# TESTIMONY OF

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THE OHIO STATE UNIVERSITY**

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## "The Dead Zone in Lake Erie: Past, Present and Future"

My name is Jeffrey M. Reutter. I have been doing research on Lake Erie, studying this wonderful resource, and teaching about it since 1971. I am the Director of the Ohio Sea Grant College Program (part of NOAA), the F.T. Stone Laboratory (the oldest freshwater biological field station in the country), the Center for Lake Erie Area Research (CLEAR), and the Great Lakes Aquatic Ecosystem Research Consortium (GLAERC). I have held these positions since 1987. I am here today to speak to you about the area of anoxia in the middle of Lake Erie, the so-called "Dead Zone." To do this I need to tell you a little about all of the Great Lakes, how Lake Erie differs from the other Great Lakes, and a little basic limnology so you can understand the problem.

But first, while this is a very complex issue, the take-home message from my testimony is simple. Due in part to changes brought about by invading species, zebra and quagga mussels, I am concerned that we are seeing indications that Lake Erie is heading back to the conditions of the "dead lake" years in the 1960s and early 70s. We must determine if that assessment is accurate, and if accurate, we must identify corrective actions and take them. Finally, we must recognize that Lake Erie may be a model for many other bodies of water in this country, and we must transfer the knowledge we gain from this lake to prevent the same thing from occurring in other locations in this country.

The Great Lakes hold 20% of all the freshwater in the world and 95% of the freshwater in the United States. The US shoreline of the lakes is longer than the Atlantic Coast, Gulf Coast and Pacific Coast, if we leave out Alaska. Approximately 30% of the US population lives around these lakes.

Lake Erie is the southernmost and shallowest of the Great Lakes. As a result, it is also the warmest. It also provides drinking water to 11 million people each day. The other Great Lakes are all in excess of 750 feet deep, and Lake Superior is 1,333 feet deep. The deepest point of Lake Erie is 212 feet in the eastern basin, off Long Point. As a result, Lake Erie is the smallest of the lakes by volume, and Lake Superior is 20 times larger than Lake Erie. The watersheds around the other four Great Lakes are all dominated by forest ecosystems. The watershed around Lake Erie is the home to 14 million people and is dominated by an agricultural and urban ecosystem. As a result Lake Erie receives more sediment and more nutrients than the other Great Lakes. Now, if Lake Erie is the southernmost, shallowest, warmest, and most nutrient enriched of the Lakes, we should expect it to be the most productive of the Great Lakes. It is. In fact, we often produce more fish for human consumption from Lake Erie than from the other four lakes combined.

Lake Erie has gone from being the poster child for pollution problems in this country to being one of the best examples in the world of ecosystem recovery. A little over 30 years ago, 1969, the Cuyahoga River burned and Lake Erie was labeled a dead lake. Nothing could have been further from the truth. In reality the Lake was too alive. We had put too many nutrients into the Lake from sewage and agricultural runoff. These nutrients had allowed too much algae to grow, and that algae, when it died and sank to the bottom, had used up the dissolved oxygen in the water as the algae was decomposed by bacteria. This sequence is a natural aging process in lakes called eutrophication, but man had accelerated the process by 300 years by putting in too much phosphorus. It is very similar to what we are seeing today in the Gulf of Mexico, but the problem in salt water is nitrogen.

Scientists divide the Lake into three basins based on significant differences in shape and depth. The Western Basin is the area west of Sandusky and has an average depth on only 24 feet. The Eastern Basin is the area east of Erie, Pennsylvania and contains the deepest point in the Lake. The Western and Eastern Basins have irregular bottoms with a lot of variation in depth. The Central Basin is the large area between Sandusky and Erie. The average depth of this basin is between 60 and 80 feet and the bottom is very flat. Unfortunately, it is this shape that causes this basin to be the home of the Dead Zones.

Many of you have probably experienced swimming in a pond and noticed that the deep water was much colder than the surface water. This layering with warm water on top because it is less dense and lighter, and cold water on the bottom because it is heavier, is very common in the Great Lakes. The warm surface layer is called the *epilimnion*. The cold bottom layer is called the *hypolimnion*. The line of rapid temperature change between the layers is called the *thermocline*. In Lake Erie, these layers form in the late spring and break up in the fall when the surface layer cools to the temperature of the bottom layer—normally around September or October.

In Lake Erie, the thermocline usually forms around 45-55 feet. Based on the depths of the three basins, this means the Western Basin is too shallow to have a thermocline except on rare occasions, the Eastern Basin will have a thermocline and there will be a lot of water below it in the cold hypolimnion, and the Central Basin will have a thermocline but there will be a very thin layer of cold water under it in the hypolimnion.

At the time the thermocline forms, there is plenty of dissolved oxygen in the hypolimnion. However, due to its depth, there is often no way to add oxygen to the water in the hypolimnion until the thermocline disappears in the fall. Therefore, throughout the summer the oxygen that was present when the thermocline formed is used by organisms living in this area, including bacteria, which are decomposing algae as it dies and sinks to the bottom. If large amounts of algae are dieing and sinking, then large amounts of oxygen will be required for the decomposition process. It should then seem logical that if we could reduce the amount of algae, we could reduce the amount of oxygen that would be required to decompose the algae.

Because the Western Basin seldom has a thermocline, this is not a problem there. And, because the Eastern Basin is so deep, there is a large reservoir of oxygen in the hypolimnion—enough to last through the summer until the thermocline disappears in the fall. The Central Basin, however, does not have a large reservoir of water or oxygen in the hypolimnion because the basin is not deep enough. As a result, loss of all the oxygen, or anoxia, can be a serious problem in the bottom waters of the Central Basin. Areas of anoxia were first observed as early as 1930, and by the 1960s and 1970s, as much as 90% or the hypolimnion in the Central Basin was becoming anoxic each year. This is why Lake Erie was labeled a "dead lake." When an area becomes anoxic, nothing but anaerobic bacteria can live there. Also, this water creates severe taste and odor problems if it is drawn in by water treatment plants servicing the population surrounding the Lake.

To reduce the amount of algae in the Lake, we needed to reduce the amount of the limiting nutrient. By "limiting nutrient," I mean the essential nutrient that is in the shortest supply. Without this nutrient algae cannot grow and reproduce. In freshwater this nutrient is phosphorus. In 1969, we were loading about 29,000 metric tons of phosphorus into Lake Erie each year. Our models told us that in order to keep dissolved oxygen in the Central Basin, we needed to reduce the annual loading of phosphorus to 11,000 metric tons. This was accomplished and the recovery of the Lake has been truly remarkable. The walleye harvest from the Ohio waters jumped from 112,000 in 1976 to 5 million in 1988 and the value of this fishery exceeds the value of the lobster fishery in the Gulf of Maine. Small businesses associated with charter fishing increased from 34 in 1975 to about 900 today, and Lake Erie became the "Walleye Capital of the World."

Then on 15 October 1988, we documented the first zebra mussel in Lake Erie. Recognizing the significance of this discovery, Ohio Sea Grant initiated a research project on 15 November to document the expansion of the mussels. One year later, the densities in the Western Basin had reached 30,000 per square meter. Their impact was so great that in 1993 I addressed the International Joint Commission and asked them to create a special task force to try to understand the huge changes that were occurring in Lake Erie. I was asked to be US Co-Chair of the Lake Erie Task Force for the International Joint Commission from 1994-1997 as we developed models to better understand the impact of the zebra mussel on the ecosystem of the Lake.

In 1998 I formed the Phosphorus Group, a group of about 50 scientists from the US and Canada to discuss phosphorus levels to determine if they might have gotten too low and were harming the fishery—at that point the walleye fishery had been reduced by about 60% and the smelt population had been decimated. This group concluded that based on changes in the system caused by zebra mussels, adding more phosphorus would create more zebra mussels and more inedible, blue-green algae.

At the end of 1998, Drs. Jan Ciborowski (University of Windsor), Murray Charlton (National Water Research Institute of Canada), Russ Kreis (US EPA) and I formed the Lake Erie at the Millennium Program to continue to lead discussions and focus attention on the huge changes that were occurring in Lake Erie. We have documented a number of new invaders to the Lake, including the round goby, and have observed the gradual transition from zebra mussels to quagga mussels.

In the mid-1990s, US EPA's Great Lakes National Program Office (GLNPO) observed an increase in phosphorus levels in Lake Erie and the increasing trend has continued. They also observed areas of anoxia in the Central Basin that showed indications of growth. In 1996 we observed a bloom of blue-green algae in the Western Basin—an indication that phosphorus levels were high. In 2001 we saw more indications that dissolved oxygen levels were critically low, and we observed that mayfly larvae had been eradicated from several regions—a clear indication that oxygen had been eliminated. We also observed reduced water transparency over the artificial reefs we had worked with the City of Cleveland to produce from old Brown's Stadium—another indication of an anoxic hypolimnion.

The above information was shared with the GLNPO and they asked me to bring together a group of Lake Erie experts for a meeting in their Chicago offices on 13 December 2001 to discuss the problems we were observing in Lake Erie and strategize about solutions. As a result of this meeting, GLNPO issued a call for research proposals in January 2002 and they are currently funding a one-year project lead by Dr. Gerry Matisoff, Case Western Reserve University, and the four scientists mentioned above from the Millennium Program, to attempt to better understand the dissolved oxygen problem in Lake Erie.

We believe the oxygen problem is real and that it is growing. We believe it is caused by excess phosphorus, but we also believe zebra mussels and quagga mussels are having an impact because they appear to alter the way phosphorus cycles through the system. I also wish we had better loading estimates for phosphorus, because it is possible that loads are increasing.

Finally, I must mention global warming and climate change because that is also exacerbating the dead zone problem in Lake Erie. When I first started working on this lake, water levels were increasing and we often said, "dilution is the solution to water pollution." This is no longer the case. Since 1997 the water level has gone down by 3-4 feet. We are currently near the long-term average water level for Lake Erie, but we are lower than we have been for over 30 years. This is important because this reduction comes primarily from the hypolimnion (the cold bottom layer). Therefore, as the water level goes down, the volume or thickness of the hypolimnion is reduced, the oxygen reservoir in the hypolimnion is reduced, and, as a result, the area of anoxia will increase and last longer each year. This will hurt fish populations, the charter and commercial fisheries (Lake Erie supports the largest freshwater commercial fishery in the world), our boating and tourism industries, and public health.

As for my predictions for this year, I hope I am wrong, but I fear that this could be a very bad year. We had a very wet spring. This means we probably received large loadings of phosphorus from agricultural runoff and from sewage treatment plants—many of our systems still have combined storm and sanitary sewers allowing untreated sewage and the nutrients it carries to enter the Lake every time we have a storm. Water levels have remained very low so the hypolimnion will not have a large reservoir of oxygen. Together these things mean we could experience a very large dead zone.

We need your support to rapidly do the necessary research to confirm our beliefs about this situation. The current GLNPO study should be expanded and continued for at least two more years. We also need to accurately measure phosphorus loading to all of the Great Lakes on a continuing basis. We need research to determine how best to reduce phosphorus loading. We need to prevent future introductions of aquatic nuisance species. We need to determine if there is a link between the dead zone and the botulism problems we are observing in the Eastern Basin. We need to do the best we can to solve these problems with our current technologies, but we also need support for research on new technologies to: address the oxygen problem, control zebra mussels and other aquatic nuisance species, remove nutrients at sewage treatment plants, reduce agricultural runoff, etc.

I believe Lake Erie is the sentinel and we should develop models to extrapolate our results to other bodies of water that contain mussels so they can be prepared for the problem and take preventative action before it occurs.