



**BMP Development for Reducing Low  
Dissolved Oxygen and  
Methylmercury Production and  
Export from Diked Managed Seasonal  
Wetlands in Suisun Marsh:  
Overview and Preliminary Findings**

**Stuart W. Siegel, Ph.D., P.W.S.**

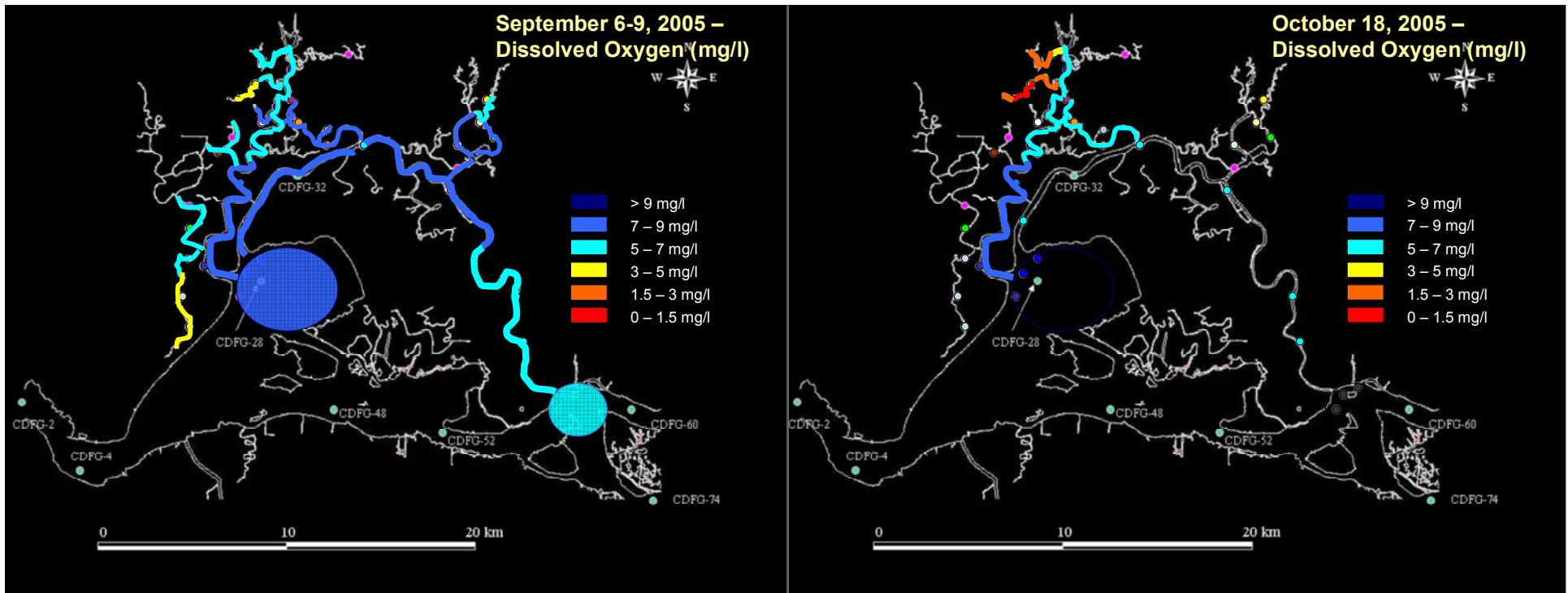
**Wetlands and Water Resources, Inc.**

**RMP Annual Mercury Meeting**

**February 5, 2009**

# Project Collaborators

- **Moss Landing Marine Laboratory** – Mark Stephenson, Wes Heim
- **U.S. Geological Survey** – Brian Bergamaschi, Frank Anderson, Jon Burau
- **Department of Water Resources** – Chris Enright
- **U.C. Davis** – Peter Moyle, Patrick Crain
- **Suisun Resource Conservation District** – Steve Chappell, Bruce Wickland, Orlanda Rocha
- **Bachand and Associates** – Phil Bachand, Sam Prentice
- **Wetlands and Water Resources** – Stuart Siegel, Dan Gillenwater



Environmental conditions in diked managed seasonal wetlands that produce low DO are well suited to produce MeHg



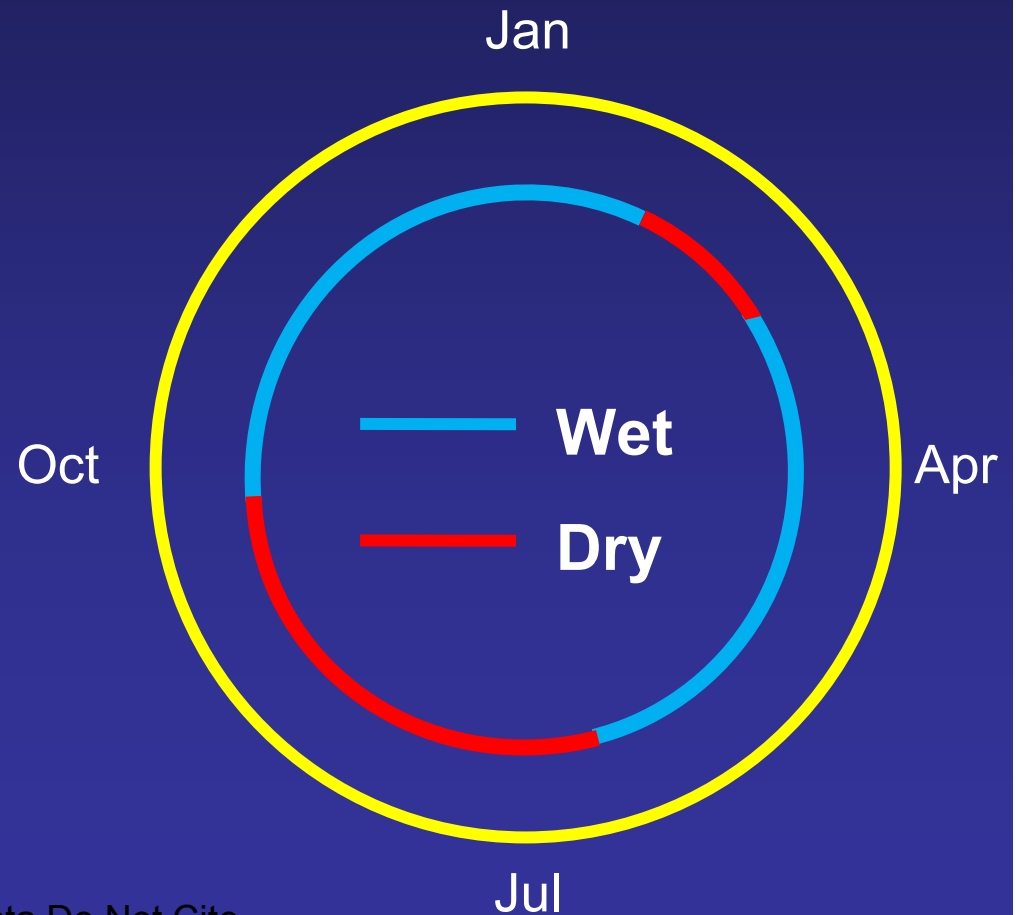
# Project Goal

Can water and vegetation management practices be improved to reduce Low DO and MeHg production in Suisun diked managed seasonal wetlands?

Typical Suisun  
Management Cycle

*approximate*

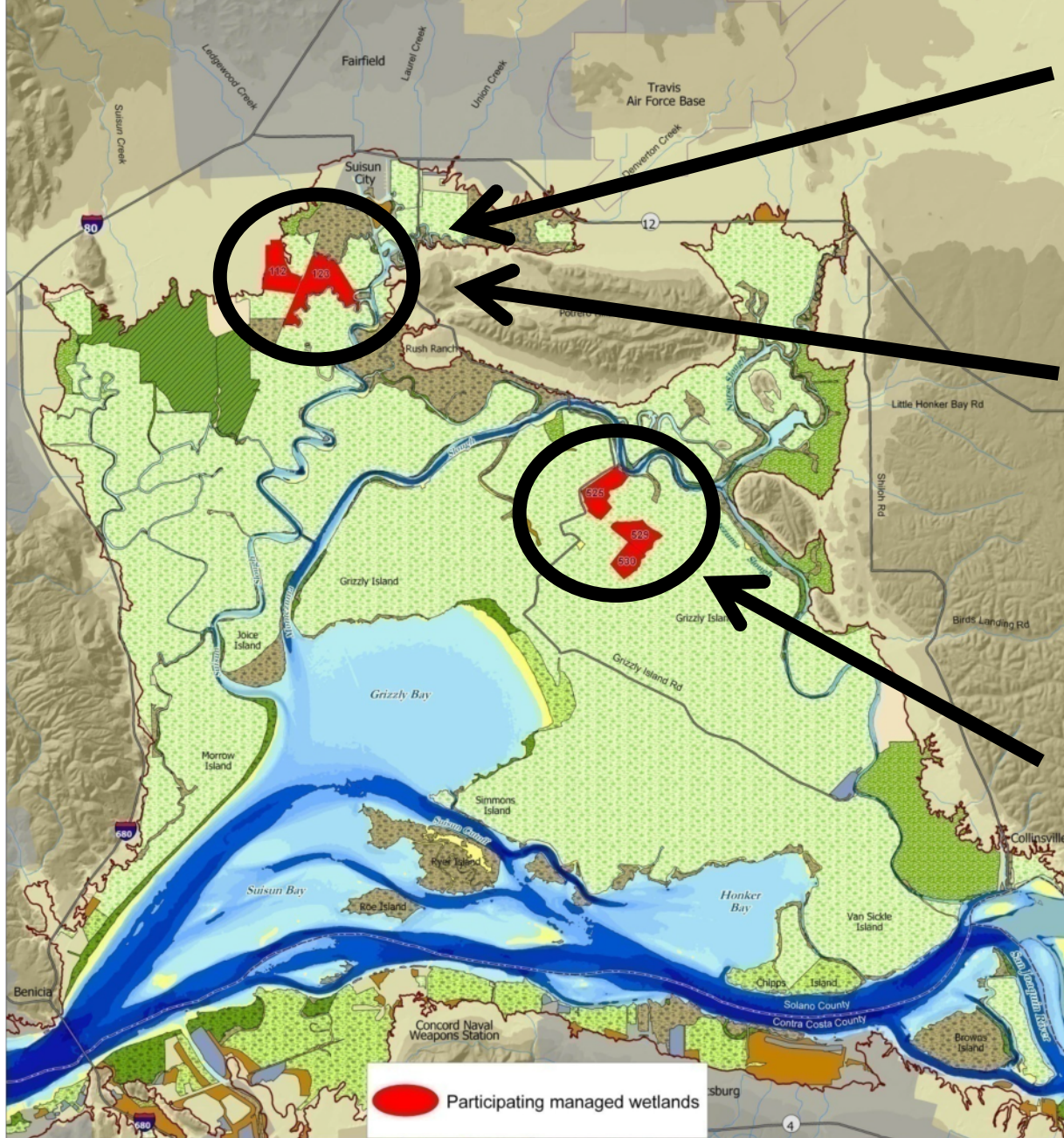
varies by year  
and club



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**Figure 1: Participating Managed Wetland Locations**  
Suisun Bay Region, California

Bathymetric data sources: USGS 10m grid (2005) for all sloughs/bays >10m wide; EcoAtlas for all sloughs <10m wide.



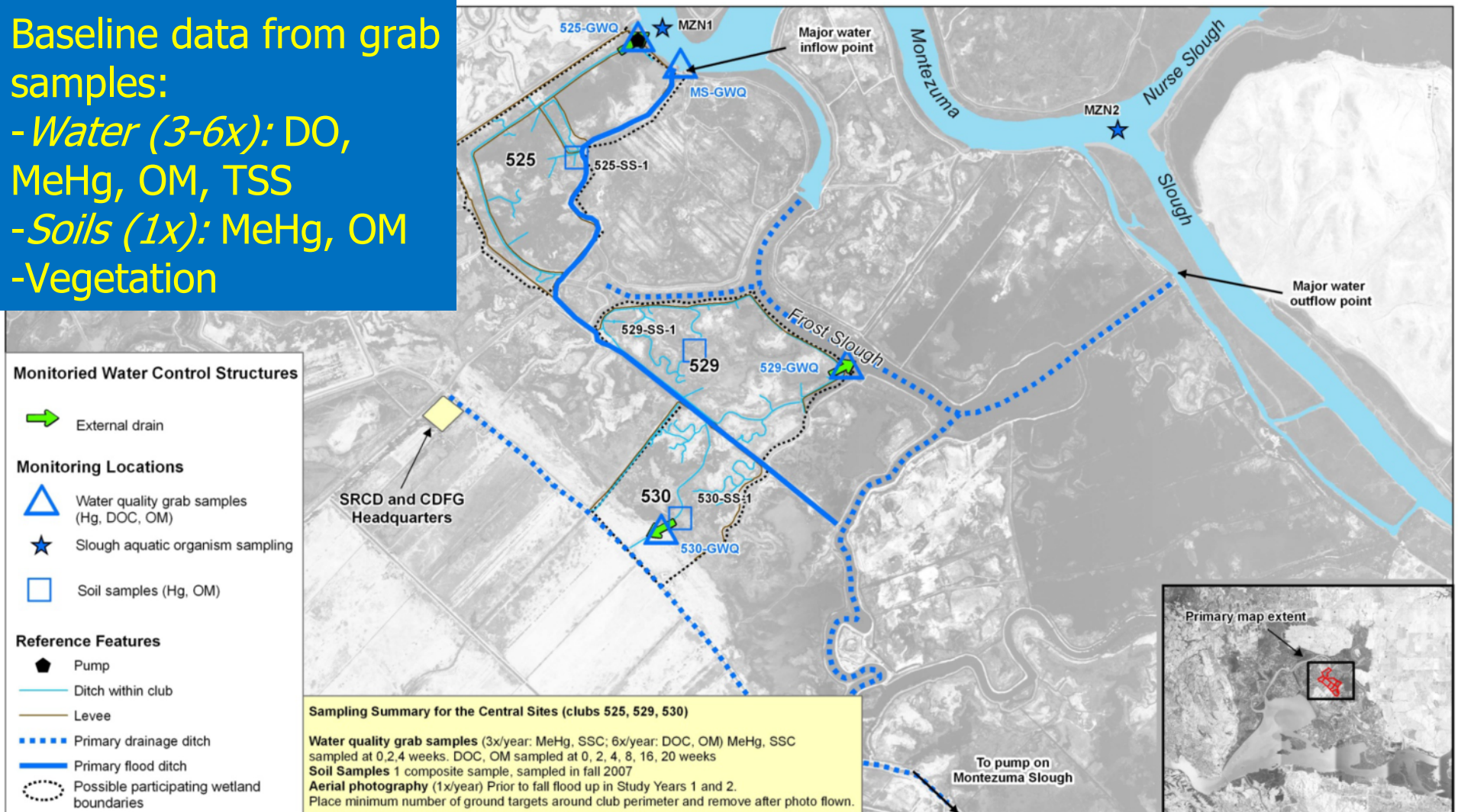
- Intensive:
  - Club 112, 199 ac
  - Club 123, 335 ac
- Sloughs:
  - Peytonia
  - Boynton
- Low-Intensity:
  - Club 525, 187 ac
  - Club 529, 151 ac
  - Club 530, 111 ac

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# Low-Intensity Sites

Baseline data from grab samples:

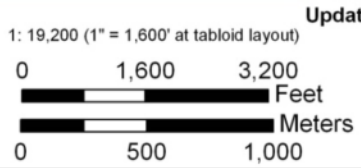
- *Water (3-6x):* DO, MeHg, OM, TSS
- *Soils (1x):* MeHg, OM
- *Vegetation*



**Sampling Summary for the Central Sites (clubs 525, 529, 530)**

**Water quality grab samples** (3x/year: MeHg, SSC; 6x/year: DOC, OM) MeHg, SSC sampled at 0, 2, 4, 8, 16, 20 weeks  
**Soil Samples** 1 composite sample, sampled in fall 2007  
**Aerial photography** (1x/year) Prior to fall flood up in Study Years 1 and 2.  
 Place minimum number of ground targets around club perimeter and remove after photo flood.

Data sources: SRCD (control structures, ditches, levees);  
 WWR (monitoring locations, 2006);  
 NAIP (photo, 2005)  
 Produced by WWR, Oct 2007  
 GIS/Cartography by Dan Gillenwater  
 Map file: MonLoc-Central-Clubs\_1119\_2007\_1008dg.mxd



**MONITORING AND SAMPLING LOCATIONS**  
**CENTRAL WETLAND CLUSTER**  
**PROPERTIES 525, 529, 530**  
 Suisun Low DO and MeHg Project  
 SWRCB Project #06-283-552-0

October 2007    Project No. 1119    Figure 3

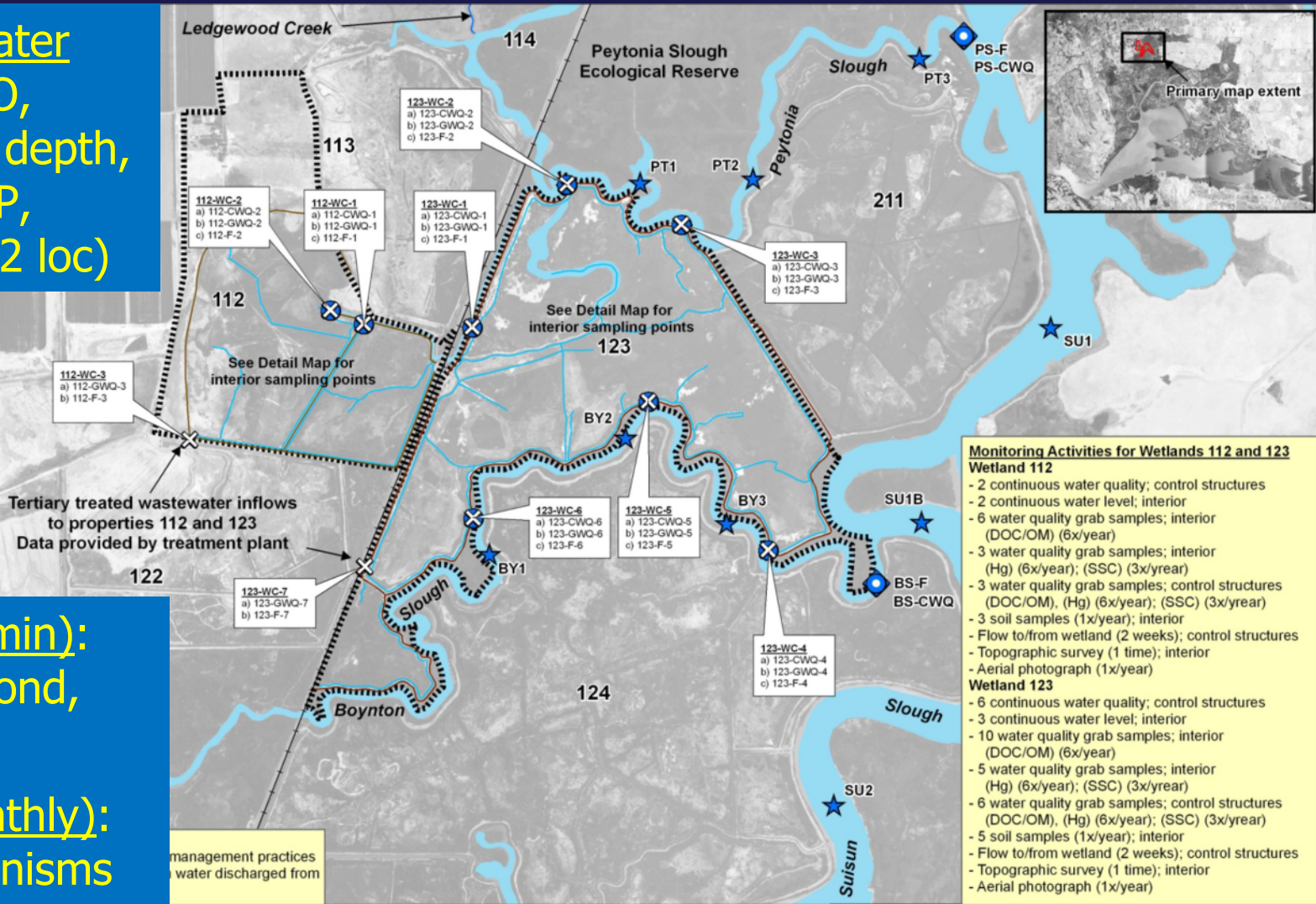
# High-Intensity Sites perimeter & sloughs

- Exchange water (15-min): DO, temp, cond, depth, turb, pH/ORP, chlorophyll (2 loc)

## Monitoring Locations - Exterior

- Continuous water quality (temp, cond, pH/ORP, DO, turb, depth) at all locations; Chl at three locations; water quality grab samples (Hg, SSC, DOC/OM)
- Continuous slough WQ (temp, cond, DO, depth)
- ⊗ Flow to/from wetlands
- ◆ Flow in sloughs
- ★ Slough aquatic organism sampling

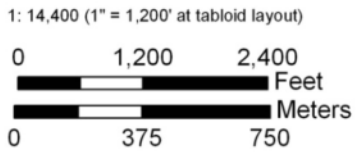
- Slough (15-min): DO, temp, cond, depth, flow
- Slough (monthly): aquatic organisms



### Monitoring Activities for Wetlands 112 and 123

Wetland 112	Wetland 123
- 2 continuous water quality; control structures	- 6 continuous water quality; control structures
- 2 continuous water level; interior	- 3 continuous water level; interior
- 6 water quality grab samples; interior (DOC/OM) (6x/year)	- 10 water quality grab samples; interior (DOC/OM) (6x/year)
- 3 water quality grab samples; interior (Hg) (6x/year); (SSC) (3x/year)	- 5 water quality grab samples; interior (Hg) (6x/year); (SSC) (3x/year)
- 3 water quality grab samples; control structures (DOC/OM), (Hg) (6x/year); (SSC) (3x/year)	- 6 water quality grab samples; control structures (DOC/OM), (Hg) (6x/year); (SSC) (3x/year)
- 3 soil samples (1x/year); interior	- 5 soil samples (1x/year); interior
- Flow to/from wetland (2 weeks); control structures	- Flow to/from wetland (2 weeks); control structures
- Topographic survey (1 time); interior	- Topographic survey (1 time); interior
- Aerial photograph (1x/year)	- Aerial photograph (1x/year)

Data sources: SRCD (control structures, levees, channels); WWR (monitoring locations, 2006); NAIP (photo, 2005)  
 Produced by WWR, Aug 2007  
 GIS/Cartography by Dan Gillenwater  
 Map file: MonLoc-NV-Clubs\_1119\_2007-0928trc.mxd



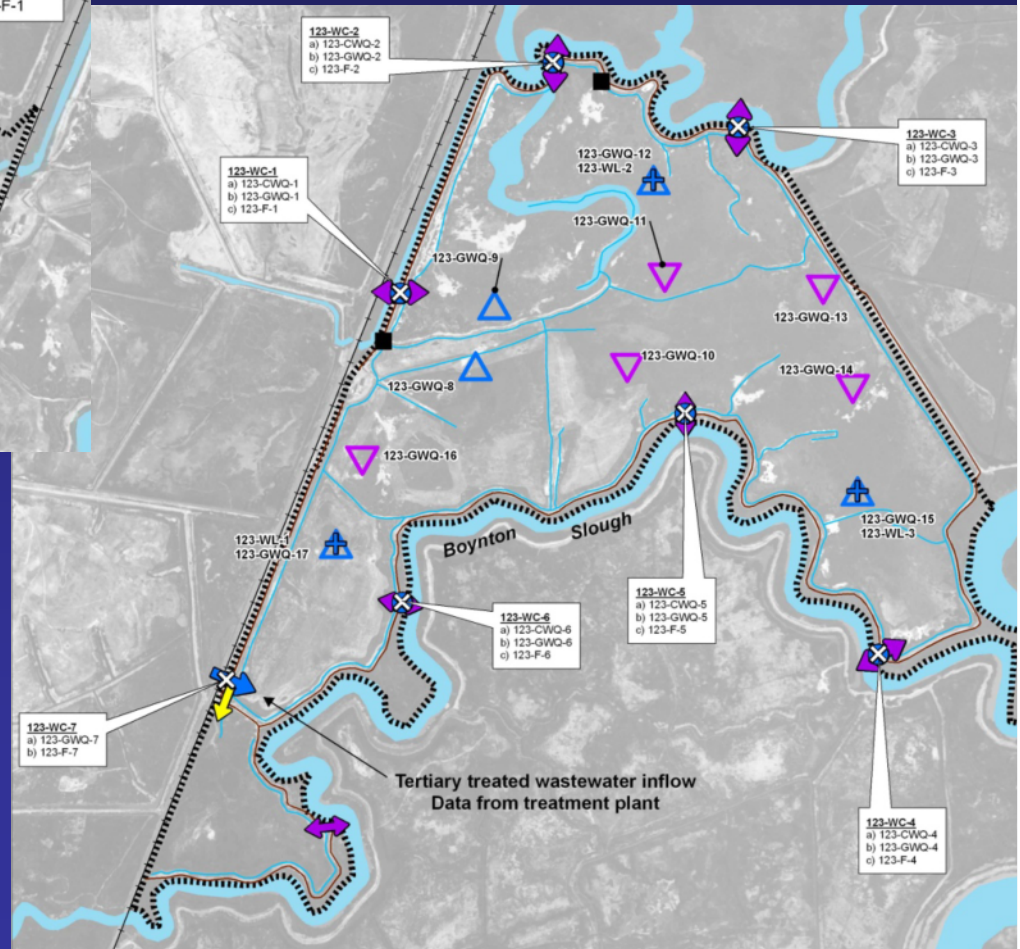
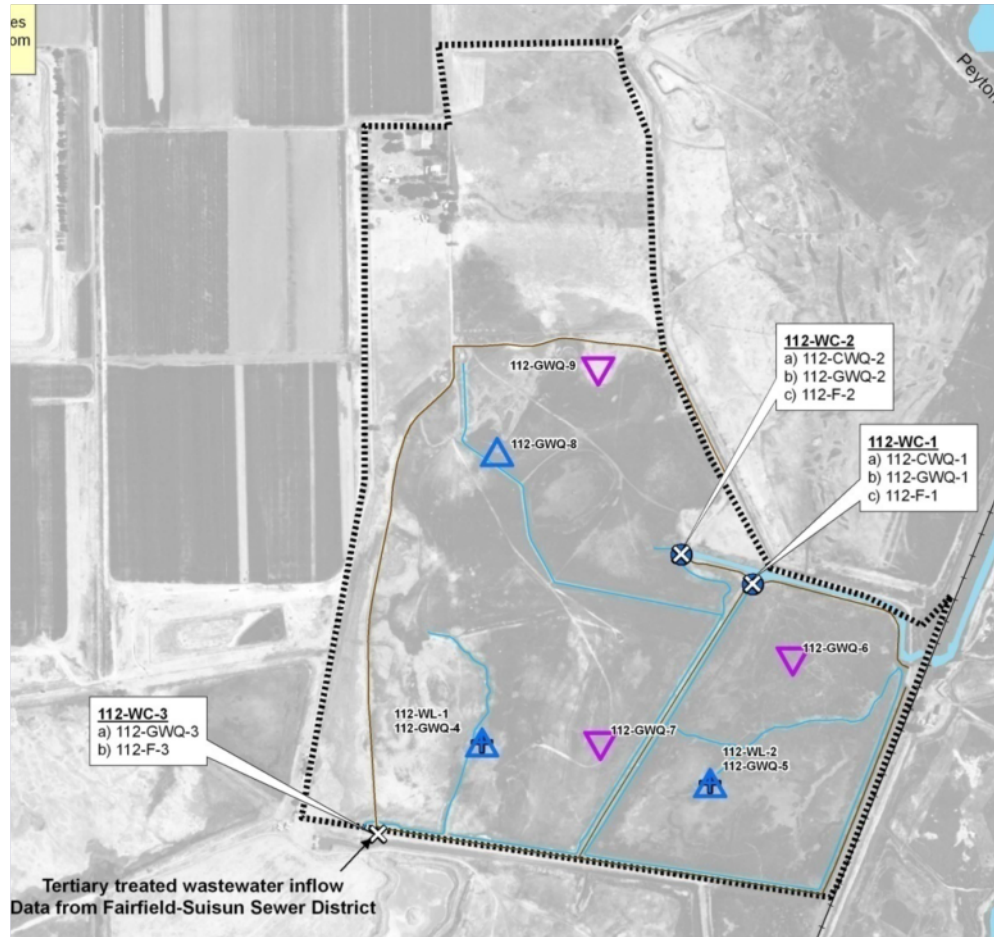
Updated: 9/28/07



**MONITORING AND SAMPLING LOCATIONS**  
**NORTHERN WETLAND CLUSTER**  
**PROPERTIES 112, 123**  
 Suisun Low DO and MeHg Project  
 SWRCB Project #06-283-552-0

September 2007	Project No. 1119	Figure 2
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# High-Intensity Sites interior



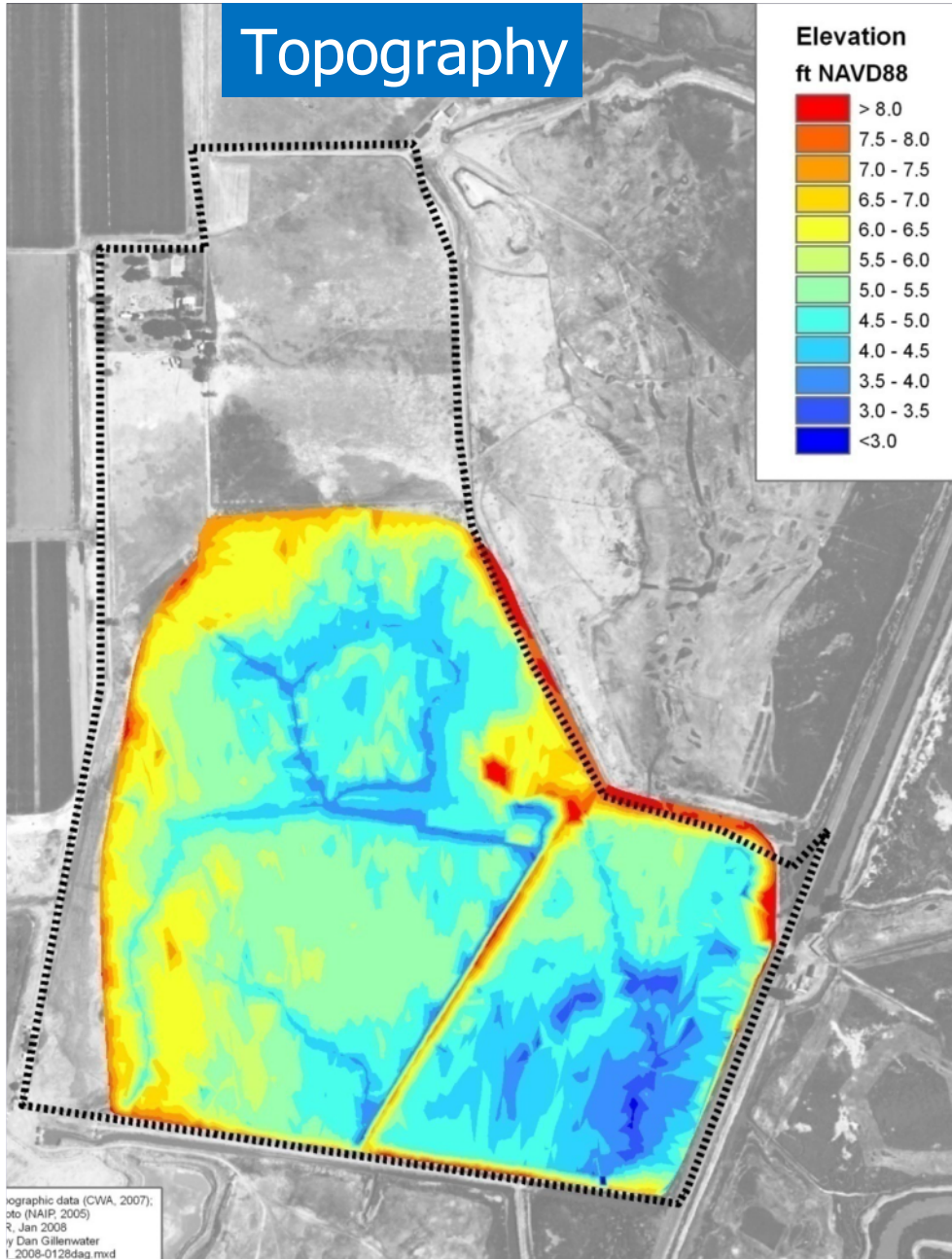
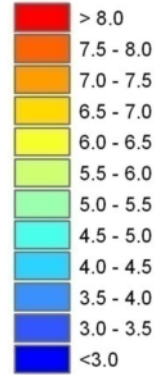
- Water grab samples (6x/fall season)
- Water depth, temp (15-min)
- Soil grab samples (1x)
- Year 2 added continuous water quality (15-min)
- Vegetation
- Topography

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# Topography

Elevation  
ft NAVD88



Topographic data (CWA, 2007);  
Photo (NAIP, 2005)  
Map file: 112-topo-2008-0128dag.mxd

1:7,200 (1" = 600' at letter layout)



## WETLAND 112 TOPOGRAPHY 2007

Suisun Low DO and MeHg Project  
SWRCB Project #06-283-552-0

Jan 2008 Project No. 1119

Note: Vegetation data from Wetland 112 and 123.

# Vegetation

## Vegetation Assemblages

### Upland assemblages

- annual grasses
- annual grasses w/mix of saltgrass and wetland vegetation
- ruderal, levee

### Salt marsh assemblages

- pickleweed
- pickleweed w/mix of annual grasses and saltgrass
- saltgrass, annual grasses

### Brackish marsh assemblages

- tule, cattail, smartweed
- alkali bulrush, fat hen
- baltic rush
- bird's foot trefoil, saltgrass
- fat hen w/mix of annual grasses and saltgrass
- smartweed w/mix of fat hen and pickleweed
- wetland grasses, bird's foot trefoil, fat hen

### Transitional

- annual grasses, pickleweed, smartweed
- annual grasses, saltgrass, pickleweed

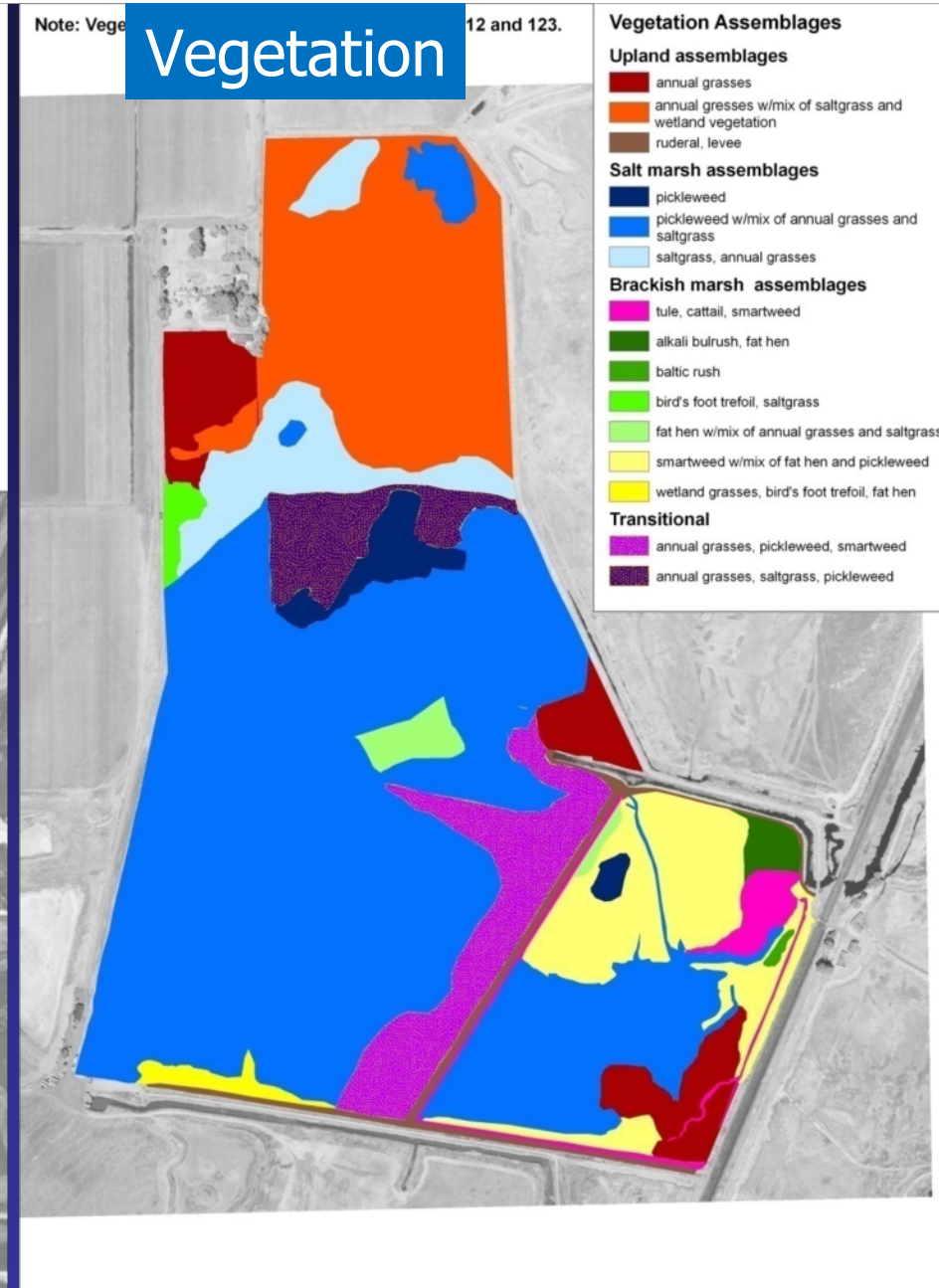


Photo: August, 2007 CIR  
Map file: 112-veg-compare\_1119\_2007-0909dg.mxd

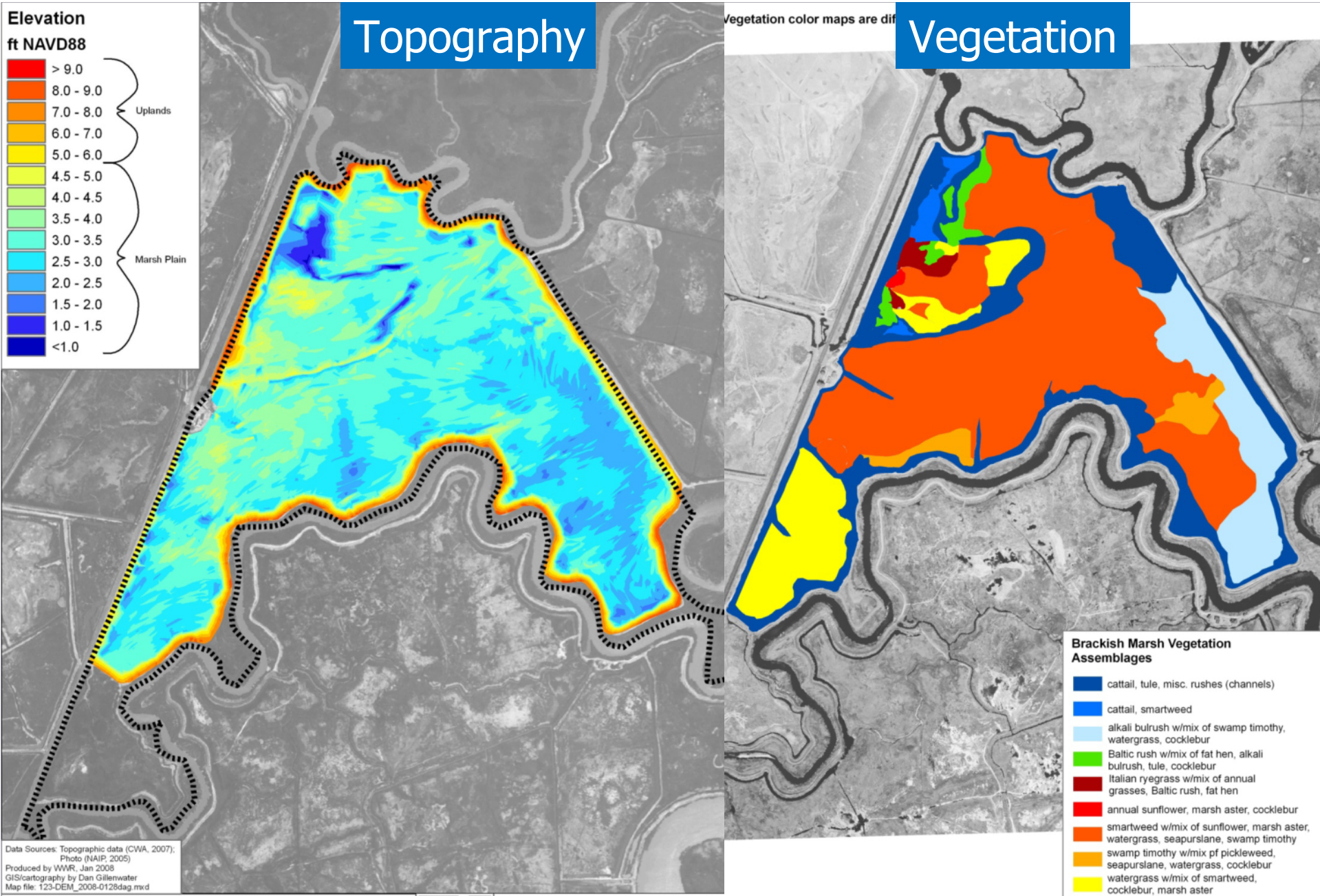
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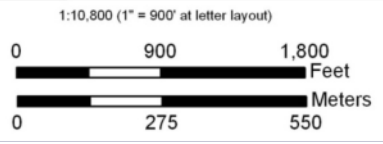
## 2007 VEGETATION COVER WETLAND 112

Suisun Low DO and MeHg Project  
SWRCB Project #06-283-552-0

December 2008 Project No. 1119

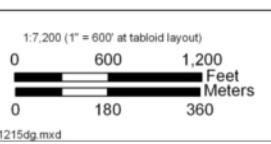
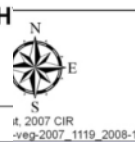


Data Sources: Topographic data (CWA, 2007);  
Photo (NAIP, 2005)  
Produced by WWR, Jan 2008  
GIS/cartography by Dan Gillenwater  
Map file: 123-DEM\_2008-0128dag.mxd



**WETLAND 123 TOPOGRAPHY  
2007**  
Suisun Low DO and MeHg Project  
SWRCB Project #06-283-552-0

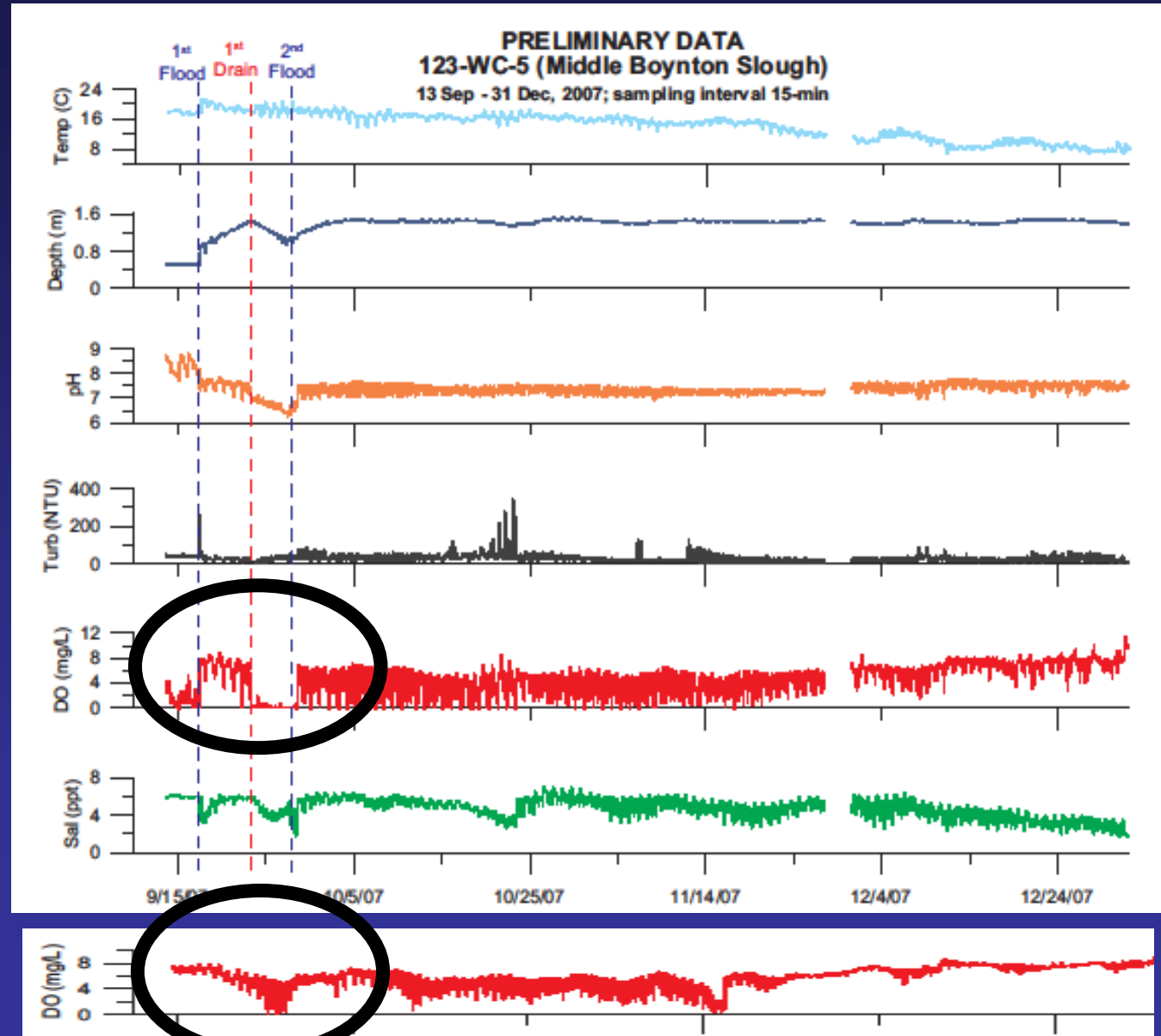
Jan 2008	Project No. 1119
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**2007 VEGETATION COVER  
WETLAND 123**  
Suisun Low DO and MeHg Project  
SWRCB Project #06-283-552-0

December 2008	Project No. 1119
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# Club 123 on Peytonia Slough, Slough, Fall 2007



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# Soil MeHg Data

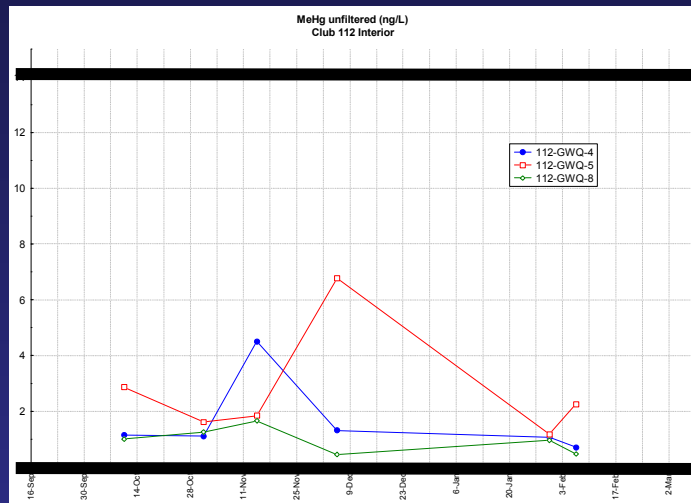
Club	Depth (cm)	# samples	MeHg (ng/g) dry
112	0-10	3	0.37- <b>1.24</b>
123	0-10	5	0.35- <b>3.99</b>
525	0-5	1	<b>12.54</b>
529	0-5	1	<b>4.44</b>
529	5-10	1	0.28
530	0-5	1	0.52
530	5-10	1	0.09

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# Water MeHg (ng/L), Club 112

Plots show period Sep 2007 to Mar 2008

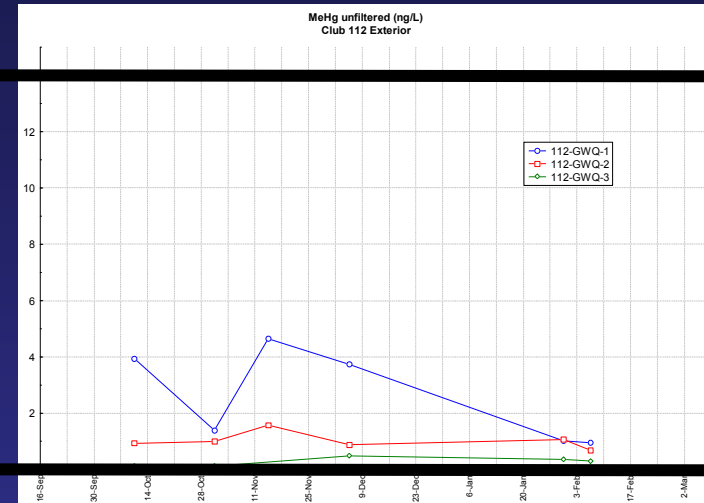
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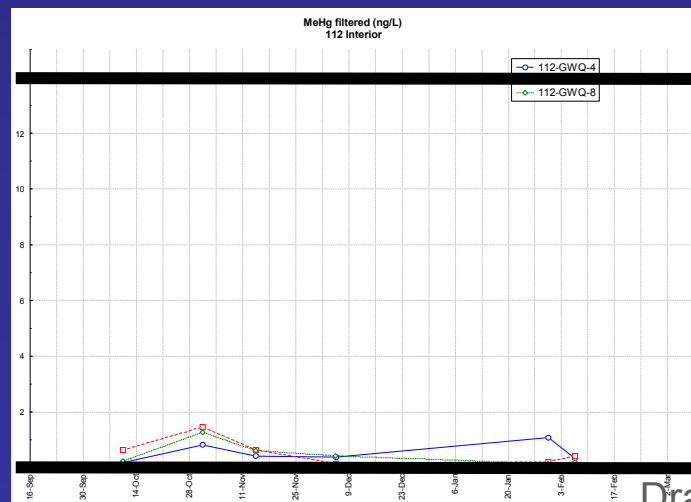
14

0

## Unfiltered, Discharge



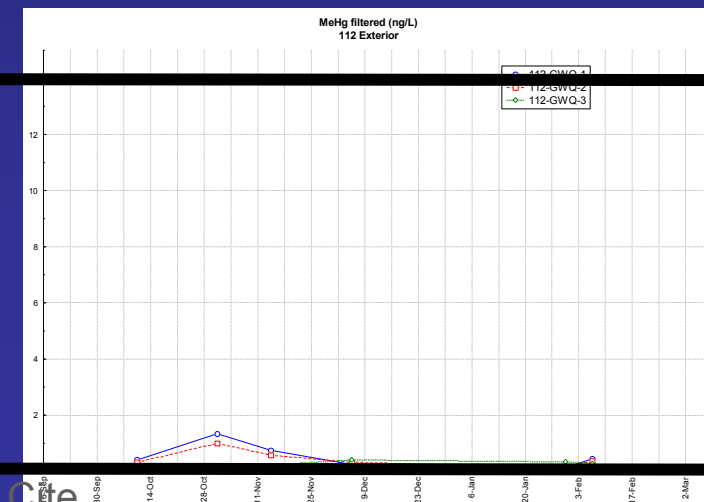
## Filtered, Interior



14

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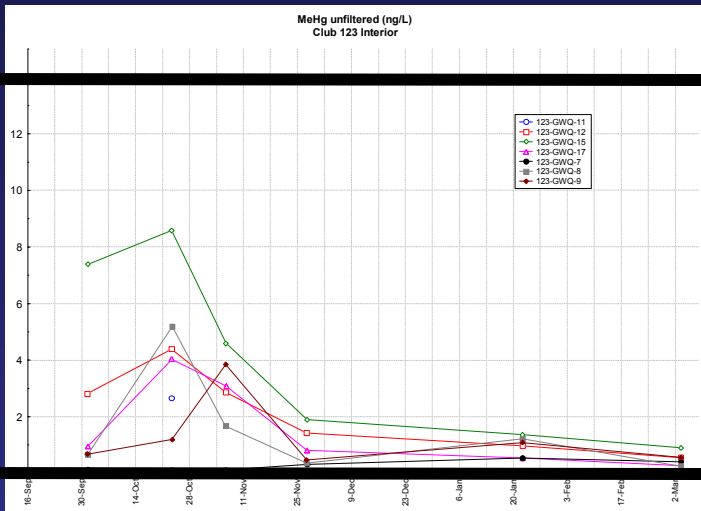
## Filtered, Discharge



# Water MeHg (ng/L), Club 123

Plots show period Sep 2007 to Mar 2008

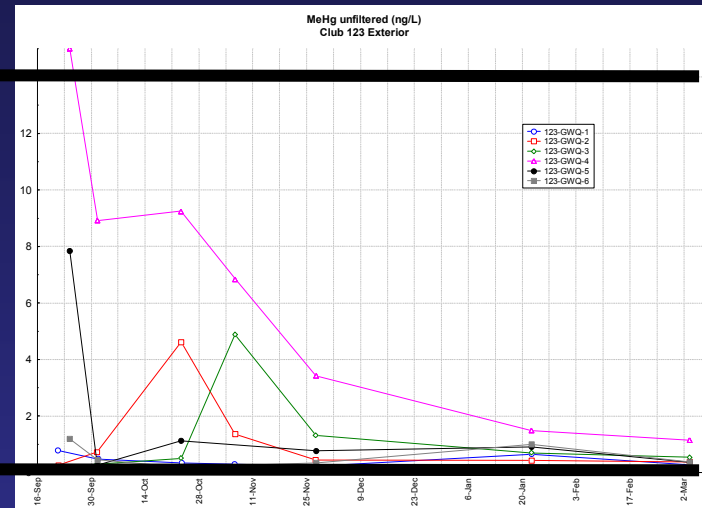
Unfiltered, Interior



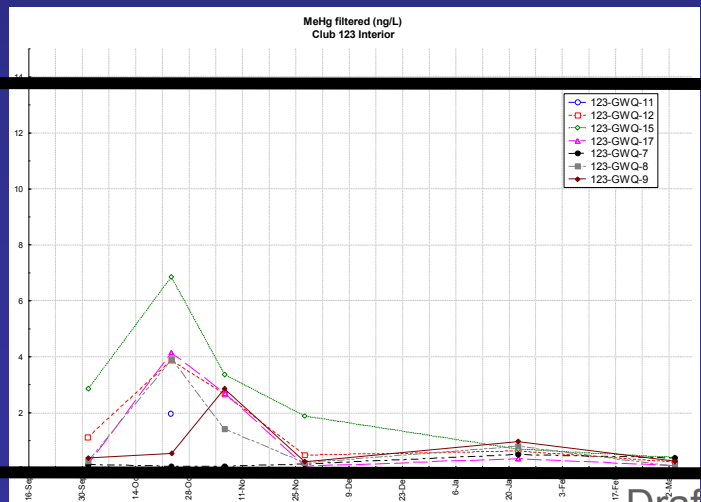
14

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Unfiltered, Discharge



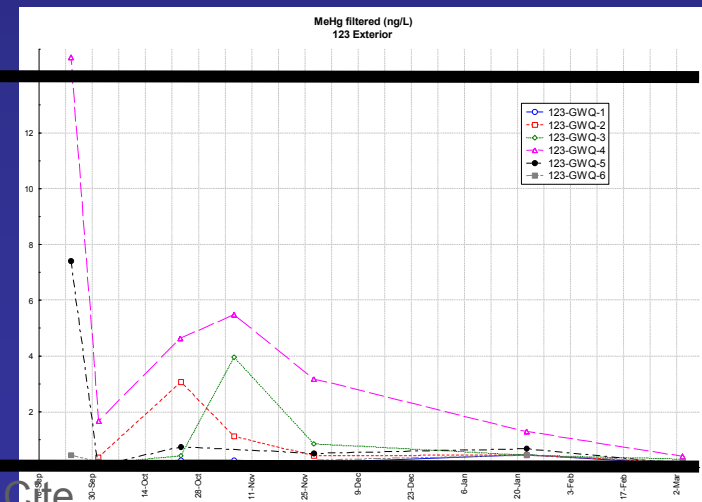
Filtered, Interior



14

0

Filtered, Discharge



# Recommended Management Changes

1. *Flail mow (vs. stalk chopper)* – increase surface area and potential decomposition rate
2. *Limit fall flood-up to brief marsh plain wetting (vs. deeper flooding) then rapid drawdown (vs. slow drawdown); reflood > 7 days (vs. < 7d)* – optimize aerobic decomposition to reduce readily decomposable organic matter on reflood
3. *Grade to improve water circulation and enhance surface water mixing* – flush mowed vegetation, reduce residence time, oxygenate water column

# Conclusions

?

Thanks to the bond freeze!

All field data collected but analysis incomplete

