UF UNIVERSITY of FLORIDA
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SGEF-189

Effects of Climate Change on the Eutrophication of Lakes and Estuaries[1]

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Summary: Recent research suggests that climate change will reinforce the negative consequences of man-made eutrophication and make it more difficult to improve water quality in lakes and estuaries.

What is eutrophication and how is it affected by our actions?

Eutrophication occurs when the amounts of nutrients such as nitrogen and phosphorus increase in lakes, estuaries, and other ecosystems, and those ecosystems respond with increased growth of plants and algae. Lakes and estuaries with high levels of nutrients are said to be eutrophic. Eutrophic conditions can occur naturally. Some Florida lakes have naturally high concentrations of nutrients simply because the nutrients occur at high levels in their regional soils and bedrock. In other areas of the state, nutrient levels are naturally low or occur at an intermediate level.

Human activities, such as sewage plant discharges, leaky septic tanks, and fertilization of lawns and farms, can transport more nutrients to lakes and estuaries than would be there naturally. This can change those ecosystems, especially if they naturally are nutrient poor. Excess inputs of nutrients can stimulate noxious algae blooms, cause reduced oxygen levels in the water, and even change the fish to unfavorable species like shad and catfish. When this cascade of events occurs, the situation is called cultural or man-made eutrophication.

Cultural eutrophication is harmful, but it can be reversed if the nutrients come from easily identified point sources such as sewage treatment plants or septic systems. It is far more difficult to control nutrients if they come from diffuse sources such as large land areas with fertilized crops, lawns, or animal pastures.

Figure 1. A bloom of blue-green algae on the water surface in the St. Lucie Estuary, Fla.
Credits: Ed Phlips, UF/IFAS Fisheries and Aquatic Sciences

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How will eutrophication be affected by climate change?

New research indicates that the symptoms of cultural eutrophication in lakes and estuaries will be made worse by climate change, adding to the challenge of restoring water quality and biological health. Eutrophication problems will worsen if climate change causes higher water temperatures in lakes and estuaries, as is predicted to occur in many areas of the world.

In a recent paper on eutrophication and climate change, a group of international experts (Moss et al., 2011) raised the following major points.

About algae blooms in lakes, estuaries and coastal rivers:

- Blue-green algae, which cause noxious blooms in lakes and estuaries (Figure 1), are favored both by increased nutrients and higher water temperature.
- Lakes with warmer water will have higher densities of fish species that eat zooplankton, the microscopic animals that normally feed on and control algae.
- A particular kind of zooplankton (*Daphnia*) that is very effective in controlling algae is most susceptible to being eaten by fish, and it is also highly sensitive to warming water (Figure 2).
- Eutrophication reduces the ability of zooplankton to control algae because it leads to dominance by blue-green algae, which is harder to feed on and digest.
- As a result, climate change *and* eutrophication together will limit the ability of zooplankton to control algae, reinforcing the potential for harmful blooms.

About fish habitat:

- Higher nutrient levels lead to loss of the submerged aquatic plants that provide good habitat for fish. At higher temperatures, even low levels of nutrient enrichment can cause such plant loss. Once again, nutrient enrichment and climate change combined make eutrophication problems worse.

Figure 2. Microscopic photograph of a *Daphnia*, a zooplankton that eats algae and can be used to manage eutrophication. Credits: Karl Havens.

About the input of nutrients from the land surrounding lakes and estuaries and from the sediments within those water bodies:

- Rising temperature increases nutrient inputs to lakes and estuaries by increasing the rate of nutrient release from soils and conversion of nutrients into forms that can be easily used by algae.
- Rising water temperature leads to increased rates of bacterial activity, which deplete oxygen from the water and stimulate release of nutrients already present in the bottom sediments.

Figure 3 illustrates how climate change can accelerate the symptoms of eutrophication. The processes involved are complex, but water resource managers must understand them and take them under consideration in order to improve the quality of our lakes and estuaries in a future with a changing climate. If our water warms, we may need to further reduce our nutrient inputs to achieve the same water quality outcomes that were anticipated without a changing climate. Existing nutrient standards may be insufficient to protect lake and estuary ecosystems from cultural eutrophication.

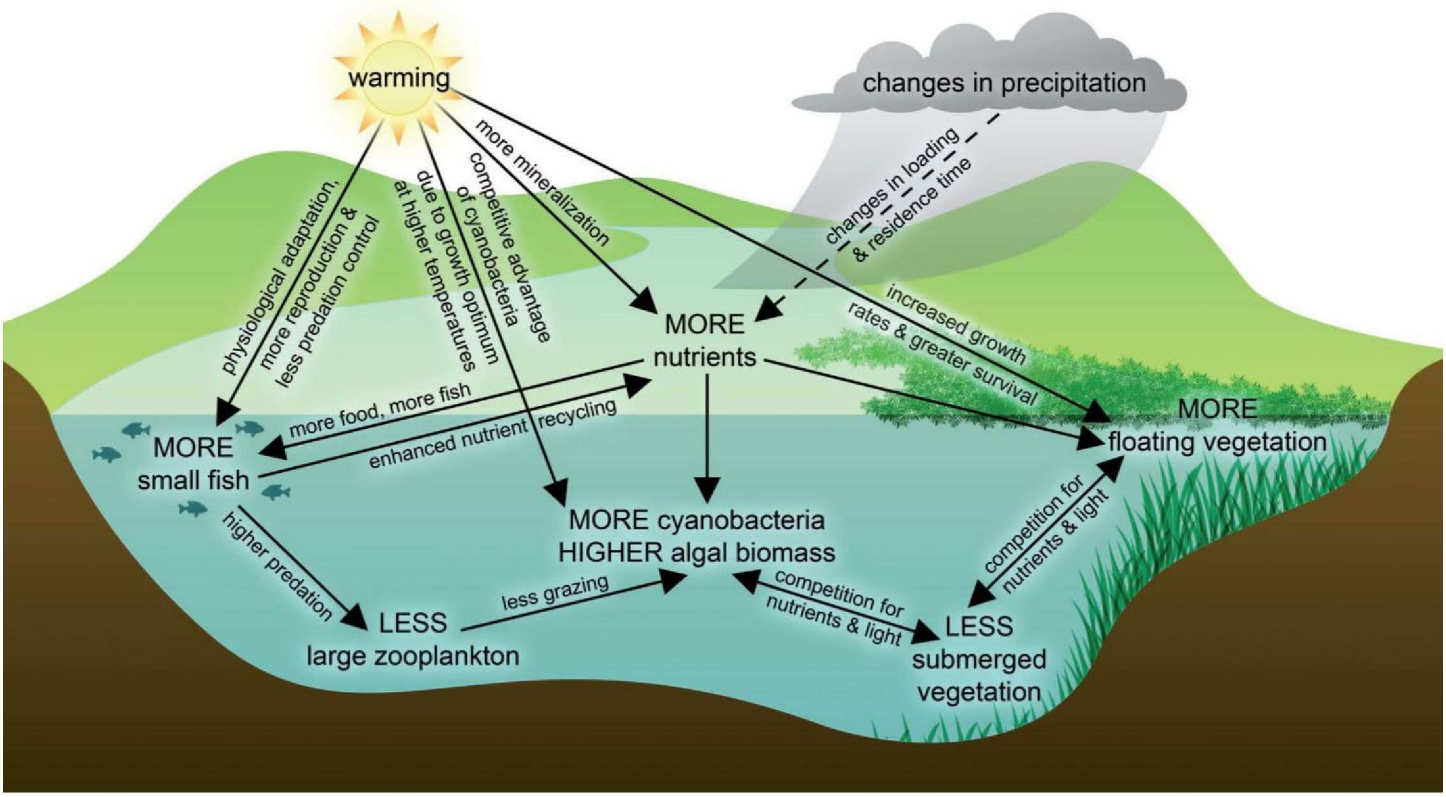

Figure 3. Diagram illustrating how climate change can affect lakes and estuaries, ultimately stimulating more growth of potentialy harmful blue-green algae.
Credits: Reprinted from Inland Waters, with permission of the editor.

Reference

Moss, B., S. Kosten, M. Meerhoff, R.W. Battarbee, E. Jeppesen, N. Mazzeo, K. Havens, G. Lacerot, Z. Liu, L. De Meester, H. Paerl and M. Scheffer. 2011. Allied attack: climate change and eutrophication. *Inland Waters* 1: 101-105.