MultiState Projects

Subaqueous Soils and Water Quality in Shallow Embayments

Building Use and Management Interpretations for Subaqueous Soil Inventories

NRCS

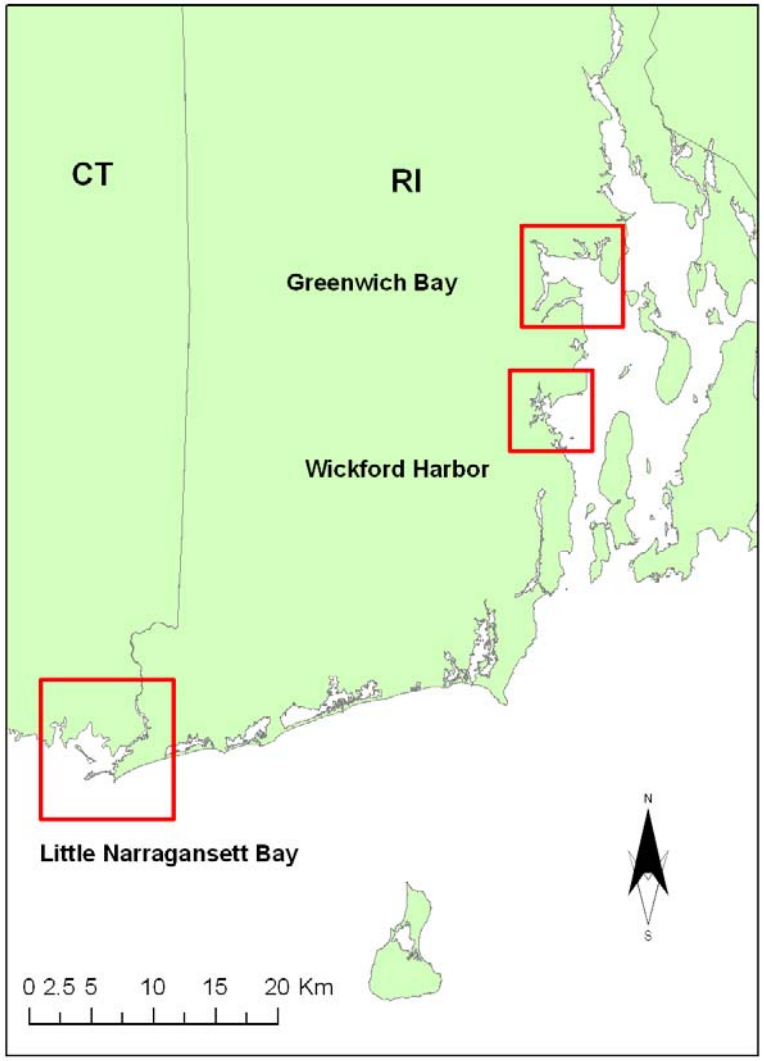
riaes
RI Agricultural Experiment Station

Landscape-Level Assessment of Subaqueous Soils and Water Quality in Shallow Embayments

Maggie K. Payne

Embayment Locations

- Greenwich Bay (1200 ha)
- Wickford Harbor (160 ha)
- Little Narragansett Bay (1000 ha)



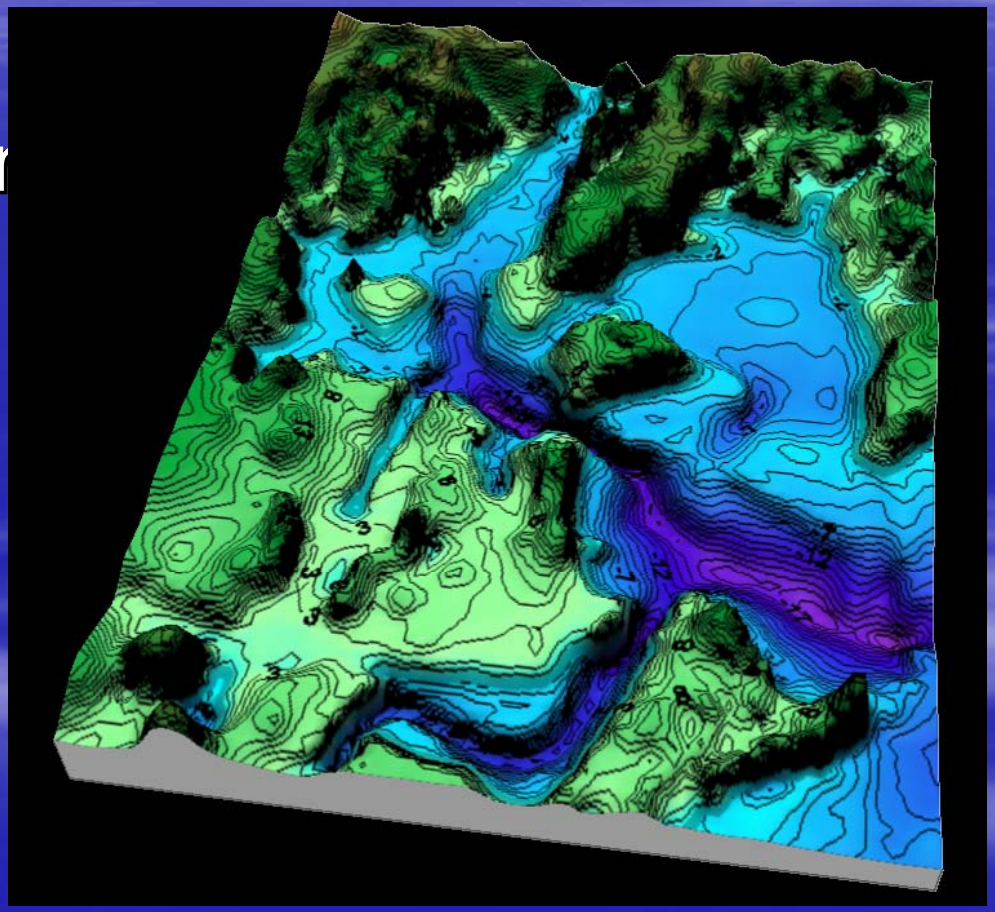
Focus of Study

- Soil-Landscape Relationships
- Soil-Water Quality Relationships
- Sulfide Distribution

Identify Landscape Units

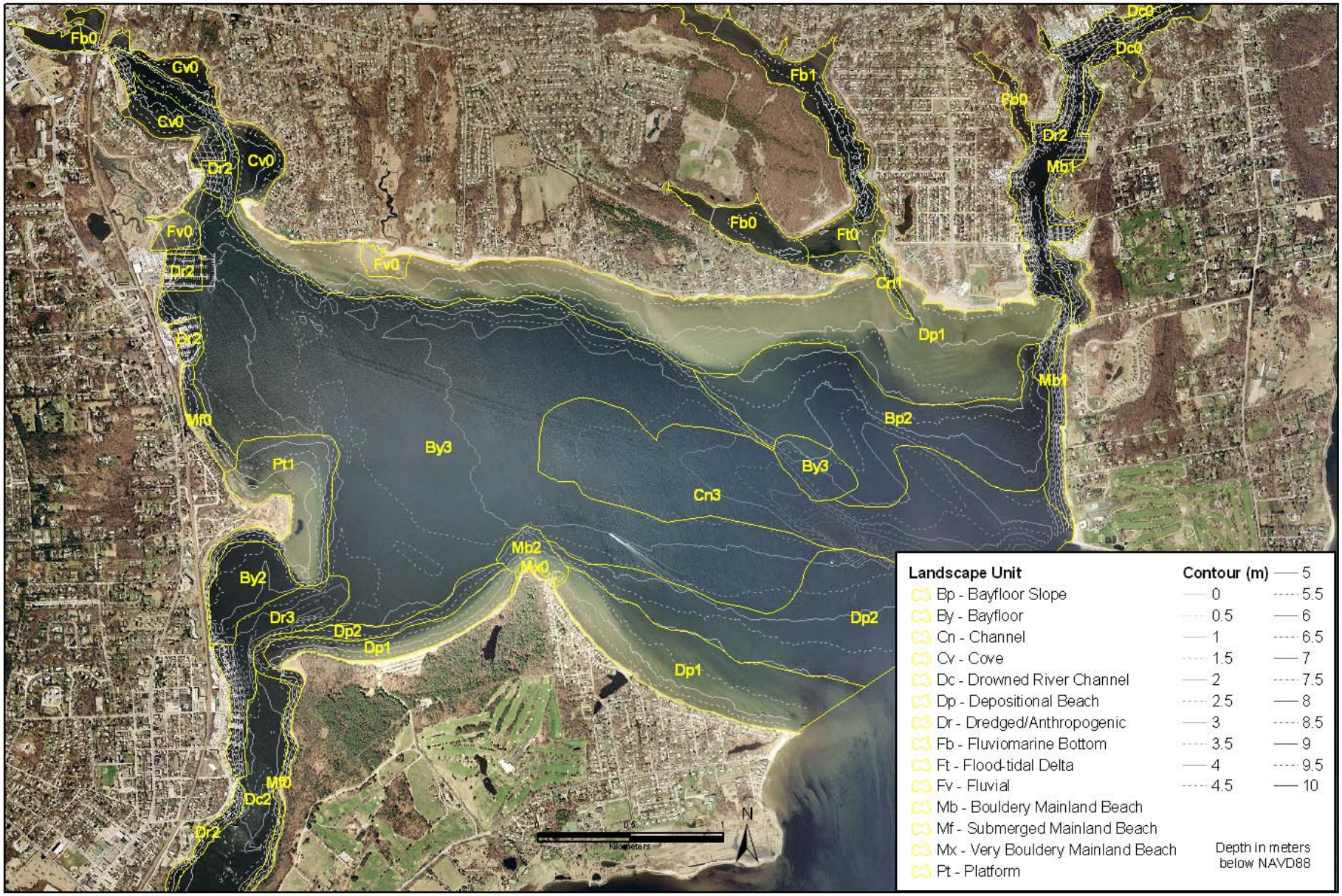
Processes:

- Bathymetric mappi
  - Fathometer
  - RTK GPS
- Sidescan sonar
  - Geosciences

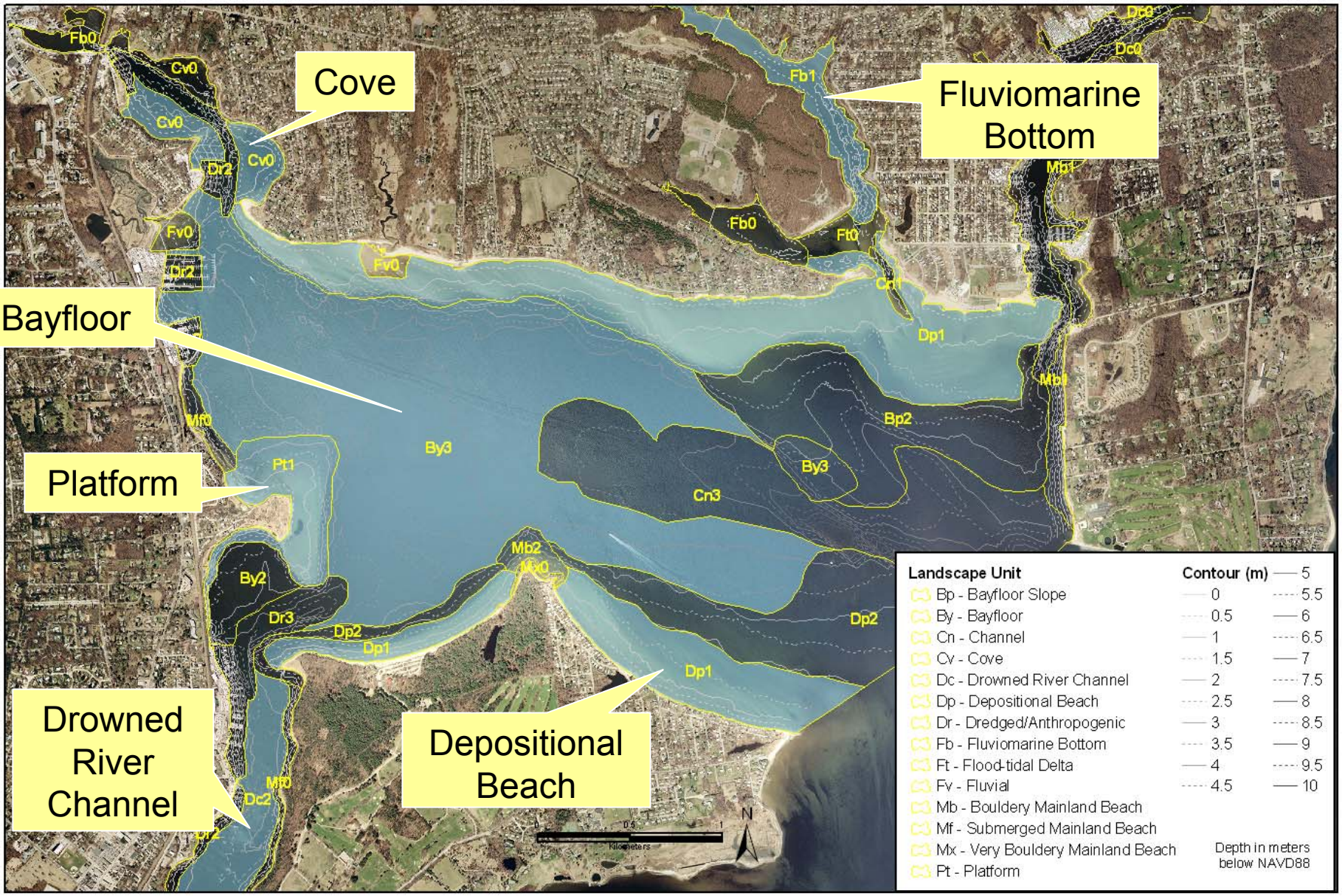


Soil Sampling and Analysis

- Field descriptions
  - Horizon, color, texture, n-value
- Particle size distribution
- Bulk density
- Nitrogen (N)
- Carbon (C)
- Calcium Carbonate ($CaCO_3$)
- Salinity
- H_2O_2 oxidized salinity
- Incubated pH
- Sulfide content



Greenwich Bay



Greenwich Bay

Common Landscape Units

Landscape Unit	Percent of Bay Area		
	Wickford	Greenwich	LNB
Bayfloor	29	32	2
Cove	12	4	8
Depositional Beach	8	25	-
Drowned River Channel	9	5	3
Fluviomarine Bottom	6	4	9
Platform	4	3	-
Shoal or Spit	2	-	1

Subaqueous Soil Classification

- Entisols
  - **Wassents**
    - Frassiwassents
    - **Psammowassents**
      - Sulfic
      - Fluventic
      - Typic
    - **Sulfiwassents**
      - Haplic
      - Fluventic
      - Typic
    - Hydrowassents
    - Fluviwassents
    - Haplowassents
  - Aquents
  - Arents
  - Psamments
  - Fluvents
  - Orthents

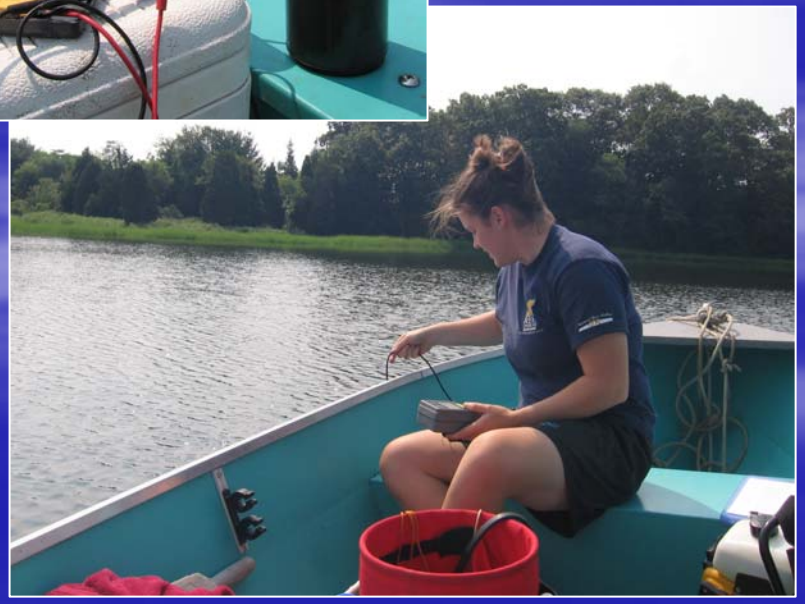
Landscape Unit	Subgroup Classification (# of occurrences)	Taxonomic Purity
Bayfloor	**Fluventic Sulfiwassents (3)**	**50%**
	Haplic Sulfiwassents (3)	
Cove	**Fluventic Sulfiwassents (6)**	**46%**
	Haplic Sulfiwassents (6)	
	Typic Hydrowassents (1)	
Depositional Beach	**Typic Psammowassents (5)**	**50%**
	Fluventic Psammowassents (3)	
	Haplic Sulfiwassents (1)	
	Sulfic Psammowassents (1)	
Drowned River Channel	**Fluventic Sulfiwassents (3)**	**75%**
	Thapto-histic Sulfiwassents (1)	
Fluviomarine Bottom	**Fluventic Sulfiwassents (5)**	**83%**
	Haplic Sulfiwassents (1)	
Platform	**Typic Psammowassents (2)**	**50%**
	Sulfic Psammowassents (1), Typic Haplowassents (1)	
Shoal	**Typic Psammowassents (2)**	**50%**
	Haplic Sulfiwassents (1), Typic Fluviwassents (1)	

Conclusions

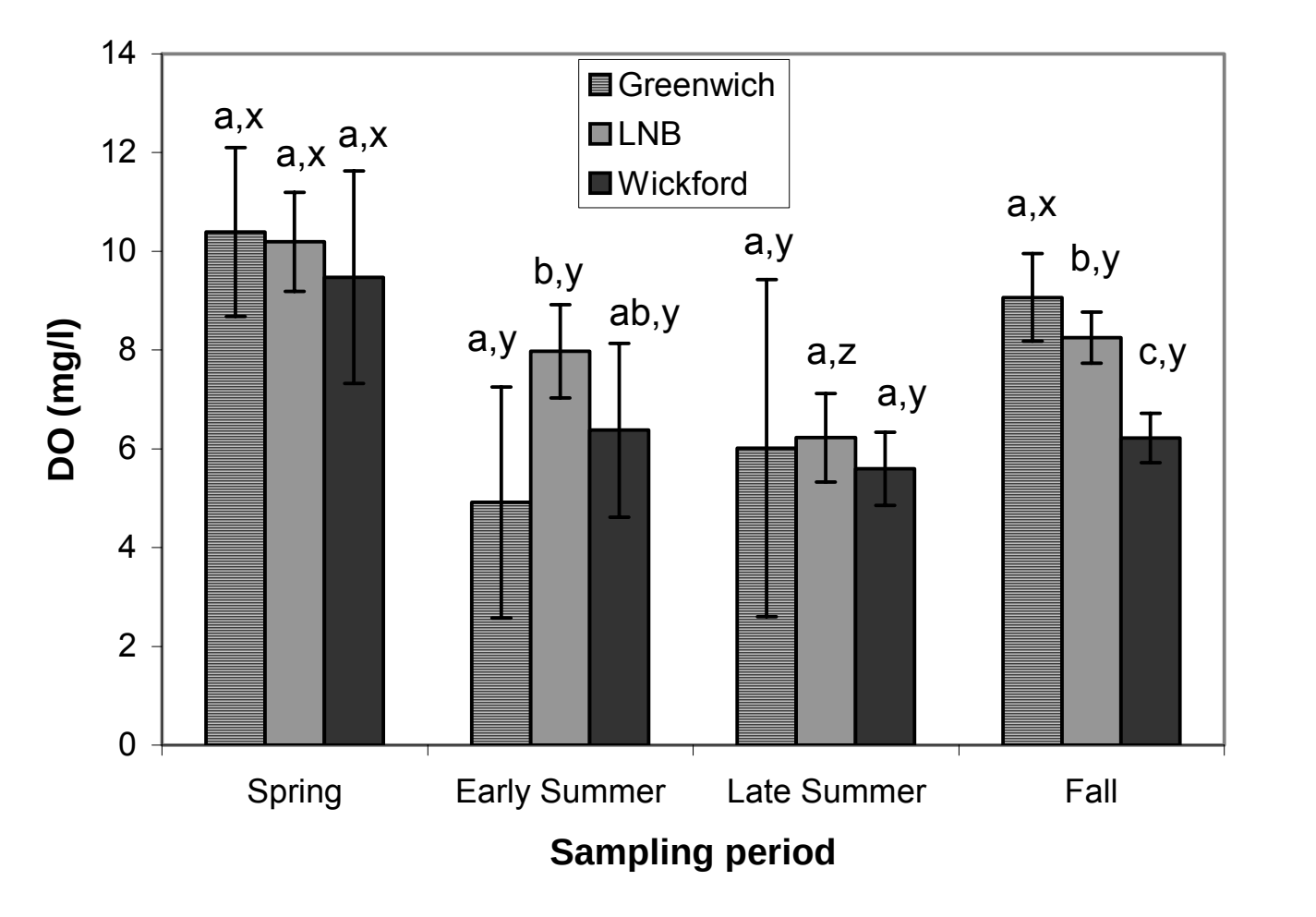
- Soil-landscape models can be used to effectively make the first cut for the various soils when mapping shallow embayments

Water Quality Assessment

- Four sampling periods
  - Spring (May-June)
  - Early Summer (July)
  - Late Summer (August)
  - Fall (September – November)
- Water Quality
  - Dissolved Oxygen (DO)
  - Chlorophyll *a* (Chl *a*)
  - Total Suspended Solids (TSS)
  - Salinity
- Redox Potential
  - Profile of top 15 cm



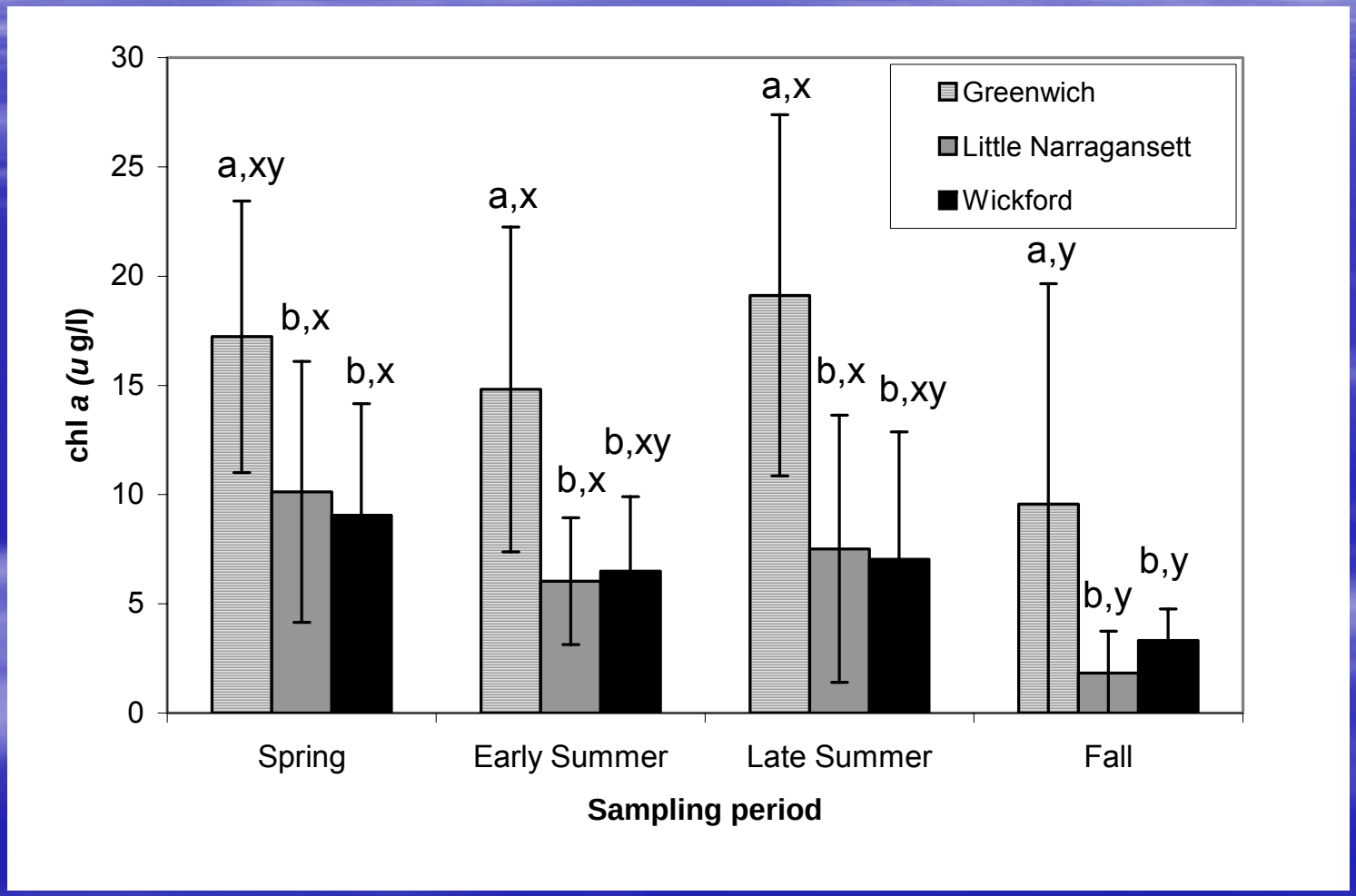
Dissolved Oxygen



a,b,c – among bays within season

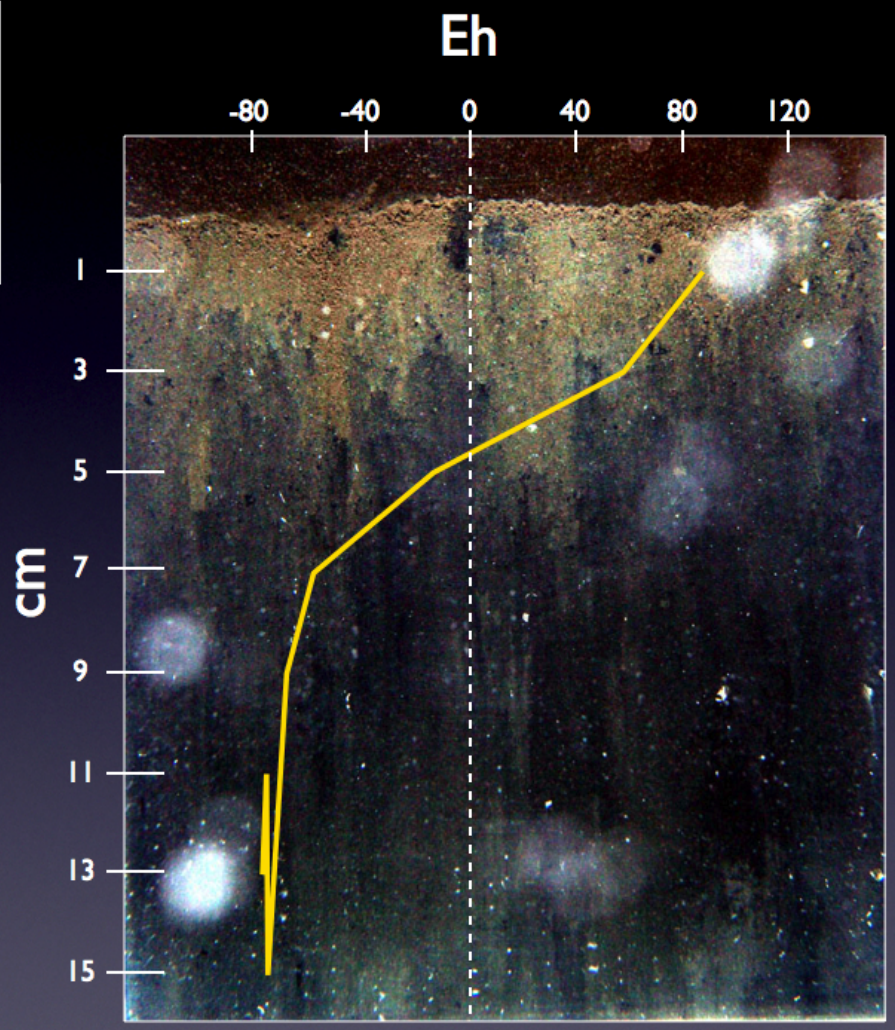
x,y,z – among seasons within bays

Chlorophyll *a*



Sediment Profile Imaging (SPI)

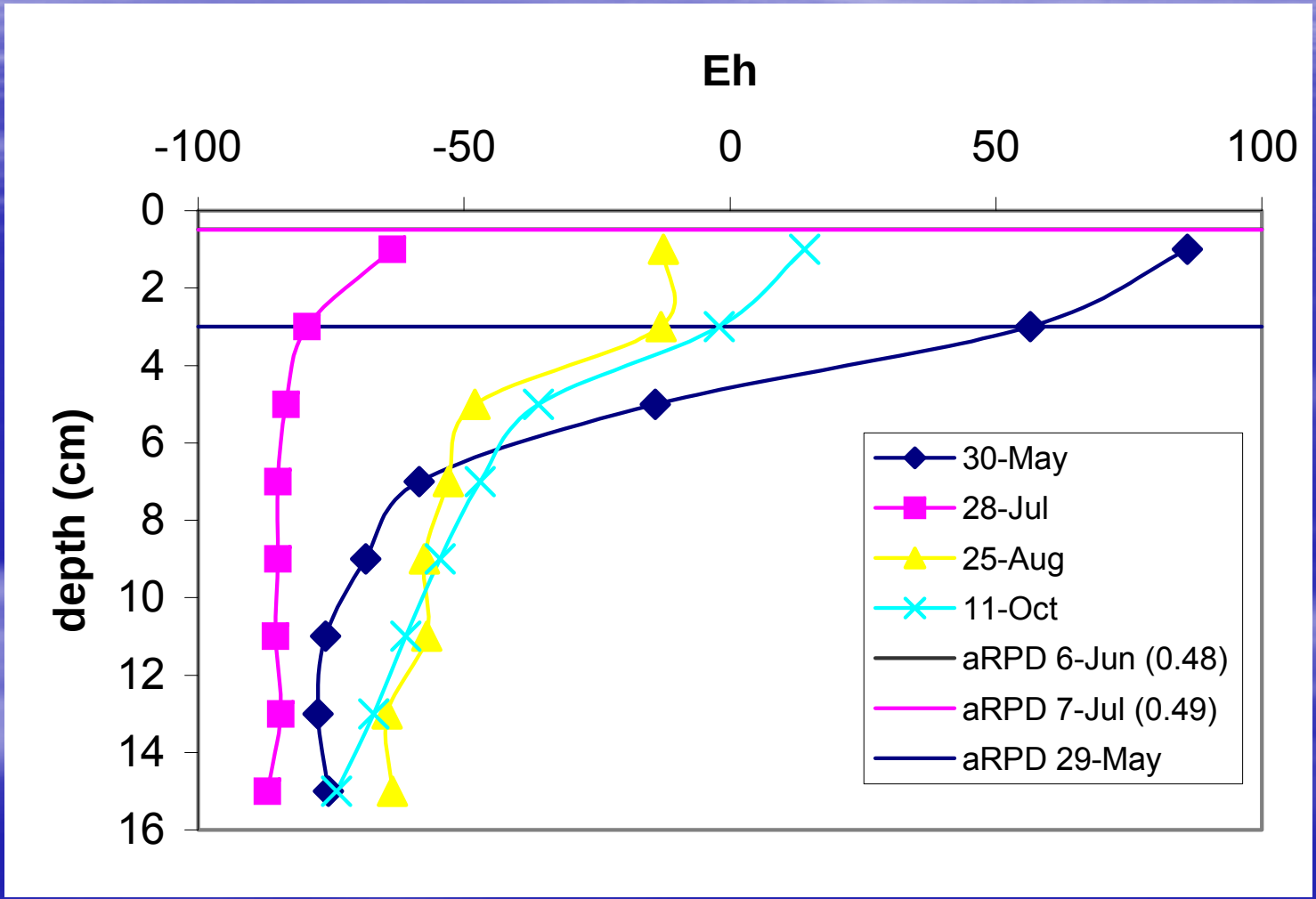
May 29/30



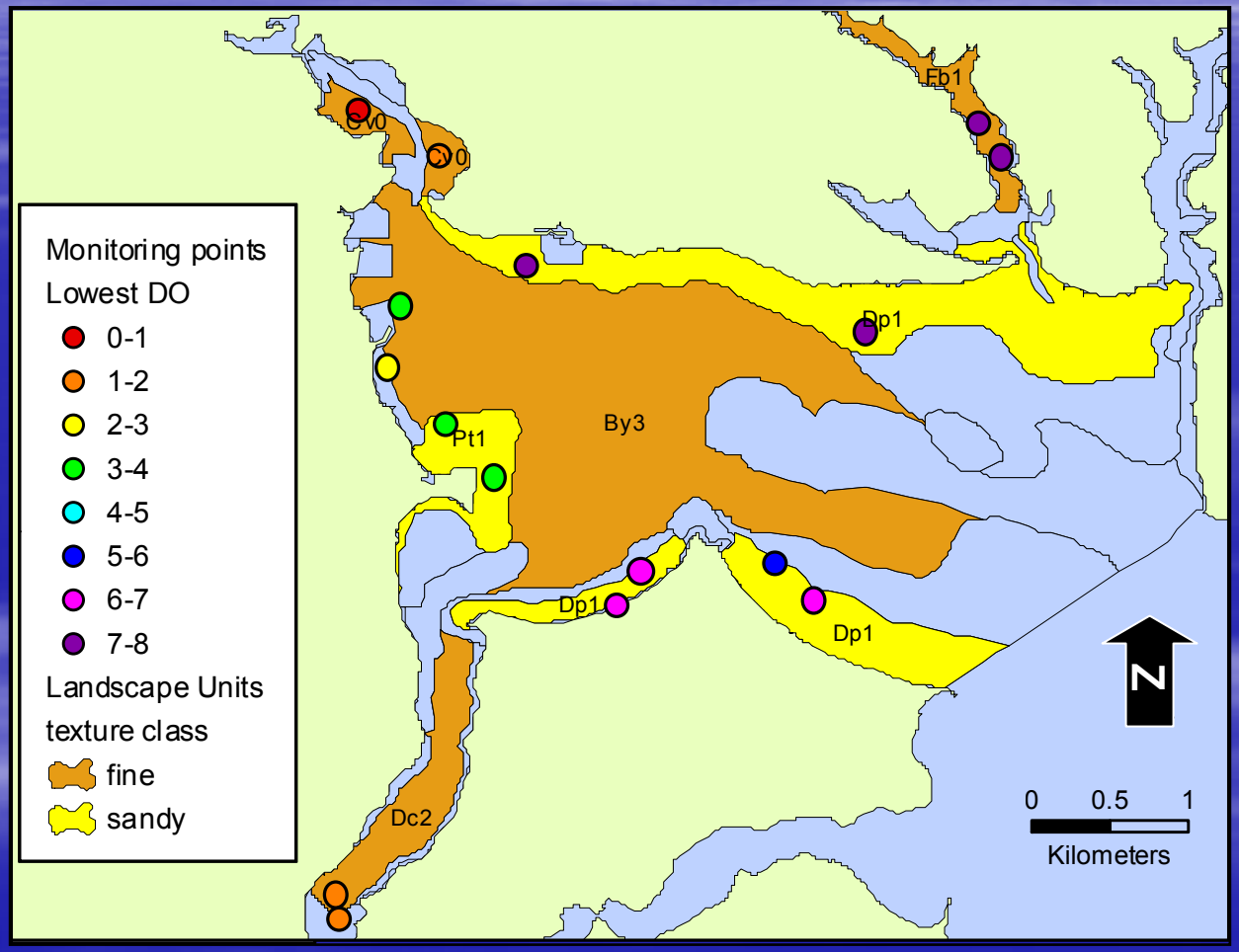
Oxidized surface (aRPD)

Reduced (sulfides)

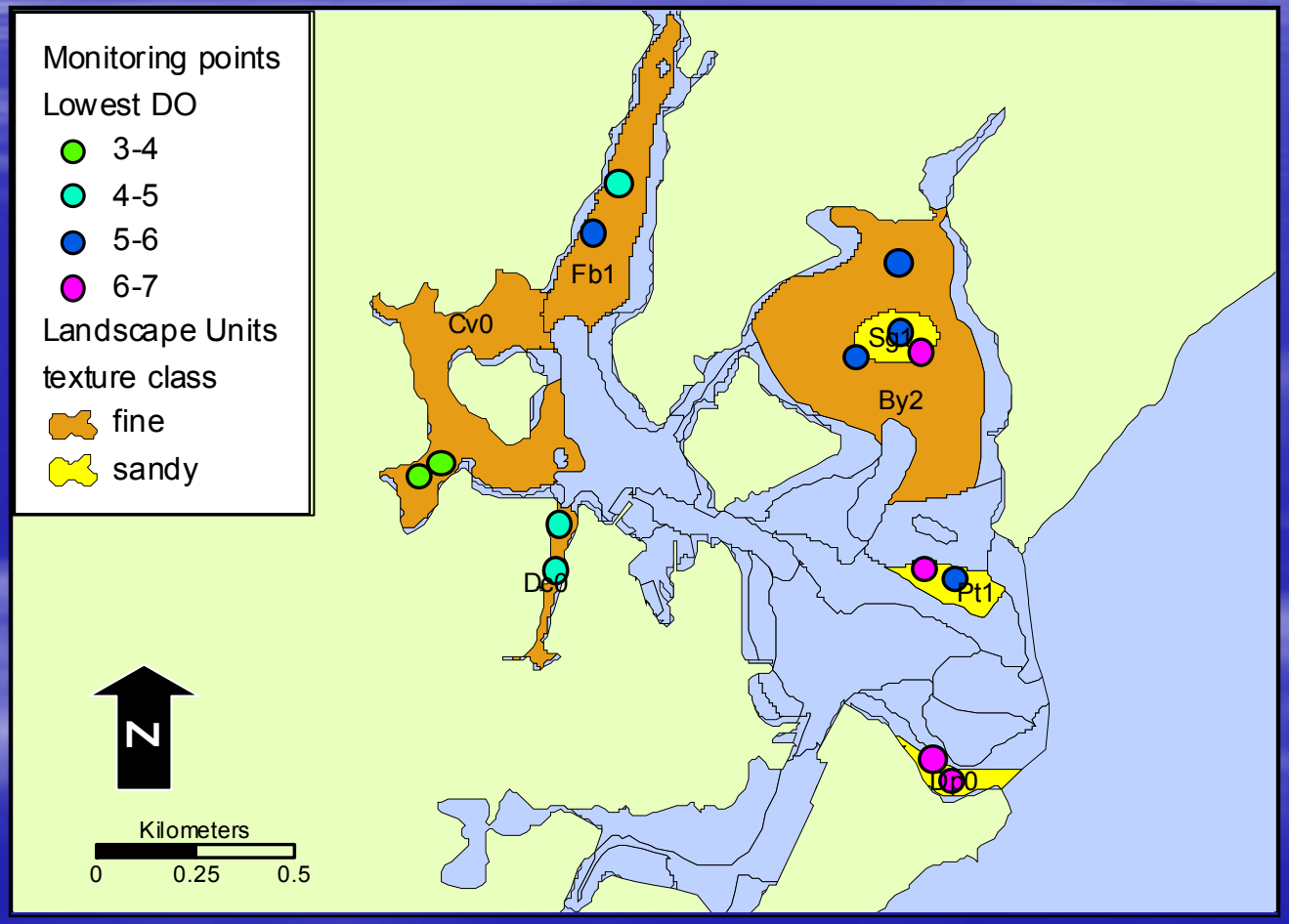
SPI and Redox



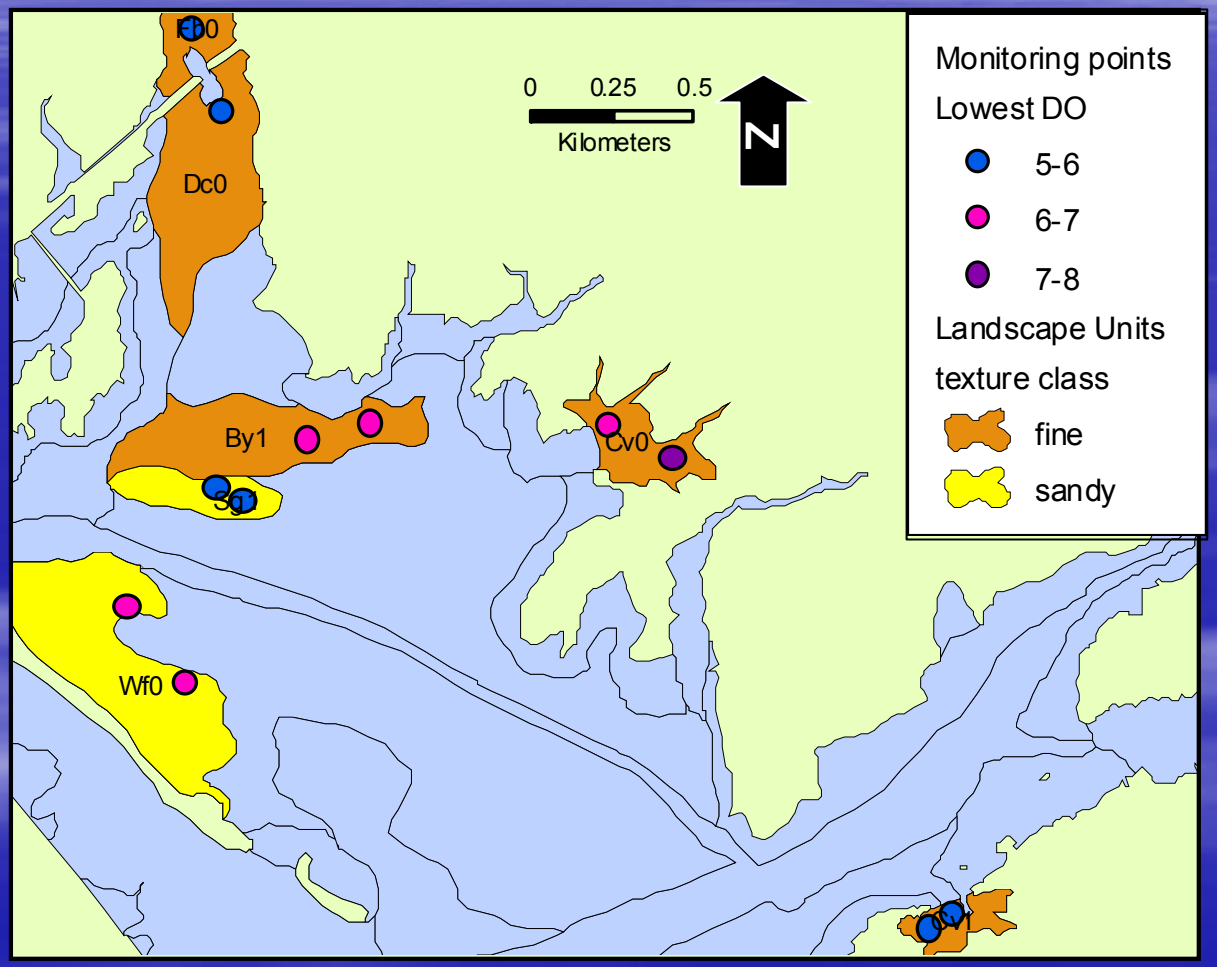
Greenwich DO and Bottom Type

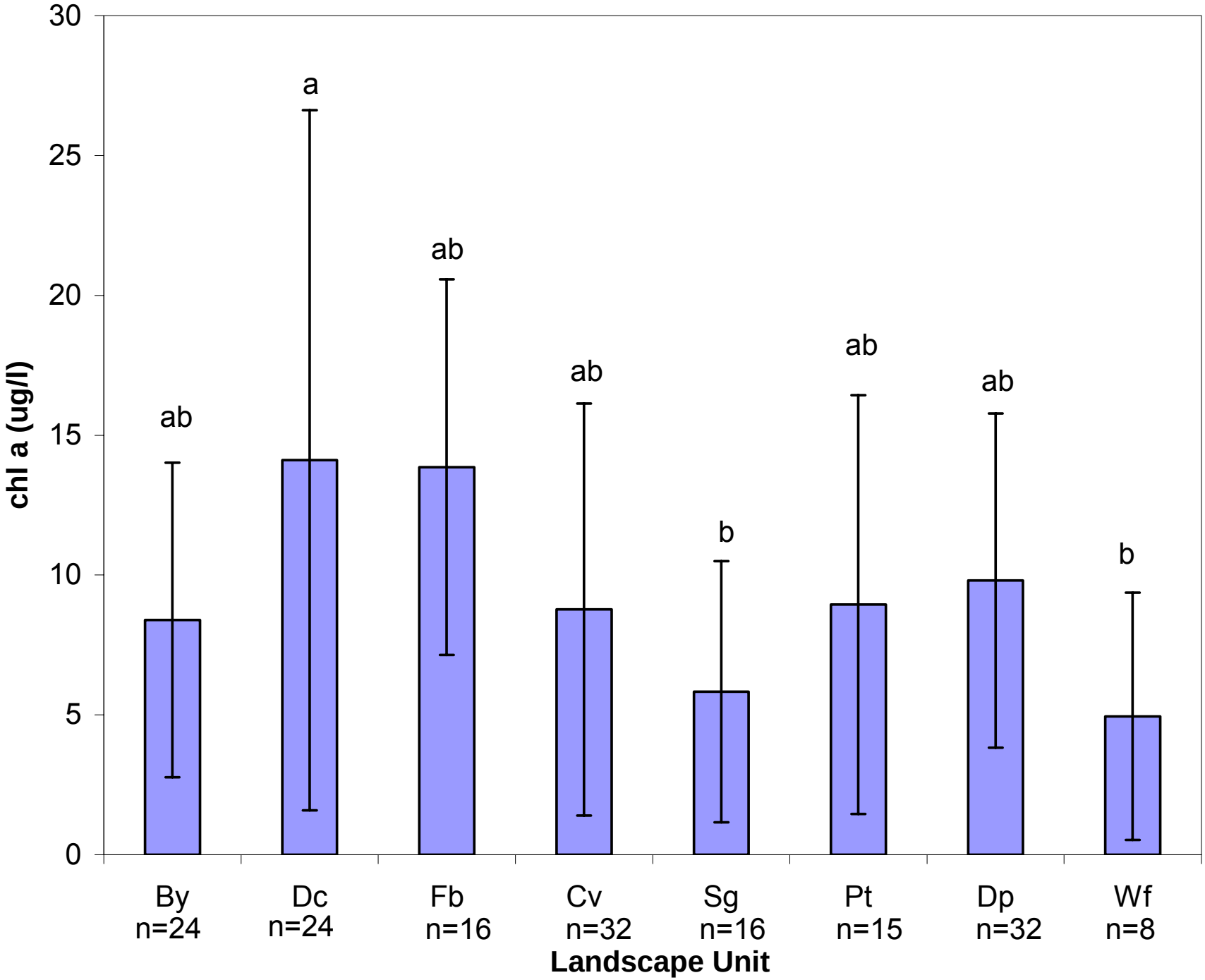


Wickford DO and Bottom Type

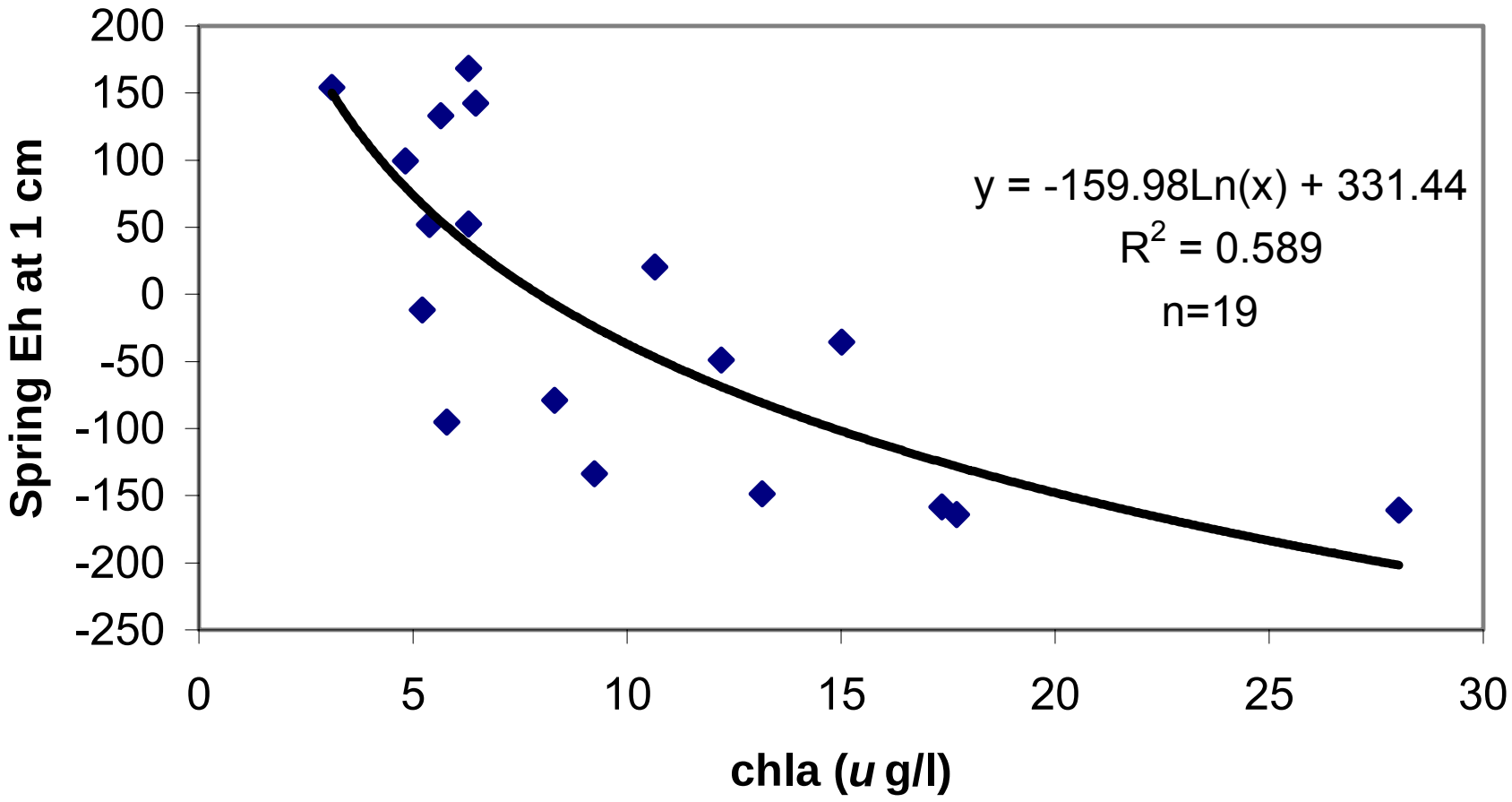


Little Narragansett DO and Bottom Type




30
25
20
15
10
5
0
chl a (ug/l)
a
ab
ab
ab
b
ab
ab
b
By
n=24
Dc
n=24
Fb
n=16
Cv
n=32
Sg
n=16
Pt
n=15
Dp
n=32
Wf
n=8
Landscape Unit

Redox Potential and Water Quality



Conclusions

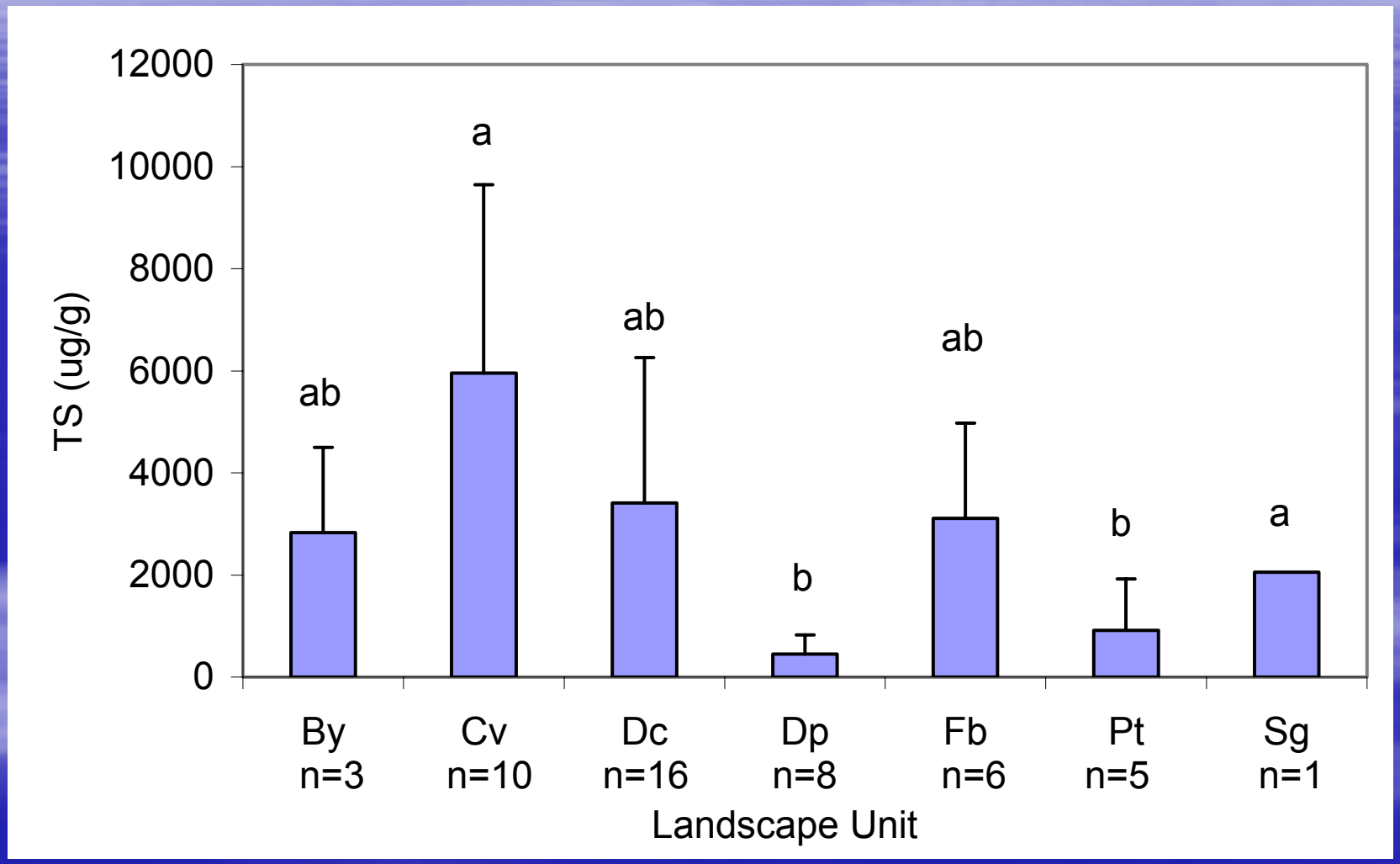
- Water quality can be assessed using a geographic/landscape model
  - Low DO and high Chl *a* in low energy landscape units
  - Redox potential indicative of long-term organic enrichment from high Chl *a* levels

Sulfides

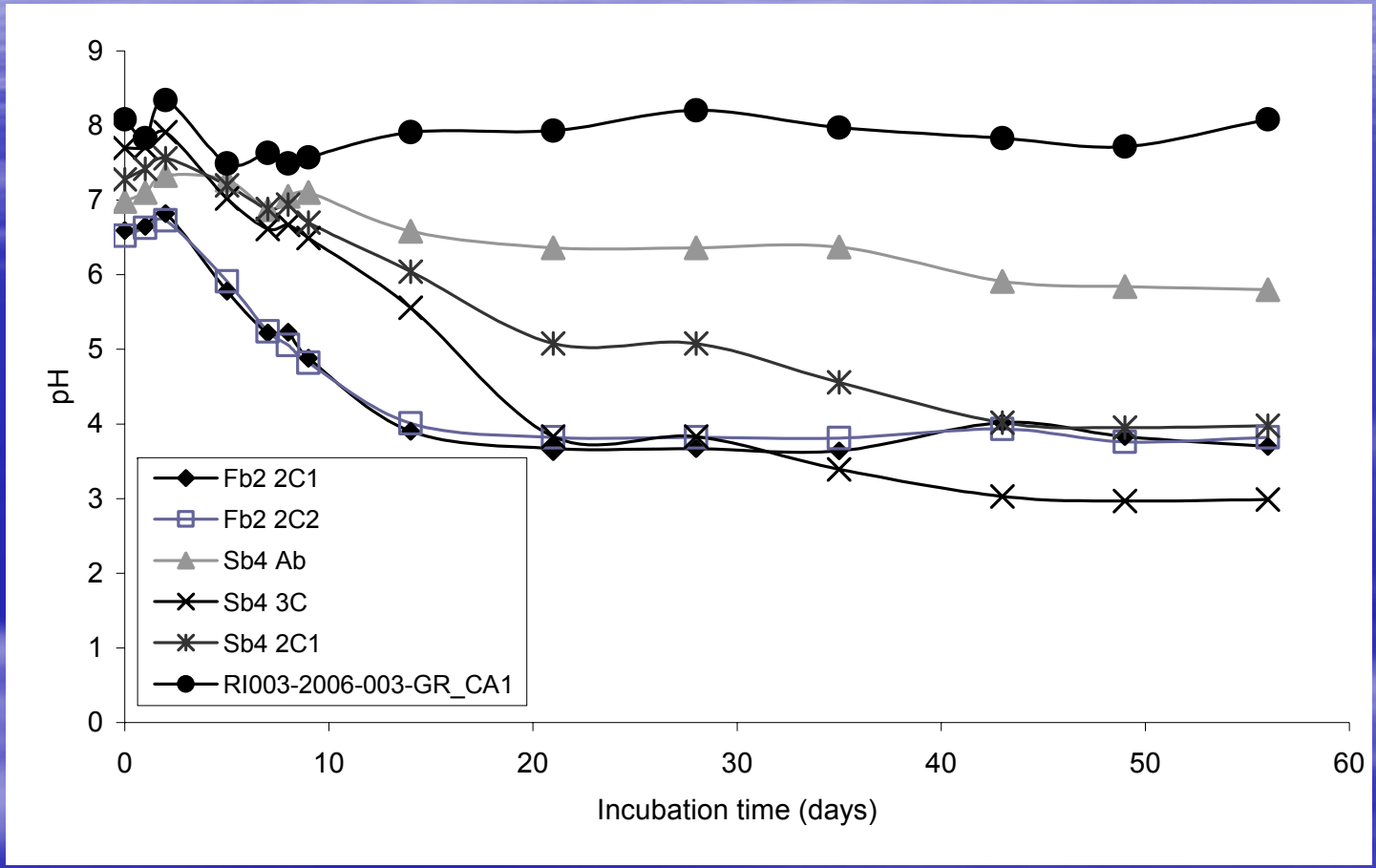
Goals:

- To assess distribution of sulfides
- To assess sulfide estimation techniques
  - Incubation pH
  - H_2O_2 oxidized salinity
  - Physical soil properties

Sulfide Distribution



Incubation pH



- Incubation pH ≤4 after 8 weeks is currently used to define sulfidic materials

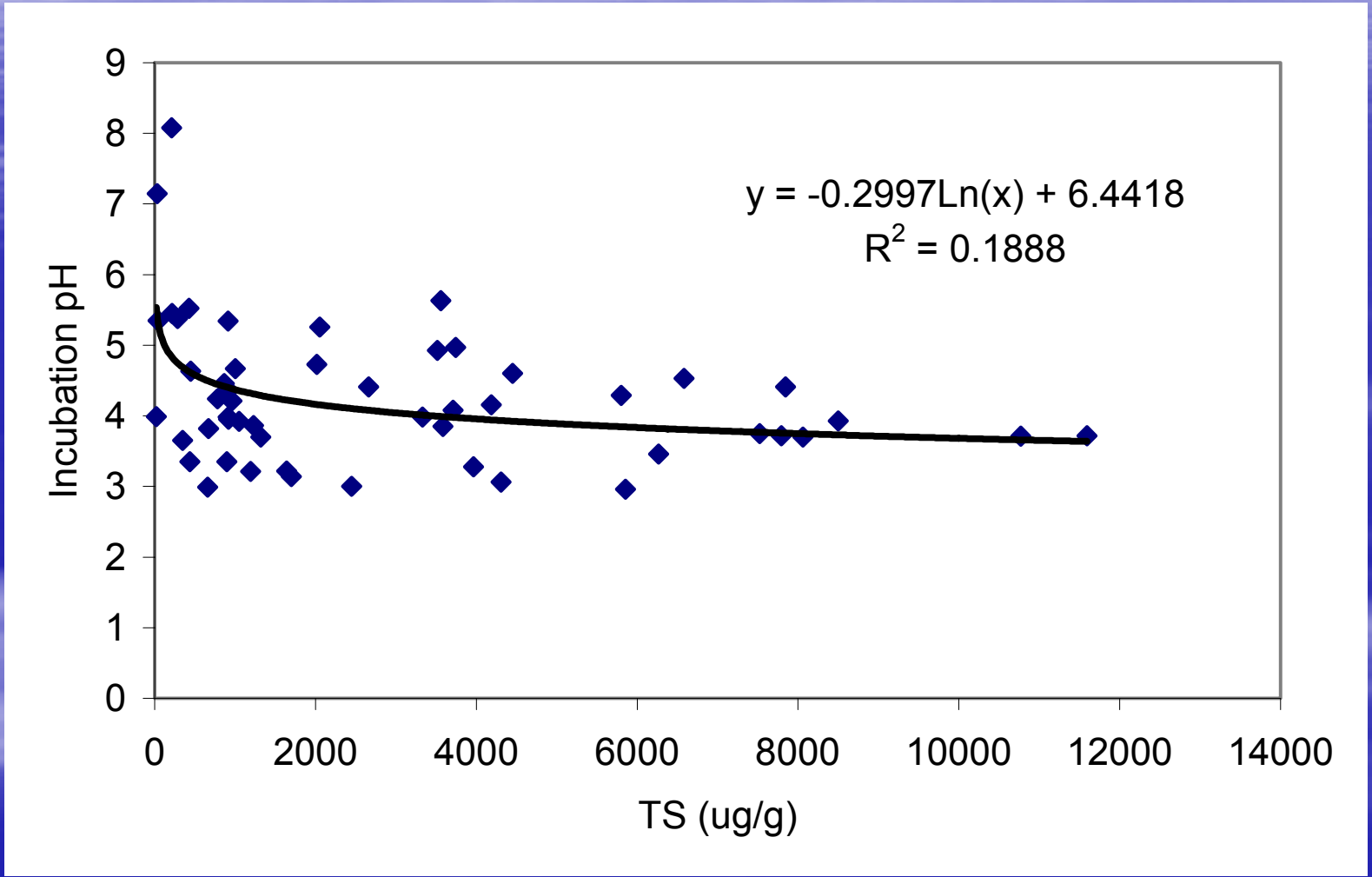
Incubation pH

(Balduff, 2007)

Length of time to drop below pH 4	Number of samples†	% of Samples that eventually show a drop in pH<4
4 weeks	25 (16%)	20
8 weeks	73 (45%)	57
12 weeks	104 (64%)	81
16 weeks	117 (72%)	91
20 weeks	125 (77%)	98
24 weeks	128 (78%)	100

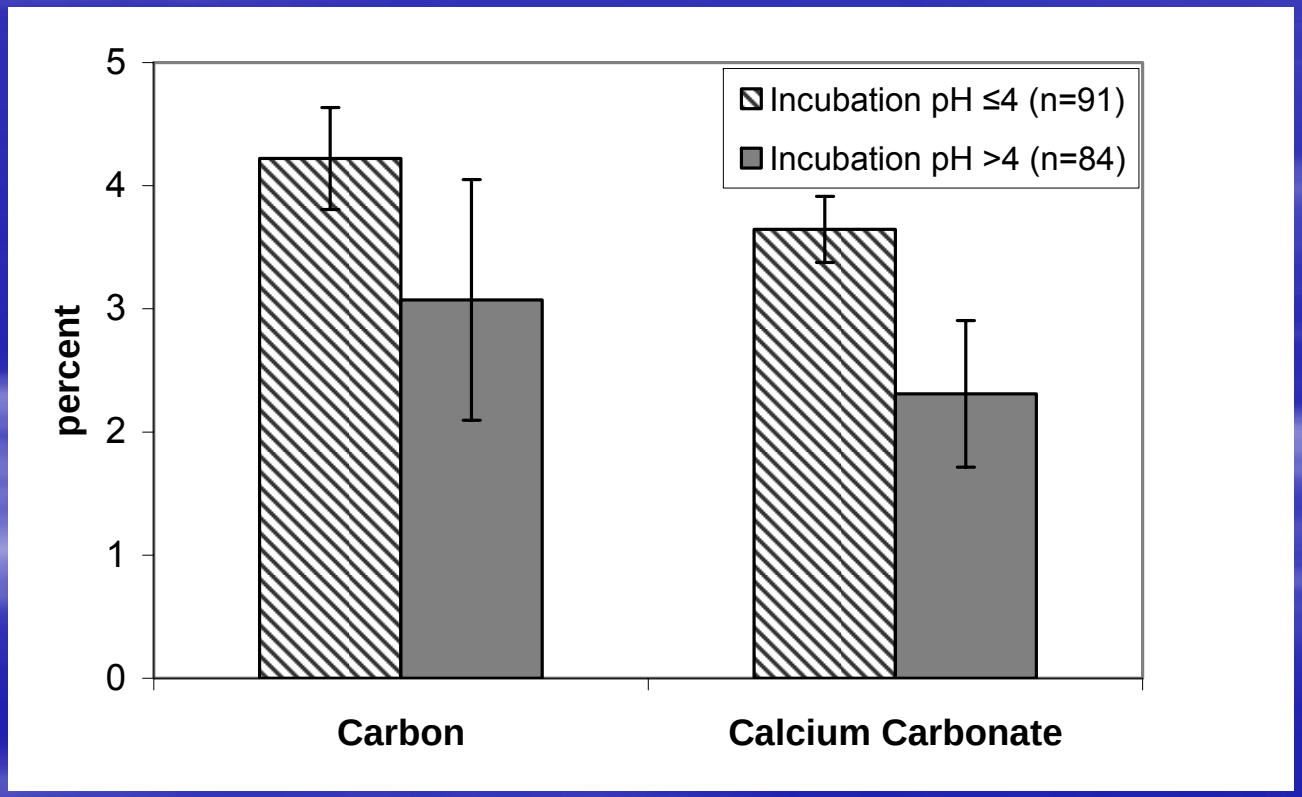
† 46 samples were only incubated for 16 weeks

Incubation pH

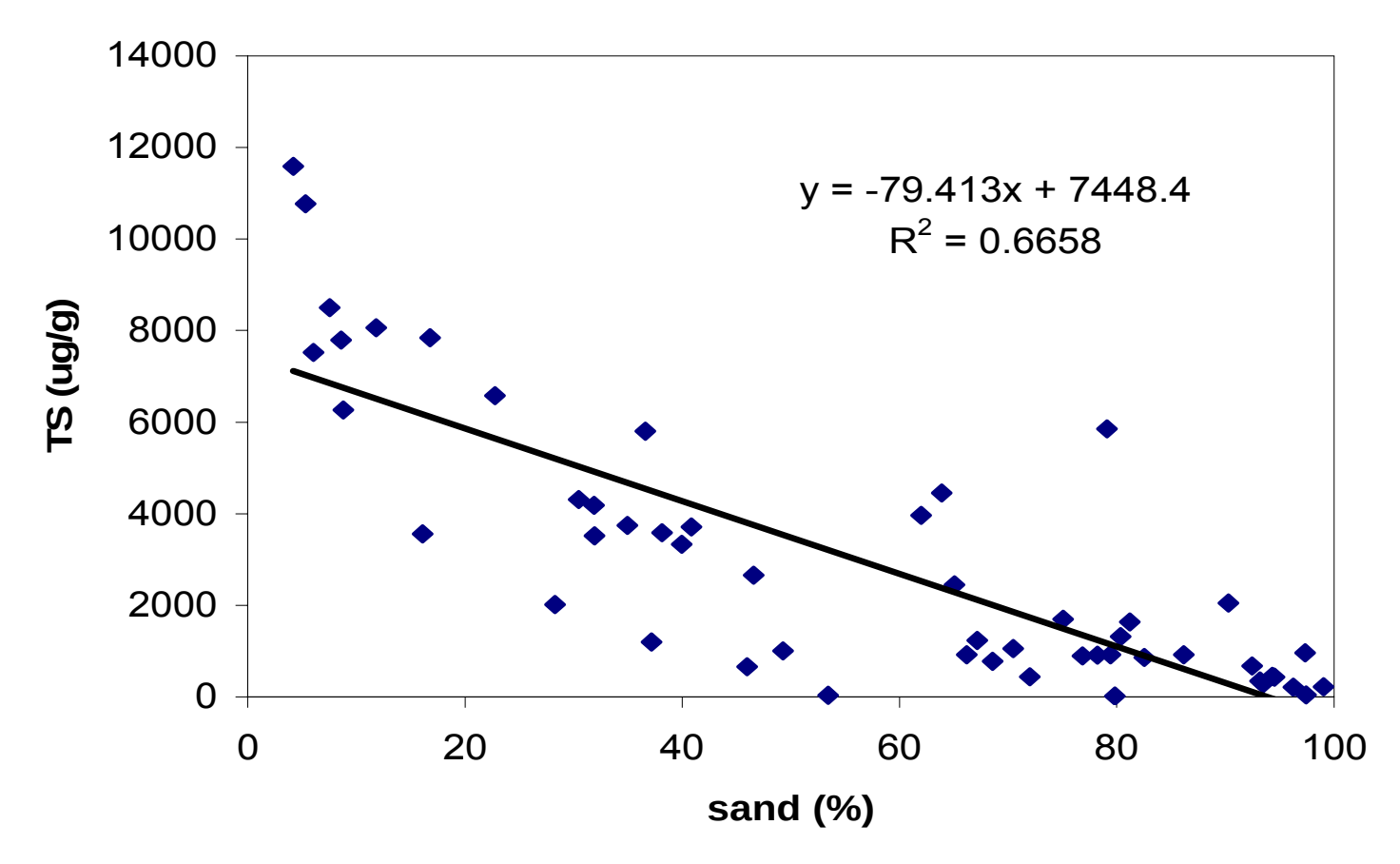


Incubation pH

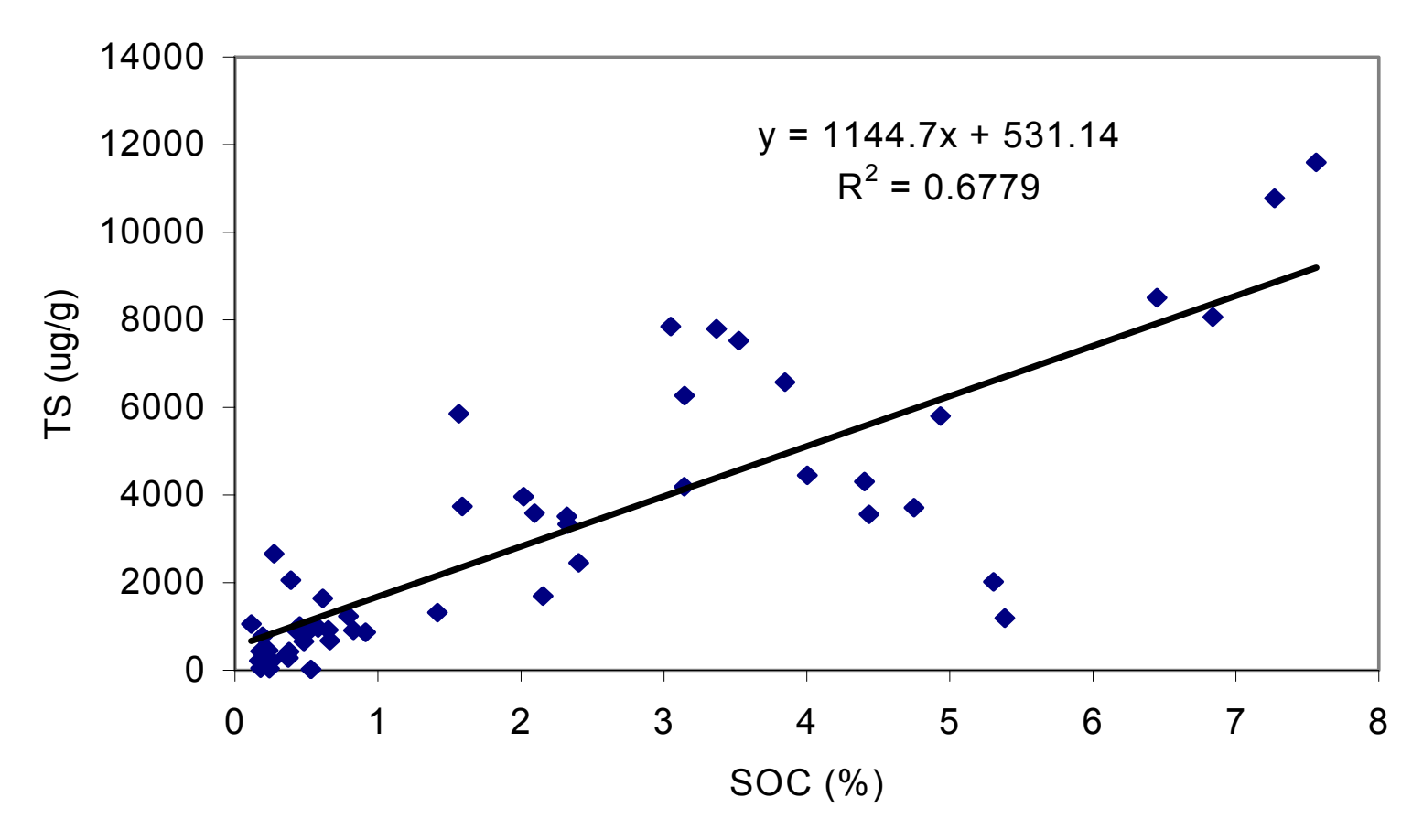
- Buffering from carbon and calcium carbonate were not significant factors in incubation pH values



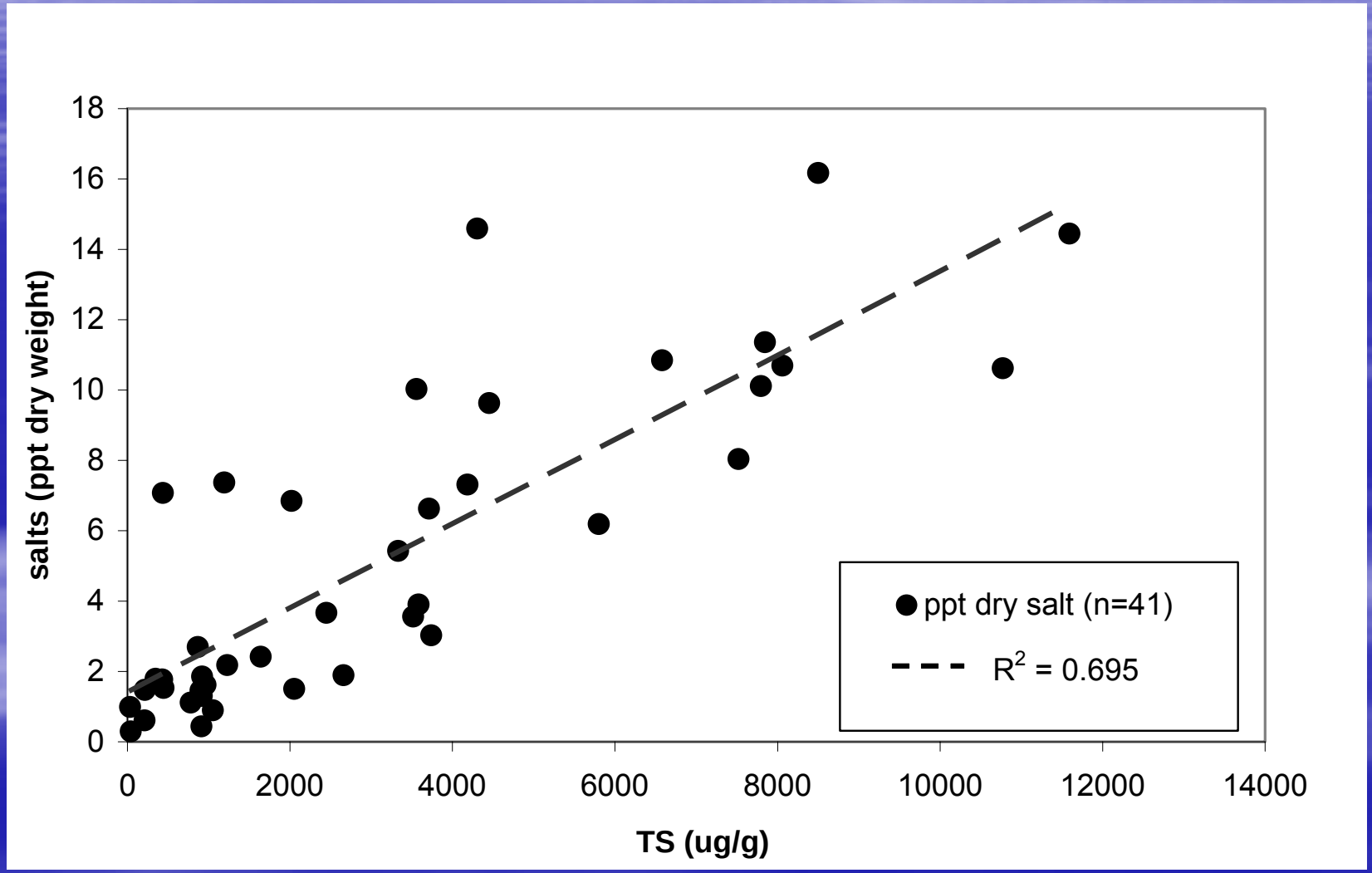
Sulfide Distribution



Sulfide Distribution



H_2O_2 Oxidized Salinity



Conclusions

- Sulfide distribution is correlated with landscape unit
- Incubated pH after 8 weeks may not be an accurate indicator of sulfide levels
  - Neutralization from biogenic $CaCO_3$ is not a factor in incubated pH values
- Sulfide content is correlated with SOM and particle size
- H_2O_2 oxidized salinity reflects sulfide content

Subaqueous Soil Interpretations Dredged Material

Alexander Salisbury

Subaqueous Soil Interpretations
Dredged Material

Soil Carbon, Eelgrass Restoration, Shellfish Productivity

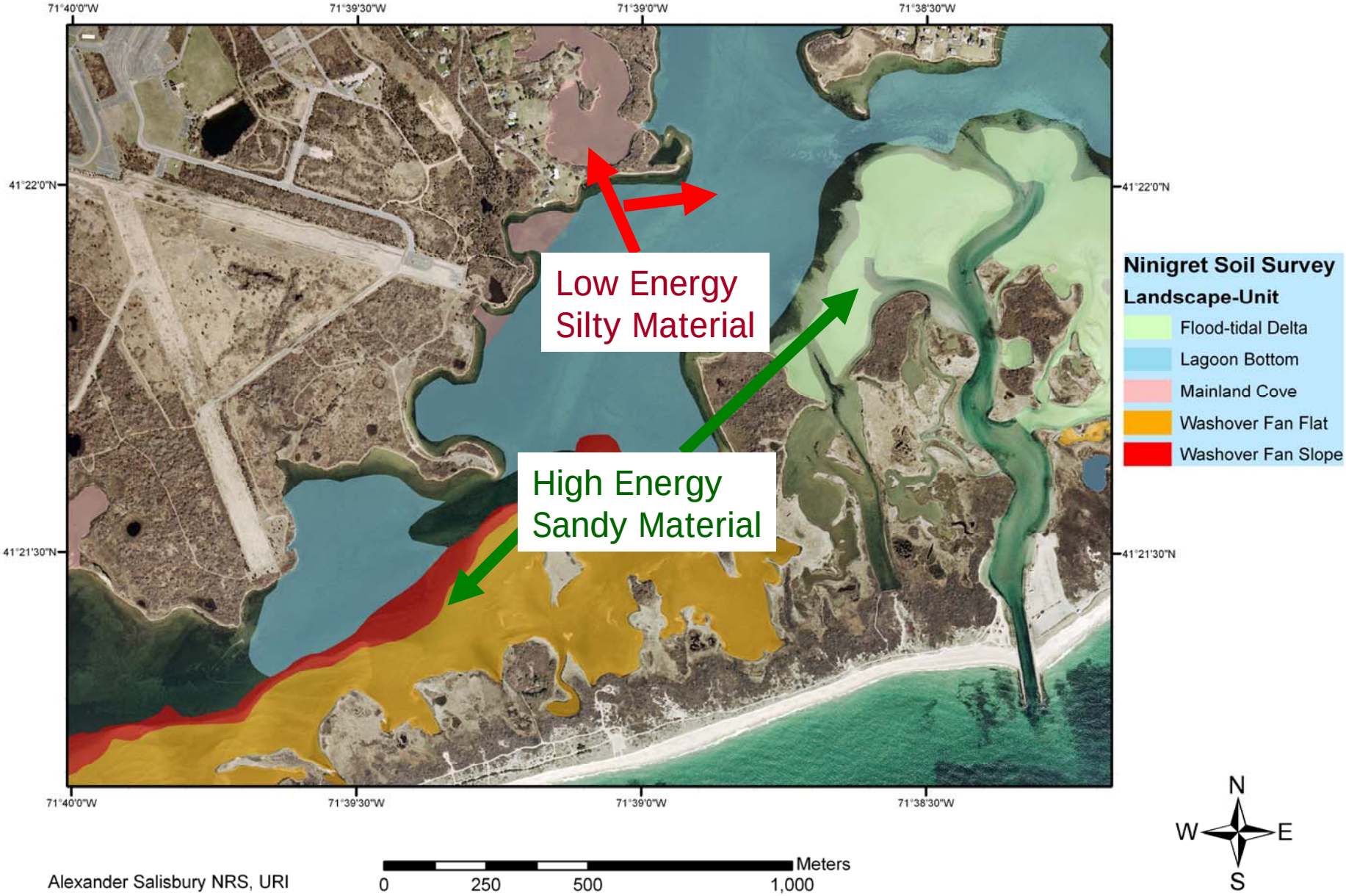
Methods

- Mesocosm study
- Locations
  - Embayments: Wickford Cove and Greenwich Bay
  - Coastal Ponds: Ninigret and Quonochontaug
- Soil Landscapes
  - Sandy Spit, Mainland Shoreface, Bay Bottom, Cove
  - Washover Fan, Flood Tidal Delta, Lagoon bottom, Mainland Cove
- 4 Mesocosms per Landscape
  - Total of 64 mesocosms

Mesocosms

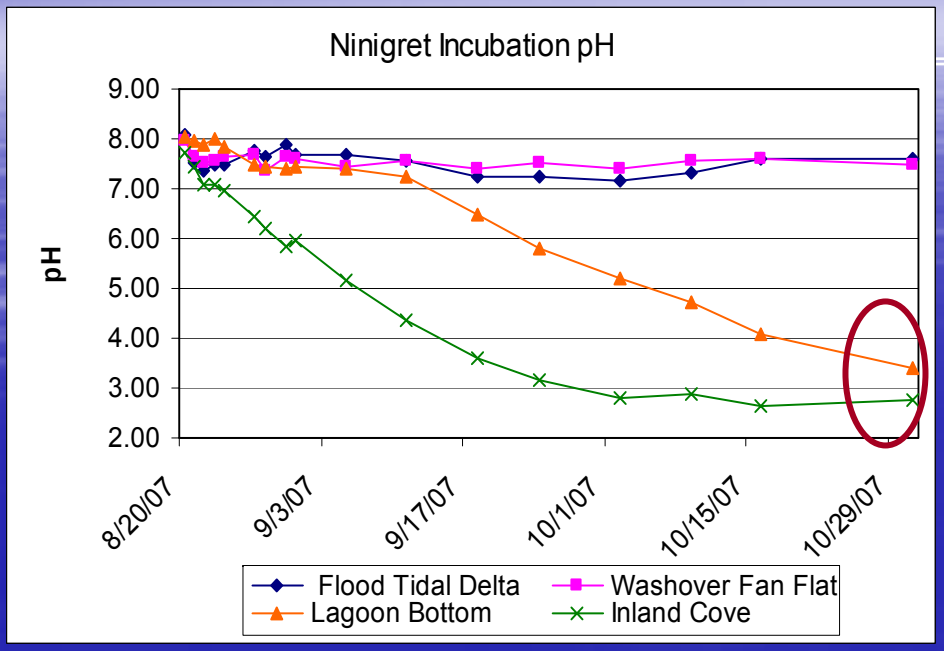
- Soil materials collected to a depth of 25 cm
- Mixed
- Placed into 4 x 10 inch cylindrical mesocosms
- Allowed to drain
- Exposed to natural conditions (rainfall)
- Rainfall leachate analyzed for:
  - Salinity
  - pH
  - Sulfate content
- Lab Analysis
  - Salinity
  - Incubation pH
  - Loss on ignition carbon and calcium carbonate
  - Acid volatile sulfides, chromium reducible sulfides
  - Particle size distribution

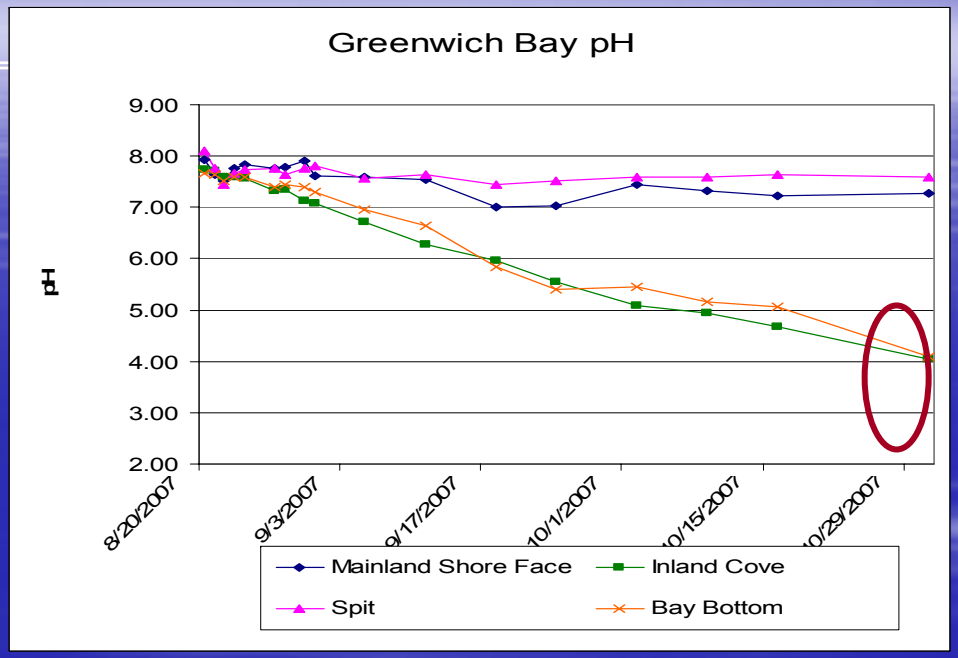
Ninigret Landscapes

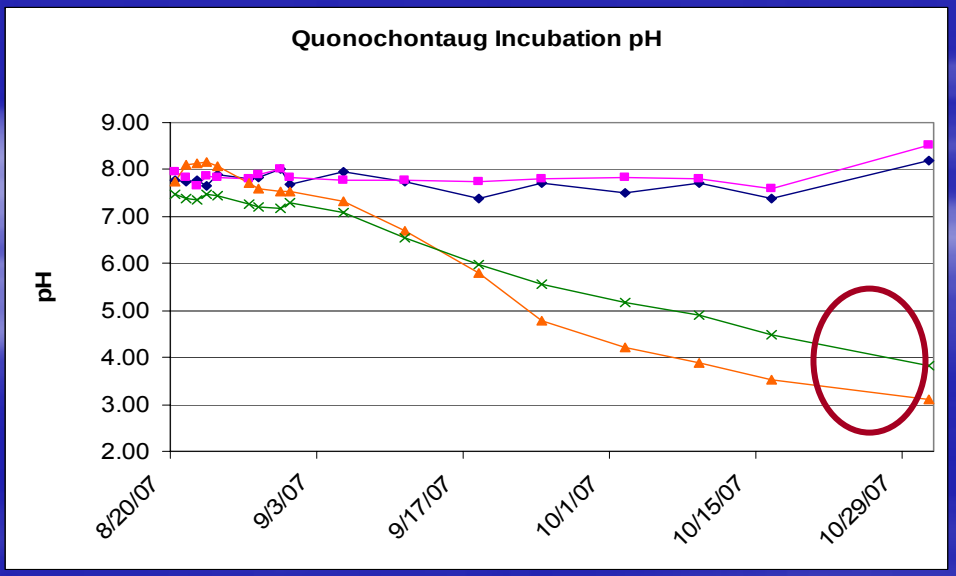


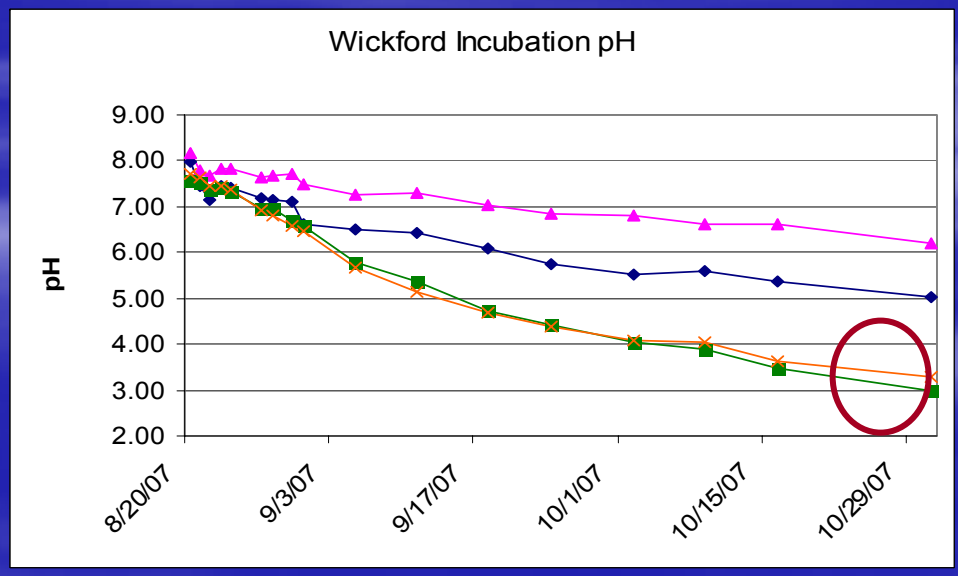
Alexander Salisbury NRS, URI

Lab Incubation pH

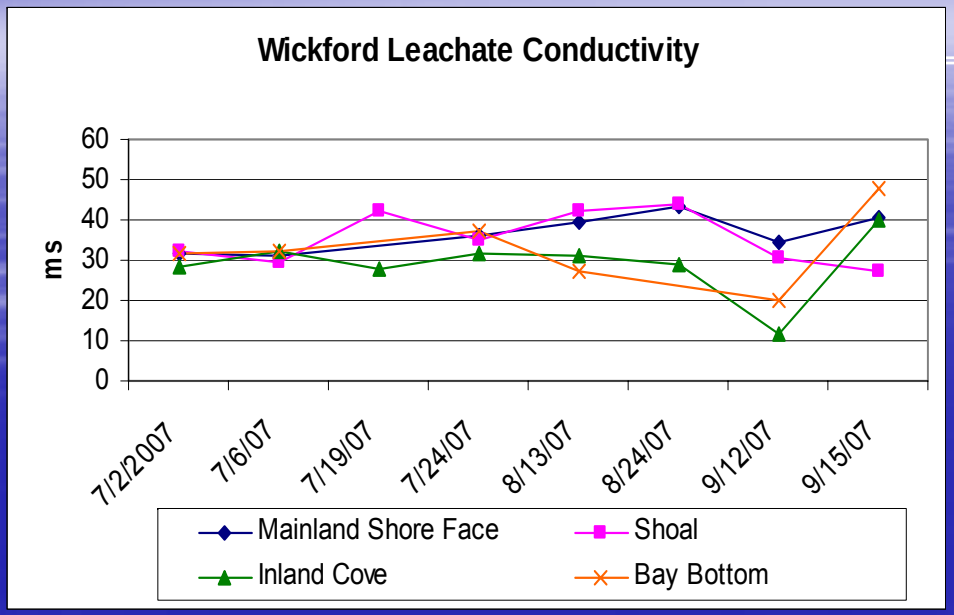


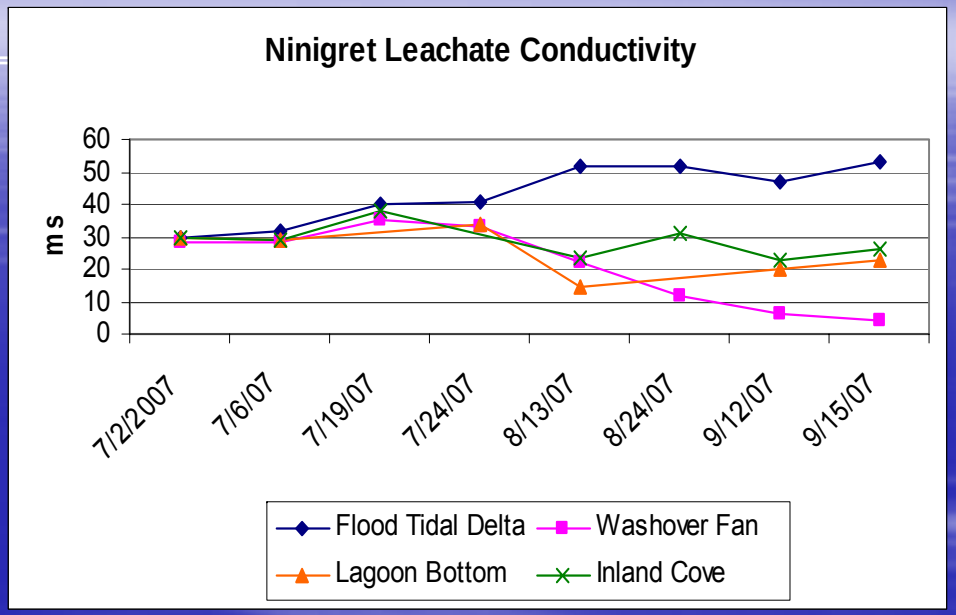


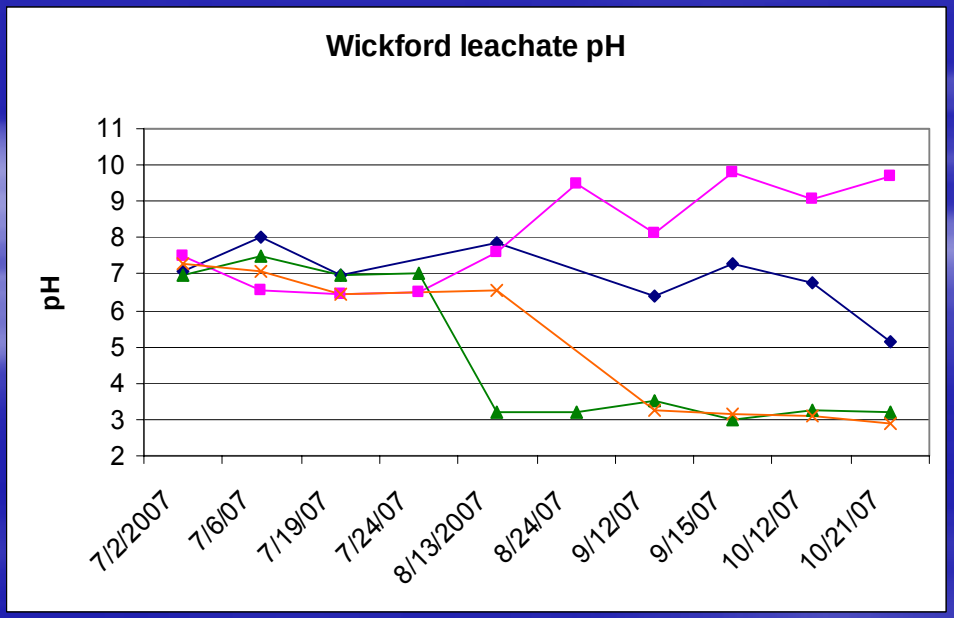


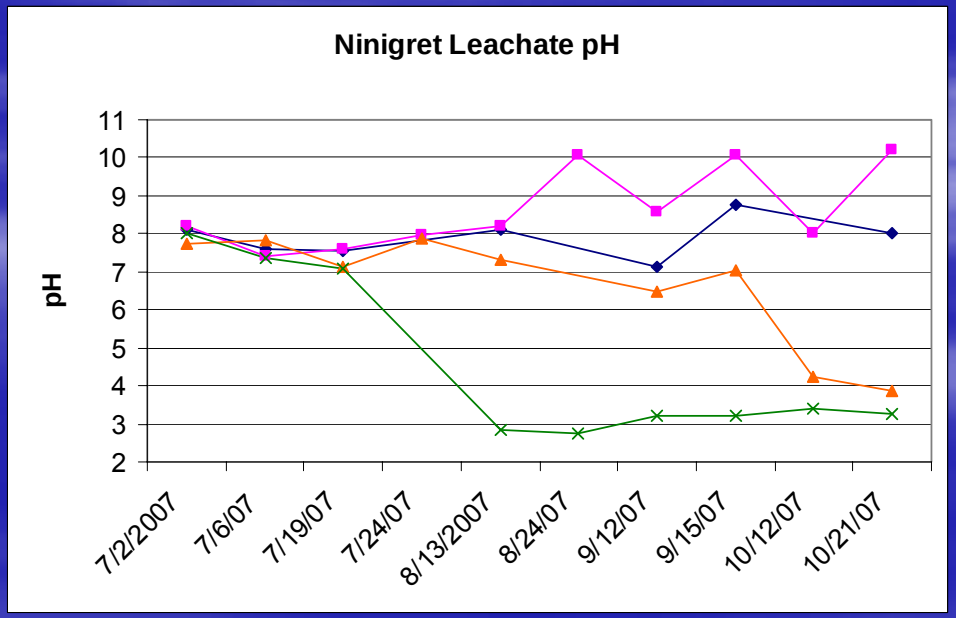


Leachate Conductivity and pH (2007)

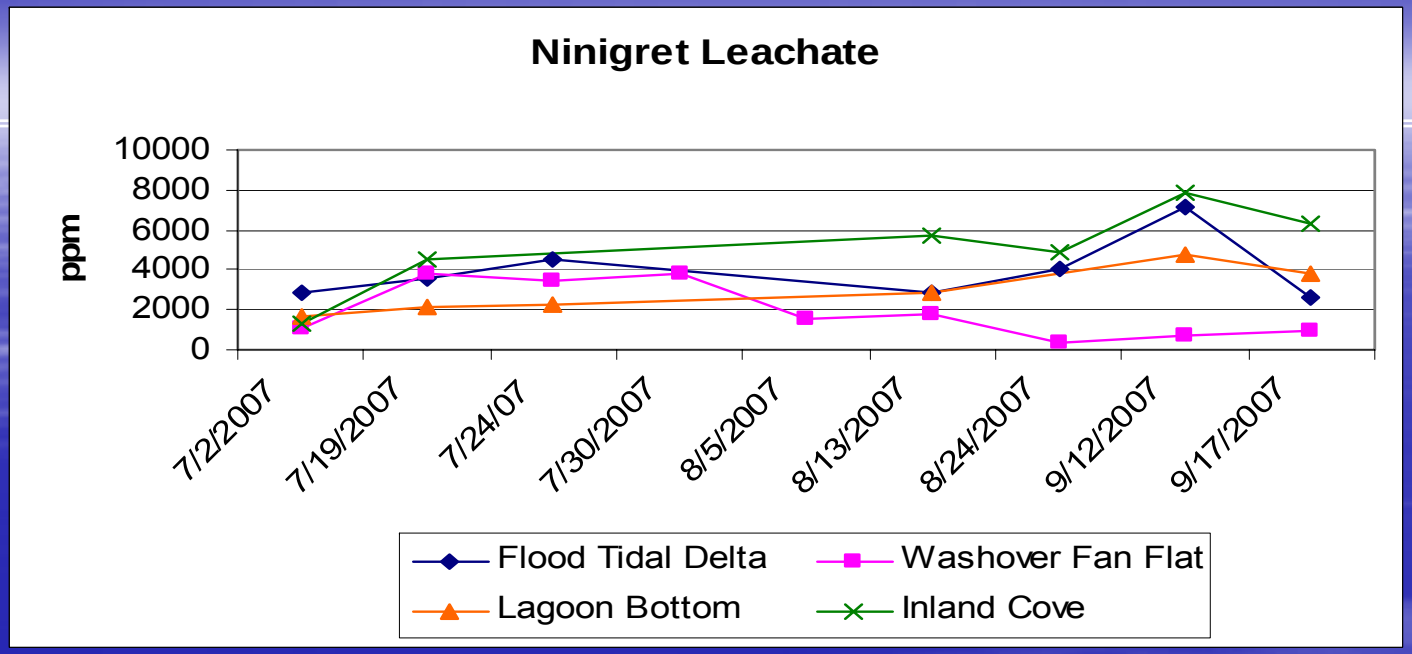


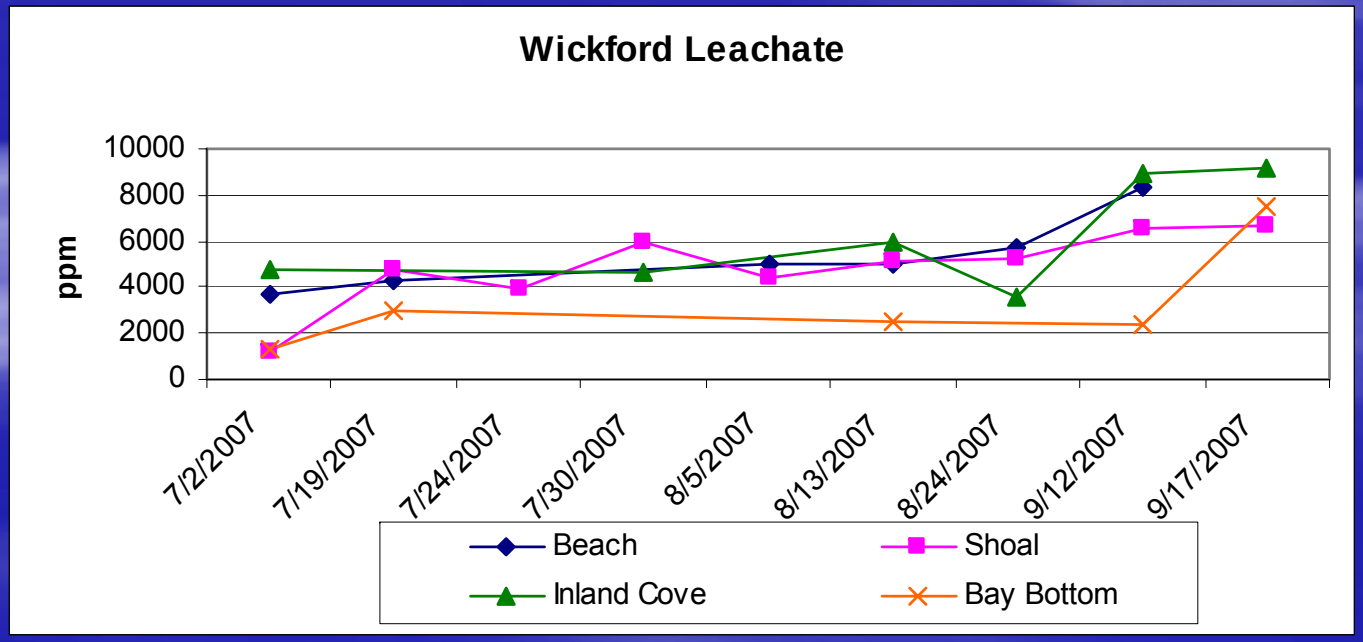






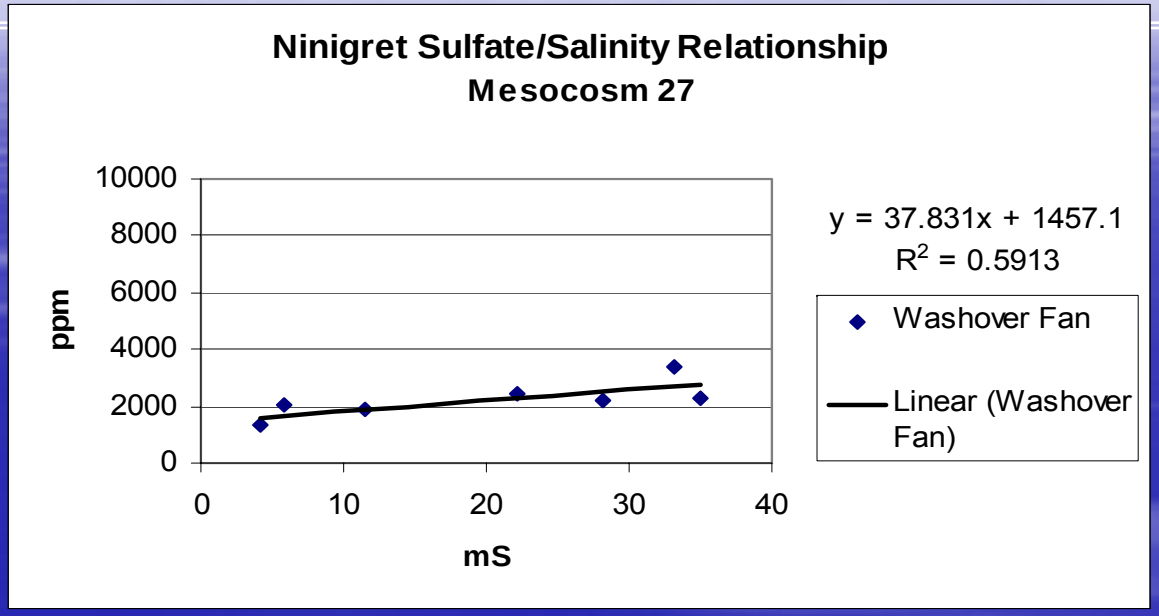
Leachate Sulfate Content

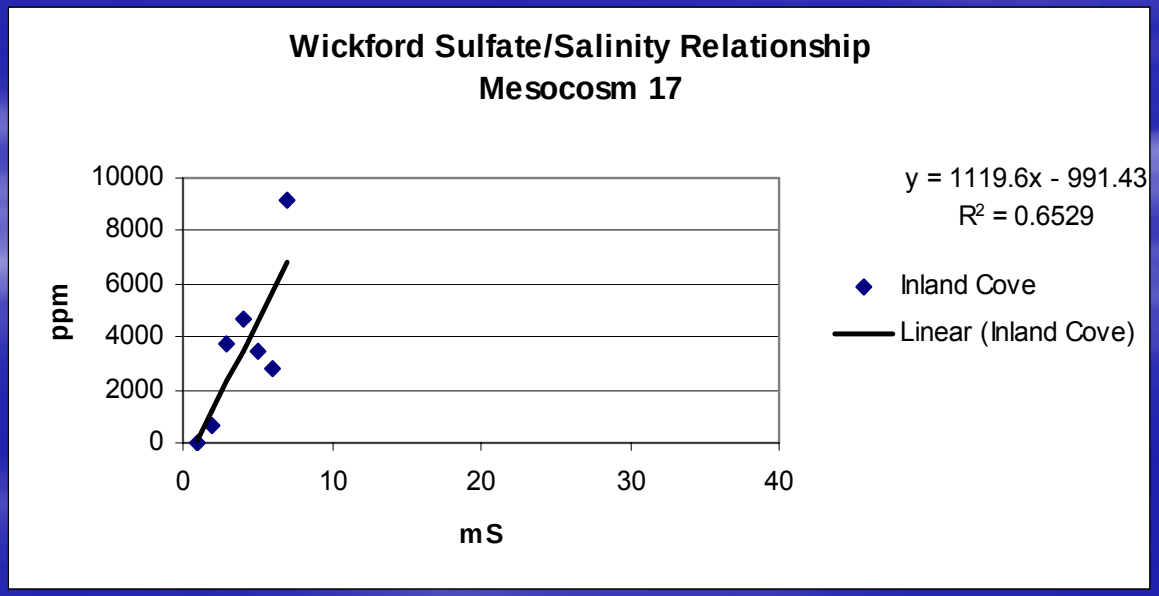




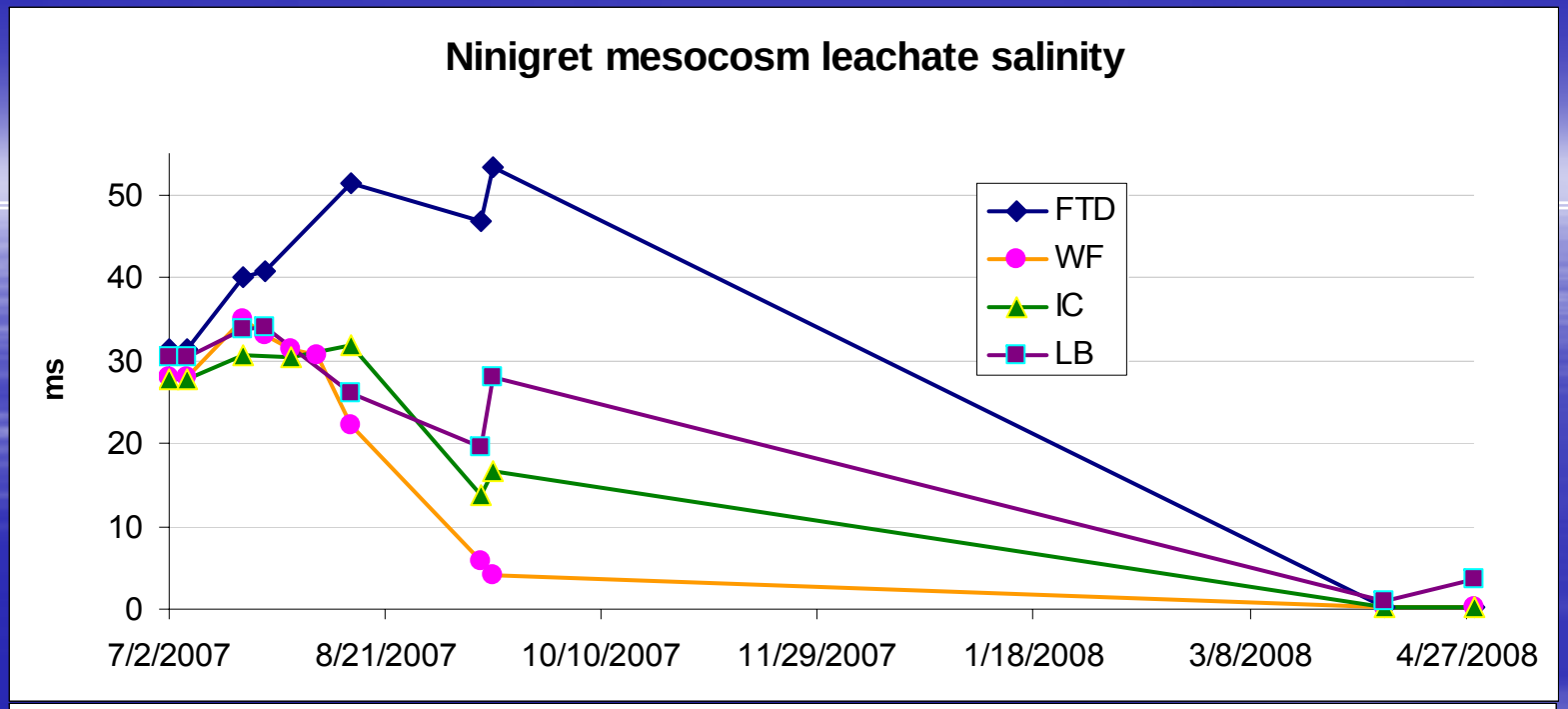
Seawater SO_4^-
URI Bay Campus
1928ppm

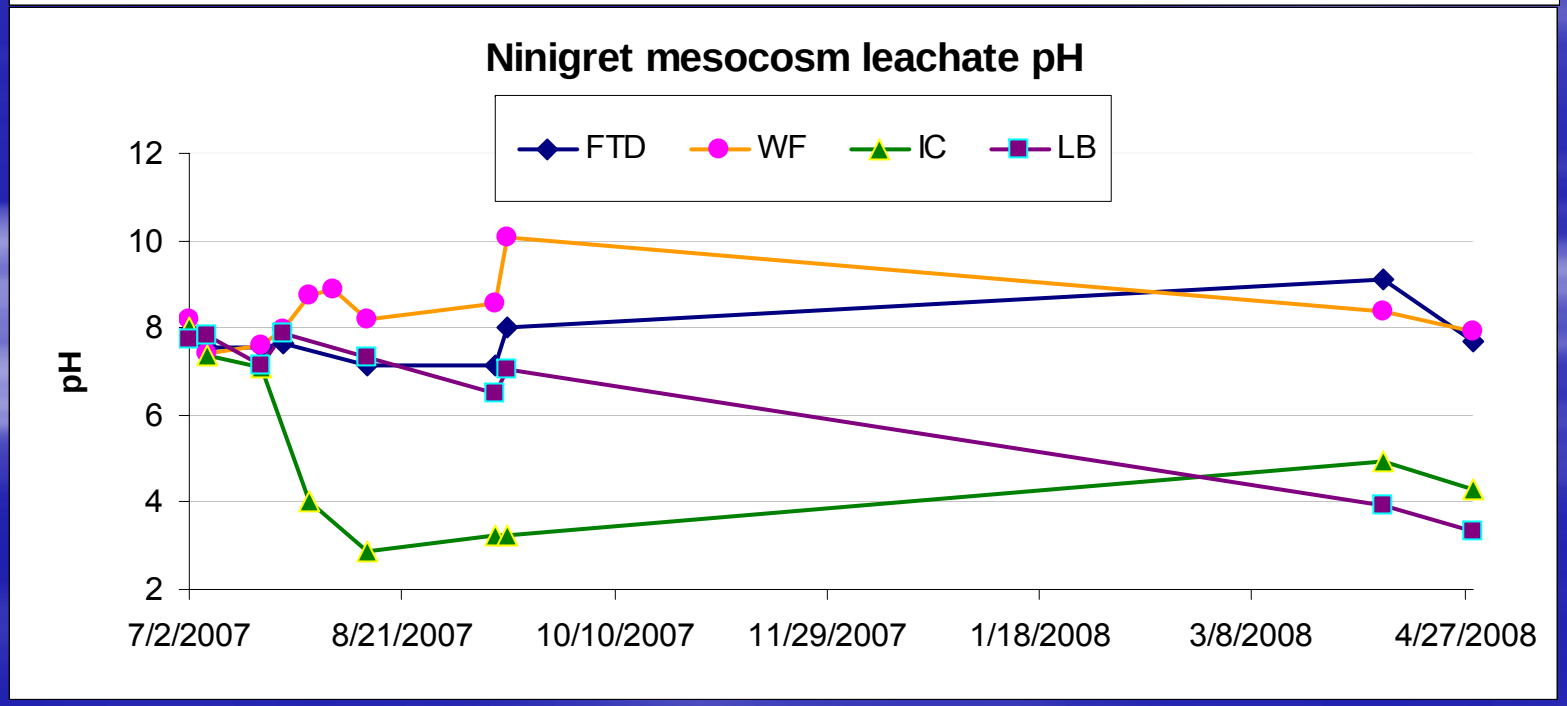
Sulfate/ Salinity Relationships





Seawater SO_4- URI Bay Campus 1928ppm


Ninigret mesocosm leachate salinity
ms
50
40
30
20
10
0
7/2/2007
8/21/2007
10/10/2007
11/29/2007
1/18/2008
3/8/2008
4/27/2008
FTD
WF
IC
LB


Ninigret mesocosm leachate pH
pH
12
10
8
6
4
2
7/2/2007
8/21/2007
10/10/2007
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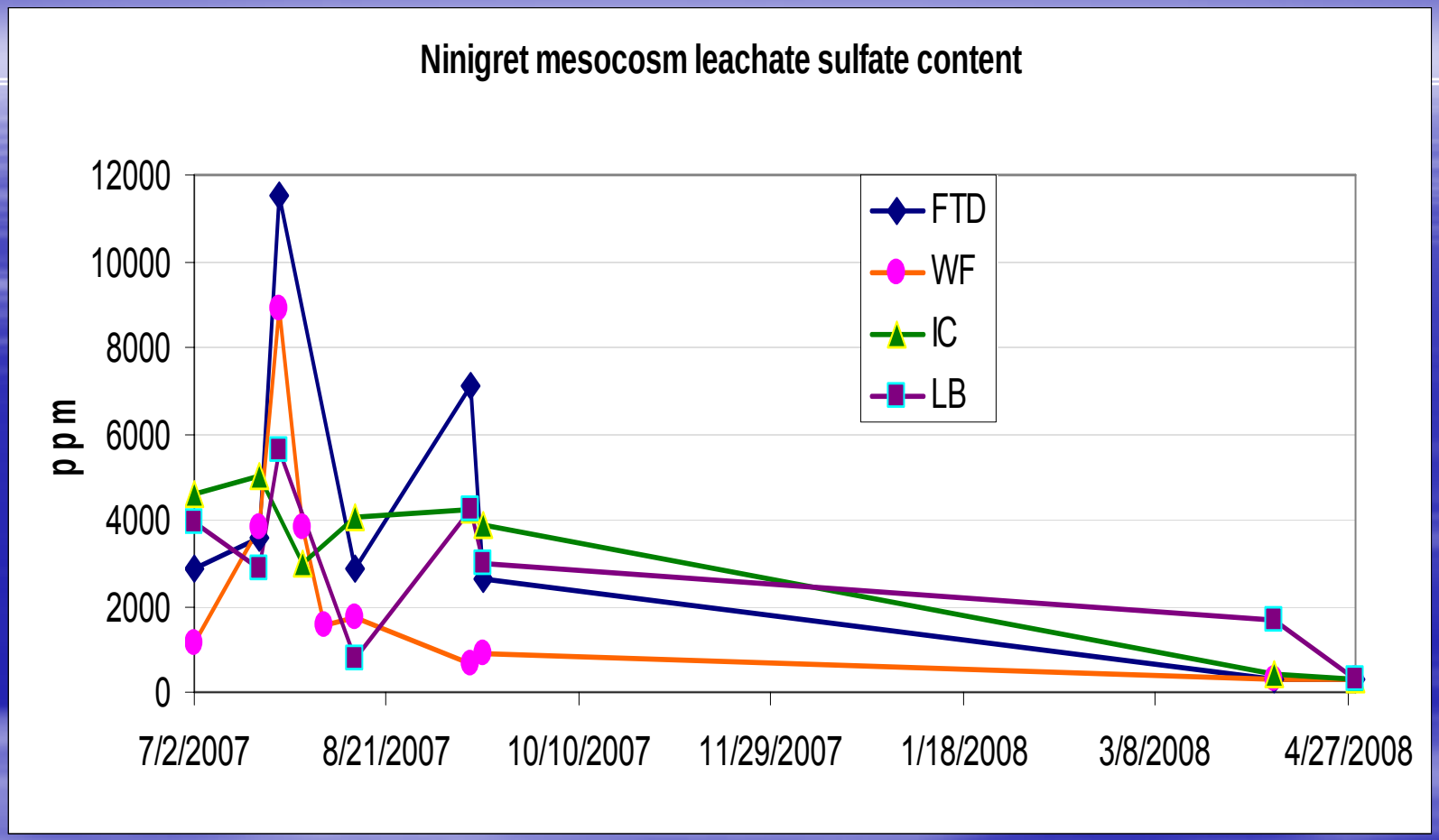
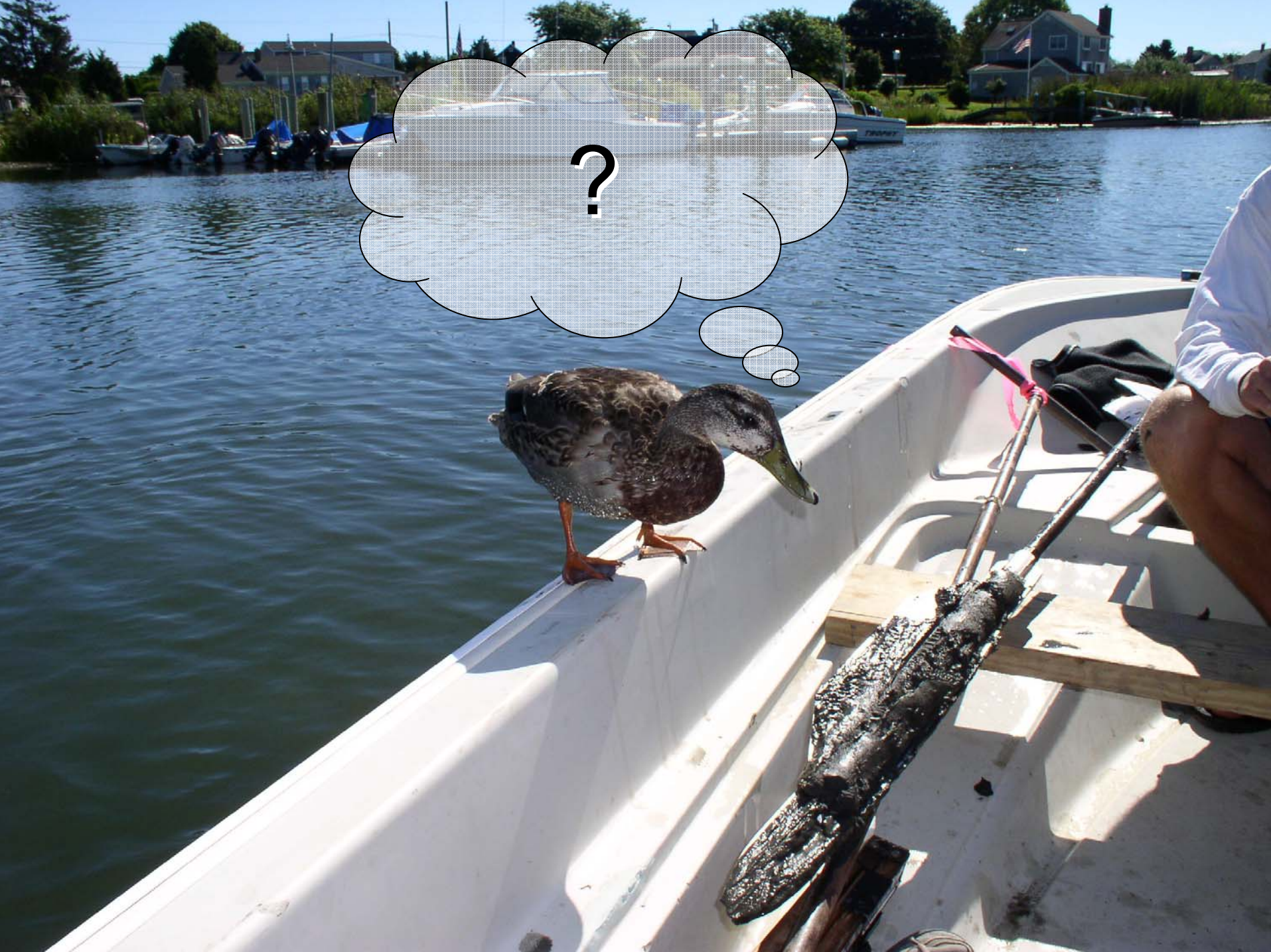
1/18/2008
3/8/2008
4/27/2008
FTD
WF
IC
LB


Ninigret mesocosm leachate sulfate content
ppm
12000
10000
8000
6000
4000
2000
0
7/2/2007
8/21/2007
10/10/2007
11/29/2007
1/18/2008
3/8/2008
4/27/2008
FTD
WF
IC
LB