

Bathymetric Analysis of Coral Reef Habitat in the Florida Keys National Marine Sanctuary

Morgan L. Shuman and Dr. Leslie Sautter, Department of Geology and Environmental Geosciences, College of Charleston, Charleston, SC

ABSTRACT

In September 2009, multibeam sonar data were collected aboard the NOAA Ship NANCY FOSTER throughout the Florida Keys National Marine Sanctuary. The three sites surveyed during the September cruise are located southeast of Vaca Key, south of Key West, and west of Dry Tortugas.

The focus of the investigation was to provide coastal managers with information concerning coral reef habitats, fish populations, and natural resource distribution, to assist with NOAA's Marine Spatial Planning initiative. CARIS HIPS 7.0 software was used to process bathymetric data that were collected using a SIMRAD EM1002 multibeam sonar data acquisition system. Water depths range between 12 and 120 m with reef habitats located in waters shallower than 30 m at the Dry Tortugas site. Numerous scientific dives were conducted to assess fish populations and reef biodiversity. Ongoing explorations are necessary west of Dry Tortugas to monitor the effect of preservation on reef habitats.

BACKGROUND

The Tortugas Ecological Reserve (TER), effective since July 1, 2001, is a comprehensive plan developed by the National Park Service and NOAA as part of the Florida Keys National Marine Sanctuary, designed to protect the biodiversity of the region. The TER covers 90 square nautical miles and is designated as a "no-take" area to protect grouper and snapper populations that are susceptible to endangerment.

The 2009 Dry Tortugas expedition aboard the NOAA Ship *Nancy Foster* was led by scientists from NOAA's Center for Coastal Fisheries and Habitat Research from September 22-30 in three areas in southern Florida (Figure 1): west of Dry Tortugas (Figure 2), south of Key West (Figure 3), and southeast of Vaca Key (Figure 4). The cruise consisted of multibeam sonar analysis used to record the bathymetry of the TER, as some areas had not been mapped previously (Figure 5). Additionally, over 30 scientific dives were employed for the purpose of characterizing reef ecosystems and monitoring fish populations. The goliath grouper (*Epinephelus itajara*) and mutton snapper (*Lutjanus analis*) can be used to indicate the health of the ecosystem, as these fish were rarely spotted in this area before the enactment of the TER due to overfishing (NOAA). These grouper and snapper populations flourish in reef and hard bottom habitats in shallow waters (Florida Museum of Natural History, Smithsonian Marine Station).

RESULTS

- Key West (Figure 3) and Vaca Key (Figure 4) are gently sloping areas with no carbonate structures present.
- Dry Tortugas (Figure 2) has a variety of bathymetric features between 12 and 26 m. Figure 7(A) and Figure 7 (Profile 1) depict coral pinnacles across a gently sloping area. Figure 7(B) and Figure 7 (Profile 2) illustrate carbonate mounds that are present throughout a large portion of the region surveyed. A deep depression is also noted in Figure 7 (Profile 2). Figure 7(C) and Figure 7 (Profile 3) illustrate the variety of features found in the area, depicting more carbonate mounds and depressions. Figure 7(C) is located atop a large platform that likely extends southward below the study area.
- The bathymetric features present west of Dry Tortugas are ideal habitats for adult snapper and grouper populations (Florida Museum of Natural History, Smithsonian Marine Station)
- The NOAA crew reported an increase in goliath grouper (Figure 8A) and mutton snapper sightings since the early 2000's before enactment of the TER.

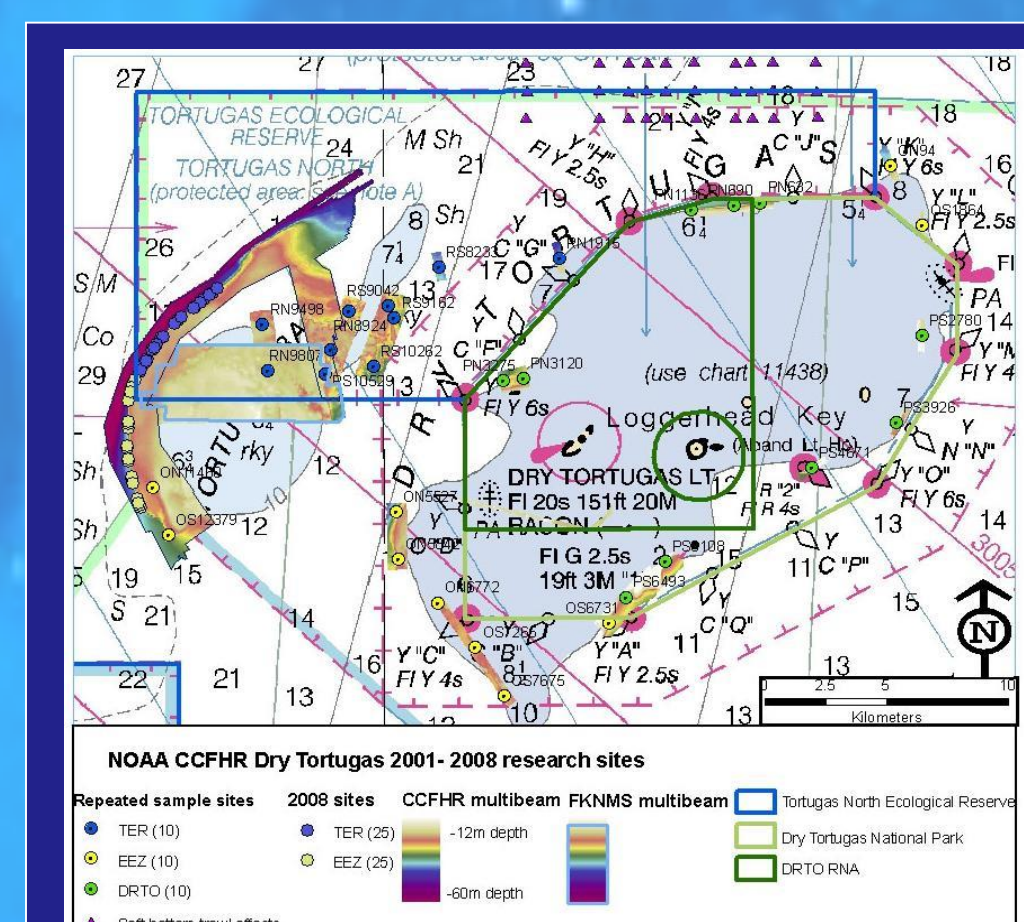


Figure 5. NOAA map showing the regions surveyed with multibeam sonar between 2001 and 2008. The Tortugas Ecological Reserve is outlined in blue, illustrating that over half of the TER has not yet been mapped by NOAA.

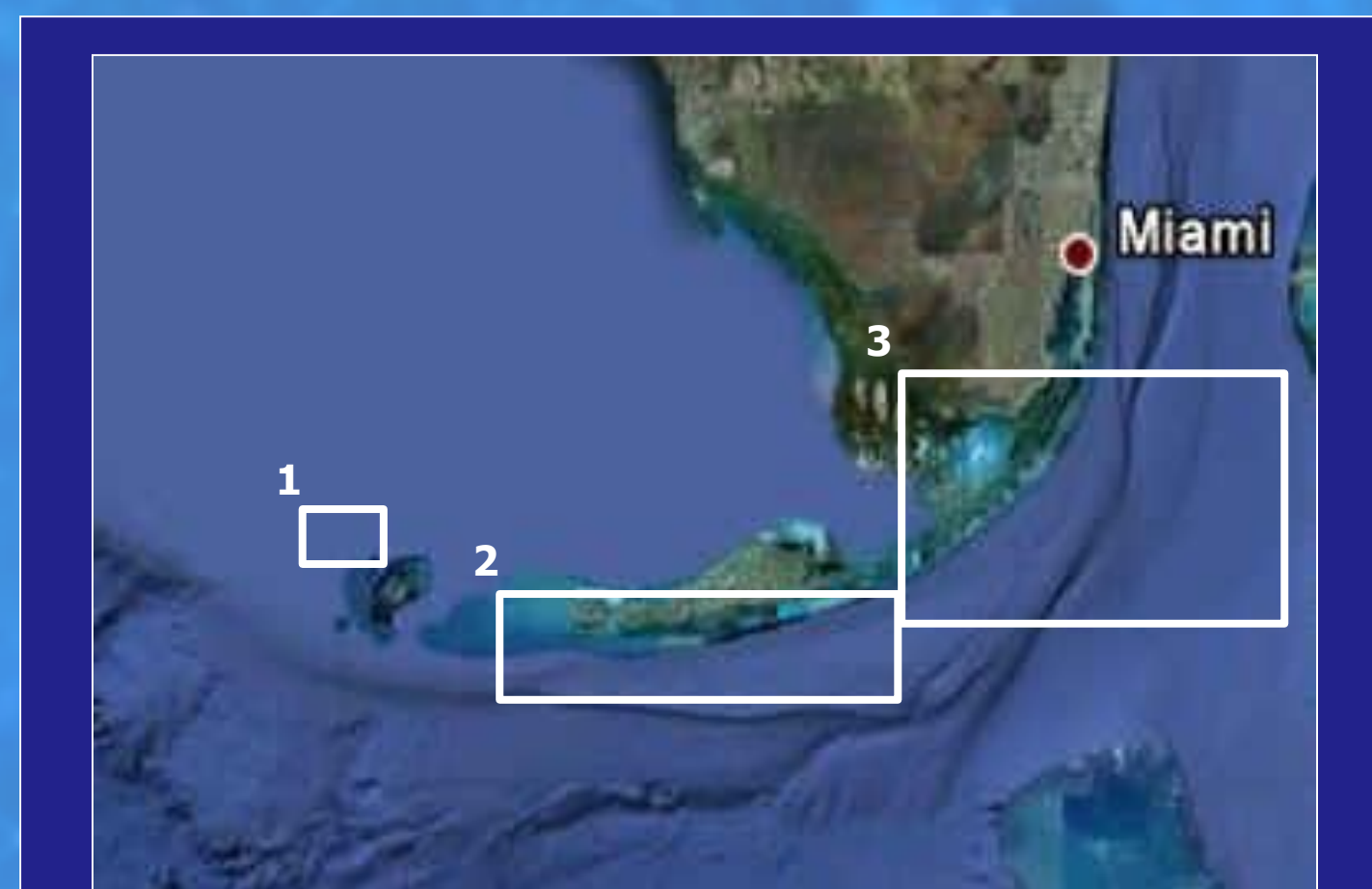


Figure 1. Regions mapped are located in three areas: west of Dry Tortugas National Park (1), south of Key West (2), and southeast of Vaca Key (3). All areas are part of the Florida Keys National Marine Sanctuary, and the area west of Dry Tortugas is part of the Tortugas Ecological Reserve. The three areas lie between longitudes 80°W and 83°W and latitudes 24°N and 25°N.

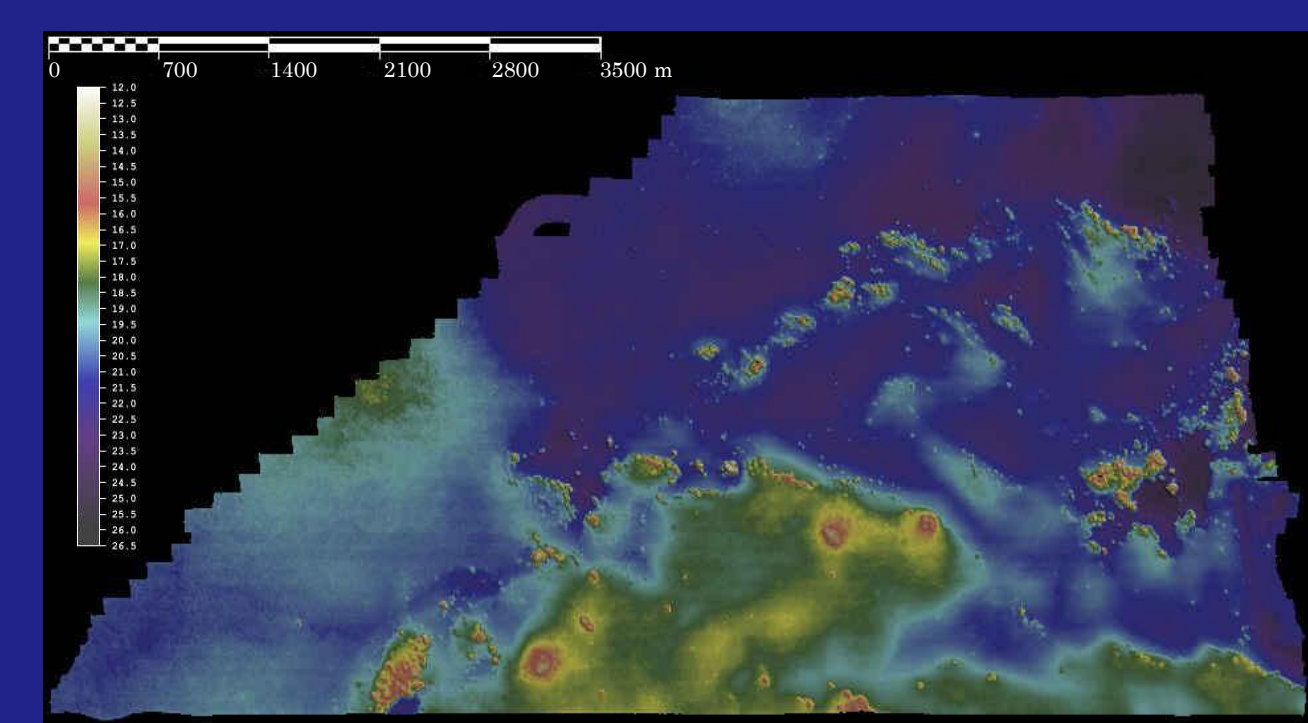


Figure 2. 2-D bathymetric image west of Dry Tortugas with depths ranging between 12 to 26 m.



Figure 4. 2-D bathymetric image southeast of Vaca Key with depths ranging between 64.5 and 98 m. Note the gently sloping, featureless surface of the 3-D image (inset) at 2.5x vertical exaggeration.

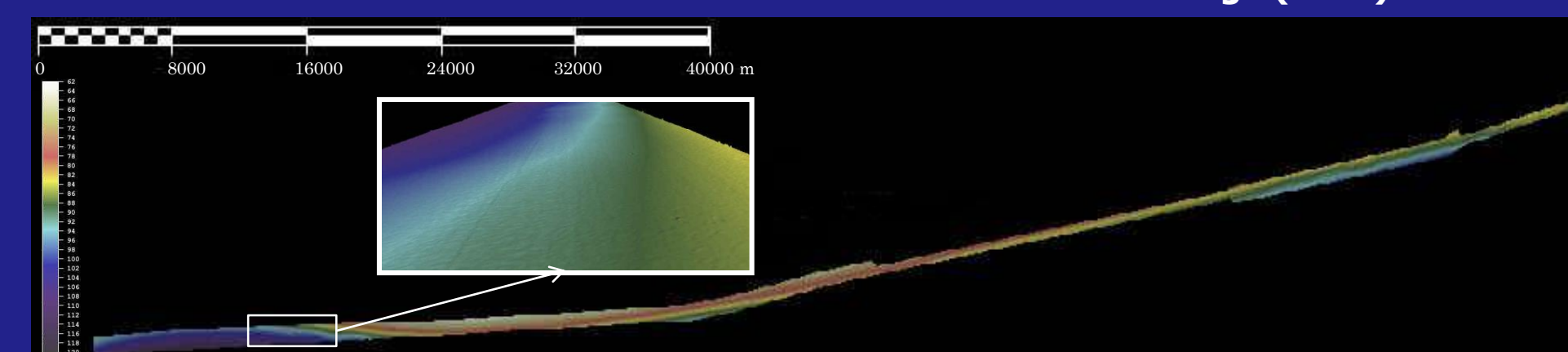


Figure 3. 2-D bathymetric image south of Key West with depths ranging between 64 and 120 m. 3-D image at 2.5x vertical exaggeration (inset) shows the change in depth.

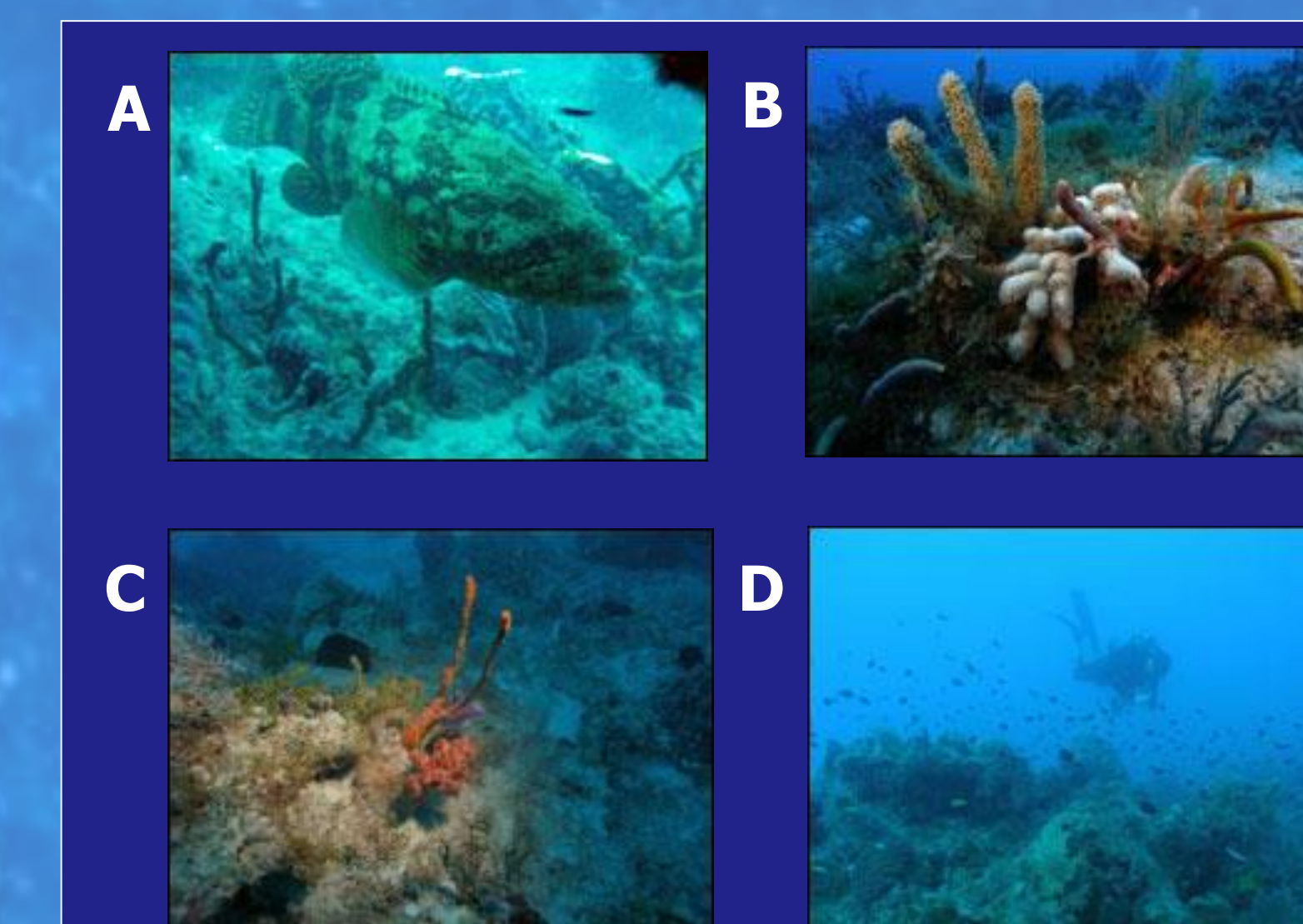


Figure 8. Photos taken by the NANCY FOSTER crew during the 2009 Tortugas expedition. (A) A goliath grouper was seen on a September 22 dive. (B and C) Detailed reef images are used to characterize the biodiversity. (D) A diver investigates fish populations and their habitat.

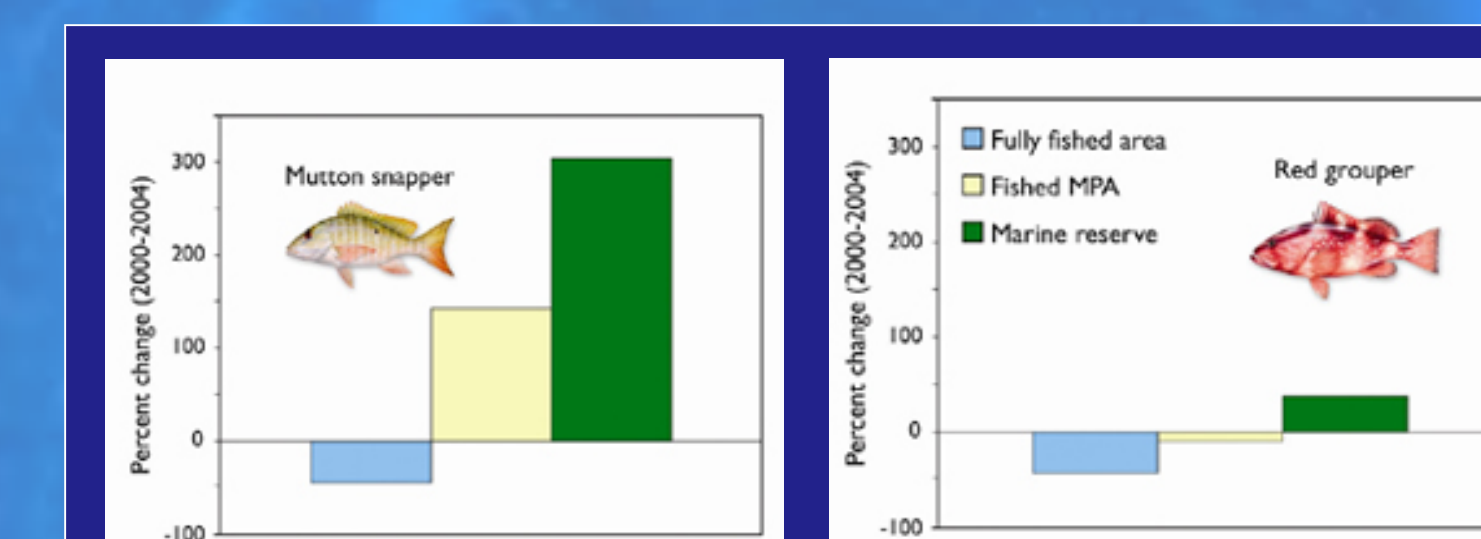


Figure 9. Bar graphs generated by Protect Planet Ocean from data collected by Ault et al. (2006) illustrating the percent change of mutton snapper and red grouper populations over a three-year span in the Dry Tortugas area. Blue designates open waters available for commercial fishing; yellow designates National Park areas that allow for recreational fishing; green signifies a "no-take" reserve (TER).

METHODS

- Cruise conducted aboard NOAA Ship NANCY FOSTER (Figure 6) from September 22-30, 2009.
- Raw data were acquired using Simrad EM1002 multibeam sonar system.
- CTD recorder employed to collect data about the water profile surveyed.
- Raw data were converted and edited using CARIS HIPS 7.0 software.
- Background research was conducted on grouper and snapper populations to provide an accurate assessment of fish habitats in coral ecosystems.



Figure 6. NOAA Ship NANCY FOSTER

Bathymetry West of Dry Tortugas

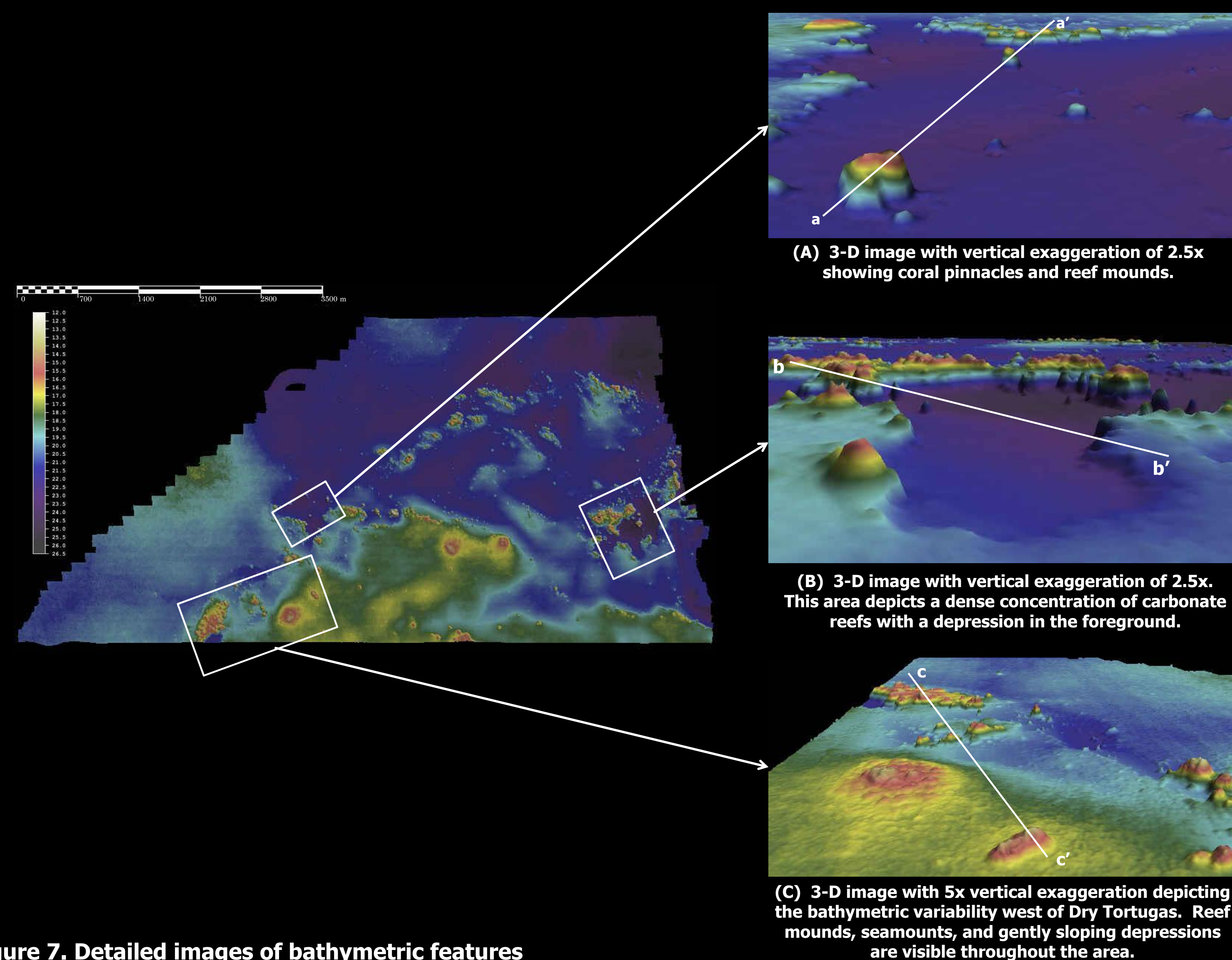
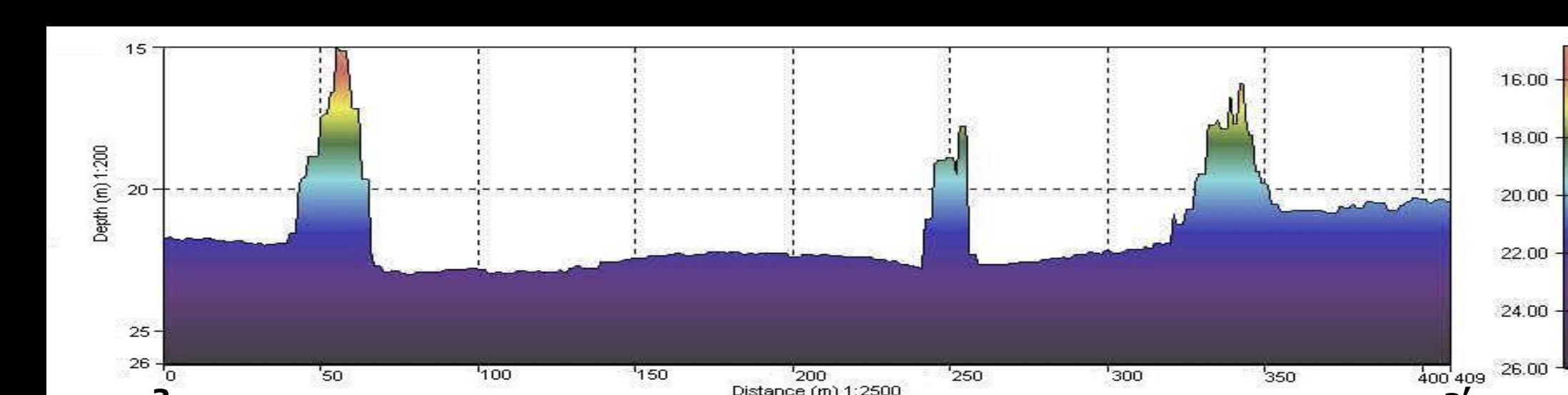
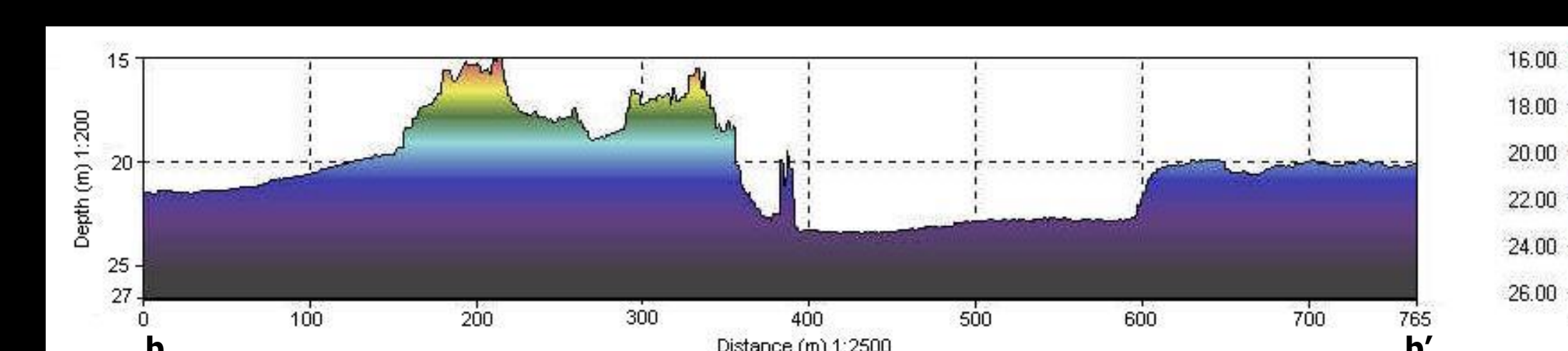


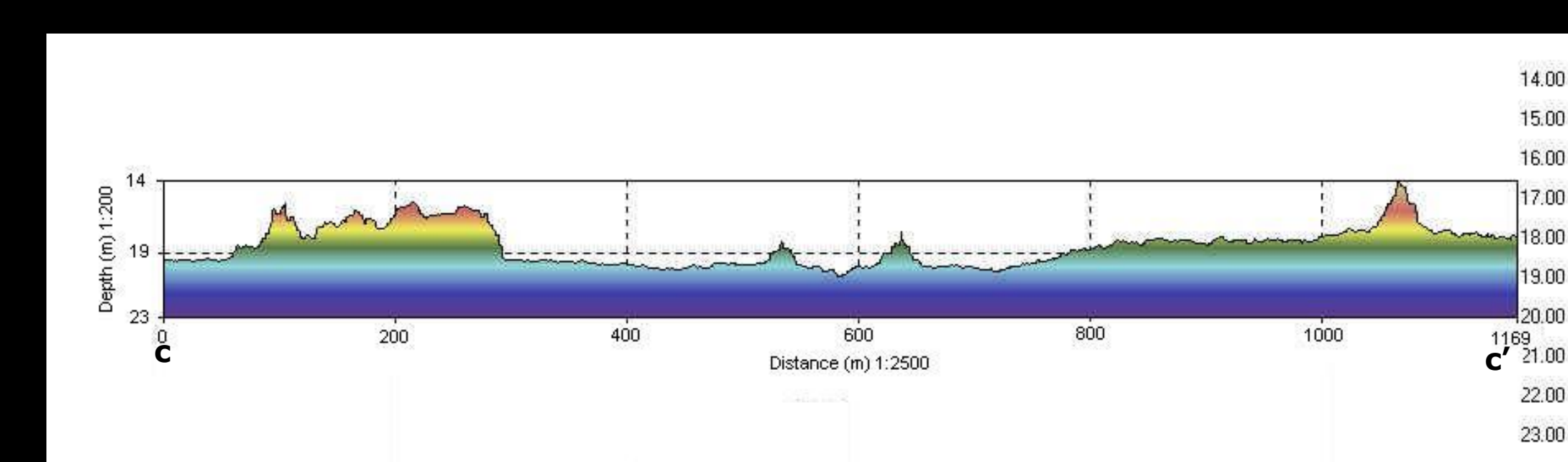
Figure 7. Detailed images of bathymetric features



Profile 1 (a-a'). A series of coral pinnacles is visible, ranging in height from approximately 4 to 7 m. The area gradually decreases in depth across the profile. These features are visible to the left in Figure 7(A).



Profile 2 (b-b'). A large 200 m wide, 6 m high carbonate structure is present along the profile. The region reaches a maximum depth of approximately 23 m in a large, flat depression. An abrupt 3 m ledge is present at a distance of 600 m. These features are visible to the left in Figure 7(B).



Profile 3 (c-c') Carbonate mounds are present throughout the profile ranging from approximately 18 to 14 m depth. The area declines into an approximately 20 m deep depression around a distance of 600m, surrounded by two small possible carbonate mounds. These features are visible to the left in Figure 7(C).

CONCLUSIONS

- The region surveyed within the TER is a prime location for grouper and snapper habitats, as the fish dwell in shallow reef ecosystems with hard, rocky bottoms (Florida Museum of Natural History, Smithsonian Marine Station).
- Enactment of the TER has been beneficial, as NOAA and Ault et al. (2006) both report an increase of grouper and snapper populations that are endangered by overfishing (Figure 9).
- Further mapping of the region should be conducted, as NOAA reports that the bathymetric data have not yet been collected for the entire TER (Figure 5).
- A complete map of the bathymetric features of the TER can be used to identify probable fish habitats for scientific dives. Additional dive areas will lead to a more accurate idea of fish populations.
- Areas outside the TER adjacent to the "no-take" zones should also be monitored over time. Increased data over time can provide coastal managers with a causal relationship between "no-take" zoning and increased fish populations. This may eventually lead to an expansion of the TER.

References

- Ault, Jerald S., Smith, Steven G., Bohnsack, James A., Luo, Jiansang, Harper, Douglas E., and McClellan, David B. "Building Sustainable Fisheries in Florida's Coral Reef Ecosystem: Positive Signs in the Dry Tortugas." *Bulletin of Marine Science*, 78(3): 633-654. 2006.
- Florida Museum of Natural History, University of Florida (<http://www.flmnh.ufl.edu/fish/gallery/descript/goliathgrouper/goliathgrouper.html>)
- NOAA Dry Tortugas Expedition 2009 (<http://sanctuaries.noaa.gov/missions/2009tortugas/welcome.html>)
- Protect Planet Ocean (<http://www.protectplanetocean.org/collections/successandlessons/casestudy/drytortugas/casestudy.html>)
- Smithsonian Marine Station, Fort Pierce (http://www.sms.si.edu/IRLSpec/Lutjan_analis.htm)

Acknowledgements

Thanks to: Scott Donahue (NOAA) for providing raw data; Chief Scientist John Burke, Survey Technicians Samantha Allen and Melody Ovard, and the rest of the 2009 Dry Tortugas Expedition crew for their online documentation of the cruise; CARIS, Inc. for the Academic Partnership with CoC; Highlands Geo for their Support of the HIPS license; and Josh Mode (CARIS) for software instruction.



This project was generated as part of the CoC Geology Department's 2010 Seafloor Mapping Program. <http://oceanica.cofc.edu/multibeam>