Physics, chemistry, and biology of the proposed LOC-NESS study site

The Northeast Shelf and Slope has been the focus of scientific research for nearly a century. As a result, there is abundant background data on the physical, chemical, and biological state of the ocean in the region. Research on the proposed LOC-NESS study location has shown that the field trial will have minimal impact on the marine environment and that work at the site is highly dependent on seasonal conditions.

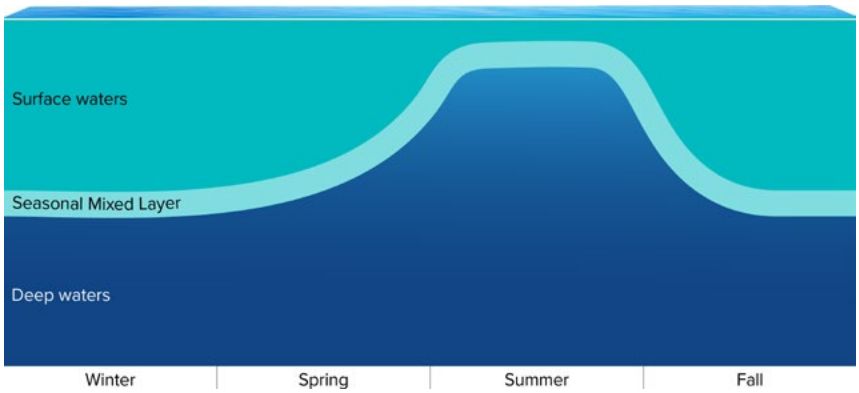


Figure 1: Stratification at the Wilkinson Basin is strongest during summer months, ensuring that dispersed alkalinity will remain at the surface and in contact with the atmosphere.

PHYSICS

For ocean alkalinity enhancement to be effective, the alkalinity added must remain on the surface to interact with the atmosphere and draw down carbon dioxide.

The best way to achieve this is to disperse alkalinity at a location where there is a shallow layer of warmer water on the surface. This often happens in the summer, when the ocean is stratified, with a warm, buoyant layer of water sits above colder water below.

The patch of ocean with elevated alkalinity will remain trapped at the surface above the Wilkinson Basin and will slowly spread, while remaining coherent as it dilutes with the surrounding seawater (Figure 2). We anticipate pH measurements returning to background conditions within about 5-6 days.

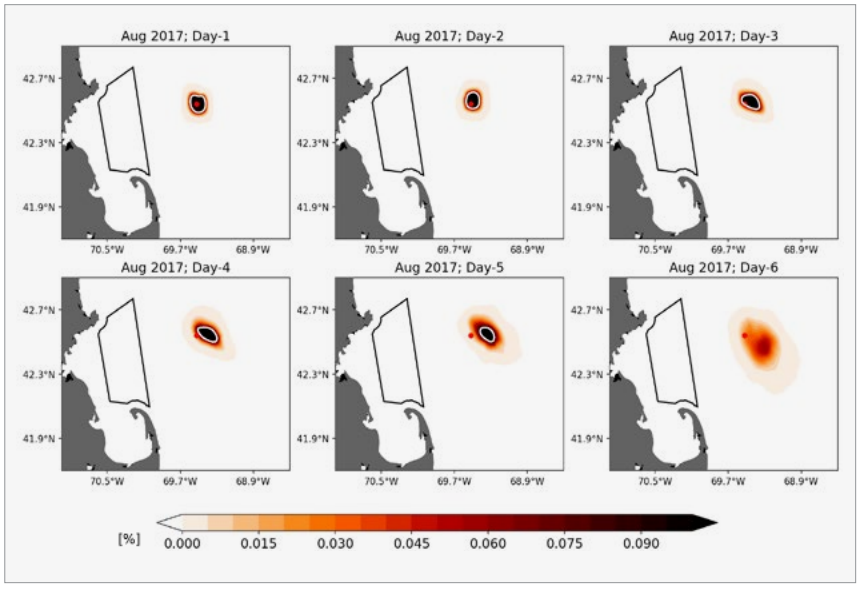


Figure 2: A series of ocean modeling experiments has shown where we expect the alkalinity patch to travel once it is released into the ocean at our proposed study site. The figures show the percentage of dye tracer and alkalinity remaining after dispersal, with the white circle showing the expected detection limit of 0.1%. Stellwagen Bank National Marine Sanctuary is shown for reference. (Guo et al. in review).

CHEMISTRY

Observations have shown that the Gulf of Maine has naturally low alkalinity (Figure 3), making it more susceptible to the impacts of ocean acidification and ideal for a field study of this kind. Any addition of alkalinity in the proposed study site will have a higher-than-average impact on carbon dioxide uptake and is one of the few places along the entire Northeast Shelf where the research team predicts that this carbon uptake can be directly measured.

BIOLOGY

This study has used background data to select a location with relatively low biological activity and human uses to minimize environmental societal impact. Analysis of these data have shown that, on average in the summer at the proposed study site, fewer than one larval fish and approximately 66,000 zooplankton can be found in every 100m^3 (26,400 gallons) of water.

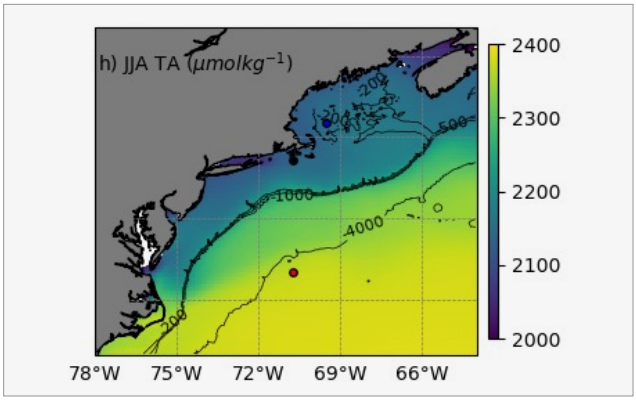
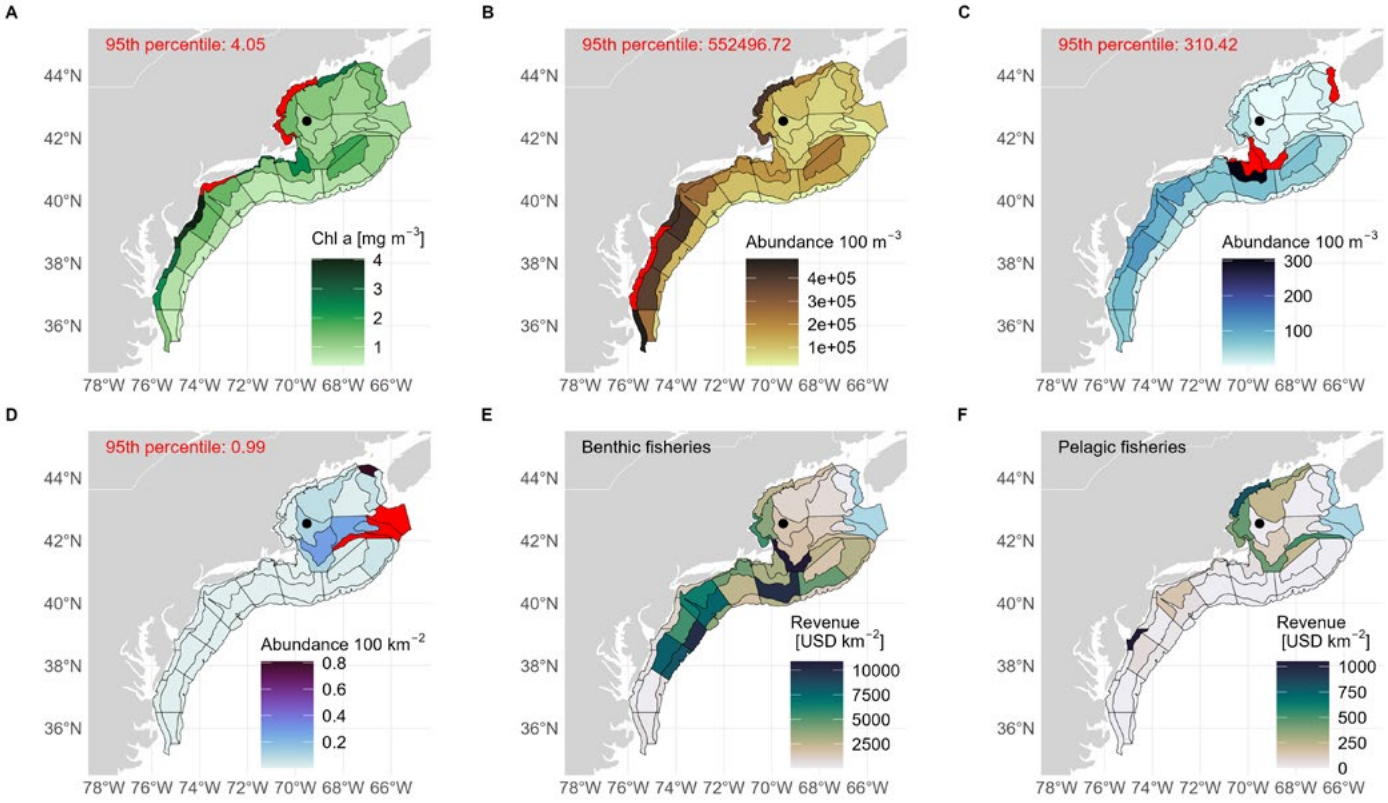


Figure 3 (above): Sea surface alkalinity of the Northeast Shelf and Slope region. (Rheuban et al., in prep.)

Figure 4 (below): These panels show the summertime distribution and abundance of (A) chlorophyll-a pigment, (B) zooplankton, (C) fish larvae, and (D) North Atlantic right whales, as well as (E) seafloor (benthic) and (F) water column (pelagic) fishing activity taken from the NOAA Fishing Footprints. The Northeast Shelf and Slope is divided into areas with similar geographic characteristics. Hotspots of biological activity are shown in red and the proposed study site is indicated by a black circle. (Marx, et al, in prep.)



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