ALGAE

Phosphorus and Algal Blooms

How did our Great Lakes turn green?

GREAT LAKES FACT SHEET

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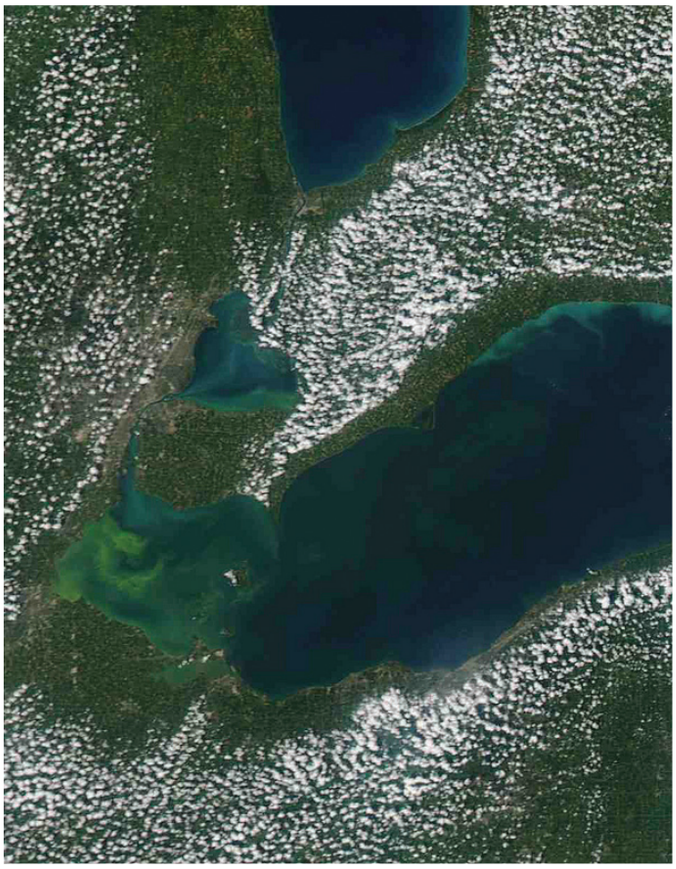
Background

By the mid-20th century, the phosphorus compounds entering the Great Lakes from agricultural and urban runoff, industrial discharges, untreated sewage, detergents and atmospheric deposits had helped to create the ideal conditions for the proliferation of algae.

In the 1970s, Lake Erie was said to be "dying" due to large algal blooms. Following research conducted by the International Joint Commission (IJC) into the causes of the algal blooms, the governments of Canada and the United States established the Great Lakes Water Quality Agreement (GLWQA) in 1972. Central to this agreement were commitments to limit phosphorus discharges into the Great Lakes. Further provisions to reduce phosphorus were added in the GLWQA's 1978 amendments. The agreement was amended again in 2012, in part to address the ongoing threats posed by algal blooms, with a primary focus on Lake Erie.

Between 1968 and 1985, Canada and the U.S. reduced annual discharges of phosphorus to the Great Lakes from 28,000 to 11,000 tonnes by limiting the amount of phosphorus allowed in detergents, investing in improved municipal wastewater treatment and encouraging soil conservation and sound management practices on farms.



WHAT ARE ALGAL BLOOMS?

Algae are simple, rootless plants that are a natural component of freshwater ecosystems. Most species of algae are not harmful to the surrounding environment and are an important source of food for fish and small aquatic organisms.

Warm temperatures, light and a supply of nutrients, including phosphorus and nitrogen, are key factors contributing to the growth of algae. Phosphorus plays a particularly important role in algal growth. Without phosphorus, algae cannot grow, but too much phosphorus can produce dense populations or overgrowths, often referred to as algal blooms. Some algal blooms are relatively harmless while others can have significant harmful effects on the surrounding ecosystem.

There are two types of algal growth that are of particular concern for the Great Lakes. Cladophora is a long, hair-like algae that grows on hard surfaces. It prefers a shallow water environment and is found largely in nearshore regions of the lakes. Cladophora can form mats that rob nearshore zones of oxygen, particularly as the plants decay. It can also wash ashore, mixed with decaying zebra mussels, other invertebrates and fish, which makes for unsightly and foul-smelling beaches. Research has shown that Cladophora mats may also sustain or even nourish the growth of bacteria, including *E. coli,* from gull droppings, sewage overflows, and urban and agricultural runoff.

The second type of algal growth of concern, blue-green algae, is sometimes referred to as a harmful algal bloom because the blooming organisms contain toxins or other noxious chemicals or pathogens. Blue-green algae are, in fact, a type of bacteria (cyanobacteria) that are of concern due to the wide range of toxins they can produce.

Historically, there have been successful initiatives undertaken to manage algae. However, new variables, including climate change, invasive species and changes in land use and agricultural practices, have resulted in an algal resurgence affecting the lakes. In 2011, Lake Erie experienced the worst algal bloom in decades. While algal blooms are of particular concern in Lake Erie, nutrient loading (the quantity of nutrients entering an ecosystem in a given period of time) and excess algal growth remain an issue throughout the Great Lakes, particularly in coastal areas. Reports in the summer of 2012 of blue-green algal blooms in Lake Superior, where problems with algae are rare, are an indication of the widening scope of the problem.

HOW DO ALGAL BLOOMS AFFECT THE GREAT LAKES?

Algal blooms ...

- **alter the aquatic food chain and affect habitat:** Algae are part of the phytoplankton community – single-celled marine plants that form the base of the aquatic food chain. Excessive algal growth alters the composition of the community by outcompeting other types of phytoplankton, which in turn reduces their availability as a food source for fish populations. When algal blooms die, they can sink to the bottom of the lake where their decomposition uses up oxygen in the surrounding water. In combination with seasonal variation in water temperature, this can contribute to low oxygen areas or "dead zones," where fish and other marine life cannot survive. Algal fouling can also degrade fish spawning and nursery habitats.

- **produce toxins:** The toxins associated with harmful algal blooms can be of concern for the health of humans, wildlife and livestock. Potential symptoms of exposure in humans include skin rashes, blisters, sore throat, difficulty breathing and other reactions. In severe cases, liver toxicity, neurotoxicity, gastrointestinal problems or even death can occur.

- **harm fisheries:** Commercial and sport fisheries can be adversely affected by algae. In addition to altering the aquatic food chain and fish habitat, algae can damage fishing nets by attaching to them, resulting in below-average fish catches.

- **impact quality of life:** Algae can interfere with the recreational and aesthetic enjoyment of waterfront areas and decrease waterfront property values. Dead algae often wash up on shore, where they collect and rot, fouling beaches and shoreline areas.

- **increase infrastructure maintenance costs:** Water infrastructure maintenance is a significant expense for municipalities and industry around the Great Lakes, and water intake pipes clogged by algae result in costly cleanups. Water treatment plants also incur additional costs because of the need to treat water contaminated with toxins that are linked to algae.

CHALLENGES AHEAD

While some sources of phosphorus have been controlled with considerable success, the management of phosphorus in the Great Lakes faces both new and ongoing challenges.

Combined sewer overflows and sewage treatment plant bypasses: Phosphorus contained in human wastes can enter the Great Lakes by way of combined sewer overflows or sewage treatment plant bypasses. Combined sewer systems collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. During periods of heavy rainfall or snowmelt, the wastewater volume in a combined sewer system can exceed the capacity of the system, and untreated wastewater is discharged directly into nearby bodies of water. Sewage treatment plant bypasses operate in a similar way to discharge partially treated or untreated wastes when the capacity of a plant is overwhelmed by extreme weather. In 2006, combined sewer overflows were responsible for releasing an additional 90 billion litres of raw sewage into the Great Lakes. Conservative estimates indicate that in 2007, approximately 8.3 billion litres of untreated sewage and stormwater entered the Great Lakes through sewage treatment plant bypasses.

Phosphorus discharges: While phosphorus deposits into the lakes originating from some sources, such as industry, have been reduced as a result of technological improvements and better management practices, nutrient loadings and runoff do still occur. Non-point sources of phosphorus – releases of phosphorus from multiple sources such as urban or agricultural runoff, septic system effluent and lawn fertilizers – can be more difficult to manage than those originating from point sources such as an individual industrial facility. Because of the intensification of farming techniques, agricultural runoff in particular remains a significant contributing source of phosphorus in the Great Lakes. Population growth in the region contributes to increased urban runoff into the lakes as well.

Invasive species: Algal resurgence may have been exacerbated in some areas of the Great Lakes by the presence of invasive zebra and quagga mussels. Typically, after phosphorus is deposited into the lake, it makes its way into deeper water, away from the shoreline. It is thought that zebra and quagga mussels have altered this process by taking up phosphorus in their diet and excreting it in a soluble form near the shoreline. In addition, the mussels' ability to filter particles that normally cloud the water allows light to penetrate further down the water column, promoting plant growth in deeper water. Finally, zebra mussels encourage toxic algal blooms by ingesting forms of algae that would normally compete with them.

Climate change: As the frequency of extreme weather increases with climate change, greater volumes of untreated water from agricultural and urban runoff are entering the lakes, contributing to elevated levels of phosphorus. Climate change also contributes to the warmer water temperatures that are conducive to algal overgrowth. Warmer temperatures and flooding related to climate change have been linked to the algal blooms recently found in Lake Superior.

WHAT IS BEING DONE?

In addition to the GLWQA, the following are a few examples of strategies that address the issue of algae in the Great Lakes:

International Collaboration

» **The State of the Lakes Ecosystem Conferences (SOLEC):** These conferences are held by the U.S. Environmental Protection Agency and Environment Canada every two years. The *State of the Great Lakes 2009* report focused in particular on nearshore areas, nutrients and harmful algal blooms.

» **Lake Erie Binational Nutrient Management Strategy (2011):** The governments of Canada, the U.S. and Ontario have completed an assessment of nutrients in Lake Erie and are collaborating on a Lake Erie Binational Nutrient Management Strategy to address phosphorus levels in the lake. This strategy is one example of the Lakewide Management Plans (LaMPs) that are in place under the GLWQA to address key Great Lakes issues, such as algae.

Federal Initiatives

» **Great Lakes Nutrient Initiative (2012):** This initiative supports the advancement of the science necessary to address the complex issue of recurrent toxic and nuisance algae in the Great Lakes, with a focus on Lake Erie.

» **Canadian Environmental Protection Act, 1999 (CEPA 1999):** Effective July 1, 2010, new federal regulations under CEPA 1999 require further reductions of phosphorus content in detergents and household cleaners.

Federal-Provincial Collaboration

» **Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem (COA):** This agreement, ratified in 1971 and currently being updated to reflect recent amendments to the GLWQA, makes provision for the federal and provincial governments to work together on issues related to the Great Lakes, including algal blooms.

» **Growing Forward (2008):** This program offers cost-share opportunities for farmers to encourage the advancement of sound environmental practices in agriculture. It will be succeeded by a new five-year agreement, Growing Forward 2, to be launched in 2013.

Provincial Initiatives

» **Ontario's Nutrient Management Act (2002):** This act outlines standards and management practices for all generators of materials that contain nutrients, including phosphorus.

WHAT CAN YOU DO?

- **Reduce or eliminate the use of fertilizers:** Fertilizer is a potential source of phosphorus entering the Great Lakes. Use natural fertilizers, such as compost, instead.
- **Help reduce stormwater overflows:** To reduce runoff, connect your downspout to a rain barrel or allow it to drain into your garden, and minimize the flow of water over impermeable surfaces such as asphalt.
- **Maintain your septic system:** Without regular maintenance, septic systems can fail and contaminate surrounding water sources with excess nutrients, such as phosphorus, found in wastewater.
- **Make informed purchasing decisions:** Where possible, make food choices that support sustainable agricultural practices and measures to reduce agricultural runoff, and buy household products that are phosphorus-free.
- **Get involved:** Look for opportunities to get involved in public consultations on important issues such as algal blooms and on agreements and legislation related to the Great Lakes. Urge government, businesses and other organizations to take action on Great Lakes issues.

SELECTED RESOURCES

For more information about algal blooms and the Great Lakes, consult the following resources:

Environment Canada. Great Lakes Nutrient Initiative. **http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=4FF37866-1**

Environment Canada. Phosphorus and Excess Algal Growth. **http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=6201FD24-1**

Health Canada. Blue-Green Algae (Cyanobacteria) and their Toxins. **http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/cyanobacter-eng.php**

Ontario Ministry of the Environment. Information about blue-green algae: Background, potential impacts to human health and safety of drinking water. **http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079454.pdf**

Ontario Ministry of the Environment. Blue-green algae: Information for cottagers and home owners. **http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079455.pdf**

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PHOTOS

Background: The light green areas in this satellite image of Lake Erie show the extent of algal blooms in the western end of the lake. NOAA Great Lakes Environmental Research Laboratory. Used with permission.
http://www.glerl.noaa.gov/pubs/photogallery/about.html