Ontario Water Works Research Consortium (OWWRC)

OUR MISSION

The mission of the OWWRC is to link member utilities to government and university researchers and through those links facilitate the completion of research that is of value to member communities.

OWWRC BACKGROUND

The Western Basin of Lake Ontario is the source of drinking water for over 5 million Ontarians. In 1998 and 1999 the whole region was impacted by prolonged and intense taste and odour in their drinking water. Extremely low concentrations of a naturally occurring substance, Geosmin, was found to be the cause. Water utilities in the region have taken effective action. They invested in control technologies at the water treatment plants and intensive research into the cause and control of taste and odour.

In the last 5-7 years, attached algae, mainly *Cladophora*, created numerous resident complaints. In 2002, research into the factors impacting *Cladophora* growth commenced.

The Ontario Water Works Research Consortium was formed in 1999. The consortium brings together all of the large municipalities on the western basin of lake Ontario with federal government, provincial government and university researchers. It has proven to be an effective model for cooperative research.

ATTACHED ALGAE RESEARCH

Researchers from both the University of Waterloo and the National Water Research Institute (NWRI) conducted intensive attached algae research in 2003.

Cladophora Today and Yesterday

There has been an increase in *Cladophora* biomass along the north shore of Lake Ontario. However, current levels remain relatively low compared to those measured in the 1960s and 1970s prior to effective phosphorus control in the Great Lakes basin.

Cladophora

2003 Research Objectives

1. Focus on distance and time differences by going deeper, and measuring nutrient levels further from the shoreline
2. Determine the importance of watershed point vs. non-point sources of nutrients for *Cladophora* growth and do hydrodynamic processes deliver higher nutrient levels to *Cladophora* in near shore waters
3. Determine if ambient nutrient levels are controlling *Cladophora* production

Overall Research Objective

The key research objective is to understand the reasons behind the apparent increase in attached algal growth along the shore.

Point vs. non point sources

Intensive monitoring was carried out in 2003, at river, sewage outfall and unimpacted locations. At each location, eight sites were selected based on distance from the point source of nutrients. Sites were sampled on a bi-weekly basis located at two and five metre depths. On average, available phosphorus concentrations decreased as the distance from the river or sewage outfall increased. The unimpacted (control) sites had significantly lower phosphorus levels and less growth.

Cladophora growth along North Shore

A survey of the north shore was conducted in late July/early August at depths of two, five, eight and ten metres. This survey was completed to assess the distribution of *Cladophora* on the north shore of Western Lake Ontario. On average, the 2m sites showed higher levels of total phosphorus (TP) concentrations than the deeper sites, although the deepest sites did not show the lowest TP concentrations.

Role of Phosphorus (P)

In 2002, "hot spots" in both biomass and P were identified. This reinforces the role for P in *Cladophora* biomass as identified in the 1960s and 1970s, however, it was difficult to establish clear relationships between high P concentrations and point sources of nutrients.

Role of Storm Water Runoff

Non-point sources of nutrients also contribute to measurable concentrations of nutrients in lake waters. Intensive monitoring by stakeholders in 2003 shed light on the large contribution of Phosphorus from storm water discharges.

Other Contributing Factors

Other factors that may be contributing to the recent increase of biomass are the invasion of zebra mussels and climate change. The hypothesis for the role of mussels is that they increase P in the near shore waters through their filtering action. Moreover, they increase water clarity by removing suspended particles and may allow *Cladophora* to grow in deeper water.

Climate change may be leading to more severe summer rainstorms, with resulting impacts on non-point sources of P. Alternatively, if there are warmer springs *Cladophora* growth would increase.

2004 Research Plan

- Ground truthing and improving of existing models to predict the influence of a range of factors.
- Determine if good predictions can be made at unimpacted sites
- Determine if we can adequately assess plant requirements
- Track historical change in growth rates using validated models
- Review nutrient loading data from point sources
- Review land use maps for surface runoff models
- Review temperature and water clarity data from water treatment plant

Cladophora on shoreline
Courtesy of Veronique Hiriart-Baer

THE RESEARCH EFFORT

Funding from the utility members has enhanced the intensive research effort conducted by scientific professionals at the National Water Research Institute in Burlington (Environment Canada), the Ontario Ministry of Environment and the University of Waterloo.

Future Work

A proposal to replace the taste and odour research program by a Source Protection Program in 2005, is under consideration. This program would be specifically designed to be sustainable over time and to meet the expected future regulatory requirements for utilities to understand their source water and to take appropriate measures to protect those source waters.

Member utilities of the Ontario Water Works Research Consortium are:

Region of Durham
City of Toronto
Region of Peel
Region of Halton
City of Hamilton
Region of Niagara
Ontario Clean Water Agency

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TASTE AND ODOUR (T&O) RESEARCH

The National Water Research Institute (NWRI) and the Ontario Ministry of the Environment continued intensive research in 2003. The key research objective is to determine the origin of late summer taste and odour (Geosmin) in Western Lake Ontario.

Taste and Odour Today and Yesterday

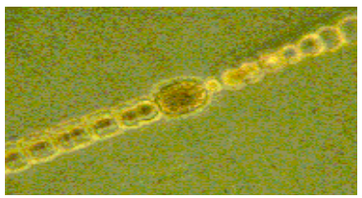
A Geosmin peak occurs at the end of August each year. In 1998 and 1999 levels of over 100 nanograms per litre were found in this late summer peak. In 2000, 2001 and 2002 peak levels of only 10-25 nanograms per litre were found. In 2003, Geosmin showed the highest peak levels since the severe T&O events in 1998-99, reaching peak levels. Most people can detect as little as 4 nanograms per litre (ng/L). (A trillion nanograms equal one gram).

2003 Research Objectives

1. Determine the mechanisms that promote the production and/or modify the severity of the T&O experienced by consumers
2. In depth view of the historical data for the Lake Ontario phytoplankton
3. Determine time course of T&O event and associated major water quality parameters

Study Sites (2003)

Intensive monitoring continued at the sampling site off the Region of Peel. There also was a sampling survey of the entire lake with locations in Hamilton Harbour, Bay of Quinte and the Upper Saint Lawrence River.



Anabaena lemmermanii

Geosmin Production

Earlier research has established that Geosmin is produced in the open lake and is delivered to the near shore zone, and the water intakes, by downwelling events driven by easterly winds. Geosmin is likely produced by the cyanobacteria (blue-green alga) *Anabaena lemmermanii.*. *Anabaena* has been isolated from Lake Ontario. Although *Anabaena* is a known Geosmin producer, samples taken from Lake Ontario have not yet produced high levels of Geosmin. Deep water (30 metres +) is essentially free of Geosmin.

Other Key Findings

The 1998 and 1999 taste and odour years both had a rapid increase in cumulative temperature during April, May and June. This trend was not apparent in the 2003 season. Further extensive analysis of data will take place in 2004 to determine the impacts of temperature, wind, sunshine and other factors.

2004 Research Plan

- Continued monitoring of Toronto area and lake-wide survey for investigation of nutrient effects on algae and T&O
- Examine the role of the sediments in seeding and/or taste and odour production
- Continued work with isolates of *Anabaena* to test growth and Geosmin production under UV, temperature and NO_3 levels
- Determine if the intensity (and timing) of the Geosmin peak/abundance of *Anabaena* in offshore waters is moderated by thermal regime, high light intensity and/or UV or irradiation and/or reduced NO_3 levels
- Intensive review of existing and historical data

The taste and odour study was carried out with assistance from the Green Municipal Enabling Fund, which was funded by the Government of Canada and is administered by the Federation of Canadian Municipalities.

2003/2004 Lake Ontario Taste and Odour and Attached Algae Research Update

ONTARIO WATER WORKS RESEARCH CONSORTIUM MEMBERS

Ontario
Regional Niagara
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National Water Research Institute / Institut national de recherche sur les eaux
Environment Canada / Environnement Canada
Toronto
Region of Peel — Working for you
Halton — a World Class Place To Be.

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