



Geospatial Patterns of Schooling Fish Across Different Artificial Reefs

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ABSTRACT

Artificial reefs are anthropogenic structures intentionally deployed and often used to supplement existing natural reefs or create new habitats for fish and invertebrates. Previous studies have explored the abundance of predatory fish on vessel-based reefs, but there is still a lack of information on how schooling fish respond to different reef materials still exists.³ Studying what fish communities look like across different reef materials is helpful in guiding reef management practices. This work assessed fish school size, density, and water column occupancy across metal, concrete, and vessel reef sites. Echosounder data was collected on twelve different reef sites of varying artificial materials during 2020 and 2021. This data was used to ask how the structure of the fish schools on a reef change based on the material type of the reef. We found that on vessel-based reefs there are trends towards larger and more dense schools. Using this information, future studies can better estimate what schools of fish will look like on deployed artificial reefs.



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INTRODUCTION

Marine reef ecosystems are home to some of the world's highest biodiversity, serve as a protective barrier between the land and sea, and sustain millions of people around the world. These critical, but fragile, systems damaged by overfishing, pollution, and climate change, leaving fewer and fewer natural reefs each year.¹ Artificial reefs, anthropogenic structures intentionally deployed, pose the opportunity to supplement and replace damaged habitat. Structures currently maintained as reef materials by the North Carolina Division of Marine Fisheries include piles of metal scraps, concrete pipes/reef balls, and sunken vessels. Artificial reef structures vary in size and shape, and their structural complexity affects the fish communities on the reef.² Understanding how reef structures affect fish communities is key to supporting balanced, long-lasting ecosystems.

Objectives

1. Learn how schooling fish are utilizing artificial reefs.
2. Explore the use of population monitoring with echosounder technology.
3. See how artificial reef materials alters the structures of schooling fish.

METHODS AND MATERIALS

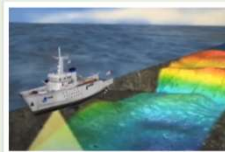


Figure 1. Illustration of echosounder sampling.

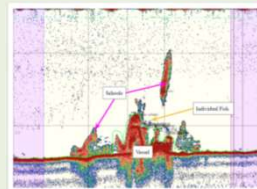


Figure 2. Echogram of AR386 labeled with key features.

During the summer of 2020 and 2021 a team on the Nancy Foster followed routes designed to bisect artificial reef materials on 12 reef sites. Data was collected with echosounder technology, producing images like Figure 2.

From the echosounder data a 200m transect centered on a reef material of interest was isolated and metrics on fish schools were exported for further analysis. Each reef site produced several transects. In total 50 transects were gathered with 122 schools of fish across them.

Data processing was accomplished through Echoview software. Data analysis was completed in R and ArcGIS Pro. Analysis of variance in R was run for statistical analysis.

RESULTS

Reef materials were divided into 3 categories; concrete, metal, and ship. There was one transect composed of concrete and a vessel that were too close to be separated and this is referred to as "mixed" reef material.

There was a high amount of variability between reef sites. Both the reef material types and fish communities greatly varied over the 12 reef sites sampled.

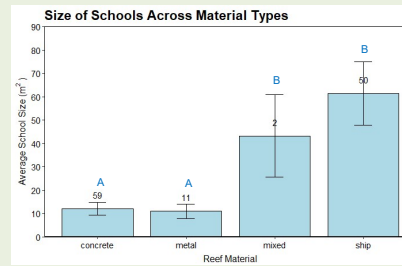


Figure 3. Average school area in meters across material types. Standard error represented by error bars. (p<0.001).

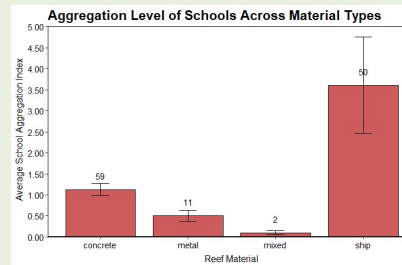


Figure 4. Average aggregation index of schools across material types. Standard error represented by error bars. (p<0.07)

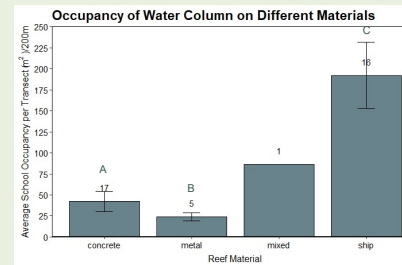


Figure 5. The area of schooling fish in the water column of a 200m transect averaged across material types. Standard error represented by error bars. (p<0.002)

DISCUSSION

The area and aggregation index of schools was averaged across material types and reefs with some vessel component had significantly larger schools. Occupancy of the water column was used to measure how much of the water column was occupied by schooling fish. More of the water column was occupied on vessel-based reefs. All figures support the hypothesis that there are more schooling fish on artificial reefs composed of submerged vessels. Figure 6 helps to visualize these trends of school structure on different material types.

Due to the nature of the sampling technique used, we were working with a limited field of view and were unable to confidently determine species identity.

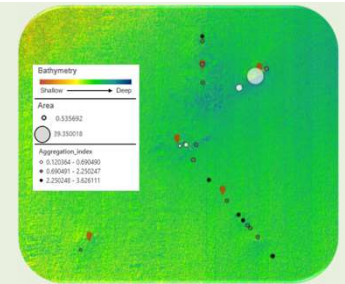


Figure 6. Map of AR285 in 2020 showing reef materials and schools present. Base map shows bathymetry with deeper waters depicted in blue, shallow in orange/red.

CONCLUSIONS

Suggestions

Vessel-based artificial reefs should continue to be deployed to create habitat for large numbers of schooling fish.

Future Directions

Following this study, we plan to see how the larger solitary fish are impacted by material type. We will also examine what physical characteristics of the reef were most impactful in supporting high amounts of schooling fish.

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