CSMI Cooperative Science and Monitoring Initiative

Tracking Oxygen in Lake Erie's Central Basin

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Imagine going about your day, walking the neighborhood with not a care in the world, when suddenly it becomes hard to breathe. Confused and a little scared, you turn around, wondering if maybe something is wrong with the local gas lines. You note with relief that breathing is getting easier again as you move away from that particular road. When city workers check out the area a few hours later, the air is clear and nothing out of the ordinary is found.

Sounds strange, right? For Lake Erie fish, a scenario like this isn't as far-fetched as it may seem.

Hypoxia, an area of low-oxygen water, develops in the central basin of Lake Erie during the summer and early fall. It's caused when bacteria at the lake bottom decompose dead algae and use up oxygen in the process faster than it can be replenished from the surface or from photosynthesis. When combined with stratification – the formation of a sharp border between an upper warm layer and a cold bottom layer of water – that region of the lake becomes hypoxic (low in oxygen) or even anoxic (no oxygen). This can lead to fish kills and other negative impacts on the ecosystem.

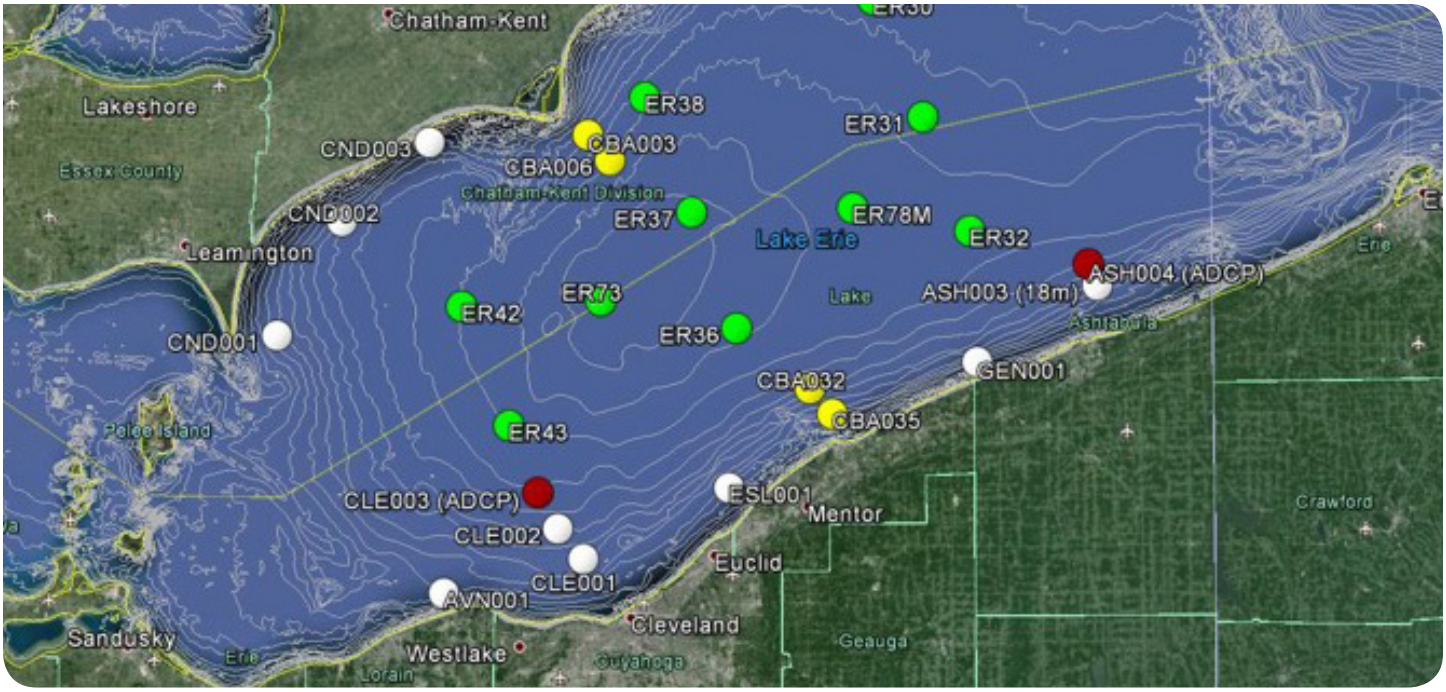
The central basin is one of three distinct parts of Lake Erie's depth profile, which also includes the shallow western basin and the much deeper eastern basin. Because the central basin's average depth is only about 18 meters, and the thermocline tends to form at around 15 meters of depth, it's the most prone to developing hypoxia that impacts life at the bottom of the lake.

Monitoring data have shown that hypoxic waters don't always remain in one place – water currents and waves can shift the edges of hypoxia into a shallow area and back out again in a matter of hours, potentially killing fish that were trapped in that area when hypoxia developed and that now can't escape that intrusion of low-oxygen water.

Researchers from the Environmental Protection Agency (EPA) monitored water movement and oxygen concentrations at the 14-16 meter depth, where it's most likely for hypoxic water to intrude into shallower areas with normal oxygen concentrations. Organisms that live there aren't adapted for those lower oxygen levels, so it's also where those intrusions can have serious negative impacts on aquatic life that can't survive these conditions for more than a few minutes.

To measure how hypoxia moves around the central basin, the EPA team, with help from the Ohio Department of Natural Resources (ODNR) and the U.S. Geological Survey (USGS), placed dissolved oxygen monitoring equipment across a 7800 km^2 area (the size of almost 1,500 football fields). The 25 dissolved oxygen "trackers" were located between Lorain and Ashtabula along the Ohio coast and between Point Pelee and just below London, Ontario on the Canadian coast, where they recorded dissolved oxygen

Automated data loggers recorded dissolved oxygen concentrations every ten minutes for about six months, from before the onset to hypoxia in late June to the end of October, when lake water mixes again.



Loggers covered about 7800 km², ranging throughout most of Lake Erie's central basin.

content in the water in 10-minute intervals for about six months, from before hypoxia tends to set up in late June to after fall turnover in October, when the water in the basin mixes thoroughly again.

Putting all of the measurements together – a task requiring assistance from the University of Illinois' National Center for Supercomputing Applications due to the hundreds of thousands of data points involved – the researchers confirmed what they were expecting: the layer of hypoxic water on the bottom of the lake was sloshing around enough to move into oxygenated areas near the lake bottom for a few hours before being pushed back again. (An animated video of the oxygen concentrations during the study period is available from the research team.)

Those changes in dissolved oxygen can have a number of impacts on Lake Erie's aquatic inhabitants. Research has shown that fish move in response to hypoxia because they don't want to be caught up in low-oxygen conditions, and they tend to congregate near the edges of the low-oxygen zone, trying to stay near the cooler water on the lake bottom while avoiding the hypoxic area. That means predatory fish may actually have an advantage, because, their prey is concentrated in shallower areas with better light where they're easier to see and hunt, instead of being distributed randomly along the darker lake bottom. And it's not just predators that are affected by those behaviors. Crews on commercial fishing boats have reported that having some hypoxia in the lake can lead to higher catches, as intrusions of low-oxygen water "push" those congregated fish into stationary nets. On the other hand, the August sample trawls that assess how many fish are present in Lake Erie each year may come up with skewed numbers if hypoxia pushes fish away from the regular sampling sites set up by ODNR and USGS.

Because of the shape of the central basin, hypoxia is a natural phenomenon and unlikely to ever go away completely. However, human-caused algal blooms and the decomposing algae they produce tend to make the problem worse, so recommendations for reducing blooms are also likely to help address excessive hypoxia.

In the meantime, the team is using data from yearly hypoxia studies like this one and joining forces with NOAA's Great Lakes Environmental Research Laboratory to develop a model of hypoxia in Lake Erie that will be able to forecast intrusions of low-oxygen water before they happen. The goal is to provide municipal water treatment plants with advanced warning of a pulse of hypoxic water near their water intakes, so they can prepare their treatment plans accordingly. Low-oxygen water isn't exactly dangerous to consumers, but there are issues with its mineral content and odor that have to be addressed before the water can be sent on to consumers.

The Cooperative Science Monitoring Initiative (CSMI) is an yearly coordinated monitoring program between the US and Canada to support the restoration and protection of the waters of the Great Lakes and led by the GLWQA Science Annex to address the science priorities of the Lakewide Management Annex.