Fishery Data Series No. 17-29

Salmon Escapement Monitoring in the Kuskokwim Area, 2016

Annual Report for Project No. 14-303 and 14-302

USFWS Office of Subsistence Management

Fisheries Resource Monitoring Program

by

Jordan M. Head

and

Zachary W. Liller

July 2017

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
Jordan M. Head and Zachary W. Liller
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

July 2017

This investigation was partially financed by USFWS Office of Subsistence Management (under Project Numbers 14-303, and 14-302), Fisheries Resource Monitoring Program under FWS Agreement Numbers F14AC00102 and F14AC00109. Additional funds were provided by Coastal Villages Region Fund, the Chinook Salmon Research Initiative, and the State of Alaska.

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Jordan M. Head and Zach W. Liller
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

This document should be cited as follows:
Head, J. H., and Z. W. Liller. 2017. Salmon escapement monitoring in the Kuskokwim Area, 2016. Alaska Department of Fish and Game, Fishery Data Series No. 17-29, Anchorage.

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ABSTRACT

The Alaska Department of Fish and Game (ADF&G), in collaboration with other entities, conducted aerial surveys and operated ground-based weir projects to monitor Pacific salmon *Oncorhynchus* spp. escapement throughout the Kuskokwim Area in 2016. This report presents results of sampling activities and escapement monitoring from all aerial surveys and weir projects operated by ADF&G. Chinook salmon *Oncorhynchus tshawytscha* escapements were successfully enumerated on 13 tributaries by aerial survey and 5 tributaries with ground-based fish weirs. Overall, Chinook salmon escapement was near average in 2016. A total of 13 Chinook salmon tributary escapement goals were assessed; 4 goals were not met, 6 goals were met, and 2 goals were exceeded. Sockeye salmon *O. nerka* were successfully enumerated on 3 tributaries by aerial survey and 4 tributaries with ground-based fish weirs. Above average sockeye salmon escapement was observed throughout the Kuskokwim Area. All 4 tributary escapement goals were assessed in 2016 and all 4 goals were exceeded. Chum salmon *O. keta* were successfully enumerated on 5 tributaries with ground-based weirs. Chum salmon escapement was below average at 2 monitored locations, near average at 2 locations, and well above average at 1 location in 2016. Both chum salmon tributary escapement goals were met in 2016. Coho salmon *O. kisutch* escapements were incomplete at 3 of 4 monitoring locations due to high waters in 2016. Coho salmon escapement was above average at Tatlawiksuk River, the only successful monitoring project in 2016. There was no effort to monitor coho salmon escapement in Kuskokwim Bay due to funding constraints in 2016.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *Oncorhynchus keta*, sockeye salmon, *Oncorhynchus nerka*, coho salmon, *Oncorhynchus kisutch*, aerial survey, resistance board weir, fixed picket weir, escapement, age, sex, and length (ASL), Kuskokwim River, North Fork Goodnews River, Middle Fork Goodnews River, Kanektok River, Kisaralik River, Aniak River, Salmon River (Aniak drainage), Kipchuk River, Holokuk River, Oskawalik River, George River, Holitna River, Kogrukluk River, Telaquana River, Cheeneetnuk River, Gagaryah River, Tatlawiksuk River, Salmon River (Pitka Fork drainage), Bear Creek, Kuskokwim Bay, Kuskokwim Area

INTRODUCTION

Pacific salmon *Oncorhynchus* spp. runs throughout the Kuskokwim Area are managed to provide for escapements within ranges that will conserve and sustain potential salmon production. As such, long-term escapement monitoring projects are important tools for fishery management. Peak aerial surveys and ground-based weirs are used throughout the Kuskokwim Area to measure annual escapement to key spawning systems (Figures 1–3) and track temporal and spatial patterns in abundance. The Kuskokwim Area comprises the Kuskokwim River and Kuskokwim Bay river systems (Figure 1). Salmon spawn in many tributaries throughout the Kuskokwim River drainage and contribute to the subsistence, commercial, and sport fishery harvests. Because it is not feasible to monitor all tributaries of the Kuskokwim River, a subset of rivers distributed over a broad geographic area is monitored to provide an indicator of Kuskokwim River salmon abundance. The rivers monitored in Kuskokwim Bay are the primary spawning drainages and main producers of salmon harvested in the area.

Formal abundance estimates do not exist for all salmon species returning to Kuskokwim Area systems. Available data indicate sockeye salmon *O. nerka* is the most abundant salmon species in Kuskokwim Bay river systems, followed by chum *O. keta*, coho *O. kisutch*, and Chinook *O. tshawytscha* salmon (Lipka et al. 2016). For the Kuskokwim River, data indicate chum salmon is the most abundant salmon species in the drainage, followed by coho, sockeye, and Chinook salmon. Pink salmon *O. gorbuscha* abundance within the Kuskokwim Area has not been estimated.

Kuskokwim Area salmon support subsistence, commercial, and sport fisheries that contribute to an average annual harvest of approximately 720,000 fish (2003–2013: Lipka et al. 2016). The subsistence salmon fishery in the Kuskokwim Area is one of the largest and most important in

the state and remains a fundamental component of local culture (Shelden et al. 2016). Although the subsistence salmon fishery occurs throughout the entire Kuskokwim Area, the majority of fishing effort occurs within the lower 200 miles of the Kuskokwim River, Goodnews Bay, and the Kanektok River within Kuskokwim Bay (Shelden et al. 2016). Since 2001, the commercial salmon fishery has occurred in 3 districts within the Kuskokwim Area (Lipka et al. 2016). District 1 is located in the lower portion of the Kuskokwim River, and Districts 4 and 5 encompass areas in Kuskokwim Bay near the Kanektok and Goodnews river systems, respectively. The sport fishery is the smallest of the 3 fisheries and occurs throughout the Kuskokwim Area.

Peak aerial surveys have been conducted annually since 1959 in select salmon spawning rivers throughout the Kuskokwim Area to index salmon escapement abundance (Molyneaux and Brannian 2006). Aerial surveys flown on Kuskokwim Bay rivers index Chinook and sockeye salmon escapement, and Kuskokwim River surveys index Chinook salmon escapement only. A total of 145 individual rivers and lakes throughout the Kuskokwim Area have been surveyed at least once (Brannian et al. 2006; AYKDBMS[1] [Arctic-Yukon-Kuskokwim Database Management System]). In 2016, a subset of 14 rivers was selected to be surveyed (Table 1 and 2). Rivers with existing escapement goals were prioritized and additional rivers were selected based on water clarity, location, salmon abundance, past survey history, and perceived local importance and interest. Although aerial surveys provide the most cost-effective means of monitoring salmon escapements, they are subject to limited reliability and high variability in precision depending on viewing conditions and the surveyor's experience (Burkey et al. 2001).

Weirs have been used annually since the late 1970s throughout the Kuskokwim Area to estimate total escapement and collect age, sex, and length (ASL) data from Chinook, chum, sockeye, and coho salmon (Molyneaux and Brannian 2006; Blain et al. 2016). The first weir project in the Kuskokwim Area was established on the Kogrukluk River in 1976 to monitor salmon escapement to the Holitna River drainage. In 1981 and 1982 a weir was operated on the South Fork of the Salmon River (Pitka Fork) to monitor Chinook salmon escapement upriver from McGrath (Molyneaux and Brannian 2006). Throughout the 1990s and early 2000s, 7 additional weir projects were added to monitor salmon escapement in the lower (Kwethluk and Tuluksak river weirs), middle (George and Tatlawiksuk river weirs), and upper (Takotna River weir) portions of the Kuskokwim River and Kuskokwim Bay (Kanektok and Middle Fork Goodnews river weirs). In 2006, a weir was established on the Salmon River (Aniak) to index salmon escapement to the Aniak River. In 2010, a weir was established on Telaquana River to index sockeye salmon escapement into Telaquana Lake. The Takotna River weir was discontinued in 2014, the Salmon River (Pitka Fork) weir was re-established in 2015 downriver of its original location, and the Kanektok River weir was discontinued in 2016. Weir locations were chosen based on salmon abundance, ability to install and operate a weir, past monitoring history, availability of funding, and perceived local importance and interest. Pink salmon escapement data were also collected at the escapement projects; however, the smaller body size of pink salmon may have allowed some to pass through the weirs undetected, making complete counts impossible. In addition to Pacific salmon, many other resident fish species are commonly observed in the monitored streams. Ground-based weir projects provide a dependable and rigorous approach to escapement monitoring. However, the relatively high costs of weir projects

[1] AYKDBMS [Arctic-Yukon-Kuskokwim Database Management System] Home Page. http://sf.adfg.state.ak.us/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx.

and limitations of installing weirs in large or fast-flowing rivers limit the number of salmon producing tributaries that can be monitored using this method.

Formal escapement goals have been established for Chinook, chum, sockeye, and coho salmon in select monitored Kuskokwim Area tributaries (Conitz et al. 2015; Tables 1–3). Within the Kuskokwim River, Chinook salmon escapement goals have been established on 10 tributaries, with 3 weirs and 7 aerial surveys. The Kogrukluk River weir is the only weir monitored by the Alaska Department of Fish and Game (ADF&G) that has established escapement goals for chum, sockeye, and coho salmon within the Kuskokwim River drainage. The Kwethluk River weir, monitored by the U.S. Fish and Wildlife Service (USFWS), has established Chinook and coho salmon goals; and the George River, monitored by ADF&G, has an established Chinook salmon goal. Aerial survey escapement goals have been established on the Kanektok and North Fork Goodnews rivers for Chinook and sockeye salmon, in Kuskokwim Bay. The only weir-based escapement goals within Kuskokwim Bay for Chinook, sockeye, chum, and coho salmon have been established on the Middle Fork Goodnews River.

Kuskokwim River Chinook salmon is the only species with an established drainagewide escapement goal (Conitz et al. 2015). Estimates of total annual abundance are achieved using a maximum likelihood model that uses data collected from ground-based escapement monitoring projects and aerial surveys (Table 3; Bue et al. 2012). The model estimate is used to evaluate the drainagewide escapement goal for Chinook salmon (65,000–120,000 fish; e.g., Liller 2017).

This report presents results of sampling activities and escapement monitoring from all aerial surveys and weir projects operated by ADF&G and partner organizations in 2016. The projects discussed in this report provide information necessary for annual assessment of escapement goals in the Kuskokwim Area, including estimation of total run size of Kuskokwim River Chinook salmon. In the Kuskokwim Area, 13 aerial survey rivers were flown, including the North Fork Goodnews, Middle Fork Goodnews, Kanektok, Kisaralik, Aniak, Kipchuk, Holokuk, Oskawalik, Holitna, Cheeneetnuk, Gagaryah, Salmon (Pitka Fork drainage), and Bear Creek rivers (Figures 2 and 3). Weir projects were operated successfully on the Middle Fork Goodnews River in collaboration with USFWS; on the Salmon River (Pitka Fork) in collaboration with MTNT, Ltd; on the Salmon (Aniak) in collaboration with the Native Village of Napaimute; on the Telaquana River in collaboration with the National Park Service; and on the George, Tatlawiksuk, and Kogrukluk rivers by ADF&G staff (Table 3; Figures 2 and 3). Supplemental to ADF&G monitoring efforts, the USFWS successfully operated salmon weirs on the Kwethluk and Tuluksak rivers in 2016, and the results from these projects are reported by USFWS. All weir projects targeted the Pacific salmon species (Table 3). Data collected to determine ASL compositions are reported in the *Salmon age, sex, and length catalog for the Kuskokwim Area* (e.g., Liller et al. 2016).

OBJECTIVES

1. Conduct aerial surveys of Chinook salmon or sockeye salmon abundance under good or fair survey conditions between 17 July and 5 August on the following Kuskokwim Area rivers in 2016:

   Kuskokwim Bay – Chinook and sockeye salmon

   - North Fork Goodnews River;
   - Middle Fork Goodnews River;
   - Kanektok River;

   Kuskokwim River – Chinook salmon

   - Kisaralik River;
   - Aniak River;
   - Salmon River (Aniak drainage);
   - Kipchuk River;
   - Holokuk River;
   - Oskawalik River;
   - Holitna River;
   - Cheeneetnuk River;
   - Gagaryah River;
   - Salmon River (Pitka Fork drainage); and
   - Bear Creek.

2. Estimate daily and annual escapements of Pacific salmon species at weirs operated on the following Kuskokwim Area rivers, during a standard target operational period in 2016:

   Kuskokwim Bay

   - Middle Fork Goodnews River – Chinook, chum, and sockeye salmon between 25 June and 31 August;

   Kuskokwim River

   - Salmon River (Aniak drainage) – Chinook, chum, sockeye and coho salmon between 15 June and 20 September;
   - George River – Chinook, chum, and coho salmon between 15 June and 20 September;
   - Kogrukluk River – Chinook, chum, sockeye, and coho salmon between 26 June and 25 September;
   - Telaquana River – sockeye salmon between 3 July and 11 August;
   - Tatlawiksuk River – Chinook, chum, and coho salmon between 15 June and 20 September; and
   - Salmon River (Pitka Fork drainage) – Chinook salmon between 1 June and 15 August.

3. Collect age, sex, and length data from adult salmon species using weir traps operated on Middle Fork Goodnews, Salmon (Aniak), George, Tatlawiksuk, Kogrukluk, Telaquana, and Salmon (Pitka) rivers in 2016, such that minimum sample sizes meet or exceed the following:
    - Chinook salmon – 230;
    - Kuskokwim River sockeye salmon – 250 (Kogrukluk and Telaquana, sex and length data only);
    - Kuskokwim Bay sockeye salmon – 400;
    - Chum salmon – Kogrukluk – 600, all other projects - 400; and
    - Coho salmon – 400.

METHODS

STUDY AREA

The Kuskokwim Area is defined in regulation (5 AAC 07.100) as all waters of Alaska between the latitude of the westernmost point of the Naskonat Peninsula and the latitude of the southernmost tip of Cape Newenham, including the waters of Alaska surrounding Nunivak and St. Matthews Island and those waters draining into the Bering Sea (Figure 1). For the purposes of this report, the Kuskokwim Area is divided into the Kuskokwim Bay and the Kuskokwim River. Kuskokwim Bay includes mainland coastal streams (excluding the Kuskokwim River) and commercial fishing Districts 4 and 5. The Kuskokwim River includes the mainstem, all tributaries of the river, and commercial fishing District 1.

Escapement monitoring was conducted in select salmon spawning tributaries draining into the Kuskokwim Area. In 2016, ADF&G coordinated escapement monitoring in 3 rivers draining into Kuskokwim Bay and 10 tributaries in the Kuskokwim River drainage (Figures 2 and 3). Chinook, chum, sockeye, and coho salmon are present at all monitoring locations; however, not all species are present in large numbers at all locations.

Kuskokwim Bay Assessment Locations

Goodnews River

Monitoring efforts within the north and middle forks of the Goodnews River provide an index of salmon escapement to the entire Goodnews River drainage and are used to inform sustainable management of the District 5 commercial fishery and local subsistence fisheries. The Goodnews River watershed drains an area approximately 2,636 km^2 (Brown 1983). Originating on the north side of the Aklun Mountains, the Goodnews River flows southwesterly a distance of 127 river kilometers (rkm) until emptying into Goodnews Bay, a small bay nested within Kuskokwim Bay. The mainstem Goodnews River is the northernmost branch of the Goodnews River system and is therefore referred to as the North Fork. Chinook and sockeye salmon escapement to the North Fork was monitored by aerial survey. The Middle Fork of the Goodnews River flows southwesterly a distance of approximately 97 rkm before joining the North Fork a few miles upriver from Goodnews Bay (Buzzell 2011). Chinook and sockeye salmon escapement to the Middle Fork was monitored by aerial survey. In addition, Chinook, sockeye, and chum, salmon escapement to the Middle Fork was monitored using a resistance board weir. The weir was located approximately 16 rkm upstream from the confluence with the North Fork at 59°9′36″N,

161°23′17″W. At the weir site, the river measured 61 m wide and 1 m deep during normal summer flow. Due to its proximity to the confluence, the weir accounted for a majority of salmon spawning within the Middle Fork.

Kanektok River

Monitoring efforts within the Kanektok River provide an index of salmon escapement returning to the entire Kanektok River and these data are used to inform sustainable management of the District 4 commercial fishery and local subsistence fisheries. The Kanektok River watershed drains an area approximately 2,261 km^2 (Walsh et al. 2006). The Kanektok River originates from Kagati and Pegati lakes, located between the Eek and Ahklun Mountains, and flows westerly for 147 rkm until emptying into Kuskokwim Bay near the village Quinhagak (Buzzell and Russell 2010). Chinook and sockeye salmon escapement to the Kanektok River was monitored by aerial survey.

Lower Kuskokwim River Assessment Locations

Kisaralik River

The Kisaralik River is located between the Kwethluk and Tuluksak rivers, which are both monitored by USFWS using weirs. Aerial surveys flown on the Kisaralik River are used to index Chinook salmon escapement to the Lower Kuskokwim River, in a portion of the drainage where subsistence, commercial, and sport fishing is common. The Kisaralik River originates from Kisaralik Lake in the Kilbuck Mountains and flows northwesterly for approximately 187 rkm until reaching Kuskokuak Slough (at rkm 135; Buzzell 2010), which then flows into the Kuskokwim River (at rkm 131).

Middle Kuskokwim River Assessment Locations

Aniak River Drainage

The mainstem Aniak River is a large tributary that drains the southern portion of the middle Kuskokwim River. The Aniak River originates from the Aniak Lake basin in the Kuskokwim Mountains and flows northerly for approximately 151 rkm until entering the Kuskokwim River (at rkm 307) near the community of Aniak (Brown 1983). Chinook salmon escapement was monitored throughout the mainstem Aniak River by aerial survey.

The Salmon River is a tributary of the Aniak River, and assessment provided an index of salmon abundance to the Aniak River. The Salmon River originates in the Kilbuck Mountains and flows northerly for approximately 71 rkm to its confluence with the Aniak River. Chinook salmon abundance was monitored using aerial surveys. In addition, Chinook, chum, sockeye and coho salmon escapement was monitored using a fixed picket weir. The weir was located approximately 1 km upstream of the confluence with the Aniak River at 61°03′46″N, 159°11′40″W. At the weir site, the river measured 35 m wide and 1.25 m deep during normal summer operations. Due to its proximity to the confluence, the weir accounted for nearly all salmon spawning within the Salmon River.

The Kipchuk River is a headwater tributary of the Aniak River and provided an index of salmon abundance to the Aniak River. The Kipchuk River originates in the Kuskokwim Mountains, several kilometers northwest of Aniak Lake. The Kipchuk River flows northerly for approximately 106 rkm until reaching the Aniak River. Chinook salmon escapement was monitored using aerial surveys.

Holokuk and Oskawalik Rivers

The Holokuk and Oskawalik rivers are relatively small tributaries that drain the southern portion of the middle Kuskokwim River. The Holokuk River flows northeasterly, approximately 72 rkm from its origins in the Buckstock Mountains, which separate the Holokuk River from the Aniak River. It joins the Kuskokwim River (at rkm 362) near the community of Napaimute (Brown 1983). The Oskawalik River originates from streams draining the Chuilnuk Mountains, which separate the Oskawalik River from the Holitna River basin. This river flows north-northwesterly for approximately 89 rkm until reaching the Kuskokwim River (at rkm 398; Brown 1983). Aerial surveys flown on each river were used to index Chinook salmon escapement to the middle portion of the Kuskokwim River drainage.

George River

The George River is the only monitored tributary that drained the northern portion of the middle Kuskokwim River. The George River originates in the northern Kuskokwim Mountains and flows southerly for approximately 120 rkm to its confluence with the Kuskokwim River (at rkm 446; Brown 1983). Chinook, chum, and coho salmon escapement was monitored using a resistance board weir. The weir is located approximately 7 rkm upstream of its confluence with the Kuskokwim River at 61°55′24″N, 157°41′53″W. At the weir site, the river channel is about 110 m wide and has a depth of about 1 m during normal summer flow. Due to its proximity to the confluence, the weir accounted for nearly all salmon spawning within the George River.

Holitna River Drainage

The Holitna River watershed is one of the largest in the Kuskokwim basin, including the Kuskokwim, Kiokluk, and Chuilnuk mountains to the west, and the Shotgun and Nushagak hills to the south. The Holitna River is formed from the confluence of the Chukowan and Kogrukluk rivers and flows northerly for approximately 218 rkm until reaching the Kuskokwim River (at rkm 491) near Sleetmute (Brown 1983; ADNR 1988). The Holitna drainage is a highly productive system that supports a large number of spawning salmon (Molyneaux and Brannian 2006). Chinook salmon escapements were monitored throughout the mainstem of the Holitna River using aerial surveys. The Holitna River is also the single largest source of river-type sockeye salmon (Gilk et al. 2011).

The Kogrukluk River is a headwater tributary of the Holitna River and assessment provided an index of salmon abundance to the Holitna River. The Kogrukluk River forms in a low plateau that divides the Tikchik Lakes system and Nushagak River basin to the south from the Holitna River basin to the north. From its headwaters, the Kogrukluk River flows northerly for approximately 80 rkm to its confluence with the Chukowan River to form the Holitna River (Brown 1983). Chinook, chum, sockeye, and coho salmon escapement was monitored with a fixed picket weir. The weir was located approximately 1.5 rkm from the confluence with the Holitna River at 60°50′28″N, 157°50′44″W. At the weir site, the channel averaged 70 m wide and 1.25 m deep. Due to its proximity to the confluence, the weir accounted for nearly all salmon spawning within the Kogrukluk River.

Stony River Drainage

The Stony River joins the Kuskokwim River at rkm 536 and supports primarily sockeye salmon and a modest return of Chinook salmon. Telaquana Lake and Two Lakes form the headwaters of the Stony River and are the largest lake systems present in the Kuskokwim River drainage. Both

lakes provide requisite habitat for lake-spawning sockeye salmon, and they are the primary producers of lake-type sockeye salmon in the Kuskokwim River drainage.

Escapement of sockeye salmon was assessed using a weir located on the Telaquana River near the outlet of Telaquana Lake. The Telaquana River originates in the mountains above Telaquana Lake, located in Lake Clark National Preserve. The Telaquana River watershed is bounded by the Neacola Mountains to the east and a low plateau to the south, separating it from the Bristol Bay watershed. From its headwaters, the Telaquana River flows westerly for approximately 30 rkm before entering Telaquana Lake. From the mouth of the lake, the Telaquana River flows another 50 rkm to its confluence with the Stony River, which then goes on to join the Kuskokwim River (at rkm 536). The Telaquana River weir was located approximately 1 km downstream of Telaquana Lake outlet at 60°57′39″N, 154°02′40″W. The weir spanned a 70 m channel, and average channel depth was approximately 1.2 m with a maximum depth of 2.1 m. The weir accounted for all sockeye salmon spawning in Telaquana Lake, including those fish spawning in the lake outlet.

Swift River Drainage

The Swift River is a large tributary that flows northwesterly and joins the Kuskokwim River at rkm 560 (Brown 1983). The Cheeneetnuk and Gagaryah rivers are parallel tributaries of the Swift River, and aerial surveys were flown on these rivers to index Chinook salmon escapement to the Swift River. The Cheeneetnuk River originates in the foothills of the Alaska Range and flows southwesterly for approximately 113 rkm before reaching the Swift River (at rkm 27). The Gagaryah River originates in the Lyman Hills and flows southwesterly for approximately 100 rkm before joining the Swift River (at rkm 61).

Tatlawiksuk River

The Tatlawiksuk River originates in the foothills of the Alaska Range and flows southwesterly for 113 rkm before joining the Kuskokwim River (at rkm 563; Brown 1983). Assessment provided an index of salmon abundance to the middle portion of the Kuskokwim River drainage. Chinook, chum, and coho salmon escapement was monitored with a resistance board weir. The weir was located approximately 4.5 rkm upstream from its confluence with the Kuskokwim River at 61°56′03″N, 156°11′33″W. At the weir site, the river measured 64 m wide and 1 m deep during normal summer operations. Due to its proximity to the confluence, the weir accounted for nearly all salmon spawning within the Tatlawiksuk River.

Upper Kuskokwim River Assessment Locations

Pitka Fork Drainage

The Pitka Fork originates in a piedmont area north of the Alaska Range and flows northerly 106 rkm before joining the Middle Fork (Brown 1983). The Middle Fork then flows northwesterly until reaching the Big River, which finally joins the Kuskokwim River at rkm 827 (Brown 1983), upstream from the community of McGrath. Tributaries of the Pitka Fork are the northernmost monitored systems within the Kuskokwim River drainage and provided an index of Chinook salmon escapement in the headwaters of the Kuskokwim River.

The Salmon River is a tributary of the Pitka Fork and flows northwesterly for approximately 47 rkm before joining the Pitka Fork 36 rkm upriver from its confluence with the Middle Fork. Chinook salmon escapement was monitored by aerial survey and a fixed picket weir. In 1981 and

1982 the weir was located on the South Fork of the Salmon River before being discontinued. In 2015, the weir was reestablished immediately downriver of the confluence of the north and south forks at 62°53′21″N, 154°30′35″W. The change in location allowed for a more complete assessment of Chinook salmon escapement to the Salmon River. At the weir site, the river measured approximately 45 m wide and 1 m deep during normal summer operations.

Bear Creek is a relatively small northwest-flowing tributary that joins the Pitka Fork approximately 44.8 rkm upriver from its confluence with the Middle Fork. The confluence of Bear Creek is located approximately 9.3 rkm southeast of the Salmon River with a nearly parallel flow direction. Chinook salmon escapement in Bear Creek was monitored by aerial survey.

ESCAPEMENT MONITORING

Aerial Surveys

Aerial surveys focused on Chinook salmon in Kuskokwim River tributaries, and both Chinook and sockeye salmon in Kuskokwim Bay rivers (Table 1). On occasion, other salmon species were counted opportunistically during aerial surveys; however, those counts were not representative of spawning escapement and are considered ancillary. Aerial survey counts of live fish, carcasses, spawning redds, survey ratings, and observer comments are archived in the AYKDBMS.

Aerial surveys were conducted on 10 tributaries in the Kuskokwim River and on 3 rivers in Kuskokwim Bay (Tables 1 and 2; Figures 2 and 3). Standardized index areas were flown within each river to allow for interannual comparisons of aerial survey counts (Appendix A; Schneiderhan 1988). Index areas were defined by geographic coordinates and often coincided with landmarks that are easily recognized from the air. For each river, lists of survey areas (Appendix A) and corresponding maps were created that depict index areas and highlight those areas that must be surveyed (i.e., index objectives) in order to produce a comparable index of escapement. Details regarding survey locations are archived in the AYKDBMS. Maps were obtained by the surveyor, then provided to the pilot prior to surveying.

One-time peak aerial surveys were conducted following standardized procedures. Aerial surveys were conducted with fixed-winged aircraft at an altitude of 150–500 feet, dependent on both surveyor and pilot preference and weather conditions. Aerial surveys were flown between the dates of 17 July and 5 August, which is believed to encompass peak spawning abundance for both Chinook and sockeye salmon across a range of locations and run timings. Observers rated survey conditions as being good (rating = 1), fair (rating = 2), or poor (rating = 3) based on criteria related to survey method, weather and water conditions, time of survey, and spawning stage (Schneiderhan 1988). During the flight, the surveyor recorded counts of live salmon and carcasses for each index area on a tally counter. Survey counts from only the objective index areas were summed to determine the escapement index. The escapement index was only reported if survey conditions were rated as good or fair for the entire survey.

Weir Projects

Weir Design and Installation

A fixed picket or resistance board weir design with an integrated fish trap was used at all locations dependent on channel morphology and flow. A resistance board floating weir is designed to sink beneath flood waters, allowing debris to pass downstream with little

obstruction. Resistance board weirs require a nearly level bottom profile and low enough water levels during the installation period to allow crew, working in snorkel gear, to attach weir components to the stream bed. In the Kuskokwim Area, where seasonal flooding occurs, resistance board weirs are preferred; however, not all rivers have conditions that allow for the installation and operation of resistance board weirs. In such cases, fixed picket weirs were employed. Fixed picket weirs have a rigid structure that requires disassembly for debris to pass freely downstream. These weirs are more prone to damage and often require disassembly during flood conditions. However, fixed picket weirs can be installed at higher flows and in more variable channel conditions. All weirs utilized a live fish trap design that was capable of freely passing fish or trapping fish for sampling purposes. The live fish trap design was the same at all projects (Linderman et al. 2002). Additional details on design and materials used for construction of resistance board weirs can be found in Tobin (1994) and Stewart (2002 and 2003) and for fixed picket weirs in Molyneaux et al. (1997), Baxter (1981), and Jasper and Molyneaux (2007).

Slight differences in picket spacing existed between projects. Weirs on the Goodnews, George, and Tatlawiksuk rivers had a gap of 3.3 cm between each picket, whereas Kanektok River weir had a gap of 4.3 cm. Salmon (Aniak) and Salmon (Pitka Fork) river weirs had a gap of 3.6 cm, Kogrukluk River weir had a gap of 3.7 cm, and Telaquana River weir had a gap of 2.6 cm between each picket. Regardless of the spacing differences, all designs prevented most adult Pacific salmon from passing through the weirs undetected. However, pink salmon and other non-salmon species were occasionally observed passing between pickets.

Weirs were installed across the entire river channel. On tributaries with resistance board weirs, the substrate rail and resistance board panels covered the middle 90% of each channel, and fixed weir materials extended the weirs to each bank. Floating and fixed weir lengths were adjusted inseason based upon minor changes in the width and depth of the river. A boat gate and a downstream fish passage chute were installed following techniques described by Linderman et al. (2002). Additional details on techniques for weir installation can be found in Stewart (2003).

Operations

Weir projects had a target operational period based on historical run timing information (Table 3). These periods were intended to cover the entire run of the target species. The operational plan for each monitoring project specified that the weir would be installed and operational prior to the arrival of salmon migration and continue until the run ended. However, actual operation dates varied with stream and weather conditions, and availability of funding (Table 3).

Daily operations were conducted by small crews, varying between 2 and 5 people across projects. Escapement counts, weir maintenance, and ASL sampling were completed by the crew.

DATA COLLECTION AND ANALYSIS

Escapement Counts

Daily escapement counts were conducted at all weirs. Crew members visually identified all species of fish observed passing upstream of the weir and recorded them on a tally counter. Fish were counted for approximately 1 hour, 4 to 8 times per day, between 0700 and 2400 hours. This schedule was adjusted as needed to accommodate variation in fish behavior and abundance or operational constraints, such as reduced visibility in evening hours late in the season. The live trap was used as the primary means of upstream fish passage. A clear plastic viewing window was placed on the stream surface to improve visual identification of fish entering the trap. Fish

were only allowed to pass freely through the weir when an observer was present and opened the passage gate. Following each counting shift, passage numbers were recorded in a designated logbook, and the weir was inspected for holes and cleaned of carcasses and debris. If holes were found, a note was made regarding the size, location, and if there was a potential for missed fish passage. Total daily and cumulative seasonal counts were reported along with operational details to ADF&G staff in Bethel or Anchorage by 8:00 AM the following morning and uploaded to the AYKDBMS that same day.

Missed Escapement Estimates

A variety of conditions occurred in which fish could not be counted through the weir, caused by 1) water levels preventing installation, requiring partial disassembly, or prompting removal of the weir; 2) water levels exceeding the top of the weir; 3) holes created from scouring, debris, or wildlife; 4) maintenance requiring partial disassembly of the weir; or 5) the counting gate being left open unattended. Duration of these inoperable periods varied from a part of a single day to several days. Missed escapement of target species was estimated for all inoperable days within the target operational period. No missed escapement estimates were created for nontarget species.

Missed escapement was estimated using a hierarchical Bayesian estimation technique (Adkison and Su 2001). All historical run timing was fitted to a log-normal distribution, in which each year's parameters were assumed to come from a common distribution (i.e., hierarchical parameters). Further, it was assumed that distribution of daily run timing follows a log-normal distribution (i.e., log plus 1 transformed count, or ln(daily count +1) was normally distributed).

Let y_{it} be the log plus 1 transformed count of year (i) and day (t) (y_{it} = ln(daily weir passage +1)); and assume that y_{it} is a random variable from a normal distribution of mean (θ_{it}) and standard deviation of day (t), σ_t. Then:

$$y_{it} \sim N(\theta_{it}, \sigma_t^2) \text{ and,} \qquad \theta_{it} = a_i \left(\frac{(\ln(t) - \ln(\mu_i))^2}{b_i^2} \right),$$

where:

$\sigma_t^2 > 0$, variance of daily passage of the day (t);

$a_i > 0$, the maximum daily passage of the year (i);

$t \geq 1$, passage date;

$\mu_i > 0$, mean passage date of the year (i); and

$b_i^2 > 0$, variance of run timing of the year (i).

The starting passage date and number and range of years with data varied between projects (Table 4). At upper hierarchical level, annual maximum daily passage (a_i), mean passage date (μ_i), and spread (b_i) were assumed to be a random sample from a normal distribution:

$$a_i \sim N(a_0, \sigma_a^2); \qquad \mu_i \sim N(\mu_0, \sigma_\mu^2); \qquad b_i \sim N(b_0, \sigma_b^2).$$

In most cases, prior distributions of the hyper-parameters for a_i, μ_i, and b_i were assumed to be non-informative as:

$a_0 \sim N(5,100)$ $(a_0 > 0)$; $\mu_0 \sim N(25,100)$ $(\mu_0 > 0)$; $b_0 \sim N(0.5,100)$ $(b_0 > 0)$;

$\sigma_a \sim$ uniform(0.1, 10) ; $\sigma_b \sim$ uniform(0.1, 2) ;

$\sigma_\mu \sim$ uniform(0.1, 10) ; $\sigma_t \sim$ uniform(0.1, 10) .

For George and Tatlawiksuk River Chinook salmon, the prior distribution of the spread parameter (b_i) was constrained to values >0.16, which is equal to the smallest (i.e., narrowest spread) parameter value observed for all prior years at both sites. This constraint was necessary to prevent an unrealistically narrow spread, and allowed for reasonable estimates of missed passage during the missed operational periods on the tails of the run.

Markov-chain Monte Carlo methods (WinBUGS v1.4; Spiegelhalter et al. 1999) were used to generate the joint posterior probability distribution of all unknowns in the model. Simulations were generated over 10,000 iterations with the first 5,000 iterations discarded (burn-in period), and samples were taken every 2 iterations. This resulted in 2,500 samples, and the median sample value was used to represent the point estimate of daily missed passage. From those, Bayesian credible intervals (95%) were obtained from the percentiles (2.5 and 97.5) of the marginal posterior distribution.

Available historical data limited estimation of missed passage to the dates of each project's target operational period. All missed escapement for Chinook, chum, and sockeye salmon that occurred on or after 1 September through the end of each project's target operational period was assumed 0 based on historical information. However, if more than 40% of the entire run was missed, based on historical run timing, estimates of missed passage were not created and total annual escapement was not determined.

Total annual escapement was estimated as the sum of the daily observed escapement counts and the daily estimates of missed escapement within the target operational period. Estimates of daily escapement were used for each day the weir was inoperable unless the estimate was less than the actual number of fish observed during partial operations. In these scenarios, the estimate was disregarded and the observed escapement was considered a minimum daily escapement estimate.

WEATHER AND STREAM MEASUREMENTS

Weather and stream data were collected at all projects (Appendices B1–B8). Water and air temperatures were manually measured (°C) using handheld thermometers. Notations about cloud cover, precipitation, and river stage were also recorded. Daily precipitation was measured (mm) using a rain gauge, and water levels were measured (cm) using staff gauges installed approximately 150 meters from the weirs. The staff gauge was calibrated to a reliable benchmark using a sight or line level. All data were collected in the morning and evening at all projects except the Middle Fork Goodnews River weir, where data were only recorded in the morning. In addition, water clarity observations were recorded at Kuskokwim River weir projects. Air and water temperature data were monitored year-round by Hobo[2] data loggers, as part of the Office of Subsistence Management Temperature Monitoring Project 14-701, conducted by the Aquatic Restoration and Research Institute.

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

AGE, SEX, AND LENGTH SAMPLING

A minimum sample size was determined for each species to achieve 95% confidence intervals of age-sex composition estimates no wider than ±10% (α = 0.05 and d = 0.10; Bromaghin 1993). Sample size goals (n) were estimated based on 10 age-sex categories for Chinook salmon (n = 190), 14 age-sex categories for sockeye salmon (n = 205), 8 age-sex categories for chum salmon (n = 180), and 6 age-sex categories for coho salmon (n = 168). Sample size goals were increased to account for unreadable scales, collection errors, and variation in run timing, and to allow for investigation of interannual changes in ASL composition. For most project locations, the collection goal was 230 Chinook, 400 chum, 250 sockeye, and 400 coho salmon. The Chinook salmon sampling goal was increased to 250 fish at the Salmon River (Pitka Fork) weir because the percentage of unreadable scales were expected to be larger than average because of scale reabsorption. At the Kogrukluk and Telaquana weirs, the sockeye salmon collection goal was 250 fish, but only sex and length measurements were collected. Sockeye scales were not collected from Kuskokwim River escapement projects because previous reports indicate that saltwater age cannot be estimated from scales because of excessive deterioration of the scale margins (Liller et al. 2016). Sampling schedules were provided for each Kuskokwim Area weir project. Schedules attempted to guide the collection of samples throughout the season in proportion to historical run timing, and ensure an appropriate distribution of sampling effort across the run.

Age, sex, and length sample collection followed standardized procedures developed for the AYK Area (Eaton 2015). Salmon were captured for sampling using a trap integrated into the weir design. Following capture, crew members used safe handling techniques to place the fish into a partially submerged fish cradle. Scales were taken from the preferred area of the fish (INPFC 1963) and transferred to numbered gum cards. 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 the middle of the eye to the fork in the tail was measured to the nearest millimeter using a straight-edged meter stick. Sex and length data were recorded on standardized numbered data sheets that corresponded with numbers on the gum cards used for scale preservation. After sampling, each fish was released upstream of the weir. The procedure was repeated until the trap was emptied. Sampling procedures were not biased for size or sex and were designed to reduced stress caused by holding and handling time. Further details regarding trapping methods or fish handling techniques can be found in Liller et al. (2016).

After sampling was completed, all ASL data and metadata were copied to Microsoft Excel spreadsheets that corresponded to numbered gum cards. Completed Excel spreadsheets were sent in digital format to the Bethel ADF&G office for processing. The original ASL gum cards, acetates, and paper forms were archived at the ADF&G office in Anchorage. Data were also loaded into the AYKDBMS.

RESULTS

OPERATIONS

Aerial Surveys

Aerial surveys were conducted on 13 rivers in 2016. All surveyed rivers were flown once between 24 July and 3 August (Tables 1 and 2). Chinook salmon escapement indices were

successfully determined for all surveyed rivers. Salmon River (Aniak) was not flown in 2016 due to poor weather (Table 1). Sockeye salmon escapement indices were determined for all surveyed rivers (Table 2).

Ground-based Weir Projects

Middle Fork Goodnews River Weir

The Middle Fork Goodnews River weir was operated from 22 June through 31 July in 2016. During this period, the weir had 1 partial day of operation, which was on the first day (Tables 5–7). The Middle Fork Goodnews River weir operations ended on 31 July because of a lack of funding. Early termination resulted in insufficient data to estimate total coho salmon escapement and ASL composition. Weather and stream observations were recorded between 26 June and 2 August (Appendix B1). Water temperature at the weir averaged 12°C (range: 10°C–16°C). Air temperature averaged 13°C (range: 7°C–17°C). A total of 4.4 mm of precipitation was recorded throughout the season. River stage averaged 27 cm (range: 13–48 cm) and was near average depth through late June and early July and below average for the remainder of operation (Figure 4).

Salmon River (Aniak) Weir

The Salmon River (Aniak) weir was installed from 21 June to 7 September in 2016. The weir was out of operation for 27 full days and 11 partial days during the 79-day period. The season was cut short by 13 days due to high water. Missed passage was a result of a variety of staffing, logistical, and environmental challenges. No estimates were made for Chinook or coho salmon because it was determined that more than 40% of the run was missed. We were able to generate estimates for chum and sockeye salmon despite a large portion of the operational period being missed. Chum and sockeye salmon escapement was estimated to be 817 fish and 254 fish respectively. These escapements were the lowest on record for this location, and both were nearly 7 times lower than escapement estimates in 2015. Our confidence in the chum and sockeye estimates is low due to limited documentation during the operational period.

Weather and stream observations were recorded between 22 June and 7 September (Appendix B2). Water temperature at the weir averaged 9°C (range: 5°C–12°C) and air temperature averaged 14°C (range: 7°C–23°C). A total of 283.3 mm of precipitation was recorded throughout the season. River stage averaged 35 cm (range: 25–50 cm). River stage was below average depth throughout the majority of the season except for 2 weeks in late August when it came back up to the historical average, before dropping to historic lows for the remainder of the season (Figure 5). The 2016 river stage may no longer be a reliable index of water velocity at this location due to changes in the channel shape. Crews reported very fast water velocity and were not able to safely keep the weir installed for substantial portions of the season, even though the water level was below average.

George River Weir

The George River weir was operated from 15 June through 12 September in 2016. The weir was inoperable for 23 partial days and 10 full days due to high water and holes in the weir (Tables 5, 6, and 8) The season was cut short by 8 days due to high water (Tables 5, 6, and 8). Weather and stream observations were recorded between 12 June and 21 September (Appendix B3). Water temperature at the weir averaged 10°C (range: 6°C–15°C) and air temperature averaged 12°C (range: 0°C–26°C). A total of 318.2 mm of precipitation was recorded throughout the season.

River stage averaged 78 cm (range: 46–131 cm) and was above average for the majority of the season (Figure 6).

Kogrukluk River Weir

The Kogrukluk River weir was installed early and operated from 25 June through 21 August in 2016. During this period, the weir was inoperable for 2 full day and 4 partial days due to high water at the weir (Tables 5–8). In addition, the Kogrukluk River weir operations ended 35 days early due to high water levels. Weather and stream observations were recorded between 23 June and 5 September (Appendix B4). Water temperature at the weir averaged 11°C (range: 9°C–15°C). Air temperature averaged 14°C (range: 4°C–28°C). A total of 303.4 mm of precipitation was recorded throughout the season. River stage averaged 286 cm (range: 260–371 cm). River stage was below average until mid-August. River stage was well above average beginning in mid-August and remained high for remainder of the operational period (Figure 7).

Telaquana River Weir

The Telaquana River weir was operated from 4 July through 16 August in 2016. During this period, the weir was inoperable for 3 partial days due to high water (Table 7). Weather and stream observations were recorded between 4 July and 16 August (Appendix B5). Water temperature at the weir averaged 13°C (range: 9°C–17°C). Air temperature averaged 13°C (range: 8°C–26°C). A total of 8.6 mm of precipitation was recorded throughout the season. The river stage was above or near record highs for the duration of the season, but continued operations were possible due to low current velocity near the lake outlet (Figure 8).

Tatlawiksuk River Weir

The Tatlawiksuk River weir was operated from 16 June through 12 September in 2016. During this period, the weir was inoperable for 13 full days due high water and 5 partial days due to high water and holes (Tables 5, 6, and 8). Tatlawiksuk River weir was removed 8 days early due to high water levels. Estimates were made for all missed days of passage. Weather and stream observations were recorded between 17 June and 22 September (Appendix B6). Water temperature at the weir averaged 11°C (range: -2°C–17°C). Air temperature averaged 15°C (range: 1°C–32°C). A total of 352.5 mm of precipitation was recorded throughout the season. River stage averaged 78 cm (range: 38–145 cm). River stage was around average throughout the season with periodic high water events lasting around 10 days in early July, early August, and mid-September, which caused the early end to the season (Figure 9).

Salmon River (Pitka Fork) Weir

The Salmon River (Pitka Fork) weir was operated from 21 June through 9 August in 2016. The weir was inoperable for 2 partial days due to holes in the weir (Table 5). Weather and stream observations were recorded between 22 June and 9 August (Appendix B7). Water temperature at the weir averaged 14°C (range: 9°C–18°C). Air temperature averaged 16°C (range: 10°C–27°C). A total of 246.1 mm of precipitation was recorded throughout the season. River stage averaged 83 cm (range: 50–114 cm; Figure 10).

ESCAPEMENT COUNTS

Chinook salmon

Aerial Survey

Chinook salmon escapement goals were assessed for 7 of the 8 tributaries with established goals throughout Kuskokwim Bay and the lower and middle portions of the Kuskokwim River (Table 9). Within these areas, aerial survey counts were within historical ranges and sustainable escapement goals (SEG) were achieved on all but 3 of the successfully surveyed rivers. The exceptions were the Aniak, Cheeneetnuk, and Gagaryah rivers, which all fell below the established SEG range. The Aniak and Cheeneetnuk rivers both had the third lowest index count on record in 2016. The Gagaryah River survey count (135) was improved compared to 2015 (19 fish) which was the lowest count on record, but was still less than half of the lower bound of the SEG. Poor survey conditions prevented an assessment of the established SEG on the Salmon (Aniak) River (Table 1). An additional 4 surveys were flown on tributaries without an established SEG throughout Kuskokwim Bay and the lower and middle portions of the Kuskokwim River. Surveys on the Middle Fork Goodnews and Kipchuck rivers had index counts slightly below their historical averages, while the Holokuk and Oskawalik rivers had index counts within the historical ranges but below average for those sites.

Aerial surveys flown on the Salmon River (Pitka Fork) and Bear Creek indicated above average escapements to the upper portion of the Kuskokwim River (Table 1 and 9). The 2016 escapement index to the Salmon River (Pitka Fork) was the fourth largest on record (1,578 fish) and was near the top end of the established SEG. The escapement index to Bear Creek was the second largest on record (580 fish) and was more than double the historical average (n = 18 years) of 269 Chinook salmon (range: 36–1,381).

Weir

Annual escapements were successfully estimated for Chinook salmon at the Middle Fork Goodnews (3,774 fish), George (1,663 fish), Kogrukluk (7,059 fish), Tatlawiksuk (2,494 fish), and Salmon (Pitka Fork; 6,326 fish) river weirs (Table 5). No estimates were made for missed passage at the Salmon River (Pitka Fork) weir because this was the second year of operations and there was not enough historical run timing information to inform the Bayesian estimation methods. It is unlikely that much of the total escapement to the Salmon River (Pitka Fork) was missed, because the weir experienced only 2 partial inoperable days during the time period when Chinook salmon were passing in large numbers.

Kuskokwim Area Chinook salmon exhibited a wide range of arrival timing in 2016. Early timing was observed in the Goodnews River in Kuskokwim Bay (Figure 11), and variable timing was observed throughout the Kuskokwim River. Chinook salmon timing past the weir on the Tatlawiksuk was early (Figure 12). Average Chinook salmon run timing was observed at the George River weir (Figure 13). Late timing was observed at the Kogrukluk River weir (Figure 14). Arrival timing at the weirs did not affect assessment and the established target operational period was adequate to observe the entire escapement past each weir.

Overall, weir counts indicate that Chinook salmon escapement was near average. Chinook salmon escapement at the Middle Fork Goodnews River was more than double the 2015 escapement, above the historical average, and above the upper bound of the SEG (Table 10). The Tatlawiksuk and Salmon Pitka Fork rivers saw similar escapements compared to 2015, and

Tatlawiksuk was the third highest escapement in its 17-year history. The SEG at the Kogrukluk River was met. The George River had the fourth lowest escapement in its 18 year history, and the SEG was not met.

Chum salmon

Annual escapements were successfully estimated for chum salmon at the Middle Fork Goodnews (41,815 fish), George (20,834 fish), Kogrukluk (45,329 fish), and Tatlawiksuk (10,564 fish) river weirs (Table 6). Each weir operated throughout the majority of the target operational period with the exception of the Middle Fork Goodnews. Chum salmon arrival timing was generally late at all the weirs, and Tatlawiksuk and Kogrukluk river weirs observed the latest and second latest run timing on record, respectively (Figures 15-18). Arrival timing at the weirs did not affect assessment and the established target operational period was adequate to observe the entire run past each weir.

Overall, weir counts indicate that chum salmon escapement was near average in 2016 (Table 11). Chum salmon escapement was larger than the previous year at all weir projects. The Middle Fork Goodnews River chum salmon escapement was the third highest on record and nearly 3.5 times the SEG threshold (>12,000 fish). Escapements on the George and Kogrukluk rivers increased relative to 2015, and were near average escapements. The SEG on the Kogrukluk River was met. The Tatlawiksuk River escapement was the fourth lowest on record.

Sockeye salmon

Aerial Survey

Aerial surveys indicated well above average escapement of sockeye salmon to Kuskokwim Bay tributaries. The Middle and North Fork Goodnews rivers had the highest escapement indices on record, while the Kanektok River had the fourth largest. The upper bounds of the SEG on the North Fork Goodnews and Kanektok rivers were exceeded (Table 12).

Weir

Annual escapements were successfully estimated for sockeye salmon at the Middle Fork Goodnews (170,574 fish), Kogrukluk (20,087 fish), and Telaquana (82,706 fish) river weirs (Table 7). Each weir operated throughout the majority of the target operational period and only minimal estimation was required. Sockeye salmon run timing was late at all weirs. In 2016, we observed the latest arrival timing on record at the Middle Fork Goodnews River weir (Figure 19), the third latest on record at the Kogrukluk River weir (Figure 20), and the second latest on record at Telaquana River weir (Figure 21). Arrival timing at the weirs did not affect assessment, and the established target operational period was adequate to observe the entire run past each weir.

Overall, sockeye salmon ground-based escapement was well above average at all projects (Table 13). The Middle Fork Goodnews River weir had the highest escapement on record and exceeded the upper bound of the SEG. Kogrukluk River escapement exceeded the upper bound of the SEG, and escapement past the Telaquana River weir was the second largest on record.

Coho salmon

Annual escapements were successfully estimated for coho salmon at the Tatlawiksuk River weir (11,897 fish) (Table 8). Coho escapement at the Tatlawiksuk River was above the long-term average (Table 14). Coho salmon arrival timing at the Tatlawiksuk River was average to late

(Figure 22). Arrival timing at the weir did not affect assessment, and the established target operational period was adequate to observe nearly the entire run past the weir.

Coho salmon escapement could not be estimated for all other projects. The George and Kogrukluk River weirs were compromised by high water and more than 40% of the coho salmon run was missed. The Middle Fork Goodnews River weir was removed prior to substantial arrival of coho salmon due to funding constraints and more than 40% of the run was missed. As a result, the established SEGs at the Kogrukluk and Middle Fork Goodnews were not assessed.

Nontarget species

Nontarget species were observed at all weir projects. In 2016, pink salmon, Arctic grayling *Thymallus arcticus,* and whitefish *Coregonus* spp. were observed at nearly all Kuskokwim Area projects. Coho salmon were observed at the Middle Fork Goodnews River weirs, sockeye salmon were observed at the George River weir, and chum salmon were observed at the Telaquana and Salmon (Pitka Fork) river weirs. Chinook salmon were observed at the Telaquana River weir. Longnose suckers *Catostomus catostomus*, Dolly Varden *Salvelinus malma*, Northern pike *Esox Lucius*, and rainbow trout *O. mykiss* were observed at multiple projects, and lake trout *Salvelinus namaycush* were observed at Telaquana River weir (Appendices C1–C7).

AGE, SEX, AND LENGTH COLLECTION

Chinook Salmon

Age, sex, and length samples were collected from Chinook salmon at the Middle Fork Goodnews (100 fish), Salmon (Aniak; 47 fish), George (46 fish), Kogrukluk (232 fish), Tatlawiksuk (64 fish), and Salmon (Pitka Fork; 288 fish) river weirs. Sample goals were not achieved at the Middle Fork Goodnews, Salmon (Aniak), George, and Tatlawiksuk River weirs, because of high water. Sample goals were achieved at the Kogrukluk and Salmon (Pitka Fork) weirs (Table 15). At both locations, samples were collected on a near daily basis spanning approximately the central 95% of the run.

Chum Salmon

Age, sex, and length samples were collected from chum salmon at the Middle Fork Goodnews (419 fish), Salmon (Aniak; 97 fish), George (328 fish), Kogrukluk (606 fish), and Tatlawiksuk (290 fish) river weirs. Sample goals were not achieved at the Salmon (Aniak), George, or Tatlawiksuk River weirs, due to high water. Sample goals were achieved at the Middle Fork Goodnews and Kogrukluk River weirs (Table 15). At both locations, samples were collected on a near daily basis spanning approximately the central 78% of the run.

Sockeye Salmon

Sex and length samples were collected from the Middle Fork Goodnews (603 fish), Kogrukluk (253 fish), and Telaquana (334 fish) river weirs. In addition, Middle Fork river weir collected paired scales for age data. The sockeye salmon sample goal was achieved at all projects (Table 15). At each project, samples were collected on a near daily basis spanning approximately the central 86% of the run.

Coho Salmon

Age, sex, and length samples were collected from coho salmon at the George (101 fish), Kogrukluk (13 fish), and Tatlawiksuk (249 fish) river weirs. No samples were collected at

Middle Fork Goodnews and Salmon (Aniak) river weirs due to the early termination of those projects. The coho salmon sample size goal was not achieved at any project (Table 15).

DISCUSSION

The escapement data collected in 2016 are comparable to data collected in prior years at the individual monitoring locations and can be used to index variation in spawning abundance over time. However, aerial survey indices and weir counts should not be considered directly comparable. Air surveys provide only an index of peak spawning abundance to a broad geographic area, whereas weir counts are used to estimate the total number of salmon that escaped past a specific location over the entire season. In addition, aerial survey indices are not directly comparable among monitored locations within the same year, due to differences in observation error and differences in the size of the survey area. Air survey and weir data can be used to evaluate changes in relative abundance over time (e.g., years) for a single monitored location as long as standardized methodology are used. In addition, weir counts may be compared among the various monitoring locations within the same year, as long as total annual escapement was estimated.

SALMON ANIAK WEIR

The Salmon Aniak weir experienced substantial operational difficulties in 2016 and, as such, we have limited confidence in the completeness of the data collected. High water conditions, local forest fires, and technical difficulties disrupted or prevented counts for a large number of days. Counts of all fish species were very low during days when the weir was reported as fully operational. A general lack of documentation in 2016 prevented us from determining the quality of the daily counts that were conducted. Escapement observations at the Salmon (Aniak) River weir appear to be outliers when compared to other weirs operated throughout the Kuskokwim River. Chum escapement at the Salmon Aniak was the smallest on record, by more than 2,000 fish. However, all other weir projects indicated that chum salmon escapement increased compared to 2015 and escapements were near average. Similarly, all other weir projects reported above average or record high escapements of sockeye salmon, while the Salmon (Aniak) River weir had the lowest escapement on record. Chinook salmon escapement was also unusually low, but too much of the run was missed to make estimates. Furthermore, counts of resident fish species were at record low levels. We believe that the weir was probably compromised in some way during days when counts took place, but we could not confirm that suspicion. We hope that escapement observations during the 2017 season will help determine if the low escapements observed in 2016 were an anomaly or if they were, in fact, an indication of low abundance.

KUSKOKWIM RIVER

High water levels throughout much of the 2016 summer/fall season caused public concern that reliable escapement observations would be lacking. This was not the case for Chinook, chum, and sockeye salmon. The Kogrukluk River had relatively average water levels throughout much of the Chinook, chum, and sockeye salmon runs, and operations were not affected. The George and Tatlawiksuk river weirs did experience high water throughout the Chinook, chum, and sockeye salmon runs, but interruptions to counts were manageable and estimates of missed passage were generated. High water did make ASL collection difficult at both the George and Tatlawiksuk rivers this season. Despite abnormally high water conditions throughout the season at the Salmon River (Pitka Fork) and Telequana River the weirs operated effectively due to low

current velocity at these sites. Our methods require that the weirs be checked for holes and potential breaches each day, and periods of high water prevented this from happening on occasion. We assumed the weirs were fish tight during these high water periods if no holes were found during the checks that immediately followed the high water events. Late season flooding throughout most of the Kuskokwim River prevented adequate monitoring of coho salmon escapement at all projects, except the Tatlawiksuk River weir.

Well above average escapements have been observed in headwater tributaries since 2014 and may be attributed to recent changes in management strategies. In 2016, a new regulation was implemented that closed salmon fishing through June 11 to allow early migrating Chinook salmon to pass through the lower river fishery to increase escapement or harvest opportunity in upriver areas of the watershed. This new regulation is very similar to management practices that occurred in 2014 and 2015. Since 2014, escapement observations in headwaters tributaries have been two to seven times larger than the historical average. Reduced exploitation of these sub-stocks, due to early season harvest restrictions, may explain the larger than expected escapements to the Salmon River (Pitka Fork), Tatlawiksuk River, and Bear Creek in recent years.

Several middle river tributaries have had consecutive years of low escapements Both the Cheeneetnuk and Gagaryah have had consistently low index counts since the mid-2000s, only meeting respective SEGs once since 2008. Similarly, the Holokuk and Oskawalik rivers have been consistently below historical averages over the same time span.

In 2016, the drainagewide escapement of Kuskokwim River Chinook salmon was estimated to be 145,718 (95%CI: 103,209–201,673) fish, which exceeded the upper bound of the established escapement goal of 65,000–120,000 fish (Liller 2017). The 2016 model estimate was informed by direct observations of the 2016 escapement at 15 locations (5 weirs and 10 aerial surveys) combined with historical observations of escapement, harvest, and run size dating back to 1976. In addition to escapement counts presented in this report, Chinook salmon escapement counts from the Tuluksak (909) and Kwethluk (7,619) river weirs were incorporated into the model (estimates provided by Ken Harper, USFWS Fisheries Biologist, personal communication). Escapement data from the new Salmon River (Pitka Fork) weir and the Salmon River (Aniak) weir were not used to estimate the 2016 drainagewide escapement because they were not part of the original model design (Bue et al. 2012).

The 2016 weir data indicated that chum salmon escapement has returned to near average levels, following 3–4 years of below average escapements. Chum salmon escapements in 2016 were similar or larger than escapements observed in 2015. The Kogrukluk and George River chum salmon escapements increased to levels very near the long-term averages. The chum salmon escapement goal on the Kogrukluk River was achieved in 2016, and annual escapement has been greater than the lower bound of the goal range since 2001.

The 2016 weir and aerial survey data indicate a very strong escapement of Kuskokwim River sockeye salmon. Sockeye escapement at Telequana was the second highest on record and the sockeye salmon escapement goal on the Kogrukluk River was exceeded for the first time since 2010. The George River weir, which has averaged only about 100 sockeye salmon annually, had an escapement of 2,807 fish in 2016. Comments from members of the public indicate that sockeye salmon were observed in places they had never seen them before.

There is limited information about the size and quality of the coho salmon escapement, but available information indicates the 2016 escapement was at least average. The total escapement to the Tatlawiksuk was average. The George River weir count was 17,239, which is comparable to the long-term average of 18,076 despite the fact that the weir was not operational for more than 50% of the run. Furthermore, the observed escapement of coho salmon to the Kwethluk weir was nearly 29,000 fish, and the SEG threshold of >19,000 was met (K. Harper USFWS Fisheries Biologist, personal communication).

KUSKOKWIM BAY

There were many changes in both the Kuskokwim Bay fishery and monitoring program that affected fish escapement and the ability to assess it in 2016. There were no commercial fisheries in Kuskokwim Bay in 2016 due to the lack of a buyer, and exploitation was limited to small localized subsistence fisheries. Funding for both Kuskokwim Bay weir projects are tied to the fishing industry. State of Alaska funding was not adequate to operate the Kanektok River weir, and the Middle Fork Goodnews weir was only able to operate for the month of July. The majority of the Chinook, chum, and sockeye salmon escapement to the Middle Fork Goodnews River was monitored despite the abbreviated operational period. Coho salmon escapement was not assessed anywhere in Kuskokwim Bay.

Chinook salmon escapements throughout Kuskokwim Bay have been persistently low since 2010, but the 2016 escapement to both the Kanektok and Goodnews rivers was improved compared to recent years. Specifically, the count of Chinook salmon past the Middle Fork Goodnews River weir exceeded the upper bound of the BEG for the first time since 2007. The aerial survey goals on both the North Fork Goodnews and Kanektok rivers were met.

The Middle Fork Goodnews weir was the only project to evaluate chum salmon escapement to Kuskokwim Bay in 2016. The chum salmon escapement goal on the Middle Fork Goodnews River was achieved for the first time since 2013. However, in both 2014 and 2015, chum salmon escapement on the Middle Fork Goodnews River was within 500 fish of the established SEG threshold (>12,000).

Aerial survey and weir data indicate that Kuskokwim Bay sockeye salmon escapements have been large relative to established escapement goals. In the past 16 years, observed escapement has never fallen below the lower bound of the SEG for any of the 3 tributaries and has exceeded the upper bound in 50%, 67%, and 71% of years for Middle Fork Goodnews, North Fork Goodnews, and Kanektok rivers respectively. The long-term average escapement for each of these systems exceeds the upper bound of the established SEG. In 2016, both Goodnews River aerial surveys, as well as the weir on the Middle Fork Goodnews, had the highest recorded escapements in their respective histories.

ACKNOWLEDGEMENTS

The many Kuskokwim Area escapement monitoring projects are only successful due to the hard work and diligence of all the individuals that have contributed to the development and operations of each project.

The U.S. Fish and Wildlife Service, Office of Subsistence Management, provided funding support for George and Tatlawiksuk Rive weirs under agreement numbers F14AC00102 (Project No. 14-303) and F14AC00109 (Project No. 14-302) respectively, through the Fisheries Resource

Monitoring Program. Funding for the Salmon River (Pitka Fork) and Salmon River (Aniak) weirs was provided by the ADF&G Chinook Salmon Research Initiative and a Tribal Wildlife Grant.

We would like to thank all of our collaborators: United States Fish and Wildlife Service, National Park Service (NPS), Native Village of Napaimute (NVN), and MTNT, Ltd. Administrative and logistical support was provided by ADF&G staff: Nick Smith, Aaron Poetter, Aaron Tiernan, Colton Lipka, Janet Bavilla, and Katie Froning; USFWS staff: Mark Lisac; and NPS staff: Dan Young. Thank you to ADF&G project crew leaders Justin Cross, Rob Stewart, Charles Grammer, Amanda Hoeldt, Mike Oexner, and Alex Nicori. A special thanks to all the technicians and interns from ADF&G, USFWS, NPS, and NVN. Jan Conitz provided regional report review, and Toshihide Hamazaki provided biometric review for ADF&G. OSM review was provided by Donald Rivard.

This report was submitted as the technical project report to U.S. Fish and Wildlife Service, Office of Subsistence Management (OSM), Subsistence Fisheries Resource Monitoring Program for project numbers 14-302 and 14-303.

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TABLES AND FIGURES

Table 1.–Kuskokwim Area Chinook salmon aerial survey locations, survey dates, ratings, index objectives, and escapement indices, 2016.

River	Survey date	Overall survey rating	Index objective	Index area survey counts					Escapement index	Escapement goal range
				101	102	103	104	Supplemental		
Kuskowkim Bay Rivers										
North Fork Goodnews R.	2 August	Fair (2)	101,102,103	50	322	748	2	[a]	1,120	640–3,300
Middle Fork Goodnews R.	2 August	Fair (2)	101, 103, 104	1123	0	76	102	[a]	1,301	[b]
Kanektok R.	25 July	Good (1)	101, 102, 103	1,819	2,878	934	0	90	5,631	3,500–8,500
Kuskokwim River Tributaries										
Kisaralik R.	3 August	Good (1)	102, 103	0	601	21	[a]	[a]	622	400–1,200
Aniak R.	28 July	Fair (2)	102, 103, 104	–	249	398	71	[a]	718	1,200–2,300
Salmon R. (Aniak)	–	–	101, 102, 103	–	–	–	[a]	[a]	[c]	330–1,200
Kipchuk R.	28 July	Good (1)	101, 102, 103	568	158	172	[a]	[a]	898	[b]
Holokuk R.	25 July	Good (1)	101, 102, 103, 104	23	41	33	3	[a]	100	[b]
Oskawalik R.	25 July	Good (1)	101, 102, 103	6	19	22	[a]	[a]	47	[b]
Holitna R.	27 July	Good (1)	102, 103	41	333	824	103	[a]	1,157	970–2,100
Cheeneetnuk R.	24 July	Fair (2)	101, 102	69	148	[a]	[a]	[a]	217	340–1,300
Gagaryah R.	27 July	Good (1)	101, 102	129	6	[a]	[a]	[a]	135	300–830
Salmon R. (Pitka Fork)	24 July	Fair (2)	102, 103, 104	0	283	533	762	[a]	1,578	470–1,600
Bear Cr.	24 July	Good (1)	101	580	[a]	[a]	[a]	[a]	580	[b]

Note: Survey ratings were based on criteria related to survey method, weather and water conditions, time of survey, and spawning stage (Schneiderhan 1988). The index objective defines the specific index areas that must be surveyed in order to produce a Chinook salmon escapement index count. Survey counts are not adjusted or expanded in any way. Escapement index is only reported when index objectives were achieved, survey conditions were rated good (1) or fair (2), and survey occurred between the target date range of 17 July and 5 August. Dashes (–) indicate no data.

[a] Index reach does not exist for the river.

[b] No escapement goal established.

[c] Escapement index not reported due to inadequate survey rating, index objective not achieved, or unestablished index objective.

Table 2.–Sockeye salmon aerial survey escapement indices in the Kuskokwim Area, 2016.

River	Survey date	Overall survey rating	Index objective	Index area survey counts					Escapement index	Escapement goal range
				101	102	103	104	Supplemental		
Kuskowkim Bay Rivers										
North Fork Goodnews R.	2 August	Fair (2)	101, 102, 103, 104	16,420	12,050	16,820	44,770	[a]	90,060	5,500–19,500
Middle Fork Goodnews R.	2 August	Fair (2)	101, 102, 103, 104	15,260	2,410	5,588	45,720	[a]	68,978	[b]
Kanektok R.	25 July	Good (1)	101, 102, 103, 104	25,810	21,880	600	31,870	4,090	80,160	14,000–34,000

Note: Survey ratings were based on criteria related to survey method, weather and water conditions, time of survey, and spawning stage (Schneiderhan 1988). The index objective defines the specific index areas that must be surveyed in order to produce a sockeye salmon escapement index count. Survey counts are not adjusted or expanded in any way. Escapement index is only reported when index objectives were achieved, survey conditions were rated good (1) or fair (2), and survey occurred between the target date range of 17 July and 5 August. Dashes (–) indicate no data.

[a] Index reach does not exist for the river.

[b] No escapement goal established.

Table 3.–Target operational periods, actual operational periods, species targeted, and escapement goals at Kuskokwim Area weir projects, 2016.

Project	Target operational period	Actual operational period	Species targeted			
Kuskokwim Bay rivers			Chinook	Chum	Sockeye	Coho
Middle Fork Goodnews River weir	6/25–7/31[a]	6/22–7/31	BEG: 1,500–2,900	SEG: >12,000	SEG: 18,000–40,000	SEG: >12,000
Kuskokwim River tributaries						
Kwethluk River	[b]	6/30–9/9	SEG: 4,100–7,500	x	x	>19,000
Tuluksak River	[b]	6/17–9/9	x	x	x	x
Salmon River (Aniak) weir	6/15–9/20[c]	6/21–9/7	x	x	x	
George River weir	6/15–9/20	6/15–9/12	SEG: 1,800–3,300	x		x
Kogrukluk River weir	6/26–9/25	6/25–8/21	SEG: 4,800–8,800	SEG: 15,000–49,000	SEG: 4,400–17,000	SEG: 13,000–28,000
Telaquana River weir	7/3–8/26	7/4–8/16			x	
Tatlawiksuk River weir	6/15–9/20	6/16–9/12	x	x		x
Salmon River (Pitka Fork) weir	6/1–8/15	6/21–8/9	x			

Note: The x indicates that species is monitored in significant numbers but there is no established escapement goal. The drainagewide Chinook salmon SEG for the Kuskokwim River is 65,000–120,000. The years that escapement goals were established varies by location and species (Contiz et al. 2015).

[a] The end of the target operational period was reduced compared to past years due to a lack of funding (Middle Fork Goodnews River).

[b] Kwethluk and Tuluksak river weirs are operated by the U.S. Fish and Wildlife Service and information is displayed to show all active salmon monitoring projects in the Kuskokwim River. For further information contact USFWS.

[c] The Alaska Department of Fish and Game operated the Salmon River (Aniak) weir from 15 June to 15August, at which point the Native Village of Napimute continued operations for the remainder of the season.

Table 4.–Starting passage dates and passage years used in the hierarchical Bayesian estimation technique to estimate missed escapement at Kuskokwim Area weir projects, 2016.

Project	Starting passage date	Weir passage years
Middle Fork Goodnews River weir	15 June[a]	2001–2015
Salmon (Aniak) River weir	15 June	2006–2009, 2012–2015
George River weir	15 June	1996–2015
Kogrukluk River weir	26 June	1976–2015[b]
Telaquana River weir	3 Jul	2010–2015
Tatlawiksuk River weir	15 June	1998–2015

Note: Starting passage dates and weir passage years only apply to target species at each project.

[a] Starting passage date is for Chinook and sockeye salmon only. Chum salmon starting passage date is 20 June.

[b] Weir passage years are for Chinook, chum, and sockeye salmon only. Coho salmon passage years are 1981–2015.

Table 5.–Daily and annual estimated escapement of Chinook salmon at Kuskokwim Area weir projects, 2016.

	Kuskokwim Bay	Kuskokwim River				
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk	Salmon (Pitka Fork)
6/1	[a]	[a]	[a]	[a]	[a]	[b]
6/2	[a]	[a]	[a]	[a]	[a]	[b]
6/3	[a]	[a]	[a]	[a]	[a]	[b]
6/4	[a]	[a]	[a]	[a]	[a]	[b]
6/5	[a]	[a]	[a]	[a]	[a]	[b]
6/6	[a]	[a]	[a]	[a]	[a]	[b]
6/7	[a]	[a]	[a]	[a]	[a]	[b]
6/8	[a]	[a]	[a]	[a]	[a]	[b]
6/9	[a]	[a]	[a]	[a]	[a]	[b]
6/10	[a]	[a]	[a]	[a]	[a]	[b]
6/11	[a]	[a]	[a]	[a]	[a]	[b]
6/12	[a]	[a]	[a]	[a]	[a]	[b]
6/13	[a]	[a]	[a]	[a]	[a]	[b]
6/14	[a]	[a]	[a]	[a]	[a]	[b]
6/15	[a]	[b]	0 [c]	[a]	0 [d]	[b]
6/16	[a]	[b]	1	[a]	0 [c]	[b]
6/17	[a]	[b]	0	[a]	0	[b]
6/18	[a]	[b]	6	[a]	0	[b]
6/19	[a]	[b]	17	[a]	0	[b]
6/20	[a]	[b]	6	[a]	1	[b]
6/21	[a]	0	34	[a]	3	1 [e]
6/22	0 [a, e]	0	25	[a]	112	2
6/23	6 [a]	0	17	[a]	47	4
6/24	1 [a]	0	17	[a]	3	43
6/25	3	21	17	3 [a, f]	178	69
6/26	66	4	116	21	37	23
6/27	62	28	8	54	20	81
6/28	210	30 [e]	1	42	36	22
6/29	100	14	43	25	52	73
6/30	171	1 [e]	24	5	64	190
7/1	142	0	28	3	21	196 [e]
7/2	310	3	59 [c]	5	138	348
7/3	289	4	62 [c]	192	242	398
7/4	55	7	55 [f]	42	65	218
7/5	69	[b]	94 [f]	23	109 [d]	473
7/6	97	[b]	99 [f]	30	108 [d]	143
7/7	65	[b]	67 [f]	154	105 [d]	82
7/8	138	[b]	57 [f]	61	101 [d]	73
7/9	94	[b]	49 [c]	137	96 [c]	307

-continued-

Table 5.–Page 2 of 4.

	Kuskokwim Bay	Kuskokwim River				
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk	Salmon (Pitka Fork)
7/10	93	[b]	47 [f]	137	36	253
7/11	245	[b]	55 [c]	301	53	73
7/12	278	[b]	93 [f]	282	101	139
7/13	228	17	43	587	30	165
7/14	232	48	44	277	116	112
7/15	124	24	43	281	94	117
7/16	33	1 [e]	42	157	78	234
7/17	95	42	43	116	71	274
7/18	72	34 [e]	29	1,444	45 [c]	88
7/19	24	[b]	8	130	40 [c]	130
7/20	27	7 [e]	31	194	37	272
7/21	21	20	7	538	47	553
7/22	5	4	23 [c]	148	17	216
7/23	6	14 [e]	14	135	17	160
7/24	15	36	21	178	24	139
7/25	7	18	18 [c]	233	26	124
7/26	22	29	15	206	26	172
7/27	9	14 [e]	14 [c]	199	10	65
7/28	98	11	13 [c]	89	13	44
7/29	39	7 [e]	7	139	5	42 [e]
7/30	31	5	8	81	4	45
7/31	37	10	9	58	8	36
8/1	17 [a, d]	12	9 [c]	98	5	24
8/2	15 [a, d]	9	9	56	2	19
8/3	14 [a, d]	3 [e]	11	30	5	19
8/4	12 [a, d]	[b]	7	8	8	23
8/5	11 [a, d]	7	10	36	6	12
8/6	10 [a, d]	2	12	20	4	4
8/7	9 [a, d]	2	13	17	4 [c]	13
8/8	8 [a, d]	1	5	11	3 [d]	11
8/9	7 [a, d]	4	10	8	3 [d]	2
8/10	6 [a, d]	6	9	12	3 [d]	[b]

-continued-

Table 5.–Page 3 of 4.

	Kuskokwim Bay	Kuskokwim River				
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk	Salmon (Pitka Fork)
8/11	5 [a, d]	[b]	3	2	2 [d]	[b]
8/12	5 [a, d]	0 [e]	3 [c]	11	2 [d]	[b]
8/13	4 [a, d]	2	2 [c]	6	2 [d]	[b]
8/14	4 [a, d]	2 [e]	3	6 [c]	2 [d]	[b]
8/15	3 [a, d]	[b]	1	5 [d]	1 [d]	[b]
8/16	3 [a, d]	[b]	2	4 [d]	1 [d]	[b]
8/17	3 [a, d]	[b]	3	3 [c]	1 [c]	[b]
8/18	2 [a, d]	[b]	2	1	0	[b]
8/19	2 [a, d]	[b]	13	3	0	[b]
8/20	2 [a, d]	[b]	1	5	1	[b]
8/21	2 [a, d]	[b]	0	5 [f]	2	[b]
8/22	2 [a, d]	[b]	1 [d]	1 [d]	0	[b]
8/23	1 [a, d]	[b]	1 [d]	1 [d]	1	[b]
8/24	1 [a, d]	[b]	1 [d]	1 [d]	0	[b]
8/25	1 [a, d]	[b]	1 [d]	1 [d]	0	[b]
8/26	1 [a, d]	[b]	1 [d]	1 [d]	0	[b]
8/27	1 [a, d]	[b]	1 [d]	0 [d]	0	[b]
8/28	1 [a, d]	[b]	0 [d]	0 [d]	0	[b]
8/29	1 [a, d]	[b]	0 [d]	0 [d]	0	[b]
8/30	1 [a, d]	[b]	0 [d]	0 [d]	0	[b]
8/31	1 [a, d]	[b]	0 [d]	0 [d]	0	[b]
9/1	[a, g]	0 [e]	0 [h]	0 [g]	0	[b]
9/2	[a, g]	0	0 [h]	0 [g]	0	[b]
9/3	[a, g]	0	0 [h]	0 [g]	0	[b]
9/4	[a, g]	0	0	0 [g]	0	[b]
9/5	[a, g]	0	0	0 [g]	0	[b]
9/6	[a, g]	0	0	0 [g]	0	[b]
9/7	[a, g]	0	0	0 [g]	0	[b]
9/8	[a, g]	[b]	0	0 [g]	0	[b]
9/9	[a, g]	[b]	0	0 [g]	0	[b]
9/10	[a, g]	[b]	0	0 [g]	0	[b]
9/11	[a, g]	[b]	0	0 [g]	0	[b]

-continued-

Table 5.–Page 4 of 4.

	Kuskokwim Bay	Kuskokwim River				
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk	Salmon (Pitka Fork)
9/12	[a, g]	[b]	0 [g]	0 [g]	0	[b]
9/13	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/14	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/15	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/16	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/17	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/18	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/19	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/20	[a, g]	[b]	[g]	0 [g]	[g]	[b]
9/21	[a, g]	[b]	[a]	0 [g]	[a]	[b]
9/22	[a, g]	[b]	[a]	0 [g]	[a]	[b]
9/23	[a, g]	[b]	[a]	0 [g]	[a]	[b]
9/24	[a, g]	[b]	[a]	0 [g]	[a]	[b]
9/25	[a, g]	[b]	[a]	0 [g]	[a]	[b]
Observed Esc.	3,619	503	1,373	7,036	1,866	6,326
Estimated Esc.	155	–	290	23	628	–
Total Annual Esc.	3,774	–	1,663	7,059	2,494	–
95% CI	3,663–4,145	–	1,614–1,723	7,031–7,153	2,357–2,648	–

Note: The sum of daily escapement that occurred within the project's target operational period is considered the annual escapement estimate for the project. Counts may have been conducted outside of the target operational period however those data are not displayed in this table and are not used in determining annual escapement. Confidence intervals are only reported for species with missed escapement estimates created from the Bayesian estimation method.

[a] The date is outside of the project's target operational period.

[b] The weir was not operational; no estimates were created or used.

[c] Partial day count; missed passage was estimated using the Bayesian method.

[d] The weir was not operational; missed passage was estimated using the Bayesian method.

[e] Partial day count; no estimates created or used.

[f] Partial day count; Bayesian estimate rejected due to observed passage being larger than estimate.

[g] The weir was not operational; missed passage was assumed zero.

[h] Partial day count; missed passage was assumed zero.

Table 6.–Daily and annual estimated escapement of chum salmon at Kuskokwim Area weir projects, 2016.

	Kuskokwim Bay	Kuskokwim River			
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk
6/15	[a]	0 [b]	0 [c]	[a]	0 [b]
6/16	[a]	0 [b]	5	[a]	0 [c]
6/17	[a]	0 [b]	4	[a]	2
6/18	[a]	0 [b]	5	[a]	2
6/19	[a]	0 [b]	13	[a]	4
6/20	[a]	0 [b]	9	[a]	8
6/21	[a]	0	11	[a]	22
6/22	2 [a, d]	0	27	[a]	29
6/23	3 [a]	0	12	[a]	10
6/24	5 [a]	0	17	[a]	18
6/25	8	14	48	2 [a, d]	34
6/26	36	2	93	16	25
6/27	184	6	45	30	30
6/28	214	8 [e]	47	38	53
6/29	98	11	76	44	34
6/30	383	11 [e]	90	38	81
7/1	350	7	119	30	47
7/2	1,096	6	246 [c]	5	109
7/3	556	1	302 [c]	141	138
7/4	224	8	358 [c]	17	148
7/5	158	2 [b]	415 [c]	49	17 [b]
7/6	328	3 [b]	470 [c]	86	30 [b]
7/7	537	4 [b]	520 [c]	253	49 [b]
7/8	246	6 [b]	541 [e]	146	74 [b]
7/9	410	8 [b]	606 [c]	571	107 [c]
7/10	1,843	10 [b]	639 [c]	598	124
7/11	1,430	13 [b]	665 [c]	591	207
7/12	909	16 [b]	918 [c]	989	305
7/13	2,010	10	730	841	210
7/14	1,616	9	837	971	329
7/15	852	40	555	1,011	361
7/16	930	28 [c]	652	634	359

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Table 6.–Page 2 of 4.

	Kuskokwim Bay	Kuskokwim River			
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk
7/17	1,436	36	811	625	435
7/18	1,499	32 [c]	640	1,889	481 [c]
7/19	478	33 [b]	390	1,073	496 [c]
7/20	648	34 [c]	636	1,147	550
7/21	763	21	659	2,233	730
7/22	352	42	585 [c]	2,099	465
7/23	612	33 [c]	358	1,629	382
7/24	1,873	46	585	2,586	477
7/25	758	36	504 [c]	2,787	417
7/26	1,653	20	647	2,274	408
7/27	1,797	30 [c]	449 [c]	2,081	299
7/28	1,862	21	441 [e]	1,885	293
7/29	754	24 [c]	347	1,298	243
7/30	317	22	365	1,218	188
7/31	796	15	319	1,455	227
8/1	776 [b]	18	322 [c]	2,125	159
8/2	739 [b]	13	207	1,410	132
8/3	703 [b]	14 [c]	264	1,031	200
8/4	669 [b]	13 [b]	256	626	146
8/5	634 [b]	11	297	726	212
8/6	602 [b]	11	279	892	154
8/7	570 [b]	10	283	698	79 [c]
8/8	539 [b]	8	223	730	66 [b]
8/9	509 [b]	10	175	325	55 [b]
8/10	481 [b]	8	157	462	46 [b]
8/11	454 [b]	5 [b]	152	598	38 [b]
8/12	429 [b]	7 [e]	253 [e]	334	32 [b]
8/13	404 [b]	1	142 [e]	235	26 [b]
8/14	381 [b]	5 [e]	157	306 [c]	22 [b]
8/15	359 [b]	3 [b]	127	267 [b]	18 [b]
8/16	338 [b]	2 [b]	63	232 [b]	14 [b]
8/17	318 [b]	2 [b]	53	201 [c]	16 [e]

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Table 6.–Page 3 of 4.

	Kuskokwim Bay	Kuskokwim River			
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk
8/18	300 [b]	2 [b]	42	23	9
8/19	282 [b]	1 [b]	50	55	5
8/20	265 [b]	1 [b]	61	28	9
8/21	249 [b]	1 [b]	31	112 [c]	5
8/22	234 [b]	1 [b]	56 [b]	97 [b]	8
8/23	220 [b]	1 [b]	51 [b]	83 [b]	8
8/24	207 [b]	1 [b]	47 [b]	72 [b]	12
8/25	195 [b]	0 [b]	42 [b]	61 [b]	5
8/26	183 [b]	0 [b]	39 [b]	53 [b]	0
8/27	172 [b]	0 [b]	35 [b]	45 [b]	0
8/28	161 [b]	0 [b]	32 [b]	39 [b]	2
8/29	151 [b]	0 [b]	30 [b]	33 [b]	2
8/30	142 [b]	0 [b]	27 [b]	28 [b]	5
8/31	133 [b]	0 [b]	25 [b]	24 [b]	4
9/1	[g]	0 [f]	1 [e]	[g]	4
9/2	[g]	0	7 [e]	[g]	1
9/3	[g]	0	1 [e]	[g]	1
9/4	[g]	0	5	[g]	1
9/5	[g]	0	8	[g]	2
9/6	[g]	0	7	[g]	1
9/7	[g]	0	3	[g]	0
9/8	[g]	[g]	0	[g]	5
9/9	[g]	[g]	1	[g]	0
9/10	[g]	[g]	8	[g]	0
9/11	[g]	[g]	2	[g]	1
9/12	[g]	[g]	2 [e]	[g]	2
9/13	[g]	[g]	[g]	[g]	[g]
9/14	[g]	[g]	[g]	[g]	[g]
9/15	[g]	[g]	[g]	[g]	[g]
9/16	[g]	[g]	[g]	[g]	[g]
9/17	[g]	[g]	[g]	[g]	[g]
9/18	[g]	[g]	[g]	[g]	[g]

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Table 6.–Page 4 of 4.

	Kuskokwim Bay	Kuskokwim River			
Date	Middle Fork Goodnews	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk
9/19	[g]	[g]	[g]	[g]	[g]
9/20	[g]	[g]	[g]	[g]	[g]
9/21	[a]	[a]	[a]	[g]	[a]
9/22	[a]	[a]	[a]	[g]	[a]
9/23	[a]	[a]	[a]	[g]	[a]
9/24	[a]	[a]	[a]	[g]	[a]
9/25	[a]	[a]	[a]	[g]	[a]
Observed Esc.	30,016	589	18,316	43,745	9,237
Estimated Esc.	11,799	293	6,465	1,653	1,650
Total Annual Esc.	41,815	817	20,834	45,329	10,564
95% CI	40,178–43,456	764–904	20,254–21,402	45,034–45,687	10,339–10,912

Note: The sum of daily escapement that occurred within the project's target operational period is considered the annual escapement estimate for the project. Counts may have been conducted outside of the target operational period, however those data are not displayed in this table and are not used in determining annual escapement. Confidence intervals are only reported for species with missed escapement estimates created from the Bayesian estimation method.

[a] The date is outside of the project's target operational period.

[b] The weir was not operational; missed passage was estimated using the Bayesian method.

[c] Partial day count; missed passage was estimated using the Bayesian method.

[d] Partial day count; no estimates created or used.

[e] Partial day count; Bayesian estimate rejected due to observed passage being larger than estimate.

[f] Partial day count; missed passage was assumed zero.

[g] The weir was not operational; missed passage was assumed zero.

Table 7.–Daily and annual estimated escapement of sockeye salmon at Kuskokwim Area weir projects, 2016.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	Salmon (Aniak)	Kogrukluk	Telaquana
6/15	[a]	0 [b]	[a]	[a]
6/16	[a]	0 [b]	[a]	[a]
6/17	[a]	0 [b]	[a]	[a]
6/18	[a]	0 [b]	[a]	[a]
6/19	[a]	0 [b]	[a]	[a]
6/20	[a]	0 [b]	[a]	[a]
6/21	[a]	0	[a]	[a]
6/22	42 [a, c]	0	[a]	[a]
6/23	216 [a]	0	[a]	[a]
6/24	282 [a]	0	[a]	[a]
6/25	215	0	0 [a, c]	[a]
6/26	710	0	0	[a]
6/27	808	0	0	[a]
6/28	1,272	0 [d]	0	[a]
6/29	844	0	0	[a]
6/30	2,263	0 [d]	0	[a]
7/1	1,563	0	0	[a]
7/2	4,996	0	0	[a]
7/3	2,700	0	0	0 [b]
7/4	2,055	0	0	0 [d]
7/5	4,487	0 [b]	1	0 [d]
7/6	3,819	0 [b]	0	0
7/7	3,258	0 [b]	0	0 [d]
7/8	6,294	0 [b]	1	1
7/9	6,892	0 [b]	1	3
7/10	7,171	0 [b]	17	0
7/11	8,145	0 [b]	35	1
7/12	6,977	0 [b]	51	8
7/13	6,091	0	149	149
7/14	6,439	0	102	320
7/15	6,674	0	173	1,197
7/16	7,519	0	300	1,649

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Table 7.–Page 2 of 4.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	Salmon (Aniak)	Kogrukluk	Telaquana
7/17	8,044	0	136	3,529
7/18	4,376	0 [d]	1,197	2,367
7/19	3,828	0 [b]	391	1,379
7/20	3,033	1 [d]	309	4,078
7/21	4,451	3	1,248	6,406
7/22	3,113	1	757	4,530
7/23	2,955	3 [d]	403	2,735
7/24	6,286	4	1,433	5,353
7/25	2,381	3	1,599	6,269
7/26	4,539	6	1,651	8,652
7/27	7,298	8 [d]	1,302	6,503
7/28	3,851	8	1,359	4,529
7/29	1,753	10 [d]	1,005	3,200
7/30	664	3	780	2,926
7/31	2,294	14	778	2,541
8/1	2,054 [b]	30	1,350	2,437
8/2	1,871 [b]	17	526	2,233
8/3	1,701 [b]	14 [d]	695	1,340
8/4	1,545 [b]	14 [b]	278	1,189
8/5	1,401 [b]	10	351	1,312
8/6	1,269 [b]	7	426	801
8/7	1,148 [b]	10	215	826
8/8	1,037 [b]	6	239	632
8/9	936 [b]	9	104	740
8/10	845 [b]	20	125	483
8/11	761 [b]	8 [b]	181	490
8/12	686 [b]	7 [d]	94	410
8/13	617 [b]	6	72	380
8/14	555 [b]	5 [d]	56 [d]	295
8/15	499 [b]	4 [b]	43 [b]	284
8/16	448 [b]	4 [b]	33 [b]	240
8/17	403 [b]	3 [b]	25 [d]	72 [b]

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Table 7.–Page 3 of 4.

	Kuskokwim Bay		Kuskokwim River				
Date	Middle Fork Goodnews		Salmon (Aniak)		Kogrukluk		Telaquana	
8/18	362	b	3	b	15		55	b
8/19	325	b	2	b	18		43	b
8/20	291	b	2	b	29		33	b
8/21	261	b	1	b	11	e	25	b
8/22	234	b	1	b	6	b	19	b
8/23	210	b	1	b	5	d	15	b
8/24	188	b	1	b	3	d	11	b
8/25	169	b	0	b	3	d	9	b
8/26	151	b	0	b	2	d	7	b
8/27	135	b	0	b	1	d		a
8/28	121	b	0	b	1	d		a
8/29	109	b	0	b	1	d		a
8/30	97	b	0	b	1	d		a
8/31	87	b	0	b	0	d		a
9/1		f	2			f		a
9/2		f	1			f		a
9/3		f	2			f		a
9/4		f	0			f		a
9/5		f	0			f		a
9/6		f	0			f		a
9/7		f	0			f		a
9/8		f		f		f		a
9/9		f		f		f		a
9/10		f		f		f		a
9/11		f		f		f		a
9/12		f		f		f		a
9/13		f		f		f		a
9/14		f		f		f		a
9/15		f		f		f		a
9/16		f		f		f		a
9/17		f		f		f		a
9/18		f		f		f		a

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Table 7.–Page 4 of 4.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	Salmon (Aniak)	Kogrukluk	Telaquana
9/19	[f]	[f]	[f]	[a]
9/20	[f]	[f]	[f]	[a]
9/21	[f]	[f]	[f]	[a]
9/22	[f]	[f]	[f]	[a]
9/23	[f]	[f]	[f]	[a]
9/24	[f]	[f]	[f]	[a]
9/25	[f]	[f]	[f]	[a]
Observed Esc.	150,058	185	19,922	82,417
Estimated Esc.	20,516	92	180	289
Total Annual Esc.	170,574	254	20,087	82,706
95% CI	170,111–172,142	224–313	20,013–20,197	82,665–82,753

Note: The sum of daily escapement that occurred within the project's target operational period is considered the annual escapement estimate for the project. Counts may have been conducted outside of the target operational period however those data are not displayed in this table and are not used in determining annual escapement. Confidence intervals are only reported for species with missed escapement estimates created from the Bayesian estimation method.

[a] The date is outside of the project's target operational period.

[b] The weir was not operational; missed passage was estimated using the Bayesian method.

[c] Partial day count; no estimates created or used.

[d] Partial day count; missed passage was estimated using the Bayesian method.

[e] Partial day count; Bayesian estimate rejected due to observed passage being larger than estimate.

[f] The weir was not operational; missed passage was assumed zero.

Table 8.–Daily and annual estimated escapement of coho salmon at Kuskokwim Area weir projects, 2016.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	George	Kogrukluk	Tatlawiksuk
6/15	[a]	0 [b]	[a]	0 [c]
6/16	[a]	0	[a]	0 [d]
6/17	[a]	0	[a]	0
6/18	[a]	0	[a]	0
6/19	[a]	0	[a]	0
6/20	[a]	0	[a]	0
6/21	[a]	0	[a]	0
6/22	0 [a, b]	0	[a]	0
6/23	0 [a]	0	[a]	0
6/24	0 [a]	0	[a]	0
6/25	0	0	0 [a, b]	0
6/26	0	0	0	0
6/27	0	0	0	0
6/28	0	0	0	0
6/29	0	0	0	0
6/30	0	0	0	0
7/1	0	0	0	0
7/2	0	0 [b]	0	0
7/3	0	0 [b]	0	0
7/4	0	0 [b]	0	0
7/5	0	0 [b]	0	0 [c]
7/6	0	0 [b]	0	0 [c]
7/7	0	0 [b]	0	0 [c]
7/8	0	0 [b]	0	0 [c]
7/9	0	0 [b]	0	0 [d]
7/10	0	0 [b]	0	0
7/11	0	0 [b]	0	0
7/12	0	0 [b]	0	0
7/13	0	0	0	0
7/14	0	0	0	0
7/15	0	0	0	0
7/16	0	0	0	0

-continued-

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	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	George	Kogrukluk	Tatlawiksuk
7/17	0	0	0	0
7/18	0	0	0	0 [d]
7/19	0	0	0	0 [d]
7/20	0	0	0	0
7/21	0	0	0	1
7/22	0	0 [b]	0	0
7/23	0	1	0	0
7/24	0	1	0	2
7/25	0	1 [b]	0	4
7/26	0	2	0	9
7/27	0	4 [b]	0	11
7/28	1	4 [b]	0	5
7/29	3	4	0	4
7/30	1	6	0	9
7/31	28	16	0	13
8/1	[e]	17 [b]	0	21
8/2	[e]	25	0	36
8/3	[e]	45	10	42
8/4	[e]	22	7	22
8/5	[e]	17	5	76
8/6	[e]	26	33	117
8/7	[e]	72	12	113 [d]
8/8	[e]	42	24	131 [c]
8/9	[e]	38	69	150 [c]
8/10	[e]	128	75	171 [c]
8/11	[e]	145	194	191 [c]
8/12	[e]	463 [b]	325	212 [c]
8/13	[e]	74 [b]	360	232 [c]
8/14	[e]	331	28 [b]	252 [c]
8/15	[e]	843	[e]	272 [c]
8/16	[e]	477	[e]	290 [c]
8/17	[e]	733	23 [b]	307 [d]

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Table 8.–Page 3 of 4.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	George	Kogrukluk	Tatlawiksuk
8/18	[e]	743	195	291
8/19	[e]	205	236	325
8/20	[e]	472	253	371
8/21	[e]	1,993	437 [b]	482
8/22	[e]	[e]	[e]	457
8/23	[e]	[e]	[e]	492
8/24	[e]	[e]	[e]	556
8/25	[e]	[e]	[e]	290
8/26	[e]	[e]	[e]	130
8/27	[e]	[e]	[e]	270
8/28	[e]	[e]	[e]	262
8/29	[e]	[e]	[e]	237
8/30	[e]	[e]	[e]	344
8/31	[e]	[e]	[e]	338
9/1	[e]	312 [b]	[e]	322
9/2	[e]	584 [b]	[e]	232
9/3	[e]	594 [b]	[e]	430
9/4	[e]	1,043	[e]	407
9/5	[e]	970	[e]	334
9/6	[e]	1,470	[e]	339
9/7	[e]	1,131	[e]	190
9/8	[e]	705	[e]	268
9/9	[e]	699	[e]	250
9/10	[e]	742	[e]	236
9/11	[e]	653	[e]	141
9/12	[e]	1,386 [b]	[e]	199
9/13	[e]	[e]	[e]	166 [c]
9/14	[e]	[e]	[e]	153 [c]
9/15	[e]	[e]	[e]	141 [c]
9/16	[e]	[e]	[e]	130 [c]
9/17	[e]	[e]	[e]	120 [c]
9/18	[e]	[e]	[e]	110 [c]

-continued-

Table 8.–Page 4 of 4.

	Kuskokwim Bay	Kuskokwim River		
Date	Middle Fork Goodnews	George	Kogrukluk	Tatlawiksuk
9/19	[e]	[e]	[e]	100 [c]
9/20	[e]	[e]	[e]	91 [c]
9/21	[a]	[a]	[e]	[a]
9/22	[a]	[a]	[e]	[a]
9/23	[a]	[a]	[e]	[a]
9/24	[a]	[a]	[e]	[a]
9/25	[a]	[a]	[e]	[a]
Observed Esc.	33	17,239	2,286	8,767
Estimated Esc.	–	–	–	3,332
Total Annual Esc.	–	–	–	11,897
95% CI	–	–	–	11,231–12,472

Note: The sum of daily escapement that occurred within the project's target operational period is considered the annual escapement estimate for the project. Counts may have been conducted outside of the target operational period however those data are not displayed in this table and are not used in determining annual escapement. Confidence intervals are only reported for species with missed escapement estimates created from the Bayesian estimation method.

[a] The date is outside of the project's target operational period.

[b] Partial day count; no estimates created or used.

[c] Weir was not operational; missed passage was estimated using the Bayesian method.

[d] Partial day count missed passage was estimated using the Bayesian method.

[e] The weir was not operational; no estimates were created or used.

Table 9.–Chinook salmon aerial survey escapement indices, Kuskokwim Area, 2000–2016.

	Kuskokwim Bay			Lower / Middle Kuskokwim River									Upper Kuskokwim River	
Year	North Fork Goodnews	Middle Fork Goodnews	Kanektok	Kisaralik	Aniak	Salmon (Aniak)	Kipchuk	Holokuk	Oskawalik	Holitna	Cheeneetnuk	Gagaryah	Salmon (Pitka Fork)	Bear Creek
2000	–	–	–	–	714	238	182	–	–	301	–	–	362	–
2001	–	–	–	–	–	598	–	52	–	4,156	–	143	1,033	175
2002	1,470	1,195	–	1,727	–	1,236	1,615	513	295	733	730	–	–	211
2003	3,935	2,131	6,206	654	3,514	1,242	1,493	1,096	844	–	810	1,093	–	176
2004	7,482	2,617	28,375	5,157	5,362	2,177	1,868	539	293	4,051	918	670	1,138	206
2005	–	–	12,780	2,206	–	4,097	1,679	510	582	1,760	–	–	1,801	367
2006	–	–	–	4,734	5,639	–	1,618	705	386	1,866	1,015	531	862	347
2007	–	–	–	692	3,984	1,458	2,147	–	–	–	–	1,035	943	165
2008	2,155	2,190	–	1,074	3,222	589	1,061	418	213	–	290	177	1,033	245
2009	–	–	–	–	–	–	–	565	379	–	323	303	632	209
2010	–	–	1,208	235	–	–	–	229	–	–	–	62	135	75
2011	853	–	–	–	–	79	116	61	26	–	249	96	767	145
2012	378	355	–	588	–	49	193	36	51	–	229	178	670	–
2013	–	–	2,277	599	754	154	261	–	38	532	138	74	469	64
2014	630	612	1,840	622	3,201	497	1,220	80	200	–	340	359	1,865	–
2015	991	515	4,919	709	–	810	917	77	–	662	–	19	2,016	1,381
2016	1120	1301	5631	622	718	–	898	100	47	1,157	217	135	1,578	580
Average	1,881	1,350	8,222	1,166	2,768	793	1,023	365	304	1,664	725	463	999	269
Escapement goal	640–3,300	–	3,500–8,500	400–1,200	1,200–2,300	330–1,200	–	–	–	970–2,100	340–1,300	300–830	470–1,600	–

Note: Average is derived from all annual escapements on record at each project except 2016, and may include escapements prior to 2000. Escapement data for all projects' entirety are archived in the Arctic-Yukon-Kuskokwim salmon database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx).

Table 10.–Annual escapement of Chinook salmon past Kuskokwim Area weir projects, 2000–2016.

	Kuskokwim Bay rivers		Kuskokwim River				
Year	Middle Fork Goodnews	Kanektok	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk	Salmon (Pitka Fork)
2000	2,670	[a]	[a]	2,959	3,242	807	[a]
2001	5,351	[b]	[a]	3,277	7,475	1,978	[a]
2002	3,025	5,304	[a]	2,443	10,025	2,237	[a]
2003	2,248	8,211	[a]	[b]	12,008	[b]	[a]
2004	4,438	19,569	[a]	5,488	19,819	2,833	[a]
2005	4,781	14,177	[a]	3,845	21,819	2,864	[a]
2006	4,572	[a]	7,075	4,355	20,205	1,700	[a]
2007	3,914	13,965	6,255	4,011	[b]	2,032	[a]
2008	2,223	[b]	2,376	2,563	9,750	1,075	[a]
2009	1,669	7,065	1,656	3,663	9,528	1,071	[a]
2010	2,176	6,537	[a]	1,498	5,812	546	[a]
2011	2,045	5,170	[a]	1,547	6,731	992	[a]
2012	524	1,561	[b]	2,201	[b]	1,116	[a]
2013	1,187	3,569	625	1,292	1,819	495	[a]
2014	750	3,594	1,757	2,993	3,732	1,904	[a]
2015	1,494	10,416	2,404	2,282	8,081	2,104	6,736
2016	3,767	[a]	[b]	1,633	7,056	2,494	6,326
Average	2,776	8,262	3,164	3,529	10,242	1,577	–
Escapement goal	BEG: 1,500–2,900	–	–	SEG: 1,800–3,300	SEG: 4,800–8,800	–	–

Note: Average is derived from all annual escapements on record at each project except 2016, and may include escapements prior to 2000. Escapement data for all projects' entirety are archived in the Arctic-Yukon-Kuskokwim salmon database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx). Dashes (–) indicate no escapement goal exists.

[a] Weir did not operate this year.

[b] Historical run timing indicates that more than 40% of the run was missed; annual escapement was not determined.

Table 11.–Annual escapement of chum salmon past Kuskokwim Area weir projects, 2000–2016.

	Kuskokwim Bay rivers		Kuskokwim River			
Year	Middle Fork Goodnews	Kanektok	Salmon (Aniak)	George	Kogrukluk	Tatlawiksuk
2000	14,405	[a]	[a]	3,507	11,416	7,076
2001	26,820	[b]	[a]	11,287	31,587	23,863
2002	29,905	41,912	[a]	6,534	52,973	24,539
2003	21,778	40,086	[a]	33,648	23,779	[b]
2004	32,442	46,008	[a]	15,012	24,405	21,245
2005	26,501	55,340	[a]	14,834	194,887	55,599
2006	54,689	[a]	42,825	42,318	188,003	32,776
2007	50,232	131,000	25,340	61,531	52,961	83,484
2008	39,548	[b]	9,459	29,396	44,744	30,129
2009	19,236	55,846	9,392	7,944	82,483	19,975
2010	24,789	68,186	[a]	26,275	69,258	37,737
2011	19,974	53,050	[a]	46,650	76,823	88,202
2012	9,065	28,726	[b]	33,310	[b]	44,569
2013	27,682	43,040	7,723	37,879	65,644	32,249
2014	11,518	18,602	2,890	17,148	30,763	12,455
2015	11,517	15,048	5,657	17,551	33,201	10,379
2016	41,815	[a]	817	20,834	45,329	10,564
Average	25,774	49,737	14,755	23,349	46,793	33,376
Escapement goal	SEG: >12,000	–	–	–	SEG: 15,000–49,000	–

Note: Average is derived from all annual escapements on record at each project except 2016, and may include escapements prior to 2000. Escapement data for all projects' entirety are archived in the Arctic-Yukon-Kuskokwim salmon database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx).

[a] Weir did not operate this year.

[b] Historical run timing indicates that more than 40% of the run was missed; annual escapement was not determined.

Table 12.–Sockeye salmon aerial survey escapement indices, Kuskokwim Area, 2000–2016.

Year	North Fork Goodnews River	Middle Fork Goodnews River	Kanektok River
2000	–	–	–
2001	–	–	–
2002	–	2,627	–
2003	50,140	29,150	21,335
2004	31,695	33,670	77,780
2005	–	–	95,900
2006	–	–	–
2007	–	–	–
2008	32,500	13,935	–
2009	–	–	–
2010	–	–	16,180
2011	14,140	–	–
2012	16,710	–	–
2013	–	–	51,517
2014	–	12,262	136,400
2015	38,390	24,780	39,970
2016	90,060	68,978	80,160
Average	26,807	18,040	47,269
Escapement goal	5,500–19,500	–	14,000–34,000

Note: Average is derived from all aerial survey escapement indices on record for each river except 2015, and may include indices prior to 2000. For additional aerial survey data refer to the Arctic-Yukon-Kuskokwim salmon database management system. (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx). Dashes (–) indicate the escapement index was not estimated or no escapement goal exists.

Table 13.–Annual escapement of sockeye salmon past Kuskokwim Area weir projects, 2000–2016.

	Kuskokwim Bay rivers		Kuskokwim River		
Year	Middle Fork Goodnews	Kanektok	Salmon (Aniak)	Kogrukluk	Telaquana
2000	40,828	[a]	[a]	2,895	[a]
2001	21,194	[b]	[a]	7,177	[a]
2002	21,329	60,228	[a]	4,084	[a]
2003	37,933	128,030	[a]	9,302	[a]
2004	54,035	105,135	[a]	6,895	[a]
2005	118,969	268,537	[a]	37,787	[a]
2006	127,245	[a]	7,086	61,382	[a]
2007	73,768	304,086	2,189	17,211	[a]
2008	43,879	[b]	1,181	19,675	[a]
2009	27,494	305,756	1,366	22,826	[a]
2010	36,574	204,954	[a]	17,139	71,932
2011	19,643	88,177	[a]	7,974	35,102
2012	29,531	115,021	924	[b]	23,005
2013	23,545	128,761	966	7,808	28,050
2014	41,473	259,406	894	6,413	24,293
2015	57,809	106,751	1,669	6,411	95,516
2016	170,574	[a]	254	20,087	82,706
Average	46,012	172,904	2,034	12,463	46,316
Escapement goal	BEG: 18,000–40,000	–	–	SEG: 4,400–17,000	–

Note: Average is derived from all annual escapements on record at each project except 2016, and may include escapements prior to 2000. Escapement data for all projects' entirety are archived in the Arctic-Yukon-Kuskokwim salmon database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx).

[a] Weir did not operate this year.

[b] Historical run timing indicates that more than 40% of the run was missed; annual escapement was not determined.

Table 14.–Annual escapement of coho salmon past Kuskokwim Area weir projects, 2000–2016.

	Kuskokwim Bay			
Year	Middle Fork Goodnews	George R	Kogrukluk	Tatlawiksuk
2000	[a]	11,269	33,063	[a]
2001	18,300	16,724	19,983	[a]
2002	27,643	6,759	14,515	11,156
2003	52,504	32,873	74,915	[a]
2004	42,049	12,499	26,078	16,446
2005	20,168	8,294	25,407	7,076
2006	26,909	12,705	16,268	[a]
2007	19,442	28,398	26,423	8,500
2008	37,690	21,931	29,237	11,022
2009	19,123	12,490	22,289	10,148
2010	26,287	12,639	14,689	3,773
2011	24,668	29,120	21,800	14,184
2012	[a]	14,478	13,421	8,015
2013	[a]	15,308	21,207	12,764
2014	[a]	35,771	52,975	19,814
2015	[a]	35,812	32,457	17,701
2016	[a]	[a]	[a]	11,897
Average	26,634	18,076	23,644	11,094
Escapement goal	SEG: >12,000	–	SEG: 13,000–28,000	–

Note: Average is derived from all annual escapements on record at each project except 2016, and may include escapements prior to 2000. Escapement data for all projects' entirety are archived in the Arctic-Yukon-Kuskokwim salmon database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx).

[a] Historical run timing indicates that more than 40% of the run was missed; annual escapement was not determined.

Table 15.–Age, sex, and length sample collection at Kuskokwim Area weir projects, 2016.

Species	Project	Season sample goal	Scales per fish sampled	Season total number of samples collected	Dates samples collected
Chinook	Middle Fork Goodnews	230	3	100	26 June–31 July
	Salmon (Aniak)	230	3	47	20 July–5 August
	George	230	3	46	11 July–2 August
	Kogrukluk	230	3	232	28 June–1 August
	Tatlawiksuk	230	3	64	25 June–28 July
	Salmon (Pitka Fork)	250	3	288	25 June–31 July
Chum	Middle Fork Goodnews	400	1	419	7 July–31 July
	Salmon (Aniak)	400	1	97	22 July–6 August
	George	400	1	328	11 July–2 August
	Kogrukluk	600	1	606	28 June–9 August
	Tatlawiksuk	400	1	290	30 June–5 August
Sockeye	Middle Fork Goodnews	400	3	603	27 June–24 July
	Kogrukluk	250	0	253	5 July–4 August
	Telaquana	250	0	334	15 July–9 August
Coho	George	400	3	101	18 August–10 September
	Kogrukluk	400	3	13	19 August
	Tatlawiksuk	400	3	249	20 August–12 September

Note: In 2015, only length and sex information was collected from sockeye salmon at Kogrukluk and Telaquana river weirs.

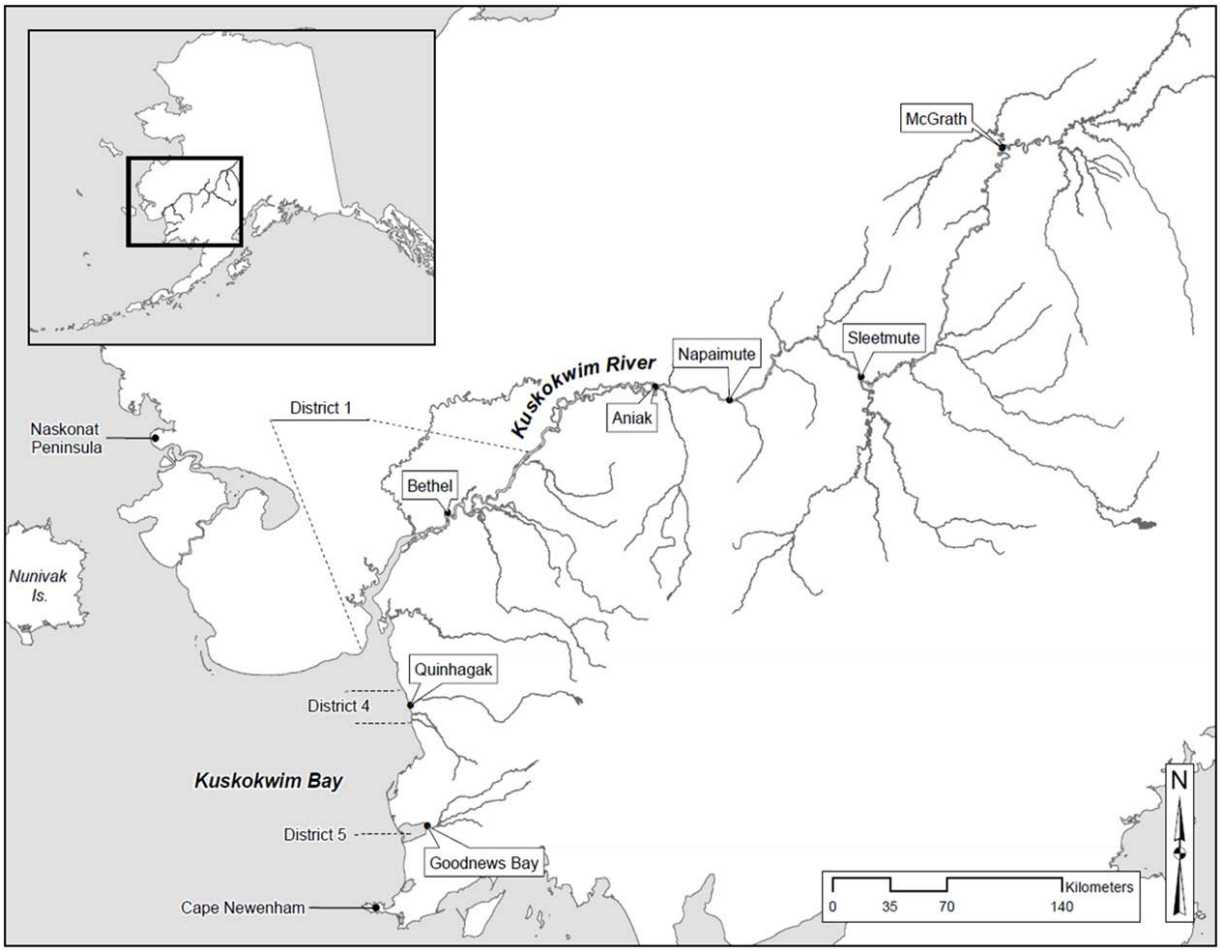

Figure 1.–The Kuskokwim Management Area, including Kuskokwim Bay, the Kuskokwim River, and select commercial fishing districts.

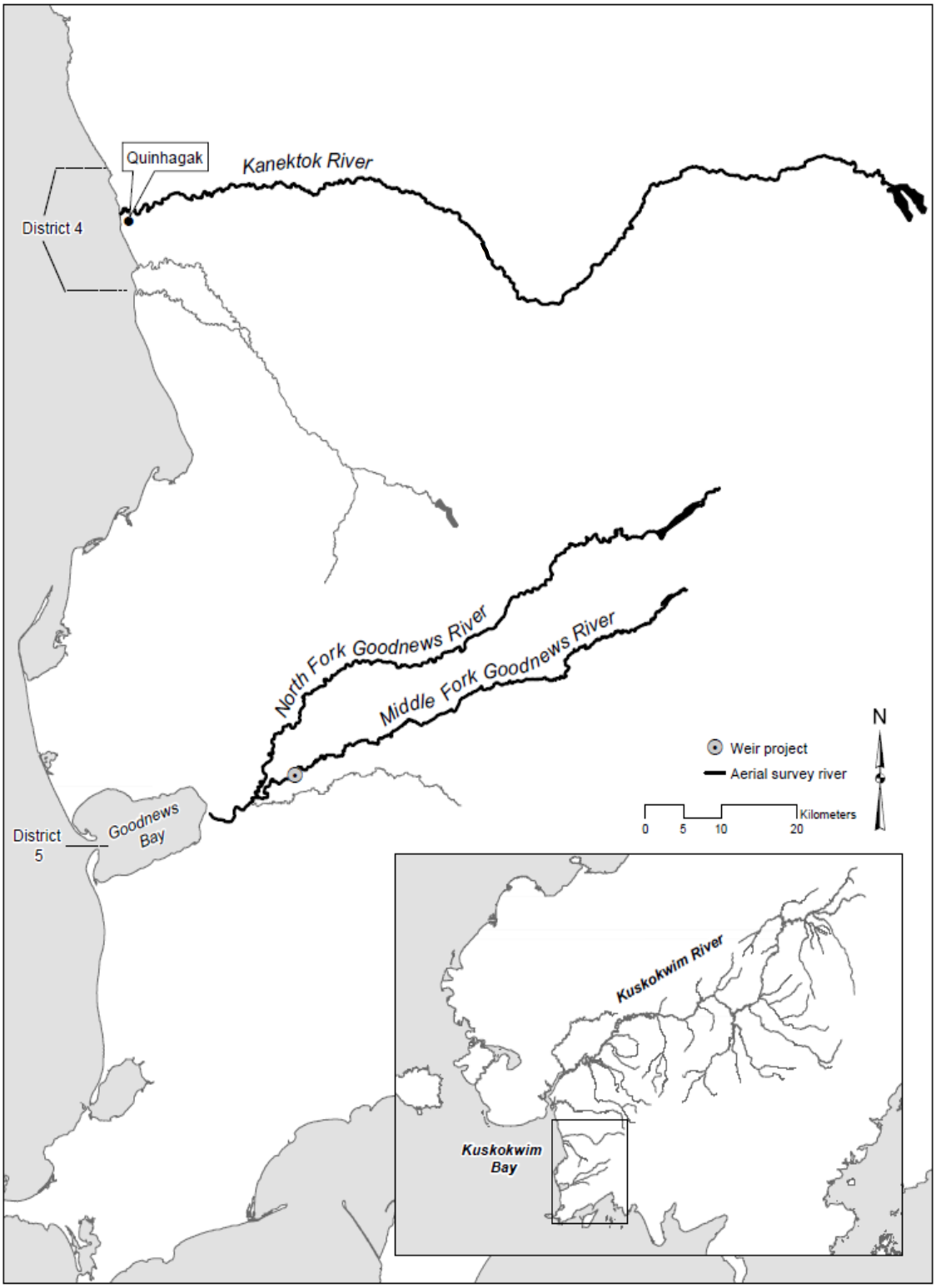

Figure 2.–Kuskokwim Bay rivers where salmon escapement is monitored by ADF&G and partners, 2016.

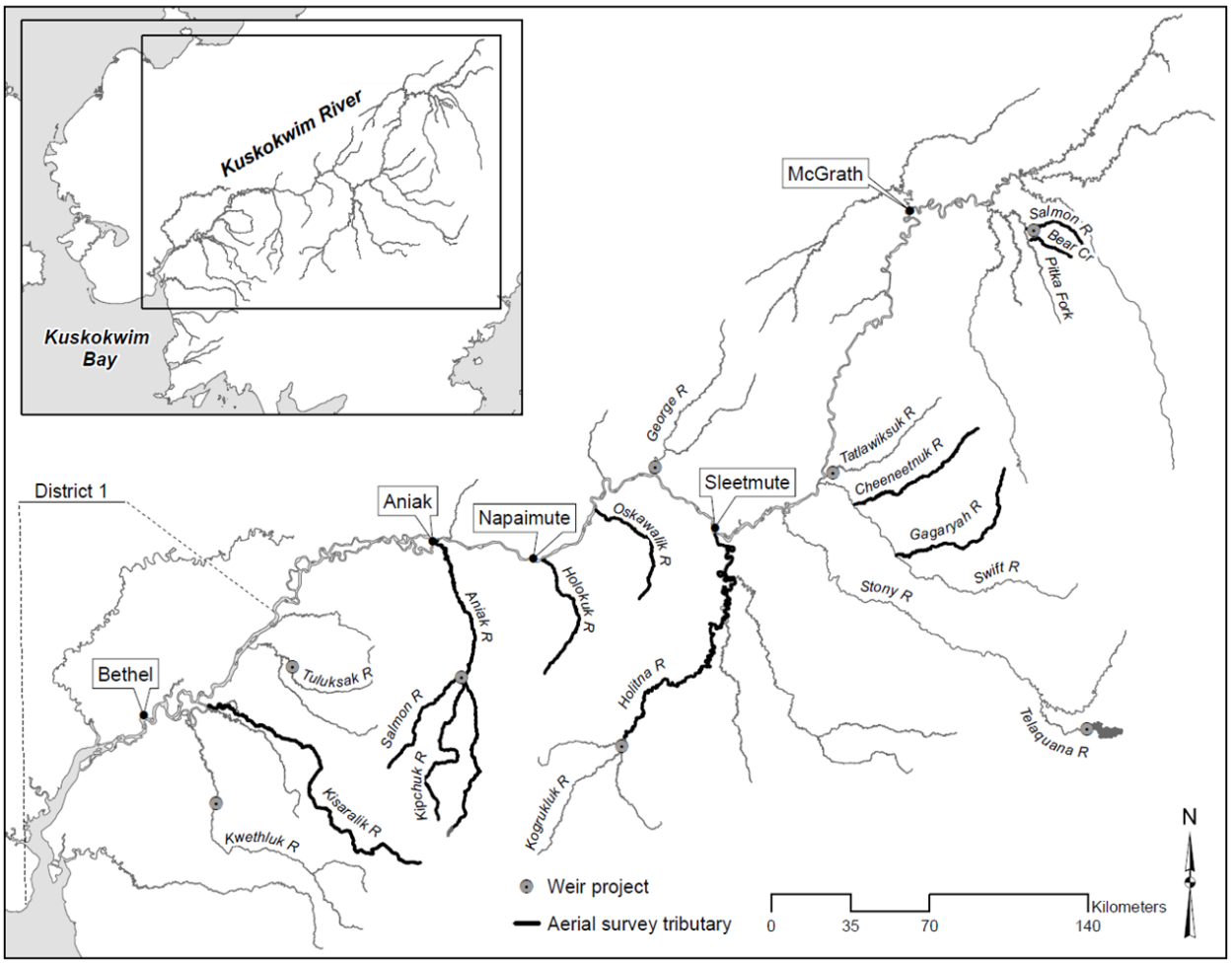

Figure 3.–Kuskokwim River tributaries where salmon escapement is monitored by ADF&G and partners, 2016.

Note: Kwethluk and Tuluksak river weirs are operated by the U.S. Fish and Wildlife Service and are displayed to show all active salmon monitoring projects in the Kuskokwim River.

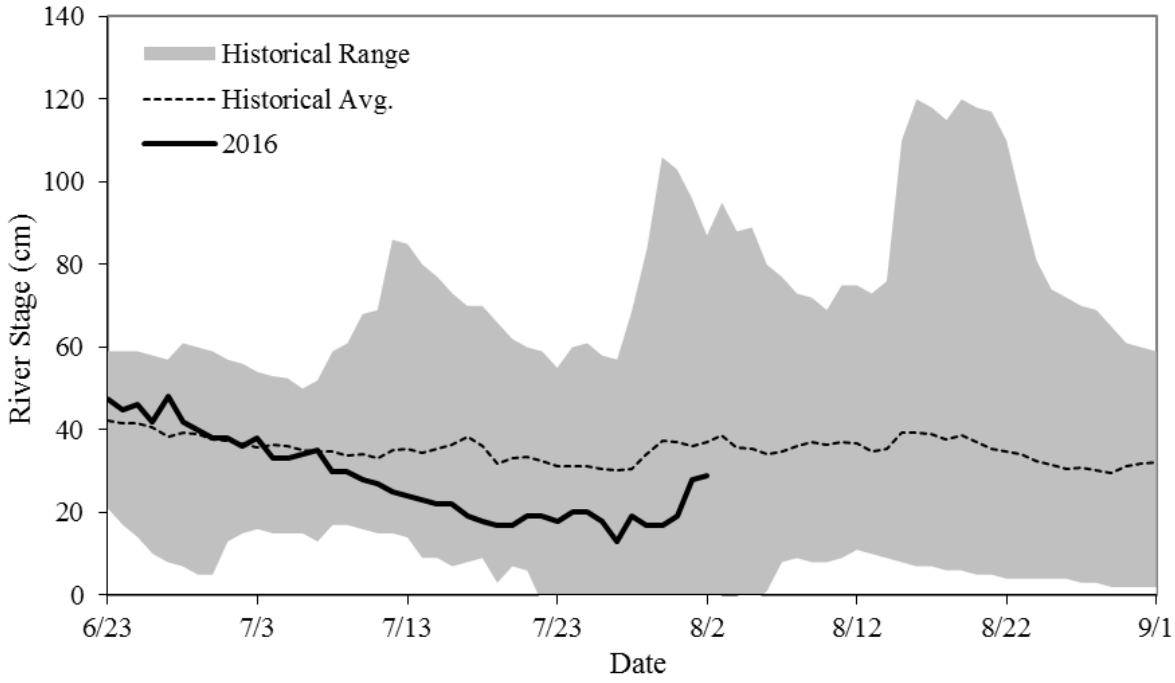

Figure 4.–Daily morning river stage at Middle Fork Goodnews River weir in 2016 relative to historical average, minimum, and maximum morning readings, 2004–2015.

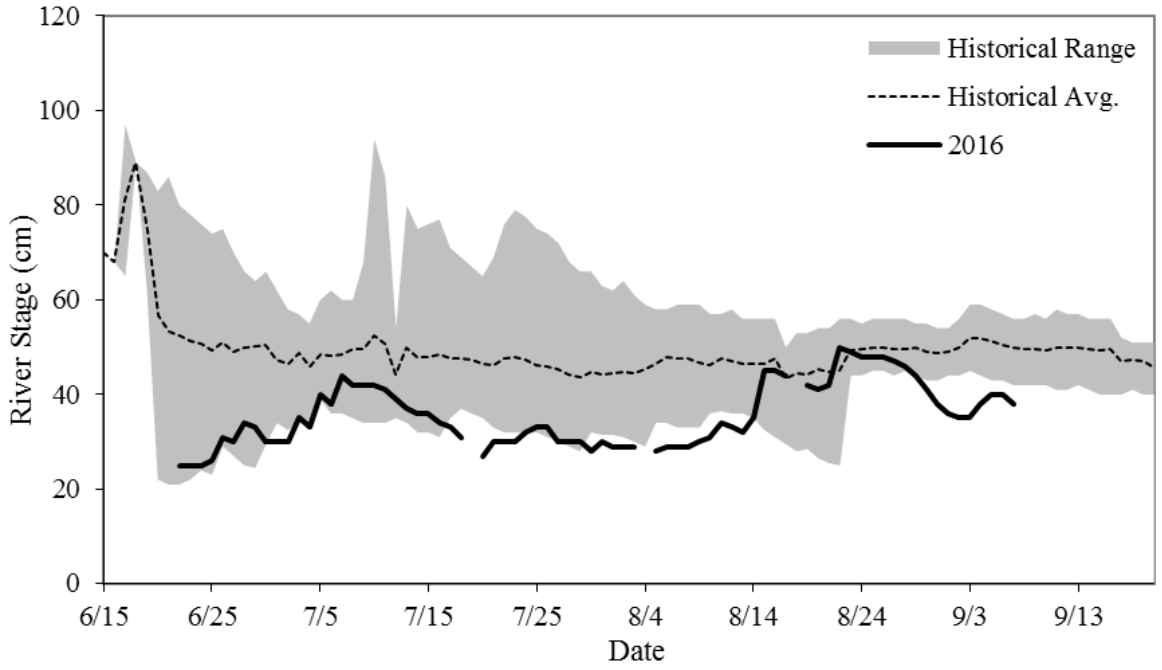

Figure 5.–Daily morning river stage at Salmon River (Aniak) weir in 2016 relative to historical average, minimum, and maximum morning readings, 2006–2009 and 2012–2015.

Note: The 2016 river stage may no longer be a reliable index of water velocity at this location due to changes in channel shape. Crews reported very fast water velocity and were not able to safely keep the weir installed for substantial portions of the 2016 season, even though the water level was below average.

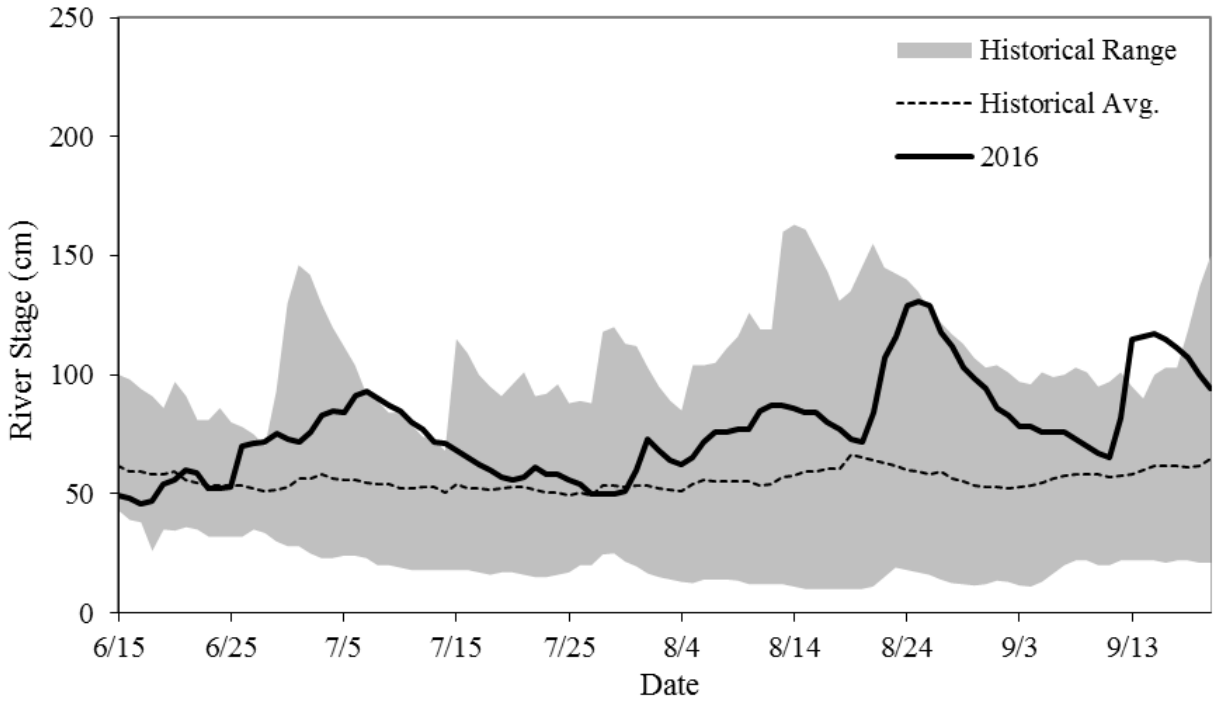

Figure 6.–Daily morning river stage at George River weir in 2016 relative to historical average, minimum, and maximum morning readings, 2000–2015.

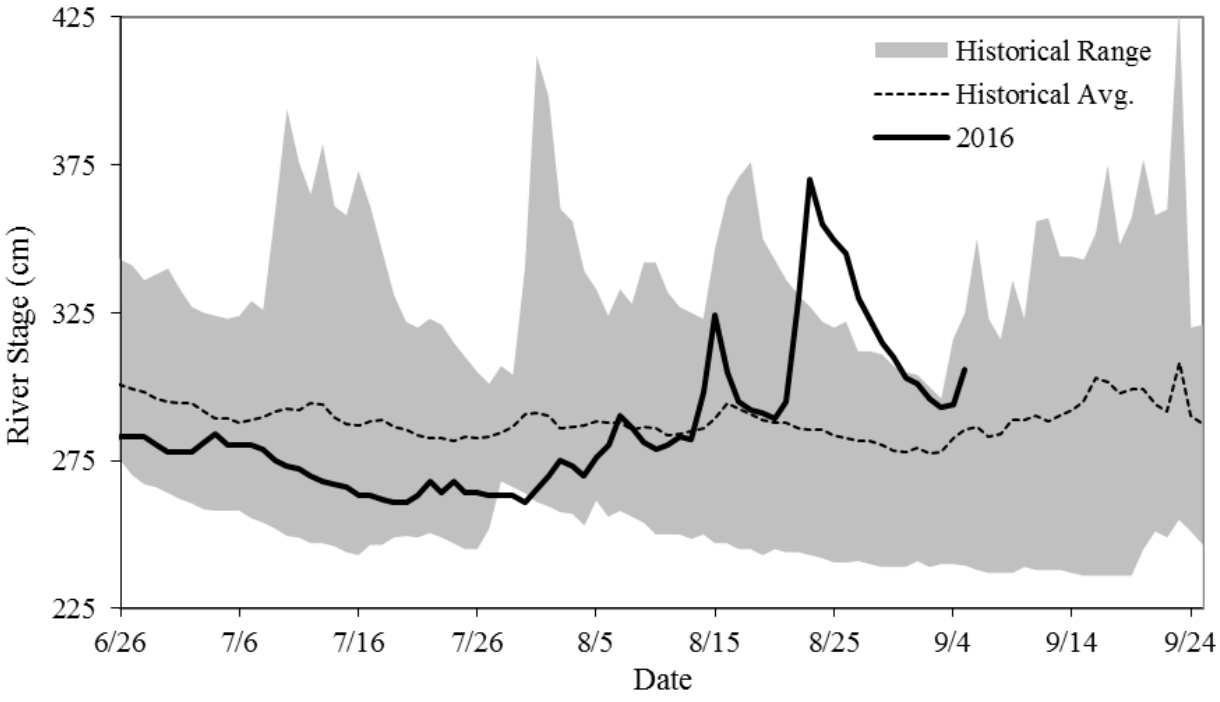

Figure 7.–Daily morning river stage at Kogrukluk River weir in 2016 relative to historical average, minimum, and maximum morning readings, 2002–2015.

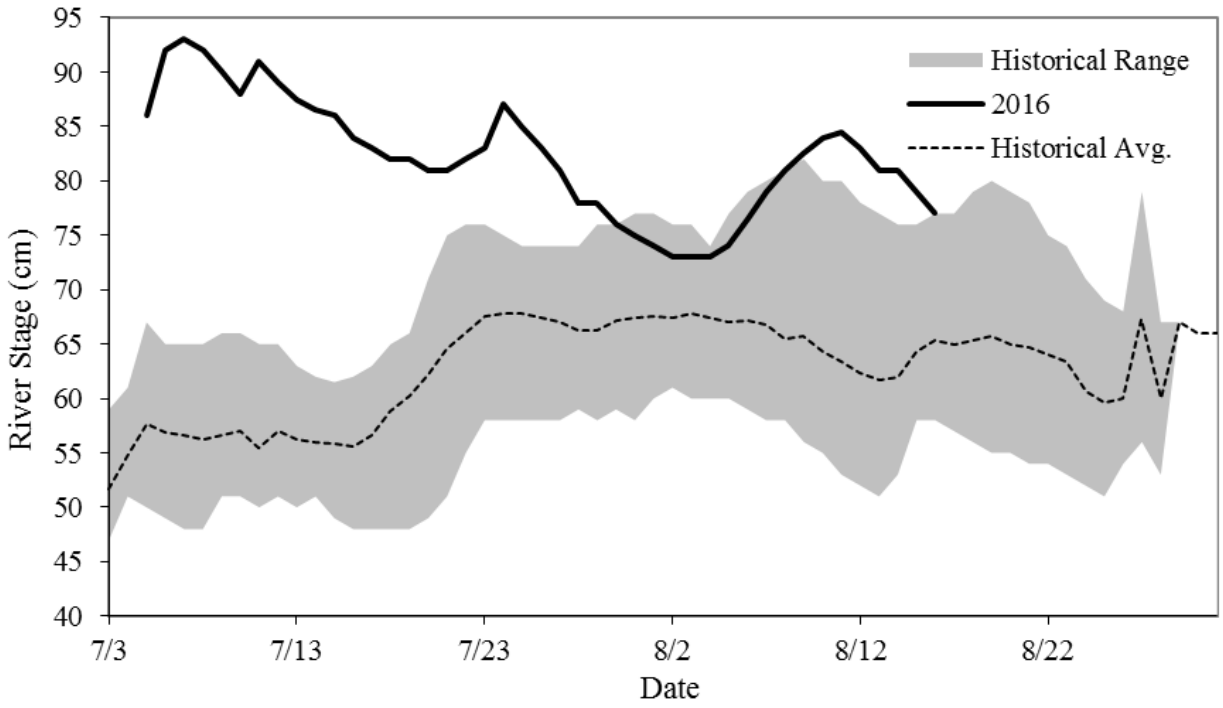

Figure 8.–Daily morning river stage at Telaquana River weir in 2016 relative to historical average, minimum, and maximum morning readings, 2010–2014.

Note: Measurements from 2015 are not included in the historical range or average because the data were not calibrated to the established benchmark.

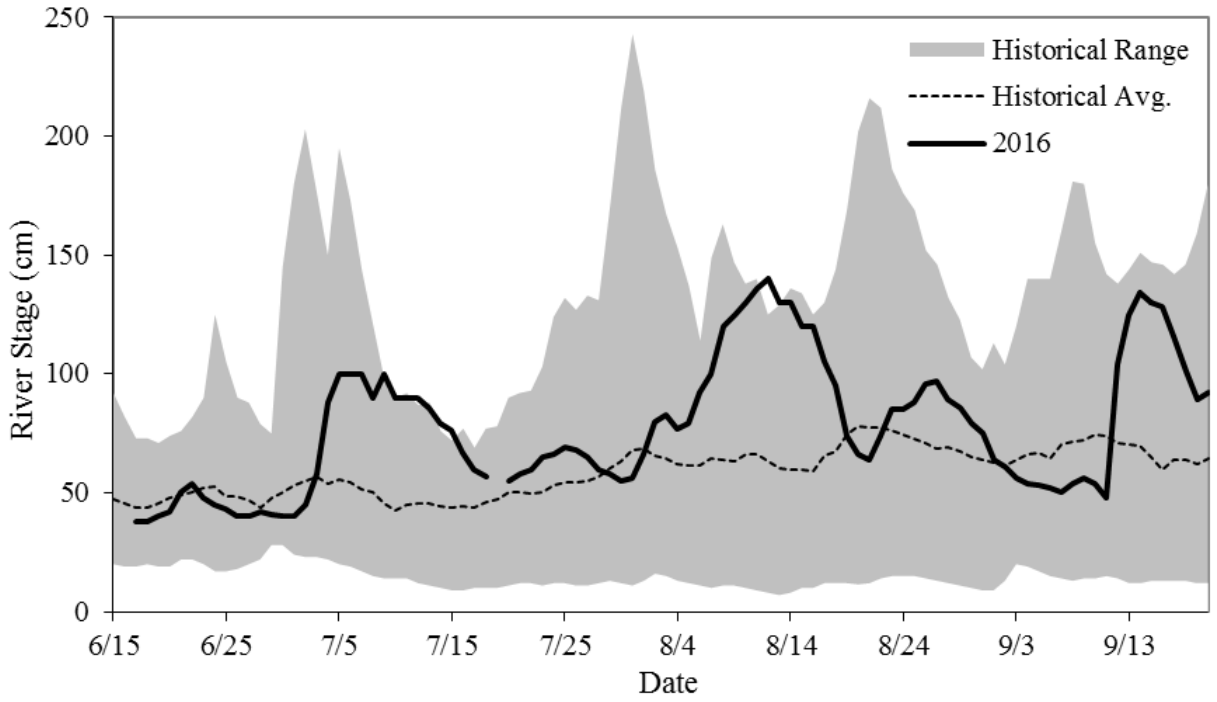

Figure 9.–Daily morning river stage at Tatlawiksuk River weir in 2016 relative to historical average, minimum, and maximum morning readings, 1998–2015.

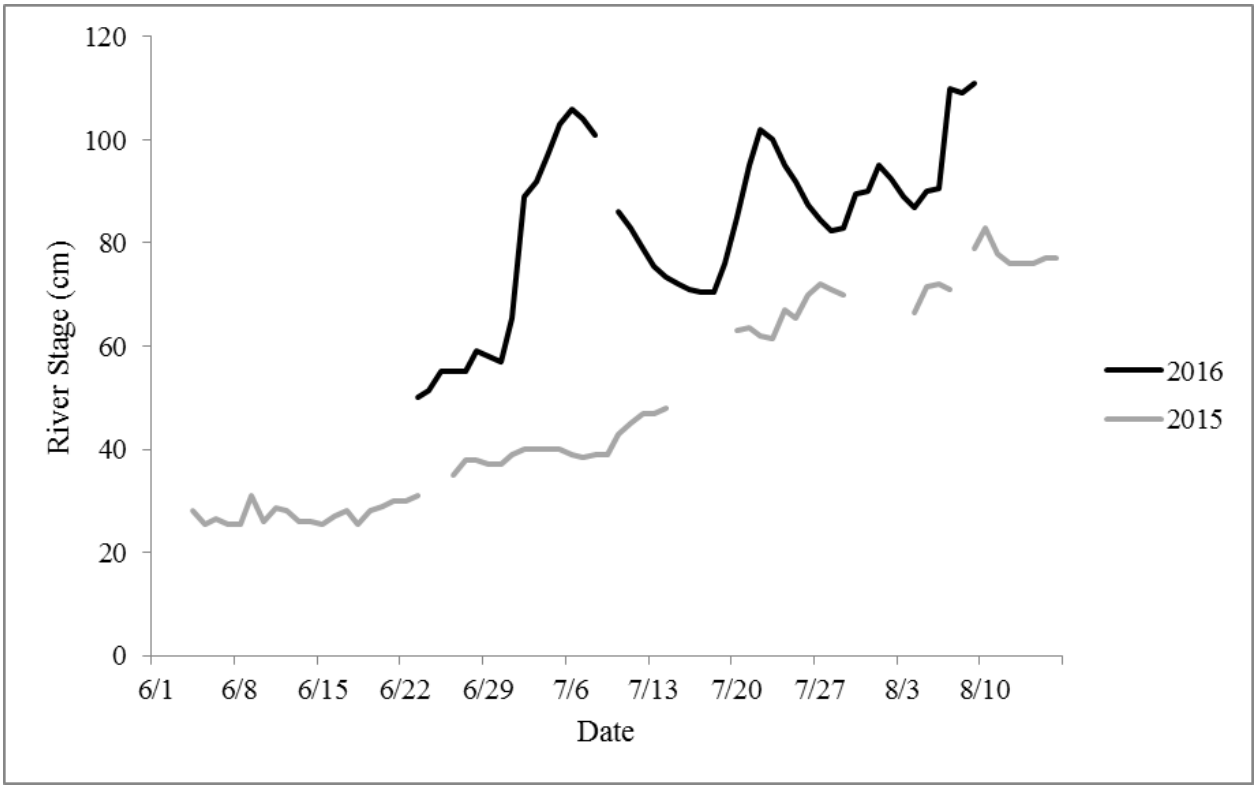

Figure 10.–Daily morning river stage at Salmon River (Pitka Fork) weir in 2016.

Note: Data from 2015 and 2016 are the only information available on river stage at this weir.

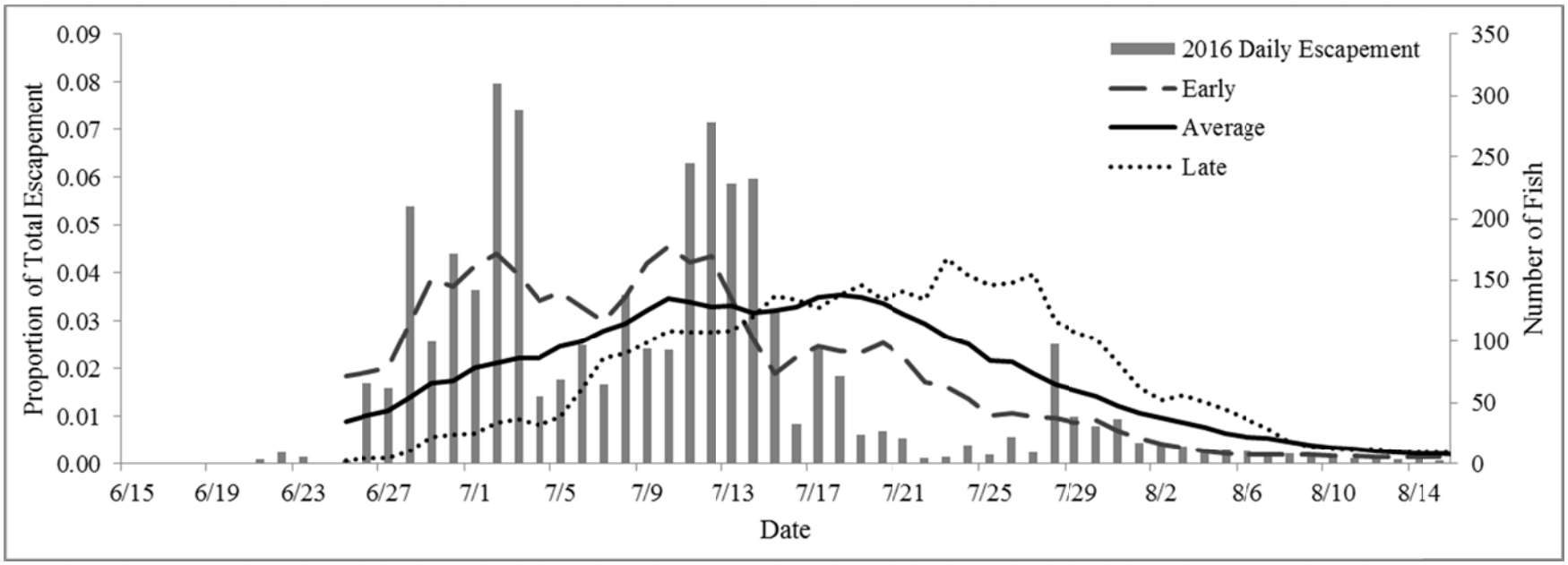

Figure 11.–Early, average, and late arrival timings and 2016 daily escapements of Chinook salmon at the Middle Fork Goodnews River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

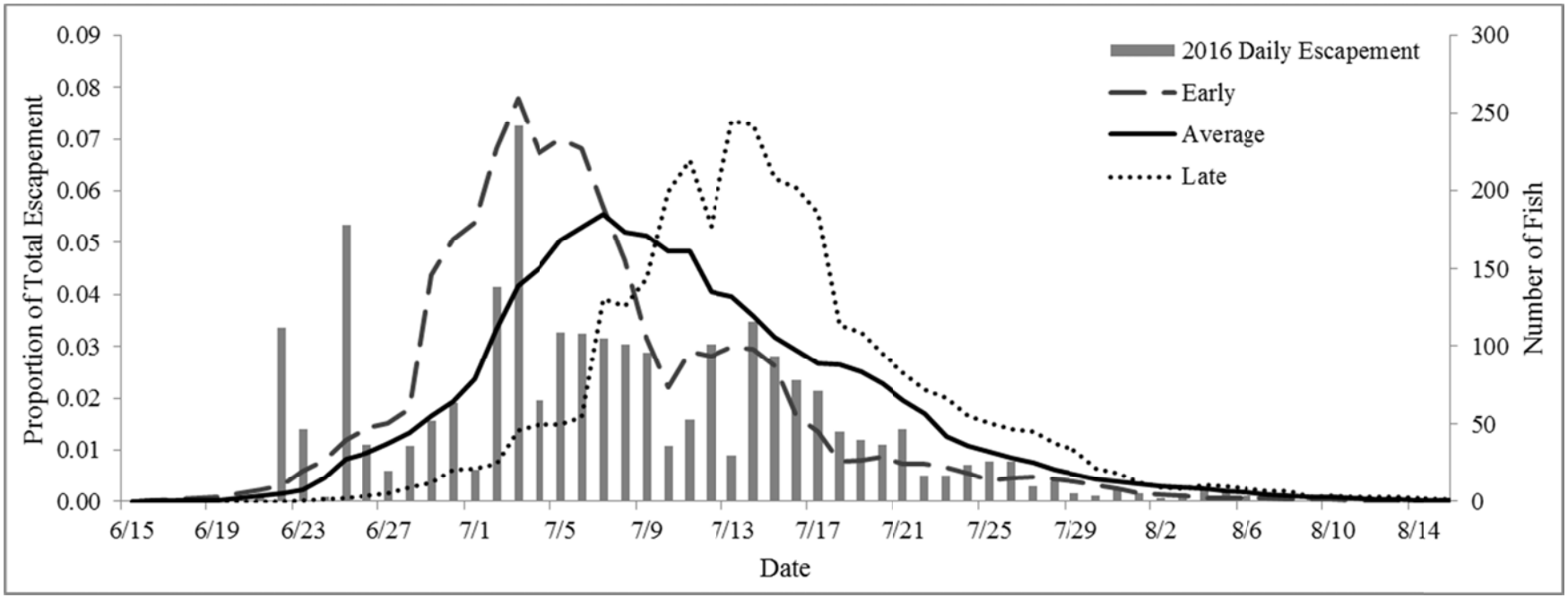

Figure 12.–Early, average, and late arrival timings and 2016 daily escapements of Chinook salmon at the Tatlawiksuk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

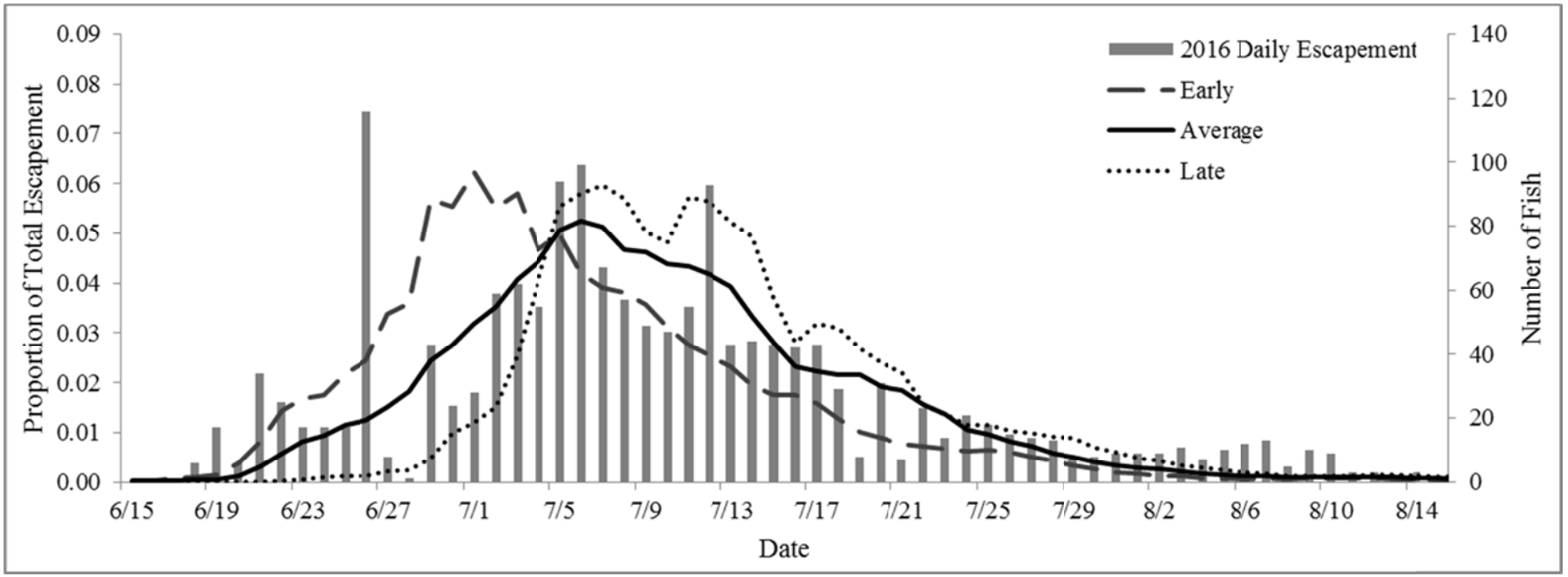

Figure 13.–Early, average, and late arrival timings and 2016 daily escapements of Chinook salmon at the George River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

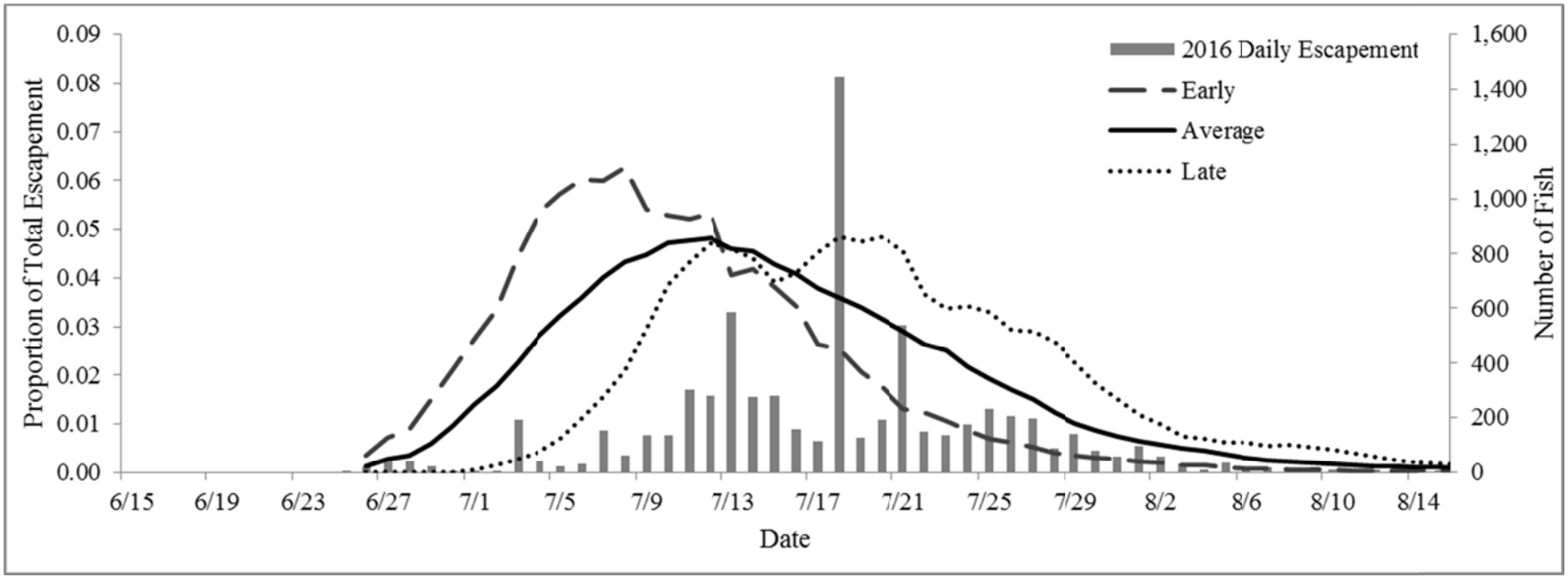

Figure 14.–Early, average, and late arrival timings and 2016 daily escapements of Chinook salmon at the Kogrukluk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

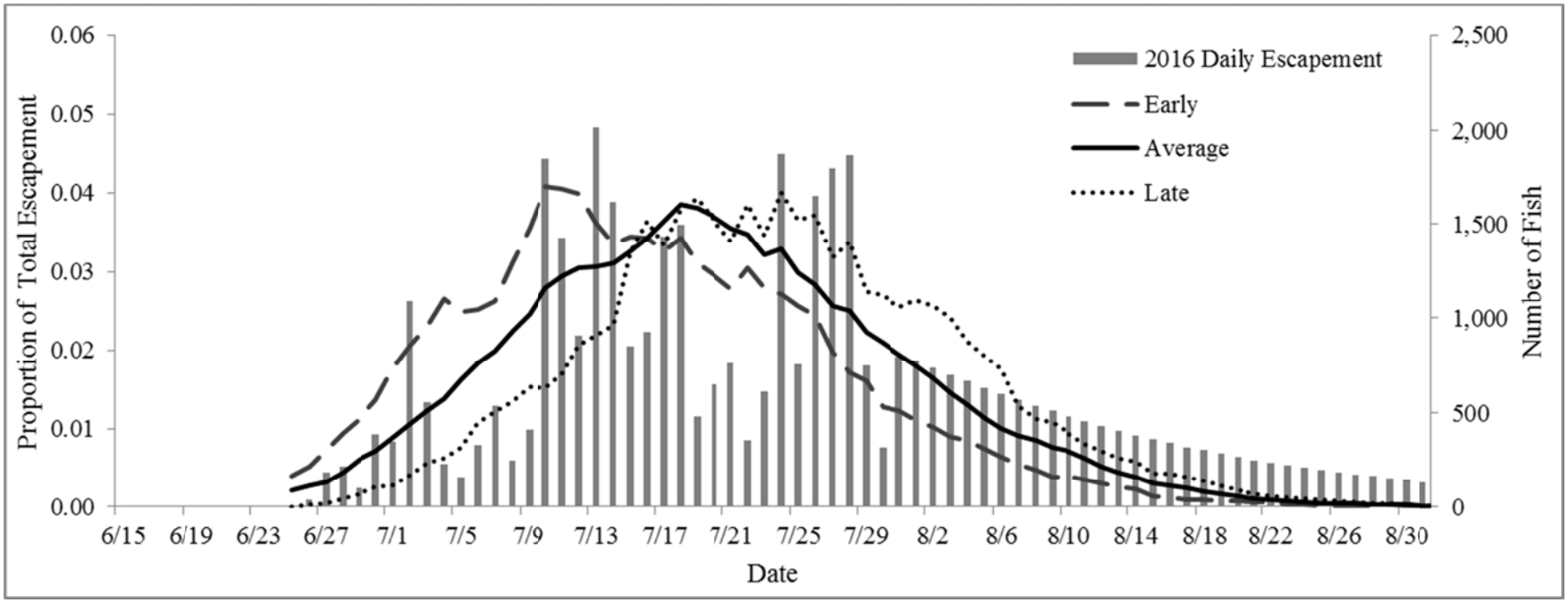

Figure 15.–Early, average, and late arrival timings and 2016 daily escapements of chum salmon at the Middle Fork Goodnews River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

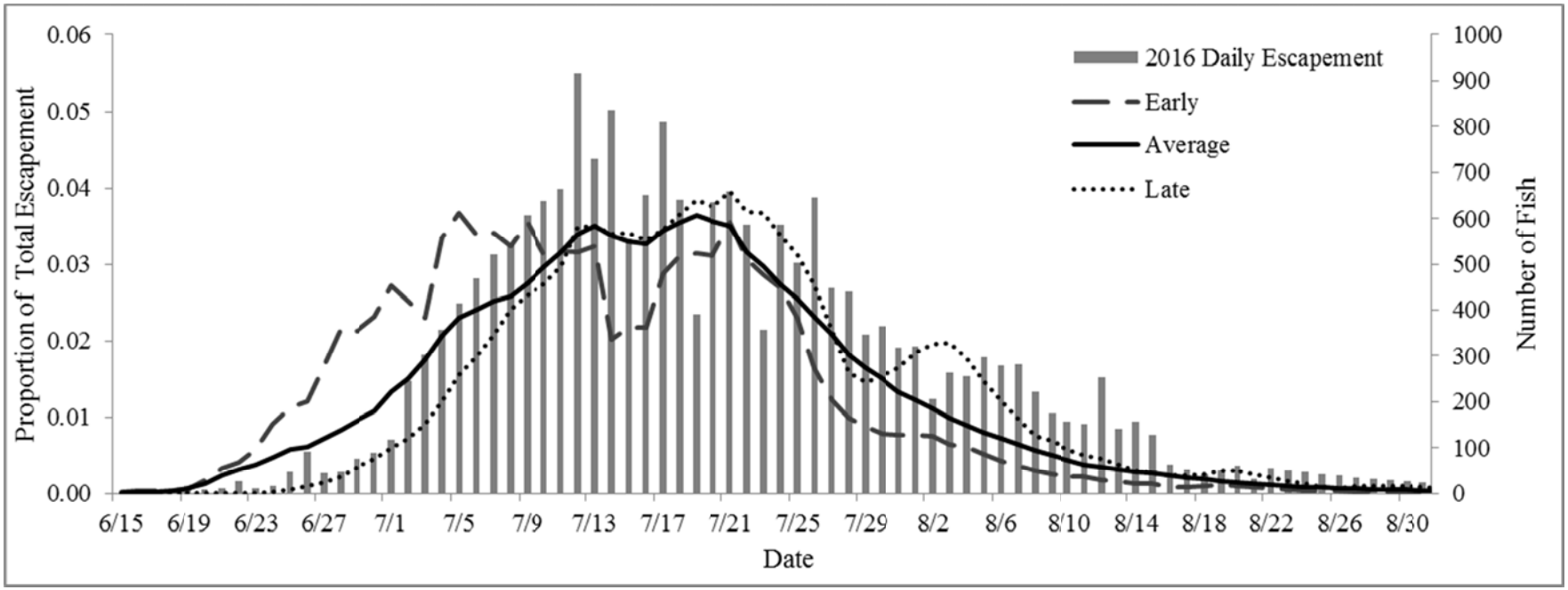

Figure 16.–Early, average, and late arrival timings and 2016 daily escapements of chum salmon at the George River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

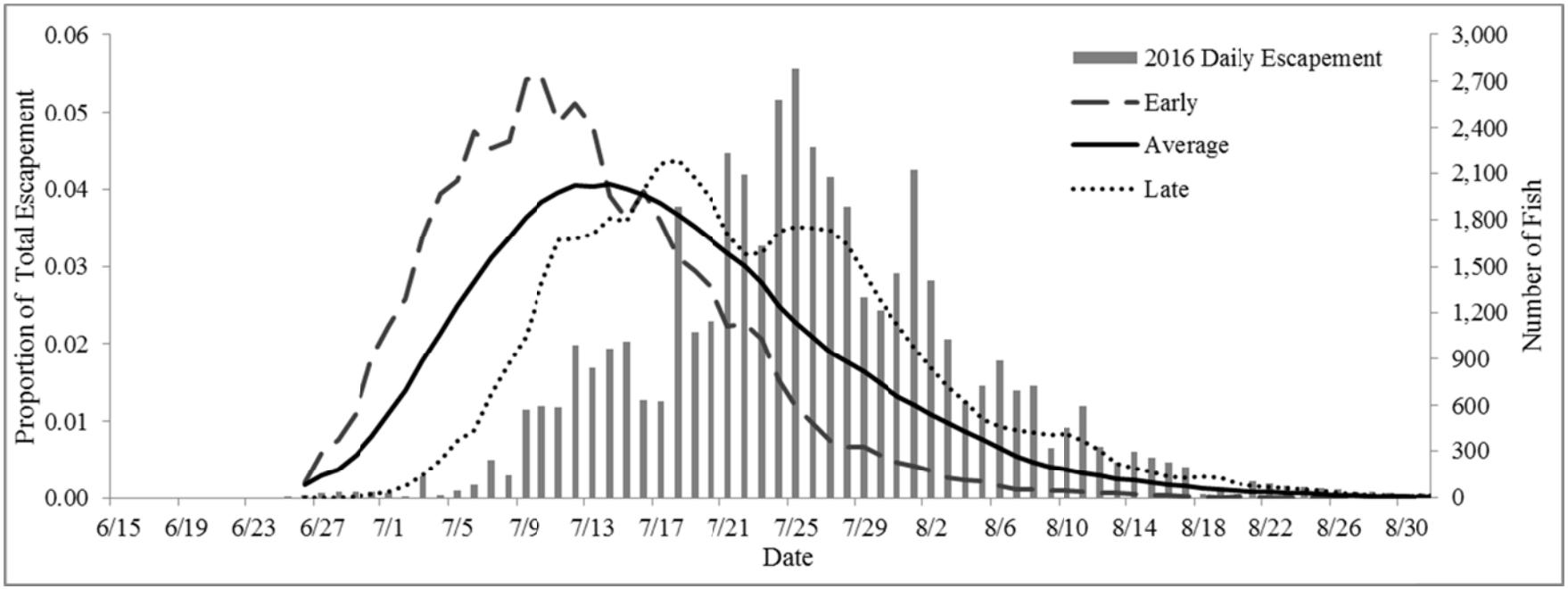

Figure 17.–Early, average, and late arrival timings and 2016 daily escapements of chum salmon at the Kogrukluk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

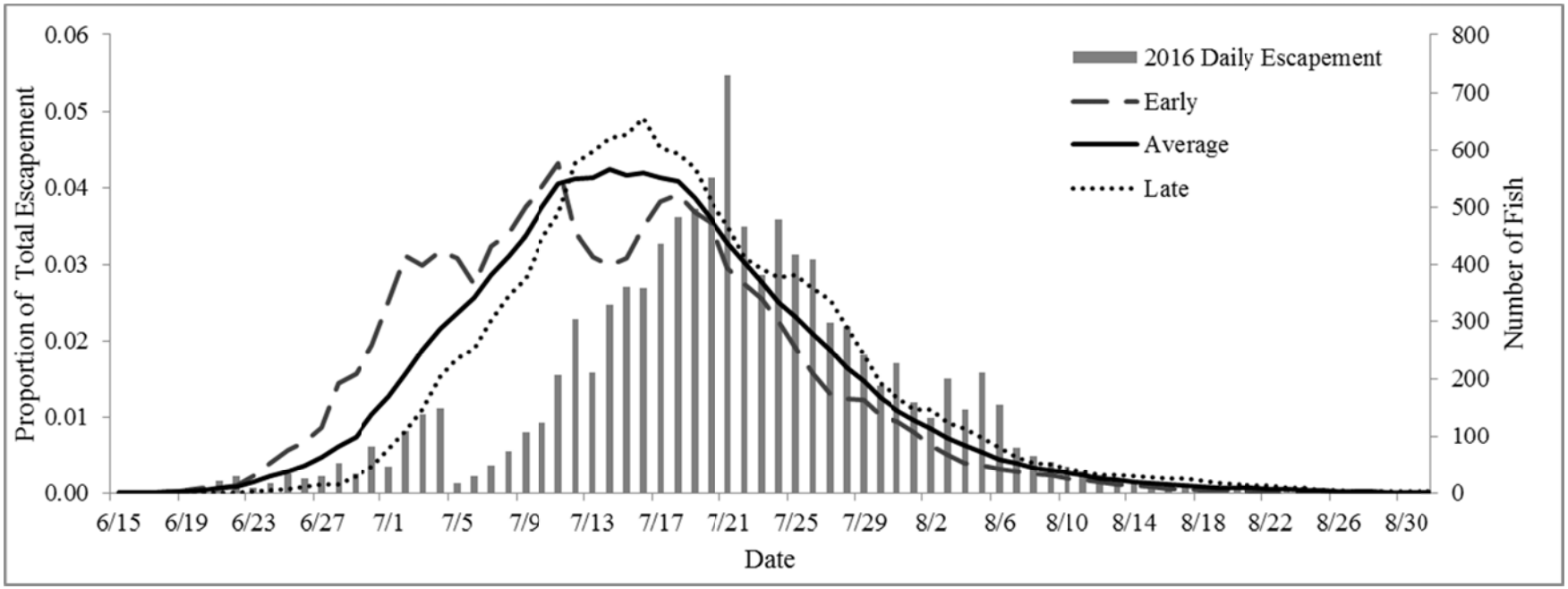

Figure 18.–Early, average, and late arrival timings and 2016 daily escapements of chum salmon at the Tatlawiksuk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

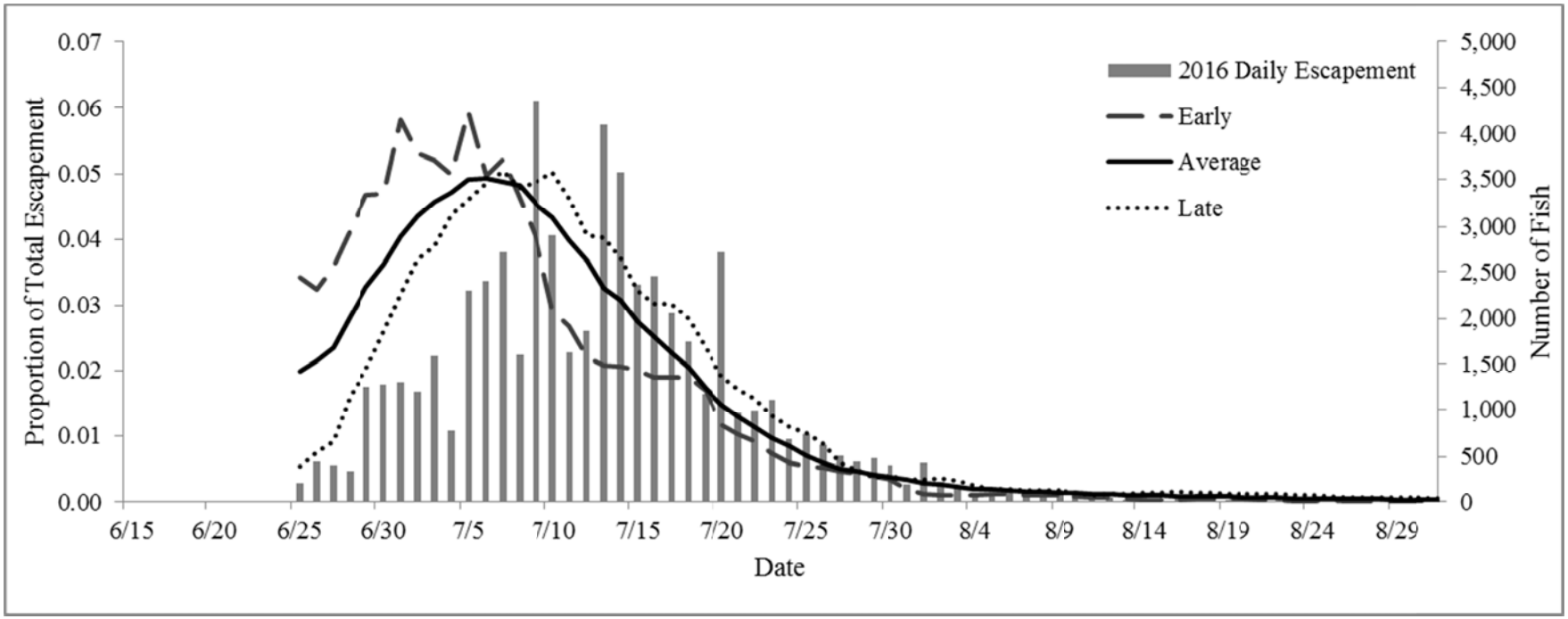

Figure 19.–Early, average, and late arrival timings and 2016 daily escapements of sockeye salmon at the Middle Fork Goodnews River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

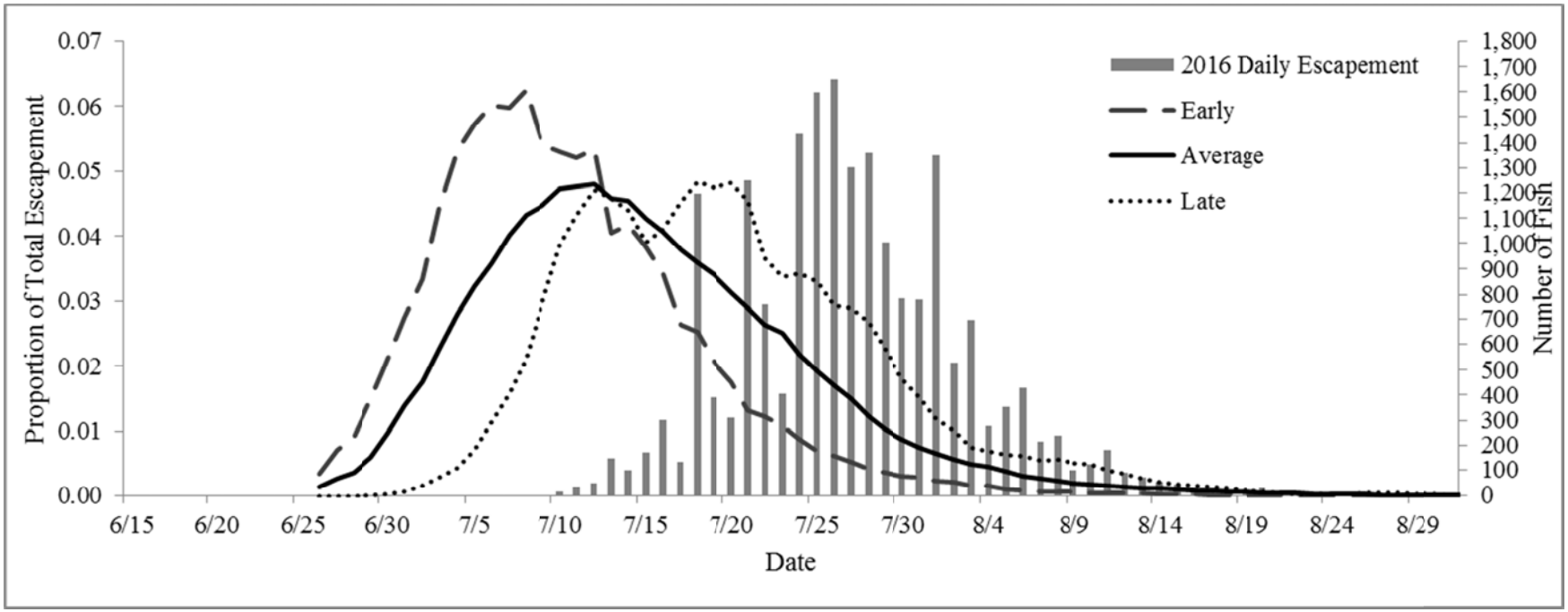

Figure 20.–Early, average, and late arrival timings and 2016 daily escapements of sockeye salmon at the Kogrukluk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

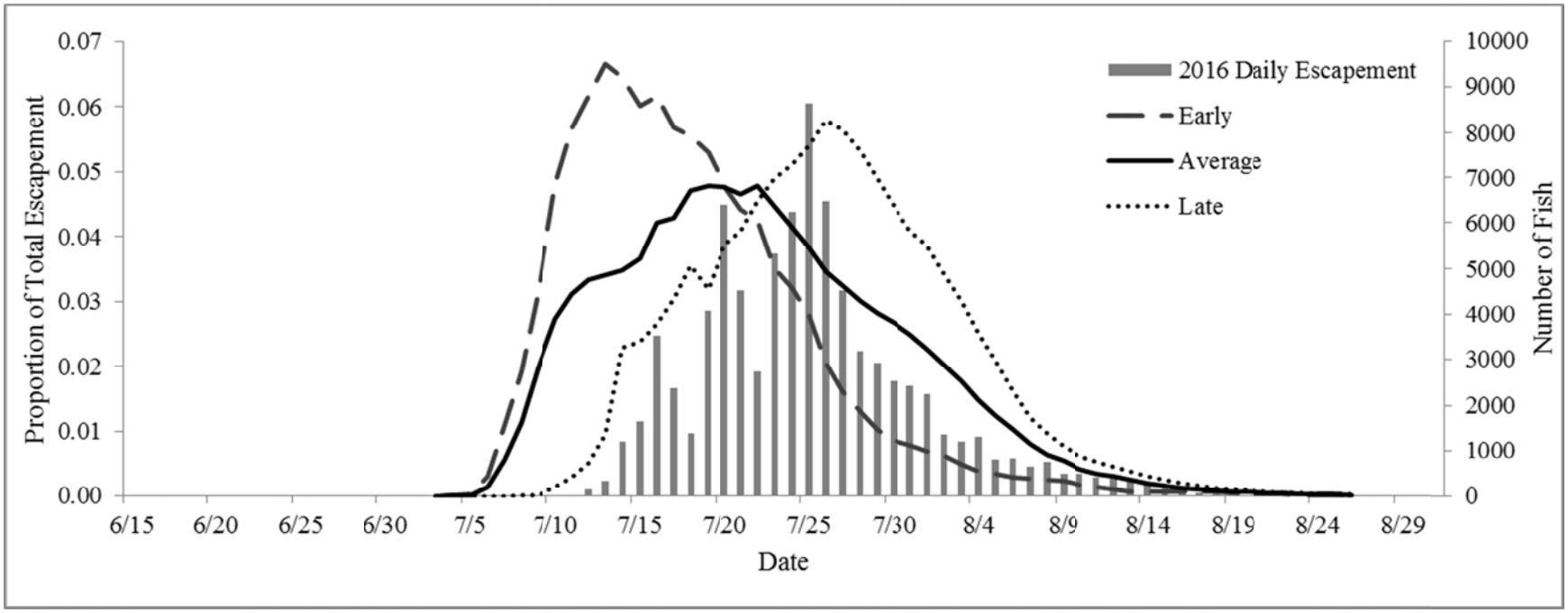

Figure 21.–Early, average, and late arrival timings and 2016 daily escapements of chum salmon at the Telaquana River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

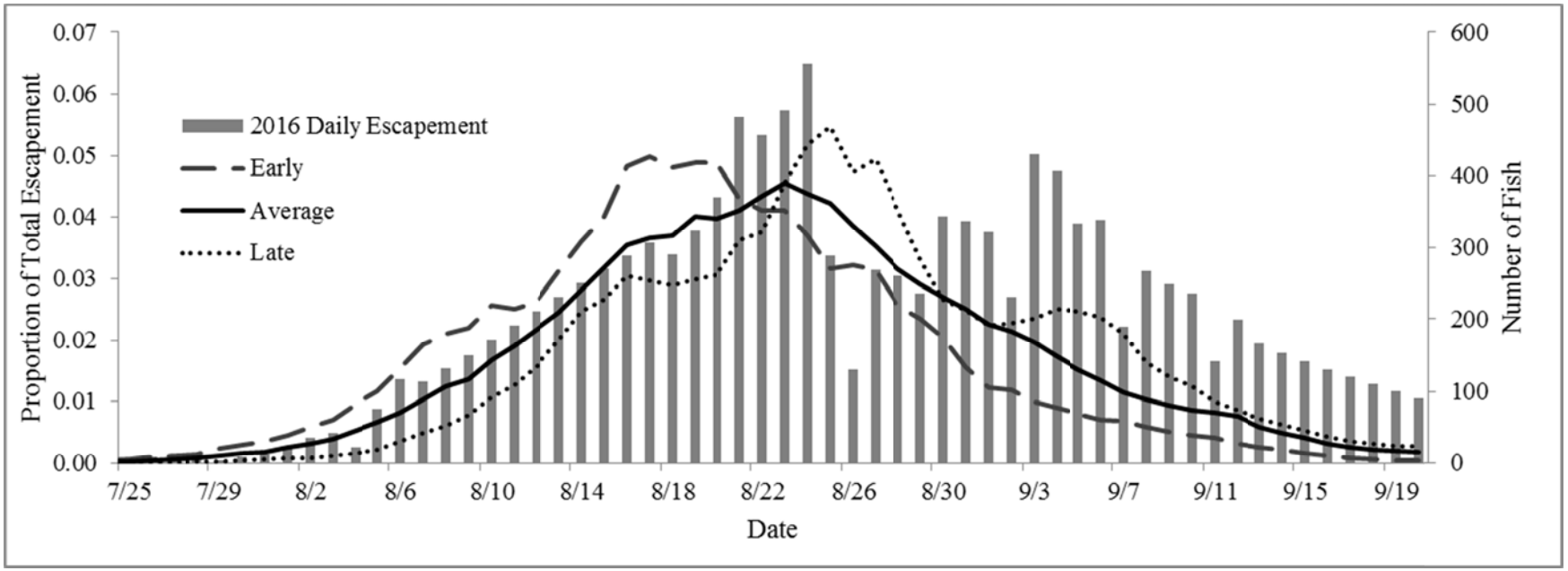

Figure 22.–Early, average, and late run timings and 2016 daily escapements of coho salmon at Tatlawiksuk River weir.

Note: Lines represent run timings displayed in proportions of total escapement (left Y-axis); columns represent daily escapements displayed in number of fish (right Y-axis). Run timings shown are 5-day averages and are derived from all annual escapements available for the project.

APPENDIX A

Appendix A1.–Index areas and objectives for survey rivers in the Kuskokwim Area.

River	Index areas[a]	Description/Landmark	Index objective[b]
North Fork Goodnews R.[c]	101 (59.17.55 N, 161.15.62 W)	Approx. 1 mi. upstream of confluence w/ Goodnews Bay	Chinook: 101, 102, 103 Sockeye: 101,102,103,104
	102 (59.27.00 N, 160.47.09 W)	Confluence w/ Slate Cr.	
	103 (59.28.57 N, 160.35.13 W)	Confluence w/ Nimgun Cr.	
	104 (59.28.56 N, 160.35.16 W)	Outlet of Goodnews Lake (survey lake and river at East end of Lakes	
	STOP (59.31.69 N, 160.28.23 W)	Approx. 3 mi. up river at East end of Goodnews Lake (Goodnews to Igmiumanik R)	
Middle Fork Goodnews R.[c]	101 (29.07.77 N, 161.28.00 W)	Confluence w/ Goodnews R.	Chinook: 101, 103, 104 Sockeye: 101,102,103,104
	102 (59.21.30 N, 160.41.11 W)	Confluence w/ North Lake Cr.	
	102 STOP (59.24.63 N, 160.35.74 W)	Outlet of North L. (Survey lake and creek at East end of lake)	
	103 (59.21.30 N, 160.41.11 W)	Confluence between North L., North Lake Cr., and M.F. Goodnews River	
	103 STOP (59.23.56 N, 160.34.25 W)	Outlet of M.F. Lake (Survey lake and creek at East end of lake)	
	104 (59.17.65 N, 160.51.15 W)	Confluence w/ Kukaktlik R.	
	104 STOP (59.20.17 N, 160.29.72 W)	Outlet of Kukatlim L. (Survey lake and all connected outlying lakes)	
Kanektok R.[c]	101 (59.44.90 N, 161.55.75 W)	Confluence w/ Kuskokwim Bay	Chinook: 101, 102, 103 Sockeye: 101, 102, 103, 104
	102 (59.42.54 N, 160.58.40 W)	Confluence w/ Nukluk Cr.	
	103 (59.52.28 N, 160.28.37 W)	Confluence w/ Kanuktik Cr.	
	104 (59.52.49 N, 160.07.35 W)	Outlet of Kagati/Pegati Lakes (survey lakes and creeks at South ends of lakes)	
	105 (59.53.50 N, 160.17.07 W)	Small chain of lakes west of Katati/Pegati L.	
	Supp. (59.44.28 N, 160.19.64 W)	Kanuktik Cr. and Kanuktik Lake	

-continued-

Appendix A1.–Page 2 of 3.

River	Index areas[a]	Description/Landmark	Index objective[b]
Kisaralik R.	101 (60.51.43 N, 161.14.31 W)	Confluence w/ Kuskokwim R.	102, 103
	102 (60.44.52 N, 160.22.75 W)	Confluence w/ Nukluk Cr.	
	103 (60.21.11 N, 159.56.63 W)	Upper falls	
	STOP (60.20.04 N, 159.24.40 W)	Outlet of Kisaralik Lake	
Aniak R.	101 (61.34.49 N, 159.29.35 W)	Confluence w/ Kuskokwim R.	102, 103, 104
	102 (61.20.33 N, 159.13.57 W)	Confluence w/ Buckstock R.	
	103 (61.03.88 N, 159.10.93 W)	Confluence w/ Salmon R. (to West)	
	104 (60.37.44 N, 159.05.20 W)	Start of island adj. to Gemuk Mountain	
	STOP (60.29.28 N, 159.09.28 W)	Outlet of Aniak Lake	
Salmon R. (Aniak)	101 (61.03.88 N, 159.10.93 W)	Confluence w/ Aniak R.	101, 102, 103
	102 (60.57.55 N, 159.23.68 W)	Confluence w/ Dominion Cr.	
	103 (60.52.91 N, 159.31.15 W)	Confluence w/ Eagle Cr.	
	STOP (60.47.11 N, 159.32.85 W)	Confluence w/ Cripple Cr. adj. to landing strip	
Kipchuk R.	101 (61.02.66 N, 159.10.50 W)	Confluence w/ Aniak R.	101, 102, 103
	102 (60.46.67 N, 159.19.14 W)	Confluence w/ small cr. from South at beginning of Horseshoe Canyon	
	103 (60.43.44 N, 159.20.53 W)	Confluence w/ trib. from South at East bend in R.	
	STOP (60.30.83 N, 159.14.37 W)	Lake outlet at end of East Fork in upper reach	
Holokuk R.	101 (61.32.15 N, 158.35.35 W)	Confluence w/ Kuskokwim R.	101, 102, 103, 104
	102 (61.26.00 N, 158.27.07 W)	Between Ski Cr. and Gold Run Cr.	
	103 (61.21.93 N, 158.17.54 W)	Confluence w/ Chineekluk Cr.	
	104 (61.16.06 N, 158.16.86 W)	Island at confluence w/ Egozuk Cr.	
	STOP (61.12.89 N, 158.18.45 W)	Confluence w/ Boss Cr.	
	2ND STOP (61.08.62 N, 158.27.39 W)	Upper reach Tri Fork	

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Appendix A1.–Page 3 of 3.

River	Index areas[a]	Description/Landmark	Index objective[b]
Oskawalik R.	101 (61.44.30 N, 158.11.30 W)	Confluence w/ Kuskokwim R.	101, 102, 103
	102 (61.41.40 N, 157.52.47 W)	Confluence w/ 1st large South tributary	
	103 (61.38.79 N, 157.42.71 W)	Confluence w/ 1st large North tributary	
	STOP (61.32.05 N, 157.40.43 W)	Fork adjacent to Henderson Mountain	
Holitna R.	101 (61.00.95 N, 157.41.37 W)	Nogamut	102, 103
	102 (60.58.24 N, 157.40.75 W)	1 mi. above Nogamut adj. to bluff	
	103 (60.57.52 N, 157.41.59 W)	Slough/confluence w/ Kiknik Cr.	
	104 (60.51.24 N, 157.50.22 W)	Kasheglok (downstream of Chukowan/Kogrukluk R. confluence)	
	STOP (60.50.32 N, 157.50.87 W)	Kogrukluk R. weir	
Cheeneetnuk R.	101 (61.48.62 N, 156.00.64 W)	Confluence w/ Swift R.	101, 102
	102 (61.51.57 N, 155.44.49 W)	Major South tributary below 1st major hills	
	STOP (61.57.28 N, 155.18.45 W)	Confluence w/ Shoeleather Cr.	
Gagaryah R.	101 (61.37.42 N, 155.38.61 W)	Confluence w/ Swift R.	101, 102
	102 (61.39.48 N, 155.21.07 W)	Head of island adj. to 1st hills	
	STOP (61.39.30 N, 155.03.41 W)	Major fork adj. to high hills	
Salmon R. (Pitka Fork)	101 (62.53.45 N, 154.34.86 W)	Salmon R. index area 101 start	102, 103, 104
	102 (62.53.37 N, 154.30.49 W)	Salmon R. index area 102/104 start	
	102 STOP (62.55.02 N, 154.17.08 W)	Salmon R. index area 102 stop	
	103 (62.53.11 N, 154.28.93 W)	Salmon R. index area 103 start	
	103 STOP (62.51.62 N, 154.19.82 W)	Salmon R. index area 103 end	
	104 (62.52.03 N, 154.30.27 W)	Salmon R. index area 103 start	
	104 STOP (62.51.00 N, 154.19.28 W)	Salmon R. index area 104 end	
Bear Cr.	101 (62.51.08N, 154.32.94 W)	Mouth of Bear Creek	101
	STOP (62.48.24 N, 154.13.66 W)	Headwaters of Bear Cr.	

[a] Parentheses following the index areas contain the start point in latitude and longitude (degrees.minutes.seconds). Index area stop points coincide with the following sequential index area start point unless otherwise designated. For the last index area of a stream, the stop point is designated with STOP.

[b] The index objective defines the specific index area(s) that must be to surveyed in order to produce a comparable index of escapement. Index objectives are for all focus species unless otherwise noted.

[c] Index areas may include lakes. Lakes are not surveyed for Chinook salmon even if the index area is required for the index objective.

APPENDIX B

Appendix B1.–Daily weather and stream observations at the Middle Fork Goodnews River weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)
6/26	AM	2	0.0	15	12	42
6/27	AM	3	0.0	10	10	48
6/28	AM	2	0.0	11	10	42
6/29	AM	2	0.0	12	10	40
6/30	AM	1	0.2	13	10	38
7/1	AM	3	0.0	12	10	38
7/2	AM	4	0.0	15	11	36
7/3	AM	5	0.0	9	10	38
7/4	AM	5	0.0	11	10	33
7/5	AM	4	0.2	12	10	33
7/6	AM	3	0.3	16	10	34
7/7	AM	4	0.1	13	11	35
7/8	AM	4	0.0	14	11	30
7/9	AM	4	0.1	11	10	30
7/10	AM	3	0.0	14	11	28
7/11	AM	3	0.0	17	11	27
7/12	AM	1	0.0	12	11	25
7/13	AM	1	0.0	13	13	24
7/14	AM	1	0.0	13	15	23
7/15	AM	3	0.1	14	14	22
7/16	AM	1	0.0	7	12	22
7/17	AM	1	0.0	13	14	19
7/18	AM	4	trace	14	16	18
7/19	AM	4	0.0	13	14	17
7/20	AM	4	0.0	12	14	17
7/21	AM	4	0.8	12	12	19
7/22	AM	4	0.1	12	14	19
7/23	AM	4	0.1	12	12	18
7/24	AM	4	0.6	12	12	20
7/25	AM	2	0.1	15	13	20
7/26	AM	4	0.0	14	14	18
7/27	AM	4	0.1	13	13	13
7/28	AM	4	0.1	15	14	19
7/29	AM	4	0.0	14	13	17
7/30	AM	4	0.0	13	13	17
7/31	AM	4	1.0	12	11	19
8/1	AM	4	0.2	12	12	28
8/2	AM	4	0.4	13	13	29
8/3	AM					
Average	–	–	0.1	13	12	27

[a] Sky condition codes:

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

Appendix B2.–Daily weather and stream observations at the Salmon River (Aniak) weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/20	AM						
6/20	PM						
6/21	AM						
6/21	PM						
6/22	AM	3	0.0	16	9	25	1
6/22	PM	4	0.0	20	11	25	1
6/23	AM	4	0.0	15	8	25	1
6/23	PM	4	0.0	14	10	25	1
6/24	AM	4	3.1	14	8	25	1
6/24	PM	3	0.0	15	9	26	1
6/25	AM	2	10.0	17	7	26	1
6/25	PM	4	9.0	14	11	29	1
6/26	AM	3	10.1	12	5	31	2
6/26	PM	3	5.9	15	7	31	1
6/27	AM	3	5.8	14	6	30	1
6/27	PM	2	0	16	8	30	1
6/28	AM	3	0	15	7	34	1
6/28	PM	2	0	20	11	36	1
6/29	AM	1	0	16	8	33	1
6/29	PM	2	0	21	11	32	1
6/30	AM	1	2.1	8	7	30	1
6/30	PM	3	0.0	14	9	30	1
7/1	AM	2	0.0	12	6	30	1
7/1	PM	0				0	1
7/2	AM	4	0.9	11	7	30	1
7/2	PM	3	1.3	14	11	31	1
7/3	AM	4	7.8	10	8	35	1
7/3	PM	4	1.7	19	12	34	1
7/4	AM	1	0.0	14	9	33	1
7/4	PM	4	15.1	14	9	34	1
7/5	AM	4	14.0	11	6	40	3
7/5	PM	4	1.9	13	8	37	3
7/6	AM	4	15.0	11	7	38	3
7/6	PM	3	3.5	14	8	40	3
7/7	AM	3	1.0	14	9	44	3
7/7	PM	4	0.0	15	7	44	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/8	AM	4	0.0	11	8	42	3
7/8	PM						2
7/9	AM	4	0.5	12	8	42	2
7/9	PM	4	0.5	11	8	42	1
7/10	AM	2	2.4	14	9	42	1
7/10	PM	2	0.0	16	11	41	1
7/11	AM	2	0.5	11	8	41	1
7/11	PM	1	0	18	10	40	1
7/12	AM	1	0.0	11	7	39	1
7/12	PM	1	0.0	23	11	38	1
7/13	AM	1	0.0	18	8	37	1
7/13	PM	2	0.0	19	10	37	1
7/14	AM	1	0.0	20	11	36	1
7/14	PM	2	0.0	22	10	36	1
7/15	AM	1	0.0	18	9	36	1
7/15	PM	1	0.0	20	11	35	1
7/16	AM	3	0.3	15	8	34	1
7/16	PM						
7/17	AM	1	0.0	18	9	33	1
7/17	PM	1	0.0	21	11	32	1
7/18	AM	1	0.0	16	10	31	1
7/18	PM	2	0.0	18	12	30	1
7/19	AM						
7/19	PM						
7/20	AM	2	1.0	15	9	27	1
7/20	PM	3	9.1	14	10	28	1
7/21	AM	3	1.0	12	9	30	1
7/21	PM	2	0.0	16	11	31	1
7/22	AM	4	5.2	10	8	30	1
7/22	PM	3	3.2	13	7	30	1
7/23	AM	3	0.5	11	8	30	1
7/23	PM	3	0.1	14	9	30	1
7/24	AM	2	1.9	12	7	32	1
7/24	PM	3	0.2	15	10	32	1
7/25	AM	5	1.0	11	9	33	1
7/25	PM	3	0.6	18	12	33	1

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Appendix B2.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/26	AM	2	0.0	13	9	33	1
7/26	PM	3	0.5	16	11	32	1
7/27	AM	2	0.0	14	10	30	1
7/27	PM	3	0.0	21	11	30	1
7/28	AM	3	0.0	12	9	30	1
7/28	PM	4	0.0	16	10	30	1
7/29	AM	3	0.0	13	9	30	1
7/29	PM	3	0.0	17	11	30	1
7/30	AM	4	0.0	13	9	30	1
7/30	PM	4	0.2	12	8	28	1
7/31	AM	4	12.5	11	9	29	1
7/31	PM	4	0.8	13	10	30	1
8/1	AM	3	1.8	16	11	29	1
8/1	PM	3	3.2	17	12	28	1
8/2	AM	3	3.0	12	8	29	1
8/2	PM	3	1.2	14	10	29	1
8/3	AM	2	0.1	15	11	29	1
8/3	PM						
8/4	AM						
8/4	PM						
8/5	AM	3	3.2	17	12	28	1
8/5	PM	3	0.4	16	11	29	1
8/6	AM	2	3.0	13	9	29	1
8/6	PM	3	1.2	15	12	29	1
8/7	AM	3	1.5	13	10	29	1
8/7	PM	3	5.0	15	12	29	1
8/8	AM	3	11.5	12	9	29	1
8/8	PM	2		16	11	30	1
8/9	AM	4	6.4	10	8	30	1
8/9	PM	3	5.4	13	9	30	1
8/10	AM	3	5.7	12	8	31	1
8/10	PM	3	6.0	15	10	32	1
8/11	AM	3	3.2	14	11	34	1
8/11	PM						
8/12	AM	3	1.0	14	10	33	1
8/12	PM	2	0.0	12	8	33	1

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Appendix B2.–Page 4 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/13	AM	2	1.1	10	7	33	1
8/13	PM	3	1.9	11	9	32	1
8/14	AM	2	1.0	16	11	35	1
8/14	PM						
8/15	AM	1	15.1	10	8	45	3
8/15	PM		1.5	15	9	45	3
8/16	AM	3	0.0	12	7	45	3
8/16	PM	3	2.2	17	10	45	3
8/17	AM	2	0.0	13	9	44	3
8/17	PM	3	1.9	15	8	44	3
8/18	AM						
8/18	PM	3	2.1	16	9	43	3
8/19	AM	1	0.0	11	8	42	2
8/19	PM	2	1.5	14	10	42	2
8/20	AM	3	1.7	11	7	41	1
8/20	PM	3	6.0	13	9	41	1
8/21	AM	3	12.5	11	8	42	1
8/21	PM	3	3.3	14	10	42	1
8/22	AM	3	3.1	9	8	50	2
8/22	PM	2	3.0	12	8	49	2
8/23	AM	2	3.6	11	7	49	2
8/23	PM	2	0.5	15	9	49	1
8/24	AM	3	0.9	12	8	48	1
8/24	PM	2	0.9	16	9	48	1
8/25	AM	3	1.9	13	7	48	1
8/25	PM	2	0.0	17	10	48	1
8/26	AM	1	0.0	14	8	48	1
8/26	PM	2	0.0	18	10	47	1
8/27	AM	2	0.0	11	7	47	1
8/27	PM	1	0.0	16	9	47	1
8/28	AM	3	0.0	9	6	46	1
8/28	PM	2	0.0	15	10	45	1
8/29	AM	5	0.0	9	8	44	1
8/29	PM	1	0.0	16	9	43	1
8/30	AM	1	0.0	10	7	41	1
8/30	PM	1	0.0	17	10	40	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/31	AM	1.0		9	7	38	1
8/31	PM	1.0		10	9	37	1
9/1	AM	2.0		7	7	36	1
9/1	PM	1.0		15	8	36	1
9/2	AM	3.0		9	7	35	1
9/2	PM	2.0		16	10	35	1
9/3	AM	3.0	1.3	10	8	35	1
9/3	PM	4.0	3.3	14	9	36	1
9/4	AM						
9/4	PM						
9/5	AM						
9/5	PM						
9/6	AM						
9/6	PM						
9/7	AM						
9/7	PM						
Average	–	–	2.2	14	9	35	1

[a] Sky condition codes:
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] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility between 0.5 and 1 meter
3 = visibility less than 0.5 meter

Appendix B3.–Daily weather and stream observations at the George River weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/12	AM	3	0.4	-	-	56	2
6/12	PM	-	-	-	-	-	-
6/13	AM	2	0.2	-	-	54	1
6/13	PM	-	-	-	-	-	-
6/14	AM	-	-	-	-	-	-
6/14	PM	-	-	-	-	-	-
6/15	AM	5	0.0	7.0	10.0	49	1
6/15	PM	-	-	-	-	-	-
6/16	AM	1	0.0	10.0	11.5	48	1
6/16	PM	2	0.0	26.0	15.0	47	1
6/17	AM	4	0.0	13.0	12.0	46	1
6/17	PM	4	0.8	13.0	12.0	47	1
6/18	AM	4	4.8	10.0	12.0	47	1
6/18	PM	4	5.2	10.0	10.0	51	2
6/19	AM	4	0.4	11.0	9.5	54	2
6/19	PM	4	0.6	11.5	10.5	56	2
6/20	AM	4	1.8	9.0	8.0	56	3
6/20	PM	3	0.9	14.0	10.0	57	3
6/21	AM	1	0.0	13.0	9.5	60	3
6/21	PM	1	0.0	18.5	11.5	60	3
6/22	AM	1	0.0	13.5	11.5	59	3
6/22	PM	3	0.0	19.0	13.0	56	2
6/23	AM	3	0.0	11.5	11.0	52	2
6/23	PM	4	0.0	14.0	12.0	53	2
6/24	AM	4	0.2	11.0	10.5	52	2
6/24	PM	3	0.3	17.0	14.0	53	2
6/25	AM	4	3.1	13.0	11.0	53	2
6/25	PM	5	11.5	14.5	12.0	56	2
6/26	AM	5	2.1	11.5	10.0	70	3
6/26	PM	4	1.4	18.5	13.5	75	3
6/27	AM	3	0.0	14.0	11.5	71	3
6/27	PM	4	0.0	19.0	13.0	70	3
6/28	AM	4	7.2	12.0	11.0	72	2
6/28	PM	4	3.0	16.0	11.0	72	2
6/29	AM	3	0.0	14.0	12.0	75	2
6/29	PM	4	0.2	17.0	13.0	74	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/30	AM	3	0.0	13.0	12.0	73	2
6/30	PM	4	0.0	16.5	13.0	72	2
7/1	AM	3	0.0	15.5	11.0	72	2
7/1	PM	4	0.1	18.0	12.0	74	2
7/2	AM	5	14.5	14.0	11.0	76	3
7/2	PM	5	4.2	14.5	10.0	78	3
7/3	AM	4	0.9	13.0	10.0	83	3
7/3	PM	4	7.5	14.0	11.0	85	3
7/4	AM	5	2.8	11.5	10.0	85	3
7/4	PM	3	0.4	16.0	12.0	84	3
7/5	AM	4	1.0	10.0	-	84	3
7/5	PM	3	0.2	16.0	10.0	91	3
7/6	AM	4	0.6	12.5	10.0	91	3
7/6	PM	3	1.6	14.0	12.0	92	3
7/7	AM	4	0.1	-	-	93	2
7/7	PM	3	0.1	-	-	94	2
7/8	AM	3	0.0	-	-	90	2
7/8	PM	4	0.0	-	-	90	2
7/9	AM	4	0.5	-	-	87	2
7/9	PM	4	0.0	-	-	85	2
7/10	AM	4	2.0	-	-	85	2
7/10	PM	3	0.5	-	-	84	2
7/11	AM	1	0.0	-	-	80	1
7/11	PM	1	0.0	-	-	80	1
7/12	AM	1	0.0	-	-	77	1
7/12	PM	1	0.0	-	-	75	1
7/13	AM	1	0.0	-	-	72	1
7/13	PM	2	0.0	-	-	71	1
7/14	AM	2	0.0	-	-	71	1
7/14	PM	1	0.0	-	-	71	1
7/15	AM	3	0.0	-	-	68	1
7/15	PM	2	0.0	-	-	68	1
7/16	AM	3	0.0	-	-	65	1
7/16	PM	3	0.0	-	-	64	1
7/17	AM	3	0.0	-	-	62	1
7/17	PM	2	0.0	-	-	64	1
7/18	AM	2	0.0	-	-	60	1
7/18	PM	3	0.0	-	-	59	1
7/19	AM	4	0.0	-	-	57	1
7/19	PM	4	0.0	-	-	56	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/20	AM	4	0.0	11.0	10.0	56	1
7/20	PM	4	0.0	12.0	11.0	55	1
7/21	AM	3	5.1	12.0	11.0	57	1
7/21	PM	4	1.6	13.0	11.0	60	1
7/22	AM	4	3.5	11.0	13.0	61	1
7/22	PM	4	0.5	11.0	12.0	60	1
7/23	AM	4	0.2	11.0	10.0	58	1
7/23	PM	-	-	-	-	-	-
7/24	AM	4	7.4	11.0	9.0	58	1
7/24	PM	2	0.1	16.0	11.0	57	1
7/25	AM	3	0.0	10.0	11.0	56	1
7/25	PM	2	0.0	11.0	10.0	56	1
7/26	AM	4	0.0	18.0	13.0	54	1
7/26	PM	12	0.0	13.0	13.0	54	1
7/27	AM	1	0.0	15.0	13.0	50	1
7/27	PM	2	0.0	15.0	13.0	50	1
7/28	AM	4	0.0	15.0	13.0	50	1
7/28	PM	4	0.5	15.0	13.0	49	1
7/29	AM	4	1.5	13.0	14.0	50	1
7/29	PM	4	0.2	14.0	12.0	50	1
7/30	AM	4	0.6	12.0	11.0	51	1
7/30	PM	4	2.6	8.0	11.0	54	1
7/31	AM	4	20.0	11.0	10.0	60	1
7/31	PM	4	1.0	15.0	11.0	68	2
8/1	AM	3	0.1	15.0	11.0	73	3
8/1	PM	4	0.4	16.0	13.0	70	3
8/2	AM	4	0.6	12.0	11.0	68	2
8/2	PM	4	2.7	12.0	11.0	66	2
8/3	AM	3	0.3	10.0	11.0	64	2
8/3	PM	3	0.0	15.0	12.0	64	2
8/4	AM	5	0.8	11.0	11.0	62	1
8/4	PM	4	2.6	-	11.0	63	1
8/5	AM	4	6.1	12.0	11.0	65	1
8/5	PM	4	1.2	14.0	12.0	69	1
8/6	AM	3	3.0	14.0	12.0	72	1
8/6	PM	3	3.0	15.0	12.0	72	1
8/7	AM	4	1.2	13.0	12.0	76	2
8/7	PM	3	0.0	15.0	12.0	75	2
8/8	AM	4	0.5	13.0	11.0	76	2
8/8	PM	3	8.2	14.0	15.0	76	2

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/9	AM	4	5.1	13.0	12.0	77	2
8/9	PM	-	-	-	-	-	-
8/10	AM	5	4.5	13.0	12.0	77	2
8/10	PM	4	0.0	13.0	12.0	80	2
8/11	AM	5	0.7	11.0	10.0	85	3
8/11	PM	3	0.0	16.0	11.0	87	3
8/12	AM	4	0.0	10.0	10.0	87	3
8/12	PM	3	0.0	16.0	11.0	87	3
8/13	AM	4	0.0	11.0	9.0	87	3
8/13	PM	3	0.0	15.0	11.0	86	3
8/14	AM	2	0.0	9.0	9.0	86	3
8/14	PM	3	0.0	12.0	11.0	84	3
8/15	AM	5	0.0	11.0	10.0	84	2
8/15	PM	3	1.2	15.0	11.0	85	2
8/16	AM	5	0.3	8.0	10.0	84	2
8/16	PM	1	0.0	15.0	11.0	84	2
8/17	AM	1	0.0	11.0	11.0	80	2
8/17	PM	2	0.0	17.0	12.0	78	2
8/18	AM	2	0.0	10.0	11.0	77	2
8/18	PM	2	0.0	18.0	12.0	75	2
8/19	AM	3	0.0	8.0	10.0	73	2
8/19	PM	2	6.0	15.0	11.0	74	2
8/20	AM	3	2.1	13.0	10.0	72	2
8/20	PM	4	6.0	12.0	10.0	74	2
8/21	AM	4	30.0	11.0	9.0	84	3
8/21	PM	4	1.5	12.0	9.0	92	3
8/22	AM	4	4.4	10.0	9.0	107	3
8/22	PM	4	0.6	13.0	9.0	115	3
8/23	AM	4	0.6	11.0	9.0	116	3
8/23	PM	3	0.0	15.0	10.0	123	3
8/24	AM	3	0.1	13.0	9.0	129	3
8/24	PM	4	0.1	14.0	9.0	130	3
8/25	AM	4	3.1	13.0	8.0	131	3
8/25	PM	3	3.0	13.0	9.0	129	3
8/26	AM	5	0.3	8.0	9.0	129	3
8/26	PM	2	0.0	17.0	10.0	124	3
8/27	AM	4	0.0	10.0	8.0	118	3
8/27	PM	3	0.0	16.0	9.0	114	3
8/28	AM	3	0.0	10.0	8.0	112	3
8/28	PM	2	0.0	18.0	9.0	107	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/29	AM	5	0.0	3.0	8.0	103	3
8/29	PM	1	0.0	19.0	10.0	101	3
8/30	AM	5	0.0	0.0	8.0	98	3
8/30	PM	1	0.0	19.0	9.0	98	3
	AM	5	0.0	5.0	8.0	94	2
8/31	PM	1	0.0	20.0	9.0	90	2
9/1	AM	5	0.0	3.0	7.0	86	2
9/1	PM	1	0.0	20.0	9.0	85	2
9/2	AM	5	0.0	4.0	7.0	83	2
9/2	PM	1	0.0	11.0	9.0	81	2
9/3	AM	2	0.0	3.0	7.0	78	2
9/3	PM	4	1.0	12.0	8.0	78	2
9/4	AM	4	5.0	5.0	7.0	78	2
9/4	PM	4	1.8	14.0	8.0	78	2
9/5	AM	5	1.0	9.0	8.0	76	2
9/5	PM	4	0.7	13.0	9.0	76	2
9/6	AM	4	8.0	10.0	9.0	76	2
9/6	PM	4	2.5	12.0	8.0	76	2
9/7	AM	4	4.4	8.0	7.0	76	1
9/7	PM	4	0.8	8.0	8.0	76	1
9/8	AM	4	0.8	6.0	7.0	73	1
9/8	PM	3	0.5	12.0	8.0	72	1
9/9	AM	5	0.0	0.0	6.0	70	1
9/9	PM	1	0.0	15.0	8.0	68	1
9/10	AM	5	0.0	4.0	6.0	67	1
9/10	PM	3	0.0	15.0	8.0	65	1
9/11	AM	4	1.1	7.0	7.0	65	2
9/11	PM	4	15.0	12.0	7.0	67	2
9/12	AM	4	10.0	11.0	8.0	82	3
9/12	PM	3	7.0	9.0	8.0	92	3
9/13	AM	3	4.2	5.0	7.0	115	3
9/13	PM	3	0.2	10.0	7.0	117	3
9/14	AM	5	0.0	0.0	6.0	116	3
9/14	PM	4	0.1	9.0	6.0	116	3
9/15	AM	4	0.9	8.0	6.0	117	3
9/15	PM	4	0.6	11.0	7.0	115	3
9/16	AM	4	0.1	8.0	6.0	115	3
9/16	PM	3	0.1	12.0	7.0	114	3
9/17	AM	4	0.7	5.0	6.0	111	3
9/17	PM	3	0.1	9.0	7.0	109	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
9/18	AM	3	0.0	4	6	107	3
9/18	PM	2	0.1	9	6	105	3
9/19	AM	4	0.3	5	6	100	2
9/19	PM	4	0.2	10	6	98	2
9/20	AM	4	4.4	9	7	94	3
9/20	PM	4	6.0	9	7	94	3
9/21	AM	4	18.0	6	6	109	3
Average	–	–	1.6	12	10	78	–

[a] Sky condition codes:
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] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility between 0.5 and 1 meter
3 = visibility less than 0.5 meter

Appendix B4.–Daily weather and stream observations at the Kogrukluk River weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/23	AM	4	0.0	13.0	10.0	285	1
6/23	PM	4	0.0	14.0	11.0	285	1
6/24	AM	4	0.0	12.0	9.0	283	1
6/24	PM	4	0.0	16.0	11.0	281	1
6/25	AM	1	0.0	12.0	10.0	282	1
6/25	PM	3	0.0	22.0	13.0	285	1
6/26	AM	3	1.0	16.0	11.0	283	1
6/26	PM	4	0.3	18.0	13.0	284	1
6/27	AM	3	0.1	14.0	11.0	283	1
6/27	PM	3	0.0	18.0	15.0	279	1
6/28	AM	3	0.0	14.0	11.0	283	1
6/28	PM	2	0.0	15.0	13.0	281	1
6/29	AM	2	0.0	14.0	11.0	280	1
6/29	PM	2	0.0	18.0	13.0	279	1
6/30	AM	2	0.5	9.0	10.0	278	1
6/30	PM	3	10.0	15.0	12.0	278	1
7/1	AM	3	0.1	9.0	12.0	278	1
7/1	PM	4	0.0	17.0	13.0	278	1
7/2	AM	4	4.0	13.0	10.0	278	1
7/2	PM	4	6.5	15.0	11.0	280	1
7/3	AM	4	13.0		10.0	281	1
7/3	PM	2	0.5	22.0	15.0	285	1
7/4	AM	4	0.0	14.0	11.0	284	1
7/4	PM	4	0.7	17.0	10.0	281	1
7/5	AM	4	3.2	12.0	10.0	280	1
7/5	PM	4	2.0	14.0	13.0	279	1
7/6	AM	4	0.9	11.0	10.0	280	1
7/6	PM	3	2.1	22.0	12.0	279	1
7/7	AM	4	2.0	10.0	10.0	280	1
7/7	PM	4	0.0	20.0	13.0	279	1
7/8	AM	4	0.0	11.0	10.0	279	1
7/8	PM	4	0.0	19.0	13.0	278	1
7/9	AM	4	0.0	14.0	10.0	275	1
7/9	PM	4	0.0	15.0	12.0	273	1

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/10	AM	4	1.2	12.0	10.0	273	1
7/10	PM	3	0.2	14.0	12.0	273	1
7/11	AM	3	0.0	6.0	9.0	272	1
7/11	PM	1	0.0	15.0	9.0	272	1
7/12	AM	1	0.0	10.0	10.0	270	1
7/12	PM	1	0.0	25.0	13.0	268	1
7/13	AM	1	0.0	11.0	12.0	268	1
7/13	PM	3	0.0	25.0	12.0	268	1
7/14	AM	2	0.1	14.0	12.0	267	1
7/14	PM	1	0.0	20.0	15.0	266	1
7/15	AM	4	0.0	16.0	13.0	266	1
7/15	PM	2	0.0	28.0	15.0	266	1
7/16	AM	4	0.0	10.0	11.0	263	1
7/16	PM	2	0.0	25.0	14.0	263	1
7/17	AM	2	0.0	10.0	12.0	263	1
7/17	PM	1	0.0	25.0	15.0	262	1
7/18	AM	3	0.0	19.0	13.0	262	1
7/18	PM	2	0.0	22.0	15.0	262	1
7/19	AM	2	0.0	14.0	13.0	261	
7/19	PM	4	0.0	15.0	14.0	261	
7/20	AM	1	0.0	13.0	11.0	261	1
7/20	PM	4	9.0	14.0	13.0	261	1
7/21	AM	2	0.1	15.0	12.0	263	1
7/21	PM	3	0.0	18.0	12.0	263	1
7/22	AM	4	5.0	12.0	12.0	268	1
7/22	PM	4	0.2	14.0	12.0	264	1
7/23	AM	4	0.4	11.0	12.0	264	1
7/23	PM	4	4.0	12.0	11.0	264	1
7/24	AM	3	0.2	15.0	11.0	268	1
7/24	PM	3	0.0	18.0	11.0	265	1
7/25	AM	3	0.5	15.0	11.0	264	1
7/25	PM						
7/26	AM	4	2.0	12.0	11.0	264	1
7/26	PM	3	0.4	21.0	11.0	261	1

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Appendix B4.–Page 3 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/27	AM	4	0.3	13.0	10.0	263	1
7/27	PM	2	0.5	22.0	13.0	261	1
7/28	AM	3	0.0	13.0	10.0	263	1
7/28	PM	3	0.0	19.0	13.0	261	1
7/29	AM	4	0.0	14.0	11.0	263	1
7/29	PM	4	0.0	16.0	13.0	260	1
7/30	AM	4	0.0	11.0	10.0	261	1
7/30	PM	4	2.5	12.0	11.0	260	1
7/31	AM	4	10.0	12.0	10.0	265	1
7/31	PM	4	3.0	14.0	11.0	265	1
8/1	AM	4	6.0	13.0	10.0	270	1
8/1	PM	3	5.0	16.0	11.0	269	1
8/2	AM	4	1.0	13.0	10.0	275	1
8/2	PM	2	0.0	14.0	11.0	272	1
8/3	AM	4	0.0	11.0	11.0	273	1
8/3	PM	4	0.0	14.0	12.0	268	1
8/4	AM	4	7.0	11.0	11.0	270	1
8/4	PM	4	10.2	15.0	10.0	269	1
8/5	AM	4	2.0	14.0	11.0	276	1
8/5	PM	4	0.2	14.0	11.0	278	1
8/6	AM	4	1.0	14.0	11.0	280	1
8/6	PM	4	0.0	15.0	12.0	282	1
8/7	AM	4	0.2	14.0	12.0	290	1
8/7	PM	2	0.5	19.0	14.0	283	1
8/8	AM	4	3.0	13.0	11.0	286	1
8/8	PM	2	1.5	16.0	10.0	282	1
8/9	AM	4	0.7	12.0	11.0	281	1
8/9	PM	4	2.0	15.0	12.0	277	1
8/10	AM	3	3.0	12.0	11.0	279	1
8/10	PM	3	15.0	15.0	13.0	276	1
8/11	AM	4	0.5	13.0	11.0	280	1
8/11	PM	3	16.0	17.0	13.0	281	1
8/12	AM	4	1.4	12.0	11.0	283	1
8/12	PM	4	7.0	14.0	12.0	281	1

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Appendix B4.–Page 4 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/13	AM	4	10.0	13.0	11.0	282	1
8/13	PM	4	13.0	14.0	12.0	284	1
8/14	AM	4	4.2	12.0	11.0	298	2
8/14	PM	3	4.0	16.0	14.0	323	3
8/15	AM	3	0.3	13.0	11.0	324	2
8/15	PM	2	0.0	19.0	14.0	311	3
8/16	AM	4	0.0	11.0	11.0	305	3
8/16	PM	3	0.0	17.0	12.0	302	3
8/17	AM	3	0.0	8.0	10.0	295	2
8/17	PM	4	0.0	14.0	10.0	295	2
8/18	AM	3	0.0	13.0	10.0	292	2
8/18	PM	3	0.0	15.0	11.0	291	2
8/19	AM	2	0.0	10.0	10.0	291	2
8/19	PM	4	0.5	14.0	12.0	289	2
8/20	AM	4	0.5	13.0	10.0	289	2
8/20	PM	4	15.0	12.0	11.0	289	2
8/21	AM	4	10.0	13.0	10.0	295	2
8/21	PM	4	17.5	13.0	11.0	310	3
8/22	AM	4	22.5	13.0	10.0	330	3
8/22	PM	4	5.0	12.0	11.0	350	3
8/23	AM	3	4.5	13.0	10.0	370	3
8/23	PM	3	0.0	19.0	11.0	371	3
8/24	AM	4	3.0	14.0	10.0	355	3
8/24	PM	4	3.0	16.0	11.0	355	3
8/25	AM	3	0.3	12.0	10.0	350	3
8/25	PM	2	0.0	16.0	12.0	355	3
8/26	AM	3	0.0	10.0	10.0	345	3
8/26	PM	2	0.0	17.0	12.0	332	3
8/27	AM	2	0.0	6.0	10.0	330	3
8/27	PM	2	0.0	12.0	11.0	325	3
8/28	AM	3	0.0	9.0	10.0	323	3
8/28	PM	1	0.0	19.0	12.0	319	3
8/29	AM	1	0.0	6.0	10.0	315	3
8/29	PM	1	0.0	19.0	12.0	313	2

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Appendix B4.–Page 5 of 5.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/30	AM	1	0.0	4.0	9.0	310	2
8/30	PM	1	0.0	16.0	11.0	308	2
8/31	AM	1	0.0	6.0	9.0	303	2
8/31	PM	1	0.0	12.0	11.0	301	2
9/1	AM	1	0.0	5.0	9.0	301	2
9/1	PM						
9/2	AM	1	0.0	4.0	9.0	296	2
9/2	PM	1	0.0	11.0	11.0	294	2
9/3	AM	4	0.0	9.0	11.0	293	1
9/3	PM	4	1.4	14.0	9.0	292	1
9/4	AM	4	18.0	10.0	9.0	294	1
9/4	PM	3	1.0	15.0	10.0	300	1
9/5	AM	3	0.0	10.0	9.0	306	1
9/5	PM	4	0.0	15.0	9.0	302	1
Average	–	–	2.0	14	11	286	–

[a] Sky condition codes:

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] Water clarity codes:

1 = visibility greater than 1 meter

2 = visibility between 0.5 and 1 meter

3 = visibility less than 0.5 meter

Appendix B5.–Daily weather and stream observations at the Telaquana River weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/4	AM	-	-	-	-	-	-
7/4	PM	4	0.9	10.0	14.0	80	1
7/5	AM	4	0.4	12.0	9.0	86	1
7/5	PM	4	0.7	9.0	13.0	90	1
7/6	AM	4	0.4	10.0	13.0	92	1
7/6	PM	3	0.4	10.0	13.0	93	1
7/7	AM	4	0.0	10.0	12.0	93	1
7/7	PM	2	0.0	16.0	13.0	94	1
7/8	AM	1	0.0	19.0	13.0	92	1
7/8	PM	2	0.0	19.0	14.0	91	1
7/9	AM	3	0.0	13.0	13.0	90	1
7/9	PM	3	0.0	14.0	13.0	89	1
7/10	AM	4	0.0	12.0	11.0	88	1
7/10	PM	3	0.1			89	1
7/11	AM	2	0.0	16.0	9.0	91	1
7/11	PM	1	0.0	15.0	12.0	89	1
7/12	AM	2	0.0	11.0	12.0	89	1
7/12	PM	1	0.0	23.0	14.0	88	1
7/13	AM	2	0.0	21.0	14.0	88	2
7/13	PM	3	0.0	18.0	16.0	86	2
7/14	AM	3	0.0	16.0	15.0	87	2
7/14	PM	1	0.0	26.0	17.0	86	2
7/15	AM	2	0.0	14.0	16.0	86	2
7/15	PM	3	0.0	16.0	16.0	84	1
7/16	AM	3	0.0	12.0	12.0	84	1
7/16	PM	1	0.0	23.0	16.0	83	1
7/17	AM	1	0.0	19.0	13.0	83	1
7/17	PM	2	0.0	23.0	15.0	82	1
7/18	AM	2	0.0	16.0	12.0	82	1
7/18	PM	3	0.0	21.0	13.0	82	1
7/19	AM	3	0.0	11.0	10.0	82	1
7/19	PM	3	0.0	12.0	10.0	82	1
7/20	AM	3	0.0	10.0	10.0	81	1
7/20	PM	3	0.0	12.0	12.0	81	1
7/21	AM	3	0.3	12.0	13.0	81	2
7/21	PM	3	0.1	15.0	13.0	82	2
7/22	AM	3	0.0	10.0	12.0	82	2
7/22	PM	3	0.1	12.0	12.0	82	2
7/23	AM	3	0.0	9.0	10.0	83	1
7/23	PM	3	0.0	12.0	10.0	86	1
7/24	AM	3	0.1	10.0	10.0	87	1
7/24	PM	3	0.0	12.0	12.0	86	1
7/25	AM	3	0.1	13.0	12.0	85	1
7/25	PM	4	0.0	14.0	14.0	85	1
7/26	AM	4	0.0	13.0	14.0	83	1
7/26	PM	4	0.0	14.0	14.0	82	2
7/27	AM	4	0.1	11.0	13.0	81	2
7/23	PM	3	0.0	12.0	10.0	86	1

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Appendix B5.–Page 2 of 3.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/24	AM	3	0.1	10.0	10.0	87	1
7/24	PM	3	0.0	12.0	12.0	86	1
7/25	AM	3	0.1	13.0	12.0	85	1
7/25	PM	4	0.0	14.0	14.0	85	1
7/26	AM	4	0.0	13.0	14.0	83	1
7/26	PM	4	0.0	14.0	14.0	82	2
7/27	AM	4	0.1	11.0	13.0	81	2
7/27	PM	3	0.0	18.0	15.0	79	2
7/28	AM	4	0.0	12.0	14.0	78	2
7/28	PM	4	0.1	13.0	14.0	77	2
7/29	AM	4	0.1	13.0	14.0	78	2
7/29	PM	4	0.0	13.0	13.0	76	2
7/30	AM	4	0.0	11.0	13.0	76	2
7/30	PM	4	0.0	13.0	14.0	75	2
7/31	AM	4	0.1	11.0	14.0	75	2
7/31	PM	4	0.2	12.0	14.0	74	2
8/1	AM	4	0.1	12.0	14.0	74	2
8/1	PM	4	0.1	13.0	14.0	73.5	2
8/2	AM	4	0.0	12.0	13.5	73	2
8/2	PM	3	0.0	14.5	14.0	73	2
8/3	AM	4	0.0	11.0	13.0	73	2
8/3	PM	3	0.0	18.0	15.0	72.5	1
8/4	AM	4	0.2	10.5	14.0	73	1
8/4	PM	4	0.4	13.0	14.0	75	2
8/5	AM	4	0.1	15.0	15.0	74	2
8/5	PM	3	0.0	17.0	15.0	75	2
8/6	AM	4	0.2	13.0	14.0	76.5	2
8/6	PM	4	0.4	12.0	14.0	78.5	2
8/7	AM	3	0.1	13.0	14.0	79	2
8/7	PM	4	0.1	12.0	14.0	80	2
8/8	AM	4	0.2	10.0	13.0	81	2
8/8	PM	3	0.4	12.0	13.0	82	2
8/9	AM	4	0.2	10.0	13.0	82.5	2
8/9	PM	4	0.0	13.0	14.0	83	2

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Appendix B5.–Page 3 of 3.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/10	AM	4	0.7	10.0	13.0	84	2
8/10	PM	4	0.2	11.0	13.0	83.5	2
8/11	AM	4	0.4	10.0	13.0	84.5	2
8/11	PM	4	0.2	12.0	14.0	84	2
8/12	AM	2	0.0	10.0	14.0	83	2
8/12	PM	3	0.0	16.0	13.0	82	2
8/13	AM	3	0.0	14.0	13.0	81	2
8/13	PM	3	0.0	16.0	14.0	81	2
8/14	AM	4	0.0	12.0	14.0	81	1
8/14	PM	3	0.0	14.0	14.0	80.5	1
8/15	AM	3	0.0	8.0	13.0	79	1
8/15	PM	3	0.1	12.0	13.0	79	1
8/16	AM	1	0.0	15.5	13.0	77	1
8/16	PM	3	0.0	16.0	13.0	76	1
Average	–	–	0.1	13	13	82	–

[a] Sky condition codes:
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] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility between 0.5 and 1 meter
3 = visibility less than 0.5 meter

Appendix B6.–Daily weather and stream observations at the Tatlawiksuk River weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C)		River Stage (cm)	Water Clarity[b]
				Air	Water		
6/17	AM	1	0.0	15.0	13.0	38	2
6/17	PM	4	1.5	14.0	13.0	39	2
6/18	AM	4	0.5	12.0	13.0	38	2
6/18	PM	4	0.1	14.0	12.0	39	2
6/19	AM	4	1.7	12.0	10.0	40	2
6/19	PM	4	1.4	13.0	11.0	40	2
6/20	AM	4	28.0	9.0	10.0	42	2
6/20	PM	4	0.4	15.0	11.0	42	2
6/21	AM	1	0.1	14.0	10.0	50	2
6/21	PM	-	-	-	-	-	-
6/22	AM	1	0.0	14.0	12.0	54	2
6/22	PM	1	0.0	27.0	14.0	50	2
6/23	AM	2	0.0	14.0	12.0	48	2
6/23	PM	2	0.0	19.0	14.0	47	2
6/24	AM	4	0.5	12.0	10.0	45	2
6/24	PM	3	0.7	20.0	14.0	44	2
6/25	AM	4	0.8	13.0	12.0	43	2
6/25	PM	1	0.0	24.0	15.0	42	2
6/26	AM	1	0.0	16.0	13.0	40	1
6/26	PM	3	0.0	22.0	16.0	40	1
6/27	AM	3	0.2	14.0	12.0	40	1
6/27	PM	3	0.5	21.0	15.0	41	1
6/28	AM	3	0.0	14.0	11.0	42	1
6/28	PM	3	0.0	23.0	14.0	42	1
6/29	AM	3	0.4	13.0	12.0	41	1
6/29	PM	2	0.0	22.0	15.0	41	1
6/30	AM	4	11.0	13.0	13.0	40	1
6/30	PM	3	0.0	20.0	14.0	40	1
7/1	AM	4	1.6	14.0	13.0	40	1
7/1	PM	3	0.8	19.0	14.0	42	1
7/2	AM	4	6.3	14.0	12.0	45	2
7/2	PM	3	5.0	19.0	14.0	50	2
7/3	AM	4	12.0	14.0	13.0	58	2

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Appendix B6.–Page 2 of 6.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/3	PM	3	0.0	22.0	14.0	68	2
7/4	AM	4	6.0	13.0	13.0	88	3
7/4	PM	3	0.0	21.0	14.0	94	3
7/5	AM	4	0.5	11.0	12.0	100	3
7/5	PM	3	0.0	18.0	13.0	100	3
7/6	AM	4	4.8	14.0	10.0	100	3
7/6	PM	3	3.0	16.0	12.0	100	3
7/7	AM	4	0.5	13.0	10.0	100	3
7/7	PM	3	0.0	19.0	12.0	100	3
7/8	AM	2	0.0	14.0	11.0	90	2
7/8	PM	2	0.0	17.0	13.0	90	2
7/9	AM	3	0.5	14.0	12.0	95	2
7/9	PM	-	-	-	-	-	-
7/10	AM	4	0.0	14.0	12.0	95	2
7/10	PM	2	2.2	17.0	13.0	95	2
7/11	AM	1	0.0	13.0	11.0	95	2
7/11	PM	1	0.0	22.0	14.0	95	2
7/12	AM	1	0.0	15.0	12.0	95	2
7/12	PM	1	0.0	29.0	15.0	94	2
7/13	AM	1	0.0	16.0	13.0	86	2
7/13	PM	1	0.0	32.0	16.0	80	2
7/14	AM	2	0.0	17.0	14.0	79	2
7/14	PM	1	0.0	27.0	17.0	76	1
7/15	AM	3	1.0	16.0	14.0	76	1
7/15	PM	3	0.0	24.0	16.0	72	1
7/16	AM	3	0.0	12.0	14.0	67	1
7/16	PM	1	0.0	24.0	16.0	64	1
7/17	AM	1	0.0	9.0	14.0	60	1
7/17	PM	2	0.0	24.0	16.0	59	1
7/18	AM	2	0.0	13.0	14.0	57	1
7/18	PM	-	-	-	-	-	-
7/19	AM	-	-	-	-	-	-
7/19	PM	-	-	-	-	-	-
7/20	AM	4	2.4	11.0	9.0	55	1

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Appendix B6.–Page 3 of 6.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/20	PM	4	0.0	20.0	13.0	55	1
7/21	AM	4	5.0	12.0	9.0	58	1
7/21	PM	4	0.0	16.0	13.0	60	1
7/22	AM	4	0.0	10.0	10.0	60	1
7/22	PM	4	0.1	11.0	10.0	65	1
7/23	AM	4	0.0	10.0	9.0	65	1
7/23	PM	-	-	-	-	-	-
7/24	AM	4	6.0	10.0	10.0	66	1
7/24	PM	2	1.5	21.0	12.0	68	1
7/25	AM	3	0.0	13.0	11.0	69	1
7/25	PM	3	0.0	25.0	12.0	68	1
7/26	AM	4	0.5	14.0	13.0	68	2
7/26	PM	3	1.0	19.0	9.0	67	2
7/27	AM	3	0.0	13.0	13.0	65	2
7/27	PM	2	0.0	21.0	15.0	64	2
7/28	AM	3	0.0	9.0	13.0	60	2
7/28	PM	3	2.2	19.0	14.0	59	2
7/29	AM	4	0.9	11.0	12.0	58	2
7/29	PM	4	0.3	16.0	12.0	58	2
7/30	AM	4	0.4	13.0	12.0	55	2
7/30	PM	4	0.0	16.0	11.0	55	2
7/31	AM	4	12.5	12.0	10.0	56	2
7/31	PM	4	2.2	15.0	11.0	59	2
8/1	AM	4	0.0	12.0	11.0	66	2
8/1	PM	4	0.7	17.0	12.0	78	3
8/2	AM	5	2.2	11.0	11.0	80	3
8/2	PM	4	0.8	15.0	13.0	84	3
8/3	AM	4	0.0	11.0	12.0	83	3
8/3	PM	3	0.0	19.0	13.0	82	3
8/4	AM	4	0.4	12.0	12.0	77	2
8/4	PM	4	5.0	16.0	12.0	77	2
8/5	AM	4	13.0	14.0	12.0	79	2
8/5	PM	4	1.0	19.0	13.0	84	2
8/6	AM	4	7.0	15.0	12.0	92	2

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/6	PM	3	5.8	17.0	12.0	94	2
8/7	AM	4	0.7	12.0	11.0	100	3
8/7	PM	4	0.0	17.0	12.0	108	3
8/8	AM	4	1.0	12.0	11.0	120	3
8/8	PM	3	2.0	21.0	12.0	124	3
8/9	AM	3	2.3	11.0	11.0	125	3
8/9	PM	-	-	-	-	-	-
8/10	AM	4	10.2	11.0	10.0	130	3
8/10	PM	3	0.0	16.0	11.0	135	3
8/11	AM	4	1.4	9.0	11.0	136	3
8/11	PM	3	1.2	18.0	12.0	145	3
8/12	AM	3	0.0	8.0	11.0	145	3
8/12	PM	3	0.0	21.0	11.0	140	3
8/13	AM	4	0.0	13.0	10.0	130	3
8/13	PM	3	0.0	24.0	11.0	130	3
8/14	AM	2	8.0	10.0	10.0	130	2
8/14	PM	2	0.5	19.0	11.0	130	2
8/15	AM	3	0.0	11.0	10.0	120	2
8/15	PM	2	0.2	19.0	12.0	120	2
8/16	AM	4	0.4	11.0	11.0	120	2
8/16	PM	2	0.0	26.0	13.0	112	2
8/17	AM	3	2.0	10.0	11.0	105	2
8/17	PM	3	0.0	21.0	12.0	99	2
8/18	AM	2	0.0	9.0	11.0	95	2
8/18	PM	2	0.0	20.0	13.0	80	2
8/19	AM	3	0.0	11.0	11.0	74	2
8/19	PM	3	0.0	20.0	13.0	70	2
8/20	AM	4	0.0	13.0	12.0	66	2
8/20	PM	4	4.0	13.0	11.0	64	2
8/21	AM	4	2.1	11.0	10.0	64	2
8/21	PM	4	5.2	14.0	11.0	68	2
8/22	AM	4	7.0	10.0	10.0	74	2
8/22	PM	4	5.0	14.0	10.0	83	3
8/23	AM	4	3.5	11.0	9.0	85	3

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
8/23	PM	3	0.3	17.0	10.0	87	3
8/24	AM	3	0.3	12.0	10.0	85	3
8/24	PM	4	0.4	15.0	10.0	85	3
8/25	AM	4	3.0	13.0	10.0	88	3
8/25	PM	3	1.8	24.0	11.0	92	3
8/26	AM	3	0.1	7.0	10.0	96	3
8/26	PM	3	0.0	21.0	11.0	100	3
8/27	AM	3	0.0	10.0	10.5	97	3
8/27	PM	3	0.0	14.0	11.0	98	3
8/28	AM	3	0.0	13.5	12.0	89	3
8/28	PM	2	0.0	32.0	13.0	88	3
8/29	AM	2	0.0	11.0	12.0	86	3
8/29	PM	2	0.0	30.0	13.0	85	3
8/30	AM	1	0.0	9.0	11.0	79	2
8/30	PM	1	0.0	22.0	12.0	76	2
8/31	AM	1	0.0	3.0	10.0	75	2
8/31	PM	1	0.0	21.0	11.0	68	2
9/1	AM	1	0.0	3.0	10.0	64	2
9/1	PM	1	0.0	30.0	11.0	68	2
9/2	AM	1	0.0	9.0	10.0	61	2
9/2	PM	1	0.0	27.0	11.0	60	2
9/3	AM	1	0.0	1.0	9.0	56	2
9/3	PM	3	0.1	18.0	11.0	54	2
9/4	AM	4	2.0	12.0	10.0	54	2
9/4	PM	4	3.5	15.0	9.0	52	2
9/5	AM	4	3.4	12.0	10.0	53	2
9/5	PM	-	-	-	-	-	-
9/6	AM	4	5.8	9.0	10.0	52	2
9/6	PM	1	1.0	20.0	10.0	50	2
9/7	AM	4	1.6	7.0	8.0	50	2
9/7	PM	4	0.5	9.0	9.0	50	2
9/8	AM	4	0.8	2.0	9.0	54	2
9/8	PM	2	0.3	13.0	9.0	55	2
9/9	AM	1	0.0	1.0	3.0	56	2

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Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
9/9	PM	1	0.0	21.0	9.0	54	2
9/10	AM	1	0.0	2.0	4.0	54	2
9/10	PM	2	0.0	26.0	9.0	50	2
9/11	AM	4	1.6	2.0	3.0	48	2
9/11	PM	4	20.0	11.0	6.0	50	2
9/12	AM	4	10.0	11.0	9.0	48	2
9/12	PM	4	18.0	9.0	9.0	78	3
9/13	AM	4	1.0	1.0	-2.0	104	3
9/13	PM	3	0.0	12.0	9.0	108	3
9/14	AM	3	0.0	1.0	7.0	125	3
9/14	PM	4	0.0	9.0	8.0	135	3
9/15	AM	3	1.6	7.0	7.0	134	3
9/15	PM	4	0.0	17.0	8.0	129	3
9/16	AM	3	1.2	7.0	8.0	130	3
9/16	PM	4	4.0	10.0	9.0	129	3
9/17	AM	4	2.0	9.0	8.0	128	3
9/17	PM	3	1.0	14.0	9.0	124	3
9/18	AM	2	0.1	2.0	6.0	116	3
9/18	PM	3	0.0	10.0	7.0	109	3
9/19	AM	4	0.0	5.0	6.0	101	3
9/19	PM	4	0.0	12.0	6.0	94	3
9/20	AM	4	4.6	9.0	6.0	89	3
9/20	PM	4	12.5	-	-	88	3
9/21	AM	4	24.5	7.0	7.0	92	3
9/21	PM	4	-	-	-	104	3
9/22	AM	4	6.0	-	-	130	3
Average	–	–	1.9	15	11	78	–

[a] Sky condition codes:

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] Water clarity codes:

1 = visibility greater than 1 meter

2 = visibility between 0.5 and 1 meter

3 = visibility less than 0.5 meter

Appendix B7.–Daily weather and stream observations at the Salmon River (Pitka Fork) weir, 2016.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
6/22	AM						
6/22	PM	2	0.0	22.0	16.0	50	1
6/23	AM	3	0.0	18.0	15.0	50	1
6/23	PM	3	0.0	18.0	17.0	51	1
6/24	AM	2	0.0	15.0	18.0	52	1
6/24	PM	3	0.0	18.0	16.0	55	1
6/25	AM	3	0.0	15.0	18.0	55	1
6/25	PM	1	0.0	25.0	18.0	54	1
6/26	AM	1	0.0	15.0	16.0	55	1
6/26	PM	3	0.0	20.0	17.0	55	1
6/27	AM	4	10.0	16.0	18.0	55	1
6/27	PM	4	0.5	17.0	13.0	58	1
6/28	AM	4	0.0	17.0	13.0	59	1
6/28	PM	2	0.0	19.0	16.0	59	1
6/29	AM	1	0.0	14.0	15.0	58	1
6/29	PM	1	0.0	24.0	15.0	58	1
6/30	AM	3	11.0	15.0	15.0	57	1
6/30	PM	3	5.0	19.0	16.0	64	1
7/1	AM	4	7.0	18.0	14.0	66	1
7/1	PM	4	11.0	15.0	13.0	72	1
7/2	AM	4	6.0	14.0	13.0	89	2
7/2	PM	3	0.0	22.0	15.0	90	2
7/3	AM	4	29.0	18.0	18.0	92	2
7/3	PM	3	2.6	20.0	14.0	93	2
7/4	AM	3	4.0	19.0	17.0	97	2
7/4	PM	2	0.2	21.0	16.0	95	2
7/5	AM	4	12.5	13.0	13.0	103	2
7/5	PM	3	4.0	16.0	14.0	106	2
7/6	AM	3	0.1	12.0	14.0	106	2
7/6	PM	3	4.0	16.0	13.0	106	2
7/7	AM	2	0.0	13.0	15.0	104	1
7/7	PM	2	0.0	19.0	15.0	104	1

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Appendix B7.–Page 2 of 3.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/8	AM	2	0.5	13.0	16.0	101	1
7/8	PM	-	-	-	-	-	-
7/9	AM	-	-	-	-	-	-
7/9	PM	3	3.6	20.0	14.0	89	1
7/10	AM	3	0.2	17.0	17.0	86	1
7/10	PM	4	2.6	13.0	14.0	85	1
7/11	AM	1	0.3	12.0	12.0	83	1
7/11	PM	2	0.0	19.0	14.0	81	1
7/12	AM	1	0.0	15.0	15.0	79	1
7/12	PM	1	0.0	27.0	14.0	78	1
7/13	AM	1	0.0	12.0	15.0	76	1
7/13	PM	1	0.0	17.0	16.0	75	1
7/14	AM	1	0.0	16.0	12.0	74	1
7/14	PM	1	0.0	23.0	16.0	74	1
7/15	AM	1	0.0	15.0	13.0	72	1
7/15	PM	1	0.0	14.0	18.0	72	1
7/16	AM	1	0.0	15.0	16.0	71	1
7/16	PM	1	0.0	18.0	17.0	71	1
7/17	AM	3	0.0	17.0	15.0	71	1
7/17	PM	4	0.0	21.0	15.5	71	1
7/18	AM	3	0.0	12.0	13.5	71	1
7/18	PM	4	1.0	13.0	13.0	70	1
7/19	AM	4	6.0	11.0	11.0	76	1
7/19	PM	4	7.3	13.0	11.0	79	1
7/20	AM	4	7.0	11.0	10.0	85	1
7/20	PM	4	3.4	12.0	10.5	90	1
7/21	AM	4	13.4	12.5	10.0	95	1
7/21	PM	4	0.5	10.5	9.0	104	1
7/22	AM	4	1.0	10.0	11.0	102	2
7/22	PM	4	4.8	11.5	10.5	102	2
7/23	AM	3	2.2	10.5	10.5	100	1
7/23	PM	3	0.4	13.0	11.0	98	1
7/24	AM	3	0.4	10.5	10.5	95	1
7/24	PM	3	1.4	16.0	13.0	94	1

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Appendix B7.–Page 3 of 3.

Date	Time	Sky Conditions[a]	Precipitation (mm)	Temperature (°C) Air	Temperature (°C) Water	River Stage (cm)	Water Clarity[b]
7/25	AM	1	1.8	13.5	12.0	92	1
7/25	PM	2	0.1	20.0	15.0	90	1
7/26	AM	3	0.0	13.0	13.0	88	1
7/26	PM	3	0.0	19.0	15.0	86	1
7/27	AM	3	0.1	13.5	13.5	85	1
7/27	PM	3	0.0	19.0	16.0	84	1
7/28	AM	3	0.0	13.5	13.5	83	1
7/28	PM	4	0.0	19.0	14.0	83	1
7/29	AM	4	8.1	12.5	12.5	83	1
7/29	PM	4	8.0	13.0	12.0	87	1
7/30	AM	4	1.2	12.0	10.0	90	1
7/30	PM	4	0.1	14.0	12.5	88	1
7/31	AM	4	6.2	12.0	10.5	90	1
7/31	PM	4	2.4	17.0	12.5	96	1
8/1	AM	4	0.3	12.5	12.5	95	1
8/1	PM	3	0.0	18.0	12.0	97	1
8/2	AM	3	3.1	12.0	11.5	93	1
8/2	PM	4	0.3	15.0	13.0	91	1
8/3	AM	3	0.2	10.5	12.5	89	1
8/3	PM	3	0.0	15.0	13.0	88	1
8/4	AM	3	0.1	11.5	11.5	87	1
8/4	PM	4	2.0	15.0	12.0	88	1
8/5	AM	4	3.2	13.5	11.5	90	1
8/5	PM	3	0.0	19.0	13.0	91	1
8/6	AM	3	0.5	13.5	13.0	91	1
8/6	PM	4	15.4	15.0	13.0	94	1
8/7	AM	3	14.9	11.0	11.0	110	2
8/7	PM	3	0.3	19.0	13.0	112	2
8/8	AM	4	3.0	12.5	12.5	109	2
8/8	PM	4	11.5	14.0	12.0	109	2
8/9	AM	3	0.1	11.0	10.5	111	2
8/9	PM	3	0.3	18.0	13.0	114	2
Average	–	–	2.6	16	14	83	–

[a] Sky condition codes:
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] Water clarity codes:
1 = visibility greater than 1 meter
2 = visibility between 0.5 and 1 meter
3 = visibility less than 0.5 meter

APPENDIX C

Appendix C1.–Daily observed passage of non-target species at Middle Fork Goodnews River weir, 2016.

Date	Pink Salmon	Dolly Varden	Rainbow Trout	Whitefish
6/22	1	0	1	8
6/23	0	18	0	2
6/24	0	50	2	4
6/25	1	34	2	6
6/26	0	174	1	9
6/27	7	159	1	17
6/28	15	761	0	19
6/29	2	197	0	4
6/30	23	770	0	12
7/1	13	323	0	17
7/2	54	1,581	0	15
7/3	47	363	0	6
7/4	24	270	2	8
7/5	37	1,176	0	1
7/6	36	1,090	0	2
7/7	70	607	0	4
7/8	135	635	0	3
7/9	217	486	0	3
7/10	175	412	1	9
7/11	351	144	1	6
7/12	326	156	0	2
7/13	570	57	0	5
7/14	871	77	0	12
7/15	413	48	0	3
7/16	300	55	0	7
7/17	307	28	0	2
7/18	496	17	0	2
7/19	384	17	0	0
7/20	246	1	0	3
7/21	346	14	0	0
7/22	211	6	0	0
7/23	217	6	0	0
7/24	615	11	0	0
7/25	276	13	0	0
7/26	552	6	0	0
7/27	822	9	0	0
7/28	993	7	1	6
7/29	719	8	0	3
7/30	156	5	1	0
7/31	1,240	9	0	0
Total	11,268	9,800	13	200

Appendix C2.–Yearly observed passage of non-target species at Salmon River (Aniak) weir, 2012–2016.

Date	Pink Salmon	Longnose Sucker	Dolly Varden	Arctic Grayling	Rainbow Trout	Whitefish
2012	62	37	311	8	3	-
2013	17	50	86	11	22	2
2014	116	154	127	3	11	8
2015	126	288	491	13	22	9
2016	77	146	5	5	0	3
Average	80	135	204	8	12	6

Appendix C3.–Yearly observed passage of non-target species at George River weir, 2012–2016.

Date	Sockeye Salmon	Pink Salmon	Longnose Sucker	Dolly Varden	Arctic Grayling	Whitefish	Northern Pike
2012	79	6,271	2,900	2	-	1	1
2013	150	278	21,808	3	32	80	9
2014	156	906	2,294	4	45	49	-
2015	159	703	9,584	6	345	106	2
2016	2,807	1,708	4,941	9	172	34	0
Total	670	1,973	8,305	5	149	54	3

Appendix C4.–Yearly observed passage of nontarget species at Kogrukluk River weir, 2012–2016.

Date	Pink Salmon	Dolly Varden	Arctic Grayling	Whitefish	Northern Pike
2012	237	259	-	35	-
2013	13	84	-	13	-
2014	288	319	4	56	-
2015	88	381	2	117	1
2016	1,237	11	0	0	0
Average	373	211	2	44	1

Appendix C5.–Yearly observed passage of non-target species at Telaquana River weir, 2012–2016.

Date	Chinook Salmon	Chum Salmon	Pink Salmon	Longnose Sucker	Arctic Grayling	Whitefish	Northern Pike	Lake Trout
2012	5	5	2	990	54	105	4	11
2013	17	83	0	348	72	17	10	5
2014	67	72	4	1,361	4	21	6	12
2015	101	92	4	115	34	1	0	1
2016	119	103	1	1,251	54	84	7	7
Average	309	355	11	4,065	218	228	27	36

Appendix C6.–Yearly observed passage of non-target species at Tatlawiksuk River weir, 2012–2016.

Date	Pink	Longnose Sucker	Arctic Grayling	Whitefish	Northern Pike	Dolly Varden
2012	27	640	14	3	6	0
2013	2	3,765	12	85	3	0
2014	5	770	2	1	1	1
2015	0	750	7	43	8	0
2016	111	433	36	18	5	0
Total	29	1,272	14	30	5	0

Appendix C7.–Yearly observed passage of non-target species at Salmon River (Pitka Fork) weir, 2015–2016.

Date	Chum Salmon	Longnose Sucker	Arctic Grayling	Whitefish	Northern Pike
2015	54	38	4	0	0
2016	55	324	2	36	3
Total	55	181	3	18	2