Applying an alternate approach to watershed management for two New Hampshire lakes with unique water quality stressors and responses

March 15, 2019
NH Water & Watershed Conference
LANDSCAPE ALTERATIONS

ECOLOGICAL PROCESSES
TRADITIONAL APPROACH
UNEXPECTED PHENOMENA
ADJUSTED ACTION PLAN
WATER QUALITY CONCERNS

ECOLOGICAL PROCESSES
TRADITIONAL APPROACH
UNEXPECTED PHENOMENA
ADJUSTED ACTION PLAN

© Fondriest
© Lake Hopatcong Commission
© Community Architect
NUTRIENT LOADING

DO <6 ppm

Benthic Decomposers Consume Oxygen
SOURCES OF PHOSPHORUS
BEST MANAGEMENT PRACTICES

- **ECOLOGICAL PROCESSES**
  - Reduce, divert, and infiltrate surface runoff.
  - Stabilize shoreline access points through vegetation or riprap.

- **TRADITIONAL APPROACH**
  - Minimize pollutants (e.g., fertilizers, detergents, and other phosphorus-based products).

- **UNEXPECTED PHENOMENA**
  - Maintain shoreline, streamside, and wetland buffers.

- **ADJUSTED ACTION PLAN**
  - Minimize and define parking areas and pathways.

Photo credit: FBE, AWWA, SOAK UP the Rain, Open Clipart
LOW DO AND LOW PHOSPHORUS?

Pleasant Lake
(Deerfield/Northwood, NH)

Spofford Lake
(Chesterfield, NH)

ECOLOGICAL PROCESSES
TRADITIONAL APPROACH
UNEXPECTED PHENOMENA
ADJUSTED ACTION PLAN
PLEASANT LAKE WATER QUALITY SUMMARY

RECENT (2006-2015), SEASONAL (May 24-Sept 15)

**TP**
- POOR: 8 ppb
- EXCELLENT: <5 ppb

**Chl-a**
- 3.3 ppb

**SDT**
- 2 m
- 6.8 m

ECOLOGICAL PROCESSES | TRADITIONAL APPROACH | UNEXPECTED PHENOMENA | ADJUSTED ACTION PLAN
Pleasant Lake is impaired for aquatic life use based on low dissolved oxygen concentrations in bottom waters.

PROBLEM: LOW OXYGEN

Pleasant Lake is impaired for aquatic life use based on low dissolved oxygen concentrations in bottom waters.
Low oxygen in bottom waters **CAN be a natural phenomenon** when thermal stratification in late summer separates oxygenated surface waters from bottom waters where decomposition of organic matter consumes oxygen.

In this case, the extent and duration of low oxygen in Pleasant Lake **may be harmful to aquatic life** seeking desirable habitat.
SPOFFORD LAKE WATER QUALITY SUMMARY

EXCELLENT

POOR

ECOLOGICAL PROCESSES

TRADITIONAL APPROACH

UNEXPECTED PHENOMENA

ADJUSTED ACTION PLAN

RECENT (2008-2017), SEASONAL (May 24-Sept 15)

TP

Chl-a

SDT

5.3 ppb

1.7 ppb

9.4 m

8 ppb

3.3 ppb

2 m

ECOLOGICAL PROCESSES

TRADITIONAL APPROACH

UNEXPECTED PHENOMENA

ADJUSTED ACTION PLAN
Nearly half the lake volume is impacted by oxygen levels undesirable for many aquatic life.

PROBLEM: LOW OXYGEN

SPOFFORD LAKE WATER QUALITY SUMMARY

ECOLOGICAL PROCESSES  TRADITIONAL APPROACH  UNEXPECTED PHENOMENA  ADJUSTED ACTION PLAN
Natural Lake Level

- Easily eroded sediment
- Less easily eroded sediment/bedrock

Elevated Water Level

Wave action leads to shoreline retreat; eroding sediment and organic matter builds up foreshore and nearshore areas, causing shallower waters.

Lower Water Level

Exposed a foreshore and leads to lakebed erosion; susceptible to ice scouring in winter.
All solid material in a watershed eventually ends up at the lowest spot. In lakes, this material is permanently trapped by the basin, so it accumulates. Coring collects these materials in their depositional sequence.

Over thousands of years, lakes fill up with sediment, becoming shallower and more organic-rich.

Human activity can greatly increase the rate of infilling, by enhancing erosion and organic deposition.
Sediment Core Collection
by Plymouth State University
Sediment Core Collection
by Plymouth State University

© Dr. Lisa Doner; Graduate Student William Tifft, Plymouth State University
Both cores have subtle but distinct changes in sediment color. Changes occur at about 10-13 cm and 36-40 cm below the core top. Smearing of sediment on the core liner blurs color transition, but remember those depths!
strong increase in organic levels starting about 10-13 cm (and a decrease between 36-45 cm). These values are also affected by changes in mineral inputs to the lake (erosion), but the recent trend is likely true.
Low dissolved oxygen in these lakes may be driven by organic matter accumulation.

This is still preliminary research and data.

Future analysis of the sediment cores will help disentangle the drivers of organic carbon in lake sediments.
FUTURE PROJECTIONS

ECOLOGICAL PROCESSES

TRADITIONAL APPROACH

UNEXPECTED PHENOMENA

ADJUSTED ACTION PLAN

PREDICTED MEDIAN IN-LAKE TP CONCENTRATION

<table>
<thead>
<tr>
<th></th>
<th>Historical (Pre-Dev)</th>
<th>Current (2016)</th>
<th>Full Buildout (2052)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP (PPB)</td>
<td>1.9</td>
<td>6.4</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Legend:
- Watershed Boundary
- Town Lines
- Existing Building (338)
- Projected Building (238)
- Buildable Area
- Road
- Parcel
- Waterbody
- Watercourse

Data supplied by NH GRANIT and ESRI. Map created by FB Environmental, April 2016.
FUTURE PROJECTIONS, Spofford Lake

TP

POOR

9.9 ppb

EXCELLENT

5.3 ppb

Chl-a

3.1 ppb

SDT

4.0 m

9.4 m

Current

Future

ECOLOGICAL PROCESSES

TRADITIONAL APPROACH

UNEXPECTED PHENOMENA

ADJUSTED ACTION PLAN
• Avoid over-fertilizing!
• Get soil tested before applying
• Apply in September, not before spring leaf-out
• Leave grass clippings
• Calibrate spreader to apply half recommended amount on bag label
• Younger lawns may need N, not P!
NEXT STEPS

• Pump out system every 2-3 years (less if seasonal; more if use garbage disposal)
• Be sure usage matches septic capacity
• Inspect systems more than 25 years old
• Divert drains, pumps, runoff from leachfield
• Keep trees and heavy machinery off leachfield
• Avoid flushing bulky items, greases, or chemicals (like bleach)

A failing septic system can go unnoticed, depending on site conditions!
Questions?

NH Water & Watershed Conference Presentation, 3/15/19
L. Diemer, FB Environmental Associates
Applying an alternate approach to watershed management for two New Hampshire lakes with unique water quality stressors and responses

Elevated in-lake total phosphorus (TP) concentrations typically drive eutrophication in lakes, leading to increases in the extent and duration of low dissolved oxygen (DO) in the hypolimnion during late summer thermal stratification. TP (bound to eroding sediment) then typically becomes the target parameter for achieving measurable reductions that meet water quality goals set in watershed management plans. Two New Hampshire lakes (Pleasant Lake in Deerfield/Northwood and Spofford Lake in Chesterfield) are listed by the NHDES as impaired for aquatic life use due to low levels of DO, but both have excellent (low) in-lake TP concentrations. We present on the alternative water quality goal setting process used for these two unique waterbodies and what insights we have gained from the water quality and sediment core analyses to help explain the apparent disconnect between TP and DO.

OUTLINE
- Understanding phosphorus and eutrophication
- Understanding low DO in the hypolimnion
- NORMAL WMP approach targets TP bound eroding sediment
- Introduce Pleasant Lake and Spofford lake
  - Impairments, DO levels
- Alternative water quality goal setting process used for these two lakes
- Insite gained from WQ and sediment core analyses
- Results -> explanation of the apparent disconnect between TP and DO.
- Moving forward
CURRENT P LOADING

Spofford Lake Watershed
TP Load

Watershed Land Cover Area
- Atmospheric: 2%
- Internal: 2%
- Waterfowl: 18%
- Septic System: 78%

TP Load by Land Cover Type
- Agriculture: 17%
- Developed: 70%
- Forest: <1%
- Water/Wetlands: 13%

ECOLOGICAL PROCESSES  TRADITIONAL APPROACH  UNEXPECTED PHENOMENA  ADJUSTED ACTION PLAN
CURRENT P LOADING

Pleasant Lake Watershed TP Load

- Atmospheric: 2%
- Internal: 4%
- Waterfowl: 14%
- Septic System: 15%
- Watershed Load: 65%

Watershed Land Cover Area

- Developed: 18%
- Forest: 78%

TP Load by Land Cover Type

- Agriculture: 17%
- Developed: 70%
- Forest: <1%
- Water/Wetlands: 13%
NEXT STEPS