The Effects of Multiple Stressors on Saginaw Bay Water Quality

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Stressor – Phosphorus

Great Lakes Water Quality Agreement - 1978

Hear ye! Hear ye!
By Joint Proclamation
Henceforth and foreverafter
Saginaw Bay shall meet a target phosphorus load of 440 tonnes/year
which probably translates to about 15 ug/L

Stressor - Dreissenid Mussels

Photo credit: Nathan Hawley

Phosphorus Input vs Time

Mussel Density vs Time

~ 80% Quaggas

"Muck"

Notes from the Bay City Recreation Area Park Ranger Log

1981 Jun 7 Our muck problem on the beach has been more severe than in past years. We plan to use the bulldozer from Otsego Lake to help on the cleanup job.

1981 Jun 14 Our muck problem continues to be very bad.

1981 Jun 28 Our priority project for this week was pushing muck from the water at the beach with the bombardier and bulldozer. We have never had a more severe muck accumulation. The water’s edge is now in fair shape, and we have sand corridors through the muck piles. Swimmers now can get to and from the water.

1982 Jun 20 The prevailing NW winds have piled up the muck on our beach to the extent our bombardier tractor can’t push it. With settled water conditions we may again make some progress in clearing our swimming area.

1984 Aug 5 Muck on the beach is very thick.

1987 May 31 A lot of people are coming out to the beach in spite of the fact that lower lake levels have resulted in an increase in the amount of muck along our shore line.

1988 Jul 3 Beach continues to be very busy in spite of the low water levels that have increased our problem with the muck.

1991 May 19 We received our new four wheel drive tractor Saturday and have already put it to use raking the beach. We have an especially large amount of muck this spring.

1991 May 26 Day use was slow because of cloudy weather and a very mucky beach.

1991 Jun 9 Continues to be very slow due to the deplorable condition of the shoreline.
What is Muck?

- Macrophytes
- Filamentous algae (Spirogyra and Cladophora)

Bay Survey Methodology

- Water Chemistry
  - P and N
- Light Parameters ($k_{PAR}$)
  - Secchi
  - Light Meter
- Community % Cover
  - SCUBA observation
  - Algae, macrophytes, substrate
- Biomass
  - Algae, macrophytes
- Mussel Density
- Algal Identification
- PAM fluorometry
  - Measure of photosynthetic health

Results

- Benthic algae is phosphorus limited
  - According to tissue phosphorus measurements

Wong and Clark (1974) found 0.16% tissue P to be limiting in Cladophora.
Results

- Benthic algae is light limited
  - Nearly all samples in a light environment below what is required for maximum photosynthesis
    - Determined by PAM Fluorometry

![Light Environment Diagram]

Beach Survey Methodology

- Measurements
  - Photos
  - Lengths/Depths
  - Observational notes
  - AFDM and Dry Mass
    - % organic matter
    - 2009 only
- Locations
  - BCRA
  - 3 agricultural drains
  - 2 additional properties N and S of BCRA

Preliminary Results

- Muck moves from north to south
  - Decompenses during this time
  - Collects additional biomass?
- Northeastern winds worsen the muck issue
  - More muck? Or more muck showing?

Preliminary Results

- “Muck” changes in composition
  - Seasonally
  - Between years
Part 1: Prevalence of Fecal Indicators in Environmental Samples

Field Survey

Part 2: Persistence of fecal indicators when muck exposed to LOW temperatures (4°C).

Lab Study

Part 2: Persistence (survival) of fecal indicators when muck exposed to sunlight.

Lab/Field Study
Summary

Phosphorus loads declined following establishment of target load
currently vary yearly with river flow
do not meet target load
Phosphorus and chlorophyll concentrations declined with TP load
fairly stable since late 80s, vary yearly
target concentrations not met
Muck has been a long-term, consistent problem in Saginaw Bay
early phosphorus declines did not eliminate problem
Muck composition varies with time – not strictly Cladophora
is there a regular pattern?
Adequate monitoring essential to understand behavior/response
Algal muck precursors are phosphorus and light limited
macrophytes…?
Muck harbors high levels of fecal indicator bacteria
Circulation maybe particularly conducive for deposition near BCRA
(show the movie!)