Operational Plan: Kenai River and Kasilof River Chinook Salmon Sonar Assessment, 2023–2025

by

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and

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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)			General			Mathematics, statistics	
centimeter	cm		Alaska Administrative			*all standard mathematical*	
deciliter	dL		Code	AAC		*signs, symbols and*	
gram	g		all commonly accepted			*abbreviations*	
hectare	ha		abbreviations	e.g., Mr., Mrs.,		alternate hypothesis	H_A
kilogram	kg			AM, PM, etc.		base of natural logarithm	*e*
kilometer	km		all commonly accepted			catch per unit effort	CPUE
liter	L		professional titles	e.g., Dr., Ph.D.,		coefficient of variation	CV
meter	m			R.N., etc.		common test statistics	$(F, t, \chi^2, \text{etc.})$
milliliter	mL		at	@		confidence interval	CI
millimeter	mm		compass directions:			correlation coefficient	
			east	E		(multiple)	R
Weights and measures (English)			north	N		correlation coefficient	
cubic feet per second	ft^3/s		south	S		(simple)	r
foot	ft		west	W		covariance	cov
gallon	gal		copyright	©		degree (angular)	°
inch	in		corporate suffixes:			degrees of freedom	df
mile	mi		Company	Co.		expected value	*E*
nautical mile	nmi		Corporation	Corp.		greater than	>
ounce	oz		Incorporated	Inc.		greater than or equal to	≥
pound	lb		Limited	Ltd.		harvest per unit effort	HPUE
quart	qt		District of Columbia	D.C.		less than	<
yard	yd		et alii (and others)	et al.		less than or equal to	≤
			et cetera (and so forth)	etc.		logarithm (natural)	ln
Time and temperature			exempli gratia			logarithm (base 10)	log
day	d		(for example)	e.g.		logarithm (specify base)	$\log_2$, etc.
degrees Celsius	°C		Federal Information			minute (angular)	'
degrees Fahrenheit	°F		Code	FIC		not significant	NS
degrees kelvin	K		id est (that is)	i.e.		null hypothesis	H_O
hour	h		latitude or longitude	lat or long		percent	%
minute	min		monetary symbols			probability	P
second	s		(U.S.)	$, ¢		probability of a type I error	
			months (tables and			(rejection of the null	
Physics and chemistry			figures): first three			hypothesis when true)	α
all atomic symbols			letters	Jan,...,Dec		probability of a type II error	
alternating current	AC		registered trademark	®		(acceptance of the null	
ampere	A		trademark	™		hypothesis when false)	β
calorie	cal		United States			second (angular)	"
direct current	DC		(adjective)	U.S.		standard deviation	SD
hertz	Hz		United States of			standard error	SE
horsepower	hp		America (noun)	USA		variance	
hydrogen ion activity	pH		U.S.C.	United States		population	Var
(negative log of)				Code		sample	var
parts per million	ppm		U.S. state	use two-letter			
parts per thousand	ppt, ‰			abbreviations			
				(e.g., AK, WA)			
volts	V						
watts	W						

REGIONAL OPERATIONAL PLAN NO. ROP.SF.2A.2023.04

OPERATIONAL PLAN: KENAI RIVER AND KASILOF RIVER CHINOOK SALMON SONAR ASSESSMENT, 2023–2025

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ABSTRACT

Alaska Department of Fish and Game (ADF&G) has monitored Chinook salmon (*Oncorhynchus tshawytscha*) passage in the Kenai River using side-looking sonar technology from 1987 to present at historical (1987–2012) and modern (2013–present) sites and with multiple updated sonar technologies. Starting in 2018, a similar sonar program to monitor Chinook salmon at the nearby Kasilof River was begun as well. This plan covers sonar project operations at Kenai RM 13.7 and Kasilof RM 8 for the 2023–2025 seasons with the goal of producing daily inseason net passage estimates of fish 75 cm or longer for the Kenai River and postseason net upstream passage estimates of fish 75 cm or longer for the Kasilof river.

Key words: ARIS, DIDSON, Chinook salmon, *Oncorhynchus tshawytscha*, acoustic assessment, Kenai River, Kasilof River, riverine sonar, fisheries sonar, multibeam sonar

INTRODUCTION

PURPOSE

Adaptive resolution imaging sonar (ARIS) will be used to produce inriver abundance estimates of Kenai River early- and late-run Chinook salmon and Kasilof River late-run Chinook salmon. These estimates of inriver Chinook salmon passage provide the basis for estimating spawning escapement and implementing management plans that regulate harvest in the competing fisheries for these stocks.

BACKGROUND

Kenai River

Chinook salmon (*Oncorhynchus tshawytscha*) returning to the Kenai River (Figure 1) are managed as 2 distinct runs (Burger et al. 1985): early (mid-May–30 June) and late (1 July–mid-August). Early-run Chinook salmon are harvested primarily by sport anglers, and late-run Chinook salmon are harvested by commercial, sport, subsistence, and personal use fisheries. These fisheries may be restricted or liberalized if the projected escapement falls below or above goals adopted by the Alaska Board of Fisheries (BOF). These goals are defined by Alaska Administrative Codes 5 AAC 57.160 (*Kenai River and Kasilof River Early-Run King Salmon Conservation Management Plan*) and 5 AAC 21.359 (*Kenai River Late-Run King Salmon Management Plan*) and are intended to ensure sustainable Chinook salmon stocks.

Although the history of the Kenai River sonar program goes back to 1987, with many updates to sonar and sonar location (Burwen et al. 1998; Hammarstrom and Hasbrouck 1999; Burwen and Fleischman 1998; Burwen et al. 2003; Burwen et al. 2007; Miller et al. 2010; Miller et al. 2013; Miller et al. 2015), since 2013, up to 5 units adaptive resolution imaging sonar (ARIS) have been used to produce inriver abundance estimates of Kenai River early- and late-run Chinook salmon at Kenai RM 13 (Figure 2; Figure 3).

Estimates of Chinook salmon abundance require information on Chinook salmon size, which has been obtained historically from an inriver gillnetting program operated at RM 8.6 (Perschbacher 2012a-d, 2014, 2015, 2018, 2022; Perschbacher and Eskelin 2016). Netting at RM 8.6 was originally restricted to a midriver corridor in order to approximately match the cross-sectional area insonified by older sonar technology, but was expanded in 2013 to include nearshore drifts to be more representative of the entire run (Perschbacher 2015), which complements the bank-to-bank insonification by ARIS at RM 13.
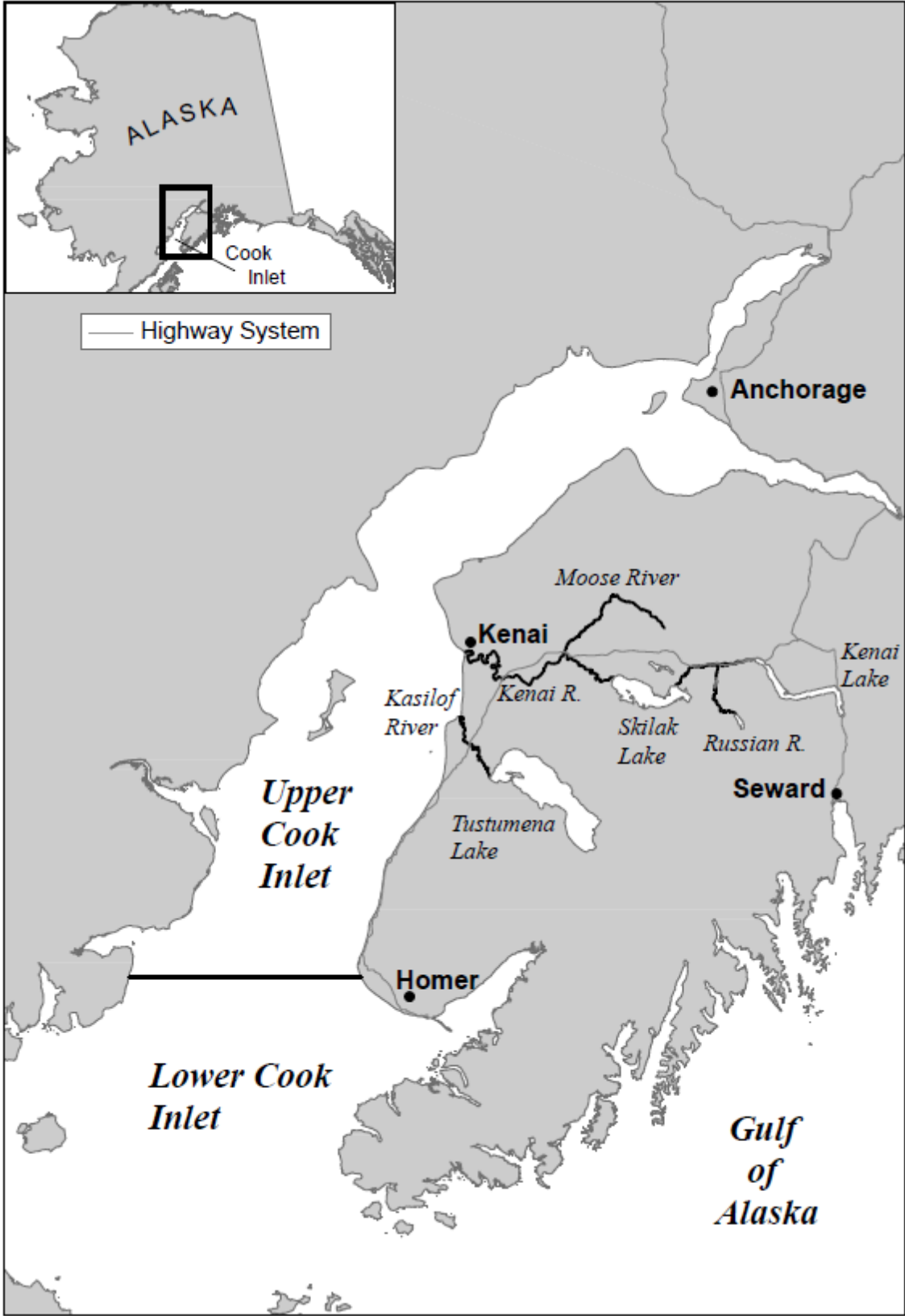
Figure 1.–Cook Inlet showing the location of the Kenai and Kasilof Rivers.
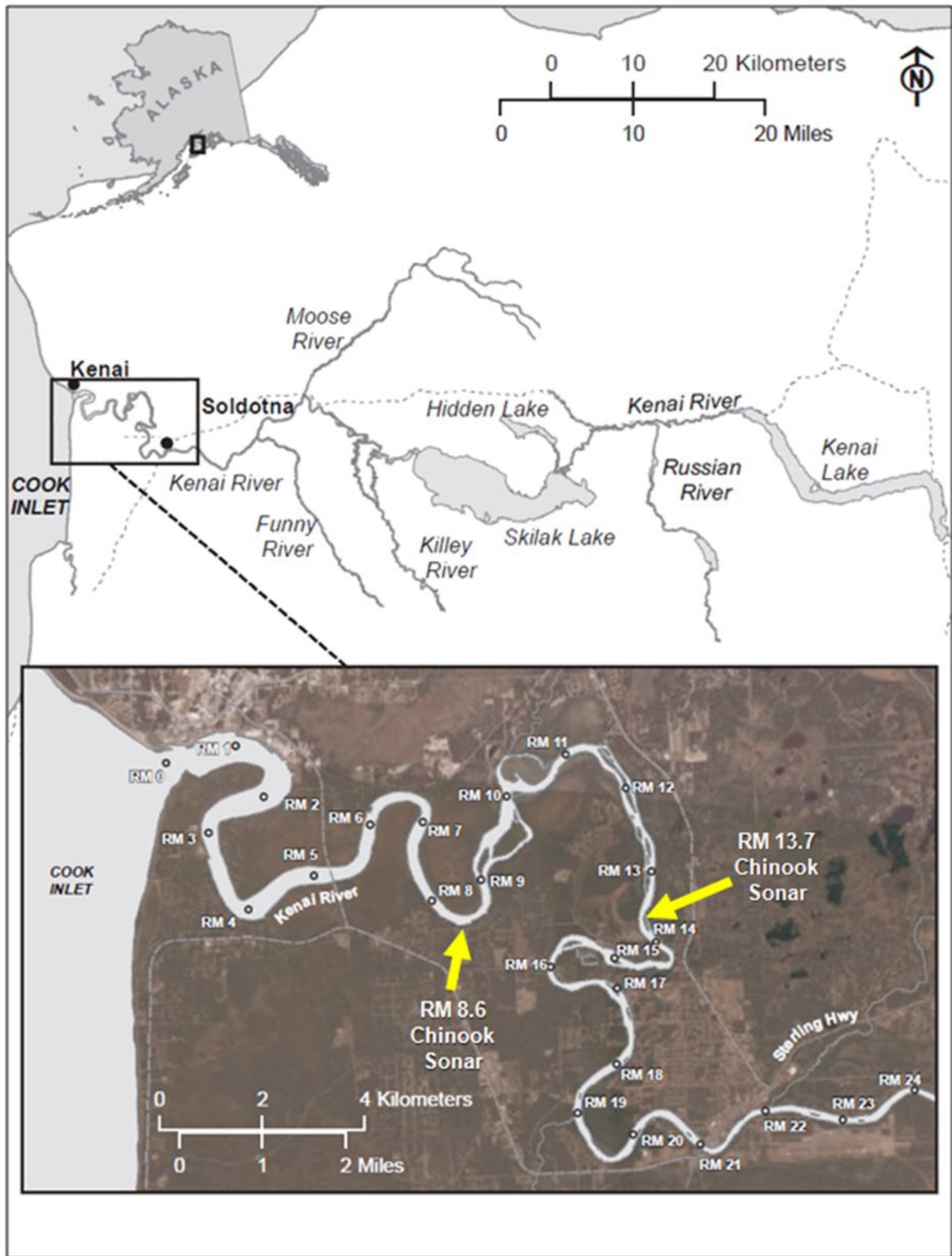
Figure 2.–Map of Kenai River showing location of historical Chinook salmon sonar site at river mile 8.6 and current sonar site at river mile 13.7.
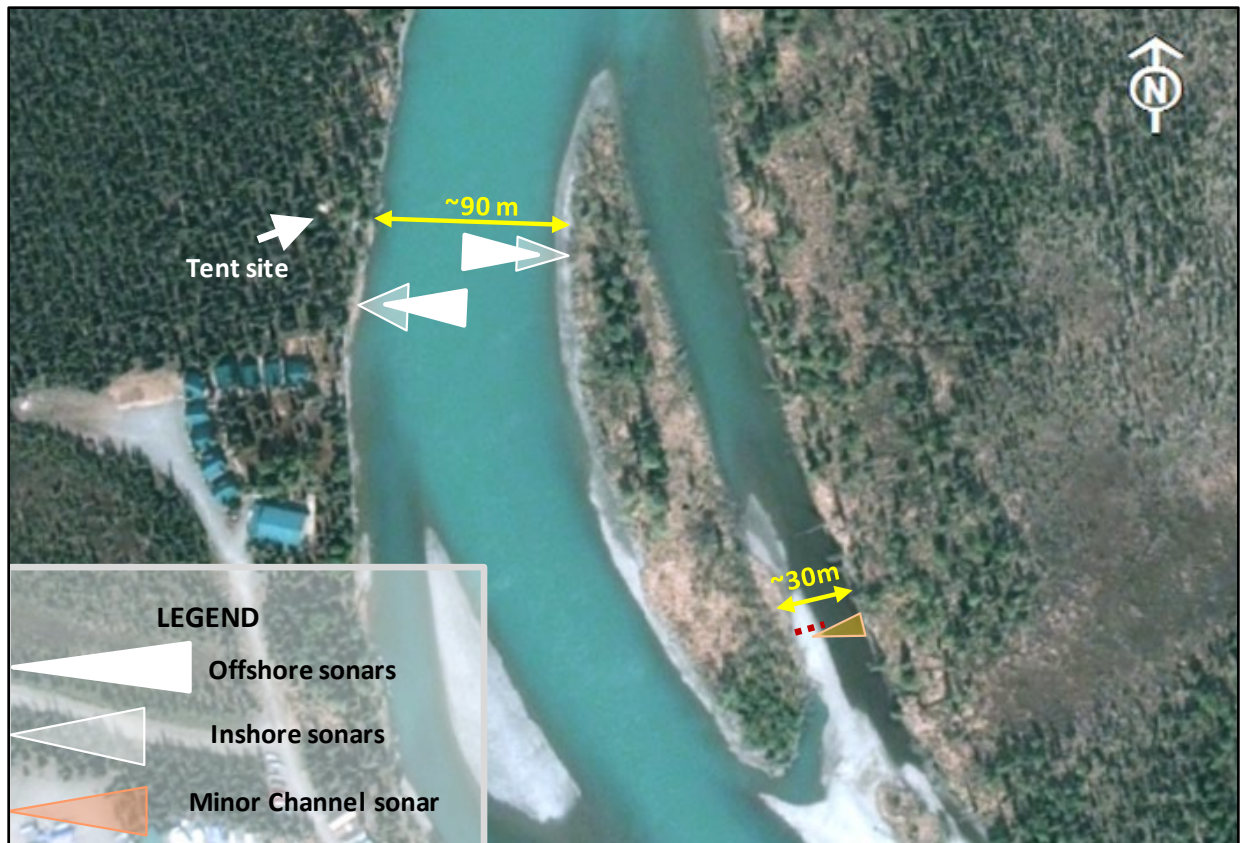
Figure 3.–Kenai River RM 13.7 sonar site showing approximate deployment locations and beam coverage of 5 ARIS units.

Although prior estimates of Kenai River Chinook salmon passage were made for all sizes of the Chinook salmon run and relied on estimates of small Chinook salmon passage using mixture model analysis (Miller et al. 2016; Key et al. 2017), beginning in 2017, Chinook salmon stock assessment and management have been based on direct sonar counts of fish 75 cm or longer as measured by ARIS (AL) at the RM 13.7 site. Fish 75 cm AL or longer (equivalent to 75 cm mid eye to tail fork [METF] or longer) are composed almost entirely of Chinook salmon. Based on a spawner–recruit analysis conducted by Fleischman and Reimer (2017), ADF&G established sustainable escapement goals (SEGs) of 2,800–5,600 early-run and 13,500–27,000 late-run Kenai River Chinook salmon 75 cm METF or longer. The early- and late-run SEGs were later superseded by optimal escapement goals of 3,900–6,600 and 15,000–30,000 Chinook salmon 75 cm METF or longer, as established by the Alaska Board of Fisheries.

The 2023–2025 RM 13.7 project will operate from 16 May to approximately 20 August each year. In addition to producing inseason estimates of Kenai River Chinook salmon 75 cm METF or longer, abundance estimates of all Chinook salmon (regardless of size) will be generated postseason using mixture model analyses that combine RM 13.7 sonar data and RM 8.6 netting data. Postseason estimates of all sizes of Chinook salmon are used for historical comparison and for providing an all-fish estimate for data requests.

Kasilof River

Chinook salmon returning to the Kasilof River (Figure 1) are composed of two runs similar in timing to the Kenai River runs: an early run that enters the river primarily in May–June and a late run that enters primarily in July–August. The early run is composed of naturally-produced and hatchery-reared Chinook salmon destined for Crooked Creek and is enumerated using a weir located 3.2 RM upstream from the Crooked Creek confluence with Kasilof River. The late run is composed of a wild stock that spawns in the Kasilof River mainstem upstream of the Crooked Creek confluence. Early-run Kasilof River Chinook salmon are harvested primarily by sport anglers, whereas late-run Chinook salmon are harvested by sport anglers and in the commercial fishery. The early run fishery is regulated according to provisions in the *Kenai River and Kasilof River Early-Run King Salmon Conservation Management Plan.* No management plan exists for the regulation of the Kasilof River late-run fisheries. However, management of these fisheries often mirrors management actions taken for Kenai River late-run Chinook salmon fisheries.

Methods for estimating passage of Kasilof River late-run Chinook salmon 75 cm METF or longer at RM 8 are similar to those of the Kenai River. Between 2018 and 2020, the Division of Sport Fish (SF) funded extended operations at an existing Division of Commercial Fisheries (CF) sockeye salmon (*O. nerka*) ARIS project at RM 8 on the Kasilof River (Figure 4) through the end of August to provide a complete estimate of late-run Kasilof River Chinook salmon inriver abundance (Miller et al. 2020, 2022). SF funding to extend the Kasilof River sonar project was eliminated prior to the 2020 season due to budget cuts, but CF was still able to operate the project through 20 August that year, which appears to have encompassed most of the late-run Chinook salmon passage (Miller et al. 2022).
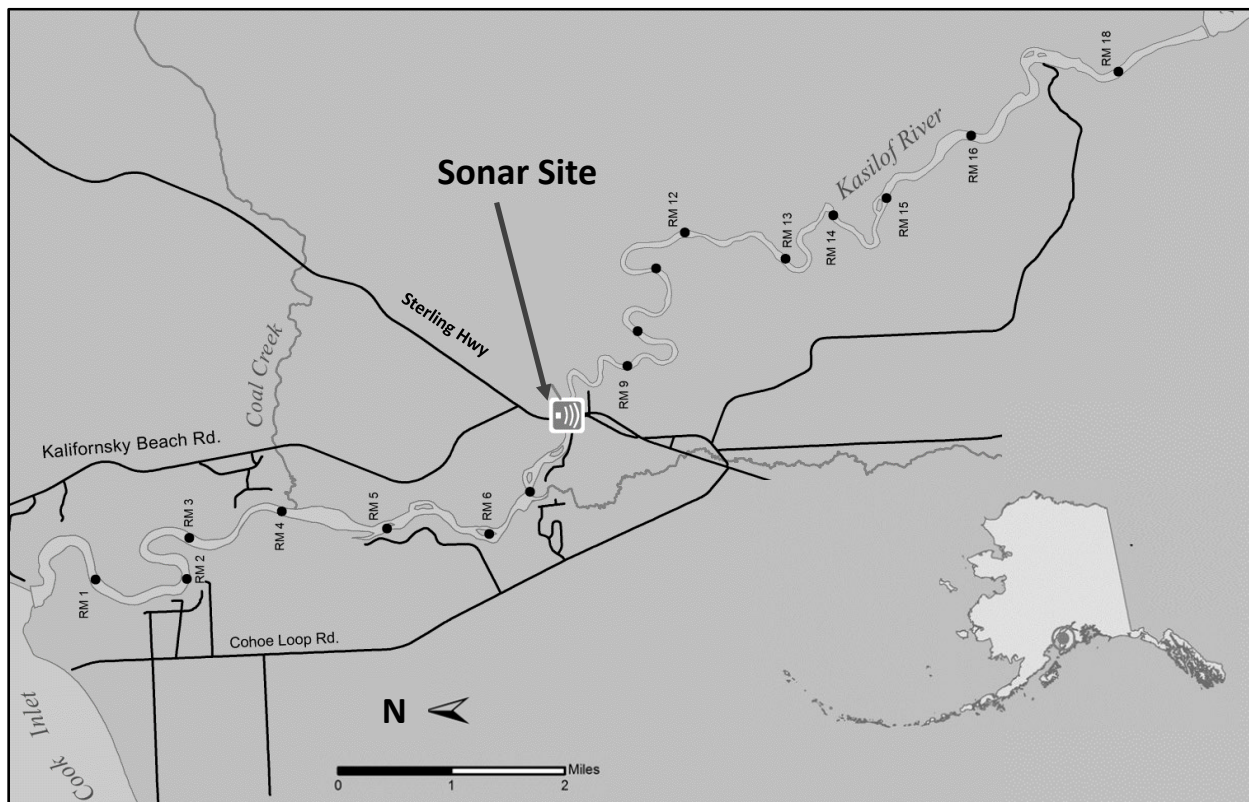
Figure 4.–Map of the Kasilof River showing the RM 8 sonar site, Kenai Peninsula, Southcentral Alaska.

In 2021 and 2022, CF operated the project through 15 August. Although the truncated seasons during those two years precluded our ability to produce daily inseason Chinook salmon abundance estimates beyond 15 August, we were able to use ARIS data collected during the sockeye salmon season to produce postseason estimates. Staff from the Kenai River project who had been processing ARIS data from the Kasilof River project through 2020 continued to process Kasilof River data in 2021 and 2022, with Kenai River data taking precedence during times of staff shortages or unforeseen emergencies. Chinook salmon passage through 31 August in 2021 and 2022 was estimated postseason using passage through 15 August and mean run timing from 2018 to 2020. Similarly, the 2023–2025 Kasilof RM 8 project will operate from 16 June to approximately 15 August each year and postseason passage estimates will be produced by extrapolating through 31 August using the 2018–2020 average run timing and estimated passage through 15 August.

OBJECTIVES

PRIMARY OBJECTIVES

1) Produce daily inseason net upstream passage estimates of fish 75 cm or longer (as measured by ARIS) at RM 13.7 of the Kenai River such that early- and late-run estimates are within 10% of the true value 95% of the time. These estimates will be based solely on ARIS fish-length measurements.

2) Produce postseason net upstream passage estimates of fish 75 cm or longer (as measured by ARIS) at RM 8 of the Kasilof River such that estimates are within 15% of the true value 95% of the time. These estimates will be based solely on ARIS fish-length measurements.

SECONDARY OBJECTIVE

Produce postseason net upstream passage estimates of Chinook salmon, regardless of size, at RM 13.7 of the Kenai River such that early- and late-run estimates are within 15% of the true value 95% of the time. These estimates will be based on fitting a mixture model to ARIS fish-length measurements and RM 8.6 netting data (midriver and nearshore drifts; see Perschbacher 2015).

METHODS

SITE DESCRIPTIONS

The Kenai River study will be conducted at RM 13.7 (Figure 2). This location was identified during surveys conducted in 2012 (Miller et al. 2015) and was selected for its location above tidal influence, its favorable physical characteristics for deploying ARIS multibeam technology, its accessibility via an adjacent boat launch facility, and legal access to property on either bank of the main channel. The main channel on the west side of the river is approximately 94 m wide, and the minor channel located along the east side is approximately 30 m wide (Figure 3). The minor channel has enough water for fish passage at higher water levels from approximately mid-June through August. Tidal fluctuation at this site is minimal (less than 1 ft) and is observable only during the large spring tide sequence. The substrate in both the main channel and the minor channel is composed of small cobble, rocks, and gravel.

Land use permits are obtained from the Department of Natural Resources Division of Parks and Outdoor Recreation. A more detailed description of the RM 13.7 site along with details and diagrams required for permit applications can be found in Key et al. (2019).

The Kasilof River study will be conducted near RM 8 just upstream of the Sterling Highway bridge (Figure 4). River width at this location increases throughout the summer as discharge increases, reaching a maximum width of approximately 60 m in August. The substrate slopes gradually from each bank (with a slightly steeper incline in the first 3 m of the north bank) and is composed mostly of large rocks 20–60 mm in diameter with larger rocks and boulders exceeding 1 m^3 along the north bank (Glick and Willette 2018).

STUDY DESIGN

Acoustic Sampling

Adaptive Resolution Imaging Sonar (ARIS) technology, developed by Sound Metrics Corporation, will be used at both sites (Table 1). ARIS multibeam technology is a similar but updated version of the dual-frequency identification sonar (DIDSON) technology used on the Kenai River prior to ARIS and is summarized in Key et al. (2017: Appendices A1–A12) along with a discussion of the features of the ARIS models used in this study. One spare ARIS 1200 system and 2 retired DIDSON LR systems will be available as backups should any of the active ARIS systems become inoperable for an extended period.

Table 1.–ARIS system components to be used for data collection.

River	System component	Qty	Description
Kenai	Sounders	4	ARIS 1200
			Left bank mainstem offshore
			Right bank mainstem offshore
			Right bank mainstem nearshore
			Right bank minor channel
		1	ARIS 1800
			Left bank mainstem nearshore
	Lens assembly	1	Standard lens for ARIS 1800 model with ~ 14° × 28° beam pattern
		4	High resolution lens for ARIS 1200 models with ~ 3° × 15° beam pattern
	Data collection computer	5	Dell Latitude 7490 laptop computers (1 for each sonar)
	Wireless bridge	3	Wireless Bridge Radio sets (Cisco Aironet model 1310s)
	Remote pan and tilt	5	Sound Metrics AR2 rotators—controlled via ARISCOPE software
Kasilof	Sounders	2	ARIS 1800
			Left (south) bank
			Right (north) bank
	Lens assembly	2	Standard lens for ARIS 1800 model with ~ 14° × 28° beam pattern
	Concentrator Lens	2	8° concentrator lens (1 for each sonar)
	Data collection computer	2	Dell Precision 7520 laptop computers (1 for each sonar)
	Wireless bridge	1	Wireless Bridge Radio set (RadioLabs)
	Remote pan and tilt	5	Sound Metrics AR2 rotators—controlled via ARISCOPE software

Sonar System Configuration and River Coverage

Kenai River

Site characteristics at RM 13.7 allow for near complete sonar coverage of the river cross-section. A total of 5 sonars are required to provide coverage: a nearshore and offshore sonar on each bank of the mainstem and 1 sonar on the right bank minor or side channel (Figure 3). During the early part of the season when the water level is low (approximately mid-May to early June), 1 sonar on each bank is sufficient to insonify most of the mainstem river cross-section (approximately

60–70 m at low water). But later in the season, as water levels rise and the mainstem river increases to 94 m in width, a second sonar will be deployed on each bank to insonify the nearshore zone and the first 3–8 m in front of the offshore sonars (Figures 3 and 5). The original (now offshore) sonars cannot be moved closer to shore as water levels rise because they already insonify the maximum range recommended for operation in high-frequency mode (approximately 30–35 m; Key at al. 2017: Appendix A1). The minor channel is dry when the project begins in mid-May but has sufficient water for fish passage starting in early to mid-June. This channel is approximately 30 m wide at high water and can be covered by a single sonar combined with a fixed weir on either bank (Figures 3 and 6).

Two different ARIS models will be used to provide optimal coverage of the mainstem cross-section (Figures 3 and 5; Key at al. 2017: Appendix A1). ARIS 1200 models operating at high frequency with high resolution lenses (HRL) will be used as the offshore sonars because they have the longer range capabilities (up to about 33 m) needed to insonify most of the mainstem river at lower water levels as well as the offshore region of the mainstem during higher water levels. An ARIS model 1200 may be operated at low frequency early in the season during periods of low water level or low water temperature to improve image quality at far range. An ARIS model 1200 with a high-resolution lens will also be used on the minor channel due to the longer (about 25 m) range requirements. In 2013, we determined that an ARIS 1200 with HRL was also required to insonify the right bank nearshore area due to the longer range covered by the nearshore sonar on this bank (Figures 5 and 7). An ARIS 1800 with a standard lens will be deployed as the nearshore sonar on the left bank because the offshore sonar will be positioned only about 8–10 m from the bank at ordinary high water, allowing it to cover the area behind the offshore sonar as well as approximately the first 3–5 m in front of the offshore sonar (Figures 5 and 7). The ARIS 1800 is more advantageous for insonifying close-range targets and nearshore areas because it operates at a higher frequency, yielding higher resolution, and the standard lens also has better focusing capabilities at closer ranges (Key at al. 2017: Appendix A5). Additionally, the wider beam dimensions of the ARIS 1800 without the HRL ($14° × 28°$ versus $4° × 15°$) provide better coverage in both vertical and horizontal dimensions at short ranges. Finally, using sonars with different operating frequencies will allow nearshore and offshore strata to be sampled simultaneously without crosstalk interference if desired.

Sampling for both banks will be controlled by electronics housed in a tent located on the left (west) bank of the river (Figure 8). The ARIS units will be mounted on SMC AR2 pan-and-tilt units for remote aiming in the horizontal and vertical axes. The offshore sonar and rotator units will be deployed in the river using a tripod-style mount that can be deployed from a boat at higher water levels; the nearshore and channel sonars may be deployed on "H" or "goal post" mounts rather than a tripod mount if water levels are too low for an individual sonar (Figure 9). In the horizontal plane, the sonar will be aimed perpendicular to the flow of the river current to maximize the probability of insonifying migrating salmon from a lateral aspect. In the vertical plane, the sonar will be aimed to insonify the near-bottom region (Figure 5). Internal sensors in the ARIS will provide measurements of compass heading, pitch, and roll as well as water temperature.

Communication cables from the left bank ARIS units will feed directly into the left bank ARIS Command Module (similar to the DIDSON Top Side Box) and data collection computers (Figure 10). On the right bank, data from the 3 ARIS systems will be transmitted via 3 wireless bridges to 3 data collection computers on the left bank (Figures 10 and 11). Two battery banks, charged daily using generators, will provide power to the right-bank sonar electronics and wireless bridges.
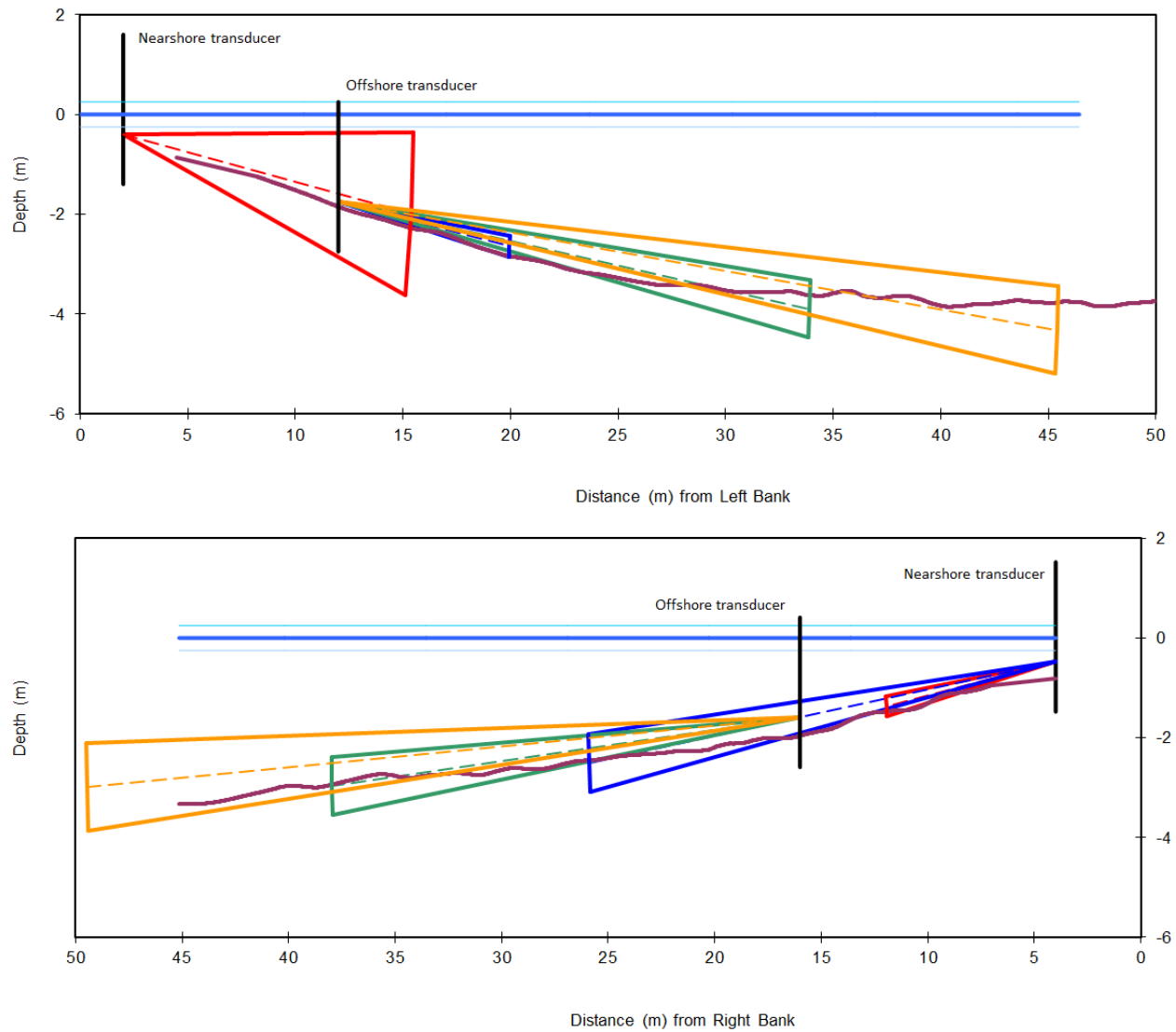
Figure 5.–Kenai River mile 13.7 main channel left and right bank bottom profiles collected on 8 July 2015 with nearshore and offshore sonar beams superimposed.

Note: On the left bank, an ARIS 1800 with a standard lens and a 14º vertical field of view was deployed nearshore (red beam) and an ARIS 1200 with a high-resolution lens and a 3º vertical field of view was deployed offshore (blue, green, and yellow beams). On the right bank, an ARIS 1200 with a high-resolution lens and a 3º vertical field of view was deployed both nearshore (red and blue beams) and offshore (green and yellow beams).

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Figure 6.–Sonar coverage of the minor channel at the Kenai River RM 13.7 sonar site is achieved using an ARIS 1200 deployed on a tripod mount combined with a fixed weir.
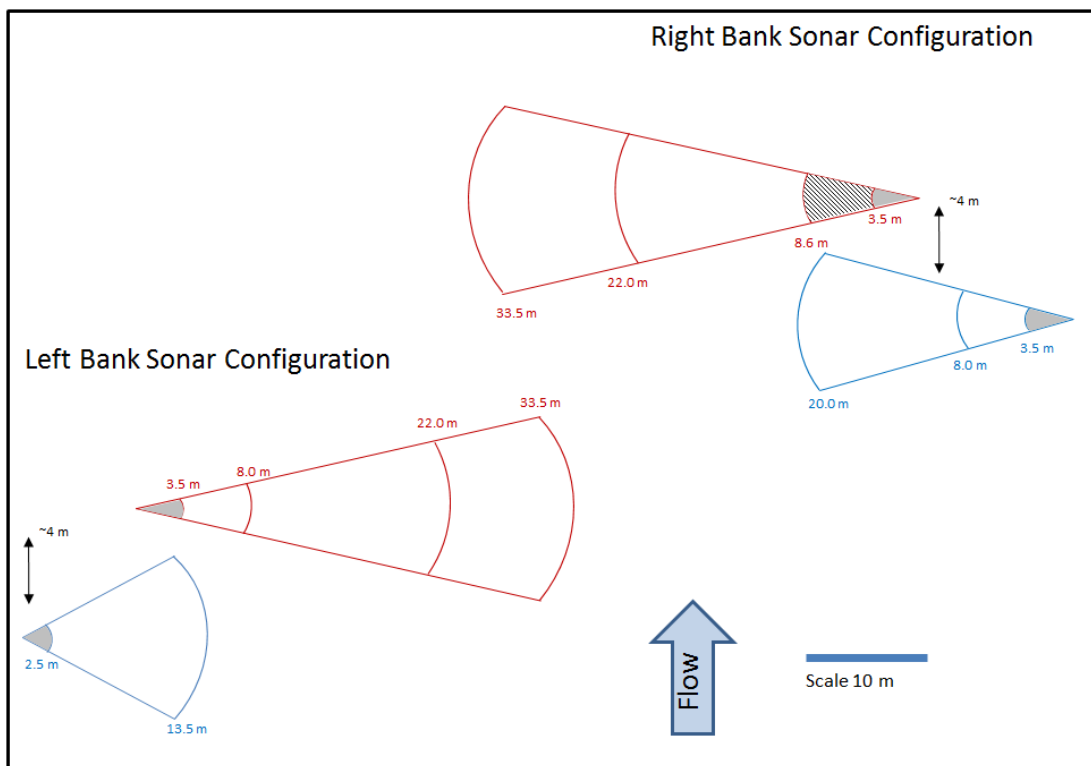
Figure 7.–Schematic for 4 left-bank (1 nearshore range [blue], 3 offshore ranges [red]) and 5 right-bank (2 nearshore ranges [blue], 3 offshore ranges [red]) range strata on the main channel of the Kenai River at RM 13.7.

Note: No data are collected between the face of the transducer and the start of the first range stratum in order to avoid range-related size bias caused by poor focal resolution at such close ranges (Key at al. 2017: Appendix A10). Data will be collected in the right bank offshore 3.5–8.0 m stratum early in the season. Increased water levels will allow the right bank inshore sonar to be deployed near the beginning of June and from that date forward, the area formerly covered by the right bank offshore 3.5–8.0 stratum will be covered by the right bank inshore 8.0–20.0 m stratum.

Figure 8.–RM 13.7 tent housing data collection computers for all 5 ARIS units.
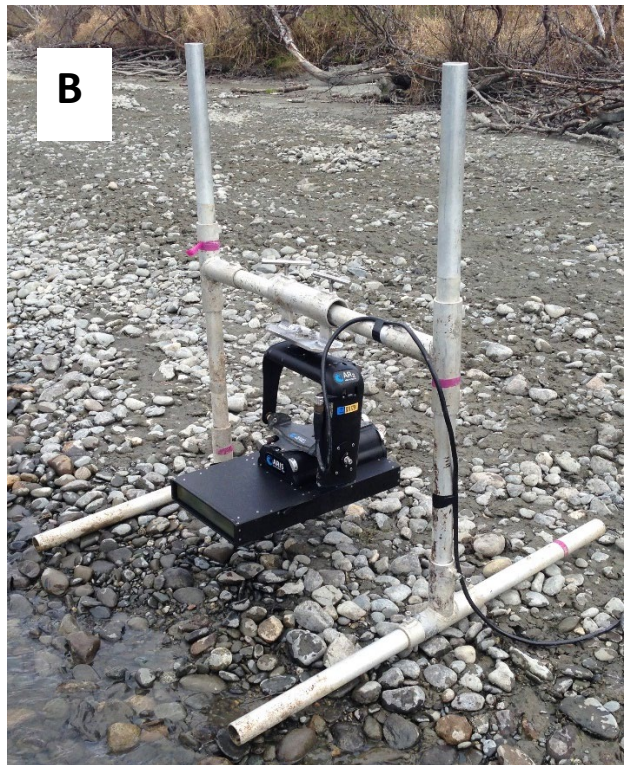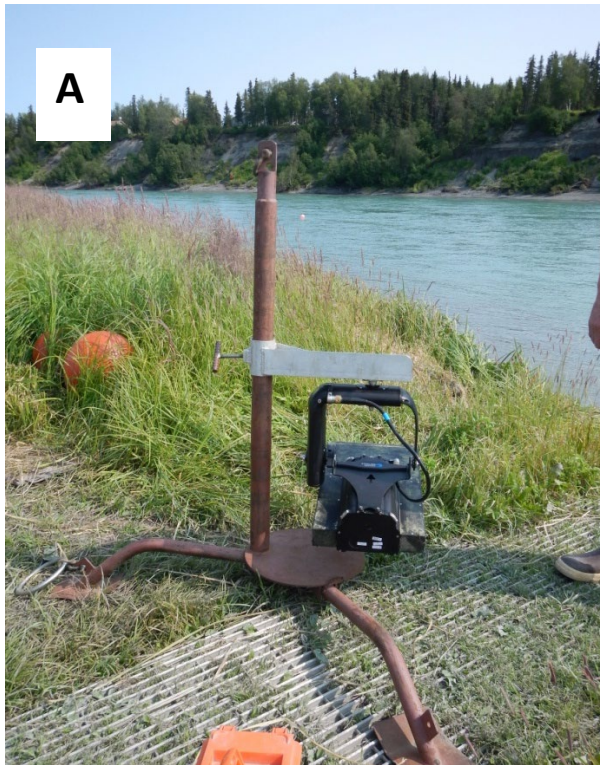
Figure 9.–An ARIS 1200 with a high-resolution lens mounted on a steel tripod for offshore deployment (A) and on an aluminum H-mount for nearshore deployment (B).
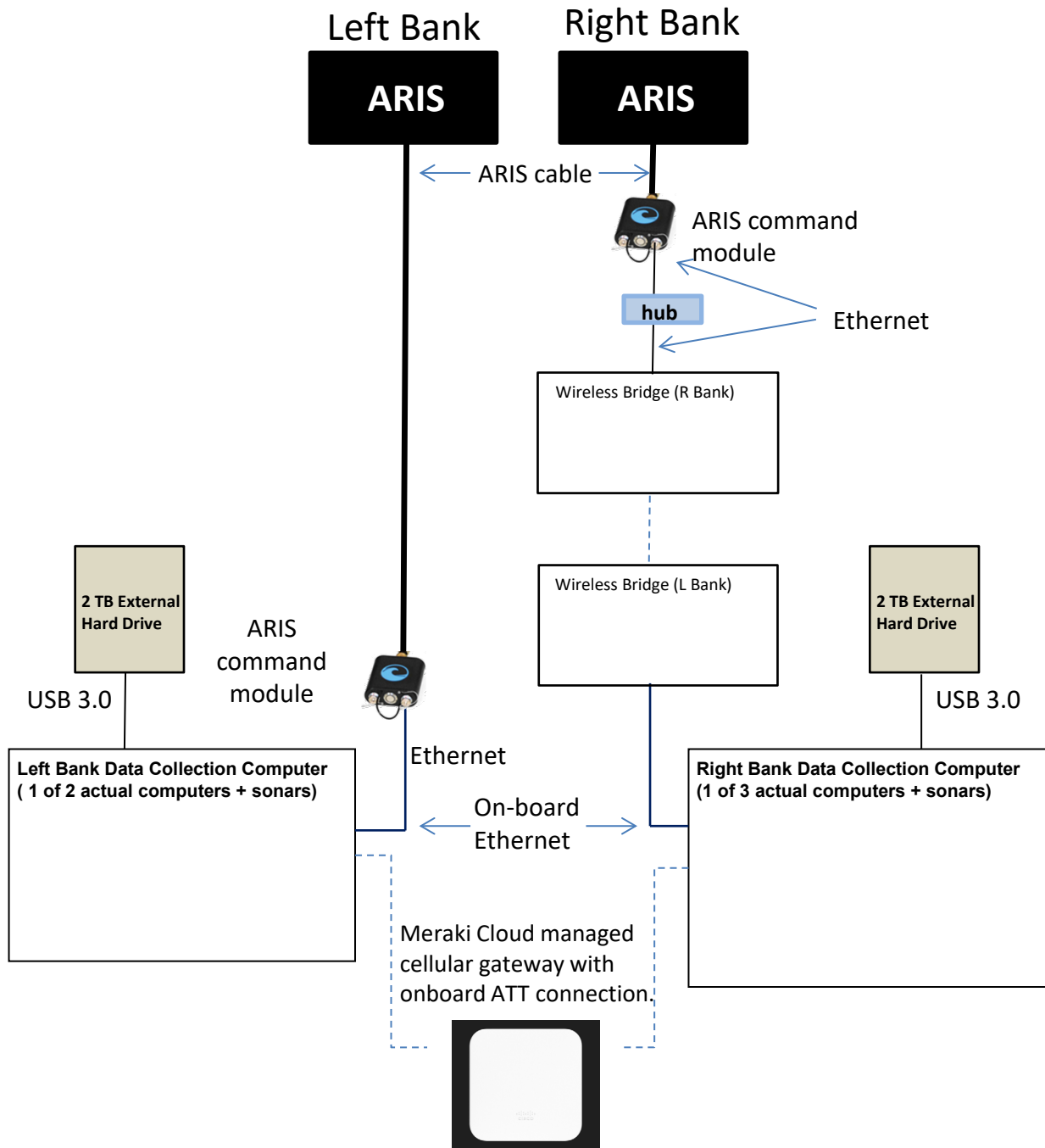
Figure 10.–ARIS data collection schematic for the Kenai RM 13.7 site.

Note: For simplicity, this diagram shows only 1 of 3 right-bank data-collection computer+sonar pairs and 1 of 2 left-bank data-collection computer+sonar pairs. Each computer is wirelessly connected to the Meraki cellular gateway equipped with an onboard AT&T connection. and can be accessed remotely using GoToMyPc accounts. ATT Mifi devices will be used temporarily if the gateway is unable to connect.

The components shown in the diagram below are housed in the small white container in the upper left corner of the fish tote (42"x29"x28"). The batteries are stored in a separate container in the lower right corner of the fish tote. The combined charger/inverter are mounted in the third container in the lower left corner.

Power Strip

Power

Remote Switch

Power from Battery Bank

Power

Power

Power

Topside 24v AC adaptor

Hub

wireless bridge power injector

ARIS Topside Box

Ethernet

Ethernet

Ethernet or Coax to Bridge

300' ARIS cable

CISCO Wireless Bridge

CISCO Wireless Bridge

Ethernet or Coax to Bridge

wireless bridge power injector

Ethernet

Data Collection Laptop on Left bank

USB 3.0

External Hard Drive

The Magnum Pure Sine Inverter kit (MMS1012-G1000 W/12V) combines the inverter and charger which are stored/mounted in the white container at the lower left corner of the fish tote. The controller (ME-RC50) is mounted on the top of the container. The system is powered by two AGM L16 6V batteries that are charged daily by 1000W Honda generator. Additional batteries can be added as required.

Figure 11.–Diagram of components required on Kenai RM 13.7 right bank for wireless transmission of ARIS data back to the main camp on left bank.

Note: A wireless bridge transmits data to a data collection computer on the left bank for storage and subsequent transport to the Soldotna office.

Kasilof River

Acoustic sampling operations at the Kasilof RM 8 sonar site will be consistent with those described in Glick et al. (2022). One ARIS 1800 system will be deployed from each bank. The ARIS systems will each be configured with a standard lens and operated at a frequency of 1.8 MHz (nearshore) and 1.1 MHz (offshore) and set to ninety-six 0.3° × 14° beams to provide the resolution necessary for obtaining accurate length measurements at all ranges. Profiles of the river bottom will be created following the methods of Faulkner and Maxwell (2009) at the start of the season and again when the river has risen to determine the best beam fit and aim for the transducer. The best beam fit includes full coverage of the water column at close range where most sockeye salmon migrate. A narrow vertical beam width in this region would compromise detection of sockeye salmon. Early in the season, when water levels are low, 8° concentrator lenses will be used as necessary to adjust the vertical beam width to better fit in the water column and thus decrease vertical interference from surface and bottom reverberation. As water levels rise, the concentrator lenses will be removed to allow for better coverage of the water column. The concentrator lenses do not affect horizontal beam width. Components of the ARIS 1800 system are listed in Table 1.

Sampling will be controlled by computers housed in a "sonar shack" located on the south bank. Communication cables from the south-bank ARIS unit will feed directly into the south-bank ARIS Command Module and data collection computer (Figure 12). On the north bank, data from the ARIS system will be transmitted via a wireless bridge to a data collection computer on the south bank (Figure 12). A battery bank, charged daily using a combination of solar panels and a generator, will provide power to the north-bank sonar electronics and wireless bridge. AC power will be used to power all south-bank equipment. The ARIS units will be mounted on Sound Metrics Corporation (SMC) AR2 pan-and-tilt units for remote aiming in the horizontal and vertical axes. The sonar and rotator units will be deployed in the river using an aluminium H-style mount (Figure 9). As described in Glick et al. (2022), deflection weirs will be installed on each bank to force fish to pass offshore of the sonar and through the insonified zone. As with the Kenai River project, the sonars will be aimed perpendicular to the flow of the river current and aimed to insonify the near-bottom region of the river.
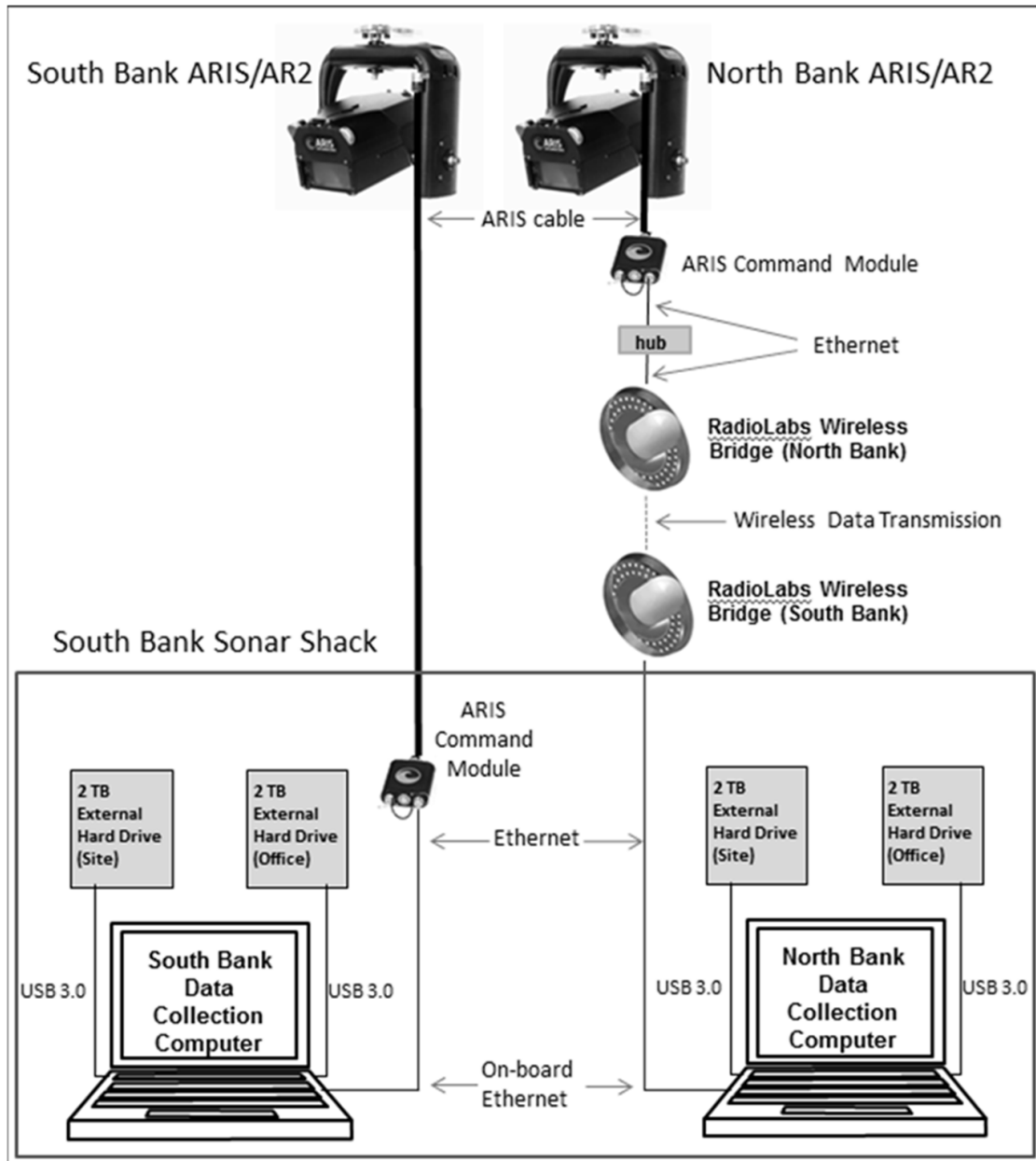
Figure 12.–ARIS data collection schematic for the Kasilof RM 8 site.

Sampling Procedure

A systematic sample design (Cochran 1977) will be used to sequentially sample discrete range strata ("range windows") for a total (minimum) of 10 minutes each hour. The ARIS can be programmed to automatically sample each range stratum using the software interface "ARIScope." Dividing the total range to be insonified into shorter range strata allows the aim of the sonar beam to be optimized for sampling a given river section (i.e., generally the aim must be raised in the vertical dimension as sections farther from shore are sampled).

Kenai River

There will be 11 individual Kenai River range strata sampled with sonar parameter setting that vary by range strata and location (e.g., Table 2 for 11 July 2022; Figure 13). Sonar range parameters also vary throughout the season as the water level rises and aims are refined (e.g., Table 3). In 2022, water levels were generally stable after June 29, and only minor changes were made to the positions of the sonars through the end of operations on 19 August.

For 2023–2025, estimates of fish passage will be made from 16 May to 20 August or until daily passage is estimated to be less than 1% of the cumulative passage for 3 consecutive days.

Kasilof River

ARIS systems on each bank of the Kasilof River will be programmed to sample 2 range strata (1–10 m and 10–30 m) and will operate 24 hours per day, 7 days per week, with parameter settings varying by range and location (e.g., Table 4 for 15 July 2020) and date (e.g., Table 5). Estimates of Chinook salmon passage will be made from 15 June to 15 August or until CF estimates daily sockeye salmon passage to be less than 1% of the cumulative passage for 3 consecutive days. Passage for the remaining days through 31 August will be estimated using passage through the final day of operations and the mean run timing for the years 2018–2020.

Expected Precision

The relative precisions of early- and late-run Chinook salmon passage estimates on the Kenai River from 2013 to 2022 using the systematic sample design described above and achieved at a significance level of $\alpha = 0.05$ range from 3% to 17% (Table 6). The relative precisions of late-run Chinook salmon passage estimates on the Kasilof River from 2018 to 2022 achieved at a significance level of $\alpha = 0.05$ were 9% in 2018, 8% in 2019, 10% in 2020, 13% in 2021, and 12% in 2022. With the same amount of sampling effort scheduled for each river in 2023–2025, the precision criteria in the primary and secondary objectives are likely to be achieved.

Table 2.–Sampling schedule and parameter settings on 11 July 2022 for each range stratum sampled by 5 sonars at Kenai RM 13.7.

Location	ARIS serial no.	Range stratum	Time (min past hour)	Frame rate (f/sec)	Range (m) Start	End	Frequency	Tx Power	Receiver gain (dB)	Pulse length (µs)	Start delay (s)	Sample period (s)	Samples per beam	AR2 tilt	Pitch	Roll	Heading
Left near	1096																
		1	00,30	10	2.5	16.5	High	Max	20	25	3,461	10	1,928	4.19	−2.8	2.1	153
Left far	1064																
		1	00,30	10	3.5	8	High	Max	4	13	4,882	10	627	3.16	−5.6	−7.6	65
		2	10,40	9	8	22	High	Max	13	20	11,154	10	1,952	4.23	−4	−7.6	67
		3	20,50	7	22	33	High/Low	Max	19	33	30,675	10	1,534	8.4	−0.9	−7.7	70
Right far	1063																
		1															
		2	00,20	9	8	22	High	Max	17	23	11,130	10	1,948	1.8	0.0	-1.0	46
		3	10,30	7	22	33	Low/High	Max	17	33	30,607	10	1,530	1.27	−0.2	-1.0	44
Right near	1098																
		1	40	10	3.5	8	High	Max	14	13	4785	10	615	-9.1	−1.6	-2.2	254
		2	50	10	8	22	High	Max	14	21	11,064	10	1901	-10.45	-2.3	-2.1	254
Channel	1095																
		1	00	8	2	6	High	Max	0	13	2,762	10	552	-3.48	−13.9	-2.2	14
		2	10	8	6	12	High	Max	10	13	8,277	10	828	2.75	−8.0	-2.2	15
		3	20	8	12	20	High	Max	15	20	16,554	10	1,103	8.83	−1.9	-2.2	13

Left bank Nearshore (1 stratum)

Stratum 1: 2.5-12.1 m

Pitch = -3.6°

Left bank Offshore (3 strata)

Stratum 1: 3.5-8.0 m

Pitch = -7.2°

Stratum 2: 8.0-22.0 m

Pitch = -6.8

Stratum 3: 22.0-35.0 m

Pitch = -5.5°

Right bank Nearshore (2 strata)

Stratum1:3.5-9.0 m

Pitch = -6.0°

Stratum 2:9.0-21.0 m

Pitch = -4.5°

Right bank Offshore (2 strata)

Stratum 2: 8.0 to 22.0 m

Pitch = -4.0°

Stratum 3: 22.1-35.0 m

Pitch = -3.8°
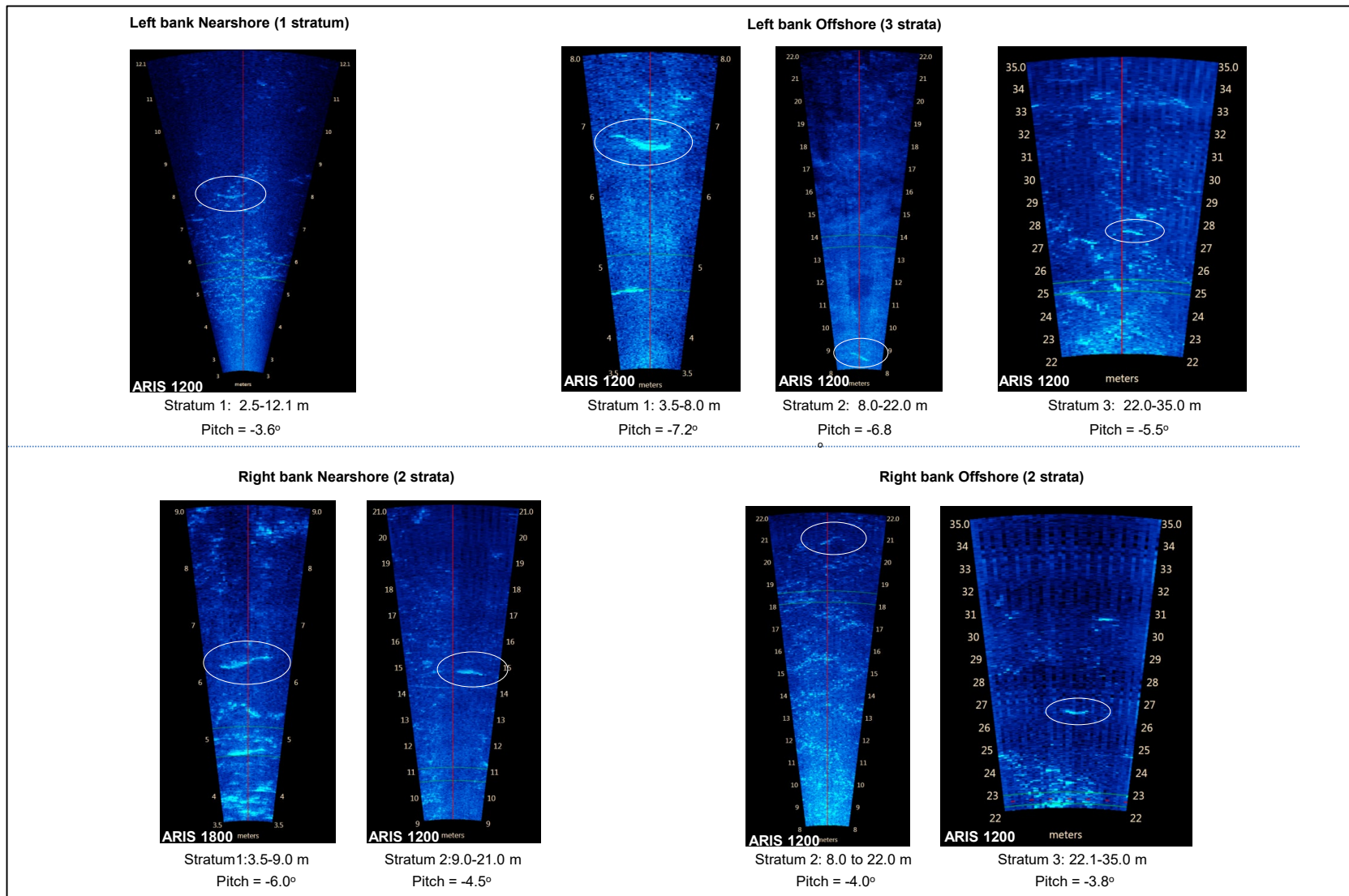
Figure 13.–Example images from each of the 4 left-bank (top) and 4 right-bank (bottom) range strata taken from the Kenai RM 13.7 sonar site on 15–18 July 2014.

Note: Fish swimming through the beams are circled on each image.

Table 3.–Summary of sonar stratum ranges (in meters) by date at Kenai RM 13.7, 2022.

Sonar location	Stratum	Start times (min past hour)	13 May	30 May	1 Jun	5 Jun	7 Jun	8 Jun	25 Jun	27 Jun	11 Jul	27 Jul	8 Aug[a]
Left near													
	1	00,30	[b]	2.5–10.8	2.5–10.8	2.5–13.3	2.5–13.3	2.5–14.5	2.5–14.5	2.5–16.5	2.5–16.5	2.5–16.5	2.5–16.5
Left far													
	1	00,30	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0
	2	10,40	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0
	3	20,50	22.0–33.0	22.0–33.0	22.0–33.0	22.0–33.0	22.0–33.0	22.0–33.0	22.0–33.0	22.0–33.5	22.0–33.5	22.0–33.5	22.0–33.5
Right far													
	1	00,30	3.5–8.0	3.5–8.0	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]	[c]
	2	10	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0	8.0–22.0
	3	20	22.0–33.0	24.0–33.0	24.0–33.0	24.0–33.0	24.0–33.0	24.0–33.0	24.0–33.0	24.0–35.0	24.0–35.0	24.0–35.0	24.0–35.0
Right near													
	1	40	[d]	[d]	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0	3.5–8.0
	2	50	[d]	[d]	8.0–15.0	8.0–16.5	8.0–16.5	8.0–18.5	8.0–21.0	8.0–20.0	8.0–22.0	8.0–20.0	8.0–18.0
Channel													
	1	0	[e]	[e]	[e]	[e]	2.6–6.0	2.6–6.0	2.6–6.0	2.0–6.0	2.0–6.0	2.0–6.0	2.0–6.0
	2	10	[e]	[e]	[e]	[e]	6.0–12.0	6.0–12.0	6.0–12.0	6.0–12.0	6.0–12.0	6.0–12.0	6.0–12.0
	3	30	[e]	[e]	[e]	[e]	12.0–21.0	12.0–21.0	12.0–21.0	12.0–20.0	12.0–20.0	12.0–20.0	12.0–20.0

[a] No changes were made to range after 8 August.

[b] The left bank near sonar was deployed on 30 May.

[c] Three strata were used on the right bank far sonar to begin the season, but Stratum 1 was eliminated on 1 June because this range was covered by the newly deployed right bank near sonar.

[d] The right bank near sonar was deployed on 1 June.

[e] The channel sonar was deployed on 7 June.

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Table 4.–Example of sampling schedule and ARIScope parameter values from 15 July 2020, Kasilof River sonar.

Sonar location	ARIS serial no.	Range stratum	Time (min)[a]	Frame rate (fps)[b]	Start range (m)	End range (m)	Frequency (MHz)	Transmit level	Gain (dB)	Pulse width (µs)	Start delay (µs)	Sample period (µs)	Samples per beam	Pitch (°)	Heading (°)
North bank	1692	1	:10	11.2	0.7	10.0	High (1.8)	Max	20	12	949	10	1,262	−4.6	160
		2	:00	4.0	10.0	29.0	Low (1.1)	Max	24	20	13,582	10	2,580	−4.6	159
South bank	1712	1	:10	11.2	0.7	10.0	High (1.8)	Max	15	12	949	10	1,262	−3.5	324
		2	:00	4.0	10.0	29.0	Low (1.1)	Max	24	20	13,571	10	2,579	−3.6	325

[a] Sample start time in number of minutes past the top of the hour.

[b] Frame rate in frames per second.

Table 5.–Summary of sonar stratum range changes by date at the Kasilof River sonar site, 2020.

Sonar location	Range stratum	Time (min)[a]	Coverage range (m) by date		
			15 June	2 July[b]	23 July[c]
North bank	1	:10	0.7–10.0	0.7–10.0	0.7–10.0
	2	:00	10.0–26.0	10.0–29.0	10.0–30.0
South bank	1	:10	0.7–10.0	0.7–10.0	0.7–10.0
	2	:00	10.0–26.0	10.0–29.0	10.0–30.0

[a] Sample start time in number of minutes past the top of the hour.

[b] The sonars on both banks were moved closer to shore due to rising water level. The stratum 2 range was extended to 29 m on both banks.

[c] The sonars on both banks were moved closer to shore due to rising water level. The stratum 2 range was extended to 30 m on both banks.

Table 6.–Relative precisions ($\alpha = 0.05$) of Chinook salmon net upstream passage estimates for ARIS-length (AL) ≥75 cm and ARIS-length mixture model (ALMM) for early and late run at RM 13.7 Kenai River, 2013–2022.

Year	Early		Late	
	AL ≥ 75 cm	ALMM (all sizes)	AL ≥ 75 cm	ALMM (all sizes)
2013	10.6%	15.3%	4.4%	5.9%
2014	10.8%	12.7%	5.2%	6.7%
2015	7.8%	8.3%	4.2%	4.8%
2016	6.0%	7.1%	4.5%	4.2%
2017	6.8%	7.5%	4.0%	3.4%
2018	10.1%	11.6%	4.7%	5.1%
2019	7.5%	9.3%	5.1%	5.9%
2020	10.6%	11.7%	5.5%	5.5%
2021	7.8%	10.8%	5.4%	5.6%
2022	10.5%	17.0%	4.8%	6.6%

DATA COLLECTION

Data Collection Parameters

In designing ARIS, the manufacturers separated the data collection (ARIScope) and data processing (ARISFish) software. ARIScope has several data collection parameters that are user selectable including window length, transmit pulse width, and downrange resolution, and these will be optimized for each range interval (Table 7; corresponding fixed values in the DIDSON system are also given). The autofocus feature will be enabled so that the sonar automatically sets the lens focus to the midrange of the selected range window.

Table 7.–Select user configurable parameters in SMC ARIScope data collection software and their corresponding values in DIDSON (high frequency identification mode only).

Parameter	ARIS 1200	ARIS 1800	DIDSON LR (1200)	DIDSON SV (1800)
Transmit pulse length	4 μs to 100 μs	4 μs to 100 μs	7 μs, 13 μs, 27 μs, 54 μs (relative to window length)	4.5 μs, 9 μs, 18 μs, 36 μs (relative to window length)
Downrange resolution (window length/samples)	3 mm to 10 cm	3 mm to 100 mm	5 mm, 10 mm, 20 mm, 40 mm (relative to window length)	2.5 mm, 5 mm, 10 mm, 20 mm (relative to window length)
Source level	~206–212 dB re 1 μPa at 1 m	~200–206 dB re 1 μPa at 1 m		
Window length	Any	Any	2.5 m, 5 m, 10 m, 20 m	1.25 m, 2.5 m, 5 m, 10 m
Samples per beam	Up to 4,000	Up to 4,000	512	512

Remote Access to Sonar Site

Because the Kenai RM 13.7 site will not be manned at all hours, a system to remotely access and determine the status of the data collection computers and sonars has been developed. Each data collection computer will have wireless internet service through a Cisco Meraki wireless access

point (connected to an AT&T cellular network providing 4G LTE service) and can be accessed remotely using a GoToMyPC account (Figure 8).

Poor cell phone coverage at the Kasilof River sonar site precludes our ability to remotely access computers at this site.

Manual ARIS Fish Length Measurements

Measurements of fish length for both rivers will be obtained using ARISFish V2.6 (or latest version) software supplied by SMC. Detailed instructions for taking manual measurements and the software settings and parameters that will be used for this project are given in Appendix A1. Electronic echograms will provide a system to manually count, track, and size individual fish (Figure 14).
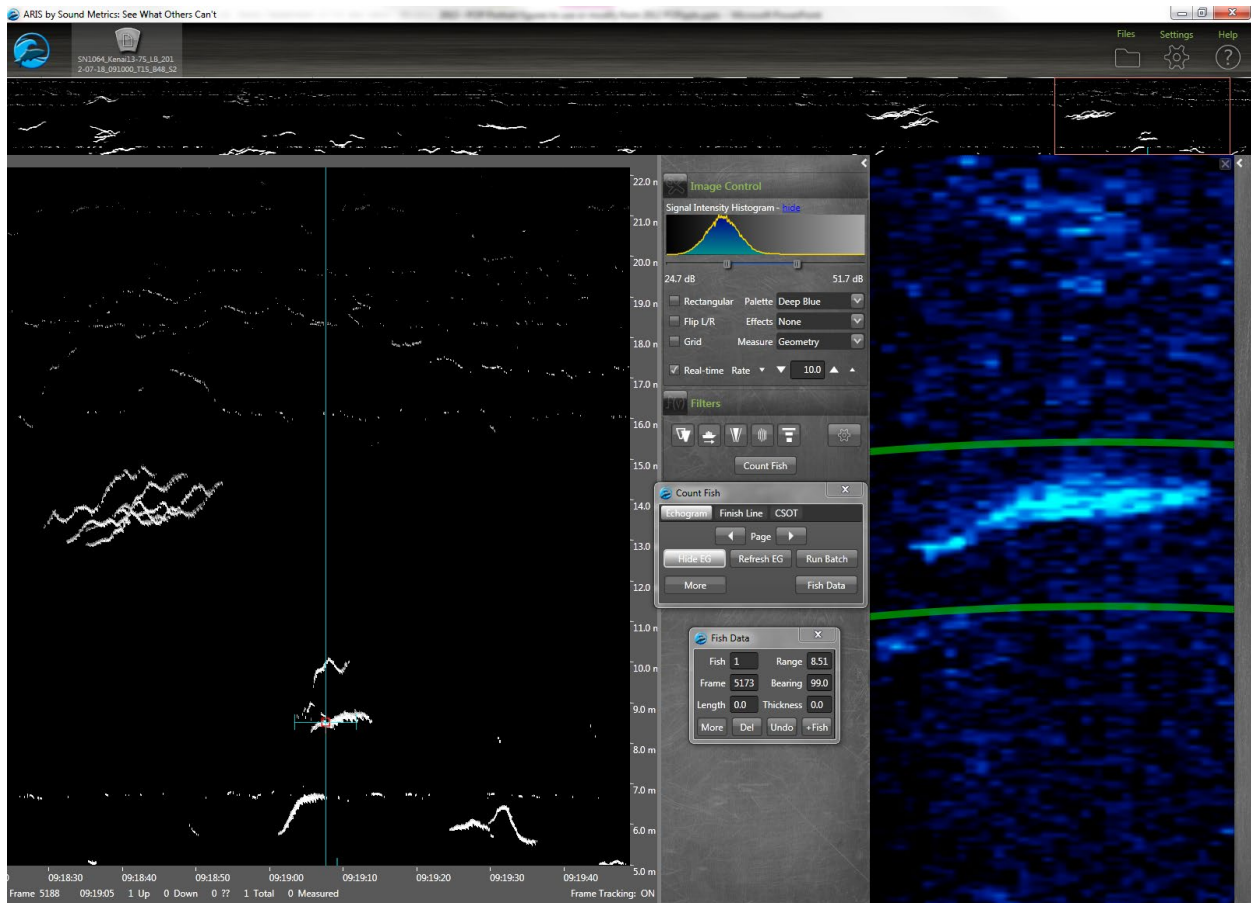
Figure 14.–ARISFish display window showing an echogram (at left) with traces of migrating fish that can be simultaneously displayed in video mode (at right) where fish images can be enlarged and measured.

Measured fish will be subjected to a "centerline rule" (Appendix A3). Only those fish that cross the longitudinal central axis of the ARIS video image will be candidates for measuring. Fish that do not cross the centerline will be ignored. This removes the opportunity for fish to be counted in multiple spatial strata, which would create a positive bias in passage estimates.

For this study, fish size will be divided into 2 categories based on ARIS length (AL) measurements. Fish with AL measurements greater than or equal to 40 cm and less than 75 cm will be referred to as "small fish." Fish with AL measurements greater than or equal to 75 cm will be referred to as

"large fish." For the Kenai River study, large fish will be broken out into 2 additional size categories: 1) fish greater than or equal to 75 cm and less than 90 cm and 2) fish greater than or equal to 90 cm.

Estimates of large-fish abundance will be produced by the sonar alone. Throughout the season, all large fish will be counted and measured, and travel direction (upstream or downstream) will be recorded. The sampling protocol, where a sample is defined as a specific spatial stratum monitored for 10 minutes, is described below:

1) During samples without dense aggregations of fish, length and direction of travel will be recorded for all salmon-shaped fish greater than or equal to 40 cm AL that meet the centerline rule (Appendix A3).

2) During individual samples with dense aggregations of fish (Figure 15), length and direction of travel will be recorded for all fish greater than or equal to 75 cm AL. However, length will be recorded for only a subsample of fish with ARIS length greater than or equal to 40 cm and less than 75 cm. The first F fish in the sampled period will be measured, where choice of F depends on daily staff time constraints. For the remainder of the sample (after the first F fish), only fish appearing to be greater than or equal to 75 cm AL will be measured and only those fish that actually measure greater than or equal to 75 cm AL will be recorded. During these times, fish measuring less than 75 cm AL will not be recorded in any way, including fish chosen for measurement that turn out to be less than 75 cm.

3) Direction of travel will automatically be recorded for all measured targets.

Netted Fish Length Measurements (Kenai River)

An established test gillnetting project at Kenai RM 8.6 (Wood 2022) will provide information on fish length by species, which is needed postseason to estimate abundance of Chinook salmon of all sizes for the Kenai River. Fish length measurements from the netting project are one source of input data required for mixture model estimates of Chinook salmon abundance (see below). Chinook salmon abundance estimates will use all inriver gillnetting data, including midriver and nearshore.
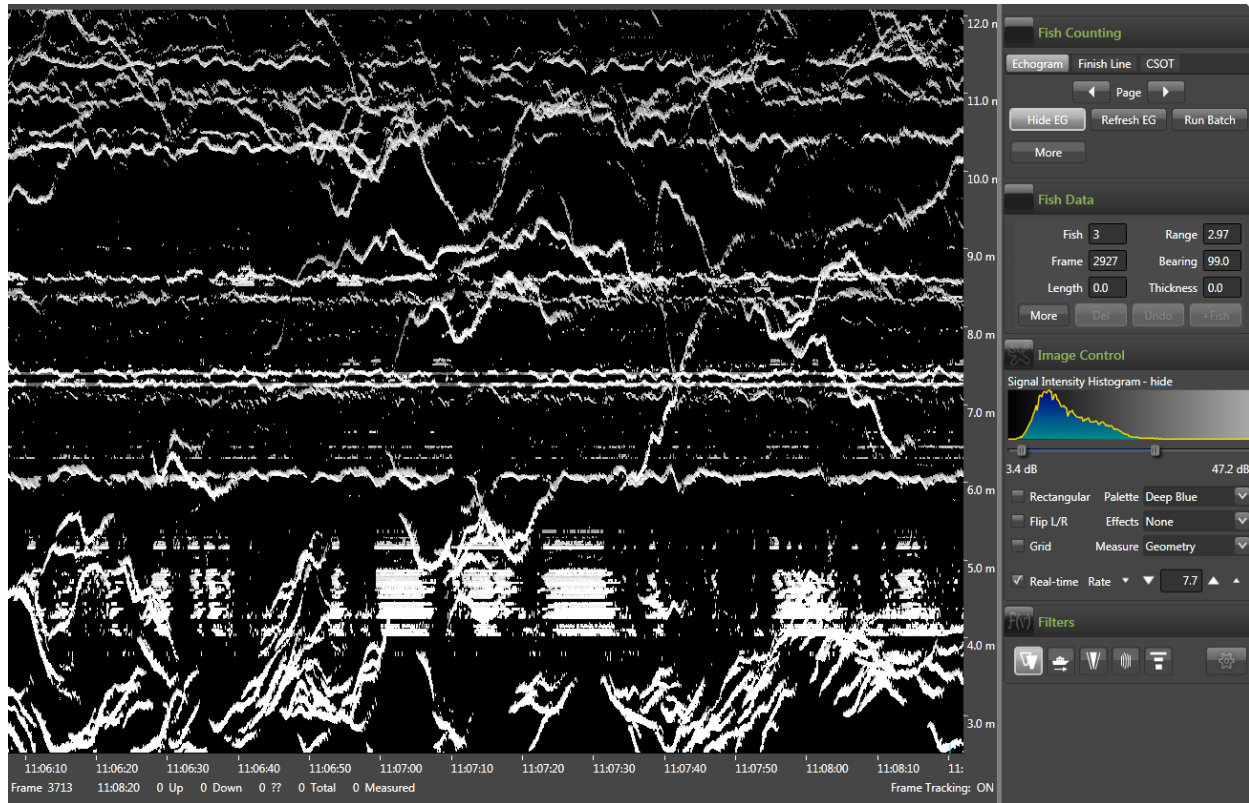
Figure 15.–An example of high-density passage from the Kenai River on 6 August 2014.

Note: There are approximately 170 fish in this 2-minute chart recording. A 10-minute sample with such high density can take several hours to process if each individual fish must be measured.

DATA REDUCTION

On-site Data Storage and Management

Individual files for each 10-minute sample will vary in size due to different ping rates for each range stratum[1]. File size also increases with the downrange resolution level. We estimate that 10-minute file sizes will vary at maximum from approximately 300,000 kB to approximately 900,000 kB (e.g., Table 8, which gives an example of a worst-case scenario for data storage needs at these sample rates).

Data from each sample will be stored to a uniquely named file. File names will be automatically generated by the ARIS software using the following selected identifiers: bank (Kenai River—right [R] or left [L]; Kasilof River—north [NB] or south [SB]), location (Kenai only—nearshore [N] or offshore [O]), year, month, day, and military time (hour, min, and sec). As an example, the Kenai River file RO_2022-07-15-041000 refers to a file collected by the right bank offshore sonar, which started data collection on 15 July 2022 at 04:10 AM. Similarly, the Kasilof River file NB_2022-08-10-141000 refers to a file collected by the north (right) bank sonar, which started data collection on 10 August 2022 at 2:10 PM.

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[1] Files from individual range strata will vary in size if the ping rate is optimized for each range strata. Because the return time for a ping increases with range, offshore range strata will require a slower ping rate and files will contain fewer frames.

One laptop will be dedicated to collecting data from each sonar. Data will be written directly to 1 of 2 external hard drives assigned to that computer and sonar (Figures 10 and 12). The hard drives will be swapped out at least once per day and transported back to the Soldotna ADF&G office.

Table 8.–Approximate data storage needs for data collected from ARIS systems at the Kenai RM 13.7 and Kasilof RM 8 sonar sites.

River	Bank	ARIS Model	Stratum (approx. range)	10-min file size (GB)	Hourly sample size (GB)	Comments
Kenai						
	Left bank nearshore [a]					
		ARIS 1800– standard lens	Stratum 1 (2–15 m)	0.9	1.8	Collect data for 20 min out of each hour. See comment 1 below.
	Left bank offshore					
		ARIS 1200– large lens	Stratum 1 (3–8 m)	0.3	0.6	Collect data for 20 min each hour.
		ARIS 1200– large lens	Stratum 2 (8–24 m)	0.5	1	Collect data for 20 min each hour.
		ARIS 1200– large lens	Stratum 3 (24–34 m)	0.3	0.6	Collect data for 20 min each hour.
	Right bank nearshore					
		ARIS 1200– large lens	Stratum 1 (3–8 m)	0.45	0.45	Collect data for 10 min out of each hour.
		ARIS 1800– large lens	Stratum 2 (8–16 m)	0.55	0.55	Collect data for 10 min out of each hour.
	Right bank offshore					
		ARIS 1200– large lens	Stratum 1 (3–8 m)	NA	NA	Right bank offshore Stratum 1 covered by right bank nearshore Stratum 2.
		ARIS 1200– large lens	Stratum 2 (8–23 m)	0.35	0.7	Collect data for 20 min each hour.
		ARIS 1200– large lens	Stratum 2 (23–35 m)	0.4	0.8	Collect data for 20 min each hour.
	Minor channel					
		ARIS 1200– large lens	Stratum 1 (3–6 m)	0.275	0.275	Collect data for 10 min each hour.
		ARIS 1200– large lens	Stratum 2 (6–12 m)	0.35	0.35	Collect data for 10 min each hour.
		ARIS 1200– large lens	Stratum 3 (12–20 m)	0.35	0.35	Collect data for 10 min each hour.
	Total	Hourly		4.725	7.5	
		Daily (hourly x24)		113.4	179.4[c]	
		Season [b]		9,866	17,543	or ~17.5 TB for season

-continued-

Table 8.–Page 2 of 2

River	Bank	ARIS Model	Stratum (approx. range)	10-min file size (GB)	Hourly sample size (GB)	Comments
Kasilof						
	Left bank offshore [a]					
		ARIS 1800– standard lens	Stratum 1 (1–10 m)	0.8	0.8	Collect data for 10 min each hour.
		ARIS 1800– standard lens	Stratum 2 (10–30 m)	0.55	0.55	Collect data for 10 min each hour.
	Right bank nearshore [a]					
		ARIS 1800– standard lens	Stratum 1 (1–10 m)	0.7	0.7	Collect data for 10 min each hour.
		ARIS 1800– standard lens	Stratum 2 (10–30 m)	0.5	0.5	Collect data for 10 min each hour.
	Total	Hourly		2.55	2.55	
		Daily (hourly x24)		61.2	61.2 [c]	
		Season [d]		3,794	3,794	or ~3.8 TB for season

Note: NA means not applicable.

[a] ARIS 1800 files can be larger than ARIS 1200 files because ARIS 1800 has twice as many sub-beams (96 versus 48 beams).

[b] Assumes offshore sonars operate 16 May to 20 August (102 days), inshore and channel sonars operate 1 June to 20 August (81 days).

[c] Amount of data generated daily will fluctuate based on sonars in operation and individual stratum settings.

[d] Assumes sonars operate 15 May to 15 August (62 days).

Office Data Management and Archiving

In the Soldotna office, data will be uploaded from each external drive to a NetApp server that is connected to the statewide network and is accessible by 7 (or more) data processing computers via a 16-port 1 GB Ethernet switch (Figure 16; Appendix B1). One of the data processing computers will be used to upload ARIS data from the external hard drives to the NetApp server (Appendix B2) using batch files that sort and store data files in the following directory hierarchy: 1) by river (Kenai or Kasilof), 2) by year (e.g., Data20XX), 3) by day, 4) by sonar (e.g., LeftFar), 5) by stratum, and 6) by set. Directory names are unique to each of the 5 Kenai River sonars (Channel [for right bank minor channel], LeftFar [left bank offshore sonar], LeftNear [left bank nearshore sonar], RightNear [right bank nearshore sonar], and RightFar [Right bank offshore sonar] and 2 Kasilof Rive sonars (NorthBank [right bank] and SouthBank [left bank]). Following upload to the NetApp server, data from each external hard drive will also be copied to a second "backup" external hard drive. Data transferred to the backup hard drive are not sorted or stored according to any hierarchy. However, the naming convention for the data files naturally sorts them by sonar and then date and time.
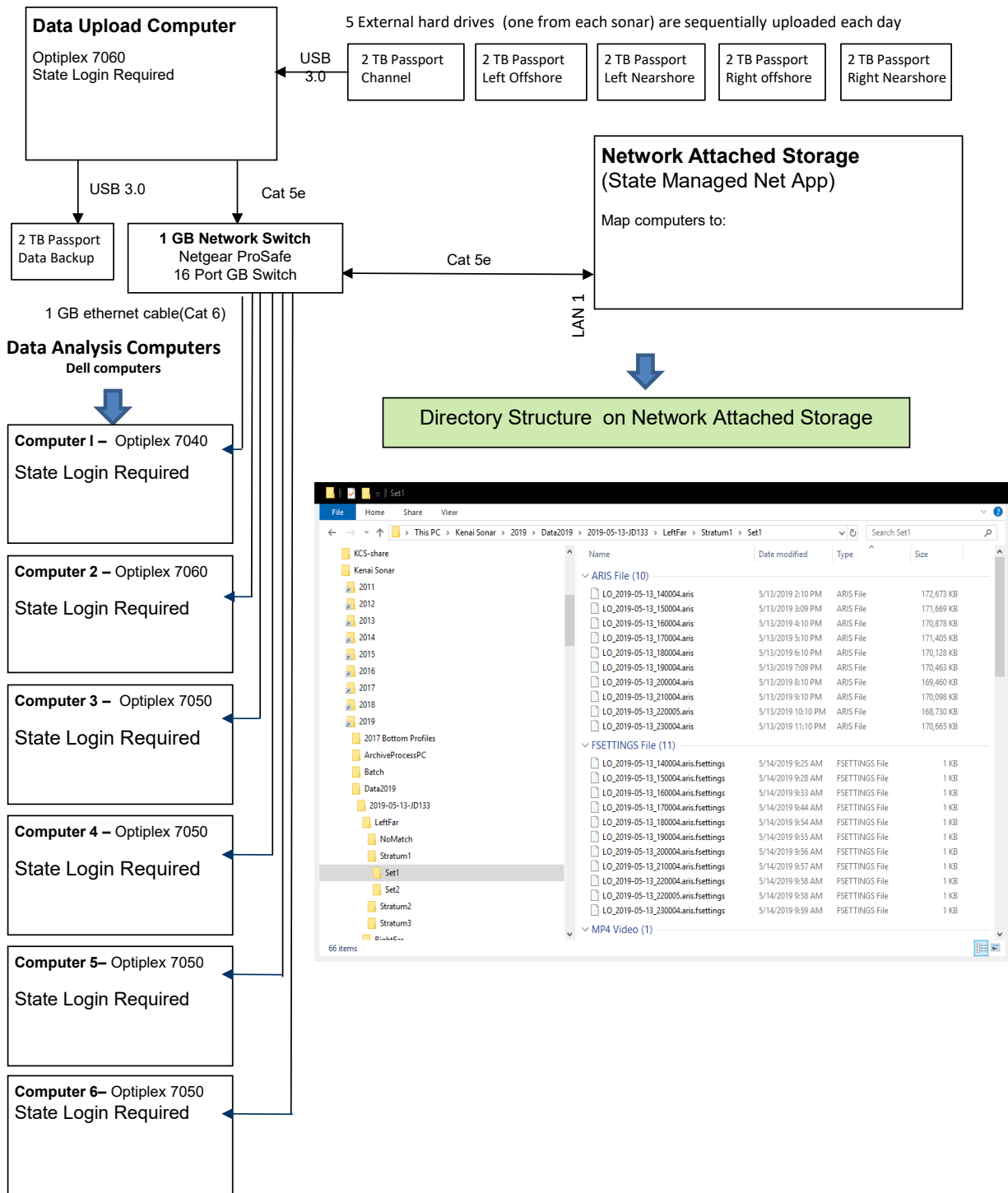
Figure 16.–Directory structure for the Network Attached Storage System in the Soldotna office showing the contents of the 2019 season folder.

DATA ANALYSIS

Once data are archived, they will be processed (Appendices C1–C4) so they can be used for abundance estimation. Abundance estimates at Kenai RM 13.7 and Kasilof RM 8 will apply to the entire river cross-section at each location.

Fish Passage

The ARIS sonar system is composed of multiple individual transducers scheduled to operate 10 minutes per hour for each spatial stratum, 24 hours per day. There will be 1–3 spatial strata sampled per transducer with 2–5 transducers deployed in the Kenai River and 2 transducers deployed in the Kasilof River at any given time. The number of fish y that satisfy a set of criteria $\mathbf{X}$ (e.g., fish with ARIS length equal to or greater than 75 cm and that migrated in an upstream direction) during day i will be estimated as follows:

$$\hat{y}_i = \sum_k \sum_s \hat{y}_{iks} \tag{1}$$

where $\hat{y}_{iks}$ is net fish passage in stratum s of transducer k during day i, which will be estimated as

$$\hat{y}_{iks} = \frac{24}{h_{iks}} \sum_j \hat{y}_{ijks} \tag{2}$$

where h_{iks} is the number of hours during which fish passage is estimated for stratum s of transducer k during day i, and $\hat{y}_{ijks}$ is hourly fish passage for stratum s of transducer k during hour j of day i, which will be estimated as

$$\hat{y}_{ijks} = \frac{60}{m_{ijks}} c_{ijks} \tag{3}$$

where

m_{ijks} = number of minutes (usually 10) sampled for stratum s of transducer k during hour j of day i, and

c_{ijks} = number of fish satisfying criteria $\mathbf{X}$ (e.g., upstream direction of travel; ARIS length greater than or equal to 75 cm) in stratum s of transducer k during hour j of day i.

The variance of the daily estimates of y, due to systematic sampling in time, will be approximated (successive difference model[2]; Wolter 1985) with adjustments for missing data as follows:

$$\widehat{var}(\hat{y}_i) \cong 24^2(1-f) \frac{\sum_{j=2}^{24} \emptyset_{ij} \emptyset_{i(j-1)} (\hat{y}_{ij} - \hat{y}_{i(j-1)})^2}{2 \sum_{j=1}^{24} \emptyset_{ij} \sum_{j=2}^{24} \emptyset_{ij} \emptyset_{i(j-1)}} \tag{4}$$

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[2] This is an assessment of the uncertainty due to subsampling (counting fish for 10 minutes per hour and expanding). The formulation in Equation 4 is conservative in the sense that it has been shown to overestimate the true uncertainty when applied to salmon passage data (Reynolds et al. 2007; Xie and Martens 2014).

where f is the sampling fraction (temporal sampling fraction, usually 0.17), ϕ_{ij} is 1 if $\hat{y}_{ij}$ exists for hour j of day i, or 0 if not, and

$$\hat{y}_{ij} = \sum_k \sum_s \hat{y}_{ijks} \tag{5}$$

Other estimates of passage will be obtained by changing the criteria $\mathbf{X}$ for fish counts c_{ijks} in Equation 3. For example, for estimates of downstream large fish, $\mathbf{X}$ would be "downstream direction of travel, ARIS length greater than or equal to 75 cm." Estimates of daily net upstream passage will be obtained by calculating separate estimates of upstream and downstream passage (Equations 1–3) and subtracting the downstream estimate from the upstream estimate. The estimated variance of net upstream daily passage will be the sum of the upstream and downstream variances.

Passage Estimates of Fish 75 cm AL or Longer

Passage estimates of fish 75 cm AL or longer will be produced inseason daily for both rivers. The number of fish x, equal to or exceeding 75 cm AL, during day i that migrate upstream will be estimated using Equations 1–3, except that c_{iksj} will equal the number of upstream bound fish in the insonified zone equal to or exceeding 75 cm in length as measured by ARIS in stratum s during hour j of day i.

Passage Estimates of Kasilof River Chinook Salmon 15-31 August

Kasilof River late-run Chinook salmon passage through 31 August ($\hat{Y}_e$) will be estimated by dividing by the mean proportion of passage ($\bar{p}$) through 15 August for the 3 years (2018–2020) when the sonar project operated through at least 20 August:

$$\hat{Y}_e = \frac{\hat{Y}}{\bar{p}} \tag{6}$$

where

$$\bar{p} = \frac{\sum_g p_g}{3} \tag{7}$$

and where

$$p_g = \frac{\sum_{i=15\text{June}}^{15\text{Aug}} \hat{y}_i}{\sum_{i=15\text{June}}^{31\text{Aug}} \hat{y}_i} \tag{8}$$

and g is the year.

The variance of $\hat{Y}_e$ is

$$\widehat{\text{var}}[\hat{Y}_e] = \widehat{\text{var}}[\hat{Y}]\bar{p}^{-2} + \widehat{\text{var}}[\bar{p}^{-1}]\hat{Y}^2 - \widehat{\text{var}}[\hat{Y}]\widehat{\text{var}}[\bar{p}^{-1}] \tag{9}$$

where

$$\widehat{\text{var}}[\bar{p}^{-1}] = \frac{\sum_{g=1}^{3}\left(p^{-1}_g - \bar{p}^{-1}\right)^2}{3(3-1)} \tag{10}$$

Passage Estimates of Kenai River Chinook Salmon Regardless of Size

Kenai River upstream Chinook salmon passage, regardless of size, will be estimated postseason by fitting daily mixture models (Appendices D1–D5) to ARIS lengths of all upstream bound fish and RM 8.6 netting data. The estimate of upstream Chinook salmon passage on day i will be

$$\hat{z}_i = \hat{w}_i \hat{\pi}_{Ci} \tag{11}$$

where $\hat{w}_i$ is sampled[3] upstream fish passage on day i, obtained by applying Equations 1–3 for upstream bound fish greater than or equal to 40 cm ARIS length, and $\hat{\pi}_{Ci}$ is the proportion of sampled fish that are Chinook salmon on day i, estimated by fitting an ARIS length mixture model to ARIS lengths for upstream bound fish from RM 13.7, and netting data from RM 8.6, as described in Appendices D1–D5.

The variance estimate will follow Goodman (1960):

$$\widehat{\text{var}}(\hat{z}_i) = \hat{w}_i^2 \widehat{\text{var}}(\hat{\pi}_{Ci}) + \hat{\pi}_{Ci}^2 \widehat{\text{var}}(\hat{w}_i) - \widehat{\text{var}}(\hat{\pi}_{Ci})\widehat{\text{var}}(\hat{w}_i) \tag{12}$$

ARIS data for upstream-bound fish will be used in the mixture model to be consistent with the drift gillnetting data, which presumably capture only upstream-bound fish. Midriver and nearshore netting data from RM 8.6 will be used so that the netting sample will best represent the length composition of all migrating Chinook salmon.

Daily net upstream Chinook salmon passage will be approximated as

$$\hat{N}_i \approx \hat{z}_i \frac{u_i - d_i}{u_i} \tag{13}$$

where u_i and d_i are daily estimates of upstream and downstream passage of fish greater than or equal to 75 cm AL, respectively, obtained using Equations 1–3.

Note that estimates of w_i and π_{Ci} are intermediate quantities only, in the sense that they are required in order to estimate z_i and N_i, but have no biological interpretation themselves because not all small fish (40–75 cm AL) are measured and counted. Estimates of z_i and N_i remain valid.

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[3] During periods with dense aggregations of fish, w is germane only to those fish selected for measuring, not all fish greater than or equal to 40 cm AL.

SCHEDULE AND DELIVERABLES

Dates	Activity
1 May–15 May	Group training on manual ARIS measures; review and update RM 13.7 ARIS office manual.
	Kenai RM 13.7 project deployment.
	Deploy Kenai River main channel offshore ARIS.
	Update batch files for Kenai RM 13.7 ARIS data as needed.
15 May–1 June	Continue training sessions with crew as needed for measuring consistency.
1 June or later	Deploy Kenai River nearshore ARIS systems when water level justifies.
	Deploy minor-channel weir and ARIS when water level justifies.
15 June	Begin retrieving Kasilof River sonar files from CF staff for processing by SF staff in the Soldotna office.
20 August–25 August	Terminate Kenai River data collection 20 August (or earlier based on less than 1% cumulative fish passage for 3 days), dismantle and store gear.

A combined 3-year report (2023–2025) meeting the requirements of ADF&G's Fishery Data Series will be published following the 2025 season. This report will provide an overview of the implemented methodology for generating ARIS-based Chinook salmon estimates for both rivers. A draft version will be completed by 1 April of 2026. The final report will be completed by 1 September of 2027.

RESPONSIBILITIES

Brandon Key, Fishery Biologist II, Project Leader
Duties: General supervision of all aspects of the study. Set up and configure DIDSON and ARIS sonar systems. Assist with inseason data collection and postseason data analysis. Share responsibility for postseason report.

James Miller, Fishery Biologist III
Duties: Assist with conducting and supervising all aspects of the study. Set up and configure DIDSON and ARIS sonar systems. Assist with inseason data collection and postseason data analysis. Assist with testing and evaluating evolving DIDSON and ARIS hardware and software. Share responsibility for postseason report.

Jiaqi Huang, Biometrician III
Duties: Provide guidance on sampling design and estimation procedures. Assist with inseason and postseason data analysis. Review project operational plan. Share responsibility for postseason report.

Mike Hopp, Fish and Wildlife Technician III, Crew Leader
Duties: Assist Project Leader with all aspects of ARIS deployment, operation, and data analysis. Assist with developing protocol and a comprehensive user manual for processing ARIS data for the purpose of generating daily estimates of Chinook salmon passage. Work dates: 15 April–31 August.

Fish and Wildlife Technician II
Duties: Assist Crew Leader with all aspects of ARIS deployment, operation, and data processing. Approximate work dates: 1 May–20 August.

Fish and Wildlife Technician II

Duties: Assist Crew Leader with all aspects of ARIS deployment, operation, and data processing. Approximate work dates: 1 June–20 August.

Fish and Wildlife Technician II

Duties: Assist Crew Leader with all aspects of DIDSON and ARIS deployment, operation, and data processing. Approximate work dates: 16 June–20 August.

BUDGET SUMMARY

The total proposed budget for the Kenai River Chinook salmon sonar project (fiscal year 2023) is $231,678.71. Budget and personnel requirements are summarized below.

Budget summary for FY23.

Line item	Category	Budget ($K)
100	Personal Services	209.4
200	Travel	0
300	Contractual	14.2
400	Commodities	8.0
500	Equipment	0.0
Total		231.6

Funded personnel for FY23.

PCN	Name	Level	Funded person months
4166	Brandon Key	Fishery Biologist II	12.0
1793	Mike Hopp	Fish & Wildlife Technician III	4.0
4146	Vacant	Fish & Wildlife Technician II	3.5
5347	Vacant	Fish & Wildlife Technician II	2.6
4305	Nathan Plate	Fish & Wildlife Technician II	3.5
Total			25.6

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APPENDIX A: INSTRUCTIONS AND SETTINGS USED FOR MANUAL FISH LENGTH MEASUREMENTS FROM ARIS IMAGES USING ARISFISH SOFTWARE VERSION 2.3

Appendix A1.–Instructions and settings for manual length measurements from ARIS images using SMC 2.3–Rev 6993.

1) Set Global Settings after a NEW installation of ARISFish

a) Open ARISFish global settings and ensure you have the following settings if you are measuring fish:
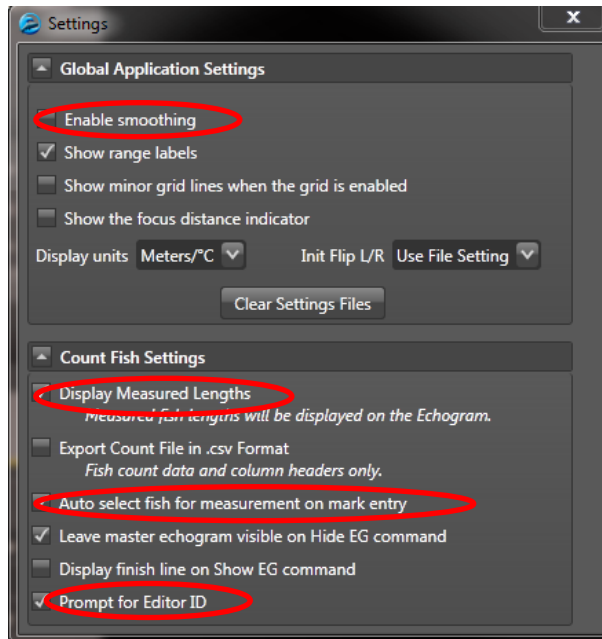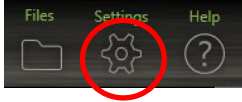
b) Enable smoothing is *off*.
c) Display Measured Lengths is *on*.
d) Auto select fish for measurement on mark entry is *on*.
e) Prompt for Editor ID is *on*.

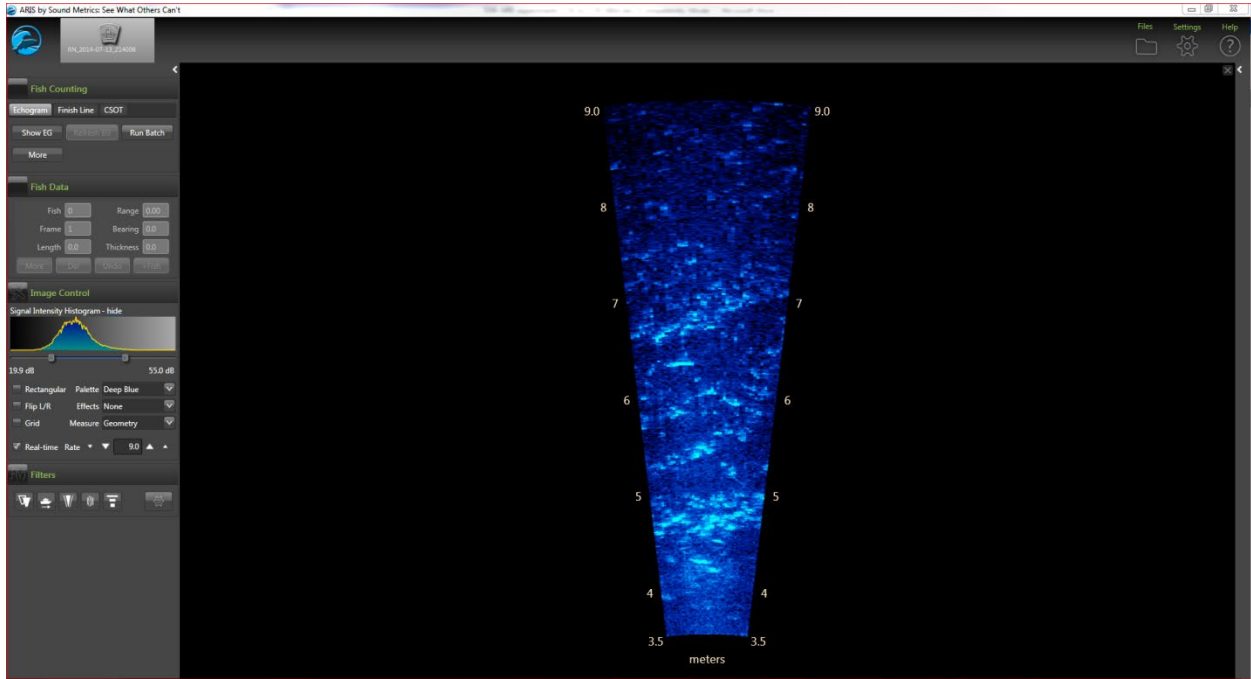## 2) Set processing parameters for a new set of files for a new day or stratum:
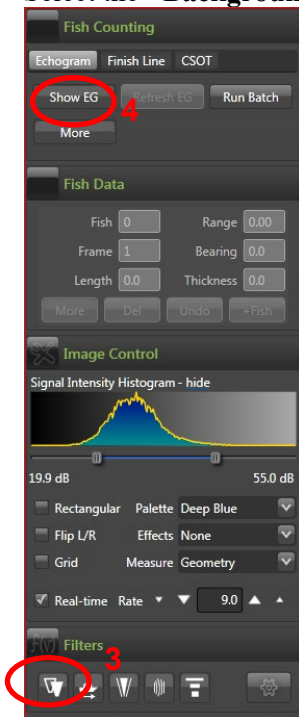
a) Select **<Files> <Open Recently Viewed>**

b) Navigate to the appropriate directory and open a file (or simply double click on the file of interest)

-continued-

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At this point, the ARISFish display should look similar to the image below:

a) Select the **<Background Subtraction>** icon and wait 30 seconds or so for background to subtract
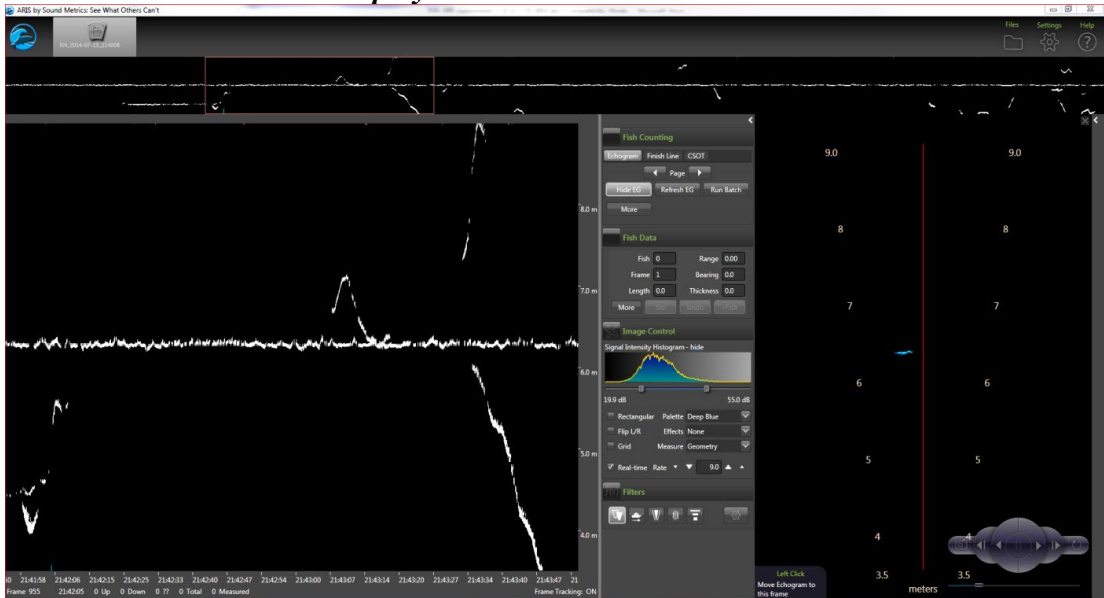

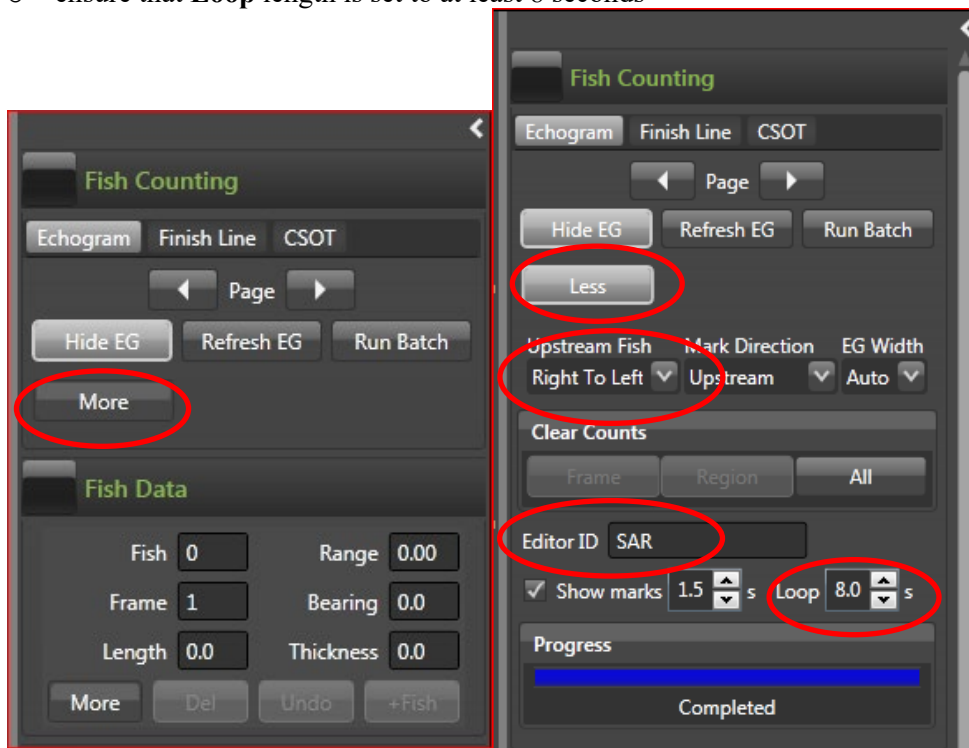b) Then select **<Show EG>** to display the Echogram.
c) You will be prompted to enter your Editor ID. Press OK.

-continued-

Your display should now look like the one below


c) Select **<More>** from the Fish Counting window to get the extended window where you can
   - o enter your **Editor ID** initials
   - o set the **Upstream Fish** direction
   - o ensure that **Loop** length is set to at least 8 seconds

   - o then select **Less** to unexpand Fish Counting window (you'll be able to access other controls like BS easier if you do this)
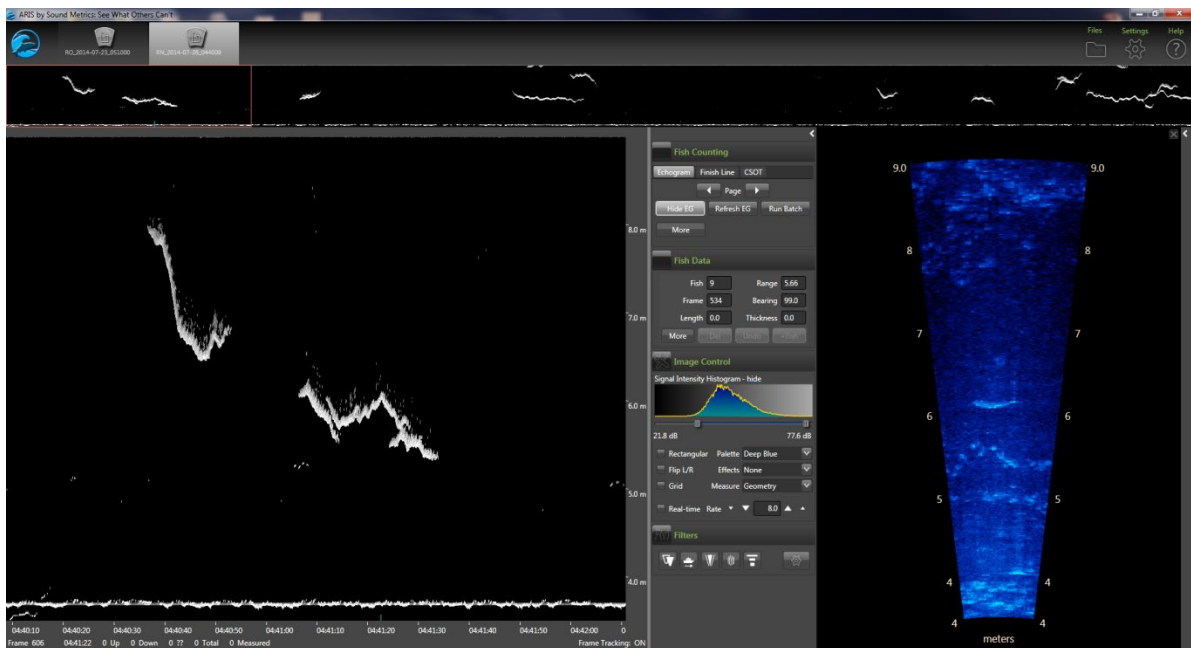
-continued-

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a) Select **<Background Subtraction>** icon on Filters Menu (Toggle)—this will now turn background subtraction off on the video image. **Failing to turn background subtraction off prior to measuring fish image length may result in an underestimate of actual fish length**[4].
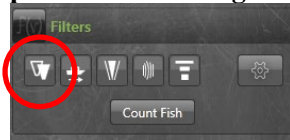
b) Set Signal Intensity sliders to optimize video image for measuring fish.
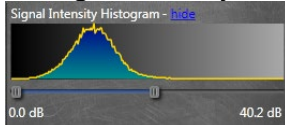
c) Your overall display should look similar to the following:

d) Now you are ready to start measuring (or marking) individual fish.
e) Once finished measure/marking all fish in the file, turn **<Background Subtraction>** on prior to advancing to the next file.

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[4] Unlike with DIDSON data, we no longer use the background selection option while measuring fish image length most of the time. The new ARIS background selection algorithm is more aggressive than the DIDSON and unless one is very careful in selecting a frame, it is easy to underestimate fish length. Toggling between background selection mode and the raw image can sometimes be helpful in determining the end of the tail or snout. If we do use background selection, we generally take background selection off before finalizing measurement. A well selected frame will give the same length measurement with or without background selection.

    d)   Select **<Alt><right arrow>** to advance to the next file.

    e)   Once the new file opens, turn **<Background Subtraction>** off before beginning to measure fish (all other parameter settings and display configuration settings should be preserved from the previous file).

    f)   When you switch banks, you will need to reset the direction of travel parameter in step 5.

    g)   Now you are ready to start measuring/marking fish in the new file.

3) Instructions for manual fish length measurements using SMC ARISFish software version 2.3 - Rev 6993 in 2016.

    a)   Ensure **<Background Subtraction>** is toggled *off* as described in step 6 above.

    b)   **<Left Click>** on the Echogram fish to be measured (Puts red marker on fish and automatically activates the movie showing the fish bounded by range arcs.
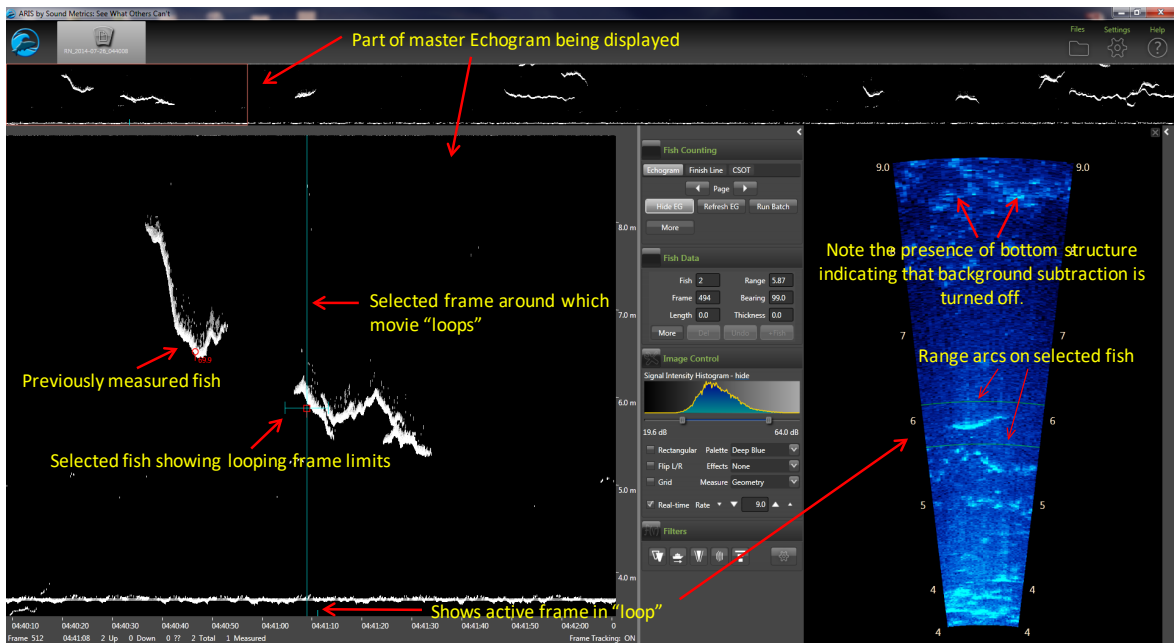
        o   Press **<space bar>** to start or stop the video playback.

    c)   Use **<right arrow>** and **<left arrow>** to step through movie one frame at a time to find a frame that displays the entire fish length well.

        o   Measurements should be taken from frames where contrast between the fish image and background are high and where the fish displays its full length.

        o   In general, the best images are obtained when the fish is sinusoidal in shape (rather than straight and/or perfectuly perpendicular to the sonar beam.

        o   Watching the behavior of the head and especially the tail over several frames, and taking several measurement, is often helpful in distinguishing the best frame.

    d)   **<Right Click Drag>** on movie image to zoom in for measurement.

    e)   **<Left Click Drag>** if necessary to center movie window prior to measuring.

-continued-

f) Measure fish image:
- o <u>Fish traveling snout-first upstream or downstream</u> - **<left click>** on the fish <u>snout</u> and continue to **<left click>** along the midline of the fish to create a "segmented

  measurement." The segments should follow the midline of the body of the fish, ending with the <u>tail</u>.
- o <u>Fish backing downstream through the beam tail-first</u> - **<left click>** on the fish <u>tail</u> and continue to **<left click>** along the midline of the fish to create a "segmented measurement." The segments should follow the midline of the body of the fish, ending with the <u>snout</u>.
- o Toggling between BS mode and the raw image can sometimes be helpful in determining the actual end of the tail or snout.

g) Select **<f>** key to add measurement to the .txt file (fish it!)—you will see measurement in red (**<Left Click>** on echogram inside mark, if you want to delete measurement and start over).
h) Select **<v>** key to unzoom movie window (not necessary if you have another fish nearby you want to measure).
i) Next fish…repeat steps 1-8, or
j) Occasionally press <E> to save your work on each sequence when complete (or before you divert to another task).
k) **<Left Click>** on Master Echogram to advance to new echogram section, or
l) **<Alt><Right Arrow>** to advance to next file.

4) To mark (count) fish in SMC ARISFish software version 2.3 - Rev 6993.
a)   **<Left Click>** on the fish trace in the echogram if upstream.
b)   **<Ctrl> <Left Click>** on the fish trace in the echogram if downstream.

-continued-

5) **Hot keys used in measuring and counting fish in SMC ARISFish software.**

  \<e\> to "save" all echogram measurements to file

  \<f\> to "fish it" (to accept the measurement and display it on the echogram)

  \<u\> to "undo" the last segment

  \<d\> to "delete" all segments

  \<space bar\> to pause in movie mode

  \<right arrow\> forward direction when you play movie or advances frame one at a time if the movie is paused

  \<left arrow\> opposite of above

  Left Click Drag to show movie over the selected time

  Right Click Drag zooms the selected area in the video image when an echogram fish is selected

  Use of a programmable mouse is recommended to increase efficiency

6) **Instructions for including or excluding fish to be counted or measured**

In order to optimize the aim of the sonar beams relative to the bottom of the river, the insonified zone is often divided into individual range strata that are sampled separately. In order to avoid over counting fish as they cross stratum boundaries, we apply the "centerline rule" where a fish is not counted unless it crosses the centerline of the sonar beam. Appendix B2 demonstrates the potential for overcounting without applying this criterion. Additional examples are given in Appendix B3.

Summary of fish measurement rules

a) For a fish to be considered valid for measurement, it must cross the centerline.
 - o If a fish enters or exits the beam on the near- or far-range boundary (beginning or end range), the snout of the fish must cross the centerline before it can be considered a valid fish to measure.
 - o If the snout of the fish enters the near- or far-range boundary right on the centerline, the fish should be considered valid for measurement.

b) Exclude fish that hold throughout the length of the sample.

c) Exclude fish that are holding at either the beginning or the end of the sample.
 - o Fish that are actively migrating (not holding) as the sample begins or ends should be considered valid targets for measurement as long as they cross the centerline.

d) Exclude fish that enter the beam from upstream, then exit the beam upstream (do not measure even if they cross the centerline).

e) Exclude fish that enter the beam from downstream and then exit the beam downstream (do not measure even if they cross the centerline).

f) Exclude fish that enter the beam from either upstream or downstream and then disappear from the image (unless there is evidence to suggest direction of travel).

g) Use the video image to identify actively migrating fish when several holding fish are present. If you have several fish holding throughout the sample, use the video mode or run your cursor across the echogram while watching the ARIS image to observe fish that are actively transiting the image. Measure fish that are actively transiting the image and that meet all criteria listed above.

Consult with others if you come across a questionable trace (fish) or are unclear of the rules listed above.
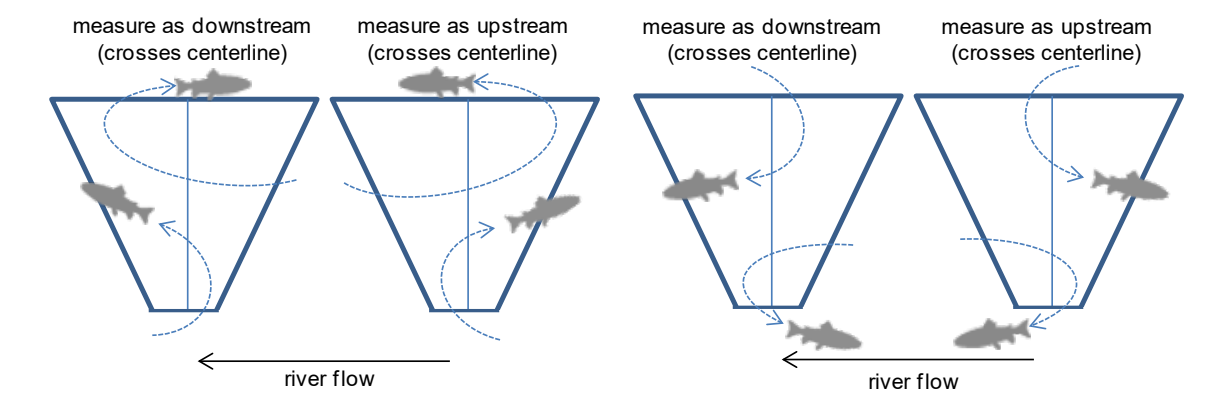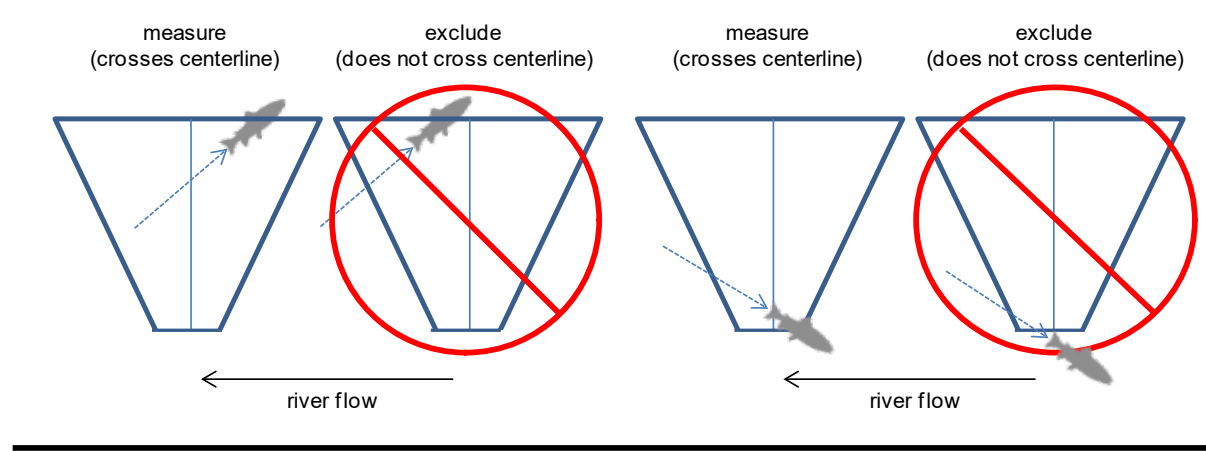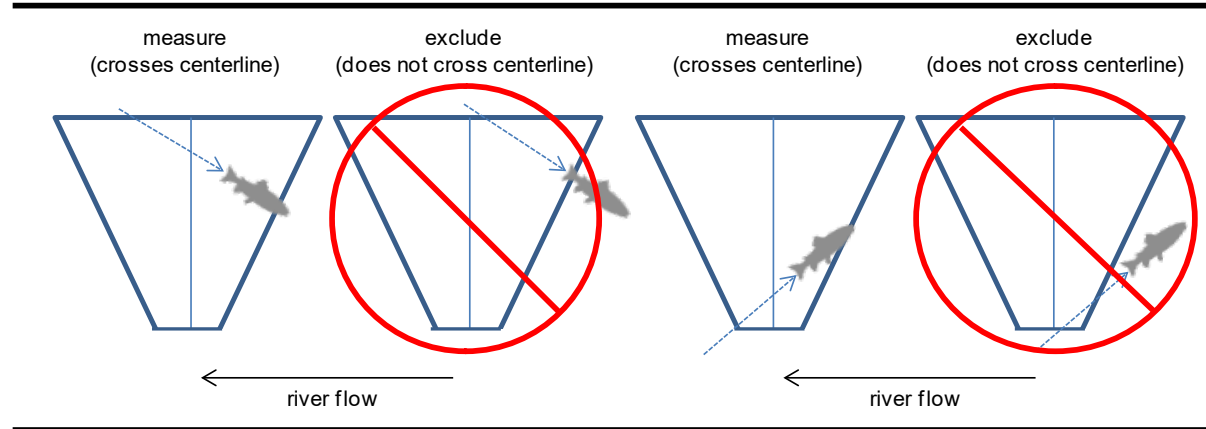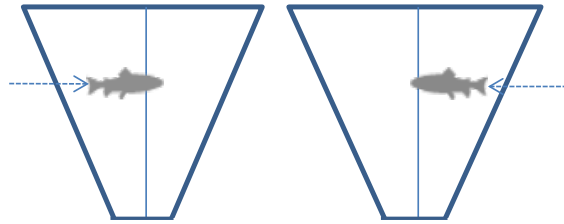
Appendix A2.–Illustration of the problem of double-counting.
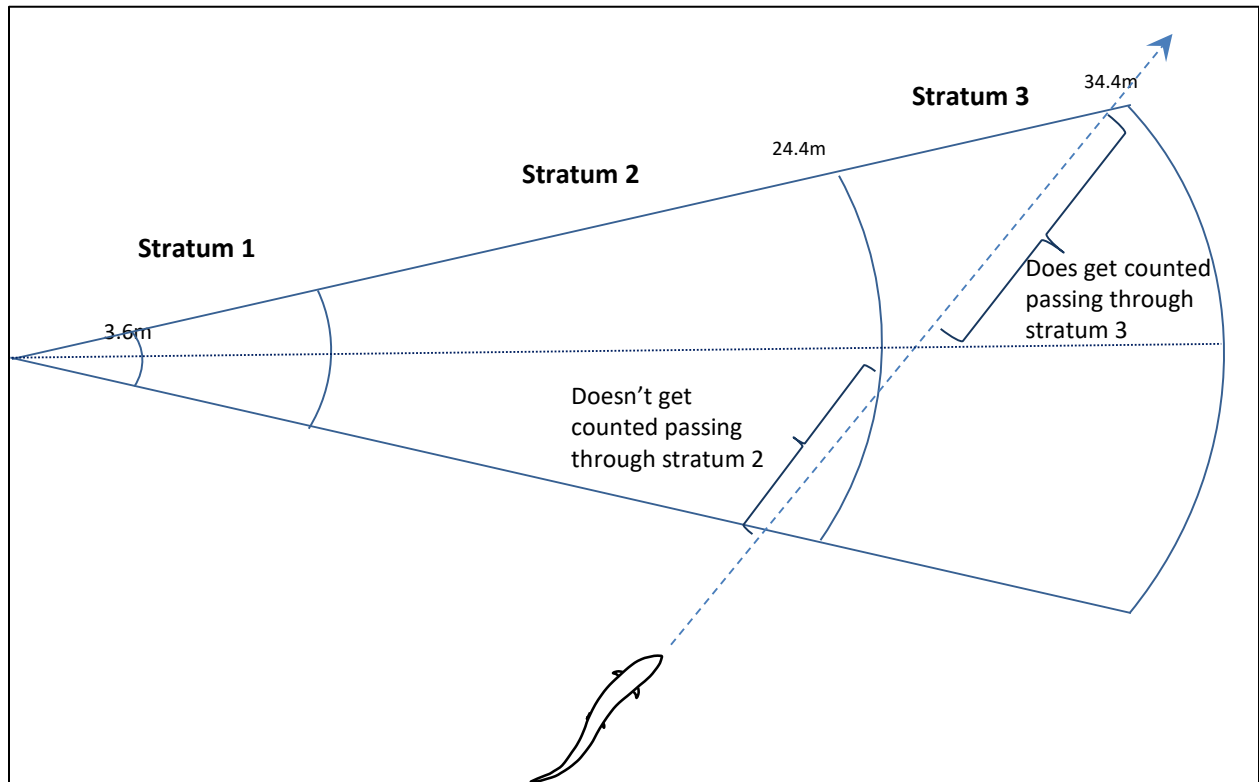
Note: To avoid counting this fish in both stratum 2 and stratum 3, the fish will only be counted in stratum 3 where it crosses the centerline of the beam.

Appendix A3.–Specific examples for applying the "Centerline Rule" when selecting fish for counting and measurements.

For a fish to be considered valid for measurement (either upstream or downstream), the snout must cross the centerline.

measure
(crosses centerline)

exclude
(does not cross centerline)

measure
(crosses centerline)

exclude
(does not cross centerline)

river flow

river flow

measure
(crosses centerline)

exclude
(does not cross centerline)

measure
(crosses centerline)

exclude
(does not cross centerline)

river flow

river flow

measure as downstream
(crosses centerline)

measure as upstream
(crosses centerline)

measure as downstream
(crosses centerline)

measure as upstream
(crosses centerline)

river flow

river flow

-continued-

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If the snout of the fish enters the near- or far-range boundary right on the centerline, the fish should be considered valid for measurement.

Exclude fish that enter the beam from upstream, then exit the beam upstream (do not measure even if they cross the centerline).
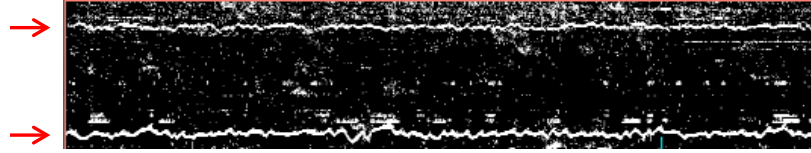
river flow
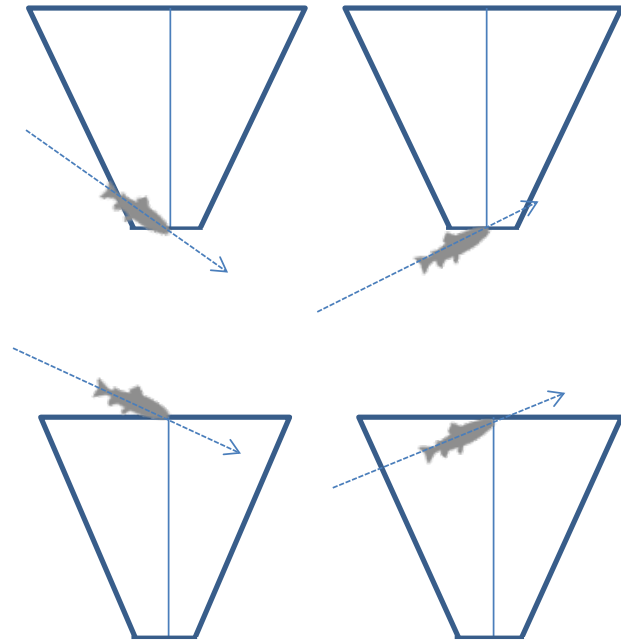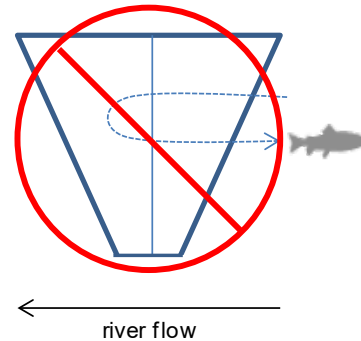
Exclude fish that enter the beam from downstream, then exit the beam downstream (do not measure even if they cross the centerline).

river flow

-continued-

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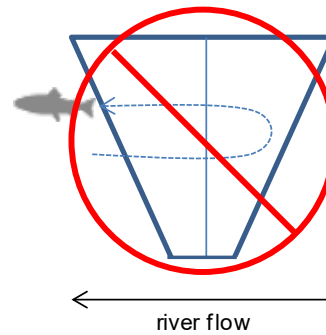
Exclude fish that hold throughout the length of the sample.

Two fish hold throughout the entire file. Exclude both fish.

Exclude fish that hold at either the beginning or end of the sample.
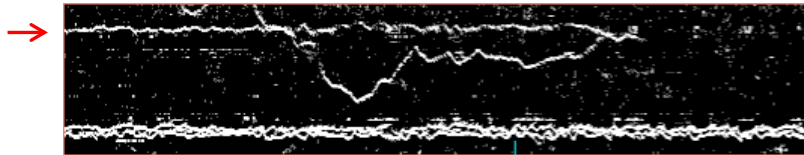
Fish holding as sample begins, then exits the beam about ¾ of the way through the sample. Exclude this fish.
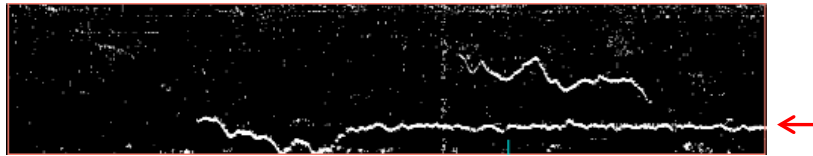
Fish enters the beam mid sample, then holds through the end of the sample. Exclude this fish

Fish that are actively migrating (not holding) as the sample begins or ends should be considered valid targets for measurement as long as they cross the centerline.

Fish is actively migrating through the beam as the sample starts. It crosses the center line and exits upstream so should be measured.

-continued-

A fish passing through the beam that turns perpendicular to the axis and disappears should be excluded unless there is other evidence to indicate direction of travel.
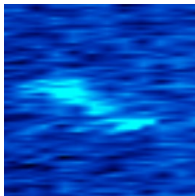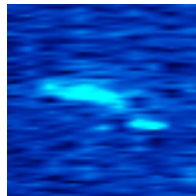
Frame #2353   Frame #2354   Frame #2355   Frame #2356   Frame #2357
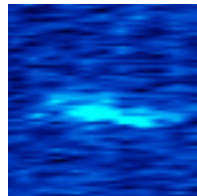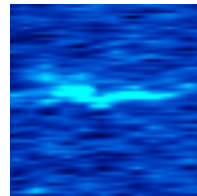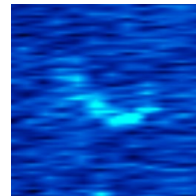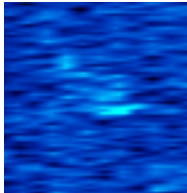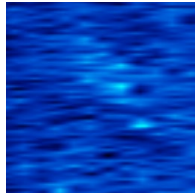
Frame #2358   Frame #2359   Frame #2360   Frame #2361   Frame #2362
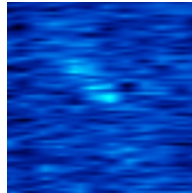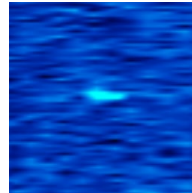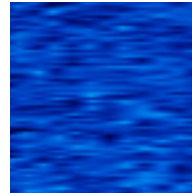
APPENDIX B: KENAI RIVER CHINOOK SALMON SONAR NETWORK CONFIGURATIONS

Appendix B1.–Soldotna sonar office computers.

SONAR Office	IP address or network	Location	Username	Device name or purpose
Network Attached Storage	10.15.161.18	Soldotna	none	NetApp Server for Storage
Computers				
Dell Optiplex 7040	DHCP	Soldotna	State Login	DFGSXQDSF115993(BHK) Also used for data-processing
Dell Optiplex 7060	DHCP	Soldotna	State Login	DFGSXQDSF122366 Main data-processing computer and upload computer
Dell Optiplex 7060	DHCP	Soldotna	State Login	DFGSXQDSF122367 (JDM)
Dell Optiplex 7050	DHCP	Soldotna	State Login	DFGSXQDSF122365 FWTIII workstation
Dell Optiplex 7050	DHCP	Soldotna	State Login	DFGSXQDSF119496 FWTII workstation
Dell Optiplex 7050	DHCP	Soldotna	State Login	DFGSXQDSF119497 FWTII workstation
Dell Optiplex 7050	DHCP	Soldotna	State Login	DFGSXQDSF119498 FWTII workstation

Once added to the permissions group, each technician will manually map to the current year's folder on the NetApp sever as follows:

1) <**Right click>** on Computer
   Select **Map network drive………..**
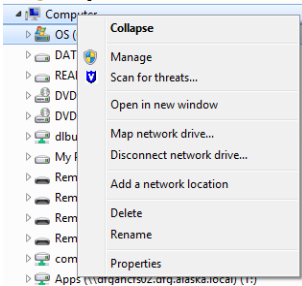
2) Select "U:" from the Drive letter dropdown menu
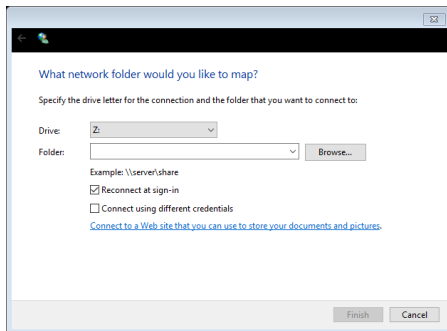
3) Enter "\\dfg.alaska.local\Research\Sonar\Kenai\YYYY) into the Folder prompt. Where YYYY is the current year.
4) Make sure the "Reconnect at sign-in" box is checked
5) Select "Finish" at the bottom

APPENDIX C: PROCEDURES FOR DAILY ARIS PROCESSING

Appendix C1.–Steps for processing RM 13.7 daily ARIS data using batch files for Kenai River Chinook salmon sonar.

The following was last updated April 2020 by Brandon Key.

Note that dates using 20XX in filenames, directory structures, and batch files correspond to each individual field season and will be updated annually.

Raw Data Transfer and Storage

Field data hard drives are brought into the office daily around 8:00 AM. These drives have data from the previous day from approximately 0800 to 2359 hours and from the current day from 0000 to 0759. Each hard drive requires 2 separate uploads when done manually (1 for each day).

1) Make sure that backup drive **X:** is present and has enough room to back up data (about 150 GB). Note: The batch file has the option to upload the next morning's data as well. Make sure there is enough space for the whole day on the backup.
2) Plug in the first field hard drives and allow each one to connect using the USB3 hub. Note the DRIVE LETTER should not matter as the batch file detects sonar files and uses the appropriate drives accordingly.
3) RUN the *UploadMenu* batch file and follow prompts to select correct **Date.** The batch file will cycle through the drives and upload all data into the appropriately dated folder on the network. After the previous day's data are complete, the current day's partial data will be uploaded if the option was selected.
4) Verify file and folder prompts.
5) The batch process should upload to the backup drive **X:** and Net App **U:** (with optional tones indicating progression)
6) Eject the DRIVEs when done.

The day's data for the 5 ARIS sonars are now backed up to X: and ready for processing (on *U:\Data20XX*).

Manual Target Measurement

1) Use the ***ARISFish*** application to process all Set1 (or Set2) *.aris files of an individual sonar for manual measurement of targets (see **APPENDIX B**).
2) process each .aris file, select parameters, create echogram, and measure fish according to specified protocols: i.e., Standard(ST), Fast Track(FT), Large Fish only(LFO).
3) If Set1 data are missing or corrupt, use corresponding Set2 data if available.

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Processing Data (To be done from the data processing computer only)

1) **Open the desktop folder "NewProcess Data20XX."**
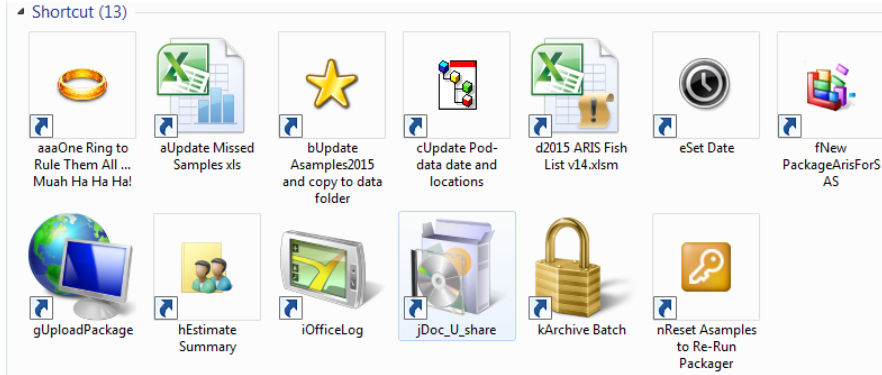
   This opens the process folder with icons listed in proper sequence for processing data

2) **Double-click the "One Ring to Rule Them All…" icon.** This starts the master batch file that opens batch or other files in the proper sequence for processing. Using the "One Ring…" helps to reduce human error in repetitive-sequential processing. Alternatively, the technician can process the data in sequence using the remaining icons, as long as the "Set Date" batch file is run before any subsequent batch file in the sequence. The following steps are called in sequence by the "One Ring…" batch file, or you can execute them separately as indicated above.

[Reminder: These next steps are called automatically by the "One Ring…" batch file, which must be left open and running throughout processing (until it closes itself at the end). In using the "One Ring…" batch, click back into it and "Press any key to continue…" after each step is done.]

---

3) **Double-click the "Update Missed Samples" icon**

   a. This opens "*20XX Aris daily summary of data quality*" Excel workbook, located in *U:\Spreadsheets*
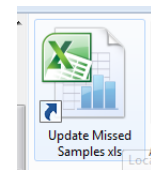
   b. Click on "missed hours for SAS" tab at the bottom of the sheet.

   c. Copy the previous day's cells down through the current day's cells by selecting the last hour (23) set and then drag-down-fill for the current day.

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d. Enter zeros for missing data: "1" for measured data and "x" for nonexistent strata.

JD	Hour	LN1	LF1	LF2	LF3	RF3	RF2	RF1	RN2	RN1	C1	C2	C3
170	19	1	1	1	1	0	0	x	1	1	1	1	1
170	20	1	1	1	1	0	0	x	1	1	1	1	1
170	21	1	1	1	1	0	0	x	1	1	1	1	1
170	22	1	1	1	1	1	1	x	1	1	1	1	1
170	23	1	1	1	1	1	1	x	1	1	1	1	1
171	0	1	1	1	1	1	1		1	1	1	1	1

e. Click on the "*Daily summary*" tab and then fill in the documentation row for that day.

f. Click on "*missed hours for SAS*" tab.

g. Save (but leave open for now).

4) **Double-click the "Update Asamples20XX" icon**
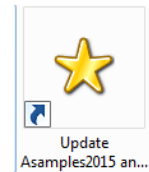
a. This opens "*Asamples20XX.txt*" file, located in *U:\DataProc16\SAS\SASinput*

b. Copy current day's data (all 24 hours) from the "*20XX Aris daily summary of data quality*" workbook, "*missed hours for SAS*" tab

c. Paste these data (0–23, for the current day) at the bottom of the "*Asamples20XX.txt*" text file (**Make sure there are no extra carriage returns at end of file; they would interfere with SAS processing**).

```
172  19  1  1  1  1  1  1  x  1  1  1  1  1
172  20  1  1  1  1  1  1  x  1  1  1  1  1
172  21  1  1  1  1  1  1  x  1  1  1  1  1
172  22  1  1  1  1  1  1  x  1  1  1  1  1
172  23  1  1  1  1  1  1  x  1  1  1  1  1
173   0  1  1  1  1  1  1  x  1  1  1  1  1
173   1  1  1  1  1  1  1  x  1  1  1  1  1
173   2  1  1  1  1  1  1  x  1  1  1  1  1
173   3  1  1  1  1  1  1  x  1  1  1  1  1
173   4  1  1  1  1  1  1  x  1  1  1  1  1
173   5  1  1  1  1  1  1  x  1  1  1  1  1
173   6  1  1  1  1  1  1  x  1  1  1  1  1
173   7  1  1  1  1  1  1  x  1  1  1  1  1
173   8  1  1  1  1  1  1  x  1  1  1  1  1
173   9  1  1  1  1  1  1  x  1  1  1  1  1
```

d. On the menu bar at the top, click on "File" then "Save."

e. *[Skip e. if you are using the "One Ring…" batch. It does this for you.]* On the menu bar at the top, click on "File" then "Save as." Save in the following directory: *U:\Data20XX\[current JD folder].*

f. Close "*Asamples20XX.txt.*"

g. Close "*20XX ARIS daily summary of data quality.xls.*"

-continued-

5) **Double-click the "Update pod data date and locations" icon.**

Update Pod- data
date and locations
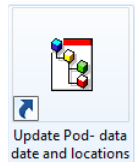
    a. This opens "*ADaily20XX.*tx"t file, located in *U:\DataProc16\SAS\SASinput\.*

    b. Copy previous day's row down, then update columns as necessary (**be sure to update dates**). Only the dates will typically change, unless a pod was reset. If a pod was reset, the new pod location is always a distance from the OHW on left bank.

```
JD     MON    DAY    LN     LF     RF     RN     CH     MAXLN  MAXRN  OLAP   ENDLO  ENDRO
136    5      16     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
137    5      17     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
138    5      18     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
139    5      19     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
140    5      20     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
141    5      21     5.0    11.3   78.3   87.5   94.0   3.4    8.7    0.0    33.5   33.5
```

    c. On the menu bar at the top, click on "File" then "Save" (saves a master copy).

    d. *[Skip d if you are using the "One Ring…" batch. It does this for you.]* On the menu bar at the top, click on "File" then "Save as." Save in the following directory: *U:\Data2015\[current JD folder]*.

    e. Close "*ADaily20XX.txt.*"

6) **Double-click the "20XX ARISfish list" icon**

    a. This opens "*20XX ARIS Fish List v17.xls,*" located in *U:\Spreadsheets*

    b. Click on Enable Content tab at top in yellow bar, if it appears.
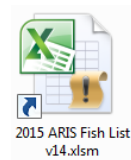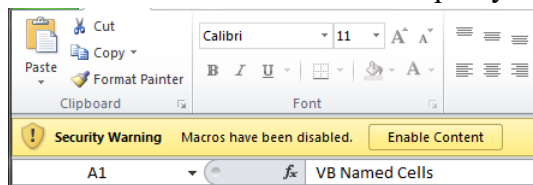
    c. Click "*SelectFiles*" tab , located in the bottom left hand corner.

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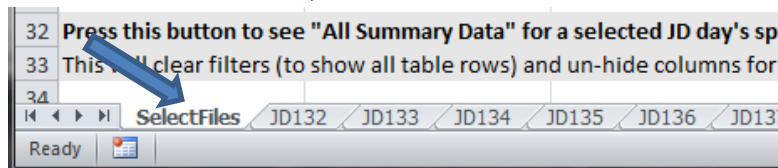
d. Update month and day (cells E2 and F2).

Year	Month	Day
2015	06	22
264	# of Stratum:	11

e. (Optional: Click on "**SetJD**" button (cell A3). "**Get Fish List**" does this for you.) (updates Julian Date).

VB Named Cells	Visual Basic Variables	Get Fish List	Year	Month	Day
Date:	2015-06-22		2015	06	22
SetJD JD:	173	Max files:	264	# of Stratum:	11
MaxFilesCount	24	72	48	48	72

f. Click "**Get Fish List**" button (cell C1, shown above). Click OK on the pop-up warning.

g. Click the hyperlink or spreadsheet tab for the current Julian Date (*JDxxx* worksheet)

All Summary Data

69 JD170 JD171 JD172 JD173 zEnd

  i. Scan the "*Aris File Summary*" data table (on this *JDxxx* sheet) for any yellow cells.

 ii. If yellow cells are found, make corrections to corresponding text files if necessary (text files found in *U:\Data20XX\[current JD folder].*

iii. If corrections are made, follow steps **c** through **g** again.

iv. Verify total file count at bottom of the table.

190 RightNear	Stratum2 Set1	21	7	0	0	0	FCe_RN_2015-06-22_215003_ID_sjs.txt
191 RightNear	Stratum2 Set1	22	5	0	0	0	FCe_RN_2015-06-22_22500∎_sjs.txt
192 RightNear	Stratum2 Set1	23	5	0	0	1	FCe_RN_2015-06-22_235004_ID_sj∎
Total			1433	0	0	15	264

v. Write down "LeftFar" temperature (both °C and °F; see orange cells), to be used later.

ArisUnit	Temperature °C
LeftNear	11.5
LeftFar	11.8
RightFar	12.3
RightNear	11.4
Channel	12.1

ArisUnit	Temperature °F
LeftNear	52.6
LeftFar	53.3
RightFar	54.1
RightNear	52.6
Channel	53.7

h. Click File on menu bar, then Save.

i. Close "*20XX ARIS Fish List v17.xls.*"

-continued-

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7) **Double-click the "Set Date" icon** (This is already done in Step 2 if using "*One Ring…*").
   a. This opens "*MonthDayMenu.bat*" file, located in "*U:\Batch\AutoDated\.*"
   b. Follow instructions to set the 2-digit month and 2-digit date. This is used in all subsequent batch files.
   c. Change dates (JULDATE and YEAR) in the *.sas* text file that opens. **Be sure to not delete the semicolon following the data** (it must be there for the SAS program).
   d. The batch file will close automatically.

8) **Double-click the "PackageARISforSAS" icon**
   a. Opens "*PackageArisForSAS-2.bat*" batch file, located in "*U:\Batch\AutoDated*"
   b. Follow instructions.
      i. It packages files for the day. You will hear several beeps as it does so…
      ii. Then it automatically opens the "*Package-[DataDate]-JDxxx.txt*" log file. Use it to double-check that there are 24 files per stratum (unless we have missing samples).
      iii. After review, close the "*Package-[DataDate]-JDxxx.txt*" log file.
      iv. Continue following the batch file instructions.
      v. The batch file automatically opens **SAS** software.
      vi. At this point, you can drag batch file window to the other monitor to move it out of the way.
      vii. Ensure **SAS** is set to the proper directory (*U:\DataProc16\SAS\SASinput*) by looking in the lower right-hand side of the SAS window. If not set to proper directory, double-click to browse to correct folder.
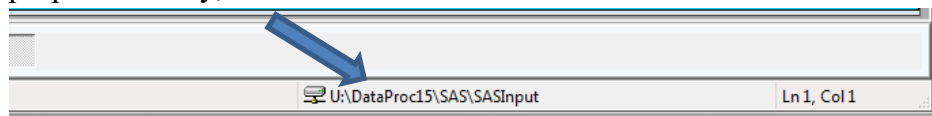
      viii. Click on "File Shortcuts" on left side of screen in the Explorer tab on the bottom left to open the folder containing all SAS programs.
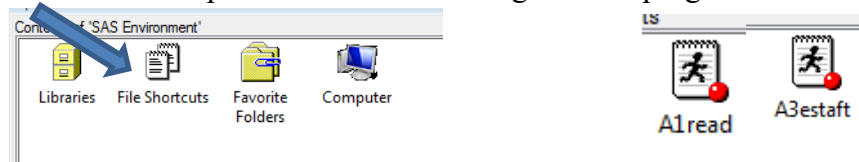
-continued-

ix. Open the **1st SAS** program by clicking on "**A0config**" (the SAS program window will open).

    1. Click the little running man on the menu bar at the top of the screen (this will run the program).

    2. Watch the log window as program runs.

    3. No output from this program; proceed to next step once it stops running.

x. Open **2nd SAS** program by clicking on "**A1Read.**"

    1. Click the little running man to run program (this one takes a while).

    2. Watch the log window as program runs.

    3. No output from this program; proceed to next step once it stops running.

xi. Open **3rd SAS** program by clicking on either "**A3estast**" or "**A3estaft**" depending on whether the data was measured using the standard (st) or fast track (ft) method.

    1. Click the little running man to run program.

    2. Watch the log window as program runs.

    3. Produces output tables in "Results Viewer" window.

    4. From the "<u>All Upstream Salmon Shaped Fish >=40</u>" table write down the number of fish >= 40 cm for the current day (found in the "dayPassage1" column).

    5. From the "<u>Net Upstream Salmon Shaped Fish >=75</u>" table write down the number of upstream fish >= 75 cm for the current day

    6. From the "<u>Net Upstream Salmon Shaped Fish >=90</u>" table write down the number of upstream fish >= 90 cm for the current day

    7. While in the Results Viewer window, click on "File" on the menu bar at the top, then "Save as"

    8. Click on "FileName" dropdown arrow to find "*SAS-OFFICE-JDxxx.mht*" in *\ Desktop*

    9. Change Julian Date to current day

    10. Click "Save" (saves output to desktop)

-continued-

       xii.   Open **4th SAS** program by clicking on "**A4Graph.**"

           1.   Click the little running man to run program.
           2.   Watch the log window as program runs.
           3.   Produces output graphs in "*GRAPH\ WORK…* " window.
           4.   Click on the graph for the current Julian Date.
           5.   Click File on the menu bar and then Export As Image.
           6.   Save as Type: PNG.
           7.   Change filename for the current Julian Date to save as *JDxxx.PNG* on the *Desktop.*
           8.   Click "Save" (saves graph to desktop).

       xiii.   Close SAS.

   c.   Continue with batch file (closes automatically).

9) **Double-click the "UploadPackage" icon.**
   a.   Opens "*UploadPackage.bat*" , located in "*U:\Batch\AutoDated\.*"
   b.   Follow instructions.
   c.   Batch file closes automatically.

10) **Double-click the "Estimate Summary" icon.**
   a.   Opens "*Estimates.bat*" located in "*U:\Batch\.*"
   b.   Follow instructions.
   c.   Automatically opens Estimate_Summary20XX.xls workbook (located in *U:\DataProcXX\Spreadsheets*).
   d.   Click on the Estimates By Day tab.
   e.   Enter estimates (that you wrote down earlier from SAS output) into the Estimates By Day table.
   f.   Write down Cumulative Totals ($>=40$, $>=75$, $>=90$) from the table.
   g.   Print table by clicking on "File" in the menu bar at top of window, then "Print."
   h.   Click on 20XX Plot (Print Me) tab to review the graph.
   i.   Print graph by clicking on "File" in the menu bar at top of window, then "Print."
   j.   Click on Daily Estimates (Email Me) tab.
   k.   Enter your name where designated in the Early Run Estimate Summary box.
   l.   Open Outlook (Email) by clicking on Outlook icon at bottom of computer screen.
   m.   In Outlook, on top left side of window, click on "New E-mail" (opens a blank email).
   n.   Copy and paste EARLY RUN ESTIMATE SUMMARY box from Daily Estimates (Email Me) tab to the body of the email (**be sure to use "Paste Options" and "Picture" when pasting to email**).

-continued-

     o. Copy and paste the title of the table (EARLY RUN ESTIMATE SUMMARY) from the Daily Estimate (Email Me) tab to the subject line of the email.

     p. Click on the Estimate By Day tab so this is the tab in view when Excel is closed.

     q. Click the "X" in the upper right-hand corner of the Excel window to close Excel.

     r. When prompted, click "Save" to save your work.

     s. Continue with batch file – follow instructions.

     t. The batch file will close automatically.

11) **Double-click the "Office Log" icon**

     a. Opens "*OfficeLog.bat*", located in "*U:\Batch\AutoDated*."

     b. Follow instructions.

     c. Automatically opens OFFICE_LOG.dotx template (located in *U:\DataProcXX\OfficeLog*).

     d. Fill in the log.

     e. Click "File" on the toolbar and then "Save As."

     f. Click the "File name" dropdown arrow and click on previous day's filename.

     g. Change Julian Date to current day's date and save as JDxxx.docx.

     h. Click on "Save as type" and in the resulting dropdown window click on PDF (*.pdf).

     i. Click "Save."

     j. Click on "File" on menu toolbar, then "Print" to print one copy of the office log.

     k. Click on the "X" at the upper right of the window to close the office log template (do not save it).

     l. Continue with batch file; follow instruction (Press any key to continue…).

     m. The batch file will close automatically.

12) **Complete and send email**

     a. Drag *Estimate Summary.xls*, *JDXXX.pdf* (office log), *SAS-Office-JDXXX.mht,* and the *JDxxx.PNG* SAS graph from computer desktop to the body of email.

     b. Click inside the "To" box in the email and then type "s."

     c. Click on "SSestimate."

     d. Click "Send" to send email.

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13) **Double-click the "Teamshare Upload" icon**
    a. Opens "*Teamshare.bat*", located in "*U:\Batch*."
    b. Follow instructions.
    c. Automatically opens Teamshare window.
    d. Login to Teamshare.
    e. Update Estimate Summary (EstimateSummary.xls) from desktop (use red arrow).
    f. Upload Office Log (*JDXXX.pdf*) from desktop; copy previous day's title first and change JD.
    g. Upload Range/Time Graph (*JDXXX.png*) from desktop; copy previous day's title first and change JD.
    h. Minimize Teamshare.
    i. Continue with batch file; follow instruction.
    j. The batch file will close automatically.

14) Upload daily estimates to the "Fish Count" website
    a. https://intra.sf.adfg.state.ak.us/FishCounts/index.cfm?FA=main.home
    b. Click "Add Count" tab
    c. Make sure the "Count Date" is correct
    d. Enter: Location (Kenai), Count, Notes (rarely applicable), Species (Chinook-early or Chinook Late) ex:

FISH COUNTS ADMINISTRATION

Home	Add Count	Edit/Delete Record	Add Bulk Records	Location Data	Contacts	Escapement Goals

Escapement Count Reports			
Count Date (mm/dd/yyyy)	**SF Location**	**Count**	**Hatchery (optional)**
03 / 23 / 2020	Kenai River (Chinook) ⌄	XYZ	
Notes (will appear online)	**Comments (will NOT appear online)**	**Up/Downstream**	**Species**
		Upstream ⌄	Chinook - Early Run ⌄

submit count | reset

Click submit count.

15) **Double-click the "Archive Batch Files" icon** (Not currently in the "One Ring…" batch process).
    a. Opens "*ArcBats.bat*". located in "*U:\Batch\AutoDated*."
    b. Follow instructions; cleans up desktop.
    c. The batch file will close automatically.

16) **Click into the "One Ring…" batch command window.**
    a. (This window has been open and running throughout the 10 steps of processing. The technician clicks into it to "**Press any key to continue …**" after each step.).
    b. "**Press any key to continue …**" one final time, to let it finish. The window will close automatically.

17) **Put printouts of the *Office Log* and the *Daily Estimates* in the 3-ring binders.**

The following was updated 18 May 2016 by Mike Hopp for the Upper River Chinook ARIS Sonar Project.

Batch files are text files containing a series of commands intended to be executed by a command interpreter. When a batch file is run, the shell program (usually COMMAND.COM or cmd.exe) reads the file and executes its commands. Batch files are useful for running a sequence of "executables" automatically and are often used to automate tedious processes.

Several batch files have hard-coded filenames, pathnames, and year values as environment variables written near the top of the file. These must be edited and saved at the start of each season (use right mouse click, <**Edit**> or <**Edit with Notepad++**>). Some batch files have hard-coded dates (JD, Day, Month): these must be edited and saved before each use.

Most batch files using dates *now* use a Date Menu system that sets the date in text files, which are then read by the batch files. These batch files do not have to be edited daily.

Batch files used on this project are organized into folders according to their purpose and dependency (some batch files depend upon or call on other batch or text files). These are described in Appendix C3. Batch files, executables, and text files are given in Appendix C4.

Appendix C3.–Overview of batch file and folder locations and the purpose of the batch file for ARIS data processing.

Location	Function	Dependencies
U:\Batch	Processing data after tracking and measuring fish is done	None. These are daily data processing batch files that are not dependent on AutoDated files. *Estimates.bat* and *Doc_U_share.bat* do not use dates.
U:\Batch\TxtCounter	Handy tool to list and count all ARIS measurement text files in a day's tracking folders	This uses 7 related .exe, .txt and .bat files. *DaterMenu.bat* executes *SetJDtxt.exe* (which writes *dateJD.txt*), then reads *dateJD.txt* and then calls *CountStrats.bat*. *CountStrats.bat* repeatedly calls *CountThisDir.bat*. *CountThisDir.bat* executes *TxtCount.exe* (which writes *txtCounted.txt*) and then reads *txtCounted.txt*.
U:\Batch\UploadDailyData	Uploads camp data from portable 2-Terabyte drives to a backup Passport HD and to organized sub-folders on the NET APP SERVER	This uses 9 related .exe, .txt and .bat files. *UploadMenu.bat* executes *SetJDtxt.exe* (which writes *dateJD.txt*), then reads *dateJD.txt* and then calls *SonarUpload.bat*. *SonarUpload.bat* repeatedly calls *UploadStrataXX.bat* (where XX=LN, LO, RO, RN or CH –identifying a sonar unit).
U:\Batch\Autodated	[New, using Date Menu] - processing data after tracking and measuring fish is done	This uses 13 related .exe, .txt and .bat files. *OneRing.bat* calls *MonthDayMenu.bat* and then reads *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*. *OneRing.bat* executes 10 different steps by starting programs or calling batch files in the proper sequence. *MonthDayMenu.bat* executes *SetJDtxt.exe* (which writes *dateJD.txt*), then reads *dateJD.txt*, then writes *DataMonth.txt* and *DataDay.txt* and then opens notepad & *A0_Configure 20XXv1.sas* (to edit date). *PackageArisForSAS-2.bat* reads *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*. Then it repeatedly calls *LogStrataYN.bat* (for each of about 20 strata). Then it repeatedly calls *CopyStrata.bat* (for each strata). *UploadPackage.bat* reads *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*. *OfficeLog.bat* reads *dateJD.txt*. ArcBats.bat reads *dateJD.txt*. *AsamplesReset.bat* reads *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*.
U:\Batch\ManualDated	[Old method] - processing data after tracking and measuring fish is done	None. These are old batch files that were in use before the Date Menu system. Before use, each batch file must first be edited and saved to change the Date and JD (if used).

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Appendix C3.–Page 2 of 2.

Location	Function	Dependencies
U:\Batch\ManualDated	[Old method] - processing data after tracking and measuring fish is done	None. These are old batch files that were in use before the Date Menu system. Before use, each batch file must first be edited and saved to change the Date and JD (if used).
U:\Batch\LOGS	Stores log files generated by batch processing of data	This folder must exist, since it is referenced in several batch files as the location to store log files.
U:\DataProc16\SAS\SASPrograms	Controls SAS processing of data	These are SAS program files, similar to –but not the same as– batch files. Sequence numbers in the filename indicate the order to be run.
U:\Batch\Archive	Stores currently unused batch programs and icons	n/a
U:\Batch\Archive\Set2Mover	Used to offload backup data	This uses 4 related .exe, .txt and .bat files. *Menu2Mover.bat* executes *SetJDtxt.exe* (which writes *dateJD.txt*), then reads *dateJD.txt* and then repeatedly calls *Set2Mover.bat*.

Appendix C4.– List of batch files, executables, and text files currently used in ARIS data processing.

File Name [a]	Location [b]	Type and function
*	*UploadDailyData*	For transferring Field data to Office NET APP SERVER and Backup drive…
UploadMenu.bat	*UploadDailyData*	Initial batch file that provides a menu to select the *DataMonth & DataDay* and ARIS Sonar pod data (*PodxFolder*) to upload. It then calls *SonarUpload.bat* with *PodxFolder* as a parameter.

[Environment variables set here are used by all the *UploadDailyData* batch files without necessarily being passed as parameters in a CALL command line. *DataYear* is hard coded and must be edited each season for a new year.] |
| *SetJDtxt.exe* | *UploadDailyData* | Executable used in *UploadMenu.bat* to calculate (based on *DataYear*, *DataMonth & DataDay* parameters) and write the data JD (Julian Date) in *dateJD.txt*. |
| *dateJD.txt* | *UploadDailyData* | Text file written by *SetJDtxt.exe* and read by *UploadMenu.bat* and stored in the JD environment variable. It is then used throughout the *UploadDailyData* set of batch files. |
| *SonarUpload.bat* | *UploadDailyData* | Batch file called by *UploadMenu.bat* with *PodxFolder* passed as a parameter into the *DestFolder* environment variable.

This is the main processing batch file used to upload daily ARIS sonar data from field hard drives to the NET APP SERVER and to the backup portable "My Passport" hard drive. It creates several subfolders on the NET APP SERVER, determined by the *DestFolder*.

Using a FOR LOOP with a *StratCount* counter, it repeatedly calls *UploadStrataXX.bat* to selectively copy the *.aris* files into subfolders based on the 10-minute time stamp in the filename.

Additionally, this batch process uses extensive error-checking and logs its progress and then finally deletes the field-source files and folders (so that those drives can be re-used daily for data collection in the field). |
| *UploadStrataLN.bat*
UploadStrataLO.bat
UploadStrataRO.bat
UploadStrataRN.bat
UploadStrataCH.bat | *UploadDailyData* | Five batch files, each uniquely identifying a sonar unit. These are called repeatedly by *SonarUpload.bat* to copy the *MINS*-selected files (by 10-minute filemask) into the proper subfolder on the NET APP SERVER.

Five different batch files are needed to conveniently deal with the different 10-minute strata definitions for each of the 5 different sonar pod locations. |

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File Name [a]	Location [b]	Type and function
*	*TxtCounter*	For checking progress & completion of ARIS measurement files for a data day…
DaterMenu.bat	*TxtCounter*	Initial batch file that provides a menu to select the *DataMonth* & *DataDay*. [*DataYear* is hard coded and must be edited each season for a new year.]
		After setting date and *DatedFolder* environment variables, it calls *CountStrats.bat*.
SetJDtxt.exe	*TxtCounter*	Executable used in *DaterMenu.bat* to calculate (based on *DataYear*, *DataMonth* & *DataDay* parameters) and write the data JD (Julian Date) in *dateJD.txt*.
dateJD.txt	*TxtCounter*	Text file written by *SetJDtxt.exe* and read by *DaterMenu.bat* and stored in the JD environment variable. It is then used throughout the *TxtCounter* set of batch files.
CountStrats.bat	*TxtCounter*	Batch file called by *DaterMenu.bat*. It repeatedly sets *StratXSetX* (as a sub-folder path environment variable) and calls *CountThisDir.bat*, which fills a text file with a count and list of .txt files for each sub-folder.
		This is the main processing batch file used to count and list all the ARIS fish-measurement .txt files in each of the sub-folders for an entire data-day. This is recorded in a *txtCounted.txt* file, located at the root of the *DateFolder*, which is then opened for the technician to review. This is a handy tool to help technicians determine fish-measurement progress during the day.
CountThisDir.bat	*TxtCounter*	Batch file repeatedly called by *CountStrats.bat*. It executes *TxtCount.exe* to count the .txt files in the selected folder and then writes that count in *txtCounted.txt*.
		It then reads *txtCounted.txt* into the *TxtFiles* environment variable and uses that to record the text count as well as a Directory list of .txt files into a *DirStrats.txt* file located at the root of the *DateFolder*.
TxtCount.exe	*TxtCounter*	Executable used in *CountThisDir.bat* to count the .txt files in the folder path (received as a command line parameter. It then writes that count in *txtCounted.txt*.
txtCounted.txt	*TxtCounter*	Text file written by *TxtCount.exe* and used in *CountThisDir.bat*. It stores a text representing a count of .txt files found in the folder path.

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File Name [a]	Location [b]	Type and function
*	*AutoDated*	For end-of-day processing of ARIS measurement files for an entire data-day…
OneRing.bat	*AutoDated*	Master batch file used to call other processes and batch files in the proper sequence of 10 steps in the Chinook ARIS Sonar post-measurement processing of a day's data.
		Files in the *AutoDated* folder use 13 related*** .exe, .txt and .bat files. *OneRing.bat* first calls *MonthDayMenu.bat* to set the *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*. These files are then read by each of the .bat files in the *AutoDated* folder.
		In proper sequence, *OneRing.bat* gives instructions and CALLS *MonthDayMenu.bat*, STARTS the *20XX ARIS daily summary of data quality.xlsx*, OPENS *Asamples20XX.txt*, OPENS *Adaily20XX.txt*, OPENS *20XX ARIS Fish List v17.xlsm*, CALLS *PackageArisForSAS-2.bat*, CALLS *UploadPackage.bat*, CALLS *Estimates.bat*, CALLS *OfficeLog.bat*, CALLS *Doc_U_share.bat*, CALLS *ArcBats.bat*.
		***[It is not mandatory to use *OneRing.bat*, but it is otherwise necessary to run *MonthDayMenu.bat* before using other .bat files in the AutoDated folder since they depend on correct dates recorded in *dateJD.txt*, *DataDay.txt* and *DataMonth.txt*.]
MonthDayMenu.bat	*AutoDated*	Batch file that provides a menu to select the *DataMonth* & *DataDay* for data processing
		MonthDayMenu.bat executes *SetJDtxt.exe* (which writes *dateJD.txt*), then reads *dateJD.txt*, then writes *DataMonth.txt* and *DataDay.txt* and then opens notepad & *A0_Configure 20XXv1.sas* (to edit the date).
		[*DataYear* is hard coded and must be edited each season for a new year.]
SetJDtxt.exe	*AutoDated*	Executable used in *MonthDayMenu.bat* to calculate (based on *DataYear*, *DataMonth* & *DataDay* parameters) and write the data JD (Julian Date) in *dateJD.txt*.

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File Name [a]	Location [b]	Type and function
dateJD.txt	*AutoDated*	Text file written by *SetJDtxt.exe* and read by several *.bat* files in the *AutoDated* folder. It is stored in the JD environment variable, which is then used throughout the batch file.
DataDay.txt	*AutoDated*	Text file recorded by *MonthDayMenu.bat* and used by several *.bat* files in the *AutoDated* folder.
DataMonth.txt	*AutoDated*	Text file recorded by *MonthDayMenu.bat* and used by several *.bat* files in the *AutoDated* folder.
PackageArisForSAS-2.bat	*AutoDated*	Batch file used to copy and also zip up a complete set of ARIS measurement .txt files for a particular data day.
		This is the main data processing batch file used copy .txt files from each of 20 different strata subfolders and gathers these copies into one pack folder. Then it zips up a copy of these .txt files; and then it moves them into a processing folder. Then it runs opens SAS to analyze and process this data.
		It uses 20 environment variables to determine which of 20 strata are copied to a *PackFolder* (*U:\DataProc16\Manual*). It calls *LogStrataYN.bat* (for each strata) to log selections. Then it calls *CopyStrata.bat* (for each strata) to copy the .txt files.
		Then it copies this set into a compressed zip folder. Then it moves the .txt files into the *SASInputFolder* (*U:\DataProc16\SAS\SASInput*), where they will be processed by SAS. It uses extensive error-checking throughout and it logs its progress.
LogStrataYN.bat	*AutoDated*	Batch file called by *PackageArisForSAS-2.bat* for each of 20 strata. This records strata selection choices for subsequent copying of .txt files.
CopyStrata.bat	*AutoDated*	Batch file called by *PackageArisForSAS-2.bat* for each of 20 strata. This copies the .txt files from each strata folder to the *PackFolder*.
UploadPackage.bat	*AutoDated*	Batch file used to copy the *Aris_JDxx_20XX-mm-dd_TxtData.Zip* from the *U:\Data20XX\RM13-Packaged* folder to the Anchorage *J:\KNCHISNR\Soldotna\ARIS* folder. It uses extensive error-checking throughout and it logs its progress.

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File Name [a]	Location [b]	Type and function
Estimates.bat	*Batch*	Batch file used to open *Estimate_Summary20XX.xls* (located in *U:\DataProc20XX\ Spreadsheets*) and also copy it to the desktop as *EstimateSummary.xls*.
OfficeLog.bat	*AutoDated*	Batch file used to open the *OFFICE_LOG.dotx* template (located in *U:\DataProc20XX\ OfficeLog*). Then it copies *JDxxx.docx* and *JDxxx.pdf* from the local *MYDOCS* folder to the *ProcLogFolder* (*U:\DataProc20XX\OfficeLog*) after user-editing and saving files.
Doc_U_share.bat	*Batch*	Batch file used to open Docushare for daily updates.
ArcBats.bat	*AutoDated*	Batch file used to archive the processing batch files & to delete temporary desktop files
AsamplesReset.bat	*AutoDated*	Batch file used to rename *JDxxx-Asamples20XX.txt* back to *Asamples20XX.txt*, located in the dated *U:\Data20XX\20XX-mm-dd-JDxxx* folder – in order to re-run *PackageArisForSAS-2.bat* (presumably after changes to data files were made). [*PackageArisForSAS-2.bat* looks for *Asamples20XX.txt* and then renames it *JDxxx-Asamples20XX.txt*. This file is used as a sentinel file to verify that the day's processing is done and ready to be packaged for SAS processing.]
*.sas	*SASPrograms*	For programming SAS to analyze and report on ARIS measurement raw data…
A0_Configure 20XXv1	*SASPrograms*	Configures SAS environment (paths, dates, etc…) for current SAS program
A1_ReadData_20XXv1	*SASPrograms*	Reads ARIS fish measurement data and data-recording time-stamps into SAS tables
A3_Estimate- Passage_20XXv1	*SASPrograms*	Estimates passage of fish of different lengths (>= 40, 75, 90)
A4_RangeTime 20XXv1dt	*SASPrograms*	Produces range-time graphs
A5_FreqDistnNetAL 20XXBHK	*SASPrograms*	Produces frequency-distribution graphs
EasyA4_RangeTime 20XXv1	*SASPrograms*	Produces range-time graphs

[a] Files are listed in general order of use in a typical day.

[b] Location refers to folders or subfolders in *U:\Batch* or *U:\DataProc16\SAS\,* as indicated in Appendix D3.

APPENDIX D: ARIS LENGTH MIXTURE MODEL AND ASSOCIATED WINBUGS PROGRAM CODE

Mixture models are useful for extracting information from the observed frequency distribution of a carefully selected measurement. If one were able to observe the exact length, but not the species, of every fish passing the sonar in the Kenai River, the distribution of such measurements might look something like that in Appendix D2, panel A. Given additional knowledge about the size of sockeye and Chinook salmon, the shape of the overall distribution can reveal much about the relative abundance of each species. For instance, if it is known that sockeye salmon do not exceed 70 cm in length and that small Chinook salmon are very rare, one can conclude that the left-hand mode of the distribution is composed almost entirely of sockeye salmon and that the species composition is perhaps 50:50 sockeye to Chinook salmon. Mixture model analysis is merely a quantitative version of this assessment in which the shape of the overall frequency distribution is modeled and "fitted" until it best approximates the data. Uncertainty is assessed by providing a range of plausible species compositions that could have resulted in the observed frequency distribution.

As another example, imagine there are substantial numbers of small Chinook salmon and there is error in the length measurements (Appendix D2, panel B). The effect of the measurement error is to cause the modes to begin to overlap, reducing the ability to detect detail in the length distribution and reducing the precision of the estimates. Under this scenario, it is still possible to make subjective assessments about the true species composition, but to quantify the uncertainty is more difficult. Mixture models provide an objective way to accomplish this.

Mixture models can be conducted on any quantity related to length, including length as measured from ARIS images (AL). Given knowledge of the relationship between length and the observed quantity (e.g., Burwen et al. 2010), it is straightforward to convert from length units to the new units by including the slope, intercept, and mean squared error of the relationship in the mixture model (Equation D1.2 below). The more closely related the surrogate measurement is to the one of interest, the more the two distributions will resemble each other and the better the resulting estimate will be. AL is a good predictor of fish length[5]; similar to DIDSON length (Appendix D3; see also Burwen et al. 2010). Thus, the observed frequency distribution of AL supplies valuable information about species composition, even though there is overlap of AL measurements between species.

The AL mixture model is described below. See also Fleischman and Burwen (2003) and Miller et al. (2012) for a similar model using split-beam echo length as the hydroacoustic variable.

The probability density function (PDF) of hydroacoustic variable y (= AL) is modeled as a weighted mixture of 2 component distributions arising from sockeye and Chinook salmon (Appendix E4),

$$f(y) = \pi_S f_S(y) + \pi_C f_C(y), \tag{D1.1}$$

where $f_S(y)$ and $f_C(y)$ are the PDFs of the sockeye and Chinook salmon component distributions, and the weights π_S and π_C are the proportions of sockeye and Chinook salmon in the population.

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[5] Preliminary analysis of ARIS tethered fish data were collected at RM 8.6 in 2014.

Individual observations of y are modeled as normal random variables whose mean is a linear function of fish length x:

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i, \tag{D1.2}$$

where β_0 is the intercept, β_1 is the slope, and ε_i is normally distributed with mean 0 and variance σ^2. Thus, the component distributions $f_S(y)$ and $f_C(y)$ are functions of the length distributions $f_S(x)$ and $f_C(x)$ and the linear model parameters β_0, β_1, and σ^2 (Appendix D4). The species proportions π_S and π_C are the parameters of interest.

Length measurements are obtained from fish captured by gillnets (e.g., Perschbacher 2015) downstream of the sonar site. Length data from multiple days of netting are paired with a single day of hydroacoustic data. In this version of the analysis, we assume no gillnet size selectivity.

Sockeye and Chinook salmon return from the sea to spawn at several discrete ages. We modeled sockeye and Chinook salmon length distributions as 3-component normal age mixtures:

$$f_S(x) = \theta_{S1} f_{S1}(x) + \theta_{S2} f_{S2}(x) + \theta_{S3} f_{S3}(x) \text{ and} \tag{D1.3}$$

$$f_C(x) = \theta_{C1} f_{C1}(x) + \theta_{C2} f_{C2}(x) + \theta_{C3} f_{C3}(x), \tag{D1.4}$$

where θ_{Ca} and θ_{Sa} are the proportions of Chinook and sockeye salmon belonging to age component a, where

$$f_{Sa}(x) \approx N\left(\mu_{Sa}, \tau_{Sa}^2\right) \text{ and} \tag{D1.5}$$

$$f_{Ca}(x) \approx N\left(\mu_{Ca}, \tau_{Ca}^2\right). \tag{D1.6}$$

The overall design is therefore a mixture of (transformed) mixtures. That is, the observed hydroacoustic data are modeled as a 2-component mixture of y, each component of which is transformed from a 3-component normal mixture of x.

Bayesian statistical methods will be employed because they provide realistic estimates of uncertainty and the ability to incorporate auxiliary information. We will implement the Bayesian mixture model in WinBUGS (Bayes Using Gibbs Sampler; Gilks et al. 1994). Bayesian methods require that prior probability distributions be formulated for all unknowns in the model. Species proportions π_S and π_C are assigned an uninformative Dirichlet(1,1) prior, as are age proportions $\{\theta_{Sa}\}$ and $\{\theta_{Ca}\}$ (Appendix D5). Likewise, informative normal priors based on historical data are used for the length-at-age means μ and standard deviations τ. Prior information about regression parameters β_0, β_1, and σ^2 is supplied by embedding an analysis of a subset[6] of tethered fish data in the mixture model (Appendix D3).

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[6] ARIS length measurements of tethered fish data are not necessarily representative of measurements from free-swimming fish. Therefore, inclusion of the entire tethered fish data set can bias mixture model results. Fortunately, only weak prior information about the regression parameters is required in order to estimate species composition with the mixture model, and this can be supplied by using only a small subset ($n = 5$) of tethered fish data, which does not cause substantial bias in the species composition estimates.

WinBUGS uses Markov chain Monte Carlo methods to sample from the joint posterior distribution of all unknown quantities in the model. We will start at least 2 Markov chains for each run and monitor Gelman-Rubin statistics to assess convergence. Burn-in periods of 10,000 or more samples will be used. Samples will be thinned 10 to 1, and at least 10,000 samples per chain will be retained.

The end product of a Bayesian analysis is the joint posterior probability distribution of all unknowns in the model. For point estimates, the posterior mean will be used. The posterior standard deviation will be presented as an analogue to the standard error of an estimate from a frequentist (non-Bayesian) statistical analysis.

The mixture model will be fit to daily ARIS length data but will utilize 7 days of netting data ending on the date of the current ARIS lengths.

By default, data will be stratified by day; i.e., daily data from different spatial and temporal strata will be pooled and the model described above will be fit to the pooled data. Sample size limitations early in the season may necessitate pooling the data across more than 1 day.

Appendix D2.–Hypothetical distributions of fish length measurements (black solid lines) from the Kenai River: (A, top) few small Chinook salmon with no measurement error and (B, bottom) 40% of Chinook salmon are small with measurement error standard deviation 10 cm.
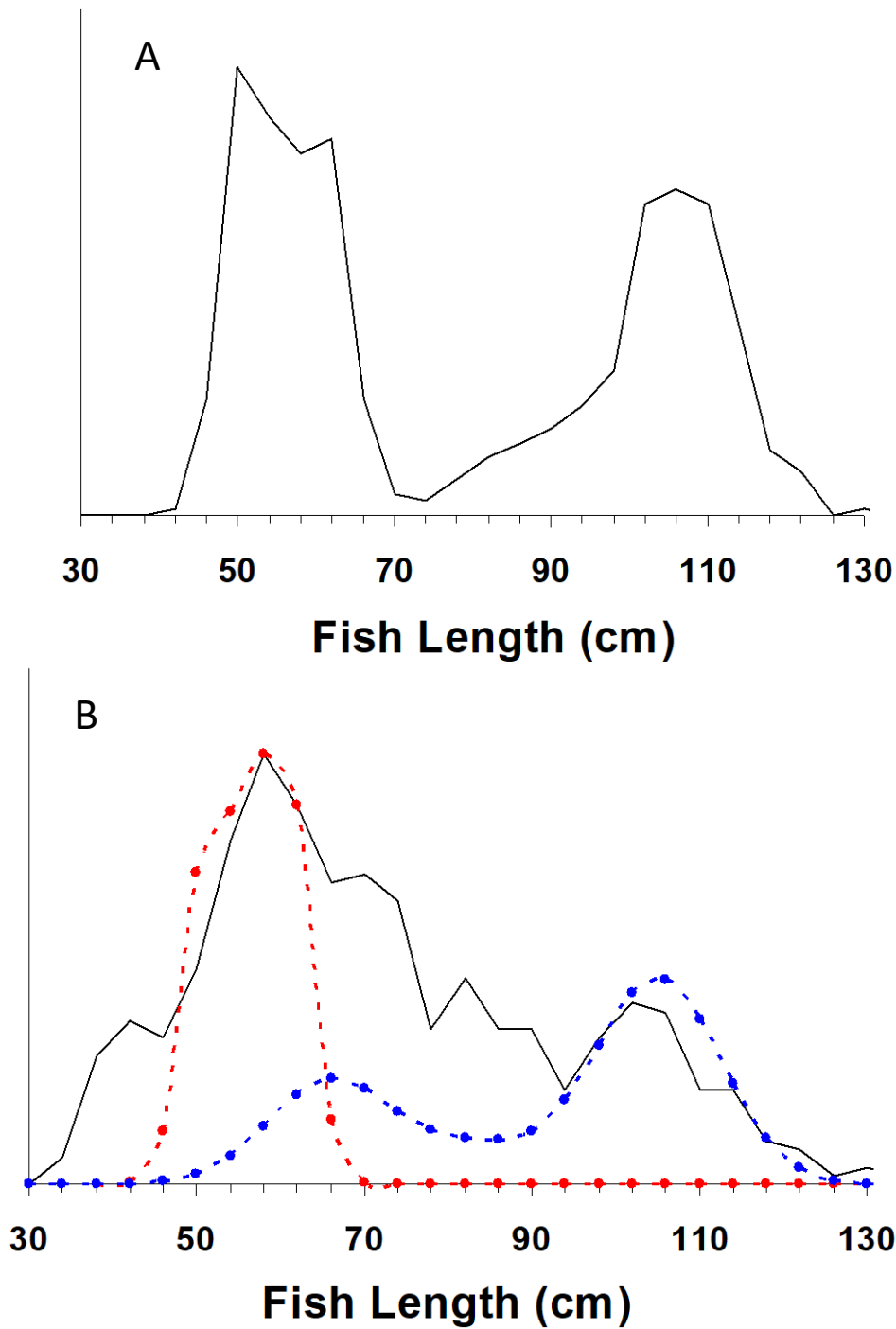

Note: Distributions of sockeye (red dashed line) and Chinook (blue dashed line) salmon true length are shown in Case B. In both cases, the true species composition is 50% sockeye and 50% Chinook salmon.

Appendix D3.–Abridged tethered fish dataset (symbols) used to provide mildly informative prior information on regression parameters to the ARIS length mixture model.
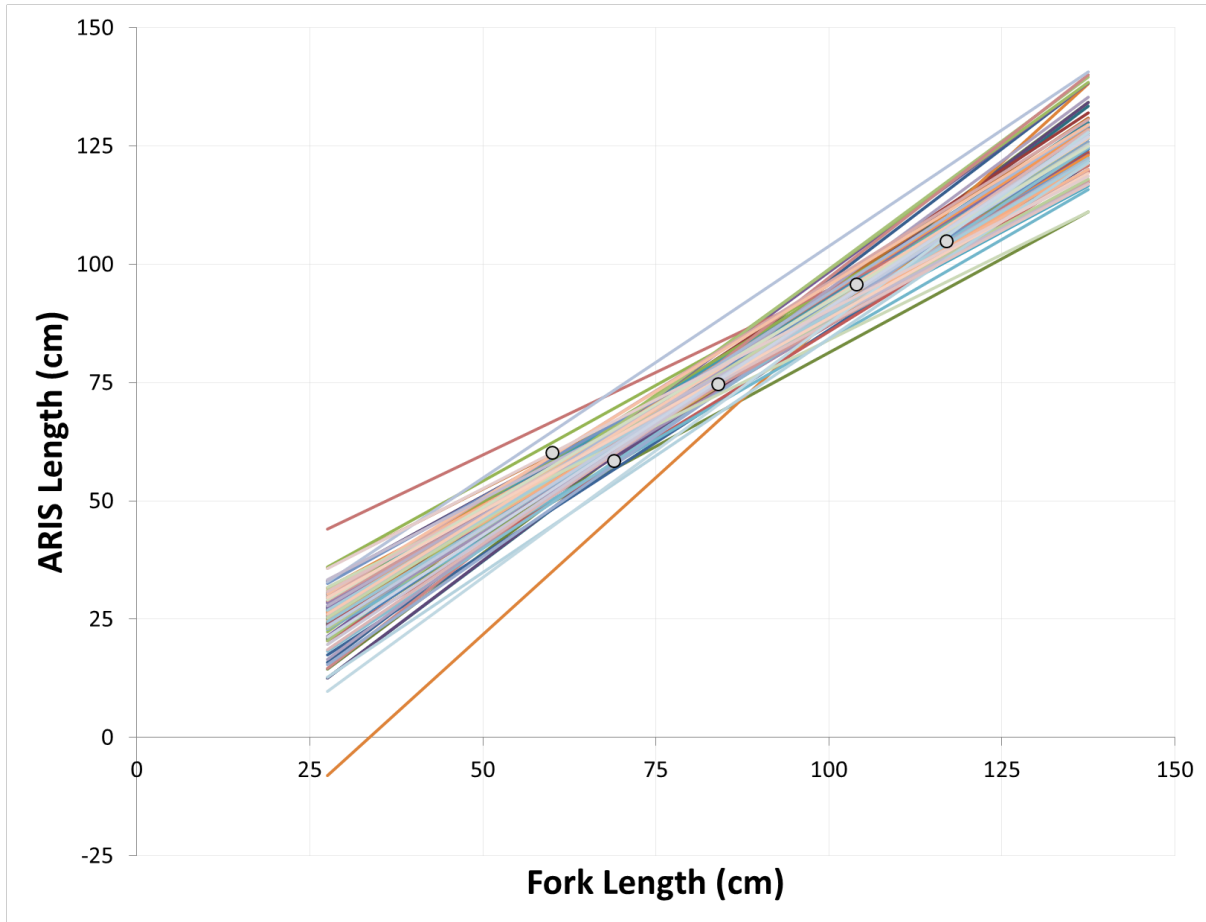
Note: Lines show a sample of 100 plausible linear relationships drawn from the resulting prior distribution.

Appendix D4.–Flow chart of the ARIS length mixture model described in the text.
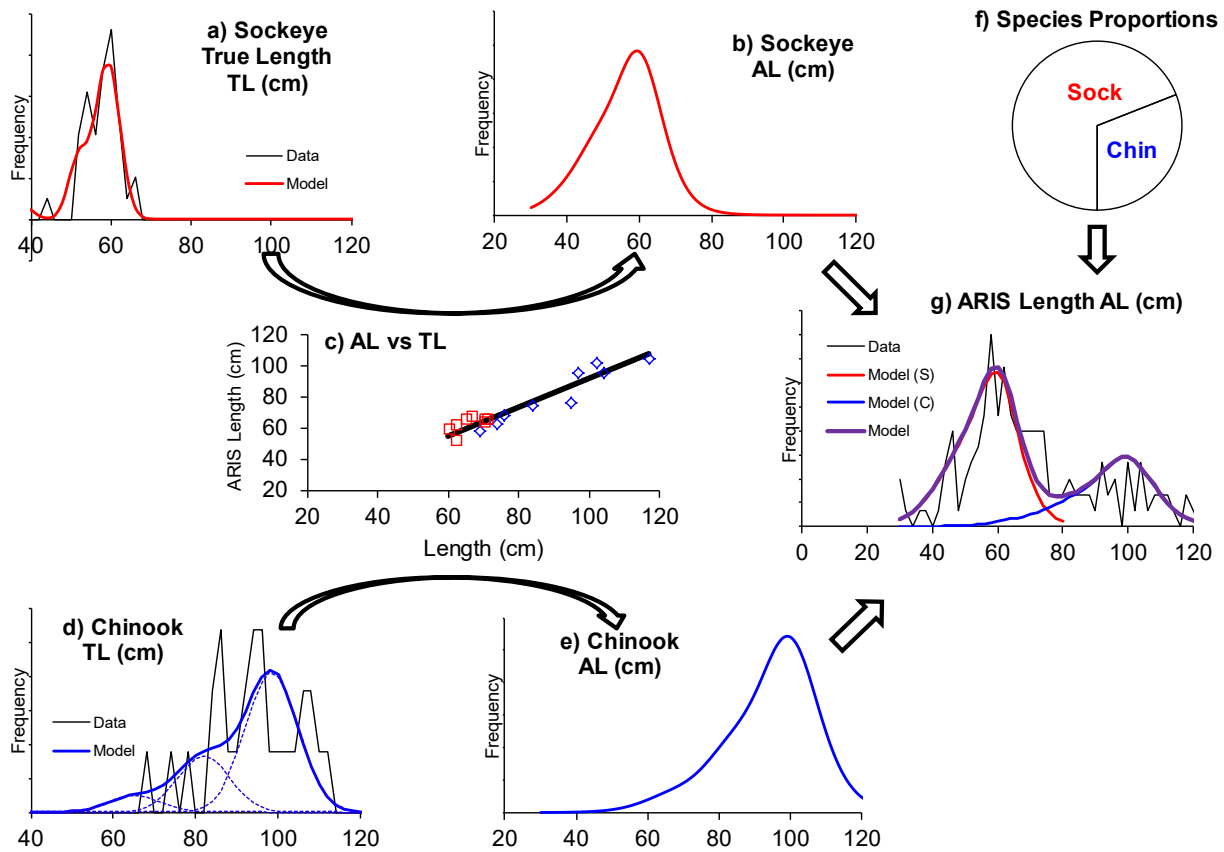
Note: The frequency distribution of ARIS length measurements (panel g) is modeled as a weighted mixture of species-specific distributions (b and e), which in turn are the products of species-specific size distributions (a and d) and the relationship between ARIS measured length and true length (c). The weights (species proportions, panel f) are the parameters of interest.

Appendix D5.–WinBUGS code for mixture model under "standard" and "all large fish" data processing protocols.

```
model{
 beta0 ~ dnorm(75,0.0025)
 beta1 ~ dnorm(1,25)
 sigma.AL ~ dunif(0,20)
 tau.AL  <- 1 / sigma.AL / sigma.AL
 ps[1:2] ~ ddirch(D.species[])
 pa[1,1] ~ dbeta(0.5,0.5)
 theta1 ~ dbeta(0.5,0.5)
 pa[1,2] <- theta1 * (1 - pa[1,1])
 pa[1,3] <- 1 - pa[1,1] - pa[1,2]
 pa[2,1] ~ dbeta(0.5,0.5)
 theta2 ~ dbeta(0.5,0.5)
 pa[2,2] <- theta2 * (1 - pa[2,1])
 pa[2,3] <- 1 - pa[2,1] - pa[2,2]

 n.chin <- ps[1] * n_meas
 p.large <- ps[1] * (1 - pa[1,1] - pa[1,2])
 n.large <- p.large * n_meas

 Lsig[1,1] <- 78
 Lsig[1,2] <- 70
 Lsig[1,3] <- 74
 Lsig[2,1] <- 25
 Lsig[2,2] <- 25
 Lsig[2,3] <- 25
 for (s in 1:2)  {for (a in 1:3)  {Ltau[s,a] <- 1 / Lsig[s,a] / Lsig[s,a] } }
 mu[1,1] ~ dnorm(621,0.0076)
 mu[1,2] ~ dnorm(825,0.0021)
 mu[1,3] ~ dnorm(1020,0.0047)
 mu[2,1] ~ dnorm(380,0.0004)
 mu[2,2] ~ dnorm(500,0.0004)
 mu[2,3] ~ dnorm(580,0.0004)
 for (a in 1:3)  {
   pa.effective[1,a] <- pa[1,a] * q1.a[a] /  inprod(pa[1,],q1.a[])
   pa.effective[2,a] <- pa[2,a]
   }
 for (k in 1:5) {
   TL.cm.75[k] <- TL.cm[k] - 75
   mu.AL1[k] <- beta0 + beta1 * TL.cm.75[k]
   DL1[k] ~ dnorm(mu.AL1[k],tau.AL)
   }
 for (i in 1:n_fish) {
   age[i] ~ dcat(pa.effective[species[i],1:3])
   mefl.mm[i] ~ dnorm(mu[species[i],age[i]],Ltau[species[i],age[i]])
   }
 for (j in 1:n_meas) {
   species2[j] ~ dcat(ps[])
   age2[j] ~ dcat(pa[species2[j],1:3])
   mefl.mm.2[j] ~ dnorm(mu[species2[j],age2[j]],Ltau[species2[j],age2[j]])
   TL2.cm.75[j] <- (1.1*mefl.mm.2[j] + 2) / 10 - 75   # CONVERSION TO TL
   mu.AL2[j] <- beta0 + beta1 * TL2.cm.75[j]
   AL2[j] ~ dnorm(mu.AL2[j],tau.AL)I(40,)
   }
 }
```

Note: Prior distributions are shown in green font, likelihoods in blue.