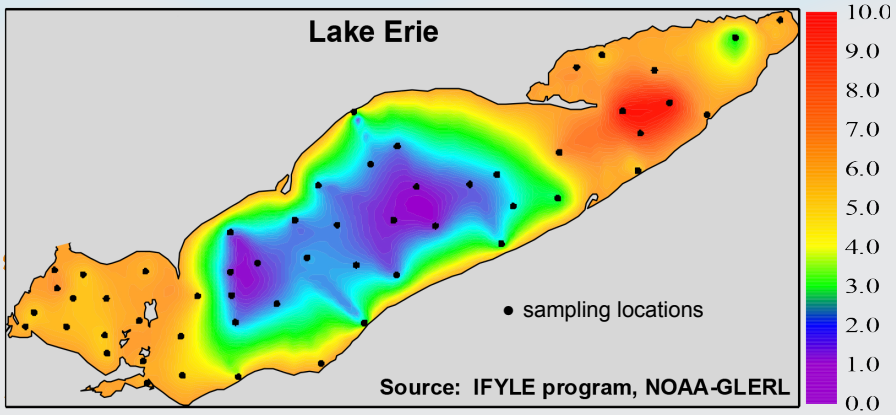
Experimental Hypoxia Warning System

Central Basin of Lake Erie at Cleveland, Ohio

The Lake Erie ecosystem faces a wide and varied range of threats to its health and integrity, including recurring low oxygen episodes generating hypoxic conditions in the central basin of the lake. Hypoxia is commonly defined as dissolved oxygen levels (DO) at or below the 2-4 mg/L range. It occurs in the bottom layer (called the hypolimnion) of some highly productive regions of the Great Lakes, such as Green Bay, Lake Michigan; Saginaw Bay, Lake Huron; and the central basin of Lake Erie.



Lake Erie hypoxic "Dead Zone" August 2005

Hypoxic conditions can occur in the central basin of Lake Erie as surface waters warm, leaving a layer of colder bottom water. The density difference between these two layers prevents oxygen-rich surface water from mixing into the bottom layer. As organic matter, such as algae, decomposes on the lake bottom, bacteria consume oxygen in the water column, also contributing to oxygen depletion. Research and monitoring indicates that the frequency and spatial extent of hypoxia is expanding with accelerated algae growth caused by human-induced nutrient enrichment resulting from rural and urban runoff.

Researchers at NOAAs Great Lakes Environmental Research Laboratory (GLERL) have developed quantitative tools to forecast the effects of hypoxia on drinking water supplies and living resources in Lake Erie.

MODIS satellite image, Lake Erie algal bloom. September 6, 2015. Credit: NOAA Great Lakes CoastWatch

The spatial extent of Lake Erie hypoxia, commonly referred to as the "dead zone" generally follows the lake bottom or bathymetric contours of the lake. However, wind induced internal waves and upwellings can facilitate movement of this zone. Periodically, the hypoxic zone can pass over water intakes, which can lead to water quality problems for over 2 million residents of northern Ohio near Cleveland.

NOAA GLERL's Hypoxia Website:

www.glerl.noaa.gov/res/HABs_and_Hypoxia

The NOAA GLERL Hypoxia Warning System is designed to provide a means of alerting water intake managers to changes in central Lake Erie that can impact drinking water quality. The system combines observed data, forecasted surface currents, and satellite imagery to provide real-time information about the potential transport of hypoxic water into water intakes for Cleveland and surrounding communities.

A Closer Look:

NOAA GLERL buoy in Lake Erie equipped with sensors to detect hypoxic conditions. Credit: NOAA

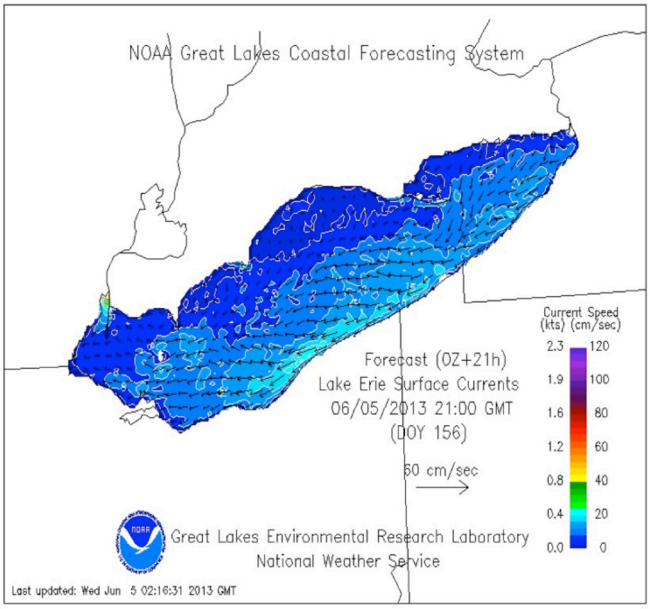
NOAA Great Lakes Environmental Research Laboratory
www.glerl.noaa.gov

EXPERIMENTAL ***Hypoxia Warning System -***
Lake Erie at Cleveland, Ohio

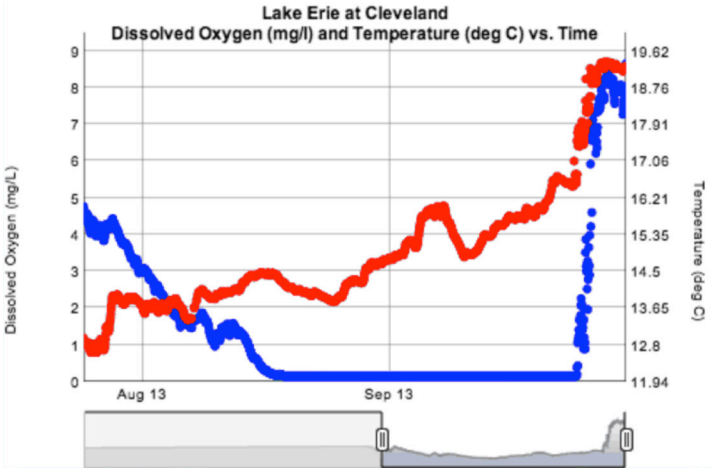
www.glerl.noaa.gov/res/waterQuality/clevelandBuoy.html

Features

- Lake Erie's surface current animation
- MODIS satellite imagery
- Lake Erie at Cleveland data plots:
  - Dissolved oxygen (mg/l) vs time
  - Temperature (°C) vs time
  - Temperature (°C) at various heights vs. time
  - Significant and maximum wave heights (m) vs. time
  - North water current measurements vs time
  - East water current measurements vs time



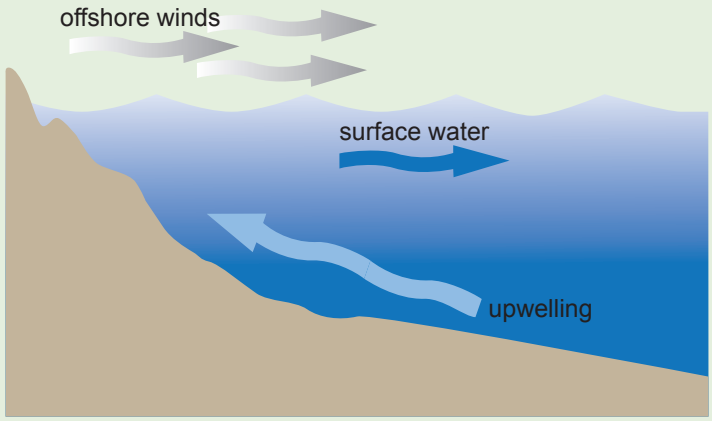
Circulation model output indicating the potential for an upwelling event.



Low oxygen conditions that occur with elevated temperature can result in an increase in anaerobic bacteria and can contribute to high level of manganese and iron in the hypolimnion that then leads to drinking water color, taste, and odor problems.

Upwelling

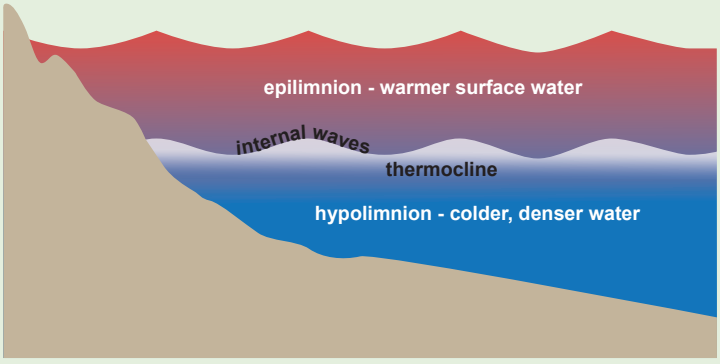
Upwelling is a phenomenon that occurs in the Great Lakes involving wind-driven motion of dense, cooler water towards the lake surface, replacing the warmer surface water. The driving forces for upwellings include the combination of persistent winds, the Earth's rotation (Coriolis effect), and restrictions on lateral movements of water caused by shorelines and shallow bottoms that induces upward and downward water movements.



Internal Waves

Internal waves are waves that oscillate within the lake, not at the surface. In the Great Lakes, internal waves develop at the thermocline where there is a marked change in temperature, and the water is stratified. During the summer, warm water, which is less dense, sits on top of colder, denser, deeper water, separated by a thermocline. The warm layer is called the epilimnion, and the cold layer is called the hypolimnion.

Internal waves can occur on the thermocline, causing the depth of the thermocline to oscillate. The waves move horizontally like surface waves, but more slowly. These internal waves can lead to redistribution of nutrients and minerals as well as the movement of the hypoxic zone.



FOR MORE INFORMATION:

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