Fishery Data Series No. 14-15

Unalakleet River Chinook Salmon Escapement Monitoring and Assessment, 2011–2012

Annual Report for Project FIS 10-102

USFWS Office of Subsistence Management

Fisheries Resource Monitoring Program

by

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and

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March 2014

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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by

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March 2014

This investigation was partially funded by the U.S. Fish and Wildlife Service, Office of Subsistence Management (Project No. FIS 10-102), Fisheries Resource Monitoring Program under agreement number 70181AJ019.

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This document should be cited as:
Kent, S. M., J. Bell, and L. Neff. 2014. Unalakleet River Chinook salmon escapement monitoring and assessment, 2011–2012. Alaska Department of Fish and Game, Fishery Data Series No. 14-15, Anchorage.

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ABSTRACT

Declining run sizes, coupled with state and federal restrictions and closures to the Unalakleet River Chinook salmon fisheries, have highlighted the need to obtain more complete estimates of the magnitude and age, sex, and length (ASL) composition of the spawning escapement. In 2010, the U.S. Fish and Wildlife Service Office of Subsistence Management began funding weir projects for the Unalakleet River to obtain reliable estimates of mainstem Chinook salmon escapement and ASL composition.

During the 2011 and 2012 seasons, an estimated 1,111 and 815 Chinook salmon were enumerated, respectively. The central 50% of the run was enumerated from 10 to 17 July in 2011 and from 18 to 28 July in 2012. Approximately 11% and 12% of the Chinook salmon passage was not directly counted but estimated using linear interpolation due to high-water events in 2011 and 2012, respectively. In 2011, estimated age composition of the Chinook salmon escapement samples was 56% age-1.2, 28% age-1.3, and 15% age-1.4, and sex composition was 27% female. In 2012, estimated age composition of the Chinook salmon escapement samples was 27% age-1.2, 58% age-1.3, and 14% age-1.4, and sex composition was 35% female.

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, resistance board weir, North River, Unalakleet River.

INTRODUCTION

Unalakleet River Pacific salmon (*Oncorhynchus* spp.) stocks contribute heavily to Norton Sound subdistricts 5 (Shaktoolik) and 6 (Unalakleet) (Figure 1) subsistence and commercial salmon fisheries (Menard et al. 2012). Although most salmon stocks to the Unalakleet River are considered healthy, Chinook salmon *O. tshawytscha* runs to the Unalakleet River drainage have been depressed and fully utilized since the late 1990s.

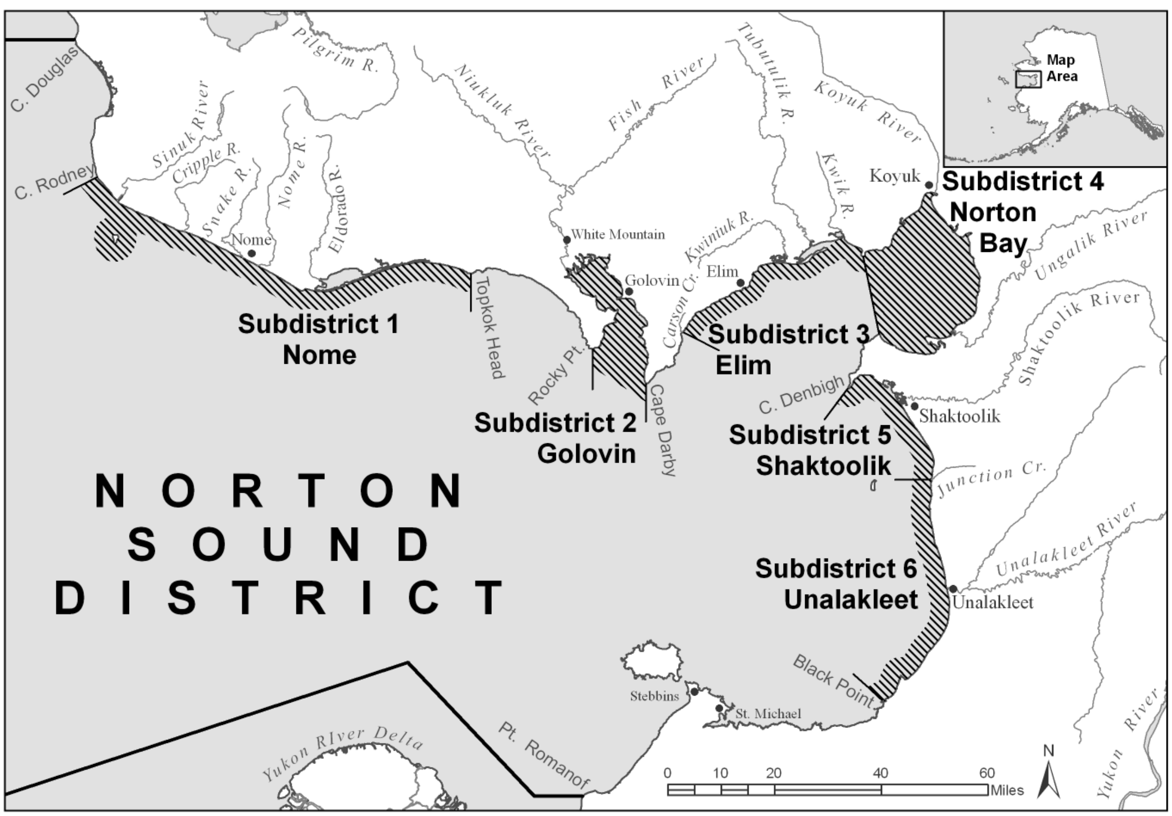

Figure 1.–Commercial salmon fishing subdistricts and major salmon-producing watersheds in the Norton Sound District.

The Alaska Board of Fisheries (BOF) designated Unalakleet River Chinook salmon as a stock of yield concern in 2004 (Kent and Bergstrom 2012). A "yield concern" is a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs. As a result of this designation, the Alaska Department of Fish and Game (ADF&G) has implemented a restrictive management plan in an effort to increase escapements and restore Unalakleet River Chinook salmon runs to historic levels of abundance.

Until recently, ADF&G has managed Unalakleet River Chinook salmon based primarily on inseason subsistence catch reports and counts of Chinook salmon observed at the North River tributary counting tower. Radiotelemetry studies revealed that North River accounts for 34–55% of the overall drainagewide Chinook salmon escapement (Wuttig 1999; Phil Joy, Fishery Biologist, ADF&G Division of Sport Fish, Fairbanks, personal communication). Lower river test-fishery set gillnet catches of Chinook salmon and spawning ground aerial surveys are also used but are considered ancillary assessment tools. Further, collection of reliable Chinook salmon age, sex, and length (ASL) data from these existing projects has been problematic due to funding limitations, small and poorly distributed annual sample sizes, and mesh-size selectivity bias (Kent 2010).

Beginning in 2010, a resistance board or "floating" weir was operated by the department, Native Village of Unalakleet (NVU), U.S. Bureau of Land Management (BLM), and Norton Sound Economic Development Corporation (NSEDC) on the mainstem of the Unalakleet River. Resistance board weirs are more effective than traditional fixed picket weirs at withstanding flood conditions, require less maintenance, and ultimately result in shorter periods of unmonitored fish passage (Stewart et al. 2009, 2010). Therefore, escapement counts from resistance board weirs are considered more complete. Additionally, weir traps may provide the least biased method of fish capture to obtain ASL data from live salmon.

This report presents the findings from the 2011 and 2012 seasons at the Unalakleet River resistance board weir project. Chinook salmon escapement, run timing, and ASL composition were estimated and compared between each season. The project is funded by the U.S. Fish and Wildlife Service Office of Subsistence Management (USFWS OSM) to provide 2 priority information needs: 1) reliable estimates of Chinook salmon escapement, and 2) unbiased ASL composition from the spawning escapement.

OBJECTIVES

Objectives for the Unalakleet River weir project were as follows:

1. Estimate daily and total Chinook salmon escapement during the target operational period.
2. Describe timing of Chinook salmon migration within the Unalakleet River mainstem.
3. Estimate ASL composition of the Unalakleet River Chinook salmon spawning escapement.

METHODS

STUDY AREA

The Unalakleet River and its 6 major tributaries have a drainage area of 2,815 square km, extending from the Nulato Hills. The river runs for approximately 210 km before emptying into the Bering Sea at the village of Unalakleet. The upper 81 river miles (130 rkm) of the mainstem of the Unalakleet River have been designated a National Wild River. Riparian vegetation throughout much of the drainage includes various assemblages of sedge grasses, muskeg bog flats, willow *Salix* spp., alder *Alnus* spp., western cottonwood *Populus fremontii*, black spruce *Picea mariana*, and white birch *Betula papyrifera*. Shale, clay, and loose soils characterize the majority of bank substrate of the Unalakleet River mainstem and its tributaries. In addition to Pacific salmon, the Unalakleet River supports resident populations of Arctic grayling *Thymallus arcticus*, whitefish (*Coregonus* and *Prosopium* spp.), Dolly Varden char *Salvelinus malma*, and burbot *Lota lota*.

In 2001, ADF&G personnel identified a suitable resistance board weir site located approximately 22 kilometers upstream of the mouth on the mainstem of the Unalakleet River (63° 53.32′ N, 160° 29.41′ W; Figure 2; Menard 2001; Todd 2003). This site was selected because of its favorable physical characteristics, including channel width (91 m), water depth (0.9–1.2 m), optimal stream velocity (0.9–1.2 m/s), and even bottom profile with gravel and small cobble bottom substrates to provide for stable anchoring of the weir. Additionally, radiotelemetry data have shown this site to be located well downstream of the entire mainstem Chinook salmon spawning distribution (Wuttig 1999; Phil Joy, Fishery Biologist, ADF&G Division of Sport Fish, Fairbanks, personal communication).

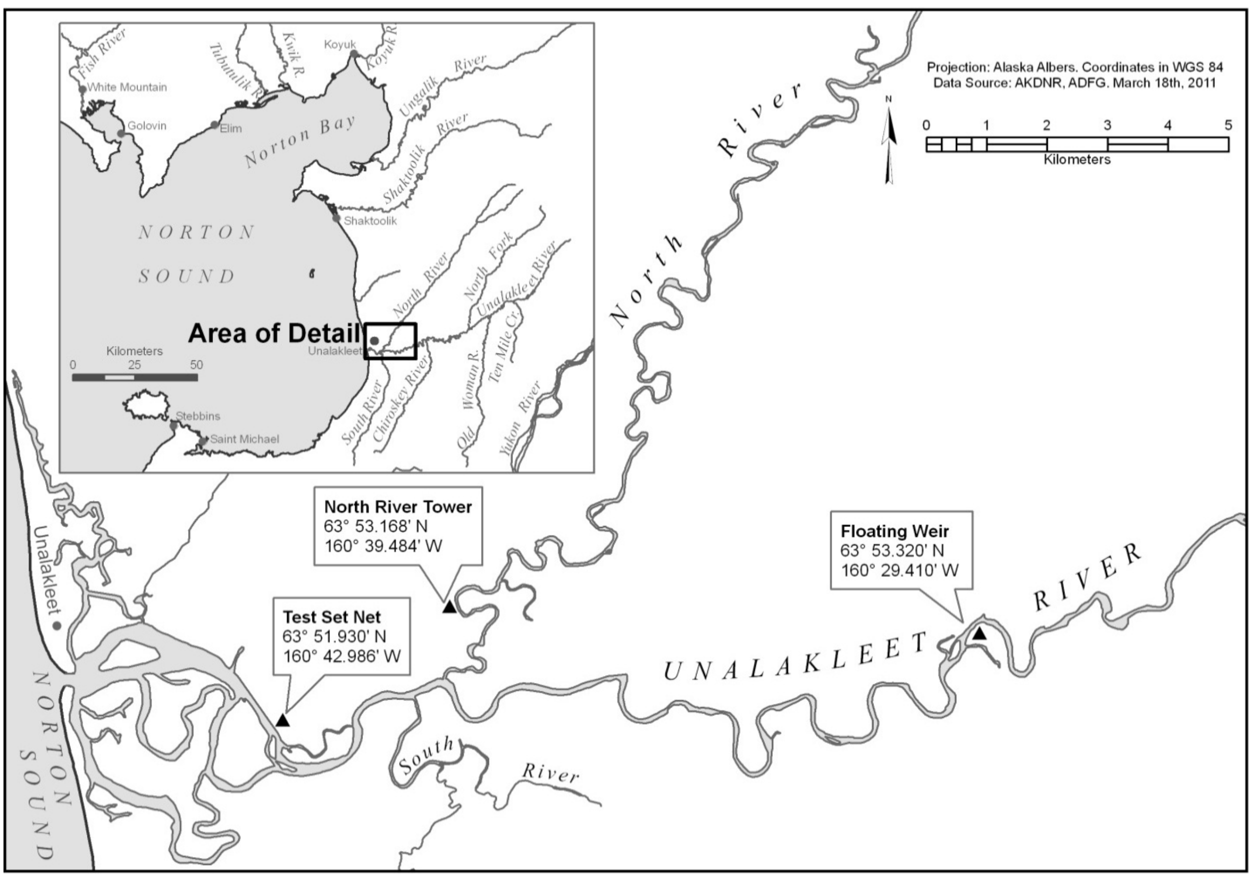

Figure 2.–Locations of salmon stock assessment projects within the Unalakleet River drainage, Norton Sound.

RESISTANCE BOARD WEIR DESIGN, INSTALLATION, AND OPERATION

Weir design and materials followed those described by Tobin (1994) with modifications outlined by Stewart (2002). Picket spacing was 3.2 cm, which imparted flexibility to the panels while allowing for a complete census of all but the smallest returning salmon.

High water levels confounded the installation during both the 2011 and 2012 seasons, particularly in the thalweg of the channel. Following methods outlined by Stewart (2003), a tethering cable system upstream of the substrate rail was used to guide weir panels into position on the rail in deep sections of the river. An enclosed passage chute and live trap were installed upstream of the weir to serve as a platform for enumeration and ASL sampling of migrating salmon. The live trap was constructed from aluminum angle and channel stock, and it measured 1.5 m wide by 2.4 m long by 1.5 m deep. The trap floor was made of sandbags. A collapsible fyke-shaped entrance and removable exit gate 16 inches wide were also installed on the trap. A second exit gate was hinged near the base of the removable gate. When water clarity diminished, the second hinged gate was raised to direct fish closer to the surface for better viewing.

For both seasons, the target operational period began in mid-June and lasted until 7 August and 15 August, for the 2011 and 2012 seasons, respectively. This schedule was to ensure that late Chinook salmon runs, like the 2010 run, were fully enumerated at the weir.

DATA COLLECTION

The weir was closed to fish passage except during onsite counting periods. Hourly or bi-hourly counts were conducted contingent upon fish passage. Flood lamps were also used at night when necessary. Counting schedules were adjusted for changes in diurnal migratory patterns or operational constraints such as less favorable viewing conditions caused by high water levels. Salmon migrating upstream were identified by species and recorded on multiple tally counters for a minimum of 1 hour or until fish passage diminished.

Counts were recorded in Rite-in-the-Rain[1] notebooks before being transferred to hourly count forms. Total and cumulative daily counts were calculated and transferred to radio log forms to relay inseason estimates to fishery managers in the Nome Area office.

WEATHER AND STREAM OBSERVATIONS

Stream and ambient air temperature (°C), relative water levels, and atmospheric observations (e.g., percent cloud cover, wind speed and direction) were measured twice daily. Additionally, a HOBO Pro v2 data logger was also secured several inches off the bottom in the thalweg of the river channel. Weather, temperature, and hydrological observations were recorded in Rite-in-the-Rain data forms and entered into Microsoft Excel spreadsheets.

INTERPOLATING UNMONITORED WEIR PASSAGE

The method used to interpolate for missed salmon passage caused by weir breach events was dependent on the amount of time the weir was inoperable. Minor weir breaches were disregarded if the problem was remedied quickly and passage thought to be minimal.

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

Single-Day Method

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

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

where

$n_{d_I - 1}, n_{d_I - 2} =$ observed passage of 1 and 2 days before the weir was breached, respectively;

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

Linear Method for Multiple Days of Unmonitored Passage

When the weir was not operational for 2 or more days and later became operational, passage estimates for the inoperable days were calculated using the procedures described by Perry-Plake and Antonovich (2009). This interpolation method was also used when counts for *k* consecutive days were suspected to be biased or compromised due to adverse viewing conditions. The moving average estimate for the missing day *i* was calculated as:

$$\hat{N}_i = \frac{\sum_{i-k}^{i+k} I(\textit{counting was successfully conducted on day } j)\hat{N}_j}{\sum_{i-k}^{i+k} I(\textit{counting was successfully conducted on day } j)} \tag{2}$$

where:

$$\mathrm{I}(\cdot) = \begin{cases} 1 & \text{when the condition is true} \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

is an indicator function.

The interpolated values were used as the point estimates for the daily counts.

AGE, SEX, AND LENGTH DATA COLLECTION

Chinook Salmon Capture Methods

An active sampling approach was implemented at the Unalakleet River weir to increase effectiveness of sampling Chinook salmon (Linderman et al. 2002). At first, one crew member would count fish at the upstream end of the trap while a second crew member sat at the back of the trap. When Chinook salmon were observed entering the trap at the rear gate, crew members simultaneously closed the front and rear gates to trap fish. Limited success capturing Chinook salmon occurred in 2010 using this method. In several instances, however, Chinook salmon were enumerated immediately after the person sitting at the rear of the trap left the scene. Beginning in 2011, the enclosed bulkhead of the fish passage chute was connected to the live trap to obscure personnel positioned near the rear trap gate from the view of migrating Chinook salmon. Consequently, Chinook salmon entered the trap less hesitantly and at a much slower speed during the 2011 and 2012 seasons, which ultimately led to considerably improved capture rates of Chinook salmon despite similarly low levels of Chinook salmon abundance observed in 2011–2012.

Distribution and Sample Sizes

Minimum ASL sample sizes were determined following Bromaghin (1993) to achieve 95% confidence intervals of age-sex composition to be no wider than ±10% (α = 0.05 and d = 0.10), assuming 10 age-sex categories (n = 190). To ensure adequate temporal distribution, ASL samples were collected during the 2011 and 2012 seasons following a daily collection schedule in proportion to average historical escapement by day; an example of a collection schedule is shown in Table 1. Historical North River run timing was used as a proxy to establish collection schedules in the absence of mainstem run timing information. When necessary, sampling distributions and schedules were adjusted inseason to address differences between expected and observed run abundance and timing.

Table 1.–Chinook salmon ASL sampling intervals and daily collection goals at Unalakleet River weir, 2011, Norton Sound.

	Date of Average Cumulative Passage	Sampling Interval Dates	Interval Sample Size	Number of Samples Collected Per Day
First Quarter Point	8 Jul	June 26–July 5	50	5
Midpoint	13 Jul	July 9–13	50	10
Third Quarter Point	21 Jul	July 16–20	50	10
95% Cumulative Passage	31 Jul	July 24–28	50	10
Season Total		June 27–July 28	200	

For the 2011 season, the Chinook salmon ASL sample size was reduced at Unalakleet River weir because of low abundance observed in 2010. The minimum sample size in 2011 was corrected for populations of 1,000 fish using the finite population correction:

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

Where:

n = sample size of unknown population size;

N = population size; and

n' = sample size corrected for a known population size.

This resulted in a 2011 minimum sample size of 160 Chinook salmon for the Unalakleet River weir. Increasing this minimum by 20% to account for unreadable scales resulted in a sampling goal of 200 Chinook salmon for the Unalakleet River weir. Accounting for unreadable scales, the 2012 ASL sampling goal was increased to 230 Chinook salmon based on an unknown population size as a result of improved capture efficiency using the modified weir trap passage chute.

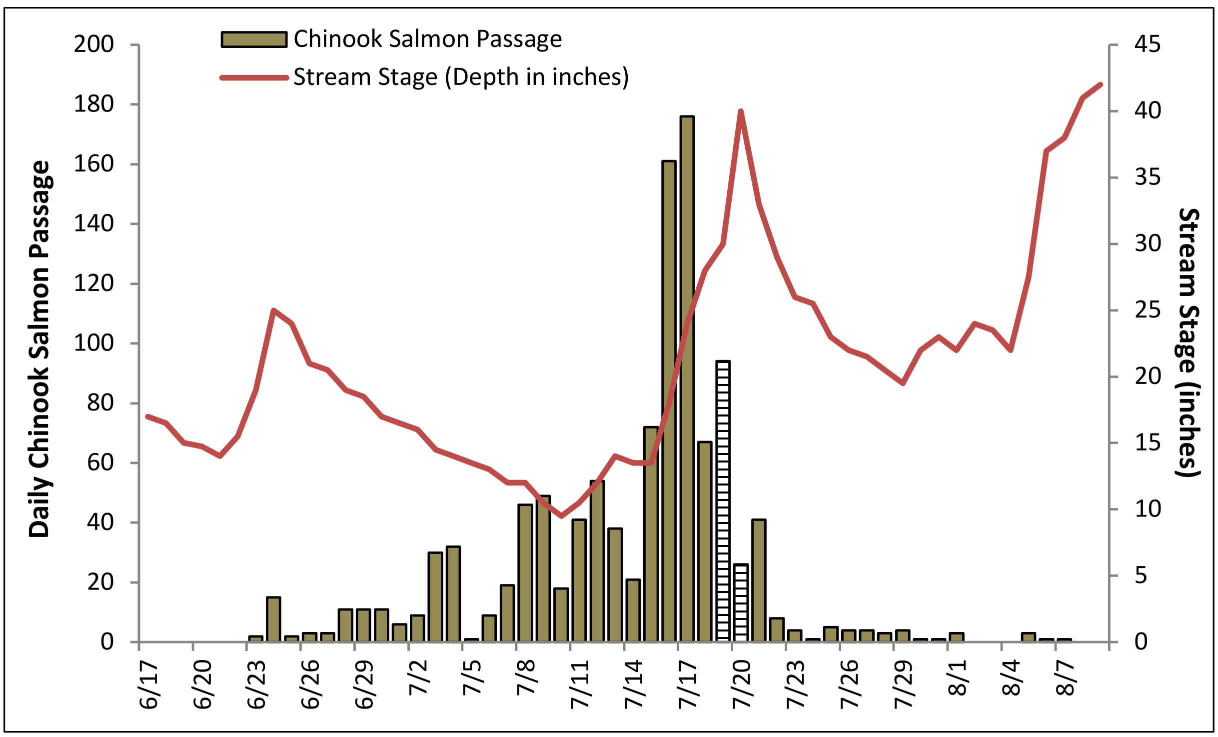
Sample Collection Procedures

Three scales were collected from each Chinook salmon for age determination. Sex was determined by visually examining external characteristics (such as body symmetry, kype development, and presence of an ovipositor), and length was measured to the nearest 0.5 cm from mid eye to tail fork. Scales were removed from the left side of the fish in an area 2–3 scale rows above the lateral line crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Scales were cleansed of slime and debris and mounted on gummed cards, and impressions were later made in cellulose acetate cards for age determination following methods described by Clutter and Whitesel (1956). Impressions were read with a microfiche reader, and ages were determined from reading annuli as described by Mosher (1969). European notation was used to report ages; in this notation, the first digit refers to the freshwater age not including the year spent in the gravel, and the second digit refers to the ocean age (Koo 1962).

RESULTS

WEIR OPERATIONS

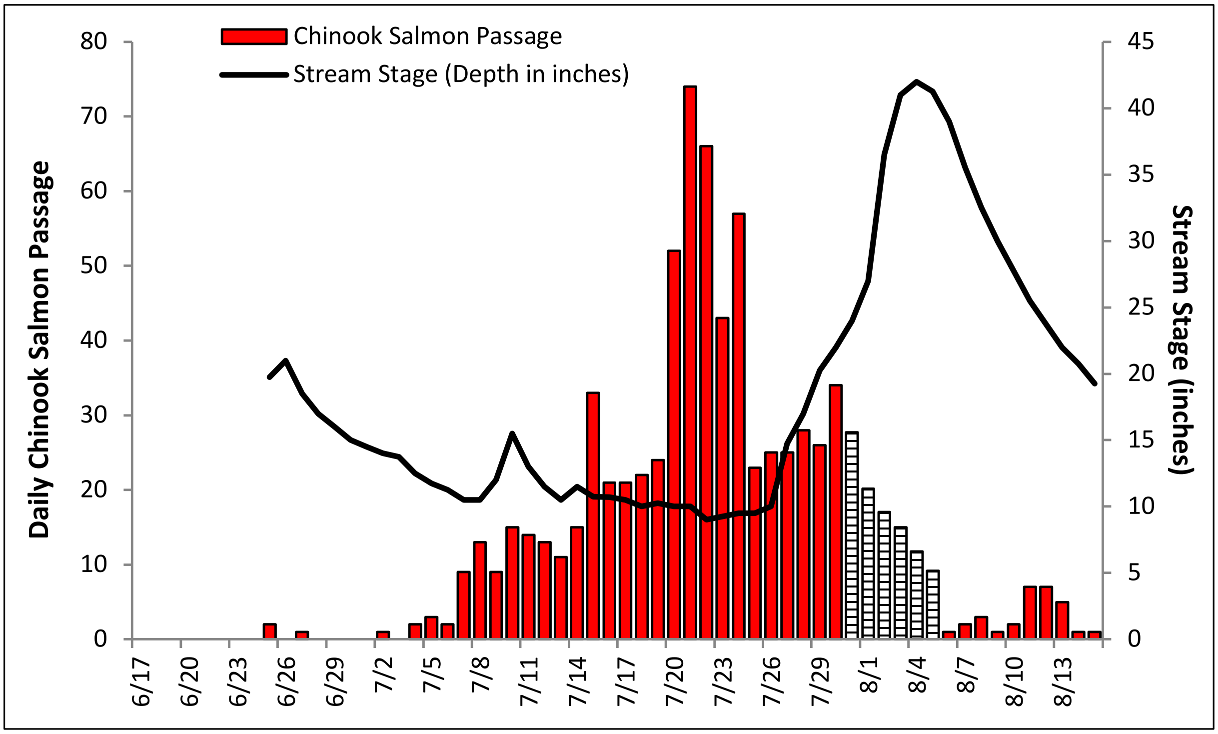
In 2011, weir installation began on 13 June and was fish tight by 17 June; counting operations continued until 7 August, when rising water levels made the weir inoperable. Water levels at the weir rose nearly 5 inches on 16 July and an additional 22 inches by 20 July (Figure 3; Appendix A1). During 19–20 July, the weir was completely submerged and salmon passed unmonitored; estimates of salmon passage for those dates were interpolated from adjacent daily counts (Figure 3).



Note: Light bars signify interpolated daily estimates of passage.

Figure 3.–Daily Chinook salmon passage compared to daily relative stream stage measurements (inches), 2011, Unalakleet River weir, Norton Sound.

In 2012, weir installation began on 21 June and was fish tight by 24 June, and counting operations ceased on 15 August. Water levels began to rise in late July and peaked at 42 inches on 4 August. High water levels from late July through early August breached the weir and allowed salmon to pass unobserved from 31 July to 5 August (Figure 4). While counts were conducted from 31 July to 1 August, some observers noted that species identification was challenging, specifically with mid-sized salmon (chum *O. keta*, sockeye *O. nerka*, coho *O. kisutch*, and small Chinook salmon). Due to the uncertainty with species composition of these counts, counts from 31 July to 5 August were estimated using linear interpolation. On August 6, water levels dropped to 39 inches and water clarity improved to a point that normal counting operations could resume at the weir (Figure 4; Appendix A1).



Note: Light bars signify interpolated daily estimates of passage.

Figure 4.–Daily Chinook salmon passage compared to daily relative stream stage measurements (inches), 2012, Unalakleet River weir, Norton Sound.

CHINOOK SALMON RUN TIMING AND ESCAPEMENT

In 2011, Chinook salmon were first observed at the Unalakleet River weir on 23 June, and an estimated total of 1,111 Chinook salmon were counted from 23 to June to 7 August (Appendix A2). Daily Chinook salmon passage peaked at the weir on 17 July (176 Chinook salmon) (Figure 3; Appendix A2). The central 50% of the Chinook salmon escapement occurred from 10 to 17 July and the median passage date at the weir was 16 July for the 2011 season (Appendix A2). Interpolated Chinook salmon passage was estimated to be 120 fish during the unmonitored period from 19 to 20 July, accounting for approximately 11% of the season's escapement (Appendix A2).

In 2012, a total of 815 Chinook salmon were estimated to have migrated above the Unalakleet River weir during the target operational period in 2012. Chinook salmon daily passage peaked on 21 July (74 Chinook salmon) in 2012 (Figure 4; Appendix A2). The median Chinook salmon passage date occurred on 22 July, and the central 50% of the run occurred between 18 and 28 July in 2012 (Appendix A2). Overall interpolated passage during the unmonitored period from

31 July to 5 August was 101 Chinook salmon, which accounted for 12% of the overall cumulative passage in 2012 (Appendix A2).

AGE, SEX, AND LENGTH COMPOSITION

In 2011, the sampling objective was to collect ASL data from a minimum of 200 Chinook salmon throughout the run. Increased effort toward active sampling and trap modifications greatly improved capture efficiency and minimum ASL sampling goals were achieved in 2011. A total of 204 Chinook salmon were sampled from 24 June to 25 July, and 88% or 179 of the sampled fish yielded readable scales. Samples comprised 56% age-1.2, 28% age-1.3, and 15% age-1.4 fish; sex composition was 27% female. Average length by age class was 556 mm (SD = 40), 707 mm (SD = 56), and 881 mm (SD = 57) for age-1.2, -1.3, and -1.4 Chinook salmon, respectively. Females averaged 748 mm (SD=154) in length and the mean length of male Chinook salmon was 609 mm (SD=100); mean length of all sampled fish was 647 mm (SD=132) (Table 2).

Table 2.–Chinook salmon age, sex, and mean length (METF in mm), 2011, Unalakleet River weir, Norton Sound.

			Brood Year and Age Class			
Sample Dates:		6/24–7/25	2007	2006	2005	
Number of Aged Samples:		179	1.2	1.3	1.4	Total
Males	Percent of Samples		49%	20%	4%	73%
	Number of Samples		100	41	8	149
	Mean Length (mm)		558	706	866	609
	SD (Length)		(4)	(9)	(17)	(100)
Females	Percent of Samples		7%	8%	11%	27%
	Number of Samples		14	17	23	54
	Mean Length (mm)		534	709	886	748
	SD (Length)		(10)	(16)	(14)	(154)
Total	Percent of Samples		56%	28%	15%	100%
	Number of Samples		115	58	31	204
	Mean Length (mm)		556	707	881	647
	SD (Length)		(40)	(56)	(57)	(132)

Note: SD = standard deviation of length. Proportion by age of aged samples was applied to un-aged samples.

In 2012, the sampling objective was 230 Chinook salmon distributed between June 25 and July 22. A total of 230 samples were collected from June 25 to July 30, and 208 (90%) of these samples were successfully aged. Samples consisted of 27% age-1.2, 58% age-1.3, and 14% age-1.4 fish; sex composition was 35% female. Average length for the major age classes was 562 mm (SD = 41), 736 mm (SD = 64), and 836 mm (SD = 80) for age-1.2, -1.3, and -1.4 Chinook salmon, respectively. Females averaged 782 mm (SD = 89) in length, and the mean length of male Chinook salmon was 657 mm (SD = 98); mean length for all sampled fish was 699 mm (SD = 112) (Table 3).

Table 3.–Chinook salmon age, sex, and mean length (METF in mm), 2012, Unalakleet River weir, Norton Sound.

			Brood Year and Age Class			
Sample Dates:		6/25–7/30	2008	2007	2006	
Number of Aged Samples		208	1.2	1.3	1.4	Total
Males	Percent of Samples		24%	37%	4%	65%
	Number of Samples		55	86	8	149
	Mean Length (mm)		555	718	776	657
	SD (Length)		(41)	(61)	(115)	(98)
Females	Percent of Samples		4%	21%	11%	35%
	Number of Samples		8	48	25	81
	Mean Length (mm)		606	769	855	782
	SD (Length)		(29)	(64)	(65)	(89)
Total	Percent of Samples		27%	58%	14%	100%
	Number of Samples		63	134	33	230
	Mean Length (mm)		562	736	836	699
	SD (Length)		(41)	(64)	(80)	(112)

Note: SD = standard deviation of length. Proportion by age of aged samples was applied to un-aged samples.

DISCUSSION

High water in both 2011 and 2012 made weir installation difficult, and creative solutions were needed to place weir panel sections in the thalweg of the channel. However, it appears likely that the weir was fish tight in time to count the beginning of the run in both seasons. This contention is supported by the fact that passage of Chinook salmon during the first week of operations in 2011 and 2012 represented 0.1% and 0.3% of the overall passage in those years, respectively. High water also rendered the weir inoperable for several days during both seasons, which required using linear interpolation to estimate unmonitored salmon passage. Weir personnel implemented key modifications to the passage chute and trap to obscure the view of personnel by migrating Chinook salmon; this modification dramatically improved live capture rates of Chinook salmon during the 2011 and 2012 seasons. The use of an enclosed passage chute resulted in fish entering the trap at a much slower speed, allowing personnel to close the live trap gates in time to capture the Chinook salmon.

The 2011 Chinook salmon run to the Unalakleet River occurred earlier than in 2012; 75% of the passage had occurred by 17 July in 2011 compared to 28 July in 2012. The 2011 run was also more compressed in time; the central 50% of the run occurred in only 8 days from 10 to 17 July. In contrast, the central 50% of the run occurred over a period of 11 days in 2012 (Appendix A2). It is possible early and compressed run timing observed in 2011 may, in part, be due to a continual rise in water levels from 11 to 20 July (Figure 3; Appendix A1) during the middle portion of the Chinook salmon run. In comparison, in 2012, major rises in water levels occurred in early July and early August (Figure 4; Appendix A1), which is typically near the end of the run (Appendix A2).

The resistance board weir provided accurate counts of Chinook salmon during the target operational periods in 2011 and 2012. Extending operations to mid-August for the 2011 and 2012 seasons was also effective at ensuring the entire Unalakleet River Chinook salmon run was enumerated. Escapement of Chinook salmon observed in 2011 was 8% above the 2010 mainstem weir count of 1,021 fish (Menard et al. 2012). However, the 2012 weir count of 815 Chinook salmon was 20% and 27% below the 2010 and 2011 weir counts, respectively. This low count of Chinook salmon at the weir was consistent with record low subsistence harvests of Chinook salmon and low North River tower count (996 fish) of Chinook salmon observed in 2012.

Modifications to the trap-passage chute assembly proved successful at capturing enough Chinook salmon to achieve minimum ASL sampling objectives during the 2011 and 2012 seasons; 204 and 230 Chinook salmon were captured, compared to only 29 Chinook salmon captured in 2010. Despite meeting the minimum ASL sample goal in 2011, the distribution of ASL data was not considered representative of the entire run. Specifically, there were 196 samples collected during the first half of the run (24 June to 16 July) compared to only 7 samples collected from the last half. Moreover, from 16 to 17 July, 30% of the passage occurred (Appendix A2), yet samples within this time period account for 4% of the total. Therefore, the ASL composition in 2011 is considered representative of the first half of the run. The high proportion of age-1.2 Chinook salmon observed in the escapement was consistent with high proportions of age-1.2 fish observed in North River escapement and Unalakleet River test fishery samples in 2011 (Kent and Bergstrom 2012). In 2012, ASL samples collected are considered representative of the entire run because 132 samples (58%) were collected from the front half of the passage and 98 samples (42%) were collected from the latter half of the run. The high proportion of age-1.3 Chinook salmon in 2012 samples was consistent with the large numbers of age-1.2 Chinook salmon observed in 2011.

Age structure of the 2011 spawning escapement, as well as test and subsistence fishery harvests, showed a high proportion of age-1.2 Chinook salmon (Kent and Bergstrom 2012). Heading into the 2012 season, ADF&G interpreted the high proportion of age-1.2 fish as a preliminary indicator of strong survival of the 2007 brood year and an improved run for 2012. However, realized production for this brood year over the 2012 return year proved to be weak. This, in combination with poor contributions from other year classes, resulted in low total escapement. Low escapements are expected to persist in the 2013 season.

ACKNOWLEDGEMENTS

The authors would like to acknowledge personnel from organizations who contributed time and resources to make the Unalakleet River weir project a success. The authors would like to thank all field biologists and technicians who assisted with the installation and operation phases of the weir from 2011 to 2012, including ADF&G employees Gary Kneupfer, Brendan Scanlon, Joshua Mumm, Nicole Dill, John Ivanoff, Peter Nanouk, and Samuel Schmidt; NSEDC employees Richard Guidry and Max Fancher; NVU personnel David Lockwood, Joanne Anderson, Rachel Katchatag, and Talailauq Katchatag; and BLM personnel Merlyn Schelske, Sara Steel, Andy Welch, and Isaac Fox. USFWS OSM provided funding support for this project (FIS 10-102) through the Fisheries Resource Monitoring Program, under agreement number 70181AJ019.

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APPENDIX A

Appendix A1.–Relative stream stage depth observations as indicated by stream gauge measurements, 2011–2012, Unalakleet River weir, Norton Sound.

	2011	2012
Date	Water Depth (inches)	Water Depth (inches)
6/17/2012	17.00	
6/18/2012	16.50	
6/19/2012	15.00	
6/20/2012	14.75	
6/21/2012	14.00	
6/22/2012	15.50	
6/23/2012	19.00	
6/24/2012	25.00	
6/25/2012	24.00	19.75
6/26/2012	21.00	21.00
6/27/2012	20.50	18.50
6/28/2012	19.00	17.00
6/29/2012	18.50	16.00
6/30/2012	17.00	15.00
7/1/2012	16.50	14.50
7/2/2012	16.00	14.00
7/3/2012	14.50	13.75
7/4/2012	14.00	12.50
7/5/2012	13.50	11.75
7/6/2012	13.00	11.25
7/7/2012	12.00	10.50
7/8/2012	12.00	10.50
7/9/2012	10.50	12.00
7/10/2012	9.50	15.50
7/11/2012	10.50	13.00
7/12/2012	12.00	11.50
7/13/2012	14.00	10.50
7/14/2012	13.50	11.50
7/15/2012	13.50	10.75
7/16/2012	18.00	10.70
7/17/2012	24.00	10.50
7/18/2012	28.00	10.00
7/19/2012	30.00	10.25
7/20/2012	40.00	10.00
7/21/2012	33.00	10.00
7/22/2012	29.00	9.00
7/23/2012	26.00	9.25
7/24/2012	25.50	9.50

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	2011	2012
Date	Water Depth (inches)	Water Depth (inches)
7/25/2012	23.00	9.50
7/26/2012	22.00	10.00
7/27/2012	21.50	14.75
7/28/2012	20.50	17.00
7/29/2012	19.50	20.25
7/30/2012	22.00	22.00
7/31/2012	23.00	24.00
8/1/2012	22.00	27.00
8/2/2012	24.00	36.50
8/3/2012	23.50	41.00
8/4/2012	22.00	42.00
8/5/2012	27.50	41.25
8/6/2012	37.00	39.00
8/7/2012	38.00	35.50
8/8/2012	41.00	32.50
8/9/2012	42.00	30.00
8/10/2012		27.75
8/11/2012		25.50
8/12/2012		23.75
8/13/2012		22.00
8/14/2012		20.75
8/15/2012		19.25

Appendix A2.–Daily and cumulative Chinook salmon passage, 2011–2012, Unalakleet River weir, Unalakleet River drainage, Norton Sound.

	2011		2012	
Date	Daily Chinook salmon	Cumulative Chinook salmon	Daily Chinook salmon	Cumulative Chinook salmon
17 Jun	0	0		
18 Jun	0	0		
19 Jun	0	0		
20 Jun	0	0		
21 Jun	0	0		
22 Jun	0	0		
23 Jun	2	2		
24 Jun	15	17	0	0
25 Jun	2	19	2	2
26 Jun	3	22	0	2
27 Jun	3	25	1	3
28 Jun	11	36	0	3
29 Jun	11	47	0	3
30 Jun	11	58	0	3
1 Jul	6	64	0	3
2 Jul	9	73	1	4
3 Jul	30	103	0	4
4 Jul	32	135	2	6
5 Jul	1	136	3	9
6 Jul	9	145	2	11
7 Jul	19	164	9	20
8 Jul	46	210	13	33
9 Jul	49	259	9	42
10 Jul	18	277	15	57
11 Jul	41	318	14	71
12 Jul	54	372	13	84
13 Jul	38	410	11	95
14 Jul	21	431	15	110
15 Jul	72	503	33	143
16 Jul	161	664	21	164
17 Jul	176	840	21	185
18 Jul	67	907	22	207
19 Jul	94 [a]	1,001	24	231
20 Jul	26 [a]	1,027	52	283
21 Jul	41	1,068	74	357
22 Jul	8	1,076	66	423

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	2011		2012	
Date	Daily Chinook salmon	Cumulative Chinook salmon	Daily Chinook salmon	Cumulative Chinook salmon
23 Jul	4	1,080	43	466
24 Jul	1	1,081	57	523
25 Jul	5	1,086	23	546
26 Jul	4	1,090	25	571
27 Jul	4	1,094	25	596
28 Jul	3	1,097	28	624
29 Jul	4	1,101	26	650
30 Jul	1	1,102	34	684
31 Jul	1	1,103	28 [a]	712
1 Aug	3	1,106	20 [a]	732
2 Aug	0	1,106	17 [a]	749
3 Aug	0	1,106	15 [a]	764
4 Aug	0	1,106	12 [a]	776
5 Aug	3	1,109	9 [a]	785
6 Aug	1	1,110	1	786
7 Aug	1	1,111	2	788
8 Aug			3	791
9 Aug			1	792
10 Aug			2	794
11 Aug			7	801
12 Aug			7	808
13 Aug			5	813
14 Aug			1	814
15 Aug			1	815
Total	1,111		815	

Note: Grey shaded boxes indicate median passage dates, and lighter enclosed boxes delineate the central 50% of run.

[a] Chinook salmon passage estimated using linear interpolation.