Fishery Data Series No. 14-44

Goodnews River Salmon Monitoring and Assessment, 2013

Final Report for Project OSM 10-300

USFWS Office of Subsistence Management

Fisheries Resource Monitoring Program

by

Davin V. Taylor

November 2014

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 14-44

GOODNEWS RIVER SALMON MONITORING AND ASSESSMENT, 2013

by

Davin V. Taylor
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

November 2014

This investigation was partially funded by U.S. Fish and Wildlife Service, Office of Subsistence Management (Project No. OSM 10-300), Fisheries Resource Monitoring Program under agreement number 70181AJ027.

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/ This publication has undergone editorial and peer review.

Davin V. Taylor
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

This document should be cited as:
Taylor, D. V. 2014. Goodnews River salmon monitoring and assessment, 2013. Alaska Department of Fish and Game, Fishery Data Series No. 14-44, Anchorage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Goodnews River is the primary salmon spawning drainage in the Goodnews Bay area and supports subsistence, commercial, and sport fisheries near the communities of Goodnews Bay and Platinum in Southwest Alaska. The Alaska Department of Fish and Game, in cooperation with the U.S. Fish and Wildlife Service, operates a resistance board weir to enumerate fish returning to Middle Fork Goodnews River. In 2013, the weir was in operation June 24 through September 2, and a total of 1,189 Chinook *Oncorhynchus tshawytscha*; 23,243 sockeye *O. nerka*; 28,091 chum *O. keta*; 530 pink *O. gorbuscha*; 23,702 coho salmon *O. kisutch*; and 5,163 Dolly Varden char *Salvelinus malma* were estimated to have passed through the weir. Flood waters resulted in an early end to project operations. A portion of the coho salmon run could not be monitored, but estimates of missed passage for September 2 through September 18 are included in the escapement total. The escapement of Chinook salmon at the weir was below the biological escapement goal range. Sockeye salmon escapement was within the biological escapement goal range, while chum and coho salmon exceeded their respective escapement goals. Overall, escapements for Chinook, sockeye, chum, and coho salmon were below average.

Key words Chinook, *Oncorhynchus tshawytscha*, chum, *O. keta*, coho *O. kisutch*, sockeye *O. nerka* and pink salmon, *O. gorbuscha*, Dolly Varden char *Salvelinus malma*, escapement monitoring, Goodnews River, Kuskokwim Area, Kuskokwim Bay.

INTRODUCTION

Salmon returning to Goodnews River support subsistence, commercial, and sport fisheries near the communities of Goodnews Bay and Platinum in Southwest Alaska. The Alaska Department of Fish and Game (ADF&G), in cooperation with the U.S. Fish and Wildlife Service (USFWS) Togiak National Wildlife Refuge (TNWR) and Office of Subsistence Management (OSM), operates a resistance board weir on Middle Fork Goodnews River. The weir provides a method for enumerating returning adult salmon, by species, and collecting data utilized in an effort to manage the resource sustainably.

ADF&G is responsible for managing the salmon fisheries of Alaska, in a manner consistent with *Sustainable Salmon Fisheries Policy* (5 AAC 39.222). A core principle of this policy is management for escapements within ranges that provide a sustainable harvest yield and maintain normal ecosystem functioning. Managing for this policy requires long-term monitoring projects that reliably measure annual escapement to key spawning systems and track temporal and spatial patterns in abundance. Data collected from escapement projects provide a means to set escapement goals and monitor the goals annually. Escapement data can be used in managing fisheries harvest, with the goal of managing for a sustainable resource. The Goodnews River weir provides a means for collection of escapement data by monitoring cumulative passage and progress toward achieving escapement goals. Goals have been set for Chinook *Oncorhynchus tshawytscha*, sockeye *O. nerka*, chum *O. keta*, and coho salmon *O. kisutch*.

SALMON FISHERIES

Subsistence Fisheries

Subsistence fishing is allowed throughout the Goodnews River drainage and in Goodnews Bay and is primarily performed with drift and set gillnets. ADF&G has quantified subsistence salmon harvests in the communities of Goodnews Bay and Platinum since 1977. Harvest estimates are determined from interviews with subsistence fishermen in October and November. Sockeye salmon have been the most utilized subsistence salmon species in the Goodnews Bay area with a 10-year (2003–2012) average harvest of 1,276 fish, followed by coho salmon (799 fish), Chinook salmon (775 fish), and chum salmon (381 fish) (Shelden et al. 2014). There is no

estimate of total subsistence harvest of Dolly Varden char *Salvelinus malma* from Goodnews River. However, in the 2012 subsistence harvest survey, 53 of 87 households in Goodnews Bay and Platinum reported a collective harvest of 1,421 char from the Goodnews drainage. It is difficult to track non-salmon subsistence harvest among years because the methods have not been consistent, but the importance of char, primarily Dolly Varden, to the subsistence diet in southwest Alaska is well known (Mark Lisac, USFWS Fisheries Biologist, personal communication). Wolfe et al. (1984) estimated that char accounted for a significant portion of the total subsistence harvested fish in the village of Goodnews Bay.

Commercial Fisheries

Commercial salmon fishing occurs in Goodnews Bay within the boundaries of District W-5, the southernmost district in the Kuskokwim Area (Figure 1). Commercial fishing has occurred annually in District W-5 since it was established by the Alaska Board of Fisheries (BOF) in 1968. Permit holders have unrestricted movement between commercial fishing districts within the Kuskokwim Area, and fishermen from distant communities often participate in the District W-5 commercial fishery. The commercial fishery is primarily directed toward harvesting sockeye and coho salmon and is conducted from skiffs using hand-pulled gillnets. Pink salmon *O. gorbuscha* are the least valuable species commercially and have not been targeted in recent years. ADF&G has collected harvest data from fish buyers and processors since the district was created.

Since 1969, combined commercial harvests of salmon species in District W-5 have ranged from 2,879 fish in 1971 to 148,036 fish in 1994. Harvest numbers have been relatively stable since the late 1990s, with the exception of the low harvest in 2002 when market demand and processing capacity were low (Brazil et al. 2013). The recent 10-year average harvest (2003–2012) was 62,063 salmon. Harvests efforts were high through the early 1990s when over 100 permits were fished annually. Harvest efforts have been relatively low in recent years, with the recent 10-year average (2003–2012) of 36 permits fished annually (Travis Elison, Commercial Fisheries Biologist, ADF&G, personal communication October 9, 2013, Anchorage).

Sport Fisheries

Sport fishing occurs throughout the Goodnews River drainage. Pacific salmon (primarily Chinook and coho), rainbow trout *O. mykiss*, Dolly Varden char, Arctic char *S. alpinus*, lake trout *S. namaycush*, and Arctic grayling *Thymallus arcticus* are targeted. Many sport fishermen take commercially guided or unguided float trips from lakes in the headwaters to the mouth at Goodnews Bay. There is currently 1 commercially operated lodge with semi-permanent camps in the drainage that offer fishing from powered skiffs. ADF&G has been estimating sport fishery harvests consistently since 1991. From 2008 to 2012 there was an average of 3,386 angler-days annually. The most recent 5-year average annual harvest (2008–2012) was 492 coho, 130 sockeye, 40 Chinook, and 20 chum salmon and 326 Dolly Varden char (Chythlook 2014).

PROJECT HISTORY

ADF&G, Division of Commercial Fisheries, has operated a salmon escapement monitoring project on Middle Fork Goodnews River since 1981 (Appendix A). The project was initiated as a counting tower in 1981 and operated through 1990 (Schultz 1982; Burkey 1990) focusing counts on Chinook, sockeye, and chum salmon. Although successful, the tower was limited by problems with species apportionment and high labor costs (Menard 1999). In 1991, resources were

redirected towards a fixed-picket weir to reduce labor costs and improve species identification. The fixed-picket weir was operated from 1991 through midseason 1997, approximately 229 m downstream from the former tower site. Fish passage could be controlled, eliminating the need for hourly monitoring and increasing the efficiency of collecting age, sex, and length (ASL) information. Seasonal flood events were problematic if the weir could not be removed in time. The weir would rapidly collect debris, damming the flow until it failed and washed downstream, which occurred several times during the early 1990s.

In the mid-1990s, ADF&G began cooperating with USFWS to build a resistance board (floating) weir that would allow the project's operational period to include the coho salmon run during August and September. In July 1997 the resistance board weir was installed. This weir is designed to shed debris loads by sinking under high water conditions and allows the project to remain operational at higher water levels compared to the fixed-picket weir. The resistance board weir design can be rendered inoperable during extreme high water events; however, the weir can regain operations quickly once the high water subsides.

Extended operation of the weir has also allowed biologists to monitor the migration of Dolly Varden char. Dolly Varden char are anadromous and believed to be aggregates of mature fish returning to spawn and mixed stocks of immature fish that intend to overwinter in the drainage (Lisac 2007). Dolly Varden char contribute to the overall subsistence harvest of the residents in the Goodnews Bay area (Wolfe et al. 1984). However, quantitative information on actual subsistence harvest is not available. The weir has provided run timing and abundance estimates for Dolly Varden char since 1996 and was used as a platform for Dolly Varden char life history studies from 2001 until 2009 (Lisac 2010).

In 2006, TNWR provided an underwater video monitoring system to the project. This system allows the passage chute to be open for more hours per day. The system is controlled by digital video recorder with motion sensing software that condenses the hours of fish passage into a shorter video stream. Video monitoring allows for a reduction in staff hours devoted to visually monitoring daily passage.

ESCAPEMENT MONITORING AND ESCAPEMENT GOALS

The Middle Fork Goodnews River weir serves primarily as a management tool for commercial and subsistence salmon fisheries in the Goodnews Bay area. These data are used to make inseason management decisions based on both sustainable escapement goals (SEG) and biological escapement goals (BEG). The project also serves as a platform for other studies in the drainage, such as collecting samples for genetic stock identification and tagging Dolly Varden char to study run timing and seasonal distribution (Lisac 2010).

An evaluation of AYK Region escapement goals in 2007 resulted in a revision of the Middle Fork Goodnews River weir Chinook and sockeye salmon escapement goals from SEGs to BEGs (Brannian et al. 2006). The BEG for Chinook salmon was set at 1,500 to 2,900 fish, and the BEG for sockeye salmon was set at 18,000 to 40,000 fish. The SEGs for chum and coho salmon remain set at 12,000 fish. The 2013 evaluation of AYK Region escapement goals did not result in changes to escapement goals set for Goodnews River salmon (Conitz et al. 2012).

AGE, SEX, AND LENGTH COMPOSITION ESTIMATES

Salmon ASL information has been collected from the weir project since 1984. Historically, the dominant age classes for Chinook salmon are age-1.2, -1.3 and -1.4 fish. Sockeye salmon escapement is dominated by age-1.3 fish. Chum salmon dominant age class alternates between age-0.3 and 0.4 fish. Age-2.1 fish are dominant for coho salmon. Chinook salmon male to female ratio varies with run timing, with males more dominant for the total run. Sex ratios are approximately 1 to 1 for sockeye, chum and coho salmon. Historical summaries of existing ASL information for salmon returning to the Goodnews River drainage can be found in Molyneaux et al. (2010). Dolly Varden char sex, length and maturity information was collected at the weir site from 2001 to 2009 (Lisac 2010) but is no longer being collected.

OBJECTIVES

Annual project objectives are to:

1. Estimate Chinook, sockeye, chum, coho salmon, and Dolly Varden char escapement at the weir.
2. Estimate the run timing of Chinook, sockeye, chum, Coho salmon, and Dolly Varden char at the weir.
3. Estimate the ASL composition of annual Chinook, sockeye, chum, and coho salmon escapements such that 95% simultaneous confidence intervals for the age composition have a maximum width of ± 10% ($\alpha = 0.05$ and $d = 0.10$).
4. Record atmospheric and hydrologic conditions at the weir site.

METHODS

SITE DESCRIPTION

The Goodnews River watershed drains an area of nearly 2,590 km^2 along the west side of TNWR (Figure 2). It flows a distance of 97 river kilometers (rkm) along its mainstem, from the Ahklun Mountains southwest into Goodnews Bay. Two major tributaries, Middle Fork and South Fork Goodnews rivers, join the mainstem a few miles from its mouth and are included within its drainage. In order to differentiate between them in this report, "Goodnews River" will refer to all 3 drainages, and the mainstem Goodnews River, upstream of its confluence with Middle Fork Goodnews River, will be referred to as "North Fork Goodnews River". Chinook, sockeye, chum, coho, and pink salmon, along with several other anadromous and resident species including Dolly Varden char and rainbow trout, spawn in the Goodnews River drainage.

Middle Fork Goodnews River parallels North Fork Goodnews River and flows a distance of approximately 72 rkm before joining the mainstem. The weir project is located approximately 16 rkm from the village of Goodnews Bay on the Middle Fork at lat 59°09.595′N, long 161°23.287′W (Figure 2). The channel at the weir location is approximately 61.0 m wide and has a regular profile from 0.3 to 1.2 m deep, which tapers to low cut banks on either side and flows 0.6 to 1.2 $m \cdot s^{-1}$ during average water conditions. The river substrate is primarily cobblestone, gravel, and sand. The channel upstream of the weir is characterized by deep water along a steep cut bank approximately 6.1 m in height on the south bank (as looking downstream), tapering to a gravel bar on the north bank. The project campsite is located on the south bank approximately 46 m upstream and 27 m inland from the weir location.

RESISTANCE BOARD WEIR

Methods for the design, construction, and installation of the resistance board weir followed Tobin (1994) and Stewart (2002, 2003). The picket spacing allows smaller fish, such as pink salmon and non-salmon species, to pass upstream and downstream through the weir. Further details of resistance board weir components used for the Goodnews River weir are described in Stewart (2004).

Two fish passage chutes were installed on the weir at approximately 15 m and 5 m from the south bank. A 3-m by 4.6-m trap used to collect fish for ASL sampling was installed directly upstream of the passage chute located furthest from the bank. The fish passage chute located nearest to the bank was connected to a passage gate that incorporated an underwater video camera to record fish passage.

Boats pass at a designated boat gate consisting of modified weir panels located near the middle of the weir. Boats with jet-drive engines were common and could pass upstream and downstream over the boat gate easily at reduced speed. Rafts could pass downstream by submerging the boat passage panels and drifting over the weir. Boats with propeller-drive engines were uncommon and required being towed upstream across the weir with assistance from crew members.

ESCAPEMENT MONITORING AND ESTIMATES

The Middle Fork weir operated from June 24 through September 2. Counting periods occurred regularly throughout the day, typically for 1–2 hours in duration, beginning in the morning and continuing as late as light permitted. During counting periods, the passage gate was opened to allow fish to pass through the weir. Video recording equipment has been used in previous seasons, to monitor passage. The equipment could not be properly installed for the 2013 season and was not used to monitor passage. Any fish observed traveling downstream through the fish passage chutes were excluded from the upstream tally.

Passage missed during inoperable periods or breach events was estimated using Hierarchical Bayesian Estimation technique (Adkison 2001). In this, a log-normal distribution run-timing model was fitted to log-plus-1-transformed daily passage weir counts (ln(daily weir count +1)).

Let y_{it} be the log plus 1 transformed weir count of i^{th} year (1998–2012) and t^{th} day, so y_{it} = ln(daily weir count +1). Further assume that y_{it} is a random variable from a normal distribution of mean θ_{it} and standard deviation of all years σ . Then:

$$y_{it} \sim N(\theta_{it}, \sigma^2) \quad \text{and,} \quad \theta_{it} = a_i \exp((\ln(t / \mu_i))^2 / b_i) \,,$$

where θ_{it} is modeled to have a log-normal run timing, and,

where $a_i > 0$: the maximum daily passage of the i^{th} year;

$t \geq 1$: passage date starting June 1 (t=1 is June 1);

$\mu_i > 0$: mean passage date starting June 1 of the i^{th} year;

$b_i > 0$: days represented by the run period of the i^{th} year.

At the upper hierarchical level, annual maximum daily passage (a_i), mean passage date (μ_i), and spread (b_i) were assumed to be normally distributed as,

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

Prior distribution of the above parameters was assumed to be non-informative, as,

$a_0 \sim N(5,1000)$ $(a_0 > 0)$; $\mu_0 \sim N(0.5,100)$ $(\mu_0 > 0)$; $b_0 \sim N(50,10)$ $(b_0 > 0)$;

$\sigma_a \sim$ uniform(0.1, 10,000); $\sigma_b \sim$ uniform(0.1, 10,000);

$\sigma_\mu \sim$ uniform(0.1, 10,000); $\sigma \sim$ uniform(0.1, 10,000).

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. Simulation was done for 10,000 iterations, with the first 5,000 burn-in period discarded, 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. Bayesian credible intervals (95%) were obtained from the percentiles (2.5 and 97.5) of the marginal posterior distribution (but not reported here). Estimates of missed passage are based on historical observed passage data collected at the weir from 2000 through the current season. Historical observed passage data adequate to estimate passage range from June 26 through September 18.

AGE, SEX, AND LENGTH SAMPLING AND ESTIMATES

Sample sizes were calculated using Bromaghin (1993) and adjusted for a non-readable scale rate of 20% such that sample sizes would produce simultaneous 95% confidence interval estimates of age composition ± 10% for each age-sex category ($\alpha = 0.05$ and $d = 0.10$). The sample size for Chinook salmon was adjusted for a finite population based on the lower bound of the SEG. Sample sizes of sockeye and chum salmon were increased by a factor of 3 to allow for postseason stratification. The minimum sample size objective for each species was 230 Chinook, 630 sockeye, and 600 chum salmon.

Daily sample objectives were based on a proportional sampling design generated from the average run timing for each species. Based on historical average passage data and sample size objectives, seasonal sample proportions were 0.08 for Chinook, 0.02 for sockeye, 0.03 for chum, and 0.02 for coho salmon. Therefore, the daily salmon sample size was the derived average percent of the previous day's passage. Due to the abundance of sockeye, chum, and coho salmon, samples could be collected every few days, and the sample size was the sum of the previous day's passage multiplied by the daily proportion. When daily sample objectives were not met attempts were made to collect additional samples during the next opportunity. Ultimately, it was up to the crew leader to determine the appropriate sample schedule based on fish passage patterns and minimum sample size objectives as outlined above. The determined proportional sample size objective total for each species was 231 Chinook, 691 sockeye, 663 chum, and 604 coho salmon.

Salmon were sampled from a trap attached to the weir. To sample sockeye, chum, and coho salmon, the exit gate was closed allowing fish entering the trap to accumulate inside. The trap was typically allowed to fill with fish, and sampling was done during scheduled counting periods. Chinook salmon passage has a relatively low proportion relative to other species.

Chinook salmon were captured during normal passage counts while allowing other species to pass through the trap (active sampling).

For escapement sampling, scales were removed from the preferred area of the fish (INPFC 1963). A minimum of 3 scales were removed from each Chinook and coho salmon, and 1 scale was removed from each chum and sockeye salmon. Scales were mounted on numbered and labeled gum cards. Sex was determined by visually examining external morphology such as the development of the kype, roundness of the belly, and the presence or absence of an ovipositor. Length was measured to the nearest millimeter from mideye to tail fork and the fish released upstream of the weir. After sampling was concluded, gum cards and data forms were completed and returned to the Bethel ADF&G office for processing.

ADF&G staff in Bethel and Anchorage aged scales, processed the ASL data, and generated data summaries as per Molyneaux et al. (2010). Samples were divided into 3 strata based on cumulative percent passage. Each stratum was then weighted by the number of fish passing in that stratum to estimate the overall age and sex composition. Age and sex confidence interval bounds were estimated to determine if the desired precision was met for the season estimate. If the desired precision level was met, then season summary was the weighted age and sex composition estimate of the escapement. If the desired precision level was not met, then only the sample age and sex composition was presented.

Ages are reported in the tables using European notation. European notation is composed of 2 numerals separated by a decimal, where the first numeral indicates the number of winters spent in fresh water, and the second numeral indicates the number of winters spent in the ocean (Groot and Margolis 1991). Total age is equal to the sum of these 2 numerals plus 1 to account for the single winter of egg incubation in the gravel. Original ASL gum cards, acetates, and mark-sense forms are archived at the ADF&G office in Anchorage. Computer files were archived by ADF&G in the Anchorage and Bethel offices.

ATMOSPHERIC AND HYDROLOGICAL MONITORING

Atmospheric and hydrological conditions were recorded at 1000 hours each day. Cloud cover was judged in percent of total sky covered; wind speed was estimated in miles per hour and direction was noted; precipitation was measured in mm per 24 hours. Daily air and water temperatures were recorded in degrees Celsius. The river level was recorded daily and was referenced to a benchmark established in 1997 representing a river stage of 150 cm. In 2011, a new benchmark was established because the old benchmark had eroded into the river. The new benchmark has been calibrated to the old benchmark and is designated by a rebar stake driven into the ground near the camp trail.

RESULTS

WEIR OPERATIONS

Weir operation began on June 24, in the evening, and passage was monitored until September 2. Video monitor equipment could not be assembled for the 2013 season and crew conducted manual passage counts. Minor flooding occurred around the camp-side fixed picket section on July 9. High water flowing over submerged panels led to incomplete escapement monitoring from August 8 through August 17. A second high water period submerged panels and caused scouring under the substrate rail, rendering the weir inoperable on September 2. Water level

remained high and further passage counts were not possible. The crew began weir removal on September 13. Passage estimates for the inoperable period are included in the total escapement counts. An estimation of missed Chinook, sockeye, chum, and coho salmon passage was determined for September 2 through September 18.

SALMON ESCAPEMENT

The 2013 Chinook salmon escapement through the Middle Fork GoodnewsRiver weir was 1,189 fish. The first Chinook salmon was observed on June 26, and the last Chinook salmon was observed on August 26. Passage during inoperable periods was estimated to be 21 fish (1.8% of total passage). Based on the operational period and inclusive of missed passage estimates, the median passage date was July 20, and the central 50% of the run occurred between July 11 and July 24 (Table 1).

Sockeye salmon escapement was 23,243 fish. The first sockeye salmon was observed on June 24, and the last sockeye salmon was observed on September 2. Passage during inoperable periods was estimated to be 214 fish (0.9% of total passage). Based on the operational period and inclusive of missed passage estimates, the median passage date was July 4, and the central 50% of the run occurred between June 30 and July 12 (Table 1).

Chum salmon escapement was 28,091 fish. The first chum salmon was observed on June 25 and, the last chum salmon was observed on September 2. Passage during inoperable periods was estimated to be 418 fish (1.5% of total passage). Based on the operational period and inclusive of missed passage estimates, the median passage date was July 20, and the central 50% of the run occurred between July 17 and July 24 (Table 1).

Coho salmon escapement was 23,702 fish. The first coho salmon was observed on July 20, and the last coho salmon was observed on September 2. Passage during inoperable periods was estimated to be 11,809 fish (50.8% of total passage). Based on the operational period and inclusive of missed passage estimates, the median passage date was September 1, and the central 50% of the run occurred between August 27 and September 7 (Table 1).

Observed passage of pink salmon was 530 fish. The first pink salmon was observed on June 8, and the last pink salmon was observed on September 1. The median passage date was August 21, and the central 50% of the run occurred between August 16 and August 26. Missed passage estimates of pink salmon are not made for inoperable periods (Table 2).

Observed passage of Dolly Varden char was 5,163 fish. The first Dolly Varden char was observed on June 24, and the last Dolly Varden char was observed on September 1. The median passage date was July 20, and the central 50% of the run occurred between July 18 and July 23. Missed passage estimates of Dolly Varden char are not made for inoperable periods. Observed passage of resident species in 2013 was 51 rainbow trout, and 179 whitefish (Table 2).

AGE, SEX, AND LENGTH COMPOSITION ESTIMATES

Sample sizes and distribution of samples were sufficient for estimating Chinook, sockeye, and chum salmon ASL composition of the escapement.

Age was determined for 175 Chinook salmon in 2013. Overall, 95% confidence intervals for the age composition of annual escapement were no wider than ± 7.2%. Age-1.4 Chinook salmon were the most abundant age class (60.8%), followed by age-1.3 (22.4%) and age-1.2 (14.8%). Females comprised 56.7% of the aged samples. Mean male length was 522 mm for age-1.2, 753

mm for age-1.3, and 865 mm for age-1.4 fish. Mean female length was 801 mm for age-1.3 and 870 mm for age-1.4 fish. Overall, male lengths ranged from 421 to 1060 mm, and female lengths ranged from 703 to 970 mm (Table 3).

Age was determined for 625 sockeye salmon in 2013. Overall, 95% confidence intervals for age composition of annual escapement were no wider than ± 4.6%. Age-1.3 sockeye salmon were the most abundant age class (52.5%), followed by age-2.3 (21.4%) and age-1.2 (6.8%). Females comprised 56.3% of the aged samples. Mean male length was 507 mm for age-1.2, 575 mm for age-1.3, and 573 mm for age-2.3 fish. Mean female length was 483 mm for age-1.2, 542 mm for age-1.3, and 535 mm for age-2.3 fish. Overall, male lengths ranged from 431 to 633 mm, and female lengths ranged from 433 to 588 mm (Table 4).

Age was determined for 494 chum salmon in 2013. Overall, 95% confidence intervals for age composition of annual escapement were no wider than ± 4.3%. Age-0.4 chum salmon were the most abundant age class (64.5%), followed by age-0.3 (32.8%) and age-0.5 (2.7%). Females comprised 44.4% of the aged samples. Mean male length was 586 mm for age-0.3, 606 mm for age-0.4, and 641 mm for age-0.5 fish. Mean female length was 551 mm for age-0.3, 570 mm for age-0.4, and 566 mm for age-0.5 fish. Overall, male lengths ranged from 502 to 798 mm, and female lengths ranged from 493 to 693 mm (Table 5).

Age was determined for 132 coho salmon in 2013. Sample results were insufficient for stratification, and a weighted age composition of escapement could not be determined. Results of processed samples were 10 age-1.1, 118 age-2.1, 3 age-3.1, and 1 age-4.1 fish. Sex composition of sampled fish was 64 male and 68 female. Mean male length of the samples was 550 mm for age-1.1 and 597 mm for age-2.1 fish. Mean female length of the samples was 565 mm for age-1.1 and 602 mm for age-2.1 fish. Overall, male lengths ranged from 406 to 668 mm, and female lengths ranged from 488 to 665 mm (Table 6).

ATMOSPHERIC AND HYDROLOGICAL MONITORING

Atmospheric and hydrological observations were recorded daily from June 21 to September 15. Air temperatures ranged from 5˚ to 20˚C. Water temperature ranged from 7˚ to 14˚C. Several rain events resulted in daily accumulations from trace amounts up to 31.75 mm for a 24 hour period. Total rainfall during this period was 299.2 mm. Water levels ranged from -9 to 82 cm. A recorded level below 0 occurs when the water level is below the set benchmark (Table 7).

DISCUSSION

WEIR OPERATIONS

The 2013 weir operation was successful in estimating escapement and run timing of Chinook, sockeye, chum, and coho salmon, and Dolly Varden char past the weir. The majority of project objectives were achieved, with the exception of the Chinook, chum, and coho salmon ASL sampling objective. Missed passage estimates for inoperable periods accounted for 10 days of Chinook, sockeye, chum, and coho salmon passage and 17 days of passage after operation ceased. The project continues to add to the long-term escapement, run timing, and ASL database for salmon returning to Goodnews River and serves as a platform to study other anadromous and resident freshwater species.

ESCAPEMENT MONITORING AND ESTIMATES

The 2013 Chinook salmon escapement at the weir was below the BEG range of 1,500 to 2,900 fish. However, the 2013 escapement improved by double the record low of the previous season, 2012, but still ranked the second lowest among recorded years with similar monitoring methods (Figure 3; Appendix A). Low Chinook salmon escapement estimates were also reported along the Kuskokwim River (Travis Elison, Commercial Fisheries Biologist, ADF&G, Anchorage, personal communication). The 50% point of the run passed 5 days later than the median passage date for 1998–2012. Chinook salmon have returned later than the median passage date since 2006 (Figure 4).

The 2013 sockeye salmon escapement at the weir was within the BEG range of 18,000 to 40,000 fish; however, it was among the lowest escapements for recorded years with similar monitoring methods. The escapement was near half of the recent 10-year average (2003–2012; Figure 3; Appendix A). Run timing was earlier than average, and the 50% point of the run passed 4 days earlier than the median passage date (1998–2012; Figure 4).

The 2013 chum salmon escapement at the weir was above the SEG lower bound of 12,000 fish and near the recent 10-year average (2003–2012; Figure 3; Appendix A). The 50% point of the run passed 2 days later than the median passage date (1998–2012; Figure 5).

The 2013 coho salmon escapement was above the SEG lower bound of 12,000 fish. The weir operated until September 2, and historical data shows coho salmon continue to run through September. The historical average run midpoint occurs September 1. Data collected in 2013 likely represented the initial 50% of the run and is sufficient to use in Bayesian method estimation. Estimates account for approximately 50% of the total run and weigh overall run timing. Combining observed data and estimates, run timing fits the average timing trend (Figure 5).

Passage estimates were included for periods of missed operation, due to flooding. Passage estimates for short term breach events were not determined. Overall passage was low, and it was determined that missed passage from short term breaches would not have a significant effect on overall escapement and run timing results.

Dolly Varden char counts generated by the weir project represented an unknown proportion of the overall Dolly Varden char migration within Middle Fork Goodnews River and should be considered an index. The current spacing between weir panel pickets was chosen for optimal weir operations during high water events and for generating escapement counts of Chinook, sockeye, chum, and coho salmon. Therefore, the weir count must be considered to be size selective for larger (> 400 mm) Dolly Varden char and probably does not well represent the younger, smaller fish that can pass through the weir unobserved (Lisac 2004). The 2013 Dolly Varden char count was the highest in over 10 years and twice the historical average (2,556; Figure 6; Appendix A).

AGE, SEX, AND LENGTH COMPOSITION ESTIMATES

Achieving Chinook salmon ASL sampling objectives continues to be problematic. Low daily passage, migration patterns, and behavior at the weir have made sample collection difficult. Chinook salmon tend to migrate in large pulses so that their passage may be slow for a period of days and then suddenly peak. Coordinating ASL sampling to coincide with these pulses is

difficult because timing of the pulses cannot be accurately predicted. An active sampling strategy of capturing Chinook salmon individually or in small groups as other species are allowed to pass freely through the trap has improved sample sizes, but the fish trap used at the weir does not present the best platform for active sampling. This strategy can work well but is time intensive, and Chinook salmon are often hesitant to approach the trap in its current fixed location and when there is increased activity around the trap. Crew was able to meet the sample objective this season; adequate sample data was last achieved in 2008 (Brodersen et al. 2013). In an effort to achieve Chinook salmon sample objectives and acquire a long term data set, active sampling will continue to be conducted at the weir.

The sample objective was met for sockeye salmon, and the samples were sufficient to estimate the age composition of the total escapement. The age-1.3 contribution was a smaller portion than observed in past years. Age-2.3 showed heavier proportion than other historical observations (Brodersen et al. 2013).

The sample size objectives were met, and readability resulted in precision criteria needed for estimating the age composition of the run. The age composition was typical for chum salmon with age-0.4 and age-0.3 as the most dominant age classes. The age-0.4 contribution was greater than observed in previous years, where the age-0.4 contribution was more dominant (Brodersen et al. 2013).

The proportional sample goals were not met for coho salmon. Sample distribution did not produce adequate representation of the second half of the run. Early weir closure prevented collection of samples after the historical midpoint of the run, and data were not available to represent all portions of the run.

RECOMMENDATIONS

Annual operation of the Middle Fork Goodnews River weir should continue indefinitely. As the only ground-based monitoring project in District W-5, the project provides valuable, reliable inseason and postseason information about Chinook, sockeye, chum, and coho salmon that is critical for sustainable salmon management. Manual counts were increased this season due to lack of video monitoring. The majority of passage was monitored through the main trap. Greater fish passage gave more opportunity for ASL collection. Focused effort on ASL collection will increase long-term trend data. The low overall passage rate can be managed by the current staffing levels without video support. Video equipment could be more advantageous at a location with heavier passage.

ACKNOWLEDGEMENTS

The author would like to thank Aaron Tiernan, for supervising field season planning and implementation, as well as various peer reviewers of this manuscript, and the 2013 weir crew: Justin Cross, Dimitrios Alexiadis, and technician Andrew Reichel with Bristol Bay Native Association (BBNA). The author would also like to thank Mark Lisac from Togiak National Wildlife Refuge (TNWR) for his assistance with all aspects of the project. The authors would like to extend thanks to the village of Goodnews Bay. The USFWS, Office of Subsistence Management, provided $14,000 in funding support for this project (OSM 10-300) through the Fisheries Resource Monitoring Program, under agreement number 70181AJ027, BBNA and TNWR.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 2004. Escapement goal review of select AYK Region salmon stocks. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A04-01, Anchorage.

Adkison, M., and Z. Su. 2001. A comparison of salmon escapement estimates using a hierarchical Bayesian approach versus separate maximum likelihood estimation of each year's return. Canadian Journal of Fisheries and Aquatic Sciences 58:1663-1671.

Brannian, L. K., M. J. Evenson, and J. R. Hilsinger. 2006. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim region salmon stocks, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 06-07, Anchorage.

Brazil, C., D. Bue, and T. Elison. 2013. 2011 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 13-23, Anchorage.

Brodersen, A. B., Z. W. Liller, and C. L. Truesdale. 2013. Salmon age, sex, and length catalog for the Kuskokwim Area, 2012. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 13-07, Anchorage.

Bromaghin, J. F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician 47(3):203-206.

Burkey Jr., C. 1990. Goodnews River fisheries studies, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3B90-16, Bethel.

Conitz, J. M., K. G. Howard and M. J. Evenson. 2012. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2013. Alaska Department of Fish and Game, Fishery Manuscript No. 12-07, Anchorage.

Chythlook, J. 2014. Fishery management report for sport fisheries in the Kuskokwim-Goodnews Management Area, 2012. Alaska Department of Fish and Game, Fishery Management Report Series No. 14-27, Anchorage.

Groot, C., and L. Margolis, editors. 1991. Pacific salmon life histories. Department of Fisheries and Oceans, Biological Sciences Branch, Canada. UBC Press, Vancouver, British Columbia.

INPFC (International North Pacific Fisheries Commission). 1963. Annual report, 1961. Vancouver, British Columbia.

Lisac, M. J. 2004. Run timing, seasonal distribution and biological characteristics of Dolly Varden *Salvelinus malma* in the Middle Fork Goodnews River, Togiak National Wildlife Refuge, 2001. Final Report. U. S. Fish and Wildlife Service, Dillingham, Alaska.

Lisac, M. J. 2007. Run timing, seasonal distribution and biological characteristics of Dolly Varden *Salvelinus malma* in the Middle Fork Goodnews River, Togiak National Wildlife Refuge, 2003-2006. U. S. Fish and Wildlife Service, Togiak National Wildlife Refuge, Alaska Fisheries Data Series Report Number 2007-8, Dillingham, Alaska.

Lisac, M. J. 2010. Abundance and run timing of Dolly Varden in the Middle Fork Goodnews River, 2008 and 2009. U.S. Fish and Wildlife Service, Togiak National Wildlife Refuge, Alaska Fisheries Data Series Report Number 2010-13, Dillingham, Alaska.

Menard, J. 1999. Middle Fork Goodnews River fisheries studies, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A99-13, Anchorage.

Molyneaux, D. B., A. R. Brodersen, and C. A. Shelden. 2010. Salmon age, sex, and length catalog for the Kuskokwim Area, 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A10-05, Anchorage.

Schultz, K. 1982. Goodnews River tower study, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kuskokwim Salmon Escapement Report No. 24, Bethel.

REFERENCES CITED (Continued)

Shelden, C. A., T. Hamazaki, M. Horne-Brine, G. Roczicka, M. J. Thalhauser, H. Carroll. 2014. Subsistence salmon harvests in the Kuskokwim area, 2011 and 2012. Alaska Department of Fish and Game, Fishery Data Series No. 14-20 Anchorage.

Spiegelhalter, D. J., A. Thomas, N. G. Best, and D. Lunn. 1999. WinBUGS user manual: Version 1.4. MRC Biostatistics Unit, Cambridge.

Stewart, R. 2002. Resistance board weir panel construction manual, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A02-21, Anchorage.

Stewart, R. 2003. Techniques for installing a resistance board weir, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-26, Anchorage.

Stewart, R. 2004. Middle Fork Goodnews River weir, 2003. Alaska Department of Fish and Game, Regional Information Report 3A04-20, Anchorage.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U. S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai.

Wolfe, R. J., J. J. Gross, G. J. Langdon, J. M. Wright, G. K. Sherrod, L. J. Ellanna, V. Sumida, and P. J. Usher. 1984. Subsistence-based economies in coastal communities of southwest Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No.89, Anchorage.

TABLES AND FIGURES

Table 1.–Daily, cumulative, and cumulative percent passage of Chinook, sockeye, chum, and coho salmon at the Middle Fork Goodnews River weir, 2013.

	Chinook			Sockeye			Chum			Coho		
Date	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum.	% passage	Daily	Cum	% passage
6/24	0	0	0	53	53	0	0	0	0	0	0	0
6/25	0	0	0	340	393	2	28	28	0	0	0	0
6/26	8	8	1	953	1,346	6	89	117	0	0	0	0
6/27	35	43	4	1,302	2,648	11	181	298	1	0	0	0
6/28	21	64	5	1,444	4,092	18	165	463	2	0	0	0
6/29	1	65	5	1,157	5,249	23	73	536	2	0	0	0
6/30	7	72	6	2,220	7,469	32	80	616	2	0	0	0
7/01	5	77	6	1,041	8,510	37	157	773	3	0	0	0
7/02	6	83	7	1,300	9,810	42	190	963	3	0	0	0
7/03	5	88	7	1,378	11,188	48	213	1,176	4	0	0	0
7/04	0	88	7	984	12,172	52	57	1,233	4	0	0	0
7/05	8	96	8	967	13,139	57	212	1,445	5	0	0	0
7/06	38	134	11	1,305	14,444	62	315	1,760	6	0	0	0
7/07	57	191	16	729	15,173	65	322	2,082	7	0	0	0
7/08	49	240	20	840	16,013	69	550	2,632	9	0	0	0
7/09	13 [a]	253	21	265 [a]	16,278	70	68 [a]	2,700	10	0 [a]	0	0
7/10	33	286	24	391	16,669	72	188	2,888	10	0	0	0
7/11	19	305	26	472	17,141	74	179	3,067	11	0	0	0
7/12	24	329	28	293	17,434	75	320	3,387	12	0	0	0
7/13	25	354	30	357	17,791	77	827	4,214	15	0	0	0
7/14	1	355	30	358	18,149	78	816	5,030	18	0	0	0
7/15	2	357	30	618	18,767	81	946	5,976	21	0	0	0
7/16	36	393	33	774	19,541	84	439	6,415	23	0	0	0
7/17	8	401	34	784	20,325	87	1,907	8,322	30	0	0	0
7/18	20	421	35	384	20,709	89	1,837	10,159	36	0	0	0
7/19	36	457	38	274	20,983	90	1,824	11,983	43	0	0	0
7/20	147	604	51	332	21,315	92	3,068	15,051	54	3	3	0
7/21	34	638	54	240	21,555	93	2,142	17,193	61	0	3	0
7/22	175	813	68	104	21,659	93	1,909	19,102	68	0	3	0

-continued-

Table 1.–Page 2 of 3.

Date	Chinook			Sockeye			Chum			Coho		
	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	% passage
7/23	58	871	73	230	21,889	94	1,453	20,555	73	0	3	0
7/24	20	891	75	167	22,056	95	1,140	21,695	77	4	7	0
7/25	13	904	76	94	22,150	95	579	22,274	79	1	8	0
7/26	7	911	77	85	22,235	96	832	23,106	82	1	9	0
7/27	120	1,031	87	76	22,311	96	968	24,074	86	3	12	0
7/28	5	1,036	87	71	22,382	96	359	24,433	87	0	12	0
7/29	4	1,040	87	82	22,464	97	610	25,043	89	5	17	0
7/30	11	1,051	88	34	22,498	97	500	25,543	91	4	21	0
7/31	4	1,055	89	37	22,535	97	376	25,919	92	1	22	0
8/01	5	1,060	89	32	22,567	97	280	26,199	93	2	24	0
8/02	5	1,065	90	24	22,591	97	245	26,444	94	9	33	0
8/03	13	1,078	91	37	22,628	97	137	26,581	95	0	33	0
8/04	14	1,092	92	41	22,669	98	195	26,776	95	9	42	0
8/05	38	1,130	95	68	22,737	98	242	27,018	96	22	64	0
8/06	9	1,139	96	41	22,778	98	204	27,222	97	27	91	0
8/07	9	1,148	97	123	22,901	99	204	27,426	98	22	113	0
8/08	10 [b]	1,158	97	38 [b]	22,939	99	86 [b]	27,512	98	65 [b]	178	1
8/09	3 [c]	1,161	98	21 [c]	22,960	99	70 [c]	27,582	98	45 [c]	223	1
8/10	3 [c]	1,164	98	22 [c]	22,982	99	66 [c]	27,648	98	52 [c]	275	1
8/11	2 [c]	1,166	98	18 [c]	23,000	99	52 [c]	27,700	99	61 [c]	336	1
8/12	2 [c]	1,168	98	18 [c]	23,018	99	41 [c]	27,741	99	76 [c]	412	2
8/13	2 [c]	1,170	98	17 [c]	23,035	99	38 [c]	27,779	99	107 [c]	519	2
8/14	2 [c]	1,172	99	15 [c]	23,050	99	37 [c]	27,816	99	122 [c]	641	3
8/15	2 [c]	1,174	99	14 [c]	23,064	99	30 [c]	27,846	99	163 [c]	804	3
8/16	1 [c]	1,175	99	13 [c]	23,077	99	24 [c]	27,870	99	197 [c]	1,001	4
8/17	2 [b]	1,177	99	11 [b]	23,088	99	23 [b]	27,893	99	226 [b]	1,227	5
8/18	3	1,180	99	25	23,113	99	37	27,930	99	302	1,529	6
8/19	2	1,182	99	11	23,124	99	13	27,943	99	280	1,809	8
8/20	3	1,185	100	15	23,139	100	40	27,983	100	605	2,414	10
8/21	0	1,185	100	1	23,140	100	9	27,992	100	463	2,877	12
8/22	0	1,185	100	9	23,149	100	12	28,004	100	608	3,485	15
8/23	0	1,185	100	6	23,155	100	5	28,009	100	713	4,198	18
8/24	1	1,186	100	1	23,156	100	12	28,021	100	206	4,404	19

-continued-

Table 1.–Page 3 of 3.

	Chinook			Sockeye			Chum			Coho		
Date	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	% passage
8/25	0	1,186	100	0	23,156	100	6	28,027	100	291	4,695	20
8/26	1	1,187	100	3	23,159	100	5	28,032	100	938	5,633	24
8/27	0	1,187	100	4	23,163	100	1	28,033	100	1,024	6,657	28
8/28	0	1,187	100	4	23,167	100	1	28,034	100	745	7,402	31
8/29	0	1,187	100	1	23,168	100	2	28,036	100	412	7,814	33
8/30	0	1,187	100	3	23,171	100	3	28,039	100	637	8,451	36
8/31	0	1,187	100	1	23,172	100	2	28,041	100	8	8,459	36
9/01	0	1,187	100	5	23,177	100	5	28,046	100	4,400	12,859	54
9/02	1 [c]	1,188	100	5 [c]	23,182	100	4 [c]	28,050	100	987 [c]	13,846	58
9/03	1 [c]	1,189	100	5 [c]	23,187	100	4 [c]	28,054	100	859 [c]	14,705	62
9/04	0 [c]	1,189	100	5 [c]	23,192	100	4 [c]	28,058	100	785 [c]	15,490	65
9/05	0 [c]	1,189	100	4 [c]	23,196	100	3 [c]	28,061	100	797 [c]	16,287	69
9/06	0 [c]	1,189	100	4 [c]	23,200	100	3 [c]	28,064	100	844 [c]	17,131	72
9/07	0 [c]	1,189	100	4 [c]	23,204	100	3 [c]	28,067	100	745 [c]	17,876	75
9/08	0 [c]	1,189	100	5 [c]	23,209	100	3 [c]	28,070	100	710 [c]	18,586	78
9/09	0 [c]	1,189	100	4 [c]	23,213	100	3 [c]	28,073	100	656 [c]	19,242	81
9/10	0 [c]	1,189	100	4 [c]	23,217	100	3 [c]	28,076	100	620 [c]	19,862	84
9/11	0 [c]	1,189	100	4 [c]	23,221	100	2 [c]	28,078	100	619 [c]	20,481	86
9/12	0 [c]	1,189	100	4 [c]	23,225	100	2 [c]	28,080	100	592 [c]	21,073	89
9/13	0 [c]	1,189	100	3 [c]	23,228	100	2 [c]	28,082	100	497 [c]	21,570	91
9/14	0 [c]	1,189	100	3 [c]	23,231	100	2 [c]	28,084	100	491 [c]	22,061	93
9/15	0 [c]	1,189	100	3 [c]	23,234	100	2 [c]	28,086	100	463 [c]	22,524	95
9/16	0 [c]	1,189	100	3 [c]	23,237	100	2 [c]	28,088	100	421 [c]	22,945	97
9/17	0 [c]	1,189	100	3 [c]	23,240	100	2 [c]	28,090	100	438 [c]	23,383	99
9/18	0 [c]	1,189	100	3 [c]	23,243	100	1 [c]	28,091	100	319 [c]	23,702	100
Observed	1,189			23,243			28,091			23,702		
Estimated	21			214			418			11,809		
% Observed	98.2			99.1			98.5			50.2		

Note: Shaded areas indicate 80% of the run. Outside boxes indicate the estimated central 50% of passage. Bold boxes indicate the date that the estimated cumulative 50% passage occurred.

[a] Partial count, a breach occurred in the weir; missed passage was not estimated.

[b] Partial count, flooding occurred; missed passage was estimated.

[c] Weir was not operational, daily passage was estimated.

Table 2.–Daily, cumulative, and cumulative percent passage of pink salmon and Dolly Varden at the Middle Fork Goodnews weir, 2013.

	Pink Salmon			Dolly Varden			Whitefish		Rainbow Trout	
Date	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	Daily	Cum
6/24	0	0	0	1	1	0	0	0	0	0
6/25	0	0	0	1	2	0	1	1	0	0
6/26	0	0	0	3	5	0	1	2	0	0
6/27	0	0	0	0	5	0	8	10	0	0
6/28	0	0	0	0	5	0	4	14	8	8
6/29	0	0	0	0	5	0	1	15	0	8
6/30	0	0	0	2	7	0	4	19	2	10
7/01	0	0	0	1	8	0	1	20	0	10
7/02	0	0	0	0	8	0	0	20	0	10
7/03	0	0	0	2	10	0	1	21	1	11
7/04	0	0	0	0	10	0	0	21	0	11
7/05	0	0	0	2	12	0	0	21	0	11
7/06	0	0	0	0	12	0	0	21	0	11
7/07	0	0	0	0	12	0	0	21	0	11
7/08	1	1	0	6	18	0	0	21	0	11
7/09	0 [a]	1	0	0 [a]	18	0	0 [a]	21	0 [a]	11
7/10	8	9	2	8	26	1	0	21	0	11
7/11	6	15	3	5	31	1	0	21	0	11
7/12	16	31	6	3	34	1	0	21	0	11
7/13	11	42	8	2	36	1	0	21	0	11
7/14	11	53	10	3	39	1	0	21	0	11
7/15	20	73	14	144	183	4	6	27	0	11
7/16	57	130	25	330	513	10	0	27	3	14
7/17	25	155	29	446	959	19	8	35	1	15
7/18	20	175	33	516	1,475	29	0	35	0	15
7/19	17	192	36	292	1,767	34	1	36	7	22
7/20	38	230	43	835	2,602	50	7	43	5	27
7/21	33	263	50	666	3,268	63	29	72	3	30
7/22	24	287	54	351	3,619	70	27	99	0	30
7/23	51	338	64	312	3,931	76	19	118	2	32
7/24	42	380	72	396	4,327	84	0	118	0	32
7/25	3	383	72	120	4,447	86	4	122	3	35

-continued-

Table 2.–Page 2 of 3.

	Pink Salmon			Dolly Varden			Whitefish		Rainbow Trout	
Date	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	Daily	Cum
7/26	14	397	75	105	4,552	88	12	134	3	38
7/27	6	403	76	142	4,694	91	16	150	0	38
7/28	2	405	76	42	4,736	92	2	152	2	40
7/29	5	410	77	93	4,829	94	5	157	4	44
7/30	4	414	78	37	4,866	94	2	159	1	45
7/31	3	417	79	49	4,915	95	0	159	0	45
8/01	5	422	80	38	4,953	96	0	159	0	45
8/02	4	426	80	32	4,985	97	3	162	1	46
8/03	4	430	81	13	4,998	97	0	162	0	46
8/04	3	433	82	28	5,026	97	2	164	1	47
8/05	6	439	83	44	5,070	98	3	167	0	47
8/06	5	444	84	39	5,109	99	0	167	2	49
8/07	11	455	86	19	5,128	99	0	167	0	49
8/08	5 [a]	460	87	17 [a]	5,145	100	1 [a]	168	1 [a]	50
8/09	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/10	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/11	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/12	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/13	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/14	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/15	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/16	0 [b]	460	87	0 [b]	5,145	100	0 [b]	168	0 [b]	50
8/17	0 [a]	460	87	0 [a]	5,145	100	0 [a]	168	0 [a]	50
8/18	14	474	89	4	5,149	100	0	168	0	50
8/19	5	479	90	2	5,151	100	1	169	0	50
8/20	17	496	94	2	5,153	100	0	169	0	50
8/21	4	500	94	0	5,153	100	0	169	0	50
8/22	2	502	95	1	5,154	100	0	169	0	50
8/23	3	505	95	0	5,154	100	3	172	1	51
8/24	1	506	95	0	5,154	100	2	174	0	51
8/25	2	508	96	0	5,154	100	0	174	0	51
8/26	3	511	96	3	5,157	100	0	174	0	51
8/27	4	515	97	1	5,158	100	0	174	0	51
8/28	3	518	98	2	5,160	100	2	176	0	51

-continued-

Table 2.–Page 3 of 3.

	Pink Salmon			Dolly Varden			Whitefish		Rainbow Trout	
Date	Daily	Cum	% passage	Daily	Cum	% passage	Daily	Cum	Daily	Cum
8/29	1	519	98	1	5,161	100	0	176	0	51
8/30	6	525	99	1	5,162	100	0	176	0	51
8/31	1	526	99	0	5,162	100	0	176	0	51
9/01	4	530	100	1	5,163	100	3	179	0	51
9/02	0 [b]	530	100	0 [b]	5,163	100	0 [b]	179	0 [b]	51
Total	530			5,163			179		51	

Note: Shaded areas indicate 80% of the run. Outside boxes indicate the estimated central 50% of passage. Bold boxes indicate the date that the estimated cumulative 50% passage occurred.

[a] Partial day counts because of a breach in weir; no estimates were made.

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

Table 3.–Age and sex composition and mean length (mm) of Chinook salmon escapement at the Middle Fork Goodnews River weir, 2013.

		Brood Year (Age)													
		2010		2009		2008		2007		2006		2006			
		1.1		1.2		1.3		1.4		1.5		2.4		Total	
Sample Size		*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
175	Male	6	0.5	176	14.8	143	12.0	190	16.0	0	0.0	0	0.0	515	43.3
	Female	0	0.0	0	0.0	124	10.4	533	44.9	12	1.0	5	0.5	674	56.7
	Total	6	0.5	176	14.8	267	22.4	723	60.8	12	1.0	5	0.5	1,189	100.0
	95% C.I. (± %)		0.9		5.2		6.2		7.2		1.8		0.8		0.3
	Male Mean Length	380		522		753		865							
	SE			10		24		21							
	Range			421-650		564-866		726-1060							
	n	1		26		19		25							
	Female Mean Length					801		870		852		949			
	SE					11		5							
	Range					703-861		746-970							
	n					19		83		1		1			

Note: Samples were sufficient for stratification based on proportions of cumulative escapement. A weighted total is presented.

Table 4.–Age and sex composition and mean length (mm) of sockeye salmon escapement at the Middle Fork Goodnews River weir, 2013.

		Brood Year(Age)																	
		2010		2009		2009		2008		2008		2007		2007		2006		2006			
		0.2		0.3		1.2		1.3		2.2		1.4		2.3		2.4		3.3		Total	
Sample Size		*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
625	Male	23	0.1	47	0.2	558	2.4	5,151	22.2	47	0.2	798	3.4	2,528	10.9	463	2.0	533	2.3	10,147	43.7
	Female	0	0.0	382	1.6	1,013	4.4	7,049	30.3	673	2.9	683	2.9	2,449	10.5	151	0.6	696	3.0	13,096	56.3
	Total	23	0.1	429	1.8	1,571	6.8	12,200	52.5	719	3.1	1,481	6.4	4,977	21.4	613	2.6	1,229	5.3	23,243	100.0
	95% C.I.		0.2		1.3		2.0		4.6		1.5		2.4		3.7		1.6		2.1		0.1
	Male Mean Length	591		576		507		575		525		608		573		588		553			
	SE			16		5		2		35		2		2		4		10			
	Range			560-592		431-543		506-618		490-559		589-633		520-621		560-613		515-600			
	n	1		2		19		147		2		17		69		10		13			
	Female Mean Length			530		483		542		474		565		535		570		523			
	SE			5		3		1		10		7		2		3		4			
	Range			470-560		448-529		498-588		433-525		520-584		485-580		565-586		500-554			
	n			9		36		167		19		17		73		4		20			

Note: Samples were sufficient for stratification based on proportions of cumulative escapement. A weighted total is presented.

Table 5.–Age and sex composition and mean length (mm) of chum salmon escapement at the Middle Fork Goodnews River weir, 2013

		Brood Year (Age)							
		2009		2008		2007			
		0.3		0.4		0.5			Total
Sample Size		*N*	%	*N*	%	*N*	%	*N*	%
494	Male	4,526	16.1	10,680	38.0	418	1.5	15,624	55.6
	Female	4,699	16.7	7,434	26.5	334	1.2	12,467	44.4
	Total	9,225	32.8	18,114	64.5	752	2.7	28,091	100.0
	95% C.I. (± %)		4.2		4.3		1.4		0.1
	Male Mean Length	586		606		641			
	SE	3.36		2.86		13.14			
	Range	503-663		502-798		605-730			
	n	82		193		8			
	Female Mean	551		570		566			
	SE	2.95		2.88		14.18			
	Range	499-603		493-693		528-615			
	n	77		129		5			

Note: Samples were sufficient for stratification based on proportions of cumulative escapement. A weighted total is presented.

Table 6.–Age and sex composition and mean length (mm) of coho salmon escapement at the Middle Fork Goodnews River weir, 2013.

		Brood Year (Age)									
		2010		2009		2008		2007			
		1.1		2.1		3.1		4.1		Total	
Sample Size		*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
132	Male	5	3.8	58	43.9	1	0.8	0	0.0	64	48.5
	Female	5	3.8	60	45.5	2	1.5	1	0.8	68	51.5
	Total	10	7.6	118	89.4	3	2.3	1	0.8	132	100.0
	Male Mean Length	550		597		590					
	SE	16		6							
	Range	494-583		406-668							
	n	5		58		1					
	Female Mean Length	565		602		610		601			
	SE	7		4		10					
	Range	542-585		488-665		600-620					
	n	5		60		2		1			

Note: Samples were sufficient for stratification based on proportions of cumulative escapement. A weighted total is not available.

Table 7.–Daily weather and hydrological at the Middle Fork Goodnews River weir, 2013.

Date	Wind (Dir./Speed)	Precipitation mm/24hr	Air Temp. °C	Water Temp °C	Cloud Cover %/altitude (ft)	Water Level (cm)
6/21	SE/10	0.0	8	11	100/2000	8.0
6/22	SE/20	2.5	8	11	fog	6.0
6/23	SE/5	1.8	9	8	100/3000	24.0
6/24	calm	0.3	10	8	100/3000	17.0
6/25	calm	0.0	14	9	50/4000	14.0
6/26	calm	0.00	15	10	40/5000	10
6/27	calm	0.00	8	11	10\4000	8
6/28	calm	0.00	12	10	100/4000	7
6/29	calm	0.00	10	10	75/4000	5
6/30	SE/5	10.16	8	9	100/1000	5
7/01	calm	6.10	8	9	100/1000	13
7/02	calm	3.30	7	8	100/1000	15
7/03	calm	2.03	8	8	100/1000	18
7/04	SW/5	5.08	6	8	100/500	23
7/05	calm	0.00	8	8	100/1500	23
7/06	SE/5	3.81	7	8	100/500	21
7/07	W/5	9.91	8	8	100/1500	24
7/08	calm	1.78	7	8	100/500	23
7/09	calm	9.65	9	8	30/4000	25
7/10	calm	0.00	6	8	20/4000	25
7/11	calm	0.00	8	9	10\5000	20
7/12	calm	0.00	8	9	10\5000	17
7/13	E/5	0.00	13	9	30/10000	14
7/14	W/5	0.00	11	9	100/500	9
7/15	calm	5.08	10	9	100/1500	9.0
7/16	calm	2.03	9	8	100/800	7
7/17	calm	7.62	10	8	100/500	8
7/18	calm	4.57	12	9	fog	9
7/19	calm	0.76	10	9	fog	8
7/20	calm	trace	10	9	100/500	7
7/21	calm	0.00	10	10	95/1000	6
7/22	calm	0.00	15	12	30/10000	-2
7/23	N/2	0.00	18	13	80/1500	-2
7/24	N/5	0.00	16	12	80/1500	-2
7/25	calm	0.00	16	12	0	-2
7/26	calm	0.00	20	13	0	-4
7/27	SW/2	0.00	15	12	fog	-5
7/28	SW/3	0.00	15	9	100/1000	-6
7/29	SW/1	0.00	16	12	50/1500	-6
7/30	calm	0.00	16	14	50/1000	-8
7/31	SW/3	0.00	16	14	90/1500	-9
8/01	SW/3	5.08	13	10	100/500	-8
8/02	E/5	8.38	12	9	100/500	-5
8/03	calm	11.18	14	9	100/500	0
8/04	SE/10	7.62	16	12	100/800	0
8/05	SE/5	9.65	13	11	100/500	-2
8/06	E/10	13.72	14	11	100/1000	1
8/07	calm	25.40	12	11	100/1000	15
8/08	E/5	7.87	11	10	100/500	28
8/09	SE/5	3.30	10	10	100/1000	42

-continued-

Table 7.–Page 2 of 2.

Date	Wind (Dir./Speed)	Precipitation mm/24hr	Air Temp. °C	Water Temp °C	Cloud Cover %/altitude (ft)	Water Level (cm)
8/10	calm	5.6	10	9	100/1000	45.0
8/11	calm	1.8	12	10	100/1000	50.0
8/12	calm	0.0	8	9	fog	48.0
8/13	E/15	0.51	13	10	80/2000	42
8/14	SE/15	2.54	11	10	100/1000	40
8/15	calm	4.57	12	9	100/1500	43
8/16	calm	2.79	13	10	100/1000	40
8/17	calm	2.03	13	10	90/1500	40
8/18	calm	5.33	11	9	50/1500	36
8/19	calm	2.79	12	10	100/1000	35
8/20	calm	0.00	15	10	100/1000	25
8/21	E/10	4.32	12	10	100/500	22
8/22	E/5	4.06	11	9	100/500	22
8/23	calm	2.29	14	10	100/1000	21
8/24	calm	0.00	10	9	10/1000	17
8/25	SE/10	12.45	11	10	100/1000	18
8/26	calm	2.29	12	10	100/500	18
8/27	SW/5	3.05	10	10		17
8/28	calm	0.76	10	9	100/2000	18
8/29	E/5	0.00	13	10	80/2000	16
8/30	calm	0.00	7	9	80/2500	15
8/31	calm	0.00	8	9	100/1000	12
9/01	–	trace	–	–	–	28
9/02	SE/5	31.75	12	10	100/1000	40
9/03	E/5	10.67	11	10	100/1000	78
9/04	S/5	7.87	7	9	90/2000	82
9/05	calm	1.27	10	9	50/3000	80
9/06	calm	1.52	8	9	20/5000	73
9/07	calm	1.02	5	9	90/2500	65
9/08	calm	1.02	7	9	80/3000	59
9/09	calm	7.62	7	9	100/3000	52
9/10	W/10	2.79	6	8	100/500	50
9/11	calm	2.03	6	7	100/2500	45
9/12	E/10	2.79	7	7	100/2000	40
9/13	calm	2.29	7	8	90/2000	38
9/14	calm	0.00	5	7	100/2000	32
9/15	calm	0.76	7	8	90/3000	24
Min		0.00	5	7		-9
Max		31.75	20	14		82
Average		3.52	11	10		22

Note: Weather conditions are recorded at 1000 hours each day.

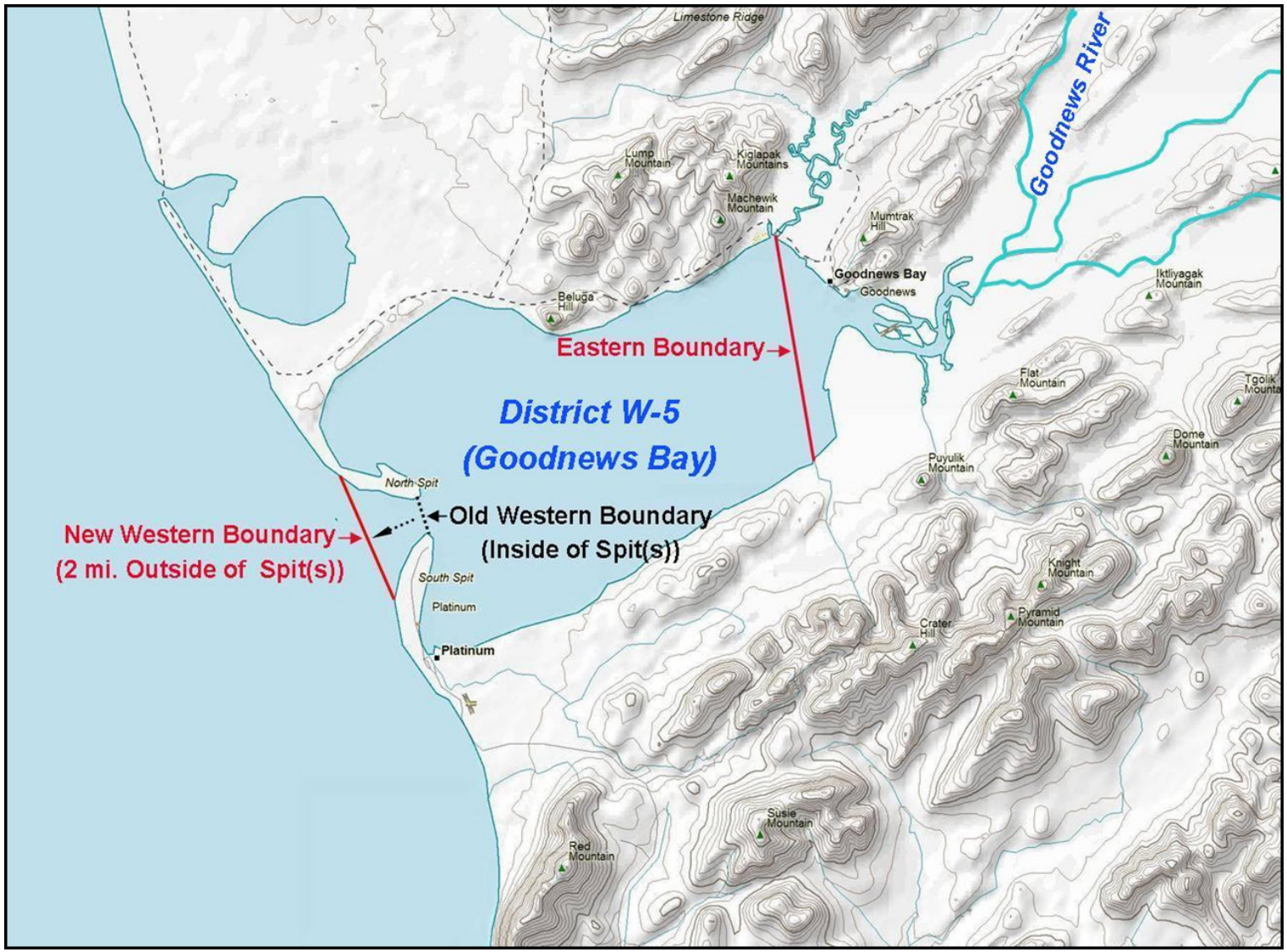

Figure 1.–Commercial fishing District W-5 (Goodnews Bay), Kuskokwim Bay, Alaska.

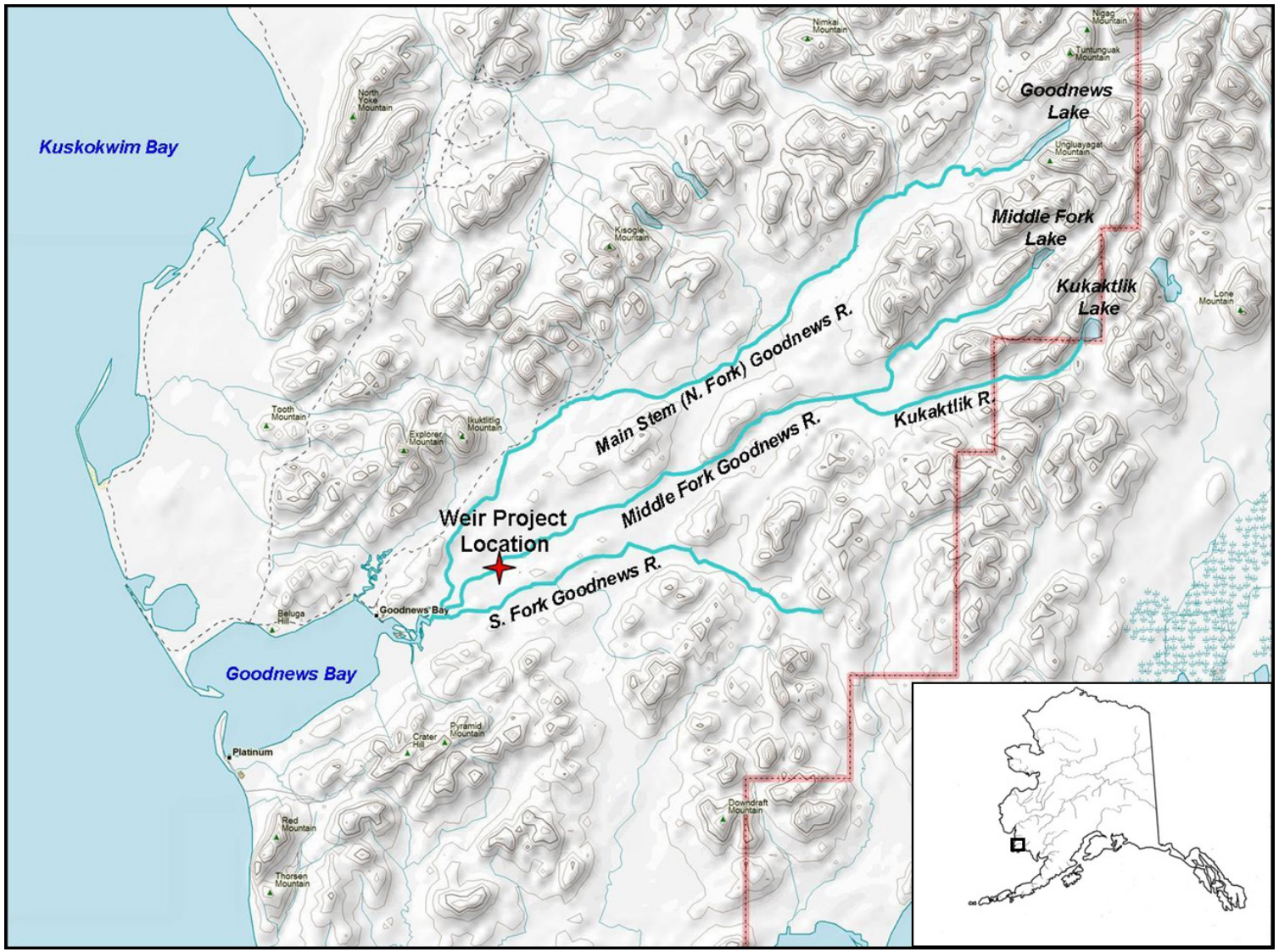

Figure 2.–The Goodnews River drainage, Kuskokwim Bay, Alaska.

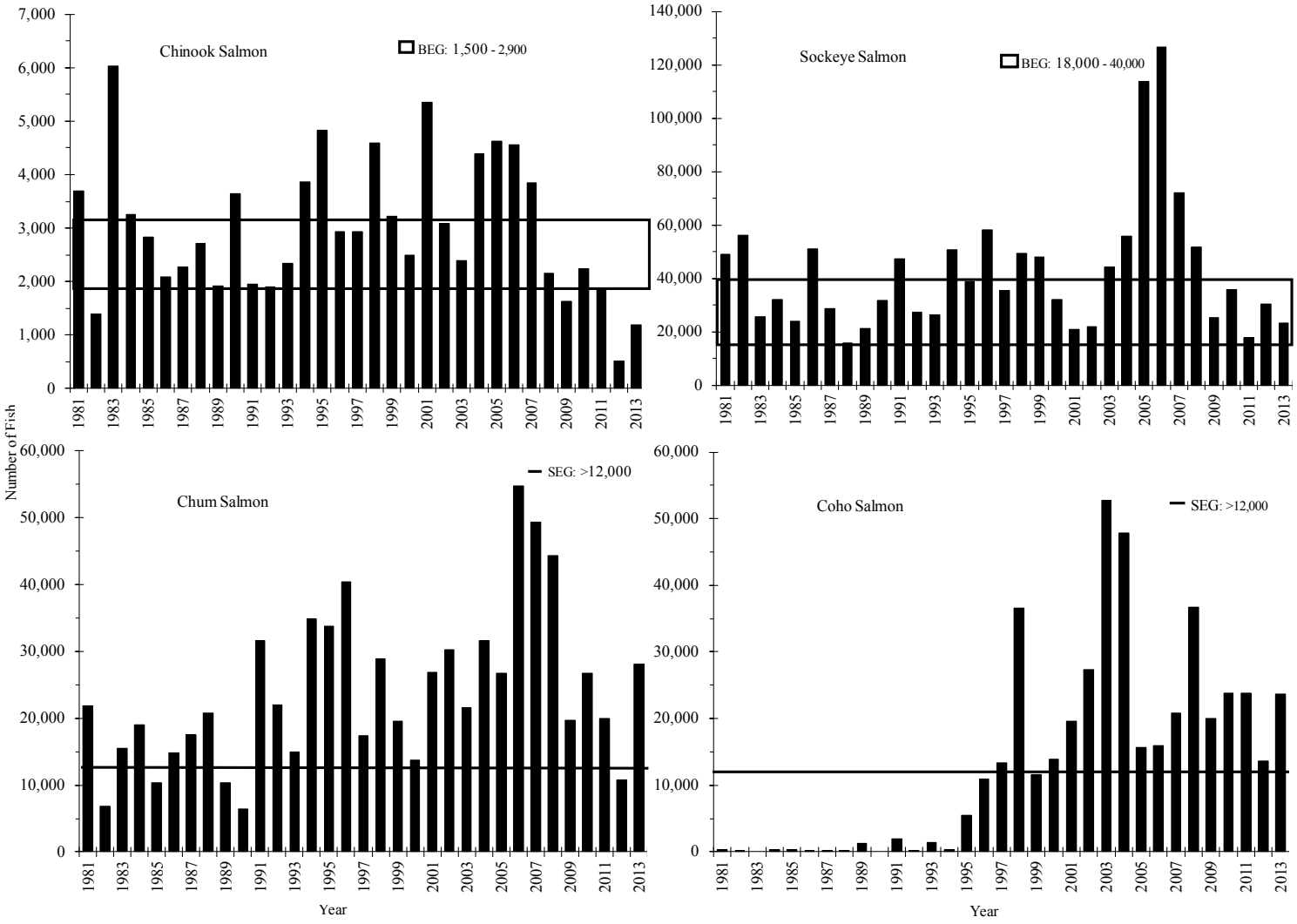

Figure 3.–Historical Chinook, sockeye, chum, and coho salmon escapement estimates at the Middle Fork Goodnews River weir, 1981–2013.

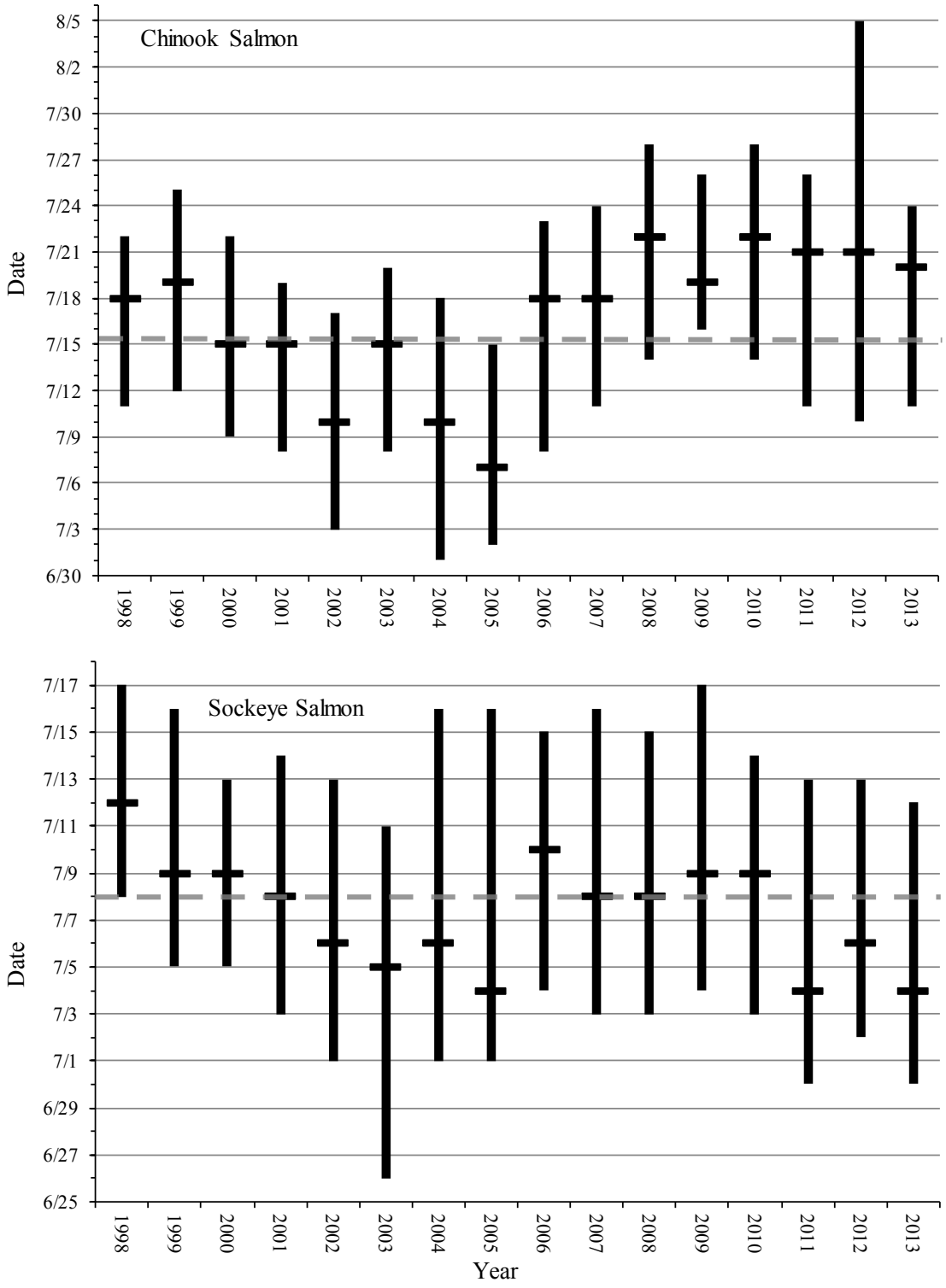

Figure 4.–Annual run timing of Chinook and sockeye salmon based on cumulative percent passage at the Middle Fork Goodnews River weir, 1998–2013.

Note: Solid lines represent the dates when the central 50% of the run passed; cross-bars represent the median passage date and dashed line represent historic median (1998–2012).

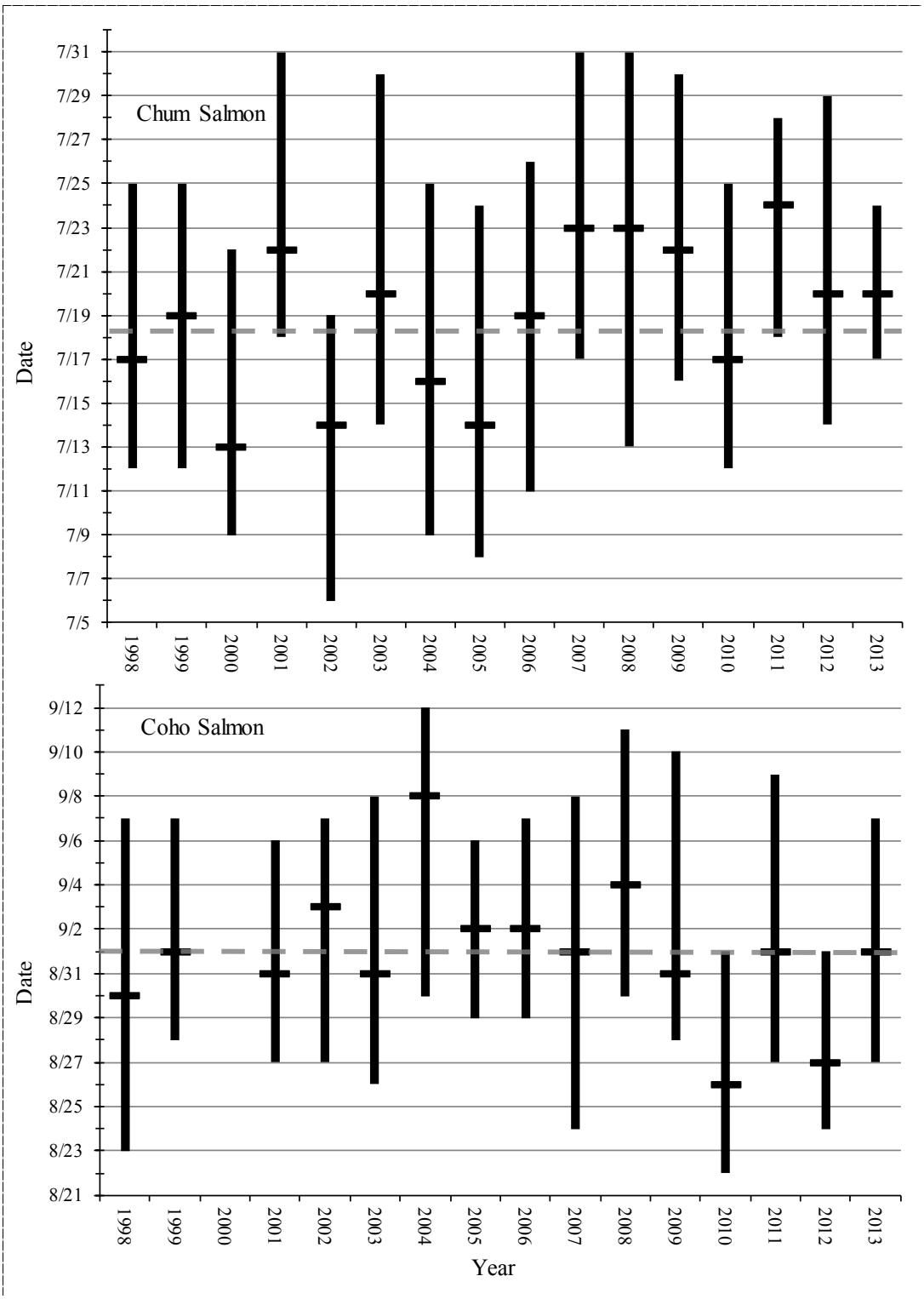

Figure 5.–Annual run timing of chum and coho salmon based on cumulative percent passage at the Middle Fork Goodnews River weir, 1998–2013.

Note: Solid lines represent the dates when the central 50% of the run passed; cross-bars represent the median passage date and dash line represent historic median (1998–2012).

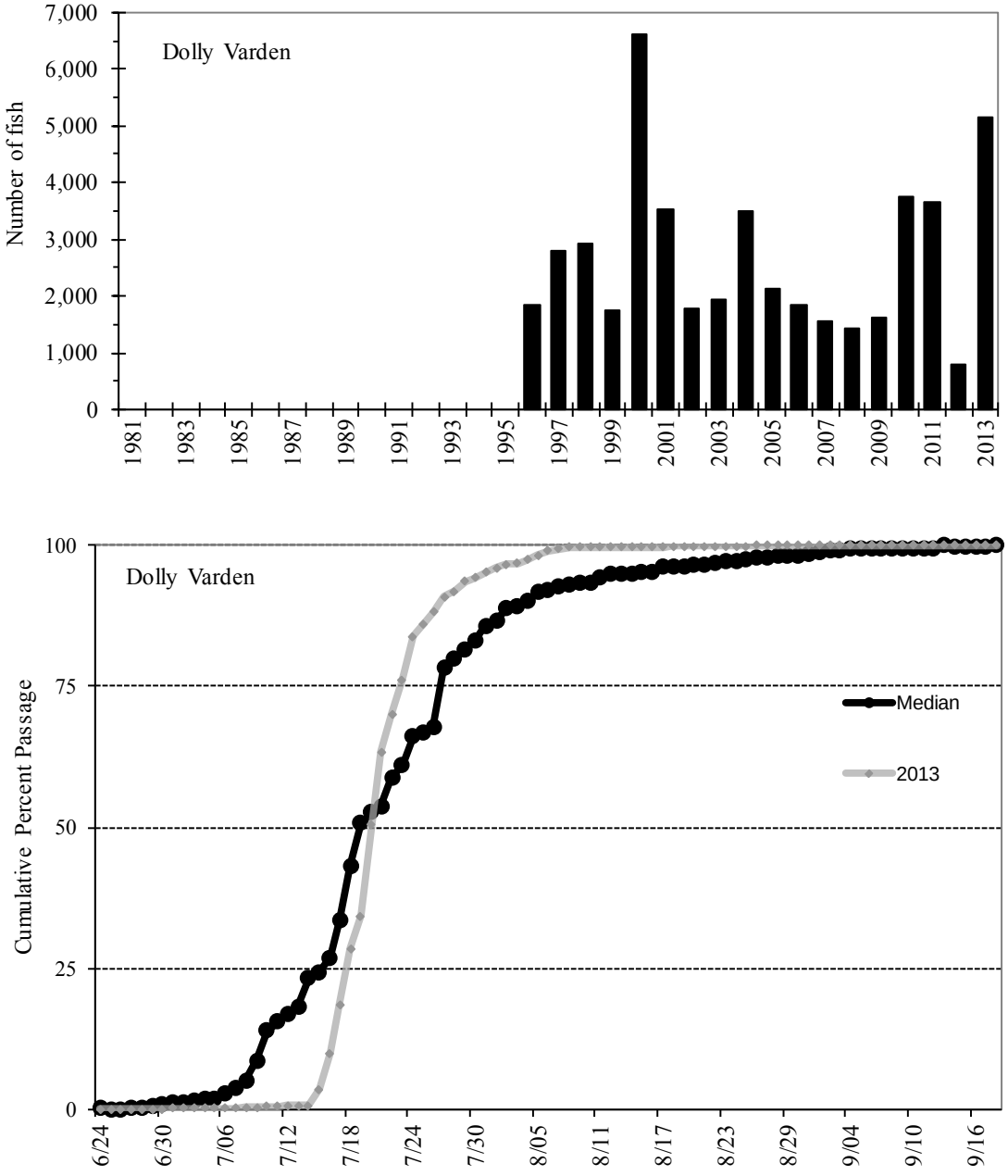

Figure 6.–Historical Dolly Varden char escapement estimate, 1981–2013, cumulative percent passage of Dolly Varden char 2013, and historical median at the Middle Fork Goodnews River weir.

APPENDIX A: HISTORICAL MIDDLE FORK GOODNEWS RIVER ESCAPEMENT PROJECTS, 1981–2013.

Appendix A1.–Historical Middle Fork Goodnews River escapement projects, 1981–2013.

Year	Method	Dates of Operation	Chinook	Sockeye	Chum	Pink[a]	Coho	Dolly Varden
1981	Counting Tower[b]	6/13–8/9	3,688	49,108	21,827	[c]	356 [d]	[c]
1982	Counting Tower[b]	6/23– 8/3	1,395	56,255	6,767	[c]	91 [d]	[c]
1983	Counting Tower[b]	6/11–7/28	6,027	25,816	15,548	[c]	0 [d]	[c]
1984	Counting Tower[b]	6/15–7/31	3,260	32,053	19,003	[c]	249 [d]	[c]
1985	Counting Tower[b]	6/27–7/31	2,831	24,131	10,367	[c]	282 [d]	[c]
1986	Counting Tower[b]	6/16–7/24	2,080	51,069	14,764	[c]	163 [d]	[c]
1987	Counting Tower[b]	6/22–7/30	2,272	28,871	17,517	[c]	62 [d]	[c]
1988	Counting Tower[b]	6/23–7/30	2,712	15,799	20,799	[c]	6 [d]	[c]
1989	Counting Tower[b]	6/27–7/31	1,915	21,186	10,380	[c]	1,212 [d]	[c]
1990	Counting Tower[b]	6/20 –7/31	3,636	31,679	6,410	[c]	0 [d]	[c]
1991	Fixed Picket Weir[e]	6/29 - 8/23	1,952	47,397	31,644	1,428	1,978 [d]	[c]
1992	Fixed Picket Weir[e]	6/21–8/4	1,905	27,268	22,023	22,601	150 [d]	[c]
1993	Fixed Picket Weir[e]	6/23–8/18	2,349	26,452	14,952	318	1,451 [d]	[c]
1994	Fixed Picket Weir[e]	6/23–8/9	3,856	50,801	34,849	38,705	309 [d]	[c]
1995	Fixed Picket Weir[e]	6/19–8/28	4,836	39,009	33,699	330	5,415 [d]	[c]
1996	Fixed Picket Weir[e]	6/19–8/23	2,931	58,290	40,450	20,105	10,869 [d]	1,829 [d]
1997	Fixed/R. Board Weir	6/12–9/17	2,937	35,530	17,369	940	13,413	2,808
1998	R. Board Weir	7/4–9/17	4,584 [d]	49,513 [d]	28,832 [d]	10,376	36,596	2,915
1999	R. Board Weir	6/25–9/26	3,221	48,205	19,513	914	11,545	1,761
2000	R. Board Weir	7/2–8/27	2,500 [d]	32,341 [d]	13,791 [d]	0	13,907	6,616
2001	R. Board Weir	6/26–9/30	5,351	21,024	26,820	5,405	19,626	3,535
2002	R. Board Weir	6/25–9/18	3,085	22,101	30,300	0	27,364	1,770
2003	R. Board Weir	6/18–9/18	2,389	44,387	21,637	1,921	52,810	1,949
2004	R. Board Weir	6/21–9/20	4,388	55,926	31,616	21,633	47,917	3,492
2005	R. Board Weir	6/26–9/8	4,633	113,809	26,690	5,926	15,683	2,128
2006	R. Board Weir	6/26–9/7	4,559	126,772	54,699	18,432	15,969	1,858
2007	R. Board Weir	6/25–9/10	3,852	72,282	49,285	4,819	20,767	1,549
2008	R. Board Weir	7/02–9/15	2,158	51,763	44,310	9,807	36,663	1,416
2009	R. Board Weir	6/28–9/21	1,630	25,465	19,715	714	20,000	1,608
2010	R. Board Weir	6/25–9/18	2,244	35,762	26,687	3,444	23,839	3,757
2011	R. Board Weir	6/25–9/19	1,861	17,946	19,974	1,394	23,826	3,667
2012	R. Board Weir	6/29–9/3	513	30,472	10,723	6,316	13,679	798
2013	R. Board Weir	6/24–9/1	1,189	23,243	28,091	530	23,702	5,160
Average (2003–2012)			2,823	57,458	30,534	7,441	27,115	2,222
Historical Average			3,048	42,765	23,842	7,979	24,600	2,556

[a] Picket spacing of the weir panels allows pink salmon to freely pass through the weir unobserved.

[b] Project located approximately 500 yards upriver from current weir location.

[c] Species not enumerated during project operations.

[d] No counts or incomplete counts as the project was not operational during a large portion of species migration.

[e] Fixed picket weir operated in the same location as the current weir.