Subaqueous Soils "A New Frontier in Soil Survey"

By Jim Turenne

http://nesoil.com.sas

Subaqueous History

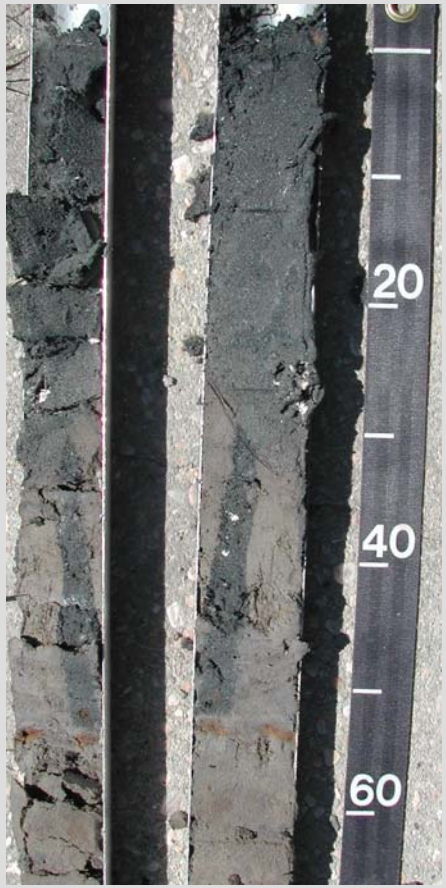
- Traditional soil survey conducted on land. Not a lot of work in wetlands and tidal marshes until the 70's.
- In 1993 – "Submerged Soils: A New Frontier in Soil Survey" by George Demas published in Soil Survey Horizons.
- Most work in Chesapeake Bay Region – Maryland/Delaware.
- George pioneered the concept of Subaqueous Soils differentiating them from sediment.

George Demas

Is it Soil or Sediment?

Qualifying Criteria:

1. **Supplies nutrients to plants**
2. **Forms horizons in place**

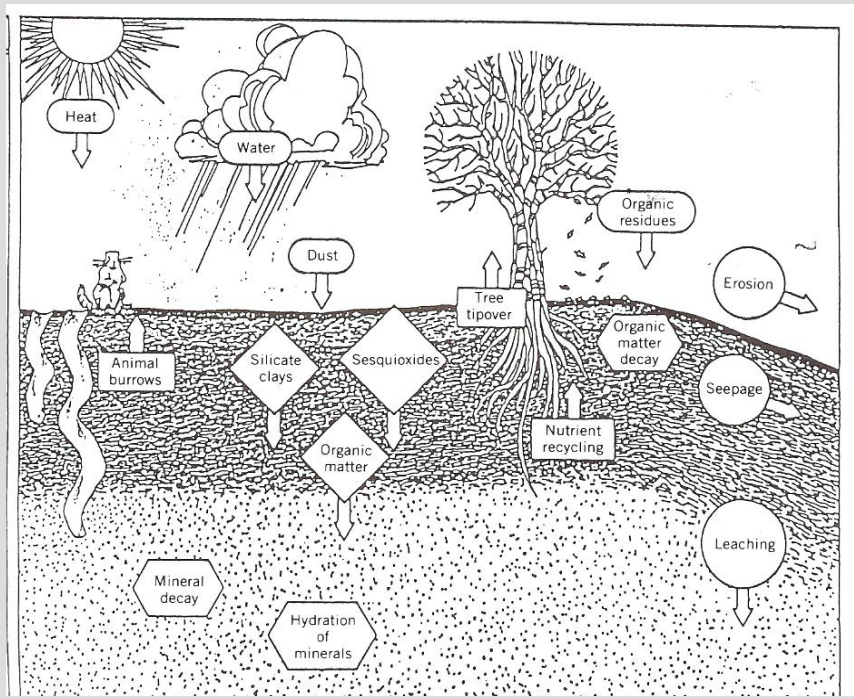


Eel Grass

Definition of Soil

Soil...is a natural body that occurs on the land surface, ...and is characterized by [either]

1. Horizons, or layers, that are distinguishable from the initial material as a result of <u>additions, losses, transfers, and transformations</u> of energy and matter or
2. The ability to support rooted plants in a natural environment.



Definition of Soil

The upper limit of soil is the boundary between soil and air [or] **shallow water**…[not] too deep (typically more than 2.5 m*) for the growth of rooted plants.

Added to Soil Taxonomy in 1999 as a result of work in Maryland/Delaware.

** Arbitrary depth set as a cut-off for soil survey.*

Cowardin Wetlands Classification

→

in these Systems. The boundary between wetland and deepwater habitat in the Riverine and Lacustrine Systems lies at a depth of 2 m (6.6 feet) below low water; however, if emergents, shrubs, or trees grow beyond this depth at any time, their deepwater edge is the boundary.

The 2-m lower limit for inland wetlands was selected because it represents the maximum depth to which emergent plants normally grow (Welch 1952; Zhadin and Gerd

Factors of Subaqueous Soil Formation

Combination of Jenny's soil forming factors and Folger's sediment genesis factors:

Ss = f(C, O, B, F, P, T, W, CE)

Ss = subaqueous soil

C = Climate/temp.

O = Organisms

B = Bathymetry

F = Flow Regime

P = Parent Material

T = Time

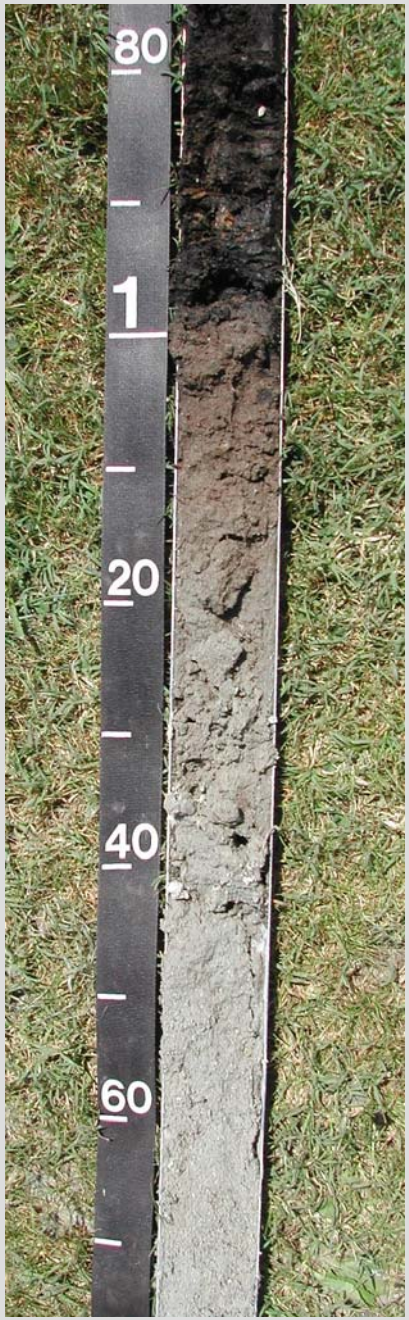
W = Water column attributes

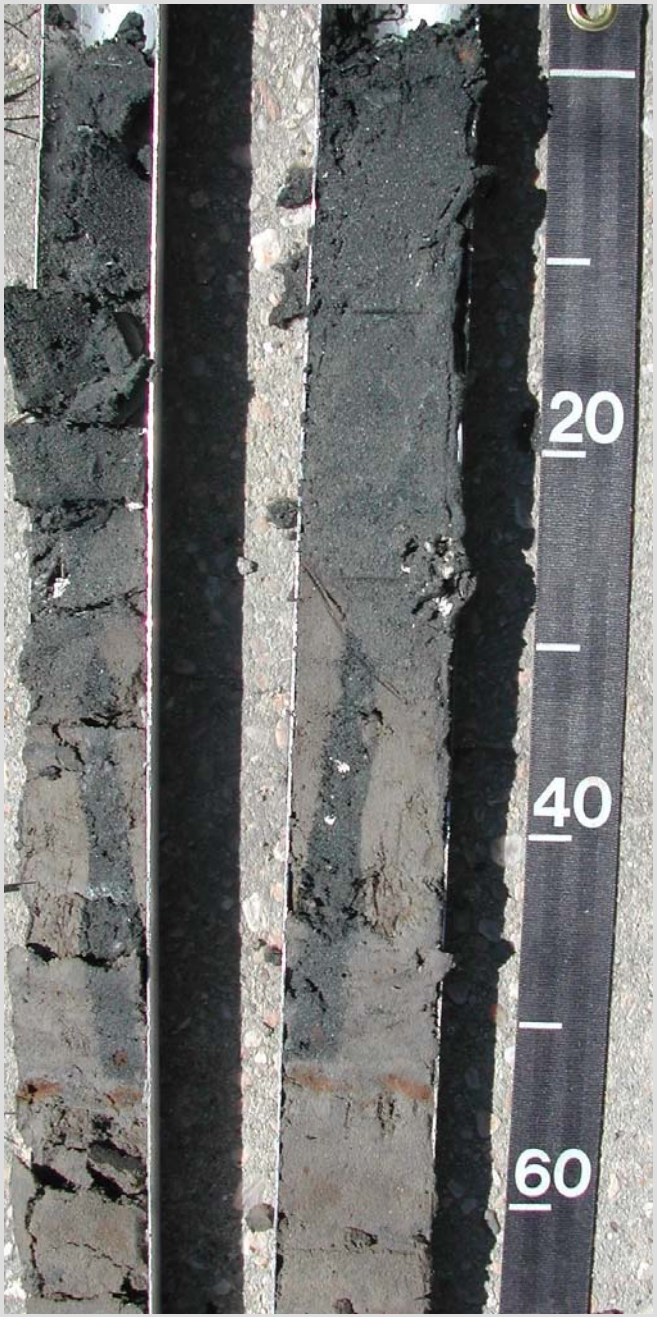
CE = Catastrophic events

Demas, Rabenhorst. 2001Factors of Subaqueous Soil Formation.

Soil Formation: Soil Horizons

- Organic (O) and mineral (A and C) horizons.
- Predominantly dealing with AC type soils (Entisols).
- Numerous buried A and O horizons.
- Some subaqueous and submerged soils have buried B horizons.


80
1
20
40
60


20
40
60


80
1
20
40
60

Soil Formation: Additions / Losses / Transfers

Additions

- Additions of mineral sediments – alluvial deposits.
- Biological additions – shells, organisms.
- Anthropogenic additions – dredge material, mechanical disturbance.

Losses

- Erosion losses – wave and storm losses, tidal currents.
- Decomposition of organic matter.

Transfers

- Diffusion – hi to low concentrations.
- Bioturbation.

Bottom Line: Shallow Water Environments can best be studied as SOIL!

Significance and Value of Subaqueous Soil Inventory

- Sediment characteristics presented to a greater depth (2 m), rather than a “surficial” approach.
- Provides a comprehensive classification scheme (Soil Taxonomy, SSM) for shallow water sediments.
- Could provide a major or missing data set for SAV restoration, estuarine protection, planning and management.
- NRCS responsibility to inventory soils.

Specific Soil Based Interpretations

- SAV Restoration
- Crab Habitat
- Clam Stocking
- Management for Sustainable Shellfish Production
- Nutrient Reduction
- Pathogens Pfesteria Cyst Residence Sites
- Benthic Preservation Site Identification
- Wildlife Management
- Wading Shore Birds, Migratory Waterfowl, Nurseries and Spawning Areas
- Habitat Protection for Horseshoe Crab and Diamondback Terrapin
- Dredging Island Creation
- Tidal Marsh Protection and Creation
- Bathymetric Map
- Navigational Channel Creation/Maintenance
- Effects of Dredging on Benthic Ecology
- Off Site Disposal of Dredge Spoil
- Acid-Sulfate Weathering Hazards
- Dune and Beach Maintenance/Replenishment
- Carbon Sequestration

Users of Subaqueous soil survey data for specific resource Management (Phil King – Delaware NRCS).

- Resource Managers
- 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
- US-ACE, US-DI
- Pamlico-Albermarle Sound NEP Program
- NOAA
- US-ACE, MD-DNR, Wor SWCD,
- DI Assateague Island National Park
- Private Aquaculture Industry
- Shellfish Harvest Industry
- NRCS, RCD, DE CIB, DNREC
- DE Sierra Club
- DNREC

Subaqueous Mapping Procedure

- Need to develop a bathymetric map which is used for subaqueous landform identification.
- Can use existing NOAA charts (order 3 mapping) or create detailed bathymetry using fathometer and survey equipment.
- Remote sensing including LIDAR, Side Scan Sonar, GPR (freshwater only), RTK GPS.

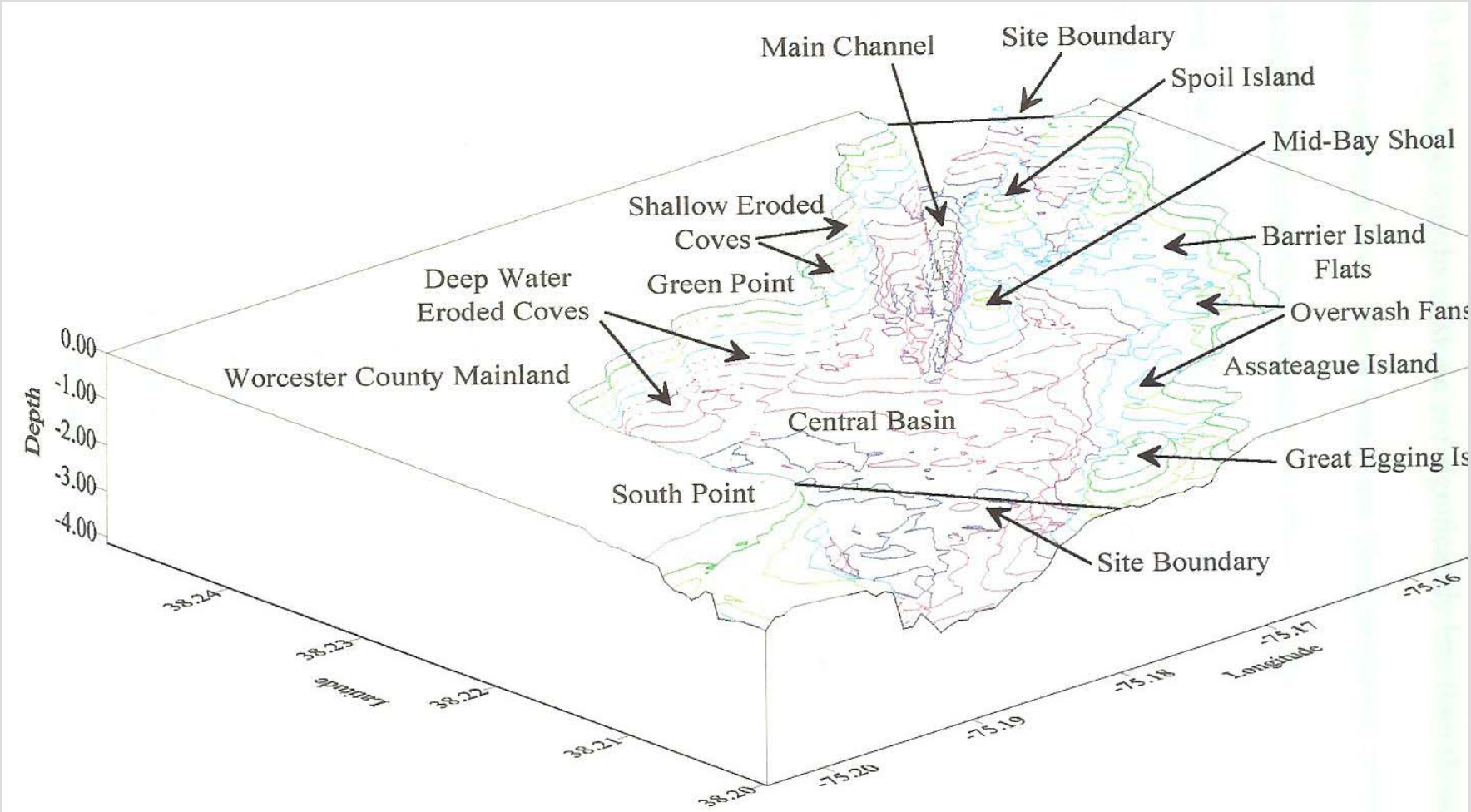
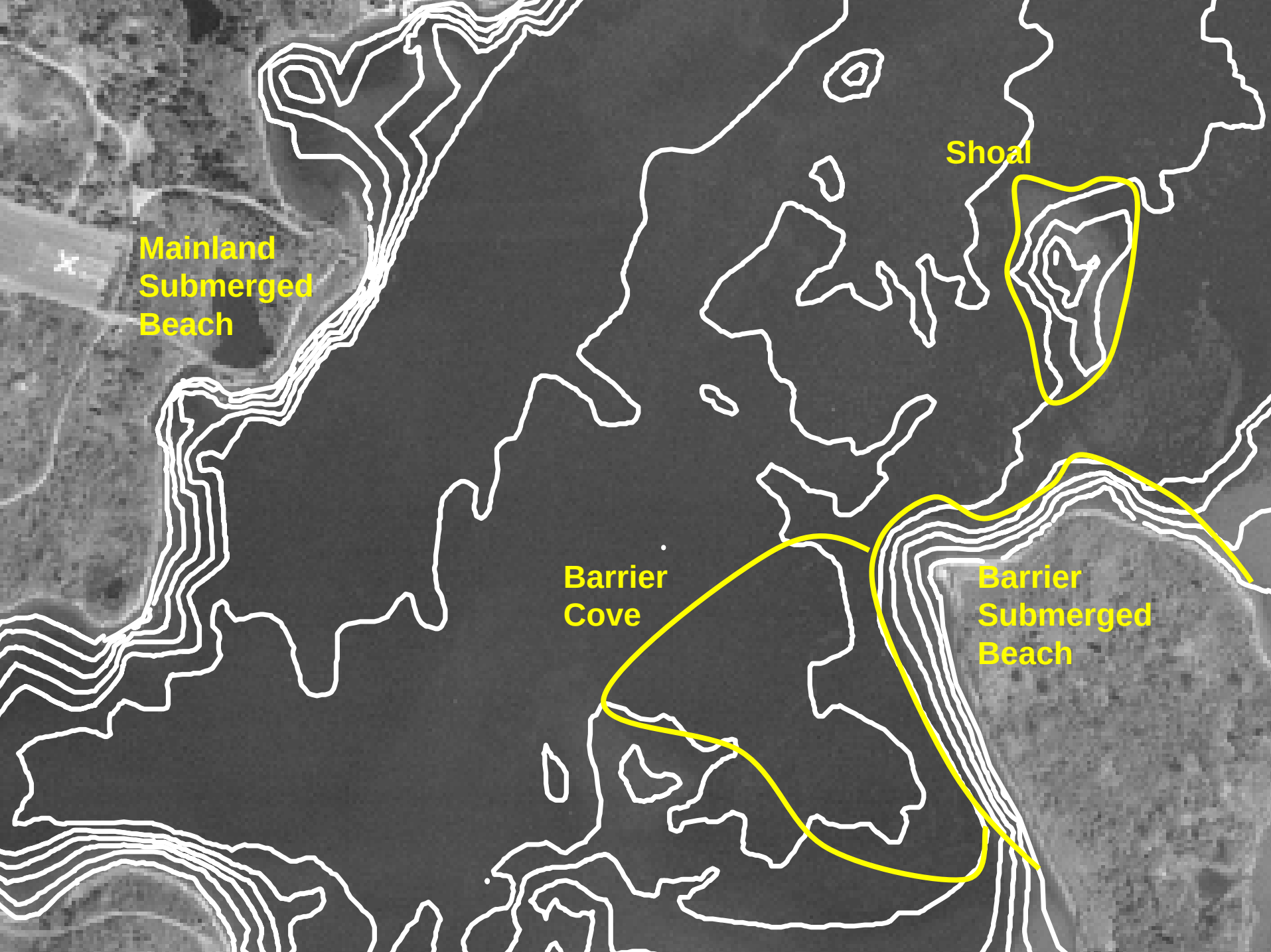
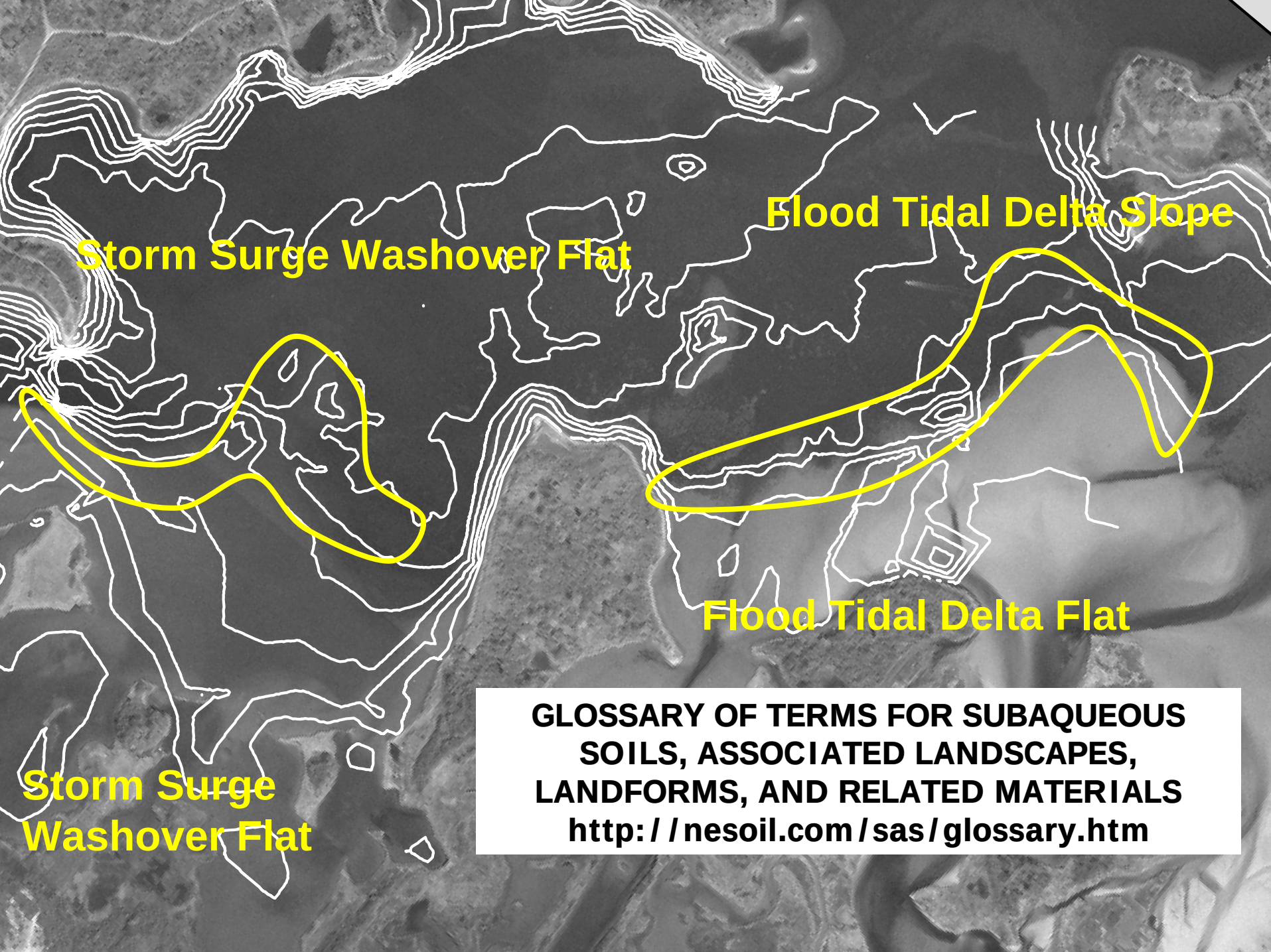


Figure 3-6. 3-dimensional surface plot of Sinepuxent Bay study area viewed from southwest to northeast (depth


Shoal
Mainland
Submerged
Beach
Barrier
Cove
Barrier
Submerged
Beach


Storm Surge Washover Flat
Flood Tidal Delta Slope
Flood Tidal Delta Flat
Storm Surge
Washover Flat
GLOSSARY OF TERMS FOR SUBAQUEOUS SOILS, ASSOCIATED LANDSCAPES, LANDFORMS, AND RELATED MATERIALS
http://nesoil.com/sas/glossary.htm

Subaqueous Soil Mapping Procedure

- Develop subaqueous soil series and map unit Legend.
- Identify and delineate landforms to determine soil map unit breaks.
- Map the area using standard NCSS procedure. Bucket augers and McCauley peat corers are used to investigate morphology.
- Vibracore techniques are used for deep and detailed observations.
- Determine map unit composition, inclusions, ROC, and other information – compile map.

Problems/Considerations

- Difficult mapping conditions and procedure (augering in water, describing profiles, etc.).
- Need inter-discipline collaboration (coastal geology, marine ecology, biologist, etc.).
- Alluvial soils are very variable and subject to change (seasonal and long term).
- Seasonal mapping (bathymetry year round).
- Safety concerns (weather, boating, environmental).
- *Requires some additional equipment, storage space, and maintenance*.

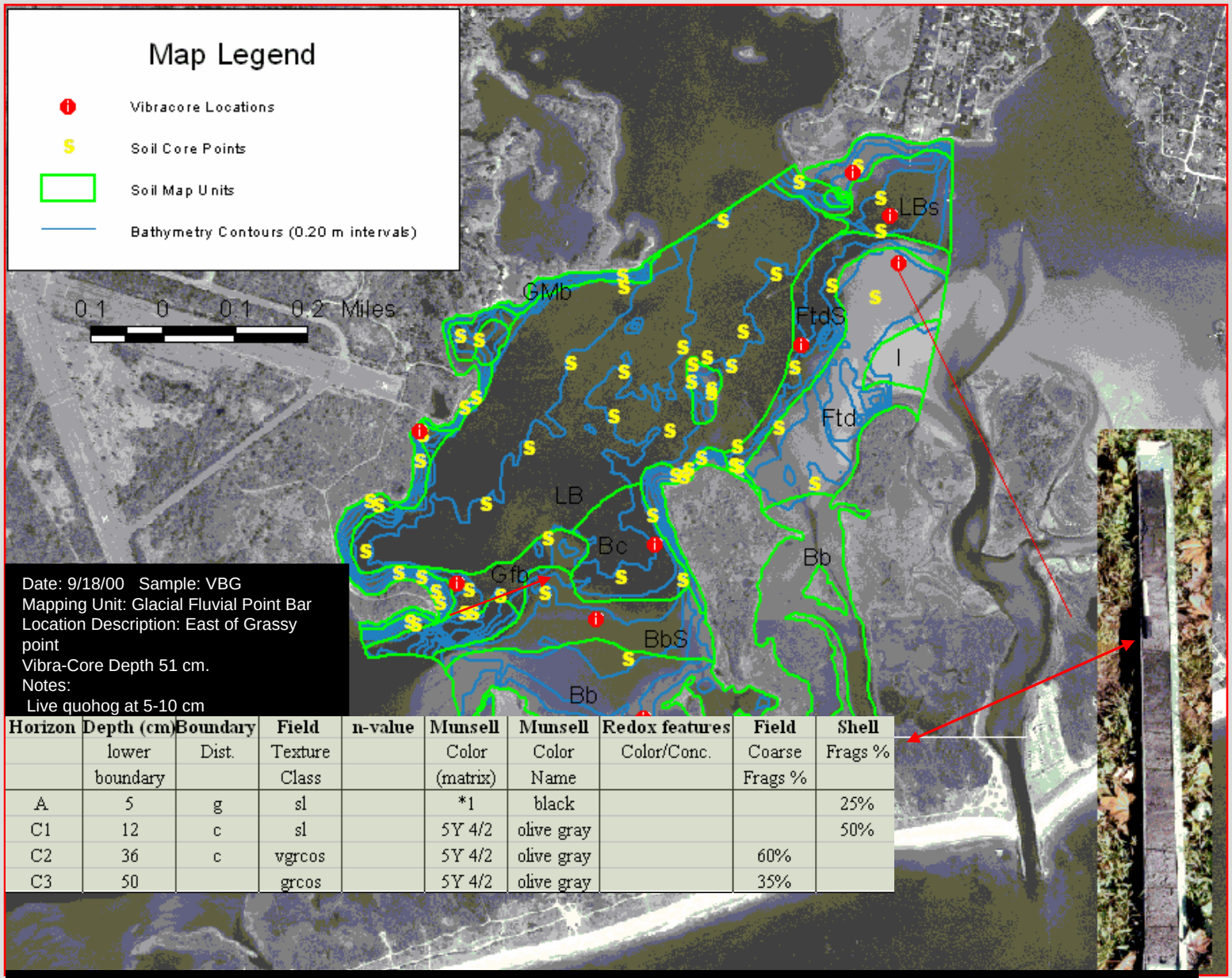
Final Product

Soil Survey of Coastal, Subaqueous and Submerged Soils of MLRA's 144A, 149B…(MO-12)

Maps showing the spatial distribution.

Manuscript:

1. Description of the soils.
2. Formation, genesis, classification.
3. Use, interpretations, and management – ecological, fisheries, SAV, engineering, hazards, etc.

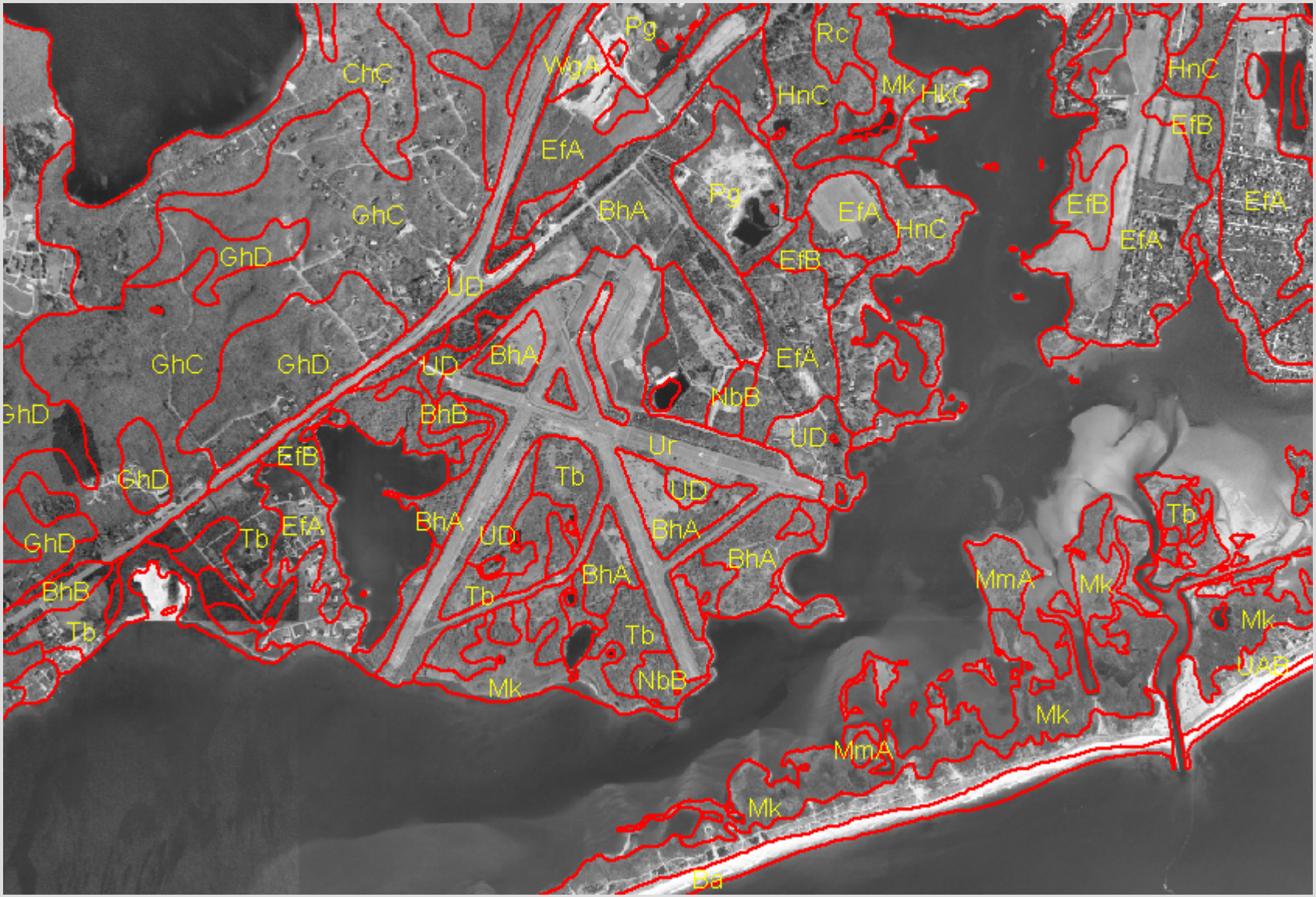


Date: 9/18/00 Sample: VBG
Mapping Unit: Glacial Fluvial Point Bar
Location Description: East of Grassy point
Vibra-Core Depth 51 cm.
Notes:
Live quohog at 5-10 cm

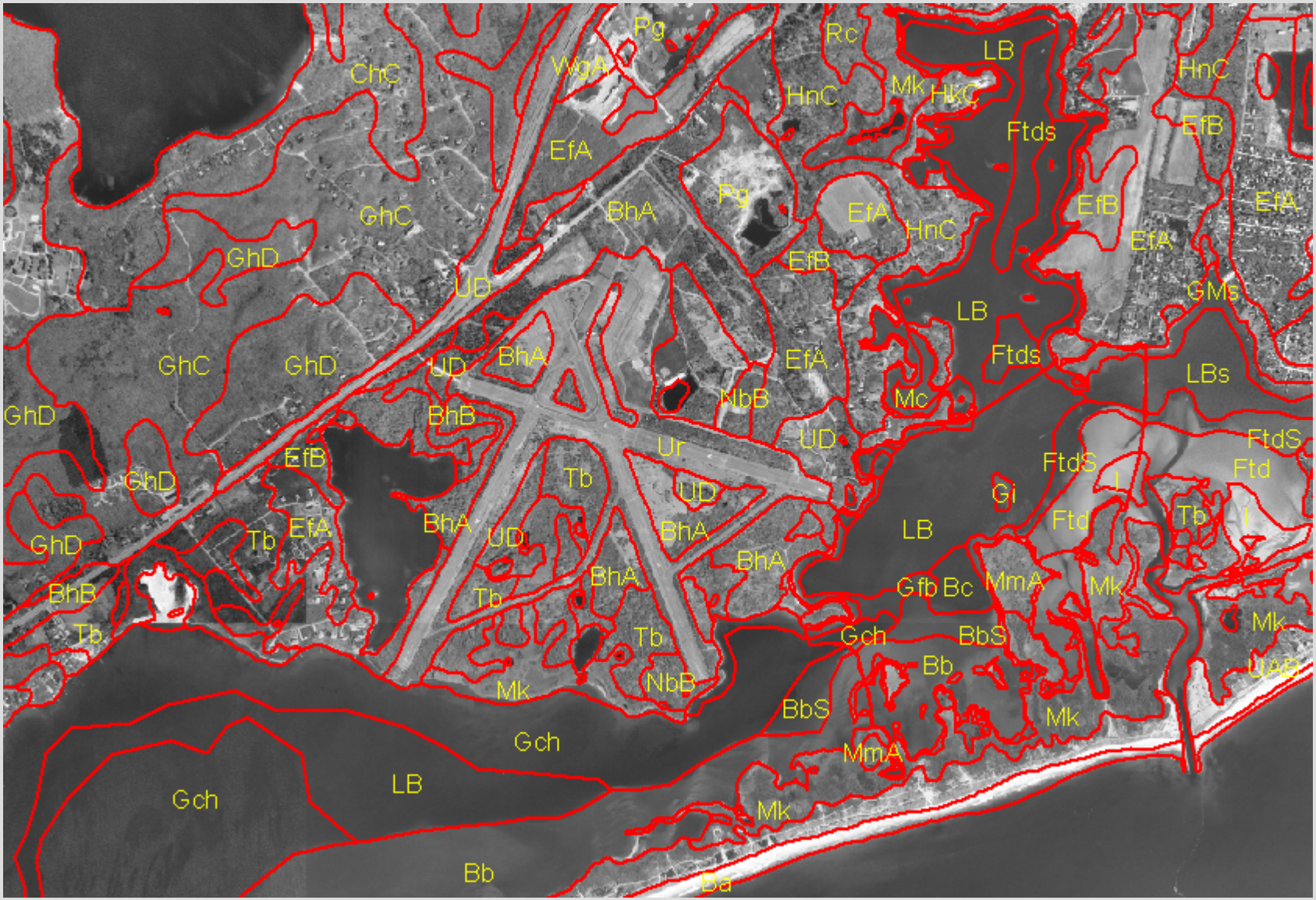
Horizon	Depth (cm) lower boundary	Boundary Dist.	Field Texture Class	n-value	Munsell Color (matrix)	Munsell Color Name	Redox features Color/Conc.	Field Coarse Frags %	Shell Frags %
A	5	g	sl		*1	black			25%
C1	12	c	sl		5Y 4/2	olive gray			50%
C2	36	c	vgrcos		5Y 4/2	olive gray		60%	
C3	50		grcos		5Y 4/2	olive gray		35%	

Ftd – Flood-tidal Delta Flat, sand flats: These soils are found on the very shallow (<1.1 m) sand flats of the flood-tidal delta. The subaqueous soils of this unit are characterized by black, very dark gray, and dark gray, sands with low (<0.5%) amounts of organic carbon. Buried horizons and stratification are occasionally identified. Most soils are classified as Typic Psammaquents. Submerged topography is flat or slightly undulating. Remnant and active channels are common inclusions in this unit. Eelgrass is virtually absent

Terrestrial Soil Survey

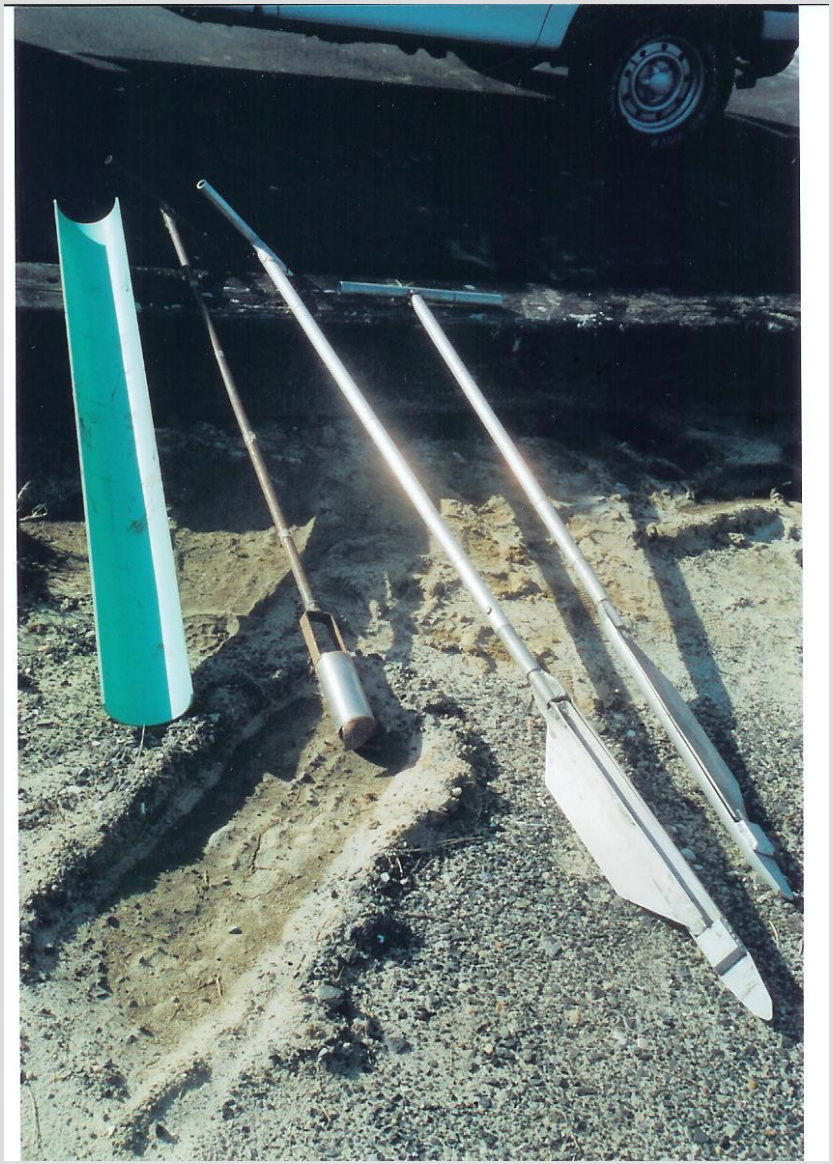


Seamless Soil Survey



Bathymetry

Vibracore



Hand Tools


The
Natural
Challenge

END

Visit: www.mapcoast.org for more information