Using a DIDSON to Estimate Salmon Escapement: Introduction

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USGS science for a changing world

HUMBOLDT STATE UNIVERSITY

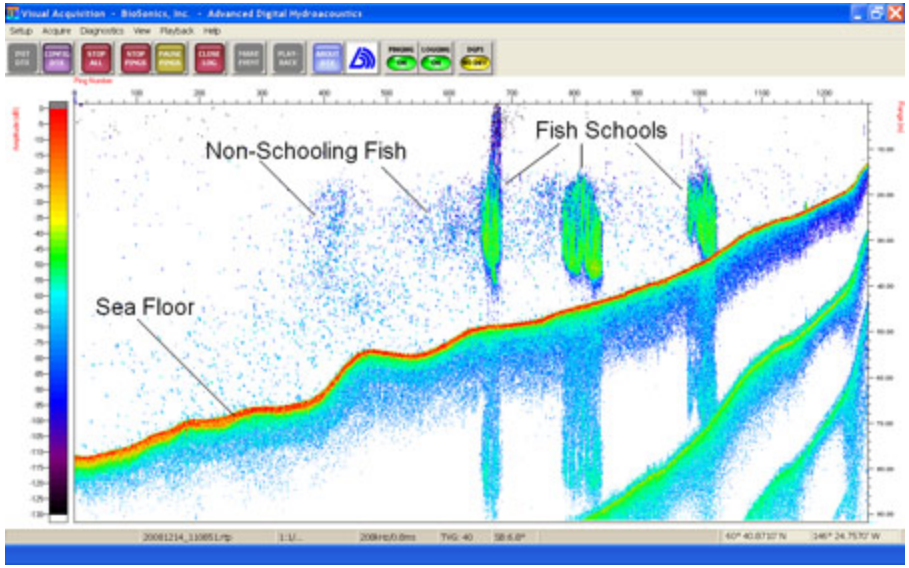
CALIFORNIA

Acknowledgements

- California Department of Fish and Game, Fisheries Restoration Grants Program
- Redwood State and National Parks
- Orick Chamber of Commerce
- U. S. Geological Survey
- Humboldt State University

History

- Hydro-acoustics and sonar used in a variety of applications
  - Stock assessments in lakes and reservoirs
  - Sport fishing
  - Mapping seafloor



History

- DIDSON technology developed for U. S. Navy by University of Washington, Applied Physics Laboratory to detect mines
  - Limpet Mine Imaging Sonar (LIMIS)
  - Dual-Frequency Identification Sonar (DIDSON)

Some DIDSON Applications

- Monitoring frequency of salmon redd construction relation to environmental variables.
- Predator-prey interactions in turbid water.
- Evaluating trawl by-catch.
- Estimating salmon escapement.
- Fish behavior

Salmon Escapement

- Alaska Department of Fish and Game adapted DIDSON technology to estimate escapement.
  - ADFG employs 27 DIDSON units for this purpose.
- Other federal, state and provincial agencies now using DIDSON for similar purposes.

How a DIDSON Works

- Components
- Concepts
- Specifications
- Resolution
- Deployment

Components

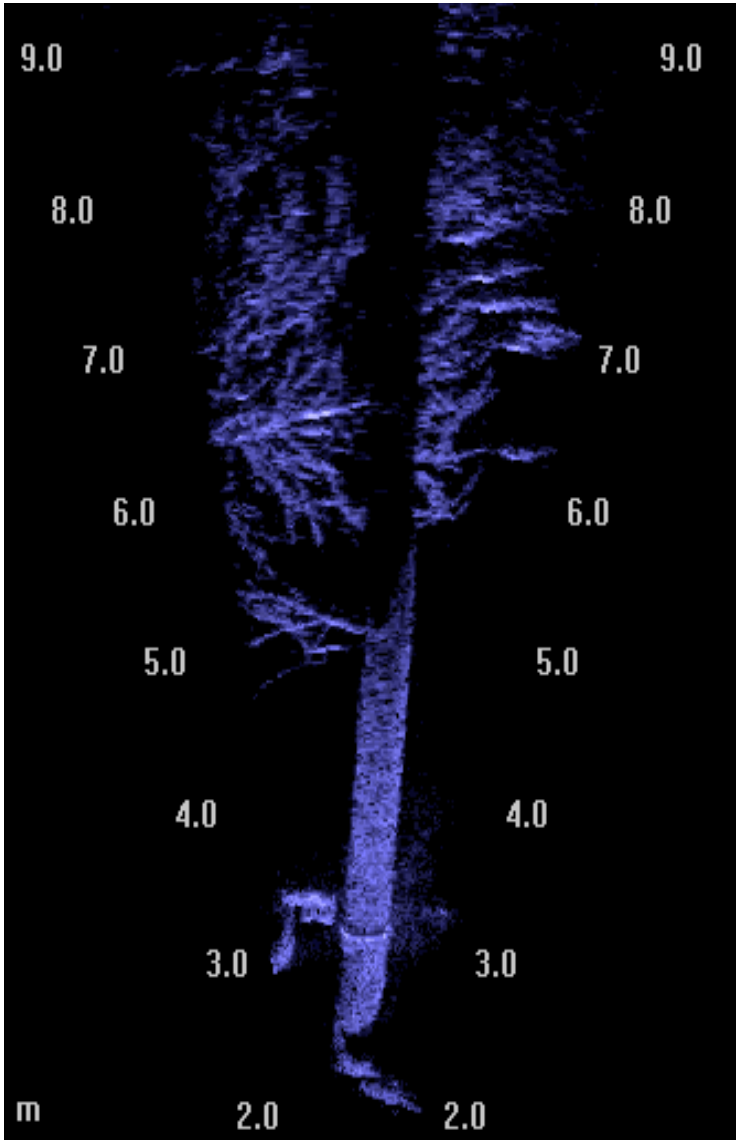
The acoustic lenses focus and form an acoustic image on the transducer array at the rear of the sonar. Electronics convert that acoustic image into a digital image on a computer screen.

Image interpretation

- Unlike scanning sonars that provide still images, DIDSON is a dual beam sonar that provides dynamic (video) images.
- Dual beam = 2 frequencies (1.1 and 1.8 MHz).
- The apparent observation view is perpendicular to the expected view.
  - Objects ensonified from the side appear to be viewed from the top
  - Objects ensonified from above appear to be viewed from the side.

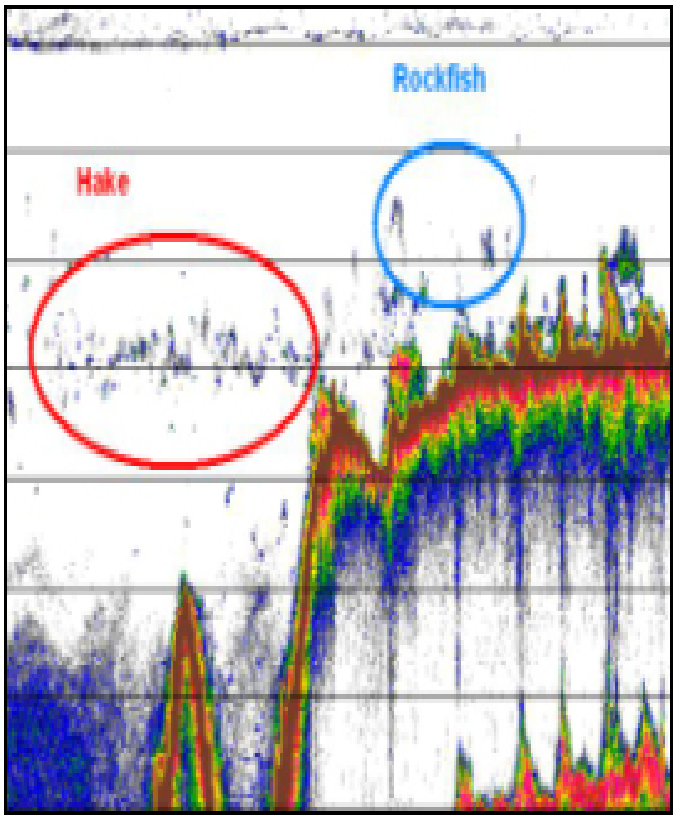
Image quality

- DIDSON produces high quality, almost photo quality, video acoustic images
- Operates at zero light and high turbidity.
- At right – image of pipe and roots in Sacramento River.



Data Interpretation is Intuitive

- DIDSON
  - Real time direction.
  - Swimming behavior visible.
- Split-beam Sonar
  - “radar blips”.
  - Not possible to determine direction.
  - Size is weakly related to target strength.



Fish passage observation technology comparison

	Optical Camera	Acoustic Camera	Traditional Sonar
Display Resolution	500,000 pixels (video)	50,000 pixels (HF mode)	500 range data bins
Maximum Range (m)	< 1 (in turbid water)	12 (HF mode)	>50
Field-of-View (degrees)	77	29	6

Moursund, R. A., T. J. Carlson and R. D. Peters. 2003. A fisheries application of a dual-frequency identification sonar acoustic camera. ICES Journal of Marine Sciences 60:678-683.

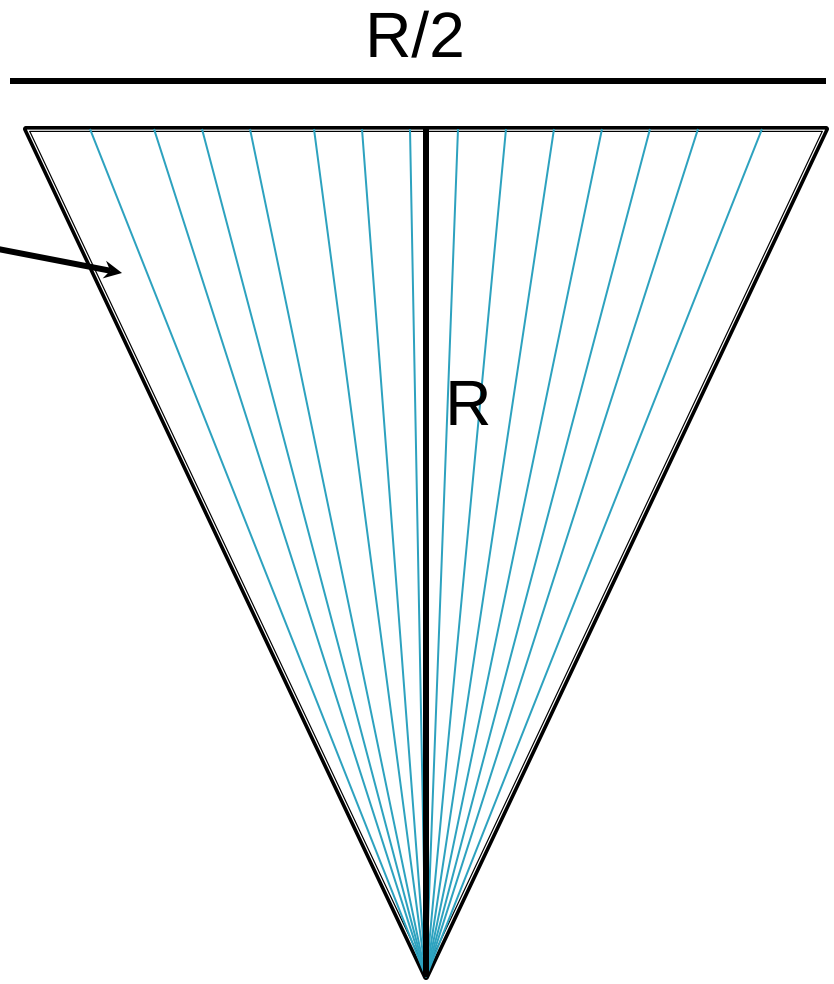
DIDSON Specifications

- Identification Mode
  - Operating Frequency 1.8 MHz
  - Beamwidth (two-way) 0.3 deg H by 14 deg V
  - Number of beams 96
  - Range 1 m to 15 m
- Detection Mode
  - Operating Frequency 1.1 MHz
  - Beamwidth (two-way) 0.6 deg H by 14 deg V
  - Number of Beams 48
  - Range 1 m to 35 m
- Both Modes
  - Field-of-view 29 deg
  - Sonar weight in air (300m) 7.7 kg (17 lbs); in water 0.7 kg (1.6 lbs)
  - Dimensions 30 cm by 20 cm by 17 cm (12-in. by 8-in. by 7-in.)

DIDSON Resolution

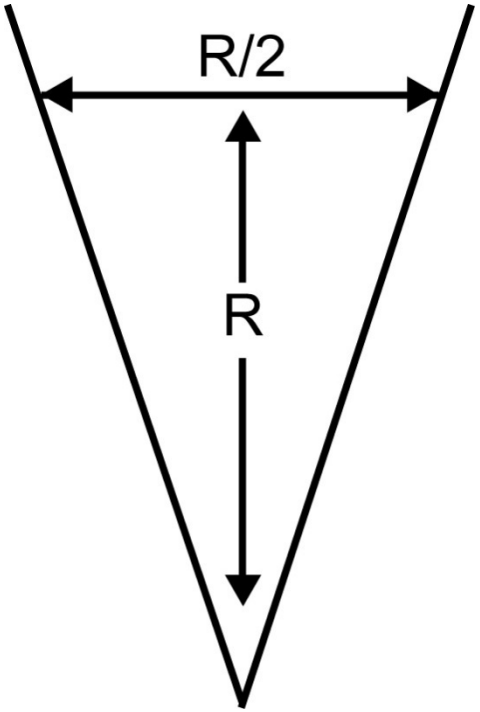
In high frequency mode
96 beams
Each:
- 0.3^{o} horizontal
- 14^{o} vertical

Total field:
- 29^{o} horizontal
- 14^{o} vertical



DIDSON Resolution

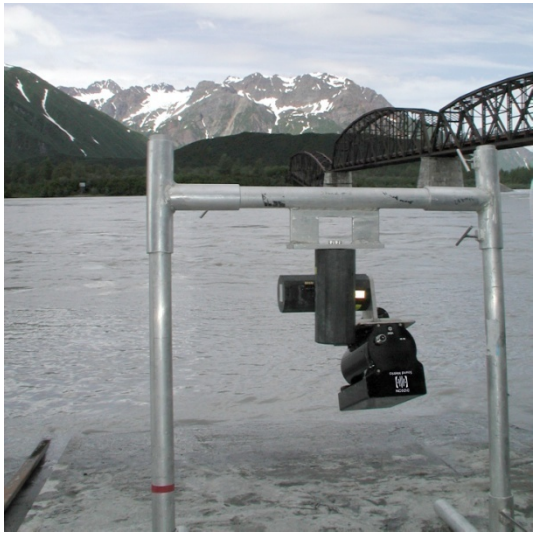
- Cross-range resolution: (range/2)/num_beams
- Down-range resolution: Window-Length/512
- Example: Range 30 m using a 40-m window Std LF
  - Cross-range resolution = 1500/48 = 31 cm
  - Down-range resolution = 4000/512 = 8 cm
- Example: Range 2 m using a 1.25-m window Std HF
  - Cross-range resolution = 100/96 = 1 cm
  - Down-range resolution = 125/512 = 0.24 cm



Deployment

Pole mount

“H” mount



Aiming to image objects

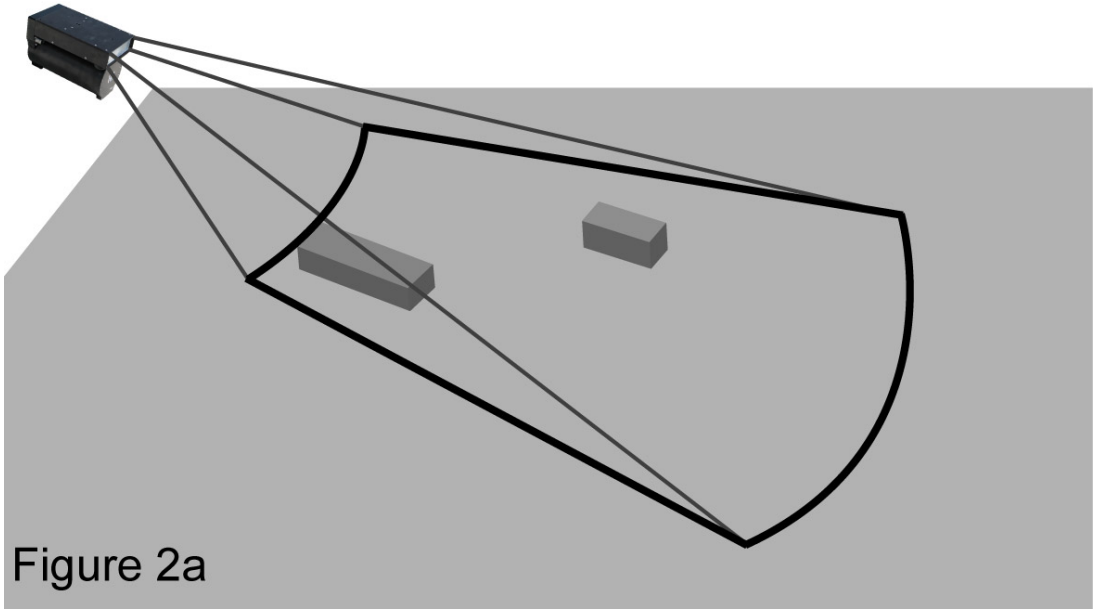


Figure 2a

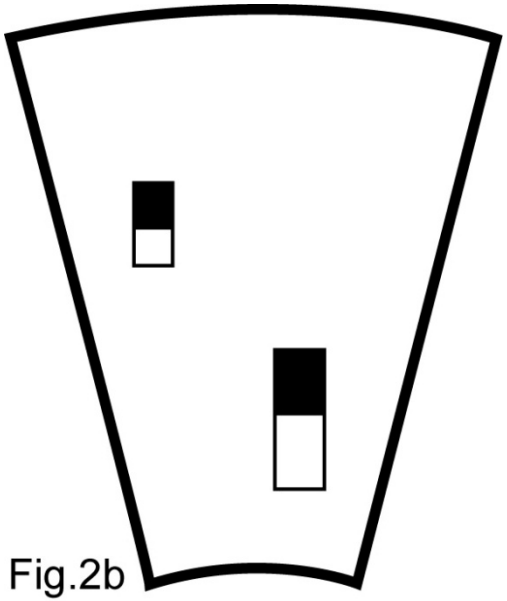


Fig.2b

96 or 48 pulses skim along the surface sending back reflectance as a function of range and beam number.

The display maps the reflectances. Objects ensonified from the side appear to be seen from above and generally have an acoustic shadow.

Data storage

```
Count Motion   = Right to Left
Sub Opp Motion = FALSE
Correct TL     = ENABLED
Background Sub = ENABLED
Detect Motion  = ENABLED

*** Echogram Counting ***
```

Total	Frame#	Dir	R (m)	Theta	L(cm)	T(cm)	L/T	Aspect	MaxArea	Time
1	35	Up	6.90	0.0	39.4	15.7	2.50	0.0	32	19:53:59
2	51	Up	5.38	0.0	51.4	12.2	4.20	0.0	47	19:54:01
3	191	Up	10.13	0.0	78.7	17.5	4.50	0.0	88	19:54:22
4	196	Up	9.45	0.0	73.3	19.2	3.81	0.0	71	19:54:22
5	235	Up	3.61	0.0	50.6	10.5	4.82	0.0	66	19:54:28
6	244	Up	3.95	0.0	74.5	19.2	3.87	0.0	208	19:54:29
7	248	Up	8.18	0.0	80.9	15.7	5.14	0.0	125	19:54:30
8	252	Up	8.51	0.0	79.8	15.7	5.07	0.0	97	19:54:30
9	255	Up	7.58	0.0	82.8	15.7	5.26	0.0	124	19:54:31
10	259	Up	7.18	0.0	83.8	15.7	5.33	0.0	114	19:54:31
11	261	Up	8.39	0.0	65.7	10.5	6.26	0.0	47	19:54:32
12	266	Up	7.90	0.0	82.3	15.7	5.23	0.0	116	19:54:32
13	269	Up	6.24	0.0	74.9	14.0	5.35	0.0	125	19:54:33

The fish statistics automatically store into a text file. One gets the total count, the frame in which a count was made, fish direction, range, length, and the time the fish passed the center beam.

Discussion & Questions