A correlation of historical and current substrate types with codfish (*Gadus morhua*) abundance in the Gulf of Maine

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Bountiful fish populations in the Gulf of Maine (GOM) once supported a thriving fishing industry. However, overfishing and poor management has left these populations at historic lows. Little is known about the movement and distribution of fish species throughout the gulf, making development of sustainable management plans difficult. The goal of this project is to investigate how spatial characteristics such as substrate and depth impact the distribution of economically important fish species such as cod and hake in the Gulf of Maine.

Data Collection

Ted Ames compiled historic fishing ground data from the 1920s through interviews conducted with fishermen and use of Walter Rich's "Fishing Grounds of the Gulf of Maine" . His work has resulted in a comprehensive map of historic fish population movements throughout the year, compiled within ArcGIS. Other historic distribution data were obtained from fall distribution maps for 1955 to 1961 published by the U.S. Bureau of Commercial Fisheries. The physical copies of the maps were georeferenced and digitized using ArcMap so they could be added to our data set of the historical distribution of fish species in the GOM (Figure 1).

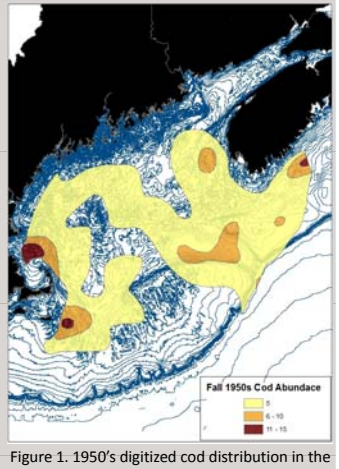

Figure 1. 1950's digitized cod distribution in the GOM.

Substrate data were obtained from a number of sources. However, no one data source covers the entire GOM and substrate data are reported differently by each source. The blue in Figure 2 represents substrate data points from recent studies by the University of Maine/Maine Geological Survey (inland polygons) and NOAA (offshore, single data points). The red polygons depict the historical fishing grounds compiled by Ames, which have substrate defined based on Rich's 1929 fishing ground descriptions and fishermen's accounts.

Substrate Comparison

The first task in our analysis of substrate was to standardize how substrate data was defined for the different data sets. Because the NOAA data set provided point data in areas where few fishing ground polygons are found, we focused on the recent data, provided by Joseph Kelley of the University of Maine, and historical data (from Rich and Ames). Ames developed a ranking system to identify substrate components of each fishing ground in percentages. For example, the "Broken Ground, BBH" ground seen in Figure 3 is defined by Ames as 50 % mud and 50 % rocks. Work in ArcGIS to edit the fishing ground polygons resulted in a layer with each fishing ground polygon possessing attribute data on substrate drawing from Ames and Rich's substrate data. Using the intersect tool in ArcMap, we created a layer of the substrate from the UM/MGS data set, that was restricted to areas contained by fishing grounds (Figure 3).

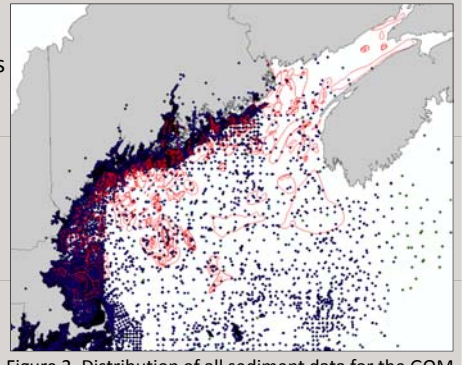
Figure 2. Distribution of all sediment data for the GOM.

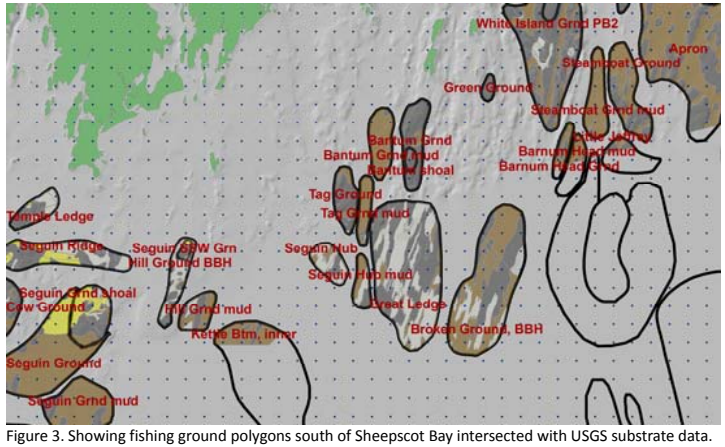

Figure 3. Showing fishing ground polygons south of Sheepscot Bay intersected with USGS substrate data. Shades of brown indicate mud, dark gray indicate rock, light gray indicate gravel, and yellow indicate sand. Bathymetry and the 1000 by 1000 point grid system are also visualized.

Results and Future Study

We were first interested in comparing the agreement between UM/MGS substrate definitions and historical definitions for fishing ground substrate. An example of this comparison is seen in Figure 4, which depicts the overall substrate percentages for the segment of grounds shown in Figure 3.

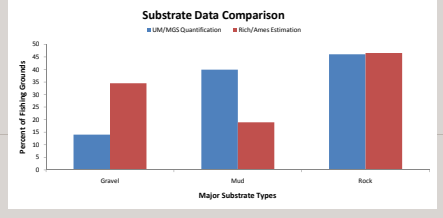

Figure 4. Comparison of major substrate types between historical and current data sets.

If there is a strong agreement between the historical (Rich/Ames) and current (UM/MGS) substrate definitions, it can be assumed that the fishing grounds not covered by the inshore UM/MGS substrate data are accurately defined by the historical substrate definitions. A 1,000 by 1,000 meter grid system (seen in Figure 3), generated in ArcMap using "Hawths Tools", was spatially joined with the fishing grounds file. The attribute data for each point can be defined to match the fields of the fishing ground which it overlays, allowing for spatial analyses concerning substrate, water temperature, historical abundance of fish species and other features of that location. This work will help identify critical habitat characteristics of different fish species as well as continue to add to our understanding of fish movement and life history in the GOM. More specifically, future points of interest for this study include multi-species interactions between the seven fish species that are included in the study. These advances will aid in future management and recovery plans for the Gulf of Maine.

Literature Cited

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