

NIPPO LAKE RESTORATION PROGRAM

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Photo borrowed from 2019
presentation with appreciation

Today's discussion

- Introductions
- How are we fixing the lake?
- Why are we doing an aluminum treatment?
- What will the treatment look like? What are the restrictions or concerns?

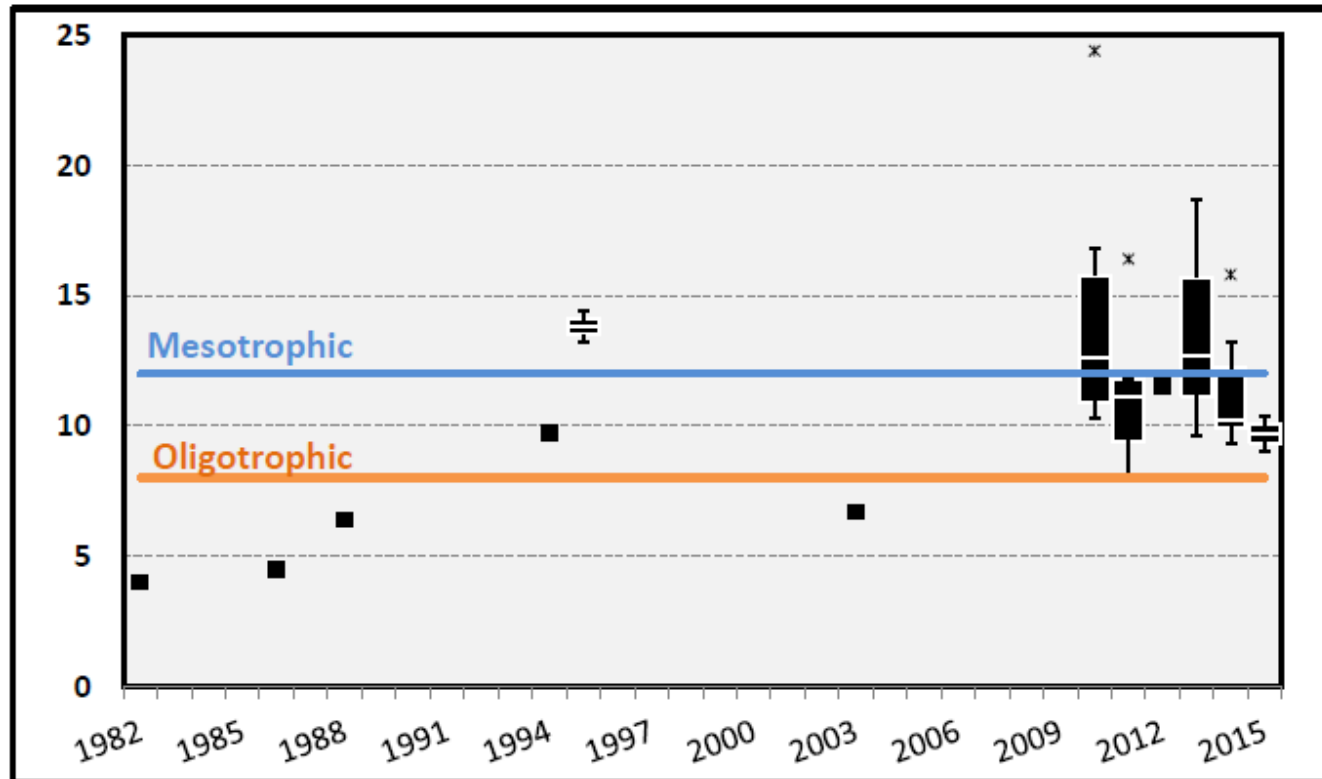
- Questions



1973 Experiment by Schindler

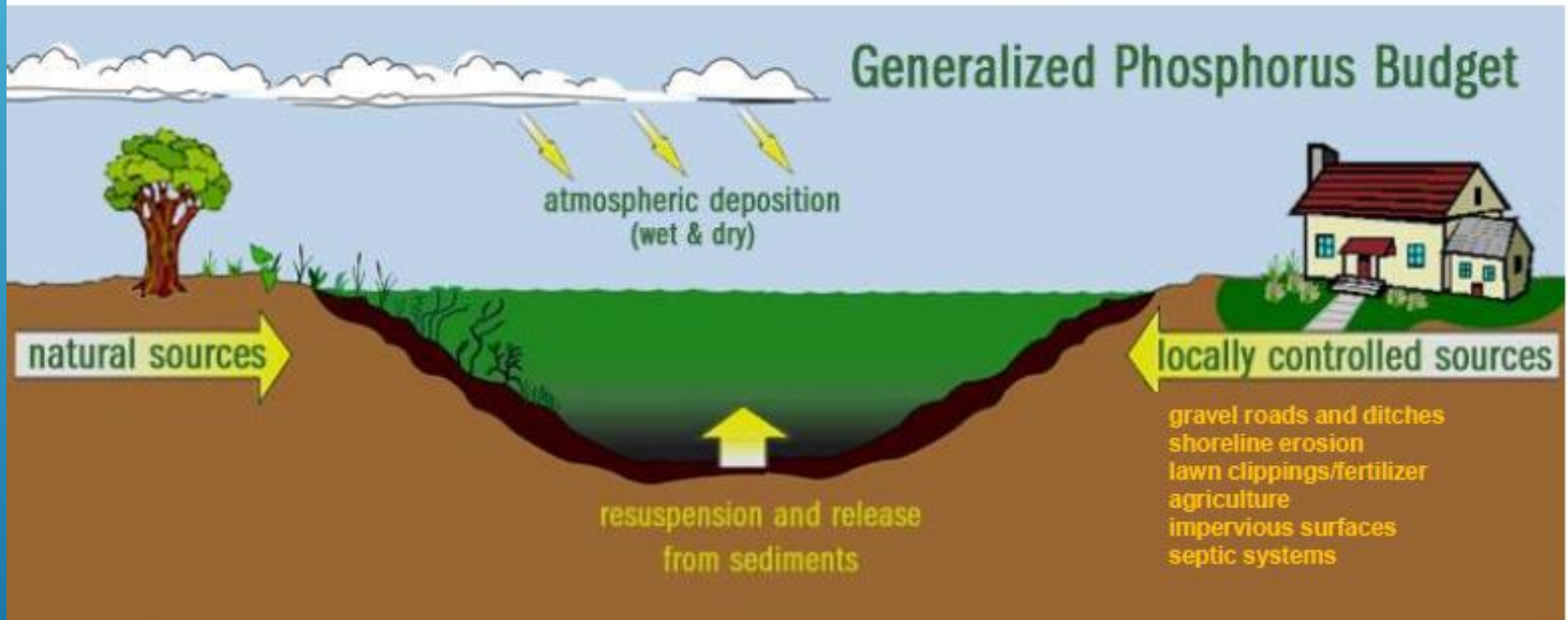
Conclusion: Phosphorus controls how much algae (or cyanobacteria) our lakes will grow.

Epilimnion Phosphorus ($\mu\text{g/L}$)

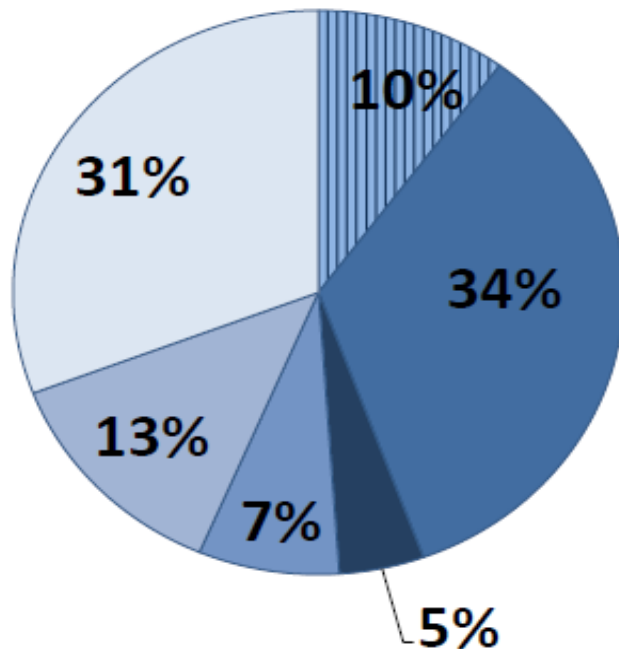


Phosphorus Loading

Generalized Phosphorus Budget



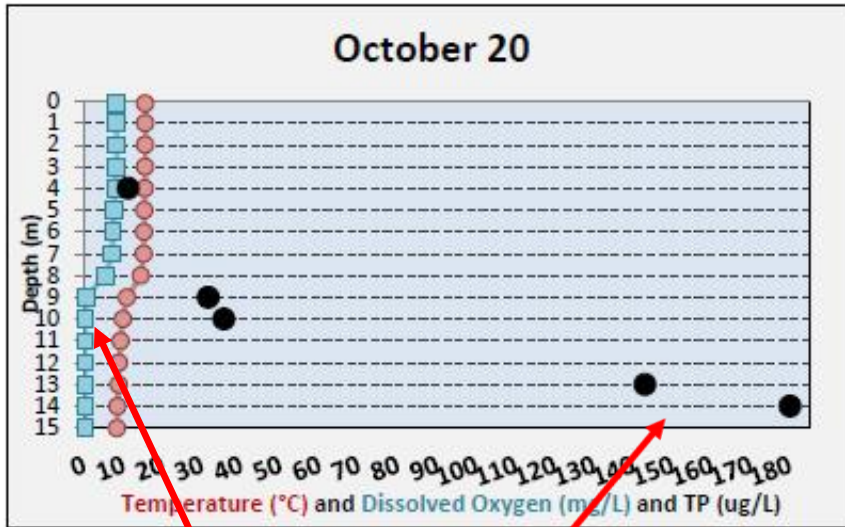
Current condition LLRM



TP Inputs	%	TP (lbs/yr)
Atmospheric	10	8.4
Internal Loading	34	28.4
Waterfowl	5	3.7
Septic System	7	6.2
Watershed –Northern	13	10.6
Watershed - Southern	31	25.6
TOTAL	100	82.9

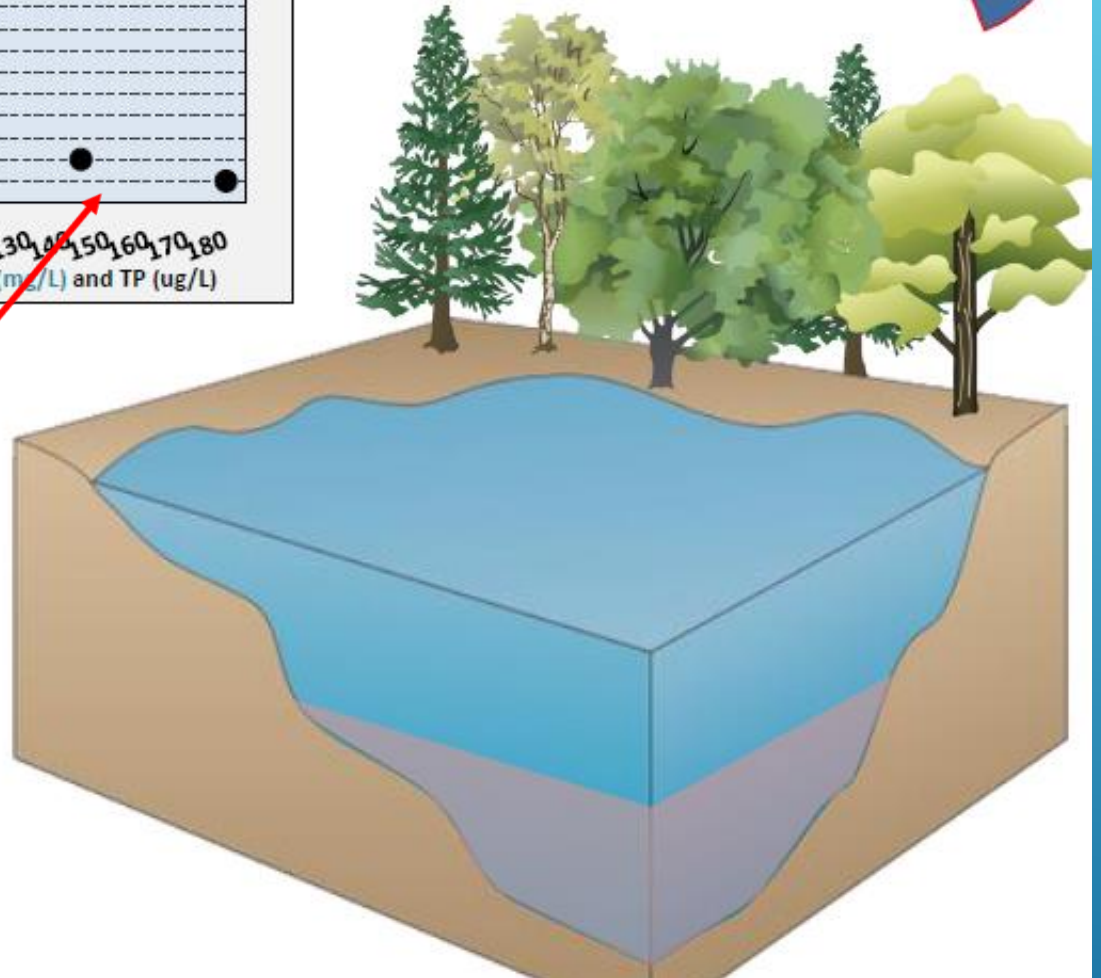
Goal in lake is 7.2 ppb – currently at 10.9 ppb
Can't get there with watershed action alone.

Nippo Lake 2017



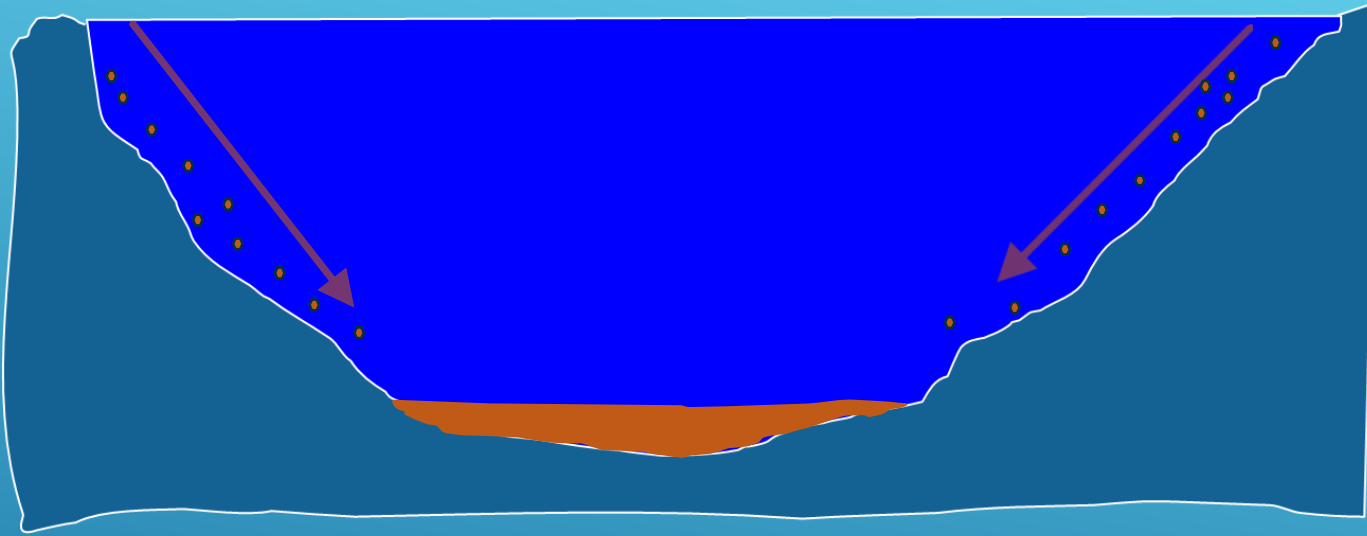
Low oxygen and high phosphorus in bottom layer.

Internal Loading

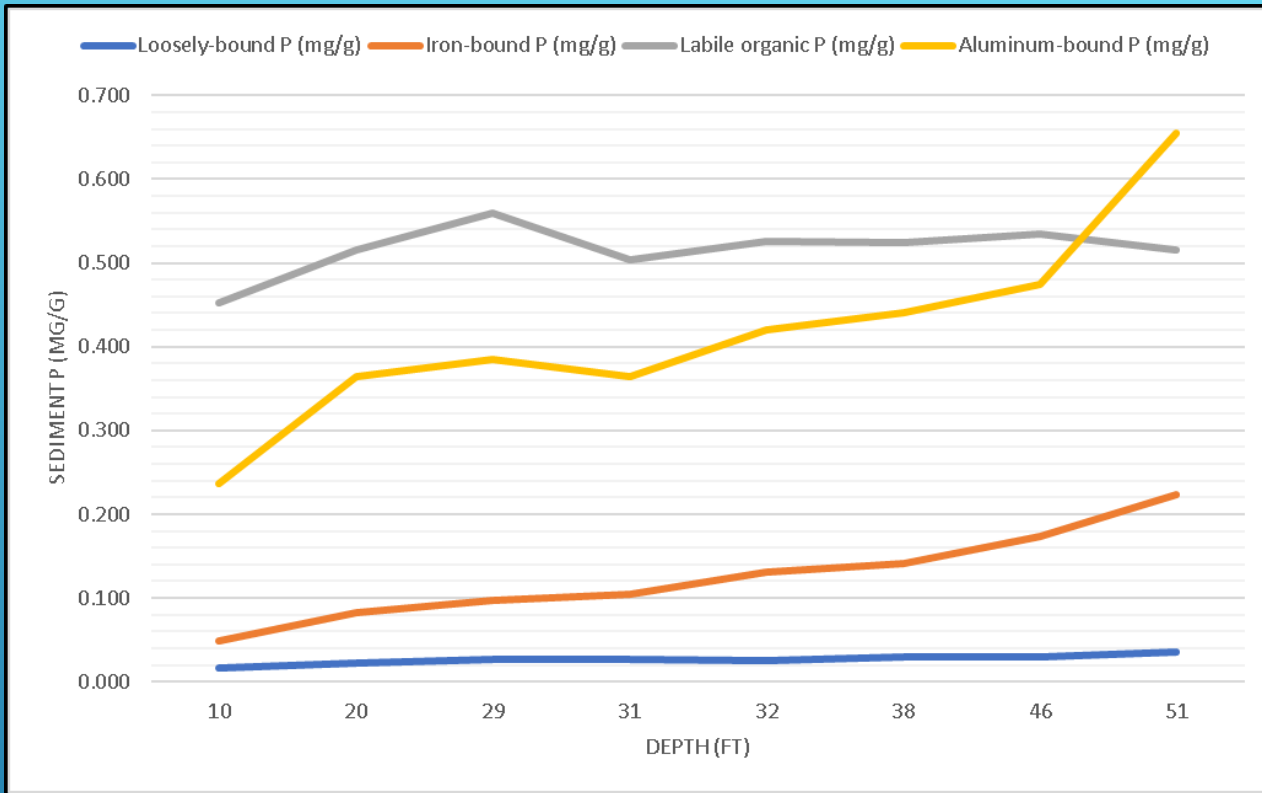


Why do we care about sediments?





Sediment movement



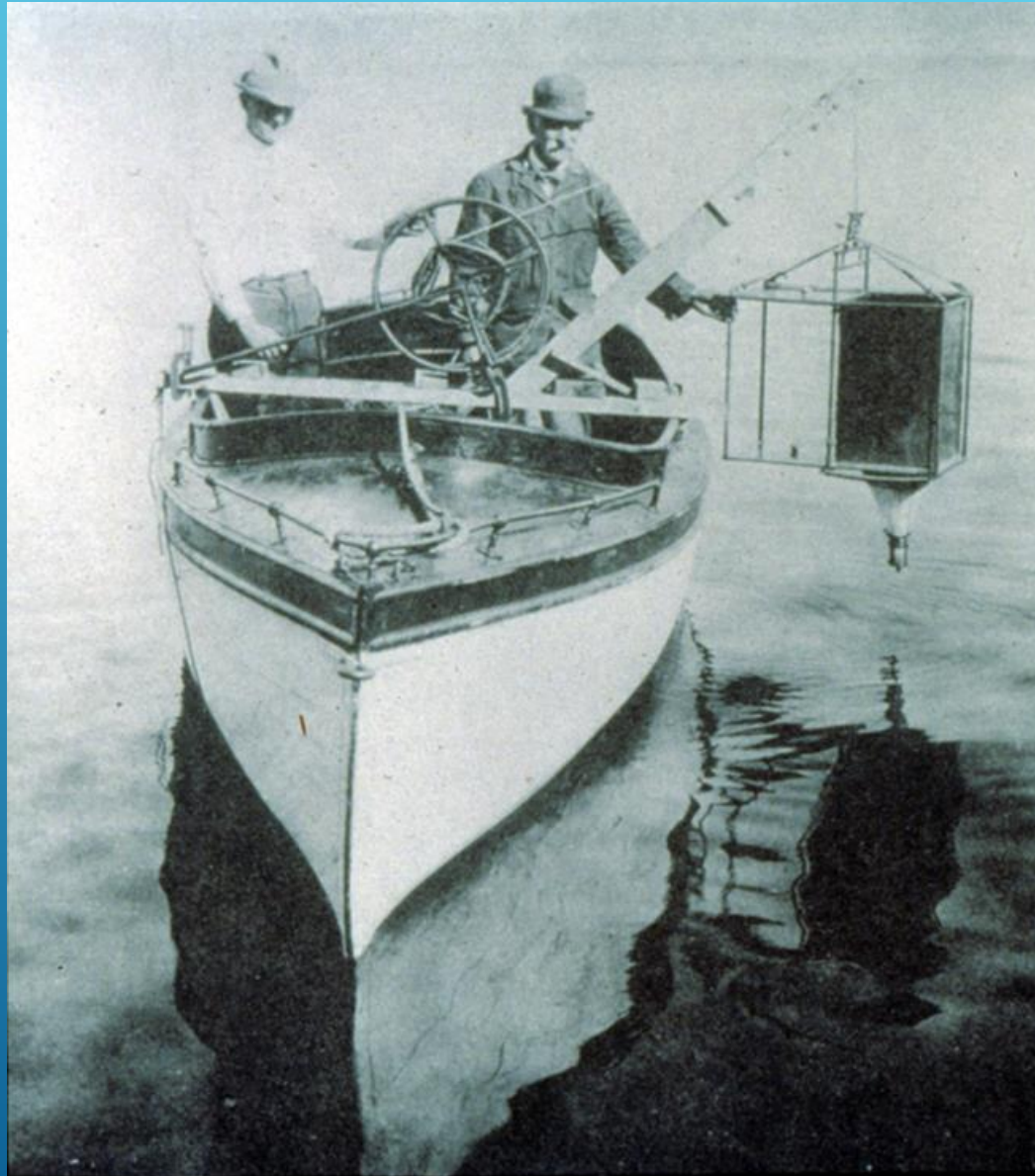
Forms of sediment phosphorus by depth in Nippo Lake

Water Depth	Water Depth	Area	Area	Loosely Bound P + Iron Bound P in upper 10 cm of sediments	Loosely Bound P + Iron Bound P + Labile Organic P in upper 10 cm of sediments
(m)	(ft)	(acres)	(hectares)	(kg)	(kg)
9	30	27	11	224	857
7	23	42	17	326	1314
3	10	65	26	462	2029
0	0	85	35	606	2663

Amount of P in upper 10 cm (4 inches)

- 1.3 metric tons of the stored sediment phosphorus could be released back to the water column
- Assuming a 10% annual release of P in upper 10 cm below 9M in depth equals a release of 22.4 kg/yr.

We have data, now what might we do?



Options for Cyanobacteria Control in Lakes (highlighted are recommended)

Options potentially applicable	Options deemed not applicable.
Nonpoint source control of phosphorus (watershed-based plan)	Point source control of phosphorus
Pollutant trapping (watershed-based plan)	Dilution and flushing
Circulation and destratification	Drawdown
Hydraulic dredging	Dry excavation of sediment after drawdown
Hypolimnetic oxygenation	Wet excavation of sediment from shore
Algaecides	Light limiting dyes
Phosphorus inactivation	Surface covers
Settling agents	Selective withdrawal of water
Sediment oxidation	Sonication
Mechanical removal/treatment on shore	Selective nutrient addition
Enhanced grazing through food chain interactions	Addition of herbivorous fish
	Bottom feeding fish removal
	Microbial competition
	Addition of pathogens
	Plantings of macrophytes for nutrient utilization
	Plantings of macrophytes for shade



Watershed
Management



Phosphorus Inactivation
with Aluminum



Balanced Aquatic
Community

THREE ACTIONS RECOMMENDED

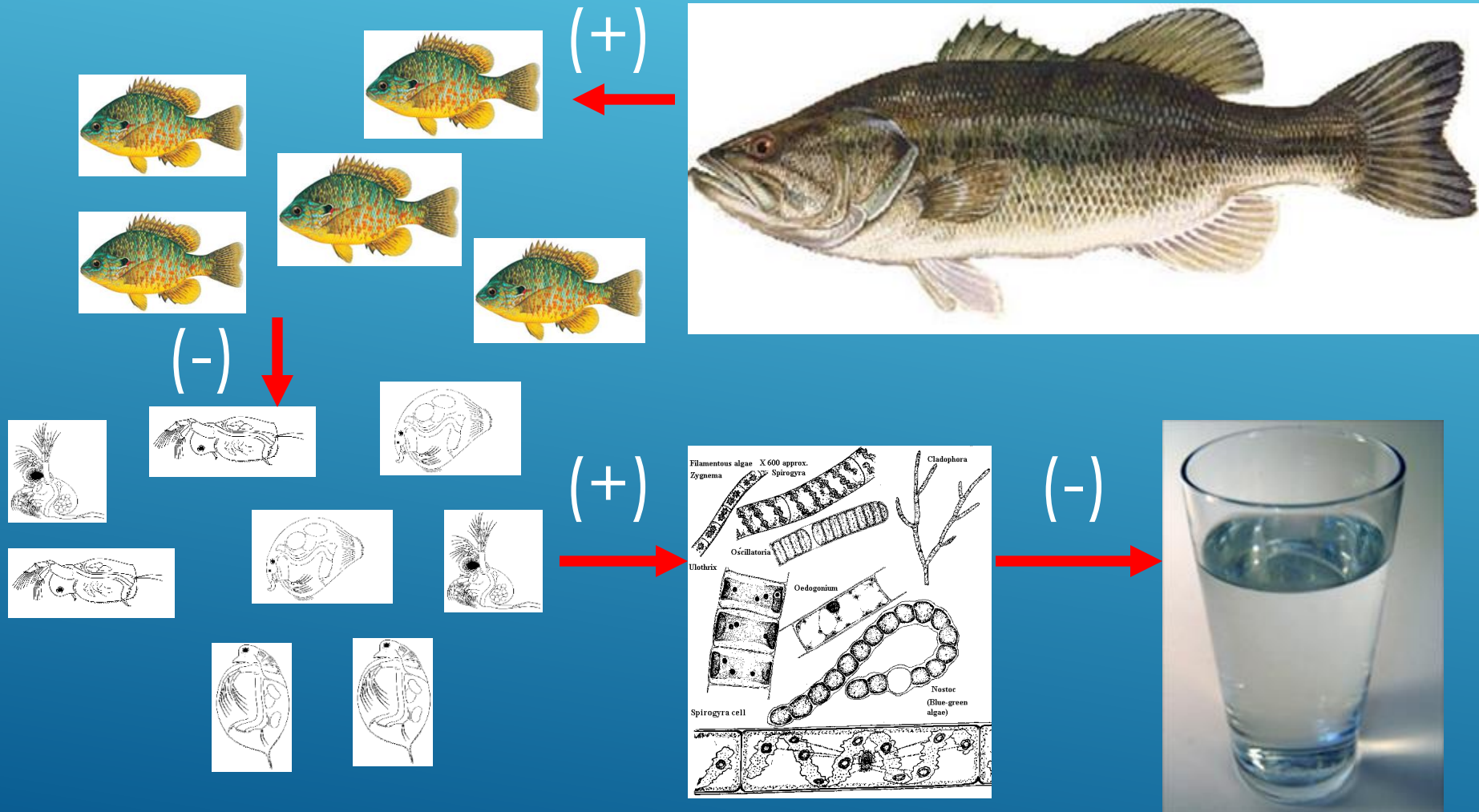


WATERSHED MANAGEMENT

Balanced Biologic Community

Manage biologic system to enhance grazing on algae

Probably not sufficient to rehabilitate lake although maintenance of a balanced fish community is encouraged



In-lake phosphorus inactivation with alum

- Reduce P release from sediment; will control P in lake if sediment is a major source
- Planned to react with upper 4 inches of sediment.
- Will use Aluminum Sulfate + Sodium Aluminate



LAKE MANAGEMENT BEST PRACTICES

ALUM FOR PHOSPHORUS CONTROL
IN LAKES AND PONDS



Treatment in progress



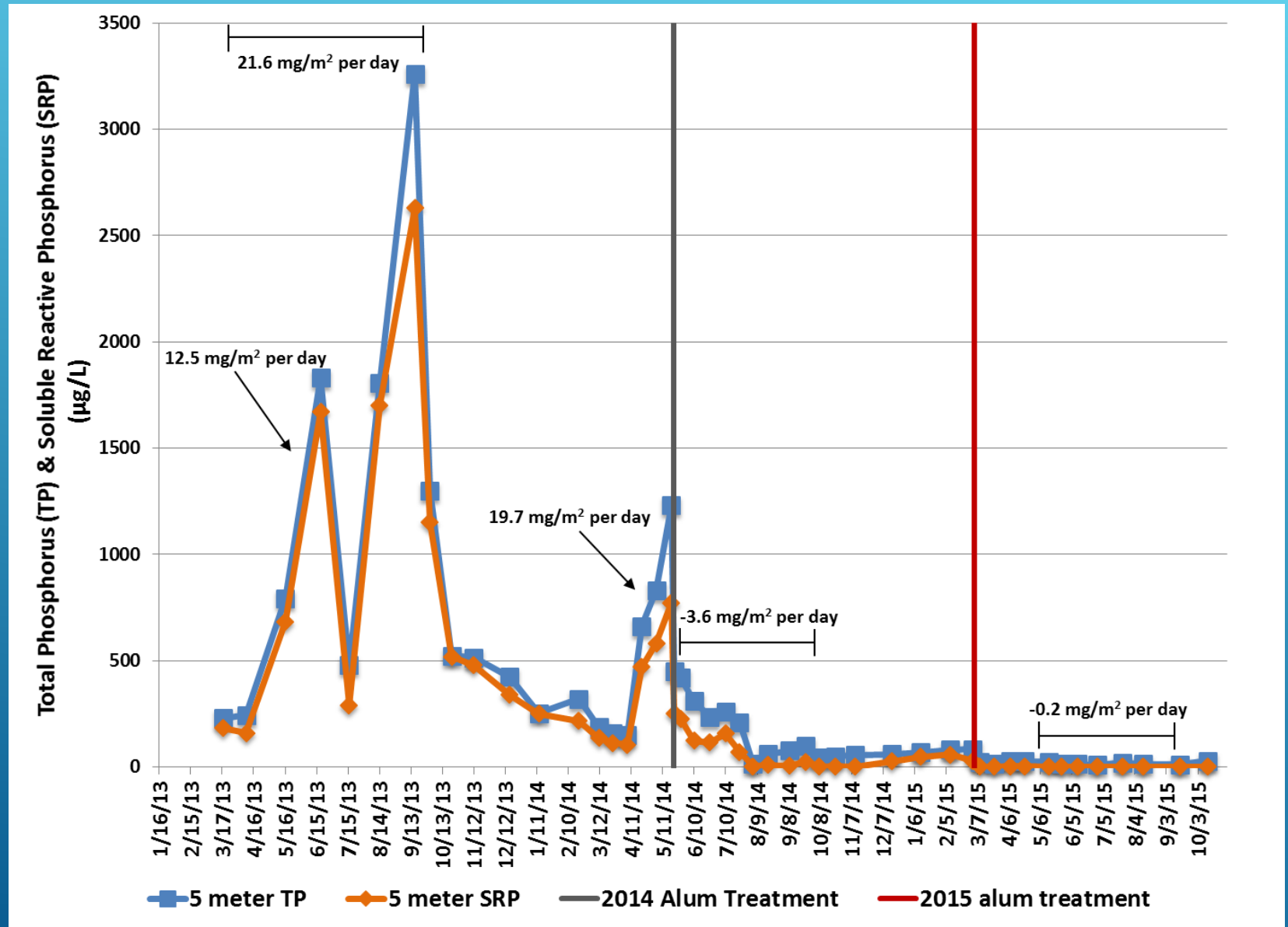
Floc on bottom (5-10 minutes after application)

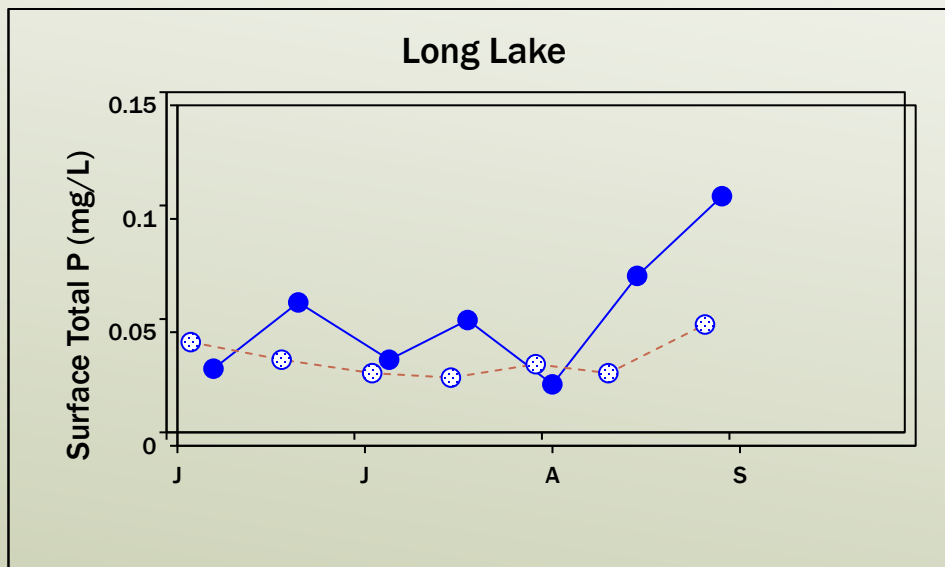


Shore staging area



Lake Ketchum results (Tetra Tech)

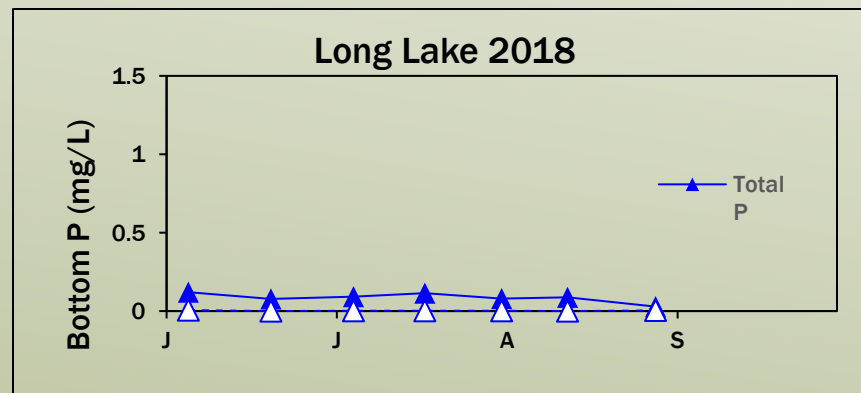
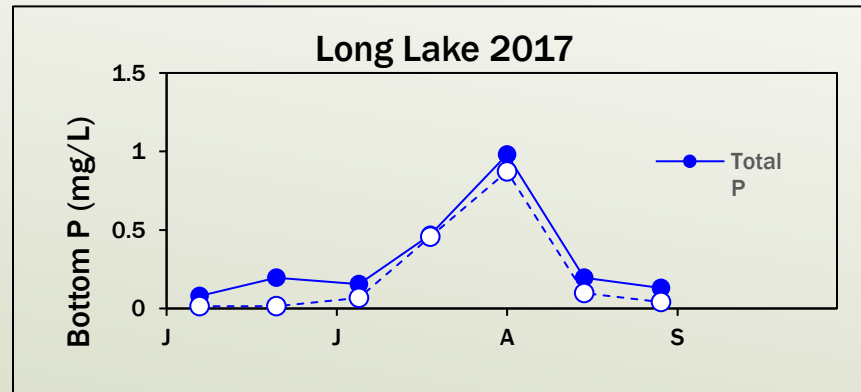




- 2017
- 2018

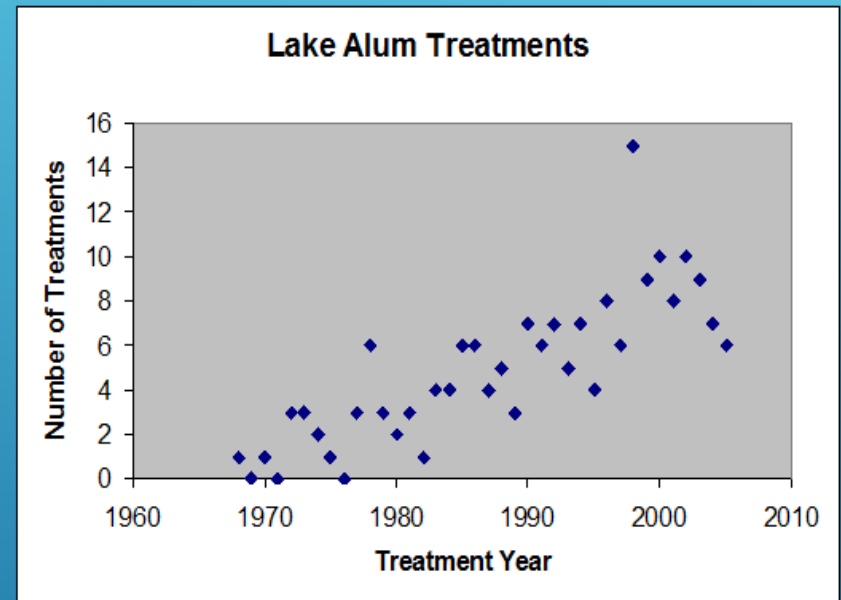
W. James, UW-Stout, unpublished data

HYPOLIMNETIC TOTAL P



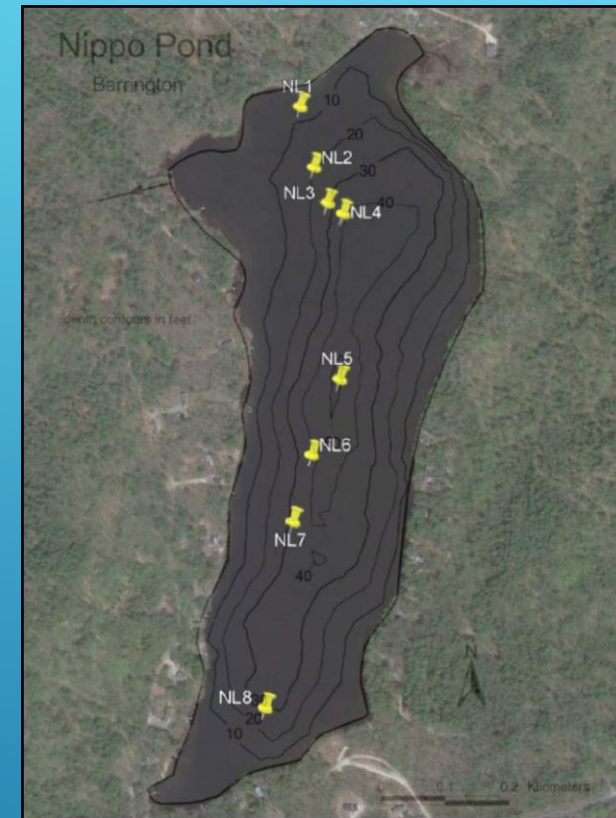
Alum Treatment Numbers

- ▶ Trend of increasing alum use in lakes/ ponds
- ▶ 200+ recorded lakes treated (14 repeats)
- ▶ 165 in Mn, FL, WA, and WI, 25 in other states, 25 in Europe
- ▶ 16 treated by interception



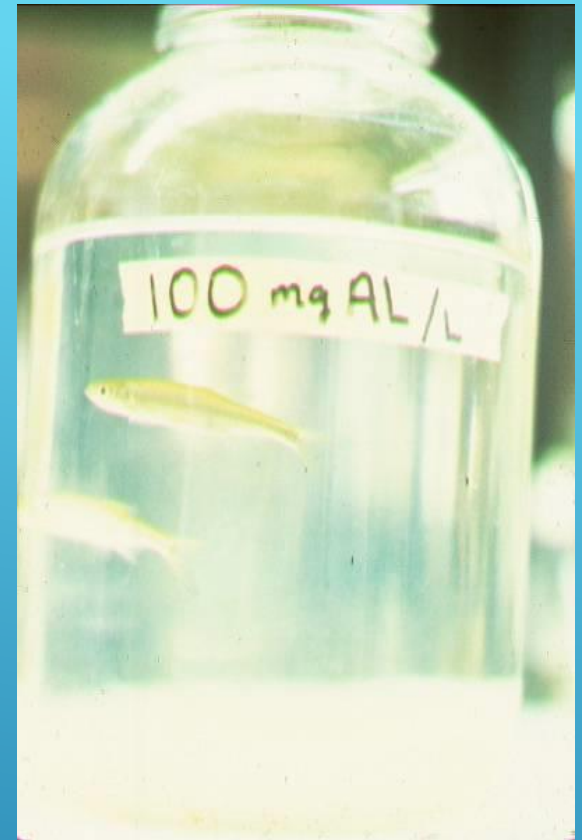
Factors we took into account in planning aluminum treatment for Nippo:

- Existing P load, sources and inactivation needs
- System hydrology – flow and flushing
- Water chemistry - pH, alkalinity, oxygen concentration
- Potentially sensitive receptors – fish, zooplankton, macroinvertebrates, reptiles, amphibians, waterfowl
- Presence of rooted plants or other interferences
- Fate and transport - future cycling, downstream movement, accumulation of residue in sediment



To Avoid Toxicity to Aquatic Life

- Aluminum dose at any one time should be below toxic levels
- Treat defined areas of the lake in a pattern that minimizes contiguous area treated at once (patchwork with adjacent blocks not treated sequentially)
- One treatment split in two or multiple applications
- Apply aluminum at enough depth to create a surface refuge
- When buffering alum with aluminate, use a ratio to maintain pH between 6 to 8



To Avoid Conflicts With Humans

- Aluminum quickly settles to bottom (areas deeper than 20 feet) so there is little if any human contact once applied.
- Form of aluminum is important. Will be as aluminum hydroxide shortly after application (main ingredient in many over the counter antacids)
- Aluminum is used in water treatment plants throughout the state (Claremont, Concord, Durham, Laconia, Lebanon, Lincoln, Manchester, Meredith, Pittsfield, Portsmouth, Rochester, Somersworth, Salem, Wolfeboro).
- No contact the day of the treatment



What to expect during and after treatment

- Water clarity improvement within a day or two- with a spring application, the summer water should be remarkably clear
- Restrictions only on day of treatment
- Much reduced incidence of cyanobacteria blooms, blooms later in the year or no blooms at all
- 15-20 years of benefit
- Low toxicity

Summary

- Lake will not recover without addressing both external and internal load
- External load is being addressed through a number of BMPs and individual actions
- Inactivation of sediment phosphorus by aluminum is the best option for Nippo due to its small watershed size and success of external nutrient control.

What if we don't deal with the internal load?

- Will still be enough phosphorus to support blooms. The internal load will not diminish any time soon and may get worse in a warming climate.

Project steps

- ▶ Monitor water quality ✓
- ▶ Model lake and watershed, develop plan ✓
- ▶ Design watershed BMP work ✓
- ▶ Sample sediments ✓
- ▶ Design in-lake plan for control of internal load ✓
- ▶ Obtain in-lake permits (in process)
- ▶ Build watershed BMP's (in process)
- ▶ Implement in-lake control
- ▶ Monitor water quality (ongoing)



“Nippy” the lake monster

Questions