Great Lakes Water Quality Agreement
Annex 4 – Nutrients
Lake Erie Phosphorus Loading and *Cladophora* Updates

EPA
Science Advisory Board
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Chicago, IL

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Phosphorus Loading – Modeling and Task Team Usage

- Dolan and Chapra (2012) JGLR: Total Phosphorus (TP) by Source Category through 2008
- Heidelberg Maumee and Tributary Monitoring Database: TP through 2013
- Provisional TP Load Calculations by Dolan: 2009 through 2011
- Provisional Dissolved Phosphorus Load Calculations by Dolan 2005 and 2007 (EcoFore)
- Preliminary TP and Soluble Reactive Phosphorus (SRP) Load Calculations by Maccoux et al through 2013 (to be discussed further)
Phosphorus Loading – Ongoing Effort/Update

• Environment and Climate Change Canada – Contract with Private Sector (Maccoux)


• Update Lake Erie TP Loads through 2013
  Re-examine 2003 – 2008 TP Loads

• Calculate Soluble Reactive Phosphorus Loads from 2009-2013
Lake Erie Phosphorus Loading Update - 1

• Maccoux et al, JGLR in review

• Method and Data Source Documentation Provided
• Update of TP Loads through 2013 Completed
• Increase in Yearly Sample Size (~3X) for 2012-2013 Thames (Ont), Sydenham (Ont), Clinton (MI), and Grand (Ont)
• Lakewide TP Loads Relative to Dolan and Chapra (2012): Approximately 2.6 % Greater (2003-2008)
Lake Erie Phosphorus Loading Update - 2

- Maccoux et al, JGLR in review

- Soluble Reactive P (SRP) Loading for 2009 thru 2013 Completed

- Direct Comparison to Provisional Dolan 2007 (EcoFore)
  - Is Not Available at this Time
  - Relative Magnitude of Primary Tributary Loads are Consistent
Lake Erie *Cladophora* Modeling

- Michigan Technological University
- Great Lakes *Cladophora* Model (GLCM)
- Computed Dose-Response
- Lake-wide TP Load Recommendation of 7000 MTA
Lake Erie *Cladophora* – Task Team Deliberations

- Generic Eastern Basin Shoreline Model Application versus a Site Specific Application
- Series of Relationships using Modeled, Ratios, and Estimated Parameters, Particularly SRP
- Task Team: Could Not Recommend Targets for *Cladophora* With Confidence
Lake Erie *Cladophora* Modeling Update

- Environment and Climate Change Canada
  In review, Journal of Great Lakes Research
  *Cladophora* Growth Model (CGM)

- Michigan Technological University
  TBA, Journal of Great Lakes Research
  Great Lakes *Cladophora* Model (GLCM)
Cladophora Update

State of Knowledge of Cladophora Workshop
NOAA-GLERL, Ann Arbor (hosted by Craig Stow)
January 26-28, 2016

Convened by Annex 10 (Science) and Annex 4 (Nutrients)
Facilitated by the Lake Erie Millennium Network
Sessions: Modeling, Monitoring, Biology, Research
Approximately 50 Attendees with 25 Presentations
Plus Facilitated Discussions and Breakout Groups
Executive Summary has been Distributed
Cladophora Update – Workshop
Selected Findings - Highlights

• Continue water quality model framework coupling and linking efforts, to the Great Lakes Cladophora Model and Cladophora Growth Model pursuant to both lake-wide and high-resolution nearshore models.

• Develop an explicit benthic boundary layer in models that can characterize and quantify microscale nutrient gradients, biodeposits, and nutrient cycling and exchange by dreissenid mussels, related to Cladophora.

• Enhance model sloughing algorithms for timing and temperature and integrate predictions with transport and fate modules to forecast the deposition of Cladophora on beaches.

• Develop a binational, coordinated Cladophora surveillance program that includes remote sensing and ground-truthing.

• Establish sentinel time-series concurrent sampling of multiple constituents over a growing season preferably at bi-weekly intervals at least one reference site and one impacted site per lake for each of the Great Lakes except Lake Superior.

• Develop a standard measurement of in-lake Cladophora biomass and on the shoreline.

• Develop a standard measurement and timing for estimating phosphorus storage (tissue concentration) in Cladophora.

• Convene a small expert panel to review updated Cladophora efforts and results and set targets for the mitigation of Lake Erie Cladophora.
## Target Phosphorus Loads and Associated Endpoints for the Great Lakes

<table>
<thead>
<tr>
<th>Lake</th>
<th>Target P* Load (MTA)</th>
<th>Target P** Concentration (µg/L)</th>
<th>CHL A** Concentration (µg/L)</th>
<th>Secchi (m)</th>
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</table>

** Great Lakes Water Quality Board, IJC, 1978
Great Lakes Annual Total Phosphorus Loads thru 2008
(Thousands of Metric Tons/Year - MTA)

Lake Superior

Lake Huron

Lake Michigan

Lake Ontario

Lake Erie


Thousands of Metric Tons

0 5 10 15 20

Target
Percent Total Phosphorus Loading by Major Source Category for Each Great Lake, 2008

Adopted from Dolan and Chapra 2012
Lake Erie Total Phosphorus Loadings 1994-2008

![Bar chart showing total phosphorus loadings for Lake Erie from 1994 to 2008. The chart includes data for direct point source, indirect point source, tributary monitored, adjustment for unmonitored area, atmospheric, and Lake Huron input. Each year's bar is color-coded to represent the different sources of phosphorus loading.]

Courtesy of Dolan & Chapra
Lake Huron Total Phosphorus Loading to the St. Clair – Detroit River Complex
(Dolan and Chapra 2012; Chapra and Dolan 2012)