WESTERN LAKE ERIE BASIN

Influence of Open-Lake Placement of Dredged Material on Harmful Algal Blooms

Presenters: Joe DePinto, Ph.D. and Ed Verhamme
LimnoTech

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Project Team

- Ecology and Environment, Inc.
- LimnoTech
- University of Toledo
- University of Wisconsin -Stout
- Heidelberg University

Other Data Providers: NOAA, USGS, and EPA
Problem Statement

• Is open-lake placement of dredged material from Toledo Harbor a significant factor contributing to harmful algal bloom (HAB) events that have occurred in the Western Lake Erie Basin (WLEB)?

• Use field sampling and modeling analyses to assess short term and long term effects

Photo: 2014 Toledo Water Intake
External Loads

Conceptual Model
External TP Load

The Maumee River higher mean TP concentration is just what cyanobacteria need to form HABs

- Maumee River TP Load delivers very high TP concentration (>0.4 mg TP/L) to Western Basin during high flow events in spring.
- The Detroit River has a large load, but very low TP concentration.
- Other tributaries/sources have a relatively small TP load.
Dredged Material

Conceptual Model
Toledo Harbor Dredging

- Toledo Harbor
  - ~1/4 of total Great Lakes maintenance dredging cost (highest in Great Lakes)
  - Designated a “critical” dredged material management area
  - 760,000 CY (20 yr. avg.) 85% from Bay Channel

- Sediment sources to Federal navigation channels
  - Maumee River is dominant loading source
  - Wind-wave resuspension focuses Maumee-delivered and other sediments into navigation channel

Western Lake Erie Basin: 2006-12 Sediment Load Distribution

- Other Sources 31%
- Detroit River 14%
- Maumee River 55%
2013 Open Lake Placement

- Mechanical dredging with placement into 1,500 CY scow
- Placement events occur ~6x per day between July and October (675 total)
- Scows have a draft of 10 feet and placement occurs in 15-20 feet of water. Placement takes <1min
Field Sampling Overview

- **Short-term event sampling**
  - Monitored placement events on six different days
  - Collected vertical profiles
  - Grab samples of nutrients & solids
  - Dredged material sampling

- **Long-term monitoring**
  - Continuous water quality sondes
  - Grab samples
  - Sediment (June & October)
    - Cores
    - Surface grabs
    - Phosphorus flux
    - Sediment traps
Water Quality

Conceptual Model

External Loads
- Tributary Loads
  - Point and Non-Point Sources
- Atmospheric Deposition
- Other Direct Sources

Exchange and Transport with Central Basin

Dredged Material
- Growth

Blue Green Algae
- Excretion, Death, Grazing

Particulate Phosphorus
- Deposition
- Rapid Zone Settling

Dissolved Phosphorus
- Resuspension
- Pore Water Diffusion
- Deposition

Water Column

Upper Sediment Layer

Lower Sediment Layer
Short Term - Plume Tracking

97.5% of placed material settles immediately remaining 2.5% within an hour
Plume Tracking

**TP in water column reaches background levels within an hour (through settling and dispersion).**

**SRP in water column reaches background levels within an hour (through dispersion).**
Biological

Conceptual Model
Biological Results

Concentrations of Phytoplankton are highest at the Maumee River Mouth

[Graph showing Chlorophyll-a (ug/L) concentrations for different months and areas.]
Sediment

Conceptual Model
Sediment Results

*Sediment concentrations of TP at the placement site and reference areas are similar, but lower than Maumee River suspended sediment.*

Maumee River Suspended Sediment: 3.5 mg/g
Sediment P Aerobic Release Rates

Phosphorus diffusion from the sediment in the placement area is lower than the rest of WLEB and <0.04 % of total diffusive load.

![Graph showing release rates in June and October](image-url)
Western Lake Erie Ecosystem Model (WLEEM) - Phosphorus Cycling

Solar Radiation

Open-Lake Placement P Loads

External P Loads

Uptake of $\text{PO}_4$

Release of $\text{PO}_4$

Decay and Mineralization - Release of $\text{PO}_4$

Phytoplankton

SRP $\leftarrow \rightarrow$ PIP

POP Mineralization

Phytoplankton Settling

Grazing

Predation

Release of $\text{PO}_4$

Zooplankton

Fecal Pellet Settling

Resuspension

Diffusive Exchange

Exchange with Central Basin

Upper Trophic Levels

PIP: Particulate Inorganic Phosphorus

POP: Particulate Organic Phosphorus

Western Lake Erie Ecosystem Model (WLEEM) - Phosphorus Cycling

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Model Calibration

Model captures deposition of open lake placed material very well.

[Graph showing the comparison of Data and Model Result with time and suspended solids mass over a period from 8/21/13 12:00 to 8/21/13 15:00.]
Model Results - Placement Site

Baseline
Increase Placement
No Placement
No Maumee
Model Results - Toledo Water Intake

Baseline
Increase Placement
No Placement
No Maumee

Open lake placement does not impact HABs at Toledo water intake
Summary

- > 95% of barge-released dredged material deposits very quickly as a single mass to the sediments at the open-lake placement site.

- Residual water column suspended sediment and phosphorus concentrations following placement return to near-background levels within an hour through settling and dispersion.

- Cyanobacteria measurements at placement and reference areas match current scientific understanding of bloom development and movement in WLEB.
Summary

- Sediment and associated phosphorus from the placement area resuspend and deposit at the same rate as other areas of similar depth in WLEB.

- TP concentrations are 4x higher in Maumee River suspended sediment than placement and reference area sediment.

- Placement area bathymetry measurements show deposited material has not been spread throughout the Western Basin.

- Sediment pore water from the placement area is not a significant source (<0.04% of total diffusive P budget) of bioavailable phosphorus.
Conclusions

- Open-lake placement of dredged material does not contribute to the development of HABs in the Western Basin of Lake Erie.

- Removing dredged material from the basin would not reduce HABs.

- Our study conclusions are in agreement with the scientific consensus that reducing HABs should focus on Maumee River phosphorus loading.

Questions?

The HAB report is available at the following link: