included an entrance gate, holding pen, and exit gate. Salmon were trapped by opening the entrance gate while the exit gate remained closed. The entrance doors to the trap could be arranged in a V-shape, or fyke, to prevent fish from easily escaping. The holding pen was allowed to fill with fish until a reasonable number was inside. Crew members used a dip net to capture fish within the holding pen. To obtain length data and aid in scale collection, fish were removed from the dip net and placed into a partially submerged fish “cradle.” Scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards (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. Mid eye to fork of tail (MEF) length was measured to the nearest millimeter using a straight-edged meter stick. Sex and length data were recorded on standardized numbered data sheets that correspond with numbers on the gum cards used for scale preservation. After sampling, each fish was released upstream of the weir. The procedure was repeated until the holding pen was emptied, to ensure no bias was introduced.

Chinook salmon samples were often collected through “active sampling.” In this method Chinook salmon were captured and sampled individually while actively passing and counting all other salmon. Attempts were made to avoid obtaining too many chum salmon in the pen along with Chinook salmon, as they are easily stressed and injured due to their typical larger size and strength. Further details of the active sampling procedures are described in Linderman et al. (2002). This method was also used for tag recoveries.

After sampling was completed, all ASL data and metadata were copied to Microsoft Excel[1] spreadsheets that correspond to numbered gum cards. Completed Excel spreadsheets were sent in digital format to the Bethel ADF&G office for processing. The original ASL gum cards, acetates, and paper forms were archived at the ADF&G office in Anchorage. Data were also loaded into the Arctic-Yukon-Kuskokwim (AYK) salmon database management system (Brannian et al. 2006). Further details of sampling procedures can be found in Molyneaux et al. (2010).

Data Processing and Reporting

Samples were aged and processed by ADF&G staff in Bethel and Anchorage following procedures described by Molyneaux et al. (2010). Postseason, the samples were partitioned into a minimum of 2 temporal strata, based on overall distribution within the run. The escapement in each stratum was divided into age-sex classes proportionately with strata sample composition. Mean length by age-sex class was determined for each stratum as well. Annual estimates were

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

calculated as strata sums, weighted by the abundance in each stratum. When sample size or distribution was not considered adequate to estimate ASL composition, results were reported but not applied to annual escapements.

Summary tables were generated for each species. The first portion of the table provides the escapement and percentage of each age-sex class by stratum, with season totals weighted by escapement in each stratum. The second portion of the table provides a summary of mean length-at-age by sex for each stratum, with season totals weighted by escapement in each stratum. Sample sizes and dates are included for each stratum. Age is reported in the European notation, composed of 2 numerals separated by a decimal. The first numeral represents the number of winters the juvenile spent in freshwater excluding the first winter spent incubating in the gravel, and the second numeral is the number of winters it spent in the ocean (Groot and Margolis 1991). The total age is therefore one year greater than the sum of these 2 numerals. Statistical analysis of length-at-age was undertaken with linear regression and analysis of variance (ANOVA) tests.

WEATHER AND STREAM OBSERVATION

Water and air temperatures were manually measured each day at approximately 10:00 and 17:00 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. Wind speed was estimated to the nearest 5 miles per hour, and daily precipitation was measured (mm) using a rain gauge (Appendix A).

Water level observations represented the stream height in centimeters above an arbitrary datum plane. Water levels were measured using a staff gage installed about 150 meters downstream from the weir. The staff gage, which is installed annually, was calibrated using a sight level to a reliable benchmark installed in 2005 (Costello et al. 2006), which replaced semi-permanent benchmarks installed in previous years (Stewart and Molyneaux 2005; (Appendix B). Calibration of staff gauge is checked periodically to ensure accuracy.

RELATED FISHERIES PROJECTS

Data Allocation

Escapement and ASL data collected at Tatlawiksuk River weir along with data from other fisheries escapement projects in the Kuskokwim River drainage are vital information used in the annual estimation of Chinook, chum, and coho salmon run abundance for the entirety of the river system. Exploitation rates and fluctuations in annual production are determined from these estimations.

Kuskokwim River Chum and Sockeye Salmon Tagging Operations

The Tatlawiksuk River weir crew participated in a basin wide mark–recapture and radiotelemetry study entitled *Kuskokwim River Chum Tagging Effects,* funded by Alaska Sustainable Salmon Initiative AKSSF (#44508). Primary objectives were the operation and maintenance of four radiotelemetry towers located between Stony River and Vinasale on the mainstem Kuskokwim River. These stations gather information to help evaluate the effects of holding time in fish wheel live-boxes on upstream chum salmon migration. Upstream passage of all fish occurred through the weir's live trap, enabling captures of tagged chum salmon.

Tatlawiksuk River weir also served as a potential recovery location for anchor tagged sockeye salmon in additional study entitled *Kuskokwim River Sockeye Salmon*. This study was funded by AKSSF (#45920). A clear plastic viewing window on the stream surface aided species identification and tag presence. Recorded data for "recovered" fish included the tag number, tag color, fish condition, presence of secondary mark, and recovery date. Tag loss was assessed at the weir by inspecting for secondary marks during routine ASL sampling.

Temperature Monitoring

Tatlawiksuk River weir also served as a site for the *Temperature Monitoring* project funded by Office of Subsistence Management, Fishery Resource Monitoring Program (FRMP 08-701). Two Hobo® Water Temp Pro V2 data loggers and one Hobo® Air Temperature R/H data logger were deployed on 7 June with previous loggers being removed and sent in for analysis. These newly placed 2010 loggers were downloaded on 20 September, but were reinstalled for continual monitoring of the site. The water temperature loggers were anchored to the stream bed near midchannel and the air temperature logger was installed using a solar shield attached to a 4-inch diameter tree.

Kuskokwim Native Association High School Internship Program

Local area high school students were recruited to participate in the Kuskokwim Native Association's (KNA) High School Internship Program at the Tatlawiksuk River weir for 3 weeks. Students spent 1 or 2 weeks at the weir site completing a daily educational curriculum and participating in weir duties. The program included a hands-on fisheries science curriculum featuring examples from current Kuskokwim Research Projects. Crew members instructed students in fish species identification, weather and stream observations, and ASL sampling. In addition, the crew assisted Carolyn Hackett, KNA Partners Fisheries Educator, in conducting daily lessons related to salmon biology and watershed ecology and accompanying field activities. All interns were expected to complete daily assignments and a final project to demonstrate their understanding of the fisheries and environmental monitoring techniques presented in the program. Career guidance and mentoring from practicing fisheries biologists and technicians is an integral part of the program and provides students with role models for future work in fisheries science.

RESULTS

WEIR OPERATIONS

Tatlawiksuk River weir operated from 0:00 hours on 17 June until nightfall on 17 September, spanning the majority of the target operational period. The weir began operation two days after the beginning of the target operations period, but Chinook, chum and sockeye salmon were not observed passing the weir for several days, thus missed passage was likely negligible. High water events on 11 August through 15 August, 18 August through 21 August and 9 September through 11 September rendered the weir inoperable, and the linear method (described above) was used to estimate missed passage of Chinook, chum, and coho salmon (Figure 3). Partial day counts were performed on 6, 7, and 22 August as a result of high water, and on 22 and 24 July resulting from holes forming in the weir (Table 1) and the single-day method was used for passage estimation. Additional full-day inoperable periods include 18–20 September, where estimation was calculated for coho salmon through the exponential method using the curve ($y=63.146e^{-0.232x}$, $R^2=0.90$). This exponential curve was determined from 12 to 17 September counts (Figure 4).

ESCAPEMENT MONITORING

Chinook Salmon

A total of 567 Chinook salmon were estimated to have passed upstream of the weir during the target operational period. The first fish was observed on 22 June, daily passage peaked at 81 fish on 7 July, and the last fish was observed on 5 September. The central 50% of the run occurred from 7 to 19 July, with a median passage date of 12 July. Estimated missed passage for inoperable periods in 2010 was 24 fish (4.2% of total estimated passage) (Table 1; Figure 5).

Chum Salmon

A total of 36,701 chum salmon were estimated to have passed upstream of the weir during the target operational period. The first fish passed the weir on 21 June, and a peak count of 2,116 fish occurred on 16 July. The central 50% of the run occurred from 9 to 23 July, with a median passage date of 15 July. Estimated missed passage for inoperable periods in 2010 was 701 fish (1.9% of total estimated passage) (Table 1; Figure 5).

Coho Salmon

A total of 3,520 coho salmon were estimated to have passed upstream of the weir during the target operational period. The first coho salmon was observed on 28 July, and a peak count of 210 fish occurred on 29 August. The central 50% of the run occurred from 20 August to 2 September, with a median passage date of 27 August. Estimated missed passage for inoperable periods in 2010 was 908 fish (25.8% of total estimated passage) (Table 1; Figure 5).

Other Species

A total of 33 sockeye salmon (of which 5 were estimated), and 22 pink salmon were observed passing upstream of the weir during the target operational period. Non-salmon species included 54 longnose suckers, 1 whitefish (*Coregonus* spp.), 38 Arctic grayling (*Thymallus arcticus*), and 3 northern pike (*Esox lucius*) (Appendix C).

Carcasses

Salmon carcass counts included 14 Chinook, 908 chum, and 6 coho salmon. Females accounted for 9%, 32%, and 34% of the Chinook, chum, and coho salmon carcasses respectively. The first Chinook salmon carcass was found on 9 July. The first chum salmon carcass was found on 28 June, and a peak count of 90 occurred on 1 August. The first coho salmon carcass was observed on 26 August (Appendix D).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Samples were collected from 106 Chinook salmon from 3 July to 4 August. Of those, age was determined for 80 (75% of the total sample), or 14% of annual Chinook salmon escapement. Sample size and distribution resulted in 95% confidence intervals for age composition no wider than ±9.9% for all age classes except age-1.3 which had a bound of 10.6% compared to the desired minimum confidence interval of ±10.0%. The escapement was partitioned into 3 temporal strata based on sampling dates, with sample sizes of 21, 27, and 32 in the first, second, and third strata, respectively. The annual escapement was predominately age-1.3 (43.2%), -1.2 (29.4%), and -1.4 (23.3%), with age-1.5 (2.0%), age-2.4 (1.1%), and age-1.1 (1.0%) individuals also detected within the run. Age-1.2 fish were all males, age-1.3 fish were predominately males (60.8% male), and age-1.4 fish were predominately females (83.3% female). Females composed an estimated 39.3% of the total run (Table 2).

Length samples ranged between 494 mm and 939 mm and sample sizes ranged from 14 to 23 fish among predominant age-sex categories (Table 2). Mean lengths of female Chinook salmon were 783 mm at age-1.3, and 816 mm at age-1.4. Mean lengths of male age-1.2, -1.3, and -1.4 fish were 578, 685, and 796 mm, respectively.

Chum Salmon

Samples were collected from 1,140 chum salmon between 10 July and 6 August. Of those, age was determined for 1,082 (95% of the total sample), or 2.9% of chum salmon escapement. The escapement was partitioned into 5 temporal strata which contained sample sizes of 228, 217, 210, 219, and 208 respectively. Sample size and distribution was adequate to estimate annual age composition of the chum salmon escapement to the weir such that the 95% confidence intervals ranged no wider than ±2.4% (Table 3).

Escapement was predominately age-0.3 (82.7%) followed by age-0.2 (8.9%) and age-0.4 (7.9%) fish. Minimal escapement occurred for age-0.5 (0.5%) individuals. Females composed 51.6% of the chum salmon escapement. Sampled fish ranged between 448 mm and 657 mm in length (Table 3).

Coho Salmon

Samples were collected from 410 coho salmon between 26 August and 6 September. Of those, age was determined for 372 (91% of the total sample), or 10.6% of annual coho salmon escapement. The escapement was partitioned into 2 temporal strata containing 189, and 183 samples respectively. Sample size and distribution was adequate for estimating annual age composition of the coho salmon escapement to the weir such that the 95% confidence intervals ranged no wider than ±3.1% (Table 4).

Escapement was predominately age-2.1 (90.4%). Minimal escapement occurred for age-3.1 (5.0%) and age-1.1 (4.6%) individuals. Females composed 57.6% of the coho salmon escapement. Sampled fish ranged between 434 mm and 652 mm (Table 4). High river stage hindered sampling and counting efforts for 12 days in August and 6 days in September amounting for 25.8% of estimated passage for 2010 (Table 1).

WEATHER AND STREAM OBSERVATION

A total of 100 complete morning weather and stream observations were recorded between 13 June and 20 September. Based on twice daily thermometer observations, water temperature at the weir ranged from 6.0°C to 15.0°C, with an average of 10.1°C. Air temperature at the weir ranged from 0.5°C to 28.0°C, with an average of 13.4°C (Appendix A).

RELATED FISHERIES PROJECTS

Kuskokwim River Chum Tagging Effects and Kuskokwim River Sockeye Salmon

A single anchor/radio tagged chum salmon was recovered at Tatlawiksuk River weir, this tag was again detected during an aerial survey flight. There were no tagged sockeye salmon recovered.

Temperature Monitoring

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

KNA High School Internship Program

A total of 8 students participated in the KNA High School Internship Program, including 4 first-year and 4 returning (one of whom was a two week intern).

DISCUSSION

OPERATIONS

Daily and total annual escapements were successfully determined for each of the target species at Tatlawiksuk River weir in 2010. While low water at the beginning of the season made for easy installation, high water contributed to interrupted operations. Passage estimates were made during these periods and several others throughout the duration of the season. ASL composition was estimated successfully for chum and coho salmon. Chinook salmon ASL sampling was problematic due to low escapement and poor distribution throughout the season (Tables 1 and 2).

ESCAPEMENTS

Chinook Salmon

The escapement of Chinook salmon was the lowest on record in 2010. Many of the rivers within the Kuskokwim drainage experienced normal run timing but low abundance in 2010 (Brazil 2010). The run-timing of 2010 Chinook salmon was similar to 2009 but extended later into the season. The duration of the run was longer and occurred later than the historical median with a median passage date occurring on 12 July (Figures 5–7).

Objectives for precision and accuracy in estimating the ASL composition of total annual Chinook salmon escapement to Tatlawiksuk River were not achieved for 2010. The sampling goal was not met and the 95% confidence interval for age composition in the total escapement was not entirely within ±10% (Table 2). However, sampling was fairly well distributed across run timing, and the 90% confidence interval was determined to be within ±10%. Although objectives for precision and accuracy were not achieved, the ASL composition provided here will be useful to managers and therefore warrants discussion. In 2010 all age classes were well below historical median abundances (Figure 8). As in all previous years age-1.3 was the largest class. For 2010 age-1.2 made up the second largest class, and age-1.4 made the third largest class. It has been unusual for the age-1.2 fish to represent a larger proportion than age-1.4. This has only occurred in one other year (2007) in the history of Tatlawiksuk River weir. Overall sex ratios could not be accurately estimated within the 95% confidence interval. However, we maintain a 90% certainty that the Chinook salmon run was composed of 39.4% females.

Years of low abundance like 2010 present an opportunity for studying the resilience to low returns of spawners of distinct tributary stocks within the Kuskokwim River. Perspectives provided by projects like Tatlawiksuk River weir also may one day be used to examine differential exploitation of stocks by commercial and subsistence fisheries in the lower river. It is our intent that by continuing to collect annual run data in concert with other data sources, we may be able to design management strategies that will take into account the needs of distinct tributary stocks within the Kuskokwim drainage. Without widely distributed projects like the Tatlawiksuk River weir, management would be focused on the sum total of fish returning to the Kuskokwim drainage in general and would fail to address the needs of stock distribution throughout.

Chum Salmon

The escapement of chum salmon in 2010 surpassed the historical median and was the third highest year of escapement on record at Tatlawiksuk River weir. Escapement at other Kuskokwim area projects exhibited typical numbers. Run timing was similar to the historical median, occurring one day earlier and extending two days later. Historical and 2010 median passage dates both occurred on 15 July (Figures 5, 6, and 9).

Objectives for precision and accuracy in estimating the ASL composition of total annual chum salmon escapement to Tatlawiksuk River were achieved for 2010. Relative to previous years, age-0.3 and age-0.2 classes were larger than the corresponding historical median classes while age-0.4 was smaller (Figure 8). This is the first year on record where age-0.2 had a higher abundance than age-0.4. The percent of females in 2010 was 52%, which is similar to most recent years (Table 3).

Coho Salmon

Coho salmon escapement in 2010 was the second lowest on record next to 1999 (Figure 6), with missed passage estimated for 25.8% of the run. Escapements of coho salmon were shown to be below average at all monitoring locations across the lower Kuskokwim (Brazil 2010; Figure 10). Escapement occurred later than most years and the median passage date was the second latest on record (Figure 5). Coho salmon run timing was late across the Kuskokwim drainage (Brazil 2010). A possible contributor to later run timing of coho salmon escapement may have been high water events which occurred in August. There was a noticeable spike in fish numbers passing the weir immediately after river stage had dropped back below 90 cm (Table 1; Figure 3). Coho salmon have exhibited milling behavior while waiting for preferable environmental conditions for spawning (Groot and Margolis 1991).

The objectives for precision and accuracy in ASL composition estimates were achieved in 2010 (Table 4). The percent of females was the highest on record at 57.6% (Table 4; Figure 6). However, the reported sex ratio may have been affected by high river stage preventing sampling in the first third of the run. Males typically make up a larger percentage of early portions of a coho salmon run (Molyneaux et. al 2010). Age-2.1, -3.1, and -1.1 abundances were all below historical median levels (Figure 8). Age composition for Kuskokwim River coho salmon populations is typically consistent throughout the run, with the age-2.1 class dominating. Age composition tends to be uniform year to year and 2010 proportions were not unusual. We consider our estimation of age composition to be accurate.

Other Species

The Tatlawiksuk River does not host large spawning populations of sockeye and pink salmon. Accurate enumeration of spawning pink salmon at the weirs is not possible because their small size allows some individuals to pass between pickets undetected. Furthermore, it is unclear to what extent either of these species represent a distinct Tatlawiksuk River spawning population or strays from nearby tributaries.

Longnose suckers are historically the most abundant non-salmon species, and Tatlawiksuk River is thought to have a distinct breeding population. Historically, as many as 5,093 longnose suckers have been observed migrating upstream of the weir. However, enumeration of longnose suckers is incomplete because smaller individuals are able to pass freely between pickets and upstream migration appears to start before weir operations typically begin. For 2010 the majority of upstream migration of longnose suckers appears to have taken place prior to weir installation based on the large downstream migration observed later in the season. Counts of all resident fishes were not unusual.

Carcass Counts

The number of salmon carcasses found on the weir is not a complete census of the number of post-spawning salmon (post-spawners) above the weir site (Appendix D). The "sucker chutes" that are installed to facilitate downstream passage of non-salmon species provide a pathway for post-spawners or weak salmon to drift downstream. Daily carcass counts noticeably decrease following chute installation, and no attempt was made to estimate missed carcasses. Additionally, the weir was removed long before most coho salmon had completed spawning, so the number of coho salmon carcasses counted on the weir largely underestimates the number of post-spawners that drifted past the weir site.

WEATHER AND STREAM OBSERVATION

Water temperature was within the historical range for much of the season with exceptions of new high point in mid-July, and extreme lows in late July, and mid-August (Figure 11). Record low river stage occurred during weir installation until the beginning of July, while record high river stage occurred on 13–16 August and 9–10 September (Figure 3). High water levels coincided with low water temperatures and low water clarity.

RELATED FISHERIES PROJECTS

In 2010, the Tatlawiksuk River weir successfully provided essential escapement and ASL data used along with data from other fisheries escapement projects in the Kuskokwim River for annual estimation of Chinook, chum, and coho salmon run abundance for the entirety of the river system.

The Tatlawiksuk River weir successfully served as a recovery site for a basin wide mark–recapture and radiotelemetry study for *Kuskokwim River Chum Tagging Effects* and *Kuskokwim River Sockeye Salmon.*

Tatlawiksuk River weir successfully served as a monitoring site for the *Temperature Monitoring* project funded by the USFWS Office of Subsistence Management.

Tatlawiksuk River weir staff successfully hosted KNA high school and college interns as in previous years. Interns took part in aquatic ecology and fisheries education, and weir operation under supervision of ADF&G and KNA staff. KNA internships benefit both students and the projects that host them. Interns gain exposure to fisheries monitoring projects and the employment opportunities associated with them. The projects gain a much needed level of community involvement, which the authors believe contributes to continued local support of the research and management utility of the weirs.

CONCLUSIONS

- Daily and total annual escapements were successfully estimated for each of the target species at Tatlawiksuk River weir in 2010.
- There were 76 days of observed passage with estimates calculated for 22 days in 2010.
- Chinook salmon escapement was the lowest on record in 2010, chum salmon exhibited the third highest escapement, and coho salmon were the second lowest on record.
- The abundance of Chinook salmon for age-1.2, -1.3, -1.4 and -1.5 were all below historical median abundance in 2010.
- The abundance of age-0.3 and age-0.2 were above the historical medians and age-0.4 chum salmon in 2010 were below their historical median at Tatlawiksuk River Weir.
- There was a higher abundance of age-0.2 than age-0.4 chum salmon for the first time since the integration of Tatlawiksuk River weir in 1999.
- The percentage of estimated passage (25.8%) of coho salmon in 2010, though not ideal, is still useful in river evaluation and analysis.
- Record low river stage in the Tatlawiksuk River was observed in June, with river stage reaching record highs August 13-16 and September 9 -10.

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Many individuals contributed to the operation of the Tatlawiksuk River weir in 2010. Administrative and logistical support was provided by Douglas B. Molyneaux and Ashley Fairbanks of ADF&G; and Melissa Smith of KNA. Thanks also to KNA field personnel: Harry George (technician); Adrian Boelens, Charlotte Phillips and Alex Nicori (college interns); and Carrie Hackett (Internship Coordinator) with the high school interns for contributing to the successful project in 2010. Thanks to additional help throughout the season provided by Rob Stewart, Stephanie Warnement, Zach Liller, and James Kvamme.

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TABLES AND FIGURES

Table 1.–Daily and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at Tatlawiksuk River weir, 2010.

	Chinook		Sockeye		Chum		Coho	
Date	Daily	%	Daily	%	Daily	%	Daily	%
6/15	0 [a]	0	0 [a]	0	0 [a]	0	0 [a]	0
6/16	0 [a]	0	0 [a]	0	0 [a]	0	0 [a]	0
6/17	0	0	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0
6/19	0	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0
6/21	0	0	0	0	3	0	0	0
6/22	1	0	0	0	5	0	0	0
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	3	0	0	0
6/25	0	0	0	0	7	0	0	0
6/26	1	0	0	0	31	0	0	0
6/27	1	1	0	0	28	0	0	0
6/28	1	1	0	0	174	1	0	0
6/29	15	3	0	0	380	2	0	0
6/30	0	3	0	0	227	2	0	0
7/1	1	4	0	0	700	4	0	0
7/2	3	4	0	0	576	6	0	0
7/3	12	6	0	0	734	8	0	0
7/4	9	8	0	0	845	10	0	0
7/5	38	14	0	0	1,458	14	0	0
7/6	34	20	0	0	1,025	17	0	0
7/7	81	35	0	0	1,032	20	0	0
7/8	27	39	0	0	1,184	23	0	0
7/9	34	45	0	0	1,101	26	0	0
7/10	4	46	0	0	987	29	0	0
7/11	16	49	1	3	1,403	32	0	0
7/12	24	53	0	3	1,832	37	0	0
7/13	35	59	0	3	1,799	42	0	0
7/14	18	63	0	3	1,721	47	0	0
7/15	19	66	0	3	1,625	51	0	0
7/16	25	70	2	9	2,116	57	0	0
7/17	4	71	1	12	1,490	61	0	0
7/18	4	72	1	15	517	63	0	0
7/19	14	74	1	18	1,112	66	0	0
7/20	16	77	0	18	1,112	69	0	0
7/21	14	80	0	18	865	71	0	0
7/22	15 [b]	82	2 [b]	23	943 [b]	74	0 [b]	0
7/23	6	83	3	32	768	76	0	0
7/24	6 [b]	84	2 [b]	38	835 [b]	78	0 [b]	0
7/25	6	85	1	41	901	80	0	0
7/26	11	87	3	50	1,229	84	0	0
7/27	6	88	1	53	1,016	87	0	0
7/28	6	89	0	53	910	89	1	0
7/29	1	90	1	56	517	90	1	0
7/30	4	90	2	63	528	92	2	0
7/31	2	91	3	72	473	93	3	0
8/1	4	91	1	75	454	94	3	0
8/2	10	93	0	75	373	95	8	1
8/3	5	94	2	81	316	96	10	1
8/4	4	95	0	81	269	97	14	1

-continued-

Table 1.–Page 2 of 3.

	Chinook		Sockeye		Chum		Coho	
Date	Daily	%	Daily	%	Daily	%	Daily	%
8/5	0	95	0	81	212	98	41	2
8/6	2	95	0	81	141	98	49	4
8/7	1 [c]	95	2	87	141 [c]	98	41 [c]	5
8/8	1	95	1 [c]	89	114	99	31	6
8/9	2	96	1	92	98	99	43	7
8/10	1	96	0	92	78	99	37	8
8/11	2 [d]	96	0 [d]	94	76 [d]	99	44 [d]	9
8/12	2 [d]	97	0 [d]	95	63 [d]	100	49 [d]	11
8/13	2 [d]	97	0 [d]	96	51 [d]	100	53 [d]	12
8/14	2 [d]	97	0 [d]	96	39 [d]	100	57 [d]	14
8/15	2 [d]	97	0 [d]	97	27 [d]	100	61 [d]	16
8/16	2 [e]	98	0 [e]	97	14 [e]	100	66 [e]	17
8/17	2	98	0	97	2	100	70	19
8/18	2 [d]	98	0 [d]	97	2 [d]	100	77 [d]	22
8/19	2 [d]	99	0 [d]	97	2 [d]	100	83 [d]	24
8/20	2 [d]	99	0 [d]	97	2 [d]	100	90 [d]	27
8/21	1 [d]	99	0 [d]	97	2 [d]	100	96 [d]	29
8/22	1 [c]	99	1 [c]	100	3 [c]	100	103 [c]	32
8/23	1	100	0	100	2	100	119	36
8/24	1	100	0	100	1	100	100	38
8/25	0	100	0	100	4	100	174	43
8/26	0	100	0	100	0	100	171	48
8/27	0	100	0	100	1	100	184	53
8/28	0	100	0	100	0	100	141	57
8/29	0	100	0	100	1	100	210	63
8/30	0	100	0	100	0	100	147	68
8/31	0	100	0	100	0	100	99	70
9/1	0	100	0	100	1	100	106	73
9/2	0	100	0	100	0	100	119	77
9/3	0	100	0	100	1	100	110	80
9/4	0	100	0	100	0	100	86	82
9/5	1	100	0	100	0	100	92	85
9/6	0	100	0	100	0	100	53	86
9/7	0	100	0	100	0	100	72	89
9/8	0	100	0	100	0	100	40	90
9/9	0 [d]	100	0 [d]	100	0 [d]	100	53 [d]	91
9/10	0 [d]	100	0 [d]	100	0 [d]	100	51 [d]	93
9/11	0 [d]	100	0 [d]	100	0 [d]	100	48 [d]	94
9/12	0	100	0	100	0	100	46	95
9/13	0	100	0	100	0	100	44	97
9/14	0	100	0	100	0	100	35	98
9/15	0	100	0	100	0	100	20	98
9/16	0	100	0	100	0	100	23	99
9/17	0	100	0	100	0	100	15	99
9/18	0 [d]	100	0 [d]	100	0 [d]	100	12 [d]	99
9/19	0 [d]	100	0 [d]	100	0 [d]	100	10 [d]	100
9/20	0 [d]	100	0 [d]	100	0 [d]	100	8 [d]	100
Totals	567	100	33	100	36,701	100	3,520	100

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Table 1.–Page 3 of 3.

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

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

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

[c] Partial day count, passage was estimated.

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

Table 2.–Kuskokwim River Chinook salmon from the Tatlawiksuk River weir escapement project age and sex composition and mean length (mm), 2010.

			Brood Year (Age)												
			2007		2006		2005		2004		2003		2002		
Sample Dates	Sample		(0.2)	(1.1)	(1.2)	(2.1)	(1.3)	(2.2)	(1.4)	(2.3)	(1.5)	(2.4)	(1.6)	(2.5)	Total
(Stratum Dates)	Size		N %	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %	N %
7/03 - 7/08	21	Male	0 0.0	0 0.0	75 33.3	0 0.0	96 42.9	0 0.0	11 4.8	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	181 81.0
(6/15-7/08)		Female	0 0.0	0 0.0	0 0.0	0 0.0	32 14.3	0 0.0	11 4.8	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	43 19.0
		Subtotal	0 0.0	0 0.0	75 33.3	0 0.0	128 57.1	0 0.0	21 9.5	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	224 100.0
		Male Mean Length	-	-	563	-	656	-	718	-	-	-	-	-	
		SE	-	-	12	-	14	-	-	-	-	-	-	-	
		Range	-	-	526-600	-	597-735	-	-	-	-	-	-	-	
		n	-	-	7	-	9	-	1	-	-	-	-	-	
		Female Mean Length	-	-	-	-	791	-	771	-	-	-	-	-	
		SE	-	-	-	-	21	-	-	-	-	-	-	-	
		Range	-	-	-	-	751-823	-	-	-	-	-	-	-	
		n	-	-	-	-	3	-	1	-	-	-	-	-	
7/09 - 7/15	27	Male	0 0.0	6 3.7	50 33.3	0 0.0	17 11.1	0 0.0	6 3.7	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	78 51.9
(7/9-7/15)		Female	0 0.0	0 0.0	0 0.0	0 0.0	28 18.5	0 0.0	39 25.9	0 0.0	6 3.7	0 0.0	0 0.0	0 0.0	72 48.1
		Subtotal	0 0.0	6 3.7	50 33.3	0 0.0	44 29.6	0 0.0	44 29.6	0 0.0	6 3.7	0 0.0	0 0.0	0 0.0	150 100.0
		Male Mean Length	-	368	563	-	691	-	925	-	-	-	-	-	
		SE	-	-	14	-	24	-	-	-	-	-	-	-	
		Range	-	-	494-625	-	644-726	-	-	-	-	-	-	-	
		n	-	1	9	-	3	-	1	-	-	-	-	-	
		Female Mean Length	-	-	-	-	727	-	858	-	764	-	-	-	
		SE	-	-	-	-	22	-	17	-	-	-	-	-	
		Range	-	-	-	-	644-777	-	810-936	-	-	-	-	-	
		n	-	-	-	-	5	-	7	-	1	-	-	-	

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Table 2.–Page 2 of 2.

			Brood Year (Age)																							
			2007				2006				2005				2004				2003				2002			
Sample Dates	Sample		(0.2)		(1.1)		(1.2)		(2.1)		(1.3)		(2.2)		(1.4)		(2.3)		(1.5)		(2.4)		(1.6)		(2.5)		Total
(Stratum Dates)	Size		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
7/16-7/21, 7/26-7/30, 8/04	32	Male	0	0.0	0	0.0	42	21.9	0	0.0	36	18.8	0	0.0	6	3.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	84	43.8
		Female	0	0.0	0	0.0	0	0.0	0	0.0	36	18.8	0	0.0	60	31.3	0	0.0	6	3.1	6	3.1	0	0.0	0	0.0	109	56.3
(7/16-9/5)		Subtotal	0	0.0	0	0.0	42	21.9	0	0.0	72	37.5	0	0.0	66	34.4	0	0.0	6	3.1	6	3.1	0	0.0	0	0.0	193	100.0
		Male Mean Length	-		-		609		-		714		-		785		-		-		-		-		-			
		SE	-		-		11		-		24		-		-		-		-		-		-		-			
		Range	-		-		573-645		-		619-793		-		-		-		-		-		-		-			
		n	-		-		7		-		6		-		1		-		-		-		-		-			
		Female Mean Length	-		-		-		-		817		-		835		-		841		806		-		-			
		SE	-		-		-		-		13		-		23		-		-		-		-		-			
		Range	-		-		-		-		781-852		-		698-939		-		-		-		-		-			
		n	-		-		-		-		6		-		10		-		1		1		-		-			
	80	Male	0	0.0	6	1.0	167	29.4	0	0.0	149	26.3	0	0.0	22	3.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	344	60.6
Season		Female	0	0.0	0	0.0	0	0.0	0	0.0	96	16.9	0	0.0	110	19.4	0	0.0	12	2.0	6	1.1	0	0.0	0	0.0	223	39.4
		Total	0	0.0	6	1.0	167	29.4	0	0.0	245	43.2	0	0.0	132	23.3	0	0.0	12	2.0	6	1.1	0	0.0	0	0.0	567	100.0
		95% C.I. (%)	±1.74				±9.98				±10.60				±8.26				±3.16									
		Male Mean Length	-		368		578		-		685		-		796		-		-		-		-		-			
		SE	-		-		7		-		12		-		-		-		-		-		-		-			
		Range	-		-		494-645		-		597-793		-		718-925		-		-		-		-		-			
		n	-		1		23		-		18		-		3		-		-		-		-		-			
		Female Mean Length	-		-		-		-		783		-		816		-		807		806		-		-			
		SE	-		-		-		-		11		-		15		-		-		-		-		-			
		Range	-		-		-		-		644-852		-		698-939		-		764-841		-		-		-			
		n	-		-		-		-		14		-		18		-		2		1		-		-			

Table 3.–Kuskokwim River chum salmon from the Tatlawiksuk River weir escapement project age and sex composition and mean length (mm), 2010.

			Brood Year (Age)											
			2007		2006		2005		2004		2003			
Sample Dates	Sample		(0.2)		(0.3)		(0.4)		(0.5)		(0.6)		Total	
(Stratum Dates)	Size		N	%	N	%	N	%	N	%	N	%	N	%
6/30, 7/01	228	Male	32	0.4	2,948	40.8	634	8.8	95	1.3	0	0.0	3,709	51.3
(6/15-7/07)		Female	254	3.5	3,012	41.7	222	3.1	32	0.4	0	0.0	3,519	48.7
		Subtotal	285	3.9	5,960	82.5	856	11.8	127	1.8	0	0.0	7,228	100.0
		Male Mean Length	586		567		584		616		-			
		SE	-		3		6		16		-			
		Range	-		512-637		556-639		587-640		-			
		n	1		93		20		3		-			
		Female Mean Length	539		549		554		572		-			
		SE	10		2		7		-		-			
		Range	500-582		495-594		528-572		-		-			
		n	8		95		7		1		-			
7/10	217	Male	344	4.1	3,215	38.7	230	2.8	0	0.0	0	0.0	3,789	45.6
(7/08-7/13)		Female	689	8.3	3,521	42.4	306	3.7	0	0.0	0	0.0	4,517	54.4
		Subtotal	1,033	12.4	6,737	81.1	536	6.5	0	0.0	0	0.0	8,306	100.0
		Male Mean Length	564		567		583		-		-			
		SE	10		3		12		-		-			
		Range	527-603		485-657		547-629		-		-			
		n	9		84		6		-		-			
		Female Mean Length	538		538		547		-		-			
		SE	5		2		8		-		-			
		Range	489-568		491-594		509-587		-		-			
		n	18		92		8		-		-			

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Table 3.–Page 2 of 3.

Sample Dates (Stratum Dates)	Sample Size		Brood Year (Age) 2007 (0.2) N	%	2006 (0.3) N	%	2005 (0.4) N	%	2004 (0.5) N	%	2003 (0.6) N	%	Total N	%
7/18, 7/19	210	Male	493	4.3	5,422	47.1	493	4.3	55	0.5	0	0.0	6,462	56.2
(7/14-7/22)		Female	657	5.7	4,108	35.7	274	2.4	0	0.0	0	0.0	5,039	43.8
		Subtotal	1,150	10.0	9,529	82.9	767	6.7	55	0.5	0	0.0	11,501	100.0
		Male Mean Length	545		571		589		569		-			
		SE	14		2		10		-		-			
		Range	501-642		514-643		553-644		-		-			
		n	9		99		9		1		-			
		Female Mean Length	531		539		541		-		-			
		SE	5		3		23		-		-			
		Range	512-562		484-600		463-590		-		-			
		n	12		75		5		-		-			
7/25-7/27	219	Male	152	3.2	1,865	39.3	195	4.1	0	0.0	0	0.0	2,212	46.6
(7/23-7/27)		Female	260	5.5	2,168	45.7	108	2.3	0	0.0	0	0.0	2,537	53.4
		Subtotal	412	8.7	4,033	84.9	304	6.4	0	0.0	0	0.0	4,749	100.0
		Male Mean Length	560		560		575		-		-			
		SE	9		3		10		-		-			
		Range	533-601		498-626		526-619		-		-			
		n	7		86		9		-		-			
		Female Mean Length	532		533		543		-		-			
		SE	7		3		8		-		-			
		Range	490-568		469-593		518-561		-		-			
		n	12		100		5		-		-			

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Table 3.–Page 3 of 3.

Sample Dates (Stratum Dates)	Sample Size		Brood Year (Age) 2007 (0.2) N	%	2006 (0.3) N	%	2005 (0.4) N	%	2004 (0.5) N	%	2003 (0.6) N	%	Total N	%
8/04-8/06	208	Male	165	3.4	1,229	25.0	213	4.3	0	0.0	0	0.0	1,607	32.7
(7/28-9/20)		Female	213	4.3	2,860	58.2	236	4.8	0	0.0	0	0.0	3,310	67.3
		Subtotal	378	7.7	4,090	83.2	449	9.1	0	0.0	0	0.0	4,917	100.0
		Male Mean Length	523		559		566		-		-			
		SE	8		4		8		-		-			
		Range	498-552		501-638		517-601		-		-			
		n	7		52		9		-		-			
		Female Mean Length	508		517		534		-		-			
		SE	11		2		10		-		-			
		Range	448-578		460-569		480-580		-		-			
		n	9		121		10		-		-			
Season	1,082	Male	1,186	3.2	14,680	40.0	1,765	4.8	150	0.4	0	0.0	17,780	48.4
		Female	2,073	5.6	15,669	42.7	1,147	3.1	32	0.1	0	0.0	18,921	51.6
		Total	3,259	8.9	30,349	82.7	2,911	7.9	182	0.5	0	0.0	36,701	100.0
		Male Mean Length	556		566		582		587		-			
		SE	6		1		5		16		-			
		Range	498-642		485-657		517-644		569-640		-			
		n	33		414		53		4		-			
		Female Mean Length	531		537		544		572		-			
		SE	3		1		8		-		-			
		Range	448-582		460-600		463-590		-		-			
		n	59		483		35		1		-			

Table 4.–Kuskokwim River coho salmon from the Tatlawiksuk River weir escapement project age and sex composition and mean length (mm), 2010.

			Brood Year (Age)							
			2007		2006		2005			
Sample Dates	Sample		(1.1)		(2.1)		(3.1)		Total	
(Stratum Dates)	Size		N	%	N	%	N	%	N	%
8/26-8/28	189	Male	50	2.1	944	39.7	76	3.2	1,070	45.0
(6/15-8/30)		Female	50	2.1	1,183	49.7	76	3.2	1,309	55.0
		Subtotal	101	4.2	2,127	89.4	151	6.3	2,379	100.0
		Male Mean Length	500		570		553			
		SE	17		5		11			
		Range	457-532		434-642		519-597			
		n	4		75		6			
		Female Mean Length	549		553		561			
		SE	7		3		10			
		Range	534-566		458-618		525-589			
		n	4		94		6			
9/03-9/06	183	Male	37	3.3	387	33.9	0	0.0	424	37.2
(8/31-9/20)		Female	25	2.2	668	58.5	25	2.2	718	62.8
		Subtotal	62	5.5	1055	92.3	25	2.2	1142	100.0
		Male Mean Length	525		558		-			
		SE	14		5		-			
		Range	490-566		460-652		-			
		n	6		62		-			
		Female Mean Length	546		558		572			
		SE	19		3		16			
		Range	491-572		499-641		527-600			
		n	4		107		4			
Season	372	Male	88	2.5	1,331	37.8	76	2.1	1,494	42.4
		Female	75	2.1	1,851	52.6	100	2.9	2,027	57.6
		Total	163	4.6	3,182	90.4	176	5.0	3,521	100.0
		Male Mean Length	508		566		553			
		SE	12		4		11			
		Range	457-566		434-652		519-597			
		n	10		137		6			
		Female Mean Length	548		554		564			
		SE	8		3		8			
		Range	491-572		458-641		525-600			
		n	8		201		10			

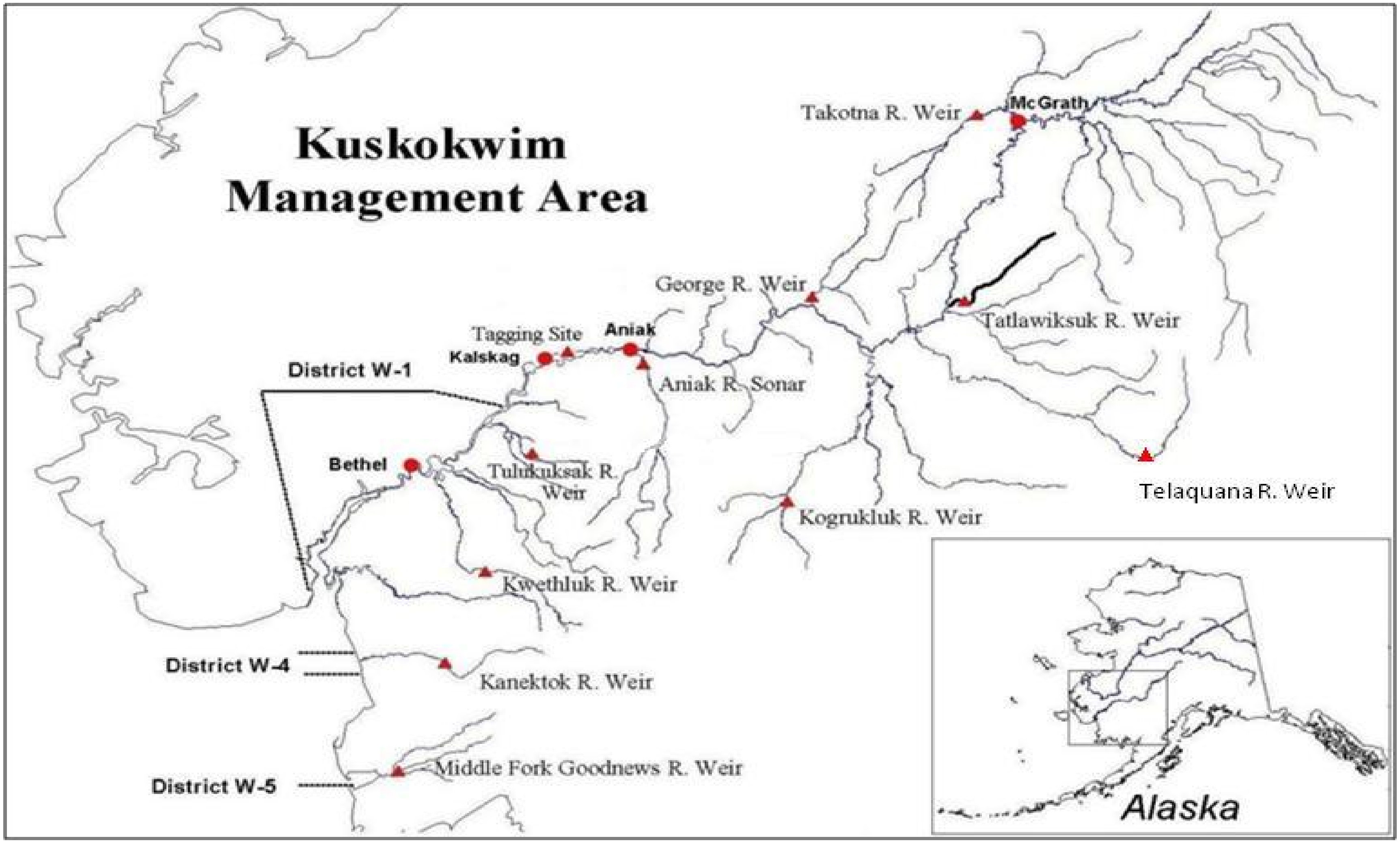


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring on the Tatlawiksuk River.

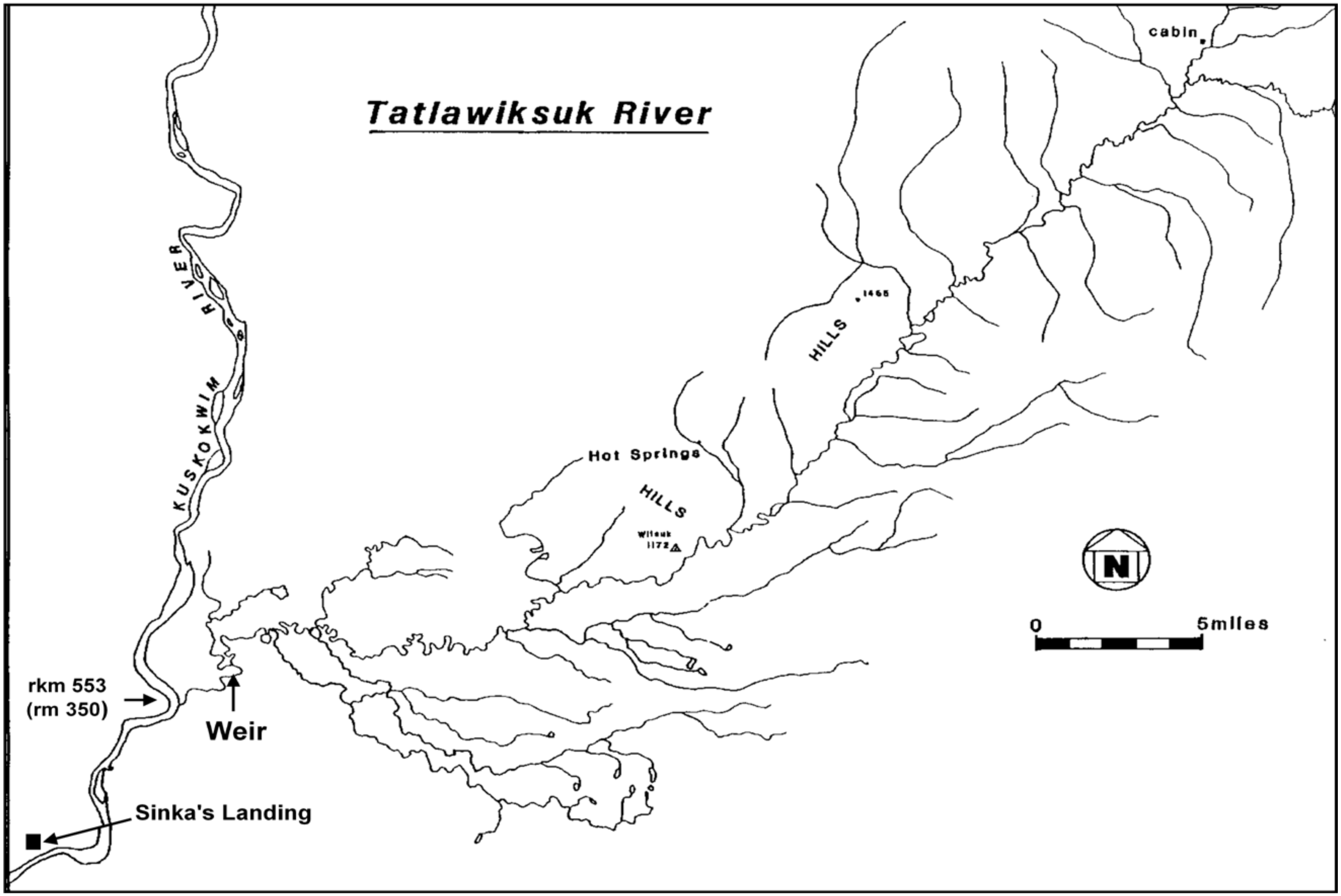


Figure 2.–Map depicting the Tatlawiksuk River drainage and the location of the weir.

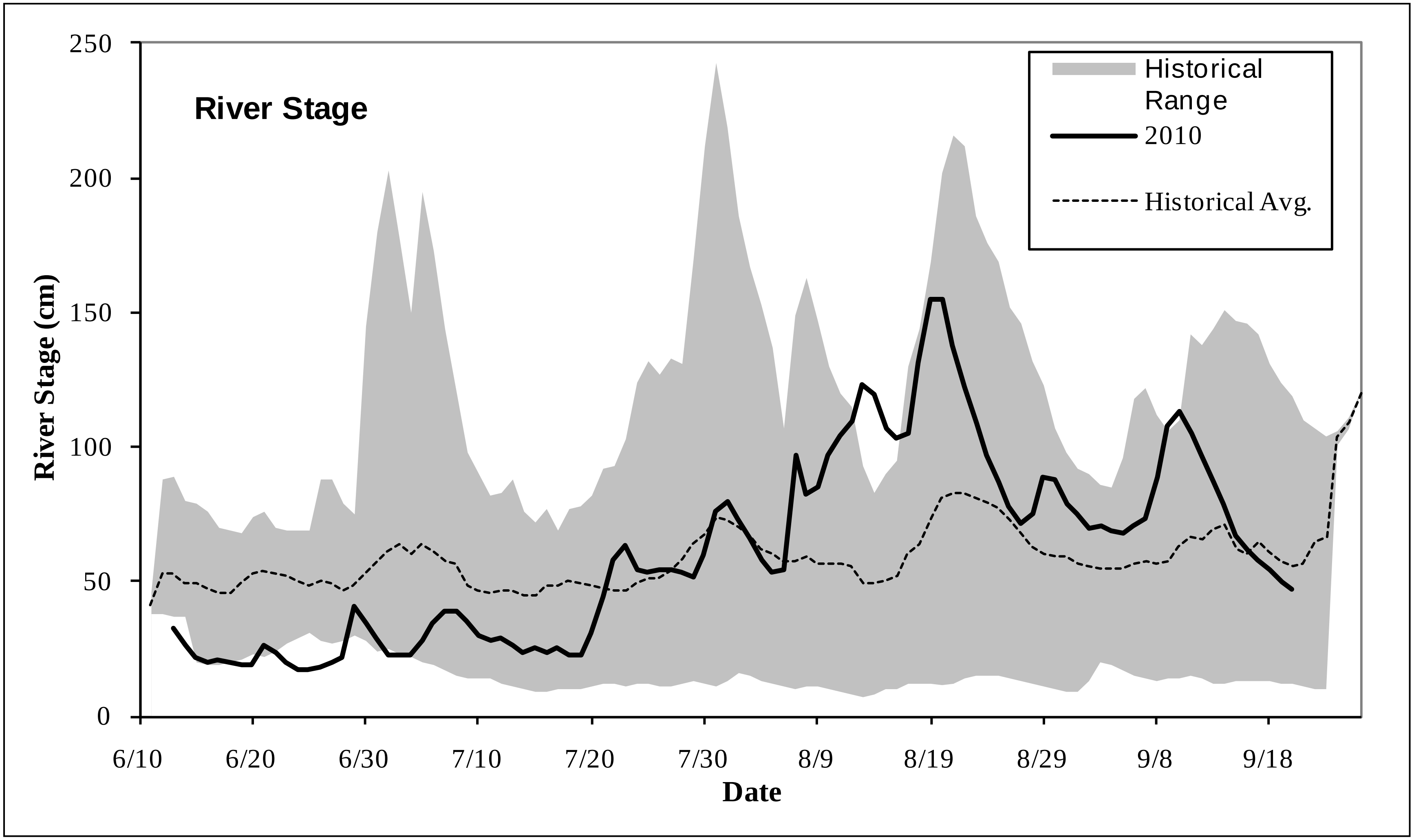
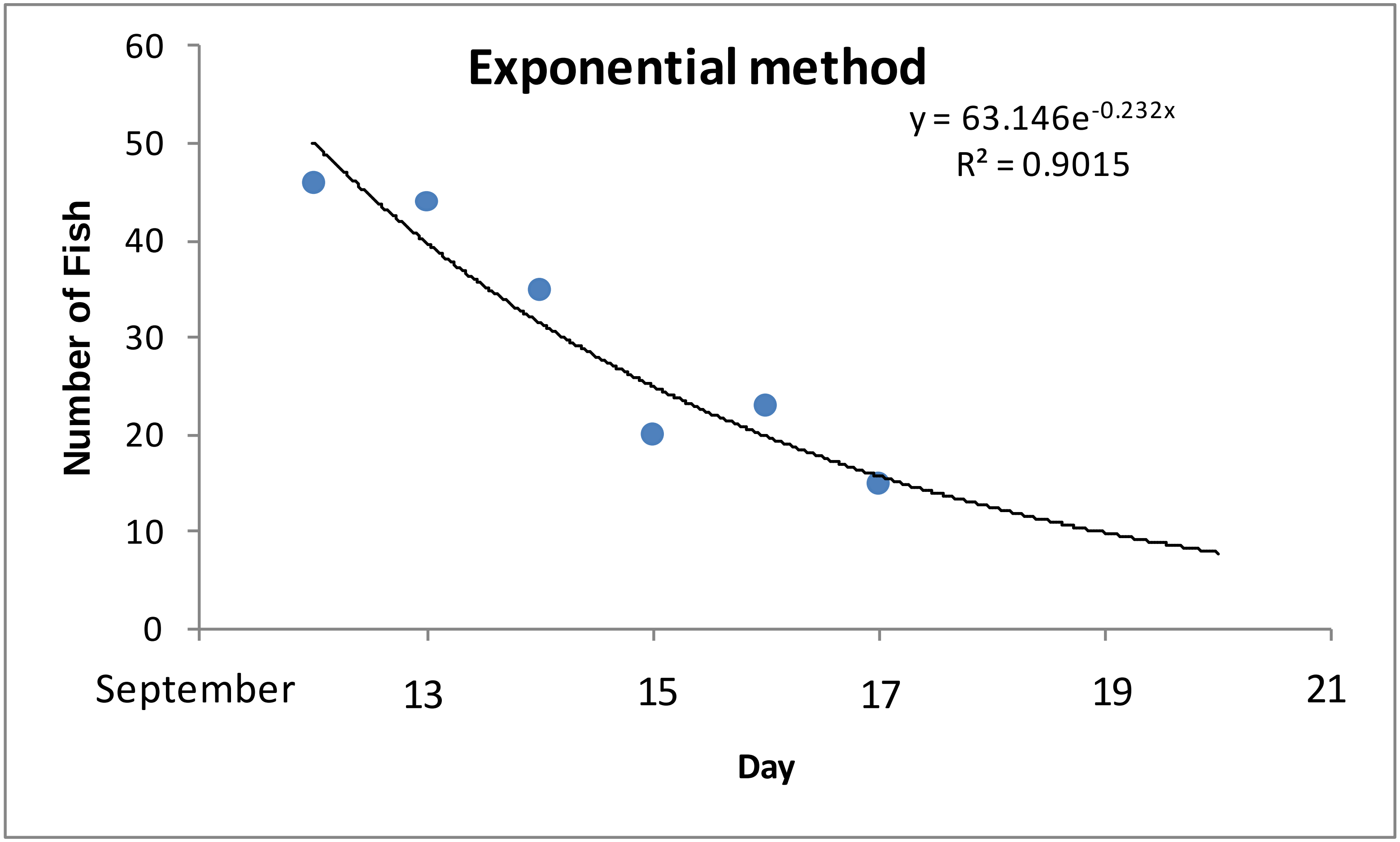
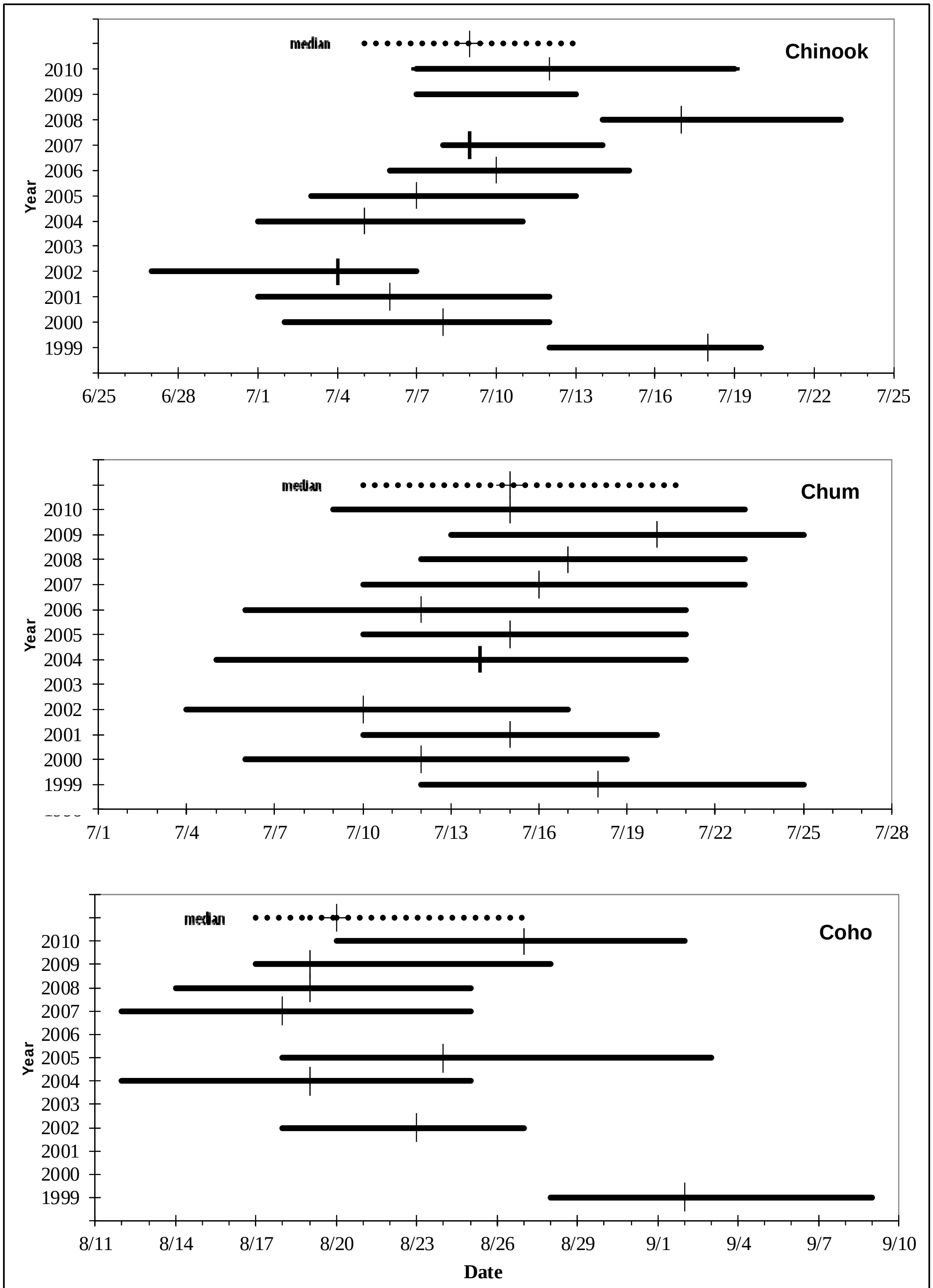


Figure 3.–Daily morning river stage at Tatlawiksuk River weir in 2010 relative to historical average, minimum, and maximum morning readings from 2000 to 2009.



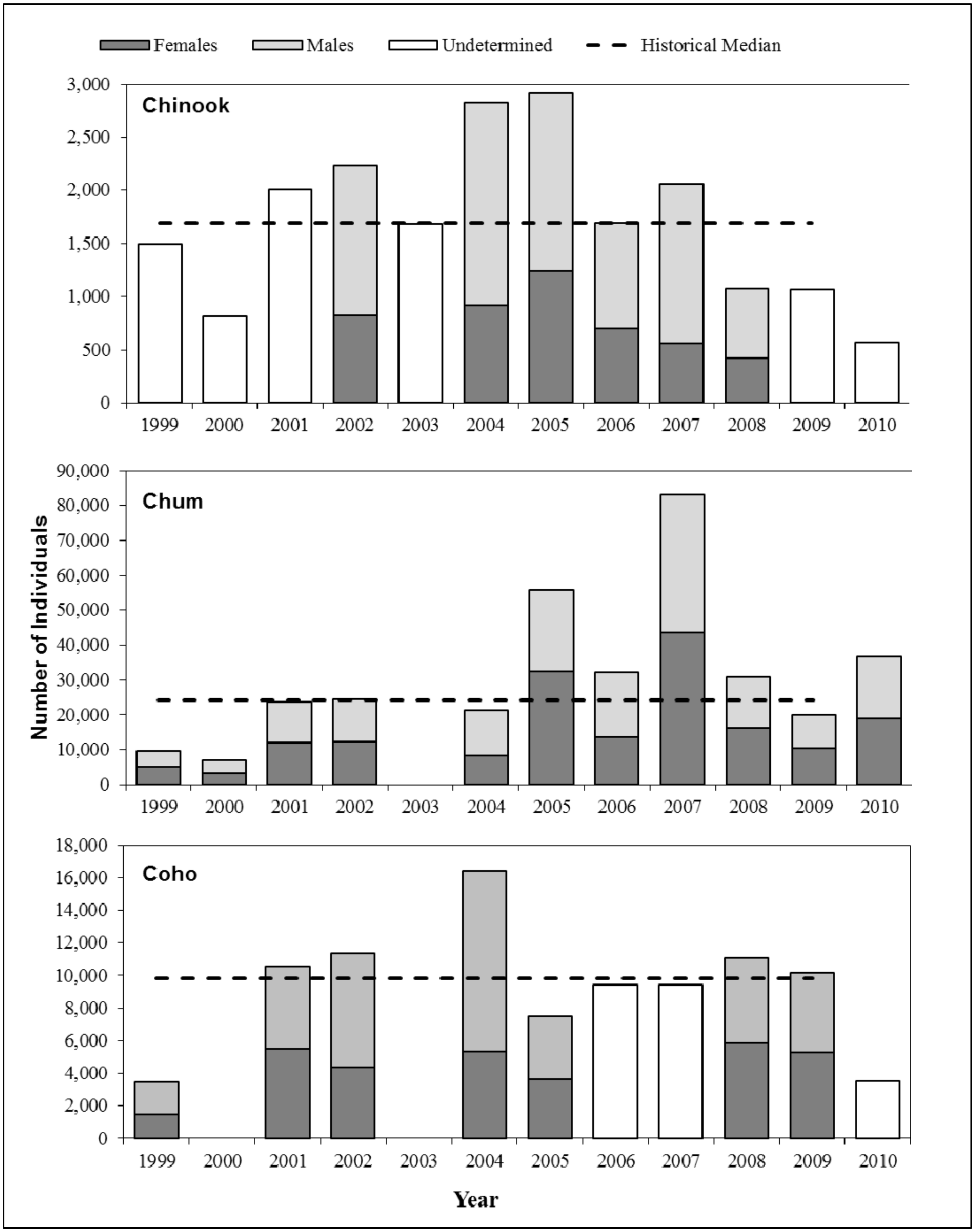
Note: Exponential estimation of coho salmon for September 18, 19, and 20, based on passage from September 12 through 17.

Figure 4.–End of season coho salmon estimation using the “exponential method.”



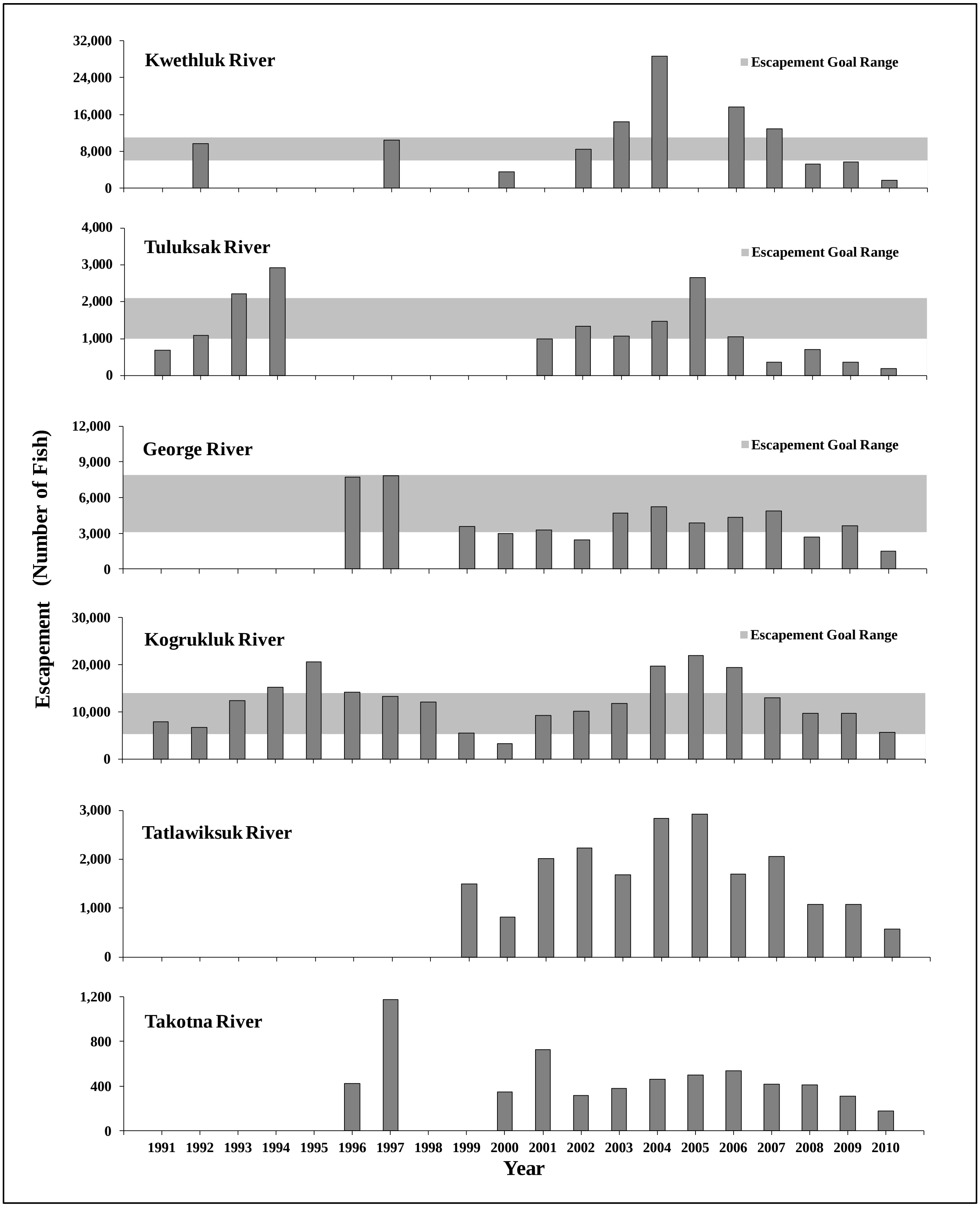
Note: Solid horizontal lines represent the dates when the central 50% of the run passed for the given year, while vertical cross-bars represent median passage dates. The horizontal dashed line represents mean historical passage dates of median escapement.

Figure 5.–Run timing of Chinook, chum, and coho salmon based on cumulative percent passage at the Tatlawiksuk River weir, 1999–2010.



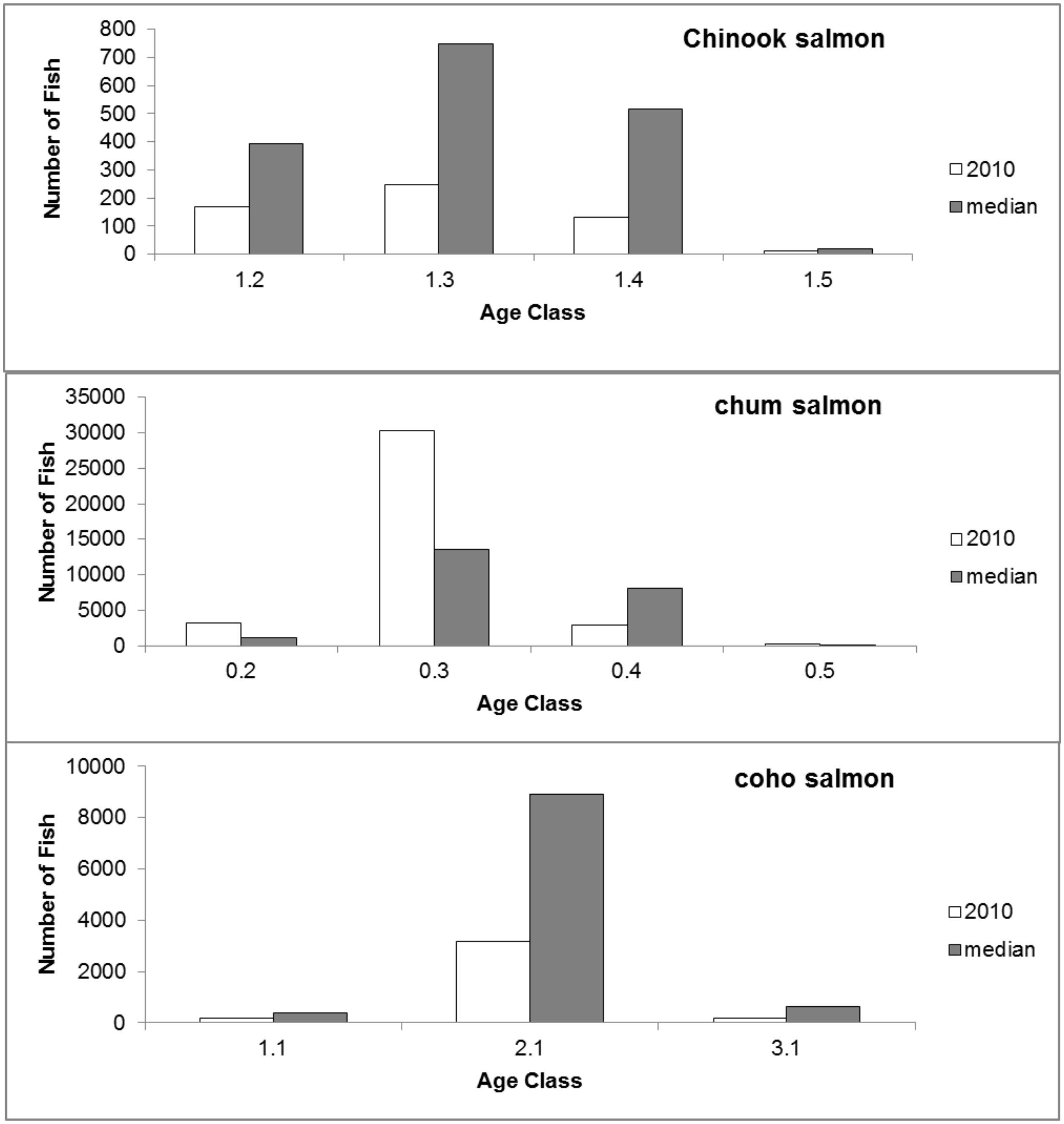
Note: Open bars indicate years when samples were not sufficient to produce sex composition. Historical median is applied to combined totals of fish.

Figure 6.–Historical escapement of salmon at Tatlawiksuk River weir, showing relative abundance of males and females.



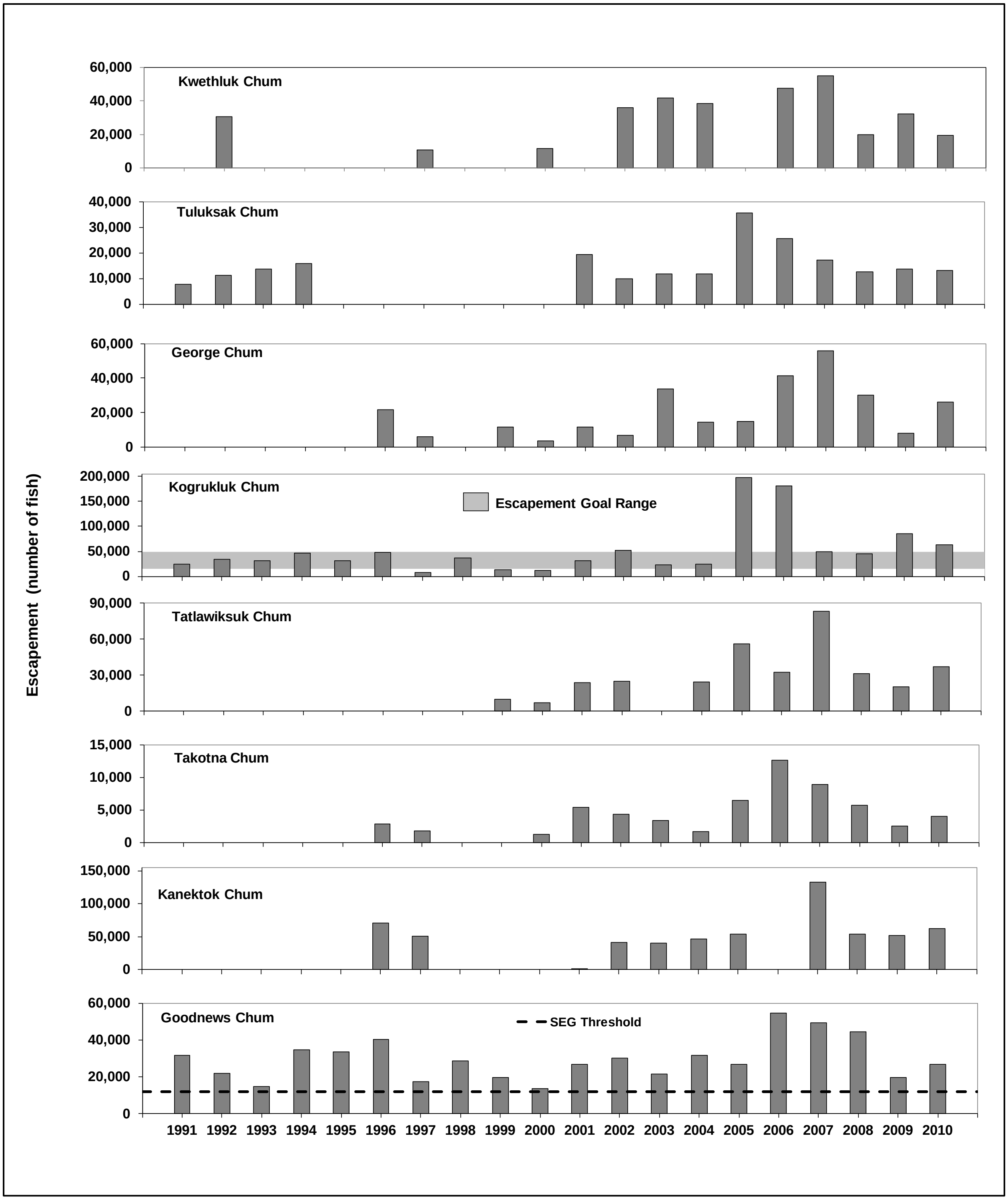
Note: Escapement not determined in years without bars. Kwethluk and Takotna were operated as counting towers 1996 and 1997.

Figure 7.–Annual Chinook salmon escapements into 6 Kuskokwim River tributaries.



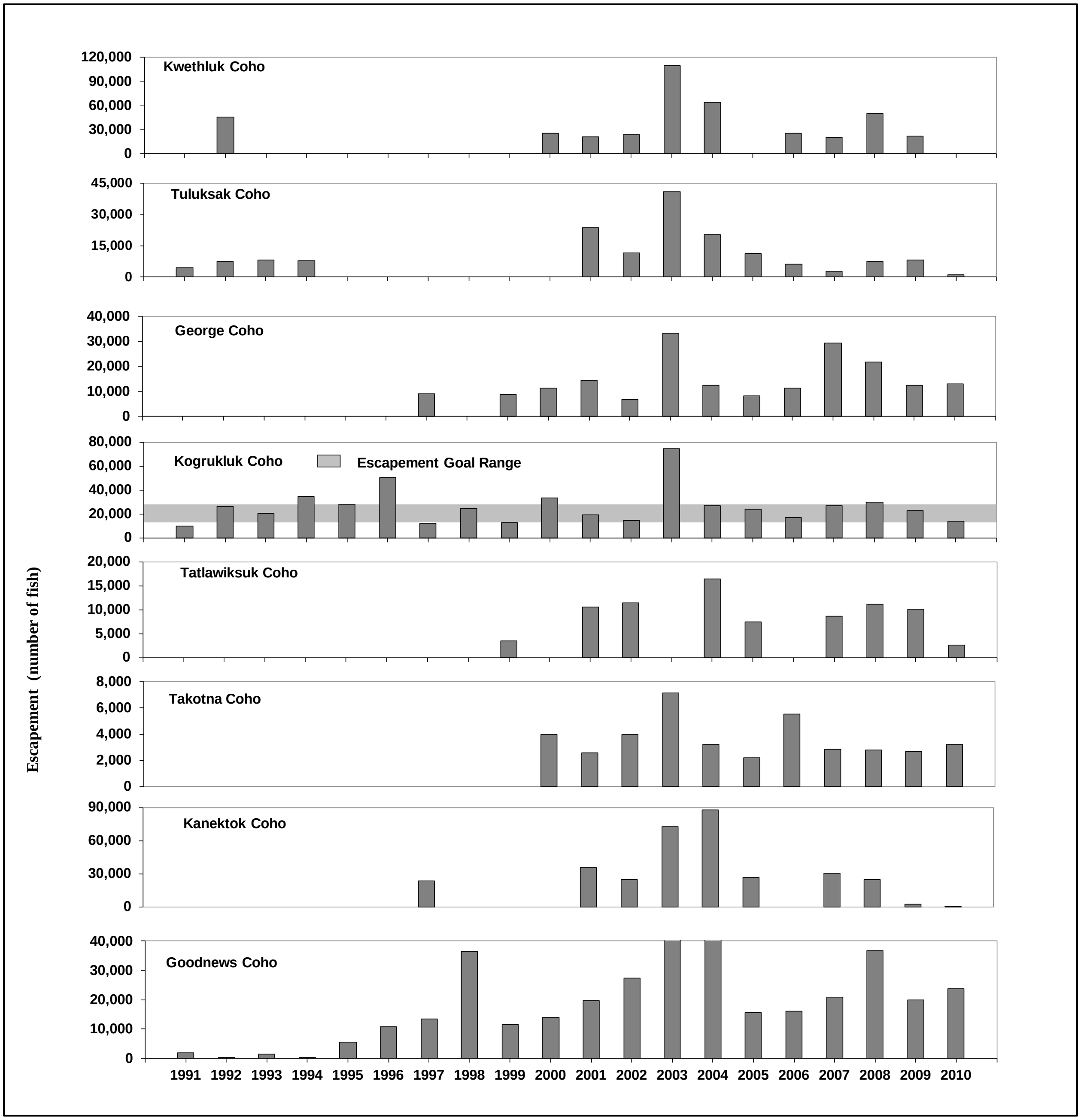
Note: Median has been calculated from years 1999 to 2009. The following years have been excluded: 1999–2001 for Chinook salmon; 2000 and 2006 for coho salmon; 2003 for all species.

Figure 8.–2010 Historical median abundance of Chinook, chum, and coho salmon by age class at Tatlawiksuk River weir.



Note: Escapement not determined in years with no bars. Kwethluk and Takotna were operated as counting tower projects in 1996 and 1997.

Figure 9.–Annual chum salmon escapements into 8 Kuskokwim River tributaries.



Note: Escapement not determined in years with no bars.

Figure 10.–Annual coho salmon escapements into 8 Kuskokwim River tributaries.

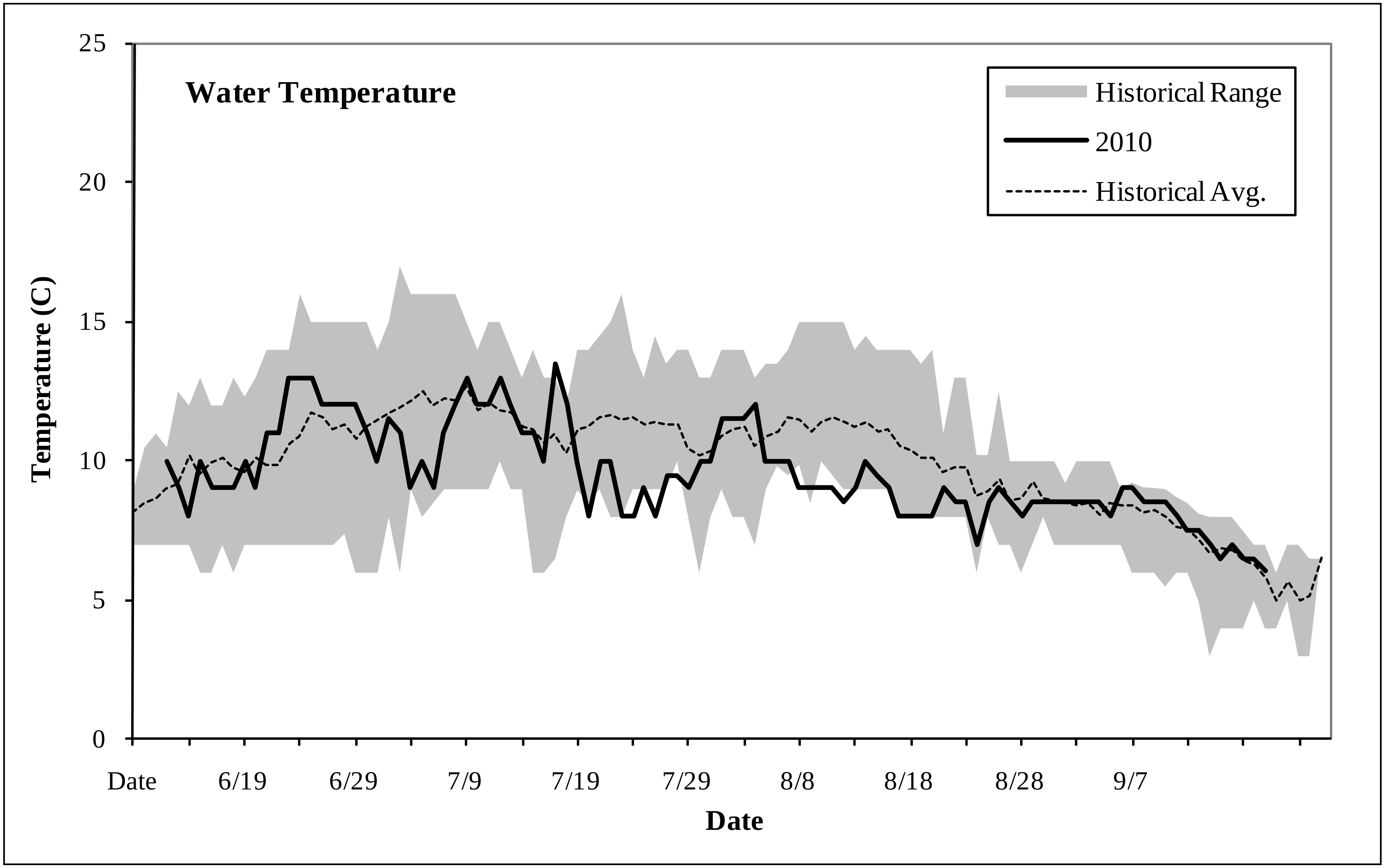


Figure 11.–Daily morning water temperature at Tatlawiksuk River weir in 2010 relative to historical average, minimum, and maximum morning readings from 1996 to 2009.

APPENDIX A: WEATHER AND STREAM OBSERVATIONS

Appendix A.–Daily weather and stream observations at the Tatlawiksuk River weir site, 2010.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
6/13	1000	4	0.0	12.0	10	33	3
	1700	3	0.0	19.0	12	30	3
6/14	1000	4	0.2	14.0	9	26	3
	1700	4	0.0	18.0	12	24	3
6/15	1000	4	8.0	13.0	8	22	3
	1700	4	1.3	13.0	10	22	2
6/16	1000	4	0.2	11.0	10	20	2
	1700	3	0.0	14.0	10	21	2
6/17	1000	3	4.4	11.0	9	21	2
	1700	4	0.5	15.0	9	20	2
6/18	1000	3	trace	12.0	9	20	2
6/19	1000	3	3.0	11.0	9	19	2
	1700	3	0.8	17.0	10	20	2
6/20	1000	2	0.5	12.0	10	19	2
	1700	2	0.0	22.0	13	23	2
6/21	1000	3	0.0	14.0	9	27	2
	1800	1	0.0	28.0	14	27	2
6/22	1000	3	0.0	13.0	11	24	2
	1700	2	0.0	19.0	13	23	2
6/23	1000	3	trace	14.0	11	20	2
	1700	2	0.0	20.0	14	19	2
6/24	1000	3	0.0	15.0	13	17	2
	1700	3	0.0	20.0	15	16	2
6/25	1000	4	1.2	12.0	13	17	2
	1700	2	0.0	20.0	15	17	2
6/26	1000	1	8.4	14.0	13	18	2
	1700	1	0.0	22.0	15	19	2
6/27	1000	4	2.0	11.0	12	20	2
	1700	4	0.5	17.0	14	20	2
6/28	1000	2	0.8	12.0	12	22	2
	1700	2	0.4	18.0	13	27	2
6/29	1000	3	1.8	14.0	12	41	3
	1700	3	0.0	18.0	14	40	3
6/30	1000	4	trace	12.0	12	34	3
	1700	3	trace	16.0	12	33	3
7/1	1000	3	trace	12.5	11	29	2
	1700	3	0.0	13.0	13	27	2
7/2	1000	4	0.0	12.0	10	23	2
	1700	3	0.0	12.0	12	23	2
7/3	1000	4	0.5	12.5	11.5	23	2
	1700	3	1.4	15.0	12	22	2
7/4	1000	4	1.0	12.0	11	23	2
	1700	3	2.0	15.0	12	24	2
7/5	845	2	3.0	10.0	9	28	2
	1700	3	0.5	16.0	11	29	2
7/6	1000	4	2.7	10.0	10	34	2
	1700	3	0.4	14.0	11.5	35	2
7/7	900	1	0.2	10.0	9	39	2
	1700	4	0.0	20.0	12	39	2
7/8	900	1	0.0	14.0	11	39	2
	1700	2	0.0	19.5	13.5	39	2
7/9	1000	1	0.0	14.0	12	35	2
	1700	1	0.0	24.0	14.5	32	2

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Appendix A.–Page 2 of 3.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C)		River Stage (cm)	Water Clarity[c]
				Air	Water		
7/10	1000	4	3.5	12.0	13	30	2
	1700	4	2.5	14.0	13	30	2
7/11	1000	4	0.8	13.0	12	28	2
	1700	2	0.0	19.0	14	28	2
7/12	900	1	0.0	13.0	12	29	2
	1700	1	0.0	24.0	14	28	2
7/13	1000	3	trace	12.5	13	26	2
	1700	3	0.0	17.0	13	25	2
7/14	1000	3	0.0	15.0	12	24	2
	1700	3	0.0	16.0	13	24	2
7/15	1000	3	0.7	11.5	11	25	2
	1700	3	trace	16.0	12	24	2
7/16	1000	1	0.0	14.0	11	24	2
	1700	3	0.0	22.0	13.5	25	2
7/17	900	2	0.0	14.0	10	25	2
	1700	3	0.0	22.0	15	24	2
7/18	1000	4	4.2	12.5	13.5	23	2
	1700	4	2.0	14.0	14	23	2
7/19	1000	4	9.5	12.0	12	23	2
	1700	4	3.1	13.0	12	24	2
7/20	1000	4	4.0	12.0	10	31	2
	1700	4	9.0	14.0	11	36	2
7/21	730	4	3.0	10.0	8	44	3
	1700	3	0.5	14.0	11	49	3
7/22	730	4	trace	10.0	10	58	3
	1700	3	0.0	15.0	11.5	62	3
7/23	730	4	trace	8.0	10	63	3
	1700	4	2.0	9.0	9	60	3
7/24	730	4	3.0	8.0	8	54	3
	1700	4	5.8	11.0	9	54	3
7/25	730	4	0.5	7.0	8	53	3
	1700	4	2.6	12.0	9	54	3
7/26	1000	4	8.0	11.0	9	54	3
	1700	4	2.4	12.0	9	53	3
7/27	1000	4	0.5	9.0	8	54	3
	1700	3	0.5	14.5	9.5	55	3
7/28	1000	4	3.4	10.5	9.5	53	3
	1700	4	2.2	12.5	9.5	53	3
7/29	1000	4	9.4	10.5	9.5	52	3
	1700	4	6.3	13.0	9.5	52	3
7/30	1000	4	15.0	13.0	9	60	3
	1700	4	0.6	18.0	10	64	3
7/31	1000	4	3.6	14.0	10	76	3
	1700	3	1.0	16.5	10	78	3
8/1	1000	2	trace	15.0	10	80	3
	1700	2	0.0	19.0	12	79	3
8/2	1000	3	0.0	15.0	11.5	73	3
	1700	3	0.0	19.5	12	73	3
8/3	1000	3	0.0	14.0	11.5	66	3
	1700	2	0.0	19.0	12	63	3
8/4	1000	4	5.6	13.5	11.5	58	3
	1700	4	0.7	18.0	12.0	55	3
8/5	1000	3	trace	14.0	12.0	53	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
	1700	4	0.0	18.0	12	53	3
8/6	1000	4	1.5	10.0	10	54	3
	1700	4	0.5	13.0	11	64	3
8/7	1000	4	11.0	10.0	10	97	3
	1700	4	5.5	13.0	10	91	3
8/8	1000	3	2.0	12.0	10	82	3
	1700	4	4.0	13.0	10	84	3
8/9	1000	4	10.0	11.0	9	85	3
	1700	4	4.0	13.0	10	86	3
8/10	1000	4	5.5	11.0	9	97	3
	1700	4	1.5	13.0	9	100	3
8/11	1000	4	7.2	10.0	9	104	3
	1700	4	2.5	13.0	9	105	3
8/12	1000	4	3.2	11.0	9	110	3
	1700	4	6.2	13.0	9	116	3
8/13	1000	3	0.8	10.5	8.5	123	3
	1700	3	trace	18.0	11	123	3
8/14	1000	3	2.0	14.0	9	120	3
	1700	3	0.5	20.0	10	115	3
8/15	1000	4	0.5	12.5	10	107	3
	1700	2	6.2	15.0	10	106	3
8/16	1000	4	0.8	9.0	9.5	103	3
	1700	4	10.0	13.0	9.5	100	3
8/17	1000	4	15.2	9.5	9	105	3
	1700	4	3.0	10.0	9.5	110	3
8/18	1000	4	2.0	8.5	8	131	3
	1700	3	.	10.0	8.5	138	3
8/19	1000	1	trace	6.5	8	155	3
	1700	3	0.0	14.5	8.5	156	3
8/20	1000	3	0.0	10.0	8	155	3
	1700	3	0.0	14.0	8	151	3
8/21	1000	1	0.0	9.5	8	138	3
	1700	2	0.0	17.0	9	133	3
8/22	1000	3	2.3	11.0	9	122	3
	1700	2	trace	19.0	9.5	118	3
8/23	1000	2	5.5	6.5	8.5	109	3
	1700	2	0.0	19.5	10	106	3
8/24	1000	1	0.0	12.0	8.5	97	3
	1700	2	0.0	17.0	10	93	3
8/25	1000	1	0.0	8.0	7	87	3
	1700	2	0.0	17.0	10	84	3
8/26	1000	3	0.0	9.5	8.5	78	3
	1700	3	0.0	17.0	9	76	3
8/27	1000	4	3.7	11.0	9	72	3
	1700	4	7.0	13.0	9	71	3
8/28	1000	4	4.2	9.0	8.5	75	3
	1700	4	0.5	11.5	9	79	3
8/29	1000	2	0.0	9.0	8	89	3
	1700	2	0.0	15.5	9.5	91	3
8/30	1000	3	0.0	9.0	8.5	88	3
	1700	3	0.0	16.0	9.5	87	3
8/31	1000	3	trace	10.0	8.5	79	3
	1700	2	1.0	13.0	9.5	78	3
9/1	1000	1	trace	9.5	8.5	75	3

-continued-

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
	1700	3	0	15.0	9.5	74.0	3
9/2	1000	3	9.3	8.0	8.5	70.0	3
	1700	4	0.7	12.5	9	72.0	3
9/3	1000	4	3.2	9.5	8.5	71.0	3
	1700	3	0.9	14.0	9	70.0	3
9/4	1000	4	4	11.0	8.5	69.0	3
	1700	4	3	13.0	9	68.0	3
9/5	1000	4	0.8	11.0	8.5	68.0	3
	1700	4	1.2	13.5	9	70.0	3
9/6	1000	4	trace	10.0	8	71.0	3
	1700	4	0.5	15.0	9	71.0	3
9/7	1000	4	17	12.5	9	73.0	3
	1700	4	4.2	13.0	10	75.0	3
9/8	1000	4	4.8	9.0	9	89.0	3
	1700	4	2.5	11.5	9.5	95.0	3
9/9	1000	4	0.8	9.0	8.5	108.0	3
	1700	3	0.3	14.0	9.5	114.0	3
9/10	1000	1	0	12.5	8.5	113.0	3
	1700	2	0	18.0	9.5	110.0	3
9/11	1000	3	0	12.5	8.5	105.0	3
	1930	2	0	14.0	9.5	101.0	3
9/12	1000	1	0	5.0	8	97.0	3
	1700	1	0	21.0	9	95.0	3
9/13	1000	1	0	5.0	7.5	87.0	3
	1700	1	0	19.5	9	85.0	3
9/14	1000	1	0	3.0	7.5	79.0	3
	1700	1	0	19.5	8.5	73.0	3
9/15	1000	1	0	2.0	7	67.0	3
	1700	1	0	19.0	8.5	65.0	3
9/16	1000	1	0	1.0	6.5	62.0	3
	1700	1	0	18.5	8	61.0	3
9/17	1000	5	0	5.0	7	58.0	3
	1700	1	0	16.0	8	56.0	3
9/18	1000	1	0	2.0	6.5	54.0	3
	1700	1	0	18.5	7	53.0	3
9/19	1000	1	0	7.0	6.5	50.0	3
	1730	1	0	18.0	8	49.0	3.0
9/20	1000	1	0	0.5	6	47.0	3.0

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

[b] Represents the cumulative precipitation in the 24 hours prior to the daily morning observation.

[c] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility between 0.5 and 1 mete
3 = visibility less than 0.5 meter

APPENDIX B: BENCHMARK

Appendix B.–Photograph showing the benchmark (river level= 300cm) established in 2005, and located in the panel storage area at Tatlawiksuk River weir.

APPENDIX C: DAILY PASSAGE COUNTS

Appendix C.–Daily passage counts at the Tatlawiksuk River weir, 2010.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	Whitefish	Other[a]
6/15	0	0	0	0	0	0	0	
6/16	0	0	0	0	0	0	0	
6/17	0	0	0	0	0	0	0	2P
6/18	0	0	0	0	0	0	0	
6/19	0	0	0	0	0	0	0	1AG, 1P
6/20	0	0	0	0	0	0	0	
6/21	0	0	3	0	0	0	0	1AG
6/22	1	0	5	0	0	1	0	5AG
6/23	0	0	0	0	0	1	0	4AG
6/24	0	0	3	0	0	13	0	4AG
6/25	0	0	7	0	0	0	0	2AG
6/26	1	0	31	0	0	5	0	2AG
6/27	1	0	28	0	0	0	0	1AG
6/28	1	0	174	0	0	0	0	
6/29	15	0	380	0	0	0	0	2AG
6/30	0	0	227	0	0	0	0	
7/1	1	0	700	0	0	0	0	1AG
7/2	3	0	576	0	0	2	0	3AG
7/3	12	0	734	0	0	1	0	
7/4	9	0	845	0	0	1	0	
7/5	38	0	1,458	0	0	5	0	
7/6	34	0	1,025	0	0	0	0	
7/7	81	0	1,032	0	0	0	0	
7/8	27	0	1,184	0	0	1	0	
7/9	34	0	1,101	0	0	8	0	1AG
7/10	4	0	987	0	0	3	0	
7/11	16	1	1,403	0	0	2	0	
7/12	24	0	1,832	0	0	1	0	
7/13	35	0	1,799	0	0	1	0	2AG
7/14	18	0	1,721	0	0	1	0	
7/15	19	0	1,625	0	0	1	0	
7/16	25	2	2,116	0	0	1	0	
7/17	4	1	1,490	0	0	0	1	
7/18	4	1	517	0	0	0	0	3AG
7/19	14	1	1,112	2	0	0	0	1AG
7/20	16	0	1,112	3	0	0	0	3AG
7/21	14	0	865	1	0	0	0	
7/22	15	2	943	3	0	0	0	
7/23	6	3	768	0	0	0	0	
7/24	6	2	835	0	0	1	0	
7/25	6	1	901	0	0	0	0	
7/26	11	3	1,229	0	0	0	0	
7/27	6	1	1,016	1	0	1	0	
7/28	6	0	910	3	1	1	0	
7/29	1	1	517	0	1	0	0	
7/30	4	2	528	1	2	1	0	
7/31	2	3	473	1	3	0	0	
8/1	4	1	454	5	3	2	0	
8/2	10	0	373	0	8	0	0	
8/3	5	2	316	0	10	0	0	
8/4	4	0	269	0	14	0	0	
8/5	0	0	212	0	41	0	0	

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Appendix C.–Page 2 of 3.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	Whitefish	Other[a]
8/6	2	0	141		49	1	0	1AG
8/7	1	2	141		41	1	0	
8/8	1	1	114		31	0	0	
8/9	2	1	98		43	0	0	
8/10	1	0	78		37	0	0	
8/11	2	0	76		44	-	-	
8/12	2	0	63		49	-	-	
8/13	2	0	51		53	-	-	
8/14	2	0	39		57	-	-	
8/15	2	0	27		61	-	-	
8/16	2	0	14		66	0	0	
8/17	2	0	2		70	0	0	
8/18	2	0	2		77	-	-	
8/19	2	0	2		83	-	-	
8/20	2	0	2		90	-	-	
8/21	1	0	2		96	-	-	
8/22	1	1	3		103	0	0	
8/23	1	0	2		119	0	0	
8/24	1	0	1		100	0	0	
8/25	0	0	4		174	0	0	
8/26	0	0	0		171	0	0	
8/27	0	0	1		184	0	0	
8/28	0	0	0		141	0	0	
8/29	0	0	1		210	0	0	
8/30	0	0	0		147	0	0	
8/31	0	0	0		99	0	0	
9/1	0	0	1		106	0	0	
9/2	0	0	0		119	0	0	
9/3	0	0	1		110	0	0	
9/4	0	0	0		86	0	0	
9/5	1	0	0		92	0	0	
9/6	0	0	0		53	0	0	
9/7	0	0	0		72	0	0	
9/8	0	0	0		40	0	0	
9/9	0	0	0		53	-	-	
9/10	0	0	0		51	-	-	
9/11	0	0	0		48	-	-	
9/12	0	0	0		46	0	0	
9/13	0	0	0		44	0	0	1AG

-continued-

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	Whitefish	Other[a]
9/14	0	0	0		35	0	0	
9/15	0	0	0		20	0	0	
9/16	0	0	0		23	0	0	
9/17	0	0	0		15	0	0	
9/18	0	0	0		12			
9/19	0	0	0		10			
9/20	0	0	0		8			
Totals	567	33	36,701		3,520	56	1	38AG, 3P

[a] Letter designations are as follows: P = Northern pike, AG = Arctic grayling. Count may not correspond to actual day observed

[b] Counts on this day were incomplete due to the occurrence of a hole in the weir.

[c] Weir was not operational due to extreme water level.

[d] Seasonal weir operation was terminated early.

APPENDIX D: DAILY CARCASS COUNTS

Appendix D.–Daily carcass counts at the Tatlawiksuk River weir, 2010.

	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
6/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6/18	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	0	0	
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1P
6/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	
6/22	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	
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
6/25	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	5	0	1P
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	1P, 1AG
6/28	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	0	
6/29	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	1	0	1	0	0	0	0	0	0	0	0	
7/1	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	1P
7/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	
7/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1P
7/4	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	3	0	
7/5	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
7/6	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	
7/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7/8	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2	0	1P
7/9	0	1	1	0	0	0	3	5	8	0	0	0	0	0	0	1	0	
7/10	0	0	0	0	0	0	6	2	8	0	0	0	0	0	0	1	0	
7/11	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	1P
7/12	0	0	0	0	0	0	4	7	11	0	0	0	0	0	0	3	1	1P, 1AG
7/13	0	0	0	0	0	0	4	5	9	0	0	0	0	0	0	14	2	1P
7/14	0	0	0	0	0	0	12	5	17	0	0	0	0	0	0	0	0	1P
7/15	0	0	0	0	0	0	5	4	9	0	0	0	0	0	0	12	1	
7/16	0	0	0	0	0	0	8	8	16	0	0	0	0	0	0	4	1	
7/17	0	0	0	0	0	0	7	3	10	0	0	0	0	0	0	27	0	
7/18	0	0	0	0	0	0	21	18	39	0	0	0	0	0	0	16	0	
7/19	0	0	0	0	0	0	20	13	33	0	0	0	0	0	0	14	2	1S
7/20	0	0	0	0	0	0	21	4	25	0	1	1	0	0	0	15	2	

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Date	Chinook Male	Chinook Female	Chinook Total	Sockeye Male	Sockeye Female	Sockeye Total	Chum Male	Chum Female	Chum Total	Pink Male	Pink Female	Pink Total	Coho Male	Coho Female	Coho Total	Longnose Sucker	White-fish	Other[a]
7/21	0	0	0	0	0	0	23	10	33	0	0	0	0	0	0	10	0	1AG
7/22	0	0	0	0	0	0	20	9	29	0	0	0	0	0	0	5	1	
7/23	0	0	0	0	0	0	12	10	22	0	0	0	0	0	0	4	0	
7/24	0	0	0	0	0	0	15	18	33	0	0	0	0	0	0	7	0	
7/25	0	0	0	0	0	0	14	13	27	0	0	0	0	0	0	17	1	
7/26	0	0	0	0	0	0	16	3	19	0	0	0	0	0	0	31	0	
7/27	0	0	0	0	0	0	26	7	33	0	1	1	0	0	0	7	1	1P
7/28	0	1	1	0	0	0	25	8	33	0	0	0	0	0	0	9	0	
7/29	0	0	0	0	0	0	27	6	33	0	0	0	0	0	0	3	1	
7/30	0	0	0	0	0	0	36	8	44	0	0	0	0	0	0	3	1	
7/31	0	0	0	0	0	0	15	5	20	0	0	0	0	0	0	0	0	
8/1	2	0	2	0	0	0	55	35	90	0	0	0	0	0	0	3	1	1P
8/2	1	0	1	0	0	0	29	14	43	0	0	0	0	0	0	3	1	
8/3	1	1	2	0	0	0	26	6	32	0	0	0	0	0	0	0	0	
8/4	1	1	2	0	0	0	30	11	41	0	0	0	0	0	0	29	0	
8/5	0	0	0	0	0	0	22	11	33	0	0	0	0	0	0	26	0	
8/6	1	0	1	0	0	0	14	6	20	1	0	1	0	0	0	21	0	
8/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8/8	0	0	0	0	0	0	12	14	26	0	0	0	0	0	0	20	0	
8/9	0	0	0	0	0	0	12	8	20	0	0	0	0	0	0	14	0	
8/10	4	0	4	0	0	0	13	14	27	0	0	0	0	0	0	14	0	
8/11	-	-		-	-		-	-		-	-		-	-		-	-	
8/12	-	-		-	-		-	-		-	-		-	-		-	-	
8/13	-	-		-	-		-	-		-	-		-	-		-	-	
8/14	-	-		-	-		-	-		-	-		-	-		-	-	
8/15	-	-		-	-		-	-		-	-		-	-		-	-	
8/16	-	-		-	-		-	-		-	-		-	-		-	-	
8/17	0	0	0	0	0	0	5	2	7	0	0	0	0	0	0	2	0	
8/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
8/19	-	-		-	-		-	-		-	-		-	-		-	-	
8/20	-	-		-	-		-	-		-	-		-	-		-	-	
8/21	-	-		-	-		-	-		-	-		-	-		-	-	
8/22	-	-		-	-		-	-		-	-		-	-		-	-	
8/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

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Appendix D.–Page 3 of 3.

	Chinook			Sockeye			Chum			Pink			Coho			Longnose	White-	
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Other[a]
8/24	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	1	0	
8/25	0	0	0	0	0	0	6	2	8	0	0	0	0	0	0	0	0	1P
8/26	0	0	0	0	0	0	3	1	4	0	0	0	0	1	1	26	9	1P
8/27	0	0	0	0	0	0	2	0	2	0	0	0	0	1	1	29	3	
8/28	0	0	0	0	0	0	2	1	3	0	0	0	0	0	0	14	8	
8/29	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	5	2P
8/30	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0	10	5	
8/31	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	10	6	
9/1	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	6	8	1AG
9/2	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0	6	11	1AG
9/3	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	5	7	
9/4	0	0	0	0	0	0	0	2	2	0	0	0	0	1	1	12	17	
9/5	0	0	0	0	0	0	1	0	1	0	0	0	1	1	2	16	12	1P
9/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	7	
9/7	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	4	7	
9/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	2P
9/9	-	-		-	-		-	-		-	-		-	-		-	-	
9/10	-	-		-	-		-	-		-	-		-	-		-	-	
9/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	
9/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	
9/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	2P
9/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	9	1P
9/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	1P
9/16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7	9	
9/17	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	6	7	1P
Totals	10	4	14	0	0	0	604	304	908	1	2	3	2	4	6	563	192	

Note: Dashes indicate there was no attempt to count carcasses.

[a] AG = Arctic grayling; P = Northern pike; S = Sheefish.

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

[c] Partial daily count.

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