Fishery Data Series No. 26-18

Sonar Estimation of Chinook and Fall Chum Salmon Passage in the Yukon River Near Eagle, Alaska, 2025

by

Quinn E. Davis

and

Mark T. Jackson

July 2026

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 figures 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. 26-18

SONAR ESTIMATION OF CHINOOK AND FALL CHUM SALMON PASSAGE IN THE YUKON RIVER NEAR EAGLE, ALASKA, 2025

by
Quinn E. Davis and Mark T. Jackson
Alaska Department of Fish and Game, Division of Commercial Fisheries, Fairbanks

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

July 2026

This investigation was financed by the U.S./Canada Treaty Implementation Fund administered by the U.S. Fish and Wildlife Service, agreement award F18AP00851; the Yukon River Restoration and Enhancement Fund, agreement award ADFG 23-109, URE-166-23; and the ADF&G General Fund.

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.

Quinn E. Davis and Mark T. Jackson,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Rd, Anchorage, AK 99518, USA

This document should be cited as follows:
Davis, Q. E., and M. T. Jackson. 2026. Sonar estimation of Chinook and fall chum salmon passage in the Yukon River near Eagle, Alaska, 2025. Alaska Department of Fish and Game, Fishery Data Series No. 26-18, Anchorage.

TABLE OF CONTENTS

Page

LIST OF TABLES ... ii

LIST OF FIGURES ... ii

LIST OF APPENDICES ... iii

ABSTRACT ... 1

INTRODUCTION ... 1

OBJECTIVES ... 3

METHODS ... 3

Study Area ... 4
Hydroacoustic Equipment ... 4
Sonar Deployment and Operation ... 4
Sonar Data Processing and Passage Estimation ... 5
Missing Data ... 6
Spatial and Temporal Distributions ... 7
Test Fishing ... 7
Species Determination ... 9
Catch Per Unit Effort Calculations ... 9
  Determination of Chinook and fall chum salmon transition date ... 9
Climatic and Hydrologic Observations ... 10

RESULTS AND DISCUSSION ... 10

Sonar Deployment ... 10
Chinook and Fall Chum Salmon Passage Estimation ... 10
Spatial and Temporal Distribution ... 11
Test Fishing ... 11
Climatic and Hydrologic Observations ... 12

ACKNOWLEDGMENTS ... 12

REFERENCES CITED ... 12

TABLES AND FIGURES ... 15

APPENDIX A: SPECIES COMPOSITION TEST FISHERY CATCH, CPUE, AND SMOOTHED DATA BY DAY AND SALMON SPECIES ... 49

APPENDIX B: CLIMATIC AND HYDROLOGIC OBSERVATIONS ... 53

LIST OF TABLES

Table		Page
1	Split-beam sonar system settings at the Eagle sonar project on the Yukon River, 2025.	16
2	Technical specifications and settings for the adaptive resolution imaging sonar at the Eagle sonar project on the Yukon River, 2025.	17
3	Net schedule of mesh sizes, in inches, used for Chinook salmon test fishing and species composition, and fall chum salmon test fishing for all zones at the Eagle sonar project on the Yukon River, 2025.	18
4	Specifications for drift gillnets used for test fishing at the Eagle sonar project on the Yukon River, 2025.	18
5	Cumulative fish passage estimates by bank and species with standard errors and 95% confidence intervals, at the Eagle sonar project on the Yukon River, 2025.	18
6	Estimated daily and cumulative Chinook salmon passage by bank at the Eagle sonar project on the Yukon River, 2025.	19
7	Sampling time, in minutes, missed by bank, stratum, and date during Chinook salmon sampling at the Eagle sonar project on the Yukon River, 2025.	21
8	Estimated daily and cumulative fall chum salmon passage by bank at the Eagle sonar project on the Yukon River, 2025.	23
9	Sampling time, in minutes, missed by bank, stratum, and date during fall chum salmon sampling at the Eagle sonar project on the Yukon River, 2025.	25
10	Fish caught using gillnets at the Eagle sonar project on the Yukon River, 2025.	26
11	Fishing effort, catch, and proportion by zone and mesh size for Chinook and fall chum salmon in the Chinook salmon test fishery at the Eagle sonar project on the Yukon River, 2025.	26
12	Fishing effort, catch, and proportion by zone and mesh size for Chinook and fall chum salmon in the species composition fishery and the fall chum salmon test fishery at the Eagle sonar project on the Yukon River, 2025.	27

LIST OF FIGURES

Figure		Page
1	Yukon River drainage.	28
2	Illustration of strata and approximate sonar ranges at the Eagle sonar project on the Yukon River, 2025.	29
3	Eagle sonar project site at Six Mile Bend on the Yukon River showing sonar and drift gillnet fishing locations, 2025.	30
4	Depth profile of the Yukon River in front of transducers and approximate sonar coverage at the Eagle sonar project, 2025.	31
5	Split-beam transducer mounted to an aluminum H-mount and the same transducer mounted to 2 single-axis automated rotators used on the left bank at the Eagle sonar project on the Yukon River.	32
6	Portable tripod-style fish lead used on the left bank and seine mesh fish lead used on the right bank at the Eagle sonar project on the Yukon River.	33
7	ARIS imaging sonar and AR2 Rotator mounted to an aluminum H-mount and close-up view of rotator mount at the Eagle sonar project on the Yukon River.	34
8	Screenshot of an echogram from a split-beam sonar data file used to count fish and determine direction of travel at the Eagle sonar project on the Yukon River.	35
9	Screenshots of an echogram and video from an ARIS data file used to count fish and determine direction of travel at the Eagle sonar project on the Yukon River.	36
10	Daily catch during species composition fishing and sonar passage estimates at the Eagle sonar project on the Yukon River, 2025.	37
11	Proportion of catch based on smoothed Chinook and fall chum salmon species composition CPUE data at the Eagle sonar project on the Yukon River, 2025.	38
12	2025 Chinook and fall chum salmon daily cumulative passage timing compared to the 2005–2024 and 2006–2024 mean passage timing at the Eagle sonar project on the Yukon River.	39

LIST OF FIGURES (Continued)

Figure **Page**

13 Daily sonar passage estimates for Chinook salmon from July 1 through August 25 and fall chum salmon from August 26 through October 18 at the Eagle sonar project on the Yukon River, 2025. 40

14 Left and right bank horizontal distribution of upstream migrating Chinook salmon from July 1 through August 25 at the Eagle sonar project on the Yukon River, 2025..41

15 Left and right bank horizontal distribution of upstream migrating fall chum salmon from August 26 through October 6 at the Eagle sonar project on the Yukon River, 2025..42

16 Percent of total Chinook salmon passage, by hour, observed on the left bank, right bank, and both banks combined from July 1 through August 25 at the Eagle sonar project on the Yukon River, 2025. 43

17 Percent of total fall chum salmon passage, by hour, observed on the left bank, right bank, and both banks combined from August 26 through October 6 at the Eagle sonar project on the Yukon River, 2025...44

18 Chinook and fall chum salmon passage, total cumulative catch per unit effort by year and mean total cumulative CPUE at the Eagle sonar project on the Yukon River, 2025. 45

19 Median daily water temperature recorded from July 1 through October 6 on the left bank at the Eagle sonar project on the Yukon River, 2025...46

20 Yukon River water level recorded daily at 1800 during the 2025 season at the city of Eagle, compared to minimum, maximum, and median gauge height from 1995 to 2024...47

LIST OF APPENDICES

Appendix **Page**

A1 Species composition test fishery catch, catch per unit effort, and smoothed data by day and salmon species at the Eagle sonar project on the Yukon River, 2025...50

B1 Climatic and hydrologic observations recorded at 1800 daily at the Eagle sonar project site on the Yukon River, 2025. 54

ABSTRACT

Adaptive resolution imaging sonar (ARIS) and split-beam sonar equipment were used to estimate Chinook (*Oncorhynchus tshawytscha*) and fall chum salmon (*O. keta*) passage in the Yukon River near Eagle, Alaska, from July 1 through October 6, 2025. A total of 23,863 (SE 182) Chinook salmon were estimated to have passed the sonar site from July 1 through August 25. The midpoint of the Chinook salmon migration occurred on July 29, which was 4 days later than the historical mean. A total of 18,404 (SE 164) fall chum salmon were estimated to have passed the sonar site from August 26 through October 6. The fall chum salmon passage estimate was subsequently expanded to 19,574 to include fish that may have passed after operations ceased. The midpoint of the fall chum salmon migration (based on the expanded estimate) occurred on September 20, which was 3 days earlier than the historical mean. Drift gillnetting was conducted to collect age, sex, and length data, as well as tissue samples for genetic analysis. Species composition was analyzed to determine when the Chinook salmon migration ended and the fall chum salmon migration began.

Keywords: Chinook salmon, *Oncorhynchus tshawytscha*, fall chum salmon, *Oncorhynchus keta*, adaptive resolution imaging sonar, ARIS, dual-frequency identification sonar, DIDSON, split-beam sonar, hydroacoustic, Eagle, Yukon River, Alaska

INTRODUCTION

The Yukon River is the longest river in the Yukon Territory and Alaska, spanning 3,190 km.[1] It flows northwesterly from its origin in northwestern British Columbia, through the Yukon Territory and Central Alaska, to its mouth in the Bering Sea. Commercial and subsistence fisheries harvest Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*O. keta*), and coho salmon (*O. kisutch*) throughout most of the drainage. These fisheries have traditionally been critical to the way of life and economy of people in dozens of communities along the river and, in many instances, have provided the largest single source of food or income.

Fisheries management on the Yukon River is complex and challenging because of the number, diversity, and geographic range of fish stocks and user groups. Information for management decisions comes from several sources, each with unique strengths and weaknesses. Gillnet test fisheries provide inseason indices of run strength, but the interpretation of these data is confounded by gillnet selectivity. In addition, the functional relationship between test fishery catches and abundance is poorly defined. Mark–recapture projects provide estimates of total abundance, but the resulting information is typically not timely enough for day-to-day management decisions. Sonar provides timely estimates of abundance but is limited in its ability to identify fish to species.

Alaska is obligated to manage Canadian-origin Yukon River Chinook and fall chum salmon stocks in accordance with the precautionary, abundance-based harvest-sharing principles set by the *Yukon River Salmon Agreement*. The goal of bilateral, coordinated management is to meet negotiated escapement goals and provide opportunities for subsistence and commercial harvests of surplus in both the United States and Canada. Timely estimates of abundance help managers adjust harvest inseason and are also crucial for postseason analysis to determine whether treaty obligations were met. The Canadian Department of Fisheries and Oceans (DFO) provided estimates of mainstem salmon passage across the U.S./Canada border using mark–recapture techniques from 1980 to 2008 (JTC 2022). Because of the highly turbid water of the Yukon River and the width of the mainstem (approximately 400 m across at the study site), daily passage estimation methods that rely on visual observation, such as counting towers and weirs,

[1] Robinson, J. Lewis. "Yukon River". Encyclopedia Britannica, September 20, 2025. https://www.britannica.com/place/Yukon-River (accessed November 5, 2025).

are not feasible. Split-beam sonar technology is used successfully by the Alaska Department of Fish and Game (ADF&G) to produce daily inseason estimates of salmon passage in turbid rivers, including the lower Yukon River at Pilot Station (Morrill et al. 2023). Multi-beam imaging sonar, such as dual-frequency identification sonar (DIDSON) and adaptive resolution imaging sonar (ARIS), have been used at several sites, including the Kenai River (Key et al. 2023) and lower Yukon River near Pilot Station (Morrill et al. 2023), to give daily passage estimates where bottom profiles and river width are appropriate for the wider beam angle and shorter range capabilities of this technology.

In 1992, ADF&G initiated a project near Eagle, Alaska (Figure 1), to examine the feasibility of using split-beam sonar to estimate the number of salmon migrating across the U.S./Canada border (Johnston et al. 1993; Huttunen and Skvorc 1994). This project was the first documented use of split-beam sonar in a riverine environment, and over the 3-year study period, several problems were identified. Phase corruption was observed and was probably exacerbated by the highly reflective river bottom (Konte et al. 1996). The errors in the phase measurement were believed to have led to overly restrictive echo angle thresholds, resulting in the removal of echoes from fish that were physically within the accepted detection regions. These and other equipment issues reflected the early state of split-beam development, most of which have since been addressed. A recommendation from these studies was to identify a more appropriate site with smaller rocks and a uniform bottom profile (Johnston et al. 1993). Too many large rocks or obstructions in the profile can compromise fish detection by limiting how close the hydroacoustic beam can be aimed at the bottom. Similarly, an uneven bottom profile permits fish to pass undetected by the sonar.

In 2003, ADF&G conducted a study to identify a more suitable location for deploying hydroacoustic equipment to estimate salmon passage into Canada. A 45 km section of river from the DFO mark–recapture fish wheel project at White Rock, Yukon Territory, to 19 km downriver from Eagle, Alaska, was explored (Pfisterer and Huttunen 2004). This area was investigated because of its proximity to the DFO project and the U.S./Canada border. Desirable characteristics included the following: consistent, downward-sloping linear bottom profiles on both sides of the river without large obstructions; a single channel; available beach above the ordinary high-water mark for topside equipment; and sufficient current (i.e., areas without eddies or slack water where fish milling behavior can occur). A total of 21 river transects narrowed potential project locations to an area between 9 km and 19 km downriver from the town of Eagle. The 2003 study identified the 2 most promising sonar deployment locations at Calico Bluff and Shade Creek. Although sonar was not deployed in 2003, the bottom profiles at the preferred sites indicated that it should be possible to estimate fish passage using a combination of split-beam sonar on the longer, linear left bank and DIDSON on the shorter, steeper right bank. ADF&G carried out a 2-week study in 2004 to test sonar at the preferred sites. The 2 types of sonar were tested at Calico Bluff and the Shade Creek area, and it was found that Six Mile Bend (11.5 km downriver from the city of Eagle and immediately upriver of Shade Creek) was an ideal site (Carroll et al. 2007a).

In 2005, a full-scale sonar project was conducted from July 1 to August 13 to estimate Chinook salmon passage at Six Mile Bend on the Yukon River (Carroll et al. 2007b). As suggested, DIDSON was deployed on the right bank, and split-beam sonar was deployed on the left bank. In 2015, an ARIS replaced the DIDSON sonar (Lozori and McDougall 2016). This equipment has been used in subsequent years to estimate border passage for both Chinook and fall chum salmon.

The project duration was extended in 2006 to estimate fall chum salmon passage (Dunbar and Crane 2007). There are 2 genetically distinct runs of chum salmon that enter the Yukon River: an early-summer component and a later-fall component (Ransbury et al. 2022). Summer chum salmon spawn primarily in runoff streams in the lower 700 miles of the Yukon River drainage and in the Tanana River drainage. Fall chum salmon migrating past the Eagle sonar project primarily spawn in the upper portion of the Yukon River drainage in streams that are spring-fed or have major upwelling features. Major fall chum salmon spawning areas include the Tanana, Porcupine, and T'eedriinjik (Chandalar) River drainages, and various streams in the Yukon Territory, Canada, including the mainstem Yukon River.

In 2025, the project deployed split-beam and ARIS sonars to estimate migration of Chinook and fall chum salmon across the U.S./Canada border. Test fisheries were conducted to determine the transition from Chinook to fall chum salmon migrations and to collect age, sex, and length (ASL) data and tissue samples for genetic stock identification. This report will describe the methods used to collect sonar and fishery sample data, and will provide passage estimates, species distributions, run timing, and climatic and hydrologic observations.

OBJECTIVES

The goal of this project in 2025 was to provide daily inseason estimates of Chinook and fall chum salmon migrating across the U.S./Canada border to fishery managers. Primary objectives included the following:

1. Begin sonar data collection prior to the arrival of Chinook salmon, then operate continuously throughout the season until October 6, when, historically, environmental conditions become unfavorable for field operations.
2. Use drift gillnets to collect species composition and catch per unit effort (CPUE) data to estimate the transition period between the Chinook and fall chum salmon migration past the sonar site.

Secondary objectives included the following:

3. Collect biological data from all fish captured in the test fisheries, including species, sex, length, and scales, as applicable.
4. Collect Chinook and fall chum salmon tissue samples for genetic stock identification.
5. Collect daily climatic and hydrologic measurements representative of the study area.

METHODS

Chinook and fall chum salmon passage was estimated using split-beam sonar on the left bank and ARIS imaging sonar on the right bank. Both sonars operated continuously, 24 hours per day, and sampled 2 horizontal strata per bank, each for 30 minutes per hour (Figure 2). Data collection for the nearshore strata began at the top of the hour, whereas data collection for the offshore strata began at the bottom of the hour. Because of the low proportion of comigrating species, sonar estimates were designated as either Chinook or fall chum salmon. Although Chinook and fall chum salmon migrations are considered discrete in time, some temporal overlaps do occur. The transition date between Chinook and fall chum salmon migrations was determined using daily CPUE proportions from the species composition test fishery, which was conducted once per day from August 1 through September 30.

STUDY AREA

The Yukon River Basin is the fourth largest basin in North America; it has a drainage area of 857,300 km^2 and an average annual discharge of 6,400 m^3/s. Flows are highest in June, but the greatest flow variability occurs in May, after which discharge and its variability decline. The upper Yukon River is turbid and silty throughout the summer and fall, and the estimated annual suspended sediment load at Eagle is 33,000,000 tons (Brabets et al. 2000).

The study area was located on the mainstem of the Yukon River at Six Mile Bend (64°52′23.8″N, 141°04′45.12″W), approximately 11.5 km downriver from Eagle, Alaska (Figure 3). The Yukon River is approximately 400 m wide at the study site. The left bank profile is linear, extending approximately 300 m to the thalweg with a gradual slope of approximately 2.1°. The right bank profile is less linear, shorter, and steeper, extending approximately 100 m to the thalweg with a slope of approximately 6.3° (Figure 4). The thalweg is approximately 11 m deep, depending on the water level. The substrate at Six Mile Bend consists of large cobbles to small boulders on the right bank and small to medium-sized cobbles and silt on the left bank. Both banks have exhibited stable bottom profiles throughout the project's history.

HYDROACOUSTIC EQUIPMENT

A fixed-location, split-beam sonar developed by Kongsberg Simrad was used to estimate salmon passage on the left bank. Fish passage was monitored using a model EK60 digital echosounder equipped with a general-purpose transceiver and a 2.5° x 10° 120 kHz transducer (Table 1). EK80 data acquisition software was controlled using a Simrad Controller program developed by ADF&G (C. T. Pfisterer, Commercial Fisheries Biologist, ADF&G, Fairbanks), installed on a laptop computer, and connected to the echosounder to collect raw data for processing.

An ARIS imaging sonar manufactured by Sound Metrics Corporation was deployed on the right bank. The sonar operated at 1.2 MHz (high frequency) for the nearshore stratum and at 0.70 MHz (low frequency) for the offshore stratum (Table 2). Both low-frequency and high-frequency modes utilize 48 beams and have a field of view of 28°.

The EK80 software and the ARIS created digital files. Operators marked each upstream fish track using Echotastic software.[2]

SONAR DEPLOYMENT AND OPERATION

River bottom profiles were checked before transducer deployment to ensure the sonar sites remained acceptable for ensonification. Profile data were collected using a boat-mounted Lowrance LCX-15 dual-frequency transducer (down-looking sonar) with a built-in Global Positioning System (GPS). Data files were then uploaded to a computer and used to generate bottom profile charts (Figure 4).

The split-beam transducer was attached to 2 Hydroacoustic Technology Incorporated (HTI) model 662H single-axis rotators, configured perpendicular to each other to provide dual-axis rotation. Aiming was performed remotely using an HTI model 660 remote control unit that

---

[2] Echotastic software. 2025. Version 3.0.20. Developed by Carl Pfisterer, ADF&G Division of Commercial Fisheries. (internal use only).

provided horizontal and vertical positioning. Operators adjusted the aim by viewing the echogram in either the EK80 program or Echotastic. The proper aim was achieved when adequate substrate was present over the majority of the ensonified range.

The split-beam sonar was deployed on the left bank from July 1 through October 6, approximately 800 m downriver from the camp (Figure 3). The transducer and rotators were mounted on a freestanding aluminum-pipe frame and deployed approximately 15 m from shore (Figure 5). The transducer height was adjusted by sliding a mounting bar up or down along riser pipes that extended above the water. The transducer was deployed at a depth of approximately 1.5 m, aimed perpendicular to the current, at a location with consistent flow and no slack water. When counting Chinook salmon, the split-beam system was configured to ensonify a 150 m range from the transducer and to sample 2 strata (S1: 0–50 m and S2: 50–150 m; Figure 2). When counting fall chum salmon, the split-beam system was configured to ensonify a 75 m range and sample 2 strata (S3: 0–25 m and S4: 25–75 m).

A portable tripod-style fish lead was constructed approximately 1.5 m downstream from the transducer to prevent fish passage inshore of the transducer and provide sufficient offshore distance for upstream-migrating fish to be detected in the sonar beam. Freestanding lead sections were constructed from 5.1 cm diameter steel pipes, connected with adjustable fittings to form tripods. Aluminum stringers, approximately 2.5 m long, were attached horizontally to the upstream side of the tripods. Vertical lengths of aluminum conduit spaced 3.8 cm apart finished the sections. Depending on water level, flow, and debris load, lead sections were placed side-by-side in the water from shore to approximately 3–5 m offshore beyond the transducer (Figure 6). The portability of this style of fish lead was important because of the gradual slope found on the left bank. As the water level rose and fell throughout the season, the transducer and lead required frequent relocation to maintain their depth in the water column.

The ARIS was mounted to a Sound Metrics AR2 Rotator and controlled by ARIScope software, which provided horizontal and vertical positioning (Figure 7). Aiming was performed remotely using a laptop computer. Operators adjusted the aim by viewing the video image for each stratum. The proper aim was achieved when an adequate substrate was present across most of the ensonified range. For the duration of the season, the ARIS was configured to ensonify approximately 40 m, beginning at 0.7 m from the face of the transducer, and to sample 2 strata (S5: approximately 0.7–20 m and S6: approximately 20–40 m; Figure 2).

A fish lead was constructed using 2 m steel "T" stakes and 1-inch heavy-duty seine mesh. The seine mesh was anchored to the river bottom with a heavy chain woven along its length, which followed the substrate contours (Figure 6). Additional flotation for the upper edge was provided by gillnet floats sewn along the top of the seine mesh at approximately 0.5 m intervals. The fish lead was located approximately 1 m downstream of the transducer and extended approximately 2 m offshore beyond the transducer. This distance provided a sufficient offshore diversion for fish migrating upstream to be detected in the sonar beam. A shorter lead was appropriate for this bank because of the steep slope and the shorter near-field view of the ARIS (approximately 0.7 m).

SONAR DATA PROCESSING AND PASSAGE ESTIMATION

Operators opened each data file in Echotastic and marked each upstream fish track (Figures 8 and 9). The counts were saved as text files and manually recorded on a count form. The upstream direction of travel was verified in Echotastic using the video (ARIS files only) or by the color gradation of the fish track when echoes were colored by horizontal angle (ARIS and split-beam files).

The estimated daily passage ($\hat{y}$) for stratum (s) on day (d) was calculated by first computing the passage rate for each sample (p) within each stratum and day as:

$$r_{dsp} = \frac{y_{dsp}}{h_{dsp}}, \tag{1}$$

where h_{dsp} is the fraction of the hour sampled on day (d), stratum (s), and period (p), and y_{dsp} is the count for the same sample. The estimated passage was then computed by averaging the sampled hourly passage rates and then multiplying by the number of hours in a day as follows:

$$\hat{y}_{ds} = 24 \cdot \frac{\sum_{p-1}^{n} r_{dsp}}{n_{ds}}, \tag{2}$$

and the total daily passage is then the sum of the estimated passage across all strata:

$$\hat{y}_{d} = \sum_{s} \hat{y}_{ds}\,. \tag{3}$$

Treating the autocorrelated sonar counts as a simple random sample would yield an underestimate of the variance of the total. To accommodate these data characteristics, the data were systematically sampled with a variance estimator based on the squared differences of successive observations (Wolter 1985). The variance for the passage estimate for stratum (s) on day (d) was estimated as:

$$\hat{V}ar(\hat{y}_{ds}) = 24^2 \left(\frac{1-f_{ds}}{n_{ds}}\right) \frac{\sum_{p=2}^{n_{ds}} \left(r_{dsp} - r_{ds,p-1}\right)^2}{2(n_{ds}-1)}, \tag{4}$$

where n_{ds} is the number of samples in the day (typically 24), f_{ds} is the fraction of the day sampled (12/24 = 0.5 when no downtime), and r_{dsp} is the hourly rate for day (d) in stratum (s) for sample (p). Assuming passage estimates are independent between strata and among days, the total variance was estimated as the sum of the variances:

$$\hat{V}ar\ (\hat{y}) = \sum_{d} \sum_{s} \hat{V}ar\ (\hat{y}_{ds}). \tag{5}$$

MISSING DATA

Estimating daily passage by multiplying the average hourly passage rates by 24 (Equation 2) compensates for missing data (either shortened or missing periods within a day), and this is reflected in the variance (Equation 4) by reducing the number of samples and the fraction of the day sampled. If entire days were missed, then daily passage was interpolated by averaging passage estimates from days before and after the missing day(s) as follows:

$$\hat{y}_{ds} = (1/n\sum_{i=1}^{n} x_i)\begin{Bmatrix} d = 1, n = 4 \\ d = 2, n = 6 \\ d = 3, n = 8 \end{Bmatrix}, \tag{6}$$

where (d) is the number of missed days, n is the number of days used for interpolation (half before and half after the missing day[s]), and x_i is the passage for each day (i).

After data checks were performed to ensure accuracy, estimates of hourly, daily, and cumulative fish passage were produced and emailed to fishery managers each day. The estimates produced during the field season were further reviewed postseason and adjusted as necessary.

Because project operations ended before the end of the fall chum salmon migration, the estimate was expanded through October 18 using a second-order polynomial equation:

$$\hat{y}_{is} = \frac{L_s}{d^2}(x_i - d)^2, \tag{7}$$

where $\hat{y}_{is}$ is the daily passage estimate on the day (i) of expansion for bank (s), L is the count on the last day of sonar operation, d is the total number of days expanding for (October 18–October 6 = 12 days), and x_i is the day number being estimated. Each bank was expanded separately and then summed to obtain the total expanded estimate for the day.

October 18 is typically the last day of the fall chum salmon expansion. This date is based on the most likely run timing scenario derived from historical data (1982–2008) collected at the DFO mark–recapture fish wheel project near the U.S./Canada border (data on file with ADF&G, Division of Commercial Fisheries, Yukon Management Group; Fairbanks).

Postseason, border passage estimates for both Chinook and fall chum salmon are calculated and published annually by the Yukon River Joint Technical Committee (JTC).[3]

SPATIAL AND TEMPORAL DISTRIBUTIONS

Range distributions for Chinook and fall chum salmon were examined by importing text files containing all fish track information into R[4] where the fish counts were binned by range. The binned data were plotted to monitor the spatial distribution of fish passing the sonar site. Histograms of hourly passage were also created to investigate diel migration patterns. Chinook and fall chum salmon run timing was examined both inseason and postseason using information from sonar estimates, fish range distributions, test fishery catches, and local subsistence harvest.

TEST FISHING

Test fisheries were implemented to monitor species composition and collect ASL and genetic samples: 1) a Chinook salmon test fishery from July 2 to August 15 collected data to estimate specific Canadian-stock proportions and the ASL composition of Chinook salmon entering Canada, and 2) a species composition fishery from August 1 to September 30 took place to determine the transition date between the Chinook and fall chum salmon runs, and to collect fall chum salmon ASL and genetic data.

---

[3] JTC (Joint Technical Committee of the Yukon River Panel). Yukon River Joint Technical Committee Reports. Pacific Salmon Commission, Vancouver, BC, Canada. Available from https://www.yukonriverpanel.com/publications/yukon-river-joint-technical-committee-reports/ (accessed July 13, 2026).

[4] The R Project for statistical computing. R version 4.3.2 (Eye Holes). [released October 31, 2023; cited October 30, 2024]. Available for download from http://www.r-project.org

Chinook salmon sampling occurred twice daily through July 31, from approximately 0800 to 1200 and 1300 to 1700 hours. The fishery specifically targeted Chinook salmon, the predominant species in July. From August 1 through August 15, Chinook salmon sampling occurred once daily from approximately 1300 to 1700 hours.

ASL and genetic samples were collected using 4 mesh sizes (5.25 in, 6.5 in, 7.5 in, and 8.5 in) and drifted on a rotating schedule during the Chinook salmon sample fishery to effectively capture all size classes present (Table 3). Nets were 25 fathoms long, approximately 8 m deep, and hung even, at a 2:1 ratio of web to cork line (Table 4). Nets were drifted for approximately 6 minutes each within the left bank nearshore (LBN), left bank offshore (LBF), and right bank nearshore (RBN) zones. The right bank zone was located approximately 2.5 km upriver from the sonar site, where river conditions were suitable for drift gillnetting on that bank (Figure 3). This resulted in 9 drifts during each Chinook salmon sample fishing period.

For each drift, 4 times were recorded to the nearest second on field data sheets: net start out *SO*, net full out *FO*, net start in *SI*, and net full in *FI*. Fishing time (t), in minutes, was approximated as:

$$t = SI - FO + \frac{FO-SO}{2} + \frac{FI-SI}{2}. \tag{8}$$

Total effort (e), in fathom-hours, of drift (j) and mesh size (m) during fishing period (l) in zone (z) on day (d) was calculated as:

$$e_{dzlm} = \frac{25t_{dzlmj}}{60}. \tag{9}$$

Fishing for species composition and fall chum salmon ASL data collection occurred once daily from August 1 through September 30 from approximately 0800 to 1200 hours on the left bank only. During the apportionment sampling period, both 5.25 in and 7.5 in nets were drifted twice within each of the 3 left bank zones: left bank inshore (LBI), left bank nearshore (LBN), and left bank offshore (LBF; Figure 3) for a total of 12 drifts. Nets were hung the same as for the Chinook salmon test fishery, except for the LBI nets, which were approximately 3 m deep (Table 4). Drifts were targeted to last 6 minutes but were occasionally shortened as necessary to avoid snags or to limit catches and prevent mortality during periods of high fish passage. LBI drifts were referred to as beach walks (Fleischman et al. 1995) and were performed with 1 person holding onto the shore end of the net and leading it downstream along the beach while a boat drifted with the offshore end. The nearshore zone began approximately 1 net length offshore, and the offshore zone began approximately 2 net lengths offshore. The order of drifts was (1) LBI, (2) LBN, and (3) LBF, with a minimum of 15 minutes between drifts in the same zone. All drifts using 1 mesh size were completed before switching to another mesh size. The starting mesh sizes were alternated each day (Table 3).

Captured fish were identified to species, and length was measured to the nearest 1 mm. Salmon species were measured from the middle of the eye to the fork of the tail (METF); nonsalmon species were measured from the tip of the snout to the fork of the tail (FL). Sex was recorded only for salmon species and was determined by visual examination of external features, such as the development of the kype, roundness of the belly, presence or absence of an ovipositor, and overall size. This is similar to the sampling routine used on the Kuskokwim River (Dissen 2025). A total of 4 scales from Chinook salmon and 1 scale from fall chum salmon were removed from the preferred area of the fish on the left side, approximately 2 rows above the lateral line, in an area transected by a diagonal line from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Clutter and Whitesel 1956). All scale samples were cleaned, mounted on gum cards, and sent to the ADF&G age determination laboratory in Anchorage for processing.

For genetic stock identification (GSI), an approximately 1 cm^2 section of pelvic fin tissue was collected from each Chinook and fall chum salmon and stored on Whatman cards. All samples were sent to the ADF&G genetics laboratory for cataloging and, from there, forwarded to the Fisheries and Oceans Canada genetics laboratory in Nanaimo, British Columbia, for processing. ASL and GSI data were paired, and all sampling data were recorded on field data sheets and entered into a Microsoft Access database. Captured fish were handled in a manner that minimized mortalities.

SPECIES DETERMINATION

Inseason, the daily proportions of Chinook and fall chum salmon CPUE from the species composition test fishery were used to determine the last day of the Chinook salmon migration. The remainder of the passage estimates for the season were then classified as fall chum salmon.

CATCH PER UNIT EFFORT CALCULATIONS

CPUE was calculated for each day (*d*) on the left bank (*b*) during species composition fishing using 2 specific gillnet mesh sizes (*g*), regardless of catch size. Chinook salmon CPUE was calculated using the catch (*c*) and effort (*e*; calculated in Equation 9) of the large mesh gillnet (7.5 in); fall chum salmon CPUE was calculated using the catch and effort of the small mesh gillnet (5.25 in). Because all nets were 25 fathoms (45.7 m) in length, CPUE estimates (in catch per fathom hour) for each species (*i*) were made daily for the species composition test fishery:

$$CPUE_{dbi} = \frac{\sum_g c_{dbig}}{\sum_g e_{dbg}}. \tag{10}$$

Determination of Chinook and fall chum salmon transition date

The transition from Chinook to fall chum salmon was determined using daily left bank CPUE values for Chinook and fall chum salmon captured in the species composition fishery. The daily CPUE values were smoothed using the function *supsmu* in *R* with the default span (Friedman 1984). The smoothed values were used to compute the estimated daily (*d*) proportions ($\hat{p}$) for the 2 species (*i*):

$$\hat{p}_{di} = \frac{CPUE_{di}}{\sum_i CPUE_{di}}. \tag{11}$$

The species transition date was defined as the day on which the proportion of fall chum salmon was greater than or equal to 0.5 and was designated as the first day of fall chum salmon estimation.

Climatic and Hydrologic Observations

Climatic and hydrologic observations were collected at approximately 1800 hours daily. Reported stream levels were taken from the U.S. Geological Survey's gauging station at Eagle[5], and relative water levels were monitored at the sonar site. Surface water temperature was measured at a depth of approximately 30 cm using a HOBO U22 water temperature data logger. Data loggers were attached to the sonar transducer pods on each bank and set to record hourly. Air temperature, wind velocity, and wind direction were measured daily using a thermometer and a Kestrel handheld wind meter. Other daily observations included precipitation and percent cloud cover.

RESULTS AND DISCUSSION

Sonar Deployment

In 2025, both the right bank and left bank transducers were deployed in approximately the same locations as in recent years (Figure 3). Occasionally, water level fluctuations and debris necessitated moving the transducers and fish leads into deeper or shallower water; however, this did not affect sonar operation. Overall, there were no significant interruptions to project operations throughout the 2025 season. Both the left and right bank sonars operated from July 1 through October 6. The primary project objective of estimating Chinook and fall chum salmon passage through October 6 was achieved.

Chinook and Fall Chum Salmon Passage Estimation

August 25 was determined to be the last day of the Chinook salmon migration based on CPUE from the species composition test fishery (Figures 10 and 11; Appendix A1). The total passage estimate for Chinook salmon was 23,863 (SE 182) from July 1 through August 25 (Table 5). The first quarter point of the run was July 21, the midpoint was July 29, and the third quarter point was August 4 (Table 6). The midpoint of the Chinook salmon run, July 29, was 4 days later than the 2005–2024[6] mean passage timing (Figure 12). Chinook salmon passage peaked on August 1 with a daily estimate of 1,123 fish, and a total of 66 Chinook salmon were estimated to have passed the sonar on August 25, the last day of the Chinook salmon season (Figure 13).

Sonar sampling time missed during the Chinook salmon migration varied by strata, with totals ranging from 14.8 to 39.6 hours (Table 7). Time missed was typically due to generator failures, computer software errors, routine moving and re-aiming of the sonar because of changes in water level, and routine cleaning of the ARIS.

The total passage estimate for fall chum salmon was 18,404 fish (SE 164) from August 26 through October 6 (Table 5). Because the fall chum salmon migration continued after project operations ceased, the passage estimate was expanded through October 18 to a total of 19,574 fish. Based on the expanded passage estimate, the first quarter point of the run was September 15, the midpoint was September 20, and the third quarter point was September 27 (Table 8). The

---

[5] USGS (U.S. Geological Survey). National Water Information System: Web Interface. USGS 15356000 Yukon River at Eagle, Alaska. https://waterdata.usgs.gov/monitoring-location/USGS-15356000/#startDT=2025-07-01&endDT=2025-10-06&dataTypeId=continuous-00065-0&showFieldMeasurements=true (cited November 6, 2025; accessed June 13, 2026).

[6] Differences in the species transition date from year to year confound the computation of the historical daily cumulative and mean. As a convenience, the historical daily cumulative percent and mean were computed by assuming that 100% of the run was completed on the date the Chinook salmon run transitioned to fall chum salmon.

midpoint of the fall chum salmon run occurred 3 days earlier than the 2006–2024[5] mean run timing (Figure 12). Fall chum salmon passage peaked on September 21 with a daily estimate of 974 fish, and a total of 333 fall chum salmon were estimated to have passed the sonar on October 6, the last day of sonar operation (Figure 13). Sonar sampling time missed during the fall chum salmon migration varied by strata, with totals ranging from 12.9 to 35.1 hours (Table 9).

The river bottom profile remained similar to previous seasons and was acceptable for fish detection throughout the 2025 season (Figure 4). Water levels and silt did not affect fish detection, and the project ran smoothly overall, with few operational interruptions.

SPATIAL AND TEMPORAL DISTRIBUTION

Fish were shore-oriented on both banks (Figures 14 and 15). During the Chinook salmon migration, on the left bank, 95% of fish were detected within 60 m of the transducer, and on the right bank, 95% were detected within 15 m. During the fall chum salmon migration, on the left bank, 95% of fish were detected within 25 m of the transducer, and on the right bank, 95% of fish were detected within 15 m of the transducer. Approximately 66% (15,767) of Chinook salmon and 67% (13,186) of fall chum salmon passed on the left bank.

Analysis of hourly sonar passage rates during the Chinook salmon migration on the right bank showed periods of slightly lower passage between 0300 and 0800 hours; however, distinct diel migration patterns were not observed for the left bank or both banks combined (Figure 16). During the fall chum salmon run, a slight diel migration was observed on both banks; however, no distinct pattern was observed when both banks were combined (Figure 17).

TEST FISHING

Chinook salmon test fishing occurred from July 2 through August 15. Species composition and fall chum salmon test fishing occurred from August 1 through September 30. A total of 242 Chinook salmon and 120 fall chum salmon were captured in drift gillnets between July 2 and September 30 (Table 10). A total of 1 burbot (*Lota lota*), 9 sheefish (*Stenodus leucichthys*), 1 arctic grayling (*Thymallus arcticus*), 1 humpback whitefish (*Coregonus pidschian*), and 3 longnose suckers (*Catostomus catostomus*) were also captured in the test fisheries.

A total of 1,891 fathom-hours were fished in the Chinook salmon test fishery, and 2,008 fathom-hours were fished in the species composition and fall chum salmon test fisheries (Tables 11 and 12). The cumulative CPUE for both Chinook and fall chum salmon was well below the 2007–2024 mean (Figure 18).

Females contributed 33% of the Chinook and 36% of the fall chum salmon samples collected. Clipped adipose fins, indicating that fish carry coded wire tags from the hatchery in Whitehorse, Yukon Territory, were observed on 1 Chinook salmon.

A total of 242 Chinook and 120 fall chum salmon were sampled for complete ASL and genetic data. Of the scales collected, 208 (86%) Chinook and 105 (88%) fall chum salmon were ageable.[7] Goals to collect biological data from all fish captured in the test fisheries, including species and ASL as applicable, and GSI tissue samples for Chinook and fall chum salmon were achieved.

---

[7] Arctic–Yukon–Kuskokwim Database Management System (AYKDBMS). 2006– . Alaska Department of Fish and Game, Division of Commercial Fisheries. Juneau, AK. https://www.adfg.alaska.gov/CF_R3/external/sites/aykdbms_website/Default.aspx (accessed April 1, 2026).

CLIMATIC AND HYDROLOGIC OBSERVATIONS

Weather and water observations were recorded at the sonar site daily beginning July 2 (Appendix B1). The water temperature on the left bank fluctuated in July and August but generally decreased over the latter two-thirds of the season (Figure 19). The maximum water temperature observed was 18.2°C on July 21, and the minimum was 5.0°C on October 5. The water level remained below the historical median (1995–2024) for most of the season, with 2 notable exceptions: July 1 to July 8 and July 26 to July 29, when the water level rose above the historical median. Water levels rose to the historical median on September 29 and remained at the median for the remainder of the season (Figure 20). All goals to collect climatic and hydrologic measurements were achieved this season.

ACKNOWLEDGMENTS

The authors wish to acknowledge the field camp personnel: ADF&G technicians Wynter Fournier, Maverick Merrill, and Matthew Phoenix, as well as DFO technicians Lauren Aghabozorgi, Maddie Peters, Nina Schwarzpech, and Madison Wiersma for collecting most of the data used in this report, which contributed to the successful operation of the project this season. We are especially grateful to the Hungwitchin Native Corporation for the use of their land and to the community of Eagle for their support and hospitality. Thanks to the Department of Transportation in Eagle for allowing us to store project equipment and boats at their facility, as well as James Jasper (ADF&G Commercial Fisheries Biometrician), Carl Pfisterer (ADF&G Commercial Fisheries Sonar Coordinator), and Jody Lozori (ADF&G Commercial Fisheries Sonar Biologist) for their review and editorial comments on this manuscript and for their technical support. This investigation was partially funded by U.S./Canada treaty implementation funds administered by the U.S. Fish and Wildlife Service Agreement Award F18AP00851, and ADF&G general funds.

REFERENCES CITED

Brabets, T. P., B. Wang, and R. H. Meade. 2000. Environmental and hydrologic overview of the Yukon River Basin, Alaska and Canada. U.S. Geological Survey Water-Resources Investigations Report 99-4204, Anchorage.

Carroll, H. C., R. D. Dunbar, and C. T. Pfisterer. 2007a. Evaluation of hydroacoustic site on the Yukon River near Eagle, Alaska for monitoring passage of salmon across the U.S./Canada Border, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 07-10, Anchorage.

Carroll, H. C., R. D. Dunbar, and C. T. Pfisterer. 2007b. Sonar estimation of Chinook salmon in the Yukon River near Eagle, Alaska, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 07-82, Anchorage.

Clutter, R. I., and L. E. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission 9, Vancouver, British Columbia.

Dissen, J. N. 2025. Salmon age, sex, and length catalog for the Kuskokwim Area, 2020. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A25-08, Anchorage.

Dunbar, R. D., and A. Crane. 2007. Sonar estimation of Chinook and fall chum salmon in the Yukon River near Eagle, Alaska, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-89, Anchorage.

Fleischman, S. J., D. C. Mesiar, and P. A. Skvorc, II. 1995. Lower Yukon River sonar project report 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A95-33, Anchorage.

Friedman, J. H. 1984. A variable span smoother. Technical Report No. 5, Laboratory for Computational Statistics, Department of Statistics, Stanford.

REFERENCES CITED (Continued)

Huttunen, D. C., and P. A. Skvorc, II. 1994. 1992 Yukon River border sonar progress report. Alaska Department of Fish and Game. Commercial Fisheries Management and Development Division, Regional Information Report No. 3A94-16, Anchorage.

Johnston, S. V., B. H. Ransom, and K. K. Kumagai. 1993. Hydroacoustic evaluation of adult Chinook and chum salmon migrations in the Yukon River during 1992. Hydroacoustic Technology, Inc. Seattle, WA, 98105 USA.

JTC (Joint Technical Committee of the Yukon River U.S./Canada Panel). 2022. Yukon River salmon 2021 season summary and 2022 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A21-01, Anchorage.

Key, B. H., J. D. Miller, S. J. Fleischman, and J. Huang. 2023. Chinook salmon passage in the Kenai River at River Mile 13.7 using adaptive resolution imaging sonar, 2017–2019. Alaska Department of Fish and Game, Fishery Data Series No. 23-09, Anchorage.

Konte, M. D., D. C. Huttunen, and P. A. Skvorc, II. 1996. 1994 Yukon River border sonar progress report. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 3A96-26, Anchorage.

Lozori, J. D., and M. J. McDougall. 2016. Sonar estimation of Chinook and fall chum salmon passage in the Yukon River near Eagle, Alaska, 2015. Alaska Department of Fish and Game, Fishery Data Series No. 16-27, Anchorage.

Morrill, R. P., K. T. Wiglesworth, and J. D. Lozori. 2023. Sonar estimation of salmon passage in the Yukon River near Pilot Station, 2022. Alaska Department of Fish and Game, Fishery Data Series No. 23-39, Anchorage.

Pfisterer, C. T., and D. C Huttunen. 2004. Evaluation of hydroacoustic site on the Yukon River to monitor passage of salmon across the U.S./Canada border, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A 04-18, Anchorage.

Ransbury, S. R., S. K. S. Decker, D. M. Jallen, C. M. Gleason, B. M. Borba, F. W. West, J. N. Clark, A. J. Padilla, J. D. Smith, and L. N. Forsythe. 2022. Yukon Management Area annual report, 2021. Alaska Department of Fish and Game, Fishery Management Report No. 22-29, Anchorage.

Wolter, K. M. 1985. Introduction to variance estimation. Springer-Verlag, New York.

TABLES AND FIGURES

Table 1.–Split-beam sonar system settings at the Eagle sonar project on the Yukon River, 2025.

Component	Setting	Stratum [a]	Value
Transducer	Beam size (h x w)	All	2.5° x 10.0°
Echosounder	Power output (W)	All	500
	Pulse width (µs)	All	256
	Ping rate (pps)	S1	8.33
		S2	4.16
		S3	16.66
		S4	8.33
	Range (m)[a]	S1	50
		S2	150
		S3	25
		S4	75
	Duration (min)	S1	30
		S2	30
		S3	30
		S4	30

[a] When counting Chinook salmon, the split-beam system ensonified a range of 150 m and sampled 2 strata (S1: 0–50 m and S2: 50–150 m). When counting fall chum salmon, the split-beam system ensonified a range of 75 m and sampled 2 strata (S3: 0–25 and S4: 25–75 m).

Table 2.–Technical specifications and settings for the adaptive resolution imaging sonar (ARIS) at the Eagle sonar project on the Yukon River, 2025.

Setting	Stratum [a]	Value
Mode	S5	Identification
	S6	Detection
Frequency (MHz)	S5	1.2
	S6	0.7
Number of beams	S5	48
	S6	48
Start range (m)	S5	0.7
	S6	20
End range (m)	S5	20
	S6	40
Frame rate (frames/s)	S5	6
	S6	4
Duration (min)	S5, S6	30
Field of view (degrees)	S5, S6	28

[a] The 2 ARIS sampling strata (S5: 0.7–20 m and S6: 20–40 m) were independently aimed using a Sound Metrics AR2 Rotator and ARIScope software.

Table 3.–Net schedule of mesh sizes, in inches, used for Chinook salmon test fishing and species composition, and fall chum salmon test fishing for all zones at the Eagle sonar project on the Yukon River, 2025.

		Stretch mesh size inches		
		Drift		
Sampling purpose	Day	1	2	3
Chinook salmon samples	1	5.25	6.50	7.50
	2	7.50	8.50	6.50
	3	6.50	5.25	8.50
	4	8.50	7.50	5.25
Species composition and fall chum	1	5.25	7.50	NA
Salmon samples	2	7.50	5.25	NA

Note: NA means not applicable.

Table 4.–Specifications for drift gillnets used for test fishing at the Eagle sonar project on the Yukon River, 2025.

	Stretch mesh size				
Method	(in)	(mm)	Mesh diameter (mm)	Meshes deep (md)	Depth (m)
Drift	5.25	133	85	69	8.00
	6.50	165	105	55	7.90
	7.50	191	121	48	8.00
	8.50	216	137	43	8.10
Beach walk	5.25	133	85	26	3.00
	7.50	191	121	18	3.00

Note: Gillnet webbing consisted of Momoi monotwist (MTC or MT), shade 11 or equivalent, double-knot multifilament nylon twine.

Table 5.–Cumulative fish passage estimates by bank and species with standard errors (SE) and 95% confidence intervals (CI), at the Eagle sonar project on the Yukon River, 2025.

					95% CI	
Species	Left bank	Right bank	Total passage	SE	Lower	Upper
Chinook	15,767	8,096	23,863	182	23,506	24,220
Fall chum (excluding expansion[a])	12,639	5,765	18,404	164	18,083	18,725
Fall chum (including expansion[a,b])	13,186	6,388	19,574	164 [b]	19,253	19,895

[a] The last day of sonar operation was October 6. Because sonar operations ceased before the end of the fall chum salmon migration, estimates were expanded through October 18.

[b] Standard error (SE) was only computed for the estimates during the period of sonar operation.

Table 6.–Estimated daily and cumulative Chinook salmon passage by bank at the Eagle sonar project on the Yukon River, 2025.

	Daily				Cumulative			
Date	Left bank	Right bank	Total	SE	Left bank	Right bank	Total	Proportion
7/1[a]	10	3	13	4	10	3	13	0.001
07/02	22	4	26	4	32	7	39	0.002
07/03	14	16	30	6	46	23	69	0.003
07/04	18	19	37	6	64	42	106	0.004
07/05	16	30	46	6	80	72	152	0.006
07/06	26	30	56	7	106	102	208	0.009
07/07	16	66	82	9	122	168	290	0.012
07/08	60	66	126	10	182	234	416	0.017
07/09	56	65	121	11	238	299	537	0.023
07/10	78	62	140	12	316	361	677	0.028
07/11	151	110	261	21	467	471	938	0.039
07/12	222	148	370	19	689	619	1,308	0.055
07/13	282	142	424	24	971	761	1,732	0.073
07/14	212	167	379	24	1,183	928	2,111	0.088
07/15	226	251	477	31	1,409	1,179	2,588	0.108
07/16	240	303	543	24	1,649	1,482	3,131	0.131
07/17	276	329	605	25	1,925	1,811	3,736	0.157
07/18	275	284	559	28	2,200	2,095	4,295	0.180
07/19	374	261	635	27	2,574	2,356	4,930	0.207
07/20	310	216	526	31	2,884	2,572	5,456	0.229
07/21	354	250	604	28	3,238	2,822	6,060	0.254
07/22	268	267	535	18	3,506	3,089	6,595	0.276
07/23	344	213	557	24	3,850	3,302	7,152	0.300
07/24	428	216	644	31	4,278	3,518	7,796	0.327
07/25	524	180	704	30	4,802	3,698	8,500	0.356
07/26	548	270	818	26	5,350	3,968	9,318	0.390
07/27	555	287	842	35	5,905	4,255	10,160	0.426
07/28	733	306	1,039	41	6,638	4,561	11,199	0.469
07/29	**677**	**399**	**1,076**	**40**	**7,315**	**4,960**	**12,275**	**0.514**
07/30	651	392	1,043	51	7,966	5,352	13,318	0.558
07/31	863	253	1,116	33	8,829	5,605	14,434	0.605
08/01	887	236	1,123	39	9,716	5,841	15,557	0.652
08/02	856	242	1,098	39	10,572	6,083	16,655	0.698
08/03	757	194	951	43	11,329	6,277	17,606	0.738
08/04	707	160	867	38	12,036	6,437	18,473	0.774
08/05	617	152	769	29	12,653	6,589	19,242	0.806
08/06	504	202	706	33	13,157	6,791	19,948	0.836

-continued-

Table 6.–Page 2 of 2.

	Daily				Cumulative			
Date	Left bank	Right bank	Total	SE	Left bank	Right bank	Total	Proportion
08/07	420	188	608	21	13,577	6,979	20,556	0.861
08/08	326	168	494	19	13,903	7,147	21,050	0.882
08/09	298	137	435	23	14,201	7,284	21,485	0.900
08/10	266	109	375	18	14,467	7,393	21,860	0.916
08/11	236	100	336	19	14,703	7,493	22,196	0.930
08/12	150	77	227	15	14,853	7,570	22,423	0.940
08/13	179	80	259	18	15,032	7,650	22,682	0.951
08/14	124	56	180	15	15,156	7,706	22,862	0.958
08/15	108	52	160	10	15,264	7,758	23,022	0.965
08/16	85	29	114	11	15,349	7,787	23,136	0.970
08/17	64	17	81	6	15,413	7,804	23,217	0.973
08/18	76	28	104	11	15,489	7,832	23,321	0.977
08/19	52	48	100	15	15,541	7,880	23,421	0.981
08/20	38	42	80	11	15,579	7,922	23,501	0.985
08/21	50	50	100	9	15,629	7,972	23,601	0.989
08/22	34	42	76	7	15,663	8,014	23,677	0.992
08/23	30	40	70	7	15,693	8,054	23,747	0.995
08/24	26	24	50	8	15,719	8,078	23,797	0.997
08/25[b]	48	18	66	8	15,767	8,096	23,863	1.000
Total	15,767	8,096	23,863	NA	NA	NA	NA	NA
Var	18,663	12,606	31,550	NA	NA	NA	NA	NA
SE	138	112	178	NA	NA	NA	NA	NA

Note: SE means standard error, Var means variance, and NA means not applicable. The upper portion of the outlined box identifies the second quartile of the run, the lower portion identifies the third quartile, and bold text identifies the median day of passage.

[a] The sonar was operational on both banks.

[b] Last day of Chinook salmon estimation.

Table 7.–Sampling time, in minutes, missed by bank, stratum, and date during Chinook salmon sampling at the Eagle sonar project on the Yukon River, 2025.

	Left bank		Right bank	
Date	Stratum 1 (0–50 m)	Stratum 2 (50–150 m)	Stratum 5 (0.7–20 m)	Stratum 6 (20–40 m)
07/01	300	282	420	390
07/02	0	0	0	72
07/03	0	0	0	0
07/04	0	0	24	216
07/05	0	0	0	138
07/06	0	0	0	0
07/07	0	0	0	48
07/08	0	24	0	138
07/09	0	30	48	12
07/10	0	0	0	54
07/11	168	150	12	180
07/12	0	0	18	0
07/13	12	30	30	0
07/14	60	60	30	30
07/15	0	18	156	0
07/16	0	0	6	0
07/17	0	0	90	24
07/18	0	0	0	0
07/19	0	0	6	0
07/20	0	0	126	0
07/21	0	0	0	30
07/22	0	30	102	0
07/23	0	18	36	6
07/24	0	0	0	0
07/25	0	0	0	0
07/26	18	60	42	30
07/27	0	0	6	0
07/28	0	0	0	0
07/29	0	0	24	0
07/30	0	0	156	0
07/31	0	0	6	0
08/01	0	0	0	18
08/02	0	0	0	186
08/03	0	0	192	0
08/04	0	0	30	0
08/05	0	0	0	0

-continued-

Table 7.–Page 2 of 2.

Date	Left bank: Stratum 1 (0–50 m)	Left bank: Stratum 2 (50–150 m)	Right bank: Stratum 5 (0.7–20 m)	Right bank: Stratum 6 (20–40 m)
08/06	0	0	150	0
08/07	30	30	0	0
08/08	0	0	0	12
08/09	0	0	108	0
08/10	0	0	30	0
08/11	0	0	0	0
08/12	0	0	48	0
08/13	138	150	0	0
08/14	0	0	0	0
08/15	0	0	0	0
08/16	36	30	48	6
08/17	0	0	30	0
08/18	0	0	114	0
08/19	0	0	210	0
08/20	120	102	30	6
08/21	0	0	6	0
08/22	0	0	12	0
08/23	0	0	30	0
08/24	6	0	0	0
08/25	0	6	0	0
Total (min)	888	1,020	2,376	1,596
Total (h)	14.8	17	39.6	26.6

Table 8.–Estimated daily and cumulative fall chum salmon passage by bank at the Eagle sonar project on the Yukon River, 2025.

	Daily				Cumulative			
Date	Left bank	Right bank	Total	SE	Left bank	Right bank	Total	Proportion
08/26[a]	54	22	76	9	54	22	76	0.004
08/27	52	10	62	7	106	32	138	0.007
08/28	83	13	96	9	189	45	234	0.012
08/29	72	12	84	9	261	57	318	0.016
08/30	72	22	94	10	333	79	412	0.021
08/31	113	20	133	10	446	99	545	0.028
09/01	94	28	122	11	540	127	667	0.034
09/02	124	26	150	12	664	153	817	0.042
09/03	136	24	160	12	800	177	977	0.050
09/04	188	36	224	14	988	213	1,201	0.061
09/05	176	33	209	17	1,164	246	1,410	0.072
09/06	208	28	236	15	1,372	274	1,646	0.084
09/07	224	38	262	18	1,596	312	1,908	0.097
09/08	233	48	281	11	1,829	360	2,189	0.112
09/09	174	31	205	14	2,003	391	2,394	0.122
09/10	192	69	261	20	2,195	460	2,655	0.136
09/11	280	70	350	19	2,475	530	3,005	0.154
09/12	380	86	466	20	2,855	616	3,471	0.177
09/13	448	71	519	24	3,303	687	3,990	0.204
09/14	581	146	727	34	3,884	833	4,717	0.241
09/15	603	130	733	26	4,487	963	5,450	0.278
09/16	752	106	858	25	5,239	1,069	6,308	0.322
09/17	701	168	869	46	5,940	1,237	7,177	0.367
09/18	723	225	948	41	6,663	1,462	8,125	0.415
09/19	731	220	951	43	7,394	1,682	9,076	0.464
09/20	**625**	**340**	**965**	**41**	**8,019**	**2,022**	**10,041**	**0.513**
09/21	551	423	974	44	8,570	2,445	11,015	0.563
09/22	478	382	860	40	9,048	2,827	11,875	0.607
09/23	391	380	771	37	9,439	3,207	12,646	0.646
09/24	402	305	707	33	9,841	3,512	13,353	0.682
09/25	350	232	582	36	10,191	3,744	13,935	0.712
09/26	338	284	622	29	10,529	4,028	14,557	0.744
09/27	304	226	530	17	10,833	4,254	15,087	0.771
09/28	284	149	433	23	11,117	4,403	15,520	0.793
09/29	305	101	406	21	11,422	4,504	15,926	0.814
09/30	252	164	416	24	11,674	4,668	16,342	0.835

-continued-

Table 8.–Page 2 of 2.

	Daily				Cumulative			
Date	Left bank	Right bank	Total	SE	Left bank	Right bank	Total	Proportion
10/01	222	104	326	15	11,896	4,772	16,668	0.852
10/02	163	112	275	20	12,059	4,884	16,943	0.866
10/03	118	194	312	24	12,177	5,078	17,255	0.882
10/04	170	210	380	22	12,347	5,288	17,635	0.901
10/05	136	300	436	25	12,483	5,588	18,071	0.923
10/06[b]	156	177	333	31	12,639	5,765	18,404	0.940
10/07[c]	131	149	280	NA	12,770	5,914	18,684	0.955
10/08[c]	108	123	231	NA	12,878	6,037	18,915	0.966
10/09[c]	88	100	188	NA	12,966	6,137	19,103	0.976
10/10[c]	69	79	148	NA	13,035	6,216	19,251	0.983
10/11[c]	53	60	113	NA	13,088	6,276	19,364	0.989
10/12[c]	39	44	83	NA	13,127	6,320	19,447	0.994
10/13[c]	27	31	58	NA	13,154	6,351	19,505	0.996
10/14[c]	17	20	37	NA	13,171	6,371	19,542	0.998
10/15[c]	10	11	21	NA	13,181	6,382	19,563	0.999
10/16[c]	4	5	9	NA	13,185	6,387	19,572	1.000
10/17[c]	1	1	2	NA	13,186	6,388	19,574	1.000
10/18[d]	0	0	0	NA	13,186	6,388	19,574	1.000
Total	13,186	6,388	19,574	NA	NA	NA	NA	NA
Var[e]	16,716	10,258	26,974	NA	NA	NA	NA	NA
SE[e]	129	101	164	NA	NA	NA	NA	NA

Note: SE means standard error, Var means variance, and NA means not applicable. The upper portion of the outlined box identifies the second quartile of the run, the lower portion identifies the third quartile, and bold text identifies the median day of passage, including the expanded estimate.

[a] First day of fall chum salmon estimation.

[b] Last day of sonar operation.

[c] Expanded passage estimate.

[d] Last day of the expanded passage.

[e] Variance (Var) and standard error (SE) calculations include data through October 6, the last day of sonar operation.

Table 9.–Sampling time, in minutes, missed by bank, stratum, and date during fall chum salmon sampling at the Eagle sonar project on the Yukon River, 2025.

	Left bank		Right bank	
Date	Stratum 3 (0–25 m)	Stratum 4 (25–75 m)	Stratum 5 (0.7–20 m)	Stratum 6 (20–40 m)
08/26	0	0	162	150
08/27	0	0	6	0
08/28	6	0	204	180
08/29	12	0	12	0
08/30	0	0	36	0
08/31	0	30	18	0
09/01	0	0	0	6
09/02	0	0	72	0
09/03	0	0	138	162
09/04	30	0	6	30
09/05	0	0	42	18
09/06	0	0	78	90
09/07	0	0	0	6
09/08	120	138	0	12
09/09	0	0	30	0
09/10	0	0	120	120
09/11	0	0	30	0
09/12	0	0	132	132
09/13	0	0	30	0
09/14	0	0	0	6
09/15	0	0	0	36
09/16	30	30	0	12
09/17	126	150	12	30
09/18	0	0	6	30
09/19	12	0	0	6
09/20	0	0	0	0
09/21	0	0	42	30
09/22	0	0	0	6
09/23	30	30	6	12
09/24	6	0	24	0
09/25	0	0	0	6
09/26	0	0	198	216
09/27	0	0	24	0
09/28	0	0	12	0
09/29	30	48	36	0
09/30	0	0	168	162
10/01	0	0	30	42
10/02	12	30	12	0
10/03	0	0	30	24
10/04	0	0	30	30
10/05	0	0	0	0
10/06	360	360	360	360
Total (min)	774	816	2,106	1,914
Total (h)	12.9	13.6	35.1	31.9

Table 10.–Fish caught using gillnets at the Eagle sonar project on the Yukon River, 2025.

Species	Sampling purpose: Species composition and fall chum salmon samples	Sampling purpose: Chinook salmon samples	Total
Chinook salmon	71	171	242
Fall chum salmon	120	0	120
Sheefish	9	0	9
Sucker	3	0	3
Humpback whitefish	1	0	1
Burbot	1	0	1
Arctic grayling	1	0	1
Total	206	171	377

Table 11.–Fishing effort, catch, and proportion by zone and mesh size for Chinook and fall chum salmon in the Chinook salmon test fishery at the Eagle sonar project on the Yukon River, 2025.

Zone[a]	Mesh size (in)	Fishing effort (fathom-hours)	Chinook salmon		Fall chum salmon	
			Catch	Proportion	Catch	Proportion
LBN	5.25	159	42	0.246	0	0.000
	6.50	164	31	0.181	0	0.000
	7.50	162	39	0.228	0	0.000
	8.50	151	15	0.088	0	0.000
Total		635	127	0.743	0	0.000
RBN	5.25	158	8	0.047	0	0.000
	6.50	156	2	0.012	0	0.000
	7.50	156	5	0.029	0	0.000
	8.50	178	6	0.035	0	0.000
Total		649	21	0.123	0	0.000
LBF	5.25	149	2	0.012	0	0.000
	6.50	154	7	0.041	0	0.000
	7.50	154	5	0.029	0	0.000
	8.50	150	9	0.053	0	0.000
Total		608	23	0.135	0	0.000
Grand total		1,891	171	1.000	0	0.000

[a] Gillnets were drifted through 3 zones: left bank nearshore (LBN) was located approximately 1 net length from shore; left bank offshore (LBF) was located approximately 2 net lengths from shore; and right bank nearshore (RBN) was located approximately 1 net length from shore.

Table 12.–Fishing effort, catch, and proportion by zone and mesh size for Chinook and fall chum salmon in the species composition fishery and the fall chum salmon test fishery at the Eagle sonar project on the Yukon River, 2025.

Zone[a]	Mesh size (in)	Fishing effort (fathom-hours)	Chinook salmon		Fall chum salmon	
			Catch	Proportion	Catch	Proportion
LBI	5.25	338	11	0.155	64	0.533
	7.50	326	1	0.014	18	0.150
Total		664	12	0.169	82	0.683
LBN	5.25	335	21	0.296	25	0.208
	7.50	337	23	0.324	12	0.100
Total		672	44	0.620	37	0.308
LBF	5.25	336	7	0.099	0	0.000
	7.50	336	8	0.113	1	0.008
Total		672	15	0.211	1	0.008
Grand total		2,008	71	1.000	120	1.000

[a] Gillnets were drifted through 3 zones on the left bank: on the left bank inshore (LBI), the net was held from shore and led downstream while a boat drifted with the offshore end; the left bank nearshore (LBN) was located approximately 1 net length from shore; and the left bank offshore (LBF) was located approximately 2 net lengths from shore.

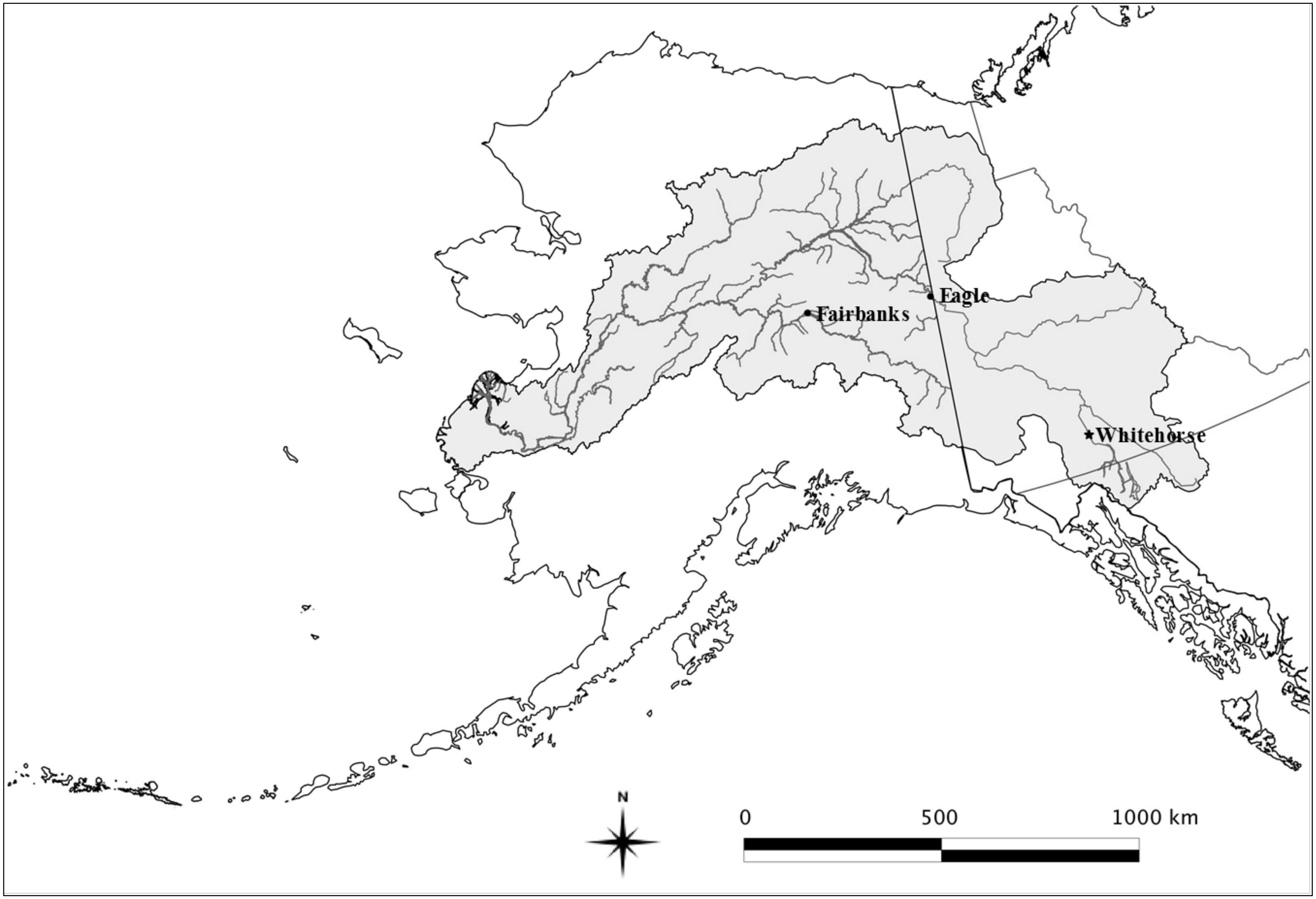

Figure 1.–Yukon River drainage.

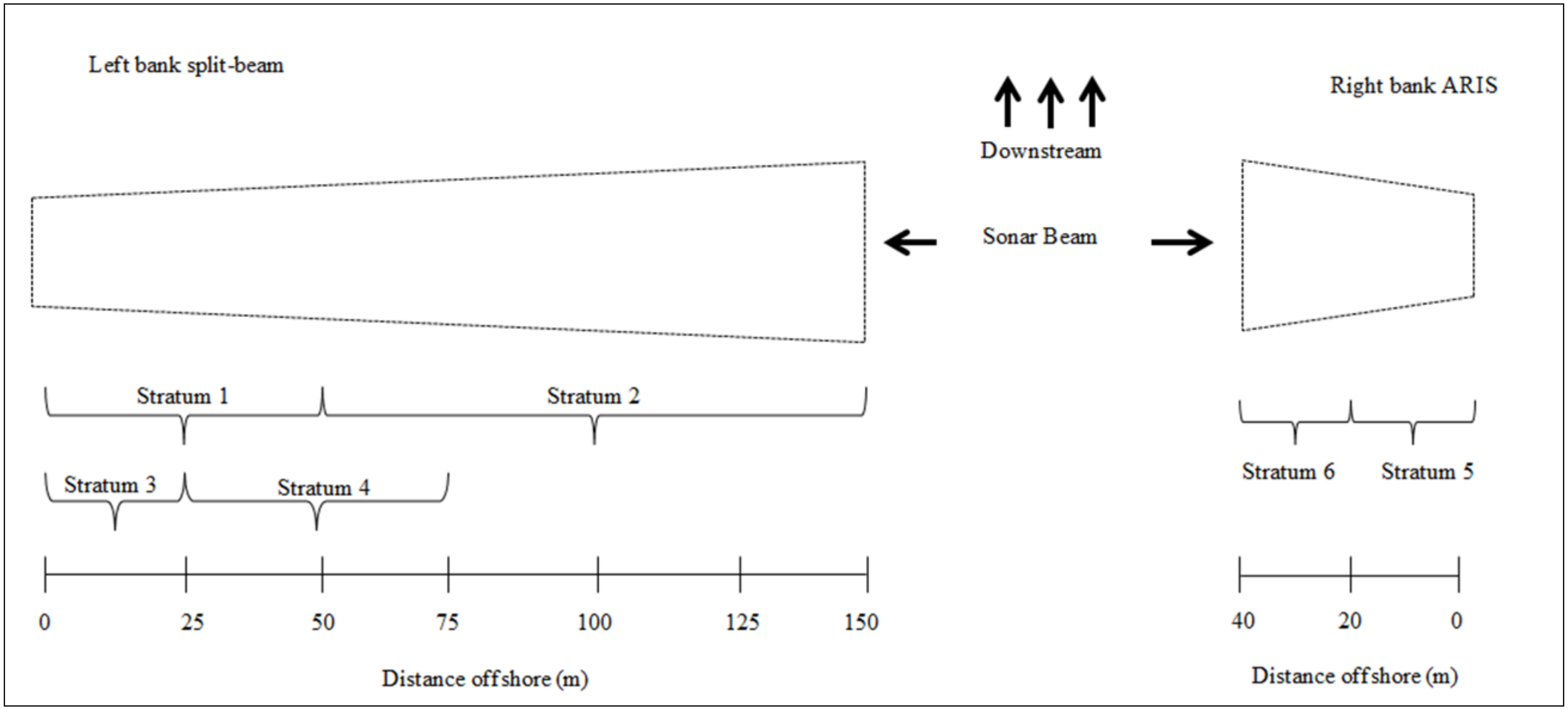

Figure 2.–Illustration of strata and approximate sonar ranges (not to scale) at the Eagle sonar project on the Yukon River, 2025.

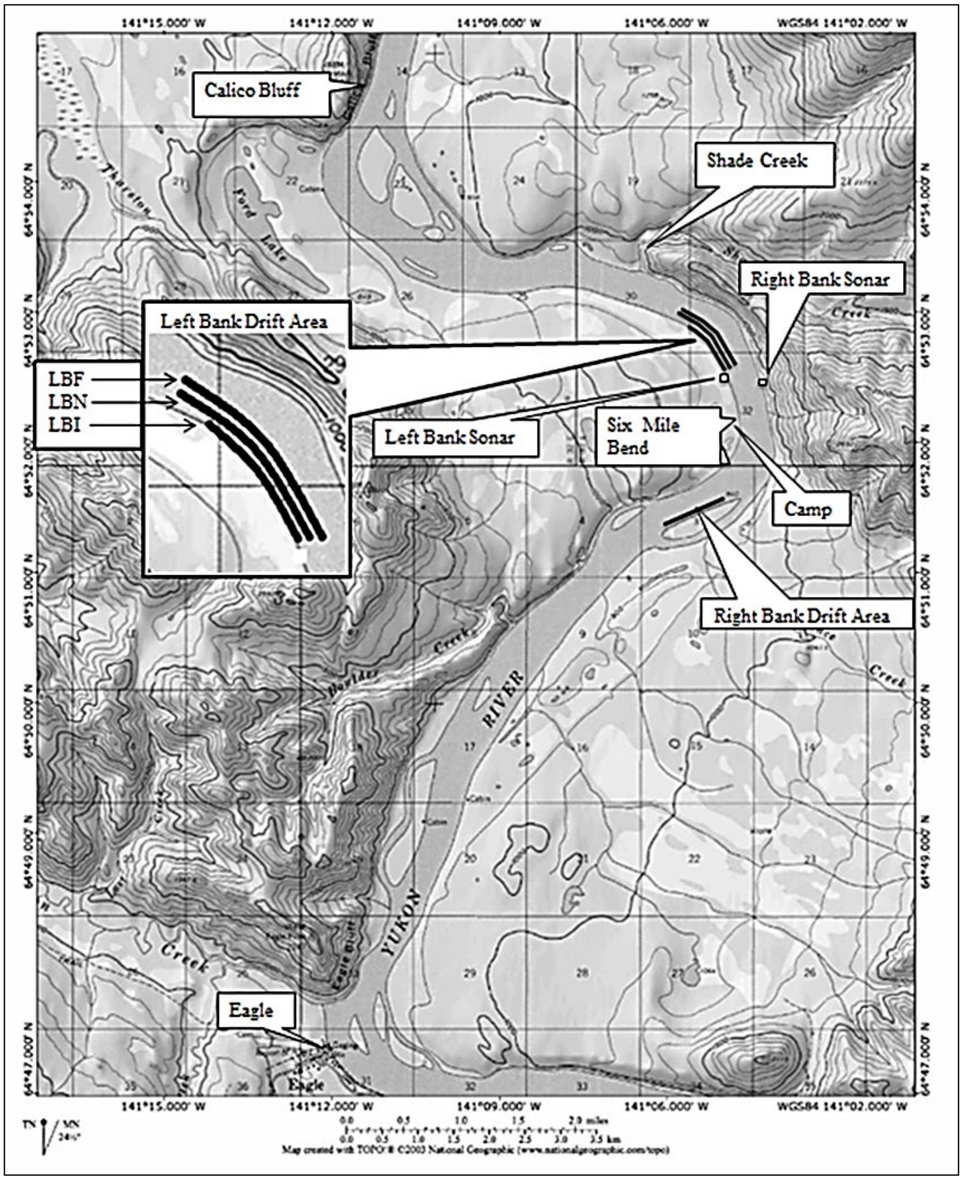

Figure 3.–Eagle sonar project site at Six Mile Bend on the Yukon River showing sonar and drift gillnet fishing locations, 2025.

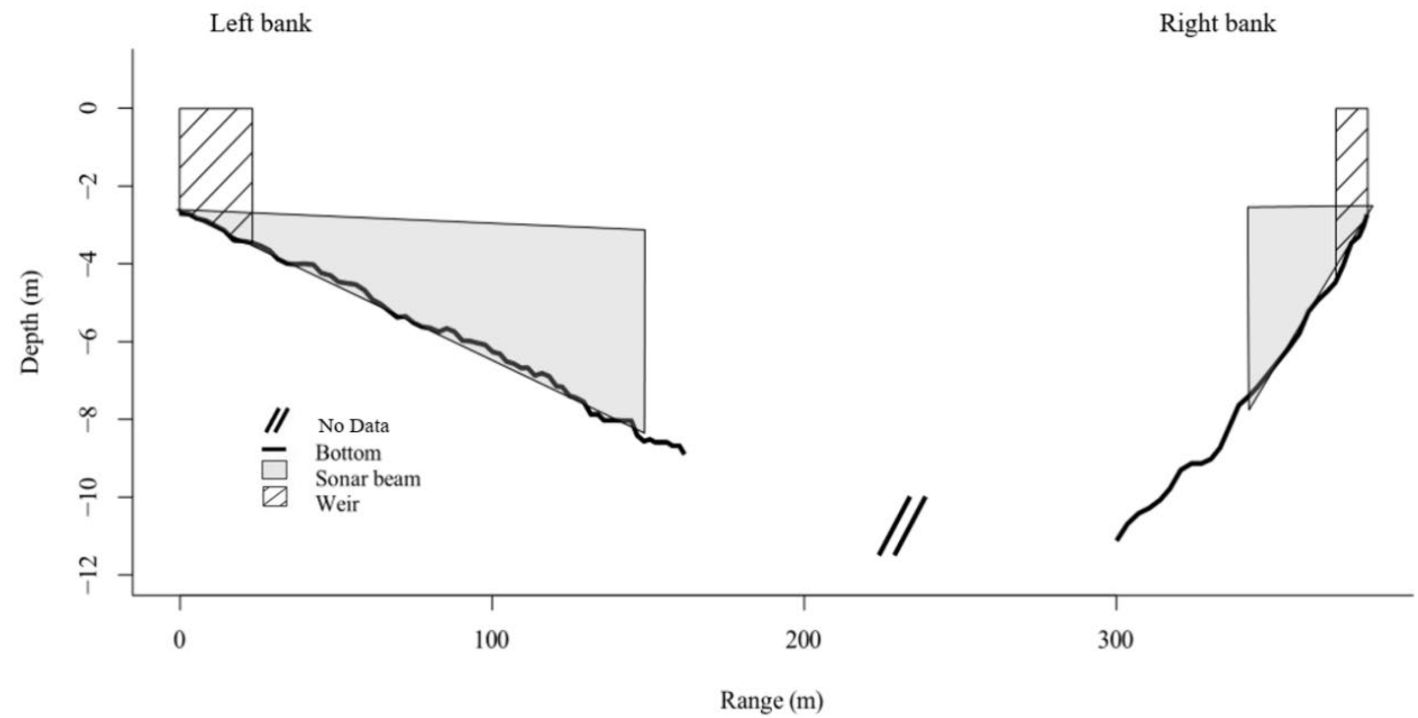

Figure 4.–Depth profile of the Yukon River in front of transducers (looking downstream) and approximate sonar coverage at the Eagle sonar project, 2025.

Note: To avoid damage to the outboard motor and transducer, bathymetric data collection began offshore at a depth of approximately 2 m.

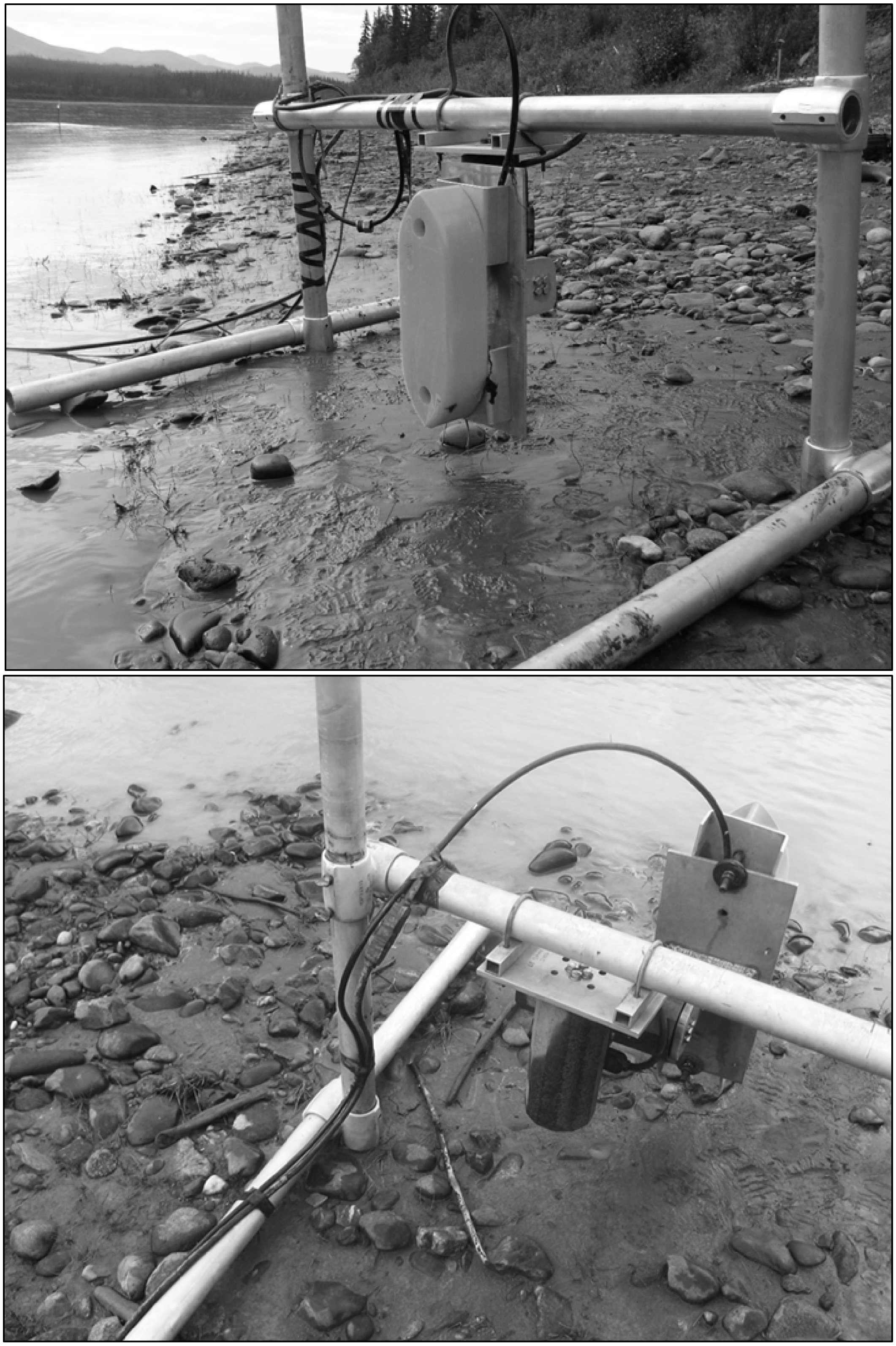

Figure 5.–Split-beam transducer mounted to an aluminum H-mount (top) and the same transducer mounted to 2 single-axis automated rotators (bottom) used on the left bank at the Eagle sonar project on the Yukon River.

Figure 6.–Portable tripod-style fish lead used on the left bank (top) and seine mesh fish lead used on the right bank (bottom) at the Eagle sonar project on the Yukon River.

Figure 7.–ARIS imaging sonar and AR2 Rotator mounted to an aluminum H-mount (top) and close-up view of rotator mount (bottom) at the Eagle sonar project on the Yukon River.

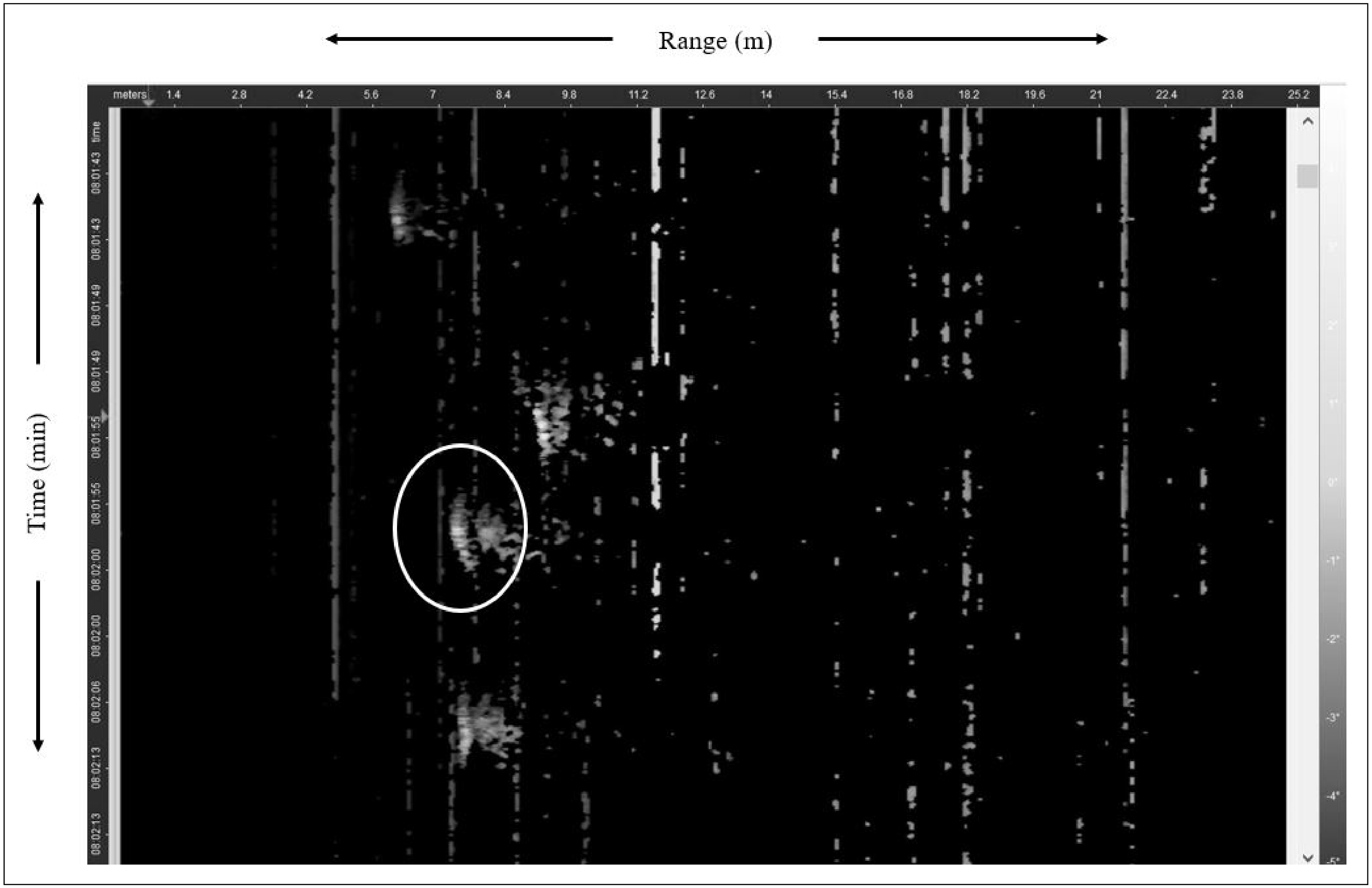

Figure 8.–Screenshot of an echogram from a split-beam sonar data file used to count fish and determine direction of travel at the Eagle sonar project on the Yukon River.

Note: The ellipse encompasses a typical upstream migrating salmon.

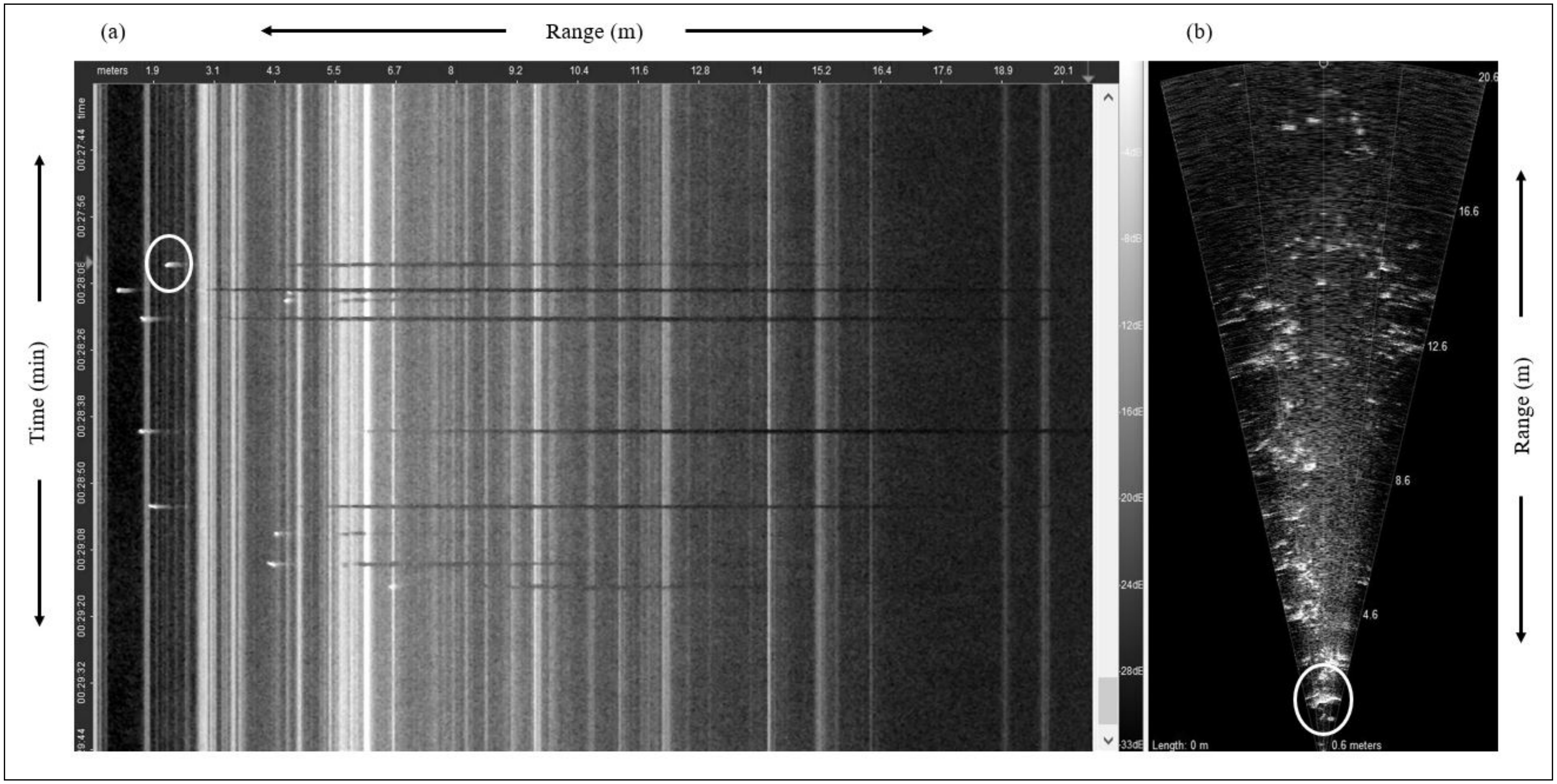

Figure 9.–Screenshots of an echogram (a) and video (b) from an ARIS data file used to count fish and determine direction of travel at the Eagle sonar project on the Yukon River.

Note: The ellipse encompasses a typical upstream migrating salmon.

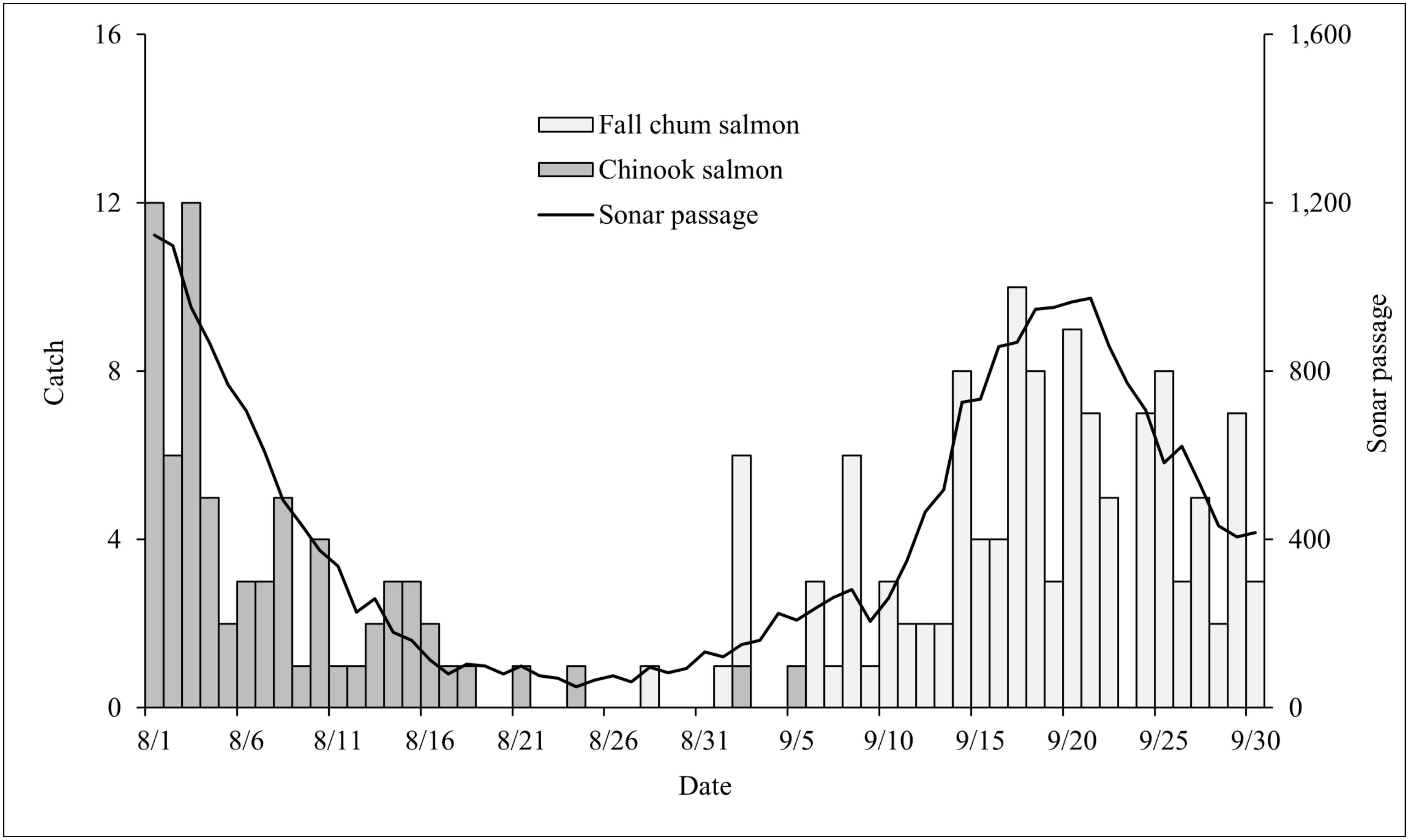

Figure 10.–Daily catch during species composition fishing and sonar passage estimates at the Eagle sonar project on the Yukon River, 2025.

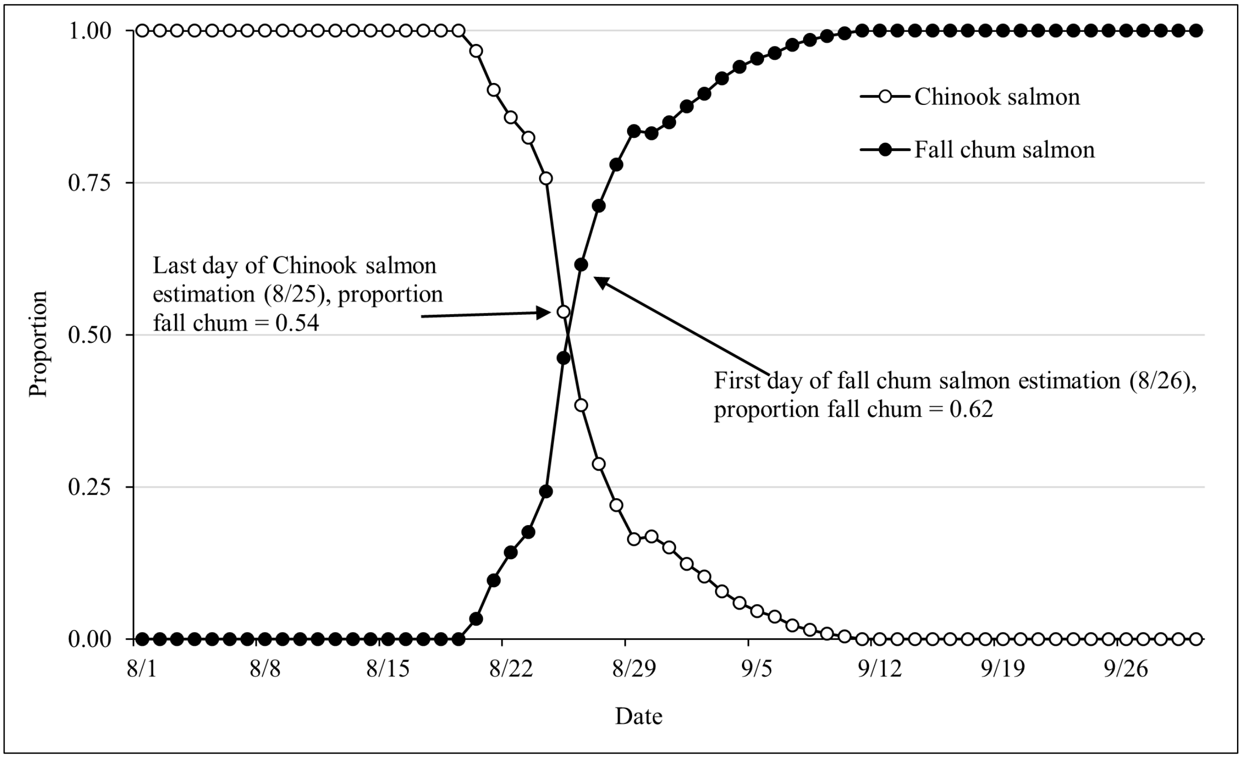

Figure 11.–Proportion of catch based on smoothed Chinook and fall chum salmon species composition CPUE data at the Eagle sonar project on the Yukon River, 2025.

Note: Species transition date (August 26) is defined as the day on which the proportion of fall chum salmon was greater than or equal to 0.5 and is designated as the first day of fall chum salmon estimation.

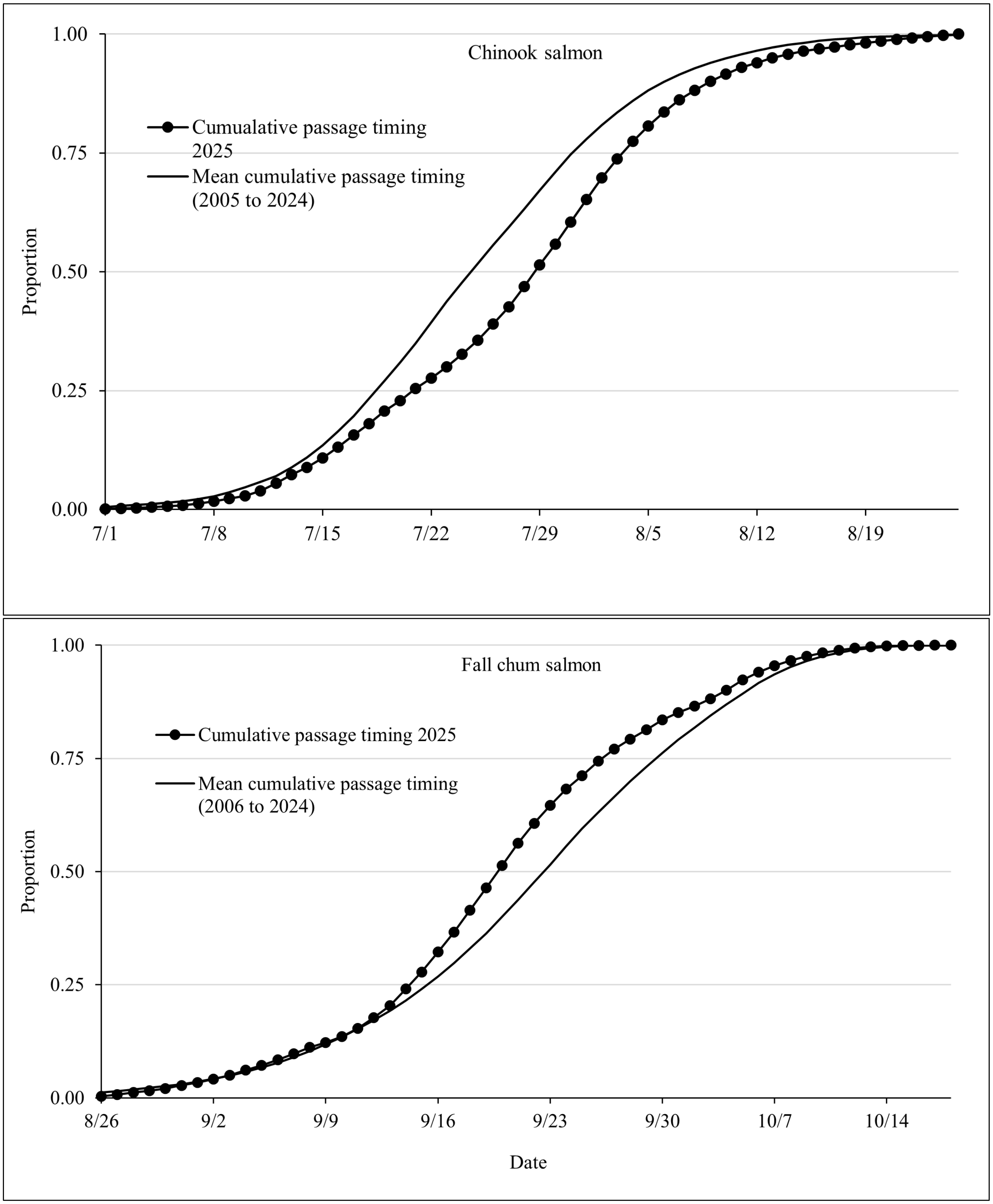

Figure 12.–2025 Chinook (top) and fall chum (bottom) salmon daily cumulative passage timing compared to the 2005–2024 (Chinook salmon) and 2006–2024 (fall chum salmon) mean passage timing at the Eagle sonar project on the Yukon River.

Note: Fall chum salmon cumulative passage timing includes postseason expansion estimates through October 18. Fall chum salmon passage was not estimated in 2005.

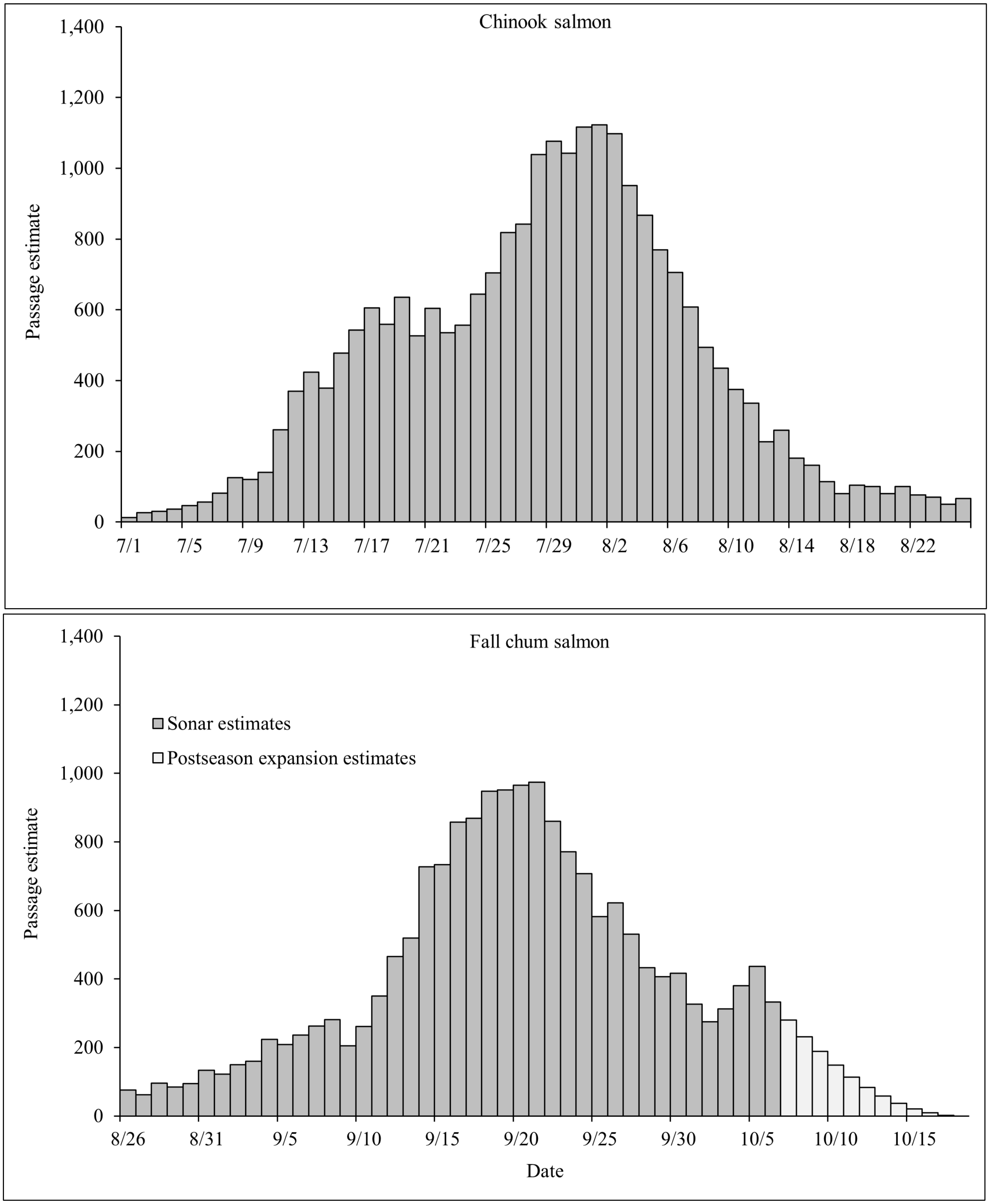

Figure 13.–Daily sonar passage estimates for Chinook salmon (top) from July 1 through August 25 and fall chum salmon (bottom) from August 26 through October 18 at the Eagle sonar project on the Yukon River, 2025.

Note: Postseason expansion estimates were calculated from October 7 through October 18.

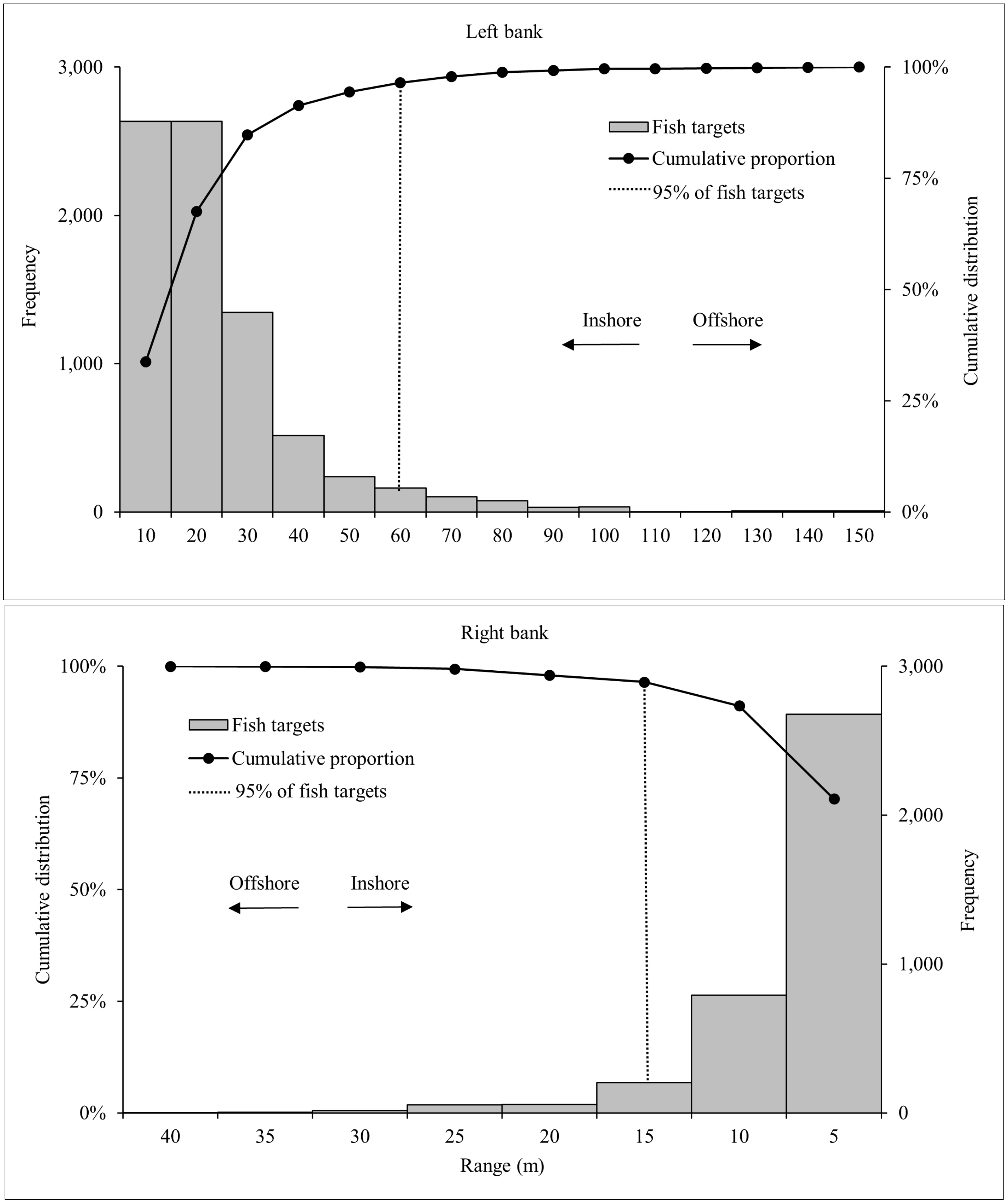

Figure 14.–Left and right bank horizontal distribution of upstream migrating Chinook salmon from July 1 through August 25 at the Eagle sonar project on the Yukon River, 2025.

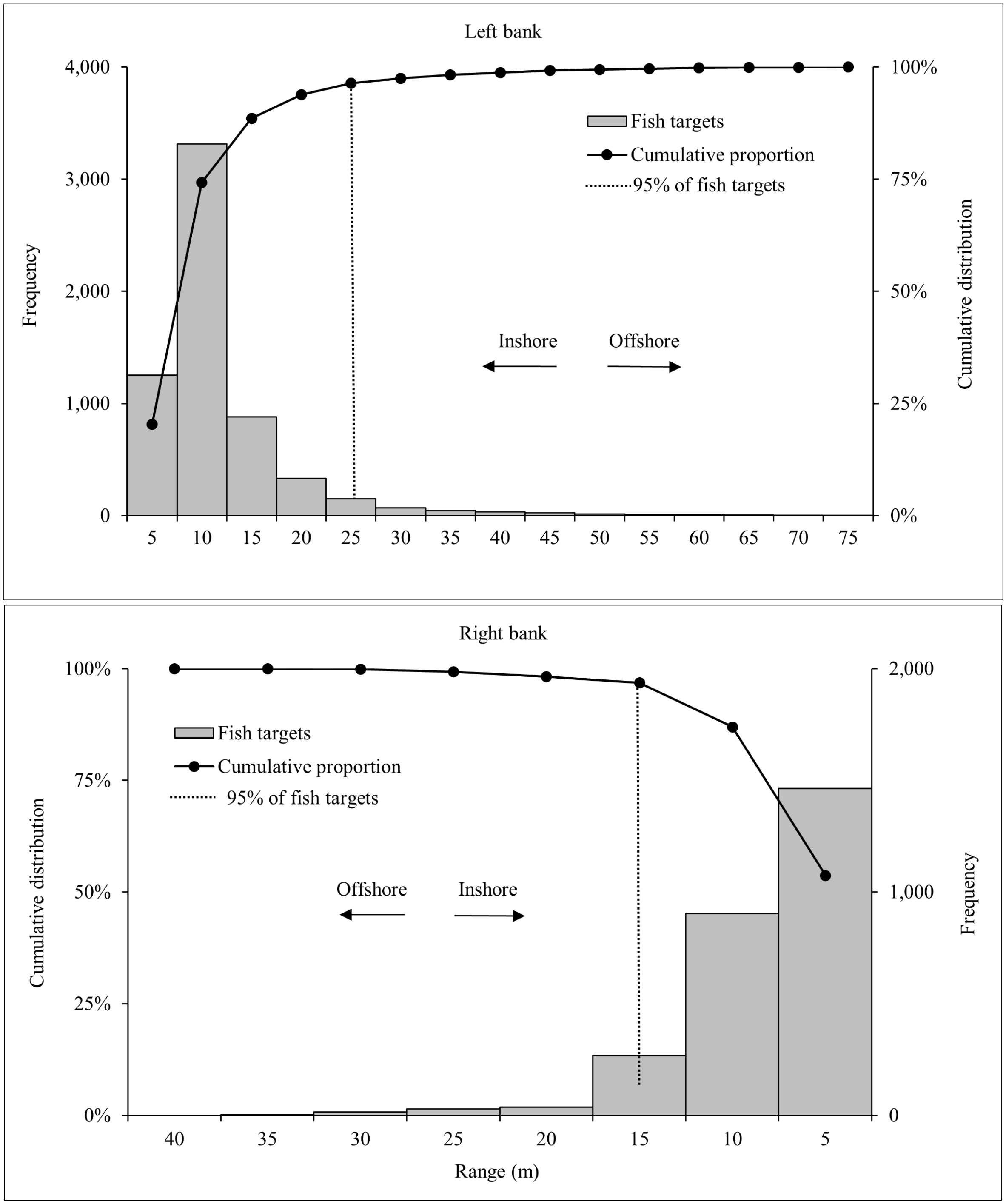

Figure 15.–Left and right bank horizontal distribution of upstream migrating fall chum salmon from August 26 through October 6 at the Eagle sonar project on the Yukon River, 2025.

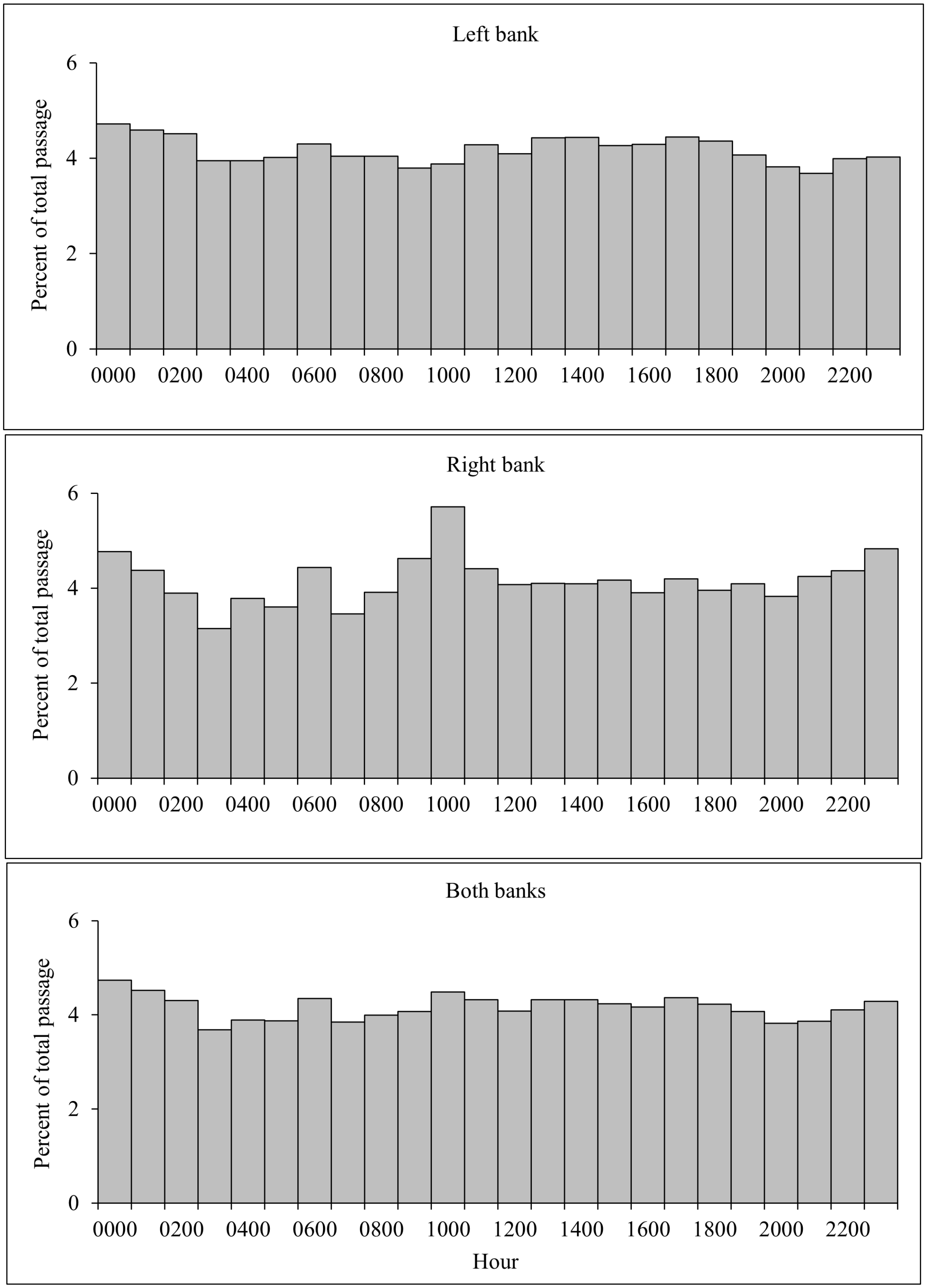

Figure 16.–Percent of total Chinook salmon passage, by hour, observed on the left bank, right bank, and both banks combined from July 1 through August 25 at the Eagle sonar project on the Yukon River, 2025.

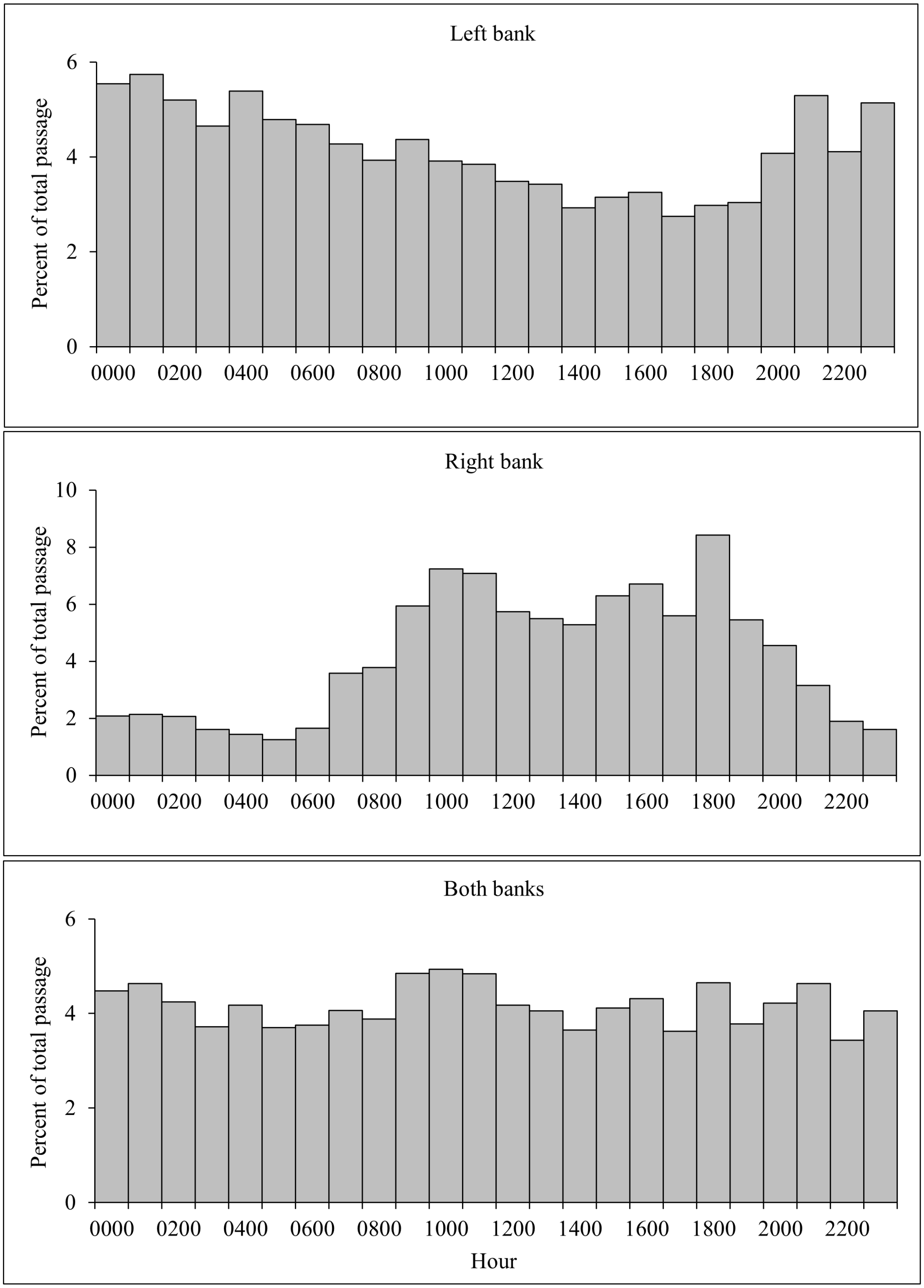

Figure 17.–Percent of total fall chum salmon passage, by hour, observed on the left bank, right bank, and both banks combined from August 26 through October 6 at the Eagle sonar project on the Yukon River, 2025.

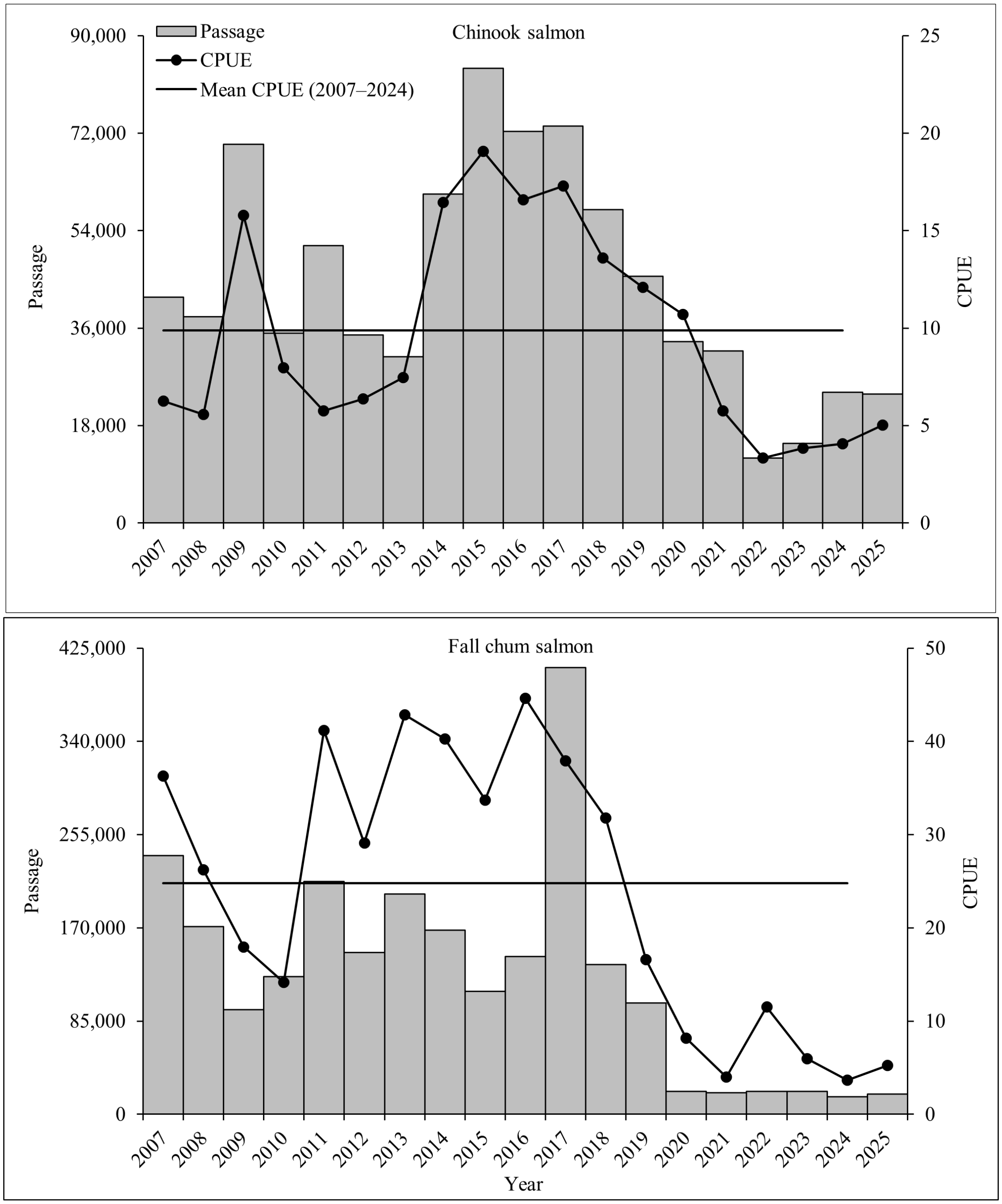

Figure 18.–Chinook and fall chum salmon passage, total cumulative catch per unit effort (CPUE) by year and mean total cumulative CPUE (2007–2024) at the Eagle sonar project on the Yukon River, 2025.

Note: Test fishing methodologies were not consistent until 2007; therefore, CPUE data prior to 2007 are not included in this figure. Because test fishing sites on the right bank changed several times throughout the project history, CPUE calculations are derived from left bank drifts only. Prior to 2013, fish were occasionally released without being sampled to avoid mortalities. For these years, the CPUE only represents fish sampled.

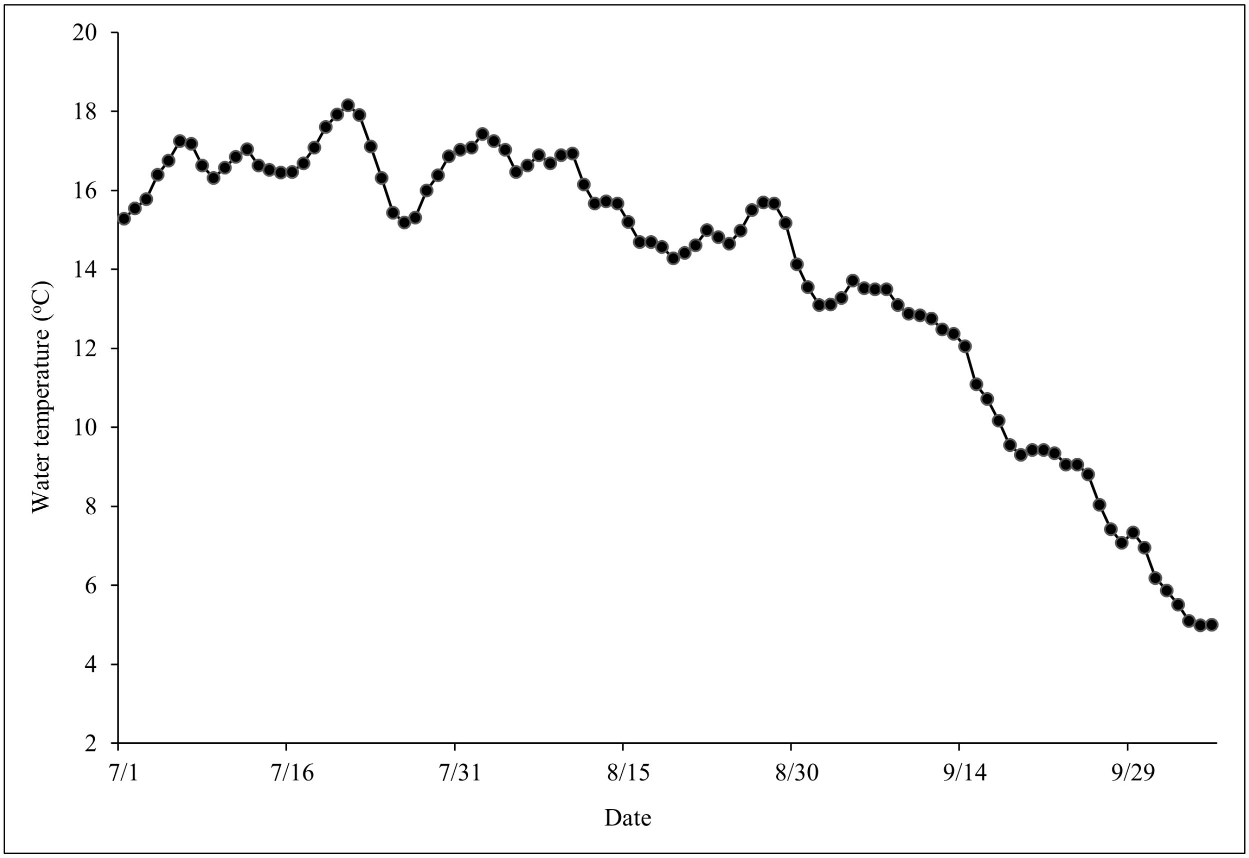

Figure 19.–Median daily water temperature recorded from July 1 through October 6 on the left bank at the Eagle sonar project on the Yukon River, 2025.

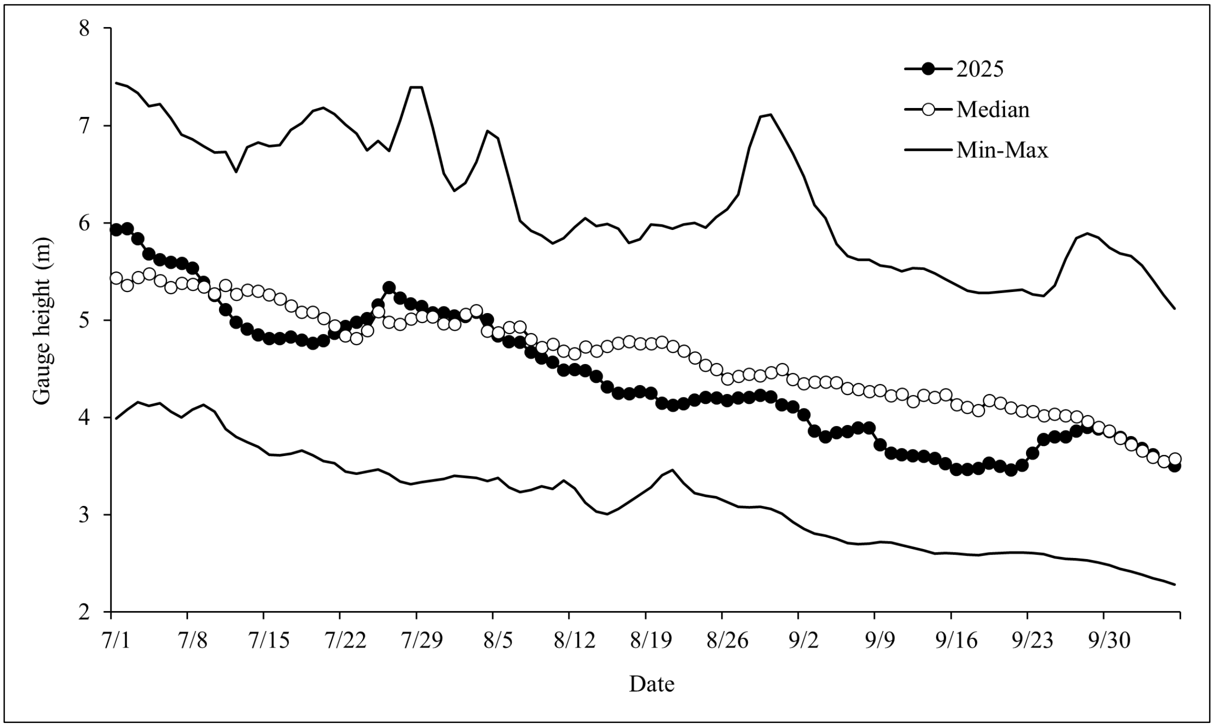

Figure 20.–Yukon River water level recorded daily at 1800 during the 2025 season at the city of Eagle, compared to minimum, maximum, and median gauge height from 1995 to 2024.

Source: United States Geological Survey (USGS). USGS gauge (15356000 YUKON R AT EAGLE AK).

APPENDIX A: SPECIES COMPOSITION TEST FISHERY CATCH, CPUE, AND SMOOTHED DATA BY DAY AND SALMON SPECIES

Appendix A1.–Species composition test fishery catch, catch per unit effort (CPUE), and smoothed data by day and salmon species at the Eagle sonar project on the Yukon River, 2025.

	Chinook salmon					Fall chum salmon				
Date	Large mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed	Small mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed
08/01	17.17	8	0.47	7.16	0.40	17.06	0	0.00	0.00	0.00
08/02	20.64	4	0.19	5.71	0.32	14.31	0	0.00	0.00	0.00
08/03	16.96	6	0.35	4.26	0.24	17.39	0	0.00	0.00	0.00
08/04	16.73	1	0.06	3.02	0.17	17.05	0	0.00	0.00	0.00
08/05	16.60	1	0.06	2.08	0.12	16.44	0	0.00	0.00	0.00
08/06	16.92	0	0.00	1.49	0.09	17.29	0	0.00	0.00	0.00
08/07	16.80	1	0.06	1.21	0.07	16.74	0	0.00	0.00	0.00
08/08	16.80	3	0.18	1.05	0.06	16.52	0	0.00	0.00	0.00
08/09	15.82	0	0.00	0.93	0.06	16.69	0	0.00	0.00	0.00
08/10	16.47	1	0.06	0.86	0.05	17.29	0	0.00	0.00	0.00
08/11	15.89	0	0.00	0.78	0.05	16.26	0	0.00	0.00	0.00
08/12	16.63	1	0.06	0.76	0.05	16.72	0	0.00	0.00	0.00
08/13	16.47	1	0.06	0.71	0.04	16.64	0	0.00	0.00	0.00
08/14	15.95	0	0.00	0.70	0.04	19.58	0	0.00	0.00	0.00
08/15	16.44	1	0.06	0.68	0.04	16.52	0	0.00	0.00	0.00
08/16	16.35	2	0.12	0.64	0.04	16.06	0	0.00	0.00	0.00
08/17	15.89	0	0.00	0.47	0.03	16.19	0	0.00	0.00	0.00
08/18	16.07	0	0.00	0.34	0.02	16.37	0	0.00	0.00	0.00
08/19	15.68	0	0.00	0.23	0.01	16.00	0	0.00	0.00	0.00
08/20	15.73	0	0.00	0.17	0.01	16.18	0	0.00	0.00	0.00
08/21	15.94	0	0.00	0.12	0.01	16.17	0	0.00	0.01	0.00
08/22	16.25	0	0.00	0.13	0.01	15.86	0	0.00	0.02	0.00
08/23	16.19	0	0.00	0.14	0.01	16.13	0	0.00	0.03	0.00
08/24	16.22	1	0.06	0.17	0.01	16.03	0	0.00	0.05	0.00

-continued-

Appendix A1.–Page 2 of 3.

	Chinook salmon					Fall chum salmon				
Date	Large mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed	Small mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed
08/25	16.59	0	0.00	0.14	0.01	16.22	0	0.00	0.11	0.01
08/26	15.85	0	0.00	0.11	0.01	15.71	0	0.00	0.17	0.01
08/27	15.71	0	0.00	0.10	0.01	15.92	0	0.00	0.24	0.01
08/28	15.67	0	0.00	0.09	0.01	15.89	1	0.06	0.30	0.02
08/29	15.87	0	0.00	0.08	0.00	15.98	0	0.00	0.39	0.02
08/30	15.93	0	0.00	0.09	0.01	16.16	0	0.00	0.44	0.03
08/31	15.55	0	0.00	0.09	0.01	16.30	0	0.00	0.56	0.03
09/01	15.91	0	0.00	0.09	0.01	16.22	0	0.00	0.70	0.04
09/02	16.29	1	0.06	0.09	0.01	16.91	4	0.24	0.87	0.05
09/03	16.37	0	0.00	0.08	0.01	16.63	0	0.00	1.04	0.06
09/04	16.04	0	0.00	0.08	0.00	16.42	0	0.00	1.25	0.07
09/05	15.90	0	0.00	0.07	0.00	16.45	0	0.00	1.42	0.08
09/06	16.45	0	0.00	0.06	0.00	16.64	2	0.12	1.60	0.10
09/07	16.88	0	0.00	0.04	0.00	16.29	0	0.00	1.78	0.11
09/08	15.74	0	0.00	0.03	0.00	16.76	5	0.30	1.94	0.12
09/09	15.65	0	0.00	0.02	0.00	16.08	1	0.06	2.12	0.13
09/10	15.98	0	0.00	0.01	0.00	16.39	2	0.12	2.30	0.14
09/11	15.42	0	0.00	0.00	0.00	16.26	2	0.12	2.43	0.14
09/12	15.66	0	0.00	0.00	0.00	16.14	2	0.12	2.60	0.16
09/13	15.67	0	0.00	0.00	0.00	15.97	2	0.13	2.74	0.16
09/14	15.77	0	0.00	0.00	0.00	16.32	5	0.31	2.86	0.17
09/15	16.44	0	0.00	0.00	0.00	16.68	2	0.12	2.97	0.18
09/16	16.25	0	0.00	0.00	0.00	16.30	2	0.12	3.13	0.19
09/17	16.12	0	0.00	0.00	0.00	17.51	10	0.57	3.27	0.19
09/18	16.35	0	0.00	0.00	0.00	16.94	7	0.41	3.45	0.20
09/19	16.04	0	0.00	0.00	0.00	16.46	2	0.12	3.60	0.21

-continued-

Appendix A1.–Page 3 of 3.

	Chinook salmon					Fall chum salmon				
Date	Large mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed	Small mesh fathom-hours	Catch	CPUE	Catch smoothed	CPUE smoothed
09/20	16.65	0	0.00	0.00	0.00	17.24	6	0.35	3.74	0.22
09/21	16.33	0	0.00	0.00	0.00	16.66	6	0.36	3.89	0.23
09/22	15.91	0	0.00	0.00	0.00	16.31	4	0.25	3.93	0.23
09/23	15.88	0	0.00	0.00	0.00	15.71	0	0.00	3.90	0.23
09/24	15.87	0	0.00	0.00	0.00	17.12	5	0.29	3.81	0.22
09/25	16.75	0	0.00	0.00	0.00	16.21	3	0.19	3.65	0.21
09/26	16.19	0	0.00	0.00	0.00	17.50	3	0.17	3.40	0.20
09/27	16.93	0	0.00	0.00	0.00	17.59	4	0.23	3.21	0.19
09/28	22.85	0	0.00	0.00	0.00	17.22	2	0.12	3.01	0.17
09/29	16.07	0	0.00	0.00	0.00	18.12	6	0.33	2.83	0.16
09/30	16.21	0	0.00	0.00	0.00	16.63	1	0.06	2.65	0.15

APPENDIX B: CLIMATIC AND HYDROLOGIC OBSERVATIONS

Appendix B1.–Climatic and hydrologic observations recorded at 1800 daily at the Eagle sonar project site on the Yukon River, 2025.

Date	Precipitation (code)[a]	Wind		Sky (code)[c]	Temperature (°C)	
		Direction[b]	Velocity (kph)		Air	Water[d]
07/02	A	E	6.6	S	22.7	15.5
07/03	A	NW	7.9	C	25.5	15.8
07/04	A	SE	4.1	B	28.7	16.4
07/05	A	SE	4.1	C	32.4	16.8
07/06	A	E	7.0	S	28.2	17.2
07/07	A	SE	6.5	B	23.6	17.2
07/08	A	NA	0.0	B	20.9	16.6
07/09	B	N	4.9	S	19.9	16.3
07/10	A	W	5.5	C	23.4	16.6
07/11	A	SW	6.2	C	23.0	16.9
07/12	A	NW	9.5	C	26.0	17.0
07/13	A	NA	0.0	C	28.0	16.6
07/14	B	S	6.4	O	18.0	16.5
07/15	B	SW	2.7	O	17.2	16.5
07/16	A	N	5.2	S	26.5	16.5
07/17	A	NW	9.7	B	23.1	16.7
07/18	A	NW	3.2	S	26.4	17.1
07/19	A	W	7.8	C	29.8	17.6
07/20	A	NW	6.9	S	26.8	17.9
07/21	A	N	6.9	B	24.0	18.2
07/22	A	N	11.7	B	17.7	17.9
07/23	A	NE	10.5	O	17.6	17.1
07/24	B	N	5	O	17	16.3
07/25	B	N	3	O	17	15.4
07/26	A	NA	0.0	C	26.2	15.2
07/27	A	NW	7.5	C	26.1	15.3
07/28	A	NA	0.0	B	26.1	16.0
07/29	C	SE	3	O	18	16.4
07/30	A	S	4.0	O	21.5	16.9
07/31	A	NE	4.3	S	22.8	17.0
08/01	A	NW	7.5	B	25.8	17.1
08/02	A	SE	7.8	B	21.6	17.4
08/03	A	NW	6.1	S	22.1	17.2
08/04	A	SE	2.5	B	19.6	17.0
08/05	A	SE	2.2	B	19.4	16.5
08/06	A	SE	4.0	B	20.0	16.6
08/07	A	SE	5.2	O	26.6	16.9

-continued-

Appendix B1.–Page 2 of 3.

Date	Precipitation (code)[a]	Wind		Sky (code)[c]	Temperature (°C)	
		Direction[b]	Velocity (kph)		Air	Water[d]
08/08	A	NW	1.8	O	18.0	16.7
08/09	A	E	1.6	S	24.2	16.9
08/10	A	NA	NA	S	17.4	16.9
08/11	A	NW	3.6	B	14.6	16.2
08/12	A	E	6.7	C	20.6	15.7
08/13	A	SE	6.4	S	22.9	15.7
08/14	A	NW	8.1	O	19.0	15.7
08/15	A	NW	11.9	O	13.9	15.2
08/16	A	N	8.2	O	9.4	14.7
08/17	A	N	8.0	O	11.7	14.7
08/18	A	SE	3.1	B	16.0	14.6
08/19	A	NA	NA	B	17.8	14.3
08/20	B	MW	5.0	O	15.4	14.4
08/21	A	SE	5.2	S	23.9	14.6
08/22	A	NA	NA	S	20.0	15.0
08/23	A	SE	7.8	B	15.9	14.8
08/24	B	SE	2.2	O	16.4	14.6
08/25	A	NW	6.6	S	21.5	15.0
08/26	A	N	3.9	C	23.8	15.5
08/27	A	NE	4.3	B	20.4	15.7
08/28	A	N	2.6	O	17.1	15.7
08/29	B	E	7.4	O	9.5	15.2
08/30	A	NW	6.9	C	16.8	14.1
08/31	A	NW	2.7	C	15.3	13.6
09/01	A	N	2.3	B	16.1	13.1
09/02	A	N	1.8	B	15.9	13.1
09/03	A	NA	NA	B	20.1	13.3
09/04	A	SE	2.2	S	26.1	13.7
09/05	A	NA	NA	O	15.6	13.5
09/06	A	SE	10.5	C	18.6	13.5
09/07	A	SE	6.6	B	18.6	13.5
09/08	A	NA	NA	B	19.0	13.1
09/09	A	S	10.5	S	18.0	12.9
09/10	A	SE	10.3	B	17.4	12.8
09/11	A	SE	2.4	B	14.9	12.8
09/12	A	NW	5.8	O	10.2	12.5
09/13	A	NW	8.8	C	12.6	12.4
09/14	A	NW	4.3	B	15.6	12.0
09/15	B	SE	7.7	O	12.4	11.1
09/16	A	SE	3.5	B	`5.7	10.7

-continued-

Appendix B1.–Page 3 of 3.

Date	Precipitation (code)[a]	Wind		Sky (code)[c]	Temperature (°C)	
		Direction[b]	Velocity (kph)		Air	Water[d]
09/17	B	NA	NA	O	9.8	10.2
09/18	A	N	2.0	B	14.3	9.5
09/19	A	S	5.7	B	12.6	9.3
09/20	B	NA	NA	O	11.6	9.4
09/21	A	SE	7.2	O	11.0	9.4
09/22	C	SE	7.1	O	7.6	9.3
09/23	A	NA	NA	O	10.8	9.1
09/24	A	NW	5.1	B	12.5	9.1
09/25	A	NE	2.2	S	12.6	8.8
09/26	A	NW	3.5	O	6.3	8.0
09/27	A	NW	4.5	B	7.6	7.4
09/28	A	SE	7.3	B	10.3	7.1
09/29	A	NW	4.2	O	6.0	7.3
09/30	A	NW	2.3	B	3.2	7.0
10/01	A	SE	2.1	O	7.0	6.2
10/02	B	NW	2.6	O	6.8	5.9
10/03	A	E	1.8	B	6.2	5.5
10/04	A	NA	0.0	O	11.0	5.1
10/05	A	NW	2.1	B	10.7	5.0
10/06[e]	A	NW	6.2	B	10.7	5.0

[a] Precipitation code for the preceding 24 h period: A = none; B = intermittent rain; C = continuous rain; D = snow and rain mixed; E = light snowfall; F = continuous snowfall; G = thunderstorm with or without precipitation.

[b] Wind direction code: N = North; S = South; E = East; W = West; V = Variable; NA = Not applicable (no wind).

[c] Instantaneous cloud cover code: C = clear, cloud cover <10% of sky; S = cloud cover <60% of sky; B = cloud cover 60–90% of sky; O = overcast (100%); F = fog, thick haze, or smoke.

[d] Water temperature collected approximately 30 cm below the surface with a Hobo U22 data logger.

[e] Observations taken at 12:00.