



NOAA's Use of Phase Differencing Bathymetric Sonar Technology to Survey the Western Sambos Ecological Reserve for Habitat Mapping and Charting Purposes

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Introduction:

The acquisition of bathymetric data in near-shore and very shallow water areas (i.e., <15m) is not efficient using current technologies that meet NOAA's Office of Coast Survey requirements for complete coverage surveys. Interferometric, or phase differencing, sonar systems provide a significant improvement in swath width in the shallow water environment. Preliminary studies have shown that the use of phase differencing bathymetric sonar (PDBS) technology enables more than double the areal coverage per time of that achievable with a typical single head multibeam echosounder while simultaneously improving overall safety of operations by allowing the survey vessel to stand further off of hazards and obstructions without sacrificing coverage (Gostnell and Yoos, 2006).

Based on the successful test and evaluation of several commercially available PDBS systems NOAA has moved forward with the procurement and integration of phase differencing technology into its suite of nautical charting hydrographic survey tools. Two Teledyne Benthos C3D phase differencing sonar systems were delivered to NOAA during the 2006 field season. A number of technical issues related to data acquisition and processing were encountered and overcome during the acceptance testing and integration process and will be discussed in more detail in a later paper.

Following software refinement and system integration, phase differencing bathymetry data were successfully acquired in Solomons, Maryland over NOAA's sonar testing study site as well as in the Elizabeth River along the Norfolk, Virginia waterfront area as part of a demonstration survey. The results of both of these studies were very promising, showing the successful resolution of features as small as 1m³. Based on these results, NOAA has moved forward with the deployment of two C3D systems; one aboard Navigation Response Team 7's vessel (S3004) and one aboard NOAA Ship RAINIER's shoreline survey launch RA-6. Operational evaluation will be conducted during the 2007 field season while acquisition and processing software refinement continues.

Operational Demonstration:

The first operational demonstration project utilizing the C3D is scheduled to take place aboard NRT-7 in April 2007. The project is a collaborative effort between the Office of Coast Survey (OCS) and the National Center for Coastal and Ocean Science (NCCOS) and will cover an area of approximately 13 square nautical miles (snm) to provide data to update the nautical charts in the area as well as critical information on the benthic habitat within the coral rich region. There is also the possibility that lidar will be acquired over the same region which would allow for a comparison of the utility of the two technologies for object detection and habitat mapping as well as efficiency and cost per area.

Due to the timeframe for the project being during the month of April 2007 and the submission deadline for papers to the 2007 US Hydrographic Conference being the end of March 2007 this paper describes the plan for the project but does not include any results; preliminary results will be provided in the accompanying presentation at the conference.

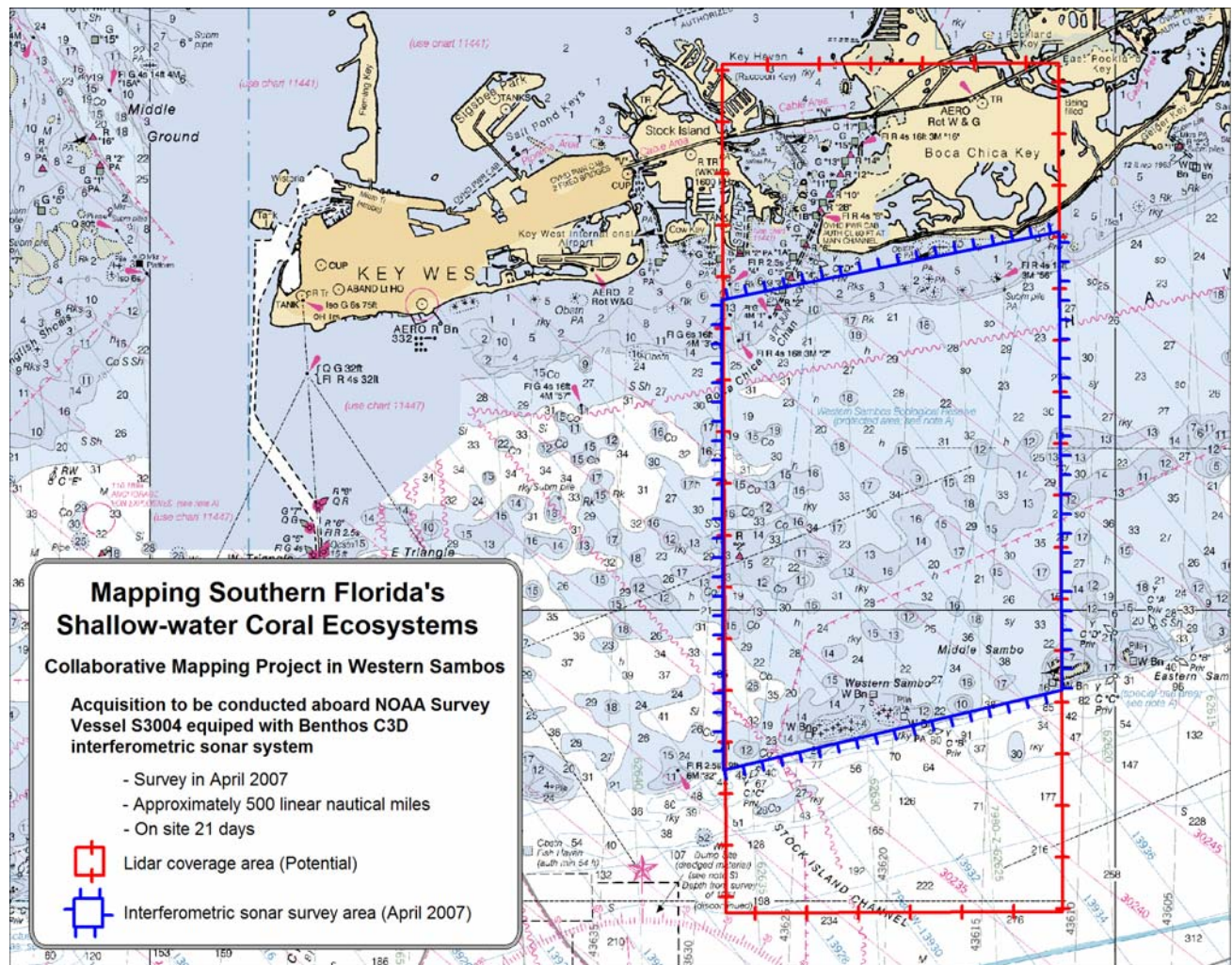


Figure 1 – Project area south of Boca Chica Key to be used for operational testing of the C3D phase differencing bathymetric sonar. The project area covers a region of ~ 13 snm including the Western Sambo Ecological Reserve and includes a number of coral reefs. Depths shown in feet.

Methods:

The project area (Figure 1) encompasses a region of approximately 13 nm running from the southern edge of Boca Chica Key, Florida to the edge of the reef with depths ranging from approximately 0 – 10m. The shoalness and variability of depth due to the preponderance of coral reefs in the area make this site an excellent operational testing ground for the C3D.

The area will be divided into prioritized quadrants with the highest priority being in the southwest corner and proceeding counter clockwise around to the northwest corner. Data will be acquired aboard NRT-7 (Figure 2), which is equipped with a C3D phase differencing sonar for bathymetry and imagery, an Odom single beam echosounder for quality control comparison of depths, and an Applanix POS/MV v4 for vessel motion and positioning. Additionally, a Seabird SBE19plus will be used for measuring sound speed profiles to compensate for refraction in the water column and an Odom DigibarPro will be used to ascertain sound speed at the sonar head to ensure accurate calculation of launch and return angles from the C3D.



Figure 2 – The NRT-7 vessel, S3004, is a 29' aluminum hulled SeaArk and is equipped with state of the art hydrographic survey equipment. Note the pole mounted C3D phase differencing sonar.

Lines will be run with 60m line spacing with the C3D operated at a 75m range scale with concurrent single beam echosounder. This will provide for 200% side scan sonar coverage and near to complete bathymetric coverage. Holiday lines will then be run to fill in the holidays in bathymetry. Concurrent operation of the C3D and the Odom will enable quality control

comparisons between the C3D bathymetry and single beam echosounder depths. This will provide for the submission of a 200% side scan sonar with single beam depths submission for charting. If the mainscheme C3D bathymetry is determined to be acceptable for charting purposes a complete coverage bathymetric grid will be produced for charting. All data will be processed in Caris HIPS/SIPS using NOAA standard processing techniques.

Discussion:

Having tested several phase differencing sonar systems with promising results in 2004 and 2005 it was deemed appropriate for NOAA to procure a system to enable in-house integration and operational testing in 2006. After a competitive selection process the Teledyne Benthos C3D system was chosen for procurement. The first of two systems was delivered in May 2006 and the second was delivered in September 2006. A significant amount of work went into software refinement and system integration between May 2006 and present and the systems now appear ready for operational testing aboard NOAA hydrographic survey vessels.

It is hoped that the system deployed aboard RA-6 will significantly improve the safety of operations in the nearshore regions of Alaska by enabling the vessel to remain farther offshore while still attaining adequate coverage. The system deployed on NRT-7 will be used for shallow water hydrography in the Chesapeake Bay and for post-hurricane mapping requirements. The system on NRT-7 will also be used for collaborative Integrated Ocean and Coastal Mapping projects such as the one in the Western Sambos. It is hoped that both systems will significantly improve safety of operations in the near-shore region while simultaneously increasing efficiency in shallow water areas.

It is anticipated that additional minor bugs in the system software will be found during operational use and Benthos has pledged to address any issues as they arise. Further effort is still required to refine the data filtering portion of data processing and this work will continue during the 2007 field season.

Acknowledgements:

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Reference:

1. Gostnell, Caleb and Jake Yoos. 2007. *NOAA Test and Evaluation of Interferometric Sonar Technology*. The Hydrographic Journal. 123():3-8.