Users of Subaqueous soil survey data for resource management (Phillip King, 2004).

US-EPA, MD-DNR, MDE
Chesapeake Bay Program
DE Inland Bay Program
Maryland Coastal Bays Program
Egg Harbor, NJ
Baltimore Harbor/Bay Dredging US-ACE
Pamlico-Albermarle Sound NEP Program
NOAA
Worchester SWCD,
Assateague Island National Park
Private Aquaculture Industry
Shellfish Harvest Industry
NRCS, RCD, DE CIB, DNREC
DE Sierra Club

Specific Soil Resource Based Interpretations

- SAV Restoration
- Crab Habitat
- Clam Stocking
- Management for Sustainable Production Clam, Oyster, and Scallop
- Nutrient Reduction
- Pathogens Pfesteria Cyst Residence Sites
- Benthic Preservation Site Identification
- Wildlife Management
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- Bathymetric Map
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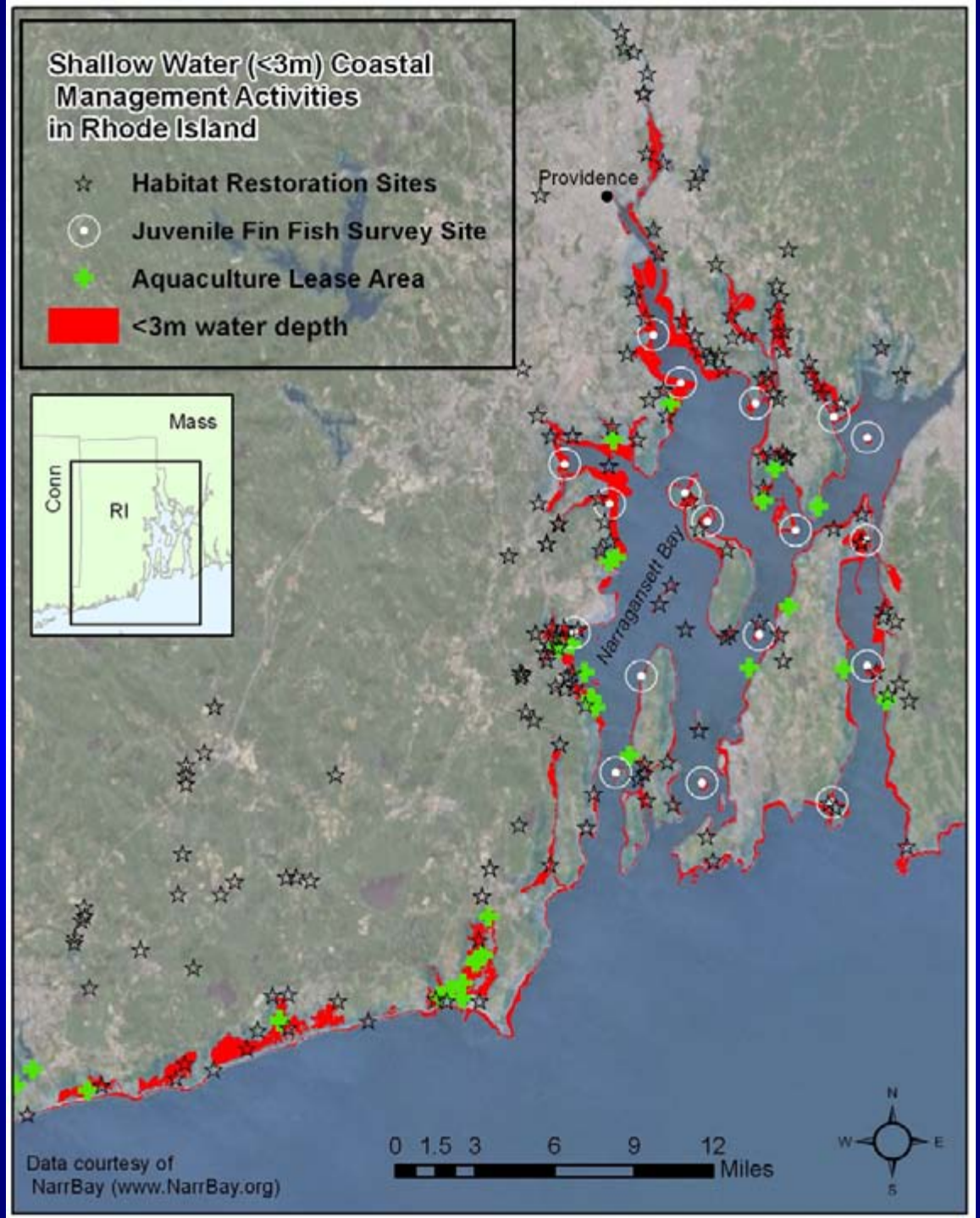
- Effects of Dredging on Benthic Ecology
- Off Site Disposal of Dredge Spoil
- Acid-Sulfate Weathering Hazards
- Dune Maintenance/Replenishment


Shallow Water (<3m) Coastal Management Activities in Rhode Island
Habitat Restoration Sites
Juvenile Fin Fish Survey Site
Aquaculture Lease Area
<3m water depth
Providence
Narragansett Bay
Mass
Conn
RI
Data courtesy of NarrBay (www.NarrBay.org)
0 1.5 3 6 9 12
Miles
N
W
E
S

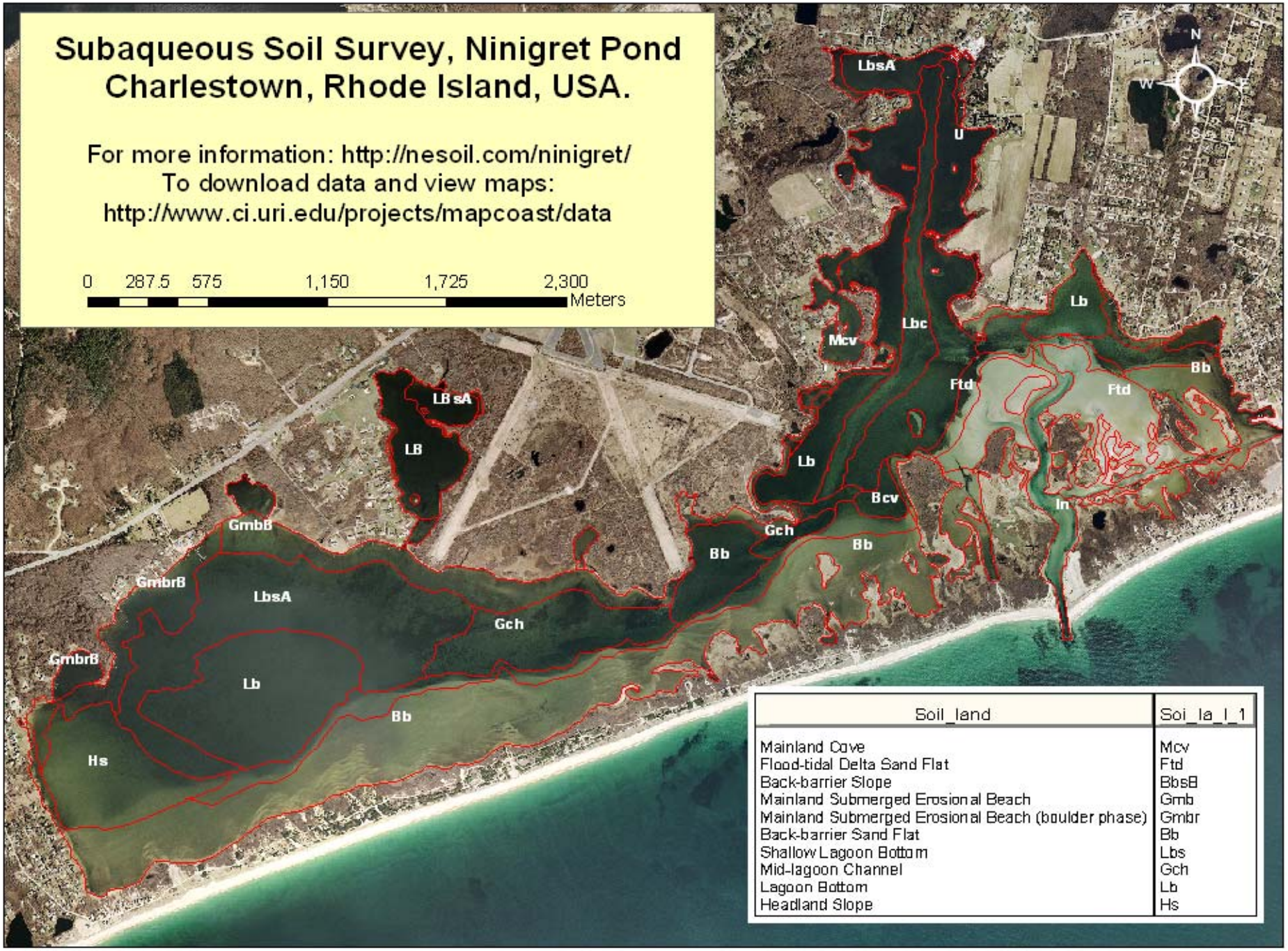
Subaqueous Soil Interpretations

- **Shellfish Aquaculture**
- **Disposal of Dredge Deposits**
- **Eelgrass Restoration**
- Carbon Accounting

Subaqueous Soil Survey, Ninigret Pond
Charlestown, Rhode Island, USA.

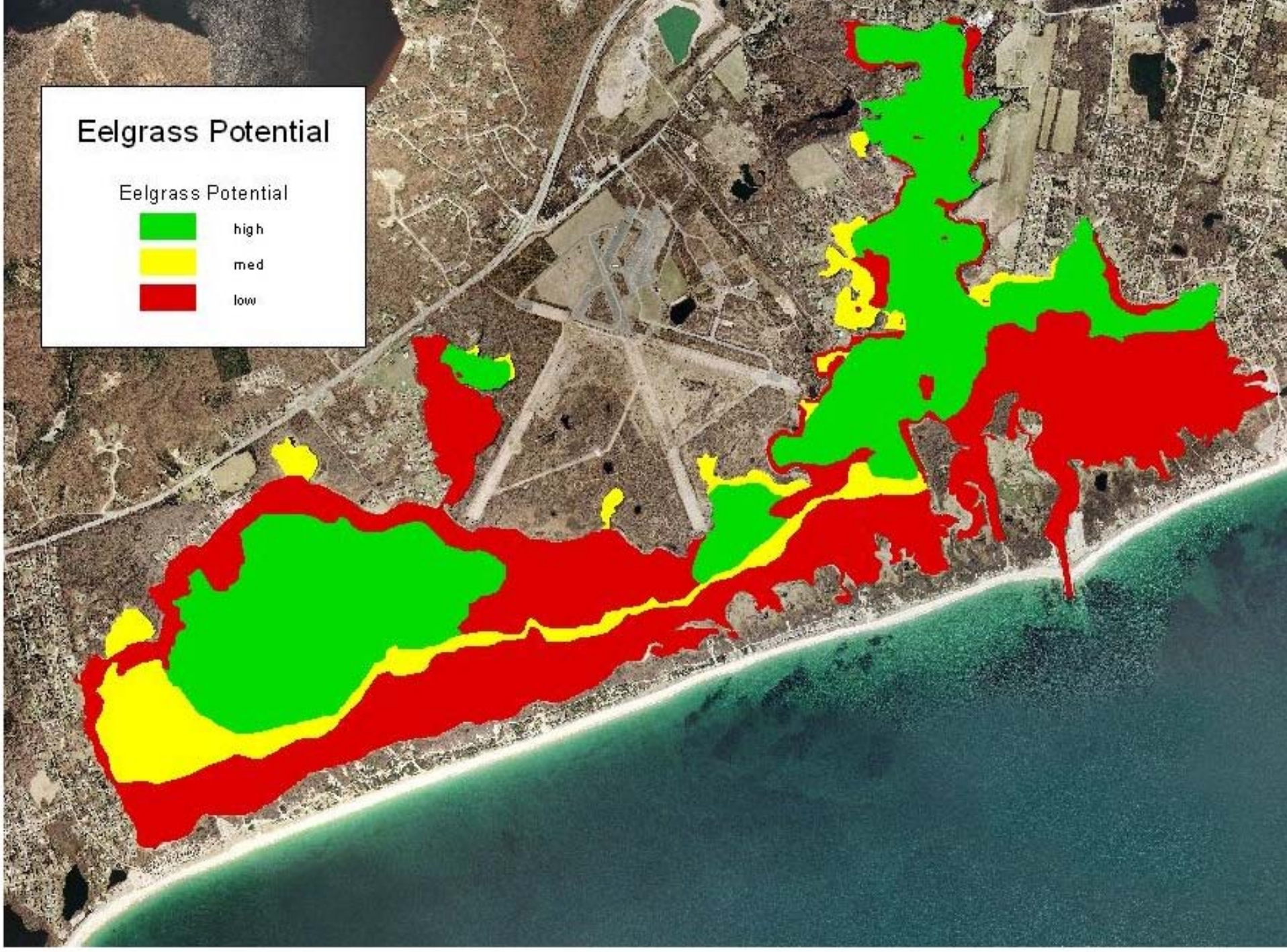
For more information: http://nesoil.com/ninigret/
To download data and view maps:
http://www.ci.uri.edu/projects/mapcoast/data

0 287.5 575 1,150 1,725 2,300
Meters

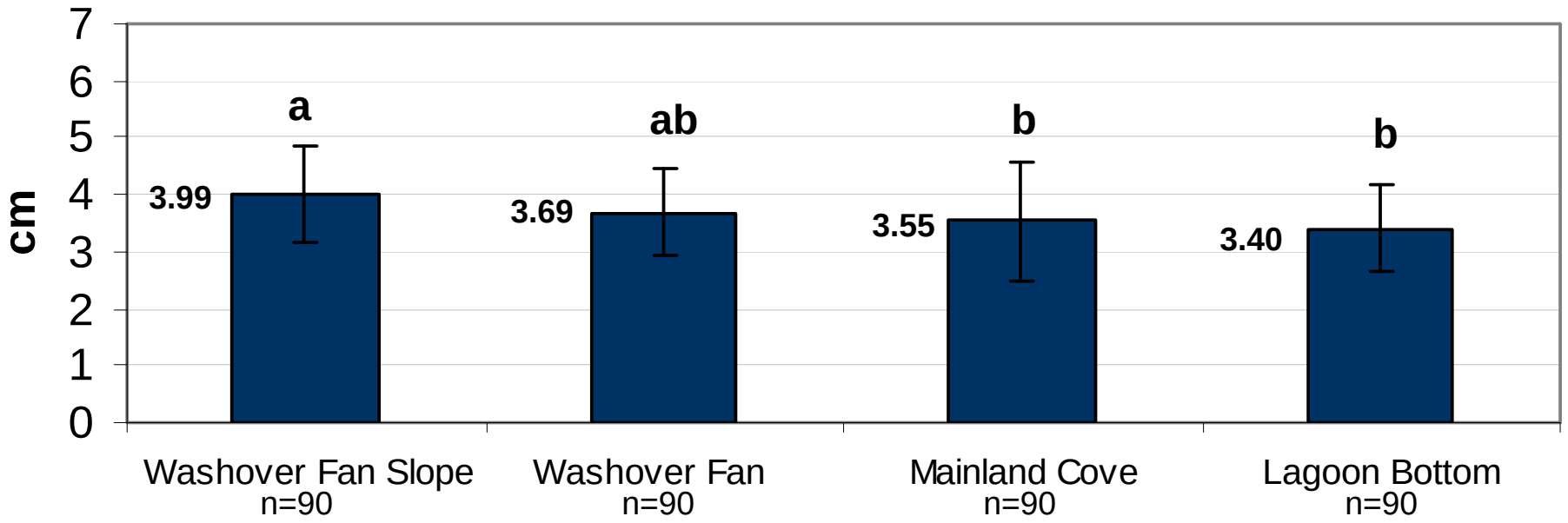


Soil_land	Soi_la_l_1
Mainland Cove	Mcv
Flood-tidal Delta Sand Flat	Ftd
Back-barrier Slope	BbsB
Mainland Submerged Erosional Beach	Gmb
Mainland Submerged Erosional Beach (boulder phase)	Gmbr
Back-barrier Sand Flat	Bb
Shallow Lagoon Bottom	Lbs
Mid-lagoon Channel	Gch
Lagoon Bottom	Lb
Headland Slope	Hs

Bradley, M.P., and M.H. Stolt. 2006. Landscape-level seagrass-sediment relationships in a coastal lagoon. Aquatic Botany 84:121-128.

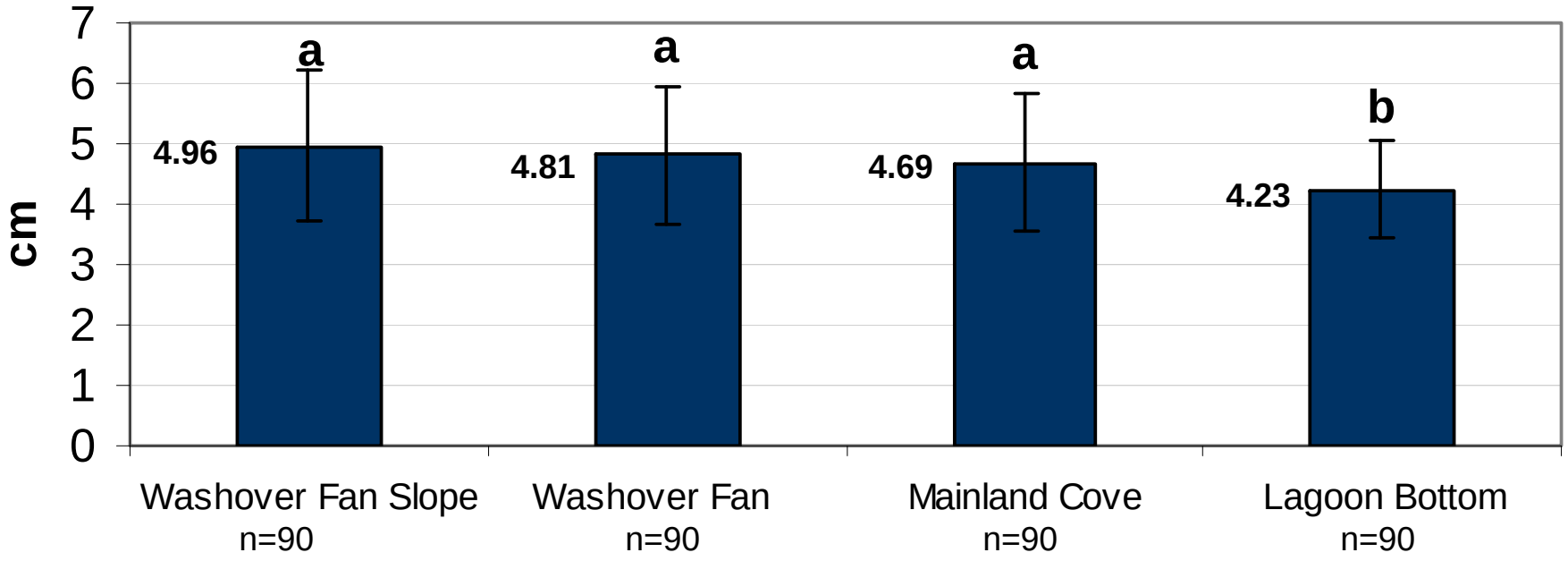

Eelgrass Potential
Eelgrass Potential
high
med
low

Ninigret Pond Mean Oyster Length (cm)
July 2008



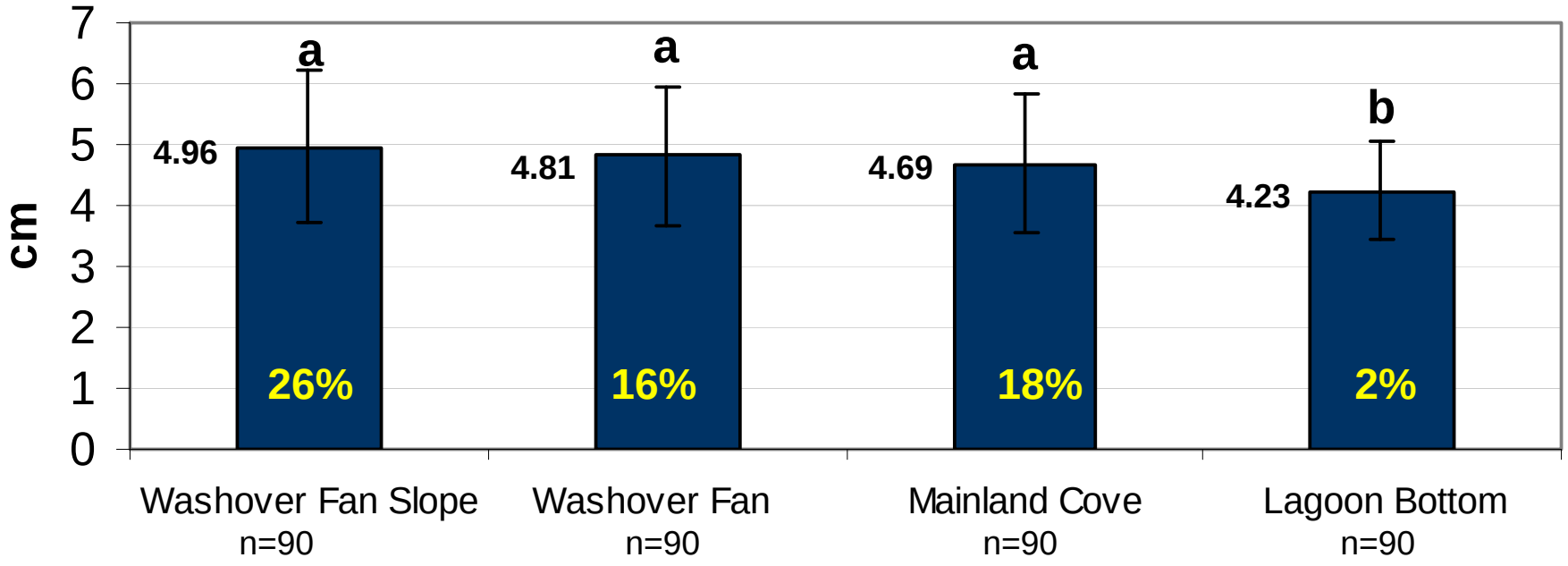
Mean oyster size on different soil-landscapes in Ninigret pond on July 22, 2008 (4 week growing period). Means with different letters are significantly different at the 0.05 level according to Tukey's HSD test. Bars represent standard deviations.

Ninigret Pond Mean Oyster Length (cm)
October 2008



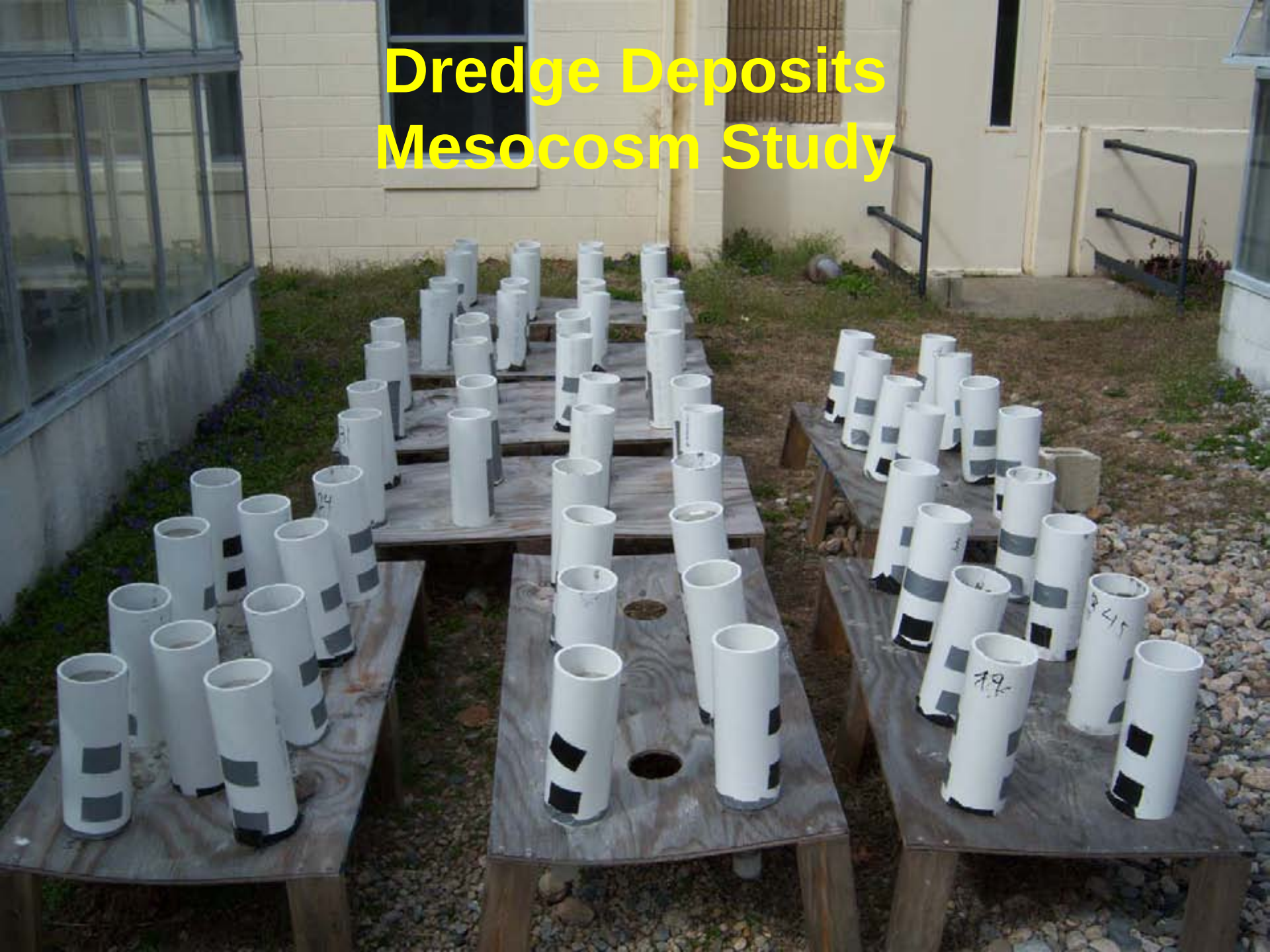
Mean oyster size on different soil-landscapes (16 week growing period).
Means with different letters are significantly different at the 0.05 level according to Tukey's HSD test. Bars represent standard deviations.

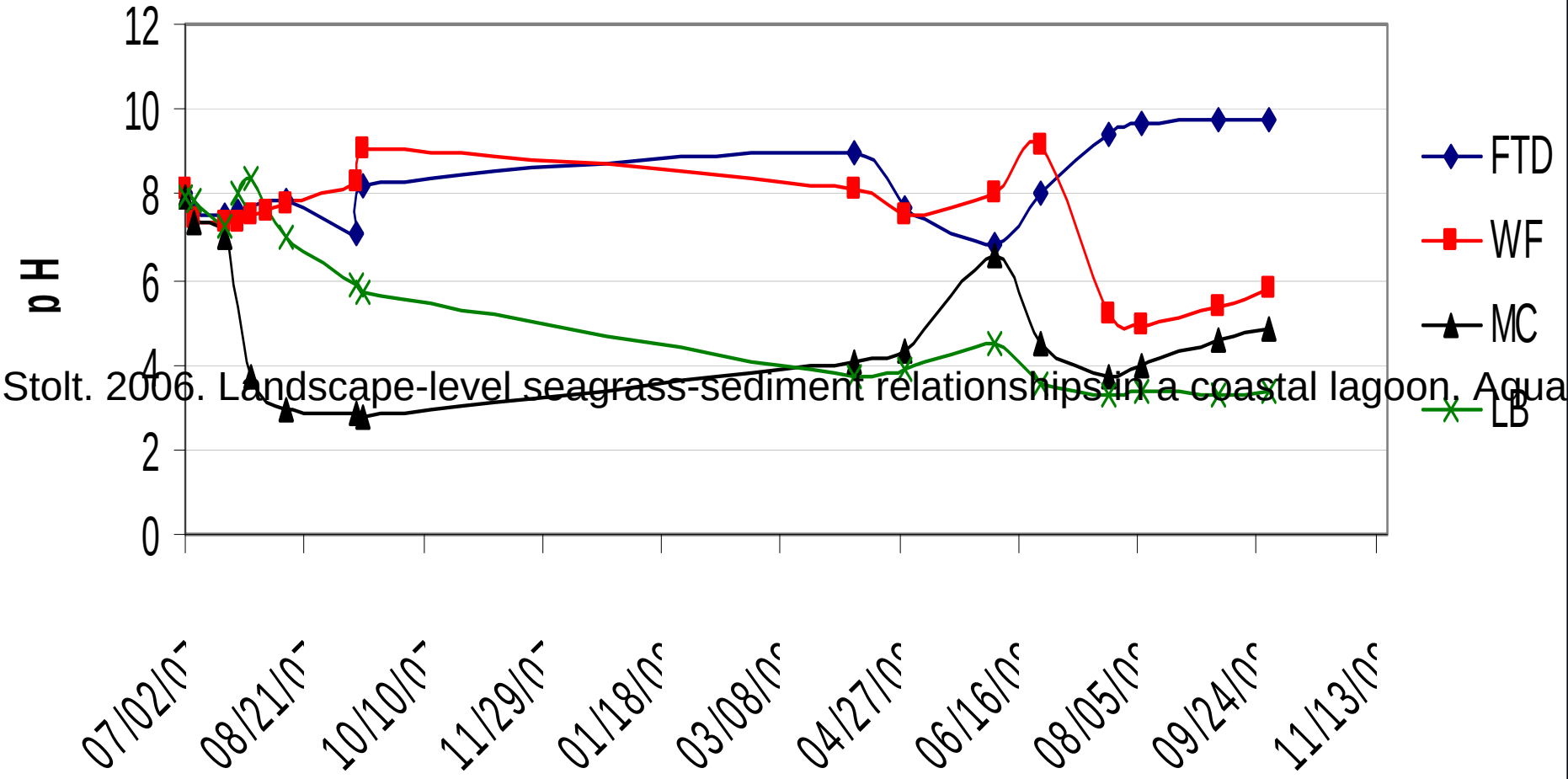
Ninigret Pond Mean Oyster Length (cm)
October 2008



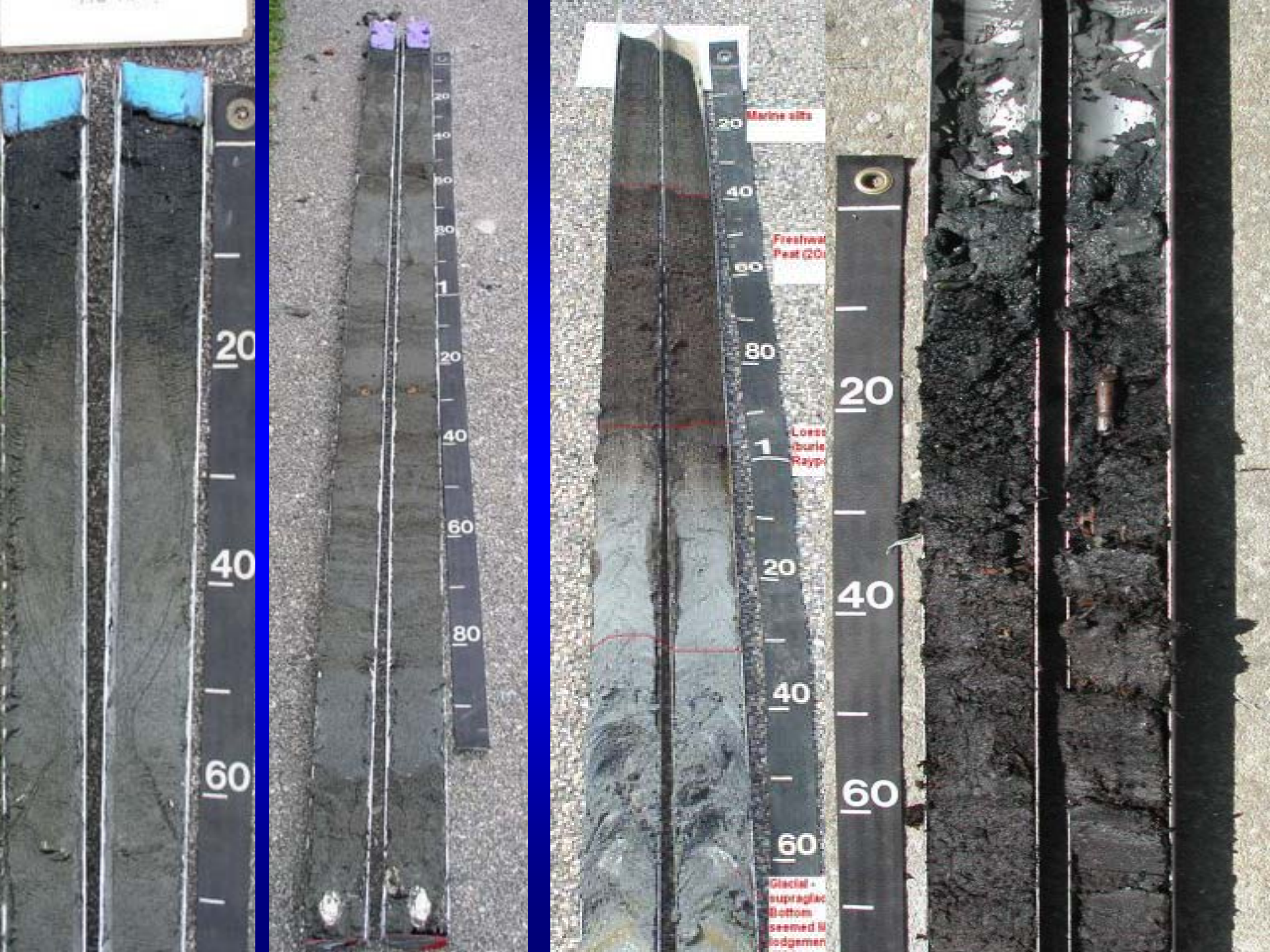
After one growing season more than 25% of the Washover Fan Slope oysters were within 15 mm of legal size or were legal sized.

Only 2% of the lagoon bottom oysters were within 15 mm of legal size.


Dredge Deposits
Mesocosm Study



H. Stolt. 2006. Landscape-level seagrass-sediment relationships in a coastal lagoon. Aquat


20
40
60
80
1
Marine silts
Freshwa
Peat (20
Loess
Glacial -
supraglac
Bottom
seemed fi
lodgemen

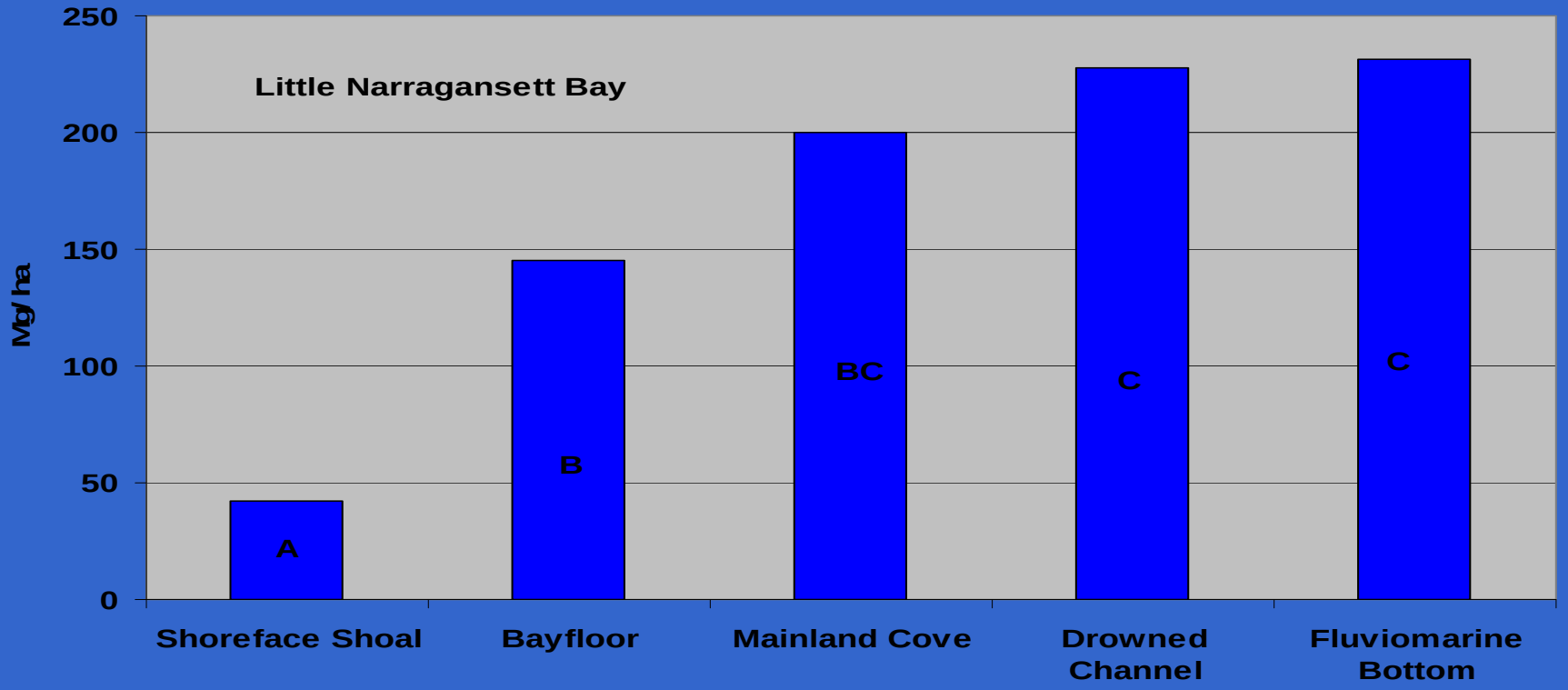
Comparison of mean SOC pools between subaqueous and subaerial soils

Subaerial*		Subaqueous	
Mg of C per hectare			
Udipsamments		**Psammowassents**	
Cultivated	Forested	Typic	Fluventic
52	82	39	127
Coarse-loamy Dystrudepts		**Coarse-loamy Sulfiwassents**	
Cultivated	Forested	Haplic	Typic
111	140	120	148
Coarse-loamy Endoaquepts		**Typic Sulfiwassents**	
Typic	Histic	Coarse-silty	Fine-silty
182	232	179	233

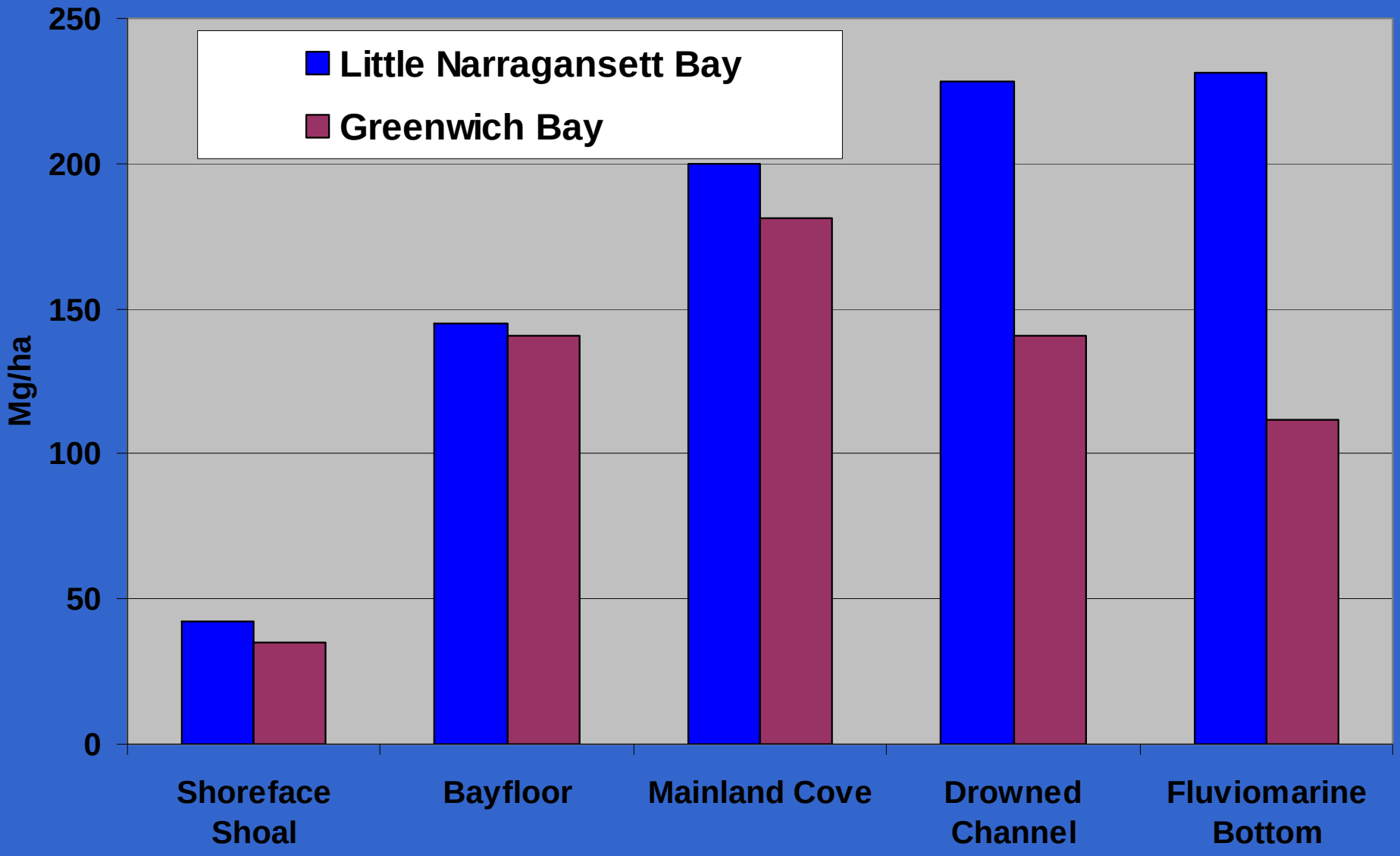
•Subaerial data based on three theses focused on SOC in southern New England: Hooker, 2000; Davis, 2001; Richardson, 2005.

Jespersen and Osher (2007) reported average SOC pools of subaqueous soils in Taunton Bay (Maine) from 67 to 177 Mg ha^{-1}.

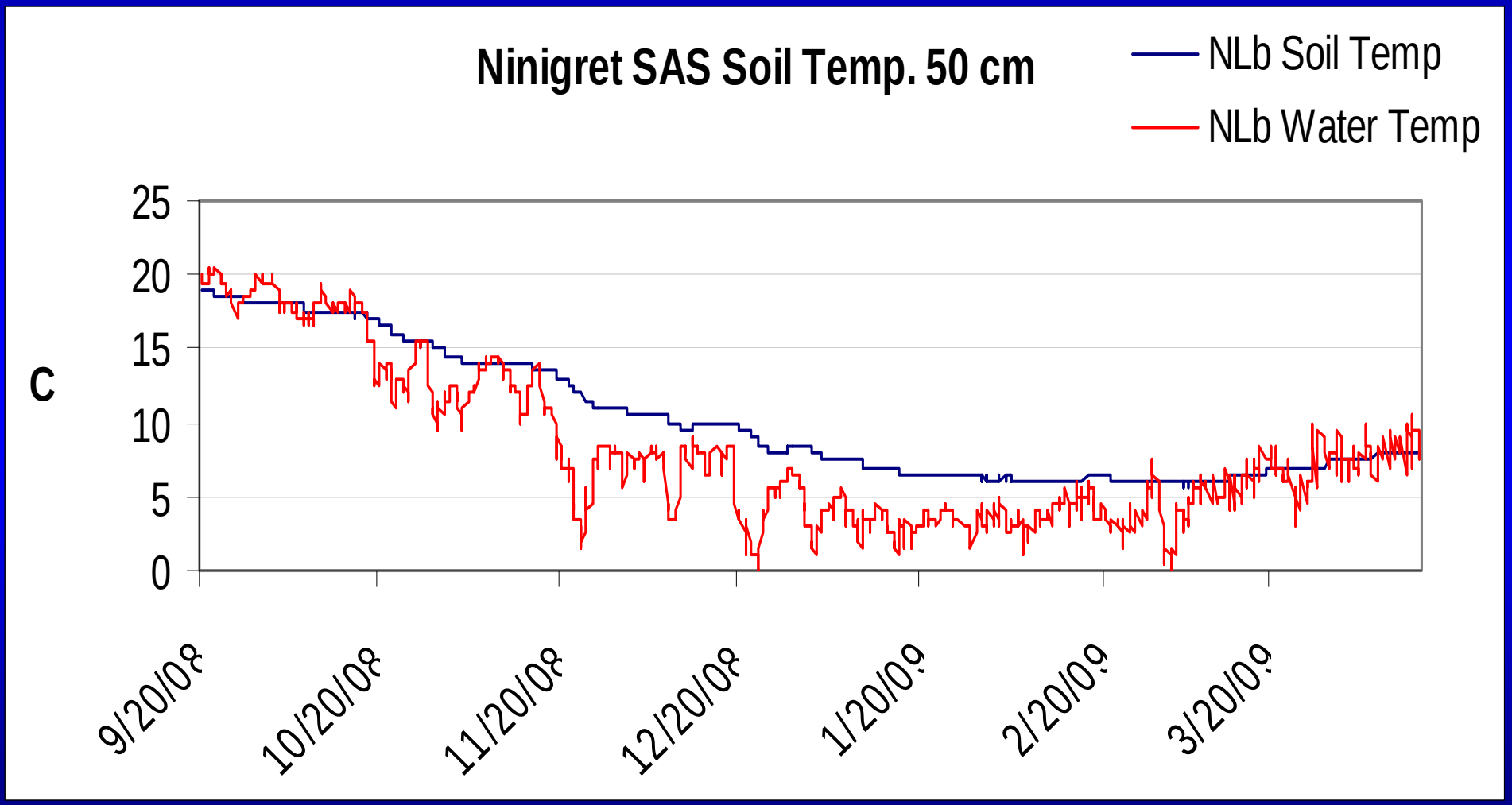
SOC Pools in Little Narragansett Bay Soil-Landscape Units



SOC Pools in Greenwich and Little Narragansett Bays



Soil Temperature



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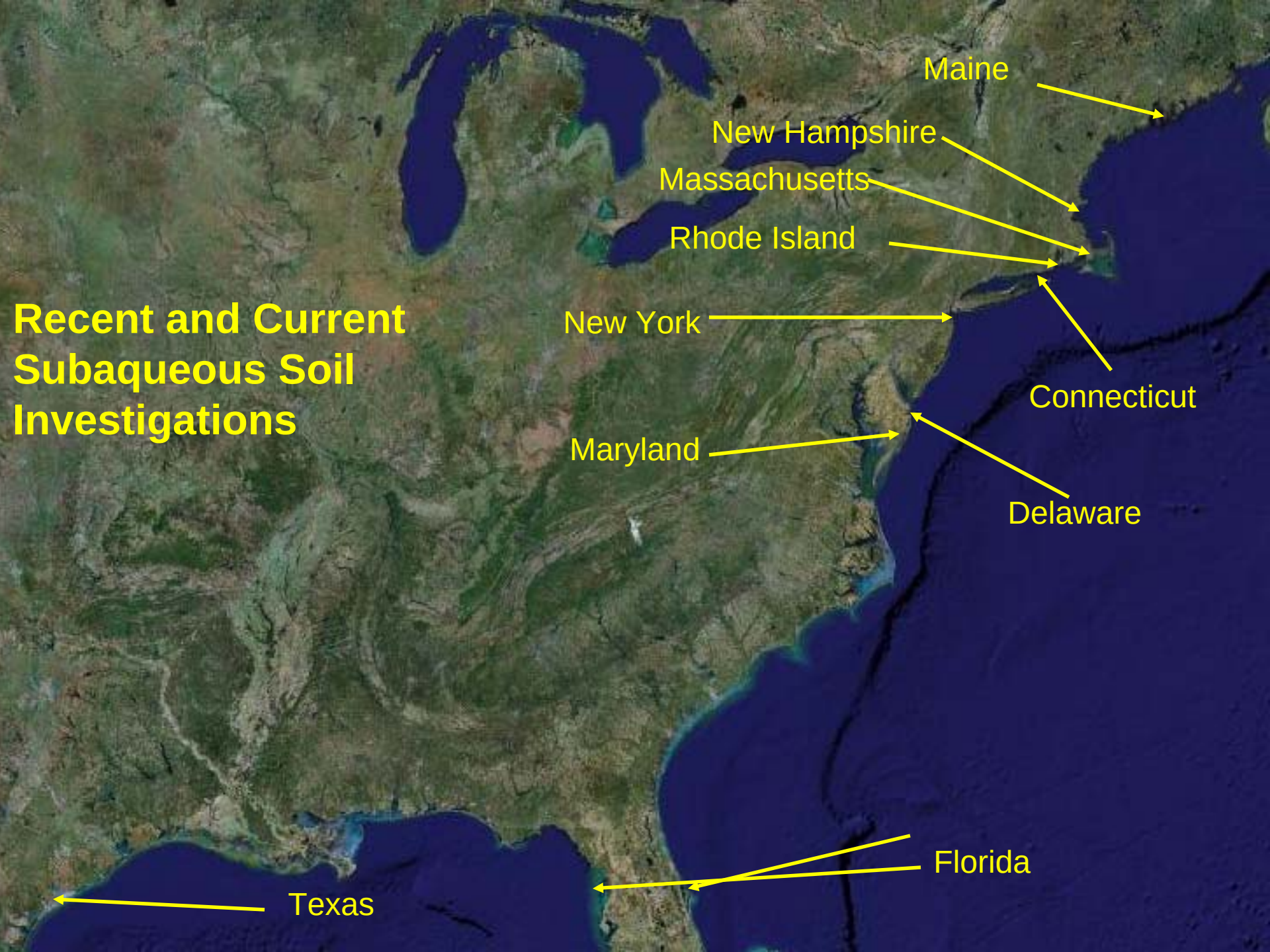
Subaqueous Soils Update

Mark H. Stolt
University of Rhode Island

Subaqueous Soils

- First defined by Kubiena (1953) in his classic book “Soils of Europe”
- Conceptually identified and defined as a resource that needed to be mapped by Demas (1993)
- Definition of soil changed in 1999 (Soil Survey Staff, 1999) to include subaqueous soils

  - any areas permanently covered by shallow water (typically <2.5 m) that can support plants or show evidence of pedogenesis


Recent and Current Subaqueous Soil Investigations
Maine
New Hampshire
Massachusetts
Rhode Island
New York
Connecticut
Maryland
Delaware
Florida
Texas

Why the Interest Subaqueous Soils?

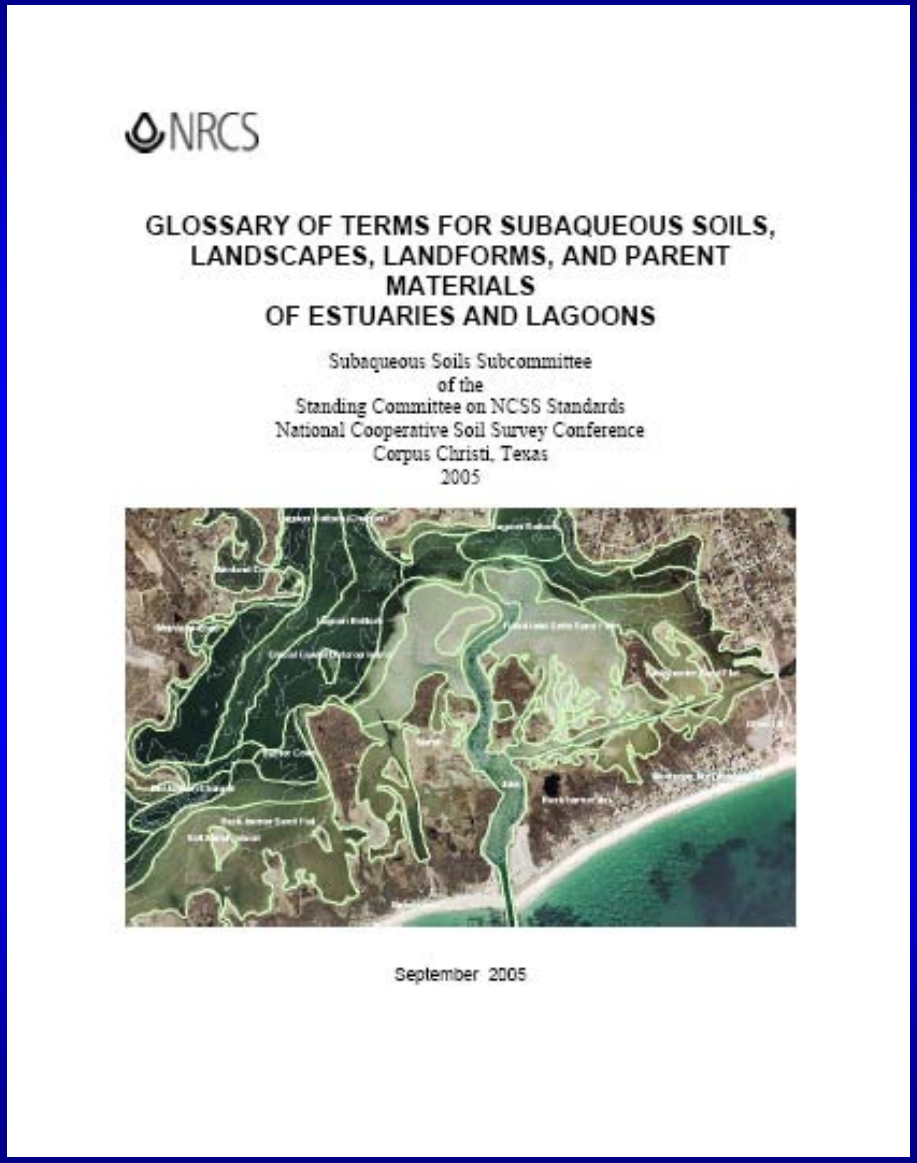
- Soil and Water

- 75% of the population will live within 25 miles of the coast

- Who better to inventory the resources than the NCSS?

Glossary

- A total of 66 terms were referenced or defined to describe subaqueous and adjacent subaerial environments and landforms
- 29 terms exclusively used for subaqueous soils added to the NSSH


NRCS

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

Subaqueous Soils Subcommittee
of the
Standing Committee on NCSS Standards
National Cooperative Soil Survey Conference
Corpus Christi, Texas
2005

September 2005

Amendments to Soil Taxonomy

- Set to be published in next edition of the KST this year (2009)
- Amendments are at the suborder, great group, and subgroup level of Entisols and Histisols
- Defined as having a positive matrix potential at the soil surface for at least 21 hours of every day
- Suborders are Wassents and Wassists

Wassent Great Groups

- **Frasiwassents:** Wassents that have, in all horizons within 100 cm of the mineral soil surface, an electrical conductivity of <0.2 dS/m in a 5/1 by volume mixture of water and soil.
- **Psammowassents:** Wassents that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers within the particle-size control section.
- **Sulfiwassents:** Wassents that have sulfidic materials within 50 cm of the mineral soil surface.
- **Hydrowassents:** Wassents that have, in all horizons at a depth between 20 and 50 cm below the mineral soil surface, both an *n* value of more than 0.7 and 8 percent or more clay in the fine earth fraction.
- **Fluviwassents:** Wassents that have *either* 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.
- **Haplowassents:** Other Wassents**.**

Wassent Subgroups

- There are between four and six subgroups for each great group.
- Examples include:
  - **Lithic Sulfiwassents**: have a lithic contact within 100 cm of the mineral soil surface.
  - **Haplic Sulfiwassents:** have, in some horizons at a depth between 20 and 50 cm below the mineral soil surface, *either or both*: 1. An *n* value of 0.7 or less; *or* 2. Less than 8 percent clay in the fine-earth fraction.
  - **Thapto-Histic Sulfiwassents:** have a buried layer of organic soil materials, 20 cm or more thick, that has its upper boundary within 100 cm of the mineral soil surface.
  - **Fluvic Sulfiwassents:** have *either* 0.2 percent or more organic carbon of Holocene age at a depth of 125 cm below the mineral soil surface *or* an irregular decrease in content of organic carbon from a depth of 25 cm to a depth of 125 cm or to a densic, lithic, or paralithic contact if shallower.
  - **Aeric Sulfiwassents:** have a chroma of 3 or more in 40% or more of the matrix of one or more horizons between a depth of 15 and 100 cm from the soil surface.
  - **Typic Sulfiwassents:** Other Sulfiwassents.

Wassist Great Groups

- **Frasiwassists:** Wassists that have, in all horizons within 100 cm of the mineral soil surface, an electrical conductivity of <0.2 dS/m in a 5/1 by volume mixture of water and soil.
- **Sulfiwassists:** Wassists that have sulfidic materials within 50 cm of the mineral soil surface.
- **Haplowassists** Other Wassists.

Wassist Subgroups

There are three subgroups for each Wassist Great Group.

Fibric subgroups: have more thickness of fibric soil materials than any other kind of organic soil material either: 1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or 2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier;

Sapric subgroups: have more thickness of sapric soil materials than any other kind of organic soil materials either: 1. In the organic parts of the subsurface tier if there is no continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier; or 2. In the combined thickness of the organic parts of the surface and subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.

Typic subgroups: others Wassist subgroups.

Amendments to NASIS and Pedon PC

- Subaqueous drainage class
- Manner of Failure (n-values)
- Use of multiple primes
  - A, C, Ab, C’, A’b, C’’, A’’b, C’’’

Official Series Descriptions

- **PISHAGQUA SERIES** MLRA: 144A
  - The Pishagqua series consists of very deep, subaquic soils that are permanently submerged in low energy depositional basins, estuaries and coastal lagoons. The Pishagqua soils formed in silty estuarine deposits.

- **SOUTHPOINT SERIES** MLRA(s): 153C, 153D
  - Southpoint sand on a smooth 0.5 percent slope in a deep mainland cove under 4.2 feet of permanent estuarine water.

- **BAFFIN SERIES** MLRA: 150B in LRR T
  - The Baffin series consists of very deep, very poorly drained (permanently submersed) soils that formed in slightly fluid sandy and loamy estuarine sediments. These nearly level soils are in shallow-water grass flats of bays and lagoons. Water depth is generally less than 1.2 meters (4 ft).

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

ECOLOGICAL SITE DESCRIPTION

ECOLOGICAL SITE CHARACTERISTICS

Site ID: 150BY728TX
Site Name: Subaqueous Grass Flat


Subaqueous Grass Flat

Publications

- Conceptual Aspects (1)
- Mapping (2)
- Creating Basemaps (1)
- Soil-Landscape Relationships (2)
- Pedogenesis (2)
- Soil-Eelgrass Relationships (1)
- Interpretations for docks and moorings (1)
- Soil-carbon accounting (1)

White Papers (unpublished)

- Field and Laboratory Methods and Procedures

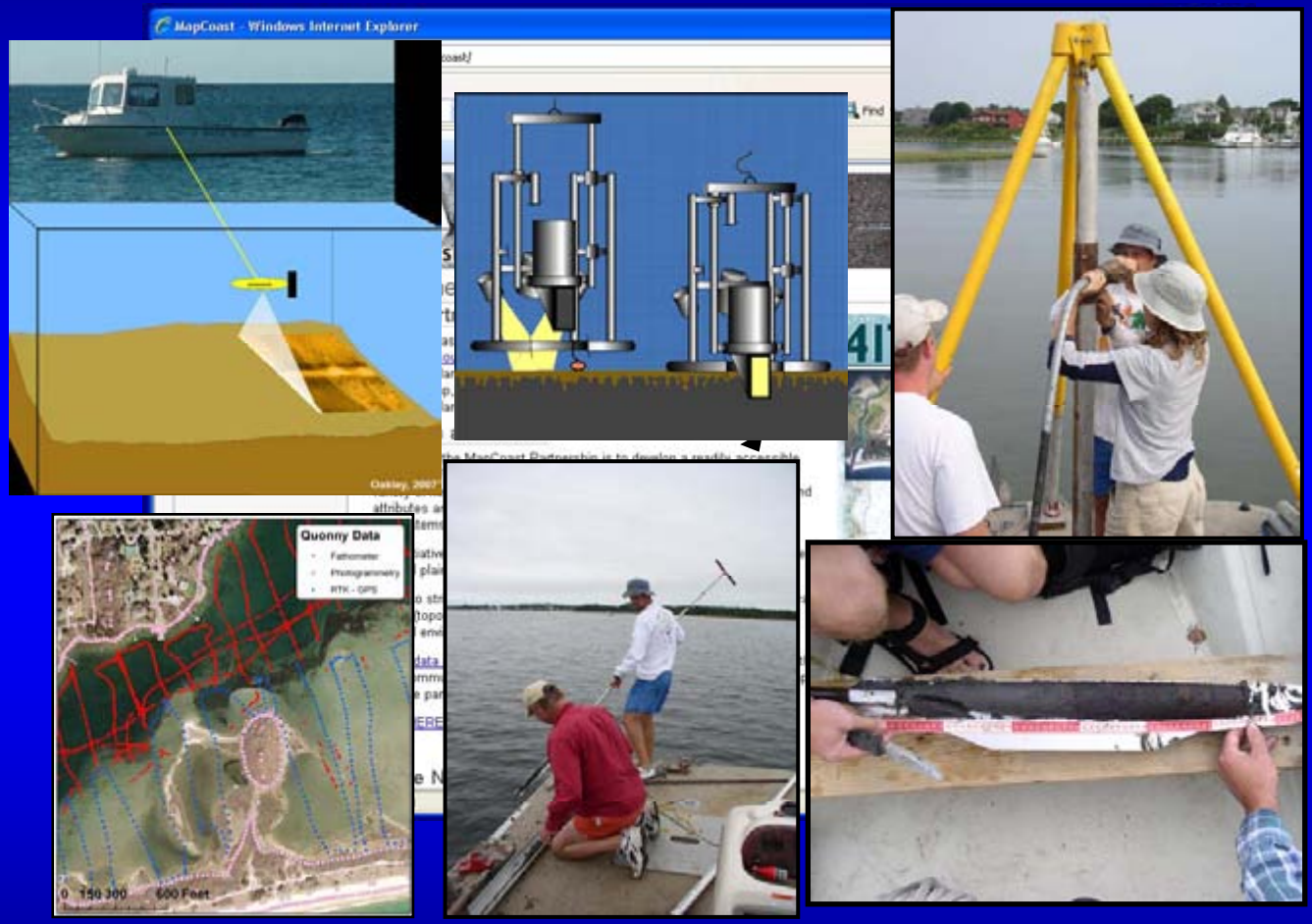
Thesis and Dissertations

- Demas
- Bradley
- Ellis
- Payne
- Yong
- Flannagan
- Jespersen
- Fishler
- Saunders
- Balduff

Organized Groups

- Subcommittee of the Northeast Regional National Cooperative Soil Survey
- Subcommittee of the National Cooperative Soil Survey (Standards and Interpretations)
- Subcommittee of the South Regional National Cooperative Soil Survey
- MapCoast Partnership

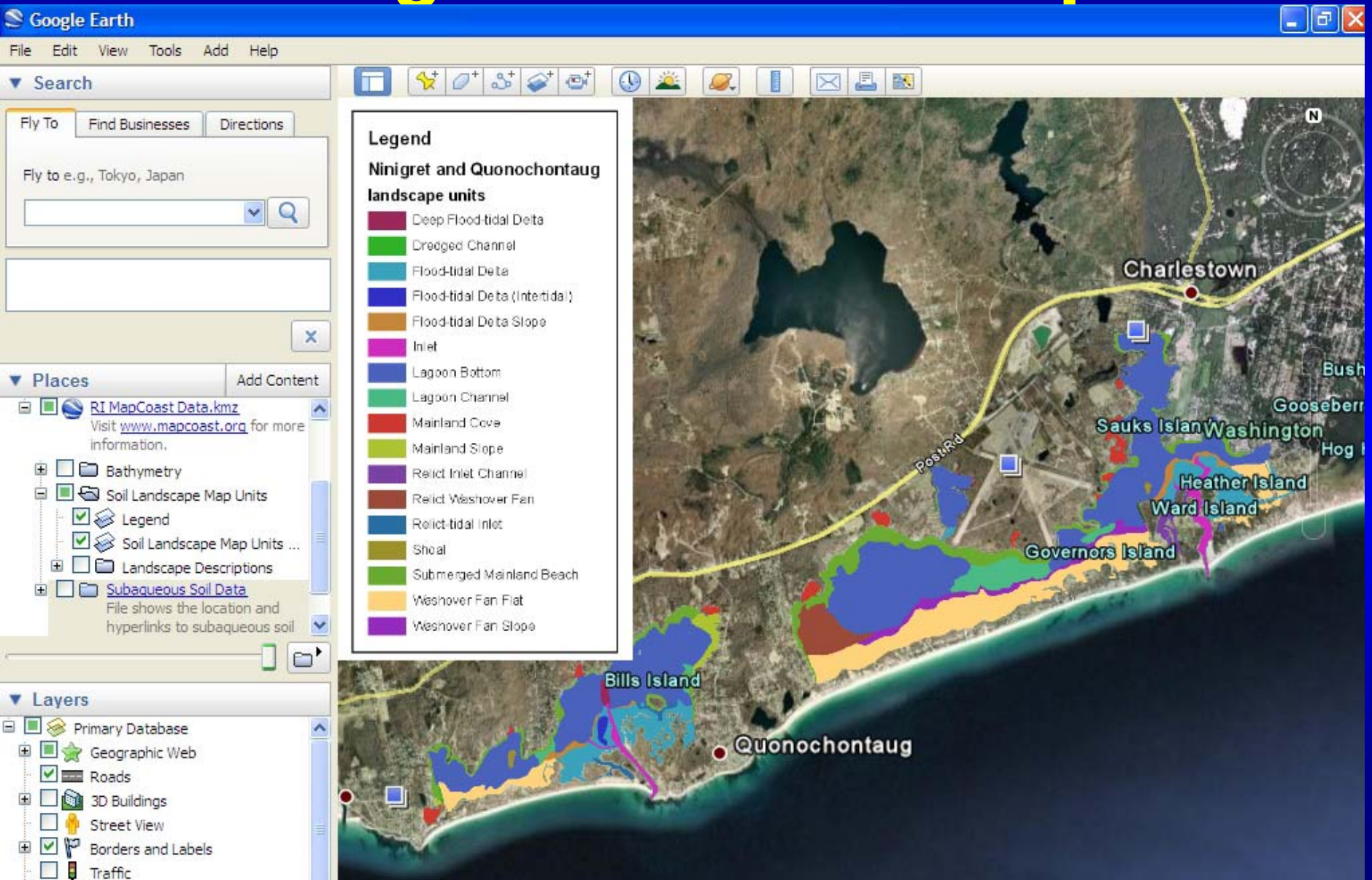
MapCoast Partnership



- Interdisciplinary group of researchers
- Publish Interactive maps on-line

www.mapcoast.org

Google-Ocean Example



COASTAL AND MARINE ECOLOGICAL CLASSIFICATION STANDARD

VERSION III

Christopher J. Madden
Kathleen L. Goodin
Rebecca J. Allee
Giancarlo Cicchetti
Chris Moses
Mark Finkbeiner
Danielle E. Bamford

February 2009
Ver. III.2009.0213

NatureServe

NOAA

CMECS

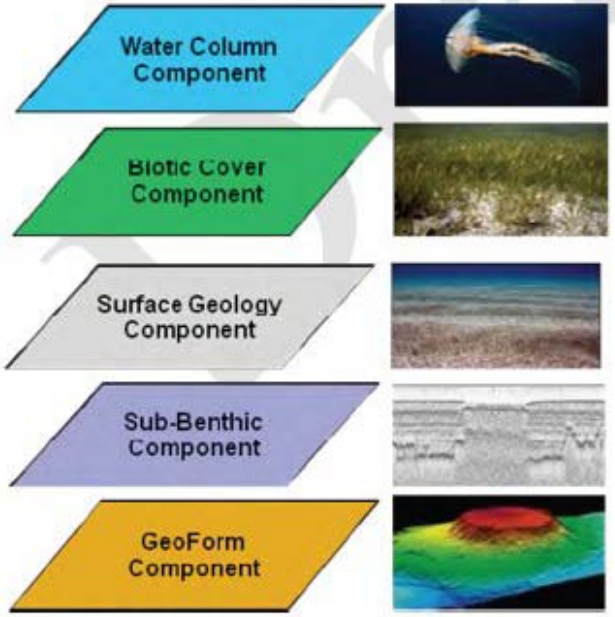
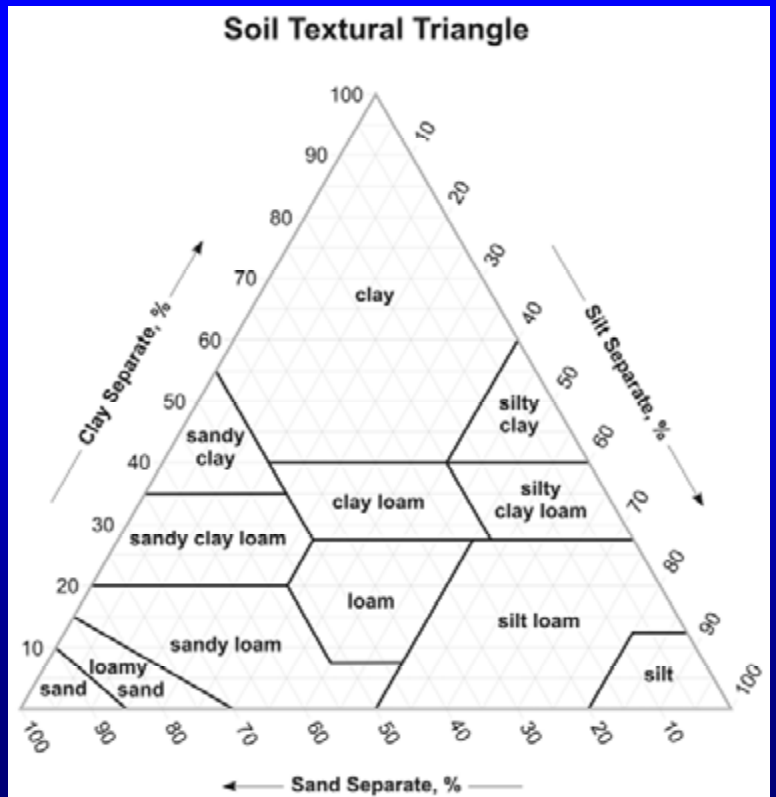


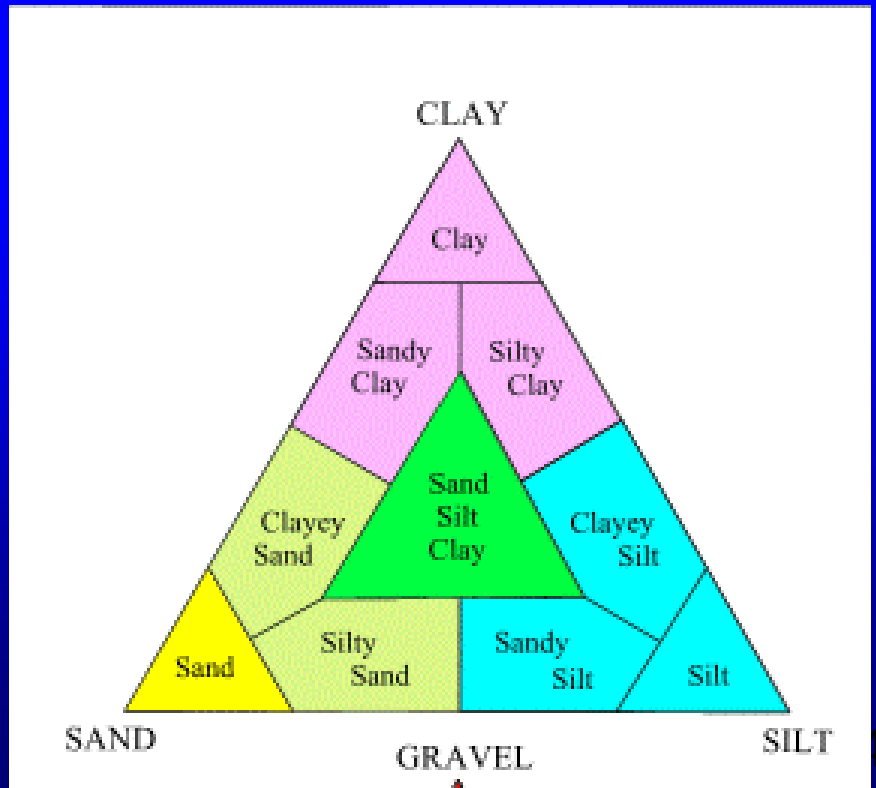
Figure 1. The Five CMECS Components.

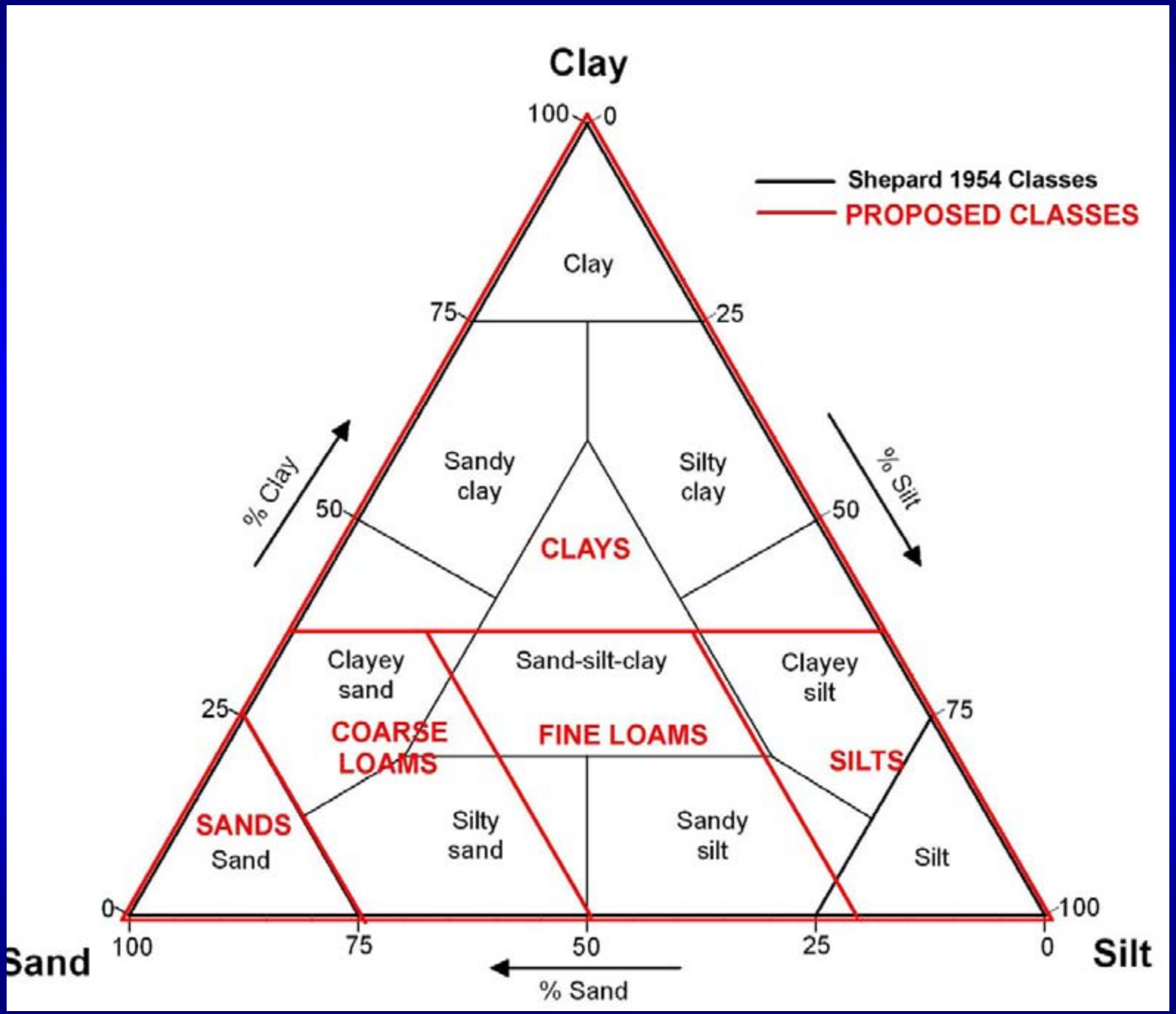
Comparison of Particle Size Classes in Different Systems

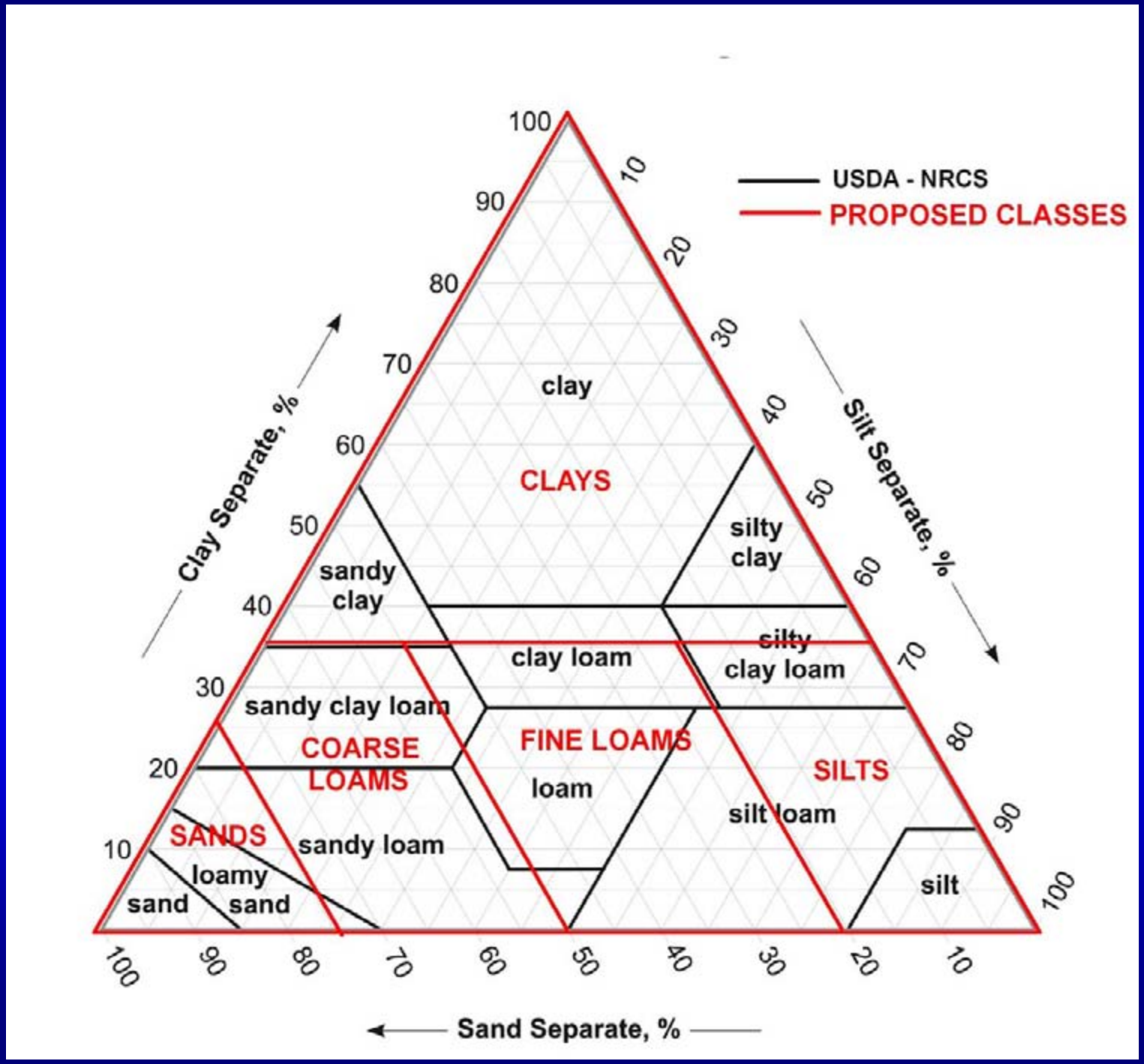
	FINE EARTH									ROCK FRAGMENTS					
										channers			flagst.	stones	boulders
USDA [1]	Clay [2]		Silt		Sand					Gravel			Cob-bles	Stones	Boulders
	fine	co.	fine	co.	v.fi.	fi.	med.	co.	v. co.	fine	medium	coarse			
millimeters:	0.0002	.002 mm		.02	.05	.1	.25	.5	1	2 mm	5	20	76	250	600 mm
U.S. Standard Sieve No. *(opening)*:					300 [3]	140	60	35	18	10	4	(3/4")	(3")	(10")	(25")

phi #:	12	10	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-12
Modified Wentworth [8]	clay				silt				sand				pebbles					cobbles		boulders			
millimeters:		.002	.004	.008	.016	.031	.062	.125	.25	.5	1	2 mm		8	16	32	64		256			4092 mm	
U.S. Standard Sieve No.:							230	120	60	35	18	10	5										






Clay
100
0
Shepard 1954 Classes
PROPOSED CLASSES
Clay
75
25
Sandy clay
Silty clay
% Clay
% Silt
50
50
CLAYS
Clayey sand
Sand-silt-clay
Clayey silt
25
75
COARSE LOAMS
FINE LOAMS
SILTS
SANDS
Sand
Silty sand
Sandy silt
Silt
0
100
Sand
100
75
50
25
0
Silt
% Sand


USDA - NRCS
PROPOSED CLASSES
Clay Separate, %
Silt Separate, %
Sand Separate, %
clay
CLAYS
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
FINE LOAMS
COARSE LOAMS
loam
SILTS
silt loam
SANDS
sandy loam
loamy sand
sand
silt

Sub-Benthic Component (SBC) (DRAFT)

- Surface Layer Class
  - Upper 15 cm
  - Describes *physical characteristics* of soil (grain size)
  - Map units delineated with acoustic methods or by landscape unit
  - Grab samples or cores to ground-truth
  - Multiple scales of mapping
- Soil
  - Using USDA Keys to Soil Taxonomy
  - Describes characteristics to a greater depth (~2 meters below surface)

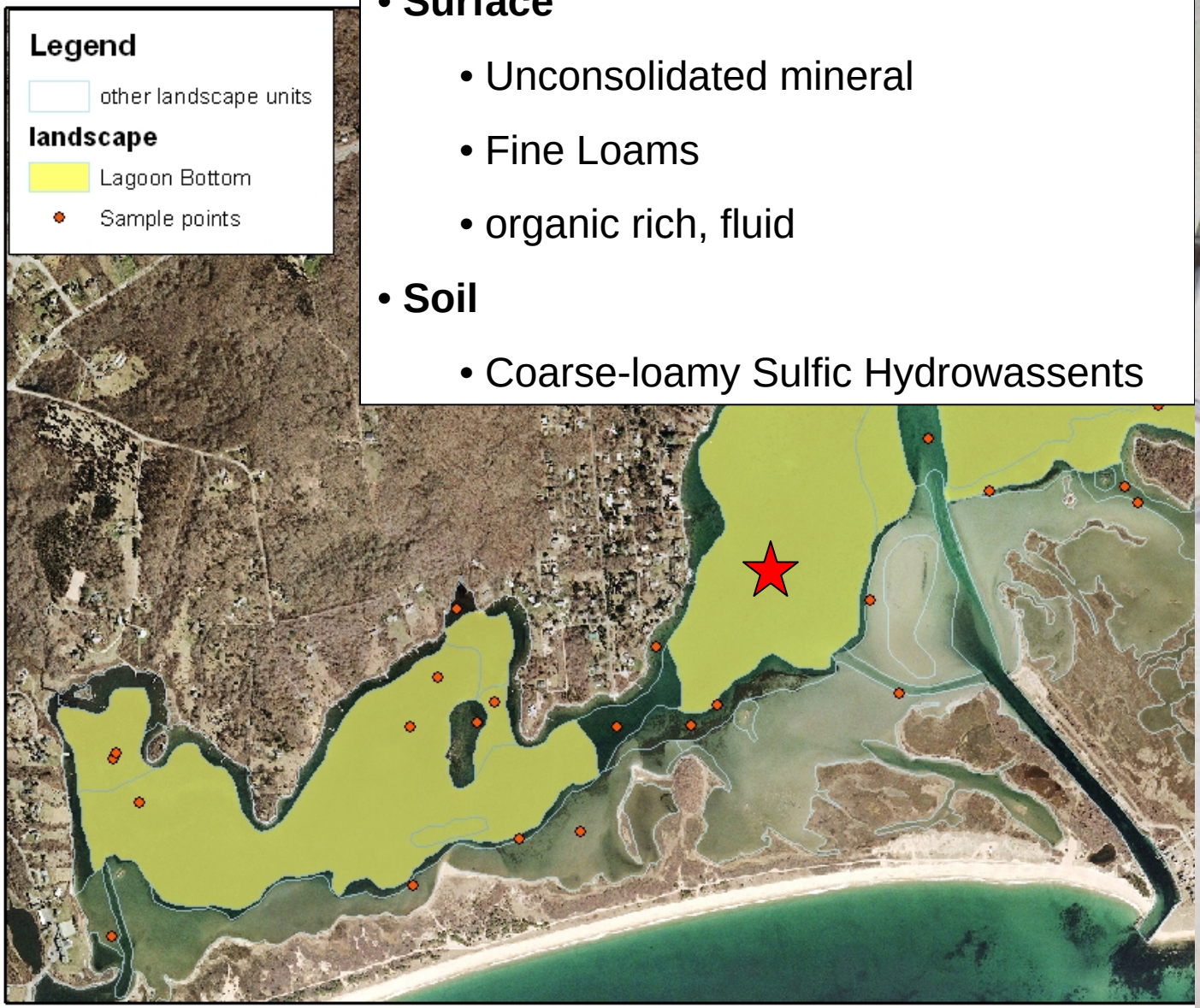
Surface Layer Class Overview

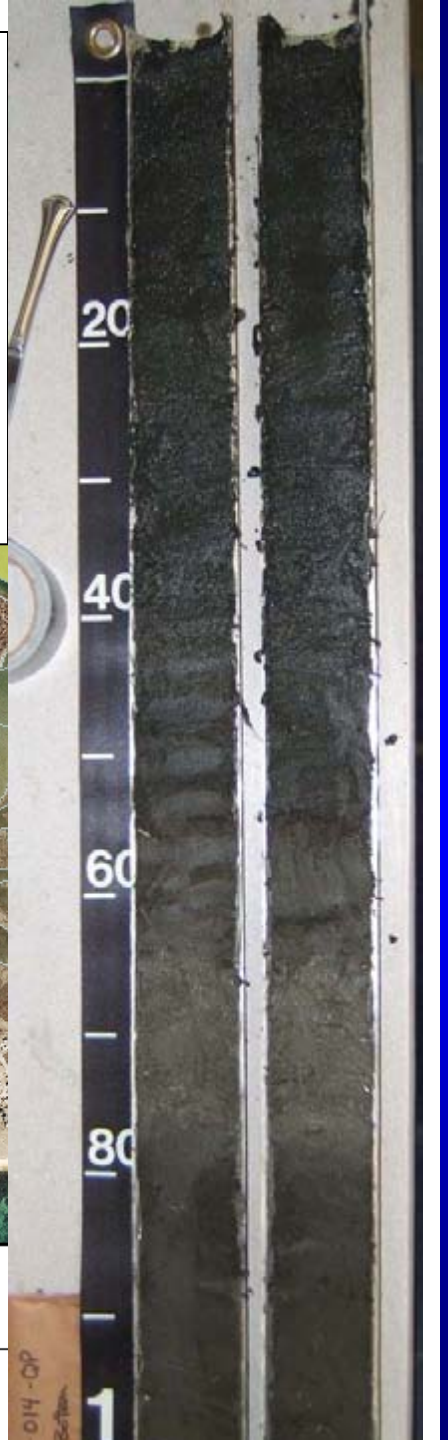
I. Bedrock
II. Organic
III. Unconsolidated Mineral
    A. Shells/Corals
    B. Fragments
    C. Shell-rich
        1. Shelly Sands
        2. Shelly Loams
        3. Shelly Silts
        4. Shelly Clays
    D. Gravel-rich
        1. Gravelly Sands
        2. Gravelly Loams
        3. Gravelly Silts
        4. Gravelly Clays Sands
    E. Loams
        1. Coarse Loams
        2. Fine Loams
    F. Silts
    G. Clays

Modifiers

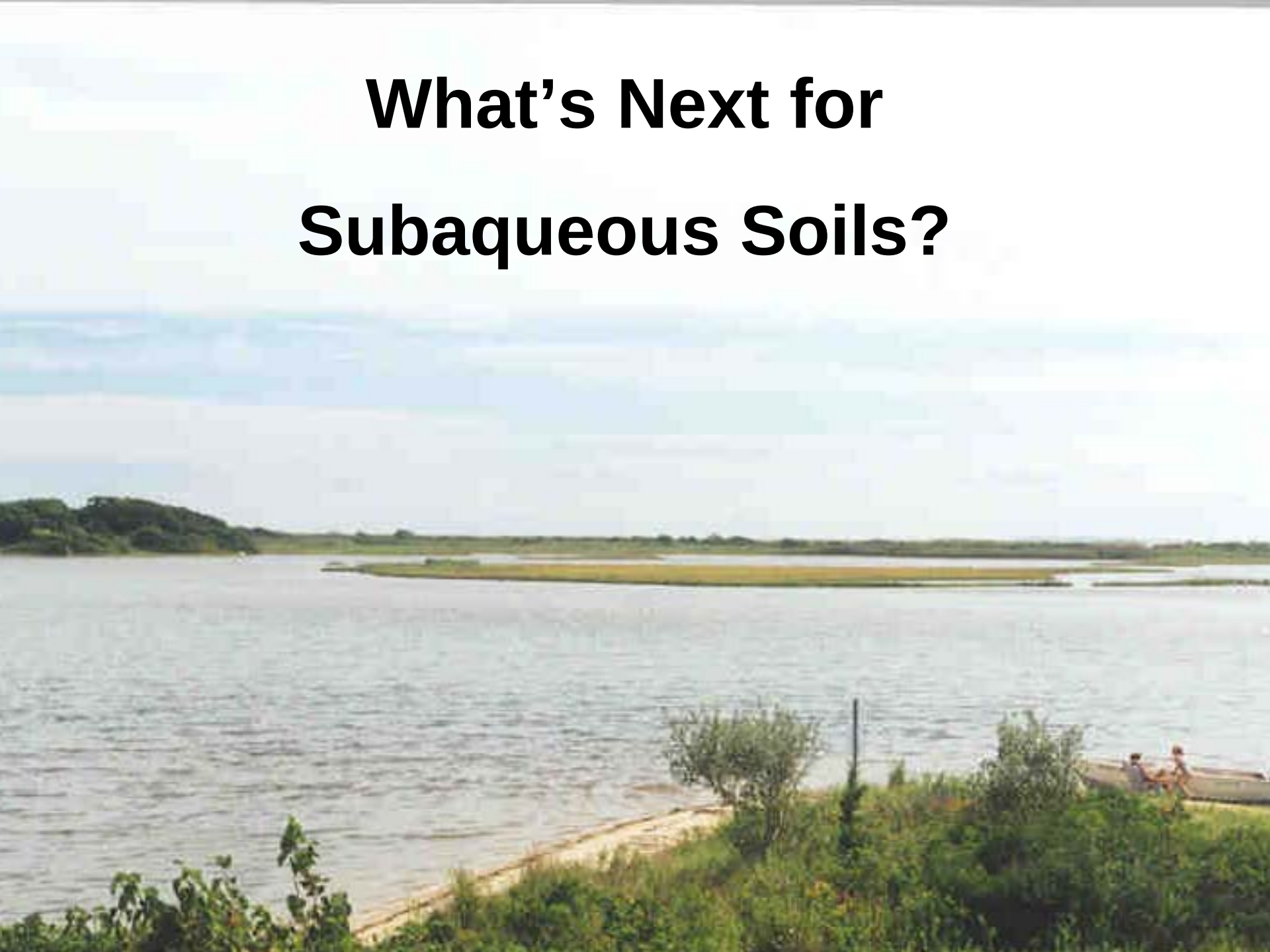
- Rock fragment modifiers for gravel-rich soil/sediment:
  - Pebble
  - Cobble
  - Stone
  - Boulder
- Organic-rich
- Fluid

- **Surface**
  - Unconsolidated mineral
  - Fine Loams
  - organic rich, fluid
- **Soil**
  - Coarse-loamy Sulfic Hydrowassents





What's Next for Subaqueous Soils?



What's Next for Subaqueous Soils?

Building Interpretations

Developing Additional Standards

- Subordinate distinction for sulfidic horizons
- Family level classification amendments