A Low-cost Acoustic Technique for Submersed Vegetation Mapping for CE Planning and Monitoring

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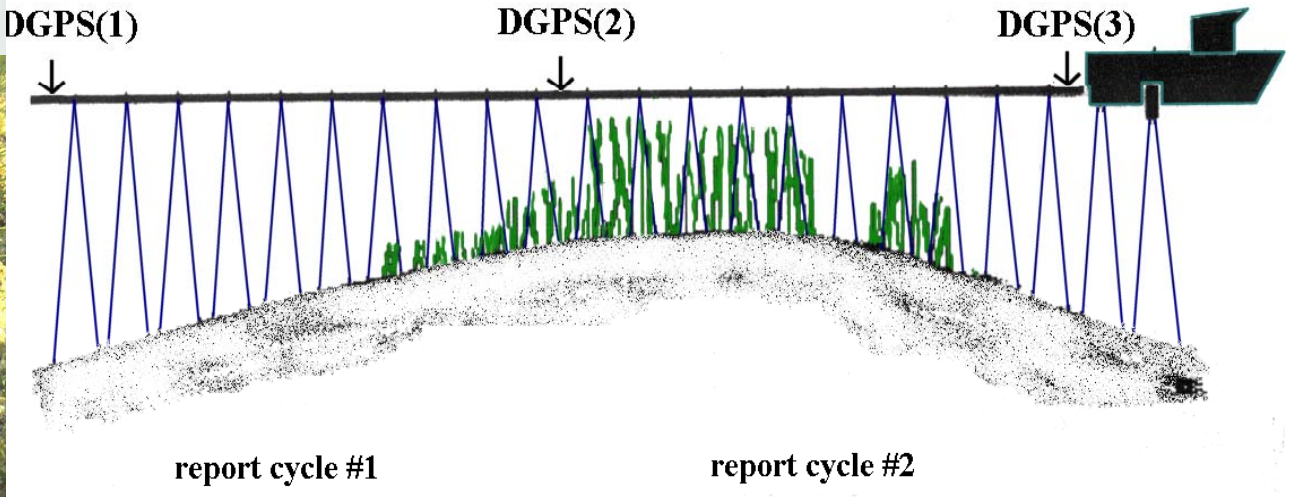
Environmental Lab
Vicksburg, MS

CE Planning Webinar
5 June 2012



Background

Knowledge of spatial distribution of SAV needed for:

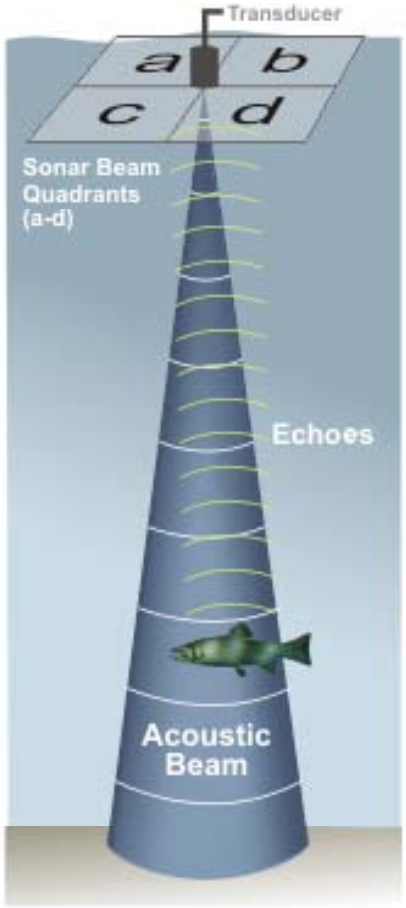
- planning and monitoring nuisance invasive plant control operations
- planning dredging operations in SAV areas
- monitoring SAV restoration projects
- general ecological and modeling studies

Standard Techniques for SAV Surveys

Type	Advantages	Disadvantages
Aerial and satellite imagery	Rapid large-area synoptic view	Detection limited by turbidity and other conditions
Physical sampling	Highest quality data	▪Limited spatial extend ▪Expensive ▪Slow

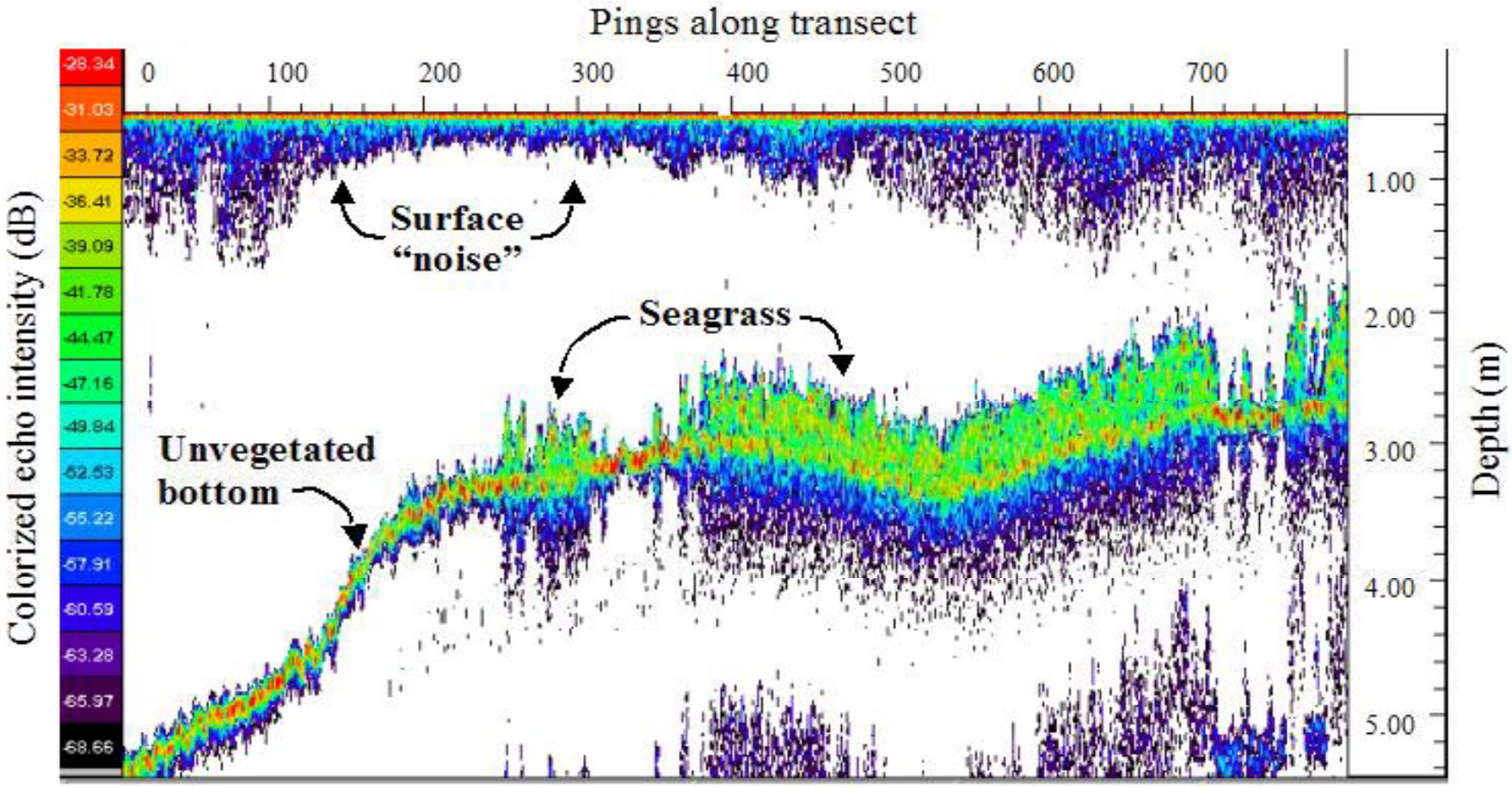
Fundamentals of Echo Sounder Application

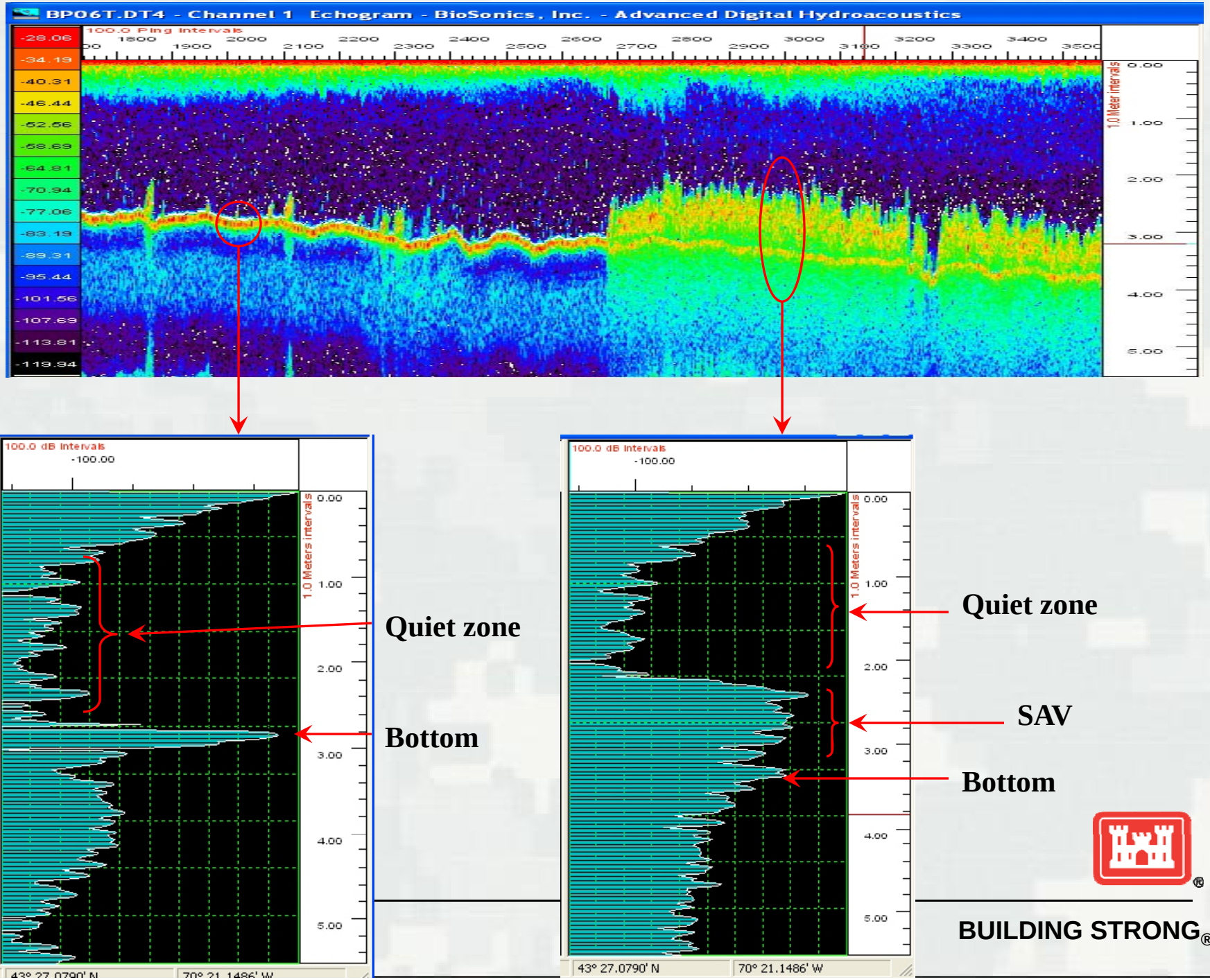
- Short pulses of high frequency (~10^5+ Hz) acoustic energy input into the water column
- The sound wave reflects off objects in the water (i.e. fish, plankton, SAV, bottom)
- Returning echoes are received by the transducer and their energy determined (dB relative to source)



Basic hydroacoustic concept.

Acoustic Environment of Submersed Aquatic Vegetation




BP06T.DT4 - Channel 1 Echogram - BioSonics, Inc. - Advanced Digital Hydroacoustics
100.0 Ping Intervals
1.0 Meter intervals
100.0 dB Intervals
-100.00
1.0 Meters intervals
Quiet zone
Bottom
SAV
43° 27.0790' N
70° 21.1486' W
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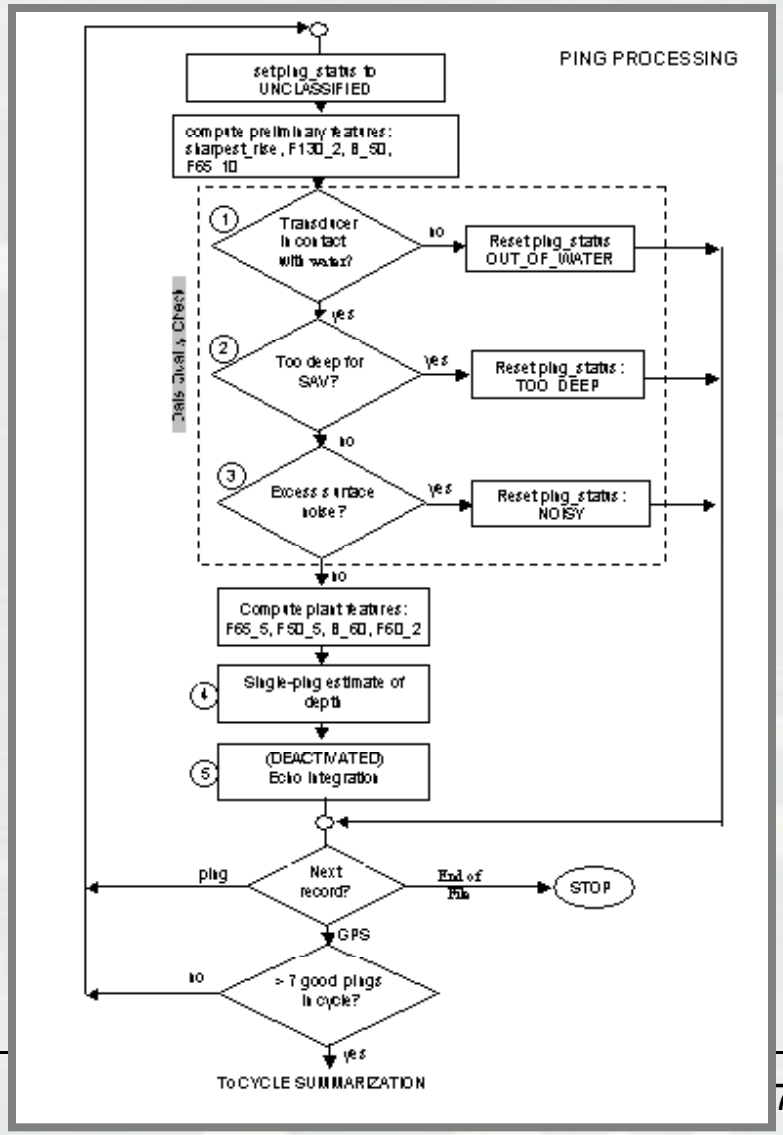
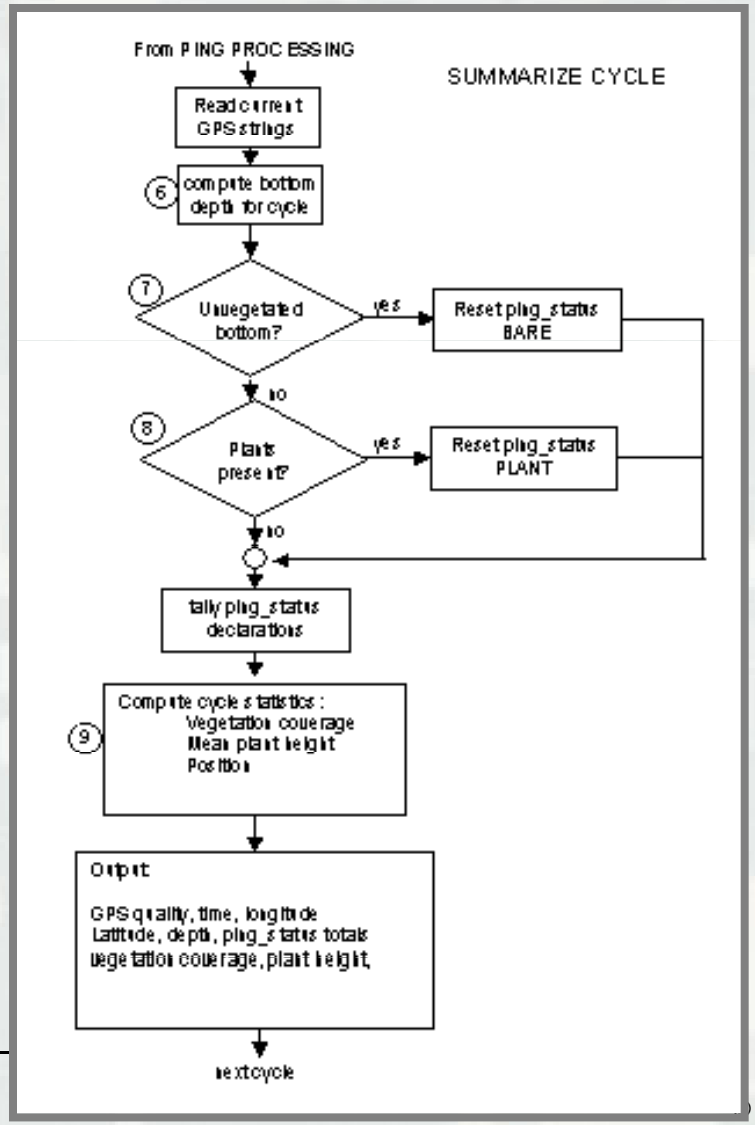
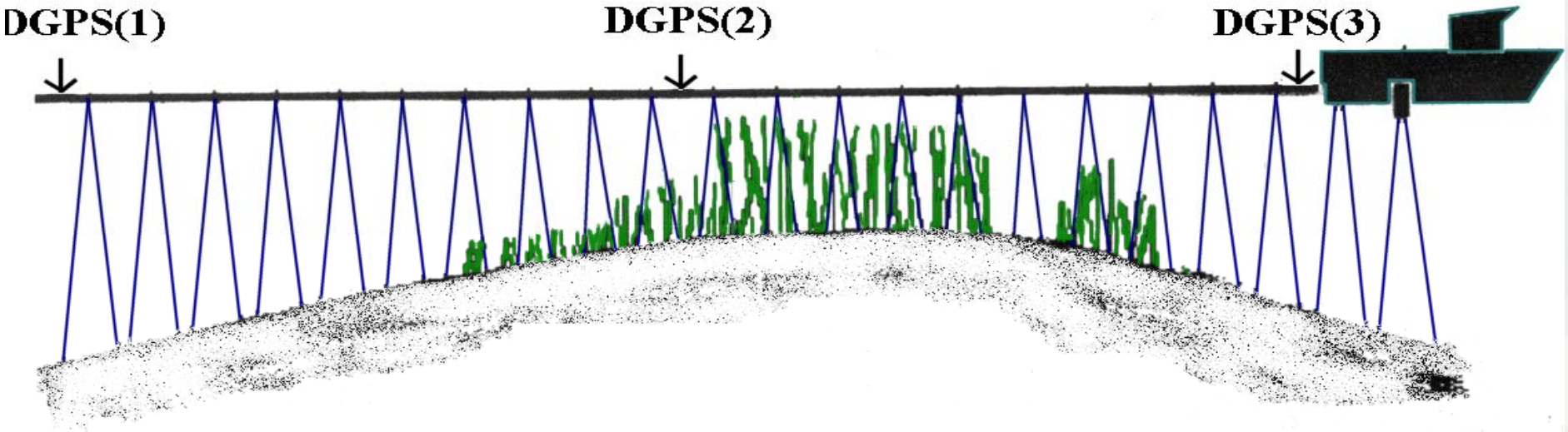
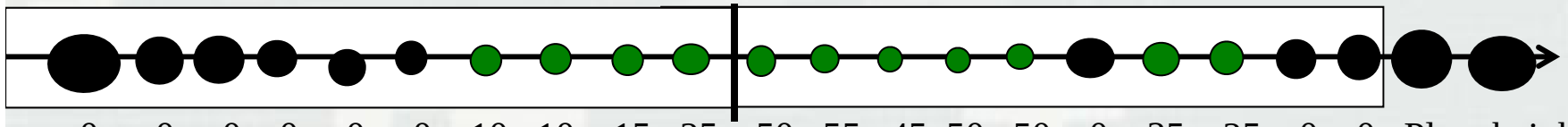
ERDC-developed Submersed Aquatic Vegetation Early Warning System (SAVEWS) Code





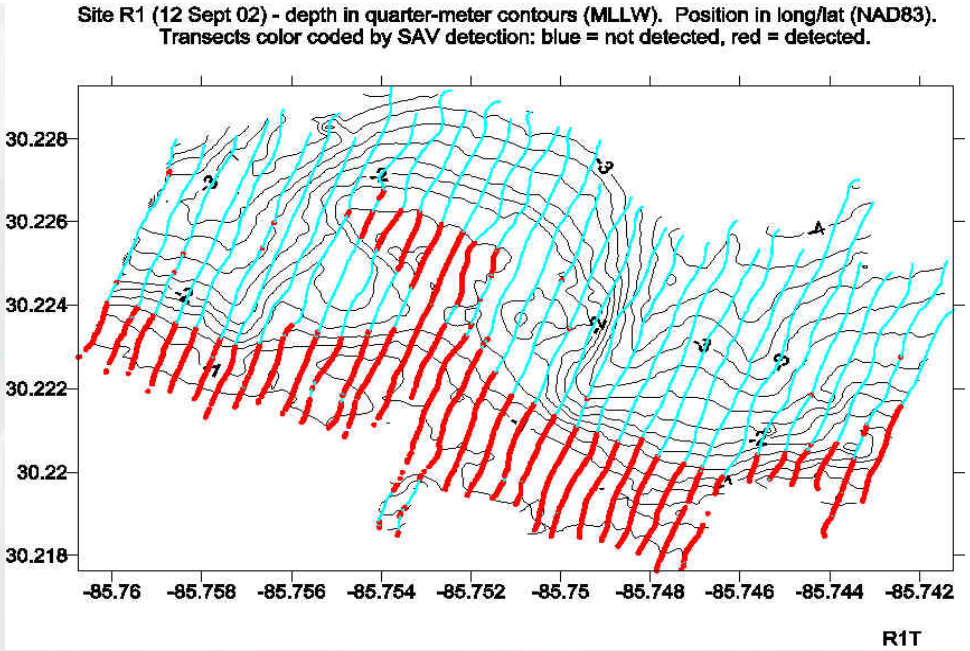




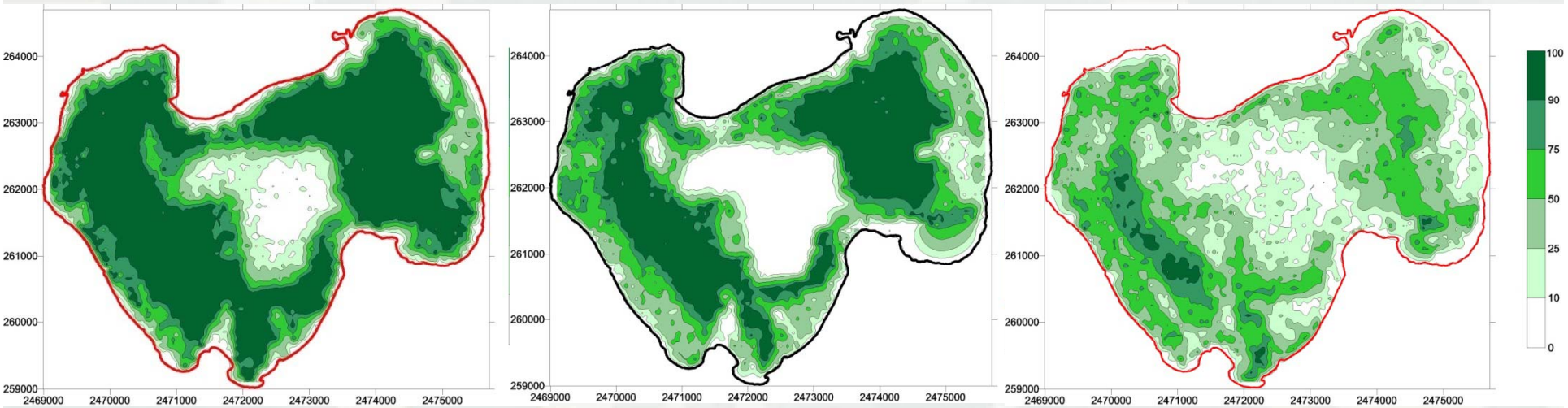
0	0	0	0	0	0	10	10	15	25	50	55	45	50	50	0	35	25	0	0	Plant height (cm)
(4/10) * 100 = 40 %										(7/10) * 100 = 70 %										Coverage (%)
(10+10+15+25) / 4 = 15 cm										(50+55+45+50+50+35+25) / 7 = 44 cm										Average Height (cm)
(DGPS (1)+ (DGPS (2)) / 2										(DGPS (2)+ (DGPS (3)) / 2										Position

SAVEWS™ Outputs and Uses

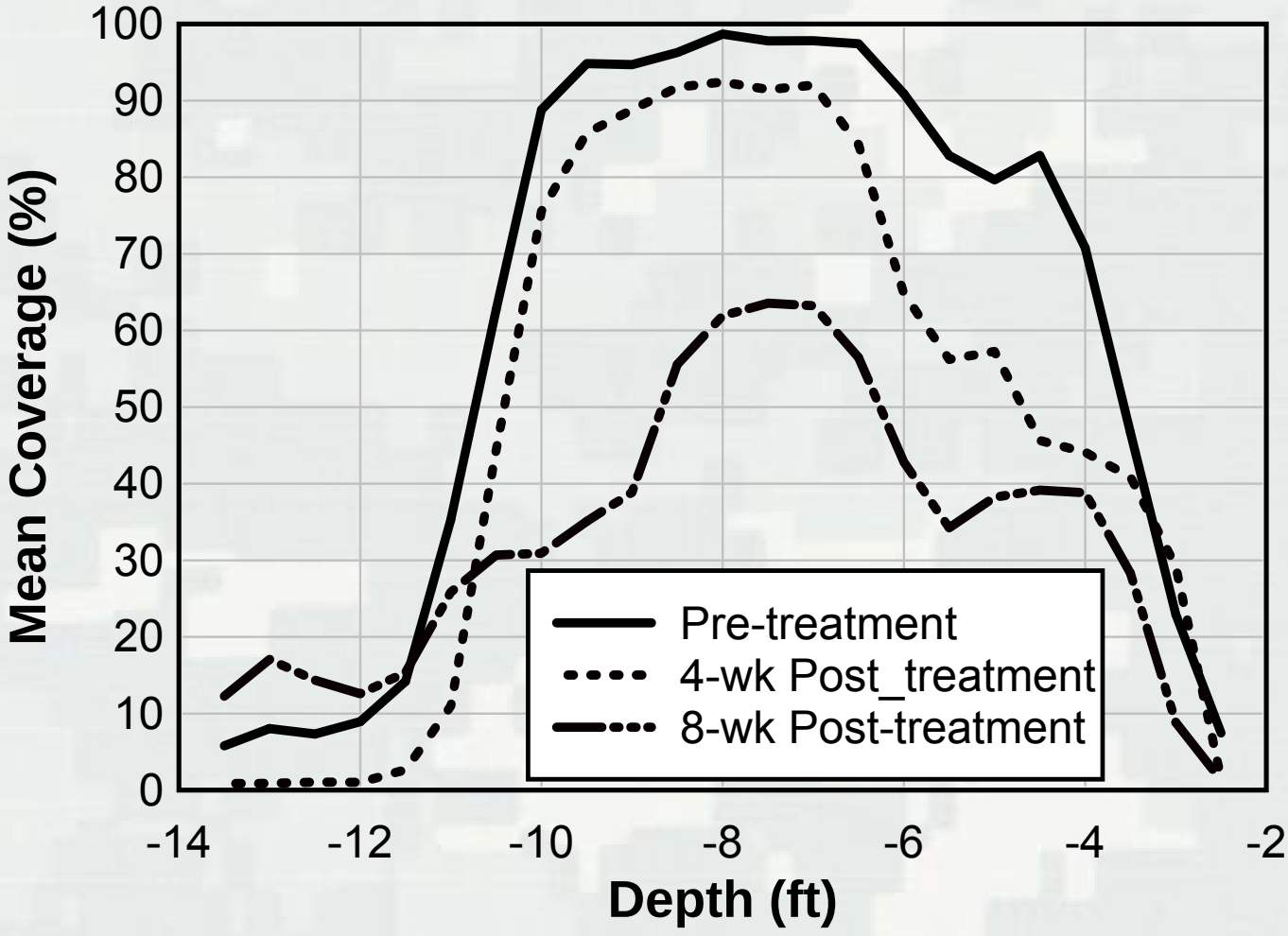
- Outputs: Location-referenced bathymetry, plant coverage & height along boat transects
- Low density detection and mapping of SAV canopy geometry, not species
- Planning treatments & monitoring responses
- Temporal change



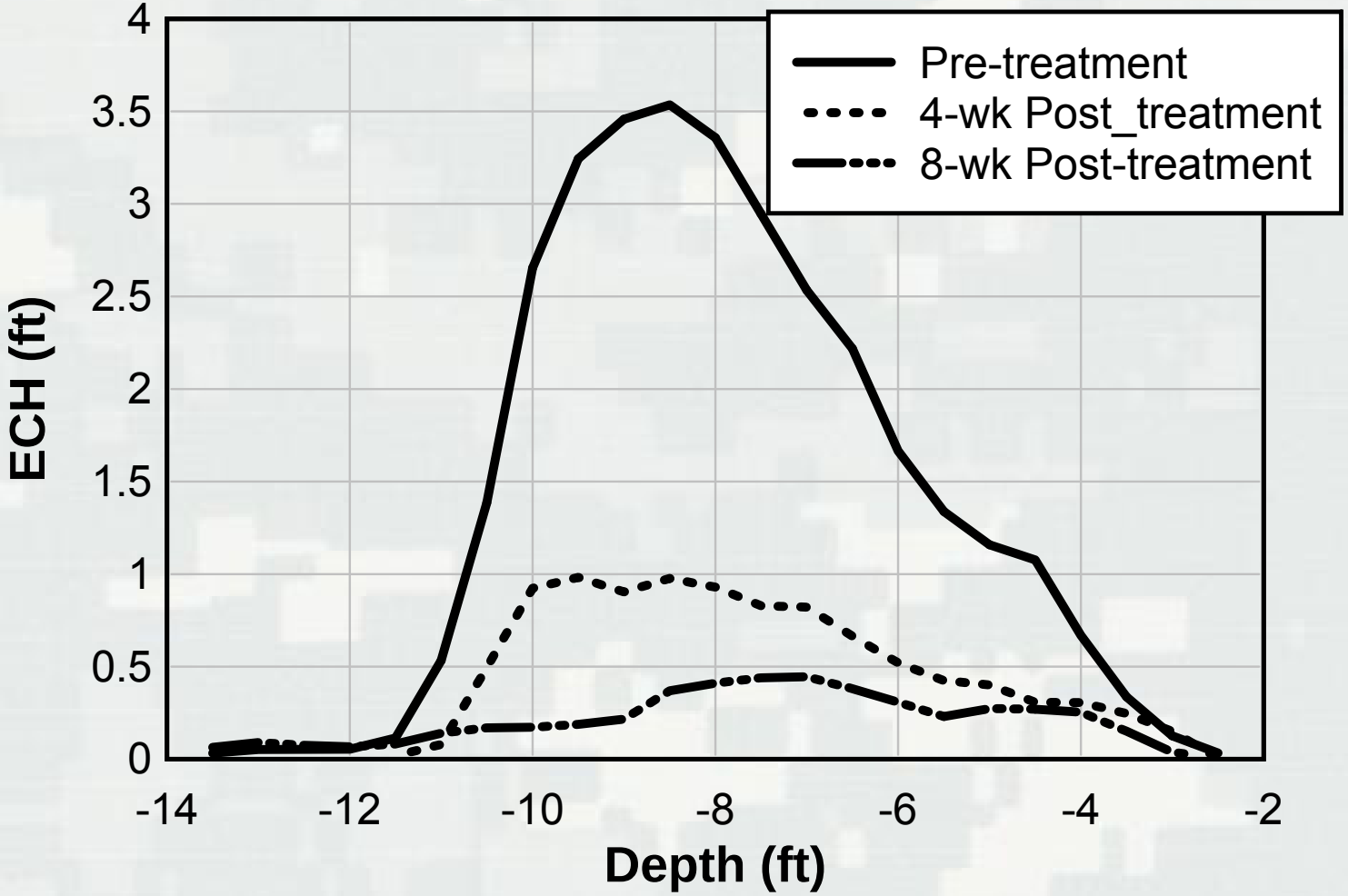
PRE- **4-WK POST-** **8-WK POST-**



Non-Spatial Analysis



Non-Spatial Analysis



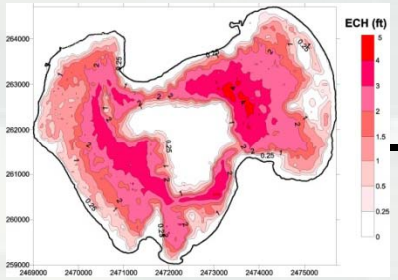
Spatial Change Analysis – Canopy Height

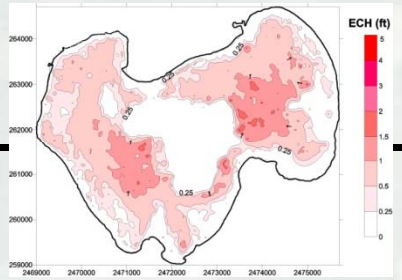
Pre-

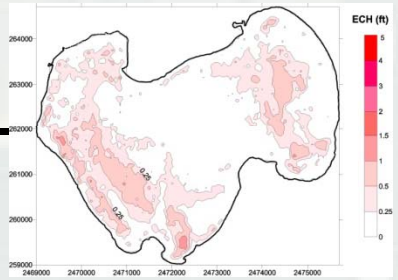
4-Wk Post-

8-Wk Post-

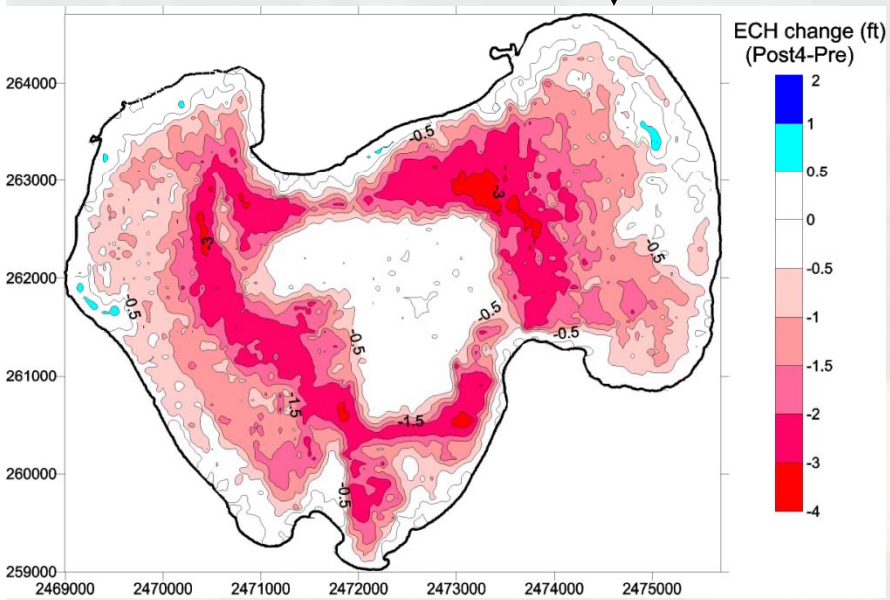
ECH

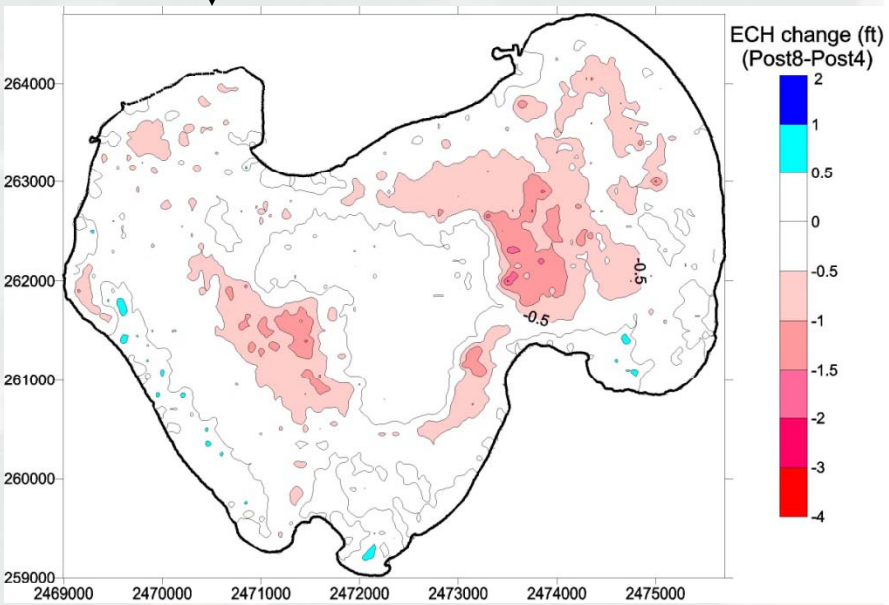






Change

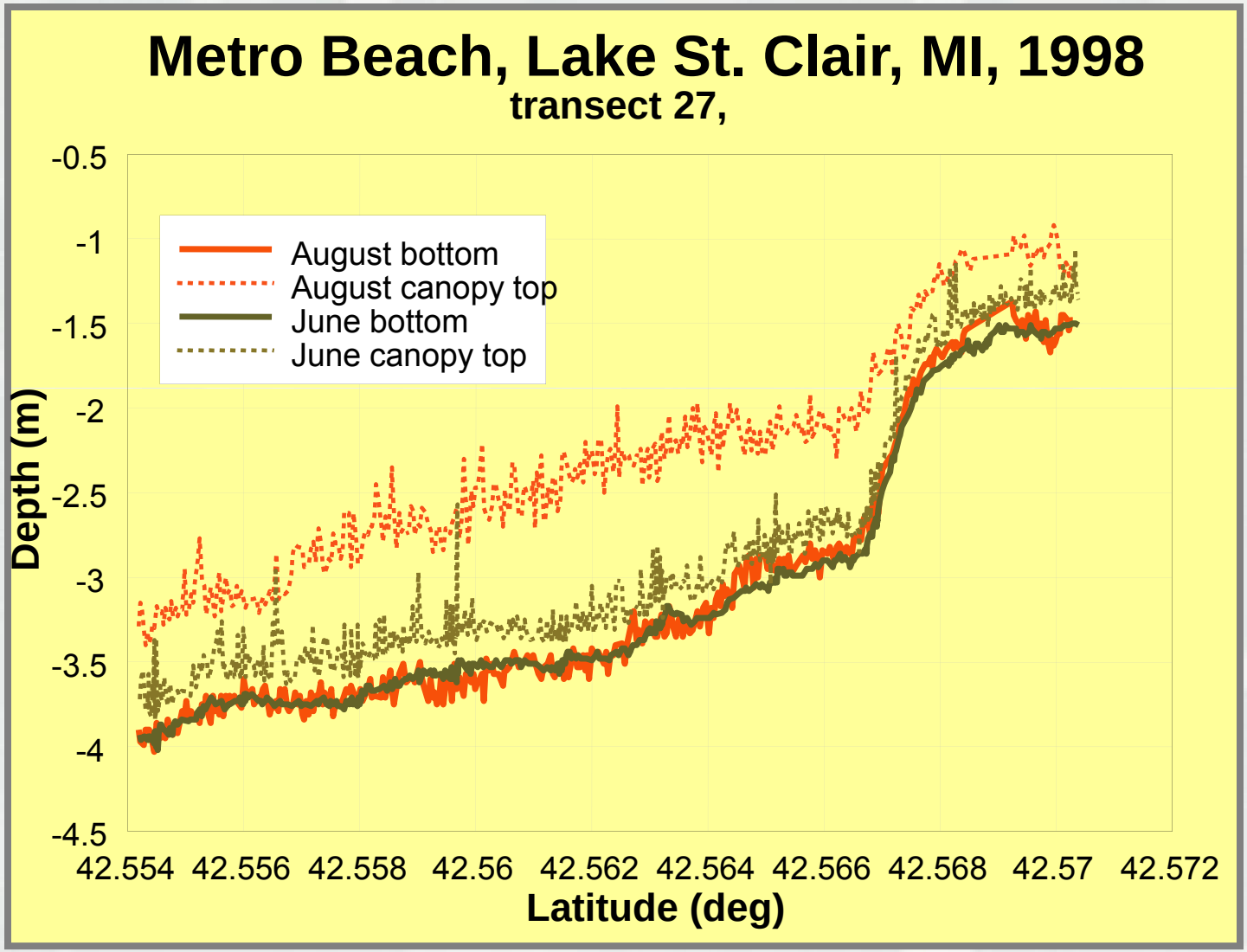




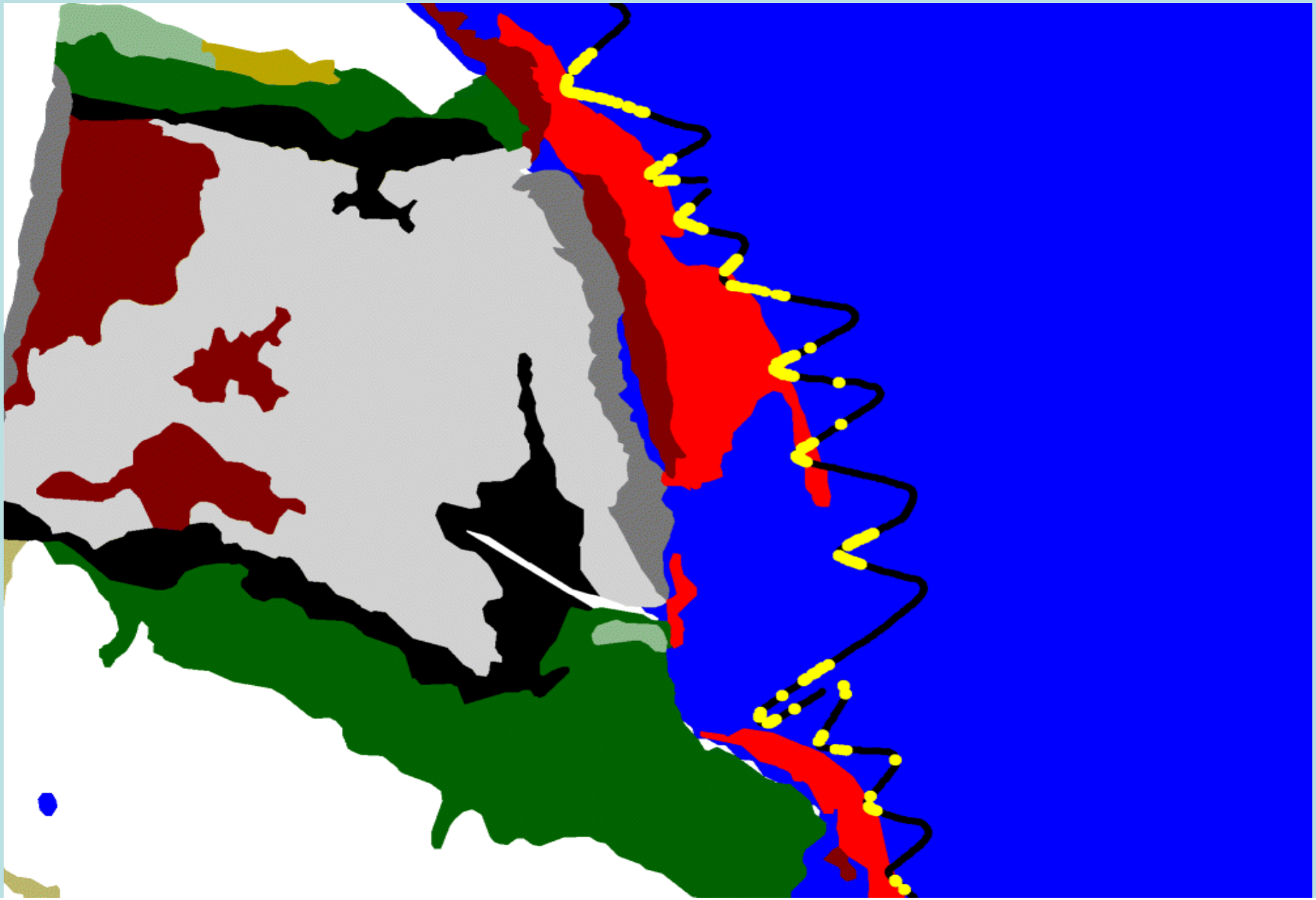
1st 4 weeks after treatment

2nd 4 weeks after treatment

Multi-Temporal Transects



St. Johns River, FL – photography vs. acoustic detection of Vallisneria



Problem/Opportunity

- Use of SAVEWS within aquatic plant management community limited by high cost of hardware (~$30K)
- Currently new low-cost digital sounder/GPS systems(<$2K) available from multiple vendors what could run SAVEWS-like algorithm
- Develop, test, verify, and demonstrate acoustic signal processing for SAV mapping on low-cost system

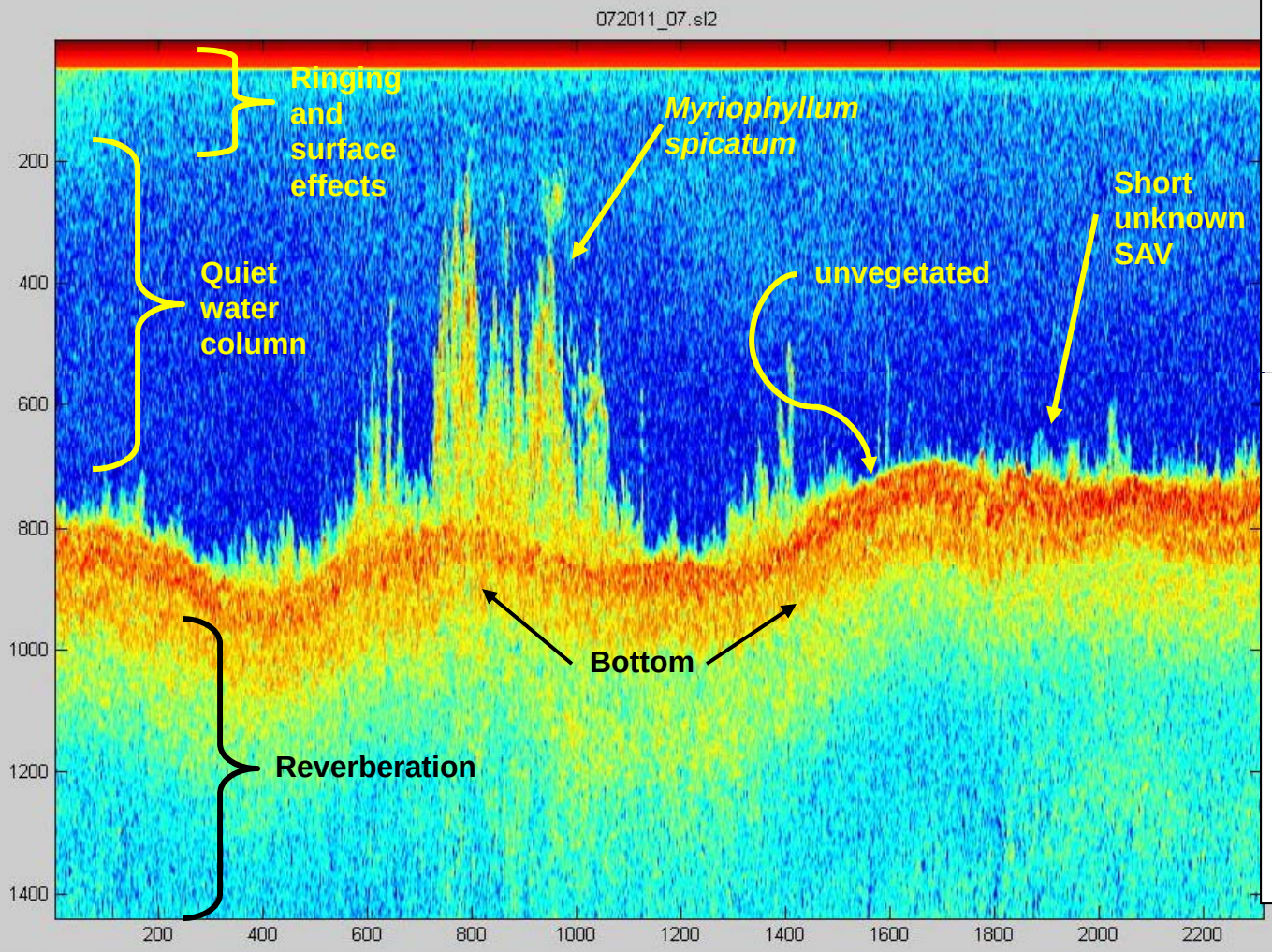
System and Signal Characteristics

Characteristic	*Biosonics DT-X*	*Lowrance HDS w/ StructureScan*
Frequency	420 kHz	200/455/800 kHz
Beam width	6-deg	Narrow (downscan)
Pulse width	0.1 ms	~0.15 ms
Ping rate (/sec)	Variable	30
Range resolution	1.8 cm	Variable
Intensity resolution	22-bit	8-bit
Calibrated	Yes	No
Digital pre-filtered	Yes	No

Biosonics DT-X

Lowrance HDS-10

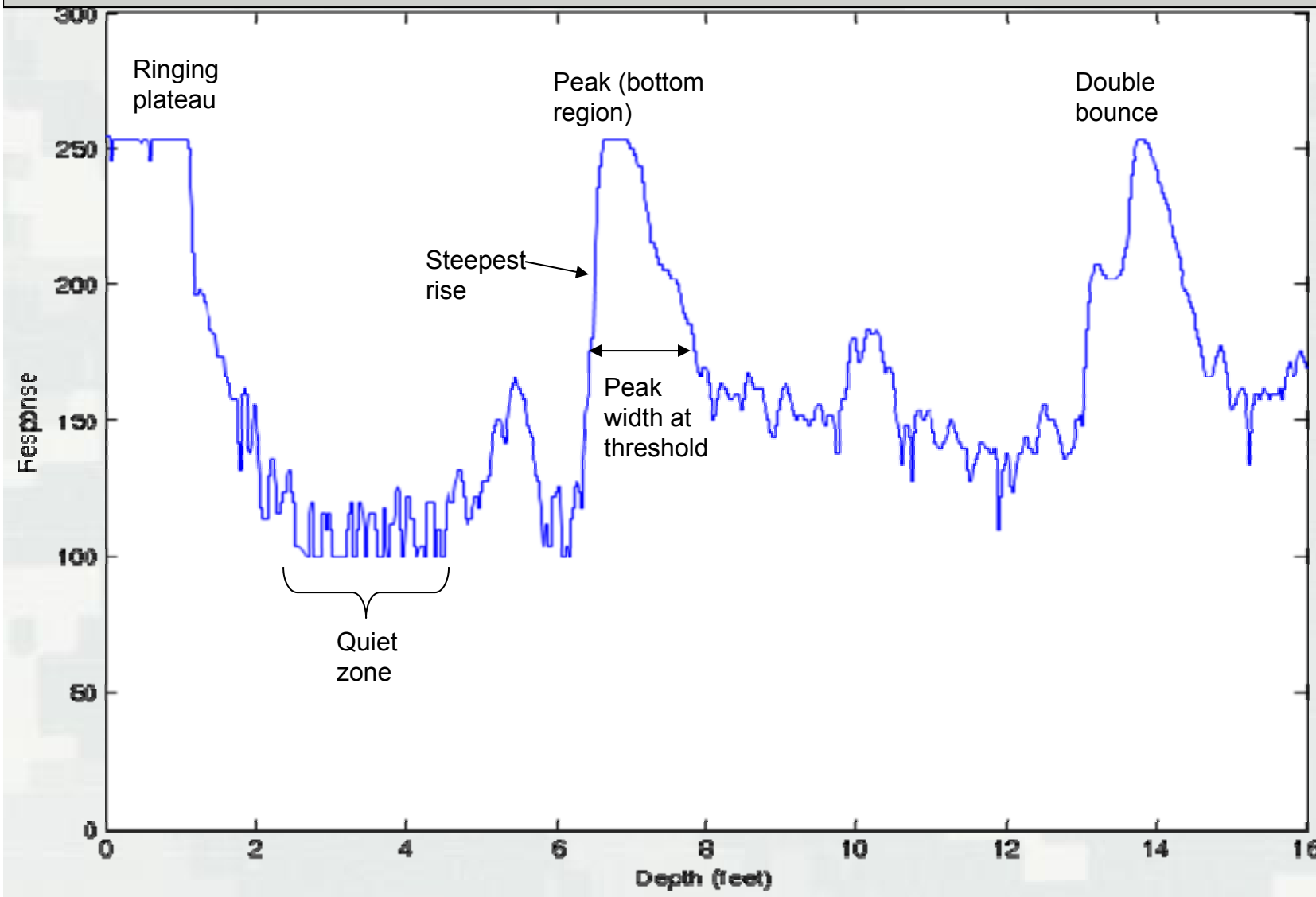
Acoustic Characteristics of SAV – downlook StructureScan 800kHz



COMMON FEATURES

- Strong detectable bottom return
- Small change in bottom depth ping-to-ping
- SAV usually weaker return
- SAV connectivity w/ bottom
- Large change in canopy height ping-to-ping

Example of Ping Features Extracted



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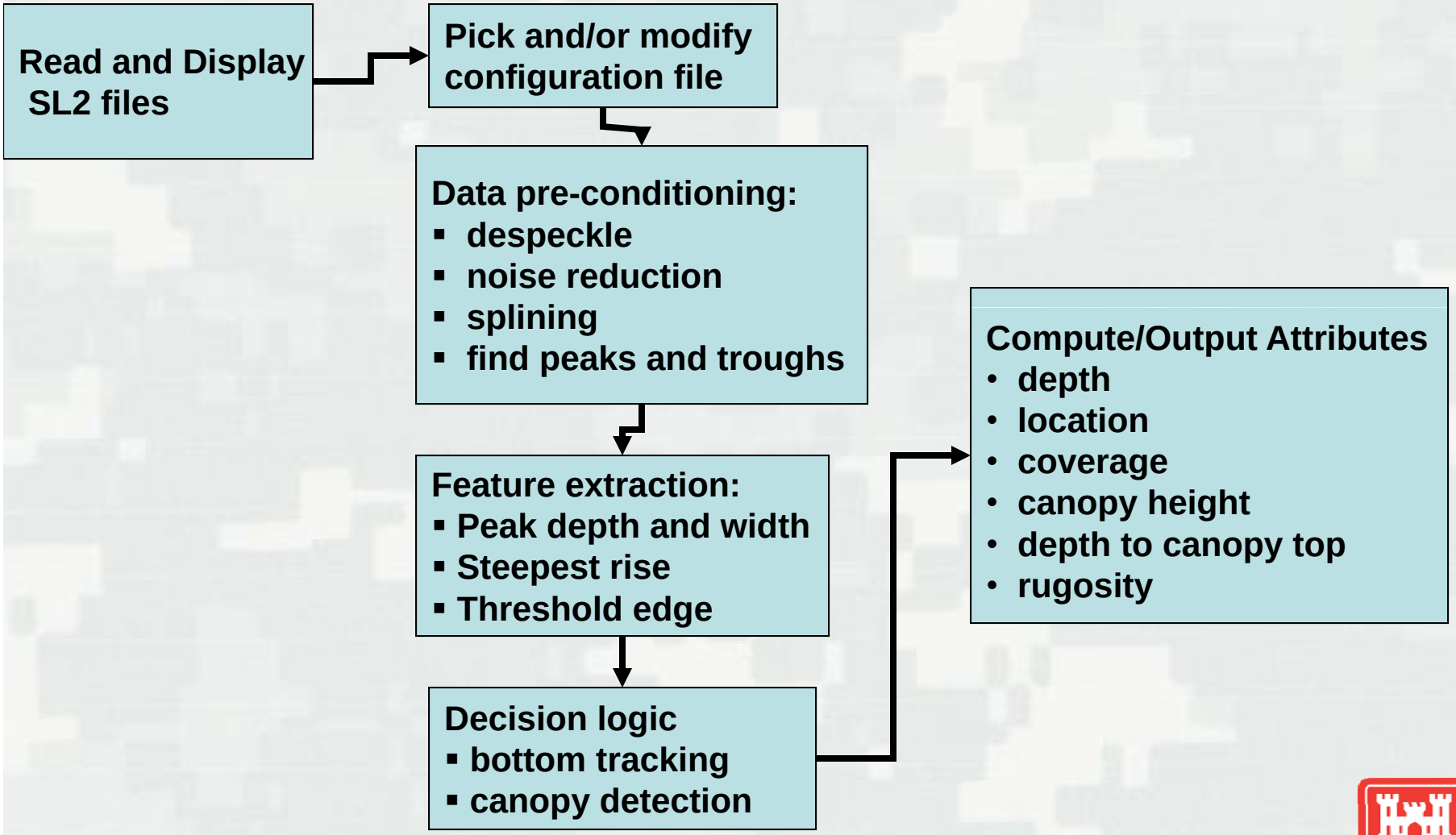
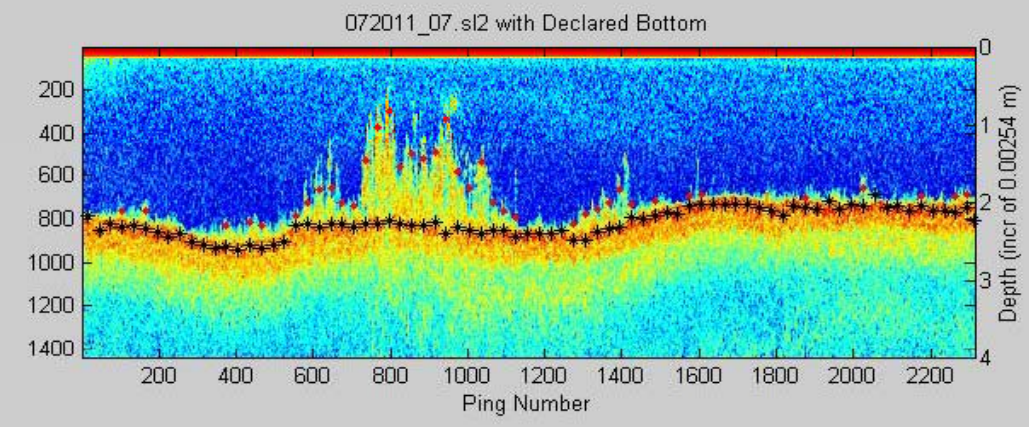
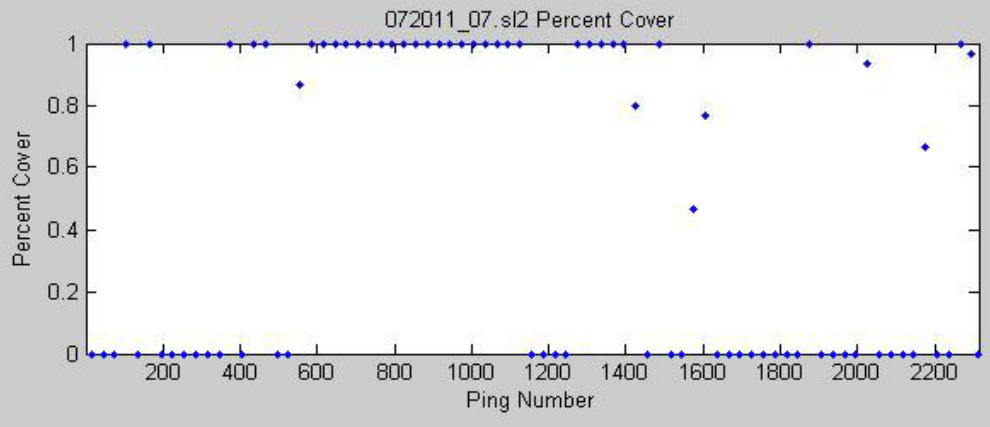
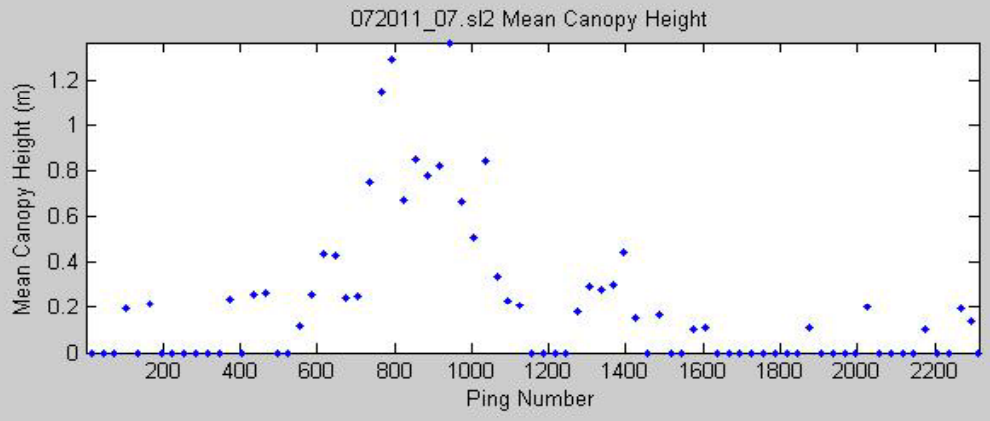
Data Processing



Outputs







Microsoft Excel - Sonar0006.xlsx

File Edit View Insert Format Tools Data Window DPlot Help

G20

	A	B	C	D	E	F	G	H
20								
21	Report Cy	Latitude	Longitude	Times(mse	Center Pir	Bottom(m)	Canopy H	Percent Cover
22	1	39.55367	-74.27143	747	15	1.05	0	0
23	2	39.55367	-74.27145	1528	45	1.009	0	0
24	3	39.55367	-74.27147	2301	75	0.991	0	0
25	4	39.55367	-74.27148	3057	105	1.031	0	0
26	5	39.55367	-74.2715	3833	135	1.009	0	0
27	6	39.55368	-74.27152	4591	165	0.991	0	0
28	7	39.55368	-74.27154	5362	195	0.991	0	0
29	8	39.55368	-74.27157	6136	225	1.009	0	0
30	9	39.55368	-74.27158	6923	255	0.991	0	0
31	10	39.55369	-74.27159	7699	285	0.95	0	0
32	11	39.55369	-74.27161	8487	315	0.991	0	0
33	12	39.55369	-74.27164	9256	345	0.931	0	0
34	13	39.55369	-74.27166	10037	375	0.931	0	0
35	14	39.5537	-74.27167	10796	405	0.931	0	0
36	15	39.5537	-74.27168	11577	435	0.95	0	0
37	16	39.5537	-74.2717	12313	465	0.931	0	0
38	17	39.5537	-74.27171	13083	495	0.891	0	0
39	18	39.5537	-74.27172	13841	525	0.95	0	0
40	19	39.5537	-74.27174	14591	555	0.869	0	0
41	20	39.55371	-74.27176	15351	585	0.95	0	0
42	21	39.55371	-74.27178	16107	615	0.95	0	0
43	22	39.55372	-74.2718	16861	645	0.891	0	0
44	23	39.55372	-74.27181	17612	675	0.969	0	0
45	24	39.55372	-74.27182	18361	705	0.891	0	0
46	25	39.55373	-74.27183	19116	735	0.991	0	0
47	26	39.55373	-74.27184	19874	765	0.969	0	0

Sonar0006

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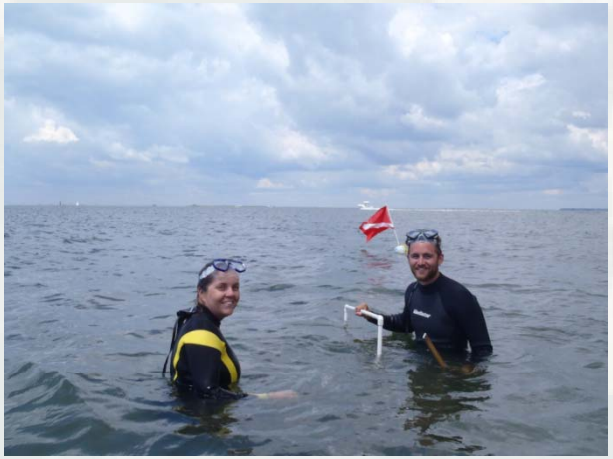
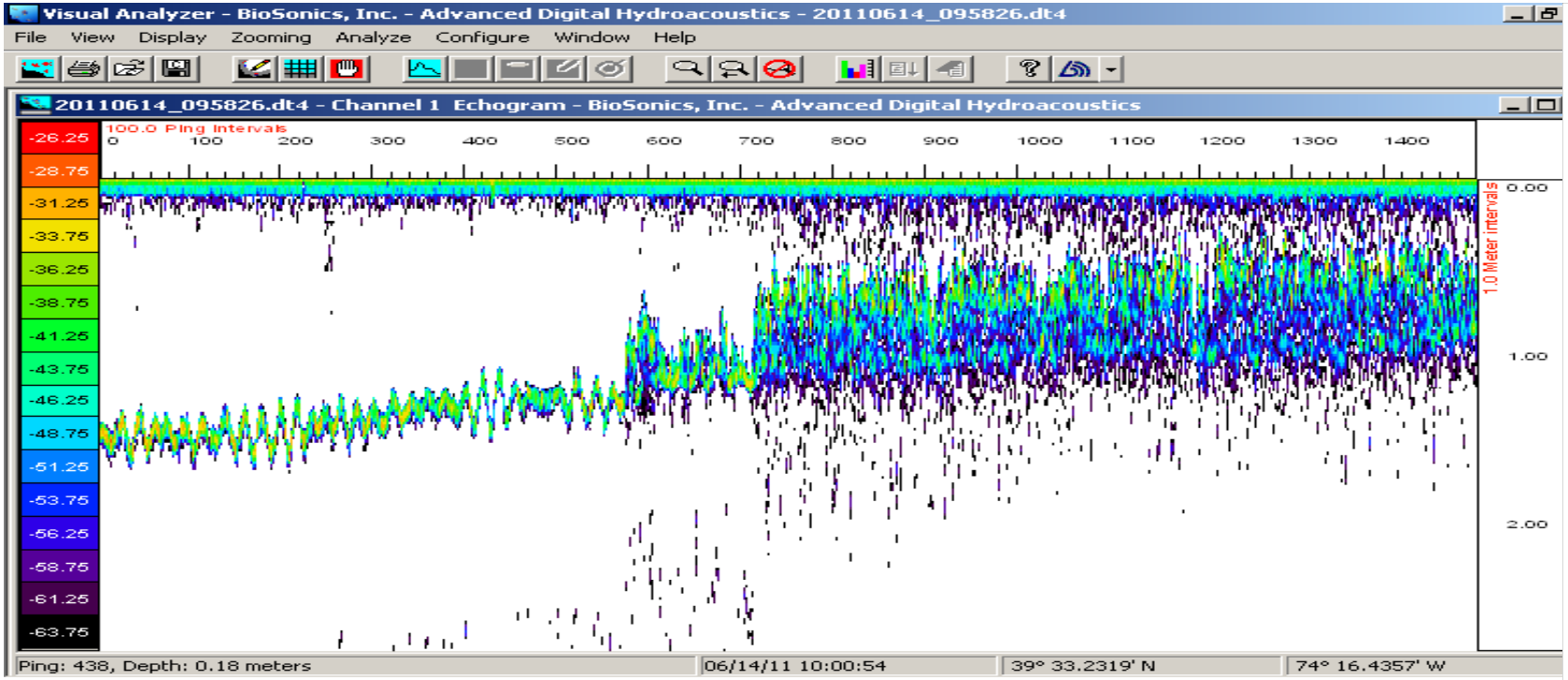
Testing Status (Sept. 2011)

Condition	location	species	finding
Tidal estuary	FL	Halidule wrightii	Detectable
	NJ	Zostera marina	Detectable
Freshwater lakes/rivers	WI	Myriophyllum spicatum	Detectable
		Potamogeton spp.	Detectable
		Vallisneria sp.	Detectable
		Elodea	Detectable
		Gratiola sp.	Detectable (>5 cm)

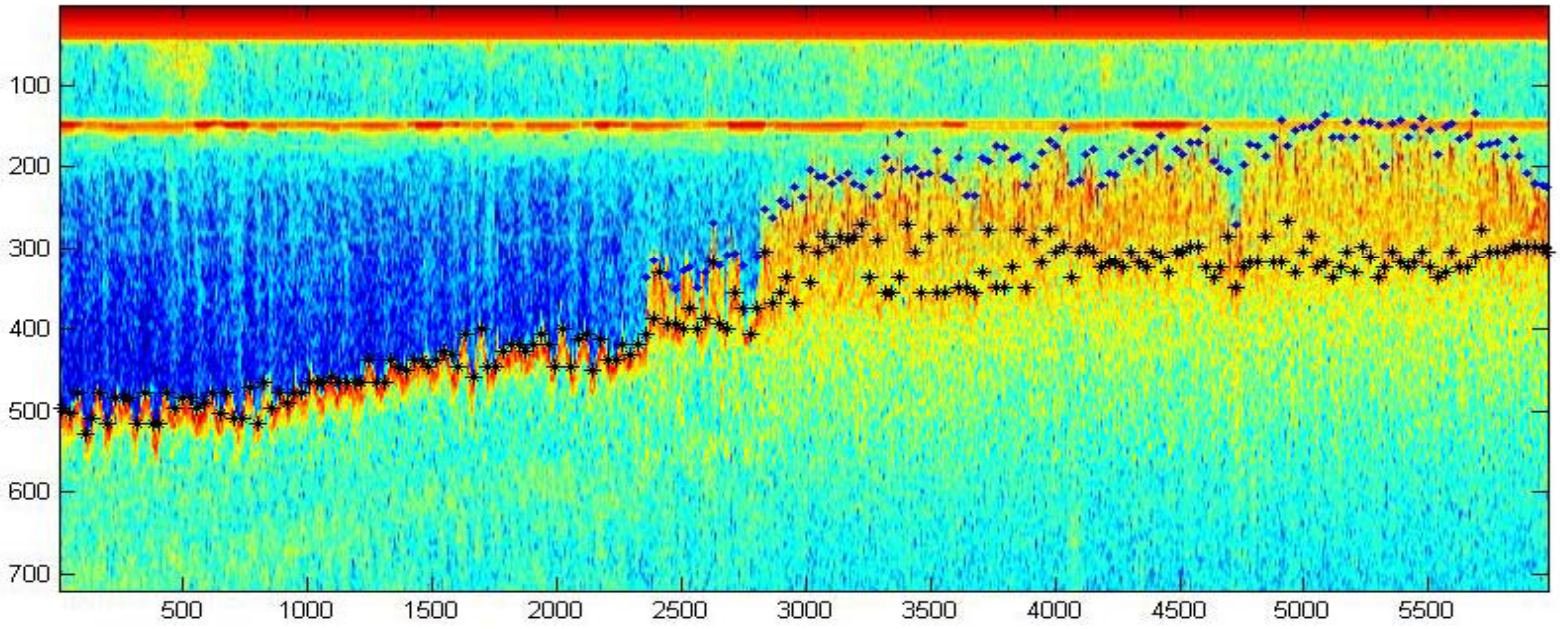
Validation Analyses in Progress

- Comparison with simultaneous Biosonic transects in Zostera (NJ)
- Comparison with Underwater Video (WI)
- Comparison with diver sampling (NJ)
- Sampling collaboration with SJRWMD (FL)



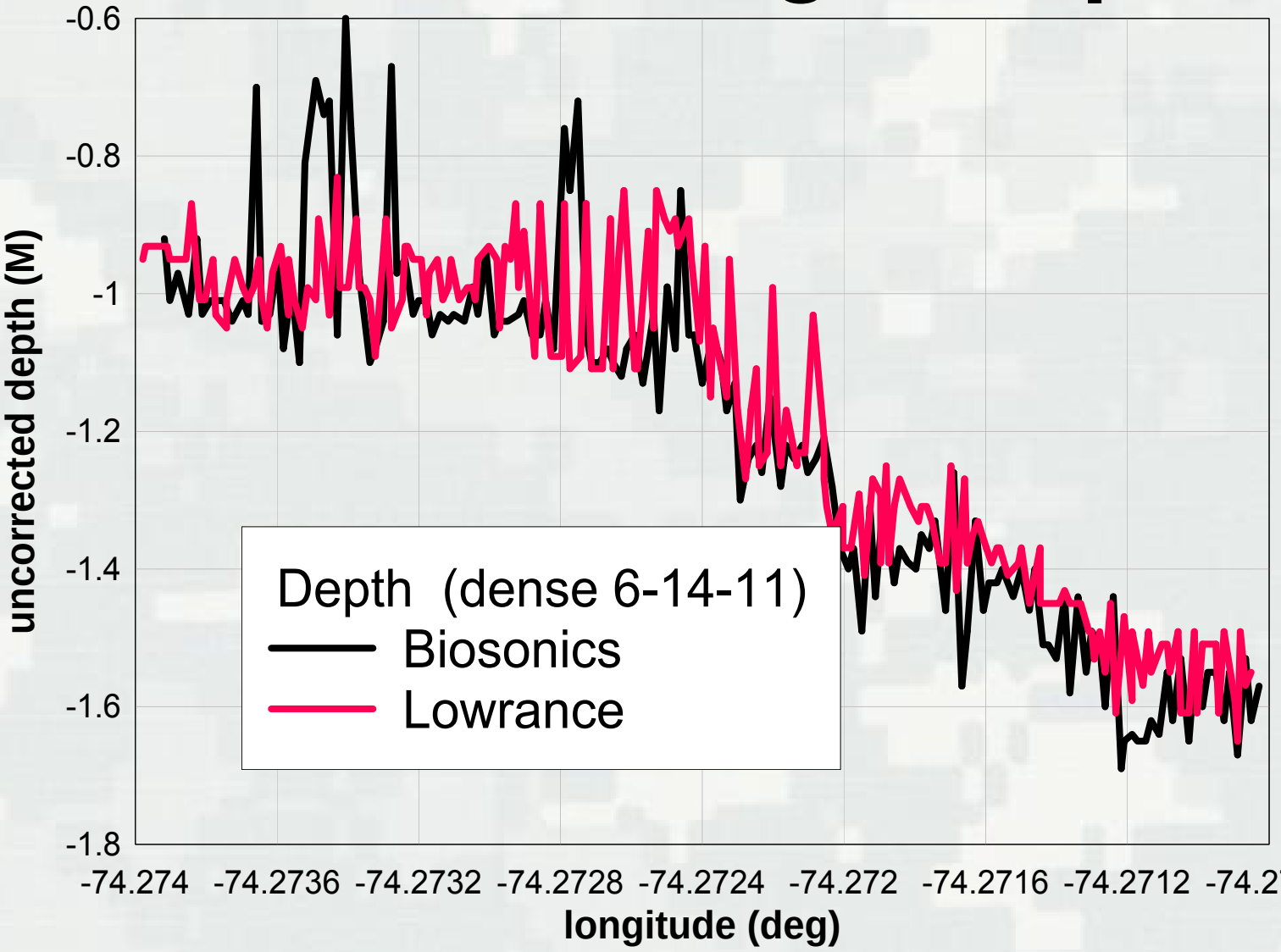


Biosonics DT-X

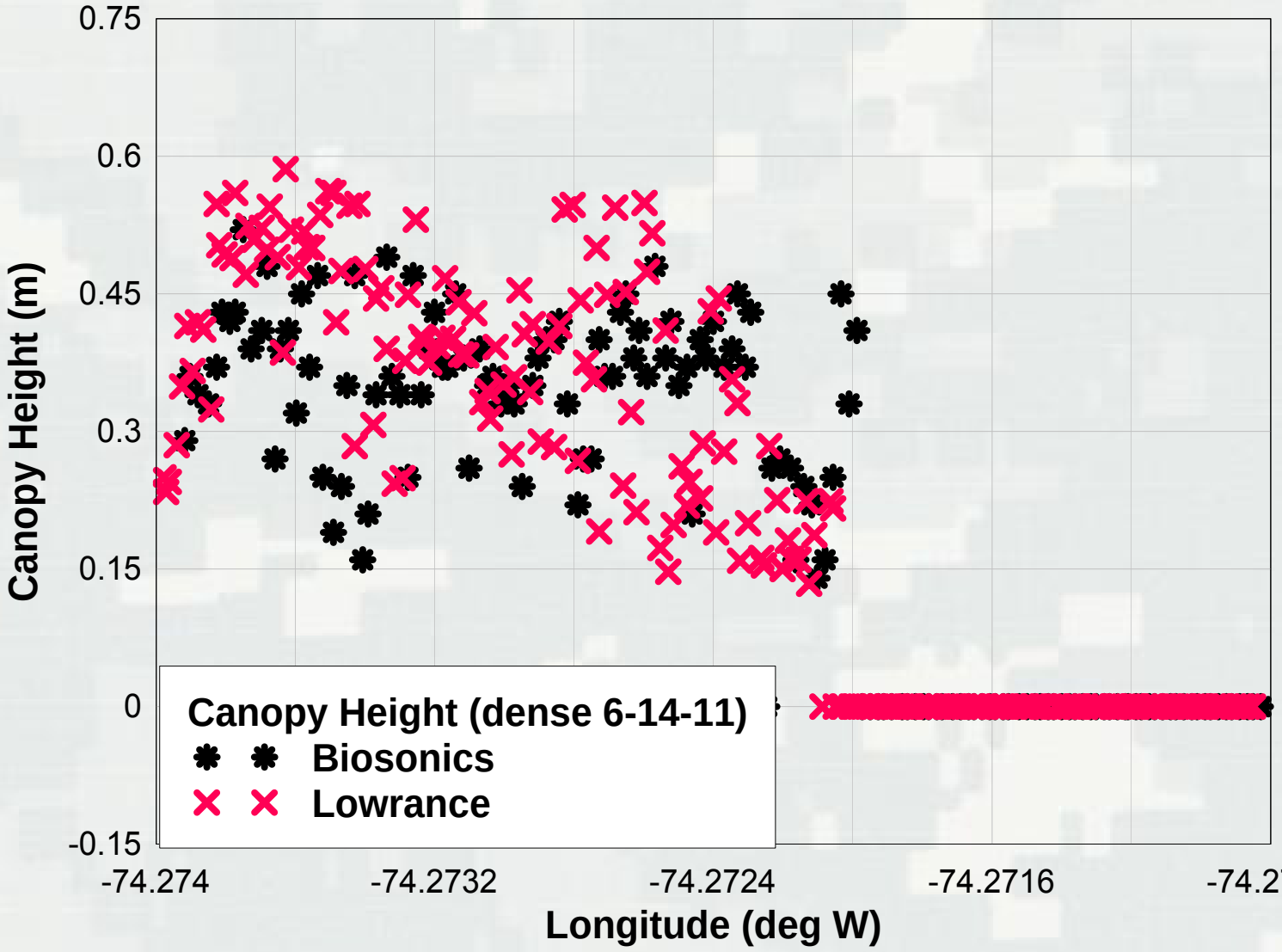


Lowrance HDS

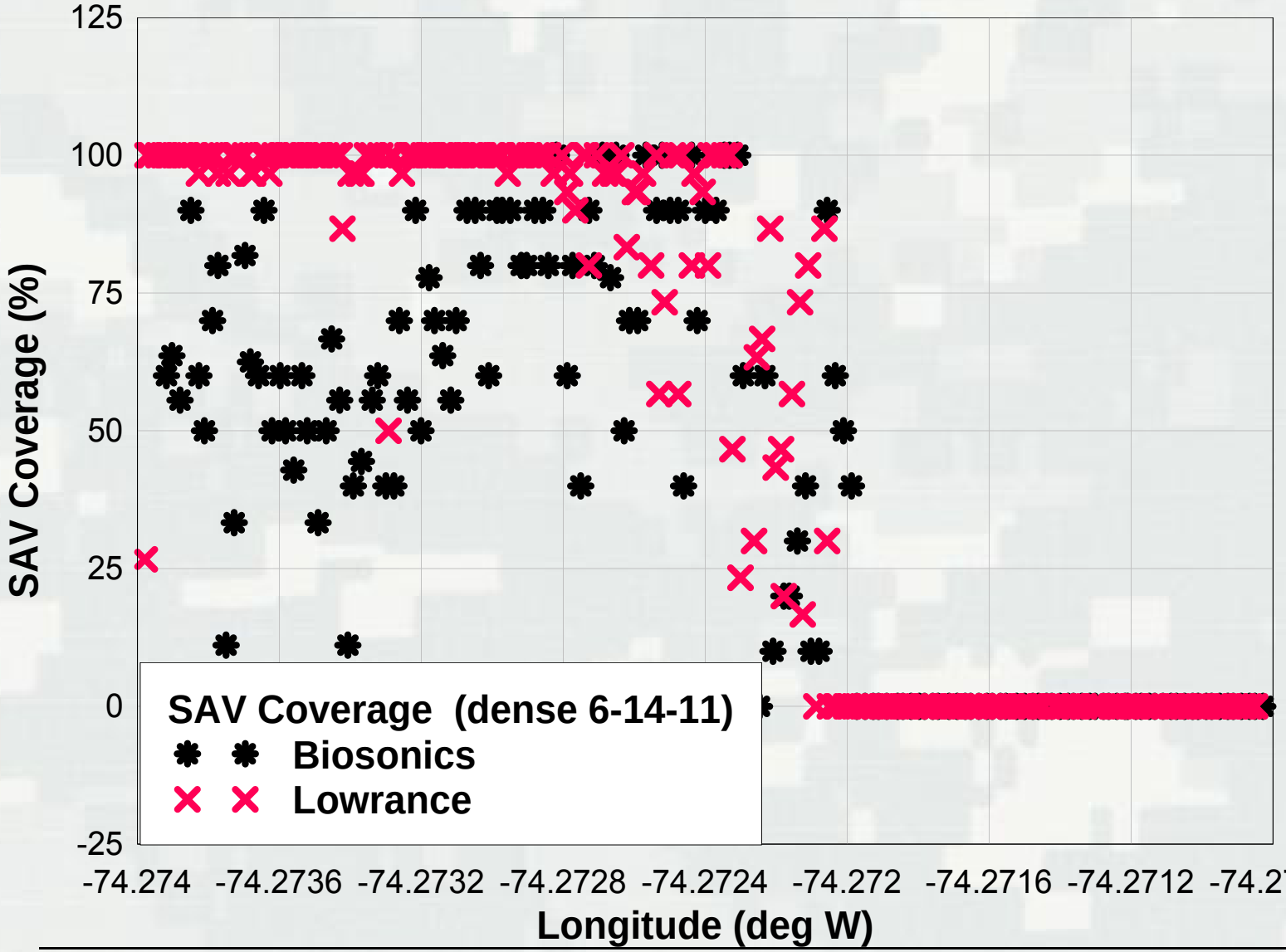
Bottom Tracking Comparison



Canopy Height Comparison



Coverage Comparison



Overall Project Status

Task	Description	Completion
Developmental testing	Analysis of species detectability and validation w/ other technques	May 2012
User manual	Guide for data collection and processing	June 2012
Beta release	Beta version available	June 2012
Training Class	Hands-on training in estuary and fresh water – New England District (31 July – 2 Aug 2012)	July 2012
Software release	Final version 1.0 release	Sept 2012

Product Availability

Item	Description	Cost
Echo sounder system	Lowrance components listed in User's Manual	$2,500-3,500 Your responsibility
Software	SAVEWS Jr. version 1.0	No cost
User Manual	Parts list, installation, configuration, data collection and processing procedures	No cost
Training	One class planned at New England District, 31 July- 2 Aug	Limited # no-cost slots at NAE*
Tech support	Guidance and discussion with developers	No cost, available through 30 Sept 2012

Contacts for Technical Support and Data File Sharing

Technical Support:

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Bruce.M.Sabol@usace.army.mil

Data File Transmittal:

https://safe.amrdec.army.mil/SAFE2/

Questions?