WAYS TO DEAL WITH ALGAL BLOOMS: MONITORING, MODELING, AND MITIGATING

JOHN F. BRATTON, PHD, PG
<table>
<thead>
<tr>
<th>Causes</th>
<th>Challenges</th>
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<tbody>
<tr>
<td>Excess watershed nutrients</td>
<td>Taste and odor issues</td>
</tr>
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<td>Internal nutrient loading</td>
<td>Toxins (drinking, aerosols, contact)</td>
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<td>Warm water</td>
<td>Fouling</td>
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<td>Long residence time</td>
<td>Analytical difficulties</td>
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<td>Little mixing</td>
<td>Public communication</td>
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<td>Dynamic conditions</td>
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<td>Multiple species</td>
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<td>Benthic and planktomic</td>
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<td>Huge variety of treatments</td>
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<td>Non-point nutrient mitigation</td>
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2015

- Largest bloom ever recorded in Lake Erie
2015

- Largest bloom ever recorded in Ohio River

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Record bloom

The toxic-algae bloom on the Ohio River covers more than two-thirds of the river's length. It started upstream of Wheeling, W.Va., and was first spotted on Aug. 19. As of Friday, the bloom stretched to Tell City, Ind., about 650 miles downstream. The bloom produces a toxin that can sicken people and kill pets, and it is costing water-treatment plants along the river hundreds of thousands of dollars to treat.
Ohio is a leader in HABs management and research.
Ohio EPA Harmful Algal Bloom (HAB) Program Update

Webinar
April 30, 2019

Heather Raymond
Ohio EPA HAB Coordinator
HABS MANAGEMENT

Monitoring, Early Warning Systems  ●  Modeling and Forecasting  ●●  Data Management, Decision Support
Control, Mitigation, Treatment  ●●●  Research and Development
MONITORING

- Lake Erie real-time observing network of buoys and drinking water plant intakes; basin-wide “HABs Grab” sampling and research programs
- Continuous watershed monitoring in Maumee and other Ohio Rivers
- Sensors and analytes include algal pigments, nitrate, phosphorus, weather, waves, webcams, thermistor strings
- Satellites, drones, aircraft
- EnviroDIY
MODELING

- Linked and mechanistic watershed and water body modelling and forecasting
- Lake Erie Ecosystem Model
- Lake Ontario Ecosystem Model
- Lake Okeechobee
- Lake Champlain
- Utah Lake
MODELING

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DATA AND DECISIONS

- Lake Champlain Clean Water Roadmap
- Big Data, Internet of Things, machine learning
- Nutrient Modeling Toolbox and Decision Tool
MITIGATION

- 4R Nutrient Stewardship evaluation
- Siting and design of agricultural nutrient treatment wetlands
- Green infrastructure planning for cities and counties
- Technical assessments to support policy development for state, federal, and bi-national agencies
### Management Action

- Algaecides
- Hypolimnetic aeration/oxygenation
- Inflow/end-of-pipe chemical treatment (e.g. alum based compounds)
- Biomanipulation through Fisheries Mgmt (Long-term)
- Biomanipulation through Fisheries Mgmt (Short-term)
- Drawdown
- Shoreline restoration/riparian management
- P coagulants (Alum & alum-based compounds)
  - P coagulants (Ca & Fe)
  - P coagulants (Other)
- Dilution and flushing
- Mechanical harvesting
- Native plant community restoration
  - Herbicides
  - Dredging
  - Microbes and enzymes
  - Shading Dye
  - Artificial Circulation
- Hypolimnetic withdrawal
GRAND LAKE ST. MARYS ALUM TREATMENT
RESEARCH

- Model development
- HABs toxin production
- New sensor technologies
- Effectiveness of mitigation practices
- NOAA Cooperative Institute
- OSU, BGSU, Case Western, U-Toledo, UK, USACE ERDC, USEPA-Cincinnati, NOAA NCCOS
Development of the Western Lake Erie Ecosystem Model (WLEEM): Application to connect phosphorus loads to cyanobacteria biomass

Edward M. Verhamme *, Todd M. Redder, Derek A. Schlea, Jeremy Grush, John F. Bratton, Joseph V. DePinto

ABSTRACT

Since the mid-1990s, Lake Erie has experienced re-eutrophication symptoms including harmful algal blooms in the western basin and summer hypoxia in the Central basin. The 2012 Protocol for the Great Lakes Water Quality Agreement (GLWQA) required phosphorus objectives and management recommendations to be set for all the Great Lakes, beginning with Lake Erie. To inform setting revised loading targets for the Lake Erie portion of the GLWQA, modeling was performed. The development and application of one of these models, the Western Lake Erie Ecosystem Model (WLEEM), is described here. WLEEM is a three-dimensional, fine-scale, process-based model that links hydrodynamic, sediment transport, and in-lake biogeochemical and ecological processes. WLEEM was applied here to assess system sensitivity to a range of variables, and ultimately to develop a robust phosphorus load – cyanobacteria response relationship to determine a maximum load of total phosphorus from the Maumee River during the period of March–July that would produce a mild cyanobacteria bloom (~7830 MT cyanobacteria bloom) in Western Lake Erie. The maximum total phosphorus load from the Maumee River for that period to produce a mild bloom was determined to be 100 metric tons. Given the natural variability of systems like this, tools like WLEEM used in a dynamic operational modeling mode, consistent tributary and lake monitoring, and ongoing research will be essential components of effective mitigation and science-based adaptive management of eutrophication in Lake Erie and other nutrient-impacted water bodies.

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Lake and Reservoir Management

The Lake Okeechobee Water Quality Model (LOWQM) Enhancements, Calibration, Validation and Analysis

R. Thomas James , Victor J. Bierman Jr., Michael J. Erickson & Scott C. Hinz

Water Research

Using models of farmer behavior to inform eutrophication policy in the Great Lakes

Robyn S. Wilson *, Derek A. Schlea, Chelsie M.W. Boles, Todd M. Redder
AREAS WITH BIG PROBLEMS

Ohio River
Ohio Inland Lakes (e.g., GLSM)
South Florida
Upstate New York
Western lakes and reservoirs
San Francisco Bay-Delta
Great Lakes
THANK YOU

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