R/V Lake Guardian
Indicators
Limnology
Sediments
Air
Data Projects
Fish
Beach closings
Plankton
Biology
Benthic invertebrates

Limnology Program

Introduction

This summary will present an overview of results for the annual limnology program for the Great Lakes which began in 1983. The limnology program provides information on key environmental factors that influence the food chain and fish of the Great Lakes. The annual monitoring of the Great Lakes began in 1983 for Lakes Michigan, Huron, and Erie; in 1986 in Lake Ontario; and in 1992 for Lake Superior. The sampling strategy is to collect water and biota samples at specific water depths from a limited number of locations in each lake twice every year.

Objectives of the annual program are:

1. Assess the state of water quality in the open lake basins (water greater than 30 meters in depth, or greater than 3 miles from shore.)
2. Provide data to detect and evaluate trends and annual changes in chloride, nitrate nitrogen, silica, phytoplankton, total phosphorus, chlorophyll a, and secchi disc depth.
3. Provide data sufficient to verify or modify water quality models.
4. Provide data to calculate the Trophic Index of each lake

Overview of Results

Chloride

Anthropogenic (human generated) input of chloride compounds (brines, road salt) has resulted in increased chloride ion concentrations in the Great Lakes. In Lake Michigan, the observed chloride ion concentration continues to increase at a slow rate of about 0.1 mg/l/year. Models predict increasing chloride ion concentrations in Lake Ontario, Erie, Michigan, Huron and Superior over the next 500 years. Chloride inputs to Lake Huron and Lake Erie have apparently decreased over the last twenty years resulting in lower chloride levels in Lakes Erie and Ontario. For more detail, see the maps of station-average chloride for the Great Lakes.

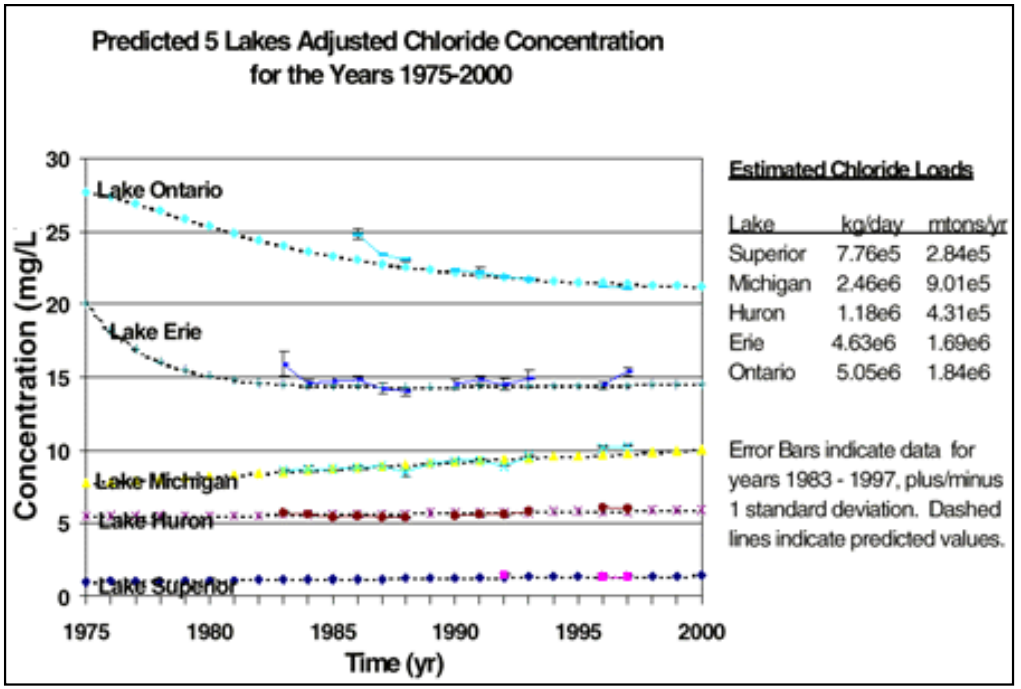

Table1. Chloride changes from Richardson and Rockwell, Chloride pollution of the Great Lakes, (in preparation, data from GLNPO's annual spring program.)

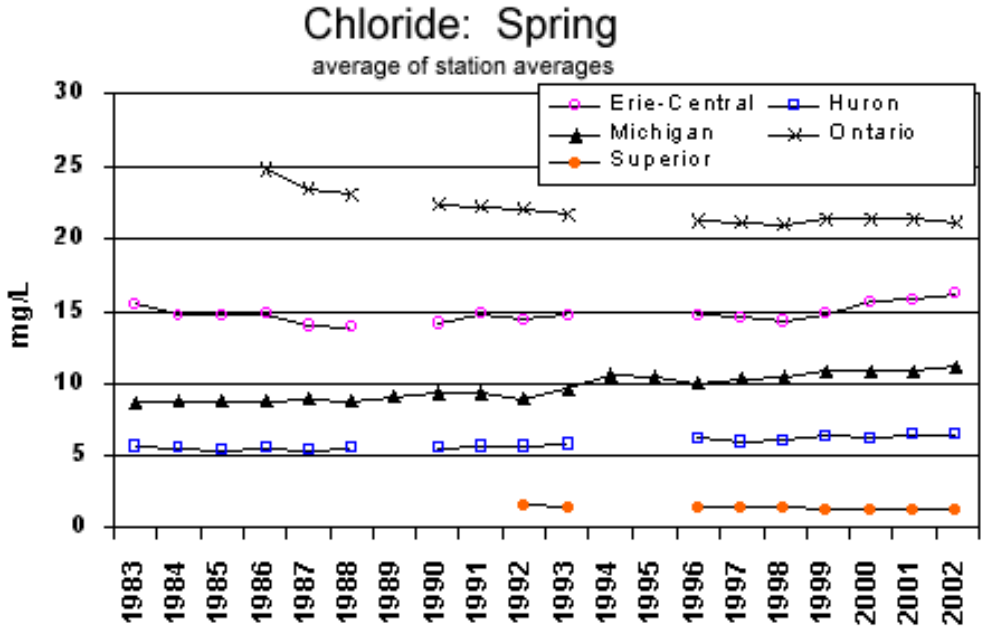

Table 2. Chloride trends in the Great Lakes from 1983 to 2001

(data from GLNPO's annual spring program.)

Nitrate and Nitrite

Nitrate concentrations in the waters of the Great Lakes continue to increase in most basins. For more detail, see the maps of station-average NO2+NO3 for the Great Lakes.

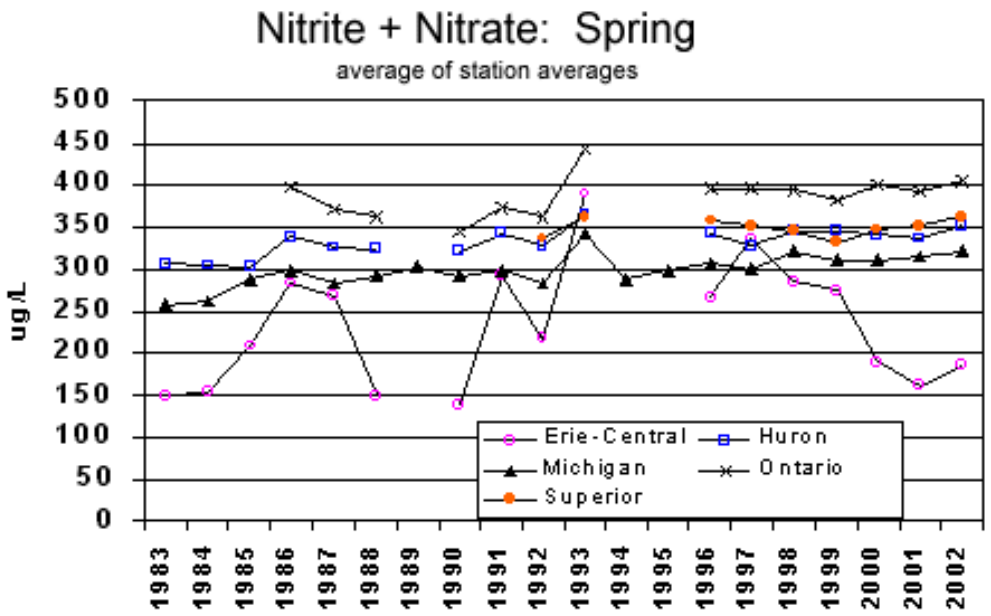

Table 3. Nitrate and Nitrite trends in the Great Lakes from 1983 to 2001
(data from GLNPO's annual spring program.)

Silica

Dissolved reactive silica (building blocks for diatom shells) has increased significantly in Lake Michigan, and in the Eastern Basin of Lake Erie while remaining stable in the other Great Lakes. Below is a graph of lake-average silica trends. For more detail, see the maps of station-average SiO2 for the Great Lakes.

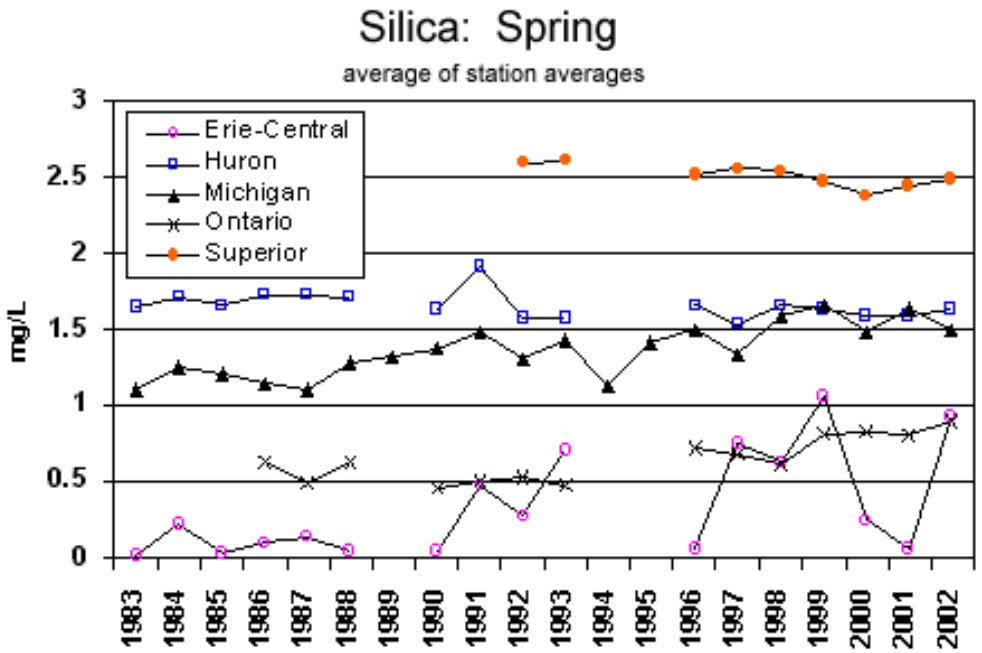

Table 4. Silica trends in the Great Lakes from 1983 to 2001 (data from GLNPO's annual spring program.)

Phytoplankton

Phytoplankton species in Lake Erie show transitions from species associated with eutrophic conditions (heavy nutrient enrichment) to species associated with mesotrophic conditions (moderate nutrient enrichment).

GLNPO's plankton program

Total Phosphorus

Phosphorus concentrations have stabilized in all of the Great Lakes except for Lake Ontario where total phosphorus concentrations are slowly declining at a rate of 0.3 ug/l /year. Total phosphorus concentrations are below the objectives set by the United States and Canada in all of the Great Lakes except in Lake Erie. Lake Erie's Western Basin has exceeded the target concentration of 15 ug/l by about 60% while both the Central and Eastern Basins have exceeded their target concentration of 10 ug/l by about 10 to 20%. Below is a graph of lake-average total phosphorus trends. For more detail, see the maps of station-average P total for the Great Lakes.

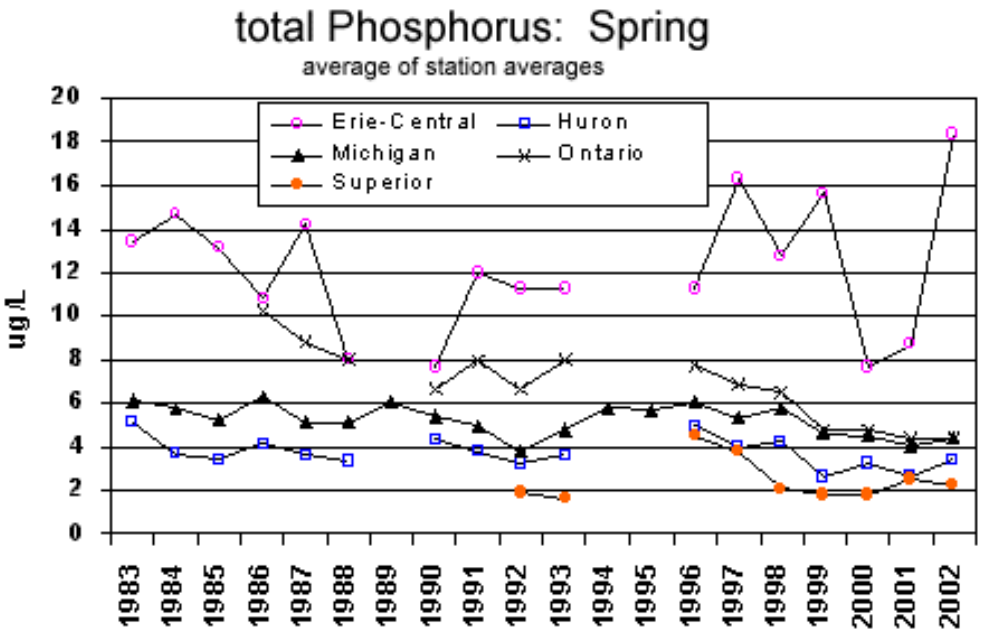

Table 5. Total Phosphorus trends in the Great Lakes from 1983 to 2001 (data from GLNPO's annual spring program.)

Chlorophyll A

Phytoplankton biomass can be indirectly estimated through the measurement of the concentrations of Chlorophyll a in the water. Chlorophyll a concentrations in all the lakes are stable with Lake Superior having the lowest levels and Lake Erie the highest levels. Central and Western basins of Lake Erie have constantly exhibited elevated/enriched chlorophyll a concentrations.

Secchi Disc

Spring time water clarity as measured by secchi disc has increased in Eastern Lake Erie, remained unchanged in Lakes Superior, Michigan, Western and Central Basin Lake Erie, and Ontario, and decreased in Lake Huron. Summer water clarity remained unchanged in all lakes except Lake Ontario where secchi disk readings have more than doubled from pre 1990 (3.1 m) to post 1990 (6.7 m).

Dissolved Oxygen

Oxygen depletion in Lake Erie's bottom waters is a persistent problem. Anoxic conditions occur when dissolved oxygen falls below 0.5 mg/l. Bottom dwelling fish would suffocate at these dissolved oxygen levels. Dissolved oxygen concentrations fall below 0.5 mg/l by late August in areas of the central basin and remain at or below this level until autumn mixing occurs in September. Oxygen depletion rates decreased in the late 1980s. Higher oxygen concentrations were also observed. Together these suggest a

moderation in the oxygen depletion of the bottom waters.

More on Lake Erie Dissolved Oxygen

Questions and Answers (Summary Results)

1. How are the Great Lakes doing?

Nutrient enrichment is under control with stable phosphorus concentrations in most basins and target concentrations being met in all lakes except Lake Erie. See the Trophic Index page for detailed information on the status of the lakes

2. Are there regional variations in the chemistry and biota?

Generally, the upper lakes (Superior, Michigan, Huron) have better water quality and lower concentrations of anthropogenic inputs. Lake Erie has the highest total phosphorus concentrations. Lake Ontario has the highest chloride concentrations because it is downstream from all the other lakes.

3. Can anthropogenic inputs be related to specific sources?

Generally, yes. The relative magnitude of sources can be estimated (such as tributary, atmospheric, sediments) when mass balance studies are employed.

4. What are some of the more interesting lessons learned?

Man made substances can be controlled when identified, but adverse consequences to ecosystem health can never be completely eliminated.

Chemical and biological changes to the Great Lakes can occur quite rapidly despite their large size.

Pollutants not affected by metabolic processes, such as chloride, are increasing in the larger Great Lakes. Reductions in concentrations can occur if excessive loadings are curtailed.

5. What is the greatest problem in the Great Lakes today?

Chemical contamination continues to result in fish consumption advisories, but introductions *of new* exotic species may present even greater dangers to the Great Lakes ecosystem health.

6. Under what conditions does the RV Lake Guardian operate?

The *R/V Lake Guardian* is very stable in all sea conditions as long as the ship is headed into the seas.

When wave heights exceed six feet high, sampling operations are halted and the ship seeks shelter in a nearby port. The Lake Guardian has sampled Great Lakes water quality during the winter, spring, summer, and fall.