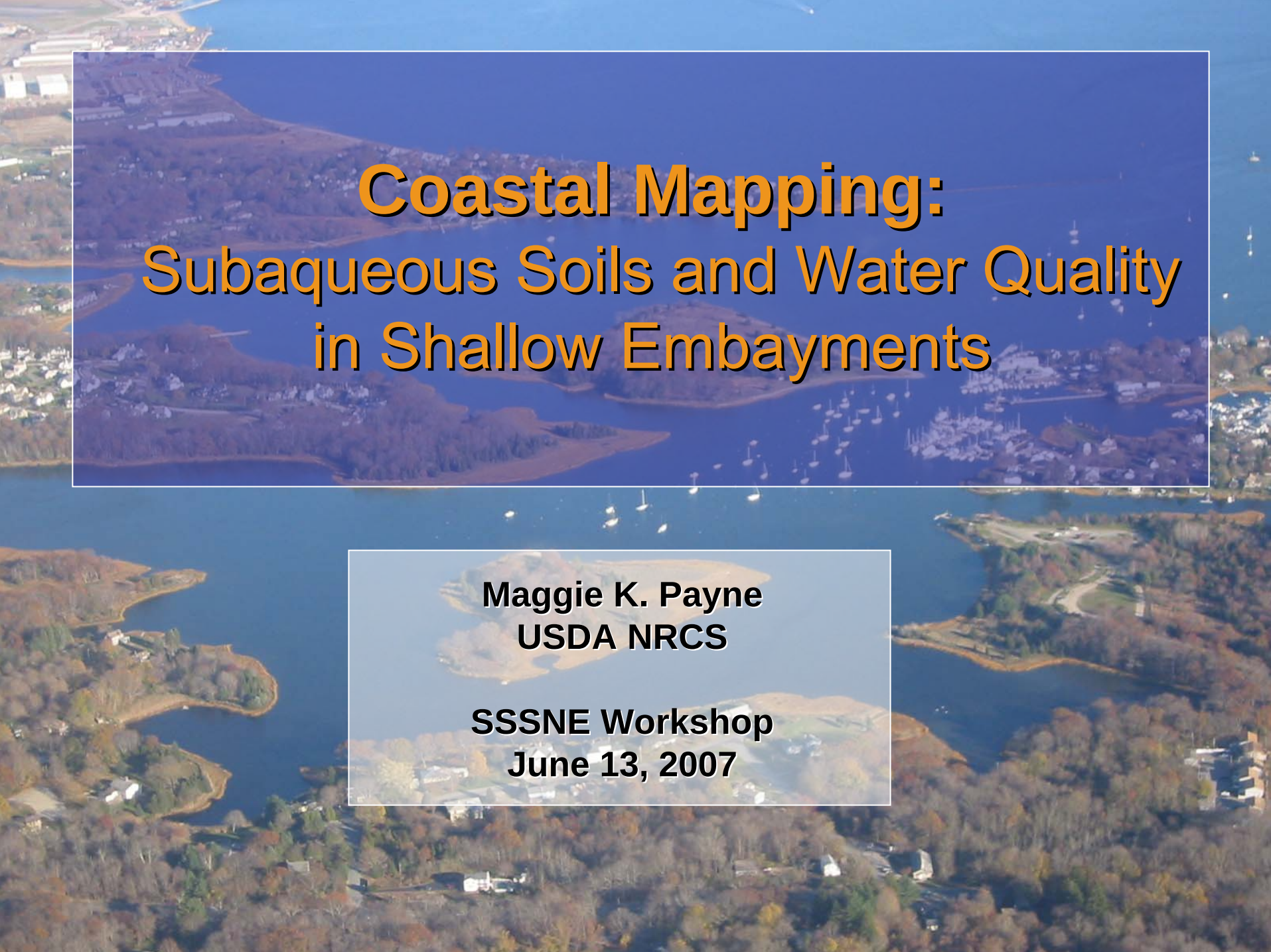


Coastal Mapping:
Subaqueous Soils and Water Quality in Shallow Embayments

Maggie K. Payne
USDA NRCS

SSSNE Workshop
June 13, 2007

The Mapping Partnership for Coastal Soils and Sediment….

In the Beginning

A lot happening in coastal soils/sediment mapping

The MapCoast Partnership - *A timely alignment of people, ideas, needs and goals*

Mapping Partnership for Coastal Soils and Sediment

16 Partners have signed our MOU

Common Ground

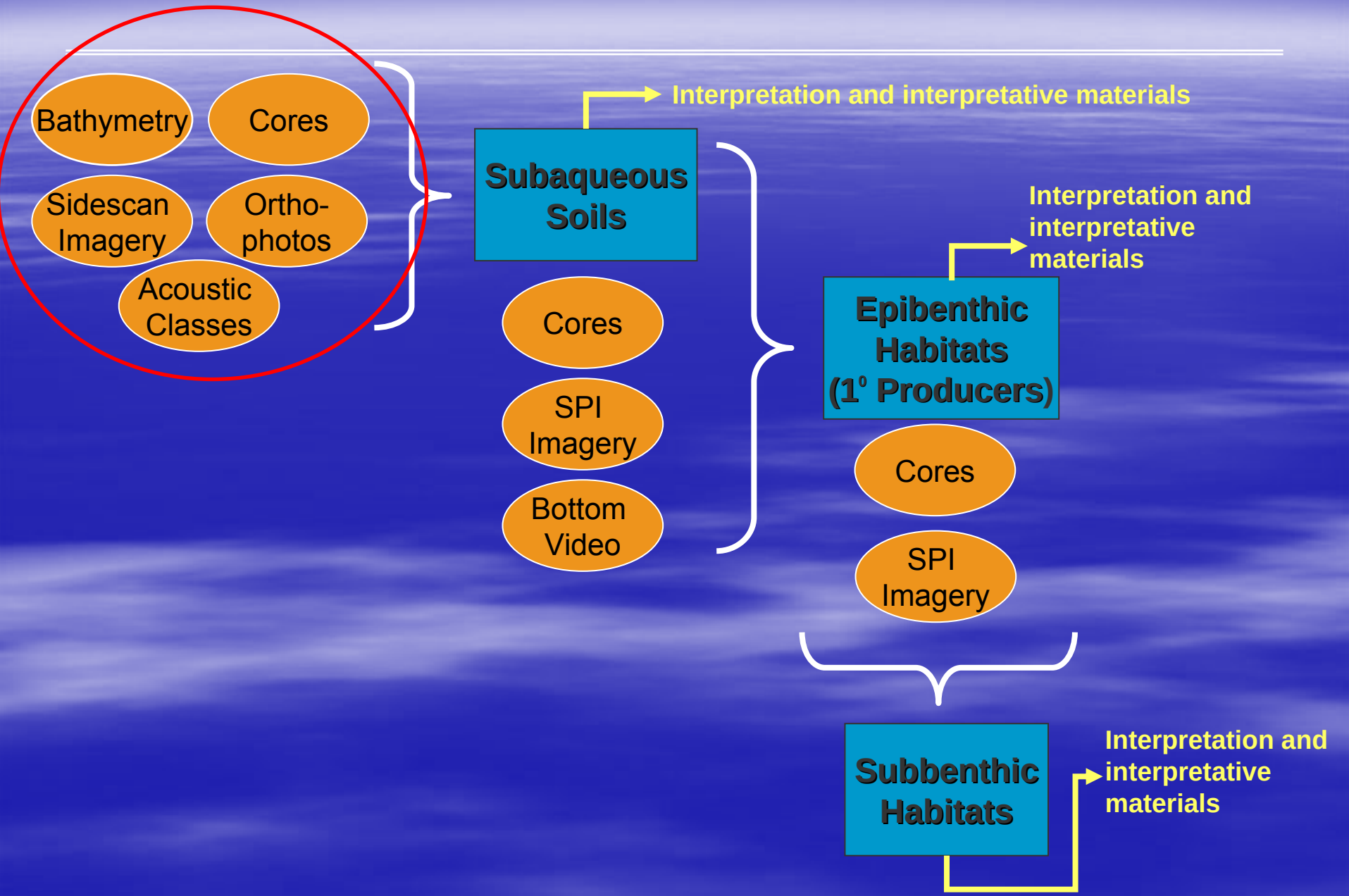
- Why stop making interpretations at the land-water interface?
- MapCoast understands the need to develop a common hierarchical system of coastal soil and sediment classification that encompasses all disciplines including biology, wetlands, geology, and pedology

George Demas

Common Objectives

- Develop mapping **standards** and **protocols** to produce accurate and useful maps.
- Build multiple **interpretations** of the data to service the coastal resource management community.
- Ensure that data collected will be made **available** to all users.
- Work will be conducted in a **cooperative** manner.
- Partners will **share** resources, technology, and knowledge.
- Provide **training** and **educate** users about the soils and sediment data and maps.

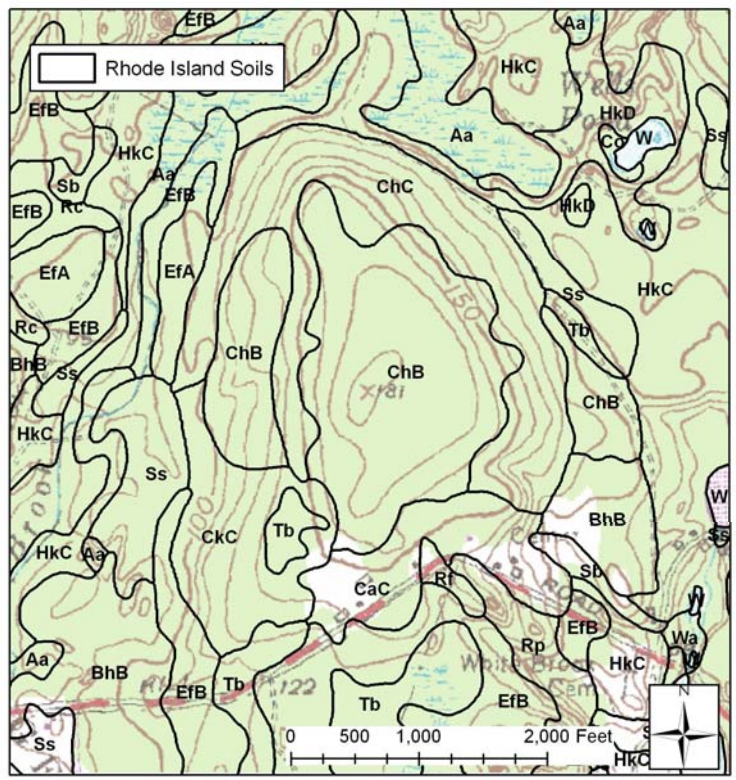
MapCoast Workflow

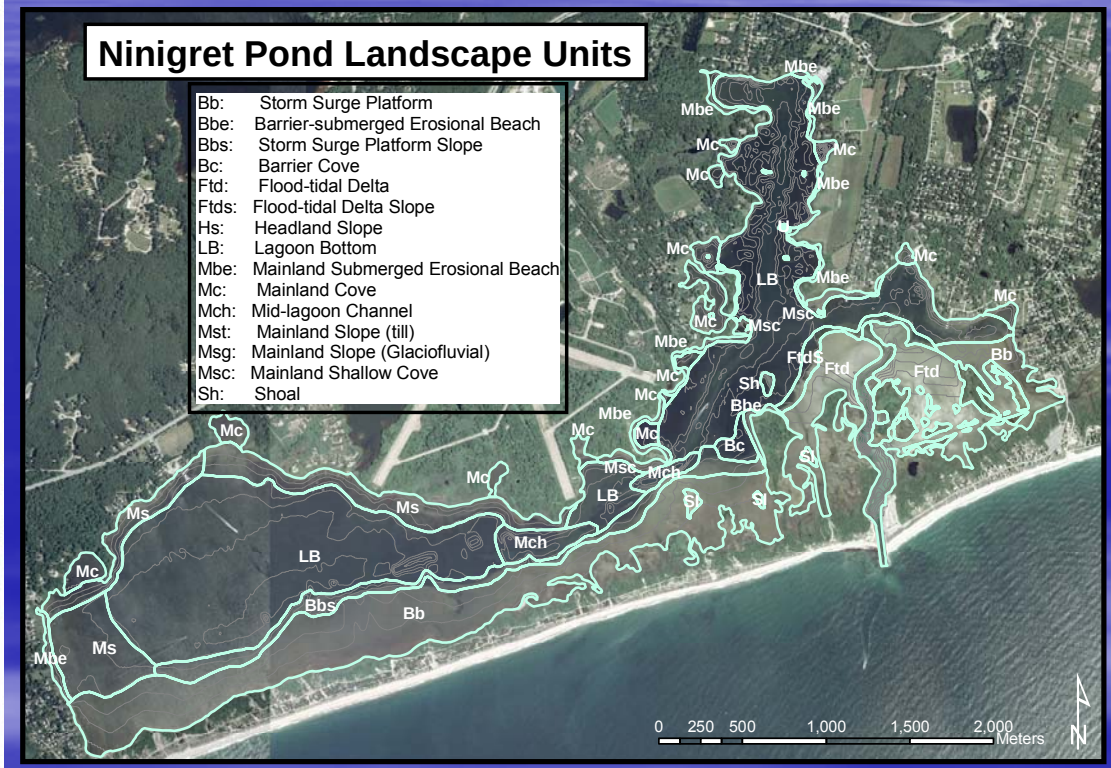


Subaqueous Soils

- Permanently submerged in shallow water (~2.5 m)
- Recently recognized as soils
  - evidence of pedogenesis (soil formation)
  - able to support rooted plants

Shallow-Subtidal Landscapes



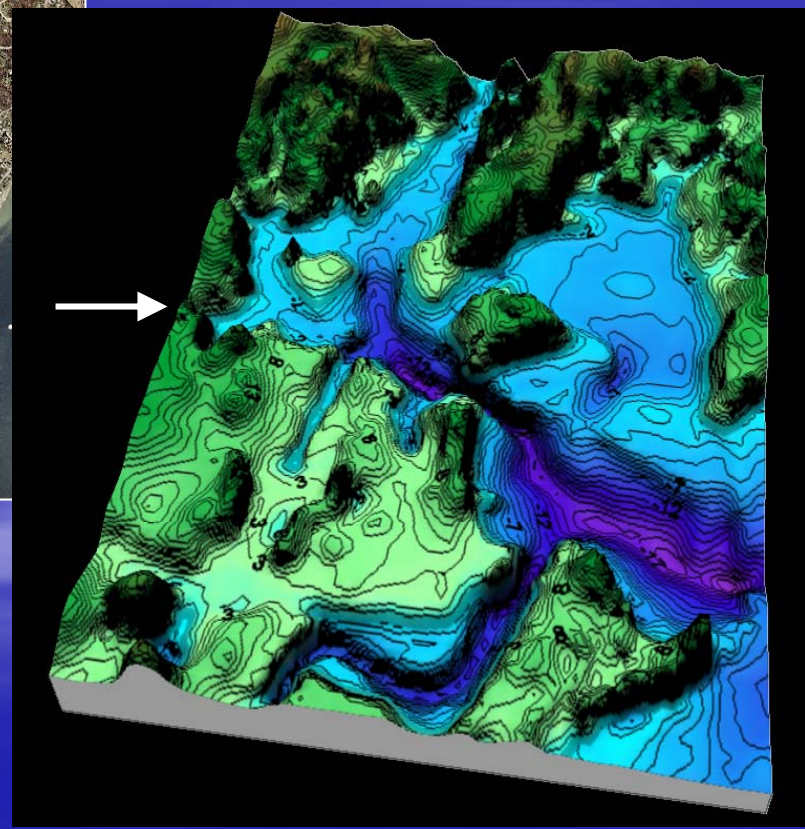


(From Bradley and Stolt, 2003. Soil Sci. Soc. Am. J. 67:1487-1495)

Landscape Units

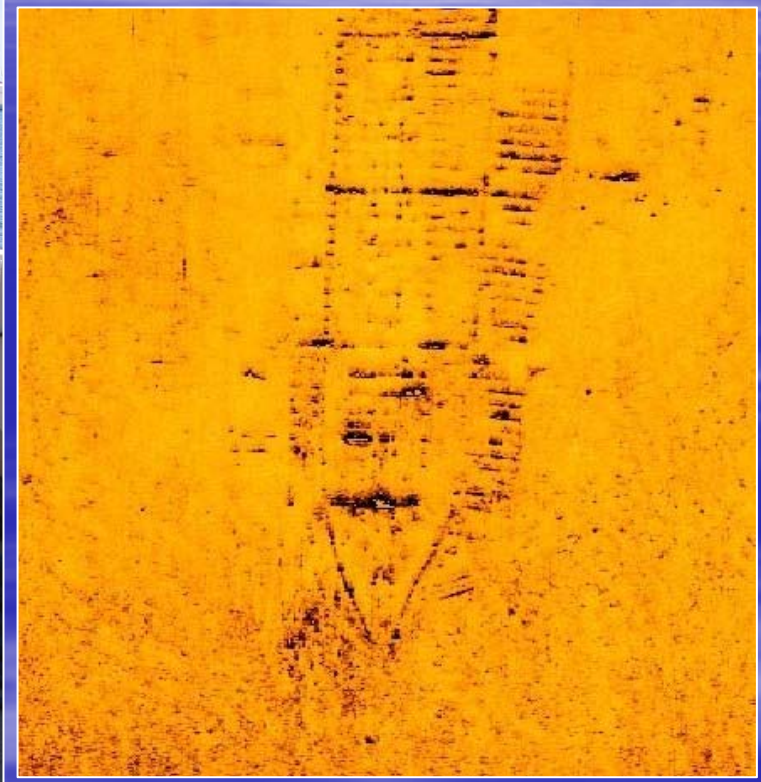
- Soil units linked to landscape
- Landscape units used as predictor of soil type

Bathymetry

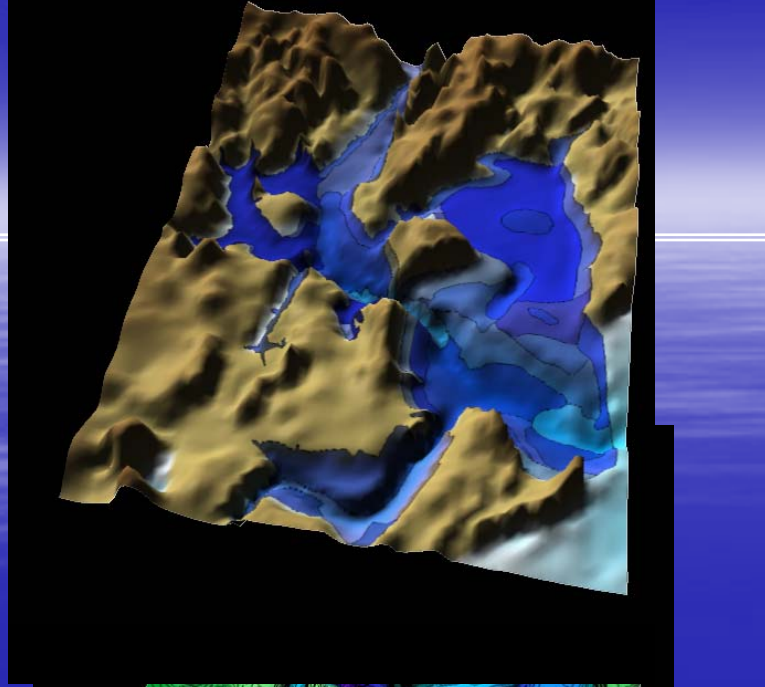


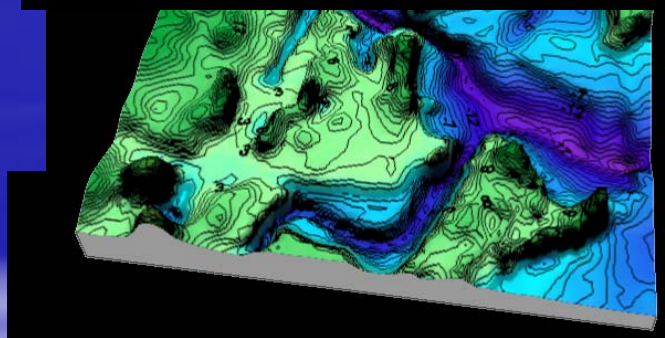
14 pts/ha

Sidescan



Soil Sampling and Analysis





Soil landscape polygons

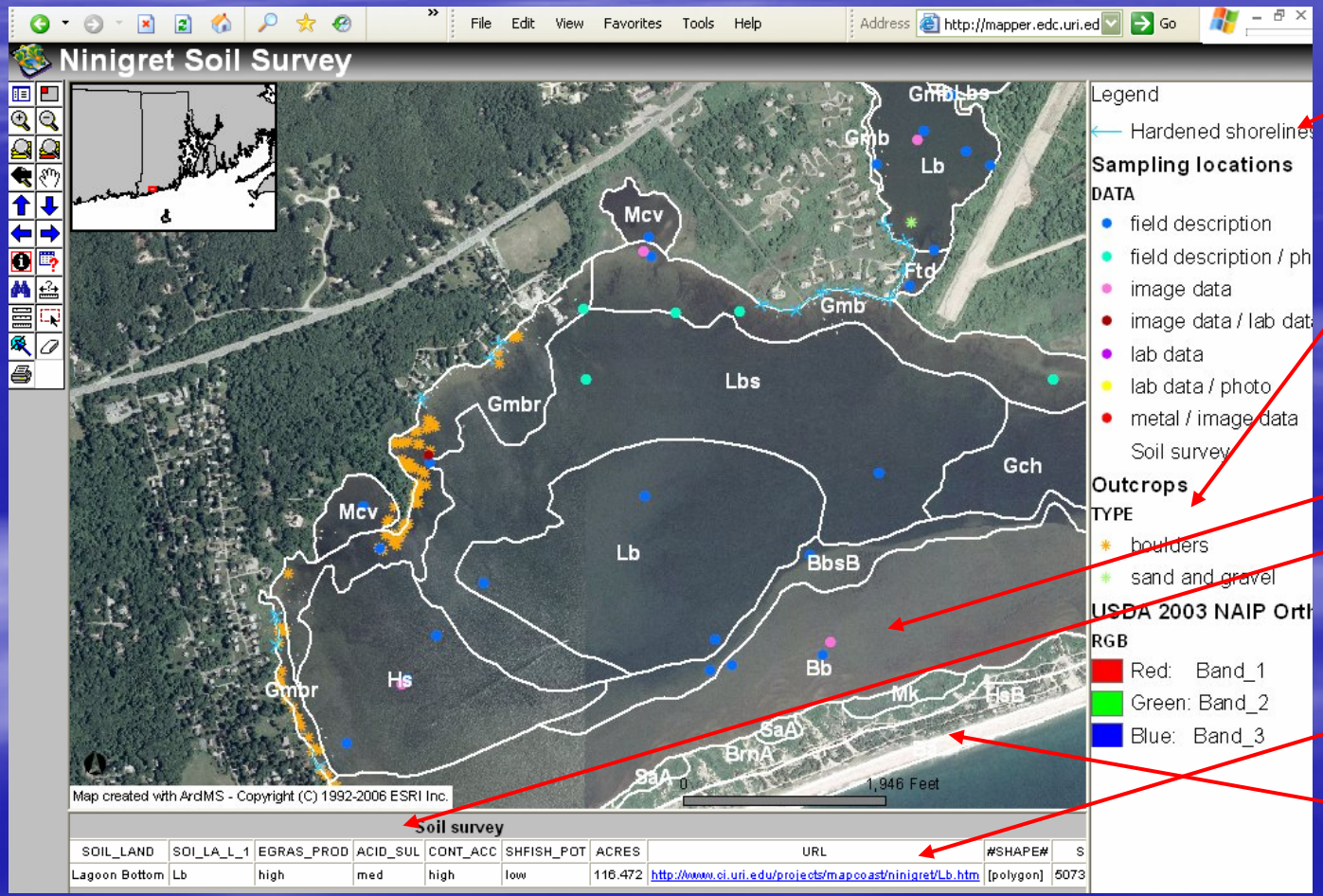
Bathymetry maps

Sidescan maps

+

Soil sampling

Soil Landscape Units → Soil Map



Lines – shoreline protection, etc.

Points – AdHoc spot symbols.

Polygons – spatial info with attribute data

Links

Coastal soils

RI009-2006-010-QP

Cg--0 to 15 centimeters; olive gray (5Y 5/2) interior, sand; single grain; loose; low excavation difficulty; organic lens at 16 cm; buried floating algal mat with scallop shell; very abrupt.

A/C--15 to 36 centimeters; 70 percent dark gray (5Y 4/1) interior and 30 percent gray (5Y 5/1) interior, loamy sand; black (5Y 2.5/1) mottles; massive; friable; low excavation difficulty; clear.

Ab--36 to 48 centimeters; dark gray (5Y 4/1) interior, fine sandy loam; massive; friable; low excavation difficulty; 1 percent unspecified fragments; trace shell fragments, n value=0.7, slight sulfur smell; clear.

C1--48 to 59 centimeters; very dark gray (5Y 3/1) interior, loamy sand; friable; 1 percent unspecified fragments; 1% shell fragments (periwinkle), slight sulfur smell; abrupt.

C2--59 to 63 centimeters; fine sand; single grain; friable; slight sulfur smell; abrupt.

C3--63 to 91 centimeters; dark olive gray (5Y 3/2) interior, fine sandy loam; massive; very friable; n value=0.7, 2 cm sand lens at 67 cm, 3% shell frags, soft shell clam at 67 cm, reed fragment at 85 cm, slight sulfur smell; clear.

CA--91 to 110 centimeters; dark gray (5Y 4/1) interior, loamy fine sand; massive; very friable; common very fine algal filaments, slight sulfur smell; clear.

C4--110 to 127 centimeters; dark olive gray (5Y 3/2) interior, fine sandy loam; massive; very friable; few very fine algal filaments, n value=0.7, 3% shell fragments, flat soft shell clam; abrupt.

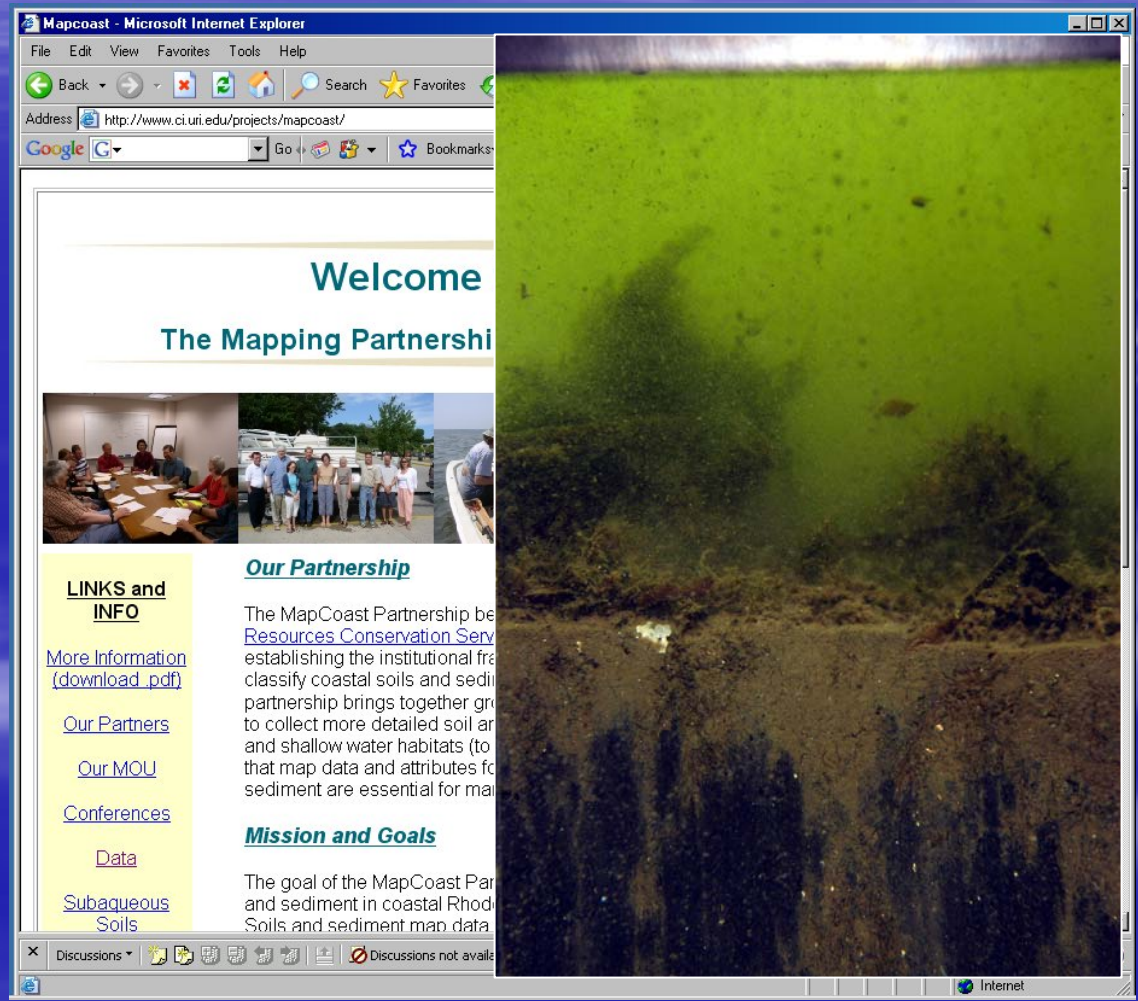
C5--127 to 134 centimeters; dark gray (5Y 4/1) interior, sandy loam; single grain; loose; 20% shells(flat), 5% gravel, 6 cm clast; abrupt.

2Cg--134 to 149 centimeters; gray (5Y 5/1) interior, sandy loam; massive; friable; 10% gravel.

Deliverables

- Bathymetry
- Benthic Habitats
- Soils
- Geology
- Imagery
- Metadata for all

www.mapcoast.org



Use and Management - Interpretations

- Water table
- Septic suitability
- Wetland delineations
- Eelgrass habitat
- Shellfish habitat
- Dredge material disposal concerns

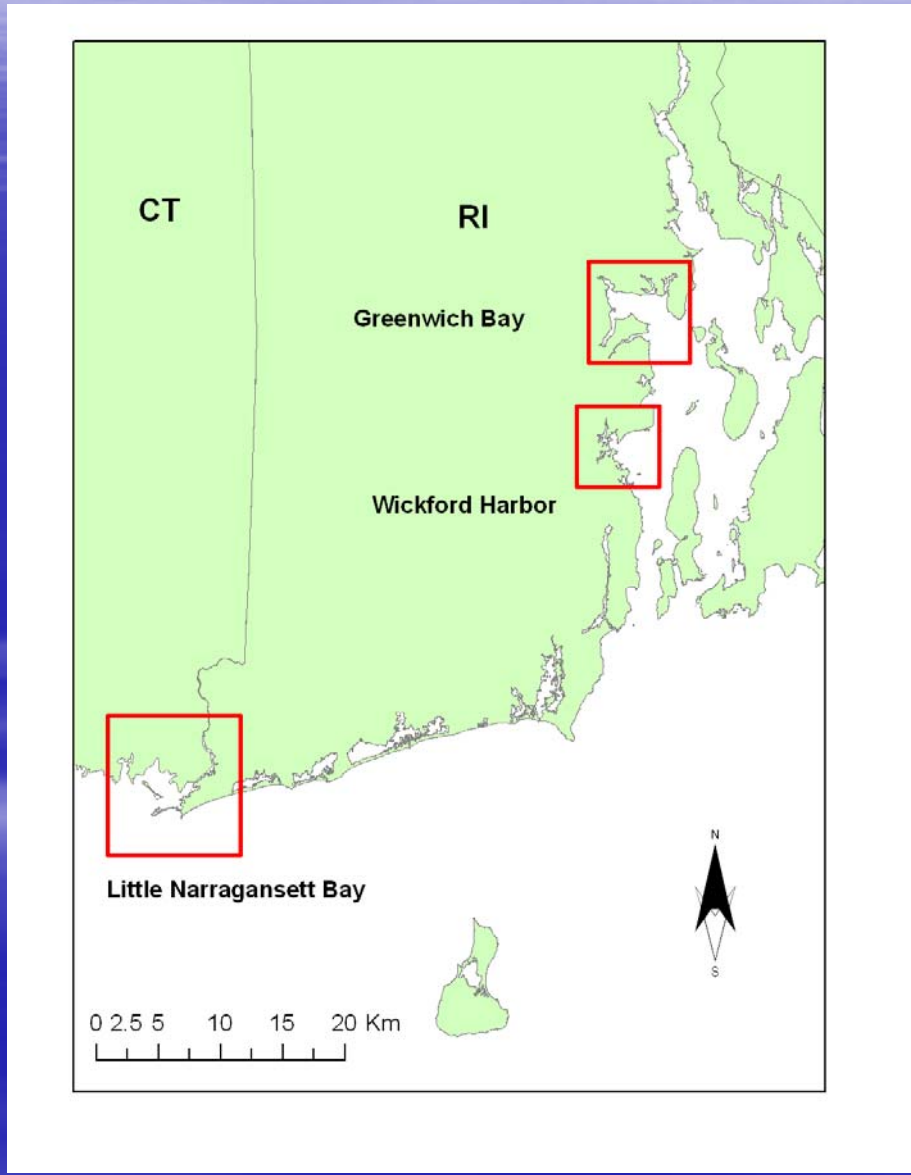
Study Overview

1) Landscape unit mapping
   - Soil-landscape model for open embayments
2) Water quality assessment
   - Water quality impact on soil redox potential
   - Can soil landscape units be used to identify areas of concern regarding water quality?
3) Sulfide distribution
   - Eelgrass seeding site selection
   - Disposal of dredged material

Study Locations

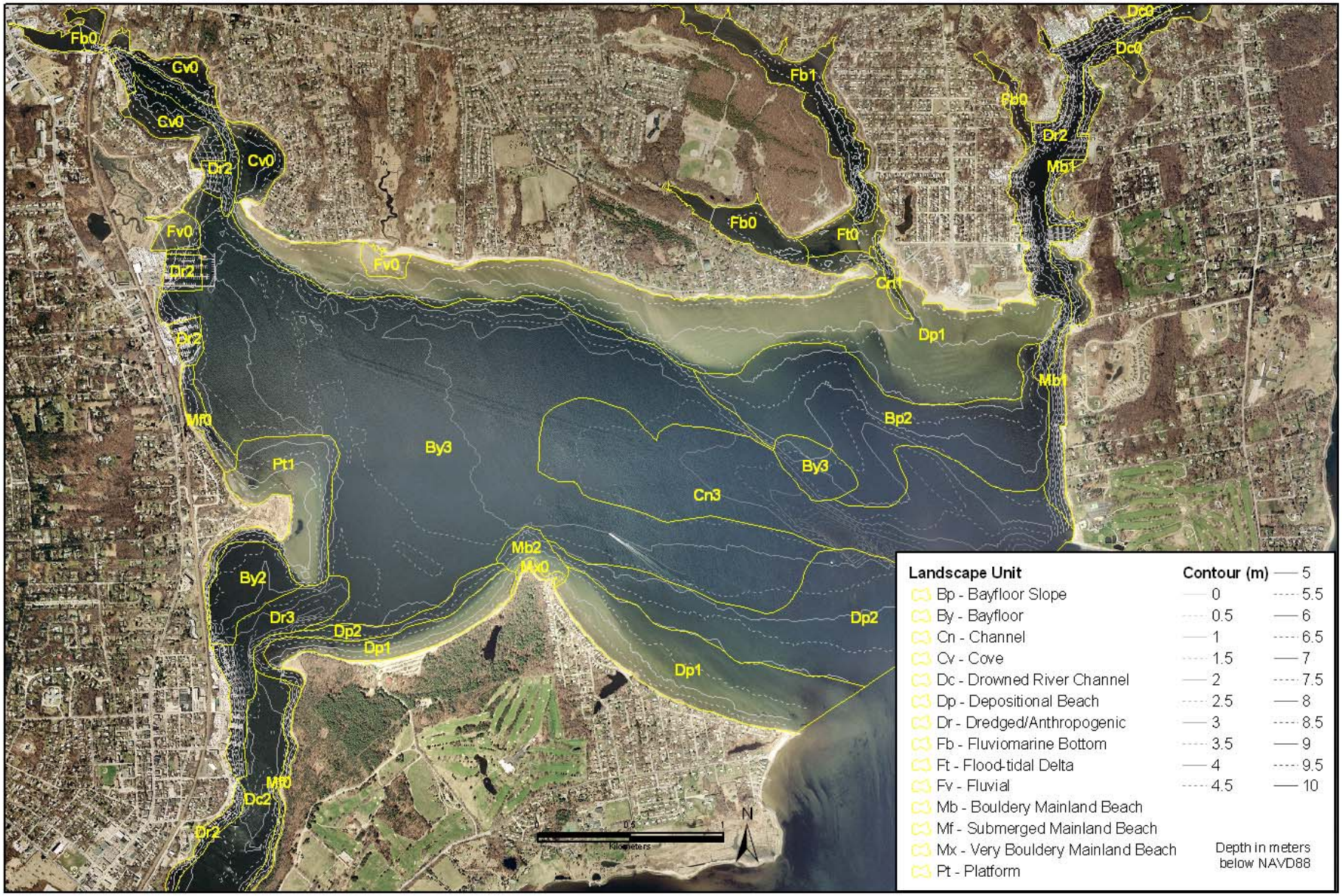
- Greenwich Bay (1200 ha)
- Wickford Harbor (160 ha)
- Little Narragansett Bay (1000 ha)

- Range of human impact
- Similar landscape units
- Similar parent materials

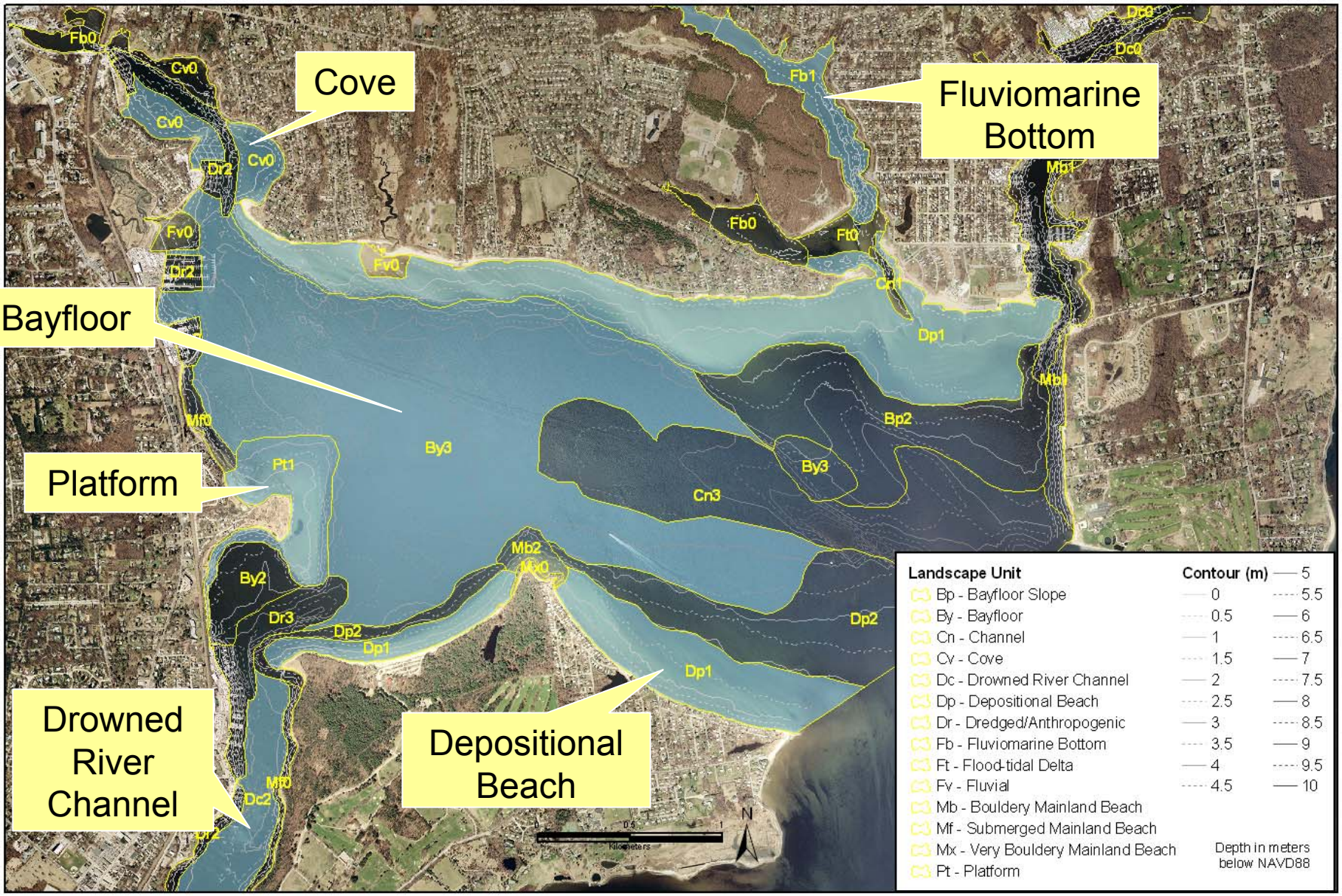


Soil Sampling and Analysis

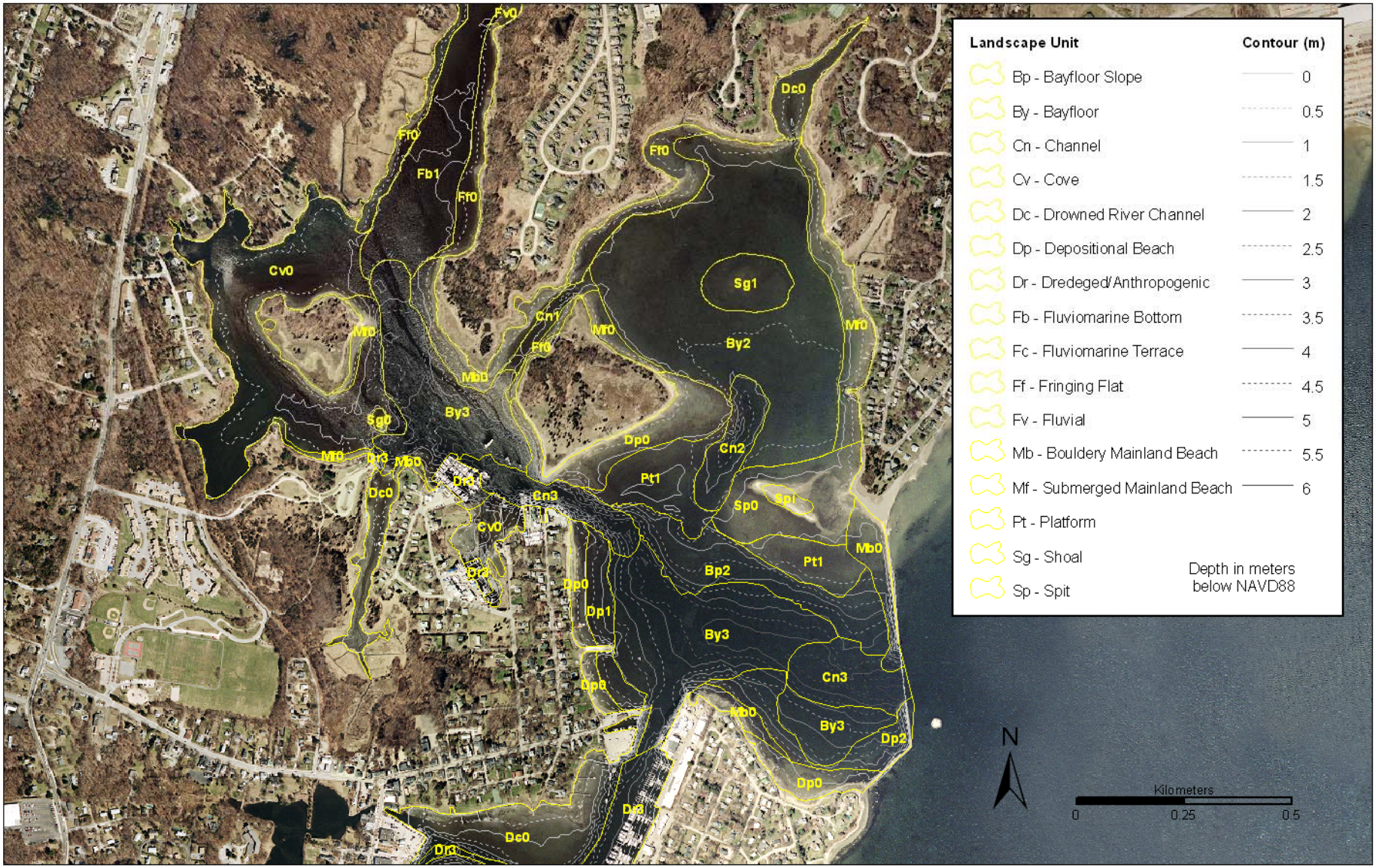
- Field descriptions
  - Horizon, color, texture, n-value
- Particle size distribution
- Bulk density
- Nitrogen (N)
- Carbon (C)
- Calcium Carbonate ($CaCO_3$)
- Salinity
- H_2O_2 oxidized salinity
- Incubated pH
- Sulfide content



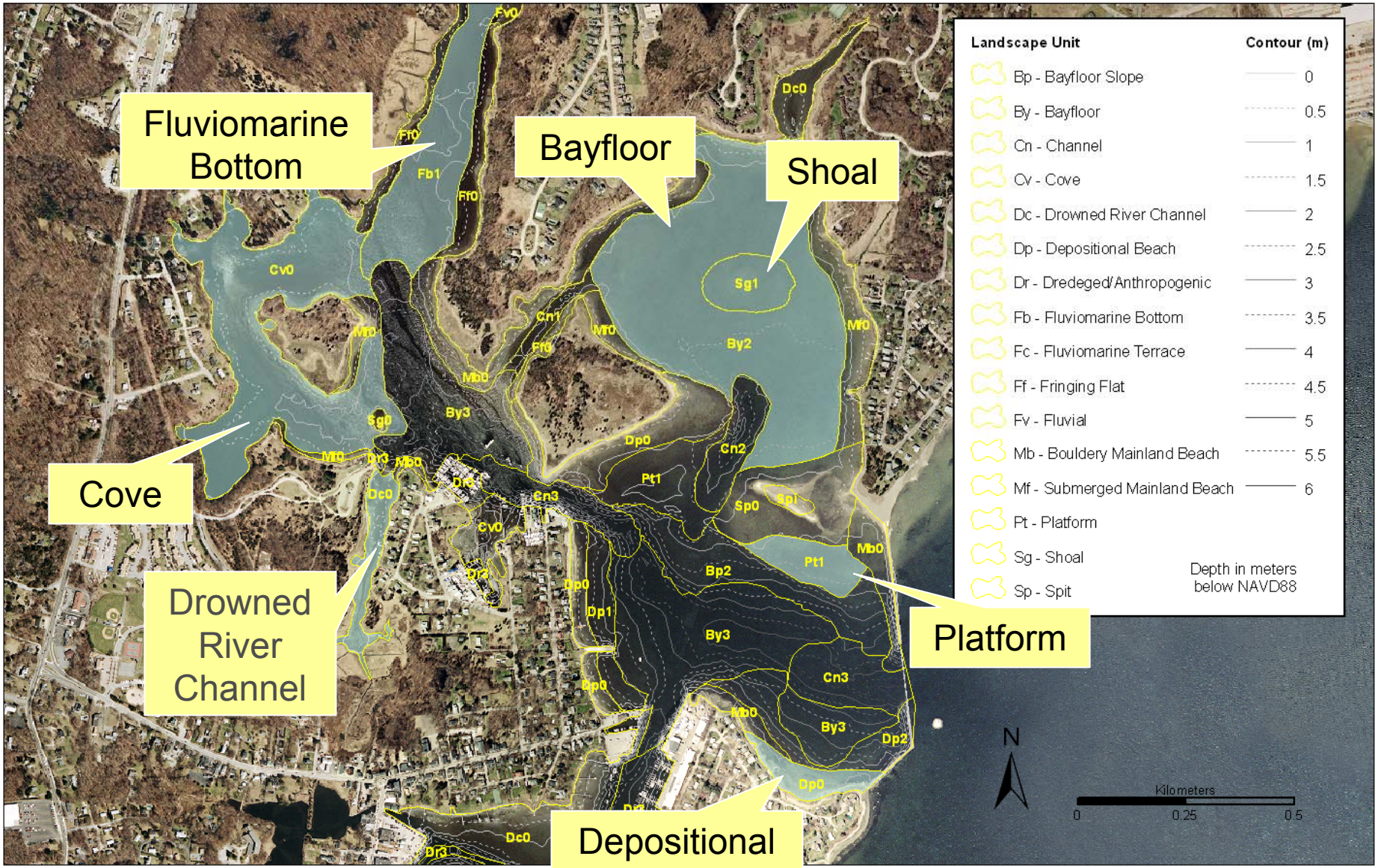
Greenwich Bay



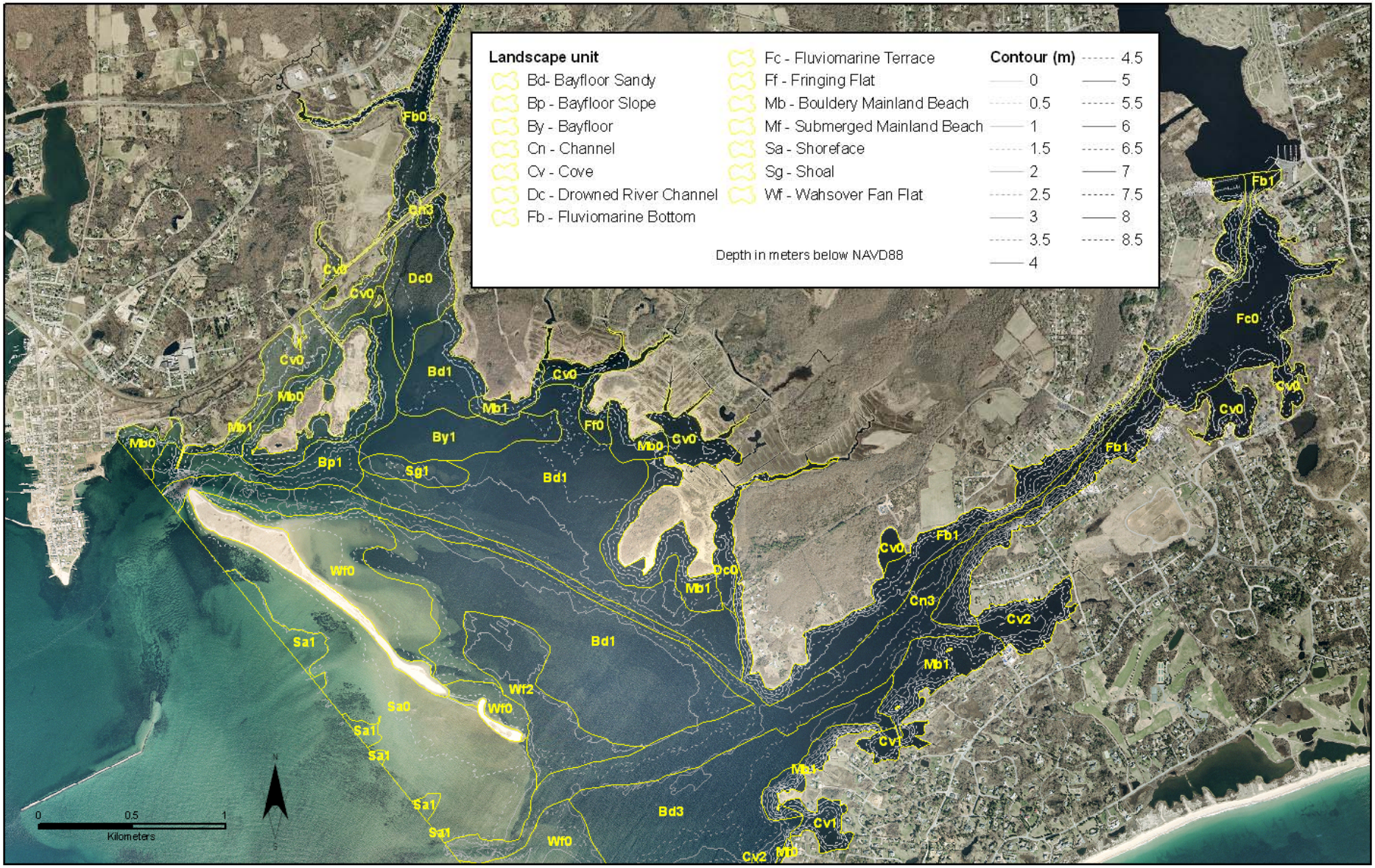
Greenwich Bay



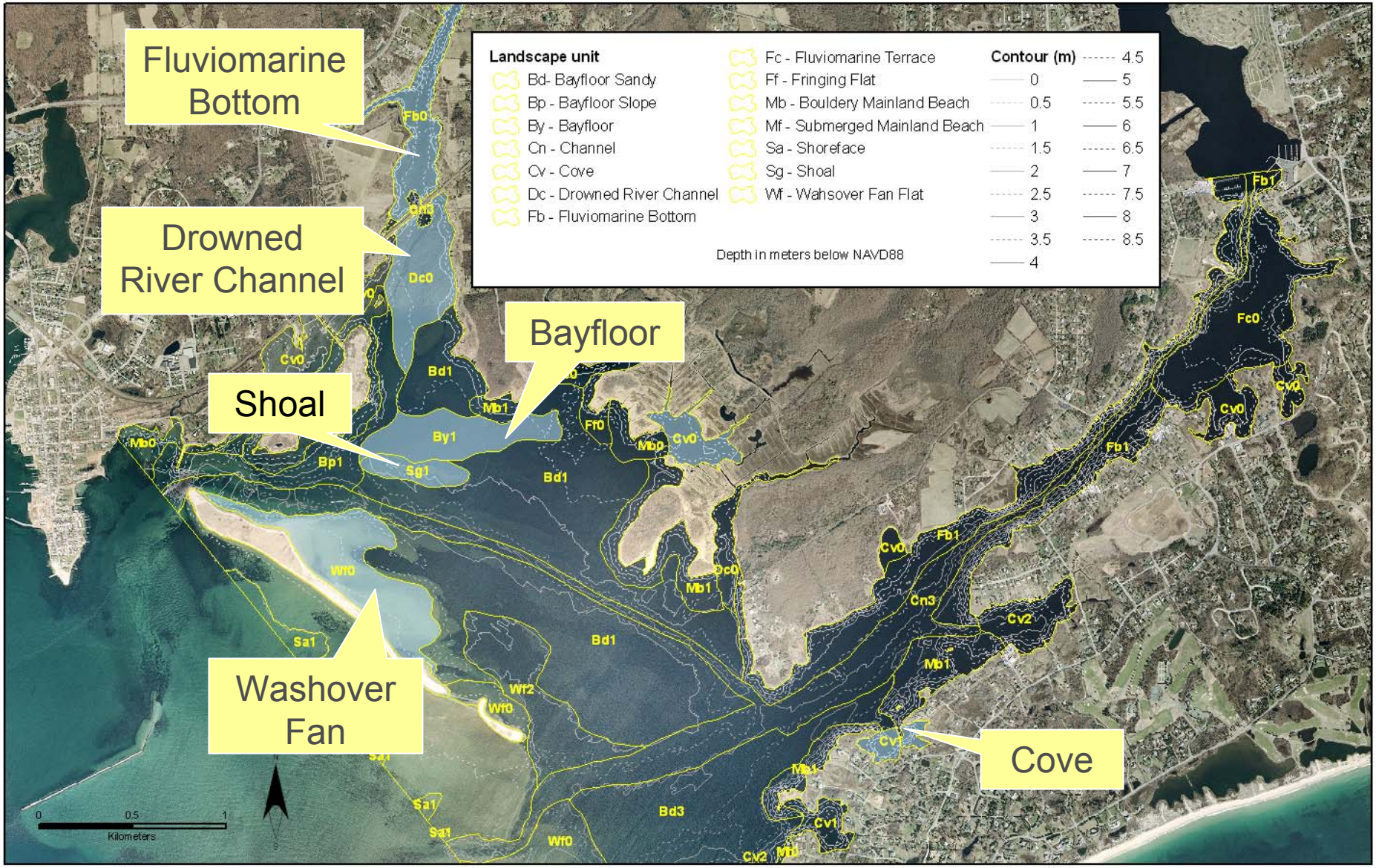
Wickford Harbor



Wickford Harbor



Little Narragansett Bay



Little Narragansett Bay

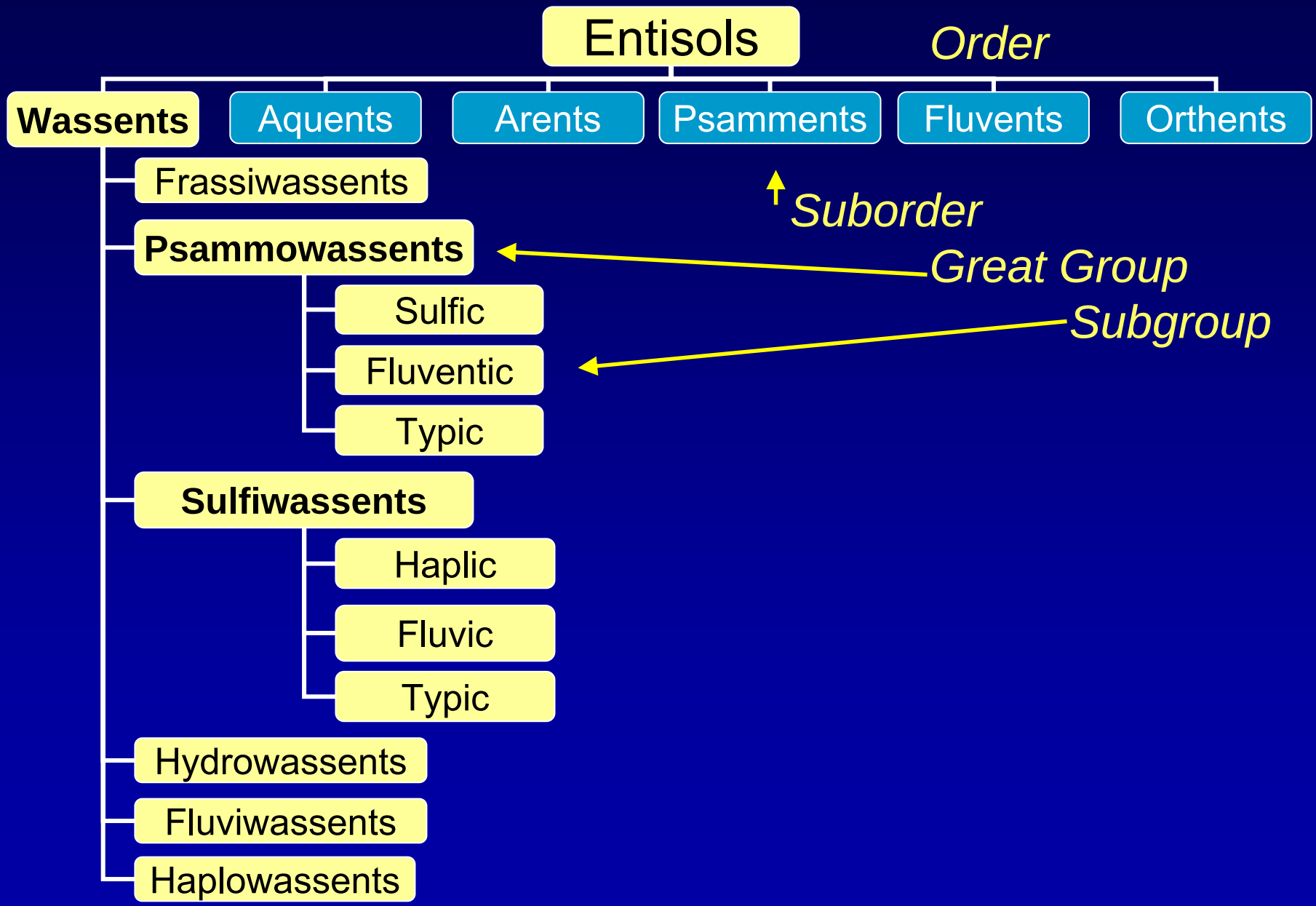
Common Landscape Units

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*	2	-	1

*GLOSSARY OF TERMS FOR SUBAQUEOUS SOILS, LANDSCAPES, LANDFORMS, AND PARENT MATERIALS OF ESTUARIES AND LAGOONS

http://www.nesoil.com/sas/glossary.htm

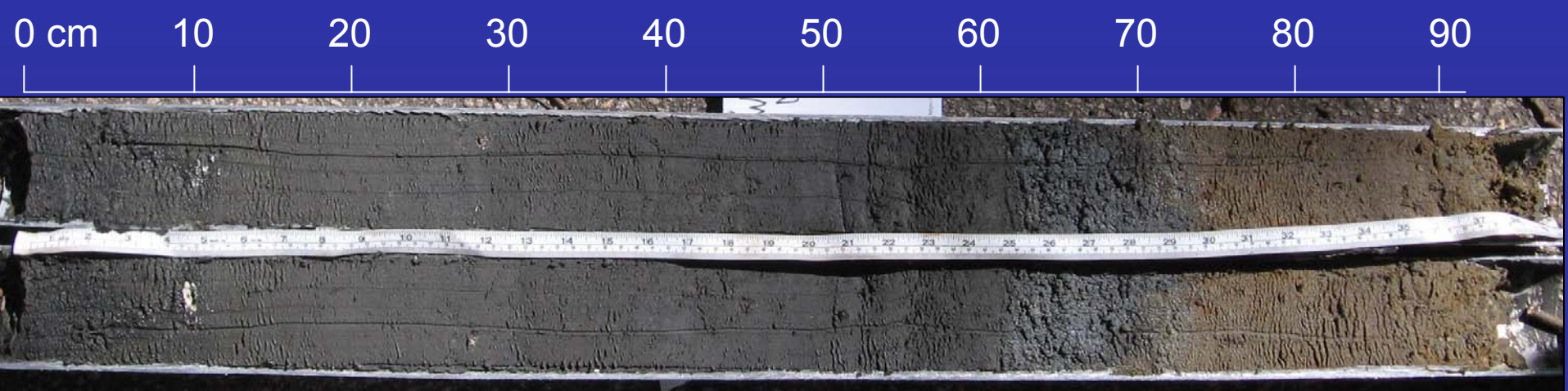
Soil Classification



Landscape Unit	Subgroup Classification (# of occurrences)	Taxonomic Purity
Bayfloor	**Fluvic Sulfiwassents (3)**	**50%**
	Haplic Sulfiwassents (3)	
Cove	**Fluvic 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	**Fluvic Sulfiwassents (3)**	**60%**
	Thapto-histic Sulfiwassents (1)	
Fluviomarine Bottom	**Fluvic 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)	

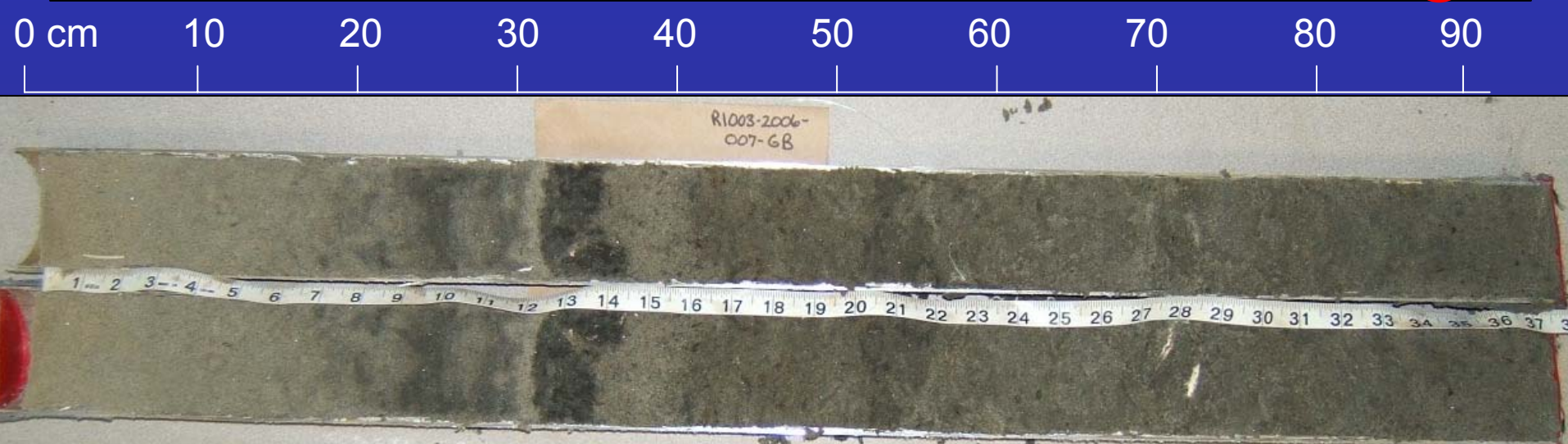
Fluvic Sulfiwassents

Horizon	Depth (cm)	Color				Field texture	Coarse Frags (%)	n-value
		%	Hue	Value	Chroma			
A	0-5	100	5Y	2.5	1	sl		2
AC	5-14	100	5Y	3	1	l	1 shell	2
C1	14-33	100	5Y	3	1	l		1
C2	33-53	100	5Y	3	1	l		1
C3	53-64	100	5Y	3	1	fsl		0
2Cg1	64-74	100	N	4	0	ls		0
2Cg2	74-95	100	2.5Y	4	2	ls		0
2C	95-96	100	2.5Y	4	3	sl	15 gravel	0



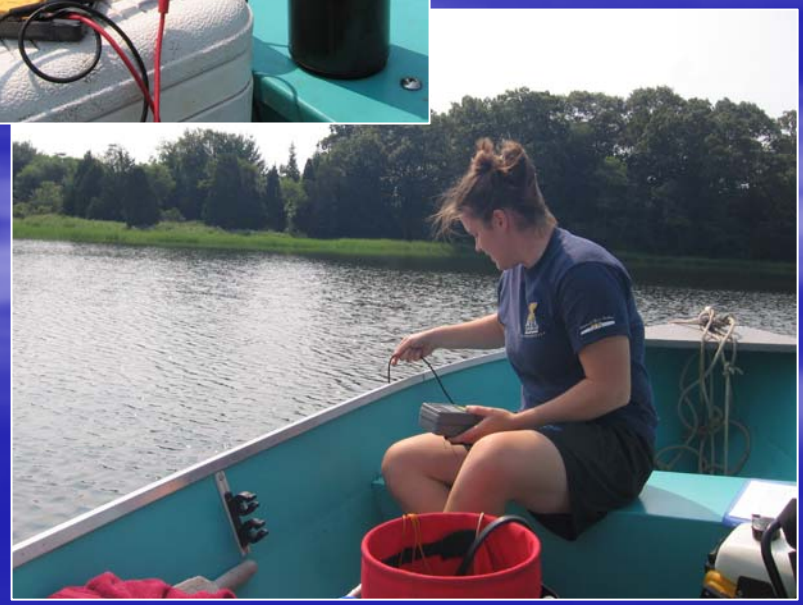
Fluventic Psammowassents

Horizon	Depth (cm)	Color				Field texture	Coarse Frags	n-value
		%	Hue	Value	Chroma		(%)	
Cg	0-17	100	10Y	6	1	s		0
C/A	17-31	50	10Y	6	1	s		0
		50	10Y	3	1			
Ab	31-36	100	10Y	3	1	ls		0
Cg'	36-41	100	5Y	5	2	s		0
CA	41-64	90	5Y	4	1	s	2 shell	0
		10	5Y	3				
Cg''	64-96	100	5Y	5	1	ls	2 shell	0



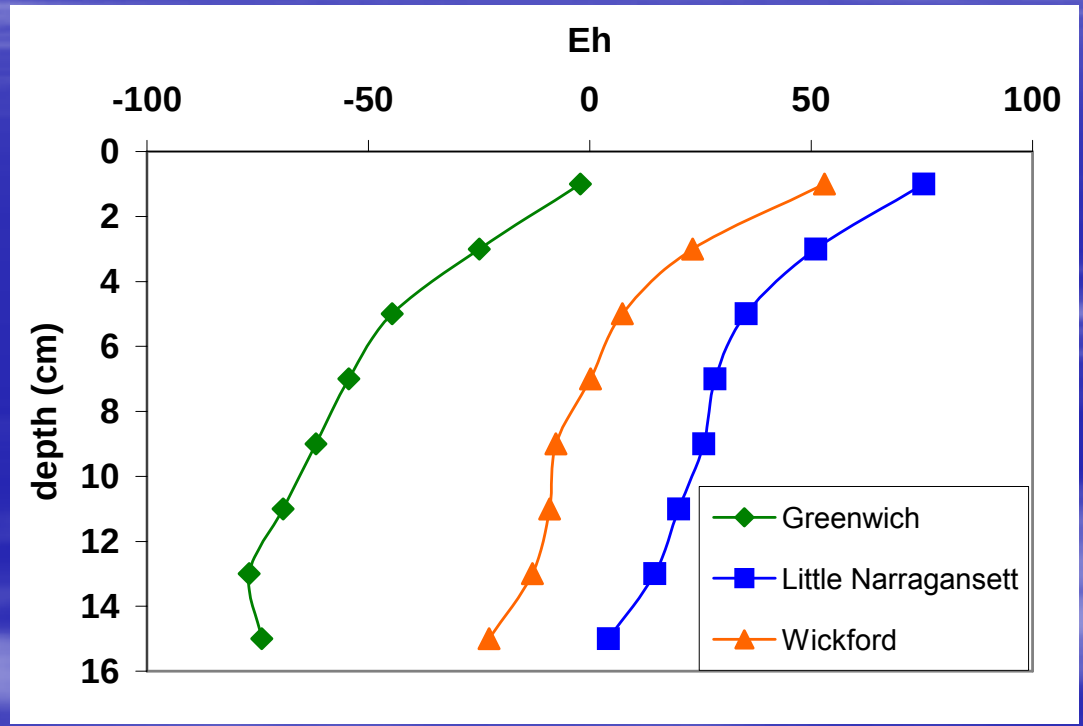
Water Quality Assessment

- 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

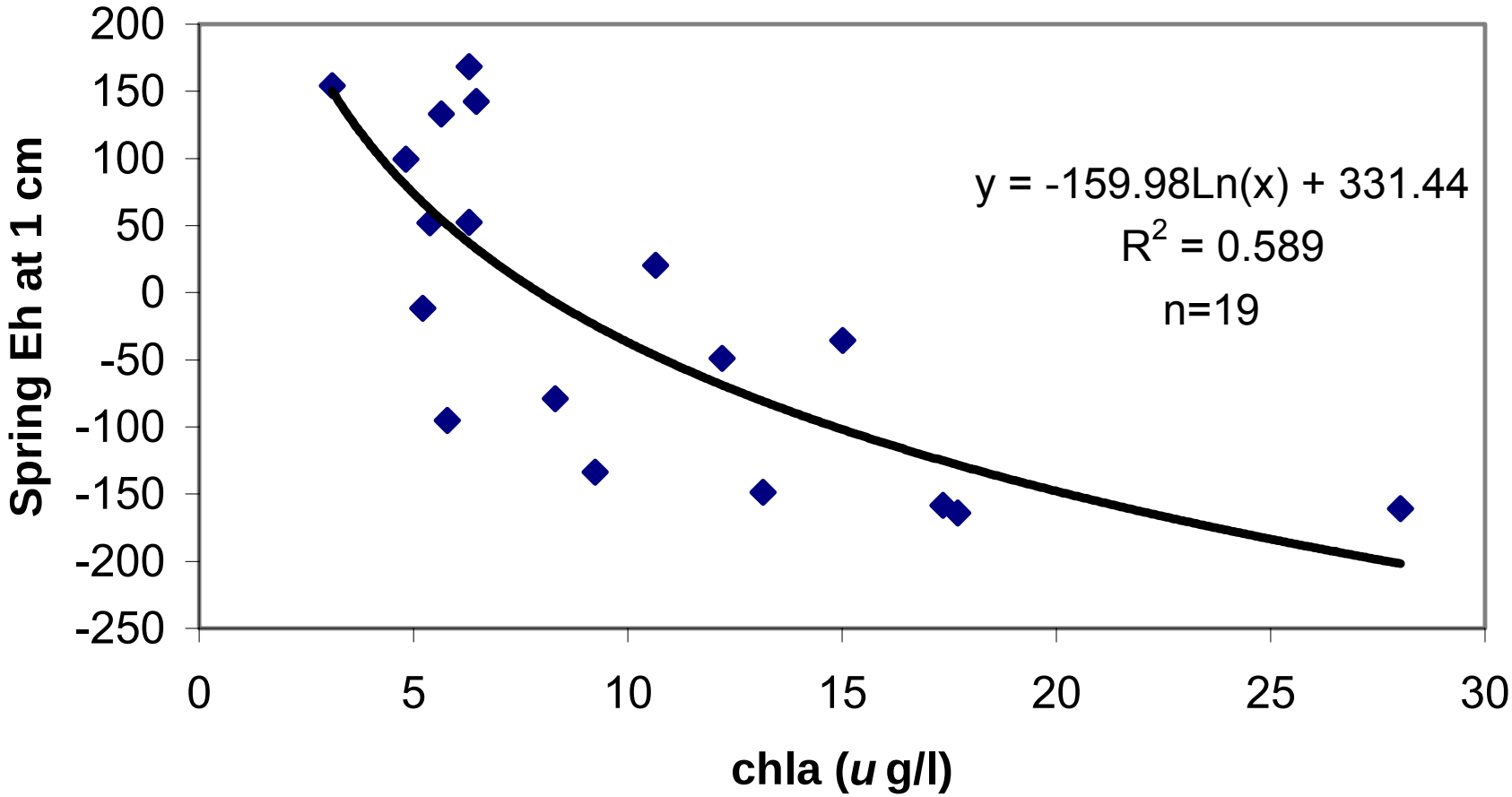


Oxidation-Reduction Potential (Eh)

- Decomposition of organic matter by microbes
- Oxygen, nitrogen, iron, and sulfur act as electron acceptors
- Redox potential gradient with oxidized surface, transition zone, and sulfidic anaerobic zone

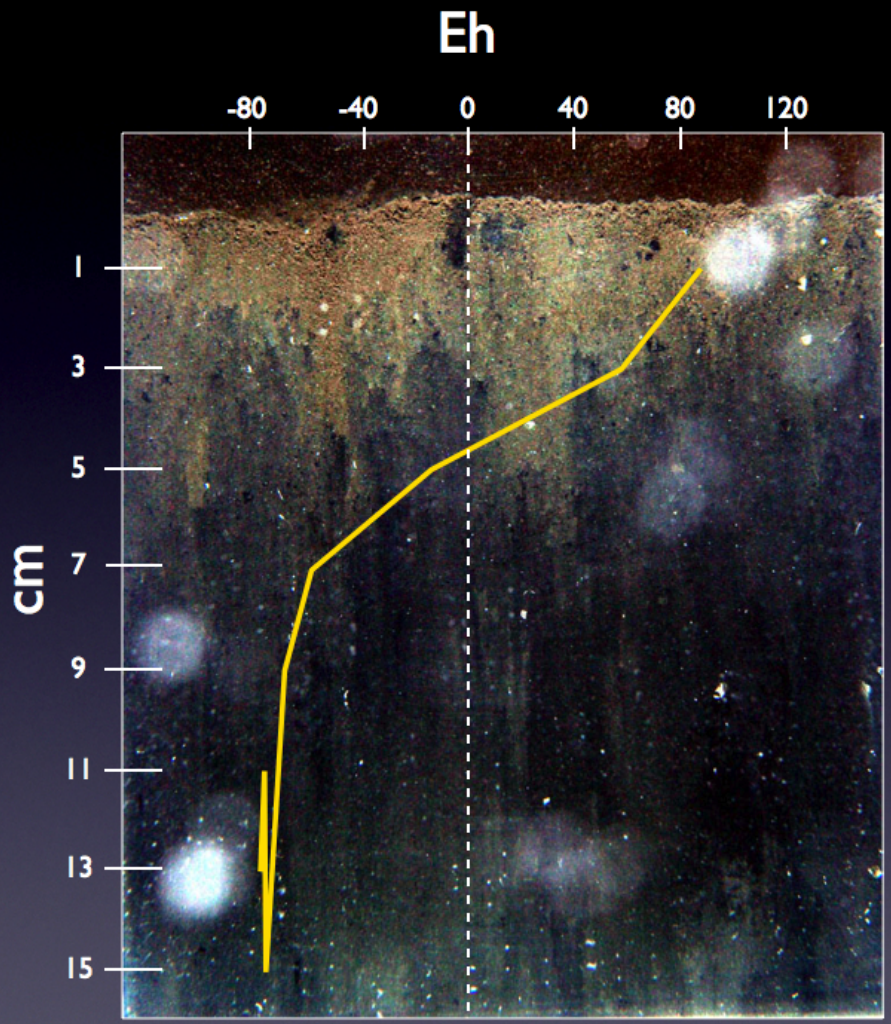


Redox Potential and Water Quality



Sediment Profile Imaging (SPI)

May 29/30



Oxidized surface (aRPD)

Reduced (monosulfides)

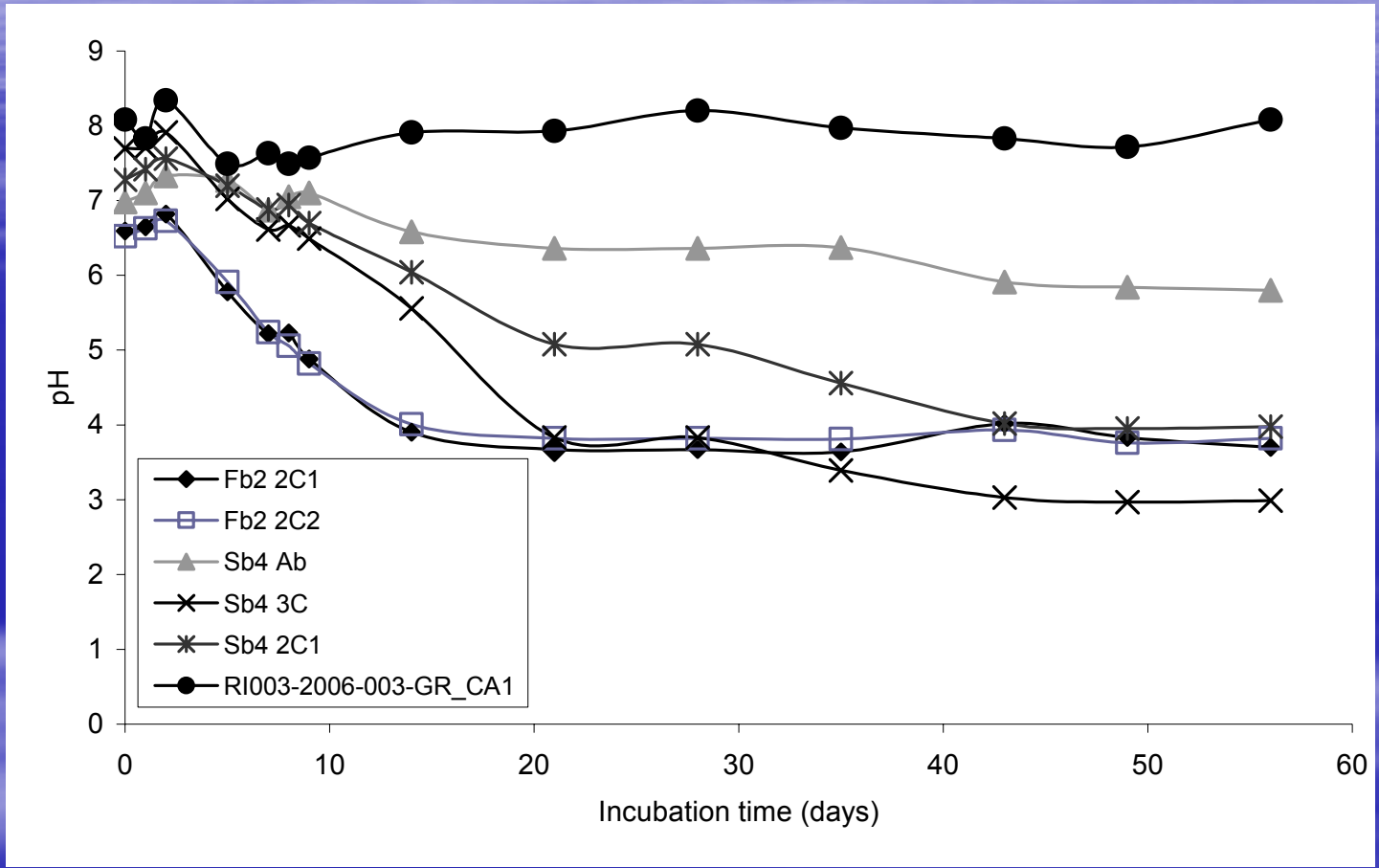
Sulfides

Goals:

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

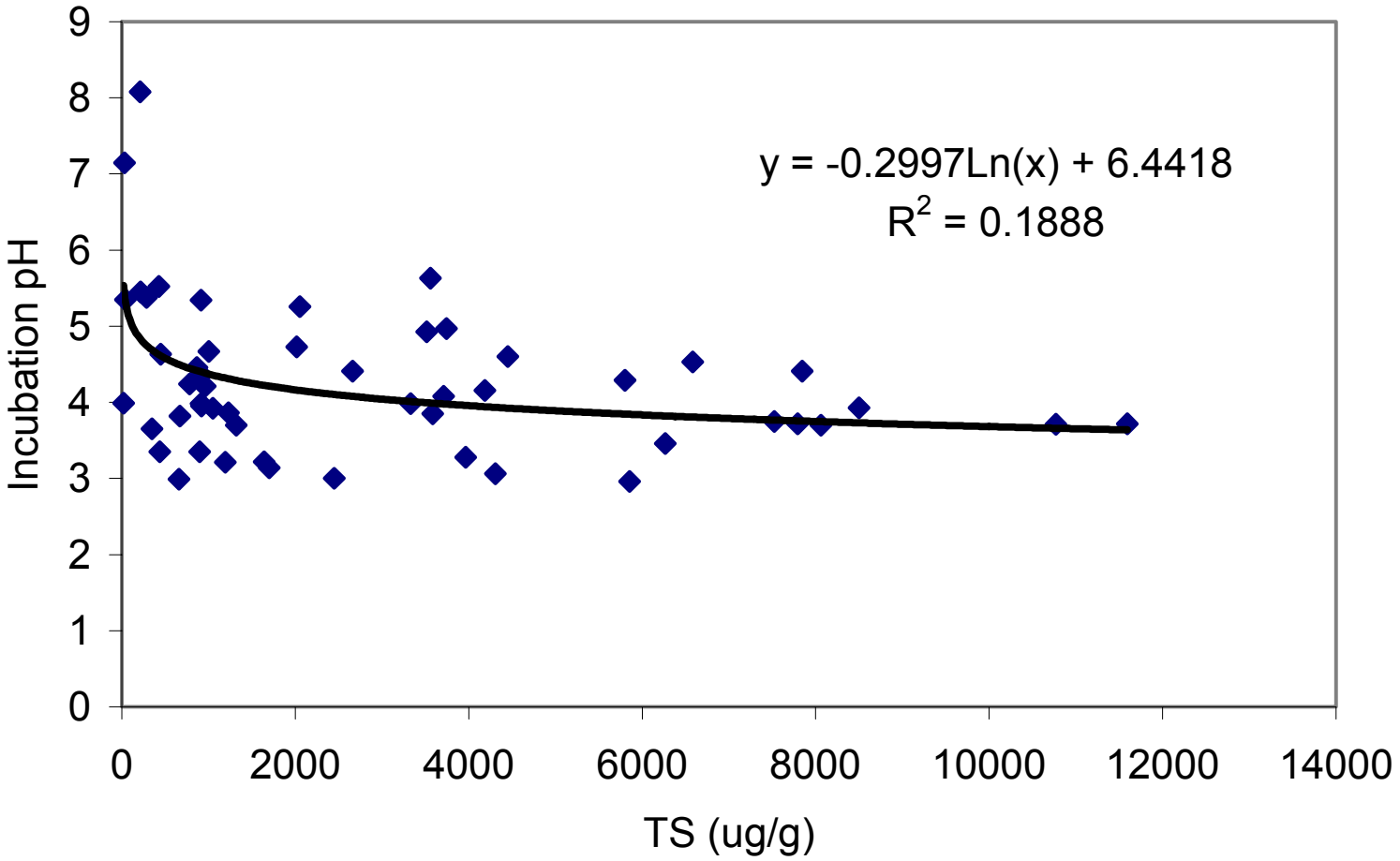
Acid sulfate soils from dredged material

Incubation pH

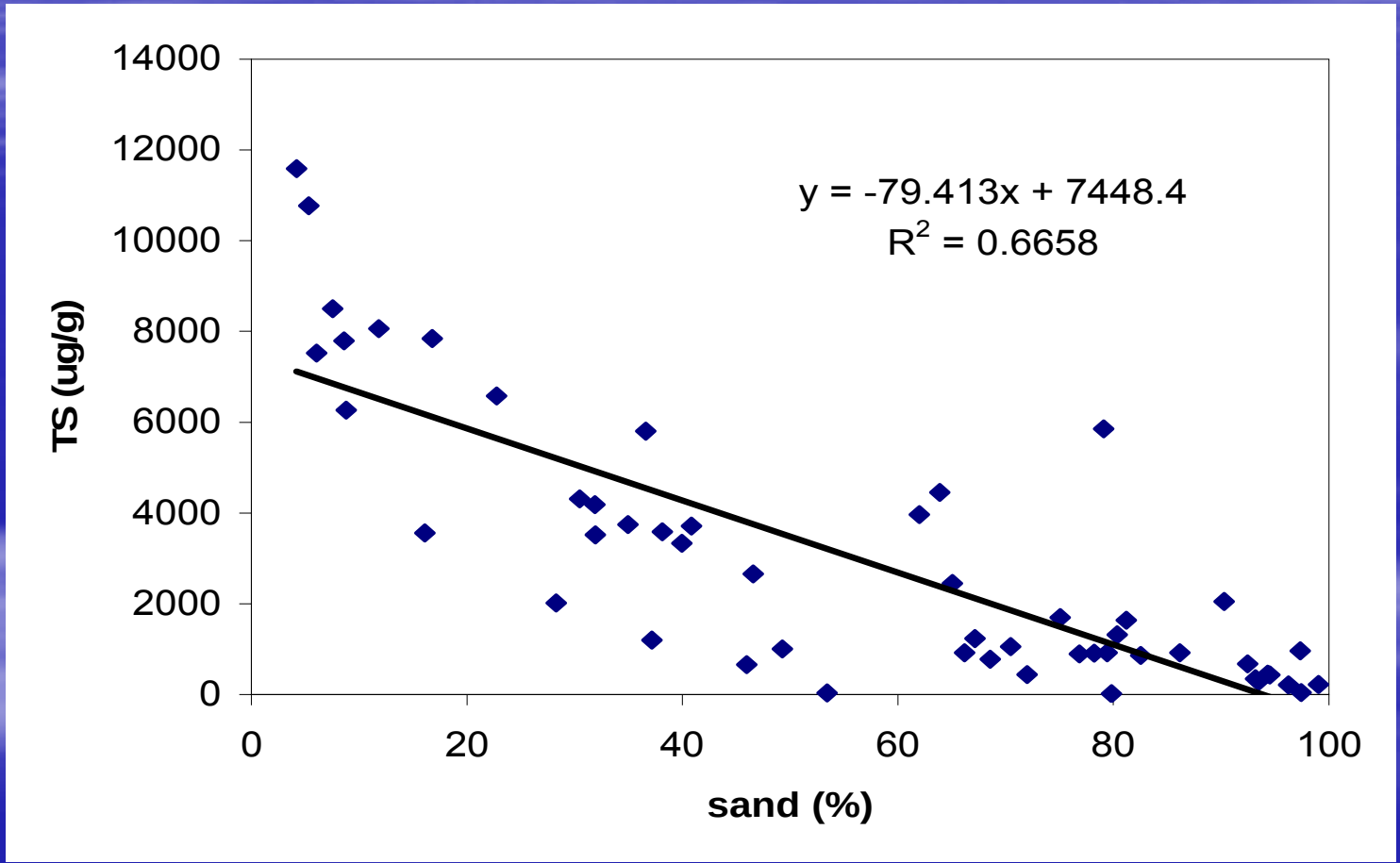


- Incubation pH ≤4 is currently used to define sulfidic materials

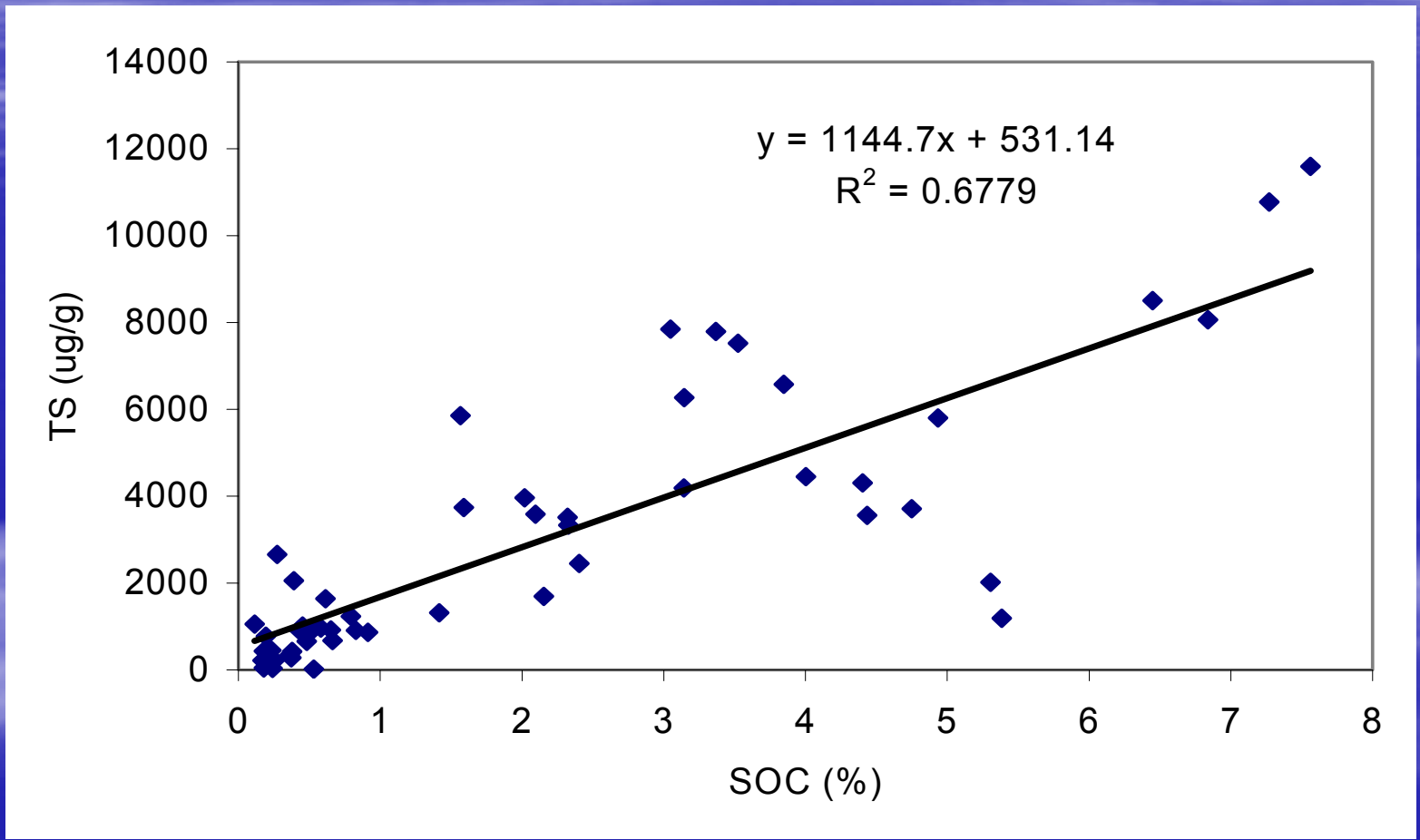
Incubation pH



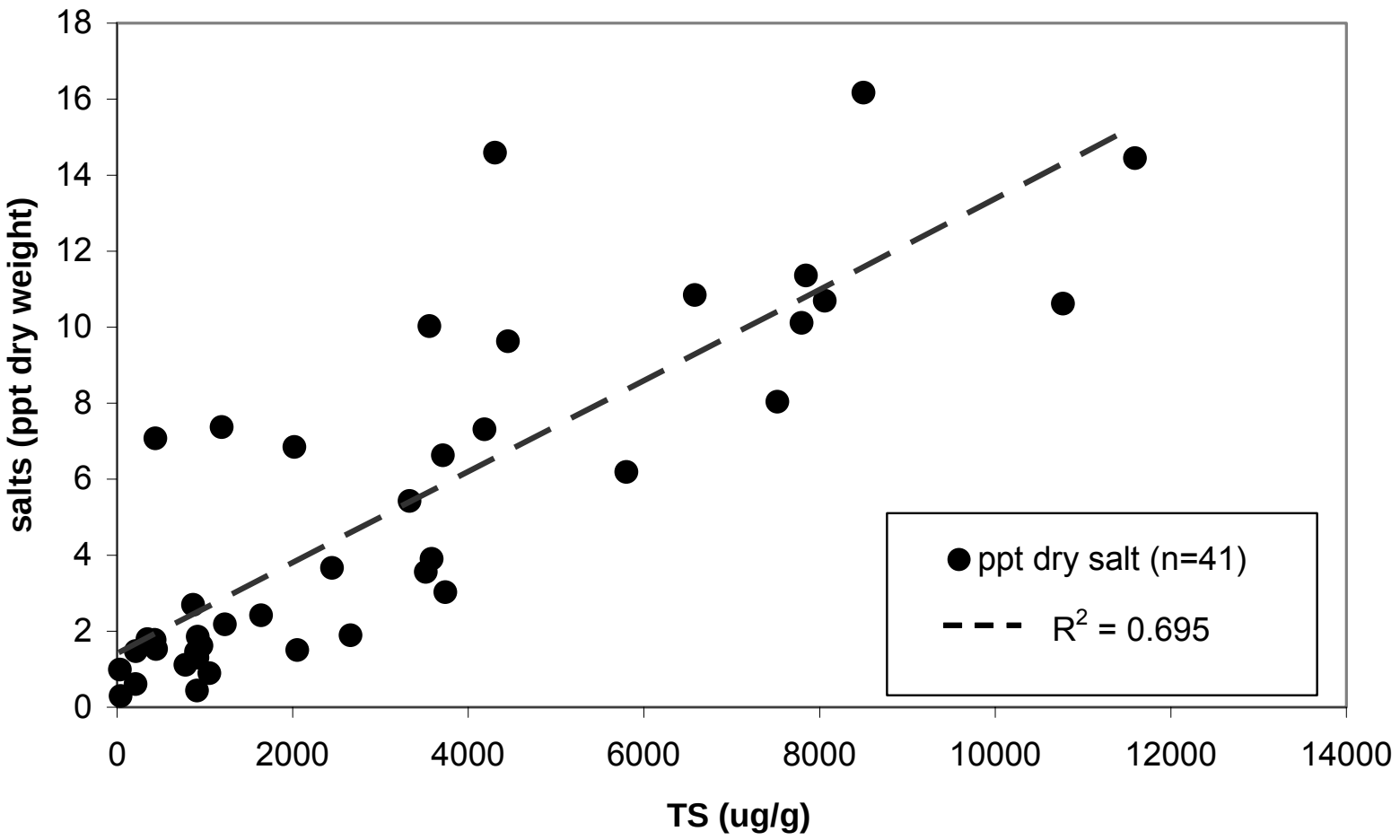
Sulfide Distribution



Sulfide Distribution



H_2O_2 Oxidized Salinity



Conclusions

- Soil-landscape model can be used effectively for shallow embayments
  - Sulfiwassents and Psammowassents are two most common great groups
  - Purity values generally ≥ 50%
    - Differences due to thickness of highly fluid materials and presence/absence of sulfidic materials

Conclusions

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

Conclusions

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

Acknowledgements

- Dr. Mark Stolt
- Dr. Jon Boothroyd
- Dr. Peter August
- Dr. John King
- Mike Bradley
- Jim Turenne
- Bryan Oakley
- Emily Shumchenia
- Kim Devlin
- Emily Blair
- Sarah Lincoln
- Michelle Marasco
- Dave Millar
- Alex Salisbury
- MapCoast
- URI Watershed Watch

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RI Agricultural Experiment Station