Nutrients and Water Quality

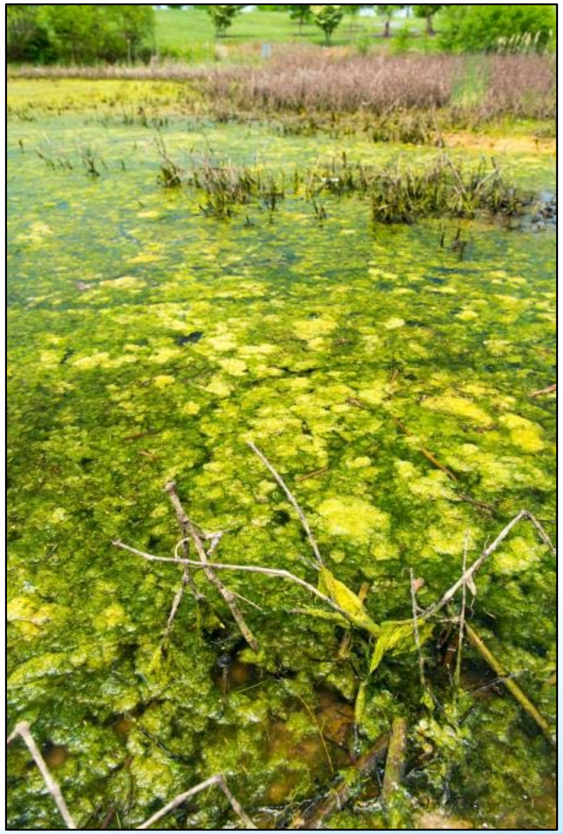
Objective:

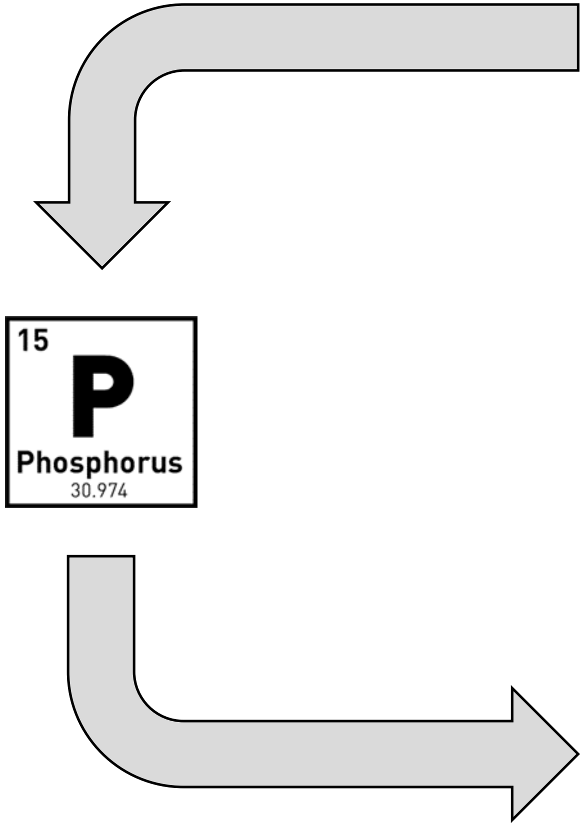
Understand how nutrients play a key role in water quality and why managing for them is important

The Stewards of Water

What can phosphorus tell us about the condition of water?

Phosphorus is usually considered the “limiting nutrient” in aquatic ecosystems, meaning that the available quantity of this nutrient controls the pace at which algae and aquatic plants are produced. In appropriate quantities, phosphorus can be used by vegetation and soil microbes for normal growth. However, in excess quantities, phosphorus can lead to water quality problems such as eutrophication and harmful algal growth. Some aquatic resources, such as wetlands, naturally serve as sinks for phosphorus found in sediments or dissolved in water. However, since phosphorus generally occurs in small quantities in the natural environment, even small increases can negatively affect water quality and biological condition.




15
P
Phosphorus
30.974

Nutrient Sources

- Watershed approach important but not enough
  - If all BMPs implemented, New Hope Creek watershed show 6% decrease of P
    (Debusk et al. 2010)

	Mass of Pollutant Removed (kg)		
	TSS	TN	TP
Bioretention	5,825.5	38.9	7.2
Green Roof	167.7	6.7	0.9
Permeable Pavement	1,077.0	43.1	6.0
Sand Filter	29.5	0.6	0.1
Vegetated Swale	201.2	1.3	0.5
Wetland	3,008.5	26.3	4.8
Total (kg) removed	10,309	117	19

- If external curtailed, still may be decades to see results
  (Jarvie et al. 2013; Jeppesen et al. 2005)

- Continued inputs
  - Soil accumulations (Reddy et al. 2011)
  - Groundwater (Martin et al. 2007; Lapointe et al. 2015)
  - Wildlife (Nürnberg and LaZerte 2016)
  - Atmospheric deposition (Wetzel 2001; Paerl et al. 2016)

The Stewards of Water

Nutrient Ratios Are Important

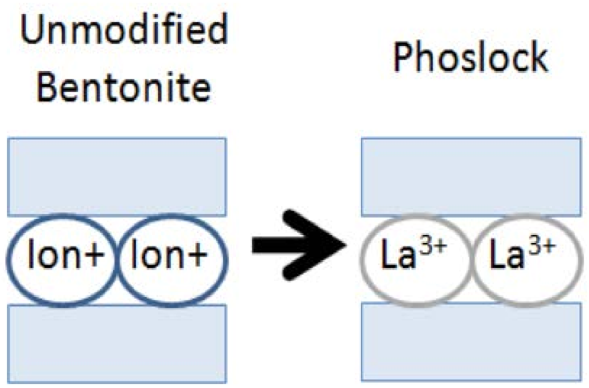
- TN:TP ratio 5:1 cyanobacteria overwhelmingly dominant artificially induced
  (Ghadouani et al. 2003)
- Low TN:TP cyanobacteria dominate in Lake Michigan
  (Seale et al. 1987)
- TN:TP ratio 29:1, dominated by green algae
  (Smith 1983; 12 lakes throughout the world)
- Si:P < 25:1 *Microcystis* dominates, more silica more *Asterionella*
  (Holm & Armstrong 1981)

- Remove P and amend N to alter N:P ratio and decrease cyanobacteria abundance

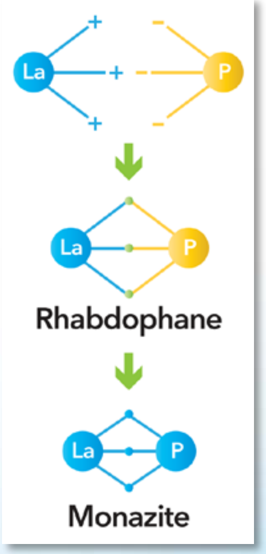
The Stewards of Water

Phoslock®

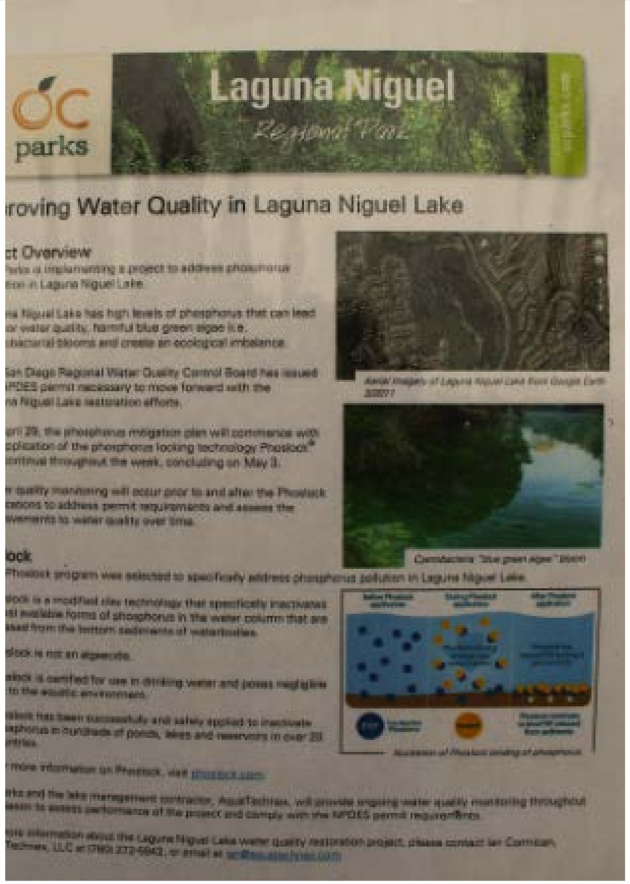
Phosphorus Locking Technology



- Lanthanum embedded in bentonite clay layers
- Specific P binding; not other elements (e.g. silica; nitrogen)
  - Does not alter pH; nor add SO_4, no buffer needed
    - Holm & Armstrong 1981
- Increases sediment stability
    - Egemose et al. 2010
- Limits phosphorus release
    - Wei and Shao-yong 2015
- Bind water column and shift sediment forms
  - Hydrated mineral Rhabdophane ($LaPO_4 \cdot H2O$) => monazite
    - Jonasson et al. 1988; Cetiner et al. 2005; Dithmer et al. 2015



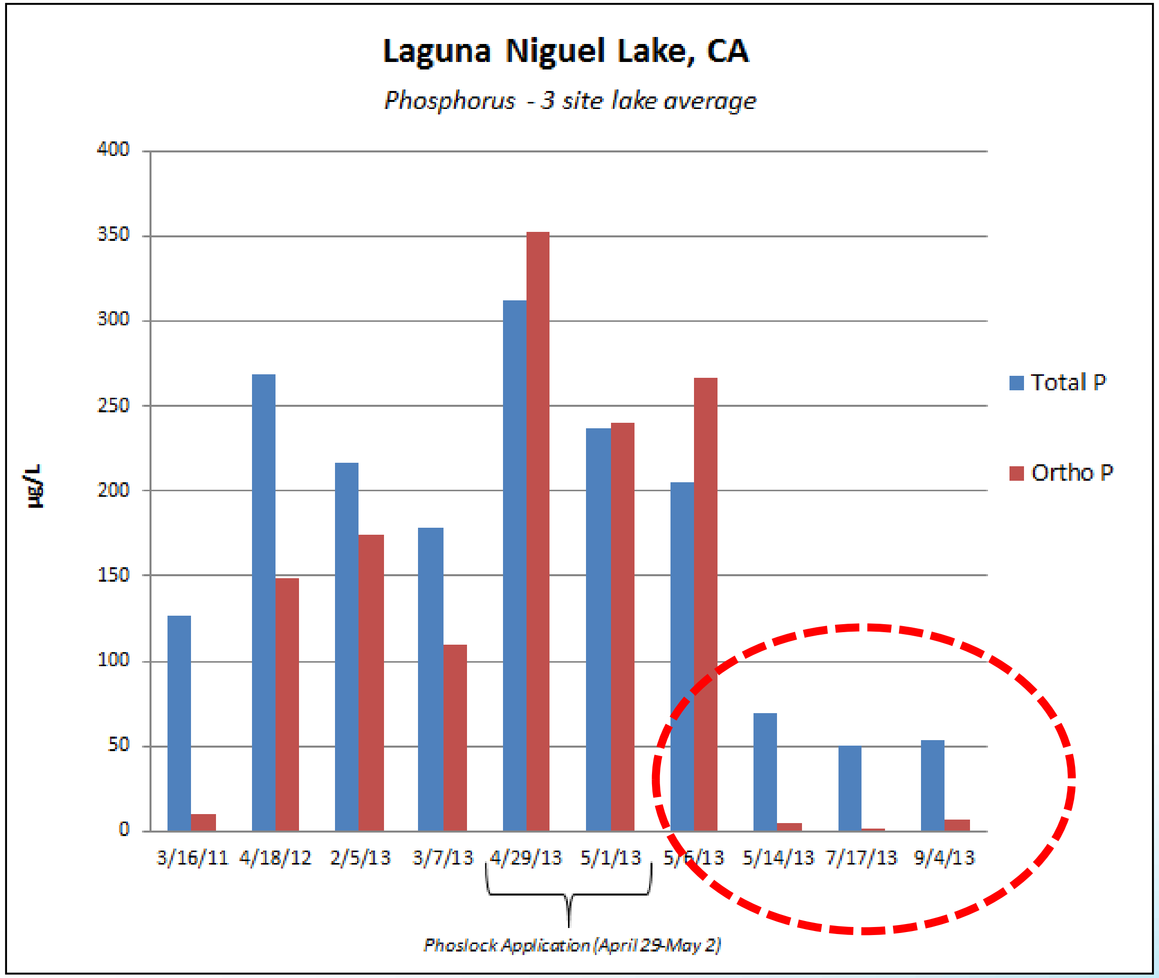
The Stewards of Water



Phoslock Application – Laguna Niguel, CA
Sulphur Creek Reservoir

Phosphorus Results

- Significant and sustain P reduction
- Average P levels since May 14th
  - TP   58 ug/L
  - FRP 4 ug/L



The Stewards of Water

Laguna Niguel Project Summary

- Successful P inactivation
- Sediment – mobile to stable fraction shift
- No cyano blooms of concern or requiring treatment with algaecide for first time in 3 years
- Widgeon grass observed following summer for the first time in ~10 years

Operational Evaluation of Phoslock Phosphorus Locking Technology in Laguna Niguel Lake, California

The Stewards of Water

Action threshold program

Open Journal of Applied Sciences, 2017, 7, *-*
http://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

Comparison of Water Resource Management Programs: An Algae Action Threshold Level Approach

West M. Bishop[1,2*], Ben E. Willis[1]

[1] SePRO Research and Technology Campus, 16013 Watson Seed Farm Rd. Whitakers, NC, USA
[2] Department of Crop and Soil Sciences, North Carolina State University, Raleigh, NC, USA
Email: *westb@sepro.com

Action Thresholds: Ponds

- NPDES (2.2.2 Weed and Algae pest control)
  - "Pest Management measures that *minimize discharges* resulting from application of pesticides to control pests."
  - "Applying the pesticide only when the action threshold has been met"
- Justify a treatment
- Decision trigger
- Based on management goals, adaptable
- Compare management programs

The Stewards of Water

SePRO UNIVERSITY THE STEWARDS OF WATER

Action Threshold Study Design

- Compared 3 pond management approaches
- Measure water quality parameters and algaecide inputs required to maintain below action triggers

SePRO Research & Technology Campus

The Stewards of Water

2012 AT Summary

Date	Copper Sulfate Pond 7	Copper Sulfate Pond 14	SeClear Pond 1	SeClear Pond 9	
6/6/12	1.7lbs (0.4ppm; 0.43lbs Cu)	1.7lbs (0.4ppm; 0.43lbs Cu)	1 gallon (0.4ppm; 0.43lbs Cu)	1 gallon (0.4ppm; 0.43lbs Cu)	
6/20/12	1.7lbs	1.7lbs	-	-	
7/5/12	3.4lbs	3.4lbs	1 gallon	-	
7/18/12	1.7lbs	1.7lbs	1 gallon	-	
8/1/12	1.7lbs	1.7lbs	-	1 gallon	
8/15/12	-	-	1 gallon	1 gallon	
8/29/12	1.7lbs	1.7lbs	1 gallon	1 gallon	
9/26/12	-	1.7lbs	-	-	
# algaecide apps	6	7	5	4	30% less
Total copper (lbs)	2.975	3.4	2.1	1.68	40% less

2013 AT Summary

Date	Copper Sulfate Pond 7	Copper Sulfate Pond 14	SeClear Pond 1	SeClear Pond 9	
6/5/13	1.7lbs (0.4ppm; 0.43lbs Cu)	1.7lbs (0.4ppm; 0.43lbs Cu)	1 gallon (0.4ppm; 0.43lbs Cu)	1 gallon (0.4ppm; 0.43lbs Cu)	
6/19/13	1.7lbs		-		
7/3/13	1.7lbs		1 gallon		
7/17/13		1.7lbs	1 gallon	1 gallon	
7/31/13	1.7lbs	1.7lbs		1 gallon	
8/14/13	1.7lbs	3.4lbs			
8/28/13	1.7lbs	1.7lbs			
9/11/13		1.7lbs	1 gallon	1 gallon	
9/25/13		1.7lbs	-		
# algaecide apps	**6**	**7**	**4**	**4**	**39% less**
Total copper (lbs)	**2.58**	**3.44**	**1.72**	**1.72**	**43% less**

Action Threshold: Study Results

SeClear Treatments

Year 1

- 30% Less Treatments
- 40% Less Copper

Year 2

- 39% Less Treatments
- 43% Less Copper

SeClear
Algaecide and Water Quality Enhancer

Even better after 2 seasons!

The Stewards of Water

SeClear

Algaecide and Water Quality Enhancer

Better Solution vs. Copper Sulfate

- Effective algaecide
- Removes phosphorus with each application
- Reduces copper input & number of applications
- Improves water quality

The Foundation for Routine Algae Management!

SePRO

Action Threshold: Study Results

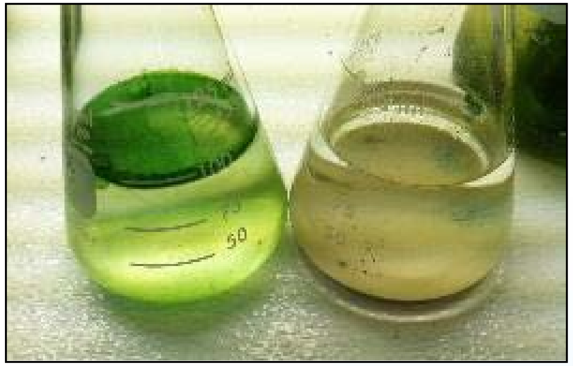
Phoslock *plus* SeClear

Year 1

- 69% Less Treatments
- 73% Less Copper

Year 2

- 77% Less Treatments
- 79% Less Copper



The Stewards of Water

Aquatic Weed Management with herbicides

- How much chemistry penetrates target species
- How fast it penetrates target species
- How long is it present – Exposure time
- Mode of Action

- If all of these reach a critical threshold
  - control is achieved

Choosing the best tool

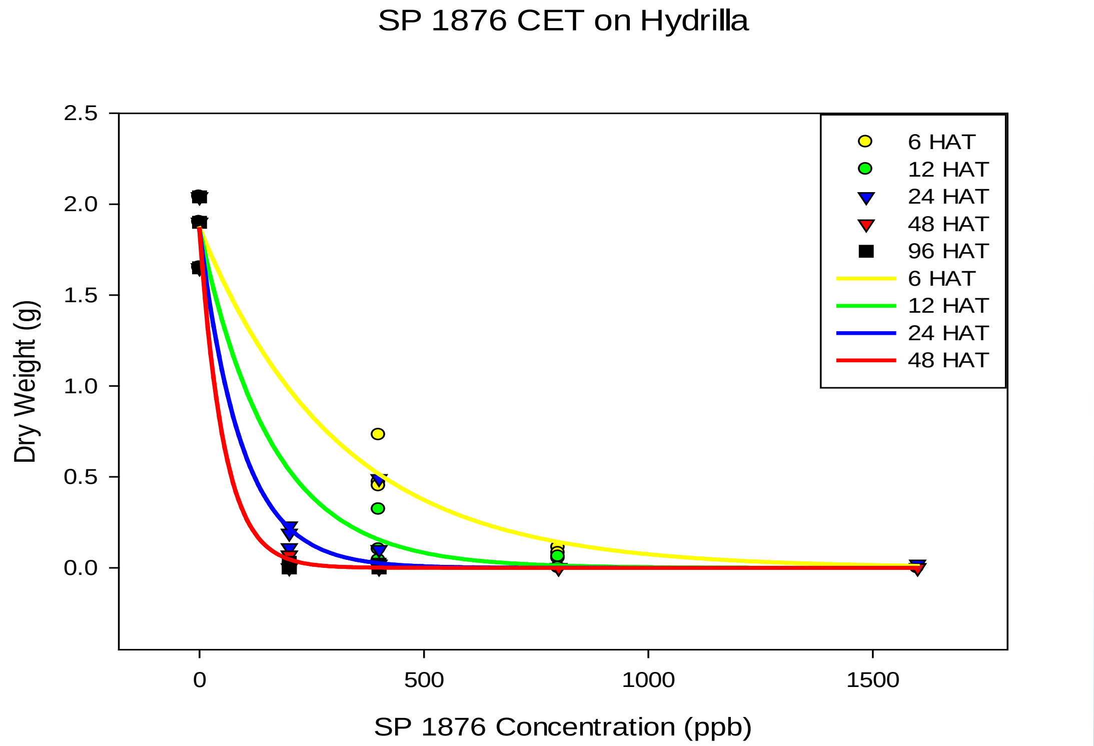
- Define the management objective
  - Selective vs non-selective
  - Bio-mass
  - Attacking the source
  - What are the environmental variables impacting treatments?

Water and Plant Dynamics

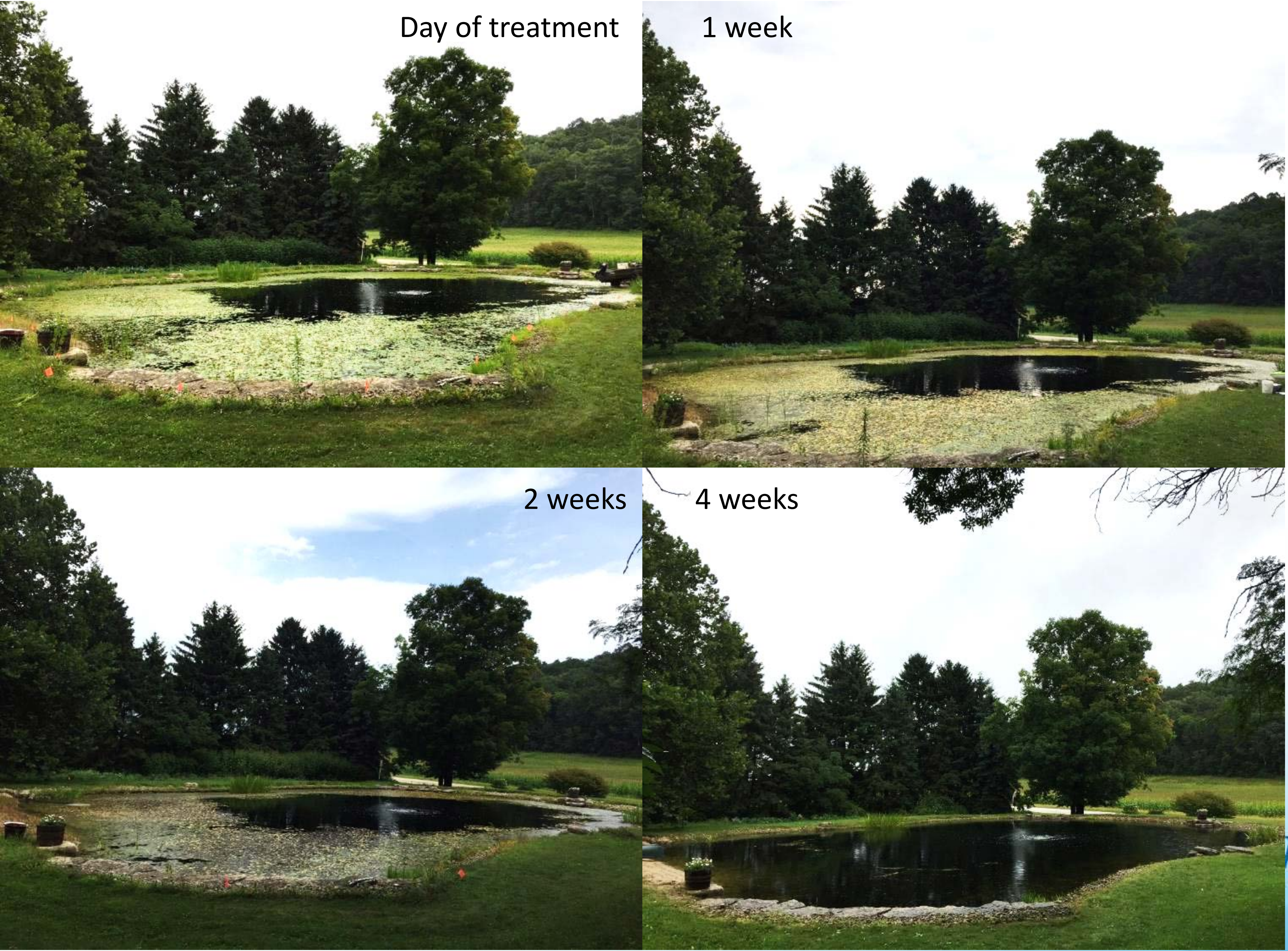
- Invasive weeds grow faster than natives
  - Faster growth equals better uptake
- Plants at surface grow slower
  - Less herbicide uptake
- Water velocity is less at bottom
  - Herbicide will dilute slower

Concentration Exposure Time

Herbicide	Concentrations	Exposure Times
Copper	0.75-1 ppm	2-4 hrs
Diquat	90-370 ppb	2-4 hrs
2,4-D	1-2 ppm	24-72 hrs
Triclopyr	0.5-2.5 ppm	24-72 hrs
Endothall	1.5-5 ppm	24-72 hrs
Fluridone	1-150 ppb	45-60 days
ProcellaCOR	1-5 PDU	3-6 hrs



The Stewards of Water



Wisconsin DNR
YFH Eradication Effort
~0.1 acre pond

ProcellaCOR (in-water)

Treated August 2, 2018

Yellow Floating Heart NC 2017

- Area of Interest 1.7 Acres
- Management Area 1.0 Acres
  - Very dense infestation targeted for eradication by NCDACS with NCSU
- % of AOI being managed 59%
- Avg. depth 3.5 ft
- Acre Feet 3.5
- Treated June 13 – 5 PDU per AF

The Stewards of Water

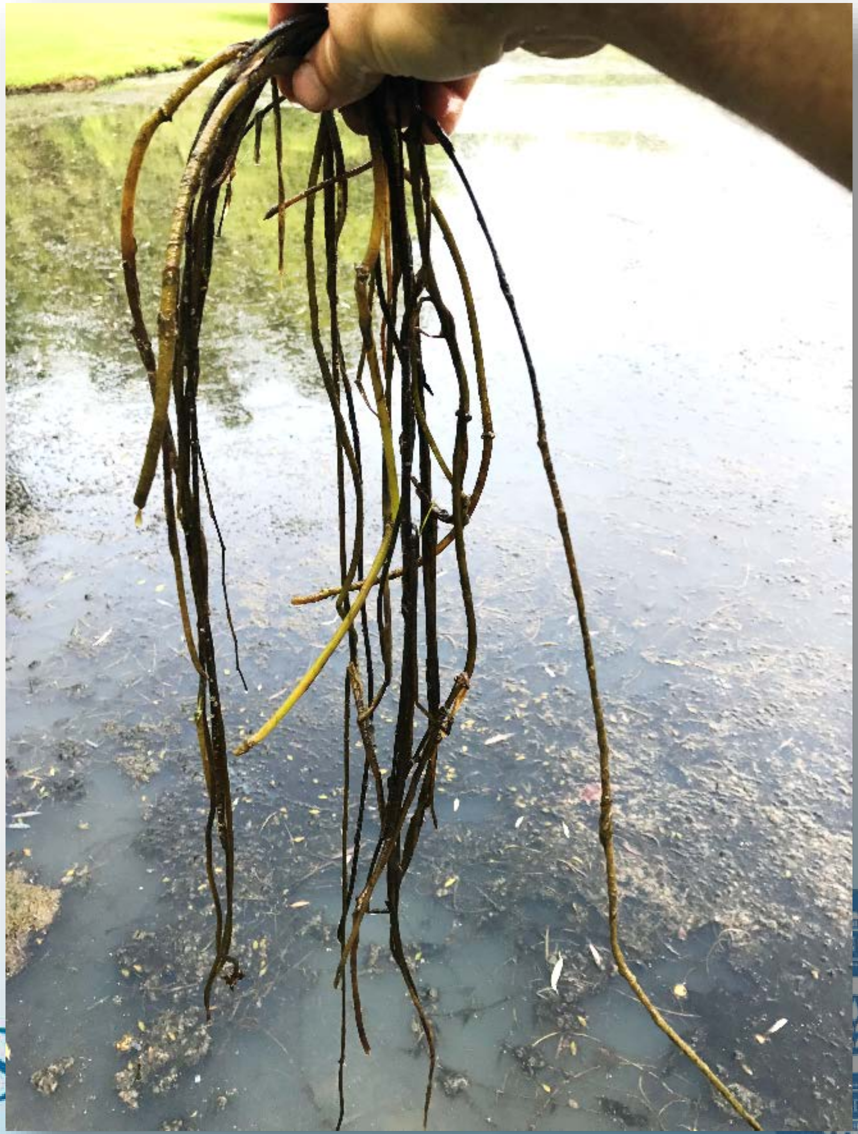

June 13, 2017 – Yellow floating heart on day of treatment


June 30, 2017 – Highly injured yellow floating heart @ 17 DAT
Seeks

July 27, 2017 – Remnant dying YFH @ 44 days after ProcellaCOR

Shatters

July 27, 2017 – Remnant dying YFH @ 44 DAT – Eliminates



September 26, 2017 – 100% YFH Control @ 105 DAT

Thank You!

Clint Formby
Technical Specialist
SePRO Corporation
clint.formby@sepro.com
512-410-9043

@StewardsofWater

The Stewards of Water