

THE APPLICATION OF CZMIL DATA TO THE PRODUCTION AND MAINTENANCE OF NAUTICAL CHARTS

A QUALITATIVE COMPARISON OF ACOUSTIC AND LIDAR BATHYMETRY AT
THE ISLE OF SHOALS, NEW HAMPSHIRE



THE UNIVERSITY OF
SOUTHERN
MISSISSIPPI

21 JULY 2016
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SILVER SPRINGS, MARYLAND
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OVERVIEW

BACKGROUND INFORMATION

METHODOLOGY

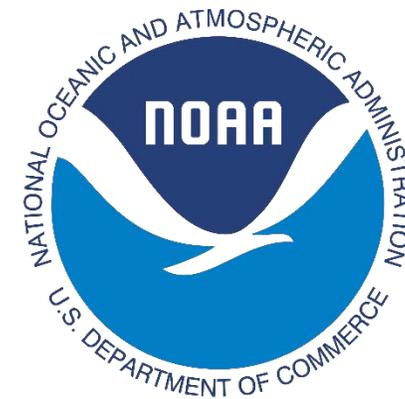
PRELIMINARY RESULTS

DISCUSSION & CONCLUSION





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&
DIVISION OF MARINE SCIENCES



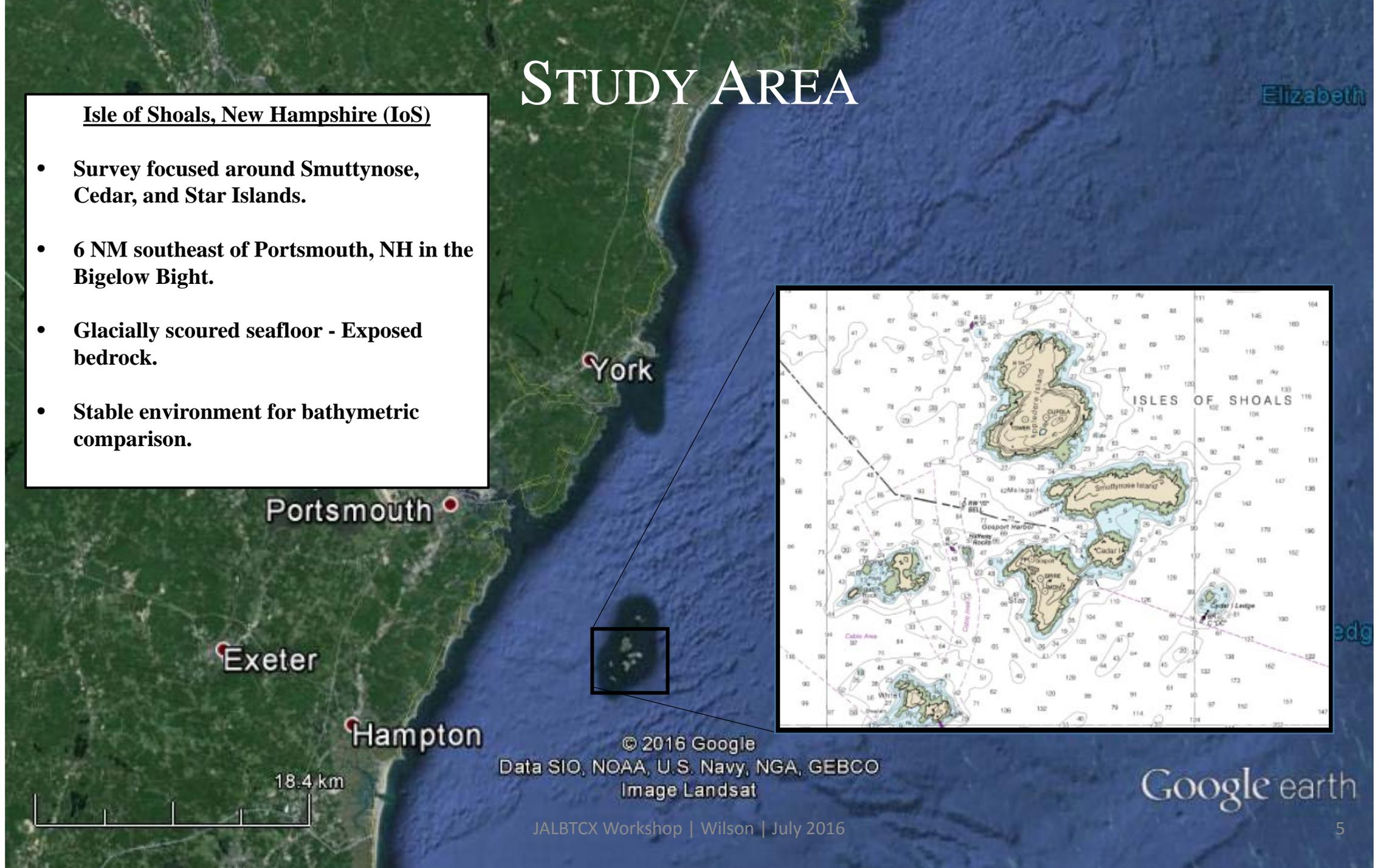
“Perform data analysis and comparison of CZMIL lidar data to multibeam data similar to data analysis done in the NOAA Technical Memo [NOS CS 32]”

“...to investigate several coincident ALB and acoustic surveys where differences are known to exist to ascertain the origin of these differences.”

STUDY AREA

Isle of Shoals, New Hampshire (IoS)

- Survey focused around Smuttynose, Cedar, and Star Islands.
- 6 NM southeast of Portsmouth, NH in the Bigelow Bight.
- Glacially scoured seafloor - Exposed bedrock.
- Stable environment for bathymetric comparison.



Elizabeth

edg



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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Google earth

COINCIDENT STUDY AREAS

University of New Hampshire 2009 Student Summer Survey

- Kongsberg EM3002 Dual-Head Multibeam System.
- Data received in Caris format.
- Survey Conducted to IHO Order 1A Standards.

JALBTCX/USACE 2014: CZMIL System Survey ID No. 4883

- Conducted using Coastal Zone Mapping and Imaging Lidar (CZMIL).
- Processed LAS point file data.
- Average point spacing of 1.5 meters per sounding.

USACE NCMS QUALITY LEVELS

- Total Vertical Uncertainty (TVU) specification for QLs 1-3 meet are equivalent to IHO Special Order Standard.
- TVU for QL4 is equivalent to IHO 1 for standard vertical accuracy.
- Defined in terms of a 95% confidence level (2σ).

$$\pm \sqrt{a^2 + (b * d)^2}$$

Bathy Lidar Quality Level	Source	Vertical accuracy coefficients a, b as in	Nominal Pulse Spacing (m)	Point Density (pt/m ²)	Example Applications
QL0	Bathymetric Lidar	0.25, 0.0075	0.7	2.0	Detailed site surveys requiring the highest accuracy and highest resolution seafloor definition; dredging and inshore engineering surveys; high-resolution surveys of ports and harbors.
QL1	Bathymetric Lidar	0.25, 0.0075	2.0	0.25	
QL2	Bathymetric Lidar	0.30, 0.0130	0.7	2.0	Charting surveys; regional sediment management. General bathymetric mapping; coastal science and management applications. Change analysis; deep water surveys, environmental.
QL3	Bathymetric Lidar	0.30, 0.0130	2.0	0.25	
QL4	Bathymetric Lidar	0.50, 0.0130	5.0	0.04	Recon/planning; all general applications not requiring higher resolution and accuracy.

Witmer et al., 2016

NOAA TM NOS CS 32

“ A Procedure for Developing an Acceptance Test for non-Hydrographic Airborne Bathymetric Lidar Data Application to NOAA Charts in Shallow Waters”

- Assess bathymetric lidar data shoreward of the navigable area limit (0 to 4 meters) and areas deeper than 10 meters.
- Four study areas containing significant overlap between Lidar and MBES surveys to determine lidar response.
- Statistical Analysis assumes MBES data as baseline.

OVERVIEW

- Background Information
- Methodology
- Preliminary Results
- Discussion & Conclusion



Image: Star Island. <http://kimbernard.blogspot.com/2013/09/star-island-retreat.html>

COMPARATIVE DATA SETS

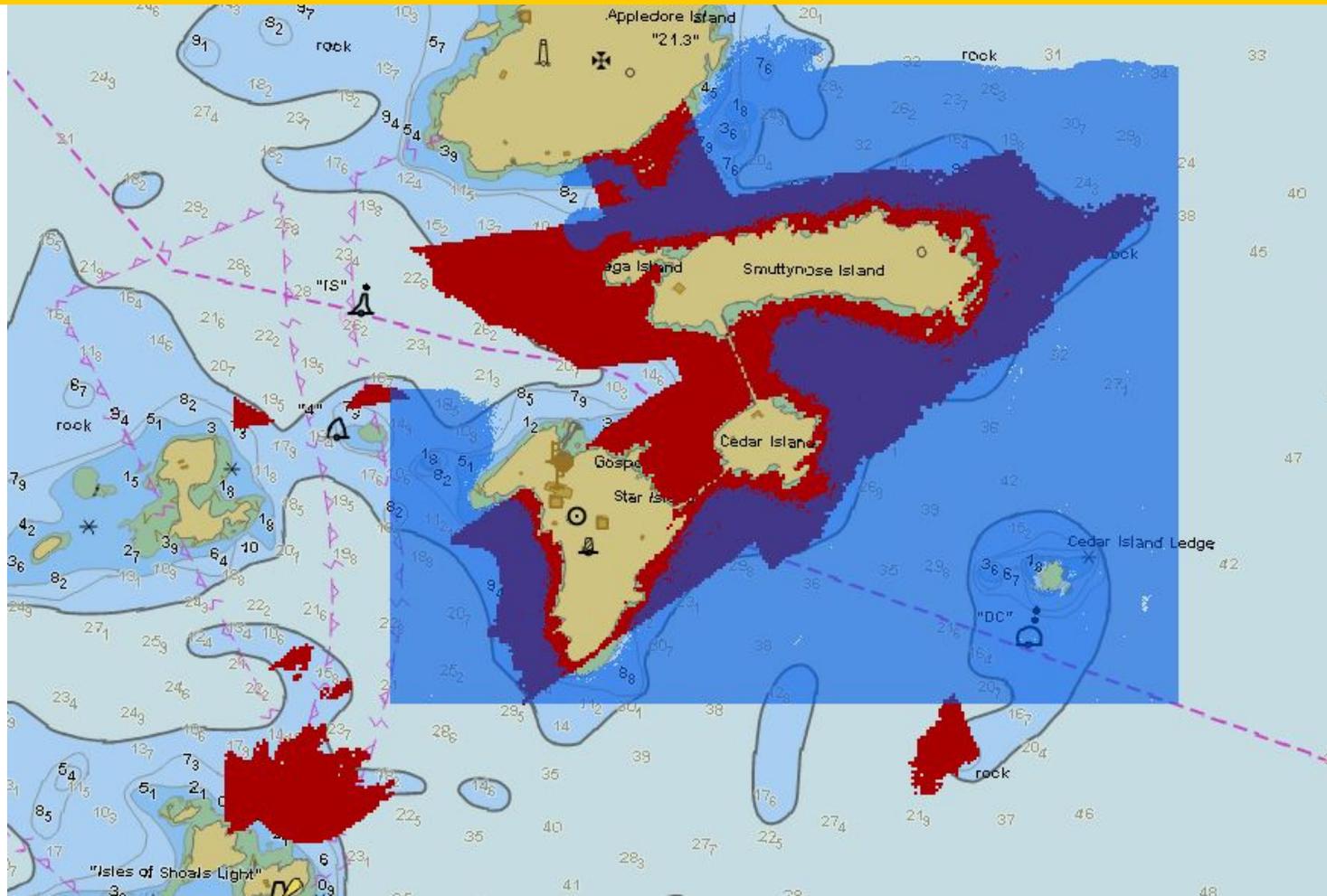
UNH 2009 MBES Data

- Processed CARIS data provided by UNH via the HSRC.
- Product for use in comparison:
 - Processed/Merged Survey Lines
 - Vertical Datum – MLLW
 - Horizontal Datum - NAD83 2007
 - Projection – UTM NAD83 Zone 19N

JALBTCX/ 2014 CZMIL

- NOAA NCMP online data viewer – LAS file containing point data.
- Product for use in comparison:
 - Point data
 - Vertical Datum – NAVD88
 - Horizontal Datum - NAD83 2011 GRS80
 - Geographic Coordinates

COMPARATIVE DATA SETS



- MBES Coverage Area
- Lidar Coverage Area
- Coincident Area

-Total Lidar coverage = 380,070 m²

-Coincident coverage = 178,466 m²

-48% Coincident Coverage

METHODOLOGY

Step 1

Vdatum to shift to MLLW (LAS file) → project to UTM NAD83 Zone 19N in Caris/ArcMap.



Step 2

Perform initial statistical comparison in Caris – Unfiltered Differencing.



Step 3

Apply Density Filter in ArcMap – Density Filtered Differencing.

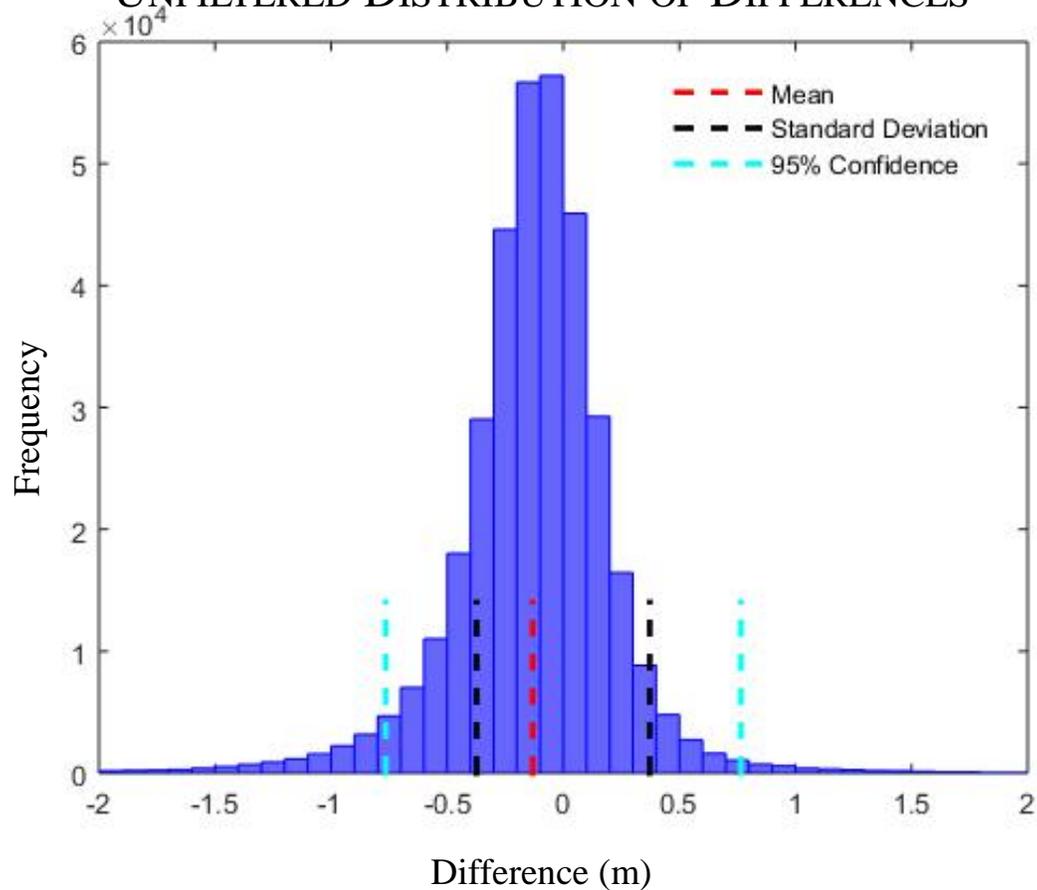


Step 4

Test differences against USACE NCMS TVU Allowances.

PRELIMINARY RESULTS

UNFILTERED DISTRIBUTION OF DIFFERENCES



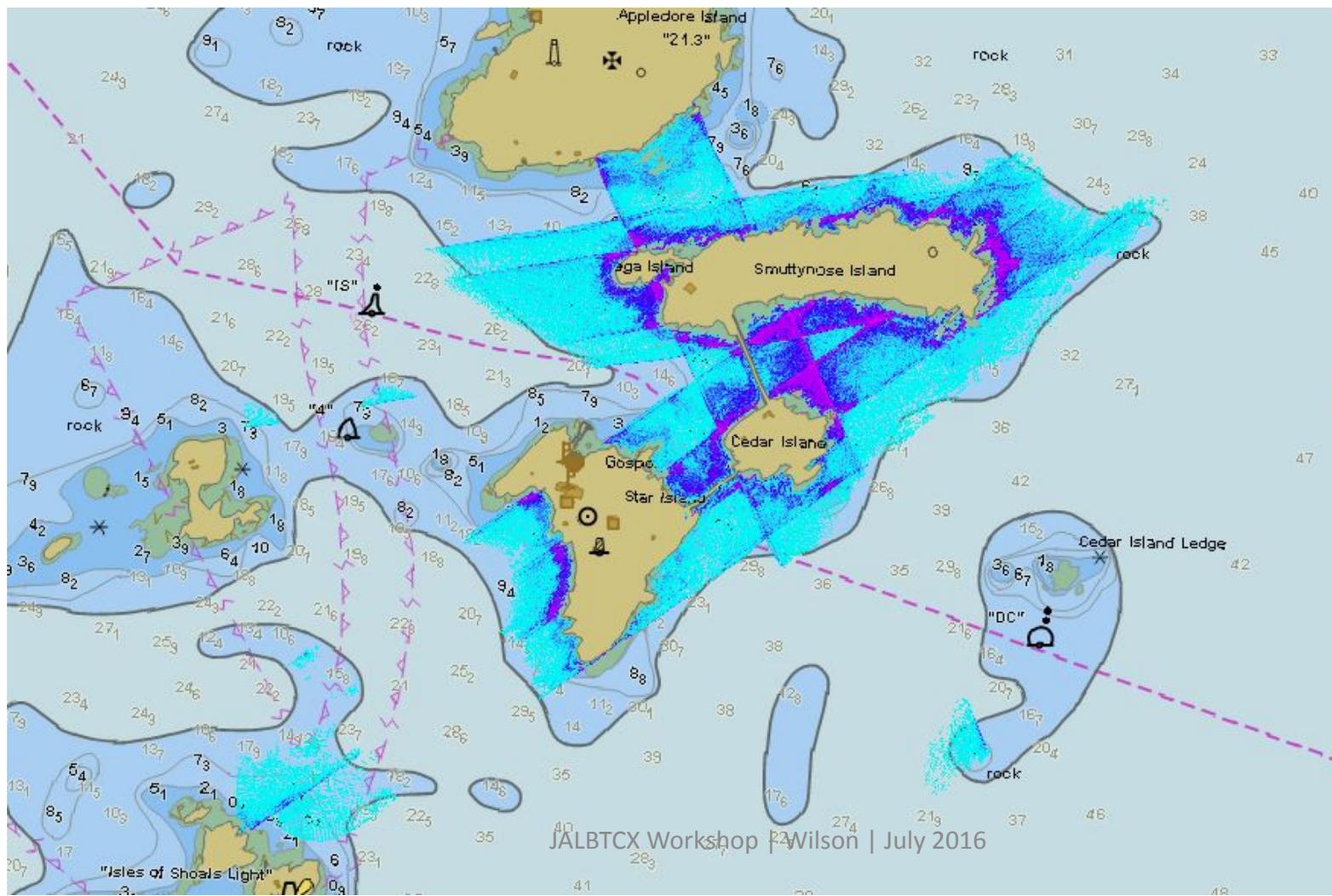
Unfiltered Comparison

Mean Difference = 0.13 m

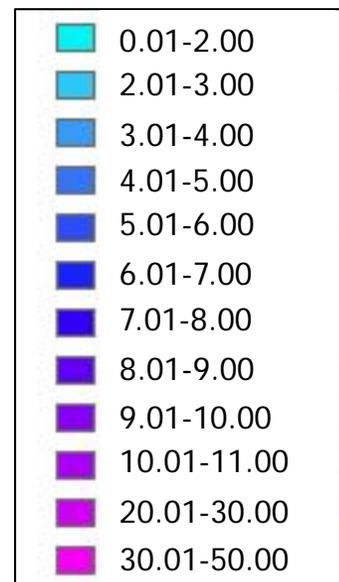
Standard Deviation = 0.37 m

95% C.I. = 0.77 m

PRELIMINARY RESULTS

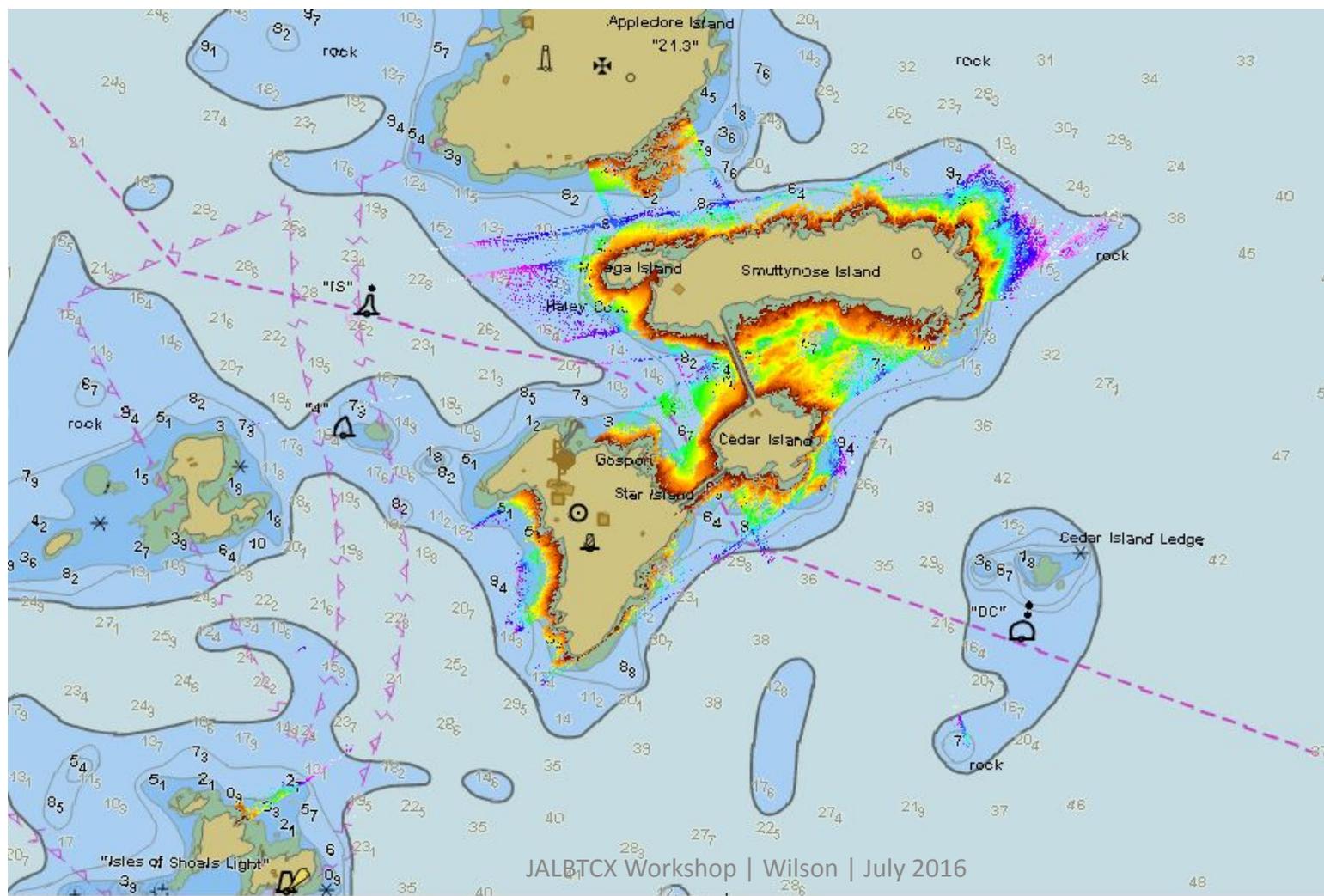


Density (pts/m²)

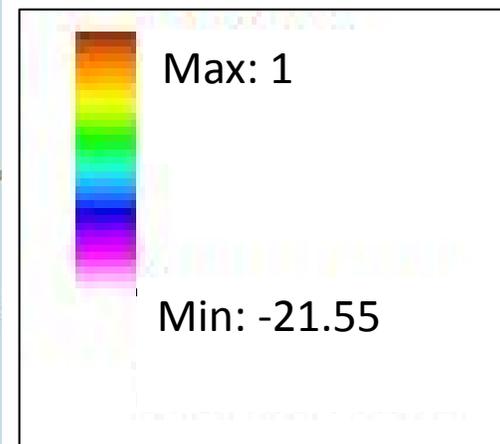


Coverage area = 178,466 m²

PRELIMINARY RESULTS



Elevation (m)

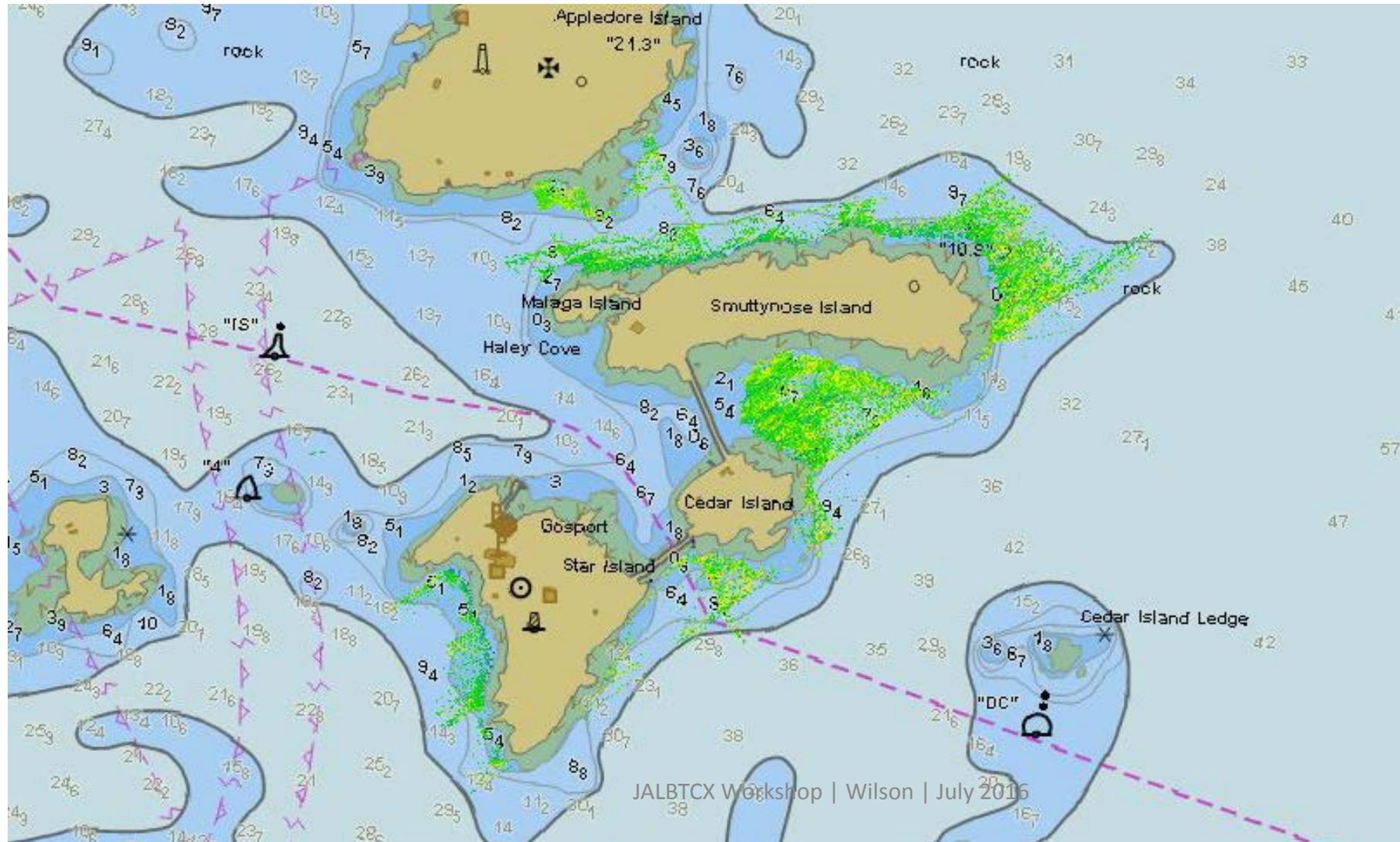


Coverage area = 85,997 m²

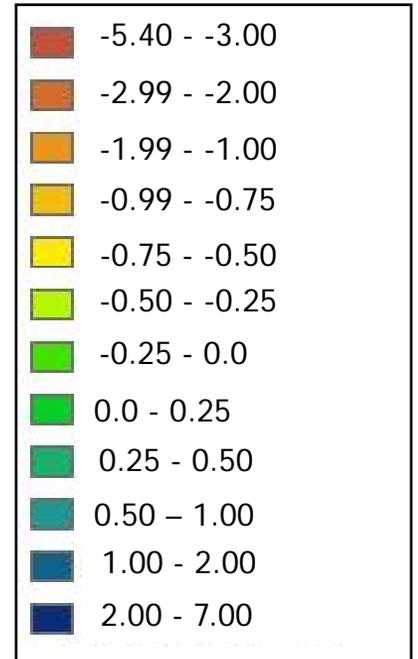
Coincidence = 48%

Avg Depth = 8.6 m

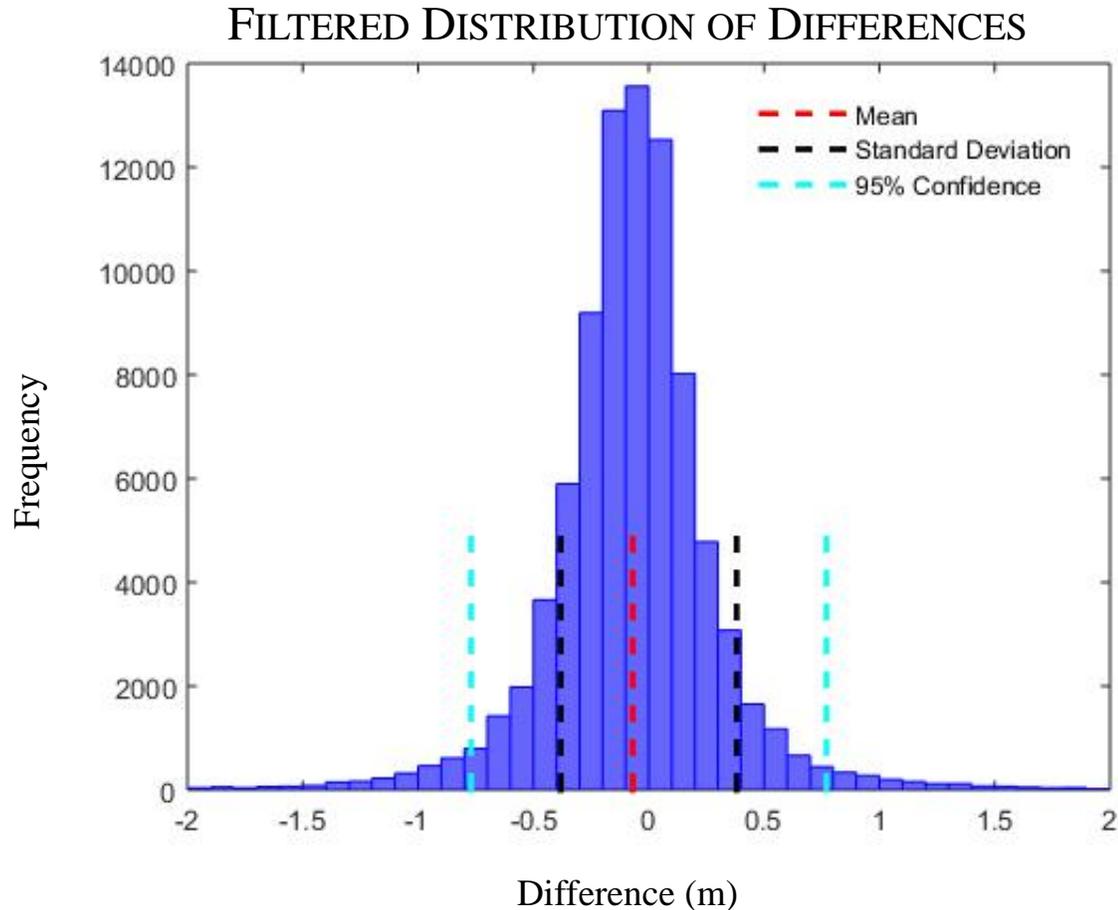
PRELIMINARY RESULTS



Difference (m)



PRELIMINARY RESULTS



Filtered Comparison

Mean Difference = 0.069

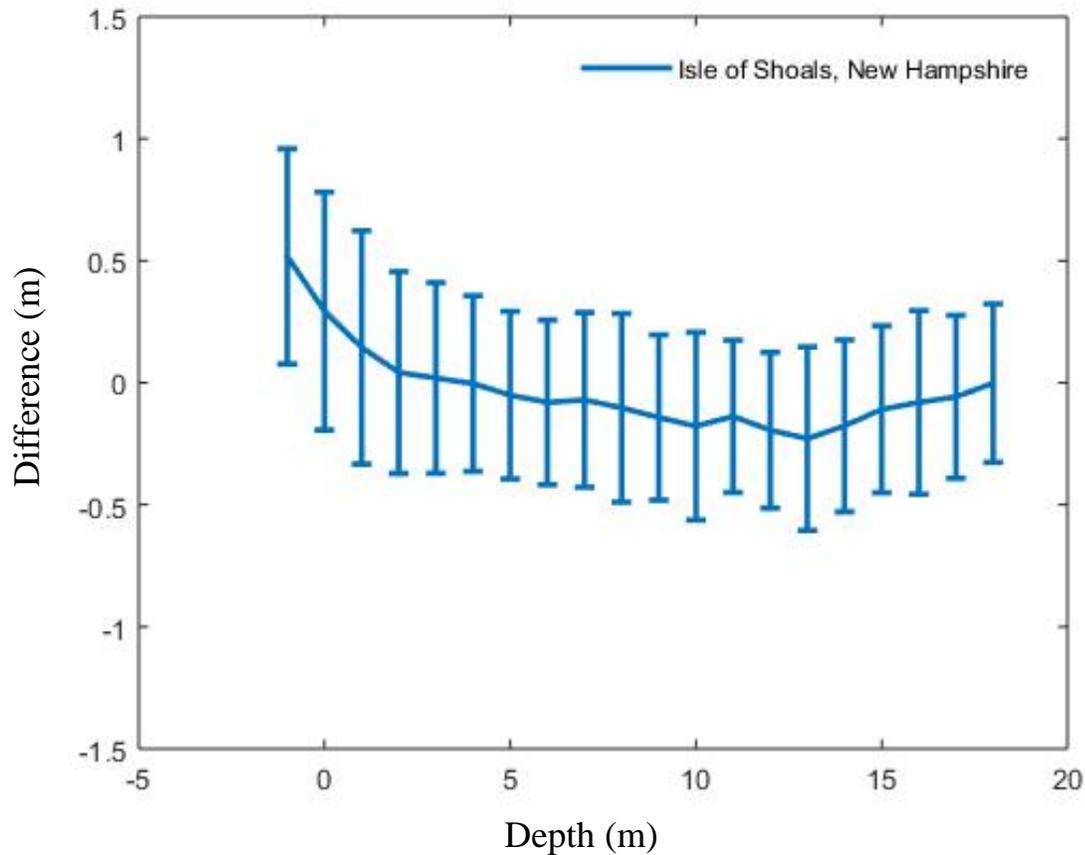
Standard Deviation = 0.38

95% C.I. = 0.77

*2.0 Points/Meter Filter Applied

PRELIMINARY RESULTS: NOAA COMPARISON

DIFFERENCE VS. DEPTH WITH ERROR BARS



DEPTH (M)	SAMPLES	MEAN DIFFERENCE	1σ
0	1082	0.29	0.49
2	4977	0.04	0.41
4	8021	0.00	0.36
6	6499	-0.08	0.39
8	5455	-0.10	0.39
10	4920	-0.18	0.38
12	5458	-0.19	0.32
14	2748	-0.18	0.35
16	1913	-0.08	0.38
18	200	0.00	0.32

*Vertical Datum MLLW

** Difference = MBES - Lidar

USACE TOTAL VERTICAL UNCERTAINTY COMPARISON

USACE Quality Level TVU						
Status	Mean Depth	Quality Level (QL)	Total Vertical Uncertainty	TVU Observed (2σ)	RMSD	TVU Obs-RMSD
1m Resolution & 2.0 Soundings/meter	8.6 m	0 / 1	0.26	0.77	0.069	0.70
		2 / 3	0.32			
		4	0.51			

- Last column assumes the RMSD a result of systematic error.
- 2σ value identical in unfiltered and filtered comparisons.
- 0.21 m from QL4/IHO Order 1.

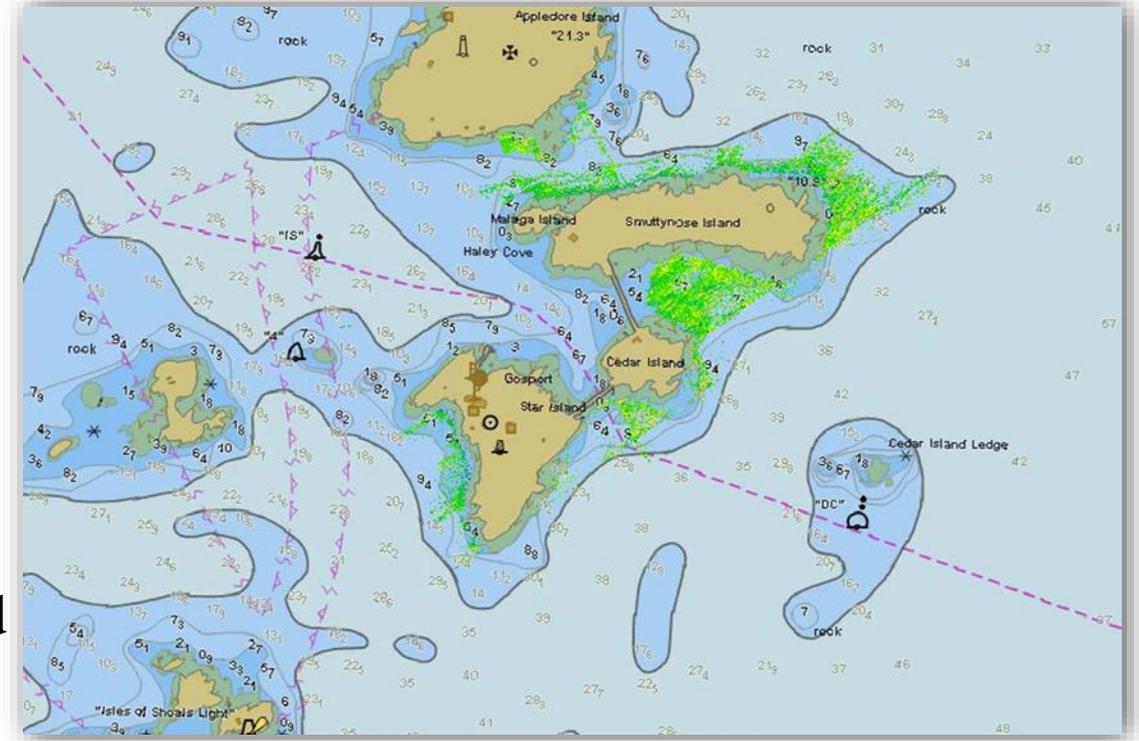
RESULTS

Study Area	Lidar/MBES Year Completed	RMSD(m)	Standard Deviation (m)
*Port Everglade, FL	2009/2008	0.54	0.27
*Kittery, ME	2007/2006	0.17	0.39
*Pensacola, FL	2009/2004	0.57	1.72
*Pensacola, FL	2010/2009	0.12	0.94
Isle of Shoals, NH	2014/2009	0.07	0.38

* Comparisons conducted in NOAA TM CS 32 (2013).

DISCUSSION

- 48% coverage capable of meeting density requirement NCMS QL2.
- Coincident survey areas display a RMSD of 6.9 cm.
- All studies show ALB deep bias.
- Changes in the seafloor are not considered with respect to TVU.



CONCLUSION

- Results support the accuracy postulated in the NOAA Technical Memorandum CS 32 2013.
- Further examination of CZMIL and MBES coincident surveys in different geophysical environments.
- An efficient way of identifying coincident CZMIL and MBES surveys.
- NCMS TVU formula for comparing accuracies across study areas.

THANK YOU,
QUESTIONS?

ACKNOWLEDGEMENTS

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