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Estimates of Chinook Salmon Abundance in the Kenai River Using Split-Beam Sonar, 1995

by

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and

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April 1996

Alaska Department of Fish and Game

Division of Sport Fish

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

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

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
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
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

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	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
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.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
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
standard length	SL
total length	TL
variance	Var

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ABSTRACT

A 420 kHz dual-beam sonar system has been used since July 1987 to estimate the riverine abundance of chinook salmon *Oncorhynchus tshawytscha* in the Kenai River. In 1995, following a one-season comparative study, the dual-beam system was replaced with a 200 kHz split-beam sonar system. Daily abundance estimates of chinook salmon were generated from 16 May through 9 August 1995. The total seasonal estimate of 66,220 chinook salmon was comprised of 21,884 early-run and 44,336 late-run fish.

Key words: Split-beam sonar, chinook salmon, *Oncorhynchus tshawytscha,* hydroacoustic, Kenai River, riverine sonar.

INTRODUCTION

Chinook salmon returning to the Kenai River support one of the largest and most intensively managed recreational fisheries in Alaska (Nelson 1994). Kenai River chinook salmon are among the largest in the world and have sustained in excess of 100,000 angler-days of fishing effort annually.

Chinook salmon returning to the Kenai River are managed as two distinct runs, early and late, which typically peak in mid-June and late July (Burger et al. 1985). Early-run fish are harvested primarily by sport fishermen; late-run fish by both commercial and sport fishermen. In November 1988 the Alaska Board of Fisheries set optimum spawning escapement goals of 9,000 and 22,300 for early-run (16 May-30 June) and late-run (1 July-10 August) chinook salmon, respectively (McBride et al. 1989). Commercial, sport, subsistence, and personal use fisheries can be restricted if the projected run size falls below these set escapement goals (ADF&G 1990).

Sonar estimates of inriver return provide the basis for estimating spawning escapement and implementing management plans that regulate harvest in competing sport and commercial fisheries for this stock. Implementation of these management plans has been a contentious issue for the state, one that commands much public attention. In recent years, some provisions of the management plan have been implemented which have resulted in significant fishery restrictions.

A creel survey program was first implemented in 1974 to estimate angler effort, harvest and success rates in the chinook salmon fishery (Nelson 1990). The need for biological information about Kenai River chinook salmon was identified as early as 1975 when the department proposed a mark-recapture project to estimate abundance of early-run and late-run fish as well as age structure, mean length-at-age, and sex ratios. A variety of methods were tested for catching chinook salmon including electrofishing, drift gillnets (Hammarstrom 1980), fish traps, and fish wheels (Hammarstrom and Larson 1982, 1983, 1984). Beginning with the late run of 1984, a mark-recapture project was implemented using drift gillnets (Hammarstrom et al. 1985). The mark-recapture project produced estimates of riverine abundance through 1990 (Hammarstrom and Larson 1986, Conrad and Larson 1987, Conrad 1988, Carlon and Alexandersdottir 1989, Alexandersdottir and Marsh 1990).

Recognizing the need for inseason information on chinook salmon abundance for more effective management of the sport fishery, the department initiated a research project in 1984 to determine whether dual-beam sonar technology could be used to estimate inriver abundance of chinook salmon. Due to the considerable size difference between Kenai River chinook salmon and other species of fish present in the river, it was postulated that dual-beam sonar could be used to distinguish the larger chinook salmon from smaller fish and estimate the number returning to the river. Feasibility studies were conducted from 1984 through 1986 (Eggers et al. 1995) and the first daily chinook salmon abundance estimates using 420 kHz dual-beam sonar were produced in July 1987.

An alternate acoustic technology known as split-beam sonar was used to test assumptions and design parameters of the dual-beam configuration in 1994 (Burwen et al. 1995). The split-beam system provided advantages over the dual-beam system in its ability to determine the direction of travel for each target and the spatial distribution of fish in the acoustic beam. A split-beam system was deployed side-by-side and run concurrently with the dual-beam for much of the 1994 season. In a comparative study, both systems performed similarly, detecting comparable numbers of fish. The split-beam data confirmed earlier studies showing that fish were strongly oriented to the bottom of the acoustic beam. However, the proportion of downstream targets estimated with the split-beam system was substantially higher than estimates from previous studies.

In 1995, the dual-beam system was replaced with the split-beam system in order to take advantage of the additional information on direction of travel and spatial position of targets. The split-beam system operated at a lower frequency which resulted in an improved (higher) signal-to-noise ratio (SNR). It also interfaced with improved fish-tracking software which reduced the interference from boat wake, and improved fish-tracking capabilities.

The primary goal of this ongoing project is to provide daily and seasonal estimates of chinook salmon passage into the lower Kenai River. These figures, used in conjunction with other run information, facilitate inseason management of the fishery. Additionally, the estimates contribute to a database used for long-term assessment of the Kenai River chinook salmon population.

In addition to normal procedures for estimating fish passage, we conducted several ancillary studies in 1995. These studies were designed to: (1) evaluate the effectiveness of our procedures for differentiating species, and (2) provide a more thorough summary of the level of downstream activity at the current site. The results of these studies are presented in a separate report (Burwen et al. *In prep*).

METHODS

STUDY AREA

The Kenai River drains an area 2,150 square miles. It is glacially influenced with discharge rates lowest during winter, increasing throughout the summer and peaking in August (USDA 1992). The Kenai River has 10 major tributaries, many of which provide important spawning and/or rearing habitat. These tributaries include the Russian River, Skilak River, Killey River, Moose River, and Funny River.

The Kenai River drainage is located in a transitional zone between a maritime climate and a continental climate (USDA 1992). This position, and local topography, influence both rainfall and temperature throughout the drainage. The average annual rainfall in the drainage ranges from over 40 inches in the Kenai Mountains at its source, to 18 inches in the City of Kenai at its mouth. Average summer temperatures in the drainage range from 40°F to 65°F, while average winter low temperatures range from -10°F to -41°F (USDA 1992).

SITE DESCRIPTION

The 1995 sonar site was located 14 km from the mouth of the Kenai River (Figure 1). This

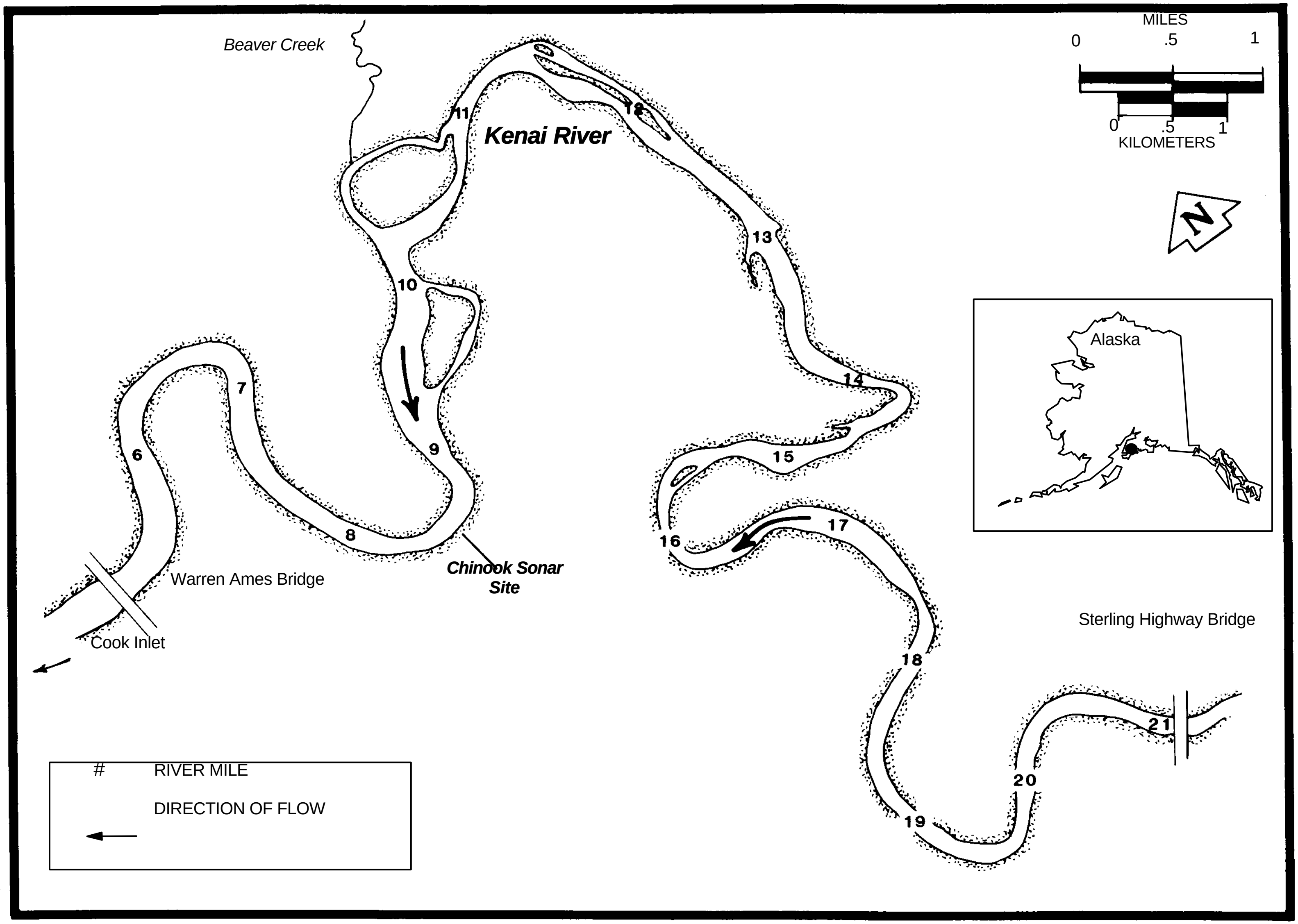

Figure 1.-Map of lower Kenai River showing location of the 1995 sonar site.

Table 1.-Principal components of the split-beam sonar system used in 1995.

System Component	Description
Sounder	Hydroacoustics Technology Inc. (HTI) Model 240 Split-Beam Echo sounder operating at 200 kHz
Signal Processor	HTI Model 340 Digital Echo Processor based in a Dell XPS Pentium 100 personal computer
Transducers	(2) HTI Split-Beam: Left Bank: nominal beam widths: 2.9^{o}x10.2^{o} Right Bank: nominal beam widths: 2.8^{o}X10^{o}
Chart Recorder	HTI model 403 digital dual-channel chart recorder
Oscilloscope	Nicolet model 310 digital storage oscilloscope
Video Display	Simrad Model CF-100 color video monitor
Remote Pan and Tilt Aiming Controller	Remote Ocean Systems Model PTC-1 Pan and Tilt Controller
Remote Pan and Tilt Aiming Unit	Remote Ocean Systems Model P-25 Remote Pan and Tilt Unit

site has been used since 1985 and was selected for its acoustic characteristics and its location relative to the sport fishery and known spawning habitat for chinook salmon.

The river bottom in this area has remained topographically stable for the past 11 years. The slope from both banks is gradual and uniform, which allows a large proportion of the water column to be ensonified without acoustic shadowing effects. On the right bank, the bottom is composed primarily of mud, providing an absorptive rather than reflective surface. This absorptive property improves the signal-to-noise ratio when the beam is aimed along the bottom. The left bank bottom gradient is steeper and consists of small rounded cobble and gravel.

The sonar site is located below the lowest suspected spawning sites of chinook salmon yet far enough from the mouth that most of the fish counted are probably committed to the Kenai River (Alexandersdottir and Marsh 1990), reducing the incidence of chinook salmon loitering in the sonar beam or returning downstream. Initially, almost all sport fishing occurred upstream of this site. In recent years, however, fishing at, and below, the sonar site has increased dramatically.

HYDROACOUSTIC SAMPLING

The sonar system operated from 16 May through 9 August 1995. Components of the system are listed in Table 1. A brief explanation of the theory of split-beam sonar and its use in estimating target strength can be found in Appendix A1. A more detailed explanation can be found in Ehrenberg (1983).

Sonar System Configuration

Sampling on both banks was controlled by electronics housed in a tent located on the right bank of the river. Communication cables led to transducers and their aiming devices on both banks with cables leading to the left bank equipment suspended above the river (Figure 2). Steel tripods were used to deploy the transducers offshore. One elliptical, split-beam transducer was mounted on each tripod. At the start of the season the transducer tripods were placed on each bank in a position close to shore but still submerged at low tide. From 16 May to 9 August 1995 water level, at low tide, rose approximately 1 m. As the water level rose, the tripods were periodically moved closer to shore so that the total range ensonified by the sonar beams increased from approximately 75 m at the lowest water conditions to 100 m at high water.

The vertical and horizontal aiming angles of each transducer were remotely controlled by a dual-axis electronic pan and tilt system. A digital readout indicated the aiming angle in the vertical and horizontal planes. In the vertical plane, the transducer was aimed using an oscilloscope and chart recorder to verify that the sonar beam was grazing the bottom of the river. In the horizontal plane, the transducer was aimed perpendicular to the flow of the river current in order to maximize the probability of ensonifying fish from a lateral aspect. The range encompassed by each transducer was determined by using a depth sounder to find the center of the river channel between the two sonar beams, deploying a large underwater target in midchannel, aiming both sonar transducers at the underwater target and recording the range from each. One half meter was subtracted from each range to prevent overlapping detection of fish from both banks.

Calibration

Both systems were professionally calibrated by Aliant Tech Systems[1] in Seattle. Target strength measurements were also obtained from a 38.1 mm tungsten carbide sphere (Foote and MacLennan 1984) at the calibration facility. At the sonar site, we measured the same standard sphere *in situ* by suspending it from monofilament line in the acoustic beam. For each bank, we performed such *in situ* calibration verifications twice more during the season to measure any drift in performance. These calibration checks were conducted near high-slack tide when ambient noise levels were low and the position of the target was stable due to minimal current. For each calibration verification, we recorded the maximum background noise level and voltage threshold in addition to the data collected automatically by the on-board signal-processing software (see Data Acquisition).

Sampling Procedure

A systematic sample design (Cochran 1977) was used to sample from each bank for 20 min per hour. Although the sonar system is capable of sampling both banks continuously, data collection was restricted to 20-min samples per hour to limit the data processing time and personnel required to produce daily fish passage estimates. The equipment was automated to sample the right bank for 20 min starting at the top of each hour followed by a 20-min left bank sample. The system was quiescent or activated for ancillary studies during the third 20-min period. This routine was followed 24 hours per day and 7 days per week unless one or both banks was inoperable.

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[1] Use of a company's name does not constitute endorsement.

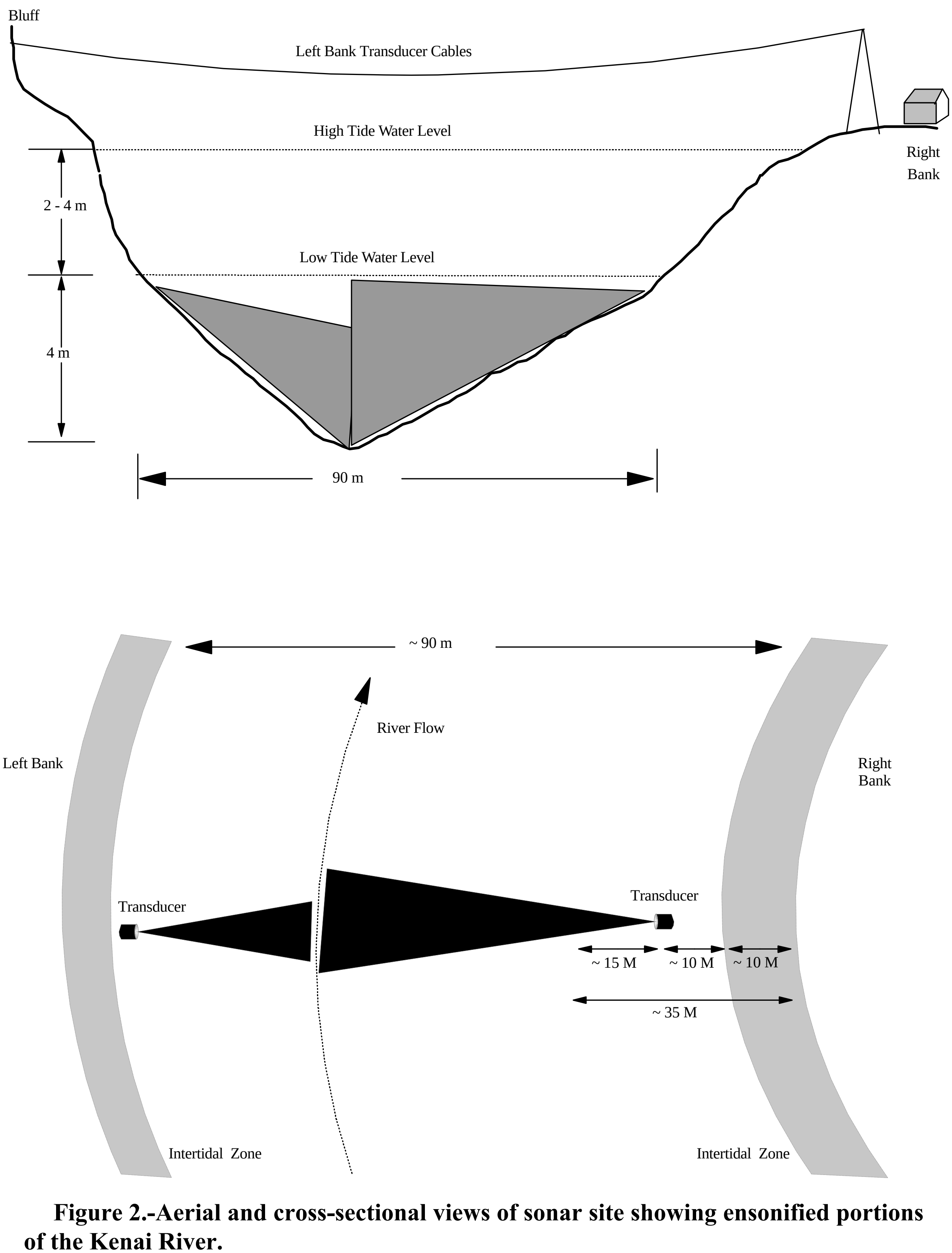

Figure 2.-Aerial and cross-sectional views of sonar site showing ensonified portions of the Kenai River.

Echo Sounder Settings

Relevant echo sounder settings are listed in Table 2 with a more complete summary in Appendix B1. Most echo sounder settings were identical for each bank and remained consistent throughout the sample period. High power and low gain settings were used to maximum SNR. The transmitted pulse width was set relatively low to maximize resolution of individual fish, and SNR.

Table 2.-1995 settings for HTI model 240 digital echo sounder.

Echo Sounder Parameters	Value
Transmit Power	25 dB
System Gain	-18 dB
TVG	40logR
Transmitted Pulse Width	0.20 msec
Ping Rate	8 pings/sec

Data Acquisition

The digital echo sounder (DES) sent data from each returned echo to the digital echo processor (DEP, Figure 3). The DEP performed the initial filtering of returned echoes based on user-selected criteria (Table 3, Appendix B), and recorded the start time, date and number of pings processed for each sample.

Echoes less than 2.5 m range from the transducer were excluded due to the transducer near-field effect (MacLennan and Simmonds 1992).

Minimum vertical and horizontal off-axis values were used to prevent consideration of unreliable data from transducer side lobes. The minimum vertical angle off-axis value for left bank data was increased from -2.0 to -2.5 because fish were traveling very close to the rocky bottom substrate.

The minimum pulse width criterion prevents narrow band noise from being mistaken for valid echoes. The maximum pulse width criterion excludes potential multiple targets when estimating target strength. Minimum and maximum pulse width parameters were set at 0.15 msec and 0.30 msec for a transmitted 0.20 msec pulse.

Voltage thresholds for data acquisition must be set high enough to exclude background noise from spurious sources such as boat wake, the river bottom, and the water surface. Collection of data from unwanted noise causes data management problems and also

Table 3.-Echo acceptance criteria for digital echo processing, 1995.

Bank	pulse width (ms) at -6 dB	Vertical angle off-axis (°)	Horizontal angle off-axis(°)	Threshold (V and dB)	Range (m)
Right	0.15 to 0.30	-2.0 to 2.0 (16 May-24 May)	-5.0 to 5.0	.600 V, -35 dB (16 May-14 June)	2.0 m
		-2.5 to 2.0 (24 May-9 Aug)		.844 V,-32 dB (15 June-9 August)	
Left	0.15 to 0.30	-2.0 to 2.0	-5.0 to 5.0	.400 V, -35 dB (16 May-15 June)	2.0 m
				.600 V,-32 dB (16 June-9 August)	

Note: Parameter entries without a range of dates were valid for the entire season (16 May through 9 August).

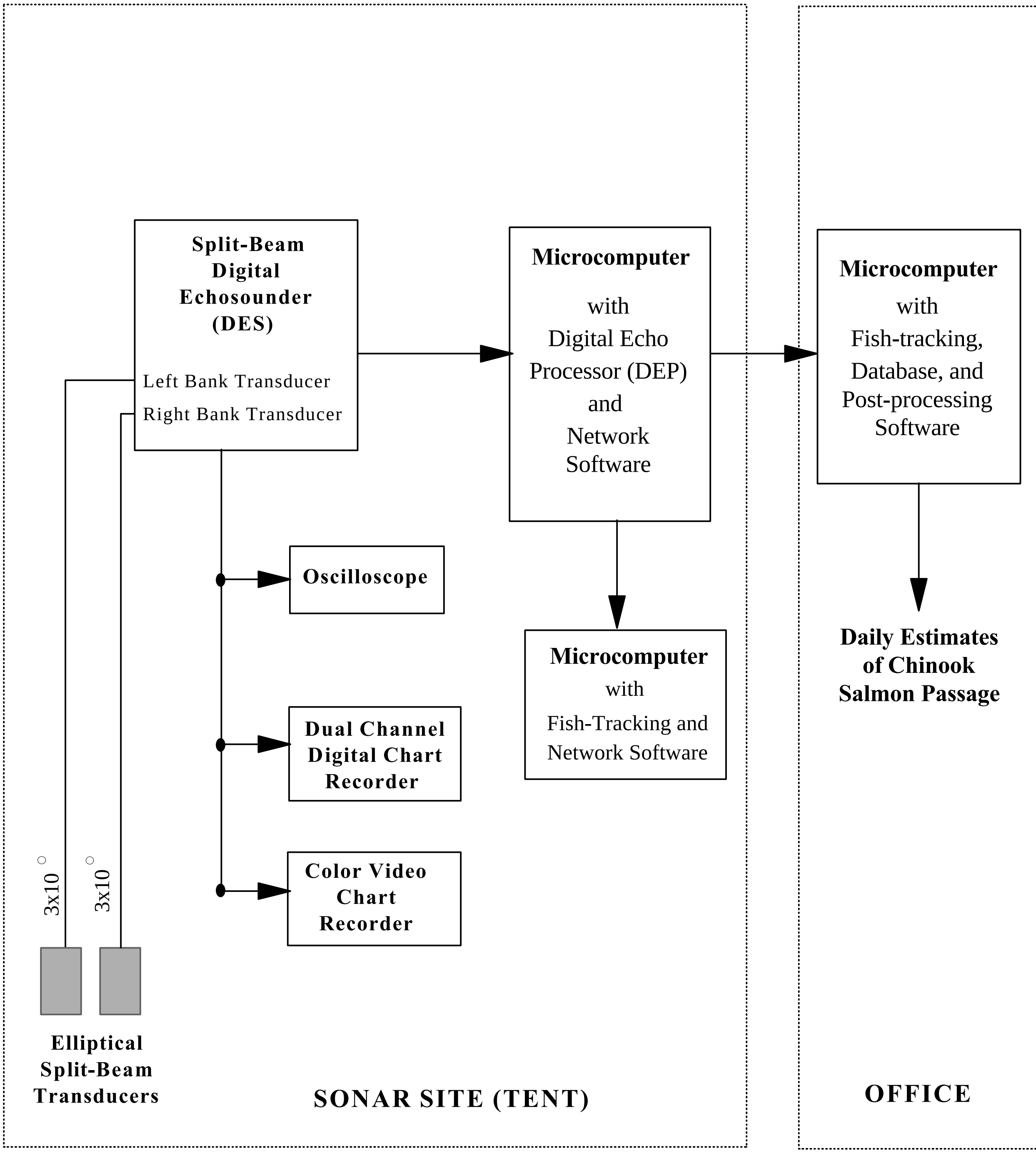

Figure 3.-Schematic diagram of 1995 split-beam sonar system configuration and data flow.

makes it difficult to distinguish echoes originating from valid fish targets. The amount of background noise is determined largely by the dimensions of the sonar beam in relation to the depth of the river. Since the water level at the sonar site is strongly influenced by tidal stage (vertical fluctuations of more than 4 m), the amount of background noise fluctuates periodically, with lowest noise levels during high tide and the highest levels during low tide. Voltage thresholds corresponding to a -35 dB target on-axis were selected initially for each bank as the lowest threshold that would exclude background noise at low tide when noise was at a maximum. These thresholds were increased to -32 dB for an on-axis target beginning on June 15.

For each echo passing initial filtering criteria, the DEP wrote information to the computer hard disk in ASCII file format *(*.*RAW files). This file provided a permanent record of all raw echo data which could then be used by other post-processing software. A uniquely-named file was produced for each sample hour and stored the following statistics for each echo: range from the transducer, sum channel voltage produced by the echo, pulse widths measured at -6 dB, -12 dB, and -18 dB down from the peak voltage, up-down (vertical) angle and left-right (horizontal) angle.

The sum channel voltage from the Model 240 DES was also output by a dot matrix printer using a Model 403 Digital Chart Recorder. Chart recorder output was filtered only by a voltage threshold which was set equal to the DEP threshold. The chart recorder ran concurrently with the echo sounder and produced real-time echograms for each sample. The echograms were used for data backup, transducer aiming, and for manual-tracking verification.

DATA ANALYSIS

Estimates of fish passage were generated daily and were available to fishery managers by noon the following day. Passage estimates were checked for errors and variance estimates were calculated postseason.

Fish Tracking and Echo Counting

Echoes in the *.RAW files were manually grouped (tracked) into fish using HTI[2] proprietary software called TRAKMAN©. TRAKMAN© produces an electronic chart recording for all valid echoes collected during a 20-min sample on the computer monitor. Selected segments of the chart can be enlarged and echoes viewed on a Cartesian grid. Echoes following a sequential progression through the beam in the vertical and horizontal axes are selected by the user and classified into fish traces. TRAKMAN© produces three output files. The first file contains each echo that was tracked in a valid target. This tracked “echo file” (i.e., *.MEC file) includes the following data for each echo: X, Y, and Z coordinates in meters, where the transducer face is the origin of the coordinate system, pulse widths measured at -6 dB, -12 dB, and -18 dB amplitude levels, combined beam pattern factor in dB, and target strength in dB.

The second fixed-record ASCII file (i.e., *.MFS file) included summary data for each tracked target. This file summarizes data from all echoes which are associated with an individual tracked target and outputs the following fields by target: total number of echoes tracked, starting X, Y, and Z coordinates, distance traveled (meters) in the X, Y, and Z directions, mean velocity (m/sec), and mean target strength.

[2] Use of a company’s name does not constitute endorsement.

The third file was identical to the *.RAW file described earlier except that it contained only those echoes combined into tracked targets.

Species Discrimination

Two parameters have been used historically on this project to separate large chinook salmon from smaller species: target strength and distance from the transducer (range). Although recent studies have questioned the usefulness of these parameters for our application (Eggers 1994, Burwen et al. 1995), we continued their use in 1995 to ensure comparability of passage estimates with those of past years, while continuing to investigate other means of discriminating between fish sizes (Burwen et al. *In prep*).

Target strength was calculated for individual echoes and averaged for each fish (Appendix A1). Fish with target strengths less than -28 dB were assumed to be species other than chinook salmon (Paul Skvorc, Alaska Department of Fish & Game, personal communication) and were excluded from further analysis.

During periods of peak sockeye salmon passage, fish within 15 m to 25 m from the transducer on the right bank and within 10 m on the left bank were excluded from chinook salmon estimates. The vast majority of fish within this nearshore area are assumed to be smaller species such as sockeye, pink, and coho salmon. Range filter criteria were used from 7 June through 9 August 1995.

Passage Estimates

An estimate of fish passage was calculated for each hour for which a sample existed. This was usually an exact 20-min count which was multiplied by 3 for the hourly estimate on each bank. In this case, the number of chinook salmon passing bank b during hour j (y_{bj}) was estimated as:

$$\hat{y}_{bj} = \frac{60}{t_{bj}} c_{bj} \tag{1}$$

where:

t_{bj} = number of minutes sampled on bank b during hour j, and

c_{bj} = sample count for bank b and hour j.

When the sonar system on one bank was not operating (1% of samples), the omission was treated as a “missing datum” with substitution as a correction. If information from the other bank was available for that hour, we applied a ratio estimator (Cochran 1977) between banks, using data from those hours when both banks were sampled for the same number of minutes. For a bank that was not operating, chinook passage was estimated as:

$$\hat{y}_{bj} = \hat{R}_b \hat{y}_{b'j} \tag{2}$$

where:

$$\hat{R}_b = \frac{\sum_{j=1}^{n_B} \hat{y}_{bj}}{\sum_{j=1}^{n_B} \hat{y}_{b'j}} \tag{3}$$

$\hat{y}_{b'j}$ = estimated passage for opposite bank b during hour j, and

n_B = number of hours during the season in which both banks were sampled for the same number of minutes.

During the season, for purposes of daily reporting of estimated passage, $\hat{R}_b$ was calculated from the cumulative number, to date, of hours when both banks were sampled for the same number of minutes. Final estimates were generated postseason.

When both banks were down for a full hour (three times during the season) estimated passage on each bank was interpolated as the mean of the estimated passage before and after the missing sample:

$$\hat{y}_{bj} = \frac{\hat{y}_{b(j-1)} + \hat{y}_{b(j+1)}}{2} \quad (4)$$

Fish passage on day i was estimated as:

$$\hat{y}_i = \sum_{b=1}^{2}\sum_{j=1}^{24}\hat{y}_{bj} \quad (5)$$

where $\hat{y}_{bj}$ was obtained from either (1), (2), or (4) as appropriate. Exceptions were 17 May and 13 June for the early run and 17 July for the late run when several samples were missing on both banks. In this case, the daily passage $\hat{y}_i$ was estimated as the following:

$$\hat{y}_i = \sum_{b=1}^{2}\frac{1440}{t_{bi}}c_{bi} \quad (6)$$

where:

t_{bi} = number of minutes counted on bank b during day i, and

c_{bi} = number of targets meeting target strength and range criteria on bank b during day i.

Finally, the number of chinook salmon migrating into the Kenai River during a run was estimated as:

$$\hat{Y} = \sum_{i=1}^{N_D}\hat{y}_i \quad (7)$$

where N_D is the number of days in the run. Its variance (successive difference model, Wolter 1985) was estimated, with adjustments for missing data, as:

$$\hat{V}\left[\hat{Y}\right] = \sum_{b=1}^{2} 9N_H^2(1-f_S)\frac{\sum_{j=2}^{N_H}\phi_{bj}\phi_{b,j-1}\left(c_{bj}-c_{b,j-1}\right)^2}{2\sum_{j=1}^{N_H}\phi_{bj}\sum_{j=2}^{N_H}\phi_{bj}\phi_{b,j-1}} \quad (8)$$

where:

N_H = total number of hours during the run, and

f_s = fraction of available periods sampled (0.33), and

ϕ_{bj} = 1 if the sonar was operating on bank b during hour j, or 0 if not.

RESULTS AND DISCUSSION

PASSAGE ESTIMATES

Total chinook salmon passage from 16 May through 9 August was estimated to be 66,220 (SE = 1,048) fish of which 21,884 (SE = 396) were early-run fish and 44,336 (SE = 970) were late-run fish (Table 4 and Table 5). The daily peak of the early run occurred on 8 June; half the run had passed by 11 June (Figure 4). The daily peak of the late run occurred on 20 July, with half the late run having passed by the same date (Figure 5). The migratory timing of the early run remained within the historic 95% confidences intervals (Figure 6). Migratory timing for late-run fish fell within normal ranges for most of the season but displayed a weak trend early and an exceptionally strong trend late in the run (Figure 6).

During the early run both banks were inoperable simultaneously for several hours on two days: 17 May and 13 June. On 17 May all underwater equipment on both banks was removed to prevent damage to transducers, remote aiming axes, and communication cables from an exceptionally high amount of large floating debris being washed out by high spring tides. On 13 June both sonar pods where displaced by debris, again during the higher spring tide series.

During the late run both banks were simultaneously inoperable for six hours on 17 July when a receiver board in the echo sounder failed.

Passage estimates from 17 May, 13 June, and 17 July should be considered somewhat conservative. Samples were missed primarily during rising and falling tide stages when fish

Table 4.-Estimated daily chinook salmon passage, Kenai River Sonar, early run, 1995.

Date	Left Bank	Right Bank	Daily Total	Cumulative Total
16-May	46	52	98	98
17-May	18	81	99	197
18-May	18	60	78	275
19-May	46	103	149	424
20-May	39	189	228	652
21-May	96	369	465	1,117
22-May	78	187	265	1,382
23-May	96	190	286	1,668
24-May	52	213	265	1,933
25-May	54	144	198	2,131
26-May	69	120	189	2,320
27-May	39	126	165	2,485
28-May	42	117	159	2,644
29-May	60	162	222	2,866
30-May	78	273	351	3,217
31-May	93	189	282	3,499
1-Jun	105	252	357	3,856
2-Jun	135	234	369	4,225
3-Jun	201	348	549	4,774
4-Jun	210	483	693	5,467
5-Jun	207	222	429	5,896
6-Jun	258	549	807	6,703
7-Jun	231	612	843	7,546
8-Jun	422	577	999	8,544
9-Jun	150	639	789	9,333
10-Jun	75	801	876	10,209
11-Jun	75	699	774	10,983
12-Jun	84	333	417	11,400
13-Jun	64	428	492	11,892
14-Jun	102	589	691	12,584
15-Jun	36	600	636	13,220
16-Jun	33	615	648	13,868
17-Jun	63	687	750	14,618
18-Jun	79	729	808	15,425
19-Jun	44	375	419	15,845
20-Jun	33	561	594	16,439
21-Jun	48	390	438	16,877
22-Jun	66	309	375	17,252
23-Jun	27	151	178	17,430
24-Jun	60	390	450	17,880
25-Jun	66	363	429	18,309
26-Jun	111	223	334	18,643
27-Jun	231	715	946	19,589
28-Jun	177	519	696	20,285
29-Jun	195	789	984	21,269
30-Jun	84	531	615	21,884

Table 5.-Estimated daily chinook salmon passage, Kenai River Sonar, late run, 1995.

Date	Left Bank	Right Bank	Daily Total	Cumulative Total
1-Jul	86	264	350	350
2-Jul	38	360	398	748
3-Jul	65	288	353	1,101
4-Jul	48	391	439	1,539
5-Jul	66	601	667	2,206
6-Jul	66	654	720	2,926
7-Jul	90	841	931	3,857
8-Jul	48	369	417	4,274
9-Jul	72	447	519	4,793
10-Jul	93	357	450	5,243
11-Jul	36	289	325	5,568
12-Jul	36	240	276	5,844
13-Jul	30	540	570	6,414
14-Jul	54	660	714	7,128
15-Jul	60	690	750	7,878
16-Jul	144	1,818	1,962	9,840
17-Jul	115	1,013	1,128	10,968
18-Jul	294	3,648	3,942	14,910
19-Jul	234	4,458	4,692	19,602
20-Jul	225	4,554	4,779	24,381
21-Jul	144	2,988	3,132	27,513
22-Jul	216	3,249	3,465	30,978
23-Jul	201	2,220	2,421	33,399
24-Jul	114	717	831	34,230
25-Jul	39	801	840	35,070
26-Jul	72	1,611	1,683	36,753
27-Jul	105	1,701	1,806	38,559
28-Jul	39	750	789	39,348
29-Jul	66	492	558	39,906
30-Jul	48	462	510	40,416
31-Jul	72	408	480	40,896
1-Aug	30	444	474	41,370
2-Aug	36	333	369	41,739
3-Aug	39	408	447	42,186
4-Aug	81	438	519	42,705
5-Aug	33	371	404	43,110
6-Aug	54	354	408	43,518
7-Aug	48	231	279	43,797
8-Aug	57	210	267	44,064
9-Aug	56	216	272	44,336

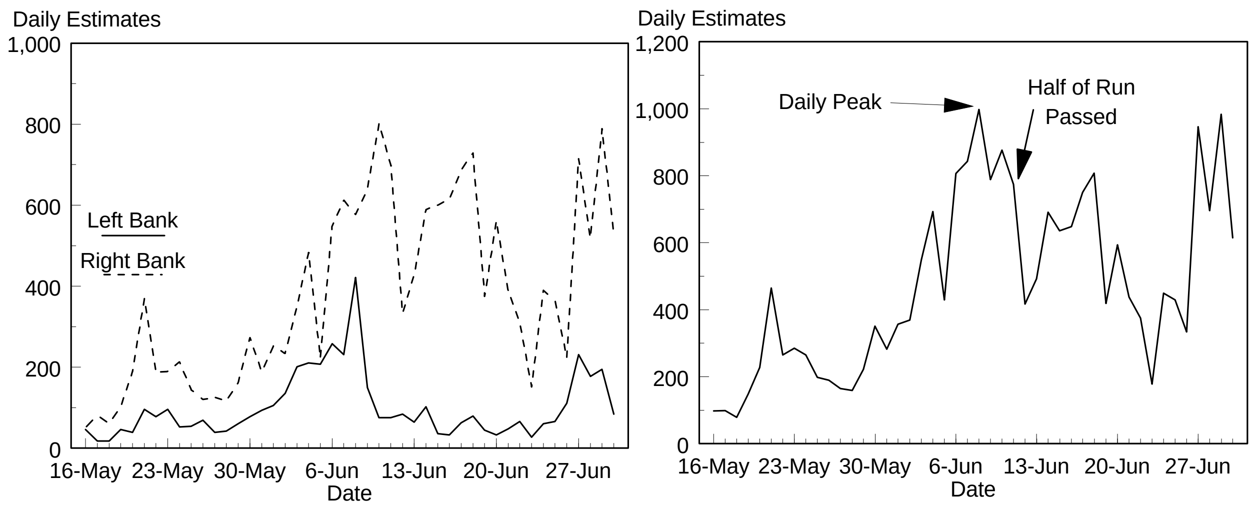

Figure 4.-Daily sonar estimates of passage for the early run of chinook salmon to the Kenai River, 1995. Estimates by bank (left) and summed over both banks (right).

passage is typically highest (Eggers et al. 1995).

CALIBRATION

Measurements of standard sphere target strengths during *in situ* calibrations for left and right banks were very stable, showing little variability over time, range, or location (Table 6). Estimated target strength on the right bank varied less than 0.5 dB over six separate measurements. Estimated target strength from the left bank varied less than 0.6 dB over three separate measurements. Measurements taken on 9 May at three ranges of 13 m, 27 m, and 44 m varied less than 0.2 dB among ranges and showed no trend. The

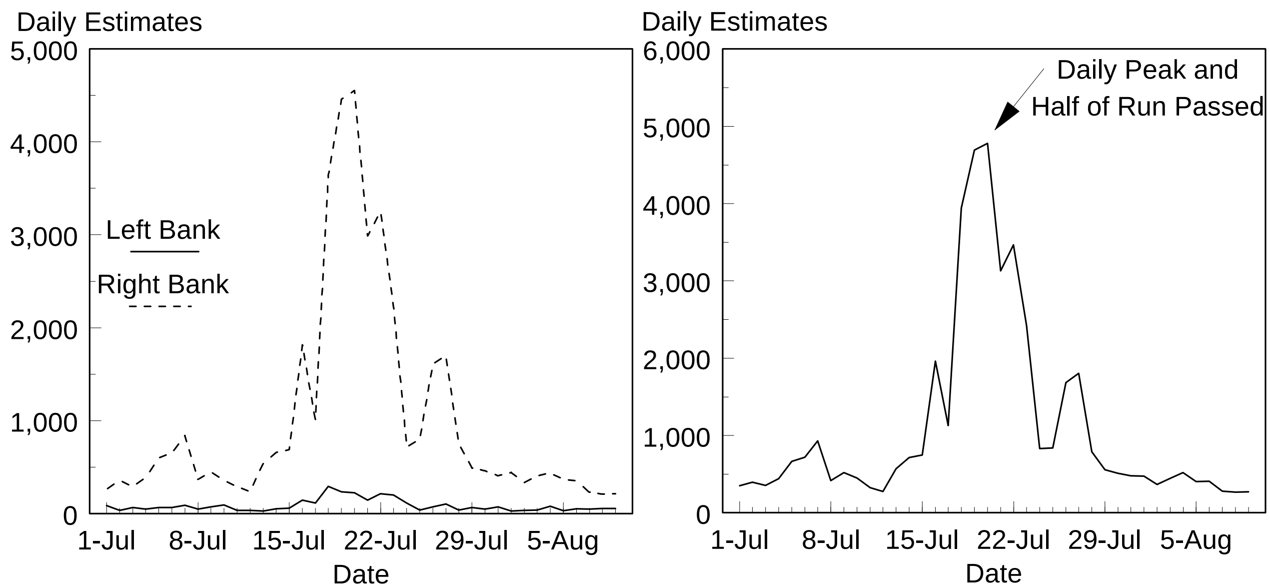

Figure 5.-Daily sonar estimates of passage for the late run of chinook salmon to the Kenai River, 1995. Estimates by bank (left) and summed over both banks (right).

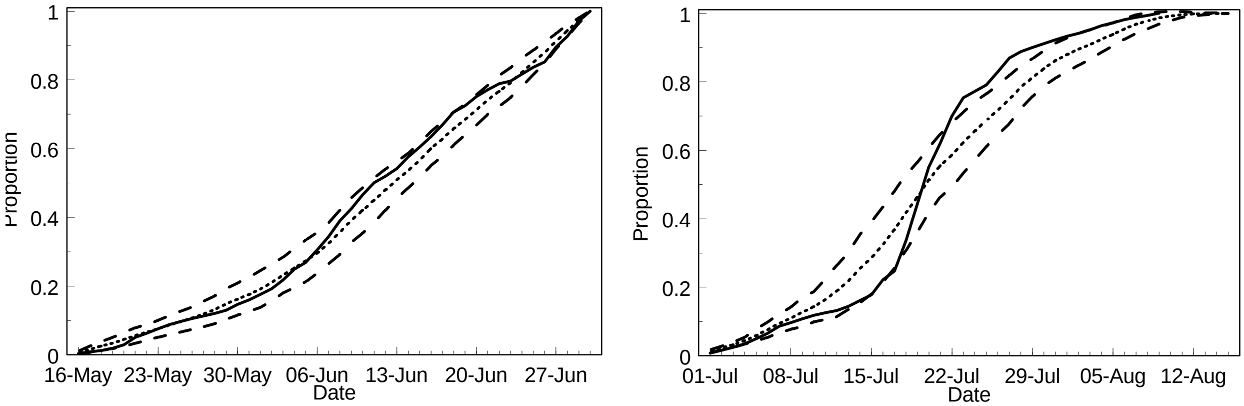

Figure 6.-Migratory-timing curves for early (left) and late (right) runs of chinook salmon to the Kenai River, 1995 (solid lines). Mean migratory-timing (dotted lines), and 95% confidence intervals (dashed lines) are presented for comparison.

highest standard deviation in target strength occurred with the highest ambient noise.

CHANGES FROM PREVIOUS YEARS

Several advantages were realized with the switch to a 200 kHz split-beam system in 1995. First, the three-dimensional location of a target could be estimated from each echo, permitting classification of each target as to direction of travel, upstream or downstream. This potentially important information had not previously been available for each target (Burwen et al. 1995). Direction of travel information from 1995 are presented in a separate report (Burwen et al. *In prep*).

Second, the manual fish-tracking software permitted more precise tracking, better separation of valid fish echoes from boat wake and other noise, and better discrimination of fish from debris. One disadvantage of the new software was that more subjectivity was introduced to the tracking process, necessitating more training to minimize differences among staff.

Third, the new system reduced the ambient noise level due to a lower operating frequency, a shorter transmitted pulse width, and more advanced transducers. This increased the signal-to-noise ratio, improving the precision with which the characteristics of each echo was measured. It also provided the option of setting the voltage threshold for data acquisition slightly lower than was previously possible, allowing measurement of more echoes per fish. We exercised this option for only a short time in 1995 in order to maintain continuity with historical data, however the ability to set a lower threshold will likely prove useful in the future.

Boat wake, which causes very high noise levels and masks valid targets, has become a bigger problem every year as more anglers have fished near the sonar site and as a technique known as back-trolling has become more popular. In 1996, we will investigate the potential for using a narrower beam transducer to reduce the effect of boat wake.

Table 6.-Results of 1995 *in situ* calibration verifications using a 38.1 mm tungsten carbide standard sphere.

Date	Bank (or location)	Tx[a] serial #	TS[b] (dB)	TS SD[c]	N	Range (m)	PW[d] (msec)	Noise (mV)	Threshold (mV)	Comments
7-May	Aliant	733	-37.69	2.35	6,475	6	0.2	N/A[e]	300	System calibration
9-May	Right	733	-37.96	2.53	2,864	44	0.2	140	150	Early season calibration verification
9-May	Right	733	-37.96	1.65	3,205	27	0.2	100	150	Compare TS at second range
9-May	Right	733	-37.8	1.47	3,148	13	0.2	100	150	Compare TS at third range
9-May	Right	733	-37.63	1.56	603	13	0.4	100	150	Paired data to compare TS at two different transmitted pulse lengths
3-Aug	Right	733	-37.49	2.3	904	26	0.2	100	150	Late season calibration verification
7-May	Aliant	738	-38.19	2.3	7,774	6	0.2	N/A[e]	119	System calibration
4-Jun	Left	738	-37.74	0.46	2,721	15	0.2	23	50	Early season calibration verification
3-Aug	Left	738	-38.34	1.32	2,161	24	0.2	80	100	Late season calibration verification

[a] TX = transducer.

[b] TS = target strength.

[c] TS SD = standard deviation of target strength.

[d] PW = pulse width

[e] Calibration test done in tank with little or no background noise.

ACKNOWLEDGMENTS

We would like to thank Linda Lowder, Tony Hollis, Mark Jensen, and Diane Campbell for meticulously collecting the sonar data and for their high motivation throughout a long field season. Dave Bernard provided expertise in simplifying the notation for the abundance variance estimates. Steve Fleischman provided editorial review. Special thanks, also, to the members of the Sport Fish staff in Soldotna who provided logistical support whenever needed.

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APPENDIX A. TARGET STRENGTH ESTIMATION

Appendix A1.-Using the sonar equation to estimate target strength with dual- and split-beam applications.

Target strength, in decibels (dB), of an acoustic target located at range R (in m), θ degrees from the maximum response axis (MRA) in one plane and ϕ degrees from the MRA in the other plane is estimated as:

$$TS = 20\log_{10}(V_o) - SL - G_r + 40\log_{10}(R) + 2\alpha R - G_{TVG} - 2B(\theta,\phi)$$

where:

V_o	= voltage of the returned echo, output by the echo sounder,
SL	= source level of transmitted signal in dB,
G_r	= receiver gain in dB,
$40\log_{10}(R)$	= two-way spherical spreading loss in dB,
$2\alpha R$	= two-way absorption loss in dB,
G_{TVG}	= time-varied-gain correction of the echo sounder, and
$2B(\theta,\phi)$	= two-way loss due to position of the target off of the MRA.

The source level and gain are measured during calibration and confirmed using *in situ* standard sphere measurements. The time-varied-gain correction compensates for spherical spreading loss. Absorption loss ($2\alpha R$) was not corrected for in this study.

In practice, the location of the target in the beam (θ and ϕ) is not known, so $B(\theta,\phi)$ must be estimated in order to estimate target strength. Dual-beam and split-beam sonar differ in how they estimate $B(\theta,\phi)$, also called the beam pattern factor.

Dual-beam sonar (Ehrenberg 1983) uses one wide and one narrow beam. The system transmits on the narrow beam only and receives on both. The ratio between the voltages of the received signals is used to estimate beam pattern factor:

$$B(\theta,\phi) = 20\log(V_N/V_W) \bullet WBDO$$

where V_N is the voltage of the returned echo on the narrow beam, V_W is the voltage of the echo on the wide beam, WBDO is the wide beam drop-off correction, specific to each transducer, and estimated at calibration.

Split-beam sonar (MacLennan and Simmonds 1992) estimates target location (angles θ and ϕ of the target from the MRA) directly, not just the beam pattern factor ($B(\theta,\phi)$). Split-beam transducers are divided into four quadrants, and θ and ϕ are estimated by comparing the phases of signals received by opposing pairs of adjacent quadrants. The beam pattern factor is a function of θ and ϕ, determined during laboratory calibration.

APPENDIX B. EQUIPMENT AND SOFTWARE SETTINGS

Appendix B1.-Criteria used for the collection of echoes for the right bank transducer.

* Start Processing at Port 1 -FILE_PARAMETERS- Wed Aug 09 06:00:00 1995

* Data processing parameters used in collecting this file for Port 1

100	-1	1	MUX argument #1 - multiplexer port to activate
101	-1	0	percent - sync pulse switch, ping rate determiner NUS
102	-1	32767	maxp - maximum number of pings in a block NUS
103	-1	32767	maxbott - maximum bottom range in samples NUS
104	-1	5	N_th_layer - number of threshold layers
105	-1	5	max_tbp - maximum time between pings in pings
106	-1	5	min_pings - minimum number of pings per fish
507	-1	FED5	timval - 0xFED5 corresponds to about 20 kHz NUS
108	-1	1	mux_on - means multiplexing enabled on board NUS
109	-1	200	mux_delay - samples delay between sync and switching NUS
110	-1	0	decimate_mask - decimate input samples flag NUS
111	-1	3	plot_up_fish - number of fish between stbar updates
112	-1	1	echogram_on - flag for DEP echogram enable 0=off, 1=on
113	-1	1	f_inst->o_raw - write raw file flag 1 = on, -1 or 0=off
114	-1	1	f_inst->o_ech - write echo file flag 1 = on, -1 or 0=off
115	-1	1	f_inst->o_fsh - write fish file flag 1 = on, -1 or 0=off
116	-1	0	f_inst->o_sum - write summary table file flag 1 or 0=on
117	-1	0	print summary table on printer, 1 = on, -1 or 0=off
118	-1	25	maxmiss - maximum number of missed pings in auto bottom
119	-1	0	bottom_code - bottom tracking, 0=fix, 1=man, 2=auto
120	-1	0	sb_int_code - sb only=0, sb-int: 40log a bot=1, 20log=2
121	-1	0	sb_int_code2 - sb only=0, sb-int 40log eg=0, 20log=2
122	-1	1	N_int_layers-number of integration strata
123	-1	1	N_int_th_layers - number of integration threshold strata
124	-1	0	int_print - print integrator interval results to printer
125	-1	0	circular element transducer flag for bpf calculation
126	-1	80	grid spacing for Model 404 DCR (in samples, 16 s/m)
127	-1	1	TRIG argument #1 - trigger source
128	-1	0	TRIG argument #2 - digital data routing
129	-1	1	FILTER argument #1 - filter number
200	-1	0.0000	sigma_flag - if!=0.0000, sigma is output, not ts
201	-1	220.0200	sl - transducer source level
202	-1	-171.4900	gn - transducer through system gain at one meter
203	-1	-18.0000	rg - receiver gain used to collect data
204	-1	2.8000	narr_ax_bw - vertical nominal beam width
205	-1	10.0000	wide_ax_bw - horizontal axis nominal beam width
206	-1	0.0000	narr_ ax_corr - vertical axis phase correction
207	-1	0.0000	wide_ax_corr - horizontal axis phase correction
208	-1	8.0000	ping_rate - pulses per second
209	-1	0.0000	echogram start range in meters
210	-1	60.0000	echogram stop range in meters
211	-1	844.0000	echogram threshold in millivolts
212	-1	13.2000	print width in inches
213	-1	-40.0000	ts plot minimum target strength in dB
214	-1	-10.0000	ts plot maximum target strength in dB

-continued-

215	-1	0.0000	range plot minimum in meters
216	-1	60.0000	range plot maximum in meters
217	-1	-2.0000	min_angoff_v - minimum angle off axis vertical
218	-1	2.0000	max_angoff_v - maximum angle off axis vertical
219	-1	-5.0000	min_angoff_h - minimum angle off axis horiz.
220	-1	5.0000	max_angoff_ h - maximum angle off axis horiz.
221	-1	-24.0000	max_dB_off - maximum angle off in dB
222	-1	-7.7867	ux - horizontal electrical to mechanical angle ratio
223	-1	-17.4163	uy - vertical electrical to mechanical angle ratio
224	-1	0.0000	ud_coef_a - a coeff. for up-down beam pattern eq.
225	-1	-0.0021	ud_coef_b - b coeff. for up-down beam pattern eq.
226	-1	-2.1669	ud_coef_c - c coeff. for up-down beam pattern eq.
227	-1	-0.0562	ud_coef_d - d coeff. for up-down beam pattern eq.
228	-1	-0.2042	ud_coef_e - e coeff. for up-down beam pattern eq.
229	-1	0.0000	lr_coef_a - a coeff. for left-rt beam pattern eq.
230	-1	0.0005	lr_coef_b - b coeff. for left-rt beam pattern eq.
231	-1	-0.2090	lr_coef_c - c coeff . for left-rt beam pattern eq.
232	-1	-0.0010	lr_coef_d - d coeff. for left-rt beam pattern eq.
233	-1	-0.0002	lr_coef_e - ecoeff. for left-rt beam pattern eq.
234	-1	5.0000	maximum fish velocity in meters per second
235	-1	10.0000	thd_up_time - minutes between 3d plot updates
236	-1	0.5000	maxpw - pulse width search window size
237	-1	2.0000	cltop - start of processing in meters
238	-1	54.8000	bottom - bottom depth in meters
239	-1	0.0000	init_slope - initial slope for tracking in m/ping
240	-1	0.0000	exp_cont - exponent for expanding tracking window
241	-1	0.3500	max_ch_rng - maximum change in range in m/ping
242	-1	0.1000	pw_criteia->min_pw_6-min -6 dB pulse width
243	-1	0.4000	pw_criteria->max_pw_6-max -6 dB pulse width
244	-1	0.0000	pw_criteria->min_pw_12 - min -12 dB pulse width
245	-1	2.0000	pw_criteria->max_pw_12 - max -12 dB pulse width
246	-1	0.0000	pw_criteria->min_pw_18 - min -18 dB pulse width
247	-1	2.0000	pw_criteria->max_pw_18 - max -18 dB pulse width
248	-1	1.0000	Intake width to weight fish to (in meters)
249	-1	10.0000	maximum echo voltage to accept (Volts - peak)
250	-1	0.2000	TX argument #1 - pulse width in milliseconds
251	-1	25.0000	TX argument #2 - transmit power in dB-watts
252	-1	-6.0000	RX argument #1 - receiver gain
253	-1	125.0000	REP argument #1 - ping rate in ms per ping
254	-1	10.0000	REP argument #2 - pulsed cal tone separation
255	-1	1.0000	TVG argument #1 - TVG start range in meters
256	-1	100.0000	TVG argument #2 - TVG end range in meters
257	-1	40.0000	TVG argument #3 - TVG function (XX Log Range)
258	-1	-12.0000	TVG argument #4 - TVG gain
259	-1	0.0000	TVG argument #5 - alpha (spreading loss) in dB/Km
260	-1	0.0000	minimum absolute distance fish must travel in x plane
261	-1	0.0000	minimum absolute distance fish must travel in y plane
262	-1	0.0000	minimum absolute distance fish must travel in z plane
263	-1	2.0000	bottom_window - auto tracking bottom window (m)

-continued-

264	-1	3.0000	bottom_threshold - auto tracking bottom threshold (V)
265	-1	11.2200	TVG argument #7 - 20/40 log crossover (meters)
300	0	0	
300	1	16256	
300	2	0	
300	3	16544	
300	4	0	
300	5	16800	
401	0	5.0000	th_layer[0] - bottom of first threshold layer (m)
401	1	25.0000	th_layer[1] - bottom of second threshold layer (m)
401	2	50.0000	th_layer[2] - bottom of third threshold layer (m)
401	3	60.0000	th_layer[3] - bottom of forth threshold layer (m)
401	4	100.0000	th_layer[4] - bottom of fifth threshold layer (m)
402	0	844.0000	th_val[0] - thr. for 1st layer (mV)
402	1	844.0000	th_val[1] - thr. for 2nd layer (mV)
402	2	844.0000	th_val[2] - thr. for 3rd layer (mV)
402	3	844.0000	th_val[3] - thr. for 4th layer (mV)
402	4	9999.0000	th_val[4] - thr. for 5th layer (mV)
403	0	1.0000	Integration layer 1 top (m)
403	1	50.0000	Integration layer 1 bottom (m)
404	0	50.0000	Integration threshold layer 1 bottom (m)
405	0	50.0000	Integration threshold layer 1 value (mV)
601	-1	HTI-SB-200kHz	Echo sounder type
602	-1	305785	Echo sounder serial number
603	-1	HTISB-2.8X10	Transducer type
604	-1	306733	Transducer serial number
605	-1	Spd-3	Echogram paper speed
606	-1	9_pin	Echogram resolution
607	-1	Board_External	Trigger option
608	-1	Left_to_Right-->	River flow direction
609	-1	All_Fish	Fish included in 3d plot
610	-1	OFF	Echogram enable flag
611	-1	C:\SBDATA\K	Drive and first letter to send files

Appendix B2.-Criteria used for the collection of echoes for the left bank transducer.

* Start Processing at Port 2 -FILE_PARAMETERS- Wed Aug 09 06:00:00 1995

* Data processing parameters used in collecting this file for Port 2

100	-1	1	MUX argument #1 - multiplexer port to activate
101	-1	0	percent - sync pulse switch, ping rate determiner NUS
102	-1	32767	maxp - maximum number of pings in a block NUS
103	-1	32767	maxbott - maximum bottom range in samples NUS
104	-1	5	N_th_layer - number of threshold layers
105	-1	5	max_tbp - maximum time between pings in pings
106	-1	5	min_pings - minimum number of pings per fish
507	-1	FED5	timval - 0xFED5 corresponds to about 20 kHz NUS
108	-1	1	mux_on - means multiplexing enabled on board NUS
109	-1	200	mux_delay - samples delay between sync and switching NUS
110	-1	0	decimate_mask - decimate input samples flag NUS
111	-1	3	plot_up_fish - number of fish between stbar updates
112	-1	1	echogram_on - flag for DEP echogram enable 0=off, 1=on
113	-1	1	f_inst->o_raw - write raw file flag 1 = on, -1 or 0=off
114	-1	1	f_inst->o_ech - write echo file flag 1 = on, -1 or 0=off
115	-1	1	f_inst->o_fsh - write fish file flag 1 = on, -1 or 0=off
116	-1	0	f_inst->o_sum - write summary table file flag 1 or 0=on
117	-1	0	print summary table on printer, 1 = on, -1 or 0=off
118	-1	25	maxmiss - maximum number of missed pings in auto bottom
119	-1	0	bottom_code - bottom tracking, 0=fix, 1=man, 2=auto
120	-1	0	sb_int_code - sb only=0, sb-int: 40log a bot=1, 20log=2
121	-1	0	sb_int_code2 - sb only=0, sb-int 40log eg=0, 20log=2
122	-1	1	N_int_layers-number of integration strata
123	-1	1	N_int_th_layers - number of integration threshold strata
124	-1	0	int_print - print integrator interval results to printer
125	-1	0	circular element transducer flag for bpf calculation
126	-1	80	grid spacing for Model 404 DCR (in samples, 16 s/m)
127	-1	1	TRIG argument #1 - trigger source
128	-1	0	TRIG argument #2 - digital data routing
129	-1	1	FILTER argument #1 - filter number
200	-1	0.0000	sigma_flag - if!=0.0000, sigma is output, not ts
201	-1	215.6400	sl - transducer source level
202	-1	-170.4400	gn - transducer through system gain at one meter
203	-1	-18.0000	rg - receiver gain used to collect data
204	-1	2.8000	narr_ax_bw - vertical nominal beam width
205	-1	10.0000	wide_ax_bw - horizontal axis nominal beam width
206	-1	0.0000	narr_ ax_corr - vertical axis phase correction
207	-1	0.0000	wide_ax_corr - horizontal axis phase correction
208	-1	8.0000	ping_rate - pulses per second
209	-1	0.0000	echogram start range in meters
210	-1	37.0000	echogram stop range in meters
211	-1	569.0000	echogram threshold in millivolts
212	-1	13.2000	print width in inches
213	-1	-60.0000	ts plot minimum target strength in dB
214	-1	-30.0000	ts plot maximum target strength in dB

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215	-1	0.0000	range plot minimum in meters
216	-1	60.0000	range plot maximum in meters
217	-1	-2.5000	min_angoff_v - minimum angle off axis vertical
218	-1	2.0000	max_angoff_v - maximum angle off axis vertical
219	-1	-5.0000	min_angoff_h - minimum angle off axis horiz.
220	-1	5.0000	max_angoff_ h - maximum angle off axis horiz.
221	-1	-24.0000	max_dB_off - maximum angle off in dB
222	-1	-7.7307	ux - horizontal electrical to mechanical angle ratio
223	-1	-28.0668	uy - vertical electrical to mechanical angle ratio
224	-1	0.0000	ud_coef_a - a coeff. for up-down beam pattern eq.
225	-1	-0.0030	ud_coef_b - b coeff. for up-down beam pattern eq.
226	-1	-2.6258	ud_coef_c - c coeff. for up-down beam pattern eq.
227	-1	-0.0563	ud_coef_d - d coeff. for up-down beam pattern eq.
228	-1	-0.1323	ud_coef_e - e coeff. for up-down beam pattern eq.
229	-1	0.0000	lr_coef_a - a coeff. for left-rt beam pattern eq.
230	-1	-0.0000	lr_coef_b - b coeff. for left-rt beam pattern eq.
231	-1	-0.2155	lr_coef_c - c coeff . for left-rt beam pattern eq.
232	-1	-0.0005	lr_coef_d - d coeff. for left-rt beam pattern eq.
233	-1	-0.0001	lr_coef_e - ecoeff. for left-rt beam pattern eq.
234	-1	5.0000	maximum fish velocity in meters per second
235	-1	10.0000	thd_up_time - minutes between 3d plot updates
236	-1	0.5000	maxpw - pulse width search window size
237	-1	2.0000	cltop - start of processing in meters
238	-1	35.5000	bottom - bottom depth in meters
239	-1	0.0000	init_slope - initial slope for tracking in m/ping
240	-1	0.0000	exp_cont - exponent for expanding tracking window
241	-1	0.3500	max_ch_rng - maximum change in range in m/ping
242	-1	0.1500	pw_criteia->min_pw_6-min -6 dB pulse width
243	-1	0.3000	pw_criteria->max_pw_6-max -6 dB pulse width
244	-1	0.0000	pw_criteria->min_pw_12 - min -12 dB pulse width
245	-1	2.0000	pw_criteria->max_pw_12 - max -12 dB pulse width
246	-1	0.0000	pw_criteria->min_pw_18 - min -18 dB pulse width
247	-1	2.0000	pw_criteria->max_pw_18 - max -18 dB pulse width
248	-1	1.0000	Intake width to weight fish to (in meters)
249	-1	10.0000	maximum echo voltage to accept (Volts - peak)
250	-1	0.2000	TX argument #1 - pulse width in milliseconds
251	-1	25.0000	TX argument #2 - transmit power in dB-watts
252	-1	0.0000	RX argument #1 - receiver gain
253	-1	125.0000	REP argument #1 - ping rate in ms per ping
254	-1	10.0000	REP argument #2 - pulsed cal tone separation
255	-1	1.0000	TVG argument #1 - TVG start range in meters
256	-1	100.0000	TVG argument #2 - TVG end range in meters
257	-1	40.0000	TVG argument #3 - TVG function (XX Log Range)
258	-1	-12.0000	TVG argument #4 - TVG gain
259	-1	0.0000	TVG argument #5 - alpha (spreading loss) in dB/Km
260	-1	0.0000	minimum absolute distance fish must travel in x plane
261	-1	0.0000	minimum absolute distance fish must travel in y plane
262	-1	0.0000	minimum absolute distance fish must travel in z plane
263	-1	2.0000	bottom_window - auto tracking bottom window (m)

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264	-1	3.0000	bottom_threshold - auto tracking bottom threshold (V)
265	-1	11.2200	TVG argument #7 - 20/40 log crossover (meters)
266	-1	1.0000	
267	-1	5.0000	
268	-1	20.0000	
401	0	5.0000	th_layer[0] - bottom of first threshold layer (m)
401	1	15.0000	th_layer[1] - bottom of second threshold layer (m)
401	2	50.0000	th_layer[2] - bottom of third threshold layer (m)
401	3	100.0000	th_layer[3] - bottom of forth threshold layer (m)
402	0	569.0000	th_val[0] - thr. for 1st layer (mV)
402	1	569.0000	th_val[1] - thr. for 2nd layer (mV)
402	2	569.0000	th_val[2] - thr. for 3rd layer (mV)
402	3	569.0000	th_val[3] - thr. for 4th layer (mV)
402	4	569.0000	th_val[4] - thr. for 5th layer (mV)
403	0	1.0000	Integration layer 1 top (m)
403	1	50.0000	Integration layer 1 bottom (m)
404	0	50.0000	Integration threshold layer 1 bottom (m)
405	0	50.0000	Integration threshold layer 1 value (mV)
601	-1	HTI-SB-200kHz	Echo sounder type
602	-1	305785	Echo sounder serial number
603	-1	HTISB-2.8X10	Transducer type
604	-1	306738	Transducer serial number
605	-1	Spd-3	Echogram paper speed
606	-1	9_pin	Echogram resolution
607	-1	Board_External	Trigger option
608	-1	Right_to_Left-->	River flow direction
609	-1	All_Fish	Fish included in 3d plot
610	-1	OFF	Echogram enable flag
611	-1	C:\SBDATA\K	Drive and first letter to send files