

HOW IS FISH HABITAT AFFECTED? LAKE ERIE'S DEAD ZONE

by Zoe Almeida

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NUTRIENTS, ALGAE, AND LOW OXYGEN

Lake Erie's Dead Zone:

In the late summer and early fall, a massive algal bloom covers green water to cover the surface of western Lake Erie every summer. These algal blooms are fed by agricultural and urban run-off. Nitrogen and phosphorus from fertilizers and waste from distant cities enter the lake, stimulating growth of algae and other plankton. But not all of the effects of this excess pollution are as visible as green slime.

algae, covering oxygen. With most large amounts of algae being decomposed, the oxygen levels become depleted by the bacteria. The oxygen at the bottom of the water column is not replenished because the water column stratifies in the late summer, with warmer, less dense water not mixing with the cooler, denser water below.

LAKE ERIE "DEAD" ZONE

In Lake Erie, the hypoxic zone can be as large as 10,000 square kilometers and almost the lake's equivalent from July to October. These low oxygen areas are often referred to as "dead zones," because many mobile organisms leave the hypoxic zone, and many sessile organisms die without adequate oxygen. Fish are forced to leave the cooler, deeper waters to inhale new water with more oxygen, but paradoxically seek different prey and warmer temperatures. The impacts of these low oxygen environments on fish populations and the consequences for local commercial and recreational fishing economies are uncertain.

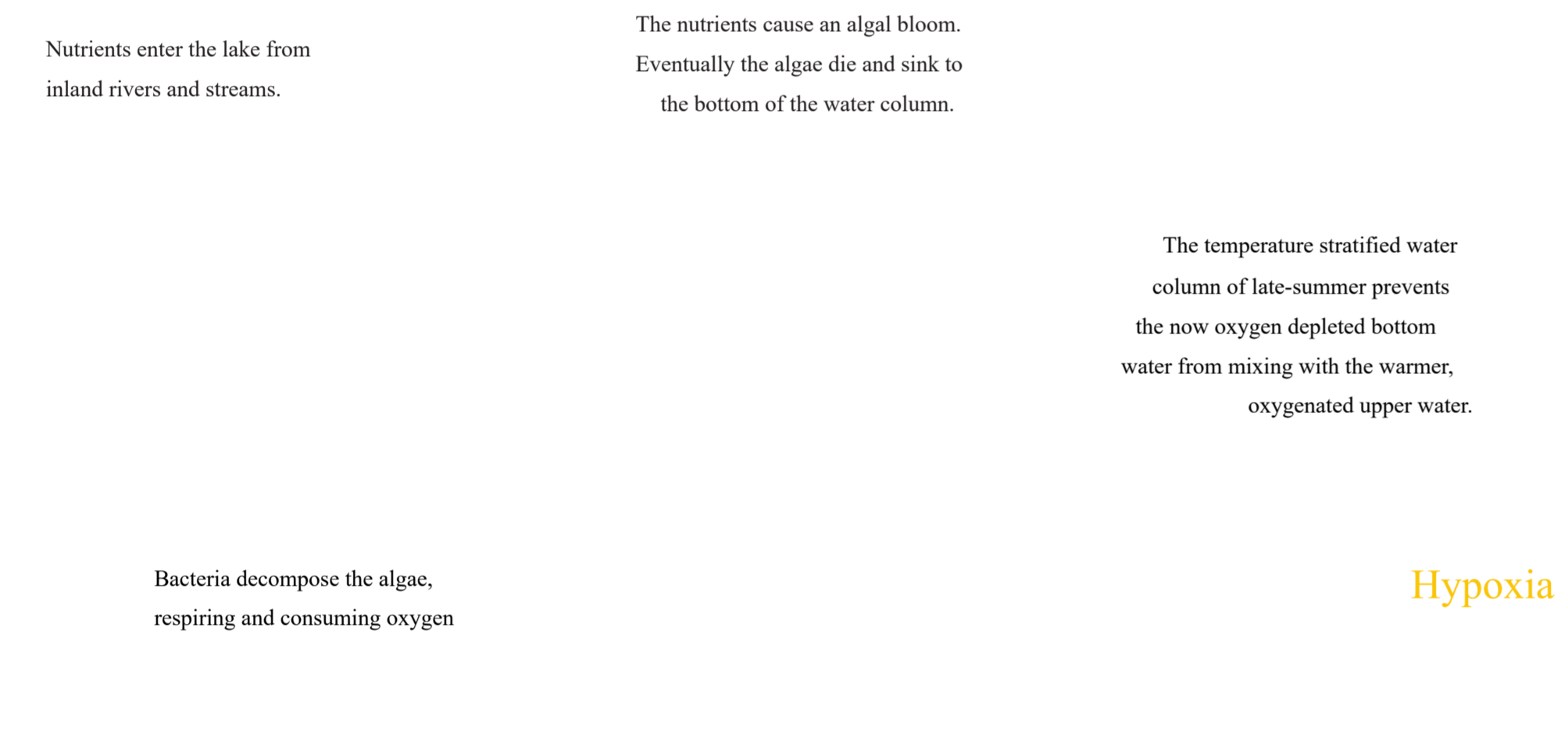
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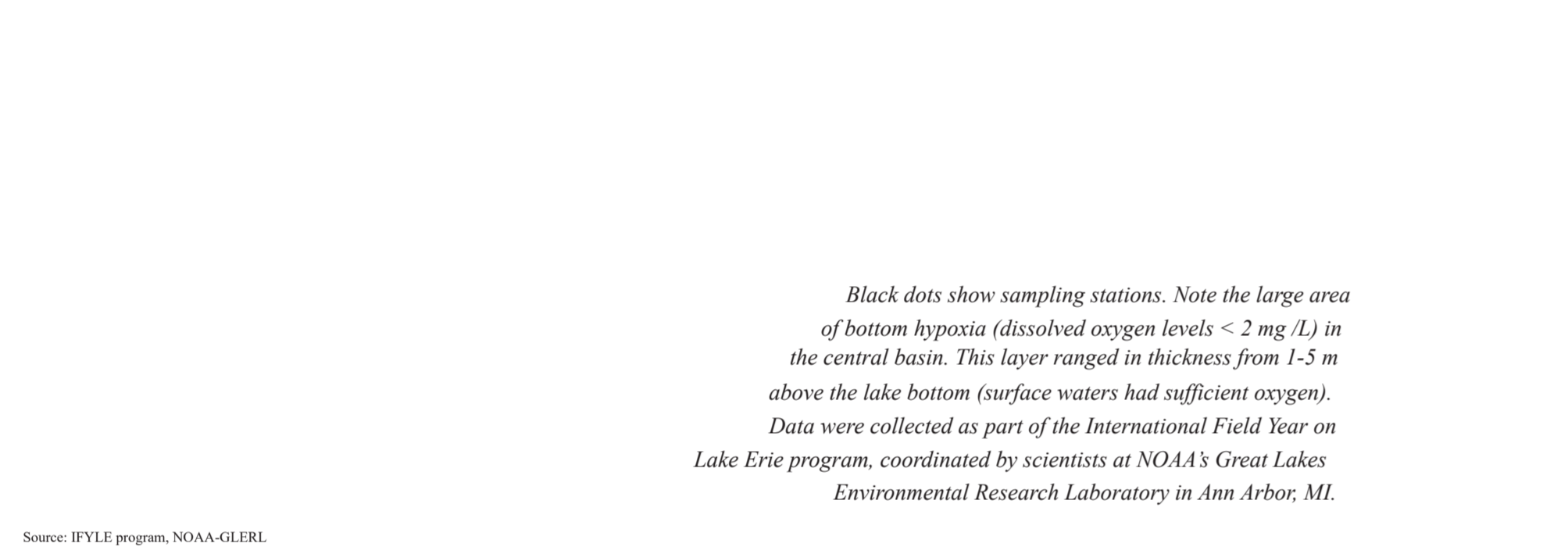
HOW A HYPOXIC ZONE FORMS

How a hypoxic zone, an area of depleted oxygen, forms in the bottom waters of Lake Erie's central basin.



DISSOLVED OXYGEN CONCENTRATIONS IN LAKE ERIE

Polychaete worms are found in oxygen concentrations (mg/L) in Lake Erie during September 7-11, 2005.



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HOW DOES LOW OXYGEN AFFECT FISH?

Because hypoxic zones do not typically kill fish directly through suffocation, their negative effects on fish can be difficult to understand. The most significant way hypoxic zones affect fish is by decreasing the amount and quality of habitat available. For habitat to be of good quality, it must meet the oxygen and temperature requirements of a fish. The habitat must also provide a fish with enough light to detect prey and enough prey to consume so that the fish can survive and grow. Because prey such as amphipods have their own oxygen, temperature, and light needs, high quality habitat for fish only occurs where these suitable habitat features overlap.

IMPACT ON HABITAT QUALITY

Dispersion of a column of water in Lake Erie's central basin throughout the summer and appropriate locations of fish based on modified habitat quality.



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CHANGES TO FISH HABITAT QUALITY

In order to identify how hypoxia alters the inter-actions between high quality habitat features in western Lake Erie, I worked with Dr. Tracya Schloesser to develop a computer model developed by Dr. Kevin Arnold that determines habitat quality for specific fish species. Our model quantifies how suitable a certain area of habitat is, given its physical characteristics and amount of prey found there. For yellow perch, rainbow smelt, emerald shiner and rock bass, we determined how the hypoxic zone altered habitat from 1987 to 2005. Additionally, we used our model to forecast how habitat may change for these fish in the central basin if nutrient loading increases or decreases.

Our model showed that during the late summer, when temperatures are warmer, most fish thrive at the bottom of the lake. In the cool, deep water, fish use less energy and can feed on blood-worm larvae. Unfortunately, at that time of year this area of high habitat quality becomes hypoxic, causing fish to move to other habitats, which might be of poorer quality. For our forecast scenarios, warmer water temperatures and more nutrients increase the amount of prey available and overall habitat suitability early in the year. However, our preliminary results show that the benefits early in the summer do not counteract the strong negative effects of a longer lasting and larger hypoxic zone during late summer.

THE FUTURE PROGNOSIS

Although farmers and cities are working to reduce the amount of nutrient pollution added to Lake Erie, we are unlikely to fully reverse the changes in climate. Our model allows for a better understanding of the impact of nutrient loading on Lake Erie's fish community. These types of predictive models can help managers anticipate what species may thrive in Lake Erie's central basin in the future.

GLOSSARY

- BENTHIC:** associated with the bottom of a body of water
- HABITAT:** the physical (temperature, oxygen, light, etc.) and biological (prey densities) components of a specific area of water
- HYPOXIA:** low dissolved oxygen concentration often defined as below 2 mg/L
- PLUMGIC:** associated with open water
- STRATIFICATION:** a separation of water layers, in this case due to a difference in temperature
- THERMOCLINE:** the zone between the warmer upper part and the cooler lower part of the water column

ABOUT THE AUTHOR

Zoe Almeida is a graduate student in the Department of Forestry and Natural Resources at Purdue University. Her research interests include the effects of hypoxia on fish in Lake Erie. She is studying the water quality and habitat quality of Lake Erie through laboratory experiments.

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Old Woman Creek National Estuarine Research Reserve (OWCNER) is managed as a cooperative partnership between the Ohio Department of Natural Resources, Division of Wildlife and the National Oceanic and Atmospheric Administration (NOAA). OWCNER is one of 29 coastal reserves connected nationally through NOAA to address state and regional coastal management needs through research, education, and stewardship. The National Estuarine Research Reserve System uses its network of living laboratories to help understand and find solutions to crucial issues facing America's coastal communities.

The mission of OWCNER is to improve the understanding, stewardship, and appreciation of Great Lakes estuaries and coastal wetland ecosystems. Integrated Reserve research, education, and stewardship programs address threats to Great Lakes coastal wetland ecosystems including nitrogen and phosphorus pollution, aquatic invasive species, habitat loss, and climate change. OWCNER provides laboratories for ecological research and education and training to support decisions and actions that benefit Lake Erie ecosystems.

OWCNER publishes the OWCNER Technical Reports series to provide consultants with information derived from Great Lakes coastal research, management, education, and outreach projects conducted in partnership with and/or at OWCNER.

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The Old Woman Creek National Estuarine Research Reserve is part of the National Estuarine Research Reserve System (NERRS), established by Section 315 of the Coastal Zone Management Act as amended. Additional information about the system can be obtained from the Estuarine Research Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 1305 East West Highway - NCEM, Silver Spring, MD 20910.