Fishery Data Series No. 13-11

Tatlawiksuk River Salmon Studies, 2011

Annual Report for Study 10-304
USFWS Office of Subsistence Management
Fisheries Resource Monitoring Program

by

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and

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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)

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 Tatlawiksuk River is a tributary of the Kuskokwim River and produces Chinook *Oncorhynchus tshawytscha*, chum *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 ASL compositions of salmon escapements, monitor environmental variables, and facilitate other Kuskokwim Area fisheries projects. In 2011, a resistance board weir was operated from 15 June to 19 September to estimate escapements of three species of Pacific salmon. Chinook salmon escapement (1,012 fish) was below the historical median, chum salmon escapement (84,202 fish) was above the historical median, and coho salmon escapement (12,928 fish) was above 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. ASL sampling in 2011 indicated the Chinook salmon escapement was dominated by age 1.2 (46.3%) and male (74.8%) fish. Chum salmon escapement was dominated by age 0.3 (67.9%) and female (52.5%) fish. Coho salmon escapement was dominated by age 2.1 (87.5%) and female (56.3%) fish.

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, stock specific run timing, Upper Kuskokwim

INTRODUCTION

Each year mature salmon return to the Kuskokwim River and support intensive subsistence and commercial fisheries that produce an average annual harvest of over one million fish (Brazil et al. 2011). 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. The salmon that support these fisheries spawn and rear in nearly every tributary of the 50,000 square miles of the Kuskokwim River drainage (Brown 1983; Coffing 1991; Buklis 1999; Coffing et al. 2001; Bavilla et al. 2010), including the Tatlawiksuk River. Local residents have reported that Athabaskan groups once harvested salmon from the Tatlawiksuk River with fish fences and traps as late as the mid-1900s. Currently little to no harvest occurs in the Tatlawiksuk River (Clark et al. 2011).

The Tatlawiksuk River weir is one of several escapement monitoring projects on the Kuskokwim River drainage (Figure 1) designed to address information gaps of salmon escapement data within the Kuskokwim drainage. Specifically, the Tatlawiksuk River weir site was chosen for logistical reasons, the availability of land use due to collaboration with Kuskokwim Native Association (KNA), and as a representation of the upper Kuskokwim River tributaries. The weir has been in operation since 1998 through the joint effort of KNA and Alaska Department of Fish and Game (ADF&G; Holmes and Burkett 1996; Linderman et al. 2002). Prior to 1998, few salmon spawning streams had been consistently monitored using rigorous techniques such as weirs (Linderman et al. 2002). Tributaries in the vicinity of Tatlawiksuk River including the Gagarayah and Cheeneetnuk Rivers have had aerial surveys attempted since 1976 (Bavilla et al. 2010). However, assessments of the Tatlawiksuk River salmon escapements had only been conducted by sporadic aerial surveys and lacked good estimates of salmon escapement due to the dark, tannic water of Tatlawiksuk River, until the weir was installed in 1998 (Schneiderhan[1]; Burkey and Salomone 1999).

The Tatlawiksuk River weir escapement project, since its inception, has collected escapement and ASL composition information on Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), and coho (*O. kisutch*) salmon. The Tatlawiksuk weir is integrated into a geographic array of projects used to monitor distribution, abundance, and quality of salmon escapements throughout the Kuskokwim River drainage. For example, data from this and other weir escapement projects are a vital input for a Chinook salmon run reconstruction model which estimates total annual Chinook salmon abundance for the entire Kuskokwim River (Bue et al. 2012). Currently, there are no established escapement goals for any salmon species on the Tatlawiksuk River. Reliable long-term escapement datasets like those provided by Tatlawiksuk River weir and other escapement projects in the Kuskokwim area ensure sustainable subsistence and commercial harvest management practices by providing managers with tools to ensure adequate salmon escapement through annual run assessments and development of escapement goals. In addition to escapement monitoring and age composition data collection, the Tatlawiksuk River project hosts high school and college interns through ADF&G's partnership with KNA.

OBJECTIVES

1. Determine daily and total Chinook, chum, and coho salmon escapements to Tatlawiksuk River from 15 June to 20 September.
2. Estimate ASL compositions of Chinook, chum, and coho salmon escapements of the Tatlawiksuk River such that 95% confidence intervals of age composition are no wider than ±10% (α=0.05 and d=0.10).
3. Collect daily air and water temperature, stream level measurements, weather observations, and maintain automated data loggers to monitor air and stream temperatures at Tatlawiksuk River weir.
4. Serve as a platform for mentoring future fisheries professionals and teaching biology to local students by hosting local area high school students as part of KNA's High School Internship Program.

METHODS

STUDY SITE

The 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). The Tatlawiksuk River weir has been installed annually since 1998 at the same location, approximately 4.5 rkm upstream from the confluence with the mainstem Kuskokwim River (lat 62°10.4' N, long 156°14.2' W; Figures 1 and 2). At the weir site, the river measures 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. The river has dense patches of willow that suggest the floodplain is at an intermediate stage of succession and terracing of the floodplain indicated that the stream channel

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[1] Schneiderhan, D. J. (unpublished). Kuskokwim stream catalog, 1954-1983. Alaska Department of Fish and Game, Commercial Fisheries Division, Arctic-Yukon-Kuskokwim Region, Anchorage.

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. In addition to Chinook, chum, and coho salmon, smaller numbers of sockeye *O. nerka* and pink salmon *O. gorbuscha* also spawn in the Tatlawiksuk River. Other species found throughout the system include: Arctic grayling *Thymallus arcticus*, inconnu (Sheefish) *Stenodus leucichthys*, round whitefish *Prosopium cylindraceum*, whitefishes *Coregonus* spp., 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*.

WEIR DESIGN

A resistance board weir designed with a gap of 3.33 cm (1-5/16 in) between each picket (Tobin 1994) with panel modifications (Stewart 2002) was used at the Tatlawiksuk River site. This gap was designed to prevent all species of adult salmon, with the exception of pink salmon, from passing through the weir. 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. The floating and fixed weir lengths are adjusted inseason each year based upon minor changes in the width and depth in the river. 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 entrance doors to the trap could be arranged in a V-shape, or fyke, to prevent fish from easily escaping. 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. The weir is inspected daily for holes and cleaned of debris and carcasses to maintain proper operation. If holes are found a note is made that there is a potential for missed passage. Carcasses are removed from the weir and identified by sex, counted, and recorded daily (Appendix A).

To accommodate downstream migration of longnose suckers and other non-salmon species, downstream passage chutes were used in the weir midseason. At locations where downstream migrants were most concentrated (typically lower velocity areas in the river), chutes were created by releasing the resistance boards on one or two 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

The target operational period for Tatlawiksuk River weir was 15 June to 20 September. Daily and total annual escapements consisted of the observed passage plus any estimated passage of Chinook, sockeye, chum, or coho salmon missed due to flooding or breach in the weir during the target operational period. Counts of all other species were reported simply as observed passage, without estimates for missing counts.

Passage Counts

Passage counts were conducted in hour long shifts five to six times per a day during daylight hours. Counts generally occurred at 0800, 1000, 1400, 1800 and 2000 hours. 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. 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. Fish were only allowed to pass freely through the weir when an observer was present and opened the passage gate. The weir was never left open intentionally without an observer present. Crew members recorded the total upstream fish counts in a designated notebook 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.

Weather and Stream Measurements

Water and air temperatures were manually measured each day at approximately 0730 and 1700 hours. Water and air temperatures were manually measured (°C) each day using a hand held thermometer. In addition, notations about wind direction, estimated wind speed, cloud cover, and precipitation were recorded. Daily precipitation was measured (mm) using a rain gauge and water levels were measured using a staff gage installed approximately 150 meters downstream from the weir (Appendix B). The staff gage, which is re-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 C). Calibration of staff gauge was checked periodically to ensure accuracy.

Passage Estimates

A variety of situations were encountered in which fish passed the weir without being counted, including a breach in the weir and a premature end date. Several methods were used to estimate passage for the given type of inoperable period. Estimates were assumed to be zero when passage was likely negligible based on historical or inseason data. In 2011, 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:

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

Variables are defined as:

n_b = fish count on day before inoperable period,

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

n_a = fish count on day after inoperable period, and

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

The daily estimated missed passage was reported unless it was less than the observed passage; in these cases, observed passage was used instead of the estimate.

Exponential Method

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

$$\hat{n}_i = ae^{bp_i} \quad (2)$$

Variables are defined as:

- a = y-intercept of the fitted line,
- b = slope of the fitted line, and
- p_i = estimated portion (p) of the run on day (i) as represented by the run curve.

AGE, SEX, AND LENGTH COMPOSITION

Sample Size and Distribution

The age composition of adult salmon was determined from scale samples collected from live fish at the weir. 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), eight age-sex categories for chum salmon (n=180), and six 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 of 230 Chinook, 1,100 chum, and 600 coho salmon scale samples.

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; therefore a pulse sampling strategy was employed to ensure adequate temporal distribution of chum and coho salmon samples. Samples were collected from each major portion of the run (i.e., early, middle, and late). Well-spaced pulse samples are thought to better represent 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, of 220 chum and 200 coho salmon samples.

The relatively low abundance of Chinook salmon at Tatlawiksuk River weir made pulse sampling impractical for this species. Instead, Chinook salmon sampling followed a daily collection schedule to distribute a sample size of 230 fish in proportion to expected run timing, based on historical passage data.

Sample Collection Procedures

Salmon were captured for sampling by opening the entrance gate while the exit gate remained closed on the live fish trap. In addition, trapping Chinook salmon can often prove difficult during periods of low passage and/or high passage of other species and "active sampling" is a technique used to capture and sample fish individually while actively passing and counting all other salmon. Following capture in the live fish trap, crew members used a dip net to capture fish within the trap. To obtain length data and aid in scale collection, fish were removed from the dip net and placed into a partially submerged fish "cradle." Scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards (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 from mideye to tail fork length was measured to the nearest millimeter using a straight-edged meter stick. Sex and length data were recorded on standardized numbered data sheets that corresponded 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.

After sampling was completed, all ASL data and metadata were copied to Microsoft Excel[2] spreadsheets that corresponded to numbered gum cards. Completed Microsoft 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 salmon database management system located at: http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx (Brannian et al. 2006). Further details of sampling procedures can be found in Molyneaux et al. (2010).

Data Processing and Reporting

Scale samples were aged and processed by ADF&G staff in Bethel and Anchorage following procedures described by Molyneaux et al. (2010). Age is reported in the European notation, composed of two numerals separated by a decimal. The first numeral represents the number of winters the juvenile spent in freshwater excluding the first winter spent incubating in the gravel, and the second numeral is the number of winters it spent in the ocean (Groot and Margolis 1991). The total age is therefore one year greater than the sum of these two numerals.

RELATED FISHERIES PROJECTS

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 14 June with previous loggers being removed and sent in for analysis. These newly placed 2011 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 mid-channel and the air temperature logger was installed using a solar shield attached to a 4-in diameter tree.

Kuskokwim Native Association High School Internship Program

Local area high school students participated in the Kuskokwim Native Association's (KNA) High School Internship Program at the Tatlawiksuk River weir. Students spent one or two weeks at the weir site completing a daily educational curriculum and participating in weir duties. The

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

program included a hands-on fisheries science curriculum featuring examples from current Kuskokwim Research Projects. Crew members instructed students in fish species identification, ASL sampling and weather and stream observations. In addition, the crew assisted Scott Fritz, KNA Partners Fisheries Educator, in conducting daily lessons related to salmon biology, watershed ecology and accompanying field activities. Career guidance and mentoring from practicing fisheries biologists and technicians was an integral part of the program and provided students with role models for future work in fisheries science.

RESULTS

WEIR OPERATIONS

Tatlawiksuk River weir operated from 14 June through 19 September, one day prior and one day before the end of the target operational period. Target species were not observed passing the weir for several days after installation (Table 1). The single day method was used to estimate Chinook and chum salmon passage on 2 July due to a hole forming in the weir. The exponential method was used to estimate chum and coho salmon passage during the high water event that occurred on 3 August through 19 August and rendered the weir inoperable (Figure 3). During this time period the run of chum salmon was coming to a close and the coho run was just beginning. In addition, the exponential method was used to estimate coho salmon on 20 September due to the weir being removed one day prior to the end of the target operational period.

Water temperature at the weir ranged from 2.0°C to 15.0°C, with an average of 8.9°C (Figure 4). Air temperature at the weir ranged from -2°C to 26.0°C, with an average of 10.6°C. A total of 295.0 mm of precipitation was recorded for the 2011 season. River stage ranged from 12 cm to 141 cm, with an average of 62.5 cm (Figure 3; Appendix B).

ESCAPEMENT MONITORING

Chinook Salmon

In 2011, a total of 1,012 Chinook salmon was estimated to have passed through the weir. The first Chinook salmon was observed on 21 June, a peak count of 144 Chinook salmon occurred on 13 July, and the last Chinook salmon was observed on 17 August (Table 1). The central 50% of the run occurred 6–14 July, with a median passage date of 12 July (Figure 5). Estimated missed passage for inoperable periods in 2011 was 45 fish (4.5% of total passage; Table 1).

Chum Salmon

A total of 84,202 chum salmon was estimated to have passed upstream of the weir during the target operational period. The first chum salmon was observed on 17 June, a peak count of 5,258 chum salmon occurred on 13 July, and the last chum salmon was observed on 14 September (Table 1). The central 50% of the run occurred 11–23 July, with a median passage date of 16 July (Figure 5). Estimated missed passage for inoperable periods in 2011 was 2,004 fish (2.4% of total passage; Table 1). The curve $y=3852.26e^{0.229i}$ was formulated using 26 July through 1 September observed passage to estimate missed passage for 3 through 19 August.

Coho Salmon

A total of 12,928 coho salmon was estimated to have passed upstream of the weir during the target operational period. The first coho salmon was observed on 23 July, and a peak count of 696 coho salmon occurred on 26 August. The central 50% of the run occurred 20–30 August, with a median passage date of 25 August (Figure 5). Estimated missed passage for inoperable periods in 2011 was 2,482 fish (19.2% of total passage; Table 1). The curve $y=3.19e^{0.021i}$ was formulated using 26 July through 1 September observed passage to estimate missed passage for three through 19 August. The curve $y=780.58e^{0.186i}$ was formulated from 14 through 19 September observed passage to estimate missed passage for 20 September.

Other Species

A total of 15 sockeye salmon and 106 pink salmon were counted passing upstream of the weir during the target operational period. An additional 8 sockeye were estimated during inoperable periods for a total passage of 23 sockeye salmon. Non-salmon species included 1,805 longnose suckers, 2 whitefish, 7 Arctic grayling, and 4 northern pike (Appendix D).

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

ASL samples were collected from 169 Chinook salmon from 1 July through 24 July. Sample collection was well distributed throughout the run and in relative proportion to run abundance. Age was determined for 123 (73%) of the fish sampled. The available samples were considered to be representative of the escapement, and the objective for precision of the estimated age composition ($d \leq 0.10$) was met. Age-1.2 fish comprised 46.3% of the total escapement followed by age-1.3 (30.1%), age-1.4 (21.1%), age-1.5 (1.6%), and age-2.4 (0.8%). Male Chinook salmon comprised 74.8% of the escapement and females comprised 25.2%. The ratio of males to females changed across the range of age classes observed. Males comprised 100% of age-1.2, 59.5% age-1.3, 46.3% age-1.4, and 0.0% age-1.5. Females comprised 0.0% age-1.2, 40.5% age-1.3, 53.7% age-1.4, and 100% age-1.5. The average length of male Chinook salmon ranged from 589 mm at age-1.2 to 736 mm at age-1.4. The average length of female Chinook ranged from 727 mm at age-1.3 to 893 mm at age-1.4. Females were on average 52 mm larger than males at age. The range of fish lengths observed for each age class overlapped broadly, for both males and females (Table 2).

Chum Salmon

ASL samples were collected from 1,076 chum salmon from 2 July through 29 August. Age was determined for 938 (87%) of the fish sampled. Escapement was partitioned into three temporal strata, 6 July through 12 June (*n*=441), 13 June through 19 June (*n*=188), and 20 June through 20 September (*n*=309), and seasonal ASL composition was weighted by escapement during these three strata. The available samples were considered to be representative of the escapement, and the objective for precision of the estimated age composition ($d \leq 0.10$) was met. The four age classes observed were age 0.3 (67.9%), age 0.4 (31.3%) age 0.2 (0.5%), and age 0.5 (0.3%). Males comprised 0.0% of age-0.2, 44.7% age-0.3, 53.7% age-0.4, and 100% of age-0.5 fish. Females comprised 100% of age-0.2, 55.3% age-0.3, 46.3% age-0.4, and 0.0% of age-0.5 fish. The average length of male chum salmon ranged from 564 mm at age 0.3 to 579 mm at age 0.5. The average length of female chum salmon was smaller at age than males and ranged from 507 mm at age 0.2 to 546 mm for age 0.4 (Table 3).

Coho Salmon

ASL samples were collected from 402 coho salmon from 27 August through 8 September. Of those, age was determined for 359 (89%) of the fish sampled. Escapement was not partitioned for the coho samples because there was no significant difference in statistical analysis between data with the maximum stratification (of two temporal strata) and data with no stratification. The available samples were considered to be representative of the escapement, and the objective for precision of the estimated age composition ($d \le 0.10$) was met. The three age classes observed were age 2.1 (87.5%), age 3.1 (7.5%), and age 1.1 (5%). Males comprised 44.6% of age-2.1, 38% age-1.1, and 37.3 % of age-3.1 fish. Females comprised 55.4% of age-2.1, 62% age-1.1, and 62.7% age-3.1 fish. The average length at age ranged from 556 mm to 567 mm for male coho salmon and 558 mm to 561 for females. The range of fish lengths observed for each age class overlapped broadly, for both males and females (Table 4).

RELATED FISHERIES PROJECTS

Temperature Monitoring

Results for temperature monitoring will be reported under U.S. Fish and Wildlife Service (USFWS), Office of Subsistence Management Project No. 08-701.

KNA High School Internship Program

A total of five students participated in the KNA High School Internship Program at the Tatlawiksuk River weir, including three first-year and two returning students.

DISCUSSION

Daily weir counts and total annual escapement estimates were successfully determined for each of the target species at Tatlawiksuk River weir in 2011, despite high water that interrupted operations at the beginning of August. High water events are not uncommon for tributaries of the Kuskokwim River however the extended period of time that the weir was inoperable was unusual. River stages on 23 through 26 June and 4 through 17 August were record highs. High water levels coincided with low water temperatures and low water clarity. In 2011, water temperature was within the historical range for much of the season with exceptions of record cold temperatures from 6 through 16 August (Figure 4).

Chinook Salmon

Run timing of Chinook salmon for the Tatlawiksuk River weir was considered to be late. Abundance was lower than the 1999–2010 median abundance for Chinook salmon (N=1,691). Similar findings of lower than normal abundance of Chinook salmon was observed at other Kuskokwim River escapement projects. The duration of the run was similar to historical observations with a median passage date occurring on 12 July, only three days later than the historical median (Figures 5 and 6). In addition, a higher proportion of younger fish (age 1.2) and a lower proportion of older fish (age 1.3 and 1.4) were observed (Figure 7).

Chum Salmon

The escapement of chum salmon in 2011 was the highest on record at Tatlawiksuk River weir with the passage of 84,203 fish. Previously the highest escapement was in 2007 with a passage of 83,250 fish. Run timing was similar to historical observations with a median passage date occurring on 16 July (Figures 5 and 6). Age classes followed historical patterns with age-0.3 and -0.4 classes being the largest classes documented (67.9% and 31.3%, respectively; Figure 7). In addition, the percentage of age-0.3 fish was slightly higher than the historical median at this project.

Coho Salmon

Coho salmon escapement in 2011 was the second highest on record, next to 2004 (Figure 6), but passage was estimated for 20.4% of the run. Based on eight years of usable data from this project, the historical median passage date for coho salmon is August 19. When including the estimates for missed passage during inoperable periods, run timing in 2011 appeared later than average with the central 50% passing six days later than the 1999–2010 median (Figure 5; Table 1). There appeared to be proportionally more female coho salmon (56.3%) in 2011 (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).

ACKNOWLEDGMENTS

The Tatlawiksuk River weir project is operated cooperatively by KNA and ADF&G, Division of Commercial Fisheries. The USFWS Office of Subsistence Management provided $184,631 in 2011 for this project through the Fisheries Resource Monitoring Program (FRMP), under agreement number 70181AJ029, with matching support from the State of Alaska and KNA. Additionally, FRMP helps fund salmon ASL data analysis for this and many other projects in the Kuskokwim Area under agreement number 70181AJ028, and provides a KNA biologist position through its Partners Program in support of this and other projects under agreement number 701818J682. Operational funds have been provided to KNA from a number of sources including grants from the National Fish and Wildlife Foundation, and grants from the U.S. Bureau of Indian Affairs administered by the Bering Sea Fishermen's Association. The Tatlawiksuk River weir was initiated under a grant from the Western Alaska Disaster Relief Program under the National Oceanic and Atmospheric Administration. Other groups such as the Kuskokwim Corporation and the ADF&G Division of Sport Fish have provided in-kind support to the project in the form of land use for camp facilities, weir fabrication, and welding services. General Fund support from ADF&G included assistance from staff biologists, fish and wildlife technicians who serve as crew leaders and crew members, equipment purchases, and a portion of operational costs.

Many individuals contributed to the operation of the Tatlawiksuk River weir in 2011. Administrative and logistical support was provided by Kevin Schaberg and Emerie Fairbanks of ADF&G; and Mike Thalhauser of KNA. Thanks also to KNA field personnel: Harry George (technician); Charles Grammer, Jared Thorson, and Wendy Parent (college interns); and Scott Fritz (Internship Coordinator) with the high school interns for contributing to the successful project in 2011. Thanks to additional help throughout the season provided by Zach Liller, Rob Stewart, Spenser Brown, Joshua Clark, Derick Williams, Dylan Williams, Cara Lucas, Tracy Hansen, Glen Lindsey, and Brad Gusty.

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TABLES AND FIGURES

Table 1.–Daily, cumulative and cumulative percent passage of Chinook, chum, coho, and sockeye salmon at Tatlawiksuk river weir, 2011.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Coho Salmon		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
15 Jun	0	0	0	0	0	0	0	0	0	0	0	0
16 Jun	0	0	0	0	0	0	0	0	0	0	0	0
17 Jun	0	0	0	0	0	0	3	3	0	0	0	0
18 Jun	0	0	0	0	0	0	3	6	0	0	0	0
19 Jun	0	0	0	0	0	0	7	13	0	0	0	0
20 Jun	0	0	0	0	0	0	6	19	0	0	0	0
21 Jun	1	1	0	0	0	0	21	40	0	0	0	0
22 Jun	0	1	0	0	0	0	12	52	0	0	0	0
23 Jun	0	1	0	0	0	0	14	66	0	0	0	0
24 Jun	0	1	0	0	0	0	17	83	0	0	0	0
25 Jun	2	3	0	0	0	0	34	117	0	0	0	0
26 Jun	0	3	0	0	0	0	82	199	0	0	0	0
27 Jun	1	4	0	0	0	0	47	246	0	0	0	0
28 Jun	1	5	0	0	0	0	65	311	0	0	0	0
29 Jun	0	5	0	0	0	0	8	319	0	0	0	0
30 Jun	9	14	1	0	0	0	220	539	1	0	0	0
1 Jul	7	21	2	0	0	0	452	991	1	0	0	0
2 Jul[a]	26	47	5	0	0	0	690	1,681	2	0	0	0
3 Jul	44	91	9	0	0	0	1,109	2,790	3	0	0	0
4 Jul	43	134	13	0	0	0	977	3,767	4	0	0	0
5 Jul	51	185	18	0	0	0	1,286	5,053	6	0	0	0
6 Jul	106	291	29	1	1	4	2,757	7,810	9	0	0	0
7 Jul	37	328	32	1	2	9	1,932	9,742	12	0	0	0
8 Jul	43	371	37	0	2	9	2,511	12,253	15	0	0	0
9 Jul	53	424	42	1	3	13	3,877	16,130	19	0	0	0
10 Jul	46	470	46	1	4	18	3,445	19,575	23	0	0	0
11 Jul	27	497	49	1	5	22	2,974	22,549	27	0	0	0
12 Jul	94	591	58	0	5	22	5,078	27,627	33	0	0	0
13 Jul	144	735	73	0	5	22	5,258	32,885	39	0	0	0
14 Jul	29	764	75	0	5	22	3,124	36,009	43	0	0	0
15 Jul	26	790	78	0	5	22	2,366	38,375	46	0	0	0
16 Jul	26	816	81	0	5	22	4,053	42,428	50	0	0	0
17 Jul	10	826	82	0	5	22	3,455	45,883	54	0	0	0
18 Jul	21	847	84	0	5	22	3,624	49,507	59	0	0	0
19 Jul	42	889	88	0	5	22	4,044	53,551	64	0	0	0
20 Jul	26	915	90	0	5	22	3,250	56,801	67	0	0	0
21 Jul	12	927	92	0	5	22	2,731	59,532	71	0	0	0
22 Jul	8	935	92	0	5	22	2,068	61,600	73	0	0	0
23 Jul	8	943	93	0	5	22	2,631	64,231	76	1	1	0
24 Jul	9	952	94	2	7	31	2,162	66,393	79	1	2	0
25 Jul	4	956	94	0	7	31	2,666	69,059	82	0	2	0
26 Jul	8	964	95	0	7	31	2,820	71,879	85	2	4	0
27 Jul	5	969	96	1	8	36	2,532	74,411	88	3	7	0
28 Jul	4	973	96	1	9	40	1,925	76,336	91	4	11	0
29 Jul	5	978	97	1	10	44	1,461	77,797	92	4	15	0
30 Jul	2	980	97	0	10	44	1,371	79,168	94	24	39	0
31 Jul	1	981	97	0	10	44	1,004	80,172	95	19	58	0

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Table 1.–Page 2 of 3.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Coho Salmon		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
1 Aug	4	985	97	0	10	44	932	81,104	96	28	86	1
2 Aug	2	987	97	0	10	44	675	81,779	97	18	104	1
3 Aug [b]	3	990	98	1	11	49	491	82,269	98	20	124	1
4 Aug [b]	3	992	98	0	11	49	390	82,659	98	24	148	1
5 Aug [b]	3	995	98	0	11	50	310	82,969	99	29	177	1
6 Aug [b]	2	997	99	0	12	51	247	83,216	99	36	213	2
7 Aug [b]	2	999	99	0	12	52	196	83,413	99	44	258	2
8 Aug [b]	2	1,001	99	0	12	54	156	83,569	99	54	312	2
9 Aug [b]	2	1,003	99	0	13	56	124	83,693	99	66	378	3
10 Aug [b]	2	1,005	99	0	13	58	99	83,792	100	81	459	4
11 Aug [b]	2	1,006	99	1	13	60	79	83,870	100	99	558	4
12 Aug [b]	1	1,008	100	1	14	62	62	83,933	100	121	679	5
13 Aug [b]	1	1,009	100	1	15	65	50	83,982	100	149	828	6
14 Aug [b]	1	1,010	100	1	15	68	40	84,022	100	182	1,010	8
15 Aug [b]	1	1,011	100	1	16	71	31	84,053	100	223	1,232	10
16 Aug [b]	1	1,011	100	1	17	75	25	84,078	100	272	1,505	12
17 Aug [b]	1	1,012	100	1	18	78	20	84,098	100	333	1,838	14
18 Aug [b]	0	1,012	100	1	19	82	16	84,114	100	408	2,246	17
19 Aug [b]	0	1,012	100	2	21	91	13	84,126	100	500	2,746	21
20 Aug	0	1,012	100	2	23	100	8	84,134	100	604	3,350	26
21 Aug	0	1,012	100	0	23	100	1	84,135	100	730	4,080	32
22 Aug	0	1,012	100	0	23	100	10	84,145	100	676	4,756	37
23 Aug	0	1,012	100	0	23	100	9	84,154	100	595	5,351	41
24 Aug	0	1,012	100	0	23	100	4	84,158	100	609	5,960	46
25 Aug	0	1,012	100	0	23	100	7	84,165	100	569	6,529	51
26 Aug	0	1,012	100	0	23	100	3	84,168	100	696	7,225	56
27 Aug	0	1,012	100	0	23	100	10	84,178	100	667	7,892	61
28 Aug	0	1,012	100	0	23	100	8	84,186	100	625	8,517	66
29 Aug	0	1,012	100	0	23	100	3	84,189	100	605	9,122	71
30 Aug	0	1,012	100	0	23	100	4	84,193	100	523	9,645	75
31 Aug	0	1,012	100	0	23	100	1	84,194	100	483	10,128	78
1 Sep	0	1,012	100	0	23	100	2	84,196	100	388	10,516	81
2 Sep	0	1,012	100	0	23	100	0	84,196	100	325	10,841	84
3 Sep	0	1,012	100	0	23	100	0	84,196	100	289	11,130	86
4 Sep	0	1,012	100	0	23	100	0	84,196	100	257	11,387	88
5 Sep	0	1,012	100	0	23	100	0	84,196	100	204	11,591	90
6 Sep	0	1,012	100	0	23	100	3	84,199	100	190	11,781	91
7 Sep	0	1,012	100	0	23	100	0	84,199	100	159	11,940	92
8 Sep	0	1,012	100	0	23	100	1	84,200	100	183	12,123	94
9 Sep	0	1,012	100	0	23	100	1	84,201	100	119	12,242	95
10 Sep	0	1,012	100	0	23	100	0	84,201	100	154	12,396	96
11 Sep	0	1,012	100	0	23	100	0	84,201	100	111	12,507	97
12 Sep	0	1,012	100	0	23	100	0	84,201	100	101	12,608	98
13 Sep	0	1,012	100	0	23	100	0	84,201	100	68	12,676	98
14 Sep	0	1,012	100	0	23	100	1	84,202	100	70	12,746	99
15 Sep	0	1,012	100	0	23	100	0	84,202	100	45	12,791	99
16 Sep	0	1,012	100	0	23	100	0	84,202	100	34	12,825	99

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Table 1.–Page 3 of 3.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Coho Salmon		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
17 Sep	0	1,012	100	0	23	100	0	84,202	100	30	12,855	99
18 Sep	0	1,012	100	0	23	100	0	84,202	100	28	12,883	100
19 Sep	0	1,012	100	0	23	100	0	84,202	100	26	12,909	100
20 Sep [b]	0	1,012	100	0	23	100	0	84,202	100	19	12,928	100

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

[a] Daily passage was estimated using single day method.

[b] Daily passage was estimated using the exponential method.

Table 2.–Kuskokwim River Chinook salmon age, sex, and length (mm) composition from the Tatlawiksuk River weir escapement project, 2011.

			Brood Year (Age)																	
			2007				2006				2005				2004					
	Sample		(1.2)		(2.1)		(1.3)		(2.2)		(1.4)		(2.3)		(1.5)		(2.4)		Total	
	Size		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Weighted Season Total	123	Male	469	46.3	0	0.0	181	17.9	0	0.0	99	9.8	0	0.0	0	0.0	8	0.8	757	74.8
		Female	0	0.0	0	0.0	123	12.2	0	0.0	115	11.4	0	0.0	16	1.6	0	0.0	255	25.2
		Total	469	46.3	0	0.0	304	30.1	0	0.0	214	21.1	0	0.0	16	1.6	8	0.8	1,012	100.0
		95% C.I. (%)		±8.29				±7.63				±6.80				±2.55				
		Male Mean Length	589		-		668		-		736		-		-		710			
		SE	6		-		13		-		20		-		-		-			
		Range	497-679		-		594-841		-		667-879		-		-		710-710			
		n	57		-		22		-		12		-		-		1			
		Female Mean Length	-		-		727		-		782		-		893		-			
		SE	-		-		18		-		23		-		3		-			
		Range	-		-		590-835		-		628-921		-		890-896		-			
		n	-		-		15		-		14		-		2		-			

Table 3.–Kuskokwim River chum salmon age, sex, and length (mm) from the Tatlawiksuk River weir escapement project, 2011.

		Brood Year (Age)									
		2008		2007		2006		2005			
Sample		(0.2)		(0.3)		(0.4)		(0.5)		Total	
Size		N	%	N	%	N	%	N	%	N	%
938	Male	0	0.0	25,622	30.4	14,170	16.8	224	0.3	40,016	47.5
Weighted Season Total	Female	459	0.5	31,545	37.5	12,183	14.5	0	0.0	44,187	52.5
	Total	459	0.5	57,166	67.9	26,353	31.3	224	0.3	84,203	100.0
	95% C.I. (%)	±0.49		±3.04		±3.01		±0.31			
	Male Mean Length	-		564		574		579			
	SE	-		2		3		14			
	Range	0-0		475-645		516-644		566-607			
	n	-		291		172		3			
	Female Mean Length	507		538		546		-			
	SE	8		1		2		-			
	Range	486-525		455-639		471-607		0-0			
	n	5		326		141		-			

Table 4.–Kuskokwim River coho salmon age, sex, and length (mm) from the Tatlawiksuk River weir escapement project, 2011.

			Brood Year (Age)							
			2008		2007		2006			
	Sample		(1.1)		(2.1)		(3.1)		Total	
	Size		N	%	N	%	N	%	N	%
Weighted Season Total	359	Male	252	1.9	5,042	39.0	360	2.8	5,654	43.7
		Female	396	3.1	6,266	48.5	612	4.7	7,274	56.3
		Total	648	5.0	11,307	87.5	972	7.5	12,928	100.0
		95% C.I. (%)	±2.23		±3.38		±2.69			
		Male Mean Length	556		562		567			
		SE	14		3		9			
		Range	506-618		415-655		511-602			
		n	7		140		10			
		Female Mean Length	559		558		561			
		SE	5		2		8			
		Range	526-590		425-651		451-601			
		n	11		174		17			

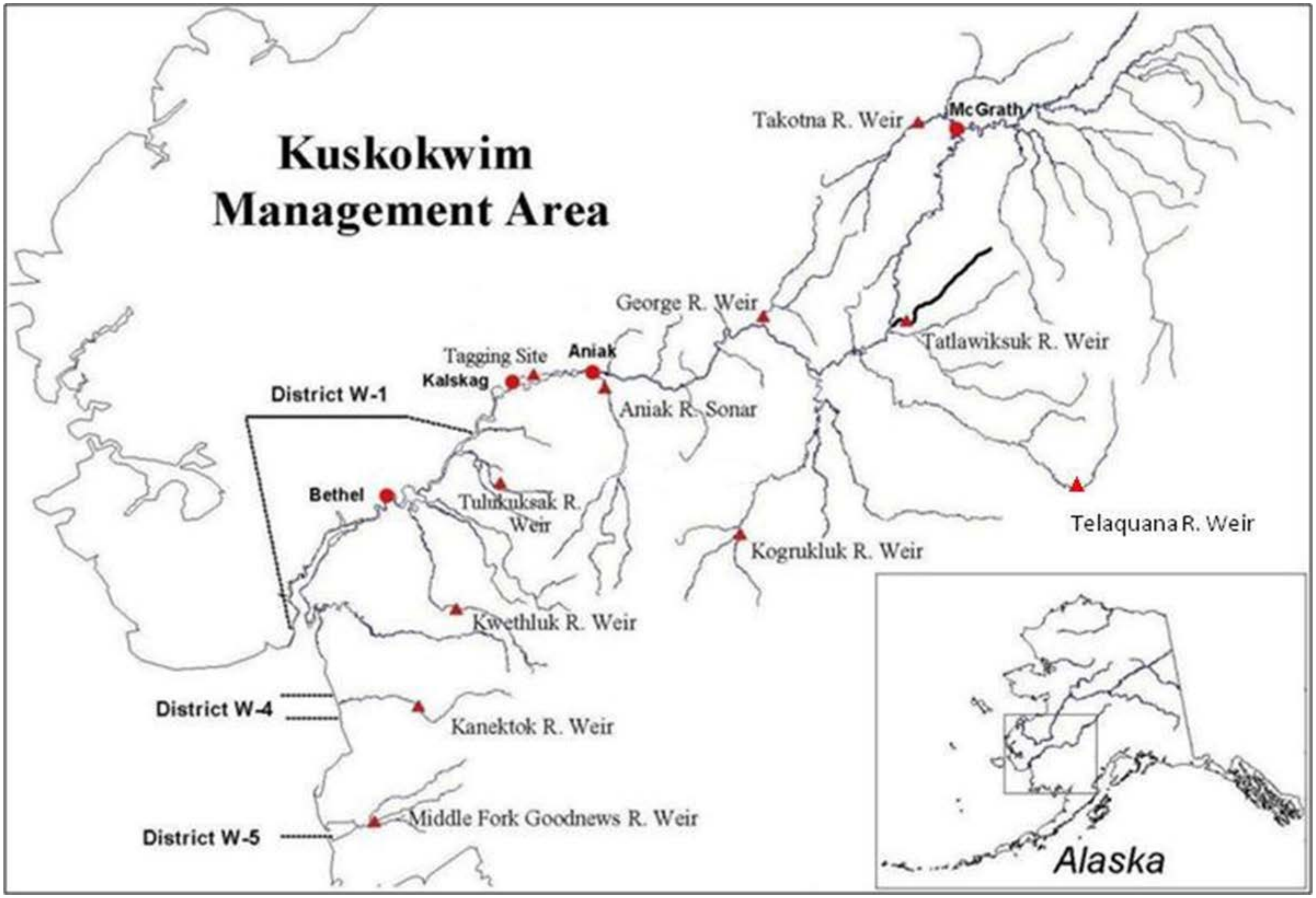


Figure 1.–Map depicting the location of Kuskokwim Area salmon management districts and escapement monitoring projects with emphasis on the Tatlawiksuk River.

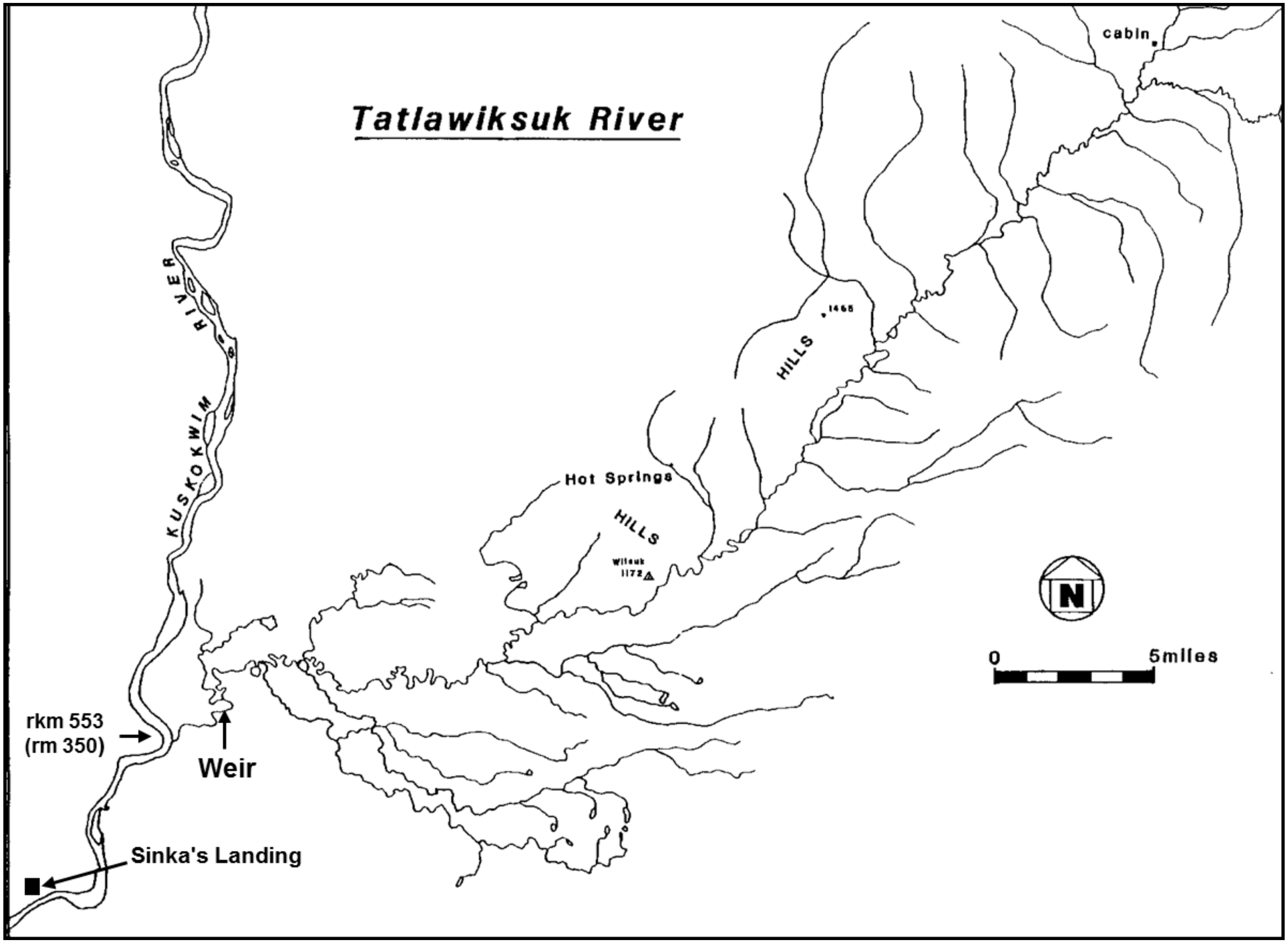


Figure 2.–Map depicting the Tatlawiksuk River drainage and the location of the weir.

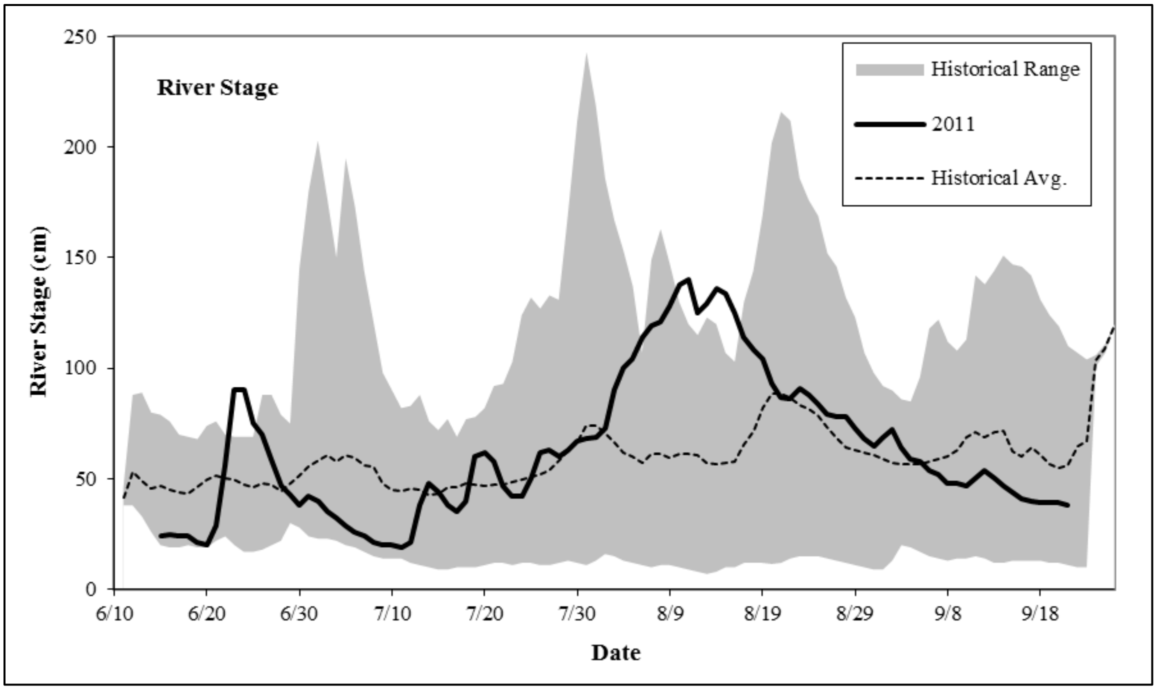


Figure 3.–Daily morning river stage at Tatlawiksuk River weir in 2011 relative to historical average, minimum, and maximum morning readings from 2000 to 2011.

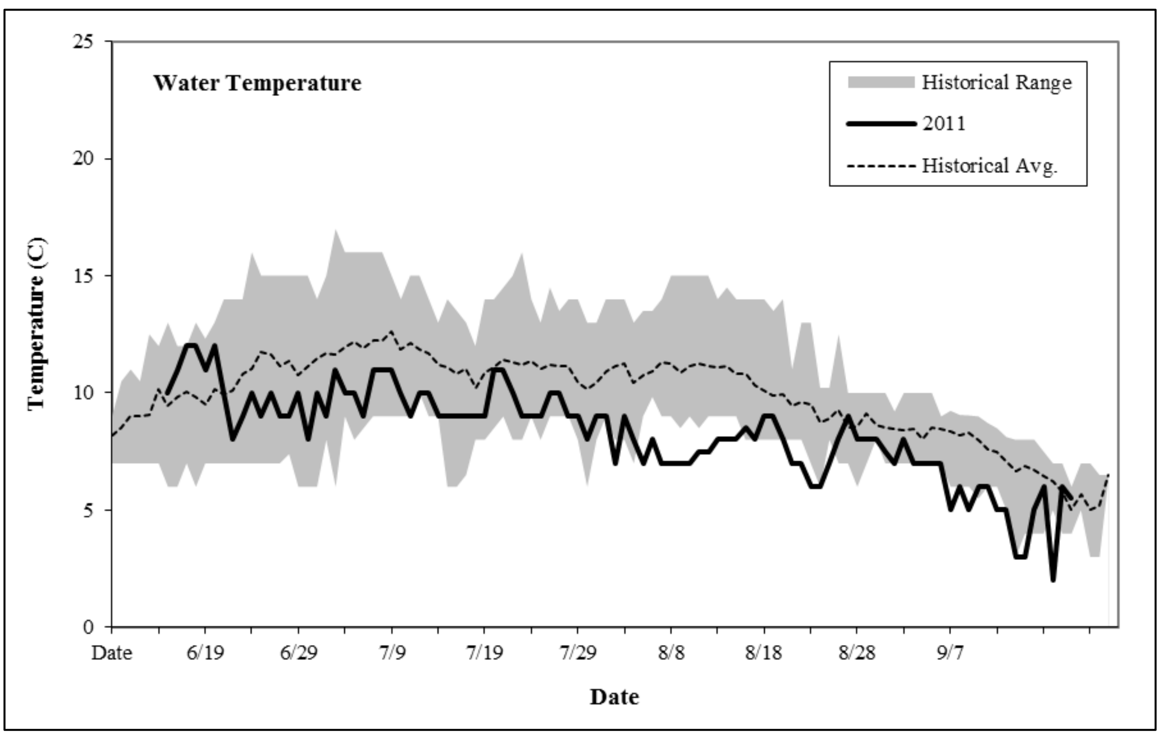
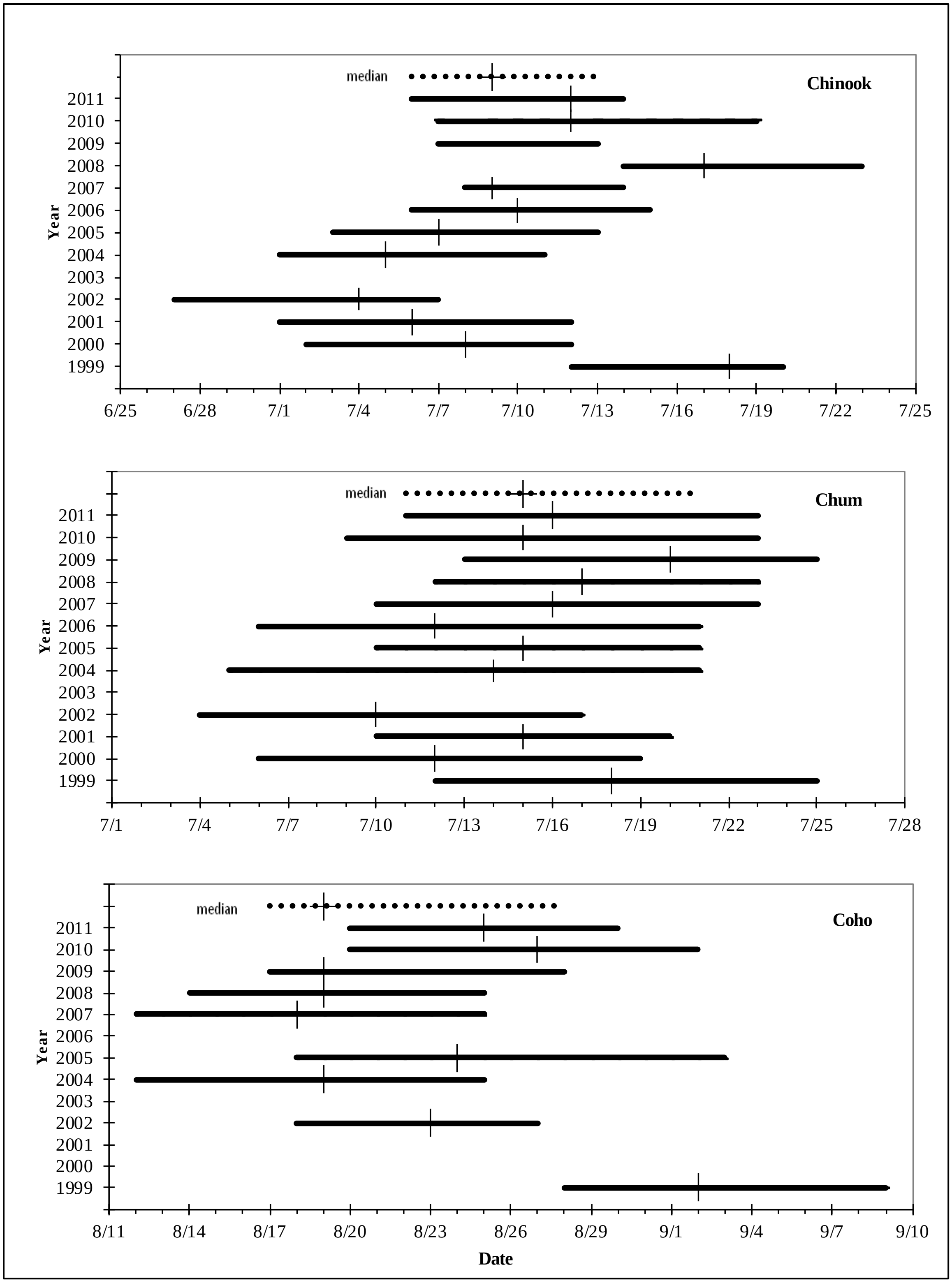


Figure 4.–Daily morning water temperature at Tatlawiksuk River weir in 2011 relative to historical average, minimum, and maximum morning readings from 1996 to 2011.



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.

Figure 5.–Run timing of Chinook, chum, and coho salmon based on cumulative percent passage at the Tatlawiksuk River weir, 1999–2011.

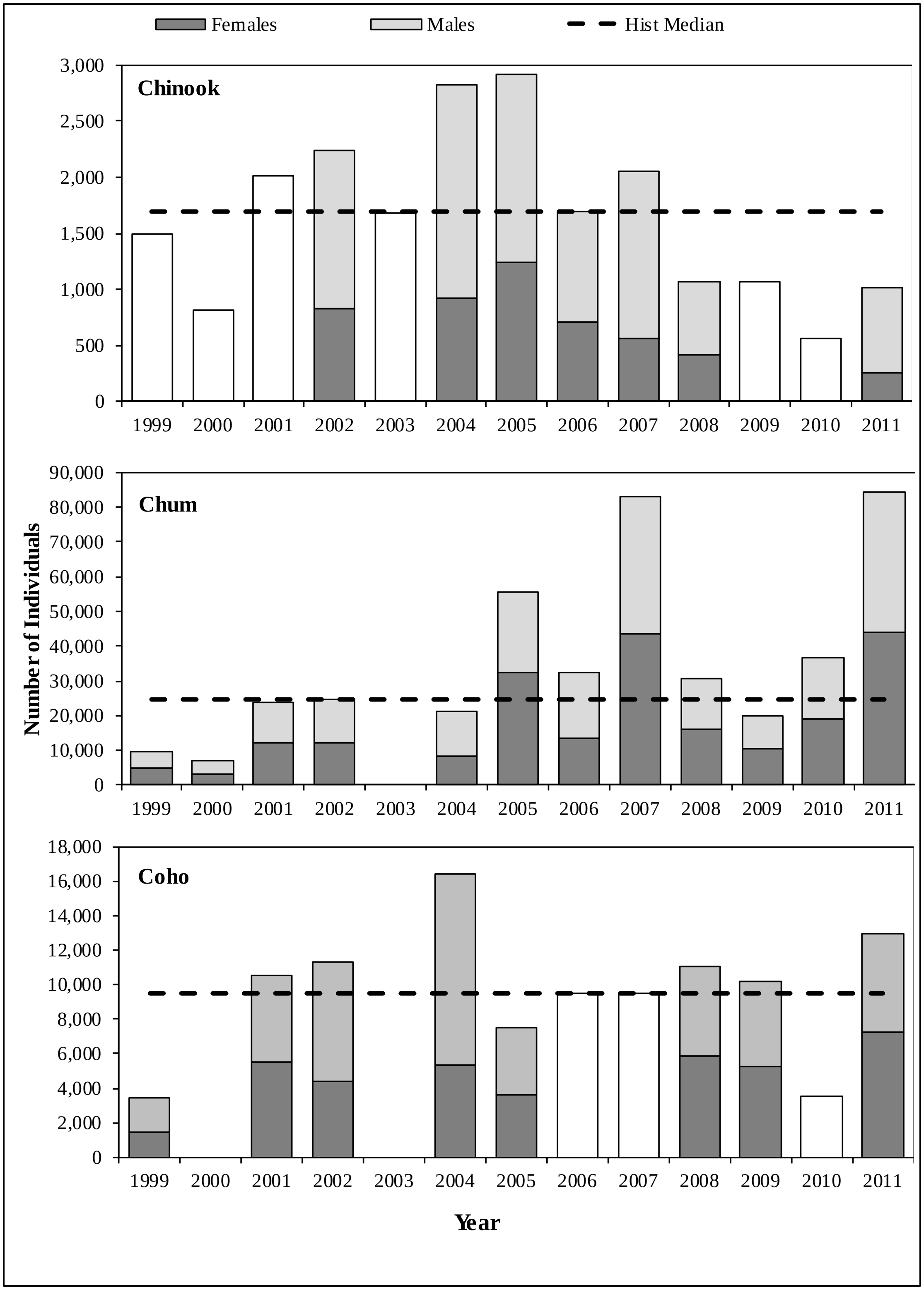
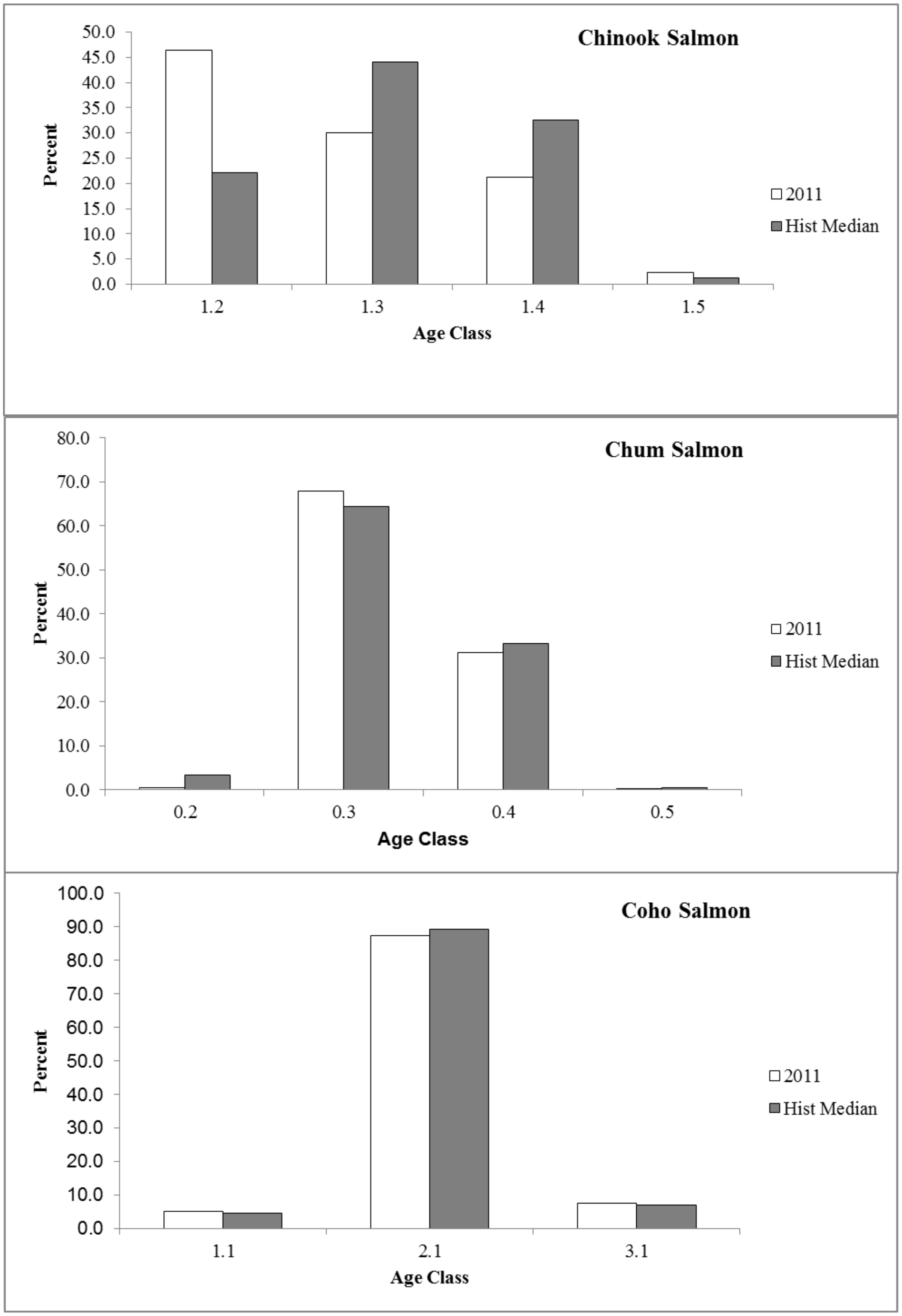


Figure 6.–Historical escapement by sex of Chinook, coho, and chum salmon at Tatlawiksuk River weir, 1999–2011.



Note: Median has been calculated from years 1999–2010. The following years have been excluded: 1999–2001 for Chinook salmon; 2000 and 2006 for coho salmon; 2003 for all species.

Figure 7.–Percent composition of dominate age classes for Chinook, chum, and coho salmon (historical median and 2011) at Tatlawiksuk River weir.

APPENDIX A: DAILY CARCASS COUNTS

Appendix A1.–Daily carcass counts at Tatlawiksuk River weir, 2011.

	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	
6/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	
6/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	
6/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1P
6/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12	
6/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1P
6/21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	
6/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	
6/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	
6/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	
6/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	
6/27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	
6/28	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	
6/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	
7/2	0	0	0	0	0	0	2	1	3	0	0	0	0	0	0	5	0	
7/3	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	2	0	
7/4	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	4	0	
7/5	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	2	0	
7/6	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	
7/7	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	
7/8	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0	0	0	1P
7/9	0	0	0	0	0	0	8	1	9	0	0	0	0	0	0	3	0	
7/10	0	0	0	0	0	0	4	1	5	0	0	0	0	0	0	2	0	
7/11	0	0	0	0	0	0	6	1	7	0	0	0	0	0	0	0	0	
7/12	0	0	0	0	0	0	9	4	13	0	0	0	0	0	0	3	1	
7/13	0	1	1	0	0	0	22	19	41	0	0	0	0	0	0	1	1	
7/14	0	0	0	0	0	0	14	5	19	0	0	0	0	0	0	5	0	
7/15	1	0	1	0	0	0	26	19	45	0	0	0	0	0	0	4	0	
7/16	0	0	0	0	0	0	25	22	47	0	0	0	0	0	0	9	0	
7/17	0	0	0	0	0	0	16	26	42	0	0	0	0	0	0	0	0	
7/18	1	0	1	0	0	0	27	18	45	0	0	0	0	0	0	14	0	

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Appendix A1.–Page 2 of 3.

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	0	0	0	0	0	0	23	18	41	0	0	0	0	0	0	5	0	1P
7/20	0	0	0	0	0	0	20	25	45	0	0	0	0	0	0	14	0	
7/21	0	0	0	0	0	0	24	24	48	0	0	0	0	0	0	0	0	1AG
7/22 [b]	0	0	0	0	0	0	23	11	34	0	0	0	0	0	0	0	0	
7/23	0	0	0	0	0	0	11	12	23	0	0	0	0	0	0	1	0	
7/24	0	0	0	0	0	0	17	15	32	0	0	0	0	0	0	0	0	
7/25	0	0	0	0	0	0	44	26	70	0	0	0	0	0	0	2	0	
7/26	0	0	0	0	0	0	64	33	97	0	0	0	0	0	0	9	0	1P
7/27	0	0	0	0	0	0	70	22	92	0	0	0	1	0	1	11	0	1AG
7/28	1	0	1	0	0	0	55	3	58	0	0	0	1	0	1	1	0	
7/29	3	2	5	0	0	0	90	36	126	0	0	0	0	0	0	12	2	
7/30	1	0	1	0	0	0	75	53	128	0	0	0	0	0	0	13	0	
7/31	0	0	0	0	0	0	63	26	89	1	0	1	2	0	2	6	0	
8/1	2	0	2	0	0	0	54	19	73	0	0	0	0	0	0	73	0	
8/2	0	0	0	0	0	0	69	34	103	0	0	0	0	0	0	6	3	
8/3 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/4 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/5 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/6 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/7 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/8 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/9 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/10 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/11 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/12 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/13 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/14 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/15 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/16 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/17 [c]	-	-		-	-		-	-		-	-		-	-		-		
8/18 [b]	0	0	0	0	0	0	-	-	4	2	0	2	0	0	0	0	0	
8/19 [b]	0	0	0	0	0	0	20	7	27	1	0	1	0	0	0	4	0	1P
8/20	0	0	0	0	0	0	23	5	28	0	0	0	0	0	0	13	0	
8/21	0	0	0	0	0	0	23	18	41	0	0	0	0	0	0	14	0	

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Appendix A1.–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]
8/22	0	0	0	0	0	0	20	7	27	0	0	0	0	0	0	13	0	
8/23	2	0	2	0	0	0	16	4	20	0	0	0	0	0	0	14	0	
8/24	0	0	0	0	0	0	7	4	11	0	0	0	0	0	0	14	0	
8/25	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	14	4	
8/26	0	0	0	0	0	0	10	2	12	0	0	0	0	0	0	18	0	
8/27	0	0	0	0	0	0	8	1	9	0	0	0	0	0	0	15	4	
8/28	0	0	0	0	0	0	9	1	10	0	0	0	1	1	2	11	8	
8/29	0	0	0	0	0	0	11	2	13	0	0	0	0	1	1	15	9	
8/30	0	0	0	0	0	0	5	1	6	0	0	0	1	0	1	10	12	
8/31	0	0	0	0	0	0	6	1	7	0	0	0	0	0	0	9	23	
9/1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	8	11	
9/2	0	0	0	0	0	0	1	3	4	0	0	0	1	0	1	9	22	
9/3	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	19	20	
9/4	0	0	0	0	0	0	1	1	2	0	0	0	1	0	1	5	2	1P
9/5	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	8	7	
9/6	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	6	3	
9/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	10	
9/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	
9/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	
9/10	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3	2	
9/11	0	0	0	0	0	0	-	-	1	0	0	0	0	0	0	9	3	
9/12	0	0	0	0	0	0	-	-	1	0	0	0	1	0	1	3	4	
9/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	
9/14	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	6	1	
9/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	1P
9/16	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	8	12	
9/17	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	8	10	1P
9/18	2	2	4	0	0	0	0	0	0	0	0	0	2	2	4	10	16	
9/19	1	0	1	0	0	0	0	0	0	0	0	0	3	4	7	2	21	6P
Totals	16	6	22	0	0	0	1001	525	1532	4	0	4	16	8	24	547	253	

Note: Dashes indicate no data.

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

[b] Partial daily count.

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

APPENDIX B: DAILY WEATHER AND STREAM OBSERVATIONS AT THE TATLAWIKSUK RIVER WEIR SITE

Appendix B1.–Daily weather and stream observations at the Tatlawiksuk River weir site, 2011.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	Stage River(cm)	Water Clarity[c]
6/15	1030	3	0.0	-	-	24	1
	1700	3	0.0	-	-	24	1
6/16	730	1	0.0	-2.0	10	25	1
	1700	3	0.0	20.0	12	24	1
6/17	730	1	0.0	6.0	11	24	1
	1700	1	0.0	24.0	14	24	1
6/18	730	3	0.0	13.0	12	24	1
	1700	1	0.0	26.0	14	21	1
6/19	730	4	trace	11.0	12	21	1
	1700	3	0.0	21.0	15	19	1
6/20	730	4	4.0	12.0	11	20	1
	1700	3	4.0	17.0	14	21	1
6/21	730	4	12.5	9.0	12	29	1
	1800	4	5.0	11.0	12	37	1
6/22	730	4	0.5	7.0	10	56	2
	1700	4	7.5	11.0	9	79	3
6/23	730	3	1.0	4.0	8	90	3
	1700	2	0.0	17.0	9	90	3
6/24	730	3	0.0	9.0	9	90	3
	1700	4	0.0	19.0	10	90	3
6/25	730	4	trace	9.0	10	75	3
	1700	4	0.0	15.0	10	74	3
6/26	730	2	3.5	7.0	9	70	2
	1700	4	1.0	16.0	11	65	2
6/27	730	4	3.8	10.5	10	59	2
	1700	4	0.5	19.0	10	50	2
6/28	730	3	0.0	8.0	9	47	2
	1700	2	0.0	13.0	10	45	2
6/29	730	4	0.0	9.0	9	43	2
	1700	4	trace	11.0	10	38	2
6/30	730	4	trace	10.0	10	38	2
	1700	4	trace	12.0	9	43	2
7/1	730	4	trace	11.0	8	42	2
	1700	1	0.0	19.5	12	40	1
7/2	730	1	0.0	8.0	10	40	1
	1700	3	0.0	23.0	14	38	1
7/3	730	3	0.0	11.0	9	35	1
	1700	2	0.0	10.0	12	32	1
7/4	730	4	1.4	8.5	11	32	1
	1700	3	1.5	16.0	12	31	1
7/5	730	3	0.0	10.0	10	29	1
	1700	2	0.0	26.0	14	26	1
7/6	730	1	0.0	6.0	10	26	1
	1700	2	0.0	19.0	11	25	1
7/7	730	3	0.0	8.0	9	24	1
	1700	3	0.0	17.0	11	22	1
7/8	730	3	0.0	8.0	11	21	1
	1700	2	0.0	18.0	14	20	1

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Appendix B1.–Page 2 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
7/9	730	4	0.0	8.0	11	20	1
	1700	4	0.0	15.0	12.0	20	1
7/10	730	4	trace	9.0	11	20	1
	1700	4	0.5	14.0	10	19	1
7/11	730	4	1.0	11.0	10	19	1
	1700	4	9.0	13.0	11	19	1
7/12	730	4	17.5	11.0	9	21	1
	1700	3	0.5	14.0	11	25	1
7/13	730	4	0.0	8.0	10	38	2
	1700	3	0.0	16.0	12	47	2
7/14	730	4	trace	9.0	10	48	2
	1700	4	0.0	12.0	10	48	2
7/15	730	4	0.0	7.0	9	44	2
	1700	3	0.0	19.0	10	40	2
7/16	730	4	0.0	7.0	9	38	2
	1700	2	0.0	15.5	11	38	2
7/17	730	4	0.0	6.0	9	35	2
	1700	4	13.0	12.0	9	36	2
7/18	730	4	trace	7.0	9	40	2
	1700	4	trace	10.0	10	48	2
7/19	730	4	trace	8.0	9	60	2
	1700	2	0.0	17.0	10	60	2
7/20	730	1	0.0	3.0	9	62	3
	1700	1	0.0	23.0	12	60	3
7/21	730	4	0.0	11.0	11	58	3
	1700	1	0.0	18.0	11	50	2
7/22	730	3	0.0	12.0	11	47	2
	1700	2	0.0	26.0	14	45	2
7/23	730	4	0.0	14.0	10	42	2
	1700	4	6.5	14.0	9	43	2
7/24	1000	4	5.4	9.0	9	42	2
	1700	4	0.5	12.0	10	44	2
7/25	730	4	6.0	8.0	9	50	2
	1700	4	trace	13.0	9	56	3
7/26	730	4	0.0	8.0	9	62	3
	1700	3	0.0	15.0	10	63	3
7/27	730	4	0.8	10.0	10	63	3
	1700	1	0.0	19.0	12	60	3
7/28	730	4	7.5	11.0	10	60	3
	1700	4	3.0	14.0	11	57	3
7/29	730	4	trace	9.0	9	63	3
	1700	4	0.0	14.0	11	68	3
7/30	730	3	0.3	9.0	9	67	3
	1700	4	2.0	11.0	9	68	3
7/31	730	3	0.0	3.0	8	68	3
	1700	4	0.0	13.0	9	68	3
8/1	730	4	4.5	9.0	9	69	3
	1700	4	8.0	12.0	9	69	3
8/2	730	4	5.0	10.0	9	73	3
	1700	4	5.0	13.0	9	78	3

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Appendix B1.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
8/3	730	3	0.8	10.0	7	90	3
	1700	4	trace	14.0	9	95	3
8/4	730	4	3.0	8.0	9	100	3
	1700	3	8.0	11.0	8.0	102	3
8/5	730	4	1.2	5.0	8.0	104	3
	1700	3	1.0	11.0	8	113	3
8/6	730	2	0.0	3.0	7	114	3
	1700	4	2.5	8.0	8	116	3
8/7	730	4	12.4	5.0	8	119	3
	1700	3	0.0	10.0	7	117	3
8/8	730	4	3.0	6.0	7	121	3
	1700	4	1.6	8.0	7	125	3
8/9	730	4	11.4	5.0	7	128	3
	1700	3	0.5	11.0	7	132	3
8/10	730	4	0.0	6.0	7	138	3
	1700	2	0.0	14.0	8	141	3
8/11	730	4	0.0	6.0	7	140	3
	1700	4	0.0	15.0	8	134	3
8/12	730	4	10.0	9.0	7.5	125	3
	1700	4	17.5	13.0	7	125	3
8/13	730	4	5.0	12.0	7.5	129	3
	1700	4	2.4	12.0	7.5	132	3
8/14	730	3	0.0	10.0	8	136	3
	1700	3	1.5	13.0	9	137	3
8/15	730	3	trace	8.0	8	134	3
	1700	3	0.0	15.0	8.5	132	3
8/16	730	2	0.0	3.5	8	125	3
	1700	3	0.0	16.0	9	12	3
8/17	730	3	0.0	7.0	8.5	114	3
	1700	3	trace	16.5	9.5	111	3
8/18	730	3	6.2	8.0	8	108	3
	1700	3	0.3	16.0	10	106	3
8/19	730	4	0.0	9.0	9	104	3
	1700	4	0.0	15.0	9.5	100	3
8/20	730	4	trace	8.0	9	93	3
	1700	4	trace	14.0	9	90	3
8/21	730	4	4.4	10.0	8	87	3
	1700	3	4.0	14.0	9	86	3
8/22	730	3	0.0	0.0	7	86	3
	1700	3	0.4	10.0	8	88	3
8/23	730	4	4.0	5.0	7	91	3
	1700	3	trace	10.0	8	88	3
8/24	730	4	trace	5.0	6	88	3
	1700	4	3.6	10.0	7	88	3
8/25	730	4	0.7	7.0	6	84	3
	1700	4	0.9	13.0	8	81	3
8/26	730	3	0.0	4.0	7	79	3
	1700	2	0.0	17.0	8.5	78	3
8/27	900	3	0.0	6.0	8	78	3
	1700	3	trace	17.0	9	77	3

-continued-

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Water	River Stage (cm)	Water Clarity[c]
8/28	900	4	8.0	8.0	9	78	3
	1700	2	0.0	16.0	9	76	3
8/29	730	3	0.0	0.0	8	73	3
	1700	3	0.0	15.5	9	71	3
8/30	730	4	1.4	9.0	8	68	3
	1700	4	0.3	11.0	9	65	3
8/31	730	4	7.0	8.0	8	65	3
	1700	3	7.8	10.0	8.0	65	3
9/1	730	3	trace	5.0	7.5	69	3
	1700	3	trace	12.0	8	69.0	3
9/2	730	4	0	8.0	7	72.0	3
	1700	3	0	14.0	8.5	67.0	3
9/3	730	4	0	9.0	8	64.0	3
	1700	4	trace	11.0	9	63.0	3
9/4	730	3	3.6	7.0	7	59.0	3
	1700	3	0	14.0	9	59.0	3
9/5	730	1	0	5.0	7	58.0	3
	1700	3	0	15.0	8.5	55.0	3
9/6	730	3	0	10.0	7	54.0	3
	1700	3	0	15.0	8.5	52.0	3
9/7	730	4	0.8	6.0	7	52.0	3
	1700	4	trace	14.0	8.5	49.0	3
9/8	730	4	4.6	8.0	5	48.0	3
	1700	4	0.9	10.0	8	47.0	3
9/9	900	4	trace	7.0	6	48.0	2
	1700	4	1.2	9.0	8	47.0	2
9/10	900	4	0	6.0	5	47.0	2
	1700	4	trace	9.0	7.5	48.0	2
9/11	900	2	0	5.0	6	50.0	2
	1700	2	trace	13.0	7.5	52.0	2
9/12	900	4	trace	4.0	6	54.0	2
	1700	3	trace	11.0	7	53.0	2
9/13	900	4	0.3	6.0	5	50.0	2
	1700	3	trace	13.5	7	48.0	2
9/14	900	2	0	3.0	5	47.0	2
	1700	3	trace	11.0	7	47.0	2
9/15	900	4	0	5.0	3	44.0	2
	1700	3	0	11.5	6	43.0	2
9/16	900	4	0	3.0	3	41.0	2
	1700	3	0	12.5	6	42.0	2
9/17	900	3	0	-2.0	5	40.0	1
	1700	1	0	11.5	6	40.0	2
9/18	900	4	5	5.0	6	39.0	1
	1700	2	2.2	10.0	6.5	39.0	1
9/19	900	1	0	1.0	2	39.0	1
	1700	3	trace	13.0	6	39.0	1
9/20	900	4	trace	5.0	6	39.0	1
	1700	3	3.2	10	6	39	1
9/21	900	3	0.2	5	5.5	38	1
	1700	2	0	12.5	6.5	38	1

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[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 meter
3 = visibility less than 0.5 meter

APPENDIX C: BENCHMARK PHOTOGRAPH

Appendix C1.–Photograph showing the benchmark (river level = 300 cm) established in 2005, and located in the panel storage area at Tatlawiksuk River weir.

APPENDIX D: DAILY FISH PASSAGE COUNTS

Appendix D1.–Daily fish passage counts at the Tatlawiksuk River weir, 2011.

Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	White-fish	Other[a]
6/15	0	0	0	0	0	0	0	
6/16	0	0	0	0	0	0	0	
6/17	0	0	3	0	0	14	0	
6/18	0	0	3	0	0	301	0	
6/19	0	0	7	0	0	287	0	
6/20	0	0	6	0	0	304	0	1P
6/21	1	0	21	0	0	83	0	
6/22	0	0	12	0	0	21	0	
6/23	0	0	14	0	0	7	0	
6/24	0	0	17	0	0	93	0	
6/25	2	0	34	0	0	32	0	
6/26	0	0	82	0	0	27	0	
6/27	1	0	47	0	0	24	0	
6/28	1	0	65	0	0	16	0	
6/29	0	0	8	0	0	0	0	
6/30	9	0	220	0	0	3	0	
7/1	7	0	452	0	0	14	0	
7/2	3	0	659	0	0	27	0	
7/3	44	0	1,109	0	0	87	2	
7/4	43	0	977	0	0	37	0	
7/5	51	0	1,286	0	0	28	0	
7/6	106	1	2,757	0	0	25	0	1P
7/7	37	1	1,932	0	0	20	0	
7/8	43	0	2,511	0	0	6	0	
7/9	53	1	3,877	1	0	5	0	
7/10	46	1	3,445	0	0	8	0	
7/11	27	1	2,974	0	0	7	0	
7/12	94	0	5,078	0	0	18	0	
7/13	144	0	5,258	0	0	199	0	
7/14	29	0	3,124	0	0	8	0	
7/15	26	0	2,366	0	0	1	0	
7/16	26	0	4,053	3	0	7	0	
7/17	10	0	3,455	4	0	1	0	
7/18	21	0	3,624	4	0	3	0	
7/19	42	0	4,044	9	0	4	0	
7/20	26	0	3,250	11	0	26	0	
7/21	12	0	2,731	9	0	16	0	
7/22	8	0	2,068	9	0	5	0	
7/23	8	0	2,631	0	1	8	0	
7/24	9	2	2,162	2	1	2	0	
7/25	4	0	2,666	2	0	2	0	
7/26	8	0	2,820	1	2	10	0	
7/27	5	1	2,532	28	3	7	0	
7/28	4	1	1,925	13	4	2	0	1P
7/29	5	1	1,461	5	4	4	0	
7/30	2	0	1,371	1	24	2	0	
7/31	1	0	1,004	1	19	1	0	
8/1	4	0	932	1	28	2	0	

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Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	Whitefish	Other[a]
8/2	2	0	675	1	18	0	0	
8/3 [b]	3	1	363	1	15	0	0	
8/4 [c]	-	-	-	-	-	-	-	
8/5 [c]	-	-	-	-	-	-	-	
8/6[c]	-	-	-	-	-	-	-	
8/7 [c]	-	-	-	-	-	-	-	
8/8 [c]	-	-	-	-	-	-	-	
8/9 [c]	-	-	-	-	-	-	-	
8/10 [c]	-	-	-	-	-	-	-	
8/11 [c]	-	-	-	-	-	-	-	
8/12 [c]	-	-	-	-	-	-	-	
8/13 [c]	-	-	-	-	-	-	-	
8/14 [c]	-	-	-	-	-	-	-	
8/15 [c]	-	-	-	-	-	-	-	
8/16 [c]	-	-	-	-	-	-	-	
8/17 [c]	-	-	-	-	-	-	-	
8/18 [c]	-	-	-	-	-	-	-	
8/19 [c]	0	2	11	0	164	0	0	
8/20	0	2	8	0	604	0	0	
8/21	0	0	1	0	730	0	0	
8/22	0	0	10	0	676	0	0	
8/23	0	0	9	0	595	0	0	
8/24	0	0	4	0	609	0	0	
8/25	0	0	7	0	569	0	0	
8/26	0	0	3	0	696	0	0	1AG, 1P
8/27	0	0	10	0	667	0	0	
8/28	0	0	8	0	625	0	0	
8/29	0	0	3	0	605	0	0	1AG
8/30	0	0	4	0	523	0	0	
8/31	0	0	1	0	483	0	0	
9/1	0	0	2	0	388	0	0	
9/2	0	0	0	0	325	0	0	
9/3	0	0	0	0	289	0	0	
9/4	0	0	0	0	257	0	0	
9/5	0	0	0	0	204	0	0	1AG
9/6	0	0	3	0	190	0	0	
9/7	0	0	0	0	159	0	0	
9/8	0	0	1	0	183	0	0	1AG
9/9	0	0	1	0	119	0	0	
9/10	0	0	0	0	154	0	0	
9/11	0	0	0	0	111	0	0	
9/12	0	0	0	0	101	0	0	
9/13	0	0	0	0	68	0	0	1AG
9/14	0	0	1	0	70	0	0	
9/15	0	0	0	0	45	0	0	
9/16	0	0	0	0	34	0	0	
9/17	0	0	0	0	30	1	0	2AG
9/18	0	0	0	0	28	0	0	
9/19	0	0	0	0	26	0	0	

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Date	Chinook Salmon	Sockeye Salmon	Chum Salmon	Pink Salmon	Coho Salmon	Longnose Suckers	Whitefish	Other[a]
9/20 [d]	-	-	-	-	-	-	-	
Totals	967	15	82,198	106	10,446	1,805	2	7AG, 4P

Note: Dashes indicate no data.

[a] Letter designations are as follows: P = Northern pike, G = Arctic grayling.

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

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

[d] Weir was not installed.