Multibeam Sonar Analysis of Marine Habitats in the Dry Tortugas

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Abstract:

The Dry Tortugas, a group of islands 70 miles west of Key West, Florida, is home to more than 450 species of fish, a diverse coral reef ecosystem, and a variety of endangered sea turtle species. The Dry Tortugas' geomorphology, consisting of corals and carbonate sands, plays a major role in the habitat in which these fish and other species live. This study will focus on what effect the underlying bathymetry has on the ecosystem.

Methods:

- The data were collected on the NOAA Ship *Nancy Foster* using a Kongsberg EM1002 multibeam system.
- Data were collected separately in 2009 and 2011 by scientists from the NOAA Florida Keys National Marine Sanctuary.
- Sonar data were analyzed using CARIS HIPS 7.1 software to create Base Surfaces as well as GeoBars and Backscatter Mosaics.

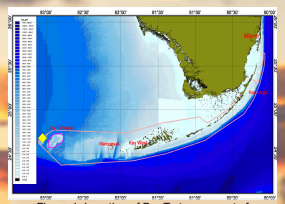


Figure 1: Location of Dry Tortugas, west of Key West, Florida. (Photo: Jerald Ault et al.)

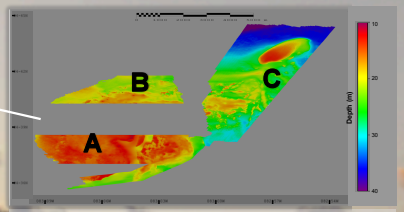
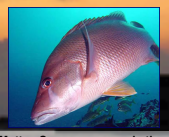


Figure 2: Overall Area of Study located off the coast of Dry Tortugas National Park. The depth range is from 10 to 40 meters. Study Areas A, B and C are detailed in Figures 3-6 at right and below.

Elkhorn Coral (Photo Credit: NOAA)



Mutton Snapper spawns in the Dry Tortugas reefs (Photo: Florida Keys National Marine Sanctuary)

Black Grouper (Photo: Florida Keys National Marine Sanctuary)

Background

Location: Florida on the Eastern Gulf of Mexico

- Area: 308 km^2, 27 x 12 km, roughly 12 to 20 meters deep, consists of 7 islands
- The composition of the islands is primarily unconsolidated Holocene sand, carbonates, and coral/algal debris (Moretzsohn et al., 2012).
- Dominant genera of coral include *Diploria, Montastraea,* and *Siderastrea.*

Importance of Reef:

- The Florida Current travels northward carrying larval fishes and invertebrates which live in the reefs and corals of the Keys. The primary reason to study the bathymetry of the Dry Tortugas is to better understand why this location is chosen as the spawning ground of so many fish species.
- NOAA scientists from the Florida Keys National Marine Sanctuary are studying the Dry Tortugas, examining fish behavior in different habitats by studying an area close to the bottom of the coral reef and sandy floor near to the area mapped in this project.

References:

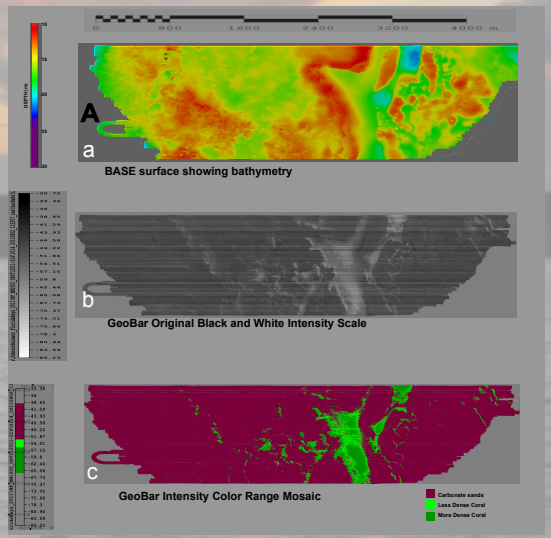
•F. Moretzsohn, J.A. Sánchez Chávez, and J.W. Tunnell, Jr., Editors. 2012. GulfBase: Resource Database for Gulf of Mexico Research. World Wide Web electronic publication. http://www.gulfbase.org, 18 March 2012.

•Jerald Ault, Natalia Zurcher, and Erik Franklin. *A Strategy for Managing Marine Ecological Resources in Dry Tortugas National Park*. University of Miami, June 2004.

•Nancy Diersing. "Reef Fish in the Tortugas Ecological Reserve". Florida Keys National Marine Sanctuary, NOAA, October 2011.

• Precht, W.F. and S.L. Miller. 2007. Ecological Shifts along the Florida Reef Tract. R. B. Aronson (Editor). Chapter 9: 237-312. Springer, NY.

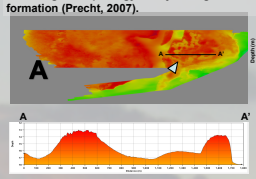
Figure 6: Comparison of (a) bathymetry, (b) GeoBar Intensity, and (c) classification mosaic for Study Area A. See Results for explanation.



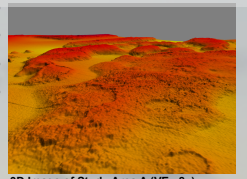
Results and Discussion

- Study Area A (Fig. 6a) was chosen for more intensive focus because the data were the most recently collected (2011) and the survey lines were the most dense.
- The backscatter mosaic generated (Fig. 6b) indicates where the coral reefs are located in the area which can be used to pinpoint spawning grounds for certain species.
- GeoBar analysis of backscatter shows harder objects that record a higher intensity return of the acoustic signal (for example coral would have a higher intensity than sand) in the above Geobar Intensity Color Range Mosaic (Fig. 6c), the two shades of green suggest coral composition.
- Study Area B (Fig. 4) shows how the distribution of corals can be spread out (200 m). They can also be clustered together as shown in Study Area C (Fig. 3, 3D image).
- Study Area C (Fig. 5) shows clusters of fairly flat-topped corals (Fig 5a). Study Area C also reveals a large flat formation with 15 m of relief near the edge of a steep drop off (Fig. 5a). Comparison of biota inhabiting these sections could be conducted to examine how marine species vary from middle of coral reef clusters to the outskirts of where the reef drops off.

Figure 3: Study Area A data were collected in 2011. This area shows the typical, relatively flat, shallow geomorphology of Dry Tortugas. Flat tops may be an indicator of water depth at formation (Precht, 2007).

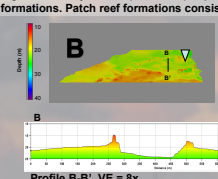


Profile A-A': Reveals semi-flat tops of the coral reefs. (VE= 58x)



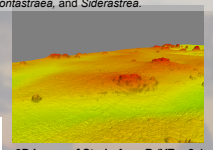
3D Image of Study Area A (VE= 8x). (Triangle on map indicates direction of view.)

Figure 4: Study Area B (2009 data) depicts the large (up to 200 m) gap between patch reef formations. Patch reef formations consist of *Diploria, Montastraea,* and *Siderastrea.*



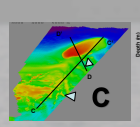
Profile below reveals two isolated patch reef formations.

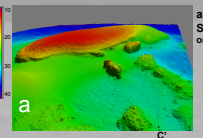
Profile B-B'. VE = 8x



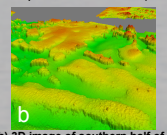
3D Image of Study Area B (VE = 8x). (Triangle on map shows direction of view.)

Figure 5: Study Area C (2009 data) has a large flat topped formation bordered by a fairly steep drop off with 15 m of relief.

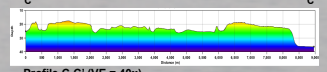




a) 3D image of northern half of Study Area C (VE = 8x). (Triangle on map shows direction of view.)

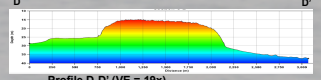


b) 3D image of southern half of Study Area C (VE = 8x). (Triangle on map shows direction of view.)



Profile C-C' (VE = 40x)

C-C' shows cross section of flat topped coral formations. D-D' depicts cross section of massive coral formation near edge of steep drop off.



Profile D-D' (VE = 19x)

Conclusions:

- Dry Tortugas' flat coral formations at various depths are likely to be responsible for diverse marine ecosystem.
- The steep drop off observed at Study Area C would be a good single location to research a wide range of marine habitats.

Future Study:

- Create an intensity color range map for the entire region to document the extent of the coral habitat.
- Compare mosaics to newer data if possible to observe potential changes.

Acknowledgements:

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