Monitoring the Efficacy of Chemical Amendments for Nutrient Control in Wetland Restorations

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The St. Johns River Watershed

LEGEND

- St. Johns River major basins
- St. Johns River Water Management District Boundary
The challenge

• The District purchased approximately 11,000 ha of former row crop farms in the Apopka and Emeralda Marsh basins during the 1990’s to reduce external P loading to water bodies
• Expected legacy phosphorus flux from just the Apopka north shore was expected to reach 158 metric tons (3 mg P/m²)
Various stages of reflooding

1) Apopka – Muck farmland (8,000 ha) left in dry condition
2) Emeralda Marsh – Muck farmland (800 ha) already reflooded, various depths, some with heavy vegetation
3) Blue Cypress Marsh – (243 ha) never farmed, but subjected to high nutrient water from broken levee, shallow with heavy vegetation
Methods of choosing products

- Lab studies (UF)
- Adsorption isotherms
- Literature reviews – In house and contracted
- Chemical characterization
- Physical characterization
- Toxicity studies (FDEP)
- Leaching studies (TCLP and SPLP)
- Mesocosm field plot
- Large field plots (0.8 ha)
Batch incubation studies – UF (1996)

- Calcium carbonate
- Calcium hydroxide
- Aluminum sulfate (alum)
- Ferric chloride
- Dolomite
- Various combinations
Dry aluminum sulfate, Al WTR, CaCO$_3$ WTR, and lime Water Treatment Residuals (WTR)
Field scale plots – Aluminum based WTR
3.6 wet tons/ac
Field scale plots - Application of calcium hydroxide
2.0 and 2.8 tons lime/ac (30% slurry)
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Alum WTR

Ca(OH)$_2$

Control

Ca(OH)$_2$
Alum water treatment residual

- By-product of drinking water treatment process
- Source water is Lake Washington
- Extremely high P bonding capacity – 60 mg P/dry g of residual
- Available for FREE in Melbourne, FL
Central processing site – Zellwood, FL
Temporary truck scale
Rotary drum screen
Dose = 6.5 to 10 wet tons per acre
• Calibration – every few hours on each of 4 spreaders
Final stats for land application

- Project ran from 1999 - 2009
- 59,974 metric tonnes were applied on 2,877 ha
- $2.5 m in contracts for trucking, processing, and application (not internal costs, lab fees or experimental work)
Condition of sites

• All flooded
• Some to be treated for water column P
• Some to be treated for wc/sediments
• Various stages of vegetation thickness and water depth
Jar tests

Photo courtesy of DB Environmental
Liquid alum application – Cells Q, T, and Z of Area 3
“Cookie Cutter”
Liquid alum application by MarshMaster™ on Cells Q, T, and Z
Liquid alum and sodium aluminate application – Area 7
### Barge Results

<table>
<thead>
<tr>
<th>Area</th>
<th>Year</th>
<th>Dose Applied (mg Al/L)</th>
<th>Δ TP-T Water Column (%)</th>
<th>Cost/kg P removed ($) Water Column</th>
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<tbody>
<tr>
<td>3-Q</td>
<td>2001</td>
<td>3.18</td>
<td>-62</td>
<td>275</td>
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<tr>
<td>3-Z</td>
<td>2002</td>
<td>10.31</td>
<td>-57</td>
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<td>3-T</td>
<td>2002</td>
<td>6.64</td>
<td>-59</td>
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<td>4</td>
<td>2002</td>
<td>9.15</td>
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<td>550</td>
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<td>13</td>
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<td>5-2</td>
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<td>-60</td>
<td>53</td>
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<td>19.9</td>
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<td>2</td>
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<td>LHCA-2</td>
<td>2010</td>
<td>29.0</td>
<td>-62</td>
<td>83</td>
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</table>
Economics of barge application

- $748/ha – includes treatment design plus application
- $41/kg P removed – water column effects only
Enclosure study – Al WTR, Baraclear™, Ferric WTR, and granular alum
Baraclear - Aluminum sulfate/bentonite product
Treatment Effects on PO4-D

- PO₄-D reductions occurred immediately
- PO₄-D was significantly reduced by all treatments

Baraclear = granular alum < Al-WTR = Fe-WTR < Control
Ansin West Tract of Blue Cypress Marsh
Challenge

- Elevated bioavailable phosphorus in sediments covering 243 ha of Ansin West of Blue Cypress Marsh.
- Expanding coverage of cattail
- Reduced habitat for endangered Snail Kite
- Heavily vegetated and very shallow
Bioavailable phosphorus levels, pre-treatment (mg/kg)
Cattail encroachment (in pink)
Pre-treatment
Plan

- Bid out chemical contract
- Use annual spray contractor
- Spray Clearcast™ - July 2012
- Prescribed burn – August 2012
- Apply granular alum – late August 2012
- Annual vegetation surveys
- Aerial photography
- Post-treatment sediment sampling
Results - vegetation

• Almost total loss of *Typha* on all transects
• Impacts to other species variable depending on transect
• Appearance of extensive areas of *Chara zeylanica* on 75% of transects likely due to changes in alkalinity and water clarity
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Transect 6

May 2012

May 2013
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Cost of aerial treatment

- **Alum** – $89,220 (165,240 kg)
- **Spray crew** – $119,150 (2.5 days)
- **Sediment sampling** - $37,648

= $1,013/ha

- **Barge applications** ~ $748/ha
1 male and 2 females
N 3058917
E 533149

1 juvenile and 1 female
N 3058789
E 533196

1 female and 1 male
N 3057809
E 534395
Summary

- Can complete P binding projects in various situations
- Dry land – manure spreaders with WTR’s
- Deep open water – barges w/ liquid alum
- Shallow marsh – MarshMaster™, airboat, and aerial granular alum applications
• Chemical amendments can be used to reduce the timeline for wetland restorations in highly impacted former farm fields with large stores of legacy phosphorus