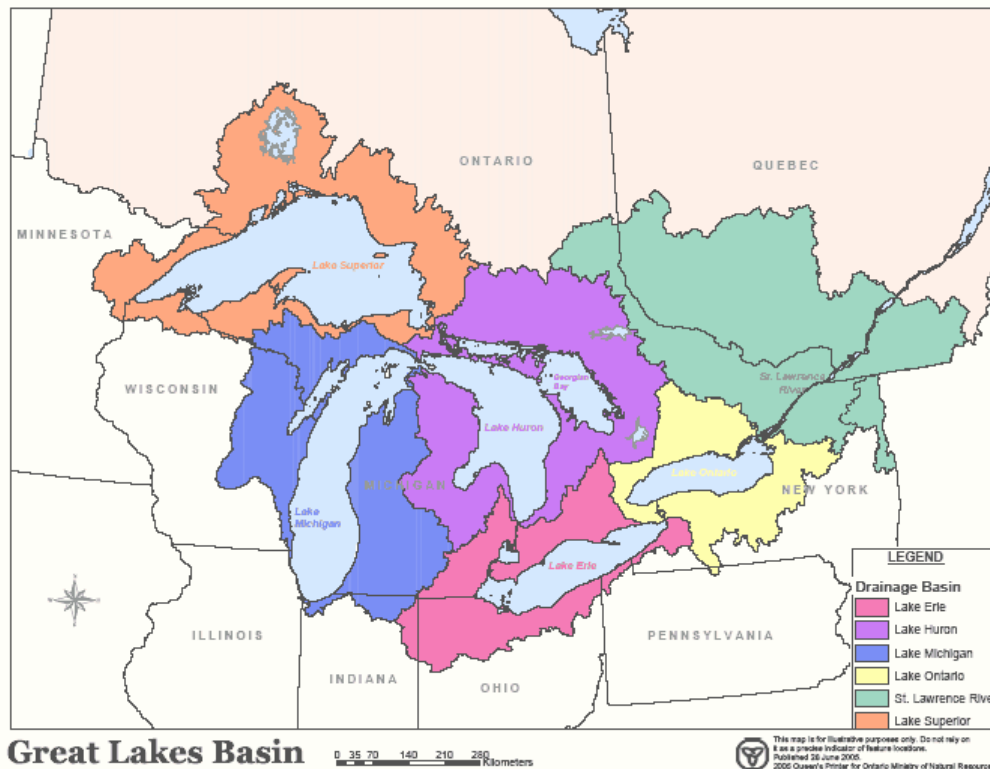


THE GREAT LAKES

The Great Lakes are a set of five lakes in Canada and the United States, connected by approximately 5,000 tributaries. The five lakes are Lake Superior, Lake Michigan, Lake Huron, Lake Erie and Lake Ontario. The Great Lakes basin includes two countries, eight states, one province, dozens of tribes and First Nations communities and hundreds of local municipal and regional governments. The map below shows the five lakes, as well as the drainage basin for each. The drainage basin (or watershed) of a lake is the surrounding area, where runoff and base flow (from groundwater) flow into the lake. For more information about groundwater and aquifers, see the [Groundwater](#) fact sheet.



The Great Lakes Basin

The Great Lakes are a very important water supply; they are the largest system of freshwater in the world, containing nearly 20 percent of the world's surface freshwater, which is the equivalent of 23,000 cubic kilometres of water. The Great Lakes have an area of 244,000 square kilometres, with a total drainage area of 745,600 square kilometres. The Great Lakes were formed about 14,000 years ago, when the glaciers retreated. Today, the Great Lakes are used by more than 30 percent of Canadians and contribute to half of Canada's manufacturing output and billions of dollars in trade.

One interesting fact about the Great Lakes is that only about one percent of the water in the lakes leaves the basin each year, through the St. Lawrence River. Because the Great Lakes are essentially a closed system, the pollutants that are dumped into the Great Lakes remain there, and become concentrated over time. And there are a substantial number of pollutants that are entering the Great Lakes in large quantities.

Though the five lakes are part of one system, each one has significantly different characteristics that influence the quality of the lake and aquatic life. Lake Superior is the largest, deepest and coldest lake; in fact, it holds as much water as the other four lakes, combined with an additional three Lake Eries. Because Lake Superior is so large, it can contain larger quantities of contaminants before it is noticed, but it also takes longer to remove the harmful contaminants, because it holds so much water. However, Lake Superior is in relatively good health, compared with the others, because it is in a forested area with little urbanization, industry or agriculture. Lake Michigan is the only Great Lake that is completely in the United States boundaries. The second largest in volume, Lake Michigan is surrounded by the world's largest concentration of pulp and paper mills in the north, and the most urbanized area in the Great Lakes area in the south. The northern region of Lake Michigan receives a great deal of wastes from the mills, and the south receives pollution from the eight million people in the Milwaukee and Chicago areas.

Third largest in volume, Lake Huron is surrounded by urban areas, forested regions and intense agricultural operations. Lake Ontario is largely influenced by industrial operations and urbanization, as Hamilton and Toronto are located on the shore of the lake. Lake Erie is the smallest, shallowest and warmest lake of the five, and has suffered the most from urbanization and intense agriculture. The lake receives a great deal of agricultural runoff, which adds nutrients, including phosphorus and nitrogen to the lake, and encourages excess algae growth.

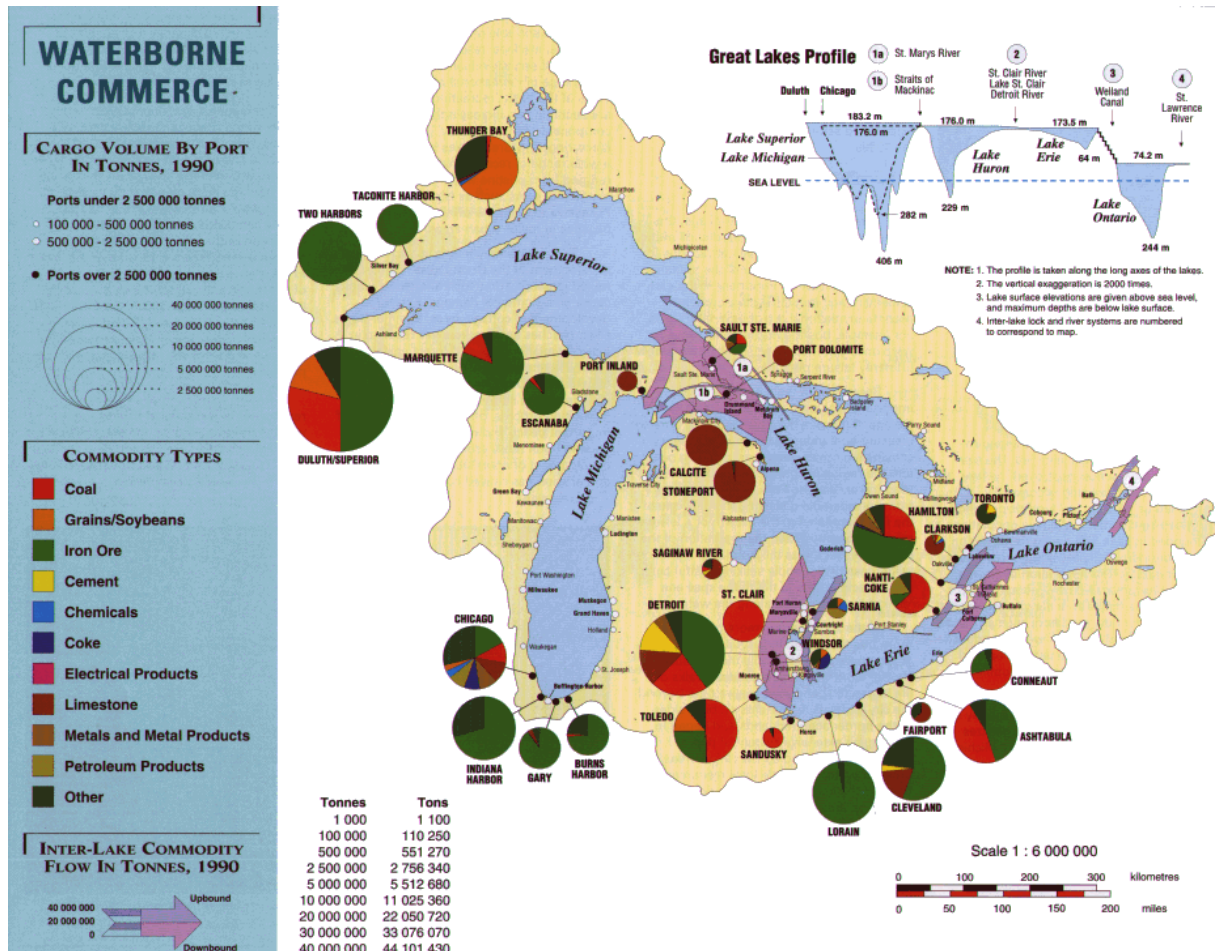
What kinds of pollutants are being put into the Great Lakes?

There are approximately 35 million people in the Great Lakes area, and that results in a lot of domestic waste, with a relatively small area to dispose of it in. In fact, a 2006 study revealed that 20 evaluated cities (representing one-third of the region's population) produced more than three trillion litres of waste in one year. That is equal to 1.2 million Olympic swimming pools of waste. More than 90 billion litres of the waste that is dumped into the Great Lakes each year is untreated sewage. That is the equivalent of dumping more than 100 Olympic swimming pools of raw sewage into the Great Lakes each day!

The United States laws require secondary wastewater treatment, but there is no corresponding Canadian federal law. Many wastewater treatment facilities in the Great Lakes are combined sewer systems, which collect stormwater (from runoff into street gutters) and domestic wastewater (everything that is put down the drain or flushed down the toilet) together. During periods of heavy precipitation and runoff, the wastewater treatment facility becomes overloaded and redirects flow to water sources, even though the waste hasn't been treated. This can also happen during maintenance and power outages. In 2001, Ontario reported 144 significant bypasses.

Regarding the waste that is treated and released into the Great Lakes, many pollutants can survive the treatment process. For example, steroids (anti-inflammatory drugs), non-prescription drugs, insect repellent, detergent metabolites and plasticizers have been found in potentially dangerous concentrations in many lakes and streams across Canada and the United States. Over 360 chemical compounds, including DDT and mercury, have been found in the Great Lakes. For more information about emerging pollutants, the ways in which wastewater is treated or water pollution in general, see the fact sheets regarding [Emerging Contaminants](#), [Wastewater Treatment](#) and [Water Pollution](#).

There is also a high concentration of industrial activity in the Great Lakes area. The map below shows the location of industrial facilities in the region. The larger circles represent a greater amount of industrial activity in the region, and each region is also broken down into the types of industrial activity that are prevalent in the area. Lake Superior is much less affected by industry, compared with the southern portion of the Great Lakes system.



Locations and Concentration of Industrial Operations in the Great Lakes Area;
<http://www.epa.gov/glnpo/atlas/images/big08.gif>

Industry pollutes the Great Lakes through wastewater and air pollution. Excessive air pollution can result in acid rain. Measurements have found that about 20 percent of the phosphorus that enters Lake Michigan is from atmospheric deposition. For more information about atmospheric deposition, see the [Acid Rain](#) fact sheet. Agricultural runoff also adds pollutants to the Great Lakes, particularly in the form of excess nutrients, including nitrogen and phosphorus, which can lead to algae blooms.

Due to intense agricultural practices and phosphorus in detergents, all five lakes have experienced excess algae growth. Lake Erie was the first to show the signs of severe eutrophication, in the 1960s. Eutrophication is a process in which a lake ages and becomes more nutrient-rich. Without nutrient pollution, this process takes thousands of years. Nutrients that were added to Lake Erie caused it to undergo the eutrophication process in only 25 years. Lake Erie is the smallest, warmest and shallowest of the Great Lakes, and it is surrounded by

agricultural operations, urban areas and industries. Phosphorus acts as a fertilizer, and encourages plant growth. When the plants die, they settle to the bottom and decompose, using up the oxygen in the lake. When this happened to Lake Erie, many people thought the lake was “dead,” because oxygen was depleted, fish and aquatic life couldn’t survive, the lake appeared mossy and slimy, and it smelled bad. To clean up the lakes, The Great Lakes Water Quality Agreement was developed in 1972, between the United States and Canada. As a part of the agreement, phosphorus levels were reduced. Currently, phosphorus levels in Lakes Superior, Huron and Michigan are all below the maximum allowable concentration, and Lakes Erie and Ontario are both below (but near) the maximum allowable concentration. For more information about the amendments and additions that were made to the Great Lakes Water Quality Agreement over the year, see the fact sheet called [Cleaning Up After Pollution](#).



Algae in Lake Erie;

<http://www.noaanews.noaa.gov/stories2006/s2734.htm>

In fact, when Dr. Suess wrote “The Lorax” in 1971, one part of the story originally went like this:

You’re glumping the pond where the Humming-fish hummed!
No more can they hum, for their gills are all gummed.
So I’m sending them off. Oh their future is dreary.
They’ll walk on their fins and get woefully weary
in search of some water that isn’t so smeary.
I hear things are just as bad up in Lake Erie.



The Lorax

In 1974, the final line about Lake Erie was removed, after the lake was cleaned up.

What’s the bad news?

A Canadian study by Sierra Legal graded 20 Canadian and American cities on their wastewater treatment facilities. There were four Canadian cities in the top ten and seven Canadian cities in the bottom ten. The cities of Kingston, Sault Ste. Marie and Windsor (all in Ontario) were the

only three cities to have wastewater treatment facilities that were capable of only primary treatment, which only removes up to 55 percent of fecal coliforms from the water! There were more American cities than Canadian cities that had adequate phosphorus removal processes. It has been estimated that between \$30 billion and \$40 billion are needed over the next 15 years to bring Ontario water and wastewater treatment systems to effective treatment levels.

The Great Lakes have been receiving large quantities of many harmful substances for many years. Even after laws are developed to limit the amount of pollution, it takes many years before the lake can return to normal. Many toxic substances can bioaccumulate as they move up the food chain. This means that, while the chemical concentration may be low in the water, it may be a little more concentrated in a minnow, a little more concentrated in a small fish, and a little more concentrated in a larger fish, and so on. By the time the food chain reaches birds and other animals that eat fish, the concentration of toxic substances may be very high. In many of the states and in Ontario, there are warnings against human consumption of certain fish, because the toxins can be so concentrated that people would become ill. According to the Environmental Protection Agency, the toxins in Lake Michigan were so concentrated in the mid-1990s that one meal of lake trout from Lake Michigan would expose a person to more PCBs than they would be exposed to if they drank lake water for their entire life!

Another area of concern is the biodiversity of the aquatic life in the Great Lakes. The balance of the aquatic ecosystem in the Great Lakes has been disturbed with the introduction of exotic species. Non-native plants and animals have eliminated certain species of native plants and animals. This change may not seem significant, but it can significantly change the habitat of the lake over time.

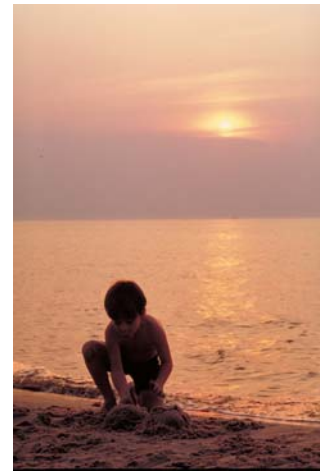


Warning Sign of Polluted Water on the Great Lakes;
<http://www.epa.gov/glnpo/atlas/glat-ch4.html#1>

Is there any good news?

There is some good news. The concentrations of some chemicals, like polychlorinated biphenyls (PCBs; used as cooling and insulating fluids in industrial transformers) and polycyclic aromatic hydrocarbons (PAHs; emitted through the burning of fossil fuels) are decreasing, but it will take between 10 and 30 years to completely eliminate them from the water. The Great Lakes have been described as a giant set of lungs, which have finally been given a chance to exhale. In other words, the atmospheric concentrations of PCBs have decreased enough to allow the chemical to evaporate from the water. Between 1992 and 1996, the Great Lakes released ten tonnes more of PCBs than were put into them.

The Great Lakes Water Quality Agreement was a great turning point in the poor quality of the Great Lakes. There is still a great deal of pollution that enters the Great Lakes, but the improvement so far has shown that the efforts are not futile. Most areas of concern are near cities and industries, where pollution is more concentrated. In many regions, stringent waste disposal regulations are being developed and applied, and agricultural practices are being observed, so that runoff and sediment pollution can be minimized. The Great Lakes are an extremely important water source to Canadians and Americans, as well as to the world. It is very important that the lakes be protected, so that they can continue to provide safe drinking water for the 35 million people in the Great Lakes region, as well as sustainable industry and agriculture.



Recreation on the Great Lakes

The Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class. Operation Water Flow looks at how water is used, where it comes from and how much it costs; it has lessons that are designed for Social Studies, Math, Biology, Chemistry and Science classes. Operation Water Spirit presents a First Nations perspective of water and the surrounding issues; it is designed for Native Studies or Social Studies classes. Operation Water Health looks at common health issues surrounding drinking water in Canada and around the world and is designed for a Health, Science and Social Studies collaboration. Operation Water Pollution focuses on how water pollution occurs and how it is cleaned up and has been designed for a Science and Social Studies collaboration. To access more information on these and other educational activities, as well as additional fact sheets, visit the Safe Drinking Water Foundation website at www.safewater.org.

Resources:

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