Mapping and Characterizing Fish Habitat in Rhode Island and Block Island Sounds

Jeremy Collie, Professor, University of Rhode Island, GSO, jcollie@gso.uri.edu
John King, Professor, University of Rhode Island, GSO
James Gartland, Virginia Institute of Marine Science, VA
Michael Marchetti, Captain, F/V Mister G
James Ruhle, Captain, F/V Darana R
David Taylor, Associate Professor, Roger Williams University

Project Summary

The overall objective of this project is to obtain up-to-date and site-specific data on benthic habitats and the fish communities they support in Rhode Island’s coastal waters—data that will contribute to sound management decisions. To do this, we are classifying and mapping fisheries habitats based on benthic habitat characteristics and site-specific fisheries data. A second objective is to assess the functional importance of fish habitat to rebuilding fisheries stocks important to Southern New England. The project domain is defined by the RI Ocean Special Area Management Plan, which includes Rhode Island Sound (RIS) and Block Island Sound (BIS). Station selection is based on existing maps of bathymetry, sediment composition, backscatter, and fishing locations.

Traditional fishing areas in Rhode Island coastal waters are currently being considered for multiple uses. This integrated spatial management planning requires activities to be sited in appropriate habitats that will minimize, to the extent possible, the cumulative impacts on resident species and the ecological and economic services derived from this near-shore region. A general understanding of the ecology of this area exists, but there is a lack of site-specific data to guide spatial management planning. We are conducting comprehensive sampling of the coastal waters to include all representative habitats, not just ones proposed for renewable energy development. In particular, we seek to understand the basis of fish-habitat relationships, the functional role of different habitat types, and the importance of benthic-pelagic coupling in supporting fish production.

Methods

An interferometric sonar system was used to simultaneously collect swath bathymetry and side-scan sonar data with 1-meter resolution. Raw data were continuously recorded with OIC Geodas acquisition software and monitored in real time with a top-side monitor. A Hemisphere GPS was used to correct for vessel heading and pitch and roll. All survey lines were logged in Hypack navigation software. The resulting habitat maps were used to guide bottom trawling and to obtain site-specific benthic habitat information. Representative photographs of the benthic habitats were taken with a stereo camera. The still photos will be used to determine sediment type, and to quantify epifaunal species abundance.

Bottom trawling was conducted as part of the NEAMAP survey in Fall 2009, 2010, and 2011. Stations were chosen (1) in areas where habitat mapping had been conducted, (2) to include representative ranges of depths and habitat types in the study area, and (3) in areas targeted for offshore renewable energy development. Trawling was conducted on the F/V Darana R, with the standard NEAMAP protocol of 20-minutes tows. The biological data included numbers, weights, length-frequency, and sex composition. For a set of key species, we also collected stomach contents for diet analysis and tissue samples for stable-isotope analysis.
Beam trawling was conducted on the F/V Mister G in order to sample hard-bottom habitats that are too rough for otter trawling. The beam trawl has a 10-foot beam, two tickler chains and cod-end mesh equivalent to that of the NEAMAP otter trawl (Figure 1). Stations were selected mainly on hard bottom and also at some of the otter-trawl stations to provide direct comparisons. The biological data included numbers, weights, and length-frequencies. Stomach contents and tissue samples were not collected because of limited scientific personnel on board the Mister G.

Environmental data were collected at each trawl site with a YSI sensor that recorded water column profiles of temperature, salinity, and dissolved oxygen. Wind speed and direction were also recorded on the Darana R.

Figure 1. Beam trawl gear aboard the Mister G. Photo credit: Anna Malek

Preliminary Results

A total of 44 otter-trawl tows were made in the three years (plus 17 tows in Spring 2011). Cluster analysis of the species abundance data from each tow revealed eight distinct species assemblage groups in RIS and BIS. The tows cluster primarily by location and in some cases by year, reflecting both the permanent (i.e. bottom type) and transient (i.e. bottom temperature) habitat characteristics. When plotted on the map, the clusters indicate geographic grouping of species assemblages. For example, there are assemblages associated with soft sediments in deeper water, soft sediments in shallow waters, and the northwest and southeast sides of Block Island. More specifically, we found higher densities of silver hake, searobins, scup and spiny dogfish inshore and around Block Island and higher densities of butterfish, Loligo squid and scallops offshore. Many sites sampled in different years fell into the same cluster, which indicates that the species composition at these sites is stable from year to year.

Benthic habitat parameters were derived from the acoustic data at two-meter resolution. The side-scan measures the acoustic backscatter, from which the bottom type is inferred (high backscatter corresponds with harder substrate). Bathymetric data include depth and slope (low areas are often depositional areas with soft substrates). The bathymetry data were also used to calculate rugosity, which is a measure of the roughness of the bottom and benthic habitat complexity.
We also conducted a cluster analysis of the otter-trawl stations based on their environmental data. Four distinct sets of oceanographic conditions were identified, based primarily on bottom temperature. The environmental groups cluster mainly by location, reflecting the unique oceanographic conditions east of Block Island, west of Block Island and offshore. The species assemblage groups are significantly correlated with bottom temperature, surface temperature, and surface salinity. The groupings based on environmental data also correspond with some of the species assemblages.

Spatial patterns were found in the diets of several fish species. For example, winter flounder diets contained a high percentage of amphipods in the Block Island Sound, whereas polychaetes (worms) dominated the diet in eastern Rhode Island sound.

A total of 28 beam trawl stations were sampled in Fall 2010 and Summer 2011. The beam trawl stations provide good spatial coverage of areas that cannot be sampled with an otter trawl (Figure 2). However, the beam trawl and otter trawl catches are not directly comparable because of differing catchability. The NEAMAP otter trawl, with its high headrope (5m) has higher catches of pelagic species. Conversely, the beam trawl catches relatively more benthic invertebrates such as scallops, and sea stars. We found that by excluding pelagic species and benthic invertebrates, and standardizing catches by the area swept, that comparable catches of the remaining demersal fish species were obtained with the beam and otter trawls (Figure 2).

![Figure 2. Map showing the proportional catch size of each otter trawl and beam trawl. Larger circles represent bigger catches and smaller circles represent smaller catches. Dark circles represent beam trawls. Light circles represent otter trawls. All catch data is standardized by area swept and excludes pelagic species and benthic invertebrates.](image-url)
Conclusions

A number of distinct fish assemblages are found in Rhode Island coastal waters. The distribution of these assemblages can be explained by a subset of benthic habitat and oceanographic features, which include surface and bottom temperature, surface salinity, bottom type, depth and rugosity. Spatial patterns in diet composition indicate habitat-specific feeding of demersal fish species. Feeding on benthic prey is therefore an important link between demersal fish assemblages and their habitats. Beam trawling provides a useful complement to otter trawling because it can be conducted in areas of hard bottom.

The final results of this project (maps and geo-referenced data) will provide guidance for marine spatial planning in Rhode Island’s coastal waters. In addition to contributing a basic understanding of fisheries ecosystem dynamics, the relationships between species assemblages and habitat variables could be used to predict range shifts and community changes that may result from climate change. These results will also provide a baseline for measuring the cumulative effects of offshore development projects, and a basis for protecting important benthic habitats.