WATER LEVELS

The Great Lakes

WATER LEVELS

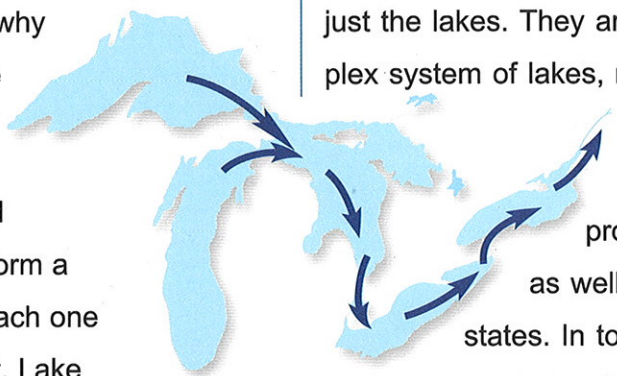
Ontario region

One spring, Lake Erie's water levels rose to the point that when a storm hit, the waves pounding the shoreline caused $5 million in damage to cottages, homes and dikes. By the following spring, the water levels in Lake Erie had dropped 60 centimetres. Marina owners were worried the water would not be deep enough for some boats to dock.

Water levels in the Great Lakes rise and fall all the time. They have been doing so since the glaciers retreated about 10 000 years ago. Most changes in water levels are natural, but some are the result of human activities. The purpose of this fact sheet is to provide some background about the Great Lakes and St. Lawrence River and to explain why their water levels rise and fall.

The Great Lakes and St. Lawrence River form a chain of lakes with each one draining into the next. Lake Superior, the largest of the five Great Lakes, drains into Lake Huron by way of the St. Marys River. Lake Michigan also drains into Lake Huron through the Straits of Mackinac. The straits are so wide and deep that the water levels in lakes Michigan and Huron are the same. From Lake Huron, water flows into Lake Erie via the St. Clair River, Lake St. Clair and the Detroit River. The water then flows into Lake Ontario through the Niagara River and the Welland Canal. Lake Ontario, in turn, empties into the St. Lawrence River. From there, the water flows into the Gulf of St. Lawrence and the Atlantic Ocean. In total, water travels some 3 600 kilometres from the western end of Lake Superior to the Gulf of St. Lawrence.

There is more to the Great Lakes than just the lakes. They are part of a complex system of lakes, rivers and streams which drains large tracts of the province of Ontario as well as eight American states. In total, the Great Lakes basin, on both sides of the border, measures 774 000 square kilometres.



Water travels some 3 600 kilometres from the western end of Lake Superior to the Gulf of St. Lawrence

Environment Canada Environnement Canada

Canada

Natural Factors

Short-term changes

Sometimes, water levels rise or fall because of the wind. These are considered to be short-term changes since they rarely last longer than a day. For example, when strong winds blow over a lake in one direction for several hours, they may push the water levels up at one end making the levels drop at the other end. This is called a *wind set up* or *surge*. This phenomena has caused the water levels in Lake Erie, the shallowest of the Great Lakes, to rise by as much as two metres at its eastern end within the span of just a few hours.

When the wind stops blowing or changes direction, the water oscillates or flows back and forth like a pendulum until it stabilizes. This is called a *seiche*.

An ice jam in a river which connects one of the lakes to another may reduce the flow of water to a trickle. This is what happened the day Niagara Falls ran dry. On March 29, 1848, the residents of Niagara Falls woke up to what was for them a strange silence. Strong winds, currents and waves had jammed hundreds of thousands of tonnes of ice into the eastern end of Lake Erie between Fort Erie and Buffalo blocking the flow of water into the Niagara River and reducing Niagara Falls to drips— for nearly 30 hours.

Seasonal changes

In general, water levels in the Great Lakes are lowest in the late fall and early winter. This is because water on the surface of the lake at this time of year is warmer than the air above. As a result, water evaporates rapidly. With more water leaving the lakes — in this case in the form of water vapour — than entering, water levels decline.

In spring, when the snow melts, water runs into the lakes. The lakes however, at this time of year, are cooler than the air above. As a result, less water evaporates now than in the fall and early winter. With more water entering the lakes than leaving them, their water levels usually rise, ultimately reaching their peak in the summer.

The seasonal range between low levels in the winter and high levels in the summer runs between 30 centimetres and 50 centimetres.

Long-term changes

Precipitation

Long-term changes in water levels are usually the result of heavier or lighter than normal levels of precipitation. For example, the low water levels in the Great Lakes during the 1960s, which left many docks a good walk from the water, followed a number of years of below-normal snow and rain fall. In contrast, heavy rains and snow in the early 1970s and mid-1980s raised the water levels in the Great Lakes to heights which were above average.

A quick look at the graph of water levels on pages four and five shows that water levels in the Great Lakes rise and fall regularly.

The earth moves

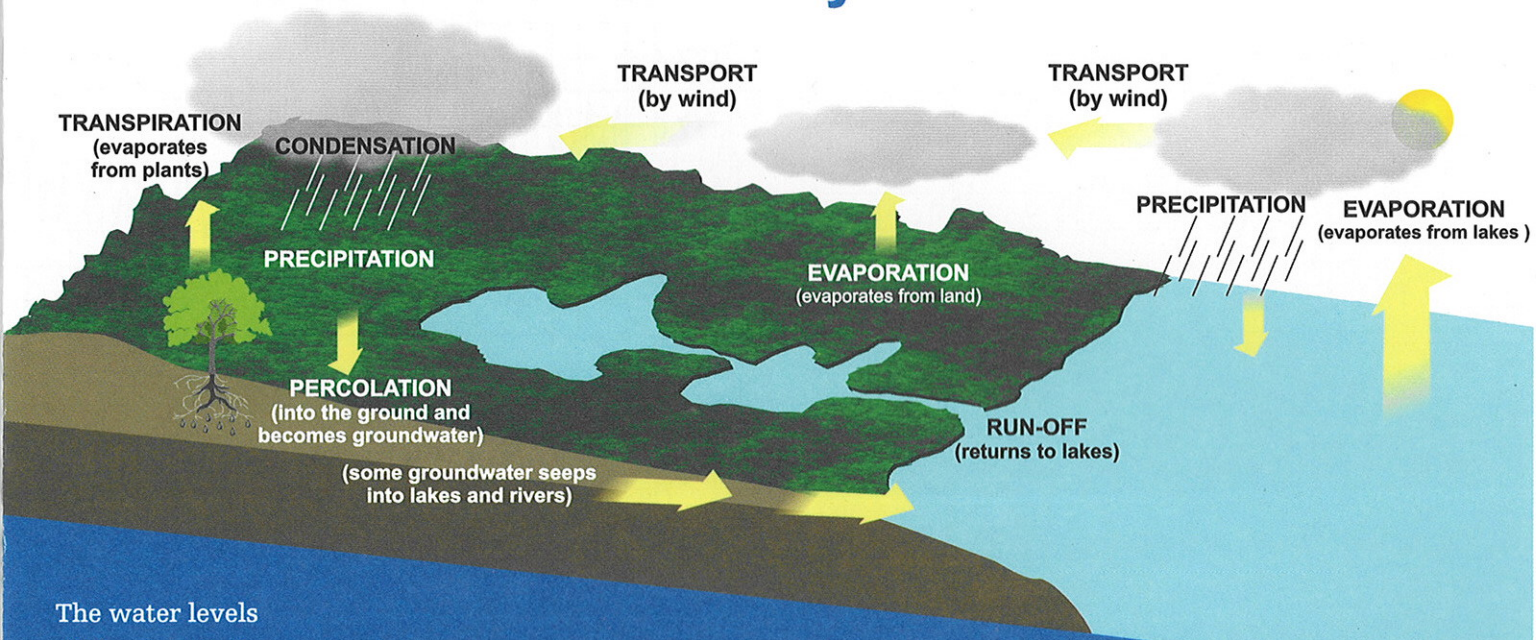
The earth rises in the Great Lakes basin by up to 50 centimetres every 100 years — this is a hangover from the ice ages. When this area was covered by glaciers, their tremendous weight compressed the earth underneath. When the glaciers melted, the land, now relieved of the weight, began to rise.

It continues to do so today. The land in the north and east rises more rapidly than the land in the south and west. Thunder Bay, for example, rises more than 30 centimetres a century, while Chicago does not move. The result is similar to tipping a bowl of water. The water level on one side rises and it falls on the other side. On Lake Superior, the water level at Duluth is rising 14 centimetres per century, and is falling 22 centimetres per century at Michipicoten.

Climate change

The earth's natural climate system is never stable. It has changed in the past and it appears to be changing again. This time it seems to be getting warmer. Although opinions vary on the effect a change in climate may have on the Great Lakes, computer models suggest that supplies of water to the lakes may drop dramatically. The mean levels of water in lakes Michigan and Huron may drop by 100 centimetres, while those in Lake St. Clair may fall by 90 centimetres, in Lake Erie by 80 centimetres and in lakes Ontario and Superior by 40 centimetres over the next 20 to 40 years.

Water Cycle



The water levels of the Great Lakes are affected by the amount of water flowing in and out of the lakes. The hydrologic or water cycle plays a role in this process.

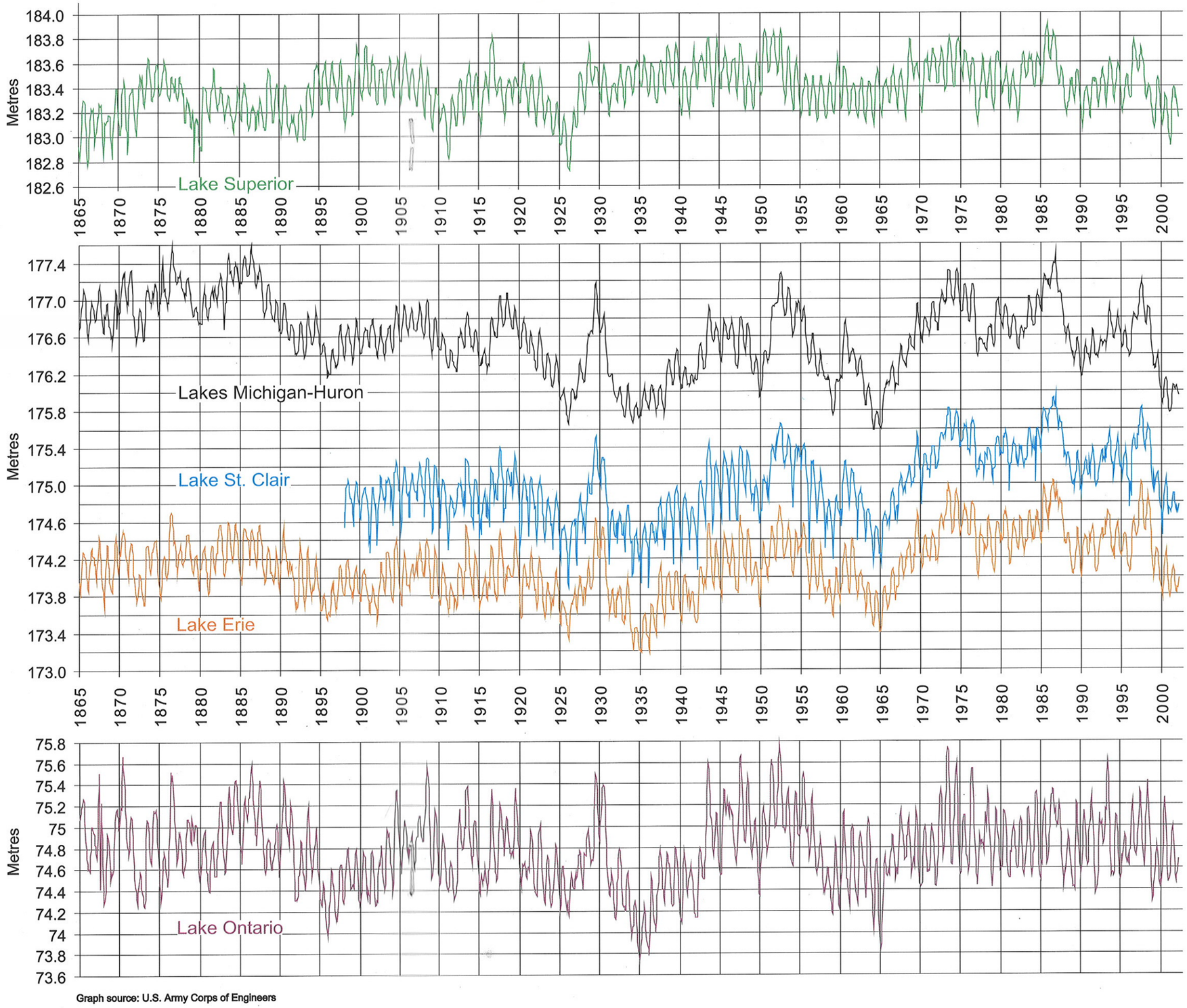
The water cycle is the natural recycling of water. It evaporates from oceans and lakes as well as from the land. Water vapour rises until it hits cooler air in the upper atmosphere, where it condenses to form clouds and returns to earth as rain, snow, drizzle and other forms of precipitation.

Not surprisingly, the rain or snow which falls directly into the lakes increases the volume of water in them, but so does some of the rain or snow which falls on the ground. For example, when the snow melts, some runs directly into the lakes and some percolates down into the earth to become groundwater which may flow eventually into the Great Lakes. Plants and trees take up some of the water in the ground and release it to the atmosphere through the process called *transpiration*.

The processes which make up the water cycle — evaporation, condensation, precipitation and transpiration — are continuous but not consistent. They vary from season to season and from year to year.

One important point about the graph: the measurement on the left side of the graph is the height of the lake's surface and is expressed in metres above sea level. For instance, in 1995 the level of water in Lake Superior was about 183.3 metres above sea level.

Monthly Mean Water Levels

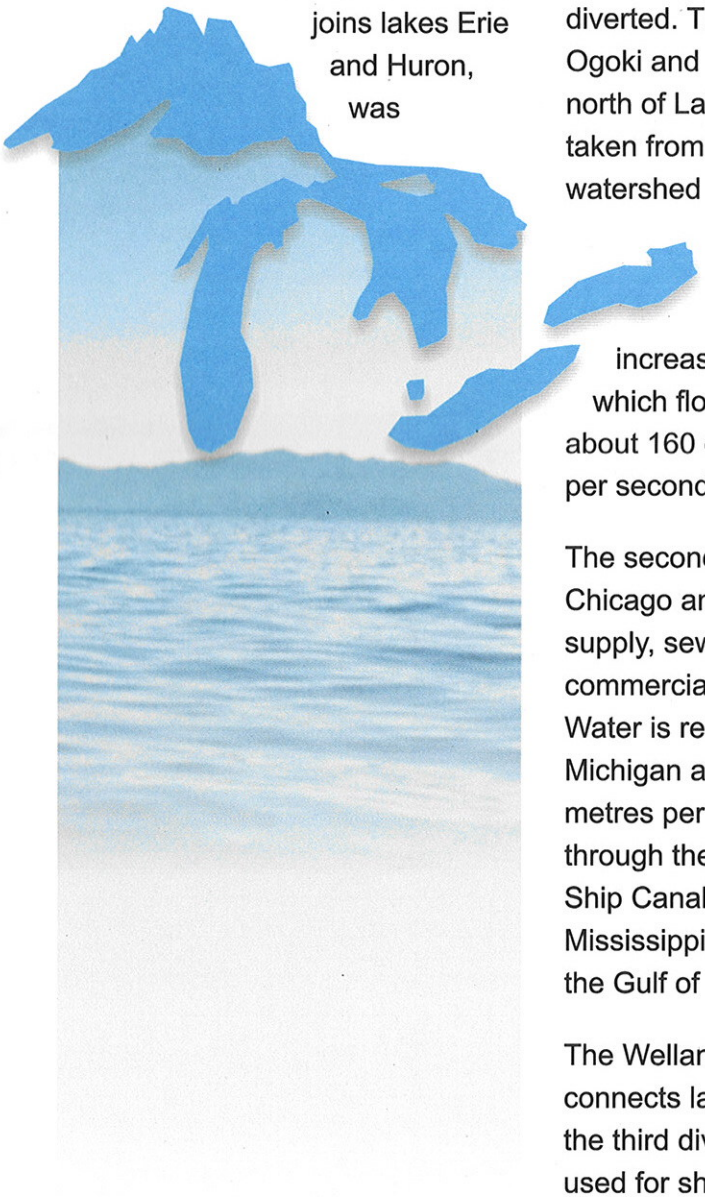


Graph source: U.S. Army Corps of Engineers

Human Factors

Dredging

As ships on the Great Lakes grew larger, it became necessary to dredge the rivers and channels to meet their new depth requirements. This affected water levels. For example, the St. Clair and Detroit River system which joins lakes Erie and Huron, was dredged many times in the twentieth century. As a result, water levels on lakes Huron and Michigan dropped by almost 40 centimetres.



Diversions

There are three main areas on the Great Lakes where water is diverted. The first area is at the Ogoki and Long Lac diversions, north of Lake Superior. Water is taken from the Hudson Bay watershed to drive hydro-electric power plants on rivers feeding Lake Superior. The result is an increase in the amount of water which flows into Lake Superior of about 160 cubic metres of water per second.

The second water diversion is in Chicago and is used for water supply, sewage disposal and commercial navigation purposes. Water is removed from Lake Michigan at a rate of 90 cubic metres per second. It is then sent through the Chicago Sanitary and Ship Canal and eventually to the Mississippi River where it flows into the Gulf of Mexico.

The Welland Canal, which connects lakes Erie and Ontario, is the third diversion. The water is used for shipping and generating electricity. The canal diverts up to 240 cubic metres of water per second from Lake Erie. All of it, however, is eventually sent into Lake Ontario.

The diversions have raised Lake Superior's water levels by two centimetres while they have reduced Lake Michigan's and Lake Huron's by one centimetre. Similarly, the diversions have raised the long term water levels of Lake Ontario by four centimetres, but have reduced Lake Erie's by nine centimetres.

Using water and not returning it

Consumptive use is a technical term which scientists use to describe the practice of taking and using water from lakes or rivers, but not returning it. Today more than 115 cubic metres of water per second is lost from the Great Lakes basin due to consumptive use. The amount will increase as the population on the Canadian side of the Great Lakes basin is expected to rise by about 20 per cent, reaching an estimated 12 million people by 2020.

Controlling the Flow

Controlling or regulating the flow of water from one lake to the next also affects the levels of water in the Great Lakes. To regulate a lake means to adjust or change the amount of water which flows out of it and into the next lake. This is done according to rules set out by the International Joint Commission (IJC). The rules were established by the Canadian and American governments and work toward the fair, equitable and environmentally sound management of the Great Lakes and other boundary waters.

The flow of water through the Great Lakes is controlled at two points: from Lake Superior to Lake Huron at Sault Ste. Marie, and from Lake Ontario through the St. Lawrence River at Cornwall.

Lake Superior

The flow of water out of Lake Superior is controlled by hydro-electric generating plants, navigation locks and a water-control structure with 16 gates. The IJC manages the flow of water through these structures through the International Lake Superior Board of Control.

The board adjusts the amount of water which flows out of the lake every month so that the water levels in lakes Superior, Huron and Michigan are kept in a rough balance when compared to their long-term averages. For example, if the water levels in Lake Superior are higher than average, and the water levels in lakes Michigan and Huron are lower than average, then the amount of water flowing out of Lake Superior is increased.

Lake Ontario and the St. Lawrence River

During the 1950s the section of the St. Lawrence from the point where the river meets Lake Ontario downstream to Cornwall was modified so commercial shipping and hydro-electric plants could expand. These changes allow the IJC, through the International St. Lawrence River Board of Control, to control the volume of water flowing out of Lake Ontario.

These two organizations take into account the rights and needs of the owners of shoreline properties, shipping companies and the hydro-electric industry while keeping in mind that any actions taken to raise or lower Lake Ontario's levels will generally have the opposite effect on river levels downstream of the dam at Cornwall.

U.S. Army Corps of Engineers

St. Marys River flow control structure

Did you know ...you can get daily water levels information at

http://www.on.ec.gc.ca/glimr/water-levels/intro.html

For more information on
water levels, please contact:
Environment Canada
Great Lakes-St. Lawrence Water Levels Information Office
P.O. Box 5050, Burlington, Ontario L7R 4A6
Tel. (905) 336-4580
e-mail: water.levels@ec.gc.ca

For more information on
the Great Lakes and
weather in Ontario, please see:
http://www.great-lakes.net/
http://www.on.ec.gc.ca/