Benthic Habitat Mapping & Assessment: Wilmington-East Call Area

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A collaborative effort:


- BOEM
- NOAA
- UNC-IMS
- Geodynamics, LLC
2008 request by the North Carolina General Assembly to assess the resource & feasibility of development

2009 UNC-CH interdisciplinary study

2011 UNC-IMS study for Duke Energy

2012 UNC-IMS study for NC Dept. of Commerce

2013 UNC-IMS study for BOEM

2015 UNC-IMS & NOAA study for BOEM
RIGGS AND AMES, 2003

ALBEMARLE-PAMLICO
ESTUARINE COMPARTMENT

NORTHERN
COASTAL
ZONE

SOUTHERN
COASTAL
ZONE

ALBEMARLE SD

PAMLICO SOUND

RALEIGH BAY
COMPARTMENT

ONSLOW BAY
COMPARTMENT

ATLANTIC OCEAN

0 50 kilometers

AMES, 2003

Cape Hatteras

Diamond Shoals

Cape Lookout

Cape Lookout Shoals

Shelf-Slope Break

Cape Fear

Frying Pan Shoals

SOURCE: Benthic Survey, Mote Marine Laboratories
Hardbottom Habitat

• Protected as Essential Fish Habitat by the Magnuson-Stevens Fisheries Conservation and Management Act (NOAA)

• Flat hardbottom: pavement, rock outcroppings & ledges, high-relief rocky reefs

• Turbine monopile & scour apron could provide substrate to enhance hardbottom habitat with proper siting
Stakeholders’ meetings

- Meetings held in each of 3 regions: northern, central, & southern
- Stakeholders shared proprietary information & knowledge about sea floor habitats, especially hardbottom (EFH)
- All data sources combined to provide BOEM with spatially explicit information indicating where wind energy development can avoid or minimize conflicts with fish, fish habitat, fishing, diving, and ecotourism
- Key stakeholder topics:
  1. Access to traditional fishing grounds
  2. Maintaining transit corridors
  3. Positive feedback on enhancing habitat

Simultaneous mapping of seafloor & fishes

Edge Tech 4200 digital sidescan sonar
Applanix POS MV inertial navigation system with DGPS correctors

Reson 7125 Seabat hydrographic multibeam sonar
Applanix POS MV inertial navigation system

Simrad EK60 Splitbeam Sonar
Applanix POS MV inertial navigation system with DGPS correctors
Seafloor mapping (to 25-cm resolution)

Sumners et al. 2014
Distribution of fish densities from Splitbeam Echosounder

White symbols are proportional in size to relative density

Large (> 29 cm)  |  Medium (12 - 29 cm)  |  Small (< 12 cm)
Where are the fishes?

Kriging interpolation of total fish density, including all size classes and fish schools. Densities are scaled from blue (zero) to red (high).

Significant hotspots for large fish size class. Gi* hotspot p-value: >90%, >95% and >99% indicating increase likelihood of clusters of high fish densities compared to random. WEA outlined in white.
Fish – habitat relationships

- Depth, relief (slope, slope change), & habitat classification clearly influence location of fish densities
- High relief & complexity = ↑ spp. richness & large fishes
- Fish more broadly distributed at night
- Higher fish abundance (& planktivorous spp.) on wrecks (Paxton et al. 2015)
SBES survey lines (black lines) over a set of diver stations on high-relief ledge hardbottom habitats (red stars). Bathymetry base layer is shown as orange (shallow) to deep (blue). Individual fish are scaled according to size class.

Cumulative frequency histograms of the distance from ledge hardbottom features show:

- 80% of the large fish were within 150 m.
- 100% were within 500 m during day.
- > 900 m at night.
Diver biological assessments
### Habitat types surveyed

<table>
<thead>
<tr>
<th>WEA habitat type</th>
<th>Geoform Component</th>
<th>Substrate Component</th>
<th>Biotic Setting</th>
<th>Biotic Component</th>
<th>Page Reference in CMECS for each site description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Sediment Wave Field</td>
<td>Unconsolidated mineral Substrate</td>
<td>None</td>
<td>None</td>
<td>Pg 148, 152-173</td>
</tr>
<tr>
<td>Ledge</td>
<td>Rock Outcrop</td>
<td>Rock Substrate</td>
<td>Benthic/Attached Biota</td>
<td>Attached fauna and diverse colonizers and benthic macroalgae including sponges, soft corals, gorgonians and algae</td>
<td>Pg 148, 152-173</td>
</tr>
<tr>
<td>Mixed HB</td>
<td>Rubble Field</td>
<td>Coarse Unconsolidated Substrate: Boulder and Cobble</td>
<td>Benthic/Attached Biota</td>
<td>Attached fauna and diverse colonizers and benthic macroalgae including sponges, soft corals, gorgonians and algae</td>
<td>Pg 148, 152-173</td>
</tr>
<tr>
<td>Pavement</td>
<td>Pavement Area</td>
<td>Unconsolidated mineral substrate</td>
<td>Benthic/Attached Biota</td>
<td>Sparse attached fauna and diverse colonizers and benthic macroalgae including sponges, soft corals, gorgonians and algae</td>
<td>Pg 148, 152-173</td>
</tr>
<tr>
<td>Artificial</td>
<td>Wreck</td>
<td>Anthropogenic Wood or Metal</td>
<td>Benthic/Attached Biota</td>
<td>Sparse attached fauna and diverse colonizers and benthic macroalgae including sponges, soft corals, gorgonians and algae</td>
<td>Pg 148, 152-173</td>
</tr>
</tbody>
</table>
Abiotic Percent Cover

Abiotic Cover
- Harbottum
- Rubble
- Sand

Bathymetry
- -21 m
- -32 m

Biotic Percent Cover

Biotic Cover
- Macroalgae
- Invertebrate
- Bare

Bathymetry
- -21 m
- -32 m

Mixed soft corals

Titanideum frauenfeldii
Fish use of habitats did not differ significantly by habitat type.

Conspicuous fish use of habitats did not differ significantly by habitat type.

Cryptic fish use of habitats did not differ significantly by habitat type.

* = significant correlation.
Fish length frequencies

Black seabass (*Centropristis striata*)
(N = 51)

Gag grouper (*Mycteroperca microlepsis*)
(N = 37)

Vermilion snapper (*Rhomboplites aurorubens*)
(mixed with school of tomates)
(N = 16)

Greater amberjack (*Seriola dumerili*)
(N = 18)
Diver seasonal assessments

Survey methods for seasonal assessments of hardbottom habitat & biological communities:
A) fishes along a belt transect
B) benthic community in a photoquadrat
C) structural complexity using a water level logger
D) sediment depth using a T-rod.

Hardbottom reef types based on structural complexity:
A) Natural reef – flat pavement; B) Natural reef – rubble field;
C) Natural reef – pronounced ledge; D) Artificial reef.
Non-metric multidimensional scaling (nMDS) ordination of snapper-grouper complex fish community on natural & artificial reefs

Fish use of habitat by habitat characteristics

nMDS plot of fishes on natural reefs that differ by structural complexity: pavement < rubble fields < ledges < artificial reefs
Benthic community composition

Principal components analysis ordination of benthic community by phyla on reefs
Red arrows and corresponding black labels represent environmental vectors

- Benthic community = invertebrates & macroalgae
- Benthic community composition on natural reefs differed between WECA vs. Onslow Bay, likely due to greater degree of sediment dynamics
- Benthic community composition did not differ with location for artificial reefs
An important update
Updated Wind Capacity Factor Map (2015)

Thomas et al. 2015
Percentage of individuals of non-pelagic (coastal) & pelagic birds (seabirds) observed with increasing distance from land

Hatteras Offshore

Distance interval (m) from inshore

% of individuals

non-pelagic species
pelagic species

~5 n mi
~22 n mi
**Inter-annual variation**: standard deviation of annual-averaged wind speeds indicate greatest variability near the coast and for Gulf Stream position at eastern boundary. Big variation at shelf-edge off NE NC in MOS scheme.
Example splitbeam echosounder echograms showing the seafloor (red) and individual fish (green-yellow-orange) near a ledge (A) or fish schools in the water column (green-yellow-orange) over a mixed hardbottom (B) or unconsolidated bottoms (C & D).

Distance above the seafloor for individual fish detected during SBES surveys for 2013 day (A) and night (B) and 2014 day (C) and night (D). Fish sizes in cm are estimated from acoustic target strength. Red vertical bars indicate divisions of pre-determined size classes for small fish (<12 cm), medium fish (12 to 19 cm) and large fish (>29 cm).
The top ten species of the conspicuous community’s mean density (#/100 m²) and mean biomass (kg/100 m²) by natural hardbottom type: ledge, MHB/sand, and pavement. The asterisk (*) denotes a member of the Snapper Grouper Management Complex managed by the SAFMC.

Cryptic fishes: top ten species by mean site density (#/100 m²) and mean site biomass (kg/100 m²) by habitat type: Ledge (N = 15), MHB/s (N = 27), Pavement (N = 3), and Artificial (N = 1).

NOAA diver counts a school of Seriola zonata, a numerous species in the large fish size class.
Effect of structural complexity of *artificial reefs* on community metrics of fish in the snapper-grouper complex on A) abundance, B) species richness, C) Shannon-Wiener species diversity, and D) evenness. Black lines represent linear models =marginal negative differences with structural complexity of artificial reefs (PERMANOVA, p = 0.0499).

Effect of structural complexity of *natural hardbottom* on community metrics of fish in the snapper-grouper complex on A) abundance, B) species richness, C) Shannon-Wiener species diversity, and D) evenness. Black lines represent linear models