ENVE 1:
Lake Chaffee Algal Bloom Management

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Introduction

I. Lake Chaffee is a 52 acre large, 6ft deep (on average), man-made Lake in Ashford, CT.

II. In 2019, the lake suffered from never-before-seen algal blooms starting in the early spring through the summer.

III. The lake is primarily fed by runoff from the surrounding watershed.

IV. The Lake Chaffee Improvement Association (LCIA) is its own municipality, which oversees the care of Lake Chaffee.

V. The LCIA requested the Lake and surrounding areas be evaluated for contributors of nutrients, and for us provide discovery, explanations, and example designs of prioritized mitigation suggestions based on our findings.

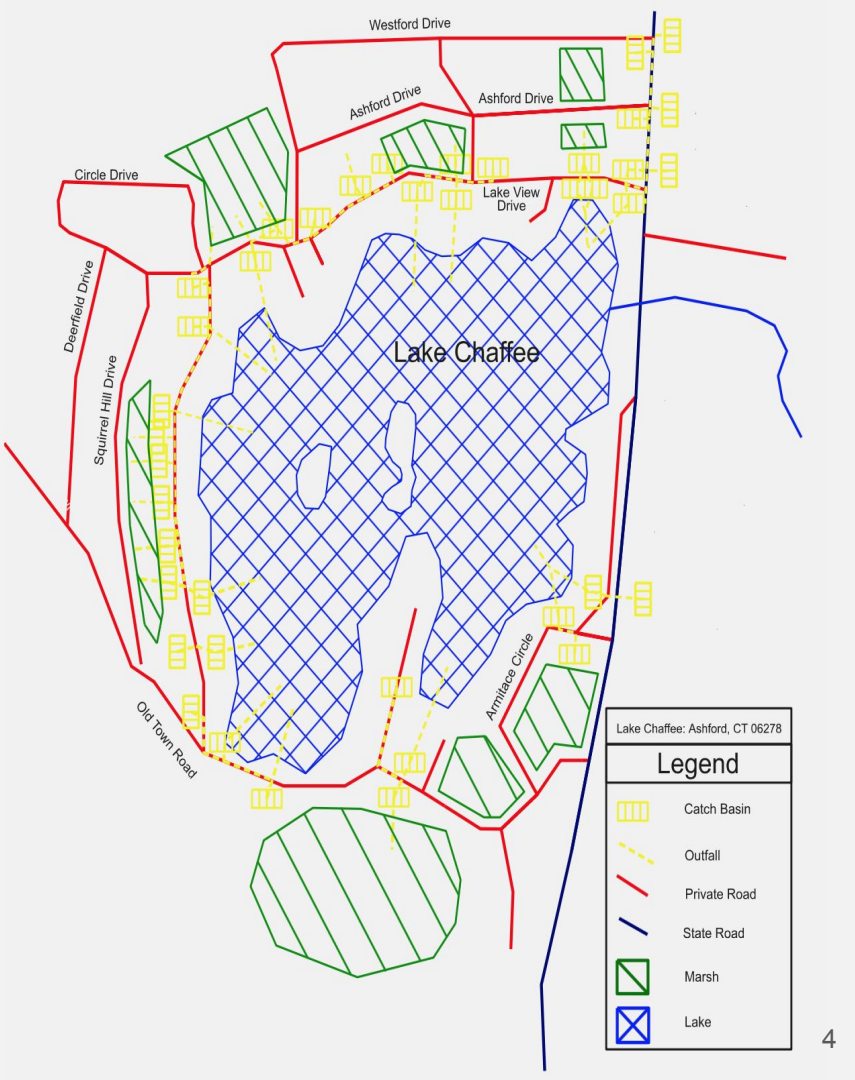
Eutrophication and Algal Blooms

Eutrophication: excessive richness of nutrients in a lake, frequently due to runoff from the land which causes a dense growth of plant life

Locating Lake Inflows

I. Visual analysis conducted to find all surrounding catch basins and conjoined piping system

II. We need to understand:
   A. How they connect
   B. Where they drain into
   C. Any apparent nutrient sources

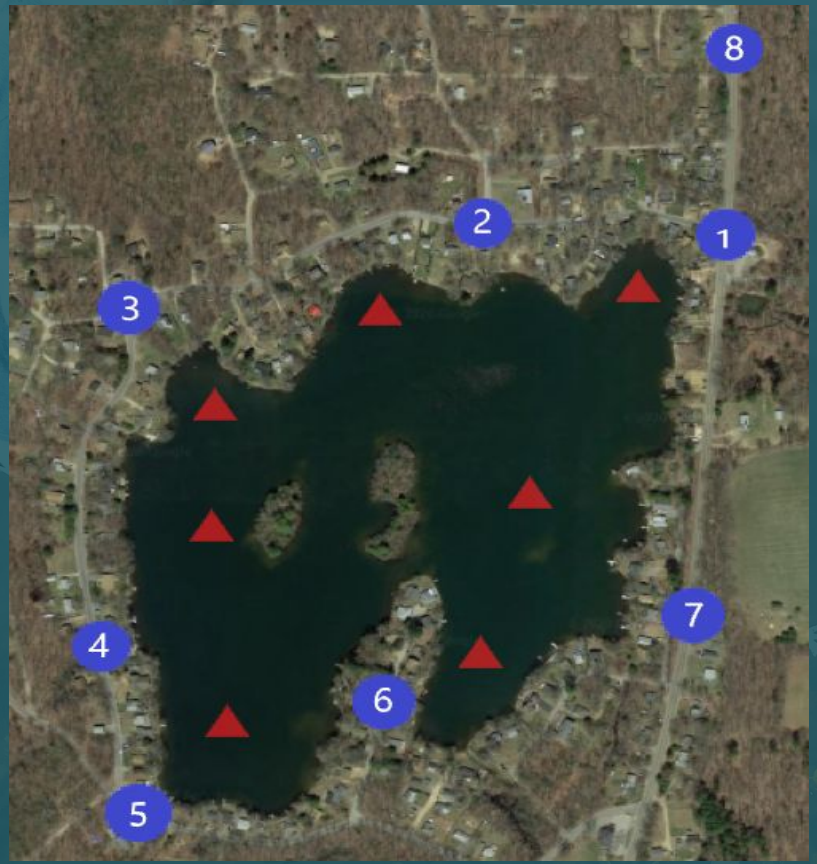


Sampling - Lake Water (Ammonia)

Sample	Absorbance	Concentration (mg/L)
1	0.0718	ND
2	0.0021	ND
3	0.0715	ND
4	0.0709	ND
5	0.0019	ND
6	0.2943	0.319
7	0.0161	ND

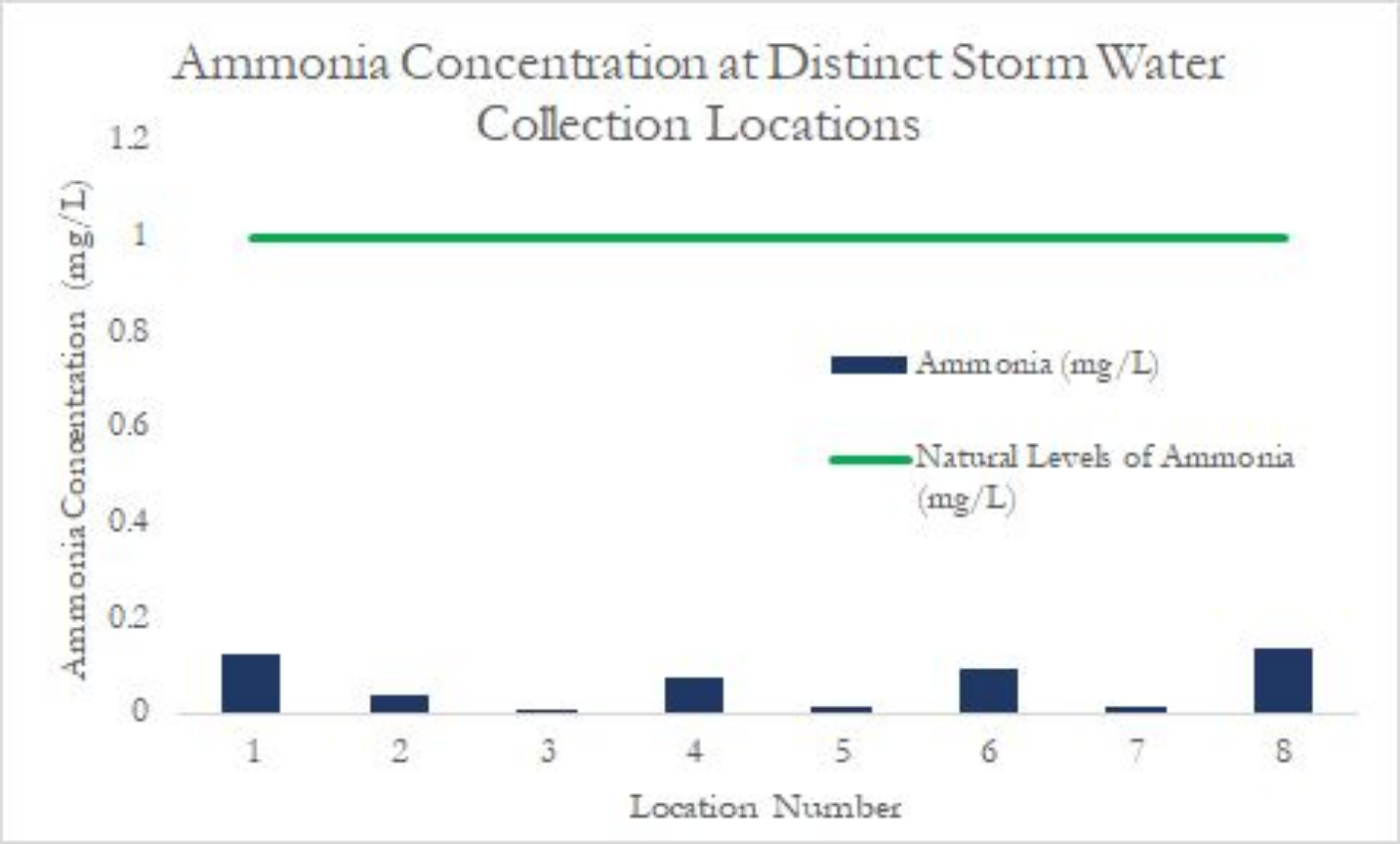
ND: Non-detect

Sampling - Stormwater (Ammonia)



Sample	Concentration (mg/L)
1	0.1271
2	0.0383
3	0.0072
4	0.0758
5	0.018
6	0.097
7	0.018
8	0.1357

Sampling - Stormwater (Ammonia)



Sampling - Takeaways

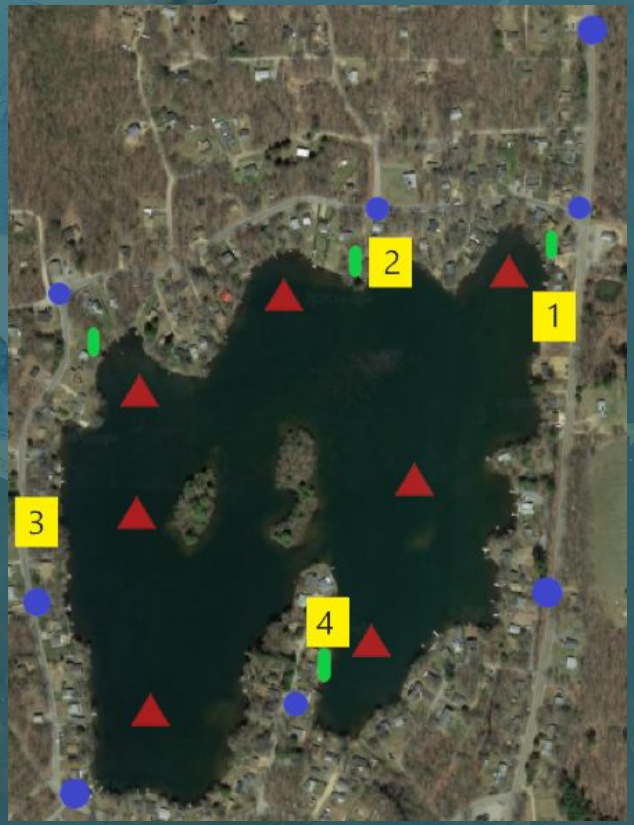
I. There were insignificant levels of ammonia in both Lake and stormwater.

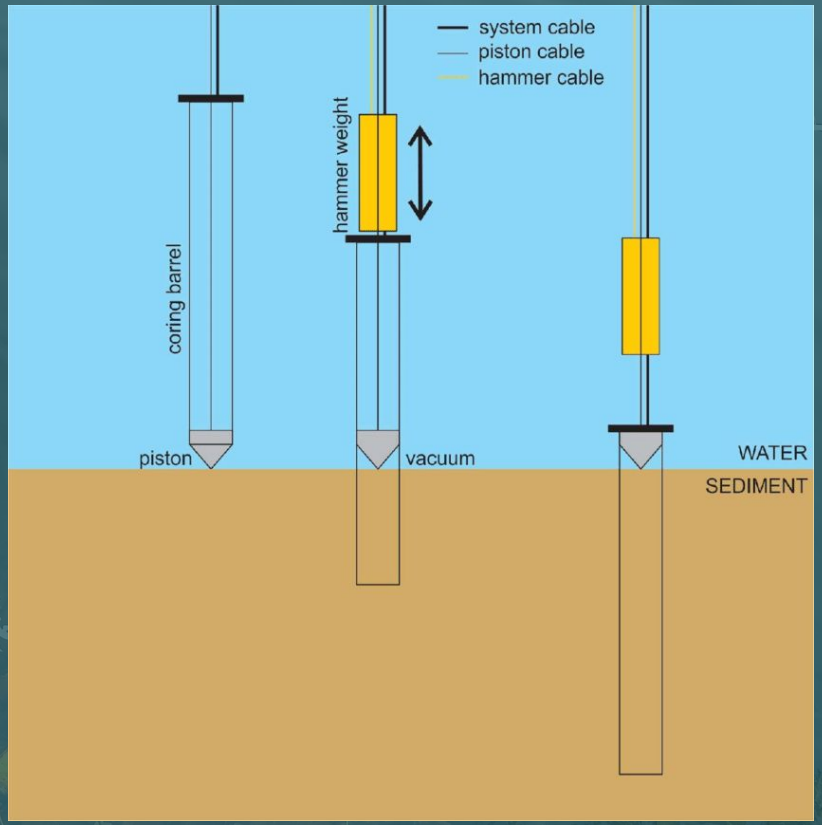
II. Typically in New England, Phosphorus is the limiting factor in algal growth.

III. The cause of Lake Chaffee's algal blooms are still not entirely known; More testing needs be conducted to fully understand nutrients in and around the lake

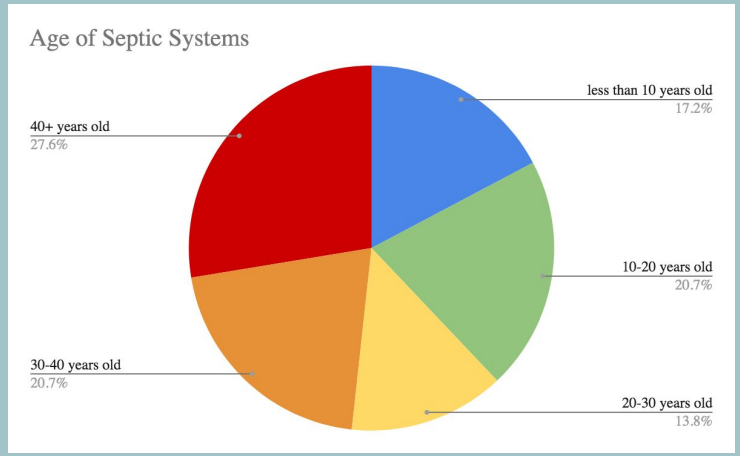
Proposed Sampling - Piezometers

Proposed Sampling - Sediment





Resident Survey



Data gathered from surveys and Land Use Office records

Surveys were distributed in October to all year round residents' homes as well as the local convenience store and there were 33 responses received (15% of residents).

Relevant Results:

- 48.3% of respondents own septic systems that are over 30 years old.
- 21% of residents do use fertilizers, both commercial and natural
- 36% of residents have pets, and therefore pet waste, on their property

Project Limitations

The current COVID-19 pandemic prevented further sampling during the spring, when things will be starting to decompose, more residents are using their lake homes, fertilizers will be applied, and stormwater flow into the lake will be at an all time high.

We were advised not to use piezometers in the winter since the ice can damage them. This limited our ability to test ground water, and how septic may be impairing water quality.

In response, we shifted the focus of our project from a direct sample-and-treat approach to the creation of a Lake Algal Management Plan. Our recommendations were created to best advise the LCIA in the future of their algal bloom issues.

Other Sources of Nutrients

1. **Septic Systems;** Almost half (48%) of respondents had septic tanks more than 30 years old.

2. **Pet Waste;** Roughly 36% of survey respondents stated they have pets on their property.

3. **Fertilizers**; the LCIA banned the use of products with more than a trace amount of phosphorus may be used. (LCIA 2001) An infraction is accompanied with a fine of $60.00 for each occurrence.

Mr. Sherman's dog, Dawson, in Lake Chaffee (10/25/19)

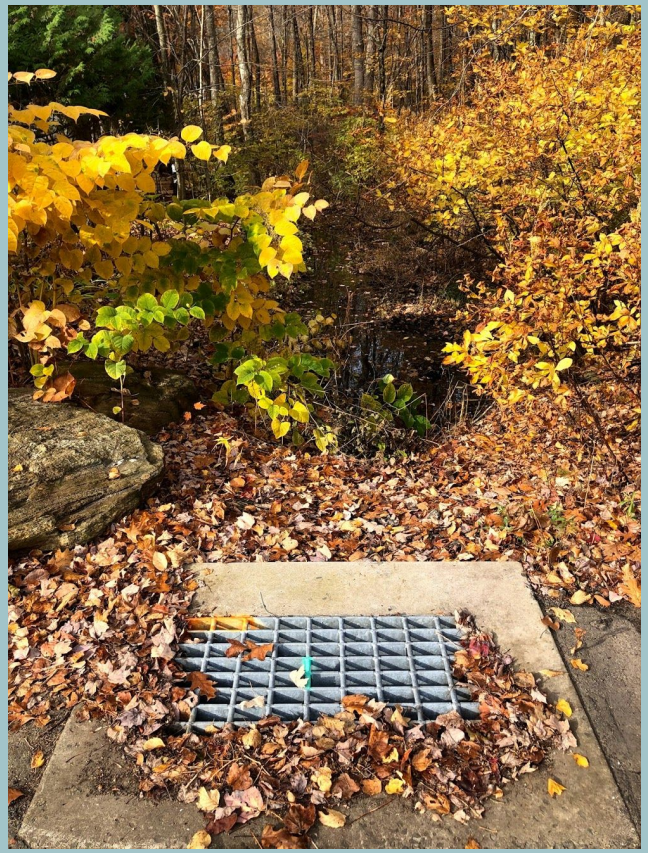
Sources of Nutrients

4. **Sediment Release;** Phosphorus release from sediments after storms can cause the lake to become eutrophic in the warmer months.

5. **Leaf Degradation;** Leaf degradation can provide phosphorus to a lake if catch basins are not maintained.

6. **Home Flooding;** ⅔ of survey responses indicated their homes flood during high precipitation events.

7. **Climate Change;** increased precipation, warmer months.



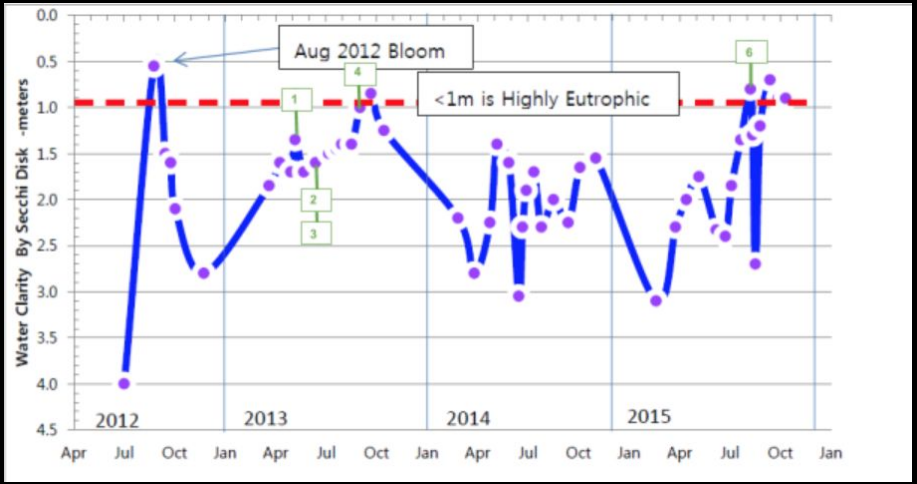
Most of Lake Chaffee's catch basins were covered in leaves, some were completely hidden by the build-up. (taken October 25th, 2019)

Case Studies

1. ***The Bolton Lakes***
   Vernon, CT
   a. Algal bloom issues from 2012-2015 lead to the creation of the FBL
   b. Pesticide treatments until 2015 were well-documented (Figures 1 and 2)
   c. Received grants to subsidize their Lake treatment.

	Date	Task
1	20-May-2013	Initial Fluridone Herbicide (Sonar-Genesis - liquid)
2	27-June-2013	Booster Fluridone (Sonar Genesis - liquid)
3	27-June-2013	Algaecide - Planktonic Cyanobacteria (Copper)
4	5-Sep-2013	Fluridone treatment of small cove fanwort (Sonar Q - granular)
5	2014	No treatment necessary
6	2-Sep-2015	Algaecide - planktonic cyanobacteria (Copper), Herbicide curly-leaf pondweed (Diquat)
7	21-Jun-2016	Herbicide curly-leaf pondweed only** (Diquat), no copper sulfate used
8	26-Jun-2017	Herbicide curly-leaf pondweed only** (Diquat), no copper sulfate used
9	2018	No treatment conducted

* Used for treatment of invasive species only, no issue with lake clarity.



Pictures courtesy of Northeast Aquatic Research

2. *Clary Lake*

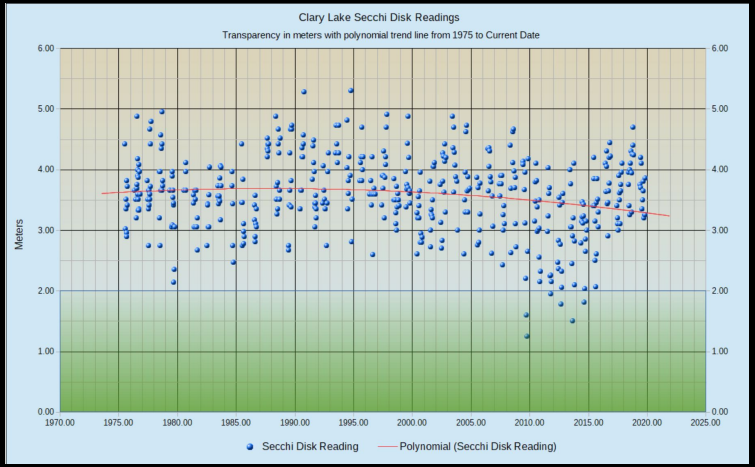
Whitefield, NY

a. Residents noticed the quality of their lake decreasing, and began an association to measure its water quality preemptively.

   i. Dissolved Oxygen
   ii. pH
   iii. Temperature
   iv. Phosphorus

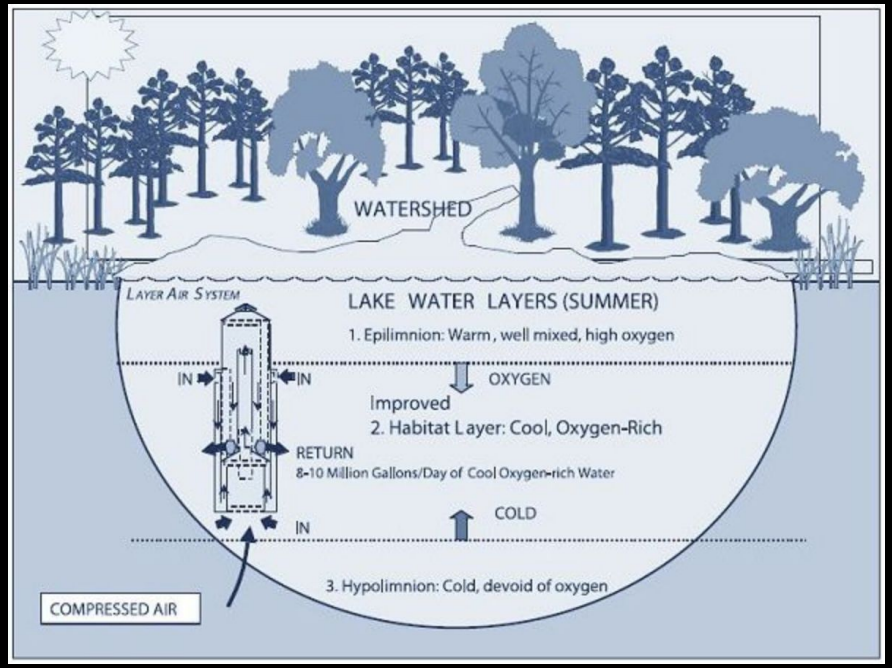
b. Their association created:

   v. Invasive plant patrols
   vi. Invasive plant surveillance forms for residents
   vii. Resident trainings and newsletters



#	Date	Secchi Disk (m)	Secchi Disk (ft)	Surface Temp(F)	Oxygen (mg/l) Surface	Oxygen (mg/l) -23 feet	Phosphorus (mg/l)	Notes
1	04/21/2012	2.47	8.10	58.5	10.3	7.6		
2	05/16/2012	2.36	7.74	61.2	10.2	8.1	0.023	
3	05/30/2012	2.83	9.28	69.3	9.0	1.0		
4	06/12/2012	3.54	11.61	68.2	9.0	2.0		
5	06/29/2012	3.41	11.19	72.1	8.2	0.2		
6	07/25/2012	2.76	9.06	76.6	7.9	0.4	0.027	
7	08/08/2012	1.78	5.84	81.7	8.8	1.4		algae bloom
8	08/22/2012	2.05	6.73	75	8.5	0.3		algae bloom
9	09/04/2012	2.32	7.61	72.7	7.6	0.2		algae bloom mostly gone
10	09/19/2012	3.45	11.32	67.8	8.7	8.4	0.022	
11	10/03/2012	3.60	11.81	63.5	9.6	8.5		dead green/blue algae along

Screenshots taken from Clary Lake Website (04/23/20)



Source: Lake Waramaug Task Force

3. *Lake Waramaug*

Litchfield County, CT

a. Underwent a study in 1992 by DEEP and US Geological Survey due to algal blooms caused from nutrient enrichment,

b. The Task Force implemented a comprehensive set of solutions to address the several points of input.

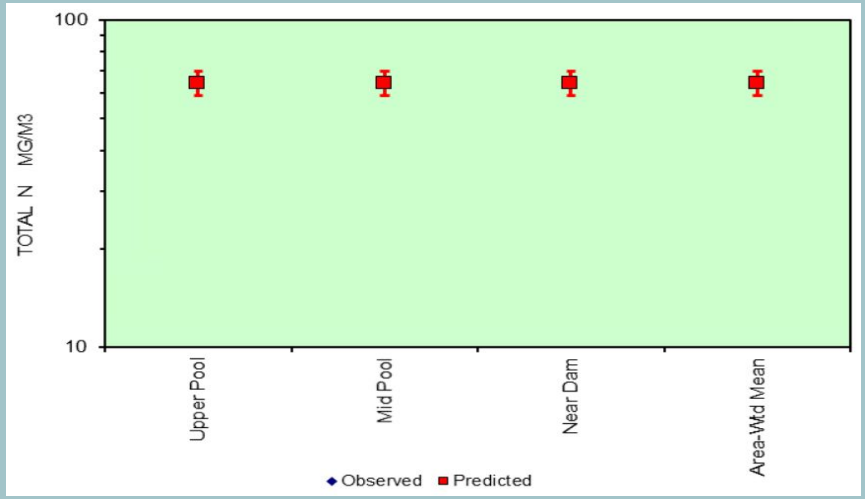
c. They installed a Layer Aeration system designed by Dr. Robert Kortmann, to de-stratify the lake, and provide more cold water habitat for the wildlife, as well as for zooplankton which prey on algae.

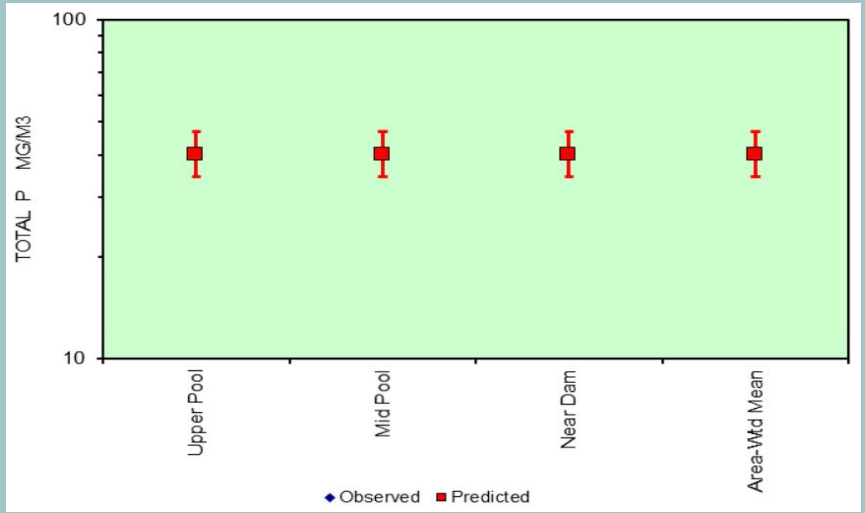
BATHTUB

The BATHTUB Simplified Technics for Eutrophication Assessment and Prediction by William W. Walker Jr. Ph.D was utilized to help pick the best methods and options to recommend for eutrophication prevention.

The model's inputs came from a variety of sources, like NOAA for precipitation and evapotranspiration rates, as well as the Lake Chaffee Improvement Association for morphological features. These values were used to create a baseline for Lake Chaffee that could be compared to other scenarios.

These graphs to the right are the baseline predicted nutrient levels in the defined zones of the lake.

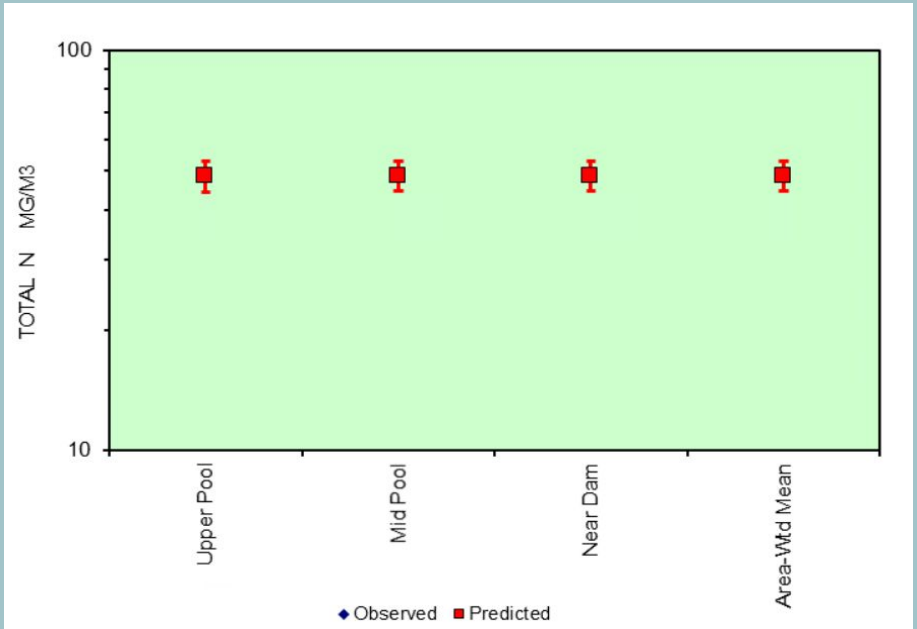


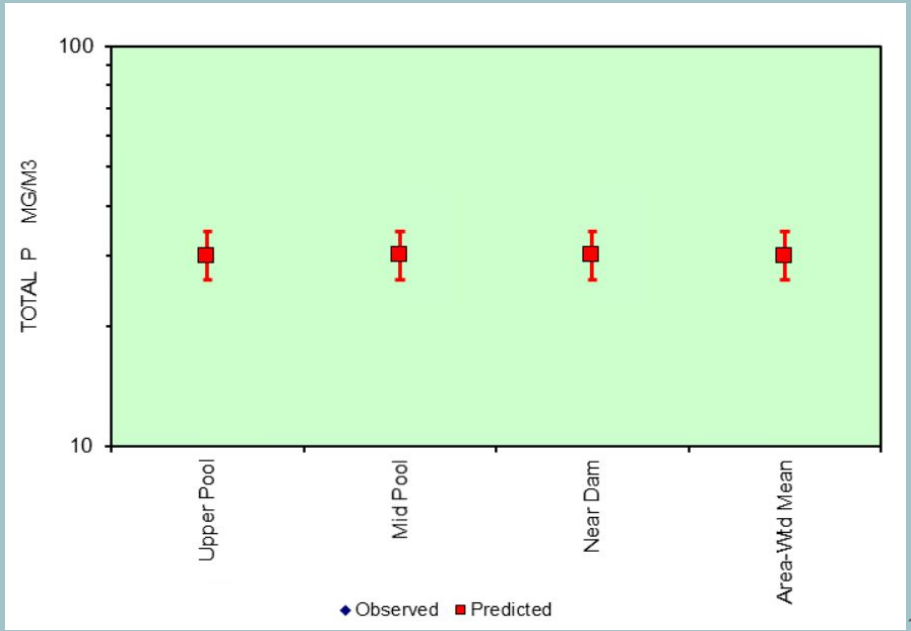


BATHTUB analysis

One prevention method tested was lifestyle changes throughout the Lake Chaffee community. This includes septic system renovations from houses with degrading or failing systems, significantly less leaf litter dumped into the lake, and less total runoff in surrounding communities.

Phosphorus dropped significantly and nitrogen is also down from baseline. Each nutrient was decreased about 10 mg/L





BATHTUB: Precipitation Explanation

Another use for the model was to illustrate how increased precipitation loads the lake with nutrients. Due to intense rain events carrying lots of nutrient rich microparticles and litter towards the lake, a higher level of nutrients is predicted in the lake after a rainy season.

This could be a cause of why there was a bloom in the past. Extra precaution must be taken with what is left out to be carried into the lake by rain.

The table to the right is values taken from the Baseline Lake Chaffee model, a model with twice the amount of runoff than usual in the spring, and another with three times the amount of runoff in spring.

Condition	Total Nitrogen (ppb)	Total Phosphorus (ppb)
Baseline	64	40
2x seasonal precipitation	66	42
3x seasonal precipitation	76	48

Final Recommendations

1. **Continue to monitor** the lake quality through regular inspection and testing.
2. **Educate the community** about adopting lifestyle changes that promote Lake health.
3. Consider **preventative measures where possible**, i.e. Barley straw
4. **Algaecides** can be used as a reactive solution to algal blooms to clear up lake clarity fast.

Data Collection

Start monitoring the water quality of the Lake;

- Dissolved Oxygen
- pH
- Temperature
- Phosphorus

A Volunteer performing a water test in Vermillion. (The Timberjay)

- Invasive Species should be monitored and recorded as well
- Nitrogen can also be investigated but is expected to have little contribution to blooms

Lifestyle Changes

- Control runoff and soil erosion
  - Pet waste
  - Leaf mulch
  - Household detergents/chemicals

- Septic system monitoring/renovation
  - Regular maintenance
  - Potential for upgrading systems

Barley Straw

- Humic acid and dissolved oxygen create hydrogen peroxide
  - Inhibits algal growth

- Each application lasts spring through fall
  - $540 per application

Algaecide

Limited time, reactionary solution

Cutrine® Plus: Double-chelated copper compound, very commonly used

a. Chemical composition of Cutrine Plus stays suspended in the water column longer
b. Water clears in 1-2 days after application

7.2 gallons algaecide per surface acre

374.4 gallons for early season application

$29.99/gallon

Total Cost: $11,228.25
(Forestry Distributing)

Similar compounds to this can also be utilized

Cost Analysis

Lifestyle Changes

- Nill

Barley Straw Application

- $540

Monitoring

- DO meter = $440, pH probe = $70, Phosphorus test = $25

Algaecide Application

- $11228.25

Questions?