#### Province Lake Sediment and Modeling Update

December 2, 2019 Don Kretchmer CLM



#### **Phosphorus Loading**







High levels of potentially toxic CYANOBACTERIA have been identified in this water

#### WATER CURRENTLY NOT SUITABLE FOR WADING OR SWIMMING!

exposure to blue-green scums may cause nausea, vomiting, diarrhea, or fever in humans and pets. Anyone who comes in contact with bluegreen scum should rinse off with fresh water

Click "beach advisory" in left column

UNIACT INFORMATION: HDES Beach Program 29 Hazen Dr.; Concord, NH (603) 2/1-0698 beaches@des.nh.gov





Similar numbers for 2019



## Potential internal loading components

- Internal loading sediment release
  - Estimated from sediment data
  - Calculated from profile data
  - Estimated from modeling
- Internal loading Wind mixing
- Internal loading Boat mixing

## **Sediment Studies**

- 1. How much phosphorus is in the sediments of Province Lake?
- 2. How much of this phosphorus (internal load) could be released under low oxygen conditions?
- 3. How much of this phosphorus is essentially permanently bound in the sediments?
- 4. If internal loading is a factor in Province Lake, what might be done about it?

#### Sediment Movement in a Lake





Data from Maine GIS, NH GRANIT, USGS, and FBE Map by FB Environmental, September 2013

# Sediment Sampling, November 8, 2018





# Sediment Sampling, November 8, 2018



## Results by depth



#### Wind and boat mixing



## Wind mixing









## Wind mixing result

- Only one event
- Nearshore areas showed 1.65 ppb increase in TP concentration after a strong wind event
- Increase was also noted at the deep site so lake may have turned over which may be a confounding effect.
- Only nearshore area was assumed to contribute to wind driven mixing contribution when calculated for model
- This will need to be confirmed with additional data.

#### Boat wake impacts





#### Boat mixing result

- Two events
- Data were inconclusive
  - One event TP increased by approx. 2 ppb
  - One event TP decreased by approx. 2 ppb
- Should be included in in model only if additional data demonstrates a problem.

## LLRM Modeling





## What's new in the model update

- Calibrated with data from 2014-2019
  - Will reflect recent BMP work
- Better, more accurate export coefficients
- Better regional estimates of waterfowl
- Estimate of internal load
  - Release from sediments
  - Wind mixing (caution limited data)
  - Boat mixing
- In-lake P predicted with 3 of 6 available models

## Province Lake Updated Phosphorus Budget

DIRECT LOADS TO LAKE		P (KG/YR)
ATMOSPHERIC		78.4
INTERNAL		
	Anoxic Release	75.5
	Wind mixing nearshore	38.2
WATERFOWL		11.7
SEPTIC SYSTEM		81.4
WATERSHED LOAD		143.2
TOTAL LOAD TO LAKE direct loads)	(Watershed +	428.3







#### Model results and limitations

- Model is underpredicting concentration in tributaries, but we don't have data from half the year.
  - Flow gaging would be helpful to calculate loads.
- Wind impact based on one event.
- Release of sediment P strongly suspected but not documented well
  - LLRM suggests it is present
  - Nurnberg empirical model suggests it is present

## How I think your lake works

- Plenty of nutrients from watershed and septic systems
- Lake stratifies for short periods each year and P is released from sediments to thin layer near bottom
- Wind event mixes this water and P up into the water column and blooms kick off several days later
- Blooms are mixed down in water column and cells die off causing turbidity but not a proportional amount of chlorophyll a
- Wind events likely resuspend nearshore sediments as well but more confirmation is needed.
- Boat impacts on water quality were not demonstrated.

## Why might it seem like it is getting worse

- P pool in sediments getting larger
- Longer growing season
- Warmer water temps
- Continued development/redevlopment
- Blooms fuel new blooms
- Recovery from acid rain
  - Low pH does not favor cyanobacteria
  - Low pH potentially leaches aluminum
- Loss of resilience

#### Next steps

- Keep monitoring, include flow if possible
  - Document stratification/ nutrient buildup in deep water (internal load)
  - Finish wind event sampling
- Continue implementation of watershed plan recommendations
  - BMP's, septic, fertilizer reduction, waterfowl, buffers, pet waste, conservation of land
- Evaluate major changes with LLRM
  - Land use or in-lake
- Update model in 5 years

#### Questions?

