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 took effective action — they invested in control technologies at the water treatment plants and in intensive research into the cause and control of taste and odour.

In the last 5-7 years, the presence of attached algae, mainly *Cladophora*, generated numerous complaints by residents. In 2002, research into the factors influencing *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 2004.

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

2004 Research Objectives

Based on field samplings in 2002 and 2003, the approach for 2004 focused on:

- **Predictability**—implementing existing *Cladophora* growth models, tracking historical changes, and developing rapid assessment tools
- **Management**—using a validated *Cladophora* growth model to predict the outcomes of possible management interventions to identify the most cost effective means of reducing *Cladophora* biomass

Predictability

Numerical models have been developed to predict *Cladophora* growth and biomass accumulation in Lake Erie. Once they have been calibrated and verified with historical data from Lake Ontario, the models can be applied to recent data to predict current *Cladophora* growth rates.

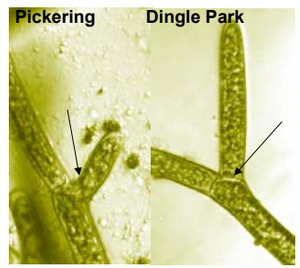
Among the most important model inputs are solar irradiance, water turbidity, water temperature and total phosphorus (TP) concentrations in the water column. Nearshore concentrations of TP are maintained by point and non-point source loadings to the nearshore and by dilution into the lake.

This project is using data from municipal and provincial agencies as well as modeling to determine the relative importance of WWTP effluent discharges, storm sewers, and rivers (all sources of P) to nuisance growths of *Cladophora.*

Preliminary experiments were undertaken in 2004 to develop a rapid assessment tool that can predict differences in potential growth rates of *Cladophora.* Initial results indicate that the interacting effects of light, temperature and TP on *Cladophora* growth must be better understood before growth rates of *Cladophora* can be rapidly assessed in the field.

Management

Analysis of TP concentrations measured in 2002 and 2003 suggests that while *Cladophora* growing at some sites would likely respond to small reductions in TP concentration, *Cladophora* in many areas will require more dramatic reductions before changes in growth rates and, therefore, biomass accumulation are noticeable.



Currently, it is unclear what species of *Cladophora* predominates or if there are multiple species present in the western basin of Lake Ontario. Differences have been seen in the branching pattern of a *Cladophora* plant taken from Oakville (Dingle Park) and from Pickering. This has management implications, as different species are likely to differ in their environmental requirements, including P needs. Researchers at the University of Waterloo continue to address this issue in the laboratory.

Analyses of samples taken at 16 sites at various distances from the mouth of Cooksville Creek in 2004 indicate that storm events can significantly increase the local concentration of TP and, thus, storm water discharges will have to be considered in developing management strategies.

2005-2006 Research Plan

- Isolation and cultivation of *Cladophora* samples to determine if variations in growth requirements exist between isolates
- Analysis of historical data to better understand WWTP discharge, river and storm water loadings to determine their contribution to making P available for *Cladophora* growth
- Biological/hydrodynamic modeling of TP concentrations and *Cladophora* growth in nearshore waters
- Compilation and interpretation of 2002-2005 field data
- Completion of a final report encompassing the 2002-2006 research efforts
- Final recommendations for possible management action

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

The Consortium is considering how best to incorporate source protection in its future research. This program would be designed to be sustainable over time and to meet the expected future regulatory requirements for utilities to understand their source water.

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 2004. The key research objective is to determine the origin of late summer T&O (Geosmin) in western Lake Ontario.

Taste and Odour Today and Yesterday

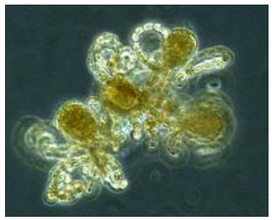
A Geosmin peak occurs at the end of August each year. In 1998 and 1999 levels of over 100 nanograms per litre were found in this late summer peak. In 2000, 2001 and 2002 peak levels of only 10-25 nanograms per litre were found. In 2003, Geosmin again reached peak levels, the highest since the severe T&O events in 1998-99. In 2004, there was a significant T&O event, which elicited consumer complaints, press releases and media coverage.

Research Objectives

- Determine biological origin of T&O caused by elevated levels of Geosmin and MIB in Lake Ontario
- Identify the mechanisms that promote production and/or modify the severity of T&O experienced by consumers
- Develop a mechanistic model to predict outbreaks

Cause of Taste and Odour Production

The correlation between increases in the abundance of the blue-green alga, *Anabaena lemmermanii* and Geosmin levels suggest that it is the major producing organism in the western basin of Lake Ontario. Intensive work is underway to culture this alga under varying environmental conditions and findings may lead to the development of control options and/or early warning tools.



Anabaena lemmermanii

Geosmin Production

Earlier research has established that Geosmin is produced in the open lake and is delivered to the nearshore zone and water intakes, by downwelling events driven by easterly winds. In 2004, researchers focused on the hypothesis that upwelling-relaxation followed by downwelling events coincided with both the production and transport of Geosmin. Field observations were consistent with this hypothesis.

Other Key Initiatives

Values of major parameters such as light, temperature, conductivity, current, insulation, nitrogen, phosphorus, chlorophyll *a* and algal community assemblages collected during the 2000-2005 field work will be used in multivariate analyses with the aim to identify the most important drivers and modifiers of these events, and thereby develop a model to predict their timing and severity.

2005 Research Plan

- Continue to collect field data on timing and severity of T&O events in Lake Ontario
- Determine if the intensity and timing of Geosmin peaks/abundance of *A. lemmermanii* in offshore waters is moderated by thermal regime, high light intensity/UV and/or reduced NO_3 levels
- Establish more *A. lemmermanii* isolates to examine: a) the robustness of Geosmin production and its response to changes in light and temperature, b) taxonomy and odour production of *A. lemmermanii* using morphometric and genetic criteria, and c) whether strains of odour and non-odour producers are of the same species or if several species are involved

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.

2004/2005 Lake Ontario Taste and Odour and Attached Algae Research Update

ONTARIO WATER WORKS RESEARCH CONSORTIUM MEMBERS

Ontario
Regional Niagara
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Durham Region
National Water Research Institute / Institut national de recherche sur les eaux
Environment Canada / Environnement Canada
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