

Wangumbaug



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www.EcosystemConsulting.com

a. Given that the level of the lake water is naturally in constant flux, are there optimal water levels throughout the seasons that will help create the healthiest possible ecosystem? The concern is not about convenience for lake sports but lake health.

Summer: Shoreline, Depths, Hazards Winter: Manage Shallows and Shoal (by 04)

b. Have any additional invasive aquatic plants been identified and should the lake be monitored going forward? (*Phragmites?*)

Myriophyllum spicatum, Potamogeton crispus, Hydrilla verticillata

Next? **Fanwort (*Cabomba caroliniana*)**

c. Why do most lakefront properties have less weeds in the shallower sections this year?

d. Why has large leaf pond weed decreased so drastically from being a nuisance in 2015 to just a few scattered colonies in 2017?

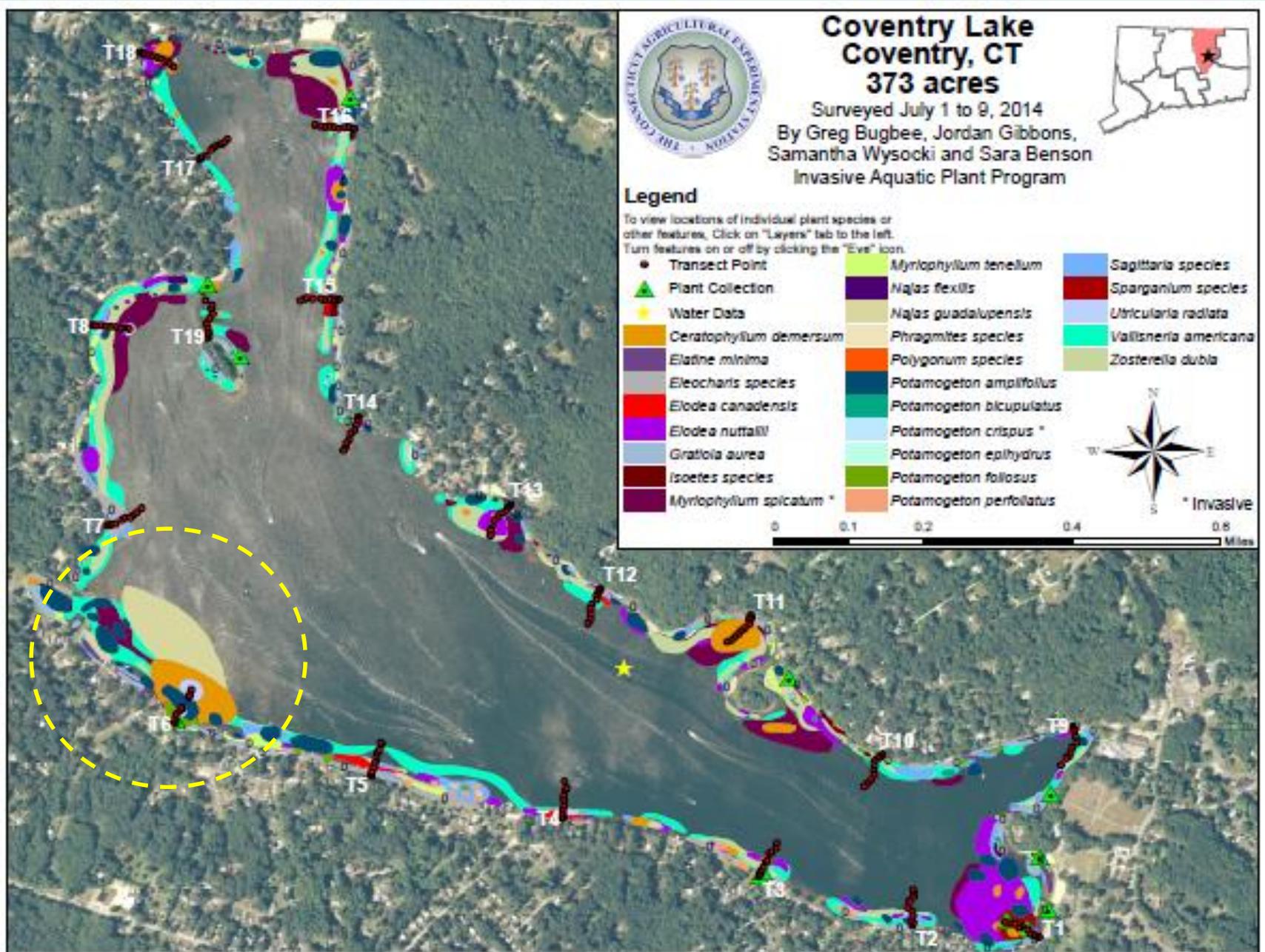
e. Did the lower draw down have any impact on the aquatic plants?

Winter 2016-17 Conditions; Drawdown/Drought

(I added this one)

f. What is the greatest threat to the long-term ecological integrity of Wangumbaug?

Alternate Productivity States



Myriophyllum spicatum, *Potamogeton crispus*, *Hydrilla verticillata*

*Wangumbaug: Ice-Out
A Wind-Swept Shoal defines a lake.*



Short Weir Spillway



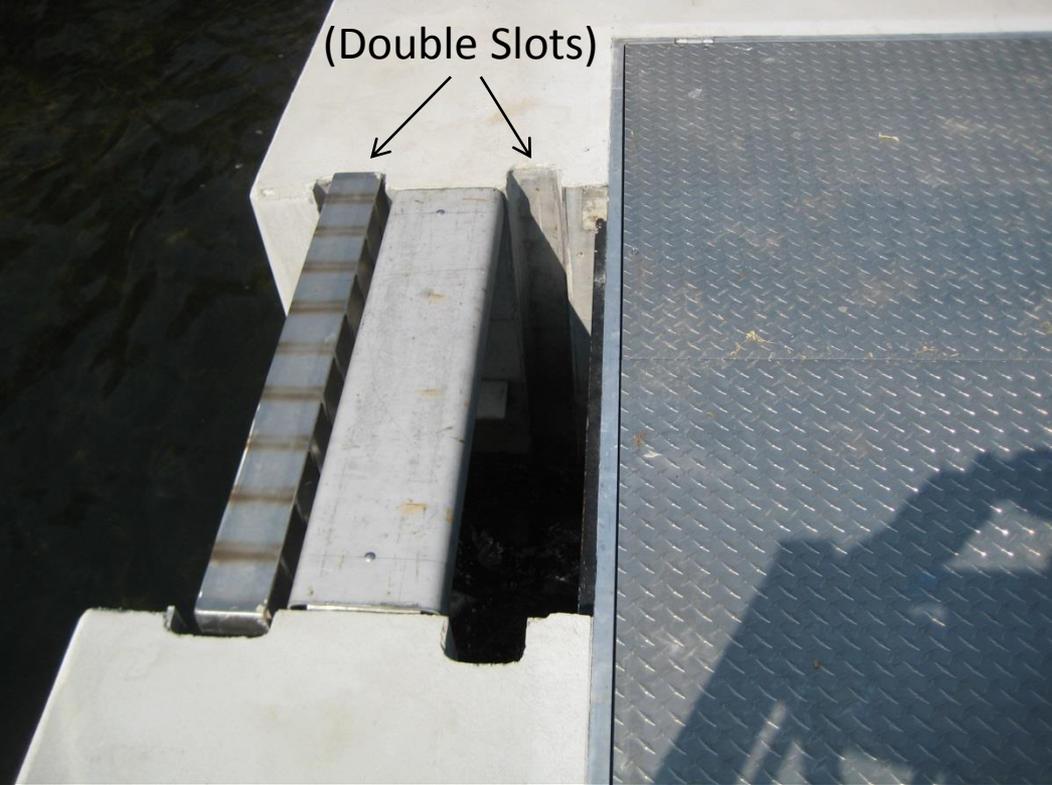
Flashboard Spillway (Double Slot)



Long Weir Spillway



Downstream



Stop-Log Boards

Relatively short weir edge until lake level reaches the concrete spillway.

“Operational Flexibility”

Full Condition
September 2017



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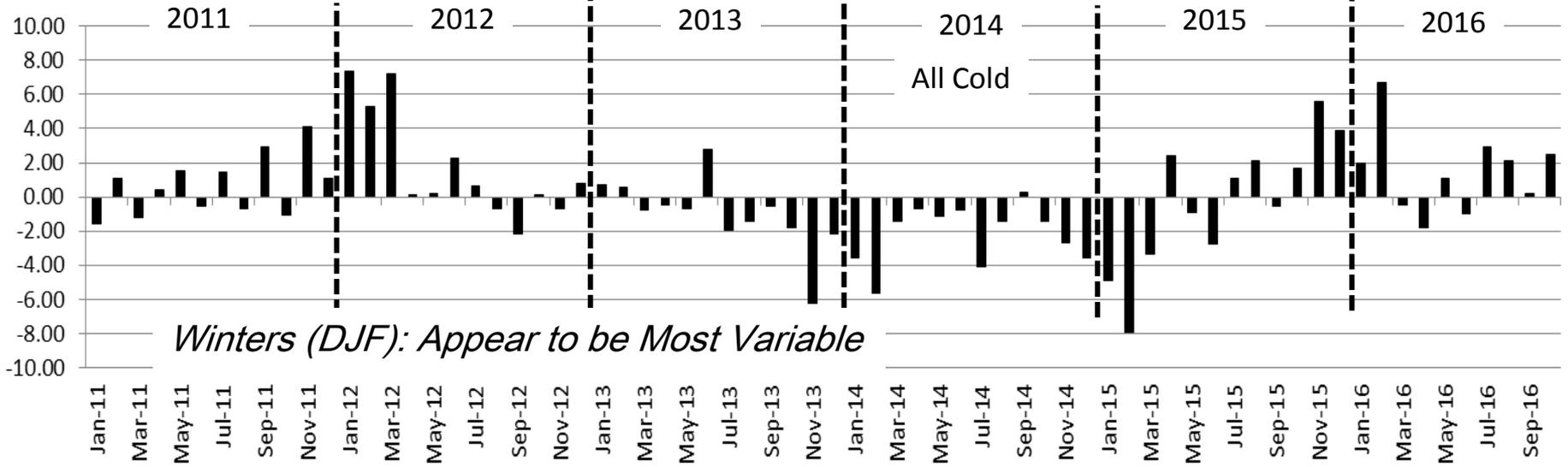
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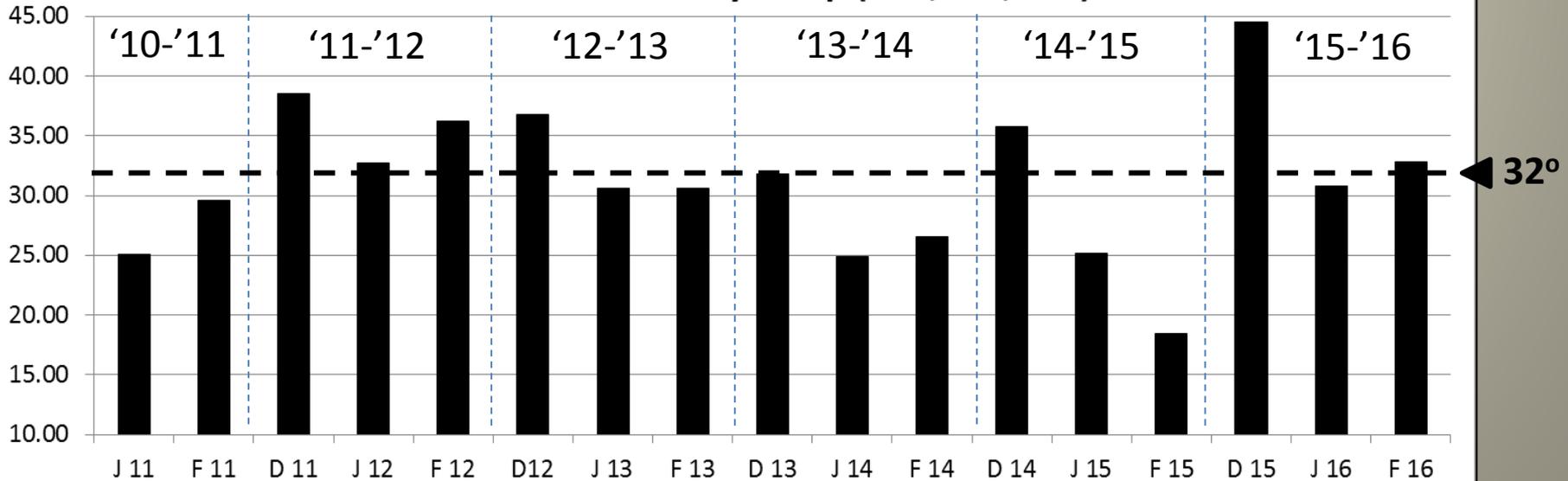
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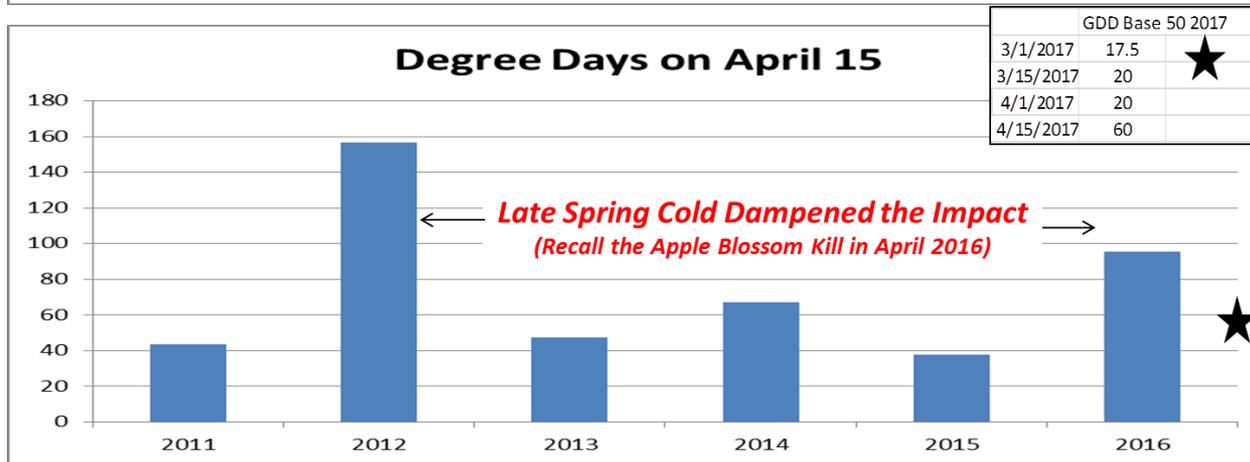
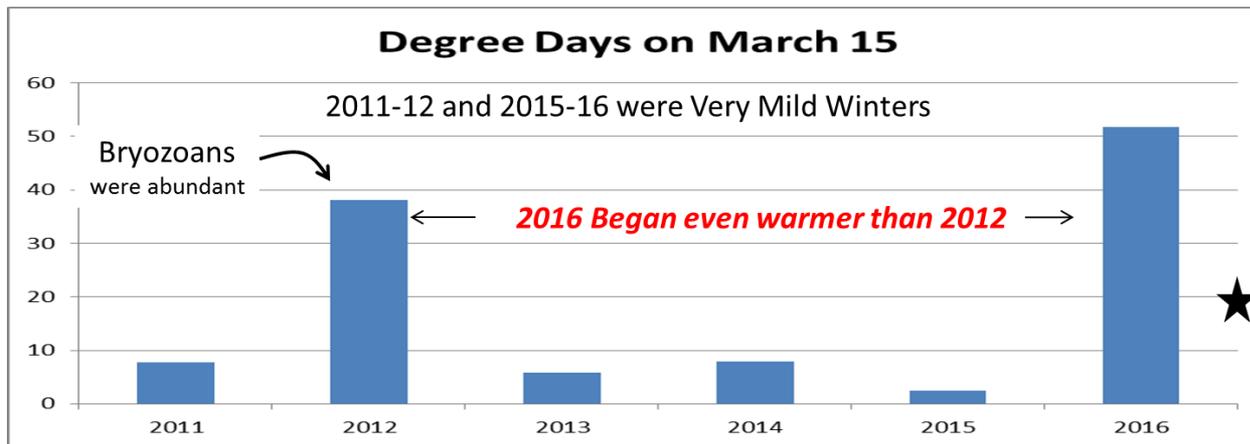
Alternate Productivity States

Monthly Mean Temp - Deviation from the 6-Year Average



Winter Mean Monthly Temp (Dec, Jan, Feb)

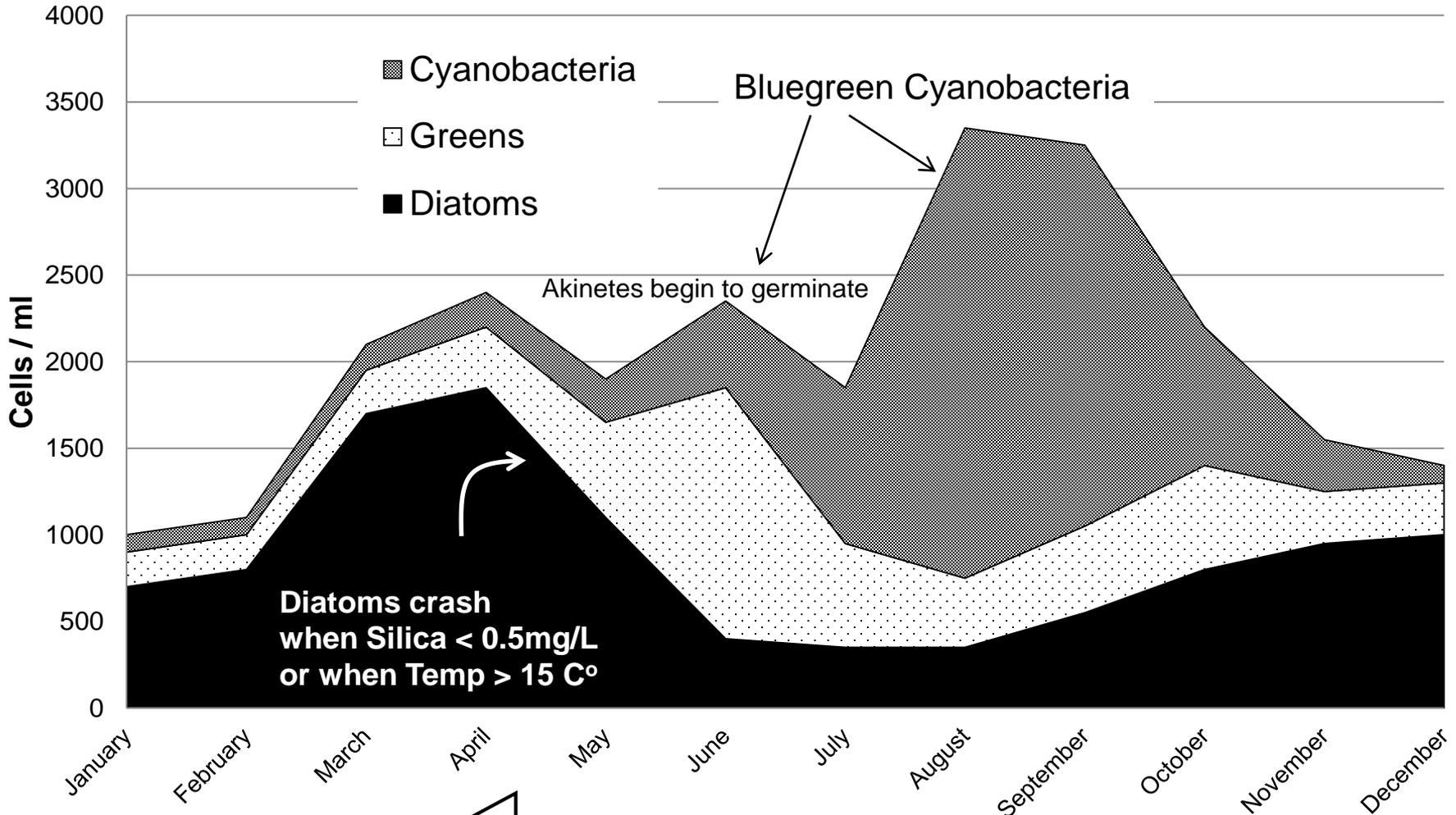




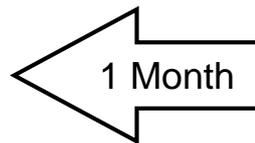
2016-17 Winter: Cold “Normal” December (with a lowered lake)
 January Thaw that lasted through February
 Very Early Ice-Out (1/20/17); then Partial Re-Freeze
 March was colder than either January or February.



Winter Weather Pattern can alter Seasonal Phytoplankton Succession



When the Growing Season begins early there is a shift in seasonal phytoplankton succession.



With an Early Growing Season Start:

- Diatoms Crash early, Cyanobacteria have more time to grow.
- Thermal Stratification is prolonged, longer duration of deep anoxia.

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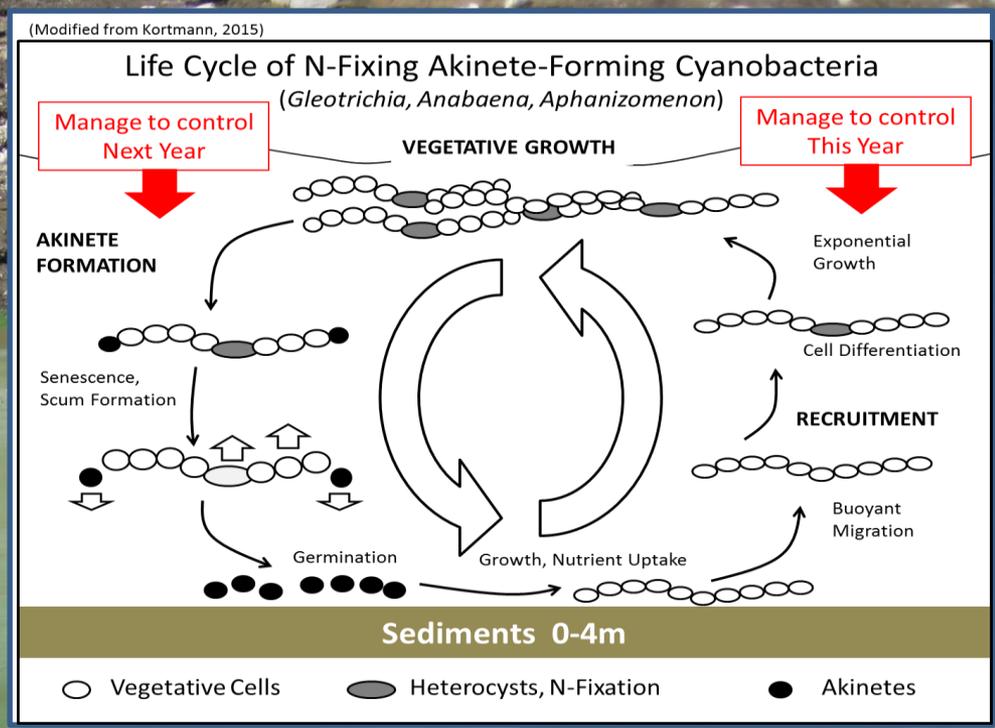
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Alternate Productivity States

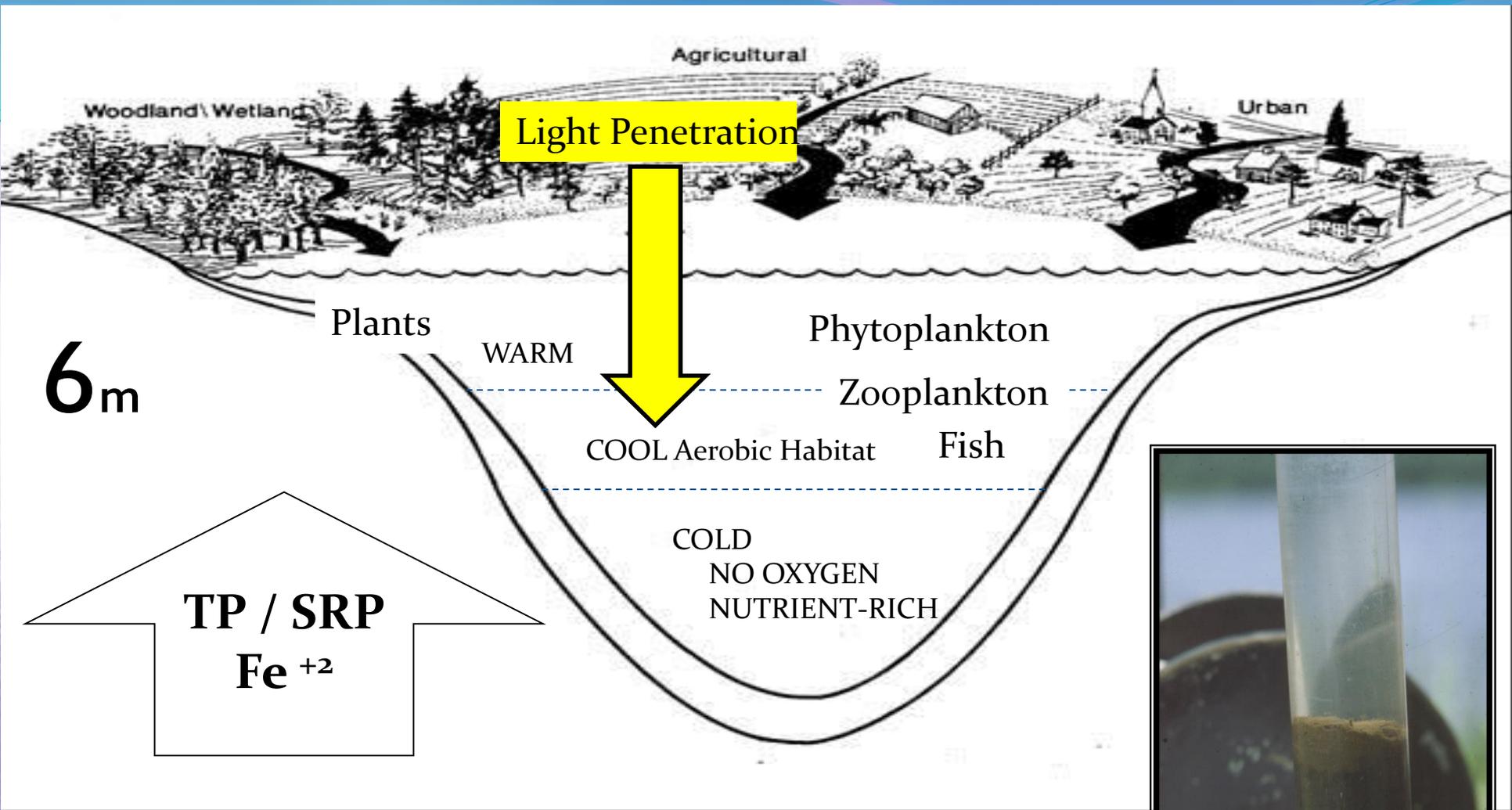
Threats to the Ecological Integrity of Wangumbaug:

- New Infestation by **Invasive Species** such as:
 - **Cabomba, Naiad**, other nuisance macrophytes
 - Zooplanktivorous fish such as the **Alewife**
 - Other Invasives such as Quaga or Zebra Mussel (low risk)
- **Watershed disturbance** that causes a turbid condition that reduces light penetration. (e.g. New Construction)
- **Sediment disturbance** that causes a turbid condition that reduces light penetration. (e.g. Flyboard?)
- **Increased Nutrient Loading from the Watershed.** (Gypsy Moth?)
- **Increased Internal Nutrient Loading**
 - Due to **intensified (or prolonged) oxygen loss in deep strata**
 - Due to **perturbation of Thermal Stratification Structure**
 - Due to **Sediment Disturbance and Re-Suspension**





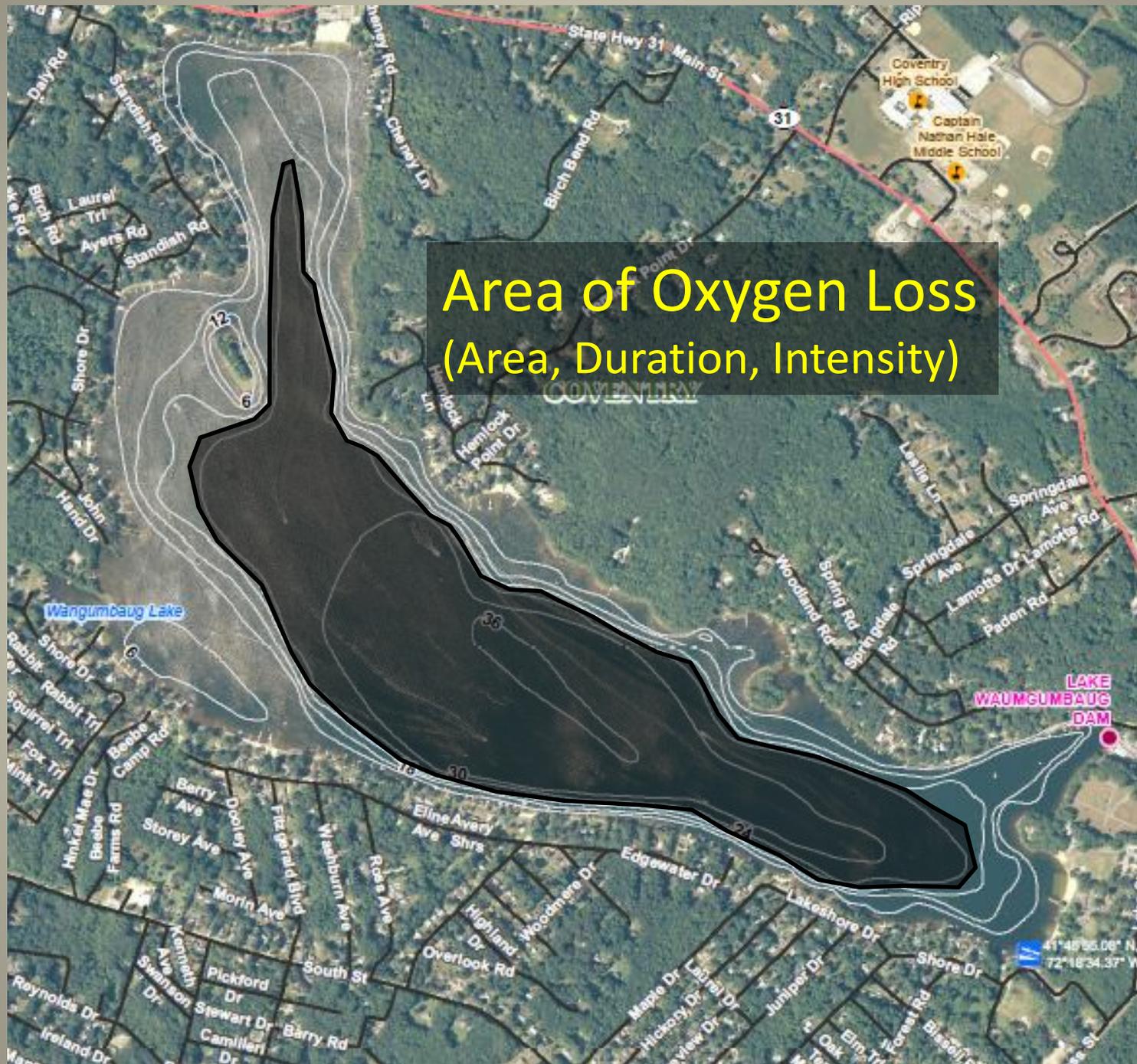
Alternate Productivity States
Plants → *Phytoplankton*
↓
Cyanobacteria



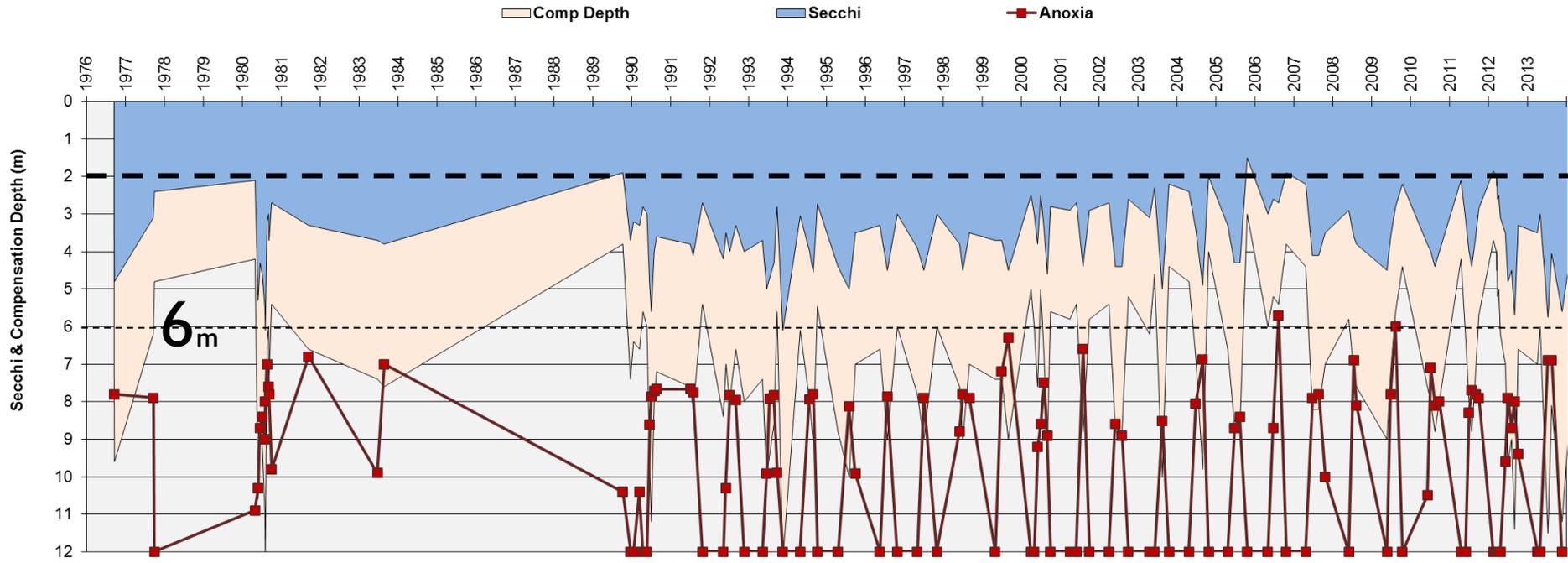
Nutrient-rich muck in most areas

Goal:
> 2.5 m SD minimum

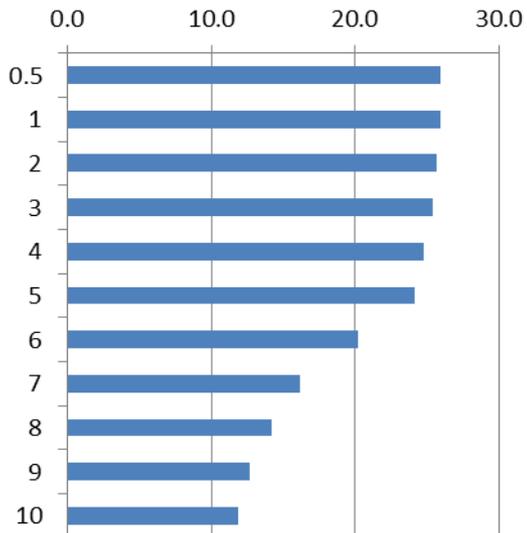
Area of Oxygen Loss (Area, Duration, Intensity)



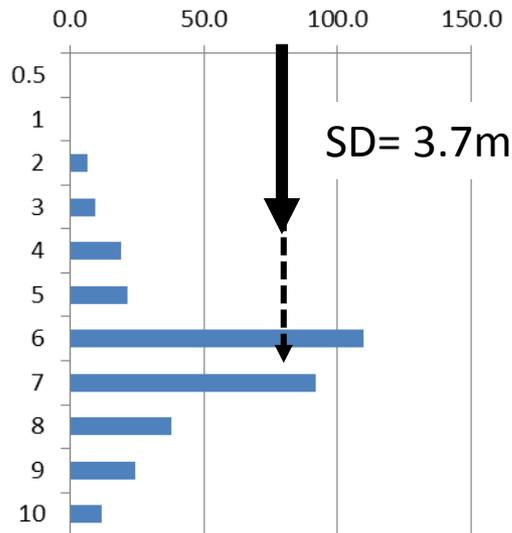
Coventry Lake 1976 - 2014 Transparency Vs Anoxic Ascent



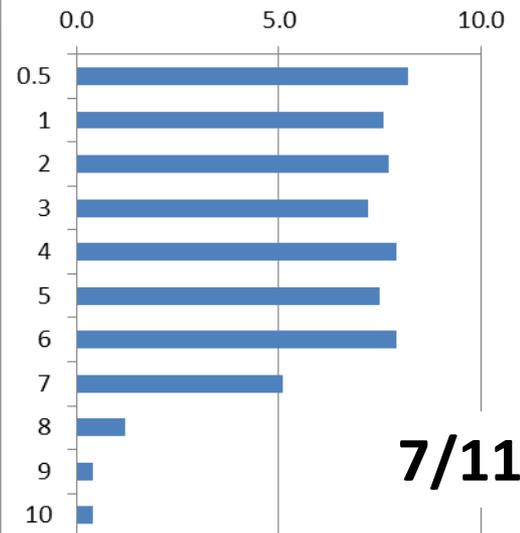
Temp (°C)



RTRM

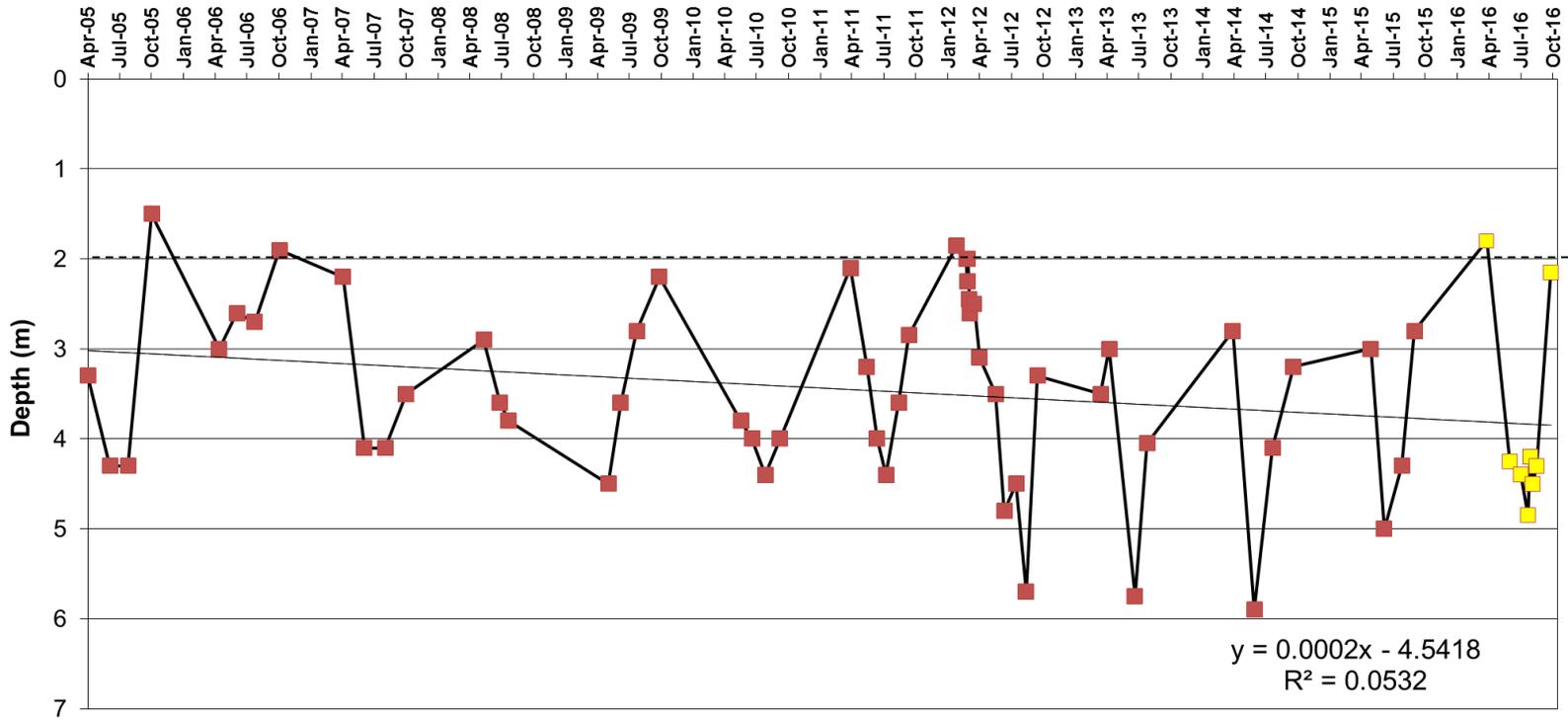


DO (mg/L)

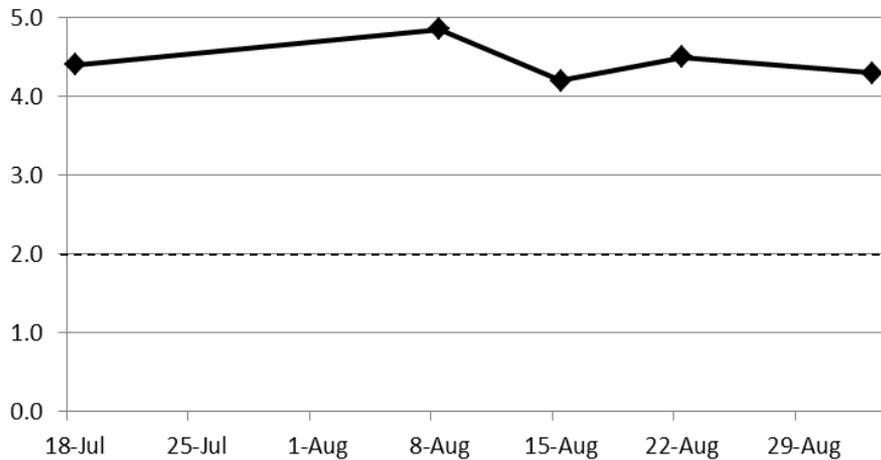


7/11/17

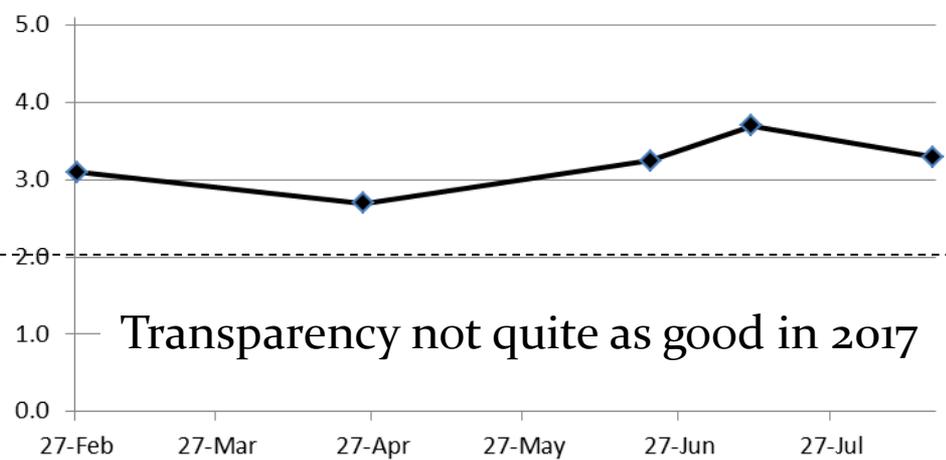
Coventry Secchi Transparency Depth 2005 - 2016



Secchi Transparency (m) 2016



Secchi Transparency 2017





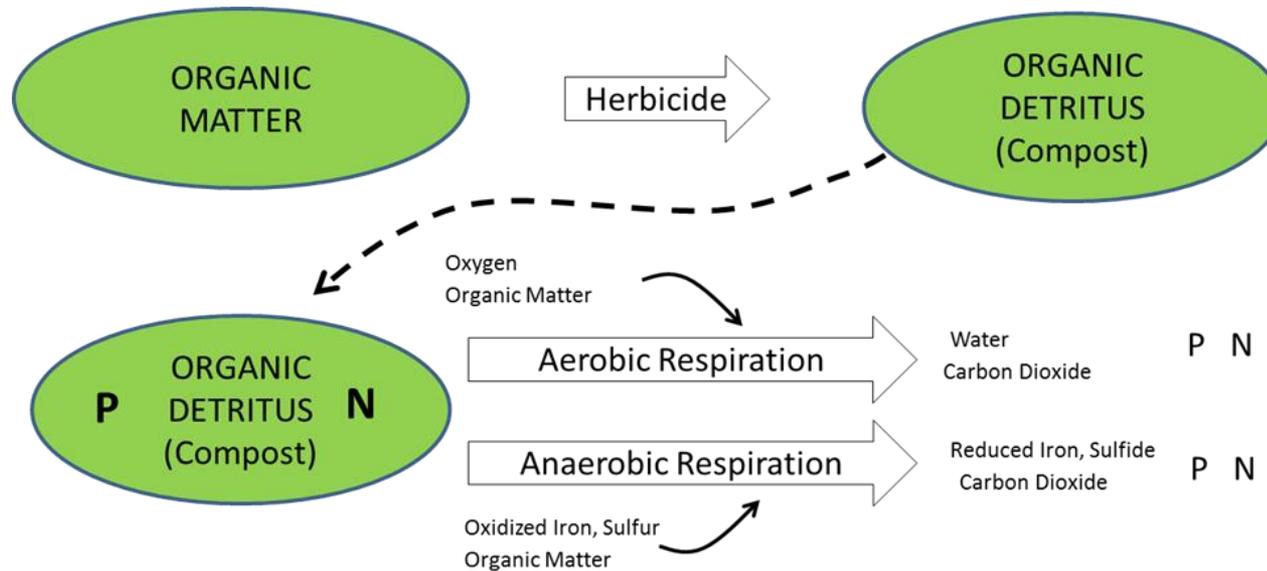


Hydrilla verticillata

- Grows to 25 ft long, creating dense floating mats of vegetation.
- Reproduces from fragments (one leaf whirl adequate)
- Reproduces from Turions (“Seeds”)
- Reproduces from Tubers on roots (subterranean turions, like small potatoes)

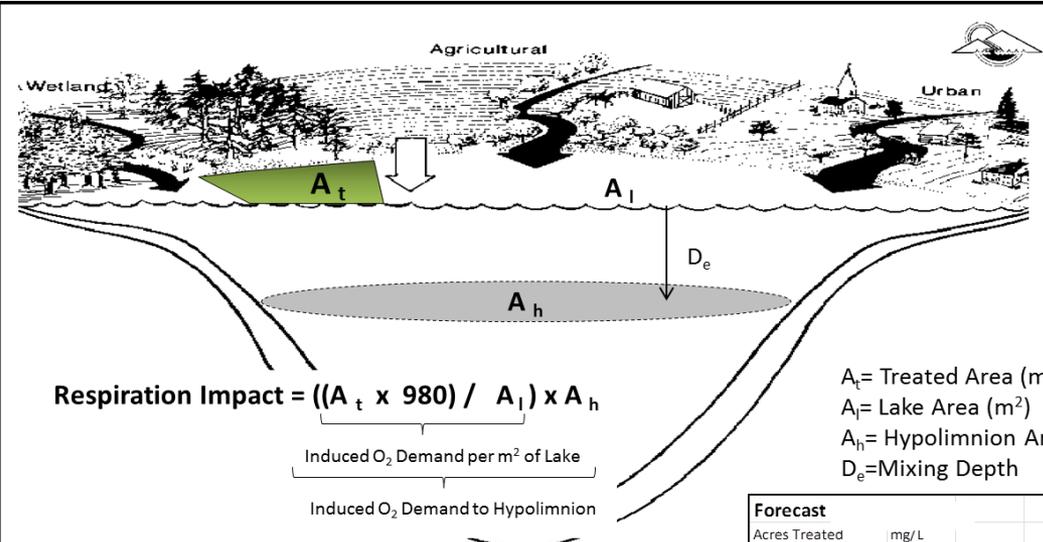
Photo from
MI SeaGrant

Do fragments re-root, does it reproduce like an annual, like a perennial? YES



Hydrilla: Post-treatment Monitoring Lake Wangumbaug 2016

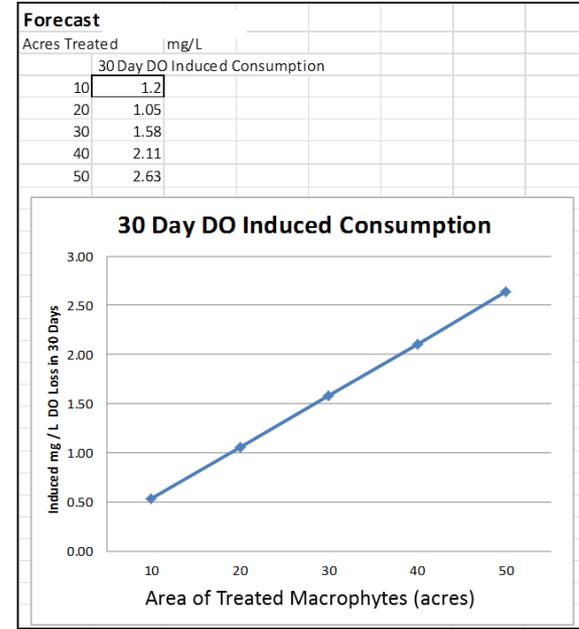
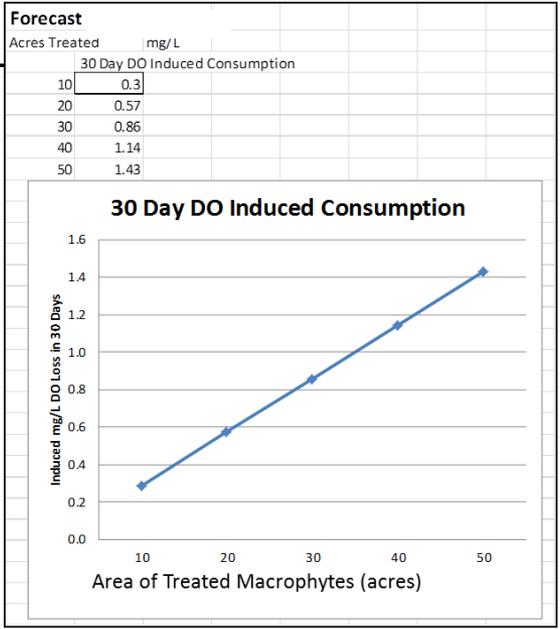
- Heterotrophic Bacteria Increased (approx. doubled)
- Some increased Respiratory Demand
 - Estimated at 0.32 mg/L Oxygen equivalents / 30 days
- Highest TP Observed anywhere in the Lake at any time since 1999.
- Highest Hypolimnetic Fe in a decade
- Highest Hypolimnetic Mn in a decade
- Estimated Direct TP to Trophogenic Zone 0.8 µg/L



Herbicide: Ecological Forecast Model

Induced Respiratory Demand and Internal Loading Direct P Load to Trophogenic Zone

$(A_t \times 1500) / V_e = \text{Induced P Increase (mg m}^3\text{)}$
 Where: A_t = Treated Area (m²)
 150 = mg Biomass P / m² Treated
 V_e = Epilimnetic or Trophogenic Volume (m³)

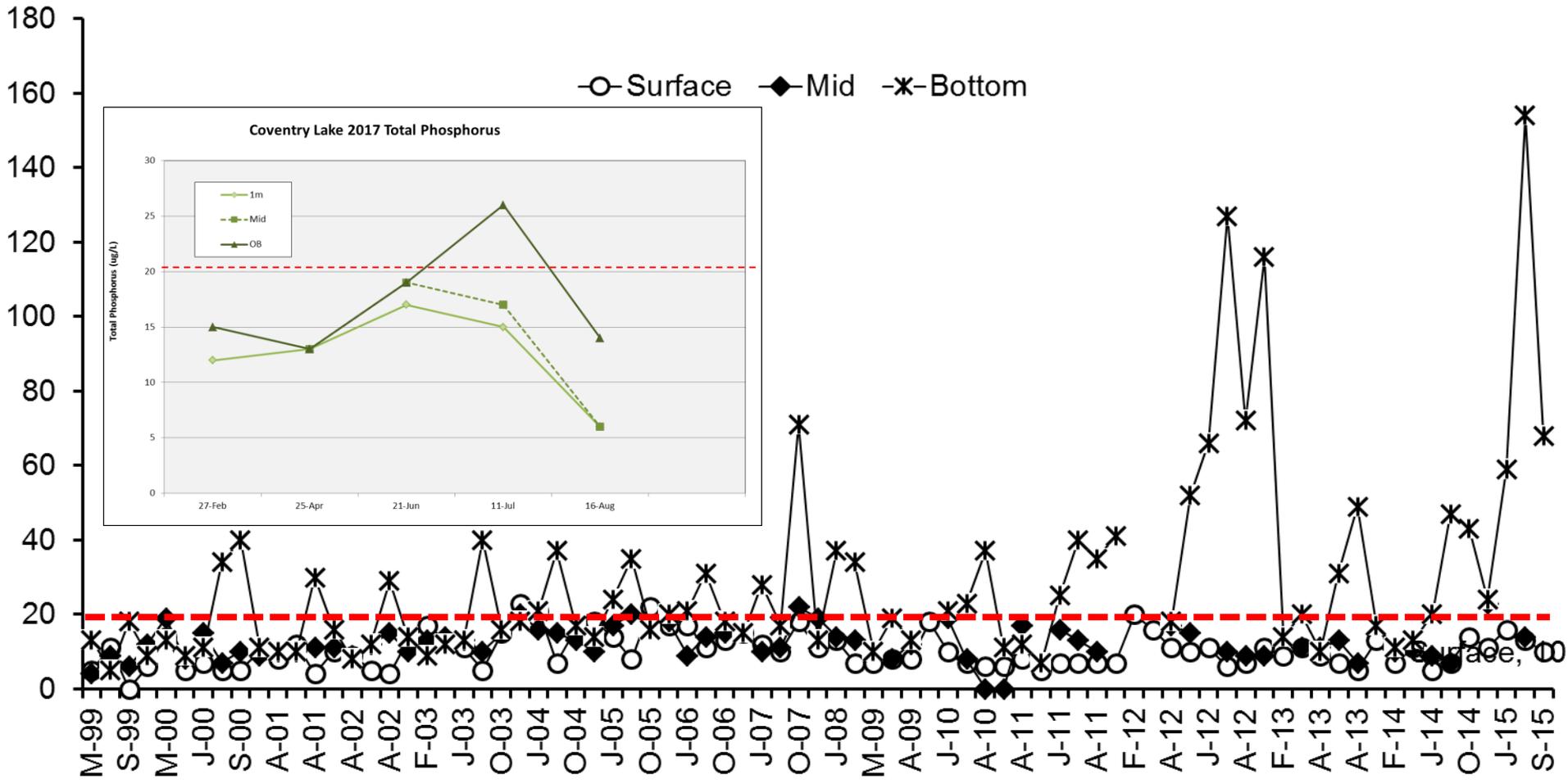


| | Lake A | Lake B | Lake C |
|---|--------|--------|--------|
| Treated Area (Acres) | 43 | 50 | 10 |
| mg DO / Liter / day Induced Hypo Demand | 0.041 | 0.088 | 0.011 |
| mg DO / Liter Induced Demand over 30 Days | 1.23 | 2.63 | 0.32 |
| Increased Trophogenic TP (µg / L) | 5.00 | 1.58 | 0.80 |

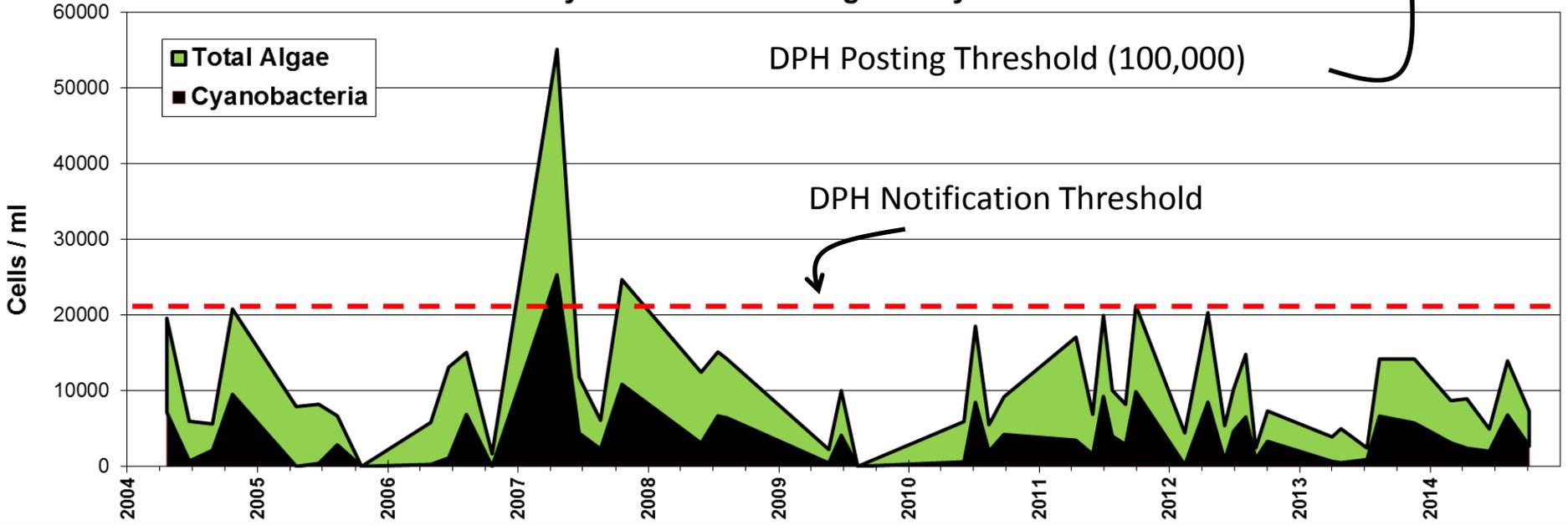
Deep TP Following Hydrilla Treatment = 234 $\mu\text{g/L}$

(Highest observed TP Concentration anywhere in the lake since 1999)

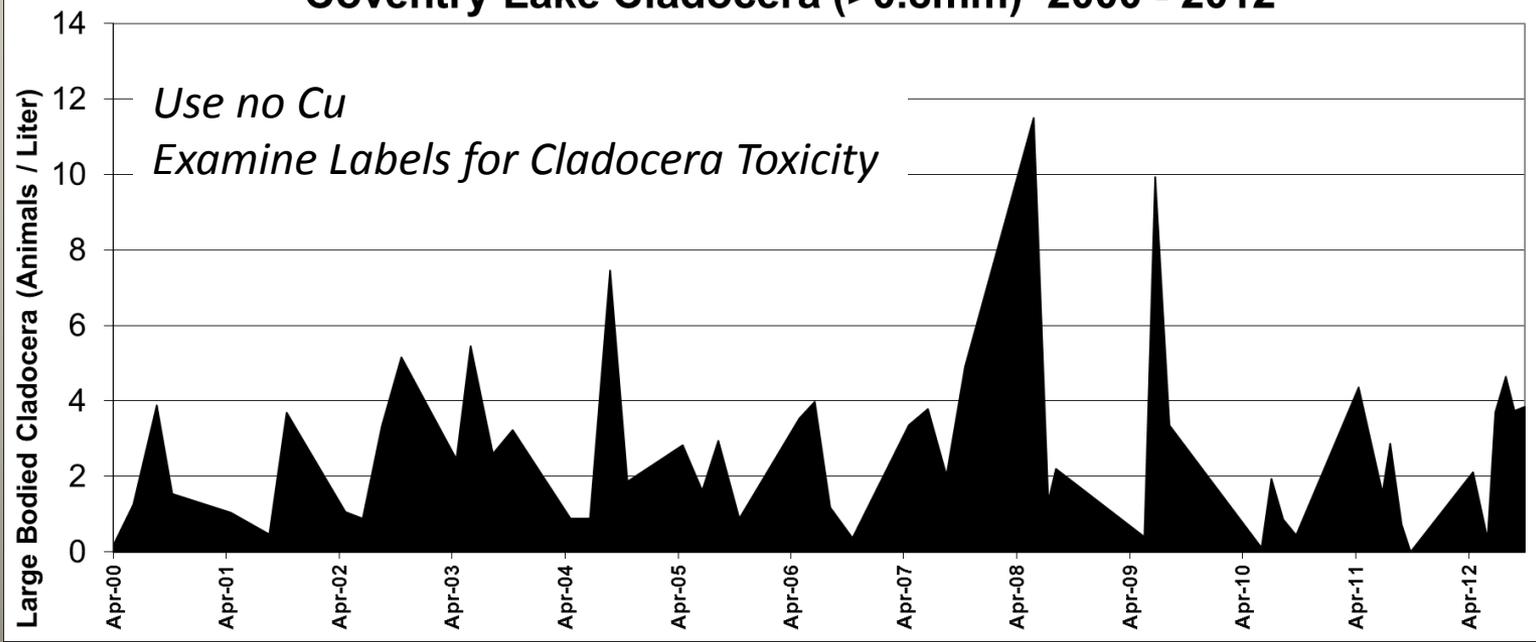
Coventry Lake Total Phosphorus ($\mu\text{g/L}$) 1999-2015



Coventry 2004-2014 Total Algae & Cyanobacteria



Coventry Lake Cladocera (>0.8mm) 2000 - 2012

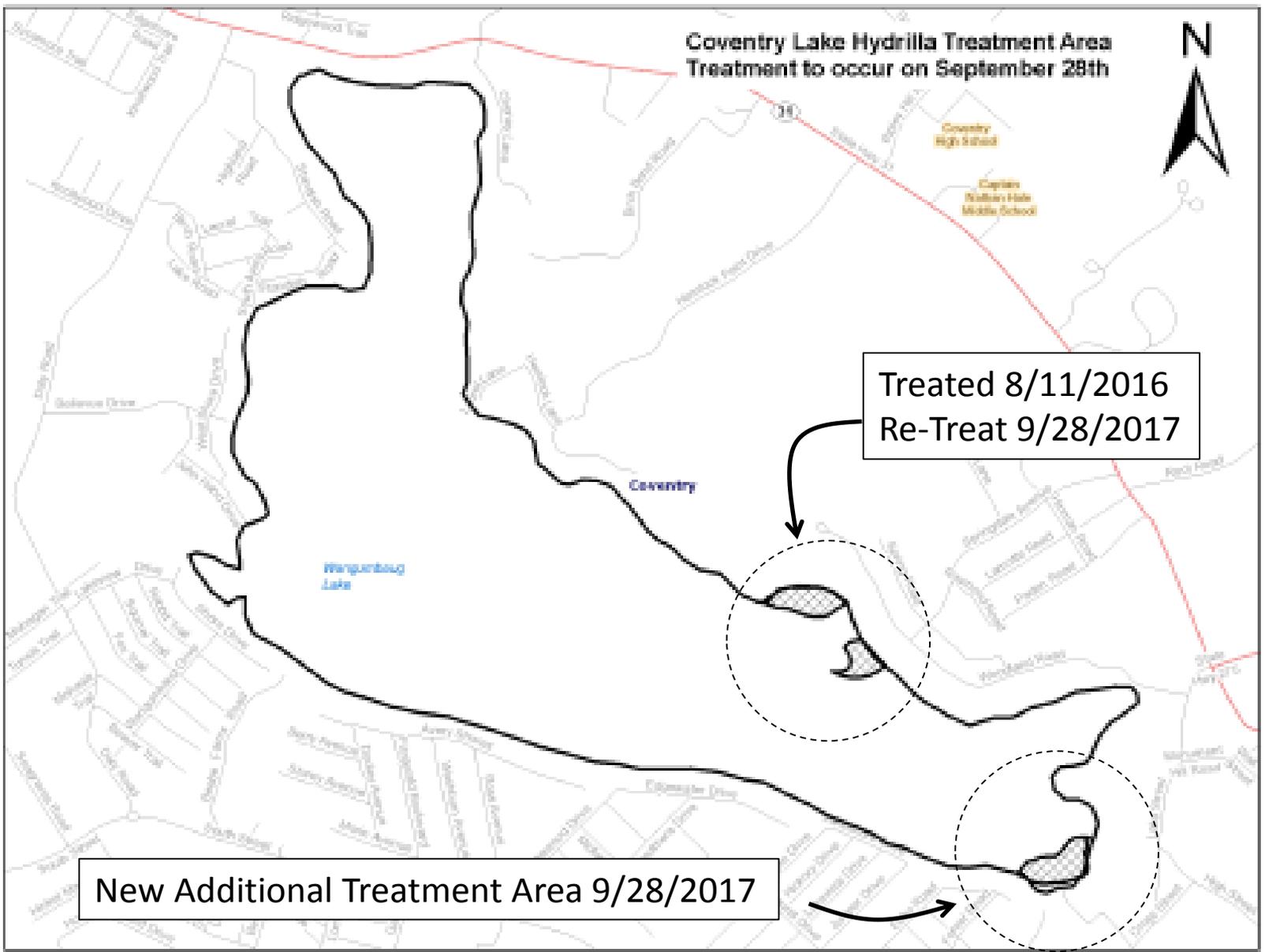


**Coventry Lake Hydrilla Treatment Area
Treatment to occur on September 28th**



Treated 8/11/2016
Re-Treat 9/28/2017

New Additional Treatment Area 9/28/2017



| Coventry Lake- Top Hypolimnion | |
|---|---|
| Proposed Treatment Area: | |
| Acres | m ² |
| 20 | 80920 |
| | 79361819.53 mg/m ² /d Induced Demand |
| Lake Area | 377 acres |
| | 1525342 sq m |
| Induced Lake-Wide Demand | |
| | 79361819.53 mg Total Induced Demand |
| | 52.02886929 mg / sq m / d Areal Demand |
| Area Top of Hypolimnion | |
| 263 | acres |
| 1,064,098 | m ² |
| Estimated Impact: | |
| 55,363,816 | mg / day Total Induced Demand-Hypolimnion |
| Hypolimnion Volume | |
| 2,100 | acre-ft |
| 2,590,350 | m ³ |
| Induced Hypolimnetic Oxygen Consumption Rate | |
| 21 | mg / m ³ /d |
| 0.021 | mg / L / d |
| In 30 days the Induced Demand results in consumption of approximately | |
| | 0.6 mg / L DO equivalents |

| Coventry Lake - Estimated P From Treated Macrophytes | |
|---|--|
| | 0.15 g P / m ² Macrophytes |
| | 2017 |
| | 150 mg / m ² |
| | 20 acres treated |
| | 80920 m ² treated |
| | 12138000 mg P Released |
| | 12.138 kg P Released |
| | |
| 1525342 | m ² Lake Area |
| 7626710 | Volume Surface 5m (m ³) |
| | |
| | 1.6 Induced Trophogenic P Increase (mg P / m ³) |

2017 Forecast:

0.6 mg/L Induced Oxygen Equiv. Demand
1.6 ppb TP Increase to Trophogenic Zone
(30 day demand)

| Temperature (°C) | > 24°C | | | | | | | |
|------------------|--------|--------|--------|-------|--------|--------|-------|--------|
| Depth (m) | 11-Apr | 17-Jun | 18-Jul | 8-Aug | 15-Aug | 22-Aug | 2-Sep | 13-Oct |
| 0.5 | | | 26.6 | 27.0 | | 26.9 | 23.7 | 17.7 |
| 1 | 8.0 | 21.1 | 27.0 | 27.0 | 28.8 | 26.9 | 24.4 | 17.7 |
| 2 | 8.0 | 21.0 | 27.1 | 26.9 | 28.7 | 26.7 | 24.7 | 17.5 |
| 3 | 8.3 | 20.9 | 26.7 | 26.8 | 28.7 | 26.6 | 25.2 | 17.4 |
| 4 | 8.2 | 20.3 | 26.1 | 26.7 | 28.6 | 26.3 | 25.3 | 17.3 |
| 5 | 8.1 | 19.7 | 25.6 | 26.7 | 28.4 | 26.1 | 25.4 | 17.1 |
| 6 | 8.0 | 19.2 | 23.9 | 25.6 | 26.3 | 26.1 | 25.5 | 16.9 |
| 7 | 7.9 | 17.9 | 22.1 | 22.7 | 22.4 | 25.9 | 25.3 | 16.9 |
| 8 | 7.7 | 16.5 | 20.3 | 18.3 | 19.7 | 19.3 | 22.6 | 16.9 |
| 9 | 7.7 | 15.0 | 18.3 | 16.0 | 15.8 | 16.4 | 21.0 | 16.9 |
| 10 | | | 17.3 | 14.9 | 13.8 | 14.7 | 19.3 | 16.6 |
| 11 | | | | 13.7 | 13.3 | 14.5 | 17.2 | |
| 12 | | | | 12.9 | | | | |

| Dissolved Oxygen (mg/L) | <1.0mg/L <0.5mg/L | | | | | | | |
|-------------------------|-------------------|--------|--------|-------|--------|--------|-------|--------|
| Depth (m) | 11-Apr | 17-Jun | 18-Jul | 8-Aug | 15-Aug | 22-Aug | 2-Sep | 13-Oct |
| 0.5 | | | 8.0 | 6.9 | | 7.0 | 7.6 | 7.9 |
| 1 | 11.1 | 8.8 | 8.0 | 7.2 | 7.3 | 7.0 | 7.4 | 7.8 |
| 2 | 11.1 | 8.8 | 7.8 | 7.7 | 7.4 | 7.2 | 7.3 | 7.8 |
| 3 | 11.0 | 8.7 | 7.7 | 7.5 | 7.6 | 7.2 | 7.2 | 7.8 |
| 4 | 11.0 | 8.7 | 7.8 | 7.5 | 7.6 | 7.3 | 7.1 | 7.7 |
| 5 | 11.0 | 8.3 | 8.0 | 7.5 | 7.6 | 7.2 | 7.2 | 7.6 |
| 6 | 10.9 | 7.8 | 8.2 | 7.3 | 7.0 | 7.0 | 7.1 | 7.4 |
| 7 | 10.8 | 6.4 | 7.3 | 7.8 | 6.2 | 6.6 | 6.1 | 7.4 |
| 8 | 10.7 | 5.6 | 4.4 | 0.9 | 3.5 | 1.5 | 0.9 | 7.2 |
| 9 | 10.5 | 2.8 | 1.2 | 1.0 | 0.5 | 0.9 | 0.4 | 6.1 |
| 10 | | | 0.2 | 0.9 | 0.5 | 0.0 | 0.1 | 2.1 |
| 11 | | | | 0.9 | 0.5 | 0.0 | 0.0 | |
| 12 | | | | 0.9 | | | | |
| 13 | | | | | | | | |

Sept 28 plus 30 days = Oct 26



| RTRM | > 20 > 50 | | | | | | | | |
|-----------|-----------|--------|--------|-------|--------|--------|-------|--------|--|
| Depth (m) | 11-Apr | 17-Jun | 18-Jul | 8-Aug | 15-Aug | 22-Aug | 2-Sep | 13-Oct | |
| 0.5 | | | 0 | 0 | | 0 | 0 | 0 | |
| 1 | 0 | 0 | -13 | 0 | 0 | 0 | -24 | 0 | |
| 2 | 0 | 5 | 0 | 3 | 4 | 7 | -9 | 7 | |
| 3 | -3 | 3 | 10 | 3 | 0 | 3 | -16 | 2 | |
| 4 | 2 | 16 | 20 | 3 | 4 | 10 | -3 | 0 | |
| 5 | 1 | 15 | 19 | 0 | 7 | 7 | 0 | 7 | |
| 6 | 1 | 10 | 50 | 36 | 72 | 0 | -3 | 2 | |
| 7 | 0 | 31 | 55 | 89 | 120 | 7 | 3 | 0 | |
| 8 | 1 | 32 | 48 | 115 | 72 | 189 | 82 | 0 | |
| 9 | 1 | 28 | 49 | 50 | 88 | 65 | 45 | 2 | |
| 10 | | | 22 | 21 | 37 | 33 | 46 | 6 | |
| 11 | | | | 21 | 8 | 4 | 48 | | |
| SumRTRM | 2 | 139 | 261 | 342 | 412 | 325 | 168 | 26 | |
| MaxRTRM | 2 | 32 | 55 | 115 | 120 | 189 | 82 | 7 | |

Total Phosphorus as P (µg/L)

| | 13-Oct |
|-----|--------|
| 1m | 13 |
| Mid | 12 |
| OB | 19 |



2017 Treatment Forecast

Resulting TP= ca. 14.6
 Cold Water Habitat not an issue
 Internal Loading not an issue
 (Thermocline Gone, Oxygen Delivery increased)





Questions?