

(R-12) PHOSPHORUS AND MUCK REDUCTION THE DYNAMIC DUO FOR WATER MANAGEMENT v1



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Aquatic Vegetation Control, Inc.

Environmental Management

Riviera Beach, FL
Port Saint Lucie, FL
Pembroke Pines, FL
Florida City, FL
Charleston, SC
Jesup, GA
Gainesville, GA

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Senior Scientist

**A New Look at an Old Problem
Using Bio-Zyme**

The Supporting Data for Bio-Zyme usage in Water:

- **Reduces nitrogen.**
- **Reduces nitrogen in muck.**
- **Reduces phosphorus.**
- **Reduces phosphorus in the muck.**
- **Reduces the amount of muck.**
- **Reduces the need of copper in lake management.**

The Suggested Benefits for Bio-Zyme:

- Will reduce the amount of harmful bacteria by outcompeting them for nutrients.
- Will reduce the amount of nutrients from septic systems and human activity entering the estuaries.
- Likely to impede the development of the Red Tide which feeds on nutrients.
- Improve fish production because nutrients are funneled into the food chain. Bacteria are eaten by protozoa and protozoa are eaten by fish.

STA (Storm Treatment Area) Review

Constructed Wetland to Reduce Phosphorous

- STA's and wetlands have been used to reduce nutrients for years.**
- STA's produce excellent habitat for wildlife.**
- STA's can produce additional water storage.**
- STA's utilize plants to remove the phosphorous from water.**
- STA's provide valuable recreational areas.**

STA's Negative Values

- STA's need large additional tracts of land.
- STA's are very expensive to buy, build and maintain.
- STA's take years before they are ready for use.
- STA's accumulate phosphorus in muck.
- STA's accumulate muck from plant deposition.

Natural Bacteria

- **How do STA's compare with the new method using incubated bacteria for nutrient reduction?**
- **Bacteria have maintained lakes since the beginning of time but have not been able to keep up with high nutrient demands.**
- **Most bacteria products work but incubated Bio-Zyme bacteria works much better and is way less expensive than any I have tried over the last 40 + years.**

Incubated Bio-Zyme

- **Bio-Zyme does not need additional land.**
- **Bio-Zyme is less expensive than STA's.**
- **Bio-Zyme works faster than STA's.**
- **Bio-Zyme reduces nitrogen.**
- **Bio-Zyme augments the effectiveness and longevity of STA's.**
- **Bio-Zyme may help control the red tide by reducing nutrients in city waterways.**
- **Bio-Zyme reduces coliform bacteria by out-competing it for nutrients.**

Names of Some of the Bacteria and a Partial List of the Tasks They Perform

- *Nitrosomonas*
 - reduces NH_3 to NO_2
- *Nitrobacter*
 - NO_2 to NO_3
 - both are soil bacteria; both are required for nitrification and both need aerobic conditions
- *Aerobacter aerogens*
 - aerobic
 - oxidizes carbohydrates $\text{C}+(\text{H}_2\text{O})$ (sugars, starches and cellulose) and short organic acid chains to CO_2 and H_2O
 - when O_2 is limited it ferments carbohydrates which become food for *Pseudomonas* sp.
- *Bacillus subtilis*
 - degrade polymers such as protein, starch, and pectin, therefore, they are thought to be an important contributor to the carbon and nitrogen cycles. Important in digestion in the gut of animals
- *B. licheniformis*
 - produces a variety of extracellular enzymes that are associated with the cycling of nutrients in nature.
- *B. amyloliquefaciens*.
 - oxidizes carbohydrates, organic acids, fats, oils, proteins and starches
 - active in the soil, its enzymes degrade organic material
 - denitrifying bacteria (NO_3 to NO_2 to N_2)
- *Cellulomonas biazotea*
 - converts cellulose to soluble carbohydrates which serve for growth of *C. biazotea* and other bacteria
- *Pseudomonas denitificans* and *P. stutzsri*
 - reduces level of nitrate nitrogen under anaerobic conditions
 - oxidizes and degrades organic compounds

Muck Reduction

- **As the bacteria digest the muck, the bacteria are consumed by microscopic animals like protozoa.**
- **Protozoa are consumed by small fish.**
- **Small fish are consumed by large fish, birds etc.**
- **The muck therefore, ends up in the food chain.**

Muck and Phosphorus Reduction

- **Muck contains phosphorus, nitrogen, carbon and other undesirable components.**
- **Muck reduction therefore, is a good measurement of the effectiveness of the beneficial Bio-Zyme bacteria.**
- **As the phosphorus is digested, the lakes are clearer, and produce a hard bottom suitable for clams, snails and fish reproduction.**
- **The apparent increase in clams may also help manage water quality.**



South Florida Water Management District Muck Reduction Trial

**AVC performed a muck reduction trial in a
Stormwater Treatment Area in 2016.**

Description of the STA

- **The STA contained large areas of floating tussocks and waist deep mud.**
- **Some of the tussocks had a lot of vegetation but many of the tussocks were little more than a few inches of mud above the water with sparse vegetation.**
- **The visible water was about 1 inch deep above the muck.**

Floating Tussocks

++ Floating Tussocks Before Treatment





**Prior to initial application
Mud to the surface**

The Bio-Zyme Program

The treatment prescription was to apply 500 gallons of incubated Bio-Zyme (12.5 lbs. + 2.5 gal, Nitrifier) per week.

A 25 acre plot within the 50 acre trial area was treated. This continued 9 months through March of 2017.

The total area impacted by the trial appears to encompass over 350 acres.

March 2017 – After Treatment



March 2017
After Treatment



Conclusion

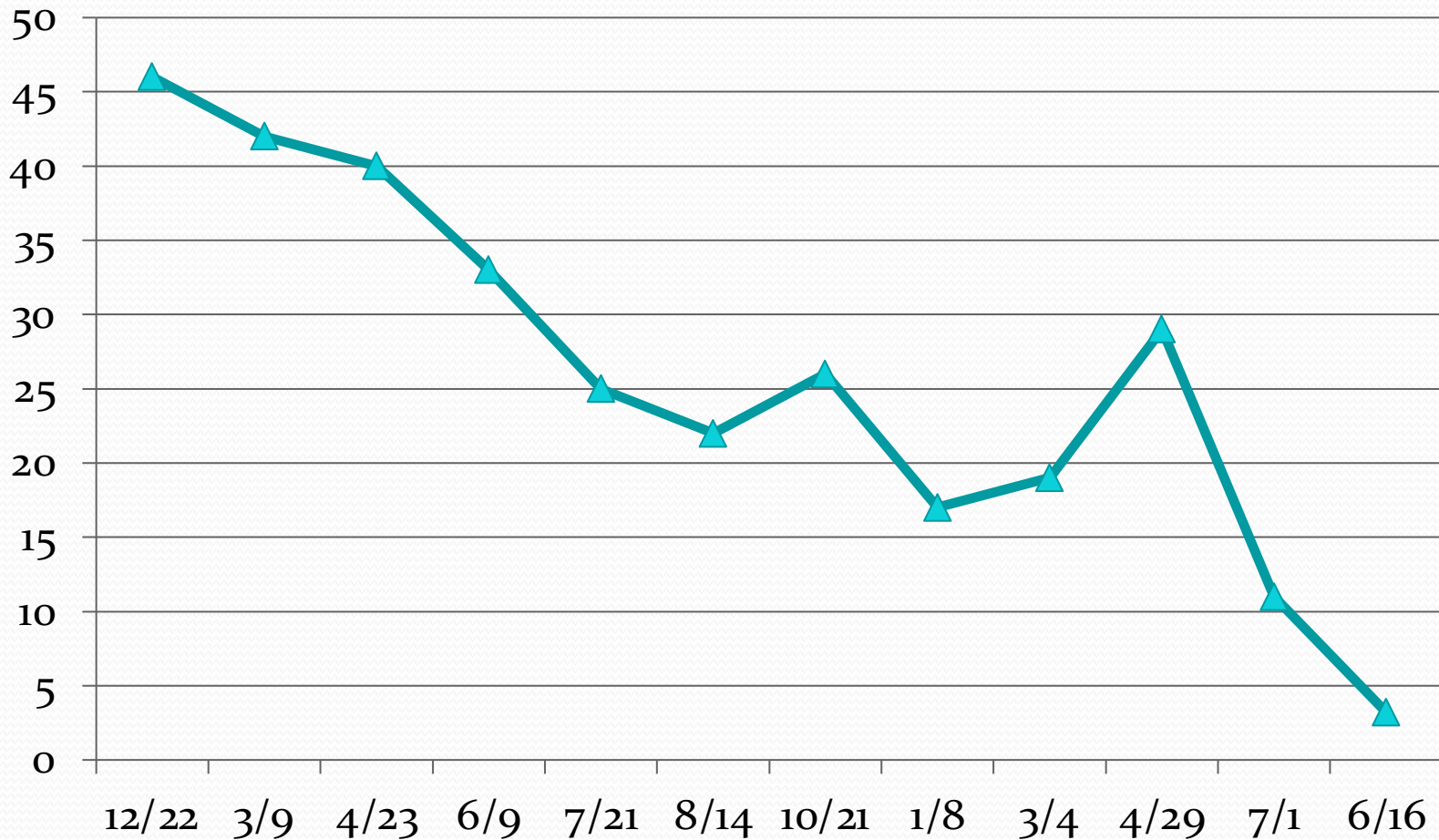
- **The impacts of the Bio-Zyme Program moved with the flow of the water to the south covering over 6 times the acreage treated.**
- **The bottom sediments became consolidated and firm compared to mush and soup.**
- **The water clarity was greatly improved.**
- **There was no improvement up current from the treatment area**

PGA Country Club Marsh

Organic Sediment Removal

Each point is an average of 3 plots, 4 measurements per plot

cm



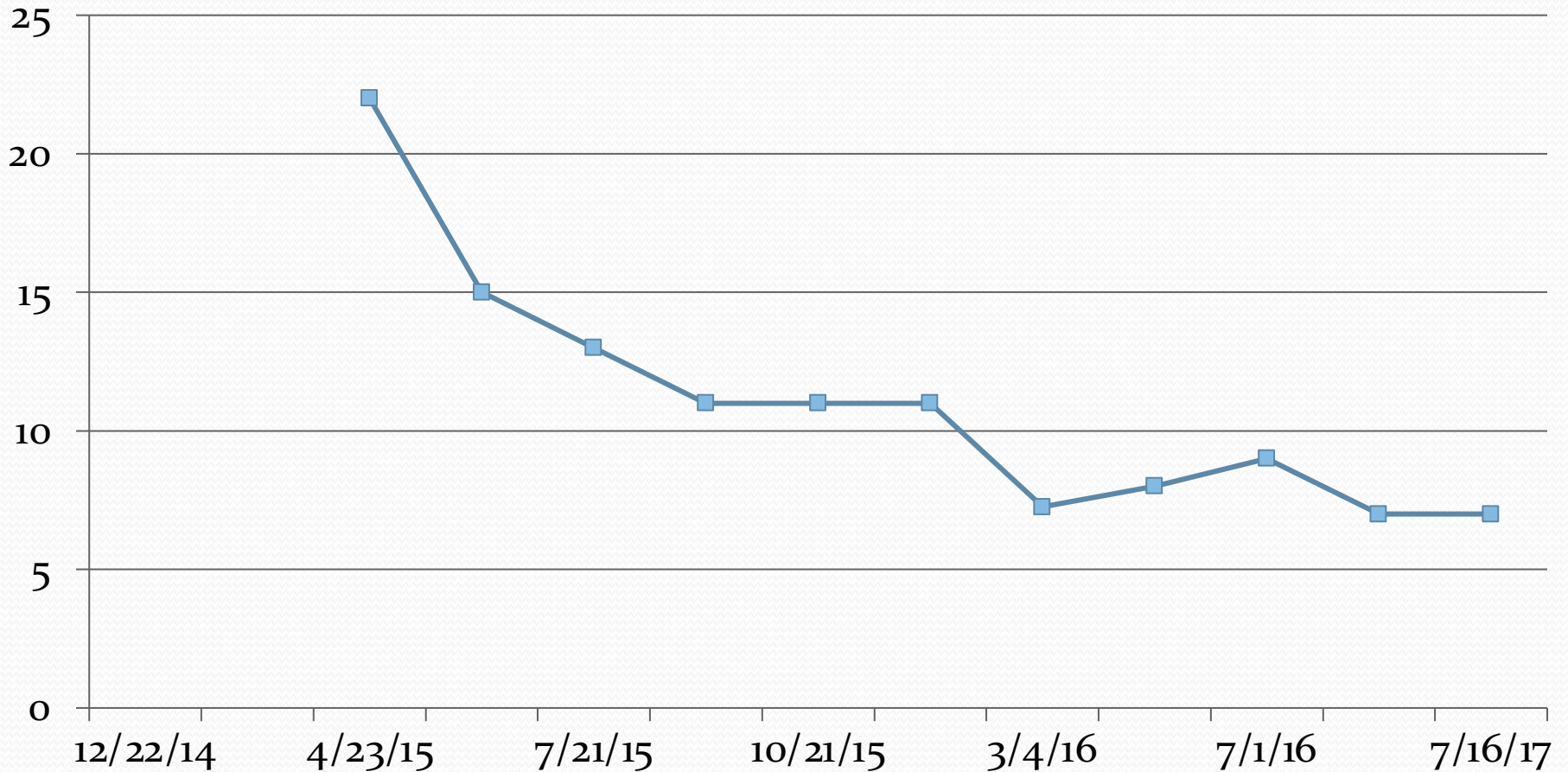
Date

PGA Country Club Pond

Organic Sediment Removal

Each point is an average of 3 plots with 4 measurements per plot

cm

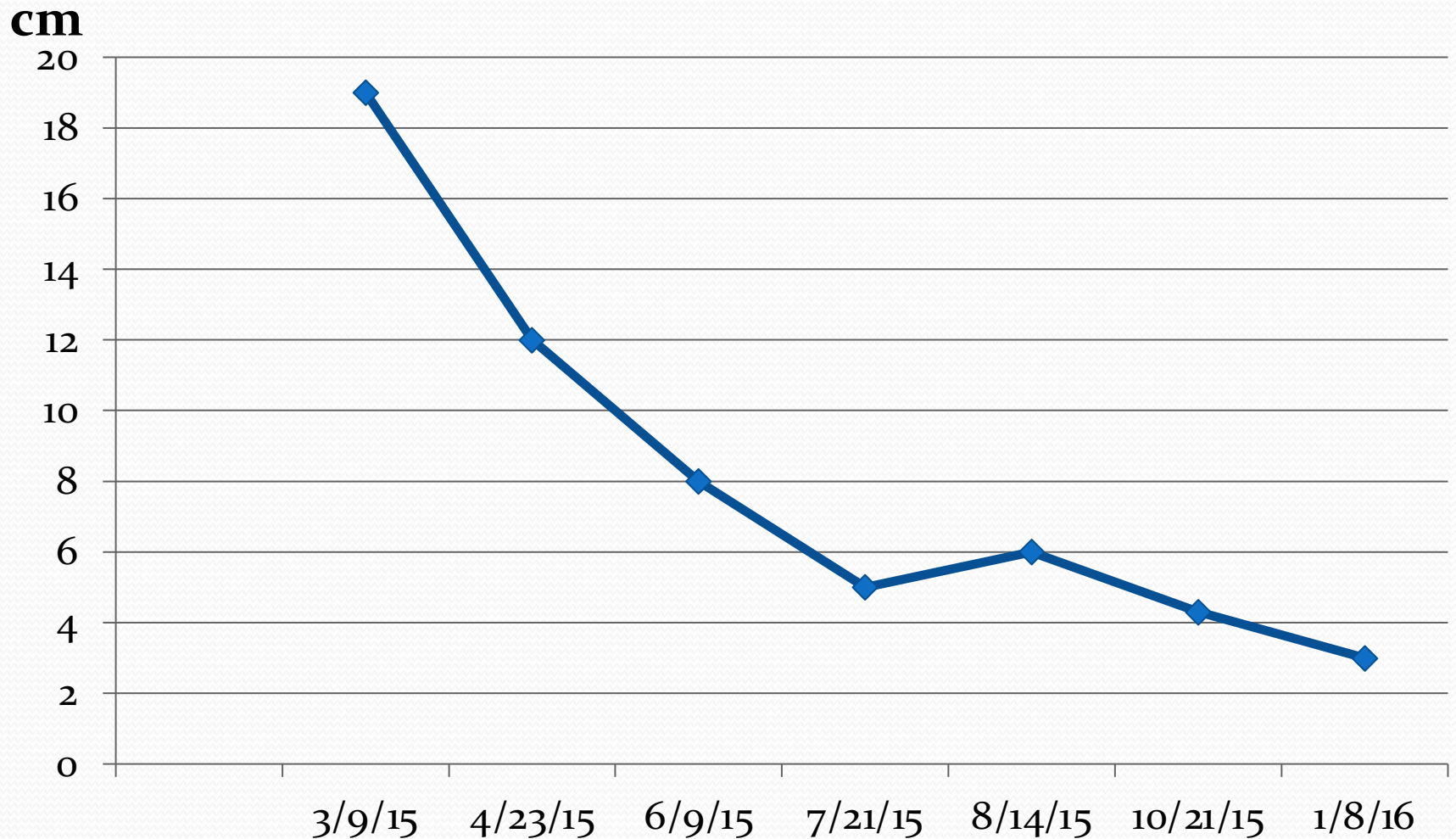


Port Saint Lucie E8

Organic Sediment Removal

1.5 cm Per Month

Each point is an average of 3 plots with 4 measurements per plot



Players Club POA

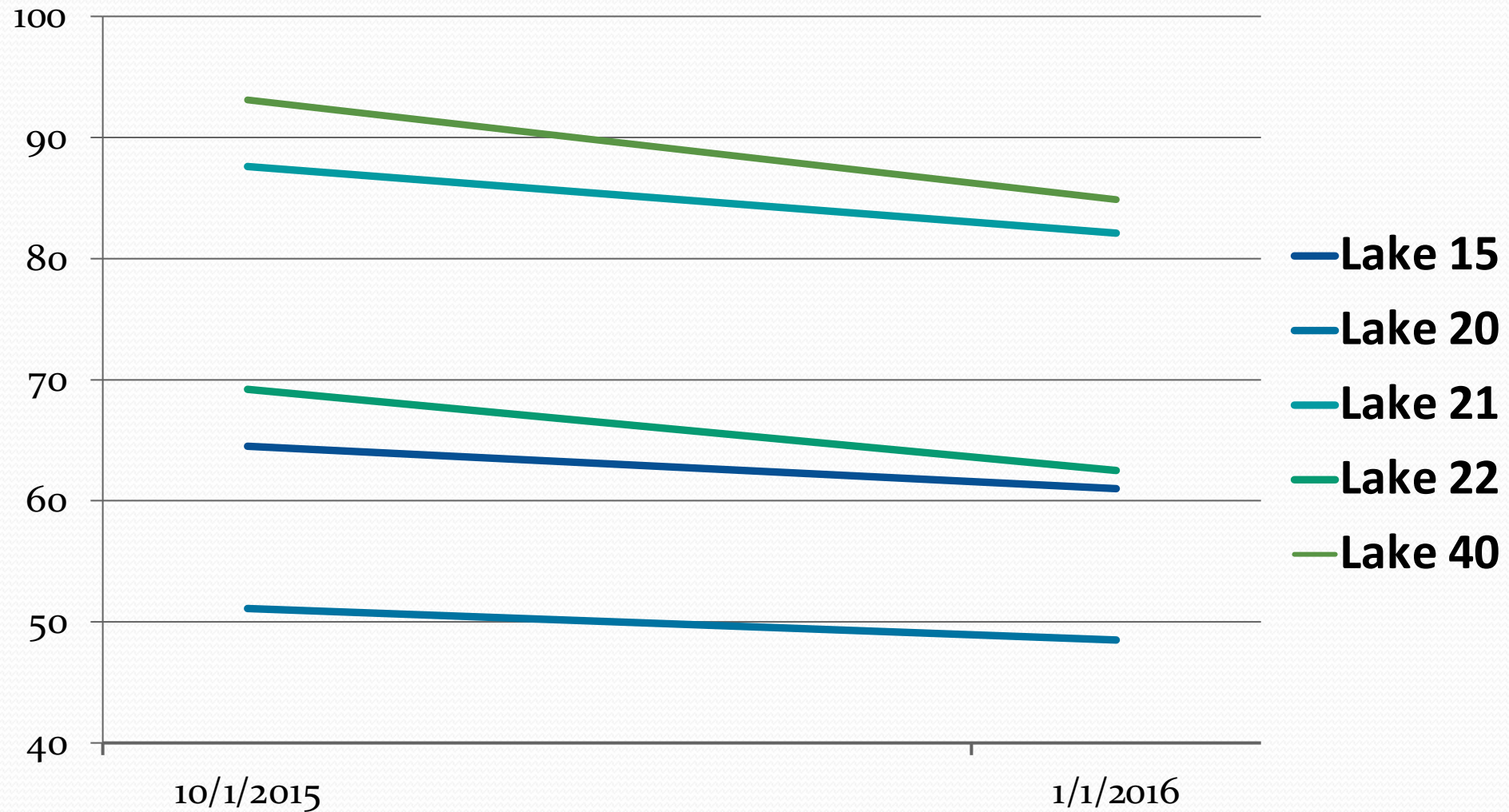
Clear Waters, Inc.

Organic Sediment Removal

1.8 cm Per Month

Each lake contains 4- 6 plots with 4 measurements per plot

cm

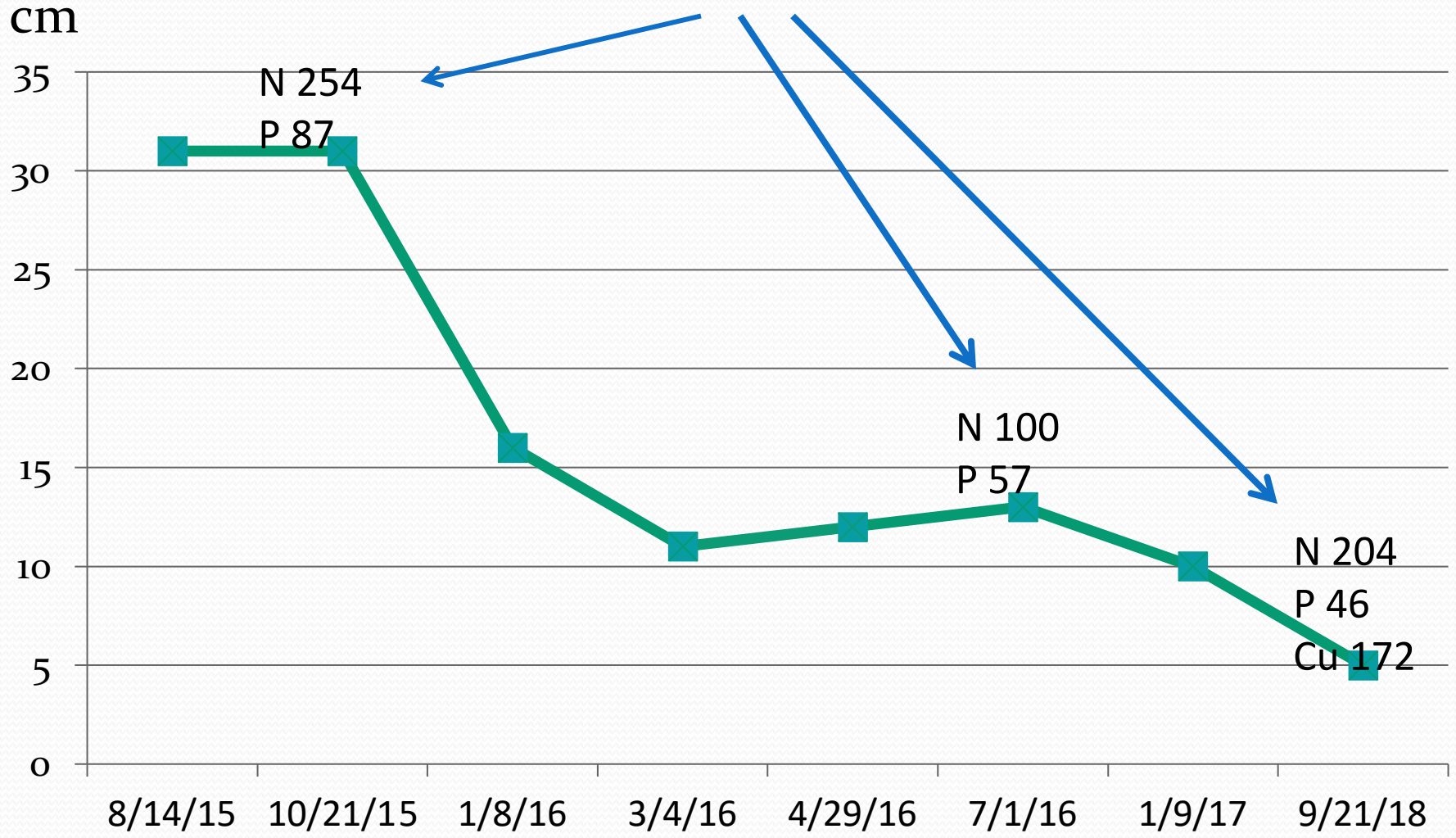


Ibis Country Club Lake 10 - Organic Sediment Removal

≈ 3000 lb. of N and 900 lb. P per acre removed in the muck in 3 years

Each point is an average of 3 plots, 4 measurements per plot

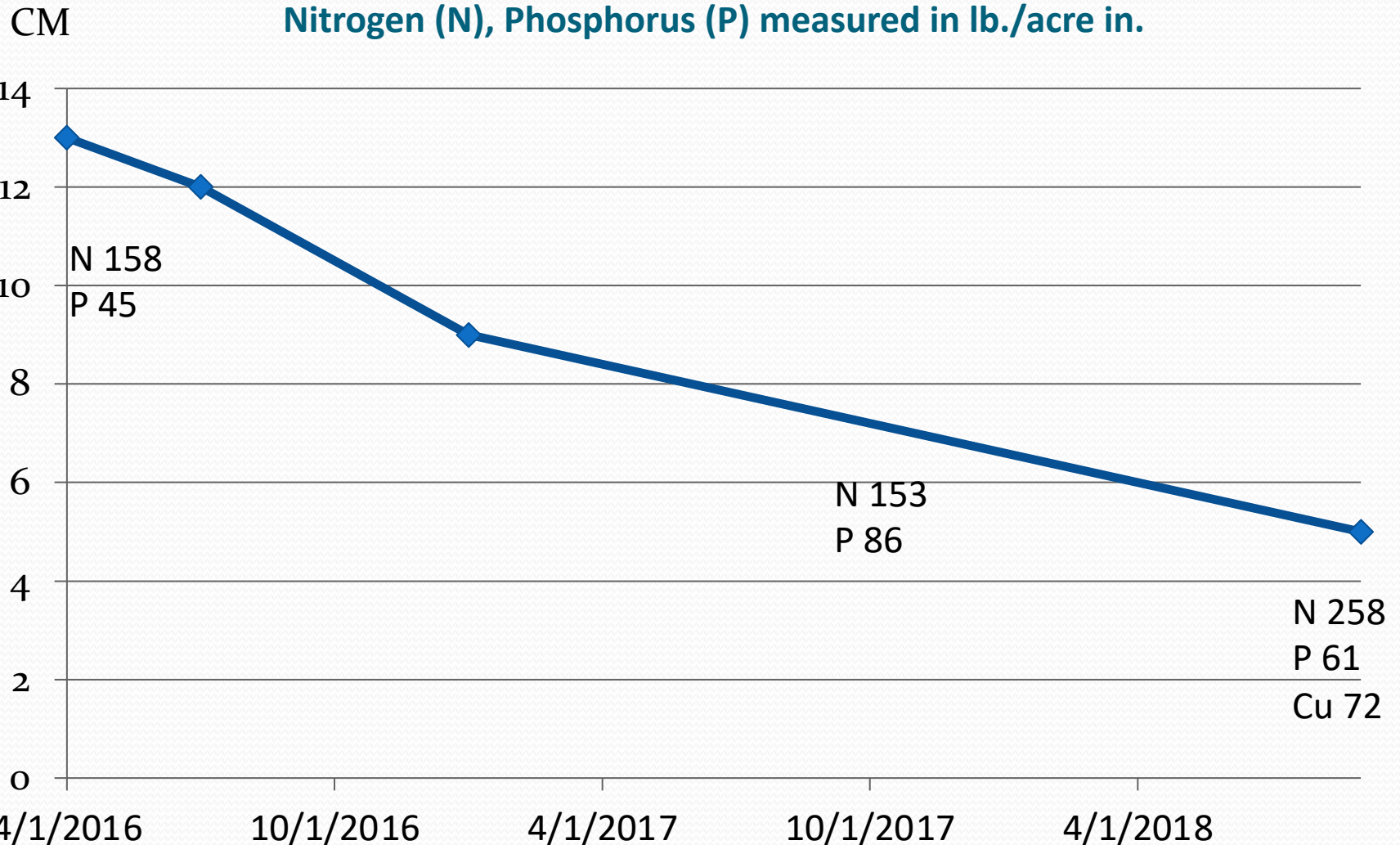
Nitrogen (N), Phosphorus (P) (lb./acre in.) in muck sample



Ibis Country Club Lake 5 – Organic Sediment Removal

Each point is an average of 3 plots, 4 measurements per plot

≈ 800 lb. of N and 300 lb. P removed in 2 years





ories
Livestock Waste Testing Laboratory, Gainesville, FL

Livestock Waste Analysis Grower Report

Clarence Elroy Timmer
482 SW Deer Run
Port St Lucie, FL 34953

PHONE: 561-249-4628

Lab #	9007
Sample Label	IS #1
Date Collected	April 29, 2016
Date Delivered	May 4, 2016
Date of Report	May 16, 2016
County of Sampl	Palm Beach
Collected By	0

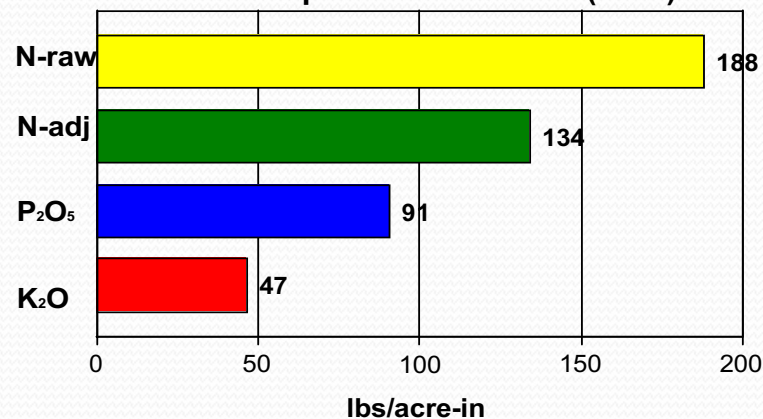
Sample Type: Dairy waste collected from lagoon.
Crop or Use: #N/A
Application Equipment: Applied through center pivot
Incorporation #N/A
Previous Applications #N/A

*****Nutrient Content in Manure as Delivered to Laboratory**

Nutrient Constituent	Raw Sample	Adjusted For Application Losses of N	Units
Nitrogen (N):	188	134	lbs/acre-in
Phosphorus (P2O5)	91	91	lbs/acre-in
Potassium (K2O):	47	47	lbs/acre-in

pH as Sampled 6.9
Moisture Content: 78.3%
Total Solids: 21.7%
Total Ash 18.8%

Fertilizer Equivalent in Manure (As Is)



Lab Number	Sample Id	Cu mg/kg	Mn mg/kg	Zn mg/kg
L9813	I 5-1	40.20	10.23	9.5

Case Study of Lake Pine Shadow *Clear Waters, Inc.*

Outfalls discharging runoff into the Turnbull Basin then Spruce Creek, a Florida Outstanding Waterway.



Goal to Improve Water Quality and Reduce the Use of Copper

Lake Pine Shadow

Clear Waters, Inc.



After 6 Months with Bio-Zyme

Copper and Bio-Zyme Cost Before and After the Bio-Zyme Bio- incubator in 2014

	Copper	Bio-Zyme
June - Sept 2011	\$ 287.55	\$ 180.30
June - Sept 2012	\$ 365.01	\$ 78.00
June - Sept 2013	\$ 0.00	\$ 383.50
June - Sept 2014	\$ 7.74	\$ 162.74
June - Sept 2015	\$ 0.00	\$ 170.13
June - Sept 2016	\$ 0.00	\$ 29.79

PEACOCK LAKE

- **Lake (100 acres) about 18 foot average depth**
- **Microcystis bloom in December 2016**
- **Objective: reduce total phosphorus**
- **Weekly treatments of Bio-Zyme**



Peacock Lake 100 acres

No watershed

Total Phosphorus
reduced from
0.05 mg/l - 0 mat
0.015 mg/l - 6 mat
<0.005 mg/l - 18 mat

Date	Bio-Zyme Bulk	Laboratory	Total Phosphorous rate mg/l
1/9/17			
1/16/17	5 lbs.		
1/18/17		Pace	0.05
1/23/17	5 lbs.		
1/30/17	5 lbs.		
2/6/17	50 lbs.		
2/21/17		Flowers	0.04U
3/27/17	50 lbs.		
3/30/17		Jupiter Env.	0.024
4/9/17		Jupiter Env.	0.021
5/23/17	10 lbs.		
5/31/17	10 lbs.		
6/8/17	10 lbs.		
6/13/17	10 lbs.		
6/20/17	10 lbs.		
6/27/17	10 lbs.		
7/3/17	10 lbs.		
7/3/17		Jupiter Env.	0.015
7/11/18	300 lbs.	Jupiter Env.	<0.005

Peacock Lake Bio-Incubator

The key to successful treatment is in
bacteria, increasing it billions of times
incorporating it into the lake



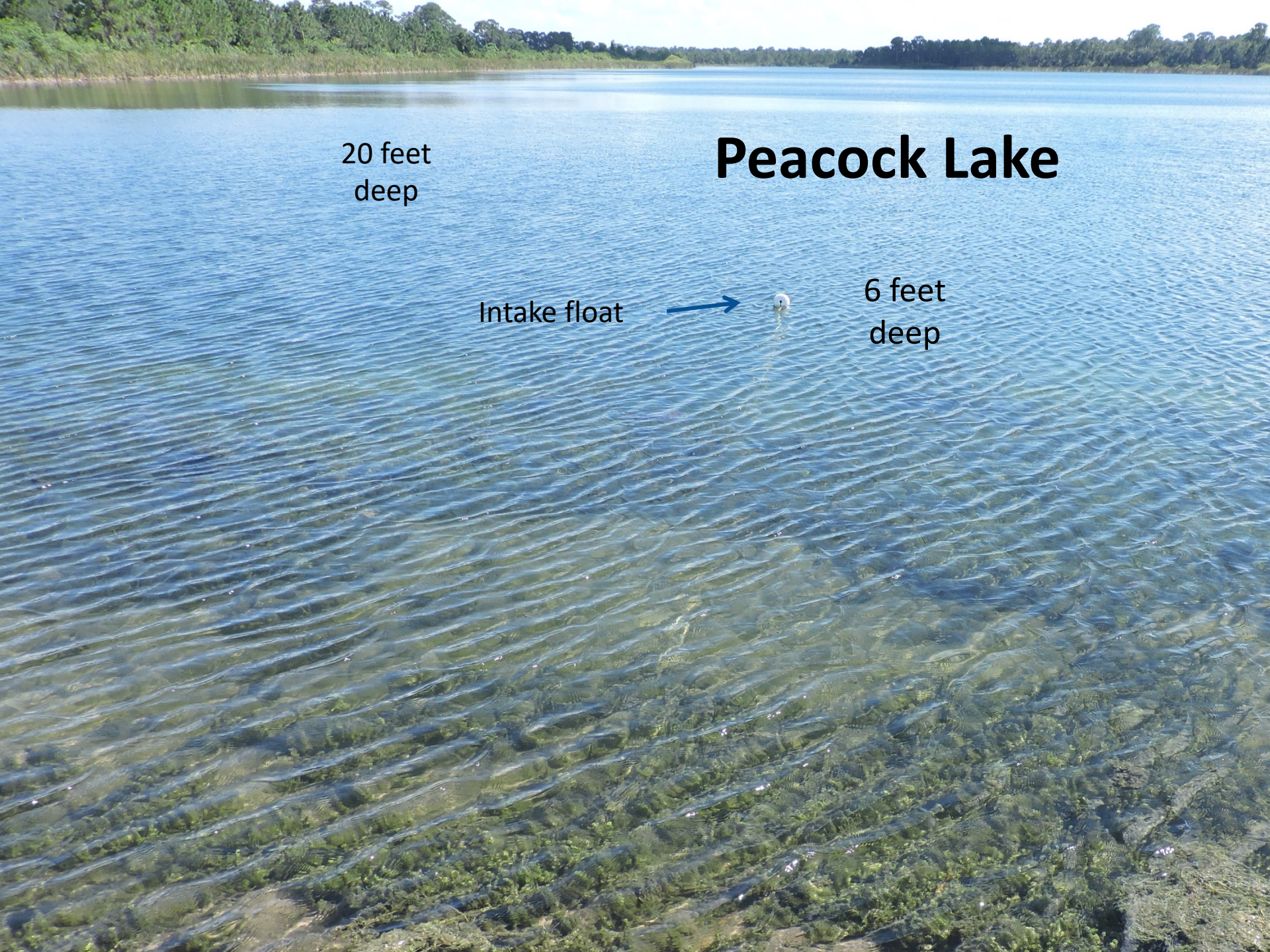
Peacock Lake

20 feet
deep

Intake float



6 feet
deep



Lake Okeechobee

- **Lake Okeechobee and lakes north would benefit from Bio-Zyme to reduce excessive phosphorus.**
- **The reduction of phosphorus in Lake Okeechobee would cost about 30-45 million per year and require about 12, 20,000 gal. bio-incubators. Perhaps it could be started in an area which has the most phosphorus.**
- **Phosphorus reduction in Lake Okeechobee, will solve many of the problems in the Caloosahatchee and Indian River Lagoon as well as save Lake Okeechobee.**
- **Microcystis algae seems to be the main concern on both coasts but the real fuel is phosphorus upstream.**

Bio-Zyme

- **Bio-Zyme is not a chemical.**
- **Bio-Zyme is not toxic or harmful to algae, plants, fish or animals.**
- **Bio-Zyme products are formulated with natural, native, probiotic bacteria that reduce nitrogen and phosphorus.**
- **Bio-Zyme also contains sludge-digesting bacteria.**
- **Bio-Zyme on large lakes needs to be directed by a TRM Biologist Certified Facilitator.**

Bio-Zyme

- Is used by 15 large aquatic management companies in Florida and the US.
- Is used in approximately 20,000 lakes and in about 60,000 acres of water
- Is used in the major golf courses in Florida where it reduces nutrients to produce better water quality, changes bottom from muck to sand, decreases sprinkler clogging and much more
- Has so much data and experience behind it that it cannot be said It may not work. It works and is cost effective!

Contacts

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A volume of data and 1000's of sites are available for inspection

Aquatic Vegetation Control owns no stock or interest in Bio-Zyme but was instrumental in its development