

Nutrients and Water Quality

Objective:

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

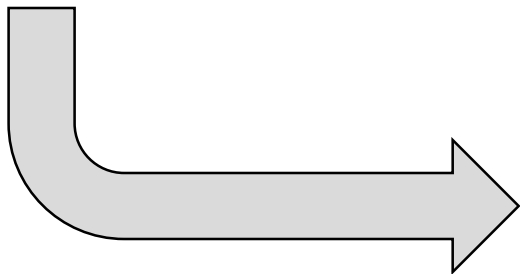
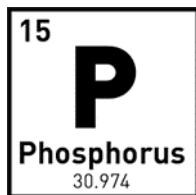
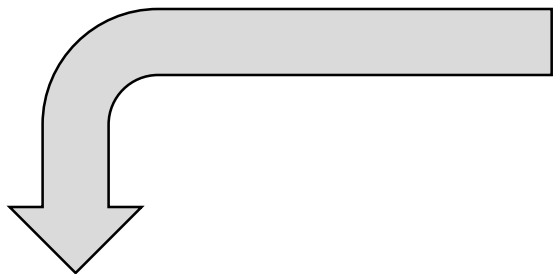
The Stewards *of* Water



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.





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)
- 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)

	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



Nutrient Ratios Are Important

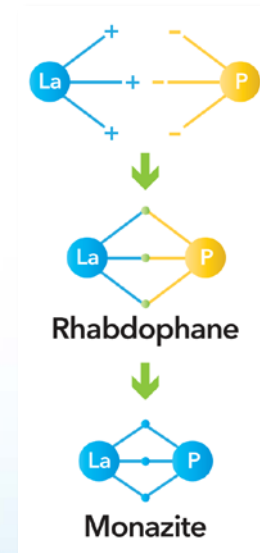
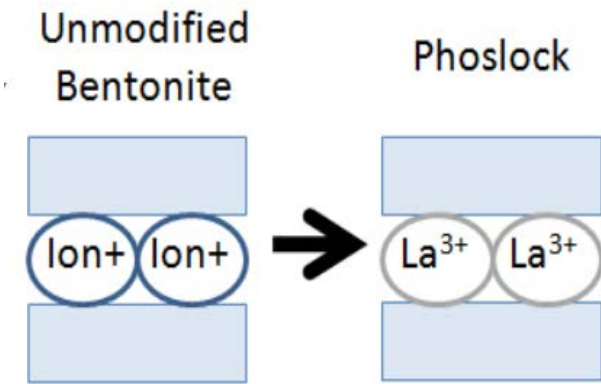
- TN:TP ratio 5:1 cyanobacteria overwhelmingly dominant artificially induced
(Ghadouani et al. 2003)
- Low TN:TP cyanobacteria dominate in Lake Michigan
(Seale et al. 1987)
- TN:TP ratio 29:1, dominated by green algae
(Smith 1983; 12 lakes throughout the world)
- Si:P < 25:1 *Microcystis* dominates,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



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 ($\text{LaPO}_4 \cdot \text{H}_2\text{O}$) $\Rightarrow$ monazite
 - Jonasson et al. 1988; Cetiner et al. 2005; Dithmer et al. 2015



The Stewards of Water





OC parks **Laguna Niguel**
Regional Park

Improving Water Quality in Laguna Niguel Lake

Project Overview
OC Parks is implementing a project to address phosphorus runoff in Laguna Niguel Lake.

Laguna Niguel Lake has high levels of phosphorus that can lead to water quality, harmful blue green algae, and bacterial blooms and create an ecological imbalance.

San Diego Regional Water Quality Control Board has issued NPDES permit necessary to move forward with the Laguna Niguel Lake restoration efforts.

On April 28, the phosphorus mitigation plan will commence with application of the phosphorus locking technology Phoslock® on the lake bottom throughout the week, concluding on May 3.

Water quality monitoring will occur prior to and after the Phoslock® applications to address permit requirements and assess the treatment to water quality over time.

Phoslock
Phoslock program was selected to specifically address phosphorus pollution in Laguna Niguel Lake.

Phoslock is a modified clay technology that specifically inactivates all available forms of phosphorus in the water column that are used from the bottom sediments of waterbodies.

Phoslock is not an algicide.

Phoslock is certified for use in drinking water and poses negligible risk to the aquatic environment.

Phoslock has been successfully and safely applied to inactivate phosphorus in hundreds of ponds, lakes and reservoirs in over 20 states.

For more information on Phoslock, visit phoslock.com.

OC Parks and the lake management contractor, AquaTechnics, will provide ongoing water quality monitoring throughout season to assess performance of the project and comply with the NPDES permit requirements.

For more information about the Laguna Niguel Lake water quality restoration project, please contact Ian Corbin, AquaTechnics, LLC at (760) 272-6642, or email at ian@phoslock.com.



Aerial image of Laguna Niguel Lake from Google Earth, 2007.



Conductors "blue green algae" bloom.

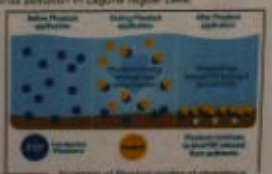


Diagram illustrating the Phoslock application process: before Phoslock application, during Phoslock application, and after Phoslock application.

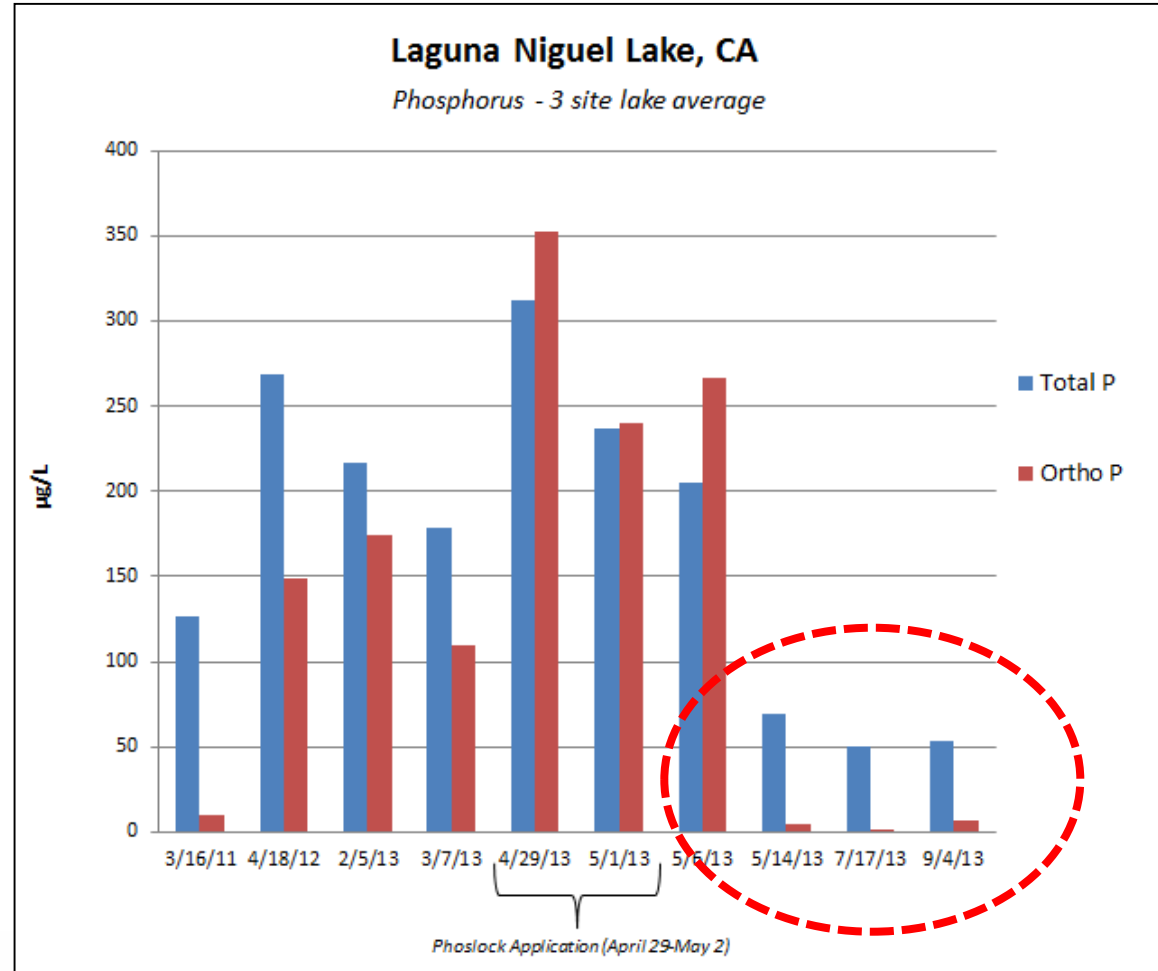


Phoslock Application – Laguna Niguel, CA

Sulphur Creek Reservoir

Phosphorus Results

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



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. Willis¹

¹SePRO Research and Technology Campus, 16013 Watson Seed Farm Rd. Whitakers, NC, USA

²Department 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



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	<u>Copper Sulfate</u> Pond 7	<u>Copper Sulfate</u> Pond 14	<u>SeClear</u> Pond 1	<u>SeClear</u> 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
Total copper (lbs)	2.975	3.4	2.1	1.68

30% less

40% less

2013 AT Summary

<u>Date</u>	Copper Sulfate Pond 7	Copper Sulfate Pond 14	<u>SeClear</u> Pond 1	<u>SeClear</u> 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
Total copper (lbs)	2.58	3.44	1.72	1.72

39% less

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!



Action Threshold: Study Results

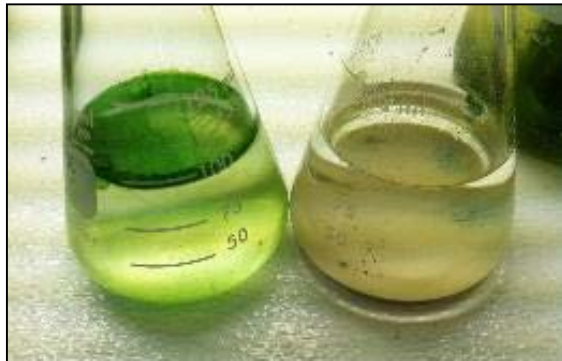
Phoslock *plus* SeClear

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



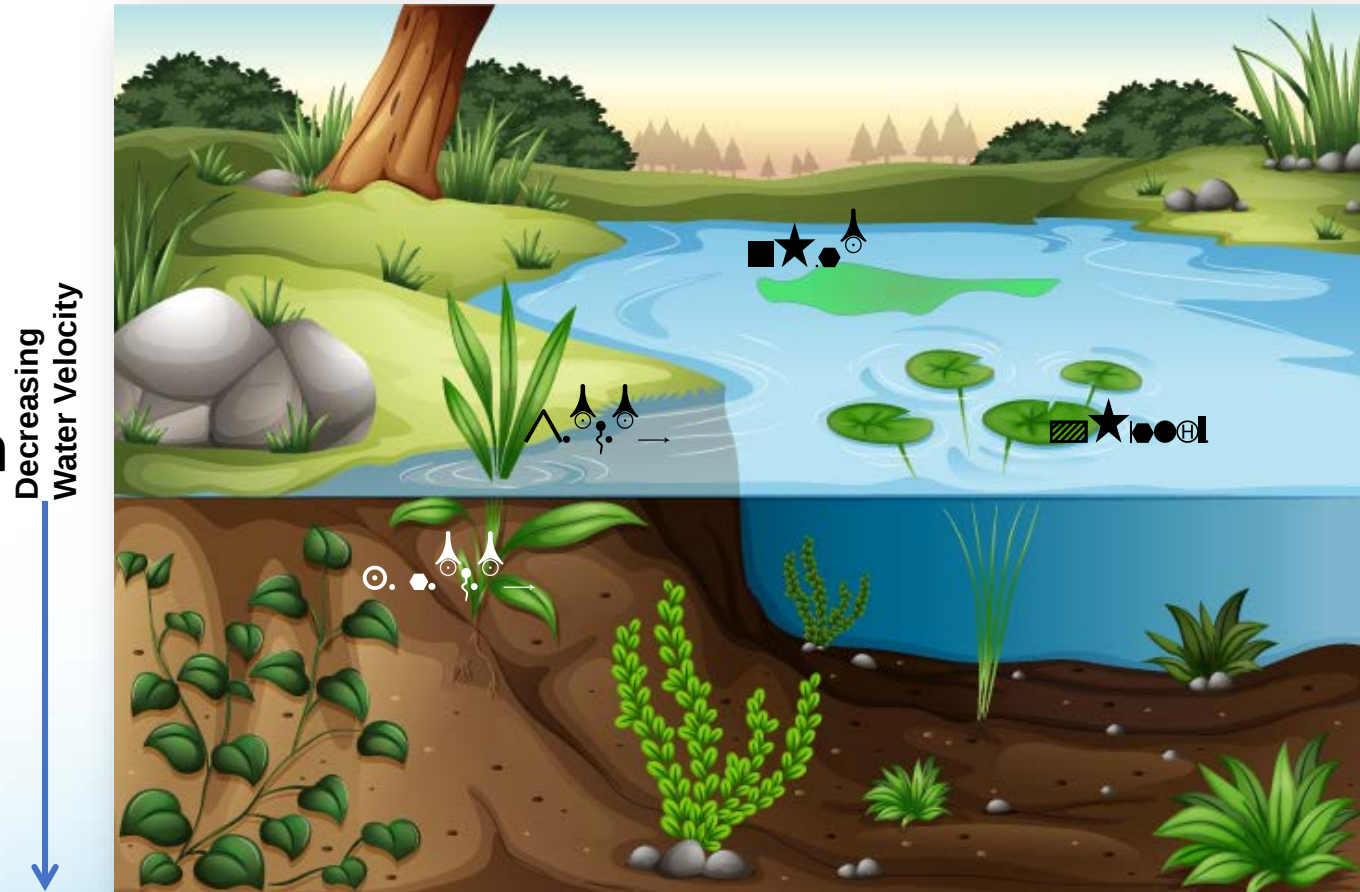
Choosing the best tool

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



Water and Plant Dynamics

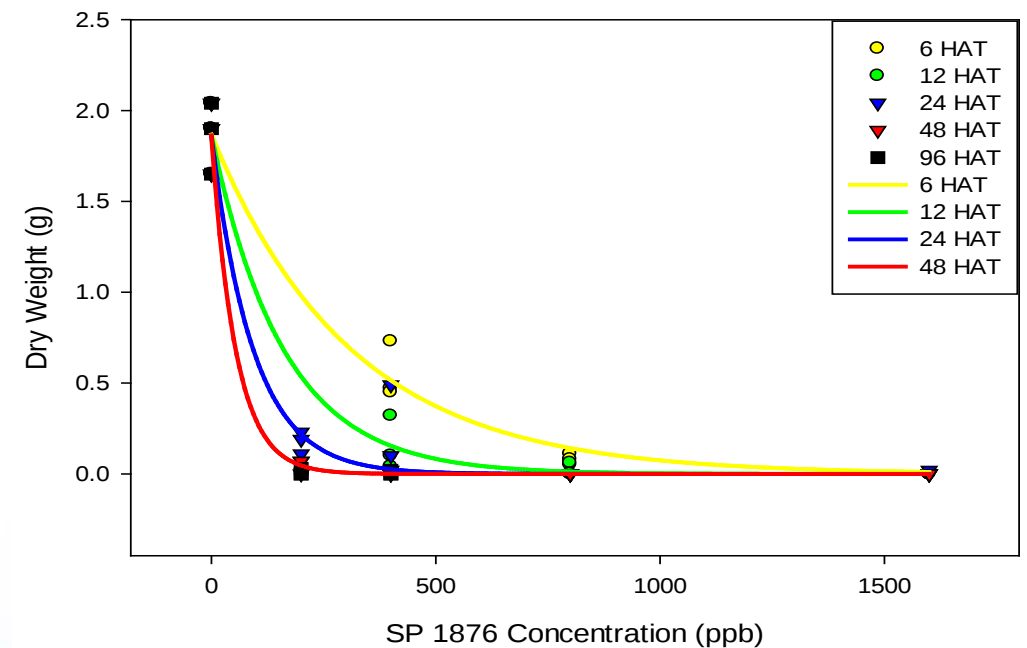
- Invasive weeds grow faster than natives
 - Faster growth equals better uptake
- Plants at surface grow slower
 - Less herbicide uptake
- Water velocity is less at bottom
 - Herbicide will dilute slower



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

SP 1876 CET on Hydrilla



Day of treatment



1 week



2 weeks



4 weeks



Wisconsin DNR
YFH Eradication Effort
~0.1 acre pond

ProcellaCOR (in-water)

Treated August 2, 2018

Water



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

