Bathymetric Analysis of a complex promontory extending into the Gulf Stream off Charleston, SC: benthic habitats of Bulls Scarp

M. G. Smythe, P.J. Bierce, L.R. Sautter and M.S. Harris
College of Charleston Dept. of Geology and Environmental Geosciences

Abstract
Bulls Scarp is a cape-like promontory located at the continental shelf edge, 100 km off the coast of Charleston, SC. Multibeam sonar data collected in July 2013 aboard the NOAA Ship Nancy Foster revealed a variety of complex bathymetric features. The 1.8 by 10.9 km survey area ranges in water depths from 40 to 210 m. Data were analyzed using CARIS HIPS and SIPS 3.3 software and reveal seafloor features including sand waves, current scour, depressions, a small canyon, multiple ledges and a possible iceberg plough mark – the southern-most feature of its kind identified in the western North Atlantic. This survey fills a gap along a 100 km section of the 50 m isobath of essential fish habitat within the South Atlantic Bight. Such bathymetric information is contributing to the designation of possible essential fish habitat and marine protected areas.

Background
The 67 survey lines that make up the Bulls Scarp study area were collected primarily to determine if the site is suitable for consideration as a marine protected area (MPA). MPAs are areas of seafloor identified based on reef morphology, fish density, fish diversity, and spawning habitat (Schobernd and Sedberry, 2009). Previous bathymetric surveys (SeaMap Program, College of Charleston) of the shelf near the project area reveal a relatively smooth bottom with areas of high-relief rocky outcrops. During the Pleistocene, algal, corals, bryozoans, and mollusks deposited during lower sea level are now the relict calcareous carbonate features that comprise the shelf-edge upper slopes reefs (Schobernd and Sedberry, 2009). In the last 20,000 years, sea level has risen from ~125 m up to the present, modifying the influences of terrestrial and oceanographic processes acting upon Bulls Scarp. The Gulf Stream in this area now flows in the deep water adjacent to Bulls Scarp, and the location of sand waves and current-scoured bottom provides information about the affects of the Gulf Stream on the seafloor today. In the past, icebergs were in the region as identified by iceberg plough marks 50 km north of the site.

Field Methods for Surface Results
- Used CARIS HIPS & SIPS 3.3 to produce Swath Angle BASE surface, using a 5 meter resolution.
- Applied a 5x5 meter interpolation using the closest eight neighbors.
- The goal was to balance fine resolution with minimum amount of interpolation over areas that received less coverage where ship track lines were spaced farther apart.
- Cross sections made over features of interest using the HIPS Profile tool
- Heave artifacts in the raw data are the result of the Applanix POS/MV 320 V4 gyrocompass not correctly applying heave offsets to the original datasets.

Discussion
Understanding the distribution of bathymetric features on the shelf-edge and upper-continental slope can assist with understanding the erosional and depositional patterns and Gulf Stream flow patterns around Bulls Scarp.
- Sand wave field has implications for speed and strength of the Gulf Stream.
- Northward transport in main flow of Gulf Stream
- Southward transport in eddy behind Bulls Scarp
- Eddies and current flow deflections, combined with complex habitats are important for biodiversity
- Sediment movement around nose of Bulls Scarp follows the Gulf Stream flow gradients
- Sediment smooths surfaces by filling in holes and covering rocky outcrops
- Areas above sediment infill remain rugged as erosional features
- The high-relief incised canyon is now being modified by modern Gulf Stream processes and may have been a fluvial channel accentuating lineaments on the shelf during the last (and previous) glacial maximum.
- Possible iceberg loch mark may provide evidence of glacial fed coastal currents that penetrated further south than previously described.
- Previous work records southwest-trending furrows at depths of 170-200 m just north of this survey area (Hill, 2008)
- Does Bulls Scarp fit the criteria for an MPA?
- Role of classifications are the first step for designating essential fish habitats and MPAs.
- High-relief bi-erosion features are ideal for sessile marine invertebrates, relating to the higher abundance and greater variability of reef fish (Schobernd and Sedberry, 2009).
- Highly diverse, closely spaced habitats are abundant in the area.

References

Acknowledgments
Thanks to NOAA and the crew aboard the NOAA Ship Nancy Foster, and to CARIS USA. Special thanks to the College of Charleston Department of Geology and Environmental Geosciences, the SeaMap Program, Dr. Norrie Liam and Josh Mode (CARIS USA).