Using Temperature and Dissolved Oxygen Data to Identify Suitable Lobster Habitat in Long Island Sound

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Introduction

Lobster fishing has been an important part of Connecticut's economy and maritime culture for hundreds of years. Formerly a multi-million dollar industry, the Connecticut lobstering business has not recovered from the Long Island Sound lobster die-off of 1999. This widespread mortality event is thought to be the consequence of a number of factors, though fishermen and fisheries scientists agree that water temperature and dissolved oxygen levels are chiefly to blame. 16 years later, the Long Island Sound lobster population remains critically low and the annual CT landing continues to decline.

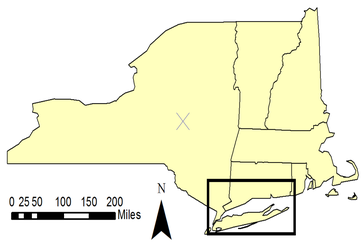
The purpose of this project is to produce a map identifying the areas of Long Island Sound that remain suitable for lobster fishing. Lobster distribution is most limited in late summer and early fall, when water temperatures can become restrictively high and seasonal hypoxic zones appear due to nutrient-rich runoff. The upper thermal tolerance level for lobsters is 20 °C , though temperatures warmer than 18 °C are considered stressful. Lobsters cannot survive in oxygen conditions less than 2 mg/L, though 4 mg/L is highly stressful.[1] Identifying areas subject to one or both of these conditions is important for fishery regulation.

[1]Balcom, Nancy and Penelope Howell. Responding to a Resource Disaster: American Lobsters in Long Island Sound. [http://seagrant.uconn.edu/publications/fisheries/lobsterpid.pdf].

Data Source: Connecticut Department of Energy and Environmental Protection

Methods

Data from the CT Department of Energy and Environmental Protection was obtained using the EPA STORET database. The data was condensed and edited in Excel to exclude water temperature values less than 15 °C (to better represent summer conditions) and values representing alternate methods of oxygen measurement. The tables were then imported into ArcMap, where XY data was displayed as points of latitude and longitude. A context map of southern CT and NY was created by clipping a U.S. map. The temperature and oxygen data was then converted to shapefiles, and the region of interest was defined by clipping a polygon shapefile to fit the Long Island Sound area. The IDW interpolation tool was used to create a raster for each of the shapefiles, and then the reclassify tool was used to assign value classes to the data based on habitat suitability. Finally, the raster calculator tool was used to create a sum raster containing 12 different classes of suitability. The data are presented in three figures (Fig.1, 2, 3) that display suitability based on water temperature, dissolved oxygen, and the sum of the two, respectively.



Results & Discussion

Based on the estuarine geography of Long Island Sound, strong suitability trends were expected. The eastern basin, which opens to the Atlantic Ocean, is continually flushed with cold, oxygen-rich water, while the central and western basins grow increasingly narrow and experience much less circulation with the Atlantic. Moving westward, the coastline grows increasingly urban and industrialized, which contributes to eutrophication and larger, more severe hypoxic areas. Although Figures 1-3 do not exhibit such strong gradual trends as expected, the lowest dissolved oxygen and the highest temperature values are located in the central and western basins, and many of the most suitable areas are in the eastern Sound.

The high variability and lack of a definitive trend in the data can be attributed to its quality and organization. The data was presumably collected at various times of year over many different research trips. Though the data tables were edited in attempt to isolate summer measurements, in reality, the time of collection is unknown. Ideally, data points would be evenly distributed across the Sound and all measurements taken at benthic depths to best represent conditions in lobster habitats. There are other factors affecting lobster abundance and distribution that could have also been included had the necessary data been available, including the prevalence of shell disease, nutrient concentrations, and larval recruitment success at various locations. Although limited by unspecific data, this project presents a viable model for measuring habitat suitability based on both single and summated parameters.

Fig.1 Long Island Sound Water Temperature (°C)

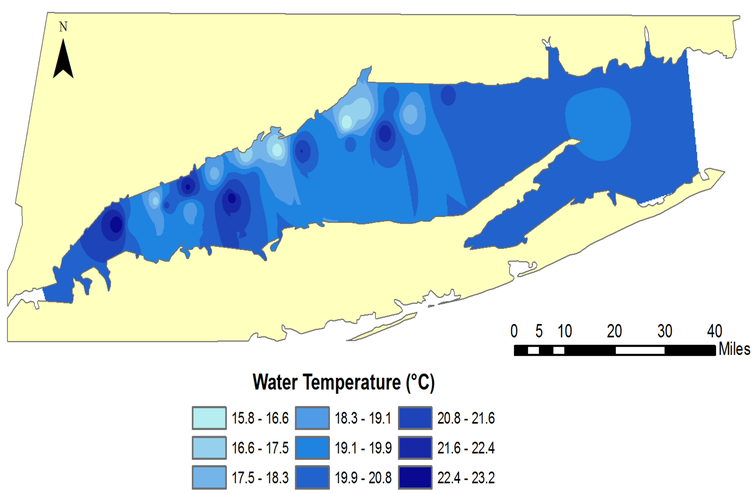


Fig.2 Long Island Sound Dissolved Oxygen (mg/L)

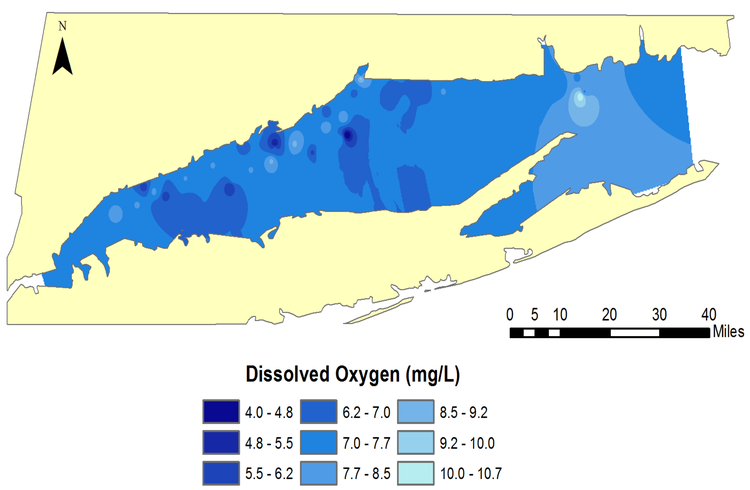


Fig.3 Long Island Sound Lobster Suitability as a Function of Water Temperature (°C) and Dissolved Oxygen (mg/L)