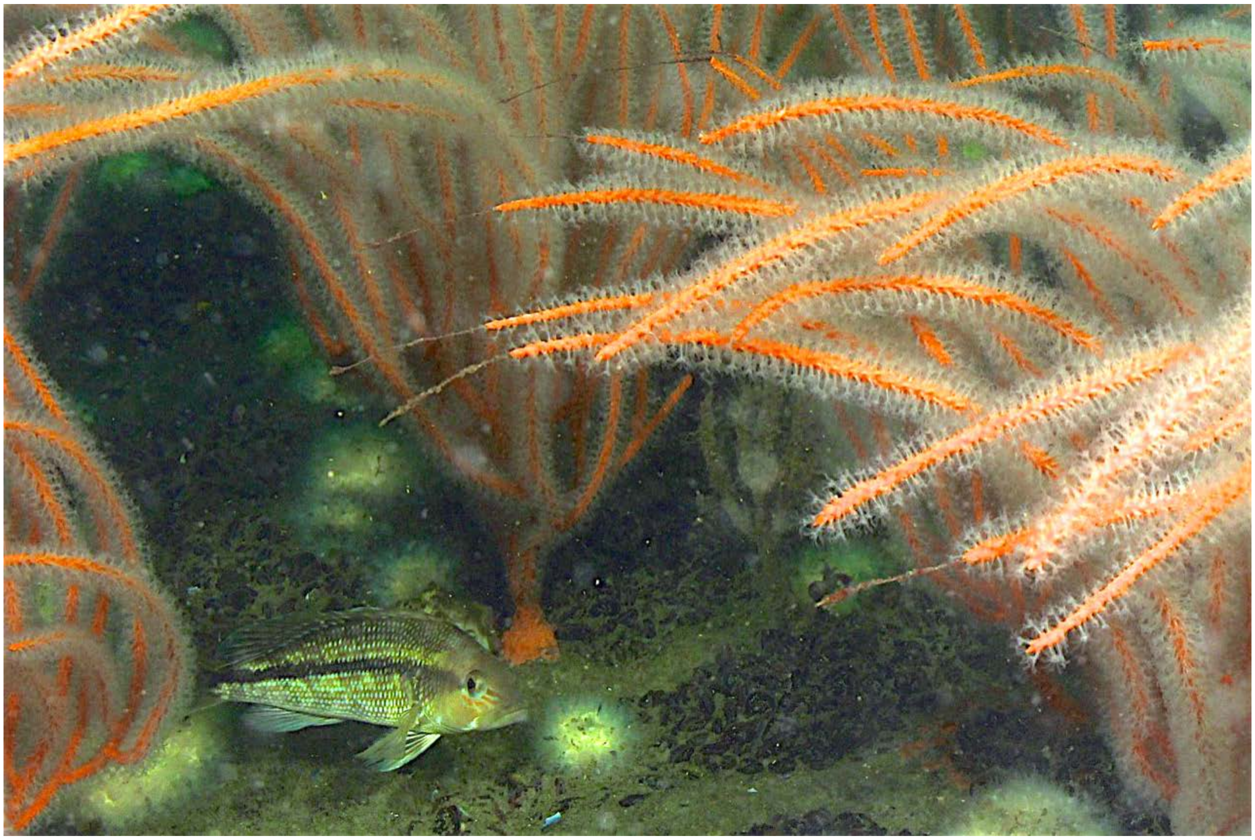
Hab in the MAB:
Characterizing Black Sea Bass Habitat in the Mid-Atlantic Bight



Final Report to the Atlantic Coastal Fish Habitat Partnership (ACFHP)

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Bradley G. Stevens*, Cara Schweitzer**, and Andre Price***

University of Maryland Eastern Shore, Princess Anne, MD, 21853

* bgstevens@umes.edu

**cara.schweitzer42@gmail.com

***andre.price@noaa.gov

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Introduction and Summary of Results

The mid-Atlantic Bight (MAB) stretches from North Carolina to Massachusetts but is poorly studied, especially the nearshore regions of the Delaware, Maryland, and Virginia (Delmarva) peninsula. The nearshore continental shelf is composed primarily of unconsolidated sediments consisting of sand, silt, shells, and small gravels. Bedforms consist mainly of sand waves, small hills, and gullies created by ancient riverbeds, with rare outcroppings of rock, consolidated mud, and clay. There is very little hard bottom in the area. The distribution of habitats in the Delmarva MAB is poorly known, although some recent surveys have produced information on the bottom characteristics within the Maryland WEA. Seafloor sediments in the Delmarva region are characterized by large expanses of sand and shell, with widely scattered hard-bottom outcrops. These outcrops form small biological oases among a sandy seafloor desert, and are populated by sedentary invertebrate organisms that create structured habitat. Sedentary organisms are also present on anthropogenic debris (mostly shipwrecks). Numerous artificial reefs have been built in the region to enhance fishing and diving opportunities.

The nearshore continental shelf in this area is inhabited by several economically valuable species, including Tautog *Tautoga onitis*, Croaker *Micropogonias undulatus*, American Lobster *Homarus americanus*, summer flounder *Paralichthys dentatus*, and Black Sea Bass *Centropristis striata*. The most valuable inshore fishery is for black sea bass (BSB), which are considered a data poor species, due to a paucity of biological information regarding reproduction, age, growth, habitat preference, and mortality. Black sea bass are targeted by both recreational and commercial fisheries in equal measure, and the majority of commercial black sea bass landings are captured via fish traps. Commercial fish traps are often deployed on or near benthic structured habitat where economically valuable species aggregate. Recreational fishing is also mostly targeted on the many wrecks, artificial reefs, and natural bottom areas that are widely scattered throughout the region.

The MAB has become a proposed focal area for wind-power development, and wind energy areas (WEAs) have been designated offshore most of the coastal states including Maryland. Future development of wind power will affect bottom habitat in ways that are unknown, but the WEAs have been designed to avoid the most important habitats and fishing areas in the region. However, there is little information on habitat preferences of black sea bass, and how fishing or wind power development will affect the fish and their habitats. To understand the impacts of fishing or wind power development on black sea bass, we need a better understanding of the distribution and composition of benthic habitats in the MAB, and their importance to fish abundance, which is currently unknown.

Black sea bass *Centropristis striata* (BSB) are a carnivorous, primarily benthic fish that range from the Gulf of Maine to the Gulf of Mexico. Atlantic populations are separated into northern and southern stocks at Cape Hatteras, NC, and are considered a separate sub-species (*Centropristis striata striata)* from their Gulf of Mexico counterparts (*Centropristis striata melana*). Northern stock BSB perform seasonal migrations, residing in coastal waters in spring and summer months, then move to deeper waters near the continental shelf in the late fall through winter. BSB are protogynous hermaphrodites, with some individuals changing sex from female to male between 1 and 8 years of age. Common prey items for BSB include amphipods, decapods, bivalves, and small fish. Black sea bass tend to reside at sites with high rugosity at depths <28 m, that are largely associated with hard structure such as corals, mussel beds, and hard-bottom habitats or “reefs”. During the summer, fish show some site fidelity to these habitats. Currently, there are few studies that describe the habitat characteristics of BSB, or their feeding dynamics, and how these two aspects of their biology are related.

This research project, designated "Hab in the MAB", was designed to answer some of these questions. The original objectives were to:

1) Determine the preference of BSB for particular habitats by assessing their abundance, size structure, and feeding ecology within natural and artificial reefs;
2) Improve the understanding of benthic habitat structure by quantitatively assessing biodiversity, rugosity, and other habitat characteristics of natural and artificial reefs;
3) Determine if reduced fragmentation and increased connectivity of habitats increases fish recruitment, by experimentally manipulating corridors between isolated habitat patches.

During the course of the research, these goals were restructured into three specific sub-projects, and several minor ones as follows:

1. Determine the composition of biogenic structure on benthic habitat patches and the relationship to fish abundance, by
    a. Estimating relative cover of fouling organisms and fish abundance at different types of reefs, and
    b. Exploring the relationship between benthic diversity and fish abundance.
2. Investigate how seascape connectivity affects fish abundance, by
    a. Establishing a small stepping-stone corridor connecting two existing reefs, and
    b. Monitoring changes in abundance of fish on the experimental and control reefs before and after deployment;
3. Determine the dietary habits of black sea bass and their trophic relationships, by
    a. Estimating trophic position using stable isotope analysis, and
    b. Comparing food habits between fish caught at artificial and natural reefs, and during NOAA surveys.

Summary of Results

<u>Chapter 1: Habitat structure and fish preference</u>

From 2016 through 2018, we investigated the interactions between black sea bass and their habitats at over a dozen artificial and natural reefs in the Delmarva MAB using a variety of techniques. At each of these reefs, we estimated fouling community composition using quadrat sampling with a digital camera and ¼ m^2 frame along linear transects. We also estimated fish abundance using digital video cameras set on tripods, and by strip-transect censusing. Quadrat and video sampling were conducted both within the structured habitats and on nearby open-sand bottoms for comparison. Surveys of benthic habitats showed that the predominant marine biogenic structures in the Delmarva MAB are comprised of multiple species including northern stone coral *Astrangia poculata*, sponge *Cliona celata*, blue mussels *Mytilus edulis*, various hydroids (i.e. *Tubularia* sp., *Obelia* sp., *Campanularia* sp.), and gorgonian corals, putatively identified as sea whips *Leptogorgia virgulata*. Sea whips are one of the most prominent structure-forming invertebrates, and are responsible for most of the vertical structure above habitat baselines. Fish abundance at the studied sites was compared to the relative abundance of all other habitat-forming organisms present. Fish abundance was significantly correlated only with the relative abundance of sea whip corals, but not with abundance of any other species, or to total coverage of biogenic structure. Sea whips are 'autogenic engineers' (i.e. they create biogenic structure) that add complexity to benthic habitats by altering the environment with their own physical structures. Previous studies (Schweitzer et al, 2018) have shown that 50% of commercial fish traps come into contact with emergent epifauna during deployment or recovery, including sea whip corals, often resulting in damage or breaking of corals. Assessment of sea whip condition (as a damage index) at our study sites showed that sea whip corals on artificial reefs off the Delmarva coast exhibited minor levels of degradation that did not differ significantly among study sites.

Chapter 2. Seascape Connectivity and Fish Abundance

To determine if increasing seascape connectivity increases fish abundance on isolated habitat patches, we used a **Before-After-Control-Impact** (BACI) experimental design. In 2016, we constructed a stepping-stone corridor (the '**Impact'**) connecting two established sections of an artificial reef (the **Impact** site). A similar, nearby, two-section reef was designated as the **Control** site. Both the Control and Impact site consisted of two structured components (parts of shipwrecks) separated by 20 or 120 m, respectively, of unstructured, open sand bottom. Fish abundance was estimated by conducting stationary video surveys during three sampling seasons for one year **Before Impact** and one year **After Impact** at both the **Control** and **Impact** sites, and on both the structured and unstructured components. Prior to Impact, fish were more abundant at the Impact than at the Control site, both sites showed seasonal variation in abundance, and fish were completely absent from unstructured bottom at both sites. After Impact, fish abundance increased significantly only at the (previously) unstructured portion of the Impact site (where the reef was built), but did not change at any of the structured portions of either site, or at the unstructured portion of the Control site. Furthermore, fish were observed on the corridor structure during all three sampling periods. Results suggest that corridor construction increased habitat availability for fish at the Impact site, without drawing fish away from nearby sites. This small-scale study demonstrated that increasing connectivity via corridor construction may be an effective method to enhance available habitat in marine ecosystems.

Chapter 3. Feeding Ecology of Black Sea Bass at Natural and Artificial Reefs

We sampled BSB at selected natural and artificial reefs near Ocean City, MD in 2016 and 2018, using hook-and-line angling to determine if reef type influenced length frequency, sex ratios, diets, and stable isotope ratios of $\partial^{12}C/\partial^{13}C$ and $\partial^{14}N/\partial^{15}N$ in liver, muscle, and mucus. BSB caught by angling were compared to a NOAA dataset of trawl-caught BSB spanning 2000-2016. There were no significant differences in size, age, or sex composition between fish at natural and artificial habitats. The primary prey items of BSB by proportion and frequency of occurrence were crustaceans (primarily *Cancer* crabs) at both artificial and natural sites and among the NOAA samples. Values of $\partial^{15}N$ and $\partial^{13}C$ differed between habitat types in liver and muscle, but not in mucus. This study showed that natural and artificial reefs are ecologically similar for Black Sea Bass caught near Ocean City, MD, but subtle differences in diet between reef types suggest that their physical form may affect access of fish to different prey items.

Conclusions and Recommendations

Previous studies suggesting that BSB are associated with "course-grained" material are but a crude approximation of habitat. The results of this project confirm that black sea bass are tightly structure-oriented, and primarily occur within <1 m of hard bottom substrata with substantial vertical and biological structure that includes the presence of gorgonian corals, aka sea whips.

While BSB did occur near newly placed structures with little overgrowth, abundance at most sites was significantly correlated with density of sea whips, but not of any other species. Increasing the presence of structured habitat, by placement of artificial structures, resulted in an increase in abundance of BSB, without detracting from nearby structures. Diets of BSB appear to derive mostly from areas surrounding reefs, rather than among them, and differ little based on the type of reef or other source. However, the structure and extent of reefs may have a minor impact on diet due to availability of different food sources. Nonetheless, this indicates that habitat selection is probably not associated with proximity to food sources, but is more likely to be associated with actual physical structure that provides other biological benefits, such as protection from predation, optimization of reproductive opportunities, or stress reduction.

With regard to future alteration of marine habitats in the MAB, we suggest that artificial reefs should be constructed out of solid structures with appropriately scaled interstitial space, rather than concrete blocks, pipe, or steel structures that are subject to degradation, subsidence, or disintegration. We also predict that construction or installation of wind power turbines will likely provide abundant hard structure supporting invertebrate fouling communities that black sea bass and other fish prefer as habitat. Increasing the availability of such artificial habitats in the MAB, and including some in protected areas, will likely have positive benefits for the regional population of black sea bass.