



Bathymetric Analysis of Important Shelf-Edge Fish Habitats off the Coast of Charleston, South Carolina

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ABSTRACT

Multibeam sonar analysis was used to map seafloor bathymetry of important fish habitats approximately 60 miles east of Charleston, South Carolina. The area of the shelf edge analyzed is a rocky reef habitat south of Bulls Scarp where many species of fish live, feed, and spawn. The Gulf Stream runs over these rocky reef habitats bringing warm water and nutrients from more tropical waters creating a habitat suitable for a very diverse population of tropical, sub-tropical and commercial species, including grouper, triggerfish, and snapper. CARIS HIPS & SIPS 7.1 software, was used to analyze multibeam sonar data acquired by the NOAA Ship *Nancy Foster* with a Kongsberg EM1002. The shelf-edge rocky reef surveyed extends over a depth range of 40 to 200 m, and includes a variety of ledges and other geologic structures that provide excellent fish habitats. Seafloor morphology is also compared to submersible and ROV dive videos provided by the South Carolina Department of Natural Resources as part of their ongoing investigations of essential fish habitat seafloor sites to be considered for designation as Marine Protected Areas.

METHODS

- Bathymetric surveys conducted aboard the NOAA Ship, *Nancy Foster*, August 18-20, 2006 and June 30-July 1, 2007.
- Multibeam sonar data collected using a Kongsberg EM1002
- Sites are located on the SE Continental Shelf near Georgetown Hole
- Data processed using the CARIS HIPS and SIPS 7.1 software

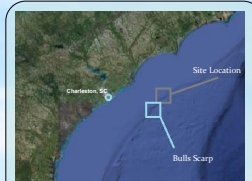


Figure 1: Site Location is about 60 miles off the coast of Charleston, SC just north of Bulls Scarp. The blue square marks the location of Bulls Scarp and the gray box marks the studied site location.

Rocky Outcrop Images from ROV Dives

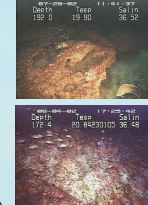


Figure 2: Image of the rocky reef outcrop also known as hardground. An angelfish (bottom right) uses the overhang as shelter and protection (Sautter et al., 2002).



Figure 3: Image of the rocky reef outcrop shown with more fish passing over the hardground using it as a habitat for shelter and protection (Sautter et al., 2002).

BACKGROUND

The purpose of this study was to investigate the location of rocky outcrops off the coast of South Carolina in relation to fish habitats. Mapping and identifying these habitats is important information for not only fishermen, but for scientists interested in the biological, chemical, and geological research on fisheries. The rocky outcrops provide annual spawning grounds for many fish species of significant economical value to South Carolina fisheries, including snappers and groupers (Sedberry et al.). The habitats within the analyzed area include one reef type, shelf-edge reef habitats based on depth, fish types and bottom type. This reef type is about 55-60 miles offshore, 50m deep, and dominated by species of gag grouper, snapper, and porgy (Sedberry and Harris, 2004).

The location of the rocky reef is similar to Bull Scarp, an escarpment just southwest of the study area with similar reef habitats, where rocky outcrops are composed of sandy biomicrite, algal limestone, calcareous quartz sandstone and quartz-rich calcarenite (Schobernd and Sedberry, 2009) and are exposed at the surface due to the strong, tropical currents of the Gulf Stream sweeping away finer sediment (lithogenic or biogenic sands and rubble) (Sautter et al., 2002). The resulting seafloor bathymetry is exposed rocky reefs, also known as hardground. The hardground has many features including outcrops, ridges, and overhangs with a moderate relief of 0-5 m. This area is an "underwater oasis" with nooks, cliffs, and holes that provide shelter and habitat for various sessile invertebrates such as bryozoa, soft coral, sponges and crustaceans (Sautter et al., 2002) and also the eggs of the concerned species of fish (Sedberry et al.). The warm nutrient-filled water that rushes up the coast with the Gulf Stream also benefits in supporting various forms of life resulting in a diverse and vital habitat.

SOUTHWEST SECTION

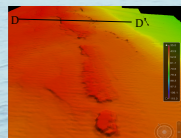


Figure 5a: 3-D view of rocky outcrop along the shelf with a depth range of about 35-65 m.

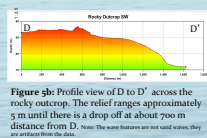


Figure 5b: Profile view of D to D' across the rocky outcrop. The relief ranges approximately 5m until there is a drop off at about 700 m distance from D. Note: The wave features are not used since they are artifacts from the data.

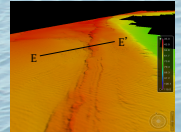


Figure 6a: 3-D view of rocky outcrops down the shelf with a depth range of 35-65 m.

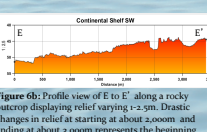


Figure 6b: Profile view of E to E' along a rocky outcrop displaying relief varying 1-2.5m. Drastic changes in relief start at about 2,000m and ending at about 3,000m represents the beginning and end of the rocky reef. Note: The wave features are not used since they are artifacts from the data.

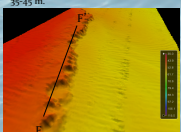


Figure 7a: 3-D view along the rocky outcrop with a depth range of 35-65 m.

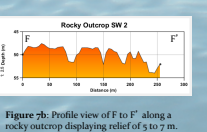


Figure 7b: Profile view of F to F' along a rocky outcrop displaying relief of 5 to 7 m. The changes in relief represent the presence and dynamics of the rocky reef topography. Note: The wave features are not used since they are artifacts from the data.

NORTHEAST SECTION

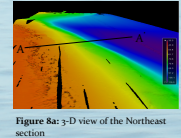


Figure 8a: 3-D view of the Northeast section topography that displays a relatively sharp decline in topography with a depth range of about 0-5m at ~900m of distance.

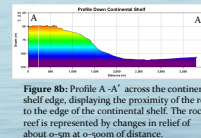


Figure 8b: Profile A-A' across the continental shelf edge, displaying the proximity of the reef to the edge of the continental shelf. The rocky reef is represented by changes in relief of about 0-5m at ~900m of distance.

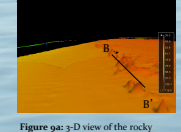


Figure 9a: 3-D view of the rocky outcrop along the continental shelf with a depth range of 35-50 m.

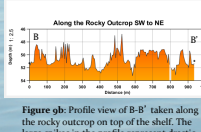


Figure 9b: Profile view of B-B' taken along the rocky outcrop on top of the shelf. The large spikes in the profile represent drastic changes in relief and topography and the presence of a rocky reef. Note: The wave features are not used since they are artifacts from the data.

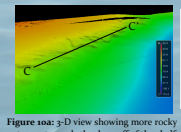


Figure 10a: 3-D view showing more rocky outcrops towards the drop off of the shelf with a depth range of 50-70m.

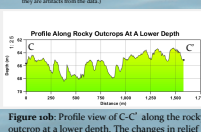


Figure 10b: Profile view of C-C' along the rocky outcrop at a lower depth. The changes in relief are 0-5 m and represent the presence and topography of the rocky reef.

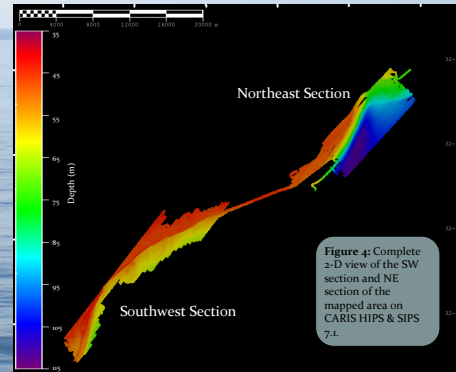


Figure 4: Complete 2-D view of the SW section and NE section of the mapped area on CARIS HIPS & SIPS 7.1.

BULLS SCARP

Bulls Scarp is located just south of the studied site near the continental shelf edge and is 60 miles off the coast of Charleston, SC, and has a very similar bathymetry and habitat. Bulls Scarp consists of relatively smooth bathymetry dominated by rocky outcrops with high relief (Smythe et al., 2011). The Gulf Stream influences the bathymetry by sweeping away finer sediments and exposing hardbottom surface and is also classified as a shelf-edge reef habitat. The Gulf Stream also creates large scale sand wave features (Figure 12)

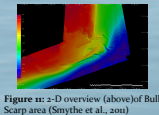


Figure 11: 2-D overview (above) of Bulls Scarp area (Smythe et al., 2011)

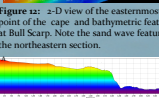


Figure 12: 2-D view of the easternmost point of the cape and bathymetric features at Bulls Scarp. Note the sand wave features in the northeastern section.

DISCUSSION

The continental shelf off the coast of South Carolina is characterized by various rocky outcrops along the shelf. The depth of the study area ranges from 40 to 200m. The 3-D views and the profiles of the rocky outcrops taken from the base surfaces represent a moderate rocky reef relief of 1-2.5 m leaving a rough topography with varying relief. The proximity of the shelf edge to the shelf edge is represented in Figures 8a-b. All of the examined outcrops and variations of relief were ranged from 35 to 75m and within the depth range of a shelf edge reef habitat. The ROV dive videos show the various outcrops, nooks and ridges typical of this area, as well as many species of crustaceans, soft coral, and bryozoa that reside in the rocky reef (Figures 2 and 3).

Bulls Scarp is located south of the study site and displays similar features, bathymetry and habitats. However, the bathymetry of Bulls Scarp is more heavily influenced by the Gulf Stream current and contains large scale sand wave features (Figure 11) (Smythe et al., 2011). The rocky outcrops at Bulls Scarp are located in the same proximity to the shelf edge and similar relief of the features (Figures 12 and 13).

The majority of the continental shelf along the South Carolina coast is not sufficiently mapped. The populations of many species of fish have been declining rapidly over the past two decades and understanding their habitats has been of growing importance (Schobernd and Sedberry, 2009). Acquiring more information about the location and topography of these outcrops will aid the scientific and commercial fishing communities in the knowledge of this area and lead to answers of why important fish species choose these rocky reefs as an annual spawning ground.

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