Fishery Data Series No. 13-01

Takotna River Salmon Studies, 2011

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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

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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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TAKOTNA RIVER SALMON STUDIES, 2011

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ABSTRACT

The Takotna River is a tributary of the Kuskokwim River. A weir has been operated annually on the Takotna River since 2000 to monitor returning Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, and coho *O. kisutch* salmon. Salmon were enumerated by species as they migrated through the weir to determine daily and annual escapements. Samples were collected to estimate the age, sex, and length composition of escapements using a live trap. Total escapements of 148 Chinook, 8,413 chum, one sockeye *O. nerka*, and 4,063 coho salmon were estimated during the target operational period 24 June to 20 September, 2011. Chinook salmon escapement was below the historical median, while chum and coho salmon escapements were above their historical medians. Age composition for Chinook salmon was estimated to be 41.4% age 1.2, 40.9% age 1.3, and 17.7% age 1.4, with 34.1% females. The age composition of the chum salmon escapement was estimated to be 60.7% age 0.3, 37% age 0.4, and less than 2% of ages 0.2 and 0.5, with 55.2% female overall. The age composition of the coho salmon escapement was estimated to be 89.3% age 2.1, 5.3% age 1.1, and 5.5% age 3.1, with 49.5% female overall.

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

INTRODUCTION

Each year mature Pacific salmon *Oncorhynchus* spp. return to the Takotna River and its tributaries to spawn contributing to subsistence, commercial, and recreational fisheries in the entire Kuskokwim area. The Takotna River weir is one of several projects used to develop reliable estimates of abundance, run timing, stock structure, productivity, and carrying capacity of salmon stocks over a broad geographic scale in the Kuskokwim area (Bue et al. 2012).

Area residents and local biologists described the Takotna River as being nearly void of salmon during the 1960s and 1970s (Molyneaux et al. 2000) however, by the 1980s Takotna residents began to notice adult salmon in the river again. Historical accounts suggest that salmon abundance was once much higher on the Takotna River. Native Athabaskans who lived in the upper Kuskokwim River basin before the early twentieth century harvested salmon from the Takotna River, including residents of *Tagholjitdochak'* which was located near the confluence of Fourth-of-July Creek and the Takotna River (Anderson 1977; BLM 1984; Hosley 1966; Stokes 1985). Hosley (1966) and Stokes (1983) reported that people from the Vinasale and Tatlawiksuk Athabaskan bands also fished in the Takotna River. The numbers of salmon that were harvested is unknown, but interviews with elderly Nikolai residents who have firsthand knowledge of the area recall the existence of fairly strong Chinook and chum salmon runs in the Takotna River until the early 1900s (Stokes 1983). After reviewing historical accounts, Stokes (1983) concluded that the decline was likely a combination of overfishing and habitat alteration associated with mining development and not a result of traditional harvest practices.

Due to the perception of a recovering salmon population, monitoring of spawning salmon on the Takotna River began in 1995 when high school students built a salmon counting tower to document salmon returning to the Takotna River. The counting tower was operated through 1999 as a cooperative project between Takotna Charter School and Training Center and the Alaska Department of Fish and Game (ADF&G) to estimate salmon escapement in the river. However, success was limited because of poor water clarity, periodic high water levels, and organizational difficulties (Molyneaux et al. 2000). In 2000, the monitoring project transitioned to a resistance board weir and has operated successfully every year since (Schwanke et al. 2001). Since monitoring began, Takotna River salmon escapement of all species has been relatively small. Chinook *O. tshawytscha*, chum *O. keta* and coho *O. kisutch* salmon are the most abundant species observed in the Takotna River. Few sockeye salmon *O. nerka* are observed in the Takotna River however, during years of large sockeye salmon returns to the Kuskokwim drainage higher numbers are observed. In addition, pink salmon *O. gorbuscha* are observed in some years and documented. The Takotna River weir also serves as a collection site for age-sex-length (ASL) data, as well as information on habitat variables including water temperature, and stream discharge (water level).

The Takotna River weir is currently the only ground based escapement monitoring project in the far upper reaches of the Kuskokwim River and is operated jointly by Alaska Department of Fish and Game, Division of Commercial Fisheries and the Takotna Community Association (TCA). It is located just upstream of the village of Takotna and is one of several monitoring projects throughout the Kuskokwim River drainage operated to provide a drainagewide perspective of salmon abundance; however, there are no established escapement goals for the Takotna River.

OBJECTIVES

1. Determine daily and total Chinook, chum, sockeye, and coho salmon escapements to the Takotna River upstream of the community of Takotna during the target operational period of 24 June to 20 September.
2. Estimate the age, sex, and length (ASL) composition of Chinook, chum, and coho salmon escapements to the Takotna River such that 95% confidence intervals for the age and sex compositions 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 Takotna River weir.

METHODS

STUDY SITE

The Takotna River originates in the central Kuskokwim Mountains of the upper Kuskokwim River basin (Figure 1). Formed by the confluence of Moore Creek and Little Waldren Fork, the river flows northeasterly and passes the community of Takotna at river kilometer (rkm) 80, before turning southeasterly near the confluence of the Nixon Fork at rkm 24. The Tatalina River joins at rkm 4.8, and then the Takotna River empties into the Kuskokwim River across from McGrath at rkm 752 of the Kuskokwim River. The Takotna River is about 160 km in length and drains an area of 5,646 sq km. The river is shallow with many meanders from its headwaters to the community of Takotna, but gradually becomes deeper downstream of that point, especially after the confluence of the Nixon Fork. In the lower reaches, the current is sluggish and the channel width averages 122 to 152 m. The river's average slope is about 89 cm per km (Brown 1983).

The weir has been installed annually since 2000 at lat 62°58.1'N, long 156°05.9'W, several hundred meters upstream of the Takotna River Bridge near the community of Takotna to monitor salmon escapement. This site allows for enumeration of nearly all spawning salmon in the Takotna River drainage only excluding those in the Nixon Fork tributary. The river channel at this site is about 85 m wide and has a wetted depth of less than 1 m during normal summer flows. The substrate is composed mostly of gravel with sand and cobble also present. In addition to salmon, Arctic grayling *Thymallus arcticus*, whitefishes *Coregonus* spp., northern pike *Esox lucius*, and longnose suckers *Catostomus catostomus* have been documented at the Takotna River weir.

WEIR DESIGN

A resistance board weir was installed across the entire 85 m channel following the techniques described by Stewart (2003). The substrate rail and resistance board panels covered the middle 75 m portion of the channel, and fixed weir materials extended the weir 5 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. Details of design and materials used to construct the weir are described in Tobin (1994) with panel modifications described by Stewart (2002). The Takotna River weir was designed with a gap of 4.29 cm (1-11/16 in) between each picket, which is sufficient to stop all salmon species from migrating upstream with the exception of pink salmon. 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, or trap numerous fish for collection of age-sex-length or genetic samples. The skiff gate allowed boat operators to pass with little or no involvement of the weir crew, while minimizing or preventing passage of migrating salmon.

To accommodate downstream migration of longnose suckers and other non-salmon species, downstream passage 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 guided downstream migrants over the weir while preventing upstream salmon passage. The chutes were monitored and adjusted to ensure salmon were not passing upstream. Downstream salmon passage was not enumerated however, few salmon have been observed passing downstream over these chutes, and their numbers are considered negligible.

ESCAPEMENT MONITORING

The target operational period for Takotna River weir was 24 June through 20 September. This timeframe covers run timing the majority of the salmon runs in the Takotna River and is used to provide for consistent comparisons of annual escapements among years. Daily and total annual escapements consisted of the observed passage plus any estimated passage of Chinook, sockeye, chum, or coho salmon missed during the target operational period. Counts of all other species were reported simply as observed passage. In addition, the weir is inspected daily for holes and cleaned of carcasses and debris. Carcasses are identified by sex and daily counts were recorded (Appendices A1 and A2). If holes were found a note was made that there was potential for missed passage.

Passage Counts

Passage counts were conducted in hour long shifts four to eight times per day between 0700 and 2400 hours. Crew members visually identified each fish as it passed upstream and recorded it by species and sex on a multiple tally counter; total fish passage was recorded at the end of each counting session. Fish were only allowed to pass through the weir when an observer opened the passage gate and allowed fish to freely pass. The weir was never left open intentionally. At the end of each day, total daily and cumulative seasonal counts were copied to logbook forms and reported to ADF&G staff in Bethel.

Weather and Stream Observations

Water and air temperatures (°C) were measured each day at approximately 0800 and 1700 hours. Temperature readings were recorded in a designated logbook, along with notations about wind direction, estimated wind speed, cloud cover, and precipitation. Daily precipitation was measured using a rain gauge calibrated in millimeters. River depth was also monitored using a standardized staff gage that consisted of a metal rod driven into the stream channel with a meter stick attached. The staff gage was calibrated to an established datum plane by a semi-permanent benchmark that corresponded to stage measurements of 300 cm. River stage was measured at approximately 0800 and 1700 hours each day.

Passage Estimates

Upstream salmon passage was estimated for days when the weir was inoperable. Inoperable periods resulted from breaches in the weir, a delayed start date, and 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.

Linear Method

When the weir was not operational for two or more days but later became operational again, passage estimates for the inoperable days were calculated using linear interpolation. Average fish counts from the two days before and two days after the inoperable period were used to estimate the counts during the period of missed passage. The estimated fish count ($\hat{n}$) on day (i) of the inoperable period was estimated as:

$$\hat{n}_i = \left(\frac{n_b + n_{b-1}}{2}\right) + i\left(\frac{(n_a + n_{a+1}) - (n_b + n_{b-1})}{2(D+1)}\right). \tag{1}$$

In this equation, we denoted an inoperable period of D days,

$d = (1,\ldots,i,\ldots,D)$.

We denoted the fish counts on the days just before and just after the inoperable period 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.

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:

$$\hat{n}_i = ae^{bp_i}. \tag{2}$$

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

A minimum sample size was determined for each species following conventions described by Bromaghin (1993) to achieve 95% confidence intervals of age-sex composition for each sample be 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), and unknown population size. The Takotna River supports a small population of Chinook salmon. Due to the small population of Chinook salmon, the sample size of 190 for this species was corrected using a finite population correction of 500 fish as the population size.

$$n' = \frac{n}{1+\left(\frac{n-1}{N}\right)} . \tag{3}$$

Variables were defined as:

- n = sample size of unknown population size,
- N = estimated normal population size, and
- n' = sample size corrected for a known population size.

Minimum sample sizes for each species were then increased by 20% to account for unreadable scales or collection errors. This yielded a minimum collection goal for each sample of 165 Chinook, 220 chum, and 200 coho salmon.

A pulse sampling strategy was employed to ensure adequate temporal distribution of chum and coho salmon samples. The term “pulse” is used to describe a sample collected over a few days and applied to a longer period. 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, as a guideline to ensure adequate temporal distribution. Well-spaced pulse samples may better represent temporal changes in ASL composition than other sampling methods (Geiger and Wilbur 1990).

The relatively low abundance of Chinook salmon at Takotna River weir makes pulse sampling impractical. Instead, the sample was collected continuously over the run following a daily collection schedule based on historical run timing information. Daily sample sizes were proportional to average historical escapements by day to ensure a good distribution across the run.

Sample Collection Procedures

Salmon were captured for sampling using the live trap installed in the weir. Salmon were trapped by opening the entrance gate while the exit gate remained closed. Fish were allowed to swim freely into the live trap, and the V-shape positioning of the entrance gate prevented them from easily escaping. The live trap was allowed to fill with fish until a reasonable number were inside. 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 short-handled dip net to capture fish within the live 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 as described in Molyneaux et al. (2010). 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 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 live trap was emptied to ensure no bias was introduced.

After sampling was completed, relevant information such as sex, length, sampling date, and sampling location was transferred to an excel spreadsheet that corresponded to numbered gum cards. The completed gum cards were sent to the Bethel and/or Anchorage ADF&G offices for processing. The original ASL gum cards, acetates, and excel data were archived at the ADF&G office in Anchorage. The computer files were archived by ADF&G in the Anchorage and Bethel offices. Data were also loaded into the Arctic-Yukon-Kuskokwim salmon database management system (Brannian et al. 2006).

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). Estimates of the ASL composition of the total escapement were generated post season by examining the distribution of ASL samples in relation to daily passage. Depending on sampling effort and run strength, the samples were stratified to represent different temporal portions of the run. Strata are then weighted by applying the age-sex composition from each stratum to the total escapement that occurred during the time period represented by the respective stratum. The results of the weighted strata are them summed to provide a season estimate of the ASL composition. In 2011, Chinook salmon were apportioned into two strata, chum salmon into three strata, and coho salmon into two strata.

Age was 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). Therefore, the total age is one year greater than the sum of these two numerals.

RELATED FISHERIES PROJECTS

Temperature Monitoring

The Takotna River weir served as a monitoring site for the *Temperature Monitoring* project (USFWS, Office of Subsistence Management, Project No. 08-701). An OSM contractor provided the monitoring equipment for installation at the weir site. Two Hobo® Water Temp Pro V2[1] data loggers and one Hobo® Air Temperature R/H data loggers were installed at the beginning of the field season by switching out the previous year's temperature loggers. The water temperature loggers were anchored to the stream bed near mid-channel using a number 68 Duckbill® anchor. The air temperature logger was installed using a solar shield attached to a small spruce tree approximately 2 m above ground level and 50 m from the river. At the end of the field season both water temperature loggers and air temperature logger were downloaded and left to continue monitoring temperature. The removed temperature loggers and data shuttle were returned to the contractor for data management and reporting, and logger maintenance, calibration, and storage. Results for temperature monitoring will be reported under USFWS, Office of Subsistence Management, Project No. 08-701.

RESULTS

WEIR OPERATIONS

The weir was installed and operated from 29 June through 18 September in 2011. This period of operation did not span the entire target operational period of 24 June through 20 September. The first inoperable period occurred from 24 June through 28 June prior to completion of the weir installation. The second inoperable period occurred from 2 August through 18 August when the weir became submerged due to high water. The final inoperable period occurred from 19 September through 20 September when weir was removed (Table 1).

Weather and stream observations were recorded between 21 June and 18 September, 2011 (Appendix A3). Water temperature at the weir ranged from 6°C to 17°C, with an average of 10.5°C. A total of 260.7 mm of precipitation was recorded throughout the season. River stage ranged from 53.5 cm to 160 cm, with an average of 81 cm (Figures 2 and 3).

ESCAPEMENT MONITORING

Chinook Salmon

A total escapement of 148 Chinook salmon was estimated at the Takotna River weir during the target operational period in 2011. Estimates for missed passage accounted for 12 fish, or 8.1% of the total escapement. Estimates were generated using the linear method for the period of 2 August through 18 August. The first Chinook salmon was observed on 7 July, daily passage peaked at 20 fish on 21 July, and the last Chinook salmon was observed on 4 September. Based on the target operational period, 50% of cumulative passage occurred on 20 July and the central 50% of the run occurred from 13 to 24 July (Table 1).

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

Chum Salmon

A total escapement of 8,413 chum salmon was estimated to have passed Takotna River weir during the target operational period in 2011. Estimates for missed passage accounted for 216 fish, or 2.6% of the total escapement. Estimates were created for the second inoperable period by fitting an exponential function ($y=772.8e^{-0.208pi}$) to the falling limb of the passage curve (21 July to 20 August). The first chum salmon was observed on 30 June, daily passage peaked at 511 fish on 21 July, and the last chum salmon was observed on 10 September. Based on the target operational period, 50% of cumulative passage occurred on 18 July and the central 50% of the passage occurred from 12 to 22 July (Table 1).

Coho Salmon

A total minimum escapement of 4,063 coho salmon was estimated to have passed Takotna River weir during the target operational period in 2011. Estimates for missed passage accounted for 103 fish, or 2.5% of the total escapement. Estimates were created for the second inoperable period by fitting an exponential function ($y=0.0181e^{0.4124pi}$) to the rising limb of the passage curve (2 August to 21 August). The first coho salmon was observed on 18 July, daily passage peaked at 313 fish on 29 August, and the last coho salmon was observed on 18 September (the last day of operation). Based on the target operational period, 50% of cumulative passage occurred on 1 September and the central 50% of the run occurred from 28 August to 6 September (Table 1).

Sockeye Salmon

A total minimum escapement of one sockeye salmon was estimated passing Takotna River weir during the target operational period in 2011 (Table 1). No sockeye salmon were estimated to have passed uncounted during this period, and the only sockeye salmon was observed on 30 August.

Other Species

In 2011, no pink salmon were observed passing upstream of the Takotna River weir. Other species observed passing upstream of Takotna River weir in 2011 included 85 longnose suckers, 161 Arctic grayling *Thymallus arcticus*, 21 whitefish *Coregonus* spp., and 4 northern pike (Appendix A2). Passage missed during inoperable periods at the weir was not estimated for these species. It is likely that small fish such as pink salmon and non-salmon species pass freely between weir pickets. Counts of these fish are therefore not considered a census of passage, but are reported here as “species detected” information.

AGE, SEX, AND LENGTH COMPOSITION

Chinook Salmon

Age, sex, and length samples were collected from 81 of the 133 Chinook salmon observed at the weir between 7 July and 1 August. Of those, age was determined for 56 fish (69.1%) of the fish sampled. The sample comprised 3 age classes: age-1.2, -1.3, and -1.4. Age-1.2 and -1.3 Chinook salmon were the most abundant (41.4% and 40.9%, respectively). The majority of Chinook salmon at the Takotna River weir were males (65.9%). Females dominated the age-1.4 class (75.7%) while males dominated the age-1.2 and -1.3 age classes (82.4% and 67.5%, respectively). The average length of male Chinook salmon ranged from 511 mm at age 1.2 to

764 mm at age 1.4. The average length of female Chinook salmon ranged from 495 mm at age 1.2 to 818 mm at age 1.4 (Table 2).

Chum Salmon

Age, sex, and length samples were collected from 1,164 chum salmon between 2 July and 31 July. Sample collection was well distributed throughout the run and in relative proportion to run abundance. Age was determined for 980 (84.2%) of the fish sampled. Age-0.3 fish were the dominant age class (60.7%) followed by age-0.4 (37%) fish. Female chum salmon were dominant in these major age classes at 56.3% for age 0.3 and 51.9% for age 0.4. The average length of male chum salmon ranged from 555 mm at age 0.2 to 566 mm at age 0.4. The average length of female chum salmon ranged from 526 mm at age 0.2 to 537 mm at age 0.4 (Table 3).

Coho Salmon

Age, sex, and length samples were collected from 600 coho salmon between 23 August and 8 September. Age was determined for 531 (88.5%) of the fish sampled. Age-2.1 fish were the dominate age class (89.3%) followed by age-3.1 (5.5%) and age-1.1 (1.8%) fish. Age-2.1 fish comprised more males (51.6%) while age-1.1 and -3.1 fish comprised more females (60.4% and 58.2%, respectively) (Table 4).

DISCUSSION

In 2011, the Takotna River weir operated with only one disruption caused by the highest water level recorded since monitoring began in 2000 (Figure 2). Nonetheless, minimum escapement was determined, and missed passage was estimated for inoperable periods. Historical run timing observed at the Takotna River weir indicates that the major inoperable period occurred at a time when Chinook and chum salmon runs were diminishing while the coho salmon run was beginning (Figure 4 and Table 1). In 2011, ASL samples were well distributed throughout run timing for all species and the objectives for precision in our escapement estimates were achieved for chum and coho salmon.

Salmon have been counted by sex at Takotna River weir since 2005, allowing for comparison between visual and physically sampled sex compositions to assess possible biases. Although determining sex from passing fish is less definitive than from physically collected ASL samples, counts by sex are considered fairly accurate given the distinct sexual dimorphism that develops by the time migrating salmon reach the Takotna River weir. In 2011, similar female sex ratios were estimated in the passage count and ASL sample, with the largest disparity between the two methods being 3.5% for coho salmon (Figure 5).

Chinook Salmon

Escapement in 2011 was the lowest reported at Takotna River weir and was one third of the historical median (Figure 6), consistent with the below average abundances observed at all the other monitored drainages within the Kuskokwim River (Figure 7). Chinook passage at the weir was later and more compacted than the 2000–2010 median; however, though the majority of passage was within the range historically seen at this project (Figure 4).

As in years past, collecting the optimal ASL sample size for Takotna River Chinook salmon was problematic, given the small population. The need to collect samples was weighed against the need to allow efficient passage through the weir. The 2011 sample (*n*=56) fell below the sample design size (n=165); however, the sample represented 40% of the total population and was well distributed throughout the run.

Chum Salmon

Escapement in 2011 was the third largest on record, nearly double the 2000–2010 median (Figure 6). Escapement at other Kuskokwim area projects exhibited average to higher than average numbers. Chum salmon passage at the weir was later and more compacted than the historical median but within the range previously seen at this project (Figure 4).

Coho Salmon

Escapement in 2011 was the third largest on record (Figure 6); however, total coho salmon escapement reported should be considered the minimum escapement. Missed passage estimates could have been markedly higher than estimated when considering the life history of coho salmon and movement during periods of higher water levels. Overall, 2011 data indicated that coho salmon abundance was average at Kuskokwim River escapement monitoring projects. Coho salmon passage at the Takotna River weir was six days later and two days shorter in duration than the historical median and the central 50% of the run was among the latest on record (Figure 4).

TCA Internship Program

The Takotna River weir has hosted internships for local area high school students annually since 2000. These internships serve to foster student career interest and improve local understanding of fisheries management and research activities. In 2011, three local area high school students were employed by the Takotna Community Association to assist with daily weir operations during summer months. This partnership started between ADF&G and the Takotna Tribal Council, however due to administrative difficulties responsibilities were passed to the TCA. Under the supervision of project crew members, students participated in routine passage counts, ASL sample collections, and weather and stream measurements. Interns worked 15 to 20 hours per week during July and August, and 15 hours per week through September. Past interns have been employed as technicians at the weir and taken positions with ADF&G in Bethel and with Kuskokwim Native Association in Aniak. The TCA technician at the weir in 2011 was a former intern.

ACKNOWLEDGEMENTS

The Takotna River salmon escapement monitoring program is a cooperative project operated jointly by TCA and ADF&G Division of Commercial Fisheries. The USFWS Office of Subsistence Management (OSM) provided funding support for this project, through the Fisheries Resource Monitoring Program under FWS Agreement Number 701818J690. Matching support for this grant was provided by the State of Alaska and Coastal Villages Region Fund. USFWS OSM Fisheries Resource Monitoring Program under FWS Agreement Number 70181AJ028 funded project FIS 10-303, which supported salmon age, sex, and length data analysis for this project among others.

Many individuals have contributed to the development and operation of the Takotna River weir. Nell Huffman with TCA assisted with administrative needs and we thank her for her support and participation. We would also like to thank our TCA partners: co-chiefs Carol Abraham and Fred Capsul for additional administration assistance and staffing, Tabatha Meglitsch, for her contributions to installation and operation, and to technician Robert Perkins for his continued diligence and dedication to the project. Thanks to student interns Larry Fox, Austin Wortman, and Sabrina Anselment for their assistance throughout the 2011 field season. This project would not be possible without these members of the Takotna community. Special thanks go out to Dylan Williams and Maureen Horne-Brine of ADF&G for help with installation and operation, Rob Stewart of ADF&G for installation and contributions to operations, Derick Williams and Jordan Palmer of ADF&G who assisted in operations and weir removal, and to Amy Brodersen of ADF&G for aging scales and producing ASL data. Our greatest appreciation goes to ADF&G crew leader Cara Lucas, whose involvement, oversight and leadership in this project shaped a successful 2011 field season. Most importantly, thanks to principal investigator Kevin Schaberg of ADF&G and head program coordinator for the Kuskokwim River cooperative fisheries research program.

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TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage for Chinook, sockeye, chum, and coho salmon.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Coho Salmon		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
24 Jun	0[a]	0	0	0[a]	0	0	0[a]	0	0	0[a]	0	0
25 Jun	0[a]	0	0	0[a]	0	0	0[a]	0	0	0[a]	0	0
26 Jun	0[a]	0	0	0[a]	0	0	0[a]	0	0	0[a]	0	0
27 Jun	0[a]	0	0	0[a]	0	0	0[a]	0	0	0[a]	0	0
28 Jun	0[a]	0	0	0[a]	0	0	0[a]	0	0	0[a]	0	0
29 Jun	0	0	0	0	0	0	0	0	0	0	0	0
30 Jun	0	0	0	0	0	0	15	15	0	0	0	0
1 Jul	0	0	0	0	0	0	32	47	1	0	0	0
2 Jul	0	0	0	0	0	0	45	92	1	0	0	0
3 Jul	0	0	0	0	0	0	75	167	2	0	0	0
4 Jul	0	0	0	0	0	0	124	291	3	0	0	0
5 Jul	0	0	0	0	0	0	73	364	4	0	0	0
6 Jul	0	0	0	0	0	0	112	476	6	0	0	0
7 Jul	1	1	1	0	0	0	168	644	8	0	0	0
8 Jul	5	6	4	0	0	0	179	823	10	0	0	0
9 Jul	5	11	7	0	0	0	266	1,089	13	0	0	0
10 Jul	5	16	11	0	0	0	296	1,385	16	0	0	0
11 Jul	0	16	11	0	0	0	256	1,641	20	0	0	0
12 Jul	14	30	20	0	0	0	431	2,072	25	0	0	0
13 Jul	6	36	24	0	0	0	374	2,446	29	0	0	0
14 Jul	5	41	28	0	0	0	481	2,927	35	0	0	0
15 Jul	5	46	31	0	0	0	363	3,290	39	0	0	0
16 Jul	3	49	33	0	0	0	402	3,692	44	0	0	0
17 Jul	0	49	33	0	0	0	392	4,084	49	0	0	0
18 Jul	1	50	34	1	0	0	424	4,508	54	2	2	0
19 Jul	11	61	41	0	0	0	363	4,871	58	0	2	0
20 Jul	18	79	53	0	0	0	508	5,379	64	0	2	0
21 Jul	20	99	67	0	0	0	511	5,890	70	0	2	0
22 Jul	10	109	74	0	0	0	415	6,305	75	0	2	0
23 Jul	1	110	74	0	0	0	293	6,598	78	0	2	0
24 Jul	1	111	75	0	0	0	254	6,852	81	0	2	0
25 Jul	5	116	78	0	0	0	206	7,058	84	0	2	0
26 Jul	1	117	79	0	0	0	189	7,247	86	0	2	0
27 Jul	3	120	81	0	0	0	147	7,394	88	0	2	0
28 Jul	3	123	83	0	0	0	199	7,593	90	0	2	0
29 Jul	4	127	86	0	0	0	127	7,720	92	0	2	0
30 Jul	2	129	87	0	0	0	146	7,866	93	0	2	0
31 Jul	2	131	89	0	0	0	148	8,014	95	0	2	0
1 Aug	1	132	89	0	0	0	103	8,117	96	0	2	0
2 Aug	1[b]	133	90	0[b]	0	0	70[c]	8,187	97	0[c]	2	0
3 Aug	1[d]	134	91	0[d]	0	0	42[e]	8,229	98	0[e]	2	0
4 Aug	1[d]	135	91	0[d]	0	0	34[e]	8,263	98	0[e]	2	0
5 Aug	1[d]	136	92	0[d]	0	0	28[e]	8,291	99	0[e]	2	0
6 Aug	1[d]	137	93	0[d]	0	0	23[e]	8,314	99	0[e]	2	0
7 Aug	1[d]	138	93	0[d]	0	0	18[e]	8,332	99	0[e]	3	0
8 Aug	1[d]	139	94	0[d]	0	0	15[e]	8,347	99	0[e]	3	0
9 Aug	1[d]	140	95	0[d]	0	0	12[e]	8,359	99	0[e]	3	0

-continued-

Table 1.–Page 2 of 2.

	Chinook Salmon			Sockeye Salmon			Chum Salmon			Coho Salmon		
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%
10 Aug	1[d]	141	95	0[d]	0	0	10[e]	8,369	99	1[e]	4	0
11 Aug	1[d]	142	96	0[d]	0	0	8[e]	8,377	100	1[e]	5	0
12 Aug	1[d]	143	97	0[d]	0	0	6[e]	8,383	100	2[e]	7	0
13 Aug	1[d]	144	97	0[d]	0	0	5[e]	8,388	100	3[e]	9	0
14 Aug	0[d]	144	97	0[d]	0	0	4[e]	8,392	100	4[e]	13	0
15 Aug	0[d]	144	97	0[d]	0	0	3[e]	8,395	100	6[e]	19	0
16 Aug	0[d]	144	97	0[d]	0	0	3[e]	8,398	100	9[e]	28	1
17 Aug	0[d]	144	97	0[d]	0	0	2[e]	8,400	100	13[e]	41	1
18 Aug	0[d]	144	97	0[d]	0	0	2[e]	8,402	100	20[e]	61	2
19 Aug	0	144	97	0	0	0	1	8,403	100	32	93	2
20 Aug	0	144	97	0	0	0	1	8,404	100	41	134	3
21 Aug	0	144	97	0	0	0	0	8,404	100	73	207	5
22 Aug	0	144	97	0	0	0	0	8,404	100	44	251	6
23 Aug	0	144	97	0	0	0	1	8,405	100	69	320	8
24 Aug	0	144	97	0	0	0	1	8,406	100	130	450	11
25 Aug	1	145	98	0	0	0	1	8,407	100	125	575	14
26 Aug	0	145	98	0	0	0	0	8,407	100	133	708	17
27 Aug	0	145	98	0	0	0	0	8,407	100	174	882	22
28 Aug	0	145	98	0	0	0	0	8,407	100	248	1,130	28
29 Aug	0	145	98	0	0	0	0	8,407	100	313	1,443	36
30 Aug	0	145	98	1	1	100	1	8,408	100	294	1,737	43
31 Aug	0	145	98	0	1	100	0	8,408	100	209	1,946	48
1 Sep	1	146	99	0	1	100	0	8,408	100	278	2,224	55
2 Sep	0	146	99	0	1	100	2	8,410	100	201	2,425	60
3 Sep	0	146	99	0	1	100	0	8,410	100	196	2,621	65
4 Sep	2	148	100	0	1	100	0	8,410	100	180	2,801	69
5 Sep	0	148	100	0	1	100	0	8,410	100	190	2,991	74
6 Sep	0	148	100	0	1	100	0	8,410	100	138	3,129	77
7 Sep	0	148	100	0	1	100	0	8,410	100	147	3,276	81
8 Sep	0	148	100	0	1	100	0	8,410	100	122	3,398	84
9 Sep	0	148	100	0	1	100	1	8,411	100	97	3,495	86
10 Sep	0	148	100	0	1	100	2	8,413	100	137	3,632	89
11 Sep	0	148	100	0	1	100	0	8,413	100	70	3,702	91
12 Sep	0	148	100	0	1	100	0	8,413	100	58	3,760	93
13 Sep	0	148	100	0	1	100	0	8,413	100	95	3,855	95
14 Sep	0	148	100	0	1	100	0	8,413	100	47	3,902	96
15 Sep	0	148	100	0	1	100	0	8,413	100	42	3,944	97
16 Sep	0	148	100	0	1	100	0	8,413	100	38	3,982	98
17 Sep	0	148	100	0	1	100	0	8,413	100	11	3,993	98
18 Sep	0	148	100	0	1	100	0	8,413	100	26	4,019	99
19 Sep	0	148[a]	100	0[a]	1	100	0[a]	8,413	100	23[e]	4,043	99
20 Sep	0	148[a]	100	0[a]	1	100	0[a]	8,413	100	20[e]	4,063	100

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

[a] The weir was not operational; daily passage assumed zero based on historic and inseason data.

[b] Partial day count, passage was estimated using the linear method.

[c] Partial day count, passage estimated using exponential method.

[d] The weir was not operational, passage estimated using linear method.

[e] The weir was not operational, passage estimated using exponential method.

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

		Brood Year (Age)							
		2007		2006		2005			
Sample Size		(1.2)		(1.3)		(1.4)		Total	
		N	%	N	%	N	%	N	%
56	Male	50	34.1	41	27.6	6	4.3	98	65.9
Weighted Season Total	Female	11	7.3	20	13.4	20	13.4	50	34.1
	Total	61	41.4	61	40.9	26	17.7	148	100.0
	95% C.I. (%)		±9.7		±10.3		±8.3		
	Male Mean Length	577		695		764			
	SE	17		12		36			
	Range	501-692		603-771		728-800			
	n	21		14		2			
	Female Mean Length	495		754		818			
	SE	16		19		32			
	Range	480-565		640-814		746-925			
	n	5		7		7			

Note: Discrepancies in sums or statistics are attributed to rounding errors.

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

	Sample Size		Brood Year (Age Class) 2008 (0.2) N	%	2007 (0.3) N	%	2006 (0.4) N	%	2005 (0.5) N	%	Total N	%
	980	Male	17	0.2	2,227	26.5	1,500	17.8	26	0.3	3,770	44.8
Weighted Season Total		Female	146	1.7	2,878	34.2	1,612	19.2	8	0.1	4,643	55.2
		Total	163	1.9	5,105	60.7	3,111	37.0	33	0.4	8,413	100.0
		95% C.I. (%)		±0.8		±2.9		±2.8		±0.4		
		Male Mean Length	555		557		566		562			
		SE	-		2		2		-			
		Range	493-605		485-678		490-640		544-605			
		n	2		258		173		3			
		Female Mean Length	526		530		537		517			
		SE	6		2		2		-			
		Range	465-576		420-693		448-592		517-517			
		n	17		338		188		1			

Note: Discrepancies in sums or statistics are attributed to rounding errors.

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

		Brood Year (Age)						Total	
		2008		2007		2006			
Sample Size		(1.1) N	%	(2.1) N	%	(3.1) N	%	N	%
531	Male	84	2.1	1,875	46.1	92	2.3	2,051	50.5
Weighted Season Total	Female	130	3.2	1,752	43.1	130	3.2	2,012	49.5
	Total	214	5.3	3,627	89.3	222	5.5	4,063	100.0
	95% C.I. (%)		±1.8		±2.5		±1.8		
	Male Mean Length	556		544		543			
	SE	16		3		12			
	Range	425-618		380-625		463-603			
	n	11		245		12			
	Female Mean Length	544		555		554			
	SE	7		2		8			
	Range	491-612		430-609		470-595			
	n	17		229		17			

Note: Discrepancies in sums or statistics are attributed to rounding errors.

Figure 1.–Kuskokwim Area salmon management districts and escapement monitoring projects.

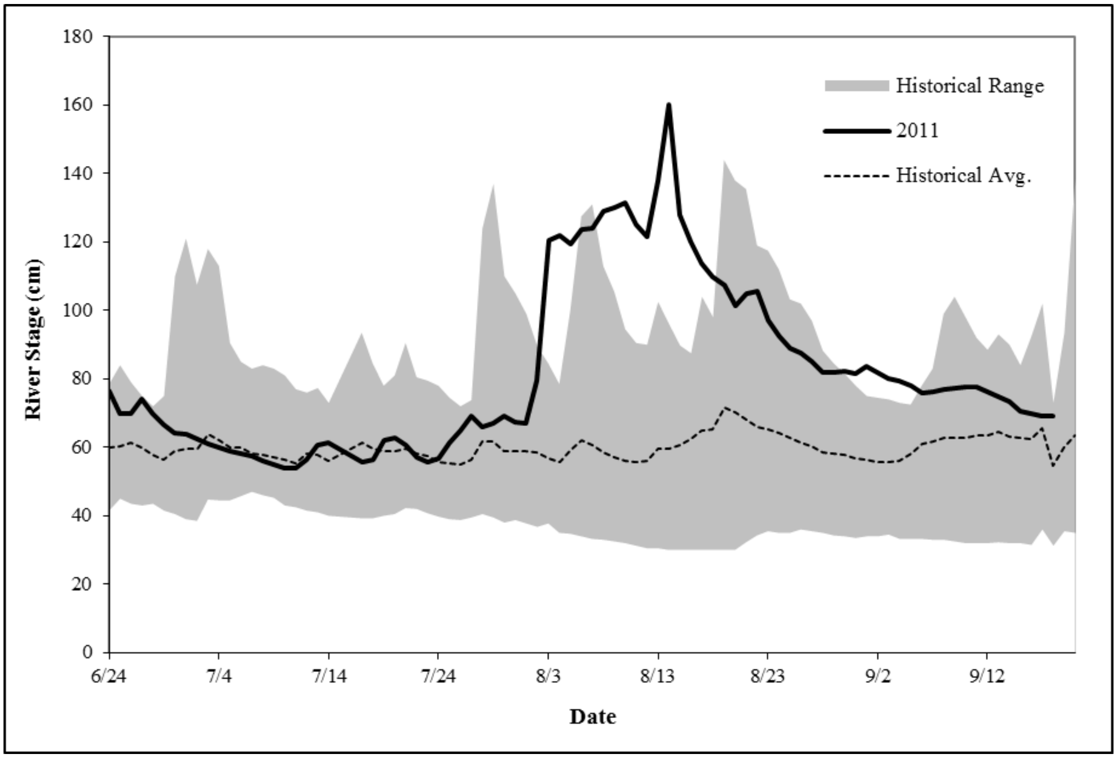


Figure 2.–Daily average water level at the Takotna River weir in 2011 relative to the historical average and range since 2000.

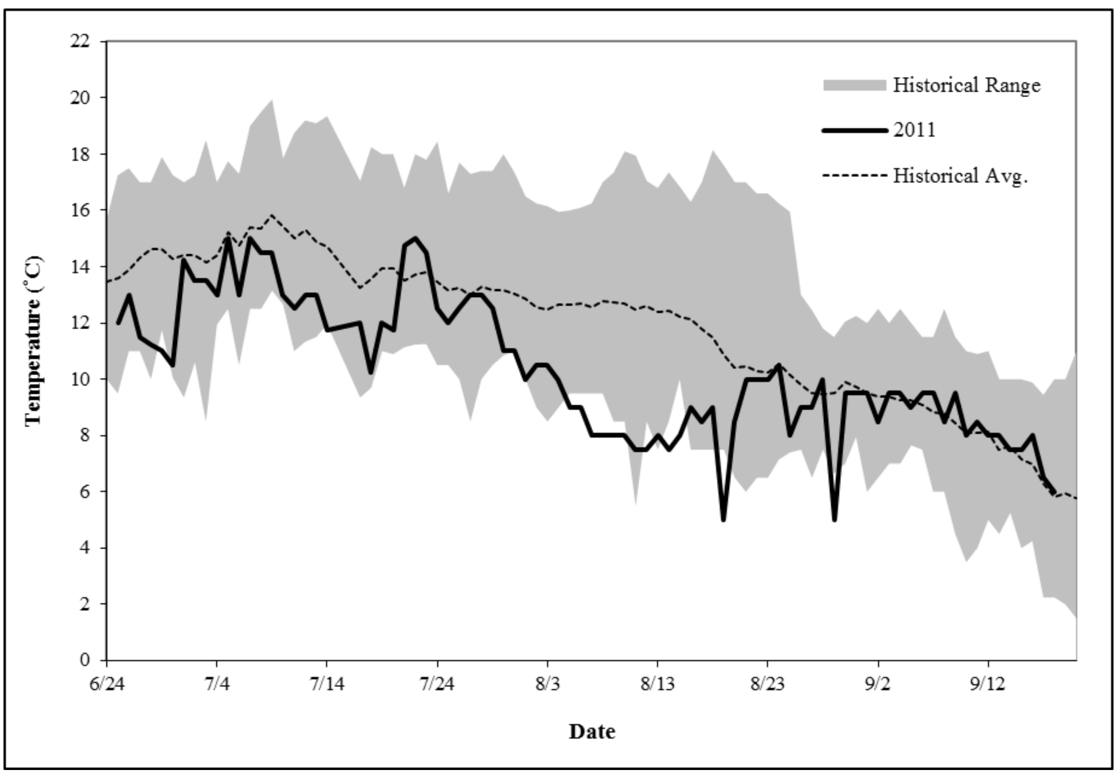
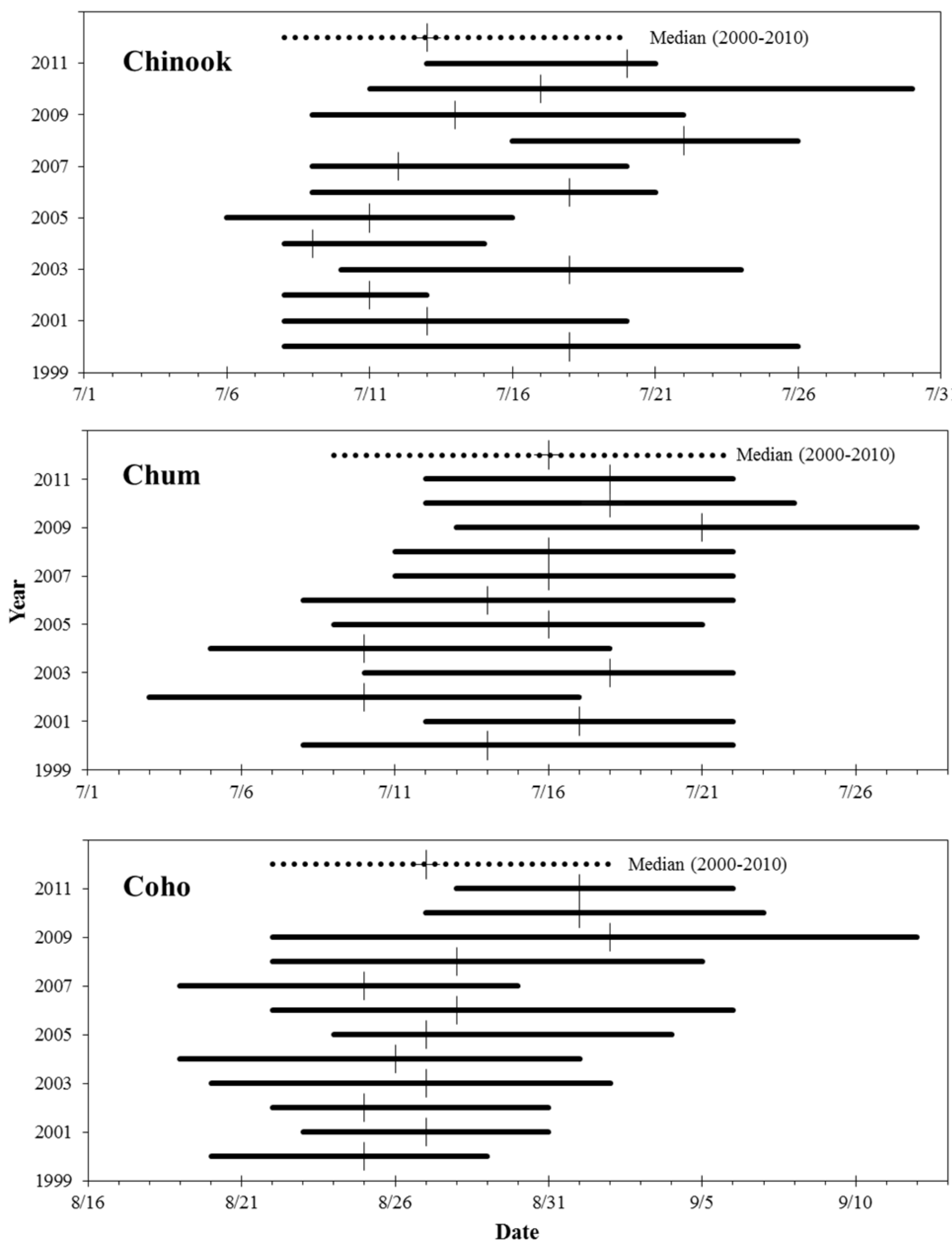
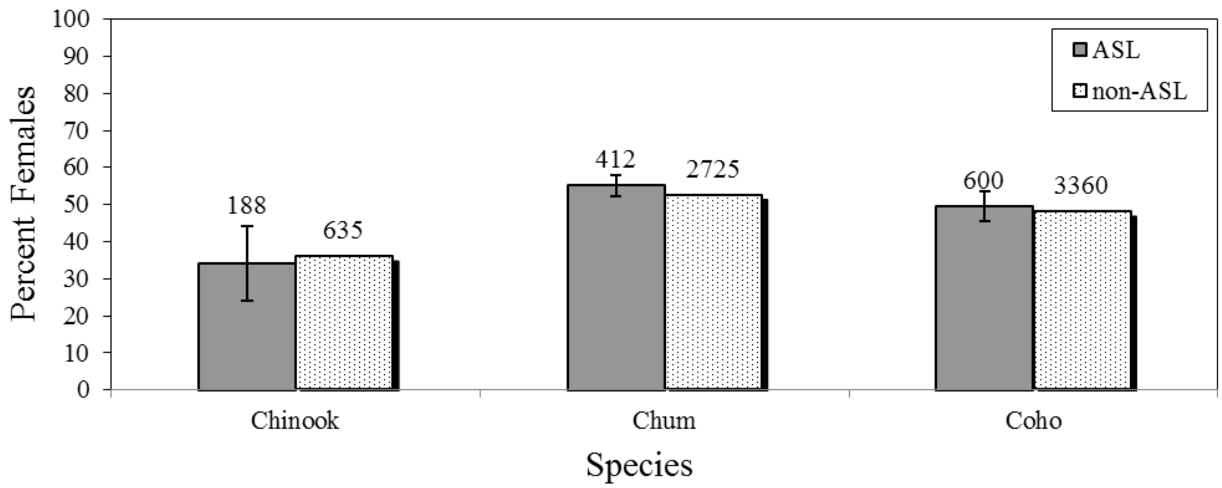


Figure 3.–Daily average water temperature at the Takotna River weir in 2011 relative to the historical average and range since 2000.



Note: Solid lines represent the dates when the central 50% of the run passed and cross-bars represent the median passage date.

Figure 4.–Annual run timing of Chinook, chum, and coho salmon based on cumulative percent passage at the Takotna River weir, 2000–2011.



Note: The number at the top of each column is sample size (*n*). Error bars represent confidence interval bounds.

Figure 5.–Comparison of the percentage of female salmon passing upstream of the Takotna River weir as determined from standard ASL sampling using a fish trap, and from visual inspection of non-ASL sampled fish using standard fish passage procedures.

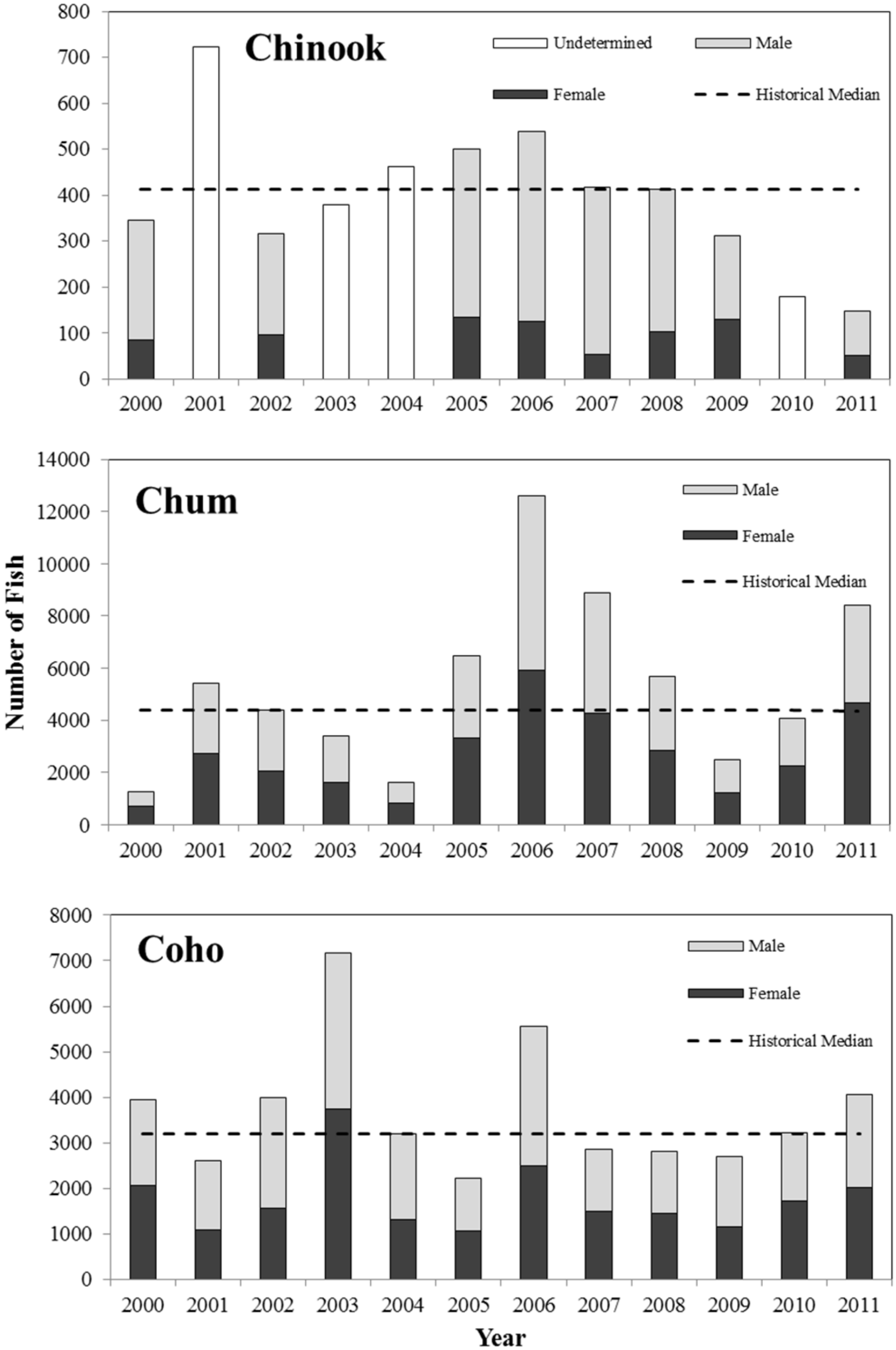
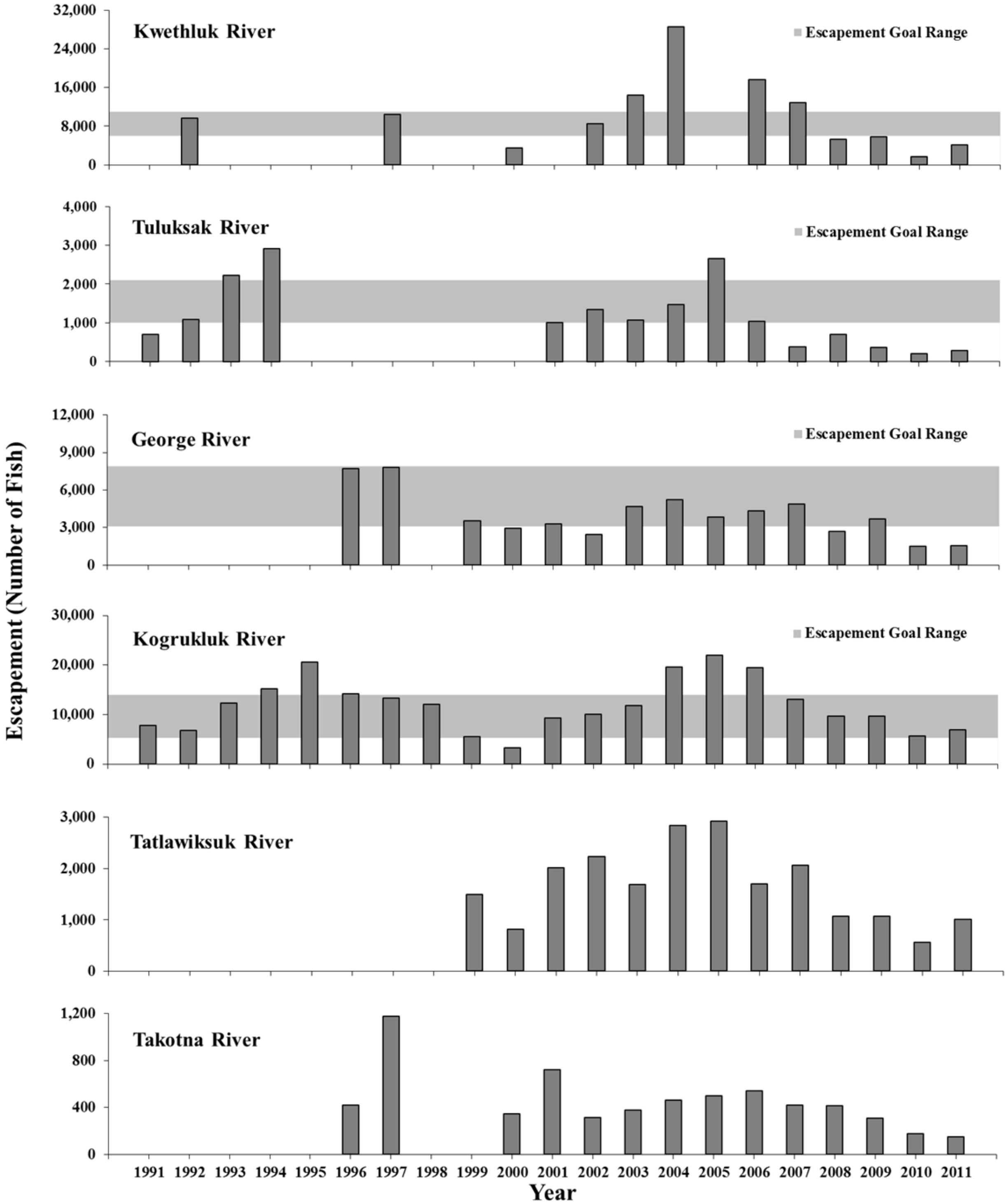


Figure 6.–Historical annual Chinook, chum, and coho escapements at Takotna River weir (2000–2011).



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

Figure 7.–Chinook salmon escapement at Kuskokwim River weirs, 1991–2011.

APPENDICES

Appendix A1.–Daily carcass counts by species at Takotna River weir, 2011.

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

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Date	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose	White-	Northern
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Pike
7/29	1	0	1	0	0	0	17	9	26	0	0	0	0	0	0	4	0	0
7/30	0	0	0	0	0	0	13	6	19	0	0	0	0	0	0	2	0	0
7/31	0	0	0	0	0	0	12	6	18	0	0	0	0	0	0	1	0	0
8/1	0	0	0	0	0	0	10	4	14	0	0	0	0	0	0	2	0	0
8/2[b]	0	0	0	0	0	0	24	8	32	0	0	0	0	0	0	1	0	0
8/3[b]	0	0	0	0	0	0	3	7	10	0	0	0	0	0	0	14	0	0
8/4[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
8/5[b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
8/6[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/7[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/8[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/9[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/10[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/12[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/14[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0
8/20	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
8/21	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	0	0
8/22	0	0	0	0	0	0	2	2	4	0	0	0	0	1	1	10	0	1
8/23	0	0	0	0	0	0	2	2	4	0	0	0	0	0	0	14	0	0
8/24	0	0	0	0	0	0	1	4	5	0	0	0	0	0	0	14	0	0
8/25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0
8/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	1
8/27	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	4	1	0
8/28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8/29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
8/30	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
8/31	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	2	0
9/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Date	Chinook Salmon			Sockeye Salmon			Chum Salmon			Pink Salmon			Coho Salmon			Longnose	White-	Northern
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Sucker	fish	Pike
9/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0
9/5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
9/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
9/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	0
9/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0
9/19[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9/20[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: Carcass deposition was influenced by the downstream passage chutes that were installed for part of the season. ND = no data.

[a] Weir was not operational; carcasses were not counted.

[b] Weir was not operational for part or most of the day; carcasses were counted but count may not represent total daily deposition.

Appendix A2.–Daily passage counts by species at Takotna River weir, 2011.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Coho Salmon		Longnose	White-		
Date	Male	Female	Male	Female	Male	Female	Male	Female	Suckers	fish	Other[a]	
6/24[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
6/25[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
6/26[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
6/27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
6/28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
6/29	0	0	0	0	0	0	0	0	2	0	0	
6/30	0	0	0	0	11	4	0	0	3	0	6	G
7/1	0	0	0	0	22	10	0	0	0	1	11	G
7/2	1	0	0	0	23	22	0	0	2	1	27	G
7/3	0	0	0	0	46	29	0	0	3	1	18	G
7/4	0	0	0	0	70	54	0	0	24	1	13	G
7/5	0	0	0	0	37	36	0	0	6	1	21;1	G;P
7/6	0	0	0	0	56	56	0	0	0	0	39;1	G;P
7/7	1	0	0	0	99	69	0	0	12	0	3	G
7/8	3	2	0	0	110	69	0	0	4	0	11;2	G;P
7/9	5	0	0	0	151	115	0	0	6	5	0	
7/10	4	1	0	0	157	139	0	0	1	0	0	
7/11	0	0	0	0	148	108	0	0	0	0	1	G
7/12	9	5	0	0	202	229	0	0	0	2	0	
7/13	3	3	0	0	186	188	0	0	1	0	4	G
7/14	1	4	0	0	234	247	0	0	5	0	2	G
7/15	2	3	0	0	174	189	0	0	2	0	2	G
7/16	1	2	0	0	192	210	0	0	0	1	1	G
7/17	0	0	0	0	180	212	0	0	0	0	0	
7/18	0	1	0	0	209	215	1	1	1	0	0	
7/19	7	4	0	0	172	191	0	0	0	2	0	
7/20	14	4	0	0	218	290	0	0	0	0	0	
7/21	13	7	0	0	235	276	0	0	1	0	1	G
7/22	6	4	0	0	162	253	0	0	0	2	0	
7/23	0	1	0	0	124	169	0	0	0	1	0	
7/24	0	1	0	0	106	148	0	0	0	0	0	
7/25	4	1	0	0	70	136	0	0	0	0	0	
7/26	1	0	0	0	78	111	0	0	0	0	0	
7/27	2	1	0	0	58	89	0	0	5	0	0	
7/28	1	2	0	0	89	110	0	0	0	1	0	
7/29	4	0	0	0	49	78	0	0	0	1	0	
7/30	1	1	0	0	56	90	0	0	1	0	0	
7/31	2	0	0	0	63	85	0	0	0	0	0	
8/1	1	0	0	0	46	57	0	0	0	0	1	G
8/2[c]	0	0	0	0	24	46	0	0	0	0	0	
8/3[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/4[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/5[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/6[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/7[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/8[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/9[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/10[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/11[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/12[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
8/13[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	

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Date	Chinook Salmon Male	Chinook Salmon Female	Sockeye Salmon Male	Sockeye Salmon Female	Chum Salmon Male	Chum Salmon Female	Coho Salmon Male	Coho Salmon Female	Longnose Suckers	White-fish	Other[a]
8/14[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/15[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/16[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/17[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/18[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8/19	0	0	0	0	0	1	23	9	0	0	0
8/20	0	0	0	0	0	1	28	13	1	0	0
8/21	0	0	0	0	0	0	43	30	0	0	0
8/22	0	0	0	0	0	0	22	22	0	0	0
8/23	0	0	0	0	0	1	40	29	0	0	0
8/24	0	0	0	0	1	0	79	51	1	0	0
8/25	1	0	0	0	0	1	67	58	0	0	0
8/26	0	0	0	0	0	0	79	54	0	0	0
8/27	0	0	0	0	0	0	90	84	0	0	0
8/28	0	0	0	0	0	0	128	120	0	0	0
8/29	0	0	0	0	0	0	168	145	0	0	0
8/30	0	0	1	0	1	0	141	153	0	0	0
8/31	0	0	0	0	0	0	115	94	0	0	0
9/1	1	0	0	0	0	0	156	122	0	0	0
9/2	0	0	0	0	2	0	107	94	2	0	0
9/3	0	0	0	0	0	0	98	98	0	0	0
9/4	1	1	0	0	0	0	85	95	0	0	0
9/5	0	0	0	0	0	0	97	93	0	0	0
9/6	0	0	0	0	0	0	70	68	1	1	0
9/7	0	0	0	0	0	0	66	81	1	0	0
9/8	0	0	0	0	0	0	58	64	0	0	0
9/9	0	0	0	0	1	0	47	50	0	0	0
9/10	0	0	0	0	2	0	64	73	0	0	0
9/11	0	0	0	0	0	0	33	37	0	0	0
9/12	0	0	0	0	0	0	23	35	0	0	0
9/13	0	0	0	0	0	0	48	47	0	0	0
9/14	0	0	0	0	0	0	18	29	0	0	0
9/15	0	0	0	0	0	0	22	20	0	0	0
9/16	0	0	0	0	0	0	14	24	0	0	0
9/17	0	0	0	0	0	0	7	4	0	0	0
9/18	0	0	0	0	0	0	12	14	0	0	0
9/19[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9/20[b]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Note: ND = no data

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

[b] The weir was not operational.

[c] Partial day count.

Appendix A3.–Daily weather and stream observations at Takotna River weir, 2011.

Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
6/21	12:00	ND	ND	ND	ND	64	ND
6/22	9:00	ND	ND	ND	ND	64	ND
	17:00	ND	ND	ND	ND	74	ND
6/23	8:00	ND	ND	ND	ND	106	ND
	20:00	ND	ND	ND	ND	106	ND
6/24	10:00	ND	ND	10.0	ND	79	ND
	17:00	ND	ND	18.0	ND	74	ND
6/25	10:00	4	1.3	10.0	10.0	71	ND
	18:00	3	2.0	16.5	14.0	69	2
6/26	9:45	2	0.0	12.0	11.0	69.5	2
	17:30	4	0.0	17.0	15.0	70	2
6/27	9:00	4	0.8	12.0	11.0	75	3
	17:00	3	0.0	17.0	12.0	73.5	2
6/28	9:00	4	0.0	10.0	10.0	71.5	2
	18:00	4	0.0	15.0	12.5	68	2
6/29	9:00	4	4.0	10.0	11.0	67	2
	18:00	4	0.7	13.0	11.0	66	2
6/30	8:00	4	0.0	10.5	10.0	64	2
	17:00	4	0.0	15.0	11.0	64	2
7/1	8:00	2	0.0	12.0	12.0	63	1
	17:00	2	0.0	16.0	16.5	64.5	1
7/2	8:00	2	0.0	9.0	12.0	62	1
	17:30	2	0.0	18.0	15.0	63	1
7/3	8:00	2	0.0	11.0	12.0	62	1
	18:00	2	0.0	17.0	15.0	60	1
7/4	8:00	3	0.0	8.0	12.0	60	1
	16:00	1	0.0	15.5	14.0	60	1
7/5	8:00	2	0.0	14.0	14.0	58	1
	17:00	2	0.0	18.0	16.0	60	1
7/6	8:00	1	0.0	12.0	13.0	58	1
	17:30	3	0.0	19.0	ND	58	1
7/7	8:00	2	0.0	12.0	14.0	58	2
	17:00	3	0.0	19.0	16.0	57	2
7/8	8:00	3	0.0	11.0	14.0	56	1
	17:00	1	0.0	19.0	15.0	56	1
7/9	8:00	1	0.0	13.5	14.0	55	1
	17:00	3	0.0	15.0	15.0	55	1
7/10	8:00	4	0.4	11.0	12.0	54	1
	17:00	4	1.1	15.0	14.0	54	1
7/11	8:00	4	0.2	11.0	12.0	53.5	1
	17:00	4	3.0	13.0	13.0	54	1
7/12	8:00	4	15.0	10.0	11.5	56	1
	16:00	2	1.0	13.0	14.5	57	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C)		River Stage (cm)	Water Clarity[c]
				Air	Water		
7/13	8:00	4	0.0	9.0	12.0	60	2
	16:00	3	0.0	16.0	14.0	61.5	2
7/14	8:00	4	0.0	8.5	11.5	62	3
	17:30	4	0.0	13.0	12.0	60.5	3
7/15	8:00	4	0.0	8.0	12.0	58	3
	17:00	4	0.4	12.0	12.0	57	2
7/16	8:00	2	0.5	8.0	10.5	56	2
	17:00	3	0.0	13.0	12.0	56	1
7/17	8:00	4	0.0	7.0	11.0	55	2
	16:00	4	9.0	10.0	13.0	56	2
7/18	8:00	3	3.0	7.0	10.0	56	1
	17:00	3	2.2	9.0	10.5	57	2
7/19	8:00	3	1.2	8.0	10.0	60	1
	17:00	2	0.0	13.0	14.0	64	1
7/20	8:00	3	0.0	6.5	9.0	63	1
	16:30	2	0.0	20.0	14.5	62.5	1
7/21	8:00	4	0.0	12.0	12.5	60	1
	16:00	3	0.0	19.0	17.0	61	1
7/22	9:30	3	0.0	9.0	14.0	57	2
	16:00	3	0.0	20.5	16.0	57	1
7/23	8:00	3	0.0	15.0	15.0	55	1
	15:00	4	0.6	15.0	14.0	56	1
7/24	8:00	4	1.7	10.0	12.0	56.5	2
	17:00	3	0.0	14.0	13.0	57	1
7/25	12:00	4	18.5	12.0	12.0	60	1
	18:00	3	1.0	15.0	12.0	63	2
7/26	8:00	5	0.0	12.0	12.0	63.5	2
	16:00	2	0.0	18.0	13.0	66.5	2
7/27	8:00	2	0.0	12.0	12.0	71	2
	17:00	2	5.1	19.0	14.0	67	2
7/28	8:00	4	7.6	12.0	12.0	65	2
	17:00	4	2.5	13.0	14.0	67	2
7/29	9:00	3	0.8	10.5	12.0	65	2
	17:00	4	0.5	12.0	13.0	69	2
7/30	9:00	4	0.5	9.0	11.0	70	2
	17:30	4	0.0	11.0	11.0	68	2
7/31	9:00	3	0.0	10.0	10.0	68	2
	17:00	3	0.0	15.0	12.0	67	2
8/1	8:00	4	1.5	9.0	10.0	65	2
	17:00	4	9.7	11.0	10.0	69	2
8/2	8:00	5	10.2	10.0	10.0	75	3
	17:00	4	3.8	12.0	11.0	84	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]
8/3	8:00	4	5.3	11.0	10.0	120	3
	16:00	2	0.5	16.0	11.0	121	3
8/4	9:00	4	3.8	9.0	10.0	122	3
8/5	9:00	4	7.1	6.0	9.0	120	3
	17:00	3	0.8	10.0	9.0	119	3
8/6	8:30	3	0.8	6.0	9.0	122	3
	16:00	4	4.3	8.0	9.0	125	3
8/7	8:30	5	6.6	6.0	7.0	124	3
	17:00	3	0.5	10.0	9.0	124	3
8/8	8:00	5	1.0	7.0	8.0	128	3
	16:00	4	1.3	7.5	8.0	130	3
8/9	9:00	3	5.8	6.0	7.0	130	3
	16:00	3	0.0	11.0	9.0	130	3
8/10	9:00	3	4.3	9.0	7.0	132	3
	16:30	3	0.3	14.0	9.0	131	3
8/11	9:00	4	0.0	8.0	7.0	128	3
	16:30	4	0.0	13.0	8.0	122	3
8/12	8:00	5	6.1	9.0	7.0	120	3
	17:45	4	12.2	12.5	8.0	123	3
8/13	8:00	4	1.5	10.0	7.0	129	3
	17:00	4	0.5	16.0	9.0	147	3
8/14	9:00	4	0.5	9.0	7.0	160	3
	18:00	4	0.0	12.0	8.0	160	3
8/15	8:00	3	0.3	11.0	7.0	ND	3
	17:00	3	0.3	18.0	9.0	128	3
8/16	8:00	2	0.0	7.0	8.0	122.5	3
	17:30	2	0.5	19.0	10.0	118	3
8/17	8:00	4	20.3	10.0	8.0	113.8	3
	16:00	4	0.5	13.0	9.0	113.8	2
8/18	8:00	3	1.0	4.0	8.0	110	2
	17:00	2	0.0	19.0	10.0	110	2
8/19	8:00	1	0.0	6.0	9.0	109	2
	17:00	2	0.0	19.0	11.0	106	2
8/20	8:00	4	1.5	10.0	8.0	102	2
	17:00	4	5.1	13.0	9.0	101	2
8/21	8:00	4	5.1	10.0	9.0	104	2
	17:00	3	0.0	17.0	11.0	106	2
8/22	8:00	5	0.0	4.0	9.0	106	2
	17:00	3	0.0	14.5	11.0	105	2
8/23	9:00	4	3.8	7.0	9.0	98	2
	17:30	3	0.3	11.0	11.0	96	2
8/24	9:00	4	0.0	9.0	9.0	94	2

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
8/24	17:30	4	1.0	8.0	12.0	91	2
8/25	9:00	4	0.8	8.0	8.0	90	2
	18:00	4	0.0	14.0	8.0	88	2
8/26	9:00	3	0.0	5.0	8.0	88	2
	16:00	1	0.0	21.0	10.0	87	2
8/27	8:00	3	0.0	9.0	8.0	85	2
	18:00	2	0.0	18.0	10.0	85	1
	21:00	2	0.0	15.0	9.0	85	1
8/28	9:00	3	0.0	9.5	9.0	82	1
	17:00	3	0.0	15.0	11.0	82	1
8/29	9:00	5	0.0	5.0	9.0	83	2
	18:00	2	0.0	17.0	11.0	81	1
8/30	9:00	4	3.8	10.5	9.0	83	2
	17:30	4	0.0	18.0	10.0	81.5	1
8/31	9:00	5	4.1	9.0	9.0	81	1
	20:00	3	0.5	10.0	10.0	82	1
9/1	9:00	4	0.0	8.0	9.0	83	1
	17:00	4	0.0	12.0	10.0	84	1
9/2	9:00	2	0.0	8.0	8.0	82	1
	17:30	2	0.0	17.0	9.0	82	1
9/3	9:00	4	8.6	7.0	9.0	80.5	1
	17:00	4	5.1	12.5	10.0	80	1
9/4	9:00	4	7.9	8.5	9.0	80	1
	17:30	2	0.3	16.0	10.0	79	1
9/5	9:00	2	0.0	7.0	8.0	79	1
	17:30	2	0.0	18.0	10.0	77	1
9/6	9:00	3	0.0	13.0	9.0	ND	1
	17:00	2	0.0	15.0	10.0	76	1
9/7	9:00	4	0.0	6.0	9.0	76.5	1
	17:30	3	0.0	16.0	10.0	76	1
9/8	9:00	4	5.1	8.5	8.0	76.5	1
	16:00	3	3.3	10.0	9.0	77	1
9/9	9:00	4	2.0	8.0	9.0	77	1
	16:00	4	0.5	11.0	10.0	77.5	1
9/10	9:00	4	0.0	6.0	8.0	77	1
	17:00	4	0.0	9.0	8.0	78	1
9/11	9:00	4	0.0	7.0	8.0	77.5	1
	17:00	4	0.0	14.0	9.0	77.5	1
9/12	9:00	4	0.0	6.0	8.0	76.5	1
	20:00	3	0.0	5.0	8.0	76	1
9/13	9:00	4	0.0	8.0	8.0	75.5	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)[b]	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[c]
9/14	9:00	3	0.0	5.0	7.0	74	1
	17:00	2	0.0	14.0	8.0	72.5	1
9/15	9:00	3	0.0	3.0	7.0	70.5	1
	17:00	3	0.0	4.0	8.0	70.5	1
9/16	9:00	4	0.0	3.0	7.0	70	1
	17:00	2	0.0	16.0	9.0	69.5	1
9/17	9:00	4	0.0	2.0	6.0	69	1
	17:00	4	0.0	8.0	7.0	69	1
9/18	8:30	4	6.1	6.5	6.0	69	1

Note: ND = no data.

[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