Regional Operational Plan SF.2A.2014.06

Kenai River Chinook Salmon Sonar Assessment

by

Debby Burwen, Jim Miller, Steve Fleischman, and Jiaqi Huang

June 2014

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

Symbols and Abbreviations

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

Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

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

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

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

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

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

REGIONAL OPERATIONAL PLAN SF.2A.2014.06

KENAI RIVER CHINOOK SALMON SONAR ASSESSMENT

by

Debby Burwen, James Miller, Steve Fleischman, and Jiaqi Huang

Alaska Department of Fish and Game, Sport Fish Division, Anchorage

Alaska Department of Fish and Game
Sport Fish Division
June 2014

Debby Burwen, James Miller, and Steve Fleischman
Alaska Department of Fish and Game, Sport Fish Division,
333 Raspberry Road, Anchorage, AK 99518

This document should be cited as:
Burwen, D. L., Miller, J. A., Fleischman, S. and Huang, J. 2014. Kenai River Chinook Salmon Sonar Assessment. Alaska Department of Fish and Game, Regional Operational Plan ROP.SF2A.2014.06, Anchorage.

SIGNATURE/TITLE PAGE

SIGNATURE/TITLE PAGE

Project Title:	Kenai River Chinook Salmon Sonar Assessment
Project leader(s):	*Debby Burwen, James Miller, Steve Fleischman and Jiaqi Huang*
Division, Region and Area	*Sport Fish Division, Region II, Southcentral*
Project Nomenclature:	
Period Covered	May 1, 2014 – April 30, 2015
Field Dates:	16 May – 10 August, 2014
Plan Type:	Category III

Approval

Title	Name	Date
Project leader	Debby Burwen	5/17/14
Biometrician	Jiaqi Huang	5/17/14
Research Coordinator	James Hasbrouck	6/3/2014
Regional Supervisor	James Hasbrouck	6/3/2014

i

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PURPOSE

Alaska Department of Fish and Game (ADF&G) has monitored Chinook salmon passage in the Kenai River using side-looking sonar technology from 1987 to present. The original acoustic technology, dual-beam sonar (1987-1994) was replaced by split-beam sonar (1995 – 2011), and most recently by DIDSON (2011- present). Starting in 2013, ADF&G will operate two sonar stations, one at the historical site at Kenai River mile 8.6 and a second experimental site at Kenai River mile 13.7.

Keywords: ARIS, DIDSON, Chinook salmon, *Oncorhynchus tshawytscha,* acoustic assessment, Kenai River, riverine sonar, fisheries sonar, multibeam sonar.

BACKGROUND

Fixed-location, side-looking sonar techniques are commonly used to obtain in-season estimates of run strength for anadromous fish stocks in rivers that are too wide and/or deep for installing weir structures or too occluded for visual observations (Daum and Osborne 1998; Enzenhofer et al.1998; Gaudet et al. 1990; Maxwell and Gove 2007). In Alaska, sonar estimates of inriver passage often provide the basis for estimating spawning escapement and for regulating harvests of commercial and sport fishers of important salmon stocks (Westerman and Willette 2006; Miller et al. 2010). Acoustic assessment sites currently exist on at least ten rivers in Alaska. One of the barriers to even wider use of sonar assessment has been the need to estimate the number of spawning salmon separately by species. Apportioning sonar counts by species often requires separate intensive sampling programs such as netting programs (Bromaghin 2005; Carroll and McIntosh 2008) or fish wheel programs (Fair et al. 2009) that are costly to implement and subject to biases that can be difficult to resolve.

From 1987 through 2011 ADF&G used dual beam (1987-1994) and split beam (1995-2011) side-looking sonar technology to estimate Chinook *Oncorhynchus tshawytscha* passage in the Kenai River. These technologies relied on acoustic size (average strength of returning echoes) and range (distance from shore) thresholds to differentiate between sockeye *O. nerka* and Chinook salmon. These criteria were based on the premise that sockeye salmon are smaller and migrate primarily near shore, whereas Chinook salmon are larger and tend to migrate up the middle of the river. However, studies have shown that these criteria can lead to inaccurate estimates (Burwen et al. 1998, Hammarstrom and Hasbrouck 1999). Extensive research has been conducted at the Kenai River Chinook sonar site toward improving our ability to identify species from acoustic data (Burwen and Fleischman 1998; Burwen et al. 2003; Miller et al. 2010). Most recently, ADF&G evaluated the potential for dual-frequency identification sonar (DIDSON) to provide improved discrimination of larger Chinook from smaller species of salmon based on size measurements taken directly from high-resolution images of migrating salmon (Burwen et al. 2007). Based on results of the DIDSON evaluations, and due to the inaccuracy of the split-beam estimates (Miller et al. 2013[1], Miller et al. 2013[2]), production of split-beam estimates was discontinued following the 2011 season, and replaced by DIDSON-based estimates in 2012.

DIDSON is a high-definition imaging sonar designed by the University of Washington's Applied Physics Laboratory for military applications such as harbor surveillance and mine identification. DIDSON incorporates a lens that provides high resolution images approaching the quality achieved with conventional optics (Simmonds and MacLennan 2005), with the added advantage that images can be obtained in dark or turbid water and at farther ranges than is possible with camera technologies. Since 2002, ADF&G has worked closely with Sound Metrics Corporation (SMC) to adapt this technology to estimating fish passage in rivers (Burwen et al. 2007, Burwen et al. 2010). The first DIDSON model (DIDSON SV, Appendix A1) did not meet the minimum range requirements of the Kenai Chinook Sonar project because it was limited in range to approximately 15m for high resolution imaging (Burwen et al. 2007), yet to adequately cover the ranges at which Chinook salmon travel at ADF&G's established sonar site at river mile (RM) 8.6 on the Kenai River, high-resolution images at ranges up to at least 30m are required. In 2007, however, SMC developed a long-range model (DIDSON LR) and a high-resolution lens to extend the range at which high resolution images could be collected. Studies conducted by ADF&G in 2007 assessed the potential for a DIDSON DIDSON-LR fitted with a high resolution (large) lens (DIDSON-LR+HRL) to provide improved image resolution at required ranges. The large lens (also referred to as a telephoto lens) provides almost twice the resolution of the standard lens. These studies concluded that sufficiently accurate estimates of fish length were now possible at ranges up to 22m (Burwen et al. 2010). Additional studies conducted in 2008-2009 with the same hardware, but newer firmware and software, extended that maximum range to 33m (Miller et al. 2012).

With the question of obtaining fish length measurements at longer ranges resolved, efforts in 2008 and 2009 were directed toward developing an efficient process to generate DIDSON-based estimates of Chinook salmon in a timely manner to meet the needs of fishery managers. Each DIDSON-LR system generates approximately 1 GB of video-like data each hour, and efficient ways of transferring, reviewing, and extracting size-related data from such a large volume of data were needed. A DIDSON-LR+HRL was deployed on the left bank of the Kenai River for 7 days in 2008 and 53 days in 2009. During this time, efforts focused on developing and testing software for collecting and processing DIDSON data efficiently. A relatively efficient procedure was developed to manually track and size individual fish. Ways to automate the process of tracking and sizing individual fish were also explored during this time with limited success (Miller et al.2013[1]).

In 2010, DIDSON was deployed on both banks to sample the same 60 m mid-section of river insonified by the split-beam sonar for most of the season (83 days, 17 May – 7 August, Miller et al. 2013[2]). To achieve a sufficiently high image resolution, DIDSON sampled the river in 10 m range increments (i.e. the shorter the range increment the higher the downrange resolution, see Appendix A) by programming it to sequentially sample three 10-m range strata (3-13 m, 13-23 m, 23-33 m) or 30m per bank. Hardware focus problems related to changing range strata rendered substantial portions of 31 days of data unusable for measuring fish size. During the remaining 45 days (15 days early run, 30 days late), image resolution was sufficiently high to generate daily estimates of Chinook salmon passage. Although image resolution was frequently reduced in the far-range (23-33 m) strata, there was little evidence that this seriously impacted the ability to distinguish large from small fish. Comparison of paired DIDSON and split-beam data revealed that DIDSON provided improved estimates of Chinook salmon not only because it provides more accurate estimates of fish length but because it could also interpret complex fish behavior more accurately than the split-beam, distinguish seals and other targets that were incorrectly classified as large Chinook salmon by the split beam sonar, and detect salmon potentially masked by eulachon schools (Miller et al. 2012).

In 2011, DIDSON was again deployed on both banks and sampled the same area covered by the split-beam sonar from May 17 through August 10, 2011 (Miller et al. 2014). Focus issues were resolved and few hardware- or software-related problems were encountered. Quality control procedures for on-site data collection and office-based data processing were developed and refined. Because data from 2010 DIDSON operations indicated that sizeable numbers of Chinook salmon were traveling in the nearshore strata (i.e. 3-13m from each transducer), a third DIDSON was deployed to insonify the region 10m immediately behind the existing left-bank tripod on 20-26 July. Substantial numbers of large fish were detected during this limited deployment.

In 2012, the split-beam sonar was discontinued and DIDSON was used to generate inseason Chinook passage estimates (Miller et al. *in prep*). Escapement goals based on DIDSON-generated estimates of passage were developed (Fleischman and McKinley 2013, McKinley and Fleischman 2013). Additionally, in 2012, crew conducted a two-week evaluation of a new sonar site located above tidal influence where more complete coverage of the river cross-section would be possible. During this evaluation, ADF&G also tested the performance of the newest generation of DIDSON technology referred to as Adaptive Resolution Imaging Sonar (ARIS).

The current site at RM 8.6 was selected primarily because of its suitability for operating a dual-beam (and subsequently a split-beam) sonar system, which requires a near-perfect linear bottom profile over the entire insonified zone or, in this case, from the near shore region to the thalweg. However this site has many disadvantages primarily related to its location within tidal influence such as: 1) incomplete coverage of the river due to tidal activity flooding the region behind the transducers, 2) milling fish behavior related to tidal flux, 3) physical risk to gear by large debris carried by extreme tidal fluxes, and lack of legal access to the property on one bank**.** Relocating the site farther upriver could improve ADF&G's ability to more accurately estimate king salmon passage by minimizing or eliminating these negative factors. In 1999, ADF&G searched for and subsequently evaluated a second sonar site at RM 13.2 for using split-beam sonar to assess fish passage; but the bottom topography was less acoustically favorable and the fish were more difficult to detect due to increased background noise levels from bottom irregularities and boat traffic (Burwen et al. 2000). Because there were no other sites identified, the idea of moving the site was abandoned.

The transition to DIDSON\ARIS multibeam technology has reopened the option of moving the sonar program above tidal influence because the multibeam technology is better able to insonify the near-bottom region despite irregularities in the river-bottom profile. During 2012, a prospective site at RM 13.7 was identified (

Figure 1) and in 2013 ADF&G operated a full-scale project at this site from May 17 – August 17, 2013. In 2014, ADF&G will again run both the historical site at RM 8.6 and the second site at RM 13.7. One of the main advantages of the RM 13.7 site is the potential to achieve bank-to-bank coverage of the river with sonar, which is not possible at the RM-8.6 site. Like the sonar project at RM 8.6, the sonar project at RM 13.7 is scheduled to operate from approximately May 16-August 10, 2014. However, because the project is still considered experimental, inseason estimates may not be produced in 2014.

I. OPERATIONS AT RIVER MILE 8.6 (RM 9)

RM-9 OBJECTIVES

This portion of the study will provide real-time estimates of the number of Chinook salmon passing RM 8.6 to fishery managers during the 2014 fishing season. Specifically:

> Estimate weekly and seasonal (early- and late-run) midriver[1] upstream passage of Chinook salmon at RM 8.6 of the Kenai River such that the seasonal estimate is within 10% of the true value 95% of the time. This estimate will be based on fitting a mixture model to DIDSON fish length measurements.

Daily estimates of upstream passage of fish greater than 75 cm will also be produced based on manual DIDSON length measurements.

In addition, a daily "net-apportioned" estimate of Chinook salmon abundance will be produced based on paired netting and DIDSON data.

Daily estimates of fish passage will be produced for 16 May to 10 August. If daily estimates comprise less than 1% of cumulative passage for three consecutive days, operations may be suspended before 10 August.

During years of high pink salmon abundance (generally even years) milling pink salmon may interfere with generating a daily estimate of all Chinook salmon, and it may only be possible to generate estimates of actively migrating Chinook salmon > 75 cm.

RM-9 STUDY DESIGN

SITE DESCRIPTION

This portion of the study will be conducted at the existing Kenai River Chinook sonar site, an established acoustic monitoring site for Chinook salmon located 14 km (8.6 mi) from the mouth of the Kenai River and operated by Alaska Department of Fish and Game (ADF&G,

Figure 1). The river is approximately 125 m wide at the site, with water depth at mid-channel varying from 3 to 8 m due to the strong tidal influence. The Kenai River is glacially fed and is generally cool and highly turbid. Water temperatures during the summer range from 10°C to 15°C and Secchi disk readings from 0.3 to 1.1 m. The bottom substrate on the right bank is comprised of fine glacial mud and on the left bank the substrate is fine gravel with larger cobble. The slope from either bank to the thalweg (approximately 3° on right bank and 5.5° on left bank) is gradual and uniform.

ACOUSTIC SAMPLING

A Sound Metrics Corporation (SMC[2]) DIDSON system will be operated from 16 May to 10 August 2014. Components of the DIDSON system at RM 8.6 are listed in Table 1. The theory behind DIDSON multibeam technology is summarized in Appendix A along with a discussion of the features of the DIDSON models used in this study

---

[1] Between, and greater than 3 m in range from, both transducers.

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

Table 1.-Components of the DIDSON sonar system to be used at RM 8.6 in 2014.

System Component	Description
Sounder	DIDSON-LR operating at 1.2 MHz (right and left banks)
Lens	Large Lens Assembly with ~3^{o}x15^{o} beam pattern (right and left banks)
Data Collection Computer	Dell Latitude E6500 laptop computer (one for each bank)
Wireless Bridge	For wireless transmission of DIDSON data from left to right bank. Model SMC XMC2891-AG
Remote Pan and Tilt Aiming Unit	Right Bank: ROS Model PT25 Pan and Tilt Left Bank: SMC Model X2 Rotator
Remote Pan and Tilt Aiming Controller	Right Bank: ROS Model PTC-1 Remote Pan and Tilt Controller Left Bank: Controlled through SMC DIDSON software
Remote Depth Sensor	Right Bank: JASCO Model AIM-2000 remote attitude sensor

Sonar System Configuration and River Coverage

At the rm 8.6 site, a single DIDSON transducer will be deployed on each bank of the river, such that it remains submerged at low tide (Figure 2). As discharge and water levels rise during the summer, tripods may periodically be moved up the river bank.

DIDSON operates at two frequencies: a higher frequency that produces higher resolution images, and a lower frequency that can detect targets at further ranges but at a reduced image resolution. Two DIDSON models are currently available based on different operating frequencies. For this study, because we require high resolution images to at least 30m, we selected the long-range DIDSON model (DIDSON-LR) that can operate at high frequency at further ranges (up to 30m) than the standard model (up to 15m). The DIDSON-LRs are equipped with an ultra-high resolution lens to further improve image resolution. A detailed discussion of available DIDSON configurations and DIDSON image resolution and a brief explanation of multibeam sonar can be found in Appendix A. More detailed theory can be found in Belcher et al. (2002).

Electronics will be housed in a tent located on the right (north) bank of the river (Figure 2). The DIDSONs will be mounted on remote pan and tilt systems (a Remote Ocean Systems PT-25 on the right bank, and a Sound Metrics Corporation X2 on the left bank) for precise aiming in the horizontal and vertical axes. The combined sonar and rotators will be deployed in the river on a tripod-style mount (Figure 3). In the horizontal plane, the sonars 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 sonars will be aimed to insonify the near-bottom region (Figure 2). Internal attitude sensors in the DIDSON will provide measurements of compass heading, pitch, and roll. An AIM 2000 attitude sensor attached to the right bank mount will provide depth measurements throughout the season.

Communication cables from the right bank DIDSON will feed directly into the right bank topside box and data collection computer. On the left bank, the DIDSON communication cable will feed to a topside box staged on top of the bluff and data will be transmitted via a wireless bridge to a data collection computer on the right bank (Figure 4).

Sampling Procedure

Transducers deployed on each bank will operate simultaneously, switching between spatial (range, i.e., distance from transducer) strata in 10-minute increments using the schedule in Figure 5. The 4 range strata are: 3.3-8.3, 8.3-13.3, 13.3-23.3, and 23.3-33.3 meters from the transducer. The 13-23m and 23-33m strata will be sampled twice hourly, however, in general, only the data from the first of the 2 periods will be processed. Data from the redundant samples will be archived and processed only in the event that the first sample is not usable.

Data Collection Parameters

The transmit power of the DIDSON sonar is fixed, and receiver gain will be maximized (40 dB) during all data collection. The autofocus feature will be enabled so that the sonar automatically sets the lens focus to the midrange of the selected display window (e.g., for a window length of 10 m that started at 15 m, the focus range would be 20 m). The frame rate (frame per second, or fps) varies for each range stratum, decreasing with range to accommodate the increased return time: 9 fps for the 3.3–8.3 m and 8.3-13.3 m stratum, 7 fps for the 13.3–23.3 m stratum, and 5 fps for the 23.3–33.3 m stratum.

DATA STORAGE AND MANAGEMENT

On-site Data Storage and Management

The process of transferring, analyzing, summarizing, and archiving 30 Gigabytes of DIDSON data generated each day is facilitated by a number of batch files. The names and functions of each batch file are listed in Appendix Table B2-1.

Individual files for each 10-minute sample will vary in size due to the different ping rates for each range strata.[3] File sizes will vary from a maximum of approximately 115,000 KB for the near range strata (3-7m and 7-13m; 9 pings/sec) to approximately 101,000 KB for the mid-range stratum (13-23m, 7 pings/sec), and to approximately 78,000 KB for the offshore stratum (23-33m; 5 pings/sec). At these data collections rates and ranges, approximately 1.2 GB/hour (both banks) or 30 GB per day (worst case) will be generated. Since the season is about 87 days long up to 3.4 TB of data may be generated.

Data from each sample will be stored to a uniquely named file. Filenames are automatically generated by the DIDSON software using year, month, day, military time, and frequency (high or low). For example, a file that started data collection using high frequency on June 1, 2014 at 3:40 AM will be automatically named: 2014-06-01_034000_HF.ddf.

One laptop will be dedicated to collecting data from each bank. To ensure correct time stamps in the filenames, laptop clocks will be synchronized using GlobalSat BU-353 Waterproof USB GPS receivers. Data will initially be collected by the host computer hard drive and subsequently transferred to two 4 TB external hard drives (two redundant copies) for permanent archiving at the site (

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

, Figure 7). Data will also be downloaded to two 32 GB USB 3.0 keys (one for each bank) for transfer to the Soldotna office. Filenames are changed via batch file to append a letter indicated Right or Left bank prior to being stored or transferred to eliminate the potential for overwriting files with the same name (i.e. have same time and date stamp) during archiving at the Soldotna office. Data collection computers will be networked with a "main computer" where data can be reviewed and processed on site.

Office data management and archiving

Data will be transferred to the Soldotna office each morning on the two 32 GB USB 3.0 keys (one for each bank). In the Soldotna office data will then be uploaded to a Network Attached

Storage Device (e.g. Buffalo TeraStation, Figure 8,

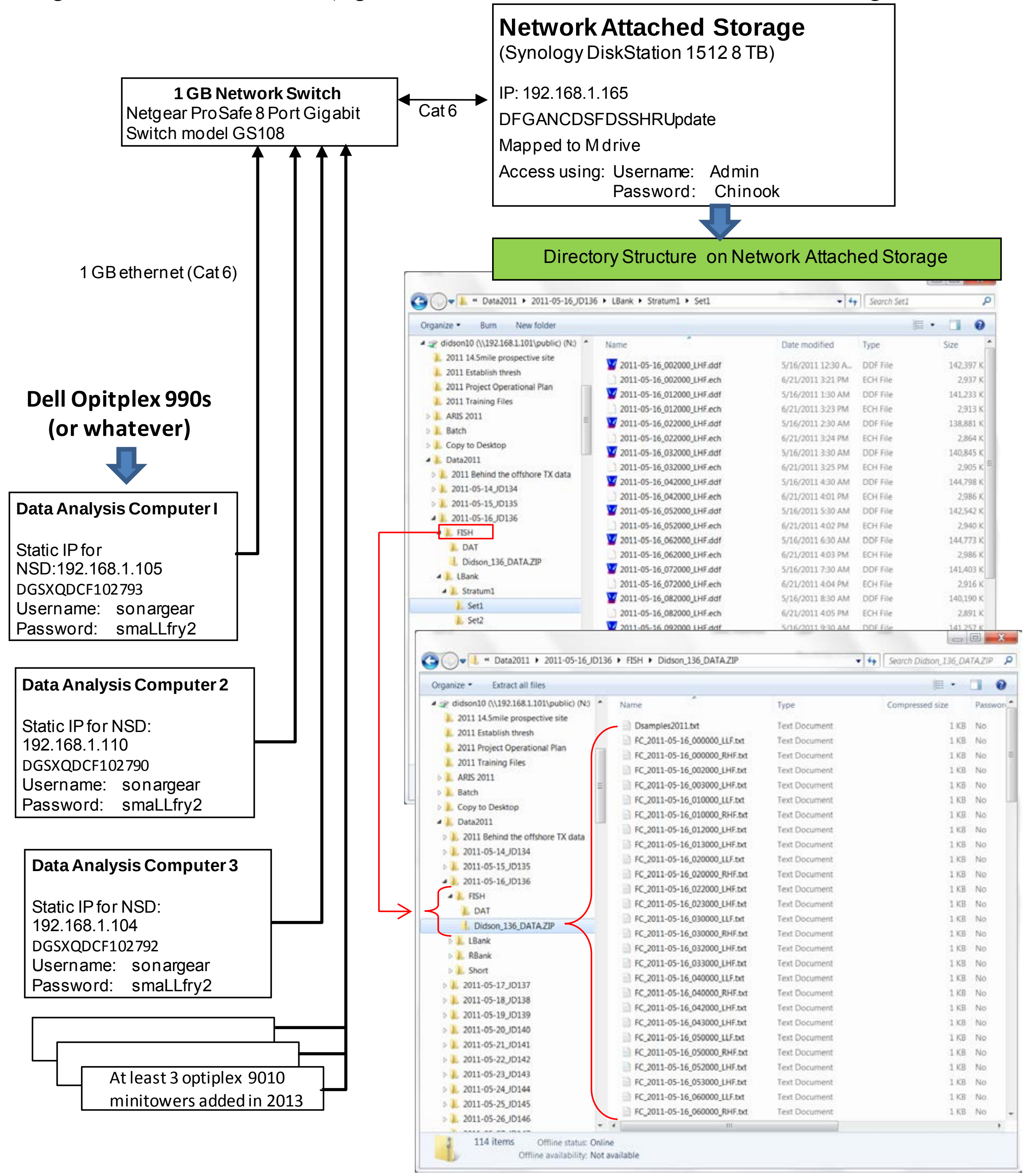


Figure 9) where it can be shared with up to 7 users through a 1 GB Ethernet network (i.e. through an 8 port 1 GB Ethernet switch and 1 GB Ethernet cards in each computer).

Manual DIDSON Fish Length Measurements

Software included with the DIDSON system (Control and Display software Version 5.25) will be used to count and measure fish from DIDSON images. Detailed instructions for taking manual measurements using DIDSON's Control and Display graphical software utilities are given in Appendix C.

Direction of travel is determined for an individual fish by observation of sufficient frames to classify it as an upstream or downstream migrant. Date, time, range, direction-of-travel, and length (cm) will be recorded by fish. Details regarding which fish to measure and whether or not to record direction of travel differ depending upon rate of fish passage, level of staffing, time constraints related to fishery management, and fish behavior. On a given day, depending on the above factors, one of 3 sampling protocols (described below and summarized in Table 2) will guide processing and analysis of RM-8.6 data.

Standard (STD) Sampling Protocol

Under standard sampling protocol at RM 8.6:

1. Length will be measured for all salmon-shaped[4] fish greater than 40 cm (DL)
2. Direction of travel will be recorded for each measured fish.

Fast Track (FT) Sampling Protocol

During the peak of the sockeye salmon run, generally mid-to-late July, it can become too time-consuming to measure each individual fish, given staffing and time constraints associated with generating daily estimates. Additionally, during periods of peak passage, fish often swim in large tightly-compacted groups and measurements cannot be uniquely associated with specific fish (

Figure 10). Under these circumstances at RM 8.6, the following "Fast-Track" sampling protocol will be practiced:

1. Length will be measured for all salmon-shaped fish greater than 75 cm DL.
2. Length will also be measured for a subset of salmon-shaped fish 40 cm < DL < 75 cm. Either the first *F* fish, or fish passing during the first *M* minutes of the sampled period will be measured. *F* (or *M*) will depend on daily staff time constraints.
3. The remaining fish 40 < DL < 75 will be marked (tallied) but not measured. To mark fish, staff will watch a short section of the DIDSON movie associated with the chart, count the number of fish in a group, and then make the counted number of marks on the chart. Medium-size fish unintentionally chosen for measurement that turn out to be less than 75 cm will be counted and length will *not* be recorded.
4. Direction of travel will be recorded *only* for salmon-shaped fish greater than 75 cm DL, *not* for fish 40 cm < DL < 75 cm.

Large Fish Only (LFO) Sampling Protocol

Occasionally milling or holding behavior can make it difficult to reliably assess the direction of travel for many fish. This is more likely to happen during even-numbered years when pink salmon are most abundant. In 2010 and 2012, staff were able to easily discern larger Chinook salmon swimming directly through the smaller holding or milling salmon (**Figure 11**). Under these conditions, fish larger than 75 cm will be measured and shorter fish will be ignored. The "Large Fish Only" (LFO) sampling protocol is as follows.

---

[4] Flatfish, seals, and beluga whales will not be recorded, and fish measured less than 40 cm will be omitted from further calculations.

1. Length will be measured for all salmon-shaped[5] fish greater than 75 cm DL.
2. Direction of travel will also be recorded for measured fish.
3. Remaining fish will not be recorded in any way, due to the difficulty in ascertaining direction of travel. Medium-size fish unintentionally chosen for measurement that turn out to be less than 75 cm will *not* be recorded.

Table 2.- Sampling protocols to be applied in 2014.

	Sampling Protocol		
	Standard STD	Fast Track FT	Large Fish Only LFO
Length Measurements (DL)	Measure all salmon-shaped fish DL>40cm	Measure all salmon-shaped fish DL>75cm Measure a *sample* of fish 40cm<DL<75cm Count remaining fish 40cm<DL<75cm Delete incidental DL<75cm	Measure all salmon-shaped fish DL>75cm
Direction of Travel (DoT)	All salmon-shaped fish DL>40cm	Record DoT for all fish DL>75cm Do *not* record DoT for fish DL<75cm	Record DoT for all fish DL>75cm
Salmon Upstream Estimate y	y Eqs 1-4 Up DL>40cm	y_{FT} Up (DL>75cm) + Up/Dn (40cm<DL<75cm) Biased slightly high	Not possible
Chinook Upstream Estimate z	$z = y\ \pi_C$ Mixture model on Up DL>40cm	$z = y_{FT}\ \pi_{FT}$ Mixture model Up (DL>75cm) / Y_{FT} Unbiased	By reconstruction only
Large Fish Upstream Estimate x	x Eqs 1-4 Up DL>75cm	x Eqs 1-4 Up DL>75cm	x Eqs 1-4 Up DL>75cm
Net Apportioned Upstream Estimate w	$w = y\ \pi_{NET}$ Eqs 5-6	$w_{FT} = y_{FT}\ \pi_{NET}$ Biased slightly high	Not possible

[5] Flatfish, seals, and beluga whales will not be recorded.

RM-9 DATA ANALYSIS

Under the standard sampling protocol (above; also Table 2) abundance estimates will be produced as follows.

RM-9 MIDRIVER SALMON PASSAGE ESTIMATES

The number of salmon *y* of all species, exceeding DL=40 cm, during day *i* that migrate upstream at RM-8.6 in mid-river at least 3 m from the face of each transducer will be estimated as:

$$\hat{y}_i = \sum_{j}^{24} \hat{y}_{ij} \tag{1}$$

where:

$$\hat{y}_{ij} = \sum_{s}^{8} \hat{y}_{sij}\ , \tag{2}$$

and $\hat{y}_{sij}$ is the estimate of passage in stratum *s* during hour *j* of day *i*, as follows:

$$\hat{y}_{sij} = \frac{60}{t_{sij}} c_{sij} \tag{3}$$

where

c_{sij} = number of upstream-bound fish greater than 40 cm in stratum *s* for hour *j* of day *i,*

t_{sij} = number of minutes (usually 10) sampled in stratum *s* during hour *j* of day *i*.

The sampling variance of the fish passage estimates on day *i*, due to systematic sampling in time, will be approximated (successive difference model, Wolter 1985), with adjustments for missing data, as:

$$\hat{V}[\hat{y}_i] \cong 24^2(1-f_i)\frac{\sum_{j=2}^{24}\phi_{ij}\phi_{i(j-1)}\left(\hat{y}_{ij}-\hat{y}_{i(j-1)}\right)^2}{2\sum_{j=1}^{24}\phi_{ij}\sum_{j=2}^{24}\phi_{ij}\phi_{i(j-1)}} \tag{4}$$

where f_i is the sampling fraction (proportion of time sampled daily, often 0.17), and ϕ_{ij} is 1 if $\hat{y}_{ij}$ exists for hour *j* of day *i*, or 0 if not.

RM-9 MIDRIVER CHINOOK SALMON PASSAGE ESTIMATES

The estimate of Chinook salmon abundance on day *i* will be calculated by multiplying the fish passage estimate by the estimated proportion of Chinook salmon ($\hat{\pi}_{Csi}$), derived by fitting a DIDSON length mixture model to *upstream* DIDSON and netting data as described in Appendix D.

$$\hat{z}_i = \hat{y}_i\hat{\pi}_{Ci} \tag{5}$$

The variance estimate follows Goodman (1960):

$$\hat{\text{var}}(\hat{z}_i) = \hat{y}_i^2\ \hat{\text{var}}(\hat{\pi}_{Ci}) + \hat{\pi}_{Ci}^2\ \hat{\text{var}}(\hat{y}_i) - \hat{\text{var}}(\hat{\pi}_{Ci})\hat{\text{var}}(\hat{y}_i) \tag{6}$$

The cumulative estimate of midriver Chinook salmon abundance, and its variance, is the sum across days:

$$\hat{Z} = \sum_i \hat{z}_i \tag{7}$$

$$\hat{\text{var}}\left[\hat{Z}\right] = \sum_i \hat{\text{var}}\left[\hat{z}_i\right]. \tag{8}$$

RM-9 Midriver Large Fish Passage Estimates

The daily estimate x_i of large fish passing RM 8.6 in mid-river will be obtained with equations 1-4 after substituting c'_{sij} for c_{sij}, where

c'_{sij} = number of upstream-bound fish greater than 3 m from the right- and left-bank transducers exceeding 75 cm in length as measured by the DIDSON during t_{sij}.

Net-Apportioned RM-9 Midriver Chinook Salmon Passage Estimates

The "net-apportioned" daily estimate of midriver Chinook salmon abundance will be calculated by multiplying the RM-9 midriver salmon passage estimate by a netting-derived estimate of the proportion of Chinook salmon ($\hat{\pi}_{NETi}$; Perschbacher 2012).

$$\hat{w}_i = \hat{y}_i \hat{\pi}_{NETi} \tag{9}$$

The variance estimate follows Goodman (1960):

$$\hat{\text{var}}(\hat{w}_i) = \hat{y}_i^2 \ \hat{\text{var}}(\hat{\pi}_{NETi}) + \hat{\pi}_{NETi}^2 \ \hat{\text{var}}(\hat{y}_i) - \hat{\text{var}}(\hat{\pi}_{NETi}) \hat{\text{var}}(\hat{y}_i) \tag{10}$$

MODIFICATIONS UNDER FT PROTOCOL

Under the Fast-Track protocol, length measurements will be available for all fish greater than 75 cm DL and a subset of fish 40<DL<75. Direction of travel will be available only for fish greater than 75 cm DL. These constraints will require the following modifications to the abundance estimators.

Daily passage y_{FTi} will be defined as the number of salmon-shaped fish > 40 cm DL, *except* downstream fish > 75 cm DL. It will be estimated as specified in equations 1-4, except that

c_{sij} = number of salmon-shaped fish > 40 cm DL, except for downstream fish > 75 cm DL, in stratum *s* for hour *j* and day *i.*

The DL mixture model, modified to accommodate censored lengths from small fish (Appendix D3), will be fit to the same subset of the data described above.

The daily proportion π_{FTi} of these fish that are upstream Chinook salmon (output from DL mixture model) will be multiplied by the estimate of y_{FT} above to estimate z_i, number of Chinook salmon migrating upstream in the midriver corridor (Equations 5 and 6).

Because direction of travel information is not available for fish 40 < DL < 75, it will not be possible to estimate y_i, daily upstream passage of DL > 40 cm, salmon-shaped fish. Quantity y_{FT} can be substituted to produce the net apportioned estimate, however it will be biased high by an unknown small amount because it includes some downstream fish 40 < DL < 75.

MODIFICATIONS UNDER LFO PROTOCOL

Under the Large-Fish-Only protocol, only those fish greater than 75 cm DL will be counted and measured. This constraint will require the following modifications to the abundance estimators.

Because small fish are not counted, it will not be possible to directly estimate y_i, daily passage of upstream, DL > 40 cm, salmon-shaped fish, nor the net apportioned estimate, of which y_i is a component.

Daily upstream passage x_i of salmon-shaped fish > 75 cm DL will be estimated as specified in equations 1-4.

The daily abundance model, described below, may be used postseason to obtain an approximate reconstruction of upstream midriver Chinook salmon passage z_i, as needed.

IMPUTATION OF MISSING DATA

In the event that DIDSON is functional for one set of spatial strata but not others, it may be necessary to estimate the passage on the non-functional set *s'* from passage on the functional set *s* with a ratio estimator:

$$\hat{y}_{s'ij} = \hat{R}_{ist}\hat{y}_{sij}, \tag{11}$$

where the estimated bank-to-bank ratio R_{ist}, for day i and tide stage t is calculated by pooling counts from all hours during the previous 2 or more days (to ensure adequate sample size) with tide stage t:

$$\hat{R}_{ist} = \frac{\sum_{j \in J_t} \hat{y}_{s'(i-2)j} + \sum_{j \in J_t} \hat{y}_{s'(i-1)j}}{\sum_{j \in J_t} \hat{y}_{s(i-2)j} + \sum_{j \in J_t} \hat{y}_{s(i-1)j}} \tag{12}$$

DAILY ABUNDANCE MODEL

Postseason, daily upstream midriver Chinook salmon passage z_i will be reconstructed as needed, using the relationship of existing daily Chinook salmon abundance estimates z_i to daily large fish abundance estimates x_i, and of z_i to daily catch rates of Chinook salmon in the inriver netting project r_i. Under this model, each index (x_i and r_i , generically denoted I_{xi}) comprises an independent measure of the relative abundance of Chinook salmon on day i:

$$I_{xi} = q_x z_i \tag{13}$$

where q_x is the mean ratio of index I_{xi} to true mid-river abundance z_i. To allow for a non-stationary relationship between each index and true abundance, an AR(1) error term will be specified.

$$\ln(I_{xi}) = \ln(q_x z_i) + \phi_x \nu_{x,i-1} + \varepsilon_{xi} \tag{14}$$

where ϕ_x is the AR(1) coefficient, the $\{\nu_{xi}\}$ are model residuals

$$\nu_{xi} = \ln(I_{xi}) - \ln(q_x z_i), \tag{15}$$

and the $\{\varepsilon_{xi}\}$ are independently and normally distributed process errors with "white noise" variance σ^2_x. Parameters q_x, ϕ_x, and σ^2_x will be estimated from the data. WinBUGS code for the daily abundance model is in Appendix D4.

II. OPERATIONS AT RIVER MILE 13.7 (RM 14)

RM-14 OBJECTIVES

This portion of the study involves deploying imaging sonar and estimating fish passage at a site above tidal influence at RM 13.7. Unlike operations at RM 8.6, where Chinook salmon passage estimates are generated solely for the midsection of river, this project seeks to provide estimates for virtually the entire river cross-section. The primary objective is as follows:

> Estimate weekly and seasonal (early- and late-run) upstream passage of fish greater than 75 cm at RM 13.7 of the Kenai River such that the seasonal estimate is within 10% of the true value 95% of the time. This estimate will be based on manual ARIS length measurements.

An additional objective will be:

> Estimate seasonal (early- and late-run) upstream passage of Chinook salmon at RM 13.7 of the Kenai River such that the estimate is within 10% of the true value 95% of the time. This estimate will be based on fitting a mixture model to ARIS fish-length measurements, and will be produced post-season.

Attainment of this objective will be conditional upon the availability of netting data that are deemed representative of the entire cross section of the river (Perschbacher or Eskelin plan, In prep).Because many operational details remain to be worked out at this site, any inseason estimates will be preliminary, internal quantities only, and they may not be available until many days or weeks after data collection.

RM-14 STUDY DESIGN

SITE DESCRIPTION

This study will be conducted at RM 13.7 on the Kenai River (

Figure **1Error! Reference source not found.**). This location was identified during surveys conducted in 2012 and was selected for 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. Bathymetric surveys conducted by Aquacoustics, Inc. on July 9, 2012 showed that the section of river at RM 13.7 has a nearly ideal bottom profile for sonar deployment (Figure 12,

Figure **13**). Land use permits are obtained from the Department of Natural Resources Division of Parks and Outdoor Recreation. Appendix G presents a more detailed description of the site RM 13.7 along with details and diagrams required for annual permit applications.

ACOUSTIC SAMPLING

At the rm 13.7 site, Adaptive Resolution Imaging Sonar (ARIS) technology, developed by the manufacturers of DIDSON, will be used. Components of the ARIS system are listed in Table 3. The theory behind ARIS multibeam technology is similar to that of the DIDSON and is summarized in Appendix A along with a discussion of the features of the ARIS models used in this study.

Table 3.- ARIS system components to be used in 2014.

System Component	Description
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 ~12°x30° beam pattern (4) High resolution lens for ARIS 1200 models with ~4°x15° beam pattern
Data Collection Computer	(5) Dell Latitude E6430 laptop computers (one 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

Sonar System Configuration and River Coverage

Unlike the RM 8.6 site where only the mid-section of the river will be insonified, almost complete sonar coverage of the river cross section at the RM 13.7 site is possible. A total of five sonars are required to provide coverage, a nearshore and offshore sonar on each bank of the mainstem and one sonar on the right-bank minor or side-channel (**Error! Reference source not found.**). During the early part of the season when the water level is low (approximately mid-May to mid-June), one sonar on each bank is sufficient to insonify most of the main-stem river cross-section (approximately 60-70m at low water). But later in the season, as water levels rise and the mainstem river increases to up to 90m in width, a second sonar will be deployed on each bank to insonify the nearshore zone and the first 5-10 m in front of the offshore sonars (

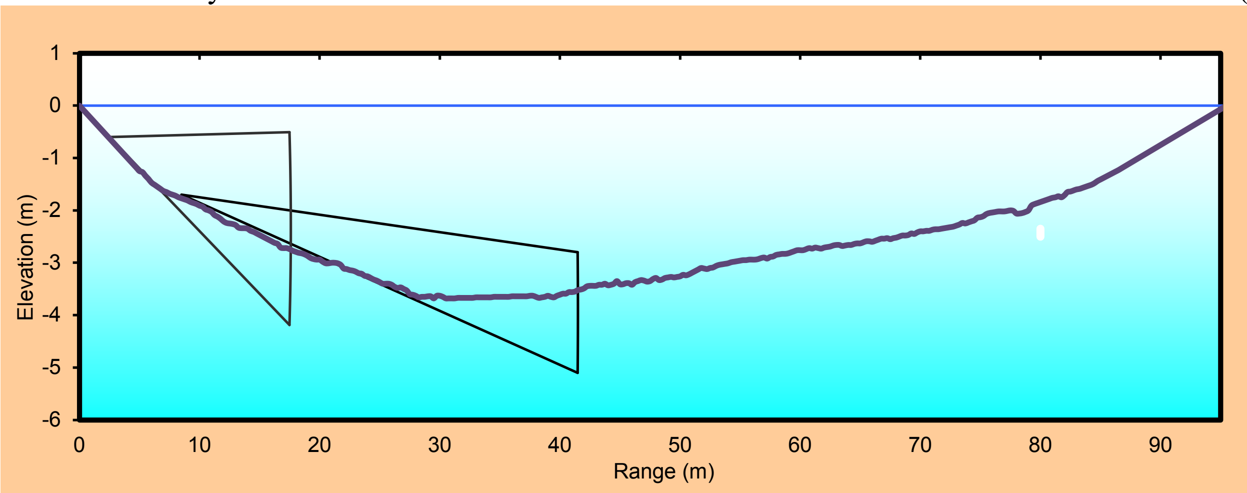


Figure **15**,

Figure **16**). 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, Appendix A). The side-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 (Figure 17).

Two different ARIS models will be used to provide optimal coverage of the mainstem cross-section (Figure 15, Figure 16, Appendix A). ARIS 1200 models with high-resolution lenses will be used as the offshore sonars because they have the longer range capabilities (up to ~33 m) needed to insonify the majority of the mainstem river at lower water levels and the offshore region of the mainstem during higher water levels. An ARIS model 1200 with a high-resolution lens will also be used on the minor channel due to the longer (~25m) range requirements. In 2013 we determined that an ARIS 1200 with a high-resolution lens was also required to insonify the right-bank nearshore area due to the longer range covered by the nearshore sonar on this bank (Figure 18). 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 ~ 8m from the bank at ordinary high water allowing it to cover the area behind the offshore sonar as well as the first ~5 m in front of the offshore sonar (Figure 18). 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 (Appendix Figure A1-3). Additionally, the wider beam dimensions of the ARIS 1800 without the HRL (14^ox28^o versus 4^ox15^o) 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. The ARIS units will be mounted on SMC AR2 pan-and-tilt units for remote aiming in the horizontal and vertical axes. Similar to DIDSON deployment at RM 8.6, the offshore sonar and rotator units will be deployed in the river using a tripod-style mount because they can be deployed from a boat at higher water levels (Figure 3). The nearshore and channel sonars may be deployed on an "H" or "goal post" mount as shown in Figure 3. 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 15). 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 **19**). On the right bank, data from the three ARIS systems will be transmitted via three wireless bridges to three data collection computers on the left bank (Figure **19**, Figure **20**, Appendix I).

Sampling Procedure

Similar to the RM 8.6 site, 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. Like DIDSON, 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 further from shore are sampled). Because there are five sonars with overlapping ranges by the near- and offshore-sonars, this is a more complex process at the RM 13.7 site. During the 2013 season, a sampling scheme was developed that with minor changes should work during the 2014 season. Table 4 lists the schedule and parameters used in sampling the 13 individual range strata on July 19, 2013. By July 19, water levels were more or less stable and no further changes were made to any parameters or to the positions of the sonars through the end of the season on August 17. Figure 21 also shows example images for each of the 9 range strata insonified by the mainstem sonars. Table 5 summarizes the changes in sonar parameters throughout the season as the water level rose and aims were refined. We anticipate following a similar schedule in 2014 with one exception, the first stratum of the right-bank offshore sonar, which covered the range from 3.6-8.6 m in 2013 (Figure 21), will be eliminated and that area will be covered instead by the second stratum of the right-bank nearshore sonar because it will provide better coverage (wider beam) and increase data-processing efficiency by eliminating one strata (Figure 18).

Table 4.-Sampling schedule and parameter settings on July 19, 2013 for each range stratum sampled by five sonars at RM 13.7.

Sonar Location	ARIS Serial #	Range Stratum	Time	Frame Rate	Start Range	End Range	Freq	Tx Power	Pulse Length	Start Delay	Sample Period	Samples/ Beam	Pitch	Heading
Left Near	1096	1	00 / 30	7.0	2.11	15.1	High	Max	20	2930	9	2000	-6.8	45
Left Far	1064	1	00 / 30	7.0	3.57	8.57	High	Max	8	4980	5	1394	-10	60
		2	10 / 40	7.0	8.6	24.38	High	Max	24	11953	11	1992	-6.5	60
		3	20 / 50	6.6	24.38	34.42	High	Max	35	33868	7	1992	-3.7	60
Right Far	1063	1	00 / 30	9.0	3.58	8.58	High	Max	8	5000	5	1400	-7	276
		2	10	6.5	8.63	23	High	Max	21	12000	10	2000	-3.5	276
		3	20	6.1	23	35.94	Low	Max	36	32000	9	2000	-3.5	276
Right Near	1098	1	40	9.0	3.6	8.61	High	Min	9	5000	4	1739	-8	209
		2	50	9.0	8.68	15.86	High	Max	16	12004	7	1418	-7	209
Channel	78	1	00	9.0	3.01	6.02	High	Max	6	4200	6	700	-10.3	339
		2	10	9.0	5.87	12.17	High	Max	12	8200	8	1100	-5.8	339
		3	30	9.0	12.17	20.05	High	Max	12	17000	10	1100	-2	339
		Weir	40	9.0	1.2	7.78	High	Max	8	1672	14	654	-13	339

Table 5.-Summary of sonar stratum range changes by date at RM 13.7, 2013.

RM 13.7 Strata Range Summary

Sonar Location	Stratum	Time	Changes Made to Stratum Range Coverages by Date							
			16-May	18-May	6-Jun	8-Jun	19-Jun	20-Jun	24-Jun	19-Jul
Left Near[1]	1	00 / 30	N/A	N/A	2.5-11.1	2.5-11.1	2.5-11.1	2.5-11.1	2.5-12.1	2.5-15.1
Left Far[2,3]	1	00 / 30	2-8	2-8	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6
	2	10 / 40	8-23.4	8-23.4	8.6-24.4	8.6-24.4	8.6-24.4	8.6-24.4	8.6-24.4	8.6-24.4
	3	20 / 50	23-38	23-38	24.4-34.4	24.4-34.4	24.4-34.4	24.4-34.4	24.4-34.4	24.4-34.4
Right Far	1	00 / 30	2-8	2-8	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6	3.6-8.6
	2	10	8-35	8-24	8.6-23	8.6-23	8.6-23	8.6-23	8.6-23	8.6-23
	3	20	N/A	24-38	23-36	23-36	23-36	23-36	23-36	23-36
Right Near	1	40	N/A	N/A	3.6-6.6	3.6-6.6	3.6-8.7	3.6-8.7	3.6-8.7	3.6-8.7
	2	50	N/A	N/A	6.6-14.1	6.6-14.1	8.7-15.9	8.7-15.9	8.7-15.9	8.7-15.9
Channel	1	00	N/A	N/A	3-6	3-6	3-6	3-6	3-6	3-6
	2	10	N/A	N/A	6-12.2	6-12.2	6-12.2	6-12.2	6-12.2	6-12.2
	3	30	N/A	N/A	12.2-20.1	12.2-20.1	12.2-20.1	12.2-20.1	12.2-20.1	12.2-20.1
	Weir	10 / 50	N/A	N/A	1.2-7.8	1.2-7.8	1.2-7.8	1.2-7.8	1.2-7.8	1.2-7.8

[1]June 20 LBN 2m from shore

[2]June 20 LBO 10.5m from shore

[3]July 9 LBO 11.5-12m from shore

Data Collection Parameters

With ARIS, the manufacturers have separated the data collection (ARIScope) and data processing (ARISFish) software. Unlike the DIDSON Control and Display interface, ARIScope has several data collection parameters that are now user selectable rather than being fixed or limited to a few discrete values including window length, transmit pulse length, and downrange resolution. The downrange resolution (i.e., Window Length/#samples) is particularly improved with ARIS. Whereas DIDSON was limited to 512 samples to define the downrange resolution, ARIS can collect up to 4,000 samples per beam. The parameters that are now selectable and that will be optimized for each range interval are given in Table 6 along with the corresponding fixed values in the DIDSON system. A consultant from Sound Metrics Corporation will be on site from May 12-16, 2014 to assist project personnel with selecting the sampling range intervals and optimizing parameters for each range interval.

As with DIDSON, the autofocus feature will be enabled so that the sonar automatically sets the lens focus to the mid-range of the selected range window.

Table 6.- 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	4µs to 100µs	4µs to 100µs	7µs, 13µs, 27µs, 54µs (relative to window length)	4.5µs, 9µs, 18µs, 36µs (relative to window length)
Downrange Resolution (window length/#samples)	3 mm to 10 cm	3 mm to 100 mm	5mm, 10mm, 20mm, 40mm (relative to window length)	2.5mm, 5mm, 10mm, 20mm (relative to window length)
Source Level	~206-212 dB re 1µPa at 1m	~200-206 dB re 1µPa at 1m		
Window Length	Any	Any	2.5m, 5m, 10m, 20m	1.25m, 2.5m, 5m, 10m
Samples per beam	Up to 4,000	Up to 4,000	512	512

Table 7.- Actual 2013 data storage needs for data from four mainstem ARIS systems at RM 13.75 site.

Stratum	**10-min file size (GB)**	**Hourly sample size (GB)**	**Comments**
Left Bank Nearshore[1,2] (ARIS 1800 – standard lens) Stratum 1 (~2m – 15m)	0.8	1.6	Collect data for 20-min out of each hour. See comment 1 below.
Left Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 1 (~3m – 8m)	0.3	0.6	Collect data for 20 min each hour
Left Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 2 (~8m – 24m)	0.4	0.8	Collect data for 20 min each hour
Left Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 3 (~24m – 34m)	0.4	0.8	Collect data for 20 min each hour
Right Bank Nearshore[2] (ARIS 1200 – Large Lens)	0.5	0.5	Collect data for 10-min out of each hour.

Stratum 1 (~3m – 8m)			
Right Bank Nearshore[2] (ARIS 1800 – Large Lens) Stratum 2 (~8m – 16m)	0.4	0.4	Collect data for 10-min out of each hour.
Right Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 1 (~3m – 8m)	0.4	0.8	Collect data for 20 min each hour
Right Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 2 (~8m – 23m)	0.4	0.4	Collect data for 10 min each hour
Right Bank Offshore[3] (ARIS 1200+Large Lens) Stratum 2 (~23m – 35m)	0.4	0.4	Collect data for 10 min each hour
Minor Channel (ARIS 1200+Large Lens) Stratum 1 (~3m – 6m)	0.2	0.2	Collect data for 10 min each hour
Minor Channel (ARIS 1200+Large Lens) Stratum 2 (~6m – 12m)	0.3	0.3	Collect data for 10 min each hour
Minor Channel (ARIS 1200+Large Lens) Stratum 3 (~12m – 20m)	0.3	0.3	Collect data for 10 min each hour
Total Hourly	3.7	4.9	
Total Daily (hourly*24)	88.8	117.6	
Season Total (Daily*87days)	7,726	10,231	Or ~10 TB for season

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

[2]Left- and right-bank near shore sonars will not be deployed until water levels rise (~mid-June), so the 10 TB estimate for the season may be generous

[3]Assumes three strata the offshore sonar

[5]Although ARIS file sizes are usually larger than DIDSON files; ARIS strata may cover larger ranges and will not necessarily generate larger files depending on the selected samples/beam parameter.

DATA STORAGE AND MANAGEMENT

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[6]. File size also increases with the down-range resolution level. Again, consultant Bill Hanot will assist with determining the optimal resolution value for individual range strata. We estimate that 10-minute file sizes will vary from a maximum of approximately 300,000 KB to approximately 500,000 KB. Table 7 gives a worst case scenario for data storage needs at these sample rates.

Data from each sample will be stored to a uniquely named file. Filenames are automatically generated by the ARIS software using optional identifiers such as sonar serial #, location, bank, year, month, day, military time (hour, min, sec), transmitted pulse length, number of beams sampled, samples/beam, resolution, and range interval. For example, the file:

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

SN 1064_Kenai13-75_LB_2012-07-17_004000_T24_B48_S2000_F12_R21-35.aris

refers to a file collected by sonar #1064, at RM 13.75 on the left bank of the Kenai River, that started data collection on July 12, 2012 at 0:40 AM using a transmitted pulse length of 24 msec, using all 48 beams, with 2000 samples/beam at resolution 12, over the range interval 21-35m.

Longer file names may be used initially, but pared back if we determine that the long filenames hinder file handling during file transfer/processing/archiving. But initially, the additional information in the filename may help during the early phase of this project when different settings are being evaluated.

One laptop will be dedicated to collecting data from each sonar. Data will be written directly to one of two external hard drives assigned to that computer/sonar (

Figure **19**). The hard drives will be swapped out once per day and transported back to the Soldotna ADF&G office.

Office data management and archiving

Procedures for processing the large volume of data generated daily by the ARIS systems were developed during the 2013 season and will continue to be refined and expanded upon in 2014. In the Soldotna office, data will be uploaded from each external drive to a 24 TB Buffalo TeraStation Network Attached Storage (subsequently referred to by NAS) where it can be shared with up to 14 users through a 1 GB Ethernet network (i.e. through a 16 port 1 GB Ethernet switch connected to computers with 1 GB Ethernet cards, Figure **19**). This process is facilitated through the use of batch files described in Appendix E. Further information on the NAS configuration and instructions for mapping to the NAS can be found in Appendix H.

As shown in

, a separate computer will be used to upload ARIS data from the external hard drives to the NAS using batch files that sort and store files in the following directory hierarchy: 1) by year (e.g. Data2013), 2) by sonar (e.g. LeftFar), and by 3) by stratum. The following folders were unique to each of the five 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). To achieve maximum upload speeds, the NAS is only connected to the upload computer while data is being uploaded from the external hard drives. Following upload to the NAS, data from each external hard drive is also copied to a second "backup" external hard drive. Data transferred to the back-up hard drive are not sorted or stored according to any hierarchy. However the naming convention of the data files naturally sorts them by sonar, then data and time. Following data upload and backup, the NAS is attached to the GB Network switch, allowing the data to now be shared and processed by up to 14 users.

Remote Access to Sonar Site

Because the RM 13.7 site will not be manned 24-7 in 2014, a system to remotely access and determine the status of the data collection computers and/or sonars will be implemented in 2014. Each data collection computer will be equipped with wireless internet service through AT&T Beams (providing 4G LTE service) and can be accessed remotely using GoToMyPC accounts (Figure 19).

FISH LENGTH AND DIRECTION OF TRAVEL

Estimates of total length will be made from images using the ARISFish V1.5 (or a more recent version provided by the manufacturer). Detailed instructions for taking manual measurements and the software settings and parameters are given in Appendix F. On a given day, depending on the above factors, one of 3 sampling protocols (summarized in Table) will guide processing and analysis of RM-13.7 data.

RM-14 DATA ANALYSIS

Abundance estimates at RM 13.7 will apply to the entire river cross-section.

RM-14 SALMON PASSAGE ESTIMATES

Unbiased estimates of the number of salmon y of all species exceeding DL=40 cm, will not be produced for the RM-14 site.

RM-14 LARGE FISH PASSAGE ESTIMATES

The daily estimate of large fish passing RM 13.7 will be obtained with equations 1-4 after substituting c'_{sij} for c_{sij}, where

c'_{sij} = number of upstream-bound fish in the ensonified zone exceeding 75 cm in length as measured by the ARIS during t_{sij}.

RM-14 CHINOOK SALMON PASSAGE ESTIMATES

If representative netting data are available, an estimate of Chinook salmon abundance will be calculated using a mixture model to upstream ARIS and netting data as described in equations (5-8).

NET-APPORTIONED RM-14 CHINOOK SALMON PASSAGE ESTIMATES

"Net-apportioned" estimate of Chinook salmon abundance at RM 13.7 will not be produced for the RM-14 site.

SCHEDULE AND DELIVERABLES

Table 8.- 2014 timeline and milestones

5/1 – 5/15/2014	**RM 8.6 site** • Normal camp set up with Windows 7 Laptops + DIDSONs • Review/update measurement protocol – create a suite of test files that can be used with a tutorial for future training especially at site • Group training on manual DIDSON measures for both "site" and "office" crews • Review/update DIDSON-based camp manual **RM 13.7 site** • 2 ARIS+AR4 upgrades are delivered on May 1, and the remaining by May 9 • Work with Mark Hatfield to develop new AR2 mounting interface • Check with Mark Hatfield to ensure we have enough tripods and mounts for one extra ARIS that we may borrow from Suzanne for tethered fish work • Modification of tent platform if necessary for permit

	• Installation of ELP walkways **IT needs – mainly Mark Jensen's Duties:** • Update batch files for RM 8.6 DIDSON data (continue with 4 range strata) • Update SAS for RM 8.6 data processing and uploading • Develop new batch files for RM 13.7 ARIS data if needed
5/12-5/16/2014	Bill Hanot on site to assist with sonar testing and configuration
5/15 -6/1/2014	• Deploy ARIS on RM 8.6 right bank when dust settles • Conduct tethered fish experiments as early as possible to compare ARIS and DIDSON fish measurements – i.e., when netters start picking up at least several fish/shift • Develop field manual with examples and test files • Training sessions with crew as needed for measuring consistency
6/1/2014 or later	• Deploy Nearshore ARIS systems when water level justifies • Deploy minor-channel weir and ARIS
7/22-7/26/2014	Bill Hanot potentially here to assist with any ARIS or DIDSON issues

A report meeting the requirements of ADF&G's Fishery Data Series will be published. This report will provide an overview of the implemented methodology for generating DIDSON-based Chinook salmon estimates. A draft version will be completed by 4/1/2015. The final report will be completed by 9/1/2015.

RESPONSIBILITIES

List of primary personnel and duties:

Personnel: Jim Miller, Fishery Biologist II, Alaska Department of Fish and Game

Duties: General supervision of all aspects of the study. Set up and configure DIDSON\ARIS sonar system. Assist with in-season data collection and post-season data analysis. Primary responsibility for post-season report.

Personnel: Debby Burwen, Fishery Biologist III, Alaska Department of Fish and Game

Duties: Assist with conducting and supervising all aspects of the study. Work with Bill Hanot/SMC personnel to develop/update needed data-processing software. Set up and configure DIDSON\ARIS sonar system. Assist with in-season data collection and post-season data analysis. Assist with testing and evaluating evolving DIDSON\ARIS hardware and software. Shared responsibility for post-season report.

Personnel: Mark Jensen, Private Data Management Consultant

Duties: Provide expertise for implementing and maintaining wired and wireless networks used to transfer sonar data. Develop batch files and other user-interface programs as needed to transfer, summarize, and archive sonar data. Assist with in-season data processing and analysis. Work dates: May 13 – May 31, 2014.

Personnel: Steve Fleischman, Fisheries Scientist I, Alaska Department of Fish and Game

Duties: Provide guidance on sample design and estimation procedures. Assist with in-season and post-season data analysis. Review project operational plan. Shared responsibility for post-season report.

Personnel: Jiaqi Huang, Biometrician III, Alaska Department of Fish and Game

Duties: Provide guidance on sample design and estimation procedures. Assist with post-season data analysis. Coauthor project operational plan and report.

Personnel: Bill Hanot, Senior Engineer, Sound Metrics

Duties: Provide training in the operation of a new DIDSON prototype (ARIS) and ensure that all hardware and software features are working correctly. Develop software features required to collect or analyze DIDSON\ARIS data. Planned visits are May 12-16, and July 21-25, 2014.

Personnel: Brandon Key, Fishery Biologist I, Alaska Department of Fish and Game

Duties: Assist Project Leader with all aspects of DIDSON\ARIS deployment, operation, and data analysis. Take lead role in developing protocol for processing DIDSON\ARIS data for the purpose of generating daily estimates of Chinook salmon passage. Primary focus is RM 13.75 sonar site. Work dates: April 1, 2014 – December 31, 2014.

Personnel: Michael Friedrich, Fishery Biologist I, Alaska Department of Fish and Game

Duties: Assist Project Leader with all aspects of DIDSON\ARIS deployment, operation, and data analysis. Take lead role in developing protocol and a comprehensive user manual for processing DIDSON data for the purpose of generating daily estimates of Chinook salmon passage. Primary focus is RM 8.6 sonar site. Work dates: May 1 – August 31, 2014.

Personnel: VACANT, Fishery Biologist I, Alaska Department of Fish and Game

Duties: Assist Project Leader with all aspects of DIDSON\ARIS deployment, operation, and data analysis. Assist in developing a comprehensive user manual for processing DIDSON\ARIS data for the purpose of generating daily estimates of Chinook salmon passage. Work dates: July 15 – August 10 to assist with processing data during the peak of the late run and at other times as needed to replace other employees requiring leave.

Personnel: Mike Hopp, Fish and Wildlife Technician III, Alaska Department of Fish and Game

Duties: On-site Crew Leader: Supervise, provide training, and oversee work quality of three technicians based at a semi-remote field camp. Assist Project Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Develop batch files and other user-interface programs as needed. Work dates: May 1 – August 15, 2014.

Personnel: Nathan Plate, Fish and Wildlife Technician II, Alaska Department of Fish and Game

Duties: Assist Crew Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Approximate work dates: May 13 – August 15, 2014.

Personnel: VACANT, Fish and Wildlife Technician II, Alaska Department of Fish and Game.

Duties: Assist Crew Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Approximate work dates: May 13 – August 15, 2014.

Personnel: Alex Pettey, Fish and Wildlife Technician II, Alaska Department of Fish and Game

Duties: Assist Crew Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Approximate work dates: May 13 – August 15, 2014.

Personnel: Cyndi Jaffa, Fish and Wildlife Technician II, Alaska Department of Fish and Game

Duties: Assist Crew Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Approximate work dates: May 13 – August 15, 2014.

Personnel: Lindsay Fagrelius, Fish and Wildlife Technician II, Alaska Department of Fish and Game

Duties: Assist Crew Leader with all aspects of DIDSON\ARIS deployment, operation, and data processing. Approximate work dates: May 24 – August 10, 2014.

BUDGETS

The total proposed budget for the Kenai River Chinook Salmon Sonar Project at RM 8.6 (fiscal year, 2014) is $263,000. Budget and personnel requirements are summarized in Table 9and Table 10.

Table 9.–Budget summary for FY14 for Mile 8.6 site only.

Line Item	Category	Allocation
100	Personal Services	226.8
200	Travel	6.1
300	Contractual	25.5
400	Commodities	4.6
500	Equipment	0.0
Total		263.0

Table 10.–Project personnel for RM 8.6 site.

PCN	Name	Title	Funded Man Months
4166	James D. Miller	Fishery Biologist II	12.0
4234	Michael Friedrich	Fishery Biologist I	3.3
1793	Mike Hopp	Fish & Wildlife Technician III	3.3
4146	Alex Pettey	Fish & Wildlife Technician II	3.0
1045	Vacant	Fish & Wildlife Technician II	3.1
4305	Nathan Plate	Fish & Wildlife Technician II	3.0
			27.7

The total proposed budget for the new ARIS-based Sonar project at RM13.7 is $322,400. Budget and personnel requirements are summarized in Table 11 and Table 12.

Table 11.–Budget summary for FY14 for Mile 13.7 site only.

Line Item	Category	Allocation
100	Personal Services	273.0
200	Travel	7.5
300	Contractual	28.3
400	Commodities	13.6
500	Equipment	0.0
Total		322.4

Table 12.–Project personnel for RM 13.7 site.

PCN	Name	Title	Funded Man Months
1960	Debby Burwen	Fishery Biologist III	12.0
N13029	Brandon Key	Fishery Biologist I	10.0
B216	VACANT	Fishery Biologist I	2.0
5361	Lindsay Fagrelius	Fish & Wildlife Technician II	3.0
5347	Cyndarienne Jaffa	Fish & Wildlife Technician II	3.0
			29.0

REFERENCES CITED

Baumgartner, L. J., N. Reynoldson, L. Cameron, and J. Stanger. 2006. Assessment of a Dual-frequency Identification Sonar (DIDSON) for application in fish migration studies. NSW Department of Primary Industries. Fisheries Final Report Series No. 84. Narrandera, New South Wales.

Belcher, E. O., W. Hanot, and J. Burch. 2002. Object identification with acoustic lenses. Pages 187–192 in R. Werner, editor. Proceedings of the 2002 International symposium on Underwater Technology. Institute of Electrical and Electronic Engineers, Piscataway, New Jersey.

Bromaghin, J. 2005. A versatile net selectivity model, with application to Pacific salmon and freshwater species of the Yukon River, Alaska. Fisheries Research 74(1-3):157-168.

Burwen, D. L., and S. J. Fleischman. 1998. Evaluation of side-aspect target strength and pulse width as potential hydroacoustic discriminators of fish species in rivers. Canadian Journal of Fisheries and Aquatic Sciences 55:2492-2502.

Burwen, D. L., J. Hasbrouck, and D. E. Bosch. 2000. Investigations of alternate sites for Chinook salmon sonar on the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 00-43, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-43.pdf

Burwen, D. L., D. E. Bosch, and S. J. Fleischman. 1998. Evaluation of hydroacoustic assessment techniques for Chinook salmon on the Kenai River, 1995. Alaska Department of Fish and Game, Fishery Data Series No. 98-3, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-03.pdf

Burwen, D. L., S. J. Fleischman, J. D. Miller, and M. E. Jensen. 2003. Time-based signal characteristics as predictors of fish size and species for a side-looking hydroacoustic application in a river. ICES Journal of Marine Science 60:662-668.

Burwen, D. L., S. J. Fleischman, and J. D. Miller. 2007. Evaluation of a dual-frequency imaging sonar for estimating fish size in the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 07 44, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-44.pdf

Burwen, D. L., S. J. Fleischman, and J. D. Miller. 2010. Accuracy and precision of manual fish length measurements from DIDSON sonar images. Transactions of the American Fisheries Society, 139:1306-1314.

Carroll, H. C. and B. C. McIntosh. 2008. Sonar estimation of salmon passage in the Yukon River near Pilot Station, 2006. Alaska Department of Fish and Game, Fishery Data Series 08-65.

Cochran, W. G. 1977. Sampling techniques, 3rd edition. John Wiley and Sons, New York.

Cronkite, G. M., H. J. Enzenhofer, T. Ridley, J. Holmes, J. Lilja, and K. Benner. 2006. Use of high-frequency imaging sonar to estimate adult sockeye salmon escapement in the Horsefly River. Canadian Technical Report of Fisheries and Aquatic Sciences 2647.

Daum, D. W., and B. M. Osborne. 1998. Use of fixed-location, split-beam sonar to describe temporal and spatial patterns of adult fall chum salmon migration in the Chandalar River, Alaska. North American Journal of Fisheries Management 18:477-486.

Eskelin, A. 2010. Chinook salmon creel survey and inriver gillnetting study, lower Kenai River, Alaska, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 10-63, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/FDS10-63.pdf

Enzenhoffer, H. J., N. Olsen, and T. J. Mulligan. 1998. Fixed-location riverine hydroacoustics as a method of enumerating migrating adult Pacific salmon: comparison of split-beam acoustics vs. visual counting. Aquatic Living Resources 11(2):61-74.

Fair, L. F., M. T. Willette, and J. Erickson. 2009. Escapement goal review for Susitna River sockeye salmon, 2009. Alaska Department of Fish and Game, Fishery Manuscript Series 09-01.

Fleischman, S. J., and D. L. Burwen. 2003. Mixture models for species apportionment of hydroacoustic data, with echo envelope length as the discriminatory variable. ICES Journal of Marine Science. Volume 60, Issue 3, Pages: 592-598.

Galbreath, P. F., and P. E. Barber. 2005. Validation of a long-range dual frequency identification sonar (DIDSON-LR) for fish passage enumeration in the Methow River," Final Report – PSC Southern Fund 2004/2005 Project.

Gaudet, D. M. 1990. Enumeration of migrating salmon populations using fixed-location sonar counters, Rapports et Proces-Verbaux des Reunions, Conseil International pour l'Exploration de la Mer 189:197-209.

Gilks, W. R., A. Thomas, and D. J. Spiegelhalter. 1994. A language and program for complex Bayesian modeling. The Statistician 43:169-178. www.mrc-bsu.cam.ac.uk/bugs Accessed 11/2004.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Hammarstrom, S. L., and J. J. Hasbrouck. 1999. Estimation of the abundance of late-run Chinook salmon in the Kenai River based on exploitation rate and harvest, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-8, Anchorage.

Holmes, J. A., G. M. Cronkite, H. J. Enzenhofer, and T. J. Mulligan. 2006. Accuracy and precision of fish-count data from a "dual-frequency identification sonar" (DIDSON) imaging system. ICES Journal of Marine Sciences 63:543-555.

Kucera, Paul A. 2009. Use of Dual Frequency Identification Sonar to determine adult Chinook salmon (Oncorhynchus tshawytscha) escapement in the Secesh River, Idaho. U.S. Department of Energy, Bonneville Power Administration Environment, Fish and Wildlife, Portland, OR. Project # 199702000, Contract # 00035429.

Maxwell, S. L., and N. E. Gove. 2007. Assessing a dual-frequency identification sonar's fish-counting accuracy, precision, and turbid river range capability. Journal of the Acoustical Society of America 122:3364-3377.

Miller, J. D., D. L. Burwen, and S. J. Fleischman. 2010. Estimates of Chinook salmon passage in the Kenai River using split-beam sonar, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 10-40, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/FDS10-40.pdf

Miller, J. D., D. L. Burwen, and S. J. Fleischman[1]. 2013. Estimates of Chinook salmon passage in the Kenai River using split-beam sonar, 2008-2009. Alaska Department of Fish and Game, Fishery Data Series No. 12-73, Anchorage.

Miller, J. D., D. L. Burwen, and S. J. Fleischman[2]. 2013. Estimates of Chinook salmon passage in the Kenai River using split-beam and dual-frequency identification sonars, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 13-58, Anchorage.

Miller, J. D., D. L. Burwen, and S. J. Fleischman. 2014. Estimates of Chinook salmon passage in the Kenai River using split-beam sonar and dual-frequency identification sonars, 2011. Alaska Department of Fish and Game, Fishery Data Series No. 14-xx, Anchorage. Mueller, A, T. J. Mulligan, and P. K. Withler. 2008. Classifying sonar images – can a computer-driven process identify eels? North American Journal of Fisheries Management 28:1876-1886.

Simmonds, E. J., and D. N. MacLennan. 2005. Fisheries Acoustics Theory and Practice. Second Edition. Blackwell Science, Oxford.

Westerman, D. L. and T. M. Willette. 2006. Upper Cook Inlet Salmon Escapement Studies, 2004. Alaska Department of Fish and Game, Commercial Fisheries Division, Fishery Data Series 06-49, pp. 80-82.

Westerman, D. L. and T. M. Willette. In prep. Upper Cook Inlet Salmon Escapement Studies, 2011. Alaska Department of Fish and Game, Commercial Fisheries Division, Fishery Data Series.

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

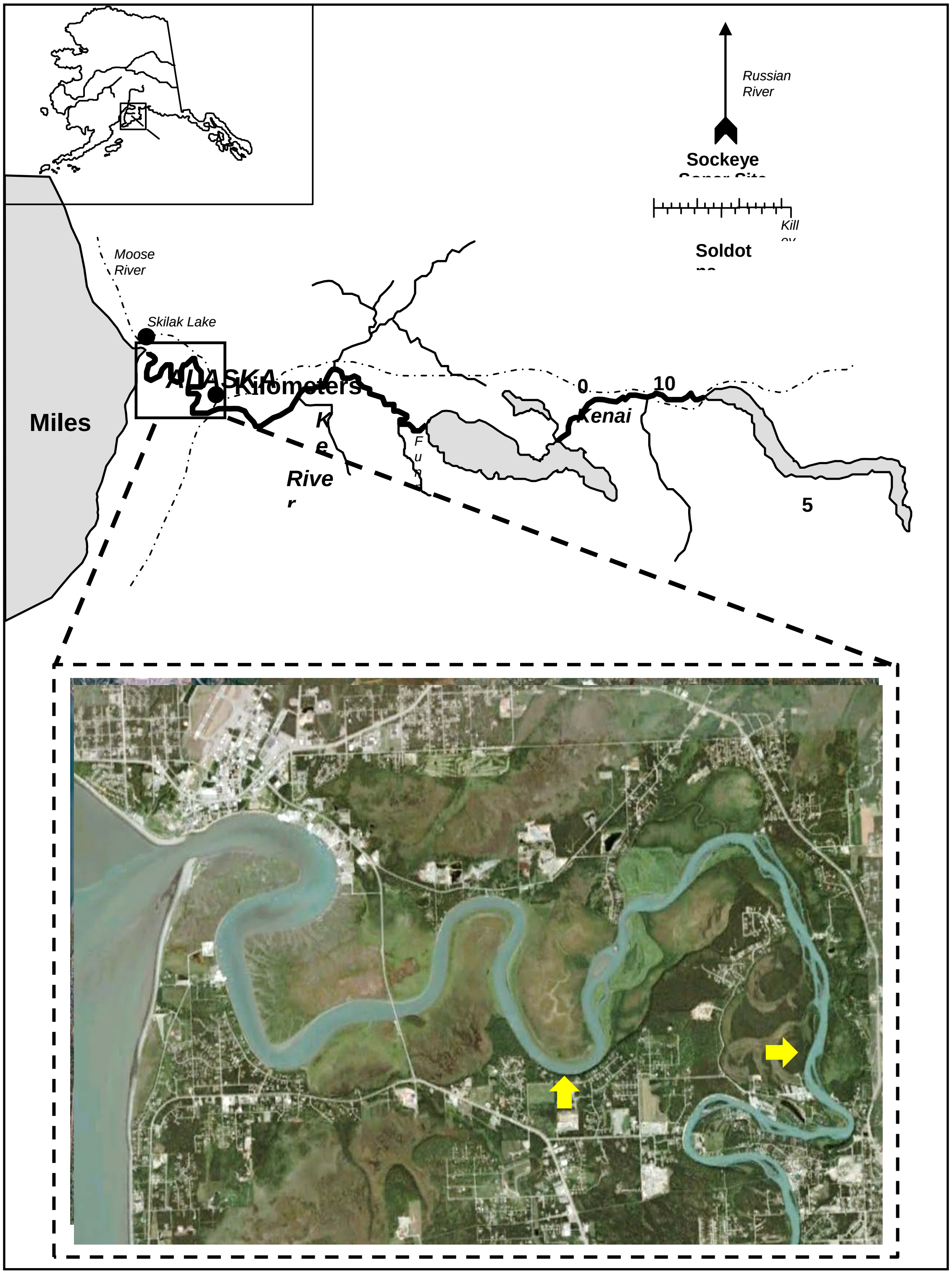


Figure 1.–Map of Kenai River showing location of Chinook salmon sonar sites at river miles 8.6 and 13.7.

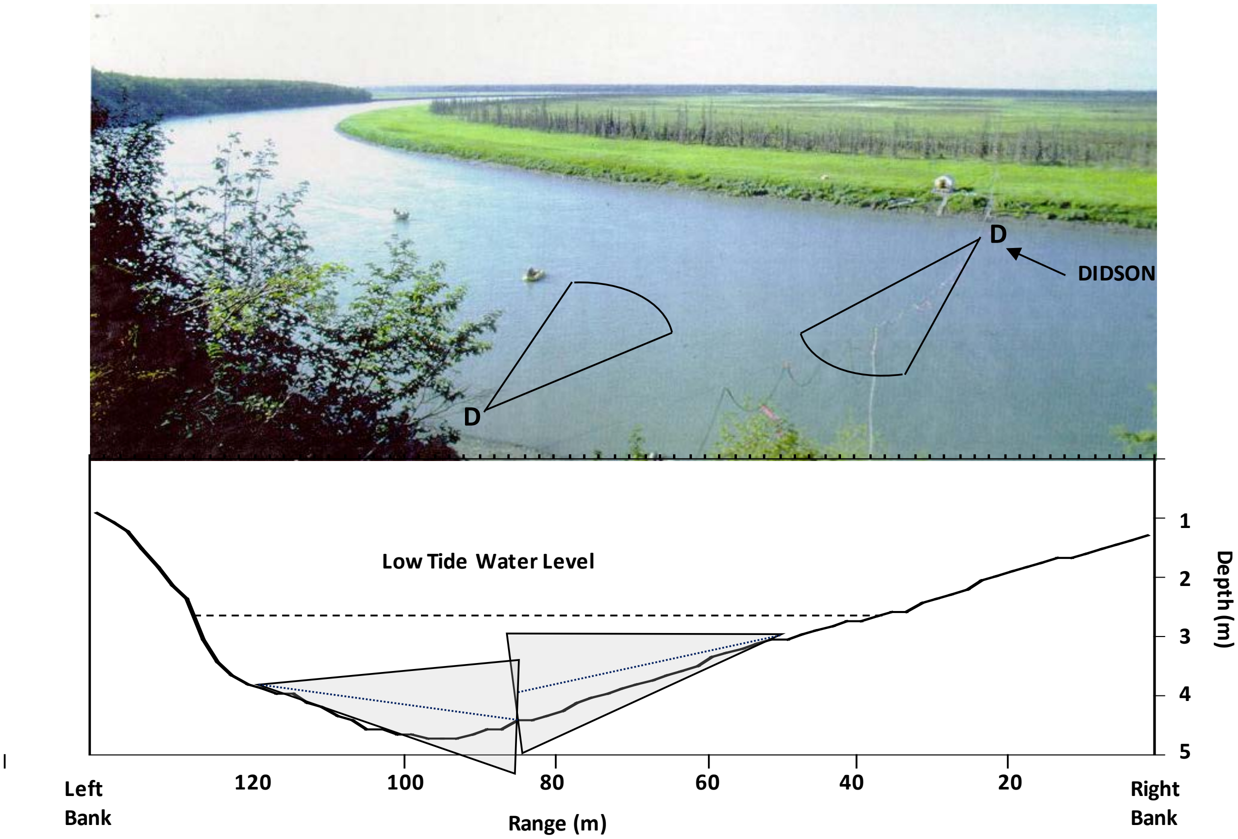


Figure 2.–Aerial view and bottom profile at the river-mile 8.6 site on the Kenai River with approximate transducer placement and sonar beam coverage.

Figure 3.– A DIDSON-LR with a high-resolution lens on a tripod mount (photos A and B). A silt-protection device is used (silt sock, photo B) to protect against silt build up in front of the lens (photo C). A goal post mount (photo D) is often used to deploy DIDSON or ARIS in nearshore locations.

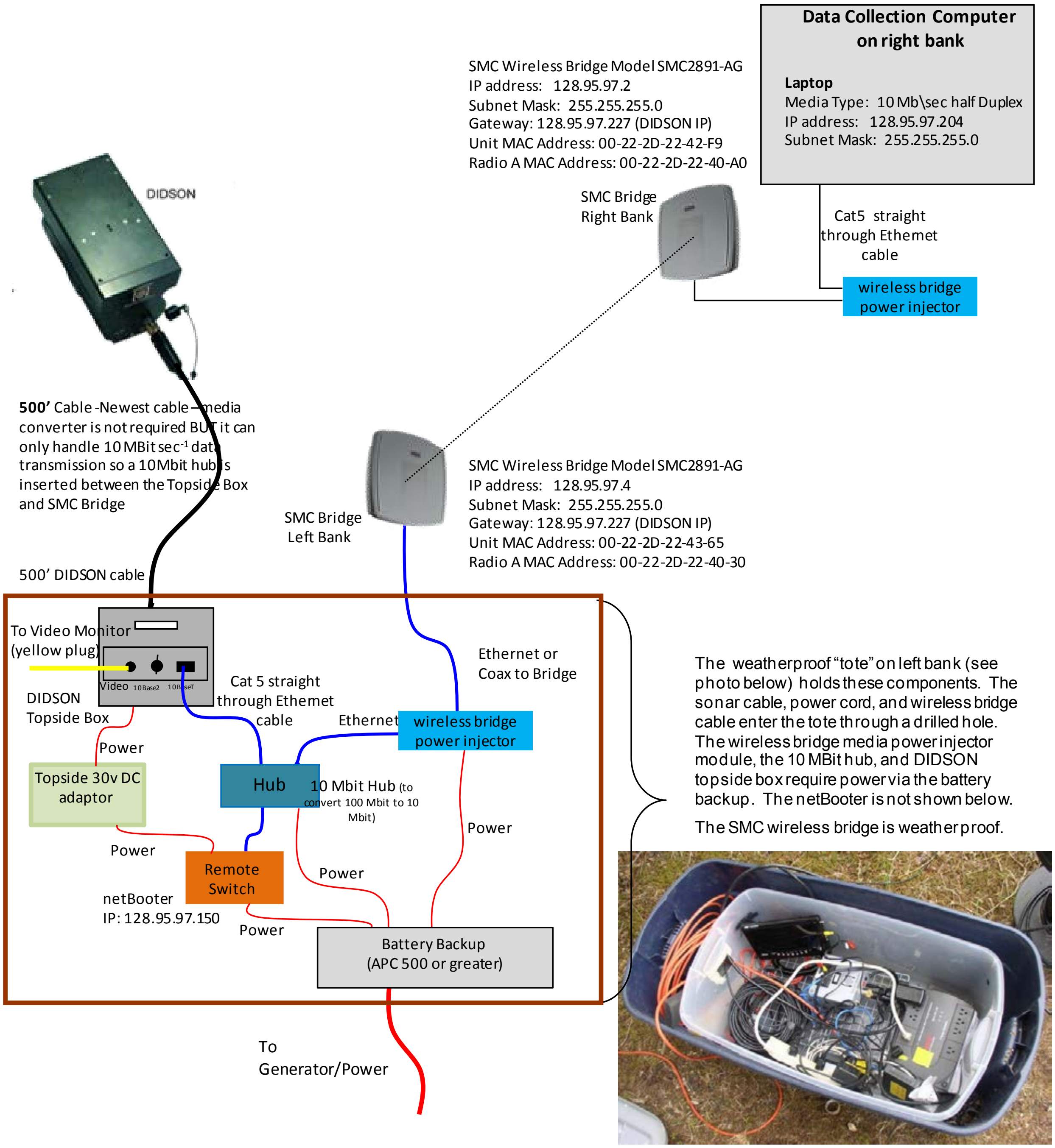
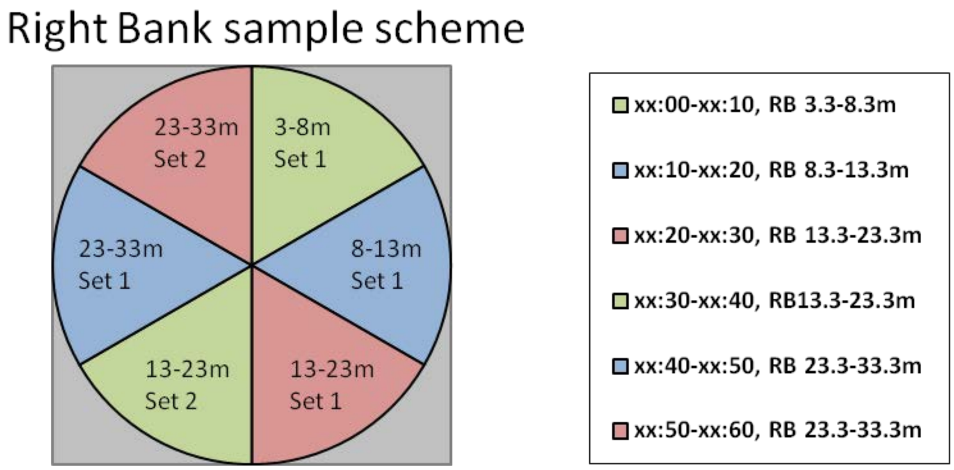


Figure 4.–RM-8.6 left bank DIDSON configuration with new (since 2009) 500' cable and SMC wireless bridge that transmits data to right bank for storage and transport to the Soldotna office.



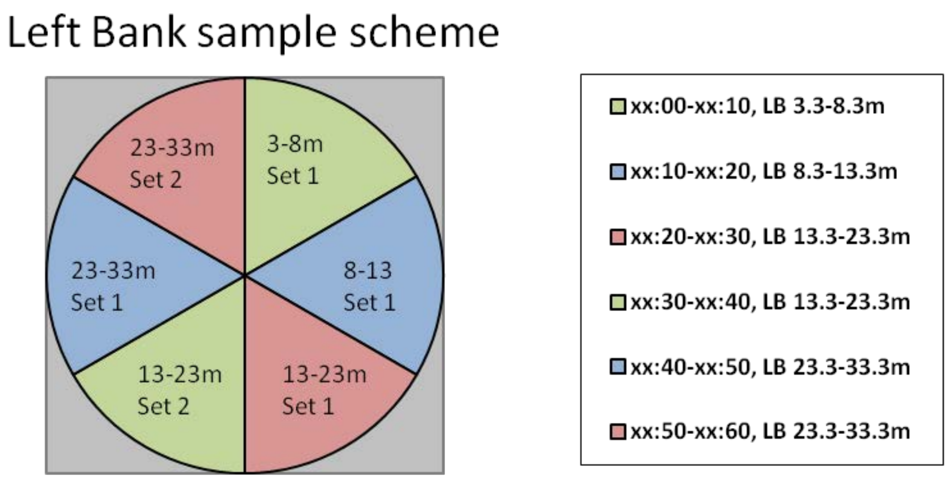


Figure 5.– RM-8.6 DIDSON sampling schedules for four range strata on the right (top) and left (bottom) banks for 2014.

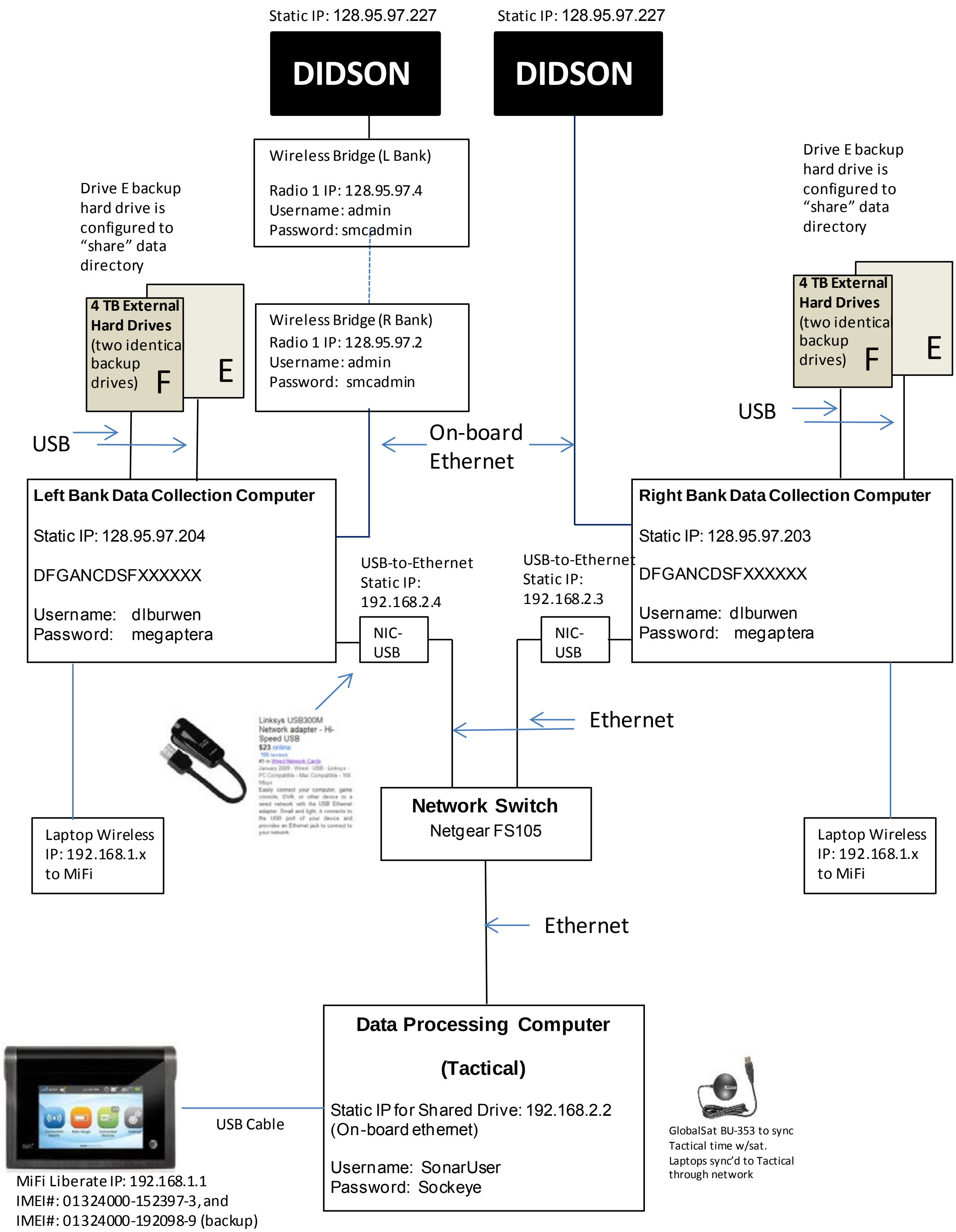


Figure 6.–DIDSON data collection schematic for the RM 8.6 sonar site.

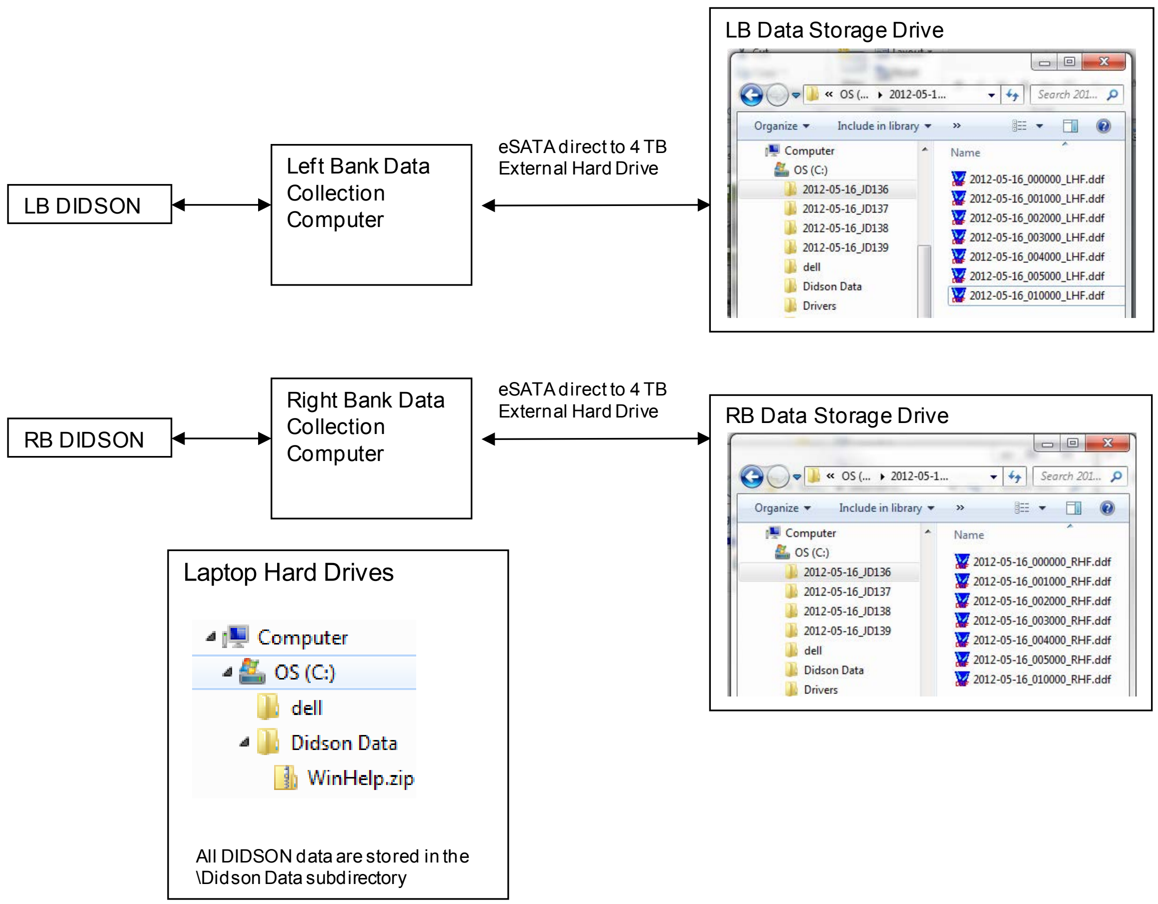


Figure 7.–DIDSON data storage configuration and directory structure at RM-8.6 site. DIDSON sample files are initially stored on the data collection computer, then transferred to the external hard drive using a batch file that also appends an "L" or "R" to each filename to indicate which bank the file originated on.

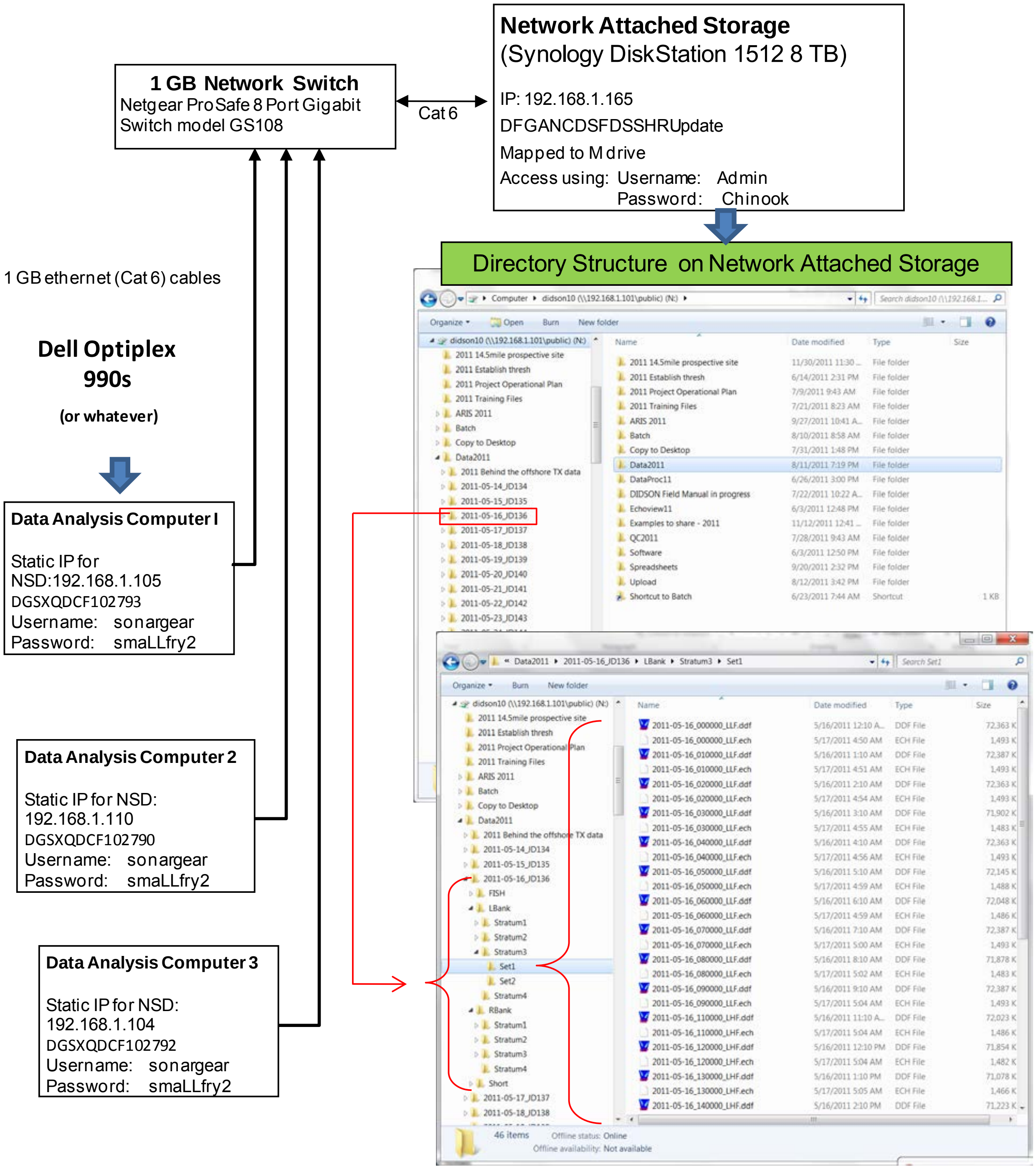


Figure 8.– RM-8.6 DIDSON data storage and file management configuration for the Network Storage Device at the Soldotna Office showing the contents of the daily subdirectory for May 16, 2011. For each day, there are Left and Right bank subfolders each of which has subfolders for four range strata. Stratum 1 (3.3-8.3 m) and stratum 2 (8.3-13.3 m) contain a single data set. There are two data sets (and folders) for range strata three (13.3-23.3 m) and four (23.3-33.3 m) because these range strata are sampled twice during two separate 10-min periods (see Figure 5).

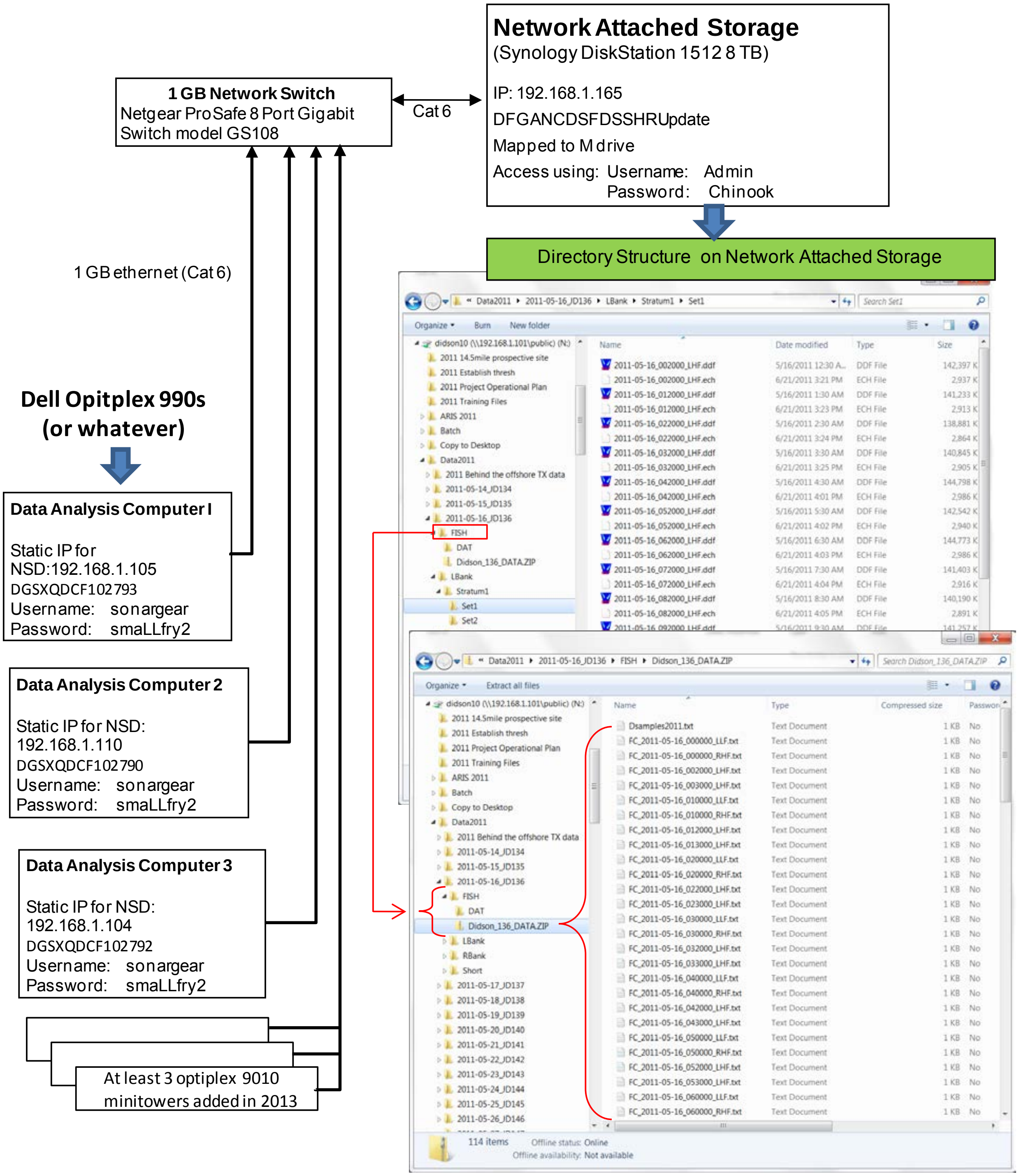


Figure 9.– RM-13.7 ARIS data storage and file management configuration for Network Storage System in the Soldotna office showing the directory structure from 2011.

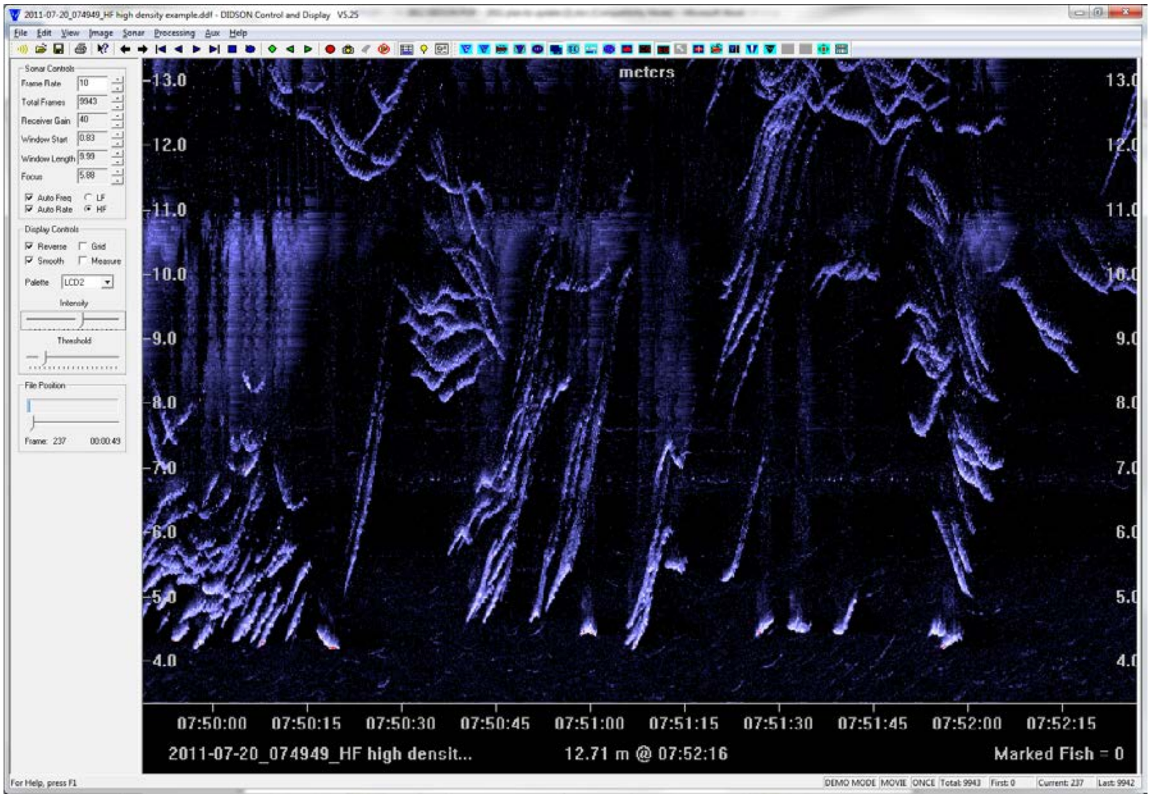


Figure 10.–Example of high density passage at RM 8.6 on July 20, 2011. There are approximately 150 fish in this 2.5 minute chart recording. A 10-minute sample with such high density can take several hours to process if each individual fish must be measured.

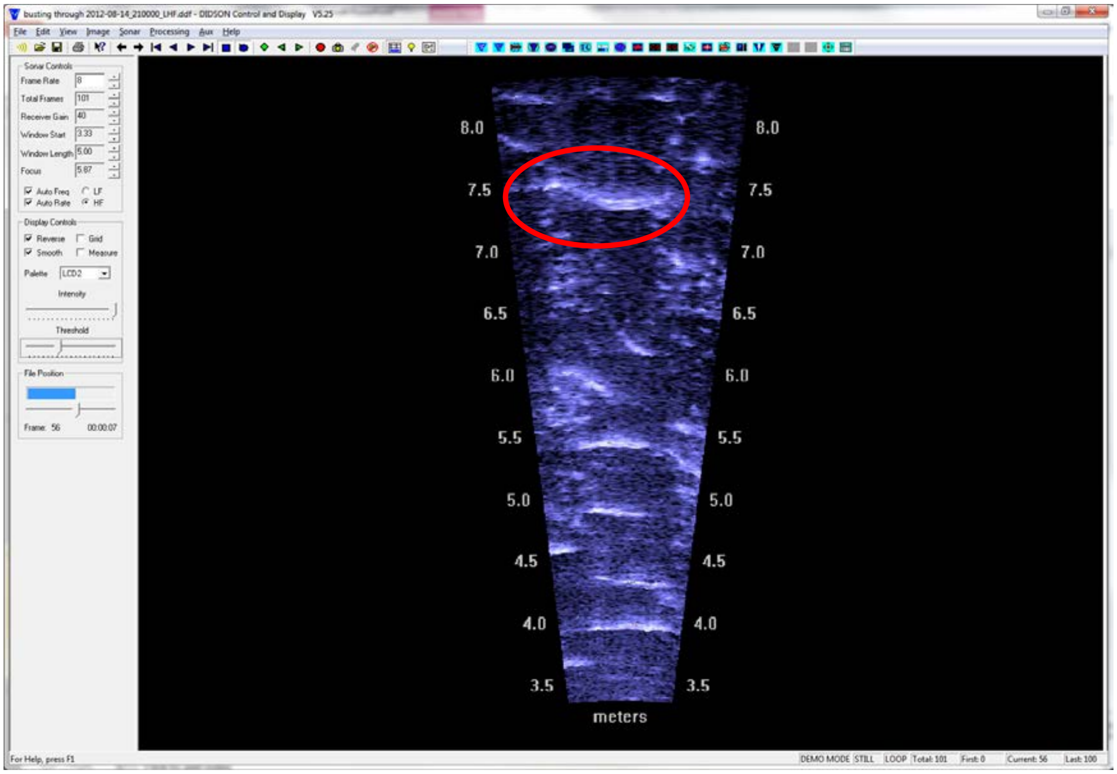


Figure 11.–Example of ~ 110 cm Chinook salmon swimming past milling pink salmon at RM-8.6 site on August 14, 2012.

Figure 12.– Location of nine transects conducted at the river mile 13.7 site on July, 9, 2012. Yellow arrows indicate preferred locations for sonars on each bank.

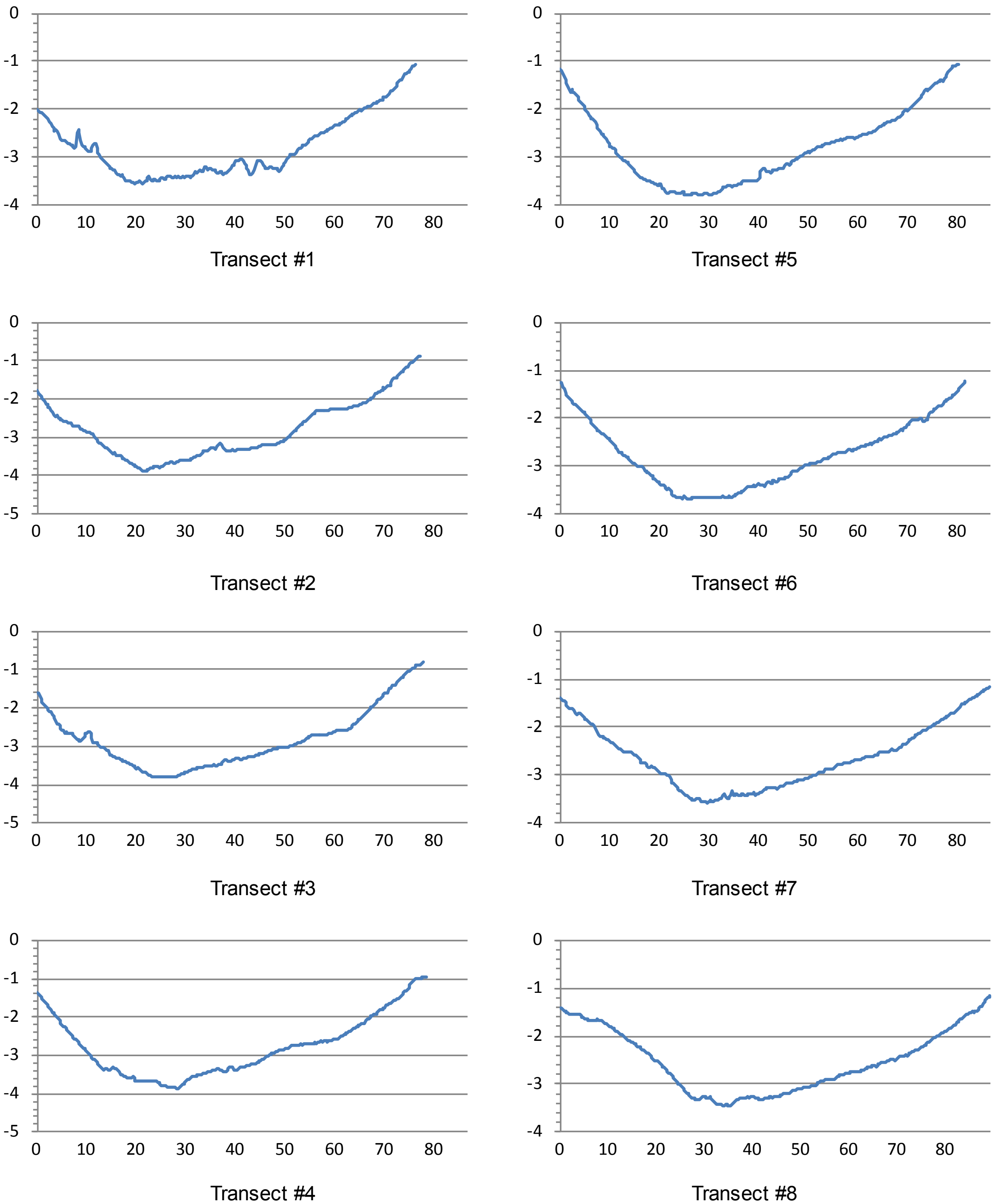


Figure 13.– Corresponding profiles for nine transects conducted near river mile 13.7 of the Kenai River (see **Figure 12**).

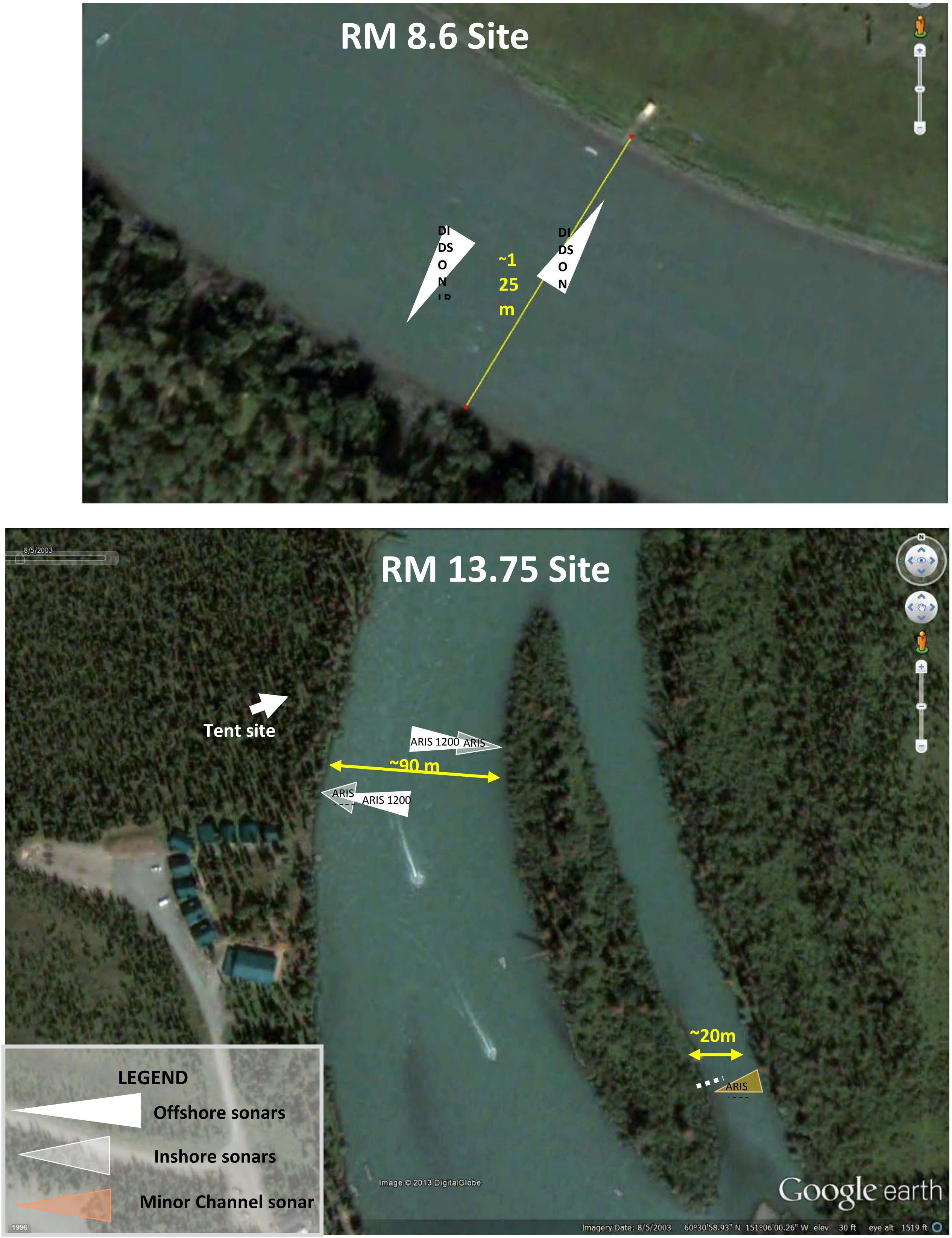


Figure 14.–Aerial view of sonar sites at Kenai river mile 8.6 (top) and 13.7 (bottom) with proposed sonar beam coverage. Diagrams are approximate and not drawn to scale.

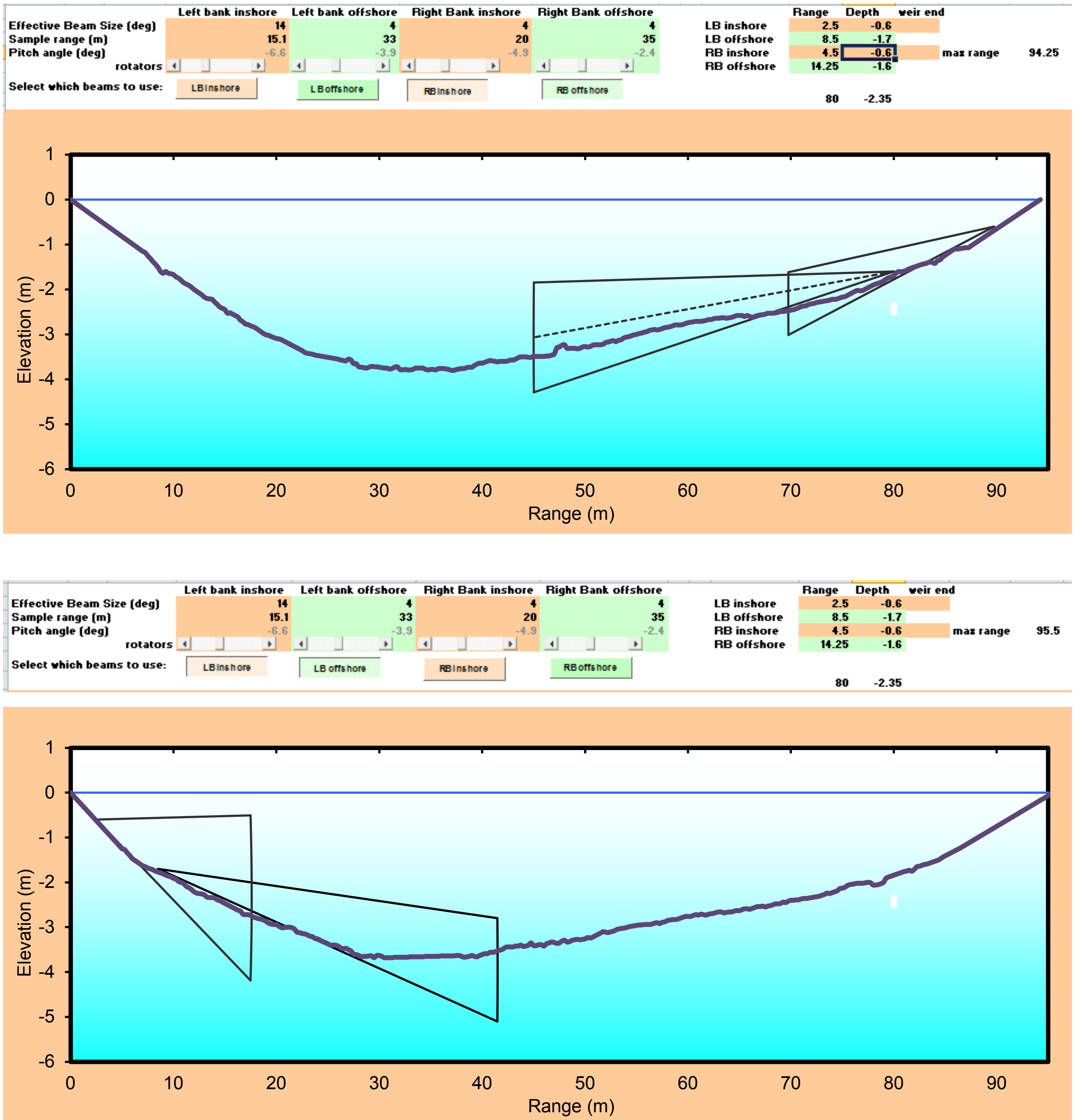


Figure 15.– Proposed coverage for the right bank (top, transect #5 in Figure 16) and left bank (bottom, (transect #6 in Figure 16) at RM 13.7. Proposed parameters are given in the headers for vertical beam width, total range insonified, sonar depth, and pitch angle.

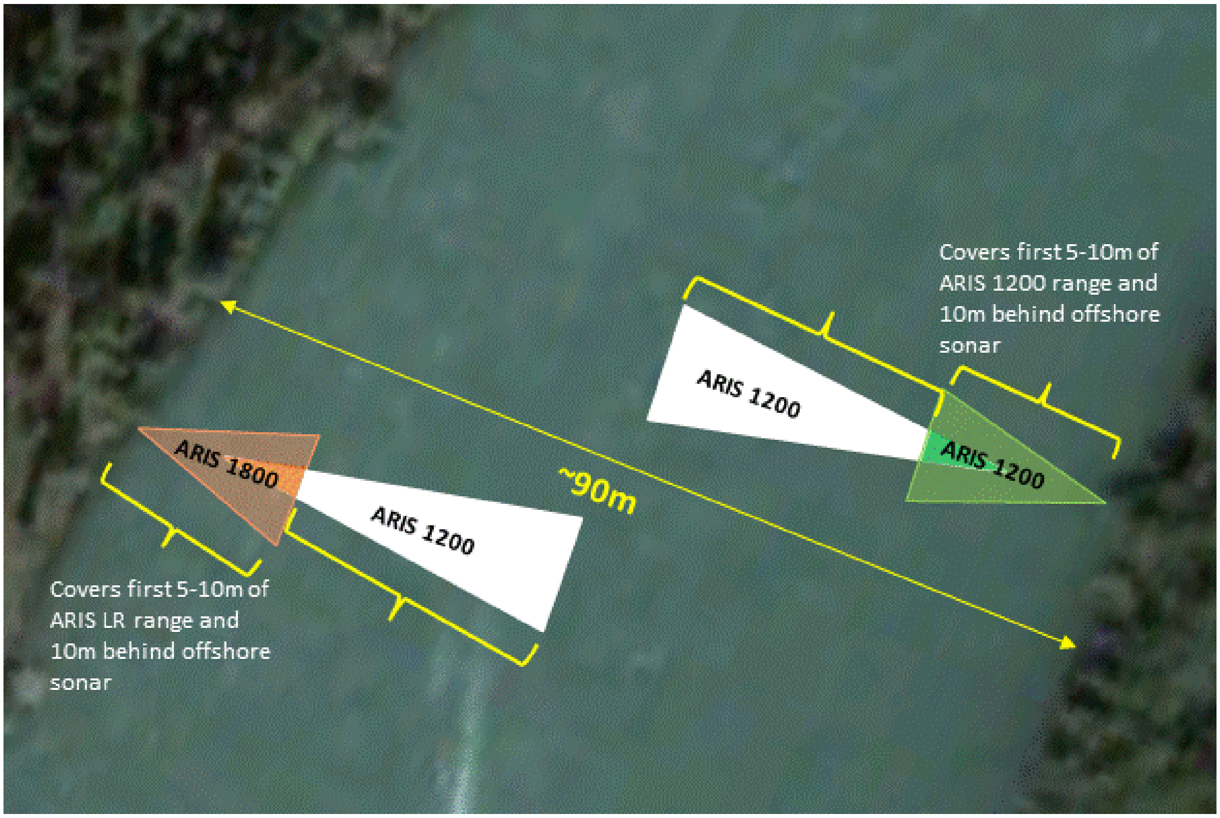


Figure 16.– Proposed deployments for ARIS systems in 2014 on the main channel at RM 13.7.

Figure 17.– Sonar coverage of the minor channel at the Kenai River mile 13.7 sonar site is achieved using an ARIS 1200 deployed on a tripod mount combined with a fixed weir.

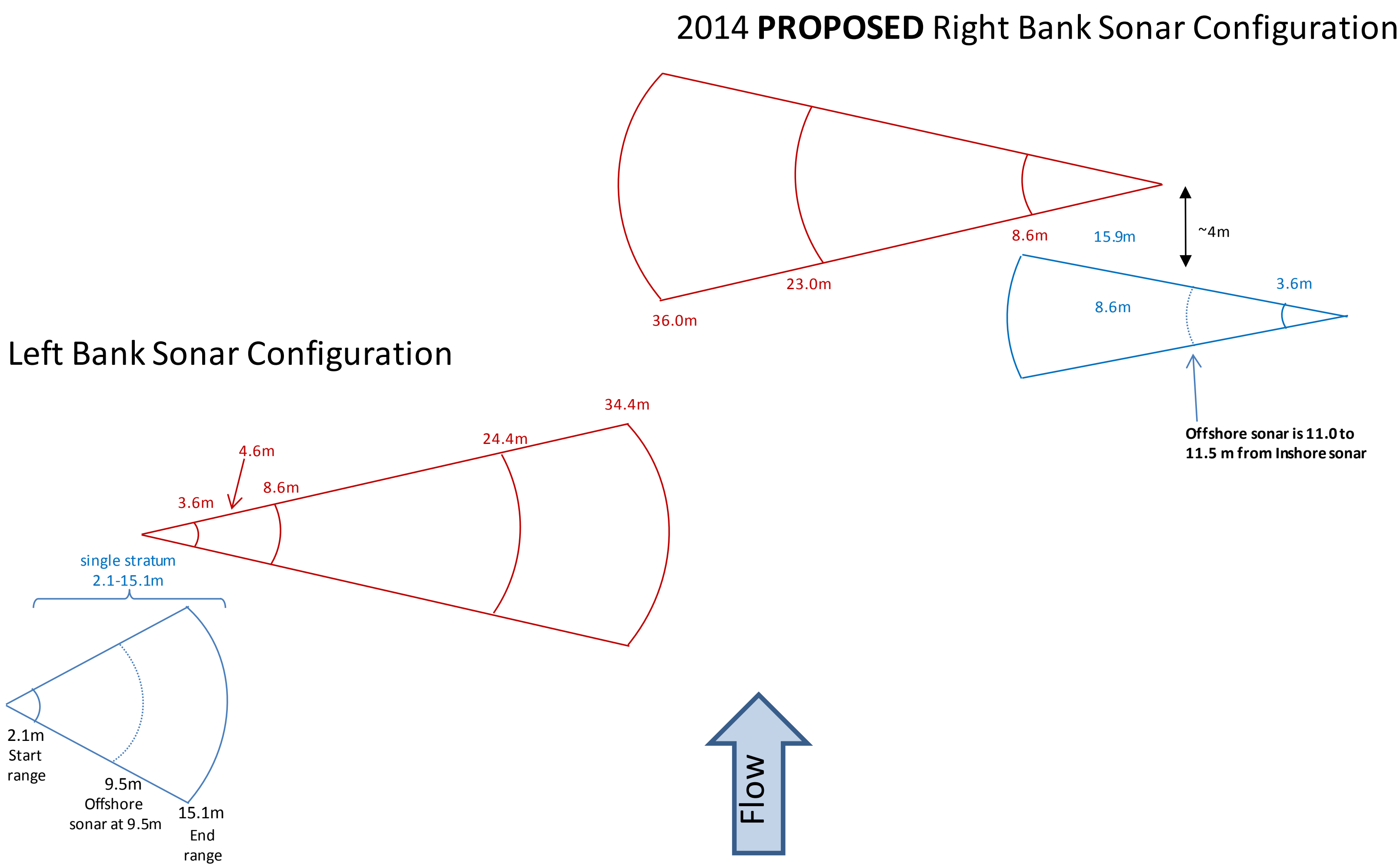


Figure 18.-Proposed nearshore and offshore sonar configuration showing proposed range strata and overlap ranges.

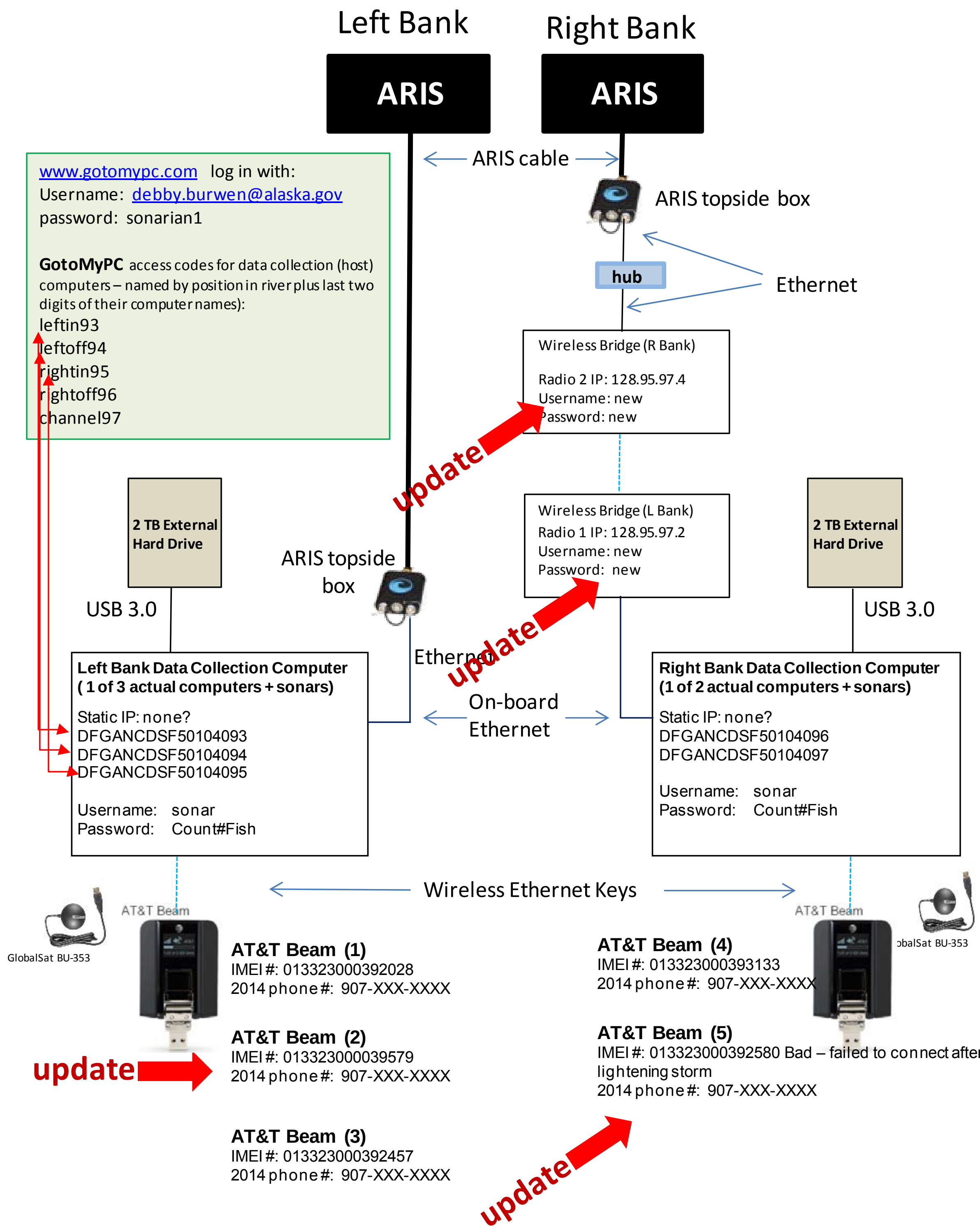


Figure 19.– ARIS data collection schematic for the RM 13.7 site. For simplicity, this diagram shows only one-of-three right bank data-collection computer+sonar pairs and one-of-two left bank data collection computer+sonar pairs. Each computer is equipped with wireless ethernet through AT&T Beams (providing 4g LTE service) and can be accessed remotely using Gotomypc accounts.

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.

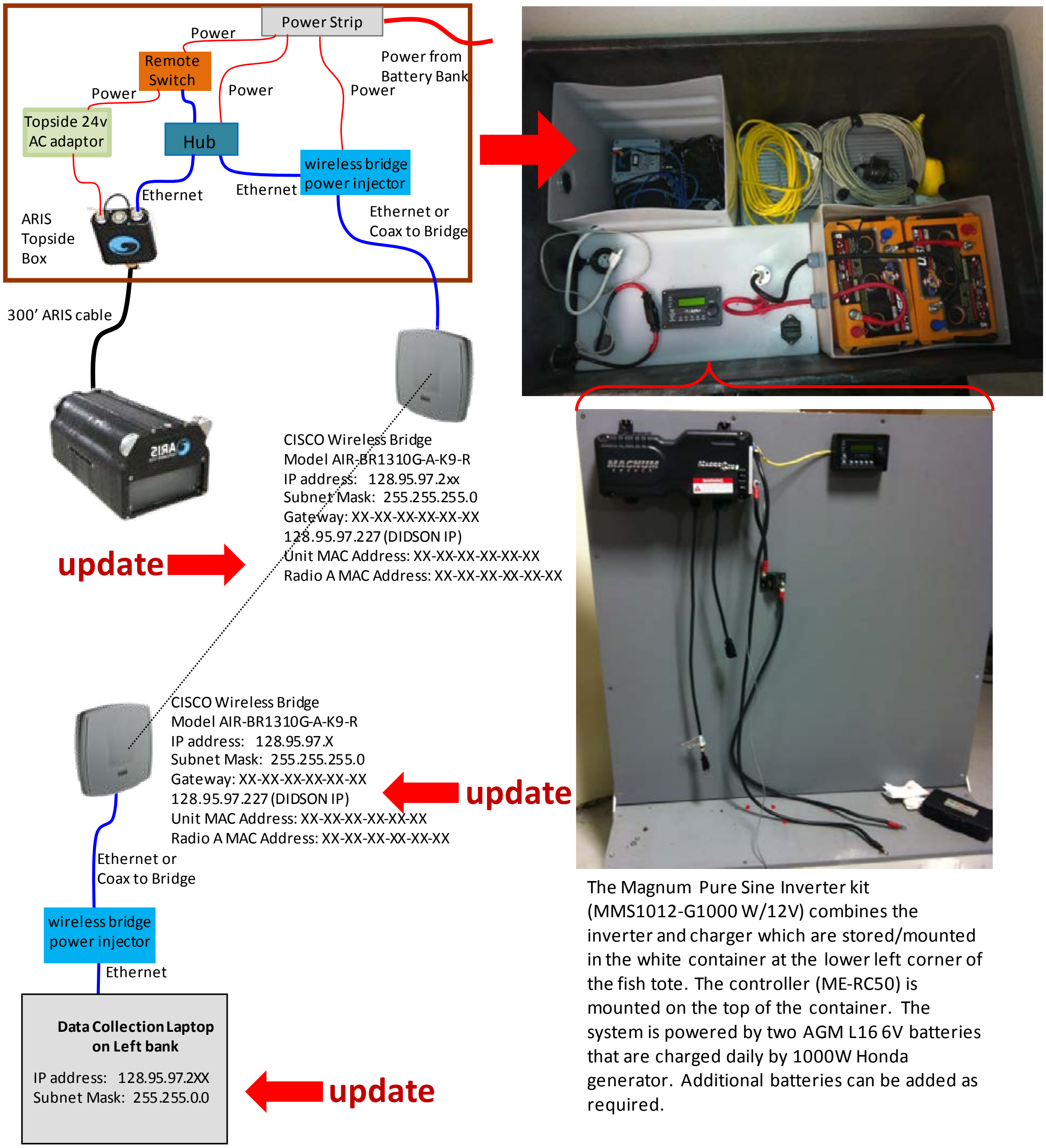


Figure 20.– Diagram of components required on RM 13.7 right bank for wireless transmission of ARIS data back to the main camp on left bank. A wireless bridge transmits data to a data collection computer on left bank for storage and subsequent transport to the Soldotna office.

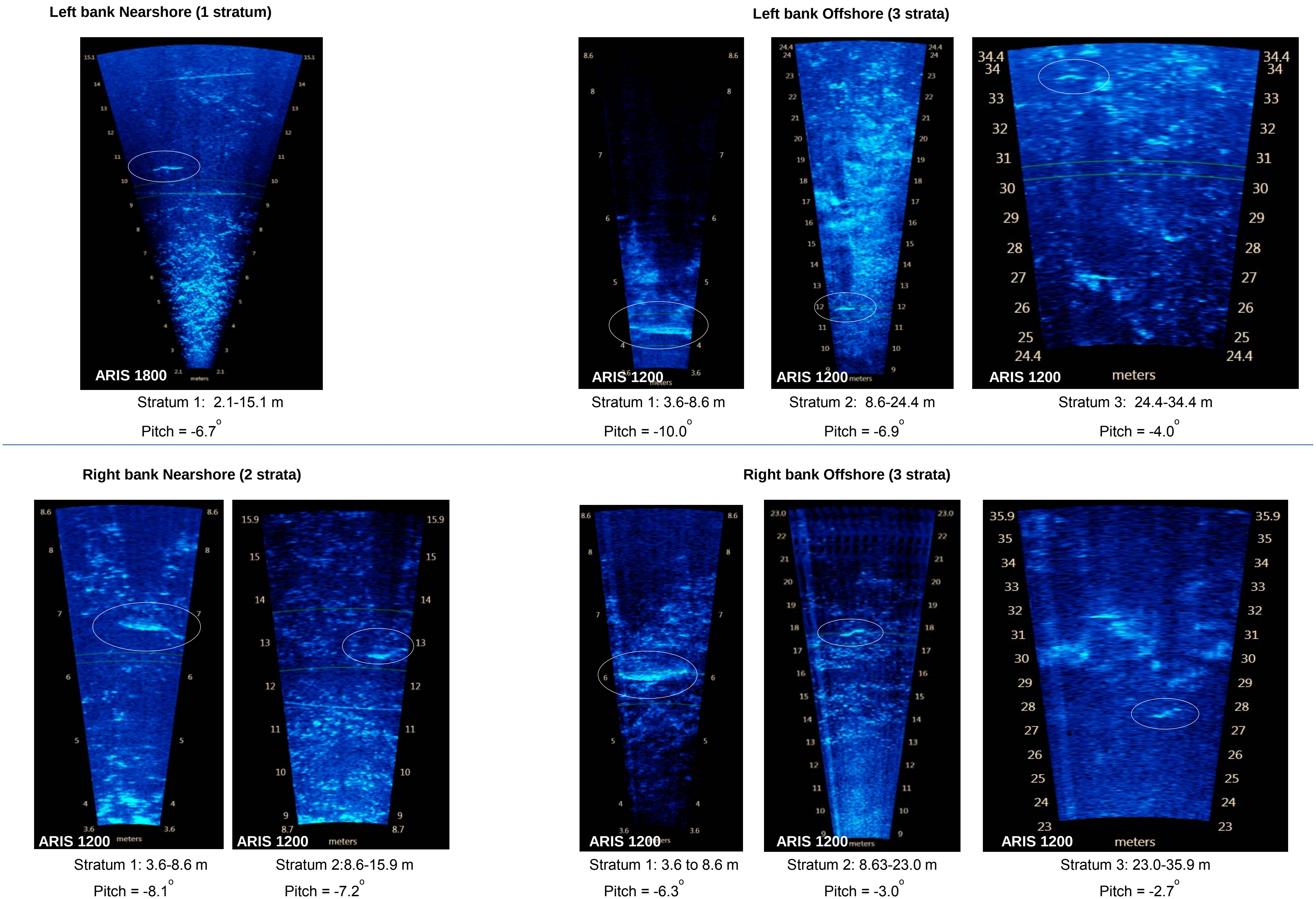


Figure 21.– Example images from each of the four left-bank (top) and five right-bank (bottom) range strata taken on August 8, 2013. Fish swimming through the beams are circled on each image.

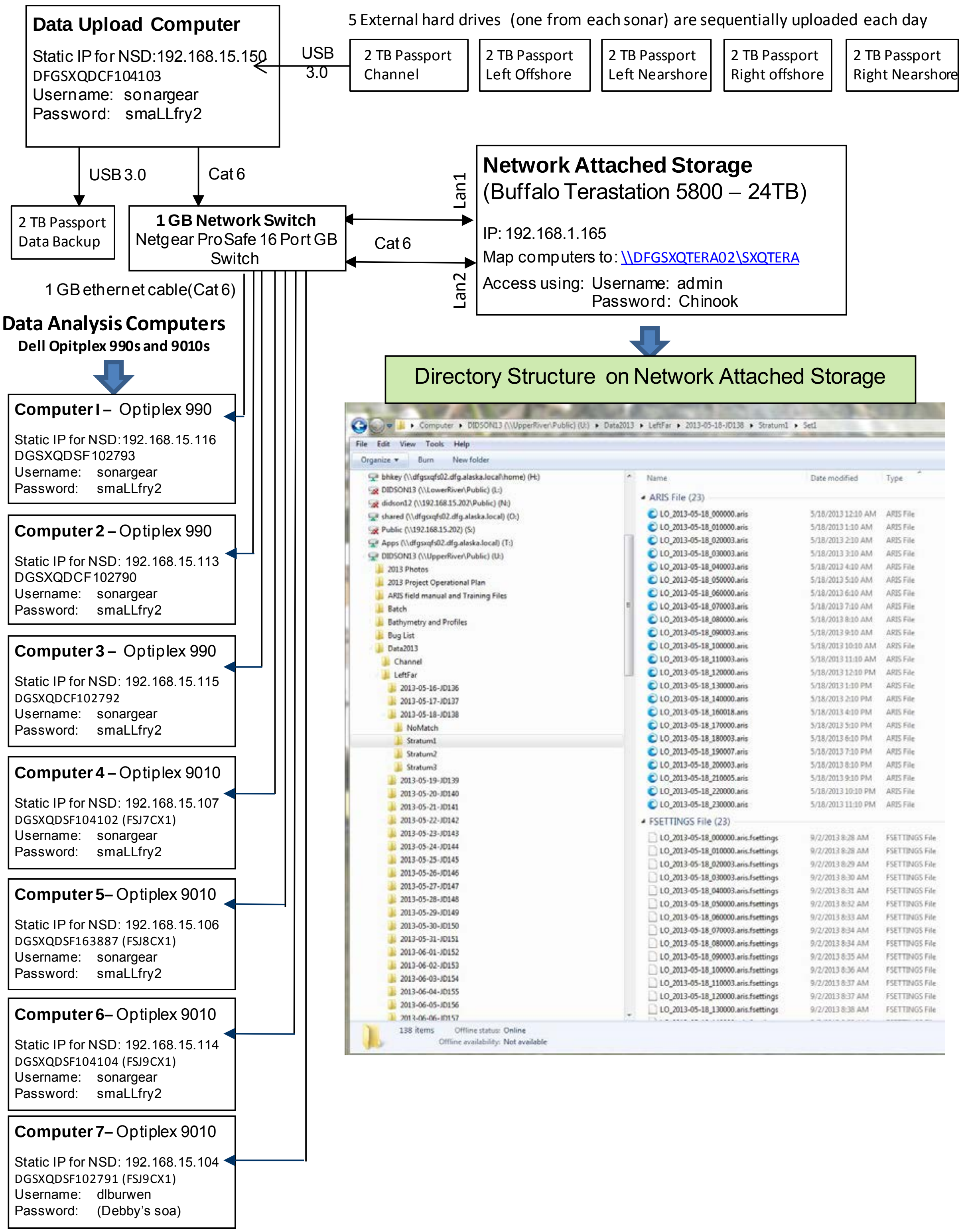


Figure 22.–Directory structure for the Network Attached Storage System in the Soldotna office (IP addresses updated by BK, 2014).

APPENDIX A. DIDSON AND ARIS CONFIGURATIONS TO BE USED ON KENAI RIVER CHINOOK SONAR PROJECTS AT RM 8.6 AND RM 13.7, 2014

Appendix A1.–DIDSON and ARIS configurations to be used on Kenai River Chinook sonar projects at RM 8.6 and RM 13.7, 2014, including an overview of features that affect resolution and range capabilities

a. Frequency

DIDSONs operate at two frequencies, a higher frequency that produces higher resolution images, and a lower frequency that can detect targets at further ranges but at a reduced image resolution. Two DIDSON models are currently available based on different operating frequencies (Table A1-1). The short-range or standard model (DIDSON SV) operates at 1.8 MHz to approximately 15 m in range and at 1.1 MHz to approximately 30 m and produces higher resolution images than the long-range model. The long-range model (DIDSON LR) operates at 1.2 MHz to approximately 30 m in range and at 0.7 MHz to ranges exceeding 100 m, but produces images with approximately half the resolution of the DIDSON-S (see explanation below). The two DIDSON LRs used in this study were operated in frequency mode to achieve maximum image resolution.

Similar to DIDSON, ARIS (for Adaptive Resolution Imaging Sonar) systems operate at two frequencies analogous to the DIDSON frequencies (Appendix A2). The two ARIS models used on this project, ARIS 1800 and ARIS 1200, are essentially updated versions of the DIDSON SV and DIDSON LR models (Table A1-1, Appendix A2). Both ARIS models used in this study were operated in high frequency mode to achieve maximum image resolution.

b. Beam Dimensions and Lens selection

The DIDSON-LRs and ARIS 1200s used in this study are fitted with high-resolution lenses to increase the image resolution to the level achieved by the DIDSON-SV and ARIS 1800 (Table A1-1, referred to as DIDSON-LR+HRL, ARIS 12000+HRL). The high-resolution lens has a larger aperture that increases the image resolution over the standard lens by approximately a factor of 2 by reducing the width of the individual beams and spreading them across a narrower field of view (Table A1-1). Overall nominal beam dimensions for a DIDSON-LR or an ARIS 1200 with a standard lens are approximately 29° in the horizontal axis and 14° in the vertical axis. Operating at 1.2 MHz, the 29° horizontal axis is a radial array of 48 beams that are nominally 0.54° wide and spaced across the array at approximately 0.60° intervals. With the addition of the high-resolution lens, the overall nominal beam dimensions of the DIDSON-LR and ARIS 1200 are reduced to approximately 15° in the horizontal axis and 3° in the vertical axis and the 48 individual beams are reduced to approximately 0.3° wide and spaced across the array at approximately 0.3° intervals. The combined concentration of horizontal and vertical beam widths also increases the returned signal from a given target by 10dB, an effect that increases the maximum range of the sonar over the standard lens.

A standard lens will be used with the ARIS 1800 deployed near shore at the RM 13.7 site because the wider beam dimensions are preferred for increasing the beam coverage at close range and reducing biases associated with focal resolution at close range (see below).

c. Resolution

The resolution of a DIDSON or ARIS image is defined in terms of down-range and cross-range resolution where cross-range resolution refers to the width and down-range resolution refers to the height of the individual pixels that make up the image (Figure A1-2). Each image pixel in a DIDSON or ARIS frame has (x, y) rectangular coordinates that are mapped back to a beam and sample number defined by polar coordinates. The pixel height defines the down-range resolution and the pixel width defines the cross-range resolution of the image. Figure A1-2 shows that image pixels are sometimes broken down into smaller screen pixels (e.g., pixels immediately to the right of the enlarged pixels), an artifact of conversions between rectangular and polar coordinates.

Cross-range resolution

The cross-range resolution is primarily determined by the individual beam spacing and beam width, both of which are approximately 0.3° for the DIDSON LR+HRL at 1.2 MHz (Table A1-1). Targets at closer range are better resolved because the individual beam widths and corresponding image pixels increase with range following the formula below:

$$X = 2R\tan(\theta/2) \quad (1)$$

Where

X = width of the individual beam or "image pixel" in meters,
R = range of interest in meters, and
θ = individual beam angle in degrees (approximately 0.3°).

Down-range resolution

"Window Length", i.e., the range interval sampled by the sonar, controls the down-range resolution of the image and is calculated using the formula:

$Y = W/N$

Where

W = Window Length (cm)

N = number of range samples (pixels)

With DIDSONs, N is fixed at 512 samples (pixels) and images with shorter Window Lengths are always better resolved. The DIDSON Window length parameter can only be set at discrete values 2.5, 5.0, 10.0, or 20.0 m for the DIDSON-LR+HRL at 1.2 MHz. Although using shorter window lengths will increase resolution, it will also require more individual stratum to cover the desired range. Dividing the total range covered into too many discrete stratum increases the data-processing time. For this study, a window length of 5m was used for the first two range strata to minimize the bias associated with close range targets (see section d below). A window length of 10 m was used for each of the two subsequent range strata sampled, a compromise which allowed a relatively high resolution while allowing a reasonable distance to be covered by each stratum. The down-range resolution (or pixel height) for a 5m range window is 1 cm (500cm/512) and for a 10 m window length is 2 cm (1,000 cm/512).

ARIS images can attain a finer down range resolution than DIDSON. With ARIS, *N* can vary to a maximum of 4,000 samples (pixels) and Window Length is user selectable. This allows the user to collect data over a longer Window Length but increase the number of samples per beam to compensate. Figure A1-2 contrasts images from a DIDSON LR+HRL with an ARIS 1200+HRL. The ARIS image in Figure A1-2 has twice the down-range resolution of the DIDSON image because it was collected at 2,000 samples (pixels)/beam with a 20m Range Window yielding a down-range resolution of 1 cm (2,000cm/2,000 pixels) compared to a down-range resolution of 2 cm for the DIDSON image that was collected at 512 samples with a 10m Range Window (1,000cm/512).

The pixels comprising the ARIS image appear less well defined because a smoothing algorithm has been applied.

d. Focal resolution in DIDSON and ARIS systems

When sizing fish from DIDSON images, there can be a bias factor beyond the geometric beam spreading issue, depending on the start range and end range of the image window. The DIDSON depth of field is reduced at closer focusing ranges, with the effect that defocused targets will appear smeared in the azimuthal direction. The degree of bias is dependent on both the set focus range, and the distance of the target from that set focus range. It is also dependent on the lens set. In general, if the focus is set to 4 m or longer for a standard lens, or 7 m or longer for a large lens, targets will be in good focus from there out to infinity. Inside of that range, focus will degrade, significantly (Bill Hanot, Sound Metrics Corporation, Seattle Washington, personal communication). One way to minimize out-of-focus images is to create a smaller range window for insonifying targets at close range. For example, we often use a 5m range window from ~3-8 m for the first range stratum when using a large (telephoto) lens.

For DIDSON, focus counts of 0-255 represent the total range of travel of the middle (focus) lens. For the ARIS 1200/1800, which uses the same lens set and has the same focus curves; focus counts of 0-1000 represent the total range of travel (0.1% per unit). Figure A1-3 shows the ARIS lens position (indicated by the numbers in the range 0-1000) versus focus range for the ARIS High Resolution (Large or telephoto) lens. There is a non-linear relationship of lens position to focus range, with short range focus requiring large movements for small increments in focus range, and long range focus having small changes in lens position for several meters of change in focus range. Also, beyond a certain range, images are generally in focus. Based on the focus curves in Figure A1-3, images are at least 75% in focus starting at 4 m for the standard lens, and starting at 7 m for the large lens.

Table A1-1.–Summary of manufacturer specifications for maximum range, individual beam dimensions and spacing for DIDSON SV, DIDSON LR, ARIS 1800, and ARIS 1200 systems at two frequencies, with and without the addition of a high resolution lens (specifications from Sound Metrics Corporation). A more complete summary is given in Appendix A2.

System	Maximum range (m)[a]	Horizontal beam width	Vertical beam width	Number of beams	Individual beam width[b,c]	Individual beam spacing[b,c]
DIDSON SV or ARIS 1800 at 1.8 MHz	15	28°	14°	96	0.30°	0.30°
DIDSON SV or ARIS 1800 at 1.1 MHz[d]	35	28°	14°	48	0.50°	0.60°
DIDSON SV or ARIS 1800 at 1.8 MHz + high-resolution lens	20	15°	3°	96	0.17°	0.15°
DIDSON SV or ARIS 1800 at 1.1 MHz + high-resolution lens	40+	15°	3°	48	0.22°	0.30°
DIDSON LR or ARIS 1200 at 1.2 MHz	25	28°	14°	48	0.50°	0.60°
DIDSON LR or ARIS 1200 at 0.7 MHz	80	28°	14°	48	0.80°	0.60°
DIDSON LR or ARIS 1200 at 1.2 MHz + high-resolution lens	30	15°	3°	48	0.27°	0.30°
DIDSON LR or ARIS 1200 at 0.7 MHz + high-resolution lens	100	15°	3°	48	0.33°	0.30°

[a]Actual range will vary depending on site and water characteristics.

[b]Beam width values are for two-way transmission at the -3 dB points.

[c]Values for beam spacing and beam width are approximate. Beam widths are slightly wider near the edges of the beam and the beam spacing is slightly narrower. Conversely, beams are slightly narrower near the center of the beam, and the beam spacing is slightly wider (e.g. the center beam spacing is closer to .34°, and the beam width is .27 for a DIDSON-S at 1.8 MHz, Bill Hanot, Sound Metrics Corporation, personal communication). Nonlinear corrections are applied by the manufacturer in software to correct for these effects in the DIDSON standard - but not the high-resolution - lens. Nonlinear corrections are applied in software to correct for these effects in both the ARIS standard and high-resolution lens.

[d]ARIS 1800 uses 96 beams at low frequency by default, where DIDSON is hard-wired for 48 beams at LF. So, 2 * 0.3 = 0.6 with respect to beam spacing. If you set ARIS 1800 for 48 beams then beam spacing is 0.6 at LF or HF.

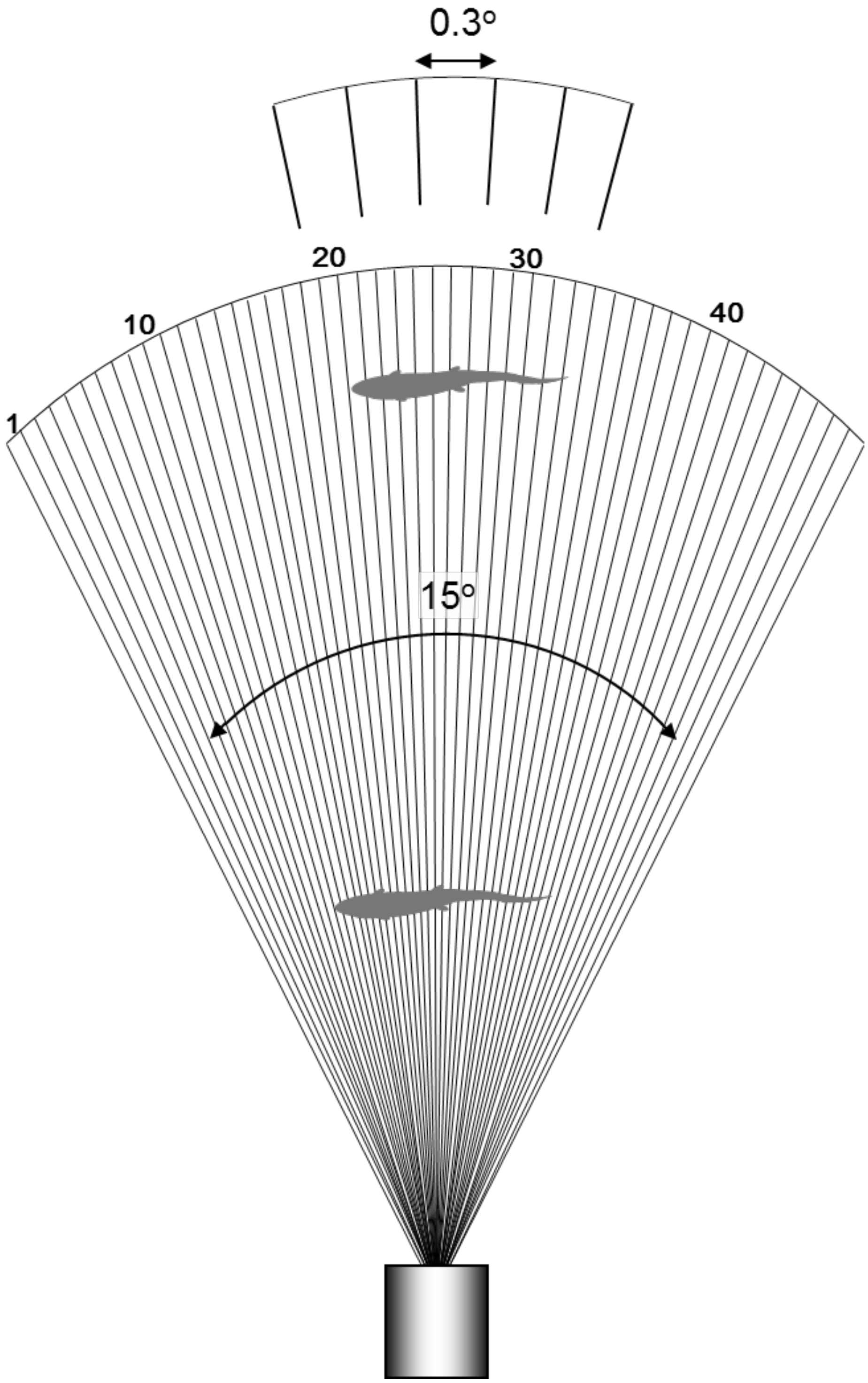


Figure A1-1.–Diagram showing the horizontal plane of a DIDSON-LR or ARIS 1200 with a high resolution lens. The overall horizontal beam width of 15° is comprised of 48 sub-beams with approximately 0.3° beam widths. Note that because sub-beams grow wider with range, fish at close range are better resolved than fish at far range (Adapted from Burwen et al. [2007]).

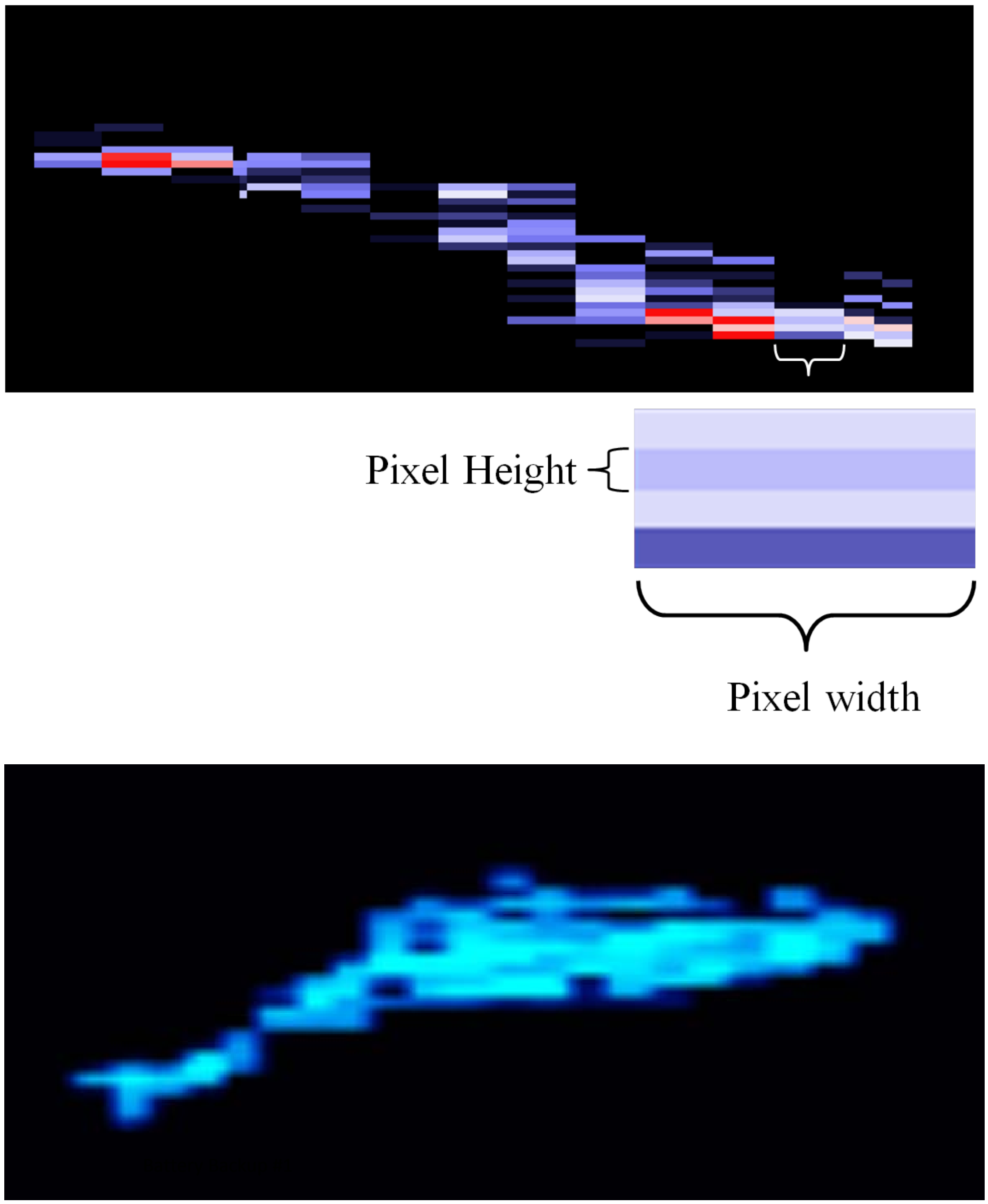
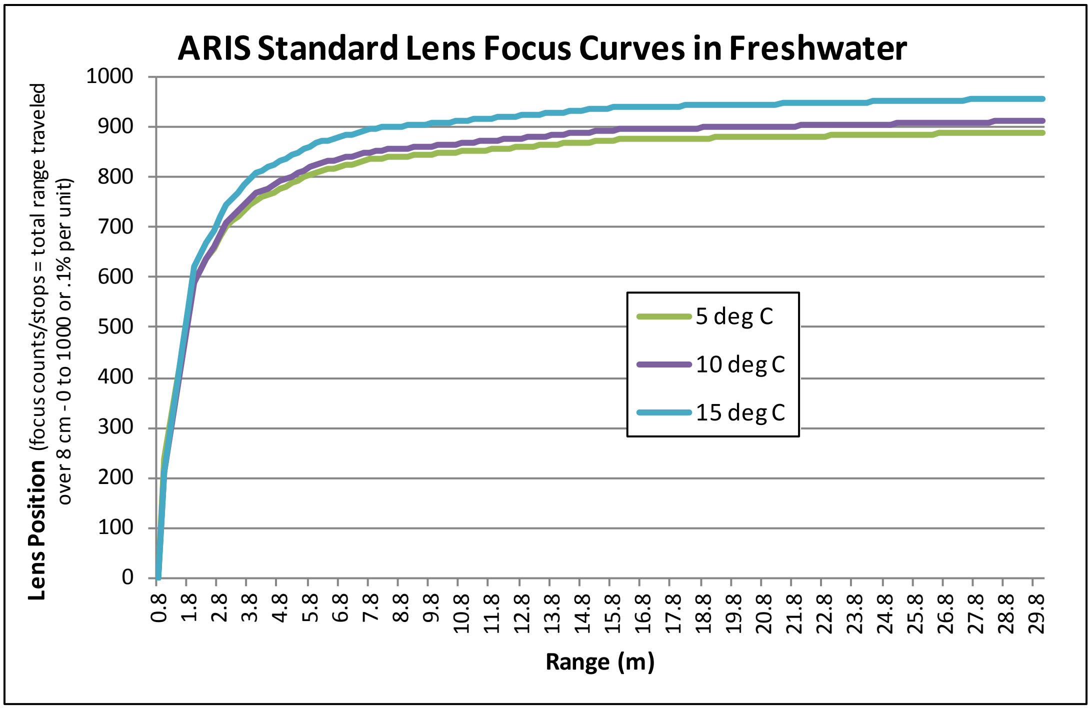


Figure A1-2.–An enlargement of a tethered Chinook salmon showing the individual pixels that comprise a DIDSON image (top) contrasted with an ARIS image of a free-swimming Chinook salmon (bottom).



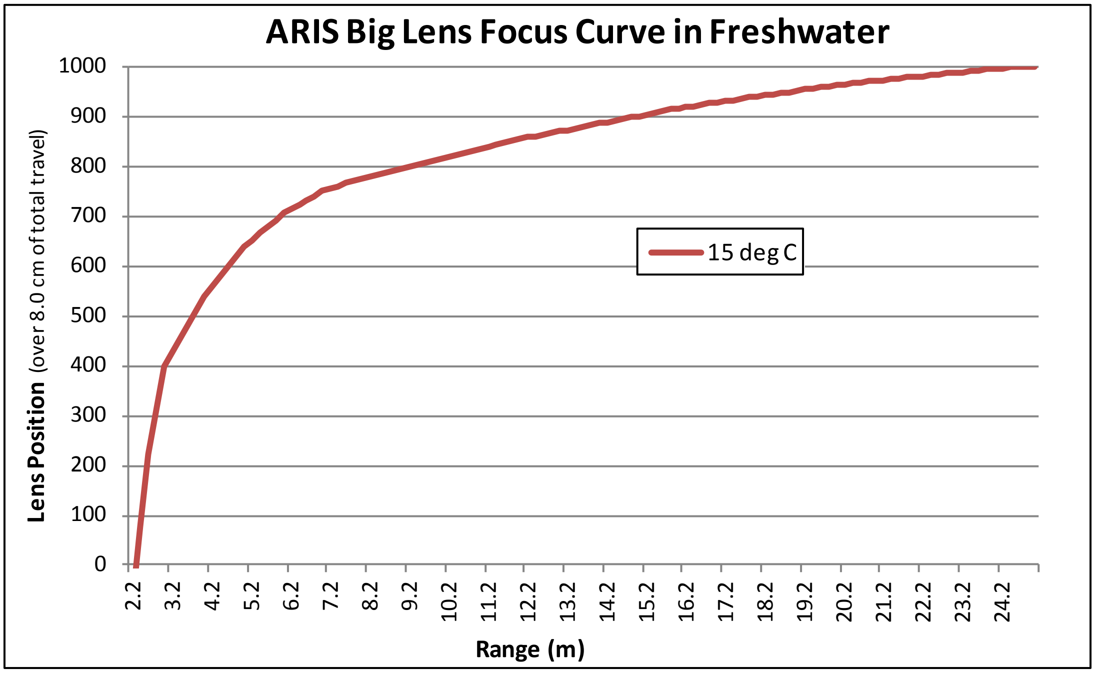


Figure A1-3.– Relationships between focal length and lens position for ARIS.

Appendix A1.–Manufacturer specifications for sonar models ARIS 1200, ARIS 1800, DIDSON SV, and DIDSON LR.

1. ARIS 1800 Specifications:

Detection Mode
Operating Frequency 1.1 MHz
Beamwidth (two-way) 0.5° H by 14° V
Source Level (average) ~200-206 dB re 1 μPa at 1 m (*TBD*)
Nominal Effective Range 35m

Identification Mode
Operating Frequency 1.8 MHz
Beamwidth (two-way) 0.3° H by 14° V
Source Level (average) ~200-206 dB re 1 μPa at 1 m (*TBD*)
Nominal Effective Range 15m

Both Modes
Number of beams 96 or 48
Beam Spacing 0.3° nominal
Horizontal Field-of-View 28°
Max frame rate (96 beams) 3-15 frames/s (6-15 frames/sec w/48 beams)
Minimum Range Start 0.7m
Downrange Resolution 3mm to 10cm
Transmit Pulse Length 4μs to 100μs
Remote Focus 0.7m to max range
Power Consumption 15 Watts typical
Weight in Air 5.5 kg (12.1 lb)
Weight in Water *TBD, ~1.4kg (3 lb)*
Dimensions 31cm x 17cm x 14cm
Depth rating 300m
Data Comm Link 100BaseT Ethernet
Maximum cable length (Ethernet) 90m (300 feet)

2. ARIS 1200 Specifications:

Detection Mode
Operating Frequency 0.7 MHz
Beamwidth (two-way) 0.8° H by 14° V
Source Level (average) ~206-212 dB re 1 μPa at 1 m (*TBD*)
Nominal Effective Range 80m

Identification Mode
Operating Frequency 1.2 MHz
Beamwidth (two-way) 0.5° H by 14° V
Source Level (average) ~206-212 dB re 1 μPa at 1 m (*TBD*)
Nominal Effective Range 25m

Both Modes
Number of beams 48
Beam Spacing 0.6° nominal
Horizontal Field-of-View 28°
Max frame rate (range dependent) 2.5-15 frames/s
Minimum Range Start 0.7m
Downrange Resolution 3mm to 10cm
Transmit Pulse Length 4μs to 100μs
Remote Focus 0.7m to max range
Power Consumption 15 Watts typical
Weight in Air 5.5 kg (12.1 lb)
Weight in Water *TBD, ~1.4kg (3 lb)*

Dimensions 31cm x 17cm x 14cm
Depth rating 300m
Data Comm Link 100BaseT Ethernet
Maximum cable length (Ethernet) 90m (300 feet)

3. DIDSON SV Specifications

Detection Mode
Operating Frequency 1.1 MHz
Beamwidth (two-way) 0.4° H by 14° V
Number of Beams 48
Beam Spacing 0.6°
(Extended) Window Start 0.83m to 52.3m in 0.83m steps
(Extended) Window Length 5m, 10m, 20m, 40m
Range Bin Size (relative to window length) 10mm, 20mm, 40mm, 80mm
Pulse Length (relative to window length) 18μs, 36μs, 72μs, 144μs

Identification Mode
Operating Frequency 1.8 MHz
Beamwidth (two-way) 0.3° H by 14 ° V
Number of Beams 96
Beam Spacing 0.3°
(Extended) Window Start 0.42m to 26.1m in 0.42m steps
(Extended) Window Length 1.25m, 2.5m, 5m, 10m
Range Bin Size (relative to window length) 2.5mm, 5mm, 10mm, 20mm
Pulse Length (relative to window length) 4.5μs, 9μs, 18μs, 36μs

Both Modes
Max Frame Rate (range dependent) 4-21 frames/s
Field-of-view 29°
Remote Focus 1m to Infinity
Control & Data Interface UDP Ethernet
Aux Display NTSC Video
Max cable length (100/10BaseT) 61m/152m (200ft/500ft)
Max cable length (twisted pair, Patton Extender) 1220m (4000ft)
Max cable length (fiber optics) kilometers
Power Consumption 25 Watts typical
Weight in Air 7.9 kg (17.4 lb)
Weight in Sea Water 1.0 kg (2.2 lb)
Dimensions 31.0cm x 20.6cm x 17.1cm
Topside PC Requirements Windows (XP, Vista, 7), Ethernet
Optional NTSC video monitor

4. DIDSON LR Specifications

Detection Mode
Operating Frequency 0.7 MHz
Beamwidth (two-way) 0.8° H by 14° V
Number of Beams 48
Beam Spacing 0.6°
Extended Range Settings
(Extended) Window Start 0.83m to 52.3m in 0.83m steps
(Extended) Window Length 10m, 20m, 40m, 80m
Range Bin Size (relative to window length) 20mm, 40mm, 80mm, 160mm
Pulse Length (relative to window length) 23μs, 46μs, 92μs, 184μs

Identification Mode
Operating Frequency 1.2 MHz
Beamwidth (two-way) 0.5° H by 14 ° V
Number of Beams 48
Beam Spacing 0.3° nominal
Extended Range Settings

(Extended) Window Start 0.42m to 26.1m in 0.42m steps
(Extended) Window Length 2.5m, 5m, 10m, 20m
Range Bin Size (relative to window length) 5mm, 10mm, 20mm, 40mm
Pulse Length (relative to window length) 7μs, 13μs, 27μs, 54μs

Both Modes
Max Frame Rate (range dependent) 2-21 frames/s
Field-of-view 29°
Remote Focus 1m to Infinity
Control & Data Interface UDP Ethernet
Aux Display NTSC Video
Max cable length (100/10BaseT) 61m/152m (200ft/500ft)
Max cable length (twisted pair, Patton Extender) 1220m (4000ft)
Max cable length (fiber optics) kilometers
Power Consumption 25 Watts typical
Weight in Air 7.9 kg (17.4 lb)
Weight in Sea Water 1.0 kg (2.2 lb)
Dimensions 31.0cm x 20.6cm x 17.1cm
Topside PC Requirements Windows (XP, Vista, 7), Ethernet
Optional NTSC video monitor

APPENDIX B. PROCEDURES FOR DAILY DIDSON PROCESSING

Appendix B1.- Steps for processing RM 8.6 daily DIDSON data using batch files, Kenai River Chinook sonar, 2014.

Last updated by Jim Miller and Brandon Key April 2, 2014. Note that filenames and directory structures highlighted in yellow will need to be updated annually.

- <u>Raw Data Transfer and Storage</u>

Edit then run *didson.bat* (located in L:\Batch\) to move/sort data from thumb drives to processing directory on the Network Storage Device.

1. Change Julian date
2. Change the Calendar date
3. Change the drive label(s) for the jump drives if needed (you will see the drive label when you plug the drive in)

- <u>Prior to Data Processing</u>

Once all files have been measured:

1. Update the "*Daily summary*" sheet (tab) for the day being processed.
2. Update the "*missed hours for SAS – dsamples*" sheet (tab).
    a. Highlight and copy previous day's rows, then update the cells with the current day's missing samples ("1" for present, "0" for missing). **Be sure to remove all zeros from the copied data before updating**.
    b. Highlight and copy the updated cells to Dsample2014.txt located in the L:/DataProc14/Manual folder.
        i. Paste entries at bottom of the file (no extra spaces at end)
        ii. Save file
3. Copy Dsamples2014.txt into the L:\Data2014 folder for the date/Julian day you are processing. i.e. "L:\Data2014\2014-06-18_JD169"
4. Open "DP2014" folder on desktop.
5. Open "Process Data" folder.

- <u>Processing Data Measured in Office</u> (**To be done from data processing computer only**)

1. **Package DIDSON** (Batch File – *package_didson.bat* – located in L:\Batch\)
    a. Edit prior to running batch file (change date and Julian date)
    b. Make sure DSAMPLES is updated and located in root folder for that day's data
    c. Run batch file

2. **Open DIDSON Data (**Processing Folder – L:\DataProc14\Manual)
    a. Open folder
    b. Look in folder to verify all files are present (195 files total – 193 data files plus three additional files)

3. **DIDSON Dater** (Batch File – *Ddater.bat* – located in L:\DataProc14\)
    a. Follow directions to edit/update batch files

    b. Update Julian and/or calendar date
    c. Also gets netting data

4. **Process DIDSON Fishes** (Batch File – *PDF.bat* – located in L:\DataProc14\)
    a. Automatically packs up libraries and programs
    b. Automatically opens SAS
        i. Click on File
        ii. Click on Open Program (arrow up one level) to DataProc14\Manual
            1. SAS Folder
            2. SAS Programs
            3. Open DO_Configure 2014 V1
            4. Verify correct Julian date
            5. Click running guy to start program
            6. Check tides table when prompted
            7. Allow program to run
        iii. In "Results Viewer – SAS Output" tab in SAS
            1. Check for missing samples at top of viewer
            2. Save the graph titled "Upstream Fish Detected by DIDSON – By Day Dlength Threshold 80"
                a. Right click on graph
                b. Click "Save Picture As"
                c. Save picture to Desktop
                    i. Click drop down menu
                    ii. Select the file that is there and change the Julian Date
                    iii. Graph will be saved as a *.png file
            3. Save the entire SAS output
                a. Click File, then Save As
                b. Click drop down arrow
                c. Save as SAS-**OFFICE**_JDxxx.mht
        iv. Now done with SAS
    c. Go back to DIDSON Fishes batch file window and continue with batch file
        i. Batch file will put data away
        ii. Look in DIDSON Data Folder (data files should be gone)

5. **Calculate Water Temperature** (Batch File – *WaterTemp.bat* – located in L:\Batch\)
    a. Run batch file – make sure the calendar and Julian dates are right
        i. If not, Control-C to stop batch program, then right click the "Calculate Water Temperature" icon, click "edit", and then update the dates – then run batch file again.
        ii. Batch file automatically starts Excel spreadsheet
        iii. Click "Click Here For Temperature Averages"
        iv. Write down temperatures
        v. Close (<u>BUT DON'T SAVE</u>) spreadsheet (will close twice)

6. **Get Netting Data** (Batch File – *GetNettingData.bat* – located in L:\Batch\)
    a. Run batch file – follow directions
    b. Automatically opens Docushare
    c. Write down the proportion of Chinook from the "Chinook Proportion" column.
    d. Downsize the Docushare window (you'll need this later)
    e. Press any key to continue (end) the batch file

7. **Estimate Summary** (Batch File – *Estimates.bat* – located in L:\Batch\)
    a. Run batch file
    b. Automatically opens the estimate summary Excel workbook
    c. Open the *SAS-OFFICE_JDxxx.mht* file that was saved to Desktop earlier – you will need this in a bit
    d. In the "Estimates By Day" tab of the Excel workbook, update each 'daily' column in the table using the summary tables (Range Threshold, >75cm, >80 cm, >85 cm) in the *SAS-OFFICE_JDxxx.mht* file.
    e. The pNet column is the Chinook proportion from the netting data
    f. Print one copy of the estimate summary table for the office notebook.
    g. Print one copy of the graph (in the *2014 Plot Early/Late [Print Me]* tab) for office notebook
    h. Open Outlook (email)
        i. Password: Counting#Fish
        ii. Create new email
    i. In the *Daily Estimates (Email Me)* tab of the Excel workbook, change the "prepared by" at the bottom of the table to the name of the person preparing the data.
    j. Highlight and copy the table into the body of the new email
    k. Copy the table title (EARLY/LATE RUN ESTIMATE SUMMARY) to the subject line of the new email.
    l. Save and close the Estimate Summary Excel workbook
    m. Batch file will continue and will put a copy of the Estimate Summary workbook onto the Desktop then terminate.

8. **Office Log** (Batch File – *OfficeLog.bat* – located in L:\Batch\)
    a. Run batch file and follow instructions
    b. Batch file opens *Tides and Currents* program
        i. Go back one day
        ii. Write down moon stage
        iii. Close *Tides and Currents*
    c. Continue with batch program – it will open Office Log template (Word document)
        i. Fill in the template
        ii. Save the template as a <u>Word document</u>
            1. Click on "File", then "Save As"
            2. Click drop down arrow
            3. Pick yesterday's file name
            4. Update with today's name, then Save

iii. Save the template as a PDF document
1. Click on "File", then "Save As"
2. Save as PDF this time
iv. Print one copy for office notebook
v. Close template
d. Press any key – batch file advances – automatically copies log files to Desktop

9. **Attach files to email**
a. In the draft email, attach all the following from the Desktop:
i. Office Log (pdf)
ii. Daily Graph (pdf)
iii. Estimate Summary (xls)
iv. SAS-OFFICE-JDxxx (mht)

10. **Docushare Upload** (Batch File – *dorkUshar.bat* – located in L:\Batch\DataProc14\)
a. Run batch file – Opens Docushare
b. Login to Docushare
c. Update Estimate Summary (red arrow)
d. Upload Office Log – copy previous day's title first
e. Upload DIDSON Range/Time Graph – copy previous day's title first
f. Close Docushare
g. Continue batch file – closes automatically.

11. **DIDSON Upload** (Batch File – *dupload.bat* – located in L:\Batch\)
a. Run batch file
b. Look in FileLog.txt on Desktop to make sure data sent.

12. **Finish and send email**
a. In the "To" field of the email, type "SS". This will import the distribution list.
b. Send email

13. **Archive Batch Files** (Batch File – *ArcBats.bat* – located in L:\Batch\)
a. Run batch file
i. Archives batch files
ii. Cleans up Desktop

- Processing Data Measured at Camp (**To be done from data processing computer only**)

1. **Process Camp Data** (Shortcut)
a. Shortcut to "Process Camp Data" folder (**located in the Process Data folder**)
b. Click to open folder

2. **Camp Dater** (Batch File – *Ddater.bat* – located in L:\CampProc14\)
a. Run Camp Dater

b. Update batch files

3. **Update Csamples** (Batch File – *Csamples.bat* – located in L:\Batch)
    a. Click to run Update Csamples batch file – follow instructions
    b. Opens Dsamples
    c. Use "control C" to copy current day's data
    d. Close notepad
    e. Automatically opens Csamples
    f. Paste data at end – make sure there are no extra spaces at the end
    g. Save Csamples
    h. Program closes
    i. **Note**: If incorrect date was entered while running Camp Dater, Update Csamples will discard your Csamples file and insert Dsamples. If this occurs, you will need to copy the previous day's Csamples from the Zip file in L:\CampProc14\ProcessedData\CAMPPOOL to L:\CampProc14\Manual and then update with the current day's Csamples data.

4. **Pack Camp DIDSON Files** (Batch File – *PackCampdidson.bat* – located in L:\CampProc14\)
    a. Click to run batch file
    b. Copies files to CampProc2014\Manual

5. **Open Camp Data Folder** (Shortcut)
    a. Shortcut to "Manual" folder in L:\CampProc14\
    b. Click to open folder
    c. Check to make sure you have 195 files (195 if a complete day) – if not, need to go back and identify missing samples
    d. Click back arrow to get to processing window

6. **Process Camp Fishes** (Batch File – *PCDF.bat* – located in L:\CampProc14\)
    a. Click to run batch file
    b. Automatically opens SAS
    c. Click "File", then up one level
    d. Open <u>CAMP-DO</u> program (<u>NOT</u> DO-Configure)
    e. Click the running dude icon
    f. File\Save As
        i. Dropdown
        ii. Save to Desktop as "SAS-Output JDxxx"
            1. **NOTE**: makes sure the file name includes the word "Output" and not "OFFICE".
    g. Close SAS
    h. Batch file automatically cleans up folder
    i. Batch file closes

7. **Office vs. Site Estimate Comparison** shortcut located in C:\Users\jdmiller1\Desktop\DP2012\Process Camp Data
    a. Click to run batch file
    b. Automatically opens Excel workbook
    c. Fill in office data (white columns)
        i. From Estimate Summary print-out and SAS-OFFICE-JDxxx.mht file on Desktop
    d. Fill in camp data
        i. From SAS-Output-JDxxx.mht on Desktop
    e. Print the Estimates by Day table and the comparison plots.
    f. Save and close Excel workbook
    g. Batch file closes

8. **Archive Camp Batch Files** (Batch File – *ArcCampBats.bat* – L:\CampProc14\)
    a. Click to run batch file – automatically archives
9. **Close all windows**

Appendix B2.-Primer on Batch (.bat) files.

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. Before executing a batch file, first edit (right mouse click, <Edit>, and <Run>) the file for the correct assignment of Julian (ordinal) date, Date, Data Set, and drive path. Then save the file with the updated settings before running batch.

Table B2-1. List of Batch files and functions currently used in DIDSON data processing

Batch File Name	Location	Function
didson.bat	L:\Batch\	Transfers DIDSON data from jump drives delivered from camp to the Network Area Storage (SAN – also referred to as SAN in batch files): • Creates directory structure for storing each days data by Julian Date\bank\stratum\set • ***Renames*** each file by inserting an R for right bank files and L for left bank (determines bank by sample time in filename) • ***Moves*** data from jump drives to appropriate directory
package_didson.bat	L:\Batch\	Moves .txt files (for a given Julian Date) AND dsamples.txt to a directory (L:\DataProc\Upload) to facilitate processing and summarizing with SAS, Access, Excel
ddater.bat (office data)	L:\DataProc14\	Prompts user to change dates in files used for SAS processing.
PDF.bat	L:\DataProc14\	Warns user to shut down open versions of SAS to prevent writing over prior files. Then initiates SAS processing.
WaterTemp.bat	L:\Batch\	Opens Excel workbook for average water temperature calculations
GetNettingData.bat	L:\Batch\	Copies CSOT files generated by SMC software to the Echoview directory for processing
Estimates.bat	L:\Batch\	Opens Daily Estimates Excel workbook for updating
OfficLog.bat	L:\Batch\	Opens new Office Log Word document
dorkushare.bat	L:\DataProc14\	Opens Docushare for daily update
dupload.bat	L:\Batch\	Transfers .txt files to Anchorage drive for mixture model processing
ArcBats.bat	L:\Batch\	Archives office processing batch files
ddater.bat (camp data)	L:\CampProc14\	Prompts user to change dates in files used for SAS processing.
Csamples.bat	L:\Batch\	Prompts user to update Csamples text file
PackCampdidson.bat	L:\CampProc14\	Moves .txt files (for a given Julian Date) AND Csamples.txt to a directory (L:\CampProc2014\Manual) to facilitate processing and summarizing with SAS, Access, Excel
PCDF.bat	L:\CampProc14\	Warns user to shut down open versions of SAS to prevent writing over prior files. Then initiates SAS processing.
ArcCampBats.bat	L:\CampProc14\	Archives camp processing batch files

APPENDIX C. INSTRUCTIONS FOR MANUAL FISH MEASUREMENTS AT RM 8.6 USING SMC CONTROL AND DISPLAY SOFTWARE VERSION 5.25

Appendix C1.- Instructions and settings to be used for manual length measurements from DIDSON images in 2014 at RM 8.6 using SMC Control and Display Software Version 5.25.28.

a. Parameter setup prior to beginning measurements:

Step 1. set the number of frames displayed (i.e., when right-clicking on a fish in echogram mode to display in movie mode) from the default of plus minus one second to +- any number of frames:

1. Select **<image><playback><set endpoints>**
2. [√] Loop on still for +/- N frames
3. Enter the number of frames (I suggest 20-30) but you be the judge

Step 2. Select **<Processing><Echogram><Use Cluster Data>** if you want to use ALL the beams when creating your Echogram (we generally do). You can use fewer beams by unchecking this option and selecting the number of beams.

Step 3. Set up your **processing parameters** (last Icon on right) for **<u>File Creation</u>** as follows:

- ✓ Auto Countfile Name
- ✓ Binary Count File (.dat)
- ✓ New Countfile on Open
- ✓ Echogram File (.ech)

Step 4. Echogram counts can be reloaded to finish or review at a later time if you have checked the Echogram file as follows:

1. Select **<File><Open> then Files of type .ech** from drop-down menu
2. Open desired file
3. The Echogram should reload showing you your previous measurements

Or this option will work as long as you saved the .dat file (as shown above)

1. Open the file and bring up your echogram as usual (follow instructions below)
2. Select **<Processing><Echogram><Import Echogram Counts>**
3. Select the **.dat** file with your saved counts – file should reload showing you your previous measurements (the filename for the .dat file will begin with **FC_**)

Step 5. Make sure <Image><Configure><Auto Threshold/Intensity> is UNCHECKED. This will keep your threshold and intensity settings from changing when you switch between echogram and movie mode

Step 6. Uncheck the 'Display Raw Data' toolbar icon (first button on left in Combined toolbar). (If you are in the movie mode and it is displaying the raw image data, it is because 'Display Raw Data' is enabled by default).

b. Instructions for manual echogram-based length measurements

***note that these settings may already be active as some of them have "memory" and are saved until changed**

1. Select **<BS>** (for background subtraction) from toolbar - or under **<Processing><Background><Background Subtraction>**
2. Select **<Processing><Background><Fixed Background>**
3. Select threshold and range settings given in Table C1-1 (To adjust these settings, use the slider bars under Display Controls to the left of the echogram).
4. Select the threshold and intensity settings for each range strata as indicated below. To adjust these settings, use slider bars under the Display Controls to the left side of the Echogram or Movie window.
5. Select **<EG>** (for view Echogram) from toolbar or under **<Processing><Echogram><View echogram**>

6. **<left click>** on the echogram near\on the fish trace of interest to "mark it" - you should see a white circle
7. **<right click>** INSIDE the white circle to switch to movie mode (movie mode will play the 16 frames encompassing this circle continuously)
8. Press **<space bar>** to pause movie
9. Step through the movie frames using the right or left arrows until you find a frame that you think displays the entire length of the fish well (see section C below for selecting optimal images).
10. **<right mouse click drag>** will magnify the area in the rectangle
11. **<left click>** on the FISH SNOUT and continue to <left click> along the body to create a "segmented measurement." ***The segments should follow the midline of the body of the fish*** – ending with the tail. Try not to use more than three or four segments to define the fish (see section C below)
12. **<double left click>** or select **<f>** key to add measurement to file (fish it!)
13. **<right click>** to unzoom
14. **<right click>** to return to Echogram

Hot keys:

1. **<e>** to "save" all echogram measurements to file
2. **<f>** to "fish it" (to accept the measurement and display it on the echogram)
3. **<u>** to "undo" the last segment
4. **<d>** to "delete" the all segments
5. **<space bar>** to pause in movie mode (if this doesn't work – click in the black area of the display)
6. **<right arrow>** forward direction when you select play or advances frame one at a time if the pause button is on (pause button = blue square on the toolbar)
7. **<left arrow>** opposite of above
8. **Left Click Drag –** to show movie over the selected time
9. **Right Click Drag –** zooms the selected area

Table C1-1.-Threshold and intensity settings for range strata. To adjust these settings, use slider bars under the Display Controls to the left side of the Echogram or Movie window.

	3.3-8.3m	**8.3-13.3m**	**13.3-23.3m**	**23.3-33.3m**
Threshold	11	11	10	9
Intensity	50	50	45	40

c. Selecting optimal images to measure

Measurements should be taken from frames where contrast between the fish image and background are high and where the fish displays its full length (e.g. Panels a, d, and f in Figure C1-1). In general, the best images are obtained when the fish is sinusoidal in shape (rather than straight and perfectly perpendicular) because the head and tail appear most visible when there is curvature to the fish body (e.g. Figure C1-2). Figure C1-2 demonstrates the process of measuring a fish using the manual measuring tool. The user pauses the DIDSON movie (top), zooms in on the fish of interest (middle), and measures the fish length with a segmented line created by mouse clicks along the center axis of the fish (bottom). The first mouse click is made at the leading edge of the pixel associated with the snout and the final click on the trailing edge of the pixel associated with the tail. The software adds the individual segment lengths that are calculated from the pixel coordinates of the DIDSON image.

Helpful Tips

- Ensure you can view the entire echogram- if you can't see the range hash marks, you need to expand the screen further with Toggle Header control and/or manually dragging EG window.
- Toggling between movie mode and echogram mode- Right mouse click on echogram to see looped movie at same echogram time stamp. Spacebar will pause loop.
- Mark targets in EG mode with mouse left click, and try to do so somewhere on target track, because this also logs target range. Right mouse click inside target marker to toggle to movie mode for manual measurement. Zoom into target by mouse right click and diagonally dragging a focal window. Use forward/reverse arrow keys to advance through frames for optimum image measurement. Note that direction of travel is logged based on how you measure the target (head to tail). Press <F> to log target. Note that echogram will now indicate target length and direction of travel (Blue marker=downstream, Yellow=Upstream).
- Some targets may hold/linger in the beam and should not be tracked unless you deem them to have made sufficient progress up or down stream. Significant over estimation of fish could occur if everything in the beam were tracked/measured without regard for upstream progress.
- Some targets may glance the corners of the beam, if you feel these targets do not provide sufficient direction of travel information, or that they may be dipping in an out of the beam throughout the sequence, use your discretion at tracking. When Chinook fall into this marginal category, give them closer attention than smaller targets, as missing a small target is less important than missing a KING.
- Use all the tools at your disposal- the echogram provides a roadmap to not only where targets occur in the sequence, but often gives strong clues to what the target species is. Trace intensity, length, and tail beat amplitude/frequency give you information that comes in handy before you toggle to video mode. Video mode and the video loop allow you to better sort out number, behavior, and location of targets in especially complex sequences.
- Press <E> to save your work on each sequence when complete (or before you divert to another task).

Known issues/bugs

- Use of Fixed Background function (Processing>Background>Fixed Background) sometimes causes the Background Subtraction function to become inoperable when advancing to subsequent files. This usually necessitates restarting the DIDSON software. Additionally, use of this function during tracking is necessary if you have reason to scrutinize target(s) by repeated advancing and retreating frames. Under this circumstance, background subtraction will make target more and more diffuse unless fixed background function is enabled.
- During length measurements, sometimes the initial mouse click on the target does not work. This missed mark just means that you have to first delete your second mark and retry first.
- Some settings are saved, while others may default to undesired values. It is wise to periodically check your settings to confirm. Oftentimes a change in settings will be apparent during normal tracking and quickly corrected.

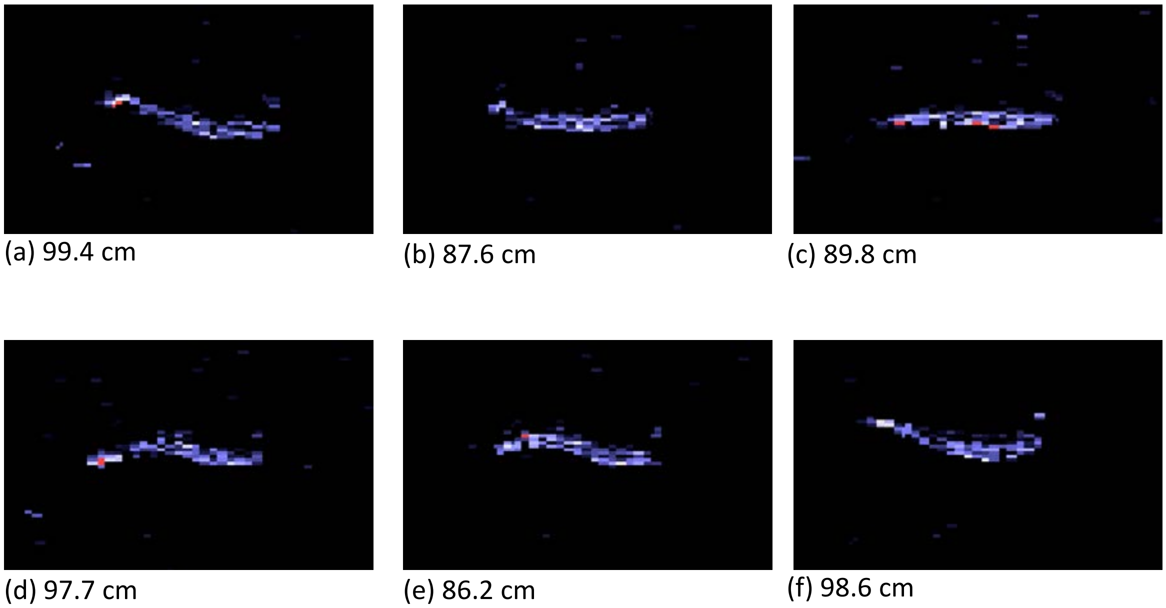


Figure C1-1. – Panels a-f show the variability in length measurements from DIDSON images of a tethered Chinook salmon during one full tail-beat cycle (adapted from Burwen et al. 2010).

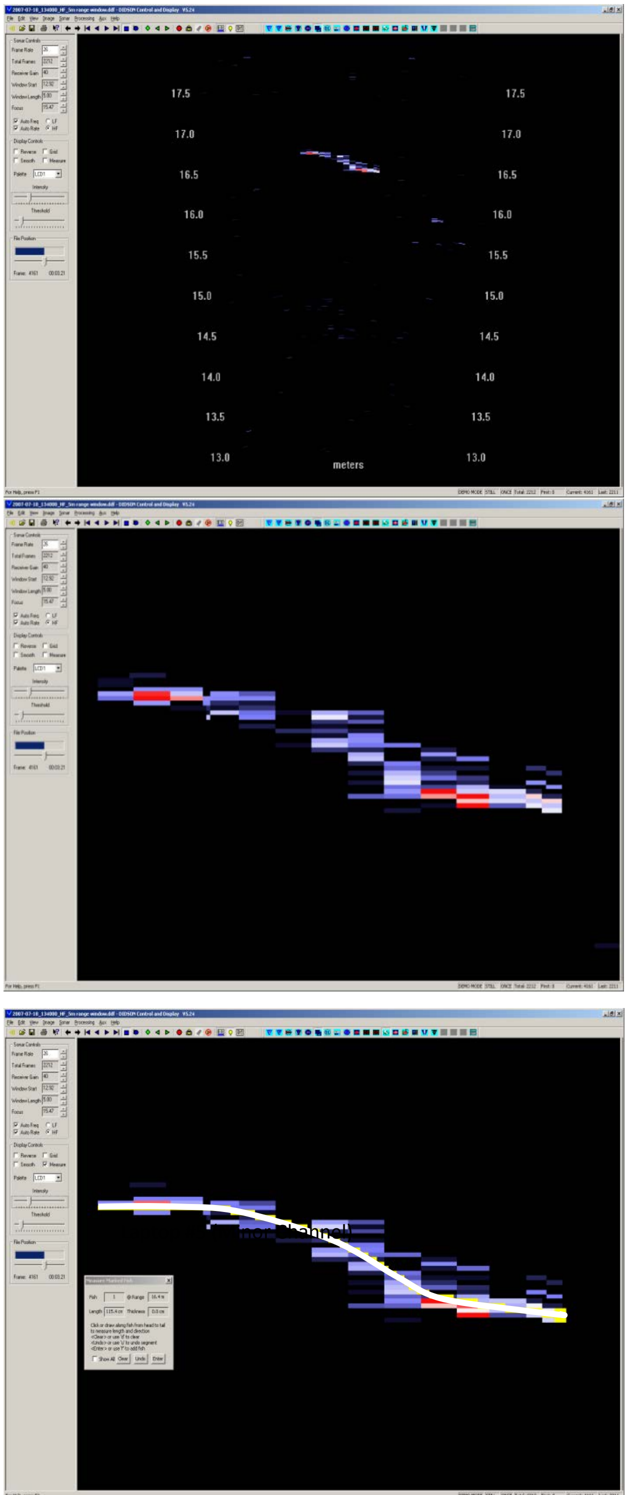


Figure C1-2. – DIDSON images from a tethered Chinook salmon showing the original DIDSON image (top), the zoomed image (middle), and the segmented lines that result when the observer clicks along the length of the fish to mark its length (bottom). Adapted from Burwen et al. 2010.

APPENDIX D. DIDSON LENGTH MIXTURE MODEL AND ASSOCIATED BUGS PROGRAM CODE

Appendix D1.– Mixture model for estimating species composition of migrating fish.

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 Figure D1-1. 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 sockeye and Chinook. For instance, if it is known that sockeye salmon do not exceed 70 cm in length, and that small Chinook 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/Chinook. 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 that there are substantial numbers of small Chinook, and that there is error in the length measurements. 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.

Such a model can be conducted on any quantity related to length, including length as measured from DIDSON images ("Dlength"). 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 10 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. Since Dlength is a reasonably good predictor of fish length (Figure D1-2; Burwen et al. 2010) the observed frequency distribution of Dlength supplies valuable information about species composition, even though there is some overlap of Dlength measurements between species.

The Dlength 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 (= Dlength) is modeled as a weighted mixture of two component distributions arising from sockeye and Chinook salmon (Figure D1-3),

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

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

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

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \quad \text{(D1.2)}$$

where β_0 is the intercept; β_1 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 (Figure D1-3). The species proportions π_S and π_C are the parameters of interest.

Length measurements are obtained from fish captured by gillnets (e.g., Eskelin 2010) immediately downstream of the sonar site. Length data are paired with hydroacoustic data from the same time periods. 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 length distributions as three-component normal age mixtures.

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

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

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

$$f_{Sa}(x) \sim N(\mu_{Sa},\tau^2_{Sa}), \text{ and} \qquad \text{(D1.5)}$$

$$f_{Ca}(x) \sim N(\mu_{Ca},\tau^2_{Ca}). \qquad \text{(D1.6)}$$

The overall design is therefore a mixture of (transformed) mixtures. That is, the observed hydroacoustic data are modeled as a two-component mixture of y, each component of which is transformed from a three-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. Age proportions $\{\theta_{Sa}\}$ and $\{\theta_{Ca}\}$ are assigned informative Dirichlet priors based on a hierarchical analysis of historical data (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[7] of tethered fish data in the mixture model (Figure D1-2).

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 two 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

[7] Preliminary work has shown that DIDSON 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 DIDSON length 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.

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 DIDSON length data but will utilize 7 days of netting data ending on the date of the current DIDSON lengths.

During times when it is impractical to measure every fish recorded by the DIDSON, a “Fast-Track” sampling protocol will be adopted (Table 1), and fish measuring less than 75 cm (DL) will be counted but not measured. These fish will be modeled accordingly, as having come from a left-censored sample. The model for censored observations is specified in the last paragraph of WinBUGS code in Appendix D3.

By default, data will be stratified by day, i.e., daily data from different spatial/temporal strata will be pooled and the above model fit to the pooled data (Equation 5). Sample size limitations may occasionally necessitate pooling the data across more than one day. Changes will not be made to stratification structure during the season. Situations that would warrant a (post-season) revision to the estimates include (1) sampling fraction differing greatly among spatial/temporal strata, or (2) evidence that the slope and intercept parameters differ by stratum. In such cases, the data will be divided into appropriate groups before analysis, and spatial and temporal expansions will be specific to each group.

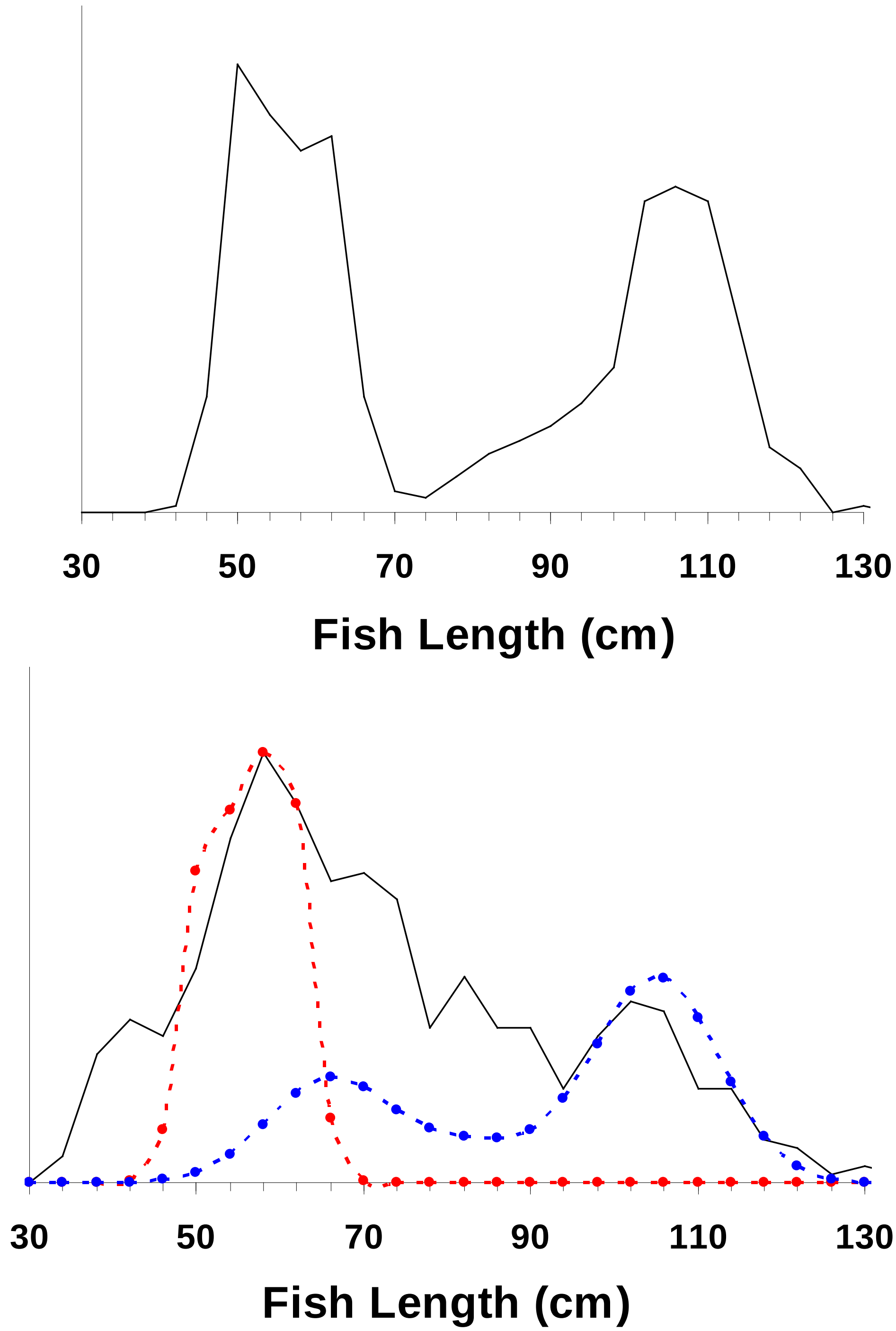


Figure D1-1.- Hypothetical distributions of fish length measurements (black solid lines) from the Kenai River. (a, top) Few small Chinook salmon, no measurement error. (b, bottom) 40% of Chinook salmon are small, measurement error standard deviation = 10 cm. Distributions of sockeye (red dashed line) and Chinook (blue dashed line) true length are shown in case b. In both cases the true species composition is 50% sockeye 50% Chinook.

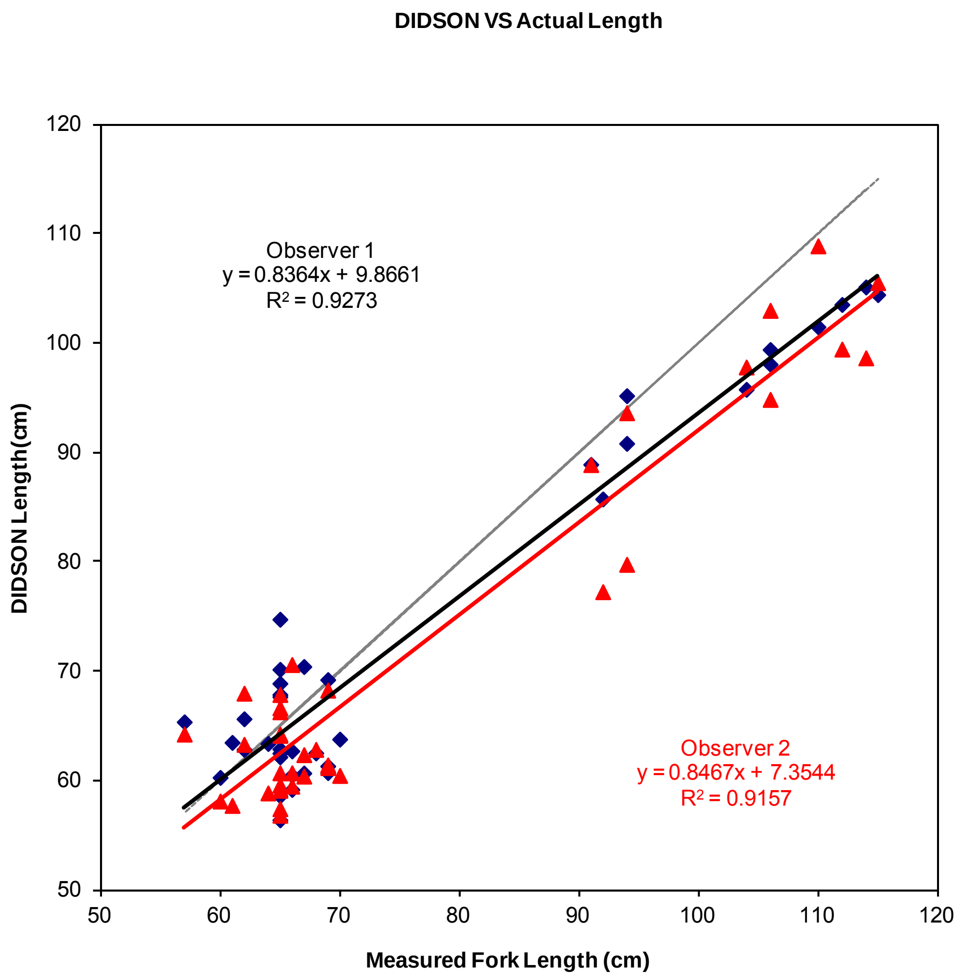


Figure D1-2.-Relationship between DIDSON-based length measures and fork length for two independent observers in 2007. Results are from 37 tethered salmon insonified by a DIDSON-LR sonar with a high-resolution lens at RM-8.6 site.

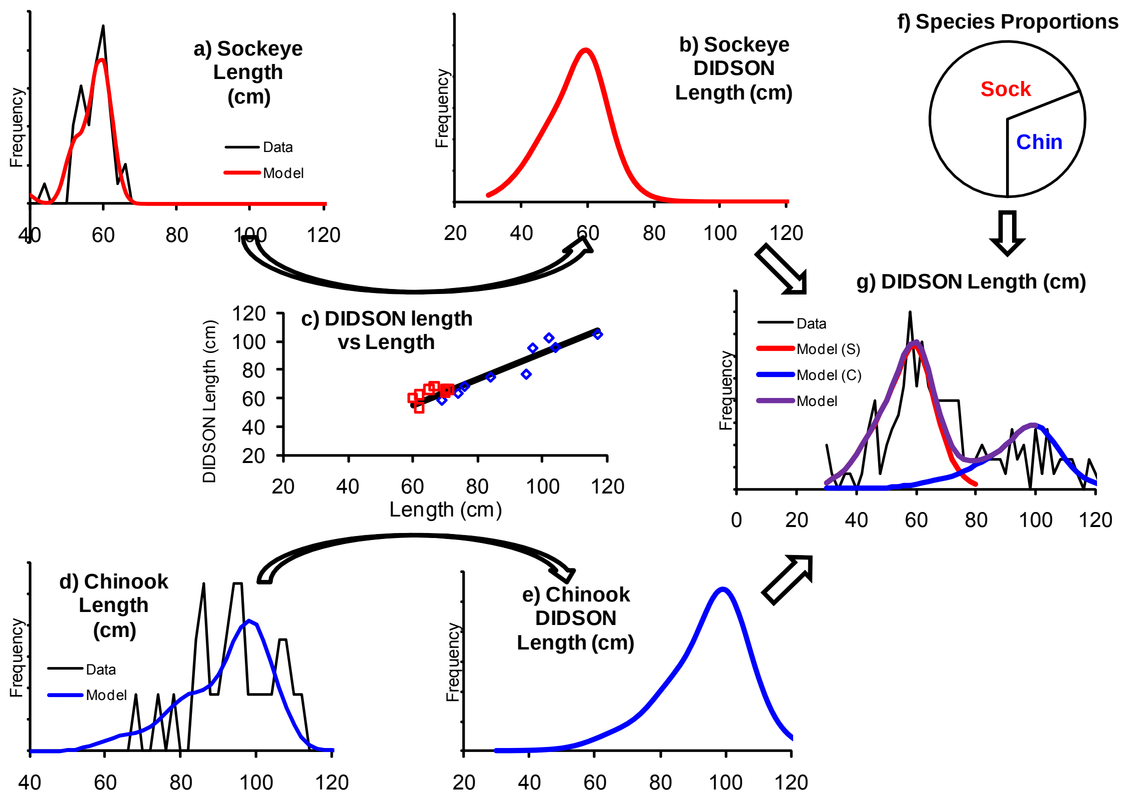


Figure D1-3.-Flow chart of the DIDSON length mixture model described in the text. The frequency distribution of DIDSON length measurements (panel g) is modeled as a weighted mixture of species-specific distributions (b and e), which in turn are the products of species-specific size distributions (a and d) and the relationship between DIDSON-measured length and true length (c). The weights (species proportions, panel f) are the parameters of interest.

Appendix D2.– WinBUGS code for mixture model, under standard data processing protocol. Prior distributions in green font, likelihoods in blue.

```
model{
 beta0 ~ dnorm(75,0.0025)    #subjective prior sd=20cm
 beta1 ~ dnorm(1,25)          #subjective prior sd=0.2
 sigma.DL ~ dunif(0,20)
 tau.DL  <- 1 / sigma.DL / sigma.DL
 ps[1:2] ~ ddirch(D.species[])
 pa[1,1] ~ dbeta(B1,B2)
 theta1 ~ dbeta(B3,B4)
 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] * ntgts
 p.large <- ps[1] * (1 - pa[1,1])
 n.large <- p.large * ntgts

 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.DL1[k] <- beta0 + beta1 * TL.cm.75[k]
  DL1[k] ~ dnorm(mu.DL1[k],tau.DL)
  }
 for (i in 1:nfish) {
  age[i] ~ dcat(pa.effective[species[i],1:3])
  mefl.mm[i] ~ dnorm(mu[species[i],age[i]],Ltau[species[i],age[i]])
  }
```

-continued-

```
for (j in 1:ntgts) {
  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.DL2[j] <- beta0 + beta1 * TL2.cm.75[j]
  DL2[j] ~ dnorm(mu.DL2[j],tau.DL)
  }
}
```

Appendix D3.– WinBUGS code for mixture model, under fast-track data processing protocol. Prior distributions in green font, likelihoods in blue.

```
model{
 beta0 ~ dnorm(75,0.0025)   #subjective prior sd=20cm
 beta1 ~ dnorm(1,25)          #subjective prior sd=0.2
 sigma.DL ~ dunif(0,20)
 tau.DL  <- 1 / sigma.DL / sigma.DL
 ps[1:2] ~ ddirch(D.species[])
 pa[1,1] ~ dbeta(B1,B2)
 theta1 ~ dbeta(B3,B4)
 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.upstr <- n_meas + n_small
 n.chin <- ps[1] * n.upstr
 p.large <- ps[1] * (1 - pa[1,1])
 n.large <- p.large * n.upstr

 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.DL1[k] <- beta0 + beta1 * TL.cm.75[k]
  DL1[k] ~ dnorm(mu.DL1[k],tau.DL)
  }
 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]])
  }
```

-continued-

```
 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 BASED ON NUSHAGAK
2001 DATA
   mu.DL2[j] <- beta0 + beta1 * TL2.cm.75[j]
   DL2[j] ~ dnorm(mu.DL2[j],tau.DL)
   }
 for (k in 1:n_small) {
   species3[k] ~ dcat(ps[])
   age3[k] ~ dcat(pa[species3[k],1:3])
   mefl.mm.3[k] ~ dnorm(mu[species3[k],age3[k]],Ltau[species3[k],age3[k]])
   TL3.cm.75[k] <- (1.1*mefl.mm.3[k] + 2) / 10 - 75
   mu.DL3[k] <- beta0 + beta1 * TL3.cm.75[k]
   DL3[k] ~ dnorm(mu.DL3[k],tau.DL)I(,70)
   }
 }
```

Appendix D4.– OpenBUGS code for daily abundance model, to be used when it is not possible to generate Chinook salmon passage estimates with DL mixture model. Prior distributions in green font, likelihoods in blue.

```
model{
q.gt80 ~ dnorm(0,1.0E-6)I(0,10)
tau.log.gt80 ~ dgamma(0.001,0.001)
phi.gt80 ~ dnorm(0,1.0E-4)I(-.8,.8)
log.resid.gt80.0 ~ dnorm(0,4)I(-3,3)
sigma.gt80 <- 1 / sqrt(tau.log.gt80)

q.ncpu ~ dnorm(0,1.0E-6)I(0,1)
tau.log.ncpu ~ dgamma(0.001,0.001)
phi.ncpu ~ dnorm(0,1.0E-4)I(-.8,.8)
log.resid.ncpu.0 ~ dnorm(0,4)I(-3,3)
sigma.ncpu <- 1 / sqrt(tau.log.ncpu)

mean.log.N ~ dnorm(0,1.0E-12)
tau.log.N ~ dgamma(0.01,0.01)
N.early <- sum(N[1:46])
N.late <- sum(N[47:87])

for (d in 1:D) {
  log.N[d] ~ dnorm(0,1.0E-12)I(0,)
DID[d] ~ dlnorm(log.N[d],tau.log.DID[d])
  gt80[d] ~ dlnorm(log.q1Nmean2[d],tau.log.gt80)
  ncpu[d] ~ dlnorm(log.q2Nmean2[d],tau.log.ncpu)
  N[d] <- exp(log.N[d])
  tau.log.DID[d] <- 1 / log(cv.DID[d]*cv.DID[d] + 1)
  log.q1Nmean1[d] <- log(q.gt80 * N[d])
  log.resid.gt80[d] <- log(gt80[d]) - log.q1Nmean1[d]
  log.q2Nmean1[d] <- log(q.ncpu * N[d])
  log.resid.ncpu[d] <- log(ncpu[d]) - log.q2Nmean1[d]
  }
log.q1Nmean2[1] <- log.q1Nmean1[1] + phi.gt80 * log.resid.gt80.0
log.q2Nmean2[1] <- log.q2Nmean1[1] + phi.ncpu * log.resid.ncpu.0
for (d in 2:D) {
  log.q1Nmean2[d] <- log.q1Nmean1[d] + phi.gt80 * log.resid.gt80[d-1]
  log.q2Nmean2[d] <- log.q2Nmean1[d] + phi.ncpu * log.resid.ncpu[d-1]
  }
}
```

Appendix D5.– WinBUGS code for hierarchical age-composition model. Posteriors distributions from fitting this model provide prior distributions for DL mixture model. Prior distributions in green font, likelihoods in blue.

```
# Age Mixture.odc  version 6a:

model {
 #Overall means and std deviations
 for (a in 1:A) {
  sigma[a] ~ dnorm(0,1.0E-4)I(0,)
  tau[a] <- 1 / sigma[a] / sigma[a]
  mu[a] ~ dnorm(0,1.0E-12)I(0,)
  }
 #Dirichlet distributed age proportions across years within weeks
 D.scale ~ dunif(0,1)
 D.sum <- 1 / (D.scale * D.scale)
 for (w in 1:W) {
  pi[w,1] ~ dbeta(0.2,0.4)
  pi.2p[w] ~ dbeta(0.2,0.2)
  pi[w,2] <- pi.2p[w] * (1 - pi[w,1])
  pi[w,3] <- 1 - pi[w,1] - pi[w,2]
  for (y in 1:Y) {
   for (a in 1:A) {
    D[w,y,a] <- D.sum * pi[w,a]
    g[w,y,a] ~ dgamma(D[w,y,a],1)
    pi.wy[w,y,a] <- g[w,y,a]/sum(g[w,y,])
    }
   }
  }
 for (i in 1:nfish) {
  age[i] ~ dcat(pi.wy[week[i],year[i],1:A])
  length[i] ~ dnorm(mu[age[i]],tau[age[i]])
  }
 }
```

Appendix D6.– Example WinBUGS data under Fast-Track sampling protocol.

```
#SNR: JULDATE=208, NET: 202<=JULDATE<=208, NETTED FISH=295, TOTAL UPSTREAM=1038, NO
        THINNING
list(D.species=c(1,1), B1=2.4, B2=17.6, B3=3.5, B4=14.1, q1.a=c(0.61,0.57,0.41),
n_fish=295, n_meas=863, n_small=175,
species=c(1,1,1,1,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,
2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,
2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,1,1,1,1,1,1,1,
2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,
2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,1,2,1,1,1,1,2,2,2,2,2,2,2,2,2,2,2,2,2,2,1,2,2,2,2,2,2,2,
2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,2,1,1,1,1,1,1,1,1,1,1,1,1,1,1
),
mefl.mm=c(705,820,920,935,430,440,450,460,460,500,500,510,510,510,520,530,530,540,540,550,550,550,
550,550,560,560,560,560,560,560,560,560,560,560,570,570,570,570,570,570,570,570,570,570,570,570,570,
570,575,580,580,580,580,580,580,580,580,580,580,580,580,580,580,580,580,580,585,590,590,590,590,
590,590,590,590,590,590,590,590,590,600,600,600,600,600,600,600,600,600,600,600,600,600,600,600,
605,605,610,610,610,610,610,610,610,610,610,610,610,610,610,620,620,620,620,620,620,620,620,620,
620,620,620,620,620,630,630,630,630,630,630,640,640,640,640,640,850,970,980,885,930,935,960,430,480,
480,510,530,540,540,540,550,550,560,560,560,570,570,570,570,570,570,570,570,570,580,580,580,580,580,
580,580,585,590,590,590,590,590,590,590,590,595,600,600,600,600,600,600,600,600,600,610,610,610,
610,610,610,610,610,620,620,620,620,620,620,620,620,620,630,630,640,640,640,640,660,660,735,960,1125
,1150,440,450,450,490,500,510,520,520,530,530,540,540,540,550,560,560,560,560,560,560,570,570,570,
570,570,570,570,580,580,580,580,580,590,590,590,590,590,590,590,590,600,600,600,600,600,610,610,
610,610,620,620,620,620,620,620,630,630,640,685,765,870,935,1000,1005,1075,610,740,750,885,905,1145
),
DL2=c(57,60,52,61,54,58,49,67,55,52,102,62,70,65,66,63,98,68,66,95,53,55,48,67,116,60,8,59,57,56,59,
71,55,45,85,50,66,69,52,62,49,54,54,61,53,49,59,68,59,62,65,65,66,58,57,112,69,62,58,66,61,65,64,57,
59,59,58,58,64,65,55,67,64,59,84,52,63,55,67,60,46,52,59,65,51,58,55,64,63,48,60,50,58,64,62,58,61,
61,52,57,59,44,53,48,66,51,45,58,60,50,55,45,64,59,61,61,52,60,57,49,83,51,41,53,61,69,64,73,65,51,
49,63,60,64,51,60,55,98,59,57,62,60,62,61,58,63,62,46,65,43,62,43,53,51,65,59,62,63,61,52,57,62,63,
69,65,67,61,80,81,55,67,50,56,65,69,46,57,63,52,57,60,59,48,42,65,49,65,50,67,59,59,69,68,55,59,55,
65,61,53,59,56,63,57,42,62,50,57,48,53,54,48,65,55,63,63,56,66,51,49,43,52,47,58,65,63,45,80,90,57,
47,60,52,40,93,59,110,57,56,63,48,50,85,93,57,102,58,63,62,67,63,69,57,52,87,95,48,63,58,88,56,91,49
. . .
100,66,60,40,49,56,54,64,55,59,61,90,81,63,75,62,90,51,58,67,104,60,64,47,60,49,60,51,60,40,57,44,58
,57,59,51,63,59,57,54,54,51,51,56,51,65,58,45,56,56,68,87,45,63,108,59,63,57,55,58,57,60,59,72,59,53
,60,54,57,65,55,54,63,62,46,60,58,54,61,62,59,58,58,67,52,52,52,47,49,59,52,60,56,47,50,50,63,60,58,
54,54,43,45,54,65,52,55,56,45,67,50,59,53,51,47,41,49,45,61,58,49,60,52,51,61,50,47,50,65,62,59,61,
62,71,61,57,61,64,69,47,53,50,98,59,63,43,50,51,56,52,62,97,62,67,95,59,55,55,60,61,48,57,55,58,50,
48,60,60,56,45,57,67,59,59,61,61,72,61,70,69,57,58,52,84,52,46,57,60,57,64,61,58,59,59,48,53,65,68,
65,66,65,68,64,64,65,66,74,65,57,62,61,57,53,50,51,50,67,64,55,54,59,60,52,49,61,58,69,61,62,62,108,
48,63,64,53,50,56,64,66,62,92,55,56,56,62,57,40,54,61,53,58,59,68,58,57,56,66,48,45,49,46,45,63,63,
63,61,60,68,55,101,61,61,60),
DL3=c(NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA)
)
```

APPENDIX E. PROCEDURES FOR DAILY ARIS PROCESSING

Appendix E1.-Steps for processing RM 13.7 daily ARIS data using batch files, Kenai River Chinook sonar, 2014.

Last updated by Brandon Key (April 2, 2014) and Michael Hopp (August 28, 2013). Note that filenames and directory structures highlighted in yellow will need to be updated annually.

- Raw Data Transfer and Storage

Ensure the "UpperRiver" Ethernet cable is plugged into the dedicated upload computer
First drive backup (first day of data)

1. Make sure drive X: is plugged in (backup drive) and that it has enough room to back up data (about 150 GB)
2. Plug in first field hard drive-*Note the DRIVE LETTER ex. E:*
3. Edit TheMenu.bat
    a. Change DRIVE LETTER if necessary
    b. Change dates to the first day if necessary- There are two calendar dates and one Julian Date(normally you do not have to change the date first time through)
    c. Save and exit
4. RUN batch file
    a. Follow prompts to select correct sonar for downloading
5. Proceed through redundancy prompts-there are many
6. DRIVE should download with tones indicating progression
7. Eject DRIVE when done

Second DRIVE backup

1. Make sure that the new DRIVE has the same DRIVE LETTER as the original (its best to edit all drives pre-season to default to the same DRIVE LETTER)
2. RUN batch and proceed through the same steps as above

Proceed through the remaining drives until all of the first day is complete

Second pass

1. Edit TheMenu.bat for the **following** data day(Change the Julian date and two calendar dates)
2. Proceed through the same steps above (First Drive backup)

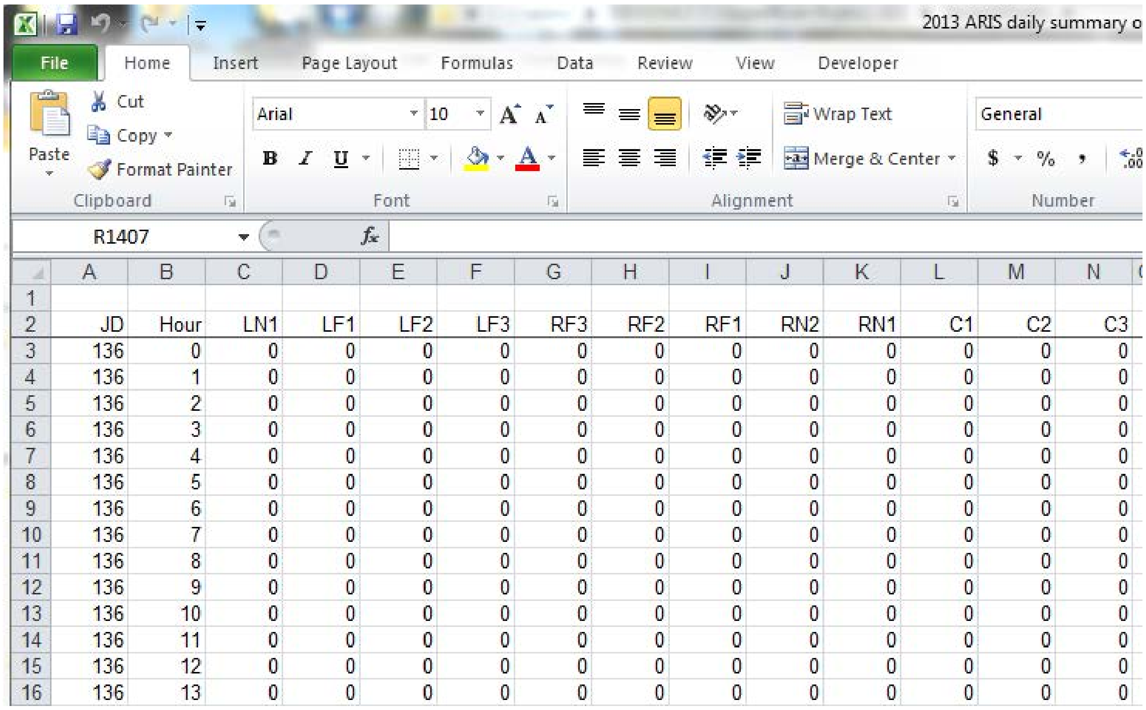
The original data day is now backed up to X: and ready for processing (U:\Data2014) and the following partial day is ready for the next day's upload.
Reconnect Ethernet Cable to the processing network

- Manual Target Measurement

1. Use ARIS FISH Application to process *.aris files for manual measurement of targets.
2. Open file, select parameters, create echogram and measure fish according to specified protocols ie. Normal, Fast Track, Large Fish only. See Table 2 for a description of tracking protocols.

- Editing Asamples.txt for missing data

Edit the Asamples.txt file located in U:\upload. This file is best modified in the file *2014 ARIS daily summary of data quality.xls* (U:\spreadsheets), then copied into the Asamples.txt file in notepad using a copy/paste command (needs to be a "tab" delimited file). Copy Asamples.txt to the data directory for that day (e.g. to L:\Data2014\2014-08-02_JD214)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2	JD	Hour	LN1	LF1	LF2	LF3	RF3	RF2	RF1	RN2	RN1	C1	C2	C3
3	136	0	0	0	0	0	0	0	0	0	0	0	0	0
4	136	1	0	0	0	0	0	0	0	0	0	0	0	0
5	136	2	0	0	0	0	0	0	0	0	0	0	0	0
6	136	3	0	0	0	0	0	0	0	0	0	0	0	0
7	136	4	0	0	0	0	0	0	0	0	0	0	0	0
8	136	5	0	0	0	0	0	0	0	0	0	0	0	0
9	136	6	0	0	0	0	0	0	0	0	0	0	0	0
10	136	7	0	0	0	0	0	0	0	0	0	0	0	0
11	136	8	0	0	0	0	0	0	0	0	0	0	0	0
12	136	9	0	0	0	0	0	0	0	0	0	0	0	0
13	136	10	0	0	0	0	0	0	0	0	0	0	0	0
14	136	11	0	0	0	0	0	0	0	0	0	0	0	0
15	136	12	0	0	0	0	0	0	0	0	0	0	0	0
16	136	13	0	0	0	0	0	0	0	0	0	0	0	0

- <u>ARIS Packaging and Upload</u>

As prepared by Michael A. Hopp, 8-28-2013

Checklist:

1. Complete the ARIS measurements for a day
2. Copy the day's completed files table into the "*Asamples2014.txt*" and save it in *U:\Data2014*
3. Edit & save the "*Package ArisMH.bat*" file found in *U:\Batch* for the selected DataDate and JD
4. Run it and observe the package process in the *U:\Data2014\RM13-Packaged* folder
5. Verify that the new zip file is created, like: "*Aris_JD229_YYYY-08-17_TxtData.Zip*"
6. Review the logfile like: "*Package-2014-08-17-JD229.txt*" and locate & fix any missing files.
7. If necessary, delete the zip file and re-pack after the missing files are tracked.
8. Edit & save the "*duploadMH.bat*" file found in *U:\Batch* for the selected DataDate and JD
9. Run it and then verify a new file is created like: *Aris_JD229_YYYY-08-17_SentToAnc.dat*
10. Check the progress report on the desktop in *ArisTxtDataSentToAnc.txt*

Details - Using the Packaging batch file: [Can be run on any data computer – with U: drive connection.]

First of all, the ARIS data for that date must be measured and finished according to rules and procedures explained in Appendix E. Then update the table in "*U:\Spreadsheets\2014ARIS daily summary of data quality - update 7-11-14.xlsx*". Then copy the JD day's table from the spreadsheet into "*Asamples2014.txt*" according to the example found in *U:\DataProc14\Manual* . This file has a table in it that identifies which ARIS files have been finished.

Then edit the "*Package ArisMH.bat*" file found in *U:\Batch* to set the DataDate and JD variables. The DataDate variable must precisely match the existing example, like: 2014-08-07

Finally, save the batch file with his changes and then double-click it to run it.

Follow the progress of this batch file by watching the *U:\Data2014\RM13-Packaged* folder. After the batch process finishes, verify that there is a new zip file in this directory named according to this example: "*Aris_JD229_2014-08-17_TxtData.Zip*" . Open it to read the count of files & compare it to the expected value.

At the end, the batch file will open in Notepad the progress file log like: "*Package-2014-08-17-JD229.txt*" . Review it to locate any missing files. If necessary, fix this error by tracking those files, deleting the zip package and then re-pack the day's data.

Using the Upload batch file: [This <u>must be run on the upload computer only</u> – with J: drive connection.]

First complete the packaging step (above) for the selected DataDate and JD.

Then edit "*duploadMH.bat*" file found in *U:\Batch* to set the DataDate and JD variables. The DataDate variable must precisely match the existing example, like: 2014-08-07

Then save the batch file with his changes and double-click it to run it.

Normally, this batch file will take just a couple of seconds to complete

Details of Packaging:

The ARIS Data is stored at Drive *U:\Data2014* at the Sonar Office in sub-folders named by the Aris unit location at RM 13.7. Each sub-folder contains folders named by date stamps like 2014-08-18-JD230 and each of those sub-folders have sub-folders according to Stratum and then by Set. So a common path =

"*U:\Data2014\LeftNear\2014-08-18-JD230\Stratum1\Set1*".

The packaging batch file does these things (after a tech sets the appropriate DataDate and JD variables at the top of the batch file):

1. Logs progress to *U:\BATCH\LOGS\Package-%DataDate%-JD%JD%.txt*
2. Selects which ARIS unit, stratum and set to copy, according to variables set in the batch file.
3. Looks for "*Asamples2014.txt*" in *U:\Data2014* as a sentinel to proceed. If this file is not found, the batch file will stop and not package anything.
4. Looks for any **.txt* files left over in *U:\Data2014\RM13-Packaged* and zips them up into *TxtFoundInPackFolder-%JD%.ZIP* located in the same folder.
5. Moves the sentinel file "*Asamples2014.txt*" to *U:\Data2014\RM13-Packaged* , renaming it: *Asamples%DataDate%.txt*
6. Copies into *U:\Data2014\RM13-Packaged* all the **.txt* files located in all the specified subfolders for the specified DataDate & JD. (These are measurement data files made as a technician measures fish.)
7. Packages (zips) all these files (now copied to *U:\Data2014\RM13-Packaged*) into a zip file named according to this example: *Aris_JD229_2014-08-17_TxtData.Zip* - and stored in the same folder.
8. Finishes the progress log - *U:\BATCH\LOGS\Package-%DataDate%-JD%JD%.txt*
9. Opens into Notepad the progress log file - *U:\BATCH\LOGS\Package-%DataDate%-JD%JD%.txt*

Details of Upload:

The upload batch file does these things (after a tech sets the appropriate DataDate and JD variables at the top of the batch file):

1. Creates a new "*AncUpload-ArisTxtDaily.txt*" located in *U:\Batch\LOGS* , overwriting any existing one. Progress is logged into this file.
2. Looks for *Aris_JD%JD%_%DataDate%_TxtData.Zip* located in *U:\ Data2014\RM13-Packaged*
3. If it finds this file, it will copy (upload) it to *J:\Soldotna\ARIS*
4. Creates a new *Aris_JD%JD%_%DataDate%_SentToAnc.dat* file in the *U:\Data2014\RM13-Packaged* folder as a convenient reference of files already uploaded. This is a simple one-line text file containing: *Aris_JD%JD%_%DataDate%_TxtData.Zip copied to Anc on %DATE% AT %TIME%*
5. Completes the log file.
6. Appends the log file to *C:\Users\sxqkenaisonar\Desktop\ArisTxtDataSentToAnc.txt* …and to *U:\Batch\LOGS\AncUpload-ArisTxtAll.txt*. (This makes a running log, appending the current upload progress log to previous ones.)

- RM 13.7 Batch files

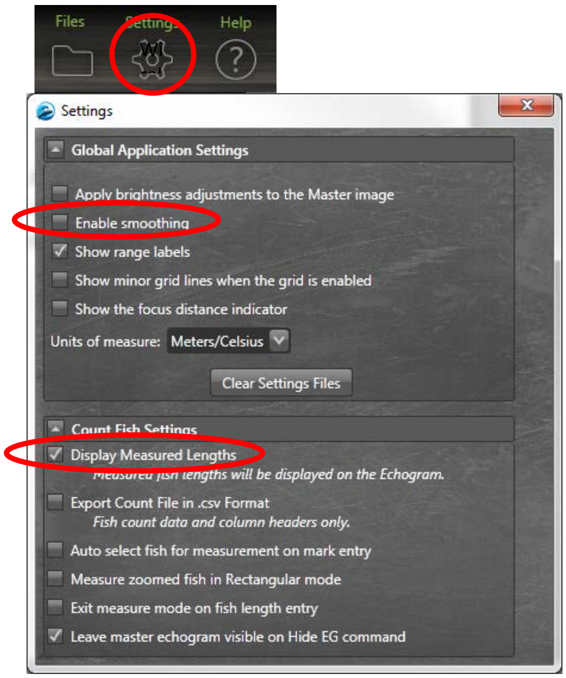
TheMenu.bat	Opens program for data download from individual sonars. Makes backup copies of files and renames them according to organization scheme
xxSonarUL.bat	Allows easy changes to be made to Sonar designations and sample times without interrupting other programs
Package ArisMH.bat	Collects ARIS tracking files for processing and upload
duploadMH.bat	Uploads data to anchorage.

APPENDIX F. INSTRUCTIONS AND SETTINGS USED FOR MANUAL FISH LENGTH MEASUREMENTS FROM ARIS IMAGES USING ARISFISH SOFTWARE VERSION 1.5

Appendix F1.- Instructions and settings for manual length measurements form ARIS images in 2014 using SMC ARISFish software Version 1.5.

a. To set Global Settings after a new installation of ARISFish

1. Open ARISFish global settings and ensure you have the following settings:



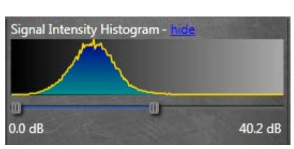
2. Enable smoothing is ***off***
3. Display Measured Lengths is ***on***

b. Set processing parameters for a new set of files for a new day or stratum:

1. Select **<Files> <Open Recently Viewed>**

2. Navigate to the appropriate directory and open file

3. Set Signal intensity sliders to 0.0 and 40.2 dB (or other recommended values for a specific stratum)

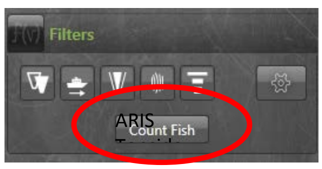


4. Select **<“settings” cog>** from Filters menu

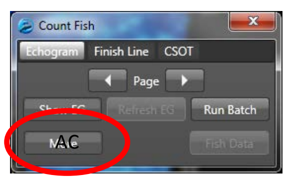
5. Select **<SMC adaptive background>**

6. Select **<Background Subtraction>** icon on Filters Menu (Toggle)

7. Select **<Count Fish>** from the Filters Menu to Display the Count Fish Window

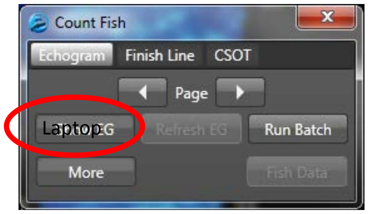


8. Select **<More>** to get expanded options



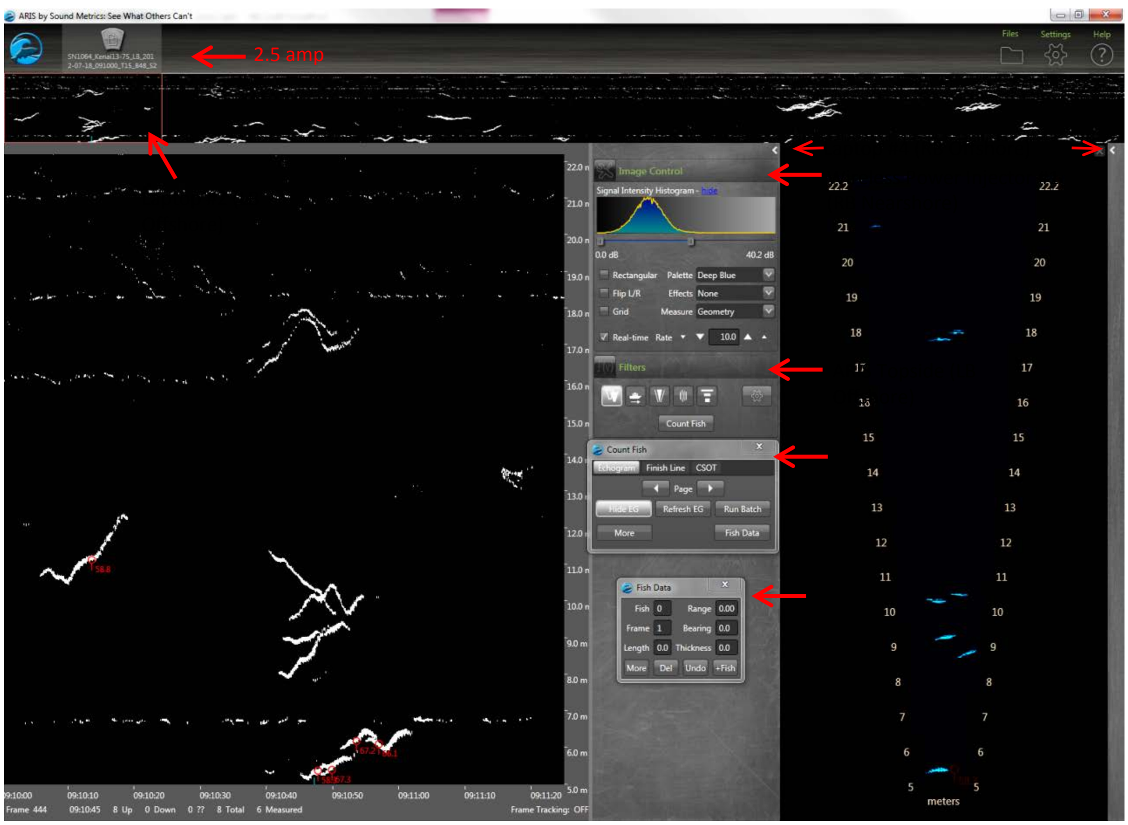
9. Increase **<Loop>** Length to at least 8 s, set **<upstream>** direction parameter appropriately, then select **<Less>** to shrink count Fish window

10. Select **<Show EG>** to display the Echogram



11. Select **<Fish Data>** to display the Fish Data Window

12. Arrange the **<Count Fish>** and **<Fish Data>** windows so your overall display looks similar to:



13. Select **<Alt><right arrow>** to advance to the next file when needed, all your parameter settings and display configuration should be preserved

14. Now you are ready to start measuring individual fish

c. Instructions for manual fish length measurements using SMC ARISFish software version 1.5 in 2014.

1. **<Right Click>** on the fish to be measured (Puts red marker on fish and automatically activates the movie showing the fish bounded by range arcs – see Figure E1-1 below)
2. **<Right Click Drag>** on movie image to zoom in for measurement
3. Press **<space bar>** to pause movie
4. 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 (see section d below for selecting optimal images)
5. **<Left Click Drag>** if necessary to center movie window prior to measuring
6. **<left click>** on the fish snout 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 tail.
7. 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)
8. Select **<v>** key to unzoom movie window (not necessary if you have another fish nearby you want to measure)
9. Next fish…repeat steps 1-8, or
10. **<Left Click>** on Master Echogram to advance to new echogram section, or
11. **<Alt><Right Arrow>** to advance to next file

Hot keys:

<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" the 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 pause d

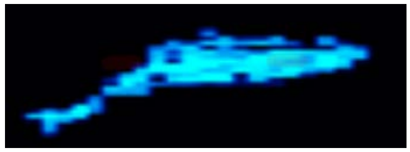
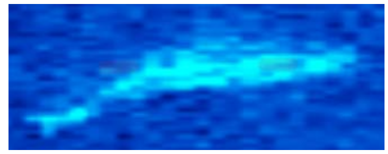
<left arrow> opposite of above

Left Click Drag to show movie over the selected time

Right Click Drag zooms the selected area

d. Helpful Tips

- Toggling between BS mode and the raw image can sometimes be helpful in determining the actual end of the tail or snout.

- Some targets may hold/linger in the beam and should not be tracked unless they make sufficient progress up or down stream. Significant over estimation of fish could occur if everything in the beam were tracked/measured without regard for upstream progress.

- Some targets may glance the corners of the beam, if you feel these targets do not provide sufficient direction of travel information, or that they may be dipping in an out of the beam throughout the sequence, use your discretion at tracking. When Chinook fall into this marginal category, give them closer attention than smaller targets, as missing a small target is less important than missing a KING.

- Use all the tools at your disposal- the echogram provides a roadmap to not only where targets occur in the sequence, but often gives strong clues to what the target species is. Trace intensity, length, and tail beat amplitude/frequency give you information that comes in handy before you toggle to video mode. Video mode and the video loop allow you to better sort out number, behavior, and location of targets in especially complex sequences.

- Press <E> to save your work on each sequence when complete (or before you divert to another task).

e. Known issues/bugs

- Some settings are saved, while others may default to undesired values. It is wise to periodically check your settings to confirm..

f. Instructions for selecting optimal images

Measurements should be taken from frames where contrast between the fish image and background are high and where the fish displays its full length. This can be difficult to determine at times, especially when the number of frames from a fish is limited (e.g. close-range fish). For example, panels a, b, c, d, g, and l in Figure E1-3 are images where the fish appears to display its full length, and consequently the length estimates are consistently higher than other measurements varying between 95cm -98cm. In general, the best images are obtained when the fish is sinusoidal in shape (rather than straight and\or perfectly perpendicular as in panel j) because the head and tail appear most visible when there is curvature to the fish body. Even when there is curvature to the fish body, it is apparent that in some frames, the fish body compressed.

Panel i in Figure E1-3 demonstrates how a fish can measure 99.1 cm (dashed line) or 88.1 cm (solid line) depending on whether the user decides to include “faint” pixels defining the snout and tail. Watching the behavior of the head and especially the tail over several frames, and taking several measurements, is often helpful in distinguishing the best frame.

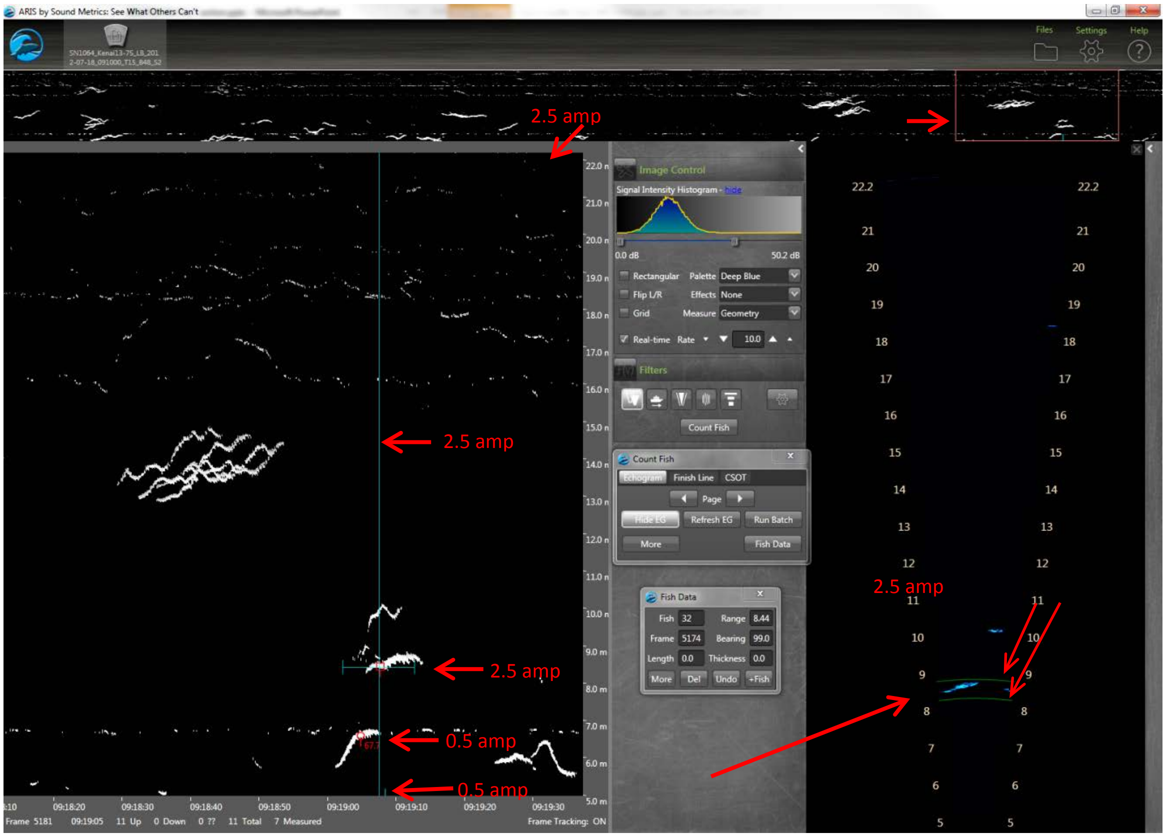


Figure F1-1.- Manual measurements in ARIS echogram mode. A left click on a fish trace places a red marker on the fish trace and automatically activates the movie showing the fish bounded by range arcs. A vertical line defines the selected frame on the echogram, and a horizontal line at the selected range shows the boundaries of the "movie loop."

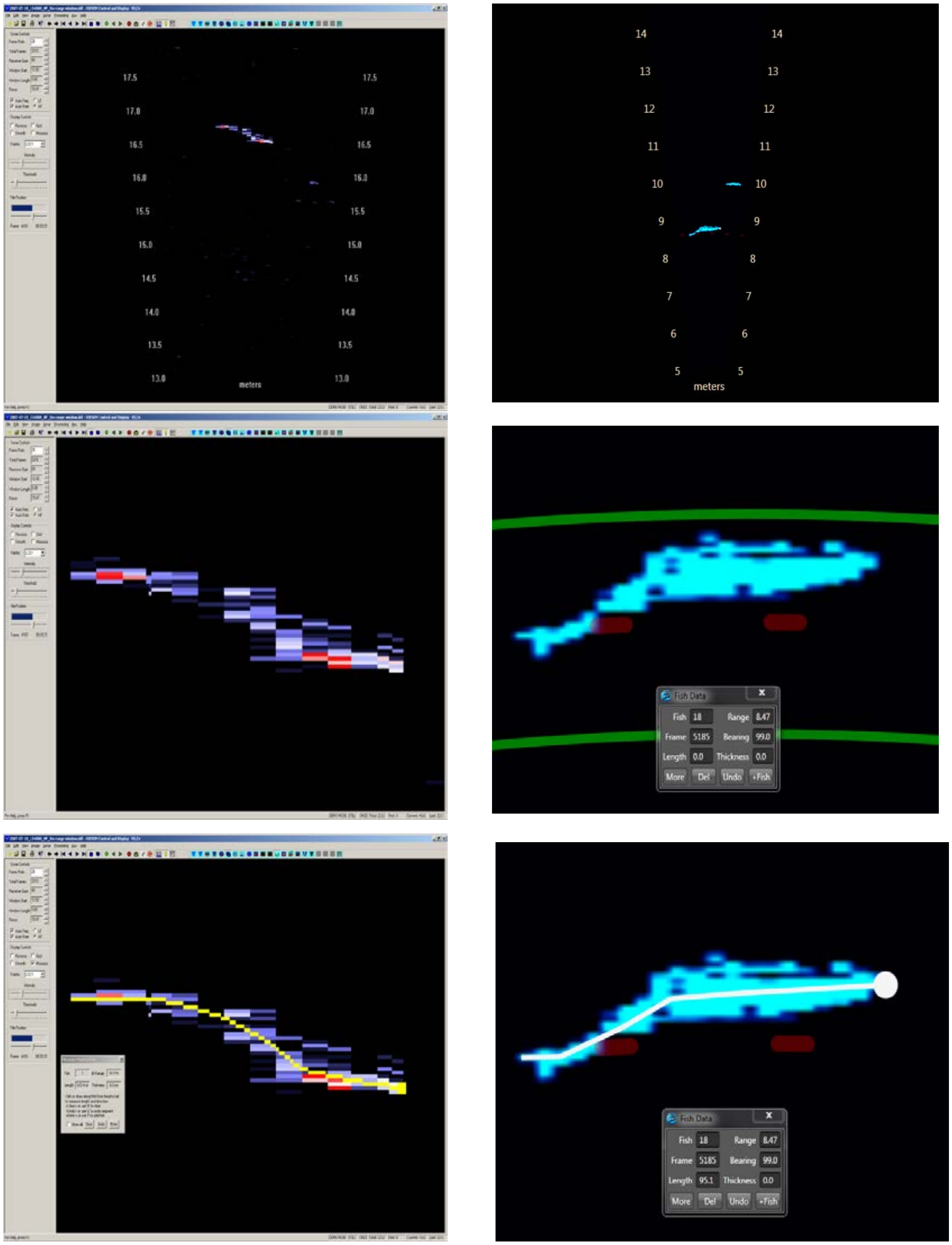


Figure F1-2.- On right ARIS images from a free-swimming Chinook salmon showing the unzoomed image (top), the zoomed image (middle), and the segmented lines that result when the observer clicks along the length of the fish to mark its length (bottom). On left, comparable DIDSON images from a tethered Chinook salmon. The pixels of the ARIS image are less defined due to a smoothing algorithm applied. Additionally the ARIS image has approximately twice the downrange resolution as the DIDSON image (ARIS = 20m/2000pixel = 1cm/pixel resolution versus DIDSON = 10m/512 = 2cm/pixel).

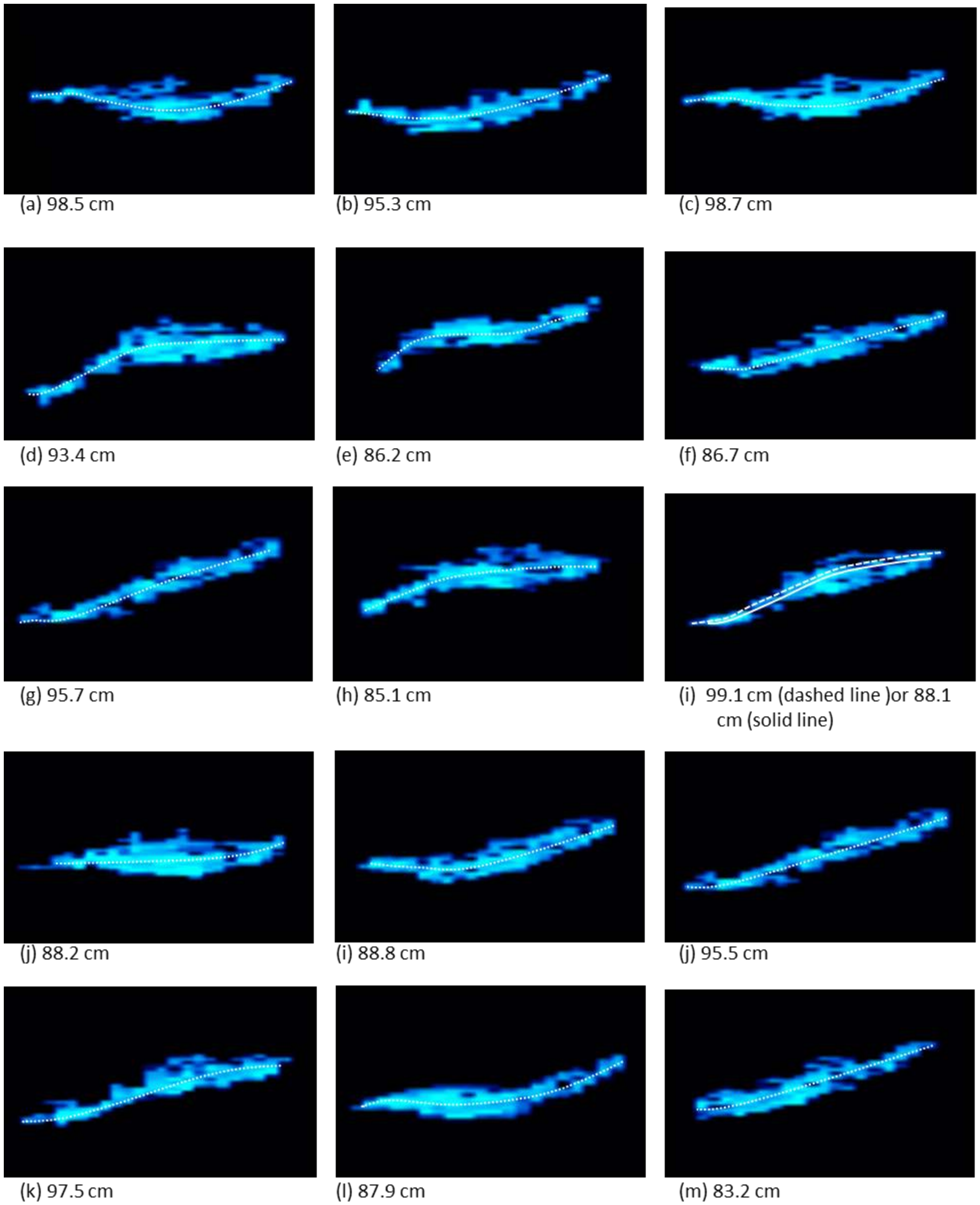


Figure F1-3.- Panels a-m show the potential variability in length measurements taken from images of a free-swimming Chinook salmon at approximately 9 m collected with an ARIS 1200 with a telephoto lens. Frames were taken from file SN1064_Kenai13-75_LB_2012-07-18_091000_T15_B48_S2000_F12_R4-22.aris, approximately frames 5175-5204). The white lines following the fish mid-section show the path taken on the image for the length measurements.

APPENDIX G: RIVER-MILE 13.7 SITE INVESTIGATION DOCUMENTION

Appendix G1.- Additional details regarding river-mile 13.7 sonar site.

Benefits of the proposed RM 13.7 site include: 1) the State owns land on both sides of the river (DNR land on the left[8] [KPB parcel #055-250-23] and right bank [KPB parcel #057-250-30]); 2) the location is above major tidal influence; and 3) the river channel is a relatively narrow at this location. Upland on both banks is composed of trees and shrubs. The main tent housing sonar electronics will be located on the left bank (Figure G1-1). Data from the right bank will be transmitted to the tent on the left bank using wireless technology.

Providing full (bank-to-bank) coverage will require a total of five sonars; four sonars on the main channel and a fifth sonar to monitor the minor channel on right bank (Figure G1-2). Proposed site diagrams for the left bank can be found in Figures G1-3 to G1-5. Proposed site diagrams for the right bank main river channel can be found in Figures G1-6 to G1-9. Proposed site diagrams for the minor river channel can be found in Figures G1-10 to G1-13.

A 10'x12' tent will be assembled on the left bank at least 50 ft from ordinary high water levels (OHW, Figure G1-3). The tent will be located in a clearing to alleviate the need to remove trees and other vegetation. Power will be supplied to the tent via two power cords running from external outlets on a cabin located approximately 60 m upstream of the tent. Electronic control cables will lead from the tent into the river and attach to each of two ARIS units (nearshore and farshore sonars) mounted to removable steel tripods (Figure G1-4). The sonars will be positioned on the river bottom approximately 6 ft and 24 ft from OWH (Figure G1-5).

On the right bank main-channel site, two waterproof totes (~ 3' x 4') will house a battery bank (Figure G1-6) and the topside sonar electronics (Figures G1-6 to G1-8) . A plywood box (~ 3'x 3') lined with plastic (for spill containment) located near the totes will house a small generator (Figures G1-7 and G1-8). A power cable will lead from the batteries to the tote housing the ARIS electronics. Electronic control cables will lead from the topside electronics tote into the river and attach to each of two ARIS units (nearshore and farshore sonars) mounted to removable steel tripods (Figures G1-7 and G1-9). The sonars will be positioned on the river bottom approximately 6 ft and 45 ft from OWH (Figure G1-9).

On the right bank minor-channel site, a single waterproof tote (~3'x4') will house the battery bank (Figure G1-10) and topside sonar electronics (Figures G1-11 and G1-12). Electronic control cables will lead from the topside electronics tote into the river and attach to a single ARIS unit mounted on a steel approximately 40'from OHW. A picket weir will extend approximately 45' from OHW to force fish in front of the sonar (Figures G1-11 and G1-13).

Submerged steel tripods will be marked with a marker float on the water's surface (Figures G1-5 and G1-9). Additional large red "warning" buoys will be placed near the offshore sonar tripods on each bank. Signage warning boaters to stay offshore of the warning buoys will be posted at all boat launches (Figure G1-14) and signage identifying the location of the new sonar project will be will be placed approximately 300' upriver and downriver of the site.

[8] Looking downstream.

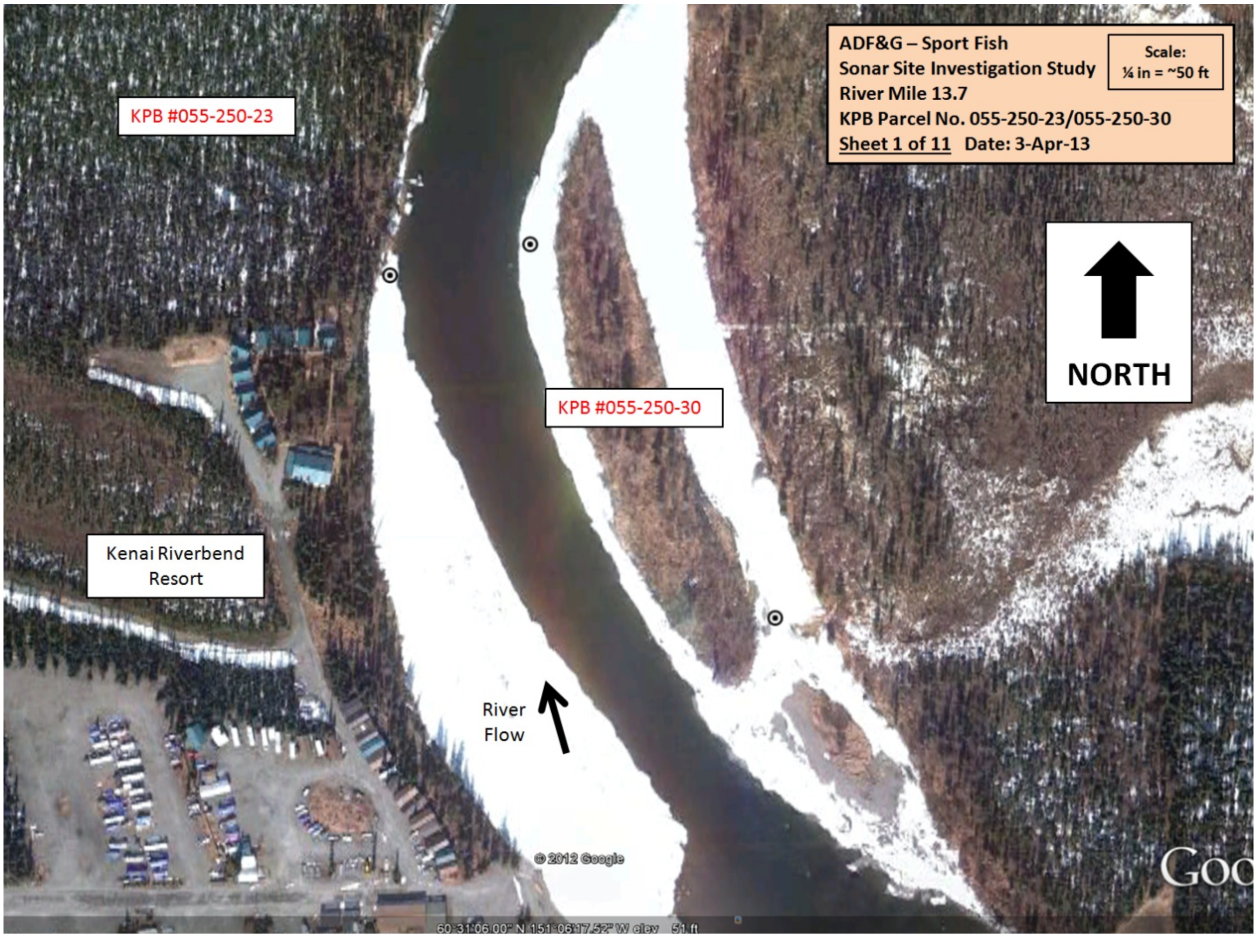


Figure G1-1.- Aerial map and parcel numbers for RM-13.7 sonar site.

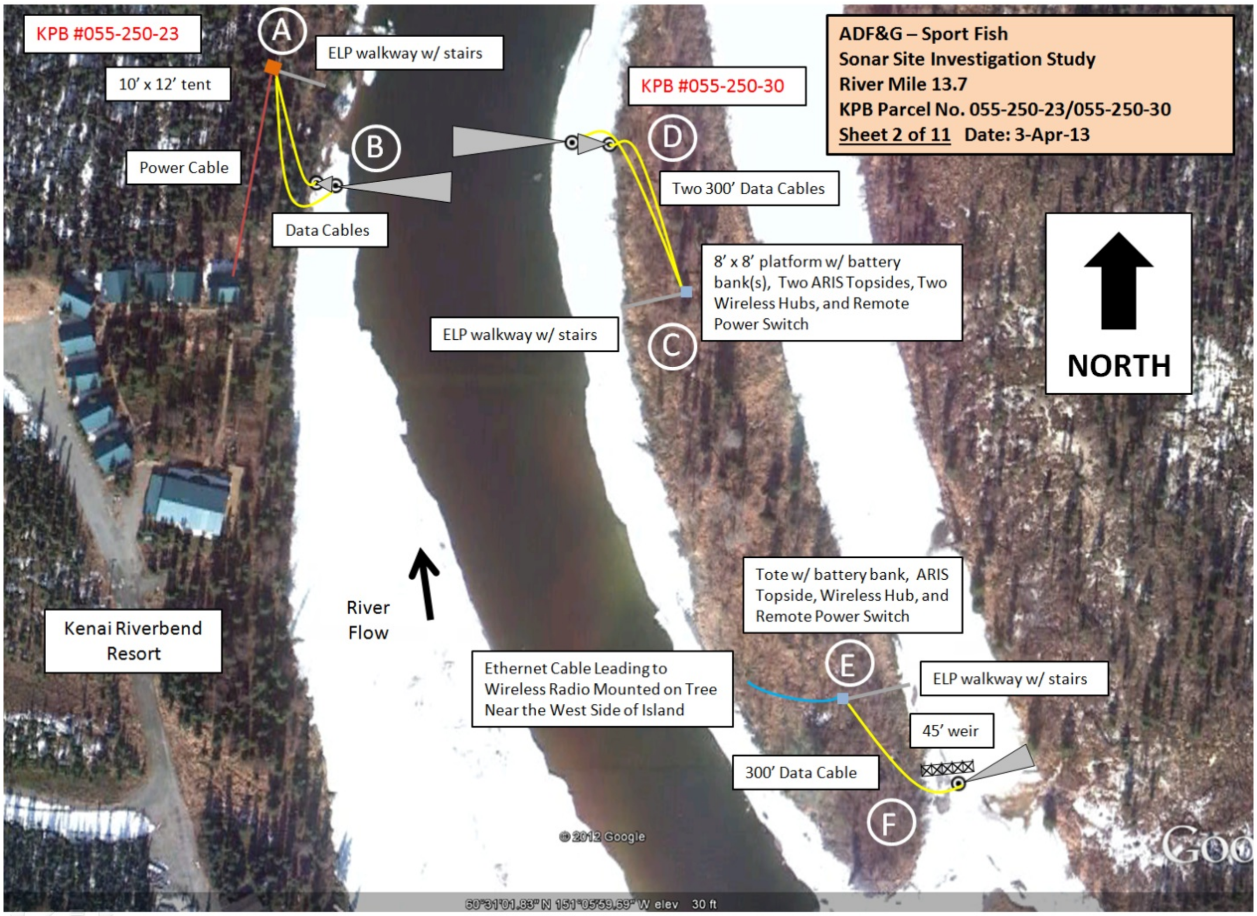


Figure G1-2.- Aerial view of sonar deployment at the RM-13.7 sonar site.

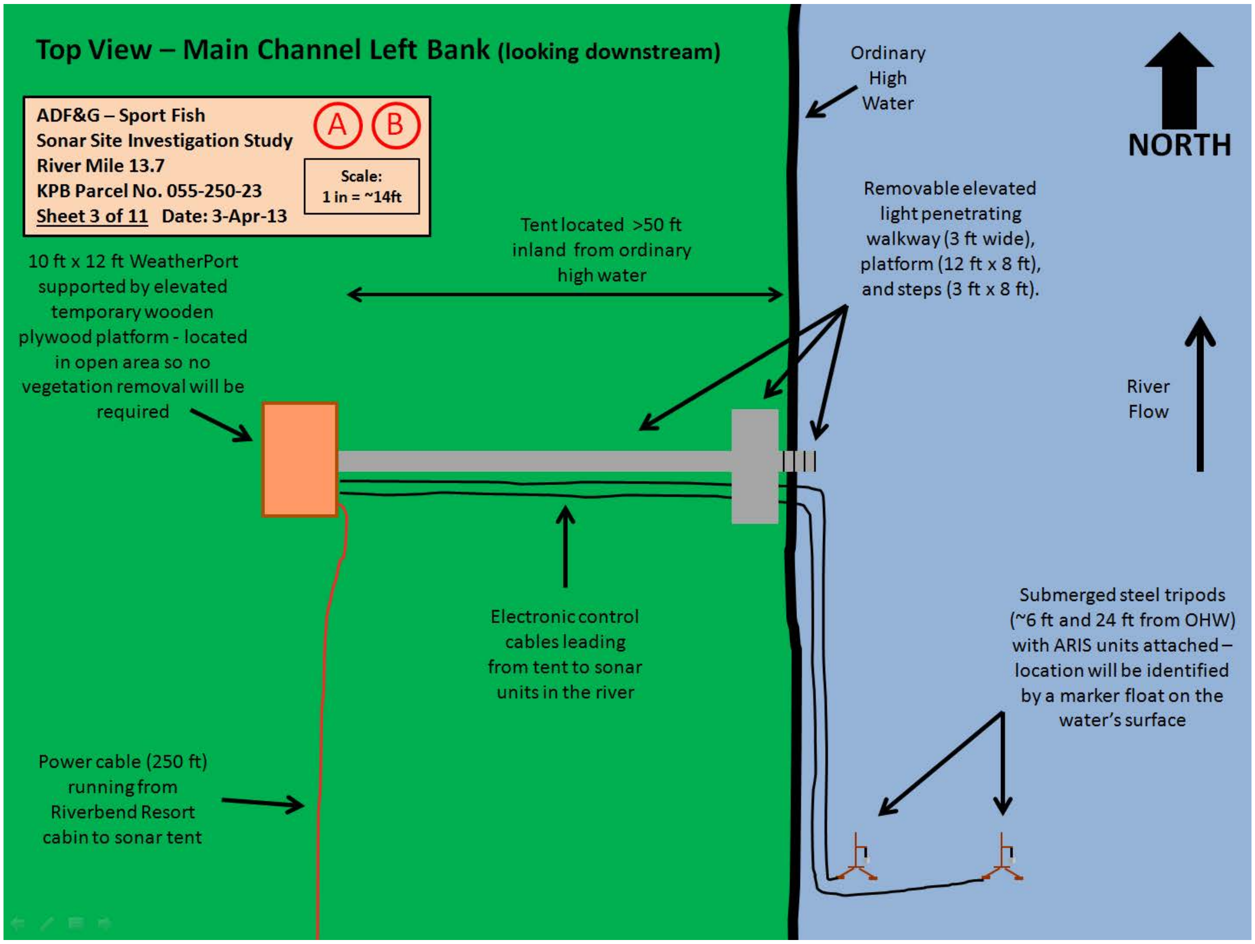


Figure G1-3.- Aerial view of main channel left-bank camp and sonar deployment at the RM-13.7 sonar site.

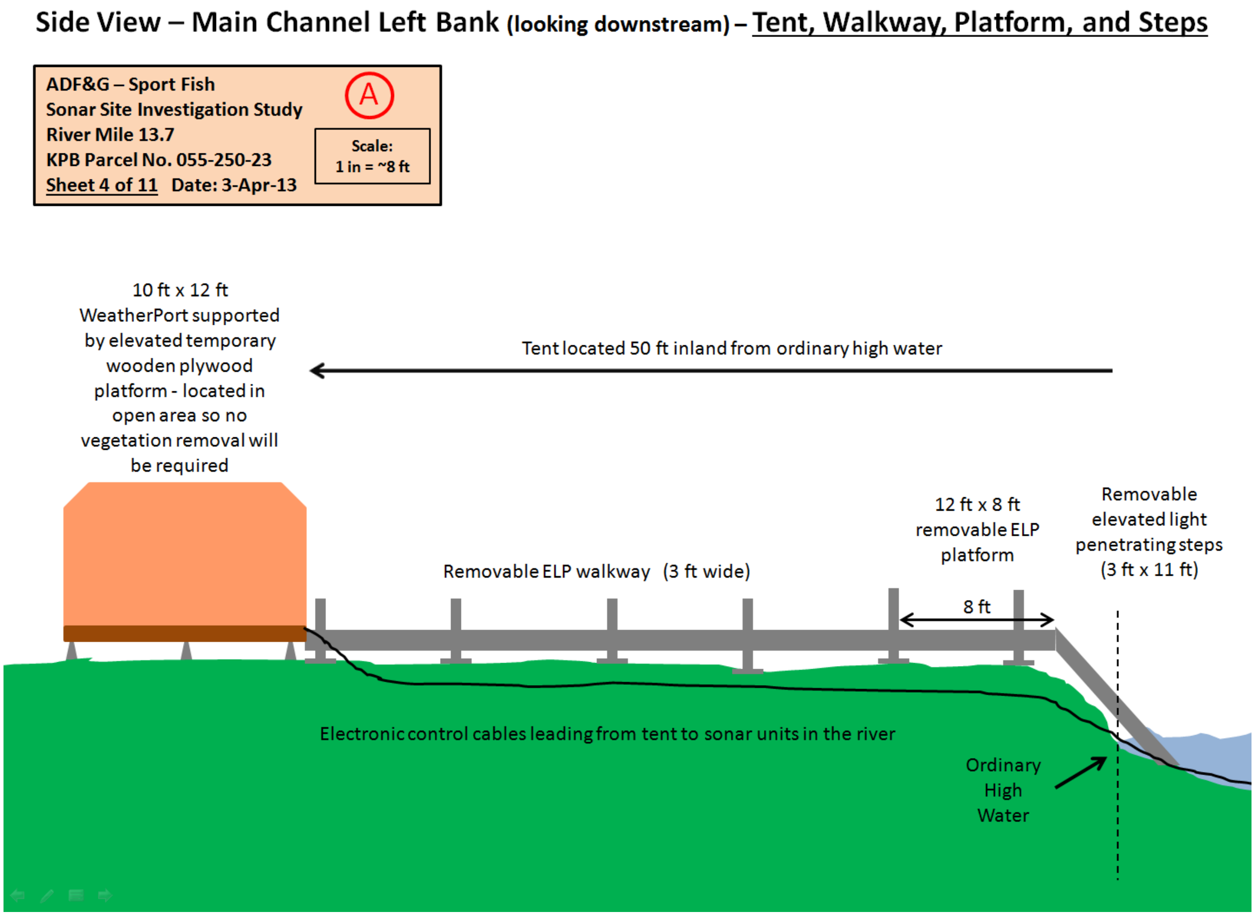


Figure G1-4.- Side view of main channel left-bank camp and walkway deployment at the RM-13.7 sonar site.

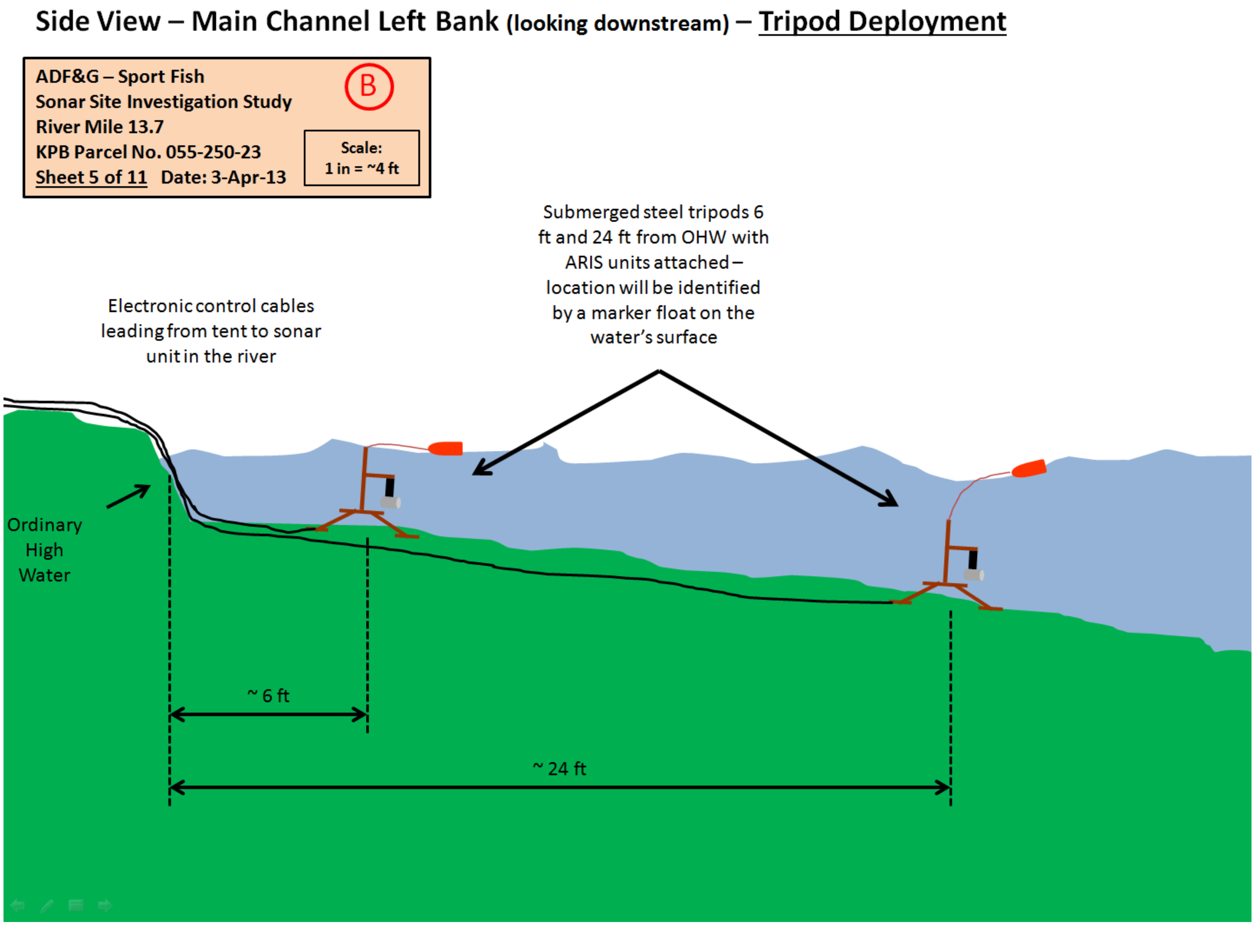


Figure G1-5.- Side view of main channel left-bank sonar tripod deployment at the RM-13.7 sonar site.

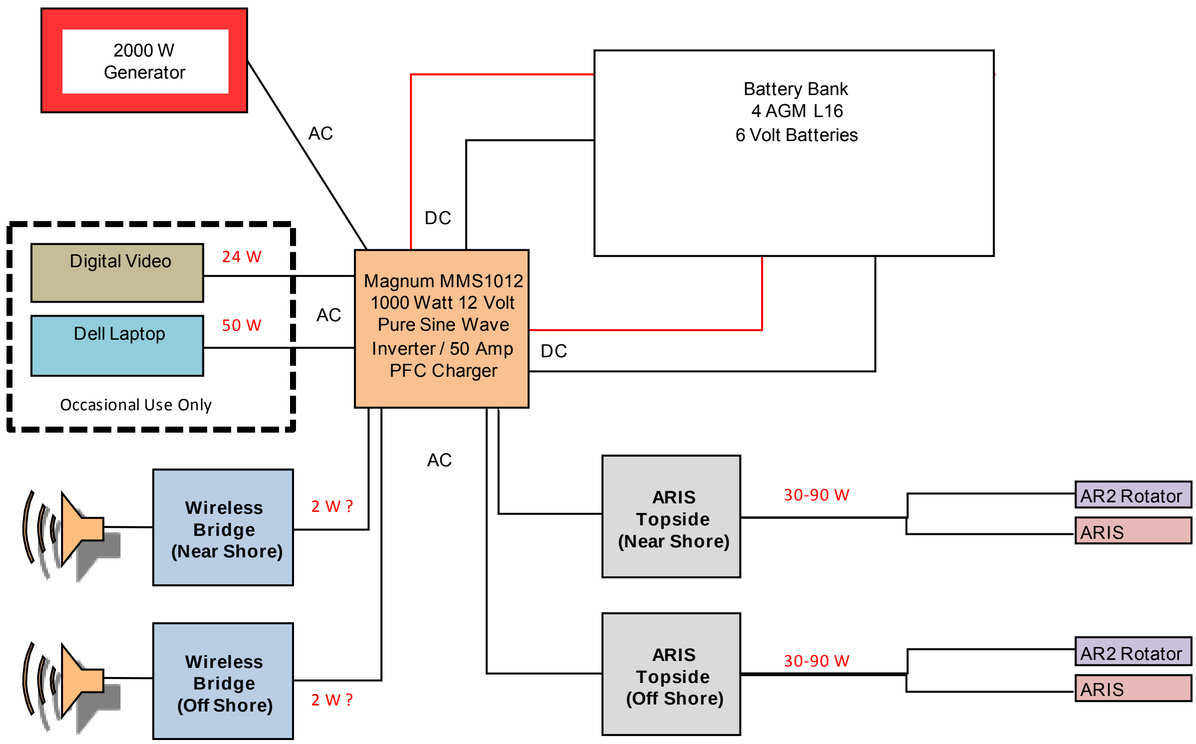


Figure G1-6.- Proposed schematic for supplying DC power to the two right-bank main channel ARIS systems at RM 13.7 via a battery bank charged by a 2000W generator.

.

Top View – Main Channel Right Bank (looking downstream) – Walkway, Platform, Tripod Deployment

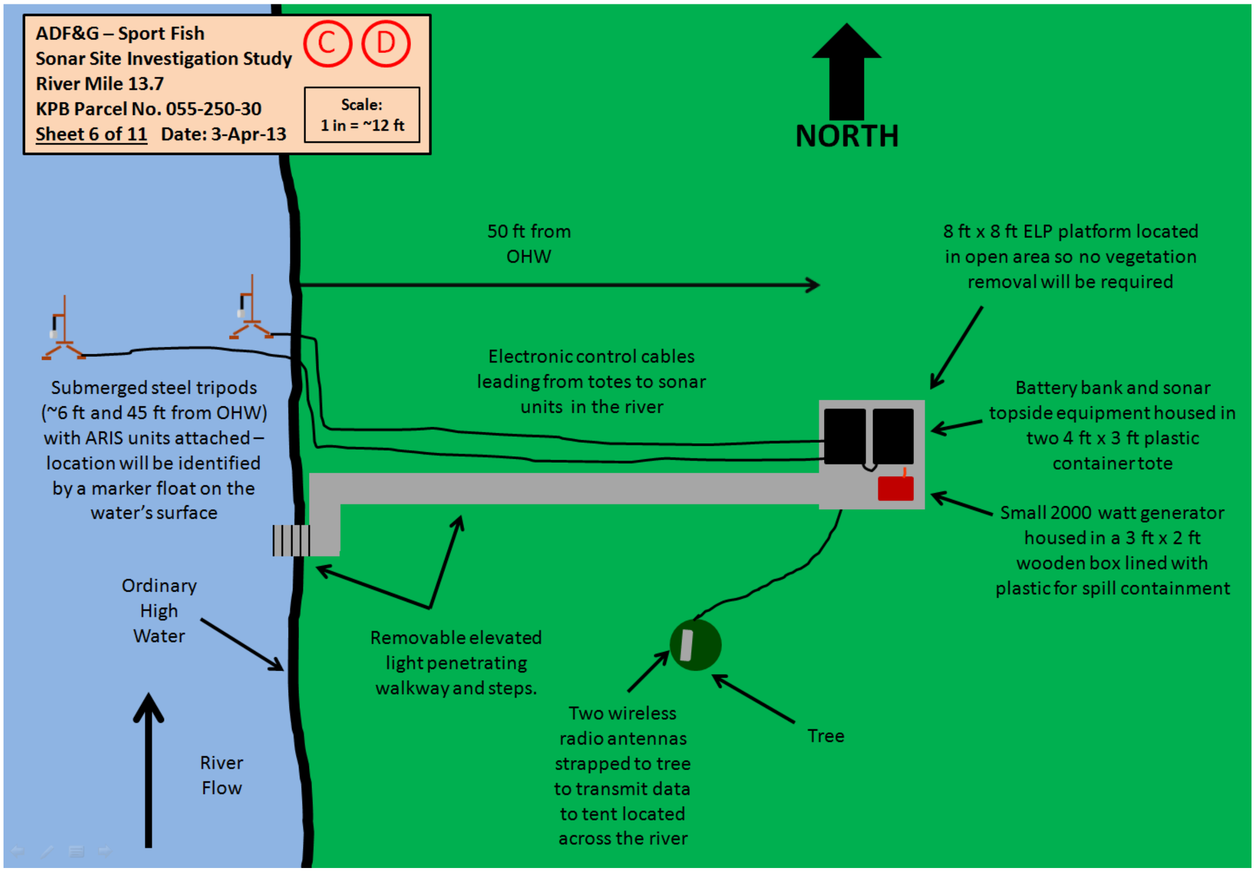


Figure G1-7.- Aerial view of main channel right-bank battery bank and sonar deployment at the RM-13.7 sonar site.

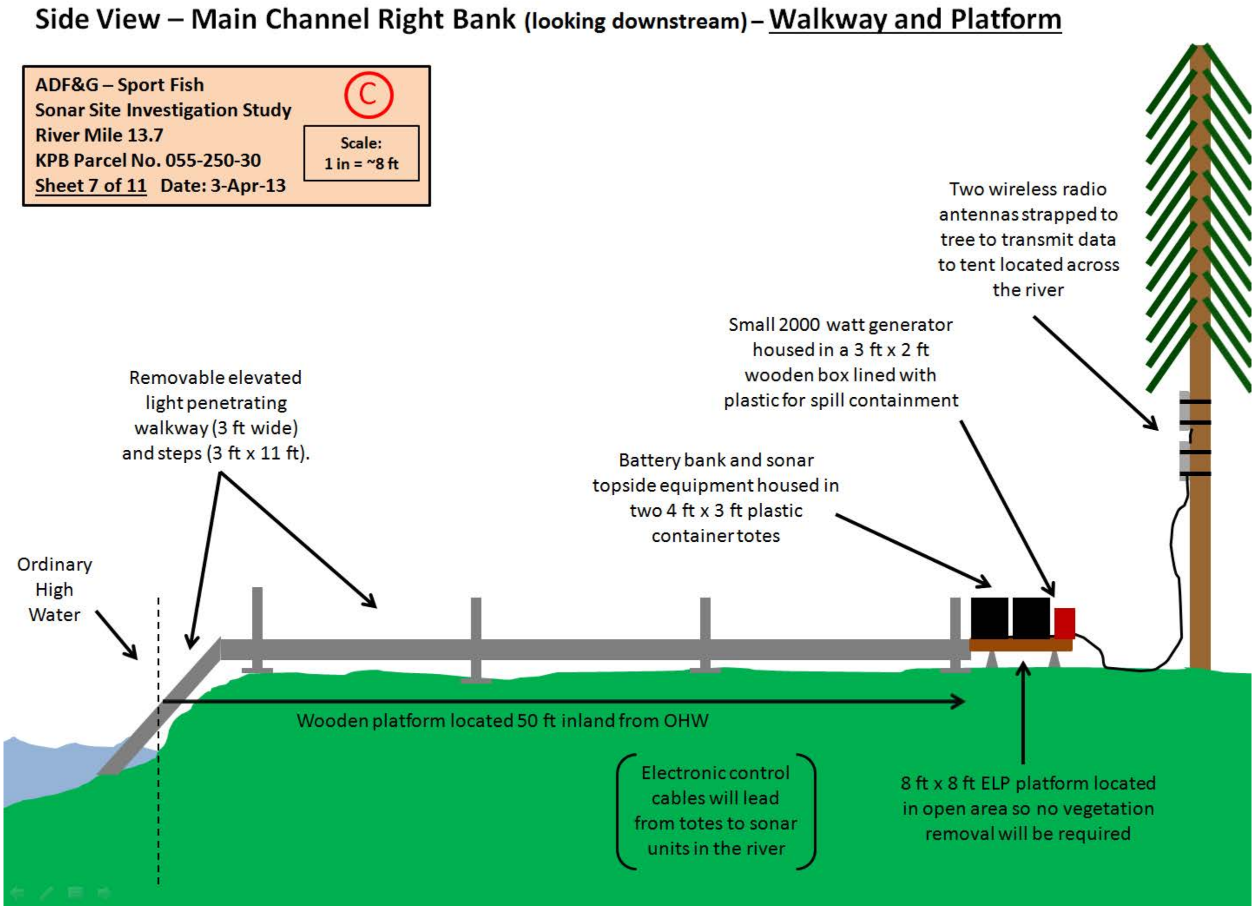


Figure G1-8.- Side view of main channel right-bank battery bank and walkway deployment at the RM-13.7 sonar site.

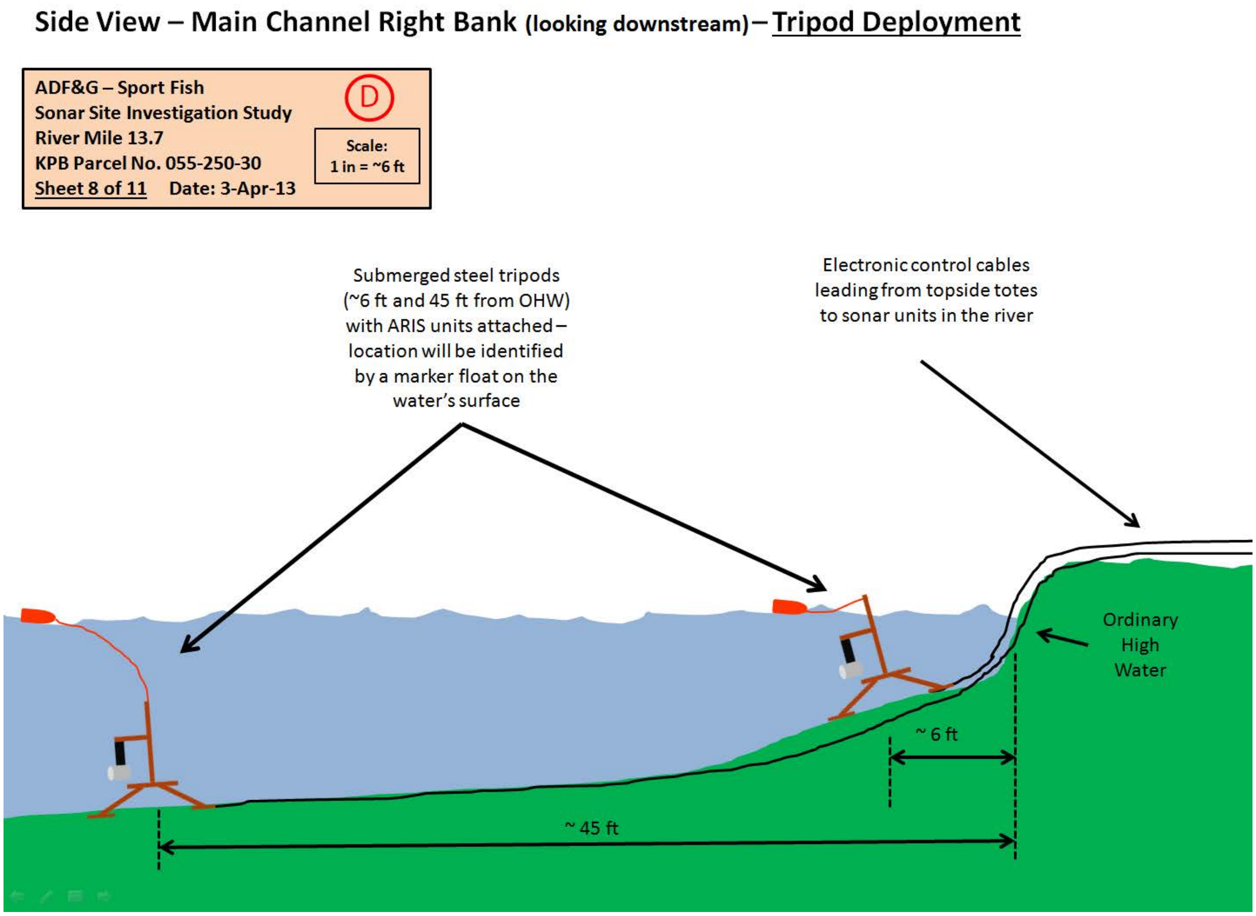


Figure G1-9.- Side view of main channel right-bank sonar tripod deployment at the RM-13.7 sonar site.

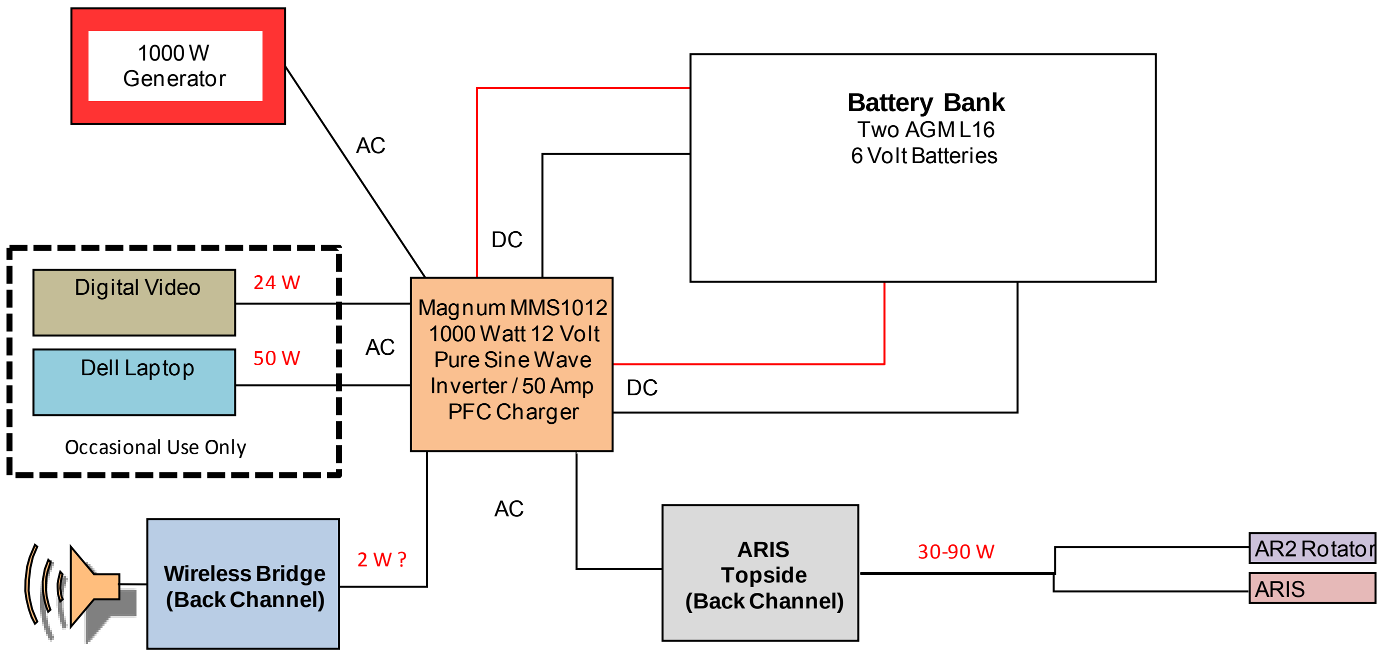


Figure G1-10.- Proposed system schematic for the supplying DC power to the minor-channel ARIS system at RM 13.7 via a battery bank charged by a 1000W generator.

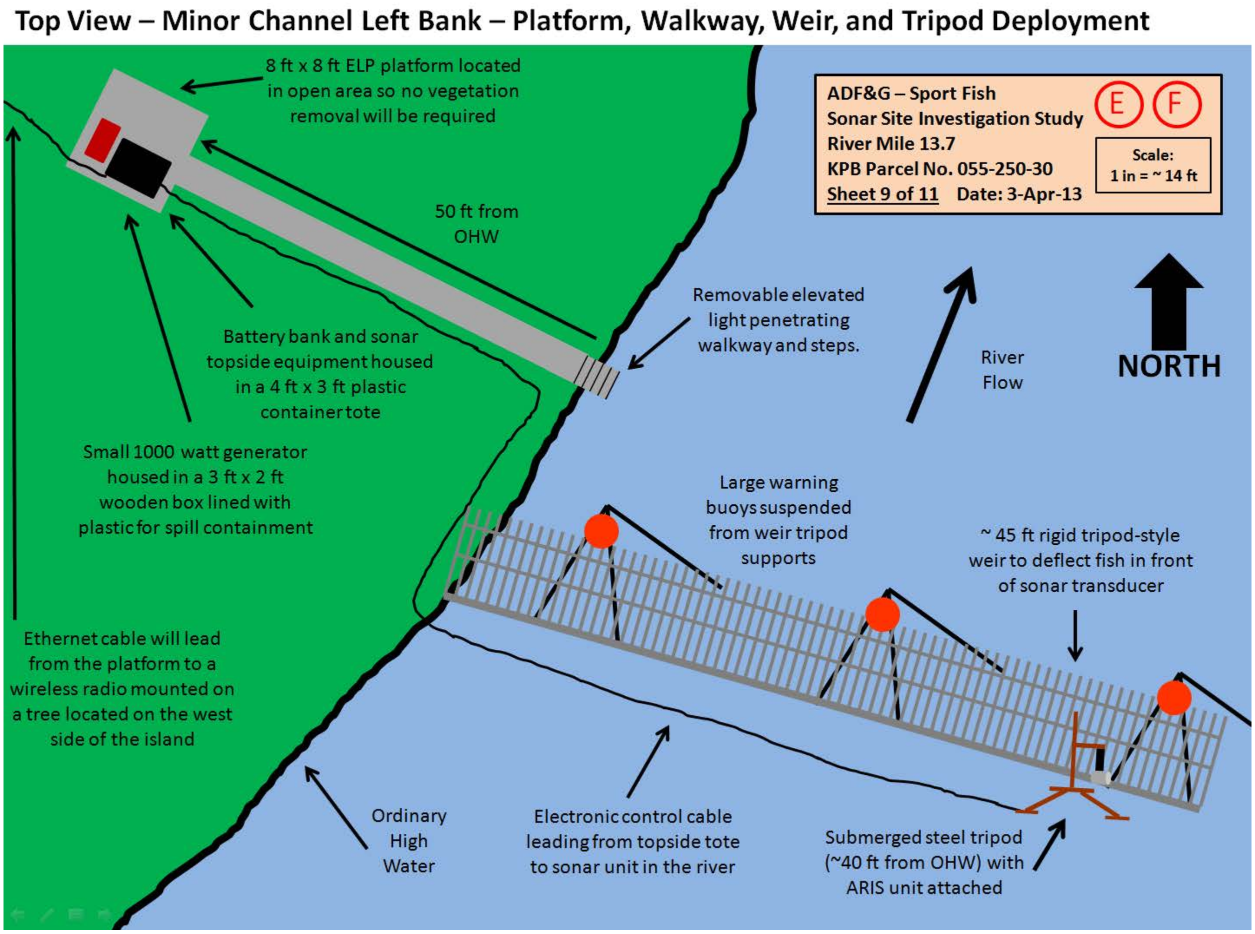


Figure G1-11.- Aerial view of minor channel battery bank, weir, and sonar deployment at the RM-13.7 sonar site.

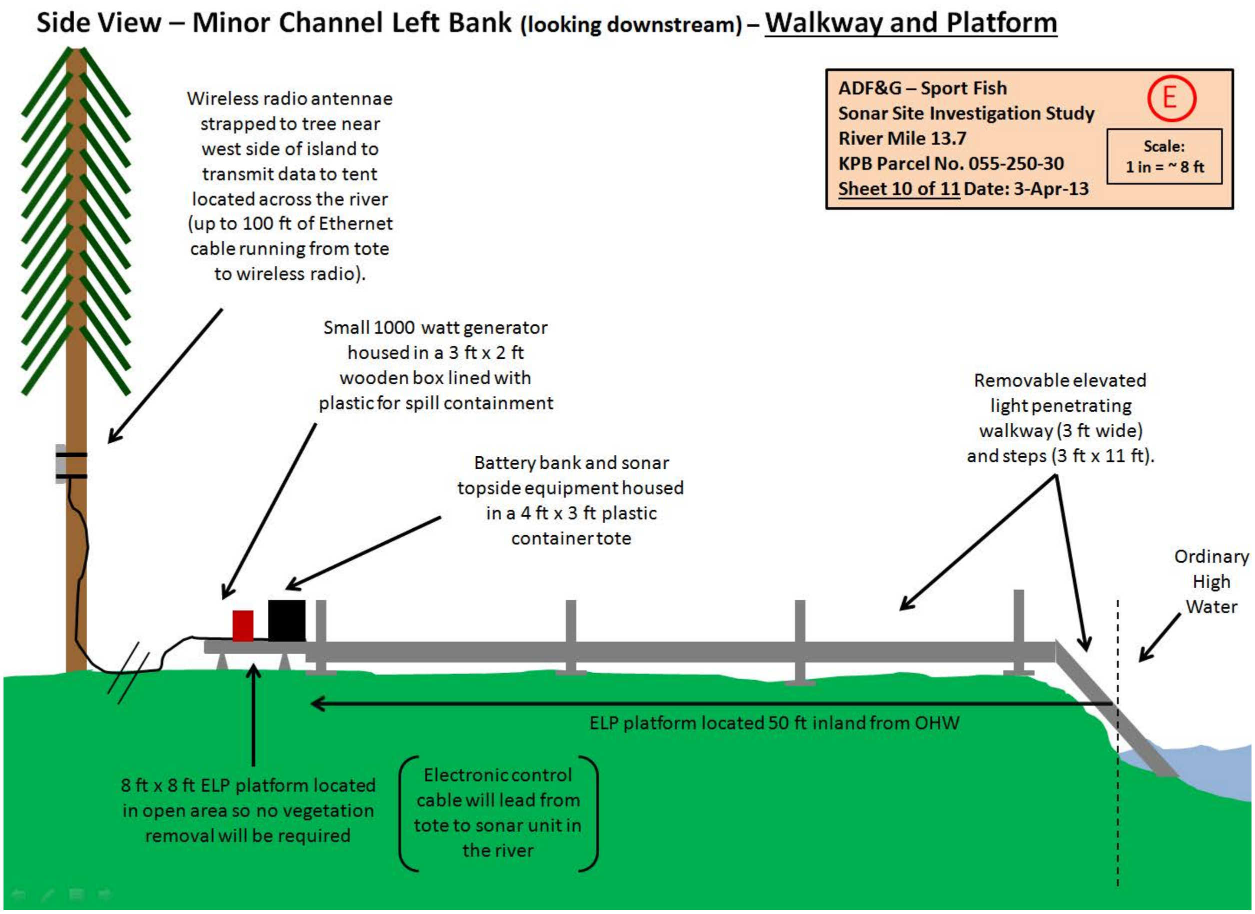


Figure G1-12.- Side view of minor channel battery bank and walkway deployment at the RM-13.7 sonar site.

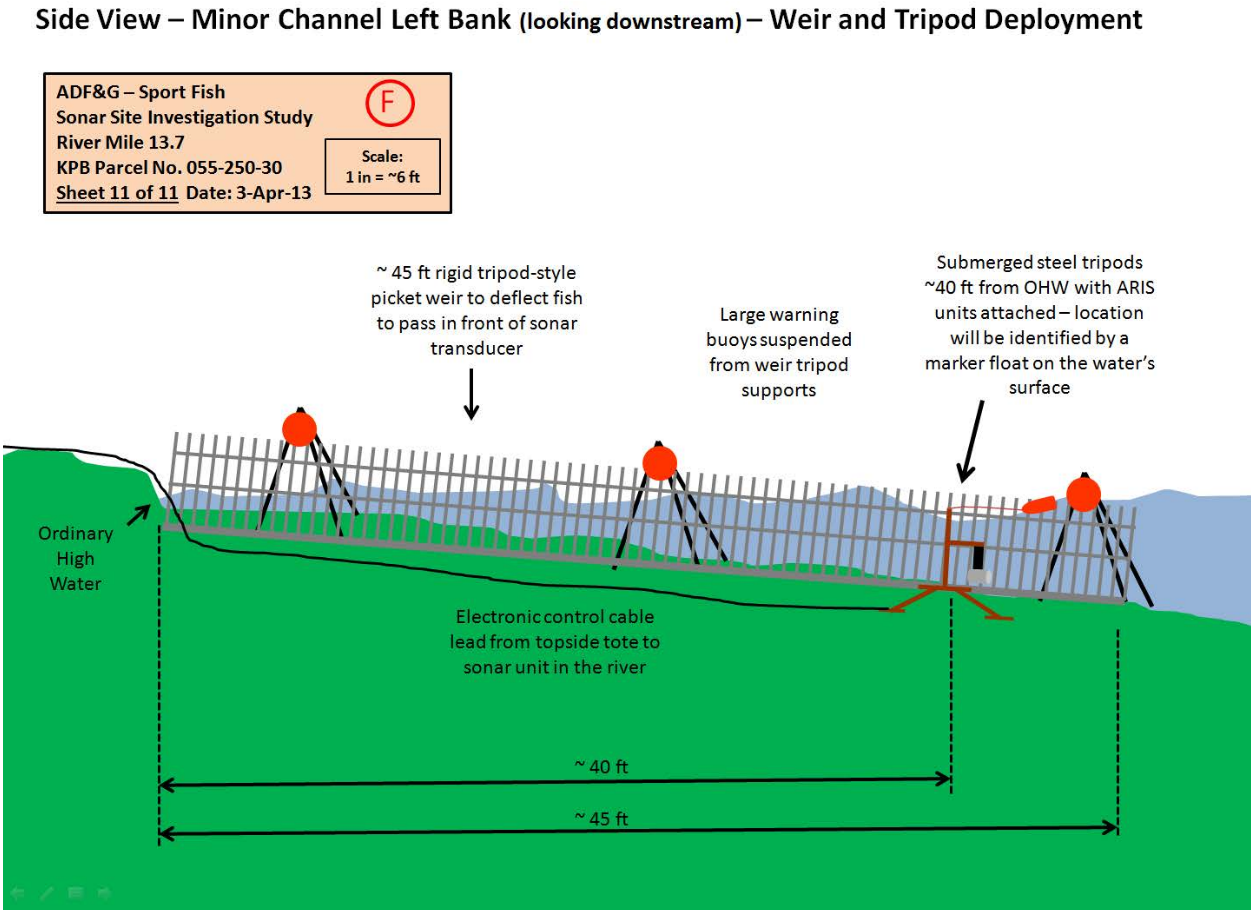


Figure G1-13.- Side view of minor channel battery weir and sonar tripod deployment at the RM-13.7 sonar site.

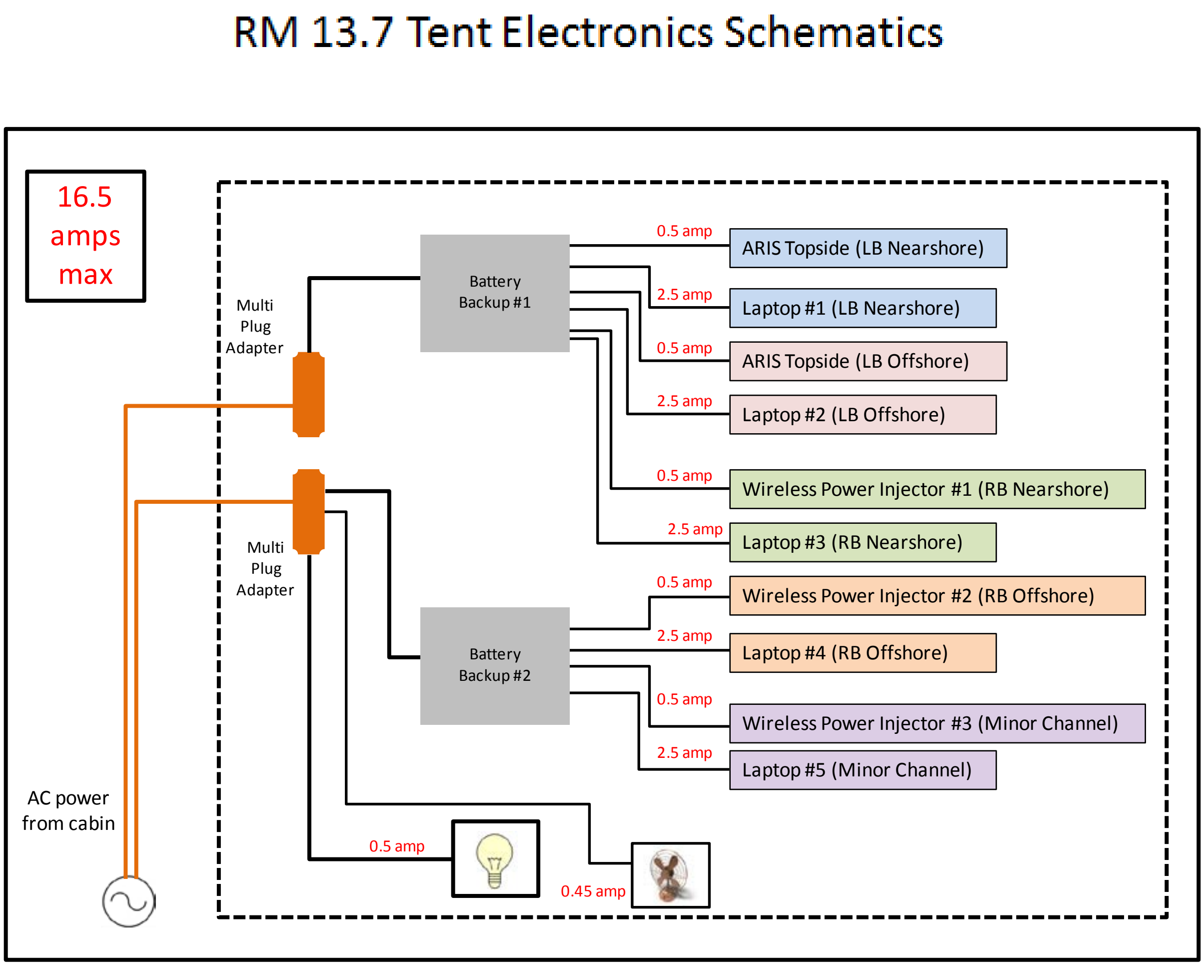


Figure G1-14.-Estimated power requirements for electronics based in the main camp on left bank.

APPENDIX H. KENAI RIVER CHINOOK SONAR NETWORK CONFIGURATIONS

Appendix H1.- RM-8.6 sonar site IP addresses

Device	IP address	Where located	Serial #	Username	Password	Device name or purpose
SONAR SITE at RM 8.6						
All subnet masks	255.255.255.0	RM 8.6				
Synapsis NetBooter – Left bank on/off switch	128.95.97.150	RM 8.6		Admin: admin User: sonar	Admin: Chinook User: Chinook	Remotely on/off Left bank DIDSON
Local\Tactical SubNet:						
Tactical Computer (one connection)	192.168.1.2	RM 8.6		SonarUser	Sockeye	Main computer for on-site data processing
Right Bank Laptop (NOT onboard but USB-to-Ethernet)	192.168.1.3	RM 8.6		dlburwen	megaptera	Sharing data from E: drive with Tactical
Left Bank Laptop (USB-to-Ethernet)	192.168.1.4	RM 8.6		dlburwen	megaptera	Sharing data from E: drive with Tactical
L-Bank Offshore DIDSON SubNet						
DIDSON SONAR LR	128.95.97.227	RM 8.6	381			
Left Bank DIDSON laptop (onboard Ethernet)	128.95.97.204	RM 8.6		dlburwen	megaptera	
SMC Bridge Radio for offshore DIDSON	128.95.97.2 (on right bank)	RM 8.6		admin	smcadmin	
SMC Bridge Radio for offshore DIDSON	128.95.97.4 (on left bank)	RM 8.6		admin	smcadmin	
L-Bank Nearshore DIDSON SubNet						
Std DIDSON (Anchor Rivers)	128.95.97.227	RM 8.6	20	dlburwen	delphi-17	DFGANCDSF164927
Nearshore DIDSON laptop (2012 temporary computer used on both banks)	192.95.97.175	RM 8.6		dlburwen	delphi-17	
CISCO Left bank Radio for NearShore DIDSON	128.95.97.2 (on right bank)			admin	Chinook	
CISCO Left bank Radio for NearShore DIDSON	128.95.97.4 (on left bank)	RM 8.6		admin	Chinook	
R-Bank Offshore DIDSON SubNet						
DIDSON SONAR LR	128.95.97.227	RM 8.6	340			
Right Bank DIDSON laptop (onboard Ethernet)	128.95.97.203	RM 8.6		dlburwen	megaptera	
Nearshore DIDSON laptop	192.95.97.175	RM 8.6		dlburwen	Delphi-17	DFGANCDSF164927

(2012 temporary computer)						
R-Bank Nearshore DIDSON SubNet						
Std DIDSON (Anchor Rivers)	128.95.97.227	RM 8.6	20			
Nearshore DIDSON laptop (2012 temporary computer used on both banks)	192.95.97.175	RM 8.6		dlburwen	delphi-17	

Appendix H2.- Soldotna sonar office IP addresses

SONAR Office	IP address	Where located	Serial #	Username	Password	Device name or purpose
Network Attached Storage						
Western Digital Sharespace 4 GB	192.168.1.101	Sonar Office	none	Admin	Chinook	DFGANCDSFDSSHR3
						2011 data
Western Digital Sharespace 4 GB	192.168.1.103	Sonar Office	none	Admin	Chinook	2012 data
Synology DiskStation 1512 10 TB	192.168.1.165	Sonar Office	none	Admin	Chinook	2012 ARIS data + 2013 RM 8.5 DIDSON
Buffalo TeraStation Pro 8 24 TB	192.168.1.165	Sonar Office	none	Admin	Chinook	2013 RM 13.7 ARIS DFGSXQTERA01
Buffalo TeraStation Pro 8 24 TB	192.168.1.165	Sonar Office	none	Admin	Chinook	2014 RM 13.7 ARIS
						DFGSXQTERA02
Computers						
Dell Workstation Laptop (LAN 2)	192.168.1.205	Sonar Office SOA network		dlburwen	Delphi-18	DFGANCDSF185749
Dell Workstation Laptop (LAN 1)	146.63.15.200					
Dell Optiplex 980	192.168.15.106	Sonar Office SOA network	B414BP1	sxqkenaisonar	Counting#Fish	Main data-processing computer DFGSXQDSF163887
	146.63.158.86					
Dell Optiplex 9010	192.168.15.107	Sonar Office netwok	FSJ7CX1	Jim's state domain login	Jim's state domain password	Backup data-processing computer (Jim's) DFGSXQDSF104102
	146.63.158.86	SOA network				
Dell Optiplex 990 mini tower	192.168.1.110	Sonar Office SOA network	BSQ86V1	sonargear	smaLLfry2	ARIS/DIDSON data processing (LBF) DFGSXQDSF102790
	146.63.15.xxx					DGSXQDCF102790
Dell Optiplex 990 mini tower	192.168.15.113	Sonar Office SOA network	BSS66V1	Michaels login	michaels soa pswd	ARIS/DIDSON data processing (Michael's) DFGSXQDSF102793
	146.63.158.86					
Dell Optiplex 990 mini tower	192.168.15.115	Sonar Office SOA network	BSR96V1	sonargear	smaLLfry2	ARIS/DIDSON data processing (CLJ's) DFGSXQDSF102792
						DGSXQDCF102792
Dell Optiplex 9010	192.168.15.150	Sonar Office SOA network	FSJ8CX1	sonargear	smaLLfry2	Upload computer DFGSXQDSF104103
Dell Optiplex 9010	192.168.15.114 146.63.158.86	Sonar Office SOA network	FSJ9CX1	Brandons Login	Brandons SOA	ARIS/DIDSON data processing Brandons DFGSXQDSF104104
Dell Latitude Laptop	192.168.1.222	Sonar Office SOA network		dlburwen	Delphi-21	Deb's personal laptop DFGANCDSF164927

Dell Optiplex 990 mini tower	192.168.15.108	Sonar Office SOA network	BSR56V1			Debs processing comp DFGSXQDSF102791
Backups for sonar field sites, sometimes in office						
Dell Latitude Laptop E6500			J8XM4M1	FISHSONAR2	Pinghappy2	Trevor's former laptop DFGANCDSF160898
Dell Latitude Laptop E6500			5L3Z8K1	FISHSONAR	Chinook1	Kara's former laptop DFGANCDSF158144
Dell Latitude Laptop E6500				FISHSONAR	Chinook1	Brandon's former laptop

Note: To attach to NAS devices, map drives to local address \\192.168.1.165\ however there cannot be two NAS with that IP address on the Network at the same time or it will cause a conflict.

Appendix H3.- RM-13.7 sonar site IP addresses (2014 configuration)

River Mile 13.75 SONAR Site	**IP address**	**Where located**	**Serial #**	**Username**	**Password**	**Device name or purpose**
L-Bank Nearshore ARIS SubNet						
ARIS sonar	169.254.XX.XX					New
Dell Latitude Laptop E6430				sonar	Count#Fish	New
L-Bank Offshore ARIS SubNet						
ARIS sonar	169.254.XX.XX					
Dell Latitude Laptop E6400				sonar	Count#Fish	New
R-Bank Nearshore ARIS SubNet						
ARIS sonar	169.254.XX.XX					New
Dell Latitude Laptop E6430				sonar	Count#Fish	New
NetBooter	128.95.97.150			admin	Chinook	
CISCO Radio for ARIS						
Left bank radio	128.95.97.4					New
Right bank radio	128.95.97.2					New
R-Bank Offshore ARIS SubNet						
ARIS sonar	169.254.XX.XX					
Dell Latitude Laptop E6430				sonar	Count#Fish	New
NetBooter	128.95.97.150			admin	Chinook	
CISCO Radio for ARIS						
Left bank radio	128.95.97.4					
Right bank radio	128.95.97.2					
R-Bank Side-Channel SubNet						
ARIS sonar	169.254.XX.XX					New
Dell Latitude Laptop E6430	169.254.50.50 255.255.0.0			sonar	Count#Fish	New
NetBooter	169.254.50.75 255.255.0.0			admin	admin	• Hold down reset button for 1 second (really) with power on

						• Default address is 192.168.1.100
CISCO Radio for ARIS						
Left bank radio	128.95.97.4					
	128.95.97.2					
Backup Computers (from 2012)						
Dell Latitude Laptop E6500	128.95.97.151	FISHSONAR	Chinook1			Brandon's former laptop
Dell Latitude Laptop E6500	128.95.97.153	FISHSONAR	Chinook1			Kara's former laptop

Other info related to networks:

- *The Didson networks for Right and Left Banks are NEVER connected together. Therefore, the separate laptops or the underwater units, respectively**, can have the same IP addresses. (**Of course, no device can have the same IP address on the same network.)
- The Local and Didson networks are not bridged together in any way.

Appendix H4.-Mapping to the Network Attached Storage, Buffalo TeraStation 5800, in 2014.

The 2014 Buffalo NAS device was configured with additional redundancy (two Network connections Trunked for failover if one is damaged or has loss of communication) and it now has Standardized names for the Devices and Shares. It is optional to connect both LAN connections.

The IP Addresses are the same across the 2013 and 2014 TeraStations: 192.168.1.165. However, two of the devices cannot be on the same network as each other as they will create a conflict with their IP Addresses.

The TeraStations are now named following our state standards:

DFGSXQTERA01 – Soldotna 2013 Kenai River Chinook Sonar ARIS data archive
DFGSXQTERA02 – Soldotna 2014 Kenai River Chinook Sonar ARIS data archive

Sky Ahrens (267-2139) in network services configured ONE folder share for the entire drive on the 2014 Buffalo NAS as follows: \\DFGSXQTERA02\SXQTERA

This drive can be mapped using the same credentials we have used for our other NAS devices:
Username: admin
Password: Chinook

The two Network connections (LAN1 and LAN2) on the back of the 2014 Buffalo TeraStation 5800 are now trunked, and must both be plugged into the network for the failover to be effective. This redundancy will give assured uptime in case there is any communication issues (severed wire, network issues on that port, etc) through one of those channels.

The following batch file can be used to map to the 2014 Buffalo NAS automatically:

Net_share_2014.bat

```
@ECHO OFF
:: Mapping Upper River Network Share ::
:: Mapped Letter: U
:: Developed by: Ron Duvall - 267-2139 ::
:: Updated by: Skye Ahrens - 267-2139 ::

NET USE U: /delete

NET USE U: \\DFGSXQTERA02\SXQTERA Chinook /USER:Admin

:NET USE U: \\DFGSXQTERA02\SXQTERA Chinook /USER:Admin

:pause
```

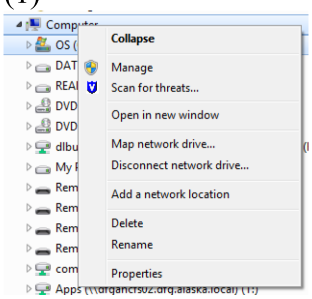
Or the user can manually Map to the 2014 Buffalo NAS as follows:

1) **<Right click>** on Computer
   Select **Map network drive………..**

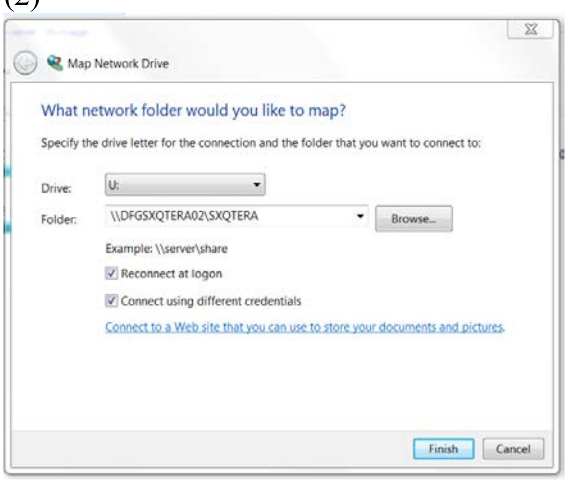
2) Select **Drive U:** from drop down menu
   Enter Folder : [\\DFGSXQTERA02\SXQTERA](\\DFGSXQTERA02\SXQTERA)
   Select\check **Connect using different credentials**
   Select **Finish**

3) When prompted enter credentials:
   Username: **dfgsxqtera02\admin**
   Password: **Chinook**
   (Don't forget to capitalize Chinook)

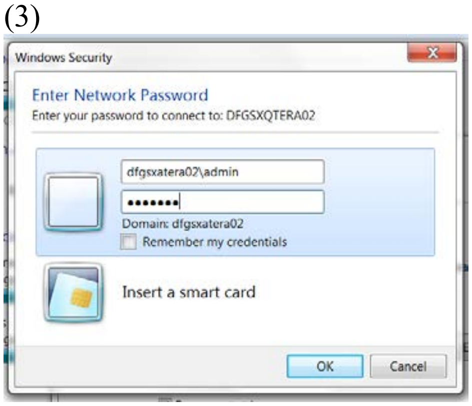
(1)



(2)



(3)



APPENDIX I. CISCO BRIDGE CONFIGURATIONS AND SETUP INSTRUCTIONS

Appendix I1.- CISCO Bridge Configurations and setup instructions

Model No.: AIR-BR1310G-A-K9
IP Address: [static, assigned below]
Username: admin
Password: Chinook

Default IP Address: NONE
Default Username: Cisco
Default Password: Cisco

(The example below assumes a Didson network. See the IP notes about an Aris network.)

Computer used to collect data
IP Address: 128.95.97.203 [for Didson network. Aris sonar uses 169.254.xxx.xxx network.]

Right_Bank (tent side of the river)
SSID: RightBank
IP Address: 128.95.97.2
Subnet Mask: 255.255.255.0
Gateway: None
Wired MAC Address: 50-3D-E5-D9-6B-7A
Radio MAC Address: 00-3A-99-D0-97-C0

Left_Bank (bluff)
SSID: LeftBank
IP Address: 128.95.97.4
Subnet Mask: 255.255.255.0
Gateway: None
Unit MAC Address: 00-07-7D-4D-18-16
Radio MAC Address: 00-3A-99-DE-CB-10

Required Connections:
The access point provides an RS-232 serial port that enables a connection to a PC for monitoring and configuration. Attach the PC to the access point (Cisco Bridge), using the serial console cable (DB9 to RJ45 adaptor cable) provided with this package.

After initial Console setup, you will then connect to the web interface using the Ethernet network interface. Connect an Ethernet cable between the PC and the Cisco Bridge's power injector. (The PC must be set to a static IP address on the same subnet as the Cisco Bridge.)

To connect to the console port, complete the following steps:
1. Connect the DB-9 end of the console cable to the serial port on the PC and connect the RJ45 end to the Console port on the access point's power injector.

2. Start your terminal program. Set the terminal emulation software is set as follows:
- Select the appropriate serial port (COM port 1 or 2).
- Set the data rate to 9600 baud (if this fails*, try 38400 – found on one unit)
- Set the data format to 8 data bits, 1 stop bit, and no parity.
- Set flow control to none.
- When using HyperTerminal, select Terminal keys, not Windows keys.

3. Power up the Cisco Bridge, and observe the boot process in the terminal program. You should be able to observe readable text. If not, try the other baud rate noted above*. After it is done booting, press the [Enter] key to initiate the console connection. The console login screen will be displayed. Enter the default username and password to access the console.

4. Set the Cisco Bridge IP Address. Enter Ethernet configuration mode by typing the following commands: (prompt is in bold and what you type is not bolded)

```
ap>enable
Password:(enter password) [Cisco is default password]
ap#configure terminal
Enter configuration commands, one per line.
End with CNTL/Z.
ap(config)#interface bvi1 [last letter is a 'one', not an 'el']
ap(config-if)#ip address 128.95.97.xxx 255.255.255.0
ap(config-if)#exit
ap(config)#exit
ap#
*Mar  1 00:02:44.209: %SYS-5-CONFIG_I: Configured from console
by console [press enter]
Ap#write
Building configuration...
[OK]
ap#write memory
Building configuration...
[OK]
ap#
```

Command-line notes – IP Address:
On the `ip address` line, the 'xxx' entry means you must enter a unique static ip address; usually 2 for the Camp-side Bridge, and 4 for the remote Bridge (Example: 128.95.97.2). The subnet mask in this example is 255.255.255.0

The subnet must be set up to match the sonar units and the PC/laptop. Didson sonar uses 128.95.97.xxx Class C subnet, and Aris sonar uses 169.254.xxx.xxx Class B subnet.

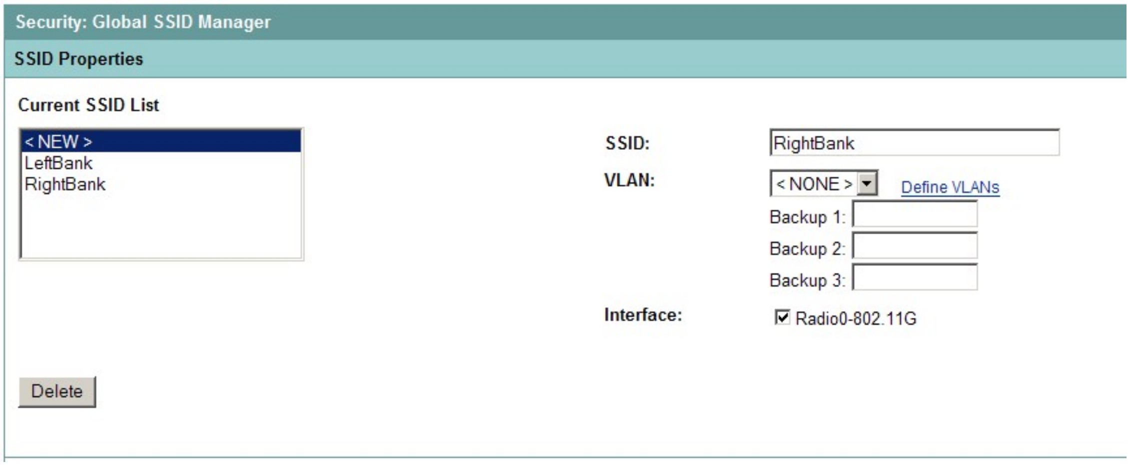
Example `ip address` **commands:**

	IP:	Subnet mask:	
ip address	128.95.97.2	255.255.255.0	[Didson Camp Bridge]
ip address	128.95.97.4	255.255.255.0	[Didson remote Bridge]
ip address	169.254.50.2	255.255.0.0	[Aris Camp Bridge]
ip address	169.254.50.4	255.255.0.0	[Aris remote Bridge]

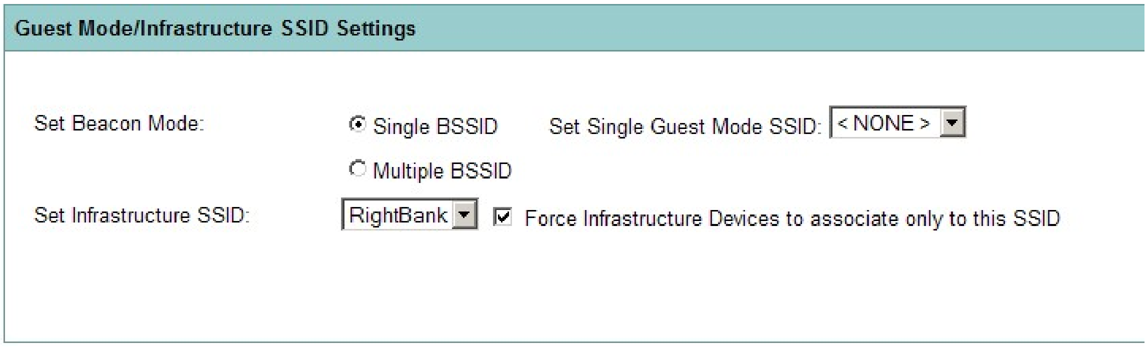
[Note that the subnet mask for Didson is 'Class C' but for the Aris, it is 'Class B']

5. You can now connect to the unit using the web browser. In the Browser URL address line (top text-entry line), enter the Cisco Bridge IP address (example: 128.95.97.2)

6. Logon and then go to the Security/SSID Manager. In the SSID Properties section, add the SSID and check the Interface Box. Just one is needed, but it must be exactly the same SSID for both Cisco Bridges of a **bridge-pair**. This must be a unique SSID: other **bridge-pairs** operating nearby cannot have the same SSID. (If they did, different **bridge-pairs** would try to connect together – and that would be bad!)



7. Scroll to the bottom of the Security/SSID Manager page and on the very last line, Set Infrastructure SSID: to the same SSID as the Cisco Bridge on the opposite bank and then check the Force Infrastructure Devices to associate only to this SSID Box, and click Apply.



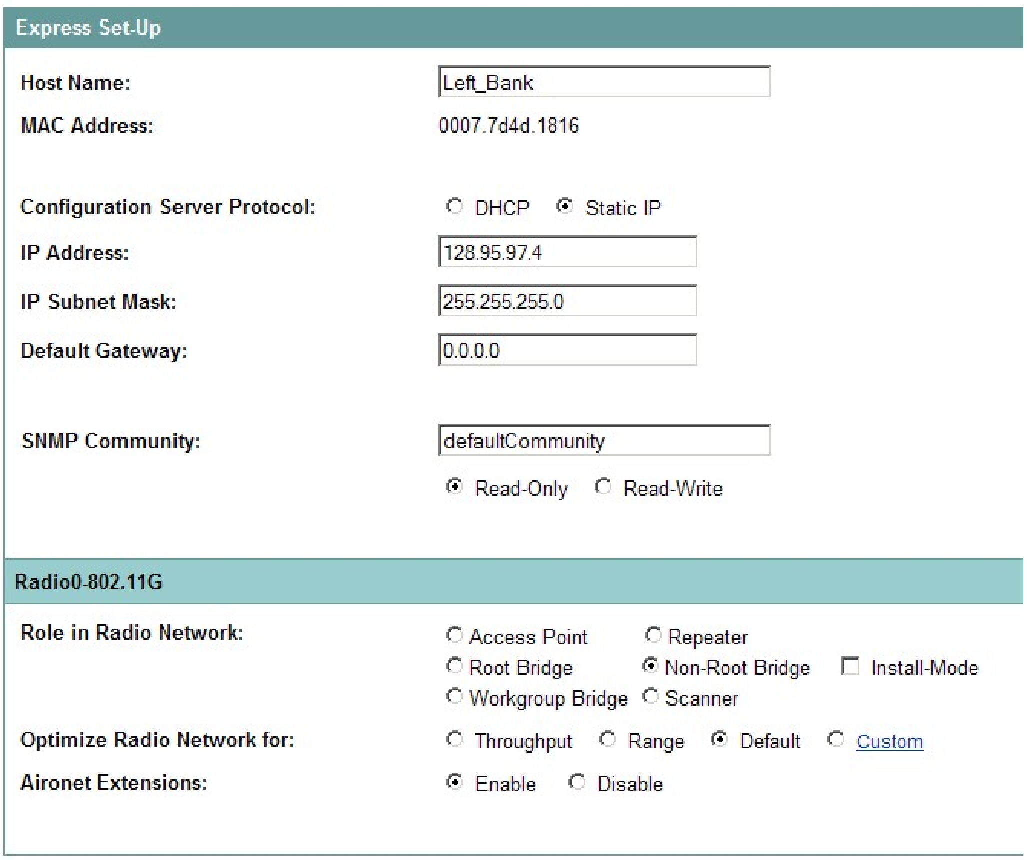
8. Go to the Express Set-Up Page and configure as shown below. Be sure to click Apply before leaving the page:

Host Name is Right_Bank or Left_Bank
Configuration Server Protocol is Static IP
Role in Radio Network for Right Bank is Root Bridge and Left Bank is Non-Root Bridge.
Leave everything else default.
Click Apply

Multiple Near-By Bridge-Pairs:
The examples shown here assumed a single bridge-pair as it was set up at the Lower River Sonar Site. The Upper River site uses 3 nearby bridge-pairs for 3 across-river Aris sonar units. Here is a suggested naming convention for them:

Bridge Pair	SSID	Laptop Bridge	Aris Bridge	Sonar Location
1	River1	Camp1	ArisUnit1	RightFar
2	River2	Camp2	ArisUnit2	RightNear
3	River3	Camp3	ArisUnit3	Channel

Because these are all separate networks, the IP addresses can be set up identically (like the examples); but the SSIDs **must** be different because these bridge-pairs are operated in proximity to each other.



Test the units by connecting a computer to the Right Bank unit.

Connect a crossover cable to the RJ-45 port of the computer and plug it into the Ethernet port on the access points power injector unit, then connect both the ports on the Bridge to both of the ports on the injector. Power everything on and wait for the bridges to connect you should now be able to ping both ends of the bridge.

Connect the Didson to the Left Bank unit.

Connect a patch cord to the RJ-45 port on the Didson topside box and plug it into an open port on a 10Mb hub then connect a patch cord from the hub to the Ethernet port on the access points power injector unit, then connect both of the Bridges ports to both of the ports on the injector. This is outlined in greater detail on the next page.

CISCO AERONET WIRELESS SYSTEM TO DIDSON

Important differences between SMC and CISCO wireless setups!

Use crossover cable from PC to CISCO power injector module
Use BOTH of the coax cables between radios and power injectors

Setup steps – better not deviate for now:

Topside box is attached to DIDSON
Video monitor is attached to Topside box (to monitor DIDSON boot etc)
Connect transmit and receive coax cables to power injectors and radios – taped coax cable ends go to remote bank (outside) radio connectors (there are two coax cables per radio to connect)
Mount radios and aim faces toward each other
Hook computer to hub using straight through patch cable, boot the computer
Hook hub to topside box using straight through patch cable
Power up the hub
Power up the DIDSON
When DIDSON says “waiting” you can ping via command window (ping 128.95.97.227)
If you can ping DIDSON, disconnect straight through from computer and connect that end to the CISCO power injector (take computer out of the equation)
Power up the remote side power injector
Power up equipment side power injector
Connect the PC to the equipment side power injector using a CROSSOVER cable
Before you ping the bridges\radios, you must wait for a LONG boot up (up to 4 minutes)
Ping right bank bridge (ping 128.95.97.2)
Ping left bank bridge (ping 128.95.97.4) – if you can’t ping left bank, but you can ping right bank, there is probably noise interference (shut down SMC to verify)
You should now be able to ping the DIDSON if everything has gone well to this point
If you can ping the DIDSON start the DIDSON software on the computer (make sure DIDSON hasn’t timed out though, if it has you must power down the DIDSON topside box and restart it.)

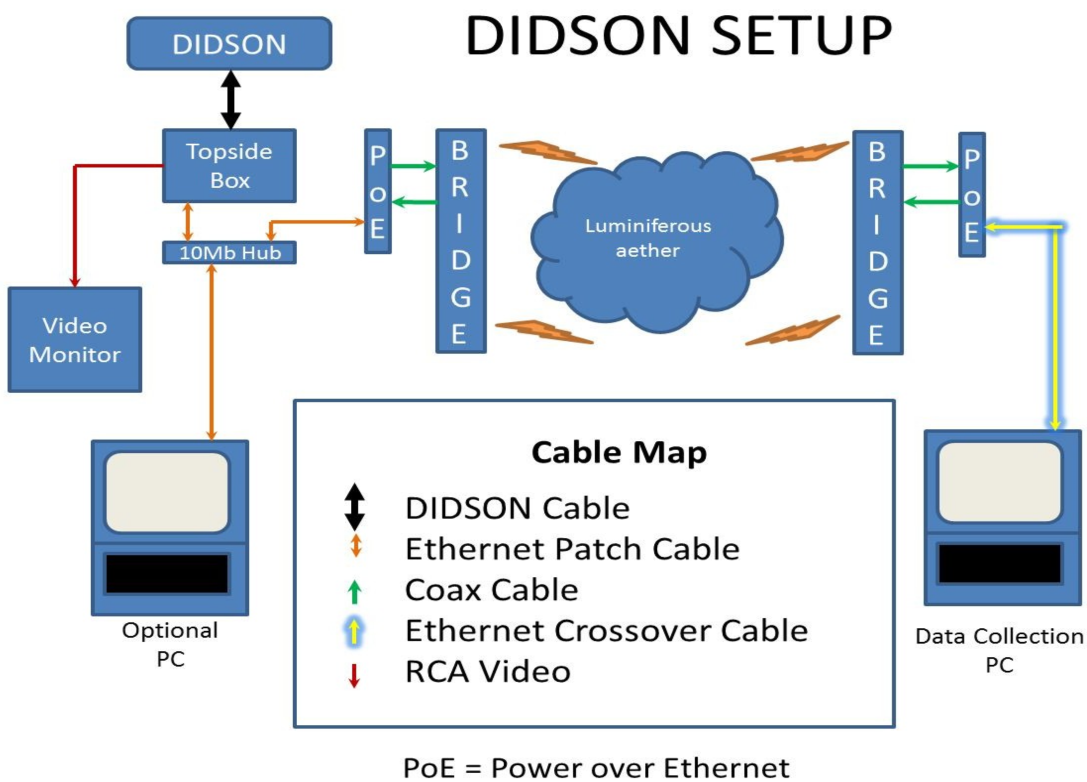


Figure I1-1.-Wireless bridge diagram.