Subaqueous Landforms , Features, and Materials

(much content from Jim Turenne, NRCS, & Mark Stolt, URI)

1) Discrete underwater features or “geoforms” (that commonly can support rooted plants), and adjacent features, ordinarily found beneath permanent open water.

   [Historically, in Soil Survey, these underwater features have been included in the generic map unit "water"].

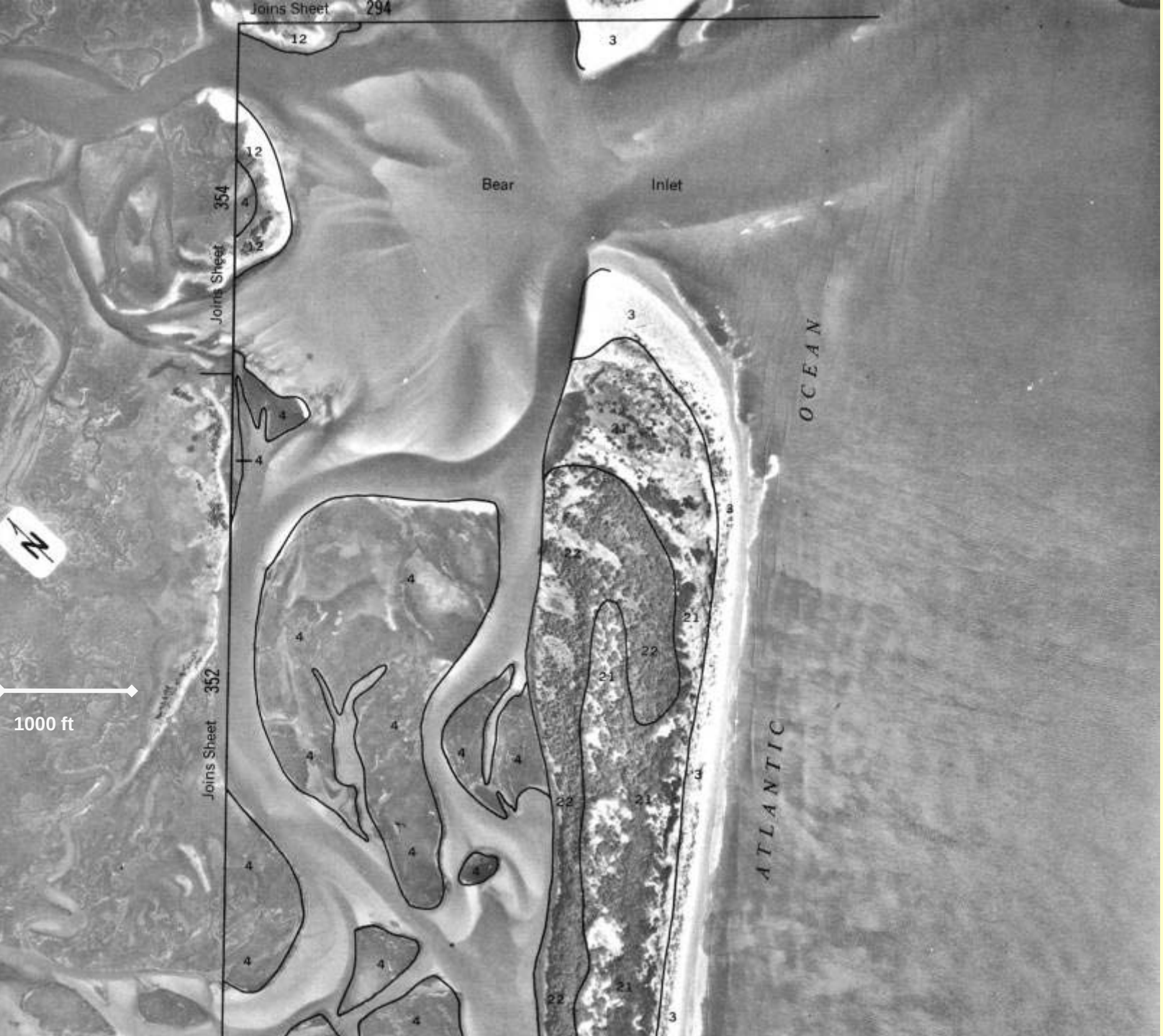
2) Soils that are submerged for > 90% of the time (e.g. > 21.5 hrs/day)

Why bother ?

- Primarily driven by interest of new soil survey / resource management customers.

- Political, financial, and societal support.

- **They are a natural extension of the terrestrial soil continuum**
  *(ecologically, transported sediments, nutrients, contaminants, etc.)***.**



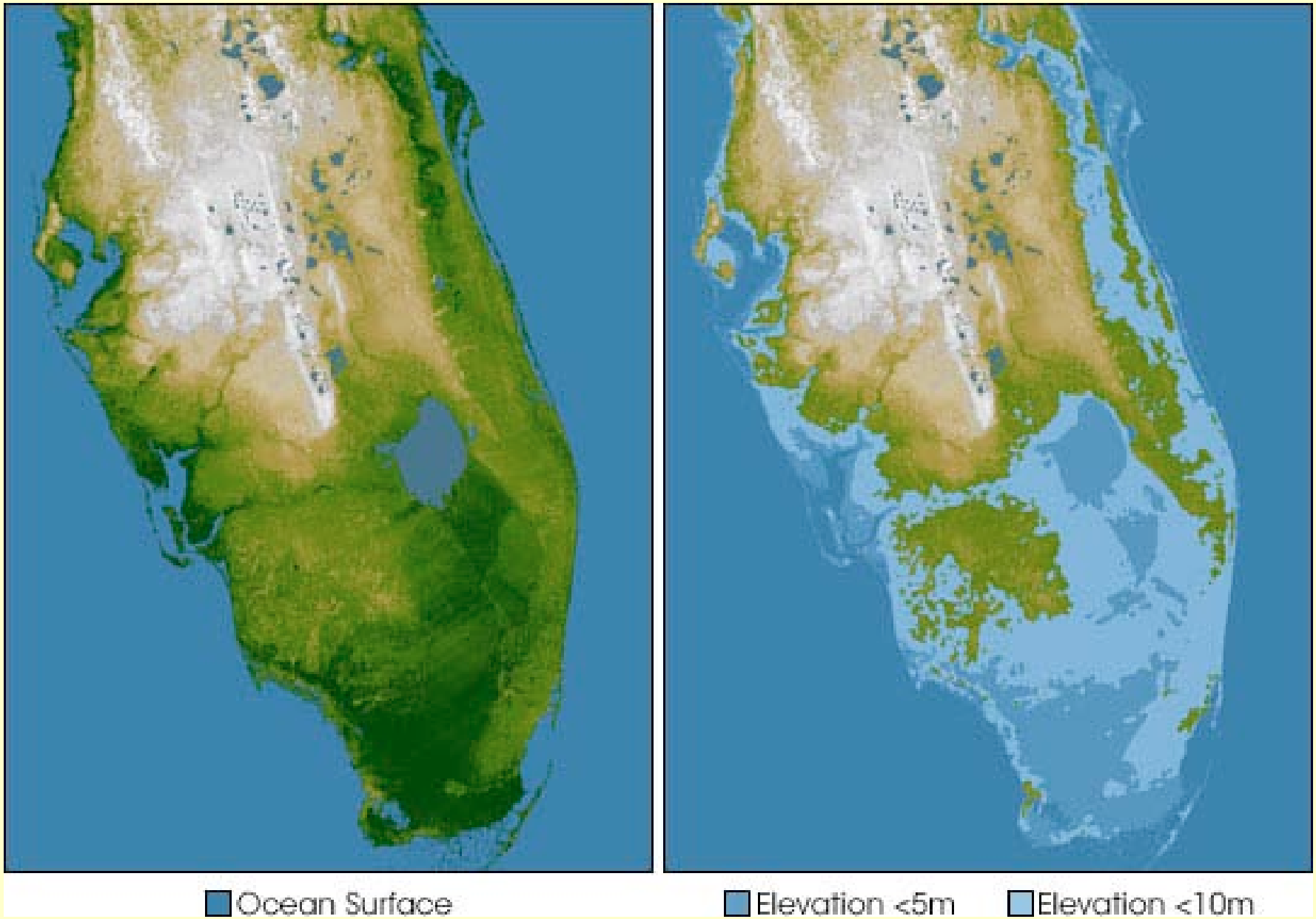
Map

Unit #	Name
3	beach-foredune complex
4	Bohicket soils, low
12	Duckston fine sand
21	Newhan fine sand
22	Newhan-Corolla complex
w	water

Bear Inlet, Onslow Co., Soil Survey Outer Banks, NC SCS, 1977.

Estimated Coastal Inundation Scenarios from Sea Level Rise:

Present Coastline vs : < 5m and < 10m



USGS

Four Principles

(mantra)

- **GEOMORPHOLOGY**

  landforms / geoforms: shape, distribution, orientation, size.

- **STRATIGRAPHY**

  materials (layers): structure, composition

- **HYDROLOGY**

  water (fluid) dynamics: direction, magnitude, etc.

- **SOIL MORPHOLOGY**

  Field observations and Interpretations of soil development.

Geomorphic Description System

Version 4.12
6 / 24 / 2009

NATURAL RESOURCES CONSERVATION SERVICE
USDA

II) GEOMORPHIC ENVIRONMENTS and OTHER GROUPINGS

Geom. Envir.

8. **Mass Movement** (gravity dominated)
9. **Volcanic & Hydrothermal**
10. **Tectonic & Structural** (bedrock structures, crustal movement)

Other

11. **Slope** (generic slope forms, geometry, arrangement)
12. **Erosional** (dominated by non-channel, non-perennial water erosion)
13. **Wetlands** (vegetated or shallow wet areas, wet soils)
14. **Depressional**
15. **Water Bodies** (permanent water features)
16. **Subaqueous Features** (permanently underwater)

Geomorphic Description System :

"Other Groupings"

'Landforms' *(geoforms?)* that share a common setting, but not necessarily formed by the same geomorphic processes.

16. SUBAQUEOUS FEATURES [Discrete underwater features that commonly can support rooted plants, and adjacent features, ordinarily found below permanent open water. *[Historically, in Soil Survey Reports these underwater features have been included in the generic map unit "Water" (e.g. lake)].*

Landscapes :

bay [coast] (water body; also LF)	--	? ocean (water body)	--
? gulf [coast] (water body)	--	? sea (water body)	--
estuary (water body; also LF)	--	? sound (water body)	--
lagoon [coast] (water body; also LF)	–	? strait (water body)	--

Landforms :

barrier cove	--	mainland cove	--
bay [coast] (water body; also LS)	--	marine lake	--
bay bottom	--	reef	*WD*
cove [coast]	--	relict-tidal inlet	--
dredged channel (Anthro Feature)	--	shoal	--
dredge-deposit shoal (Anthro. Fea.)	--	sound (also Landscape)	--
estuary (also Landscape)	*WD*	strait (also Landscape)	--
flood-tidal delta	--	submerged back-barrier beach	
flood-tidal delta flat	--	submerged mainland beach	
etc.		*etc.*	

Microfeatures :

channel (permanent water)	--

Glossary

- Some 66 terms are 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

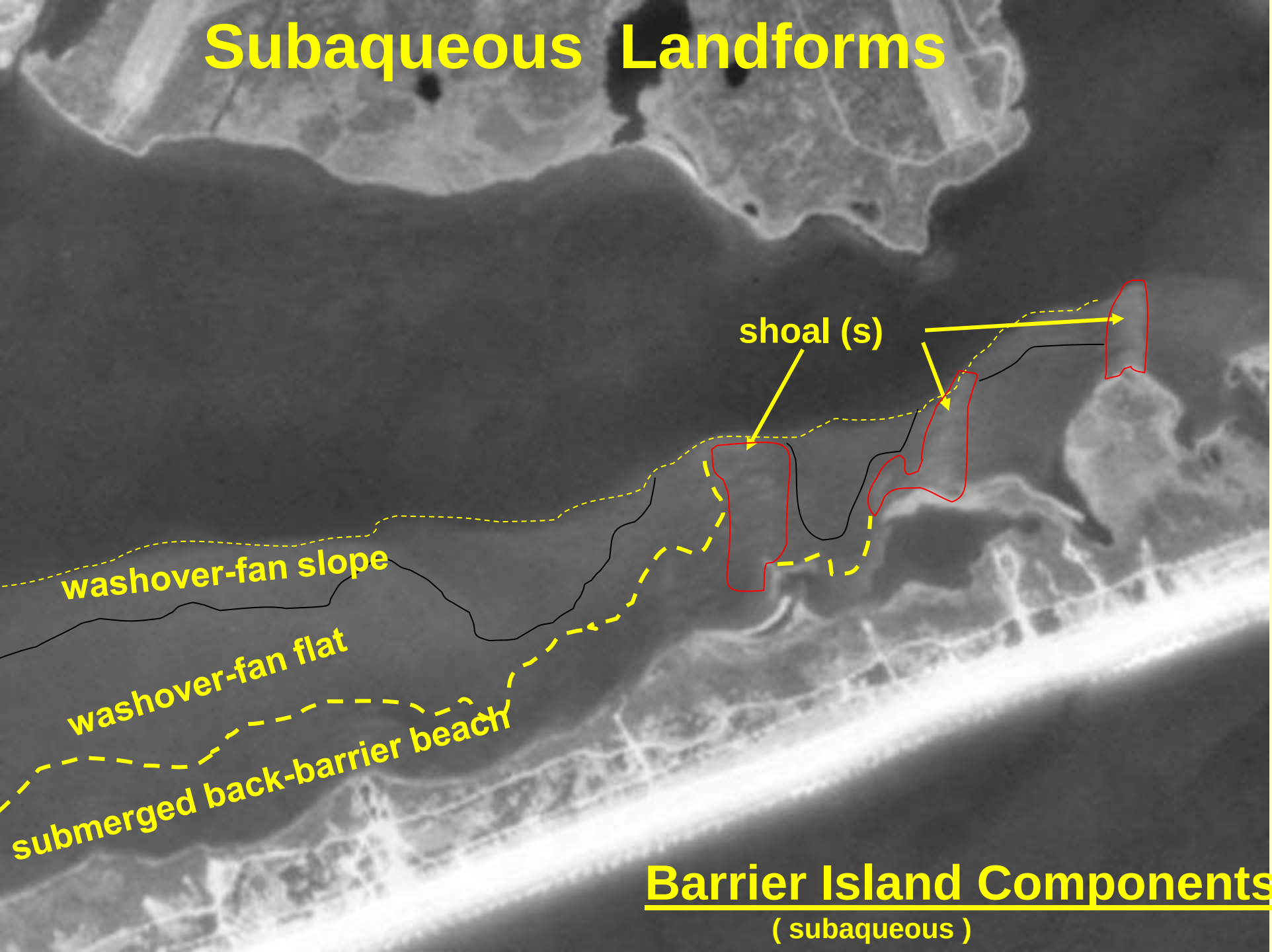
Subaqueous Soils Subcommittee
of the
Standing Committee on NCSS Standards
National Cooperative Soil Survey Conference
Corpus Christi, Texas
2005

September 2005

Subaqueous "environment"

Erosion	***Transport***	***Deposition***
channel	tidal inlet *(active)*	washover-fan slope
		flood-tidal delta
(voids , modified features)	*(dynamic deposits and features)*	*("stable" deposits and features)*

Subaqueous Landforms



Barrier Island Components

(subaqueous)

RI

Geomorphic Systems may be better for evaluating landform subsets within SAS:

- **barrier systems (open coasts)**
- **lagoon / estuary**
- **fluviomarine systems** ***(drowned but active fluvial systems)***
- **lacustrine**

Not just geology:

Pedogenic processes are active in the subaqueous environment, and drive the formation of soil horizons.

Horizon Differentiation

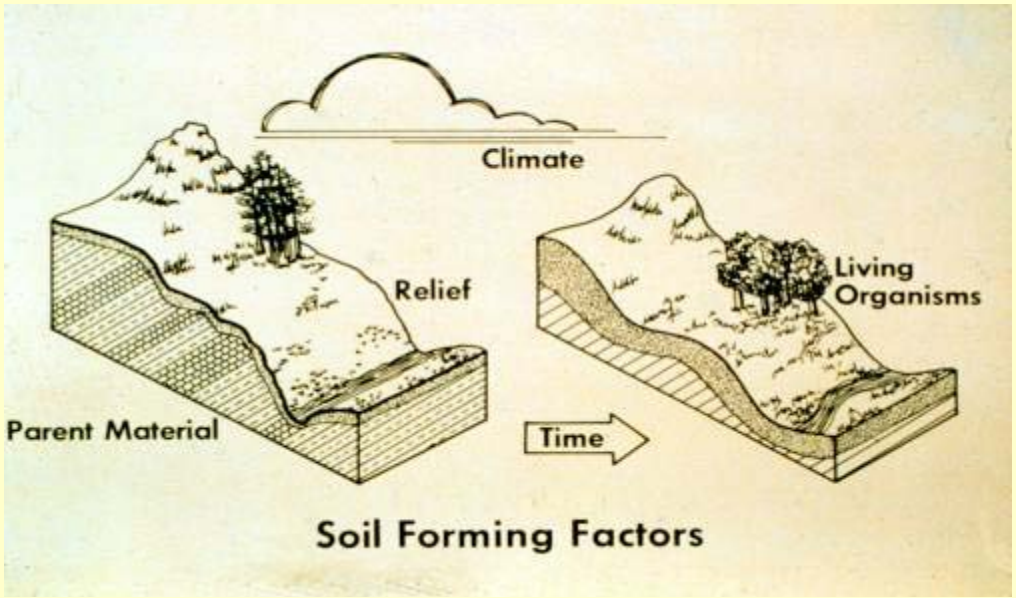
- Additions
- Removals
- Transfers
- Transformations

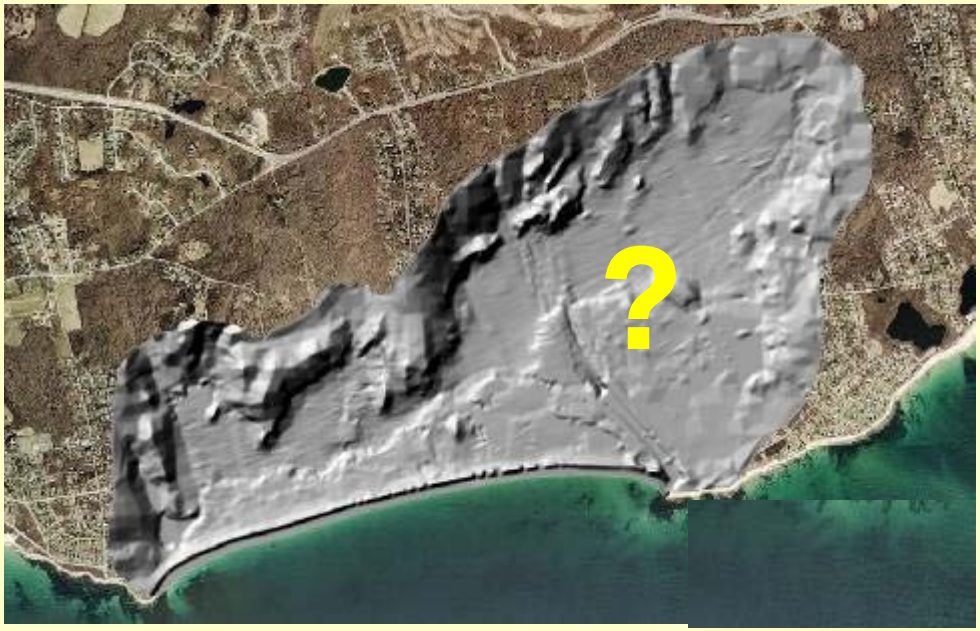
(Simonson, 1959)

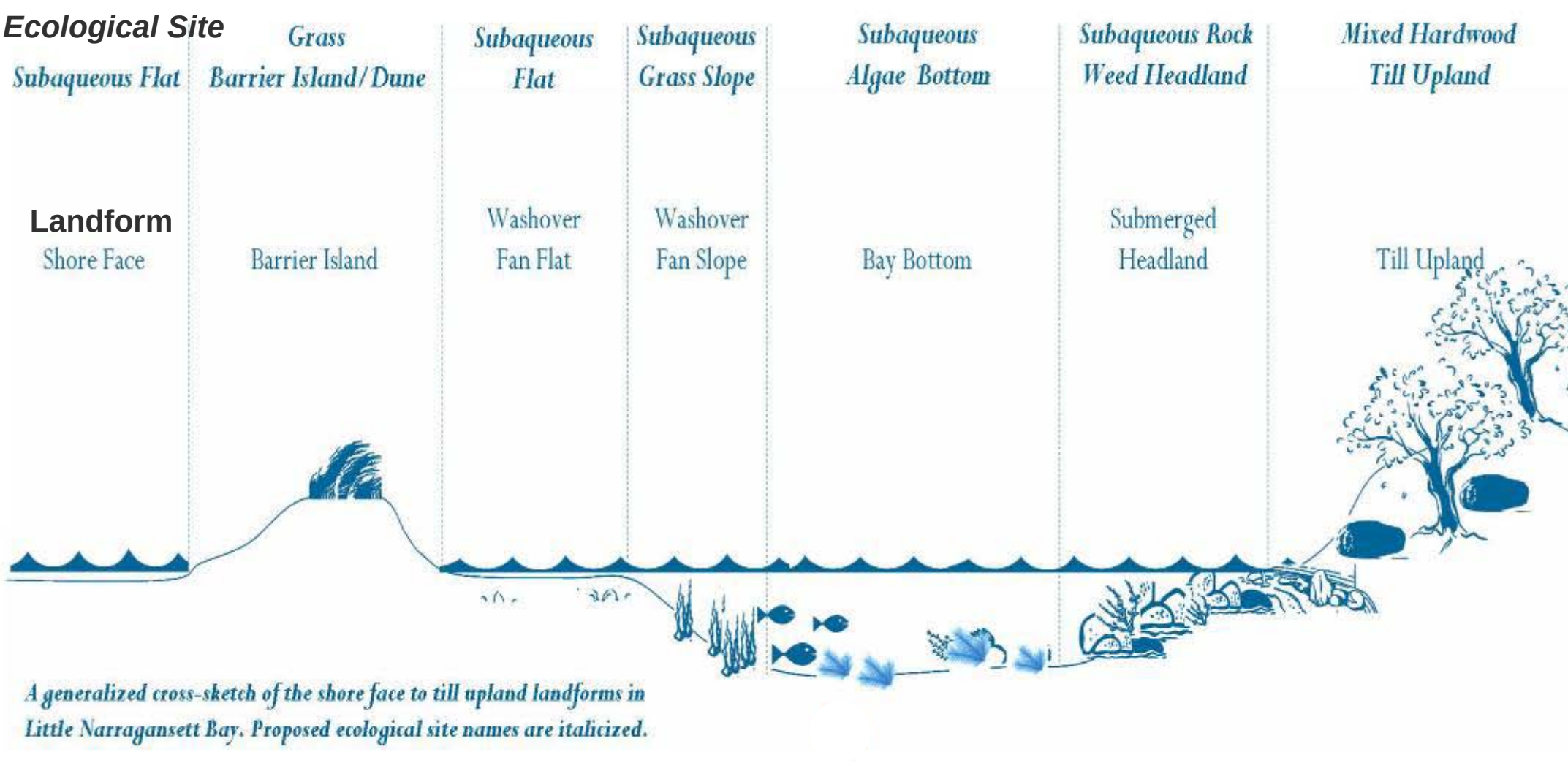
ex. 4 Subaqueous Soils

Soil - Aquascape Relationships

- Are there subaqueous “landforms”?
- Do they have predictable sediment / soil patterns (can they be mapped)?







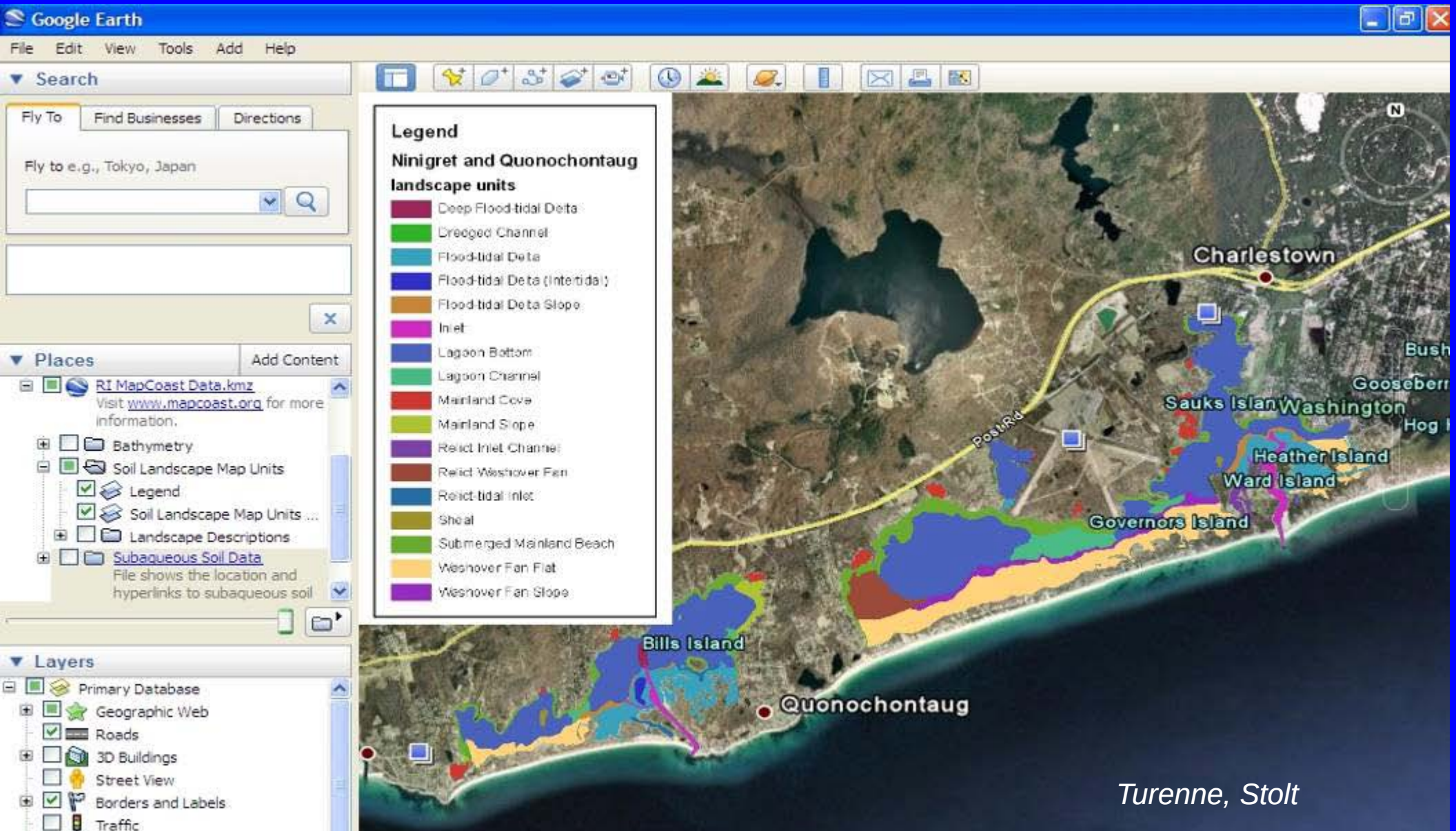
A generalized cross-sketch of the shore face to till upland landforms in Little Narragansett Bay. Proposed ecological site names are italicized.

The soil-landscape paradigm is valid in the subaqueous environment.

Little Narragansett Bay, RI

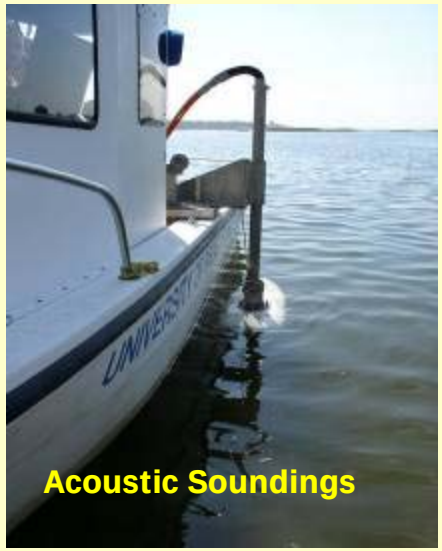
Debra Surabian

Google-Ocean Example



Can’t as easily observe landforms, but can manage.

Bathymetric Map required.



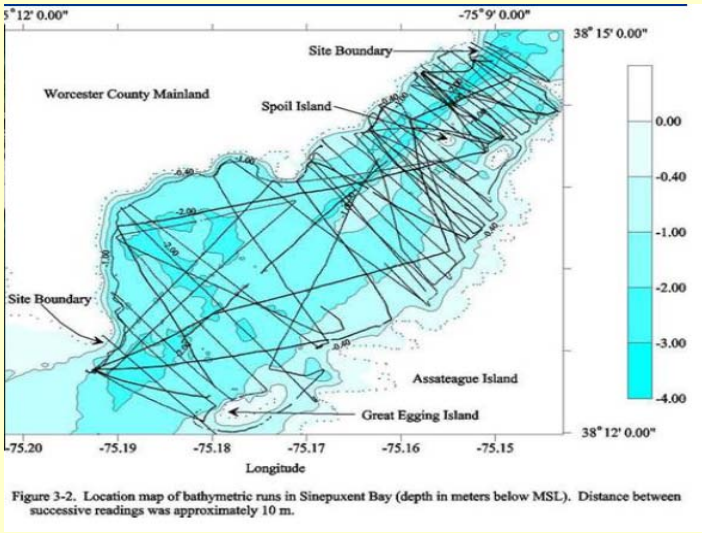


Figure 3-2. Location map of bathymetric runs in Sinepuxent Bay (depth in meters below MSL). Distance between successive readings was approximately 10 m.

Turenne, Stolt

Parent Materials:

e.g. Acid-Sulfate Materials

- Dredge Materials
  - Acid producing upon oxidation.

Turrene, Stolt

Materials / Sediments

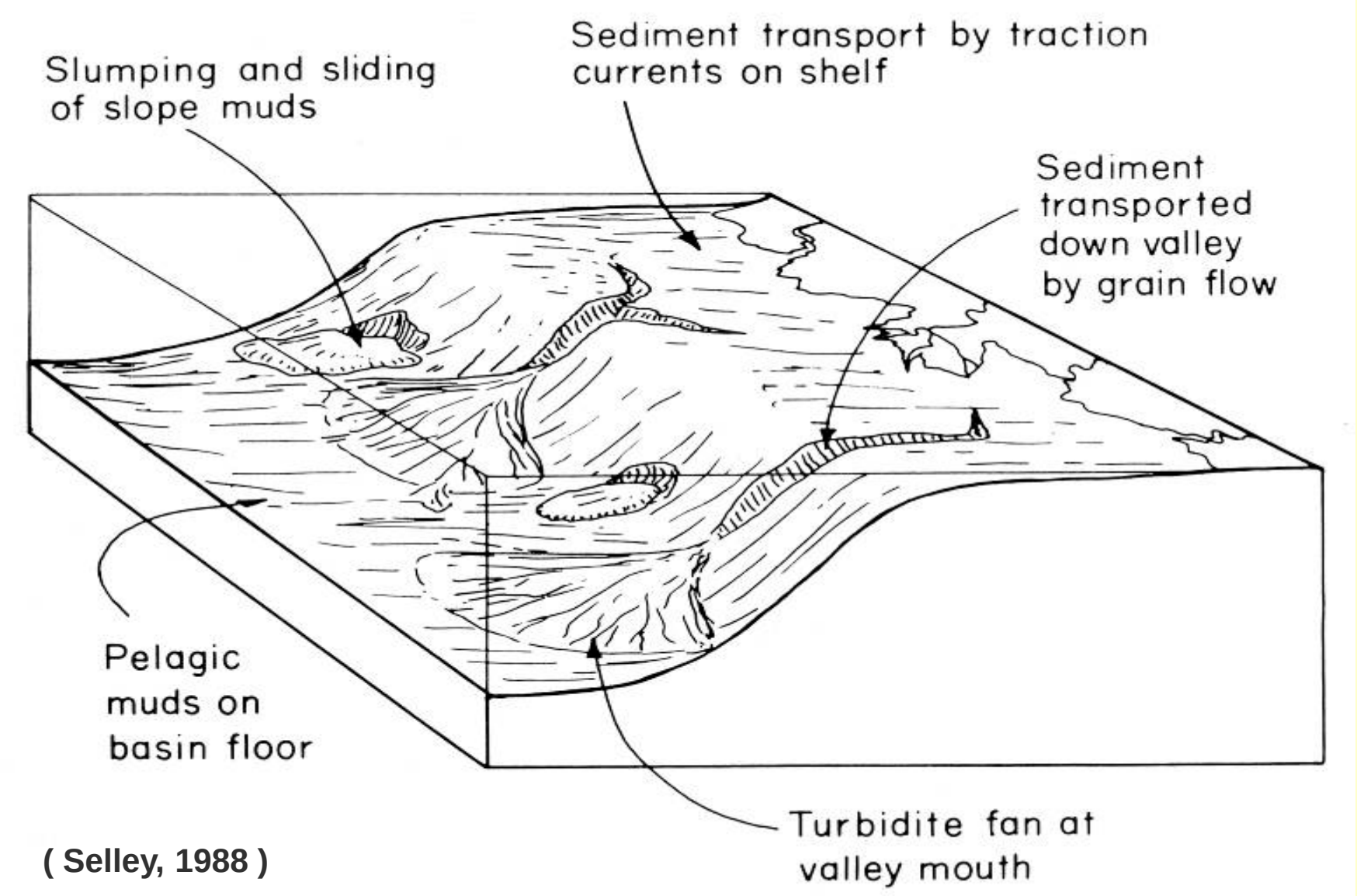
(SAS Glossary, NSSH)

- estuarine deposit
- fluviomarine
- lacustrine deposit
- lagoonal deposit
- marine deposit
- overbank (barrier) deposit

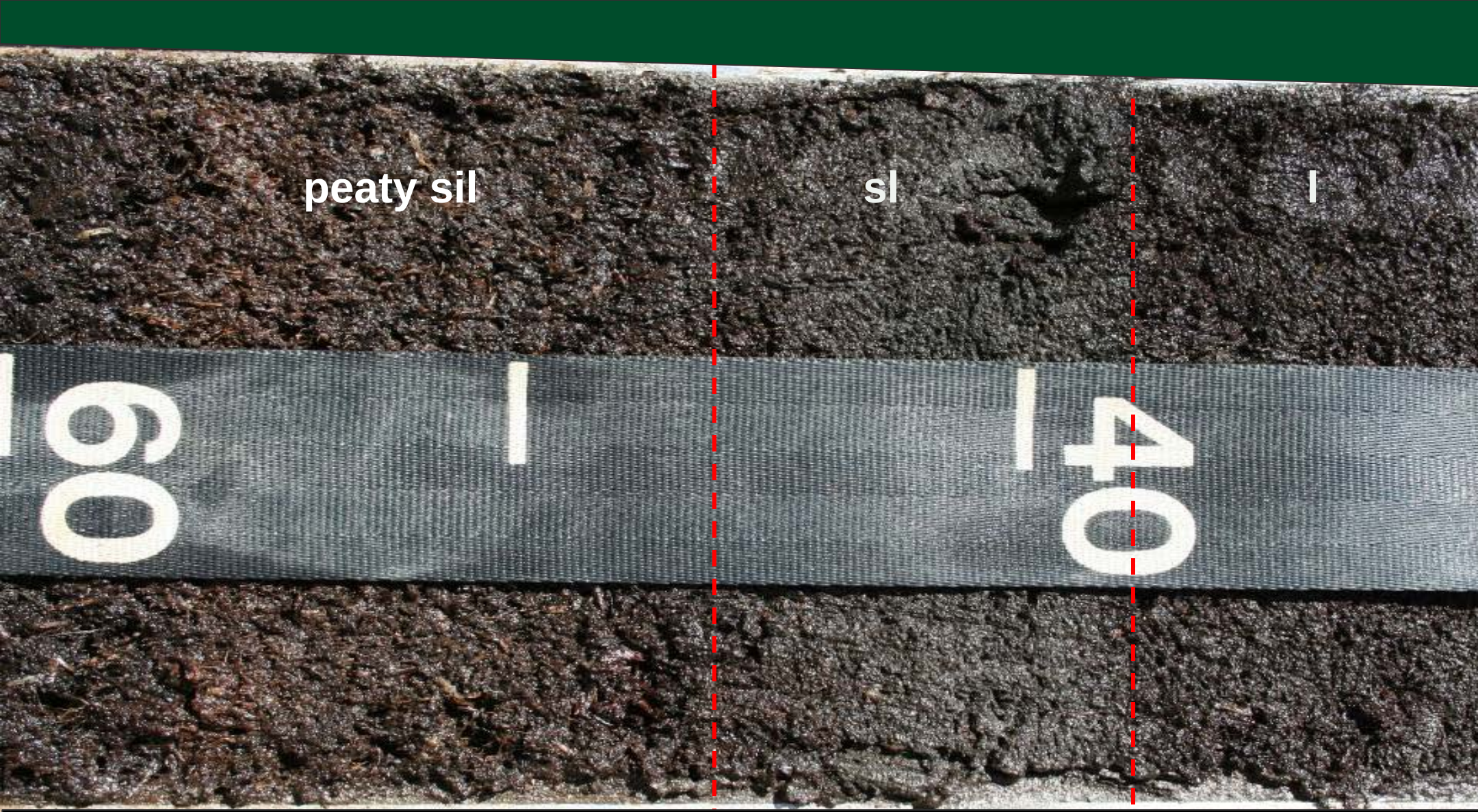
- Mass wasting deposits ? (landslides, turbidite)

Subaqueous turbidity flow deposits

(proglacial lakes / lacustrine / estuarine systems)



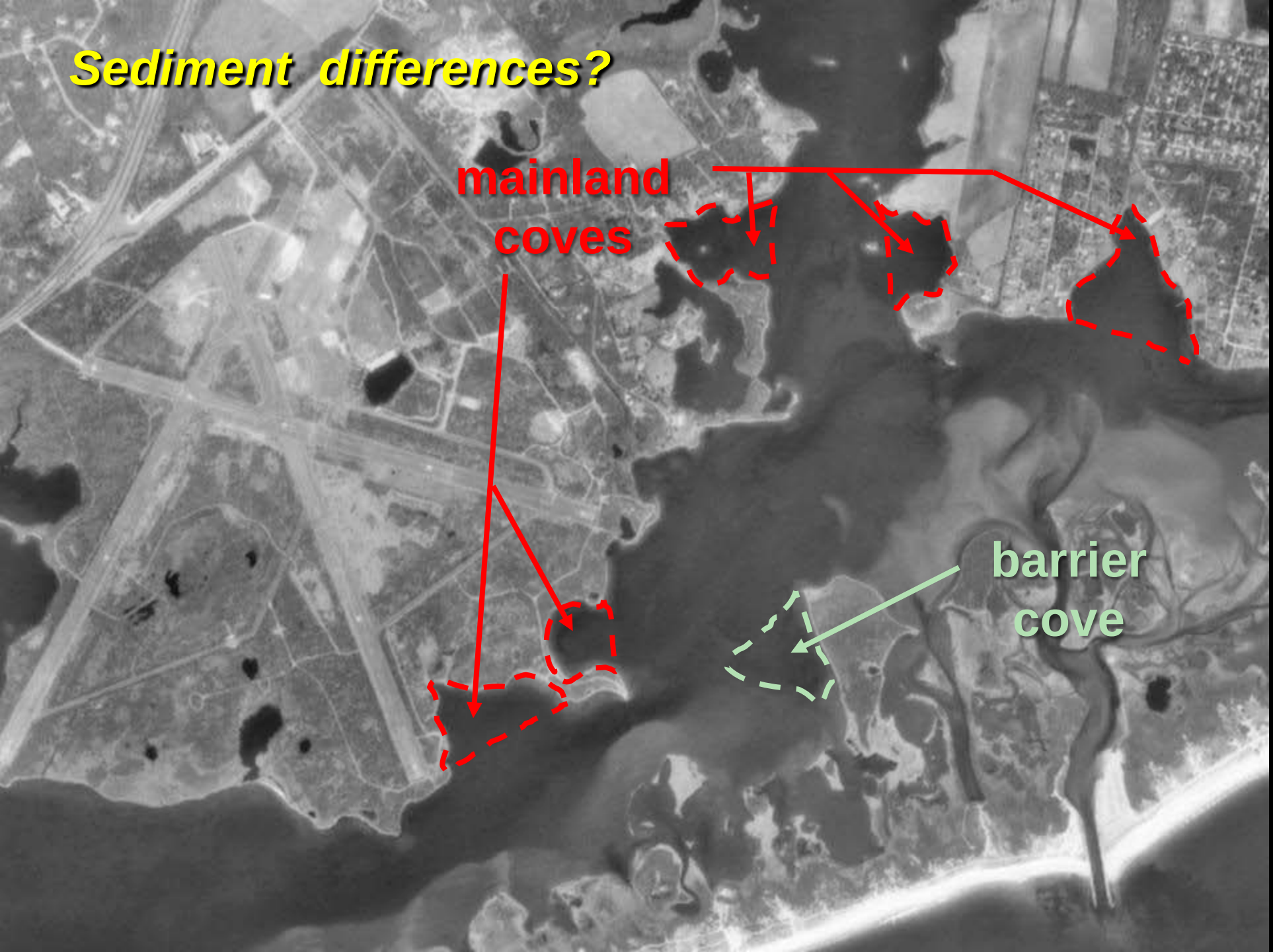
(Selley, 1988)



(Schoeneberger, McVey)

Subaqueous soil : gray loamy sediment over buried organic-rich (fibric) material

Naraganset Bay, RI



RI

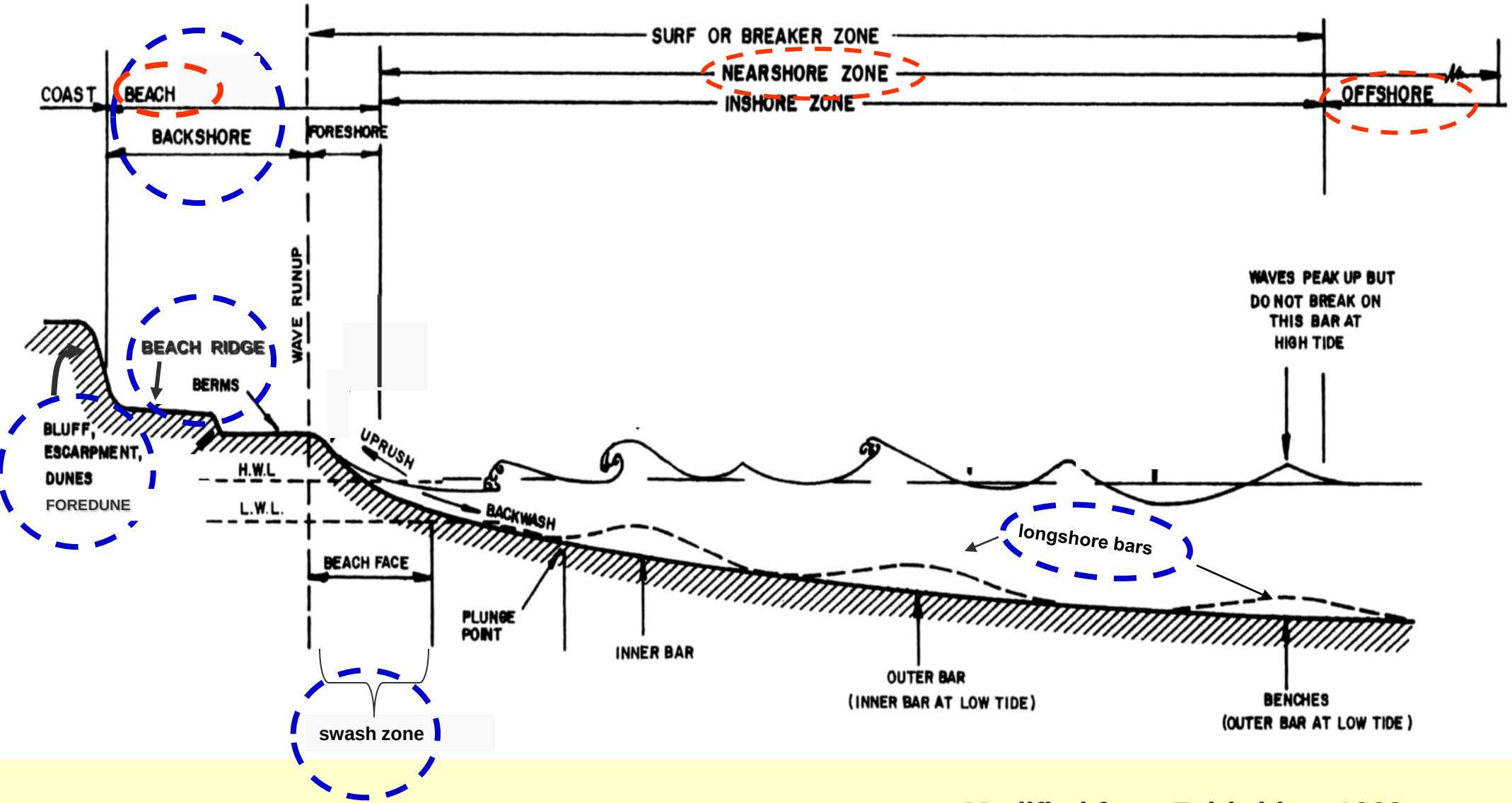
Conventional Shore / Coastal Facies

- **beach : coarser sediments** (***med. - co.s, gr, cob, st***)
- **near shore : medium textured seds.** (***med. – vfs; si further out***)
- **offshore : fine textured seds.** (***fsi, c, organics***)

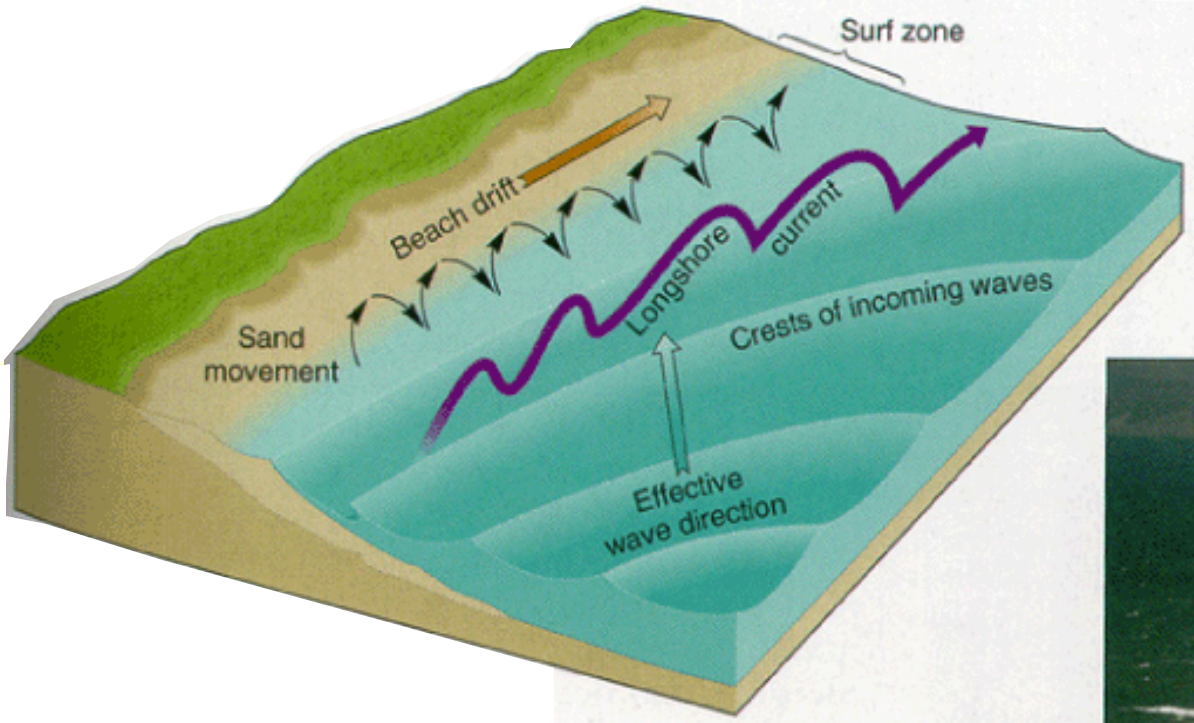
Geomorphic Systems may be better for evaluating subsets:

Barrier Systems (open coasts)
Laggoon / estuary
Fluviomarine systems (drowned but active fluvial systems
Lacustrine

Common landforms, zones & processes of non-rocky coasts.

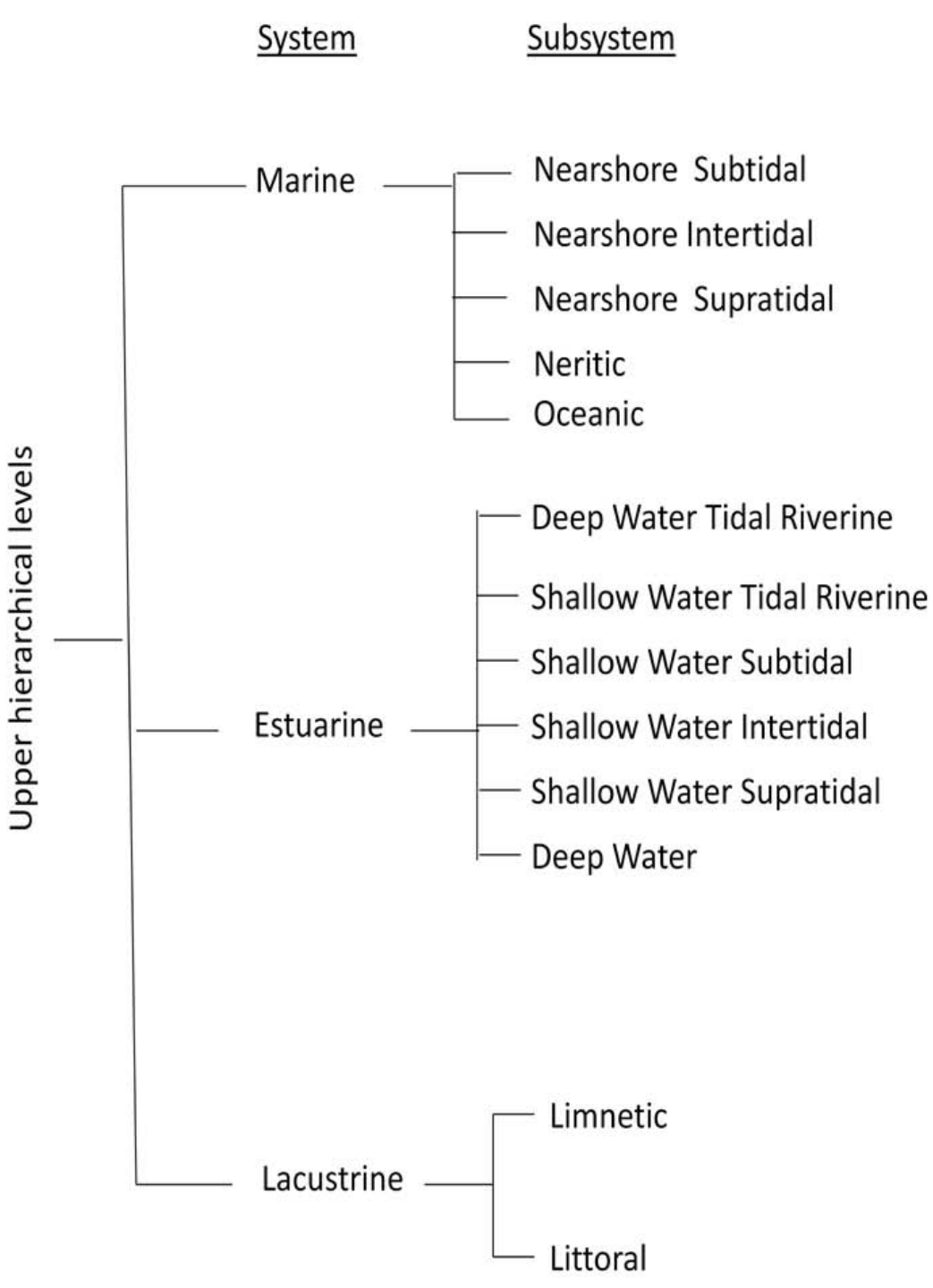


Modified from Fairbridge, 1968



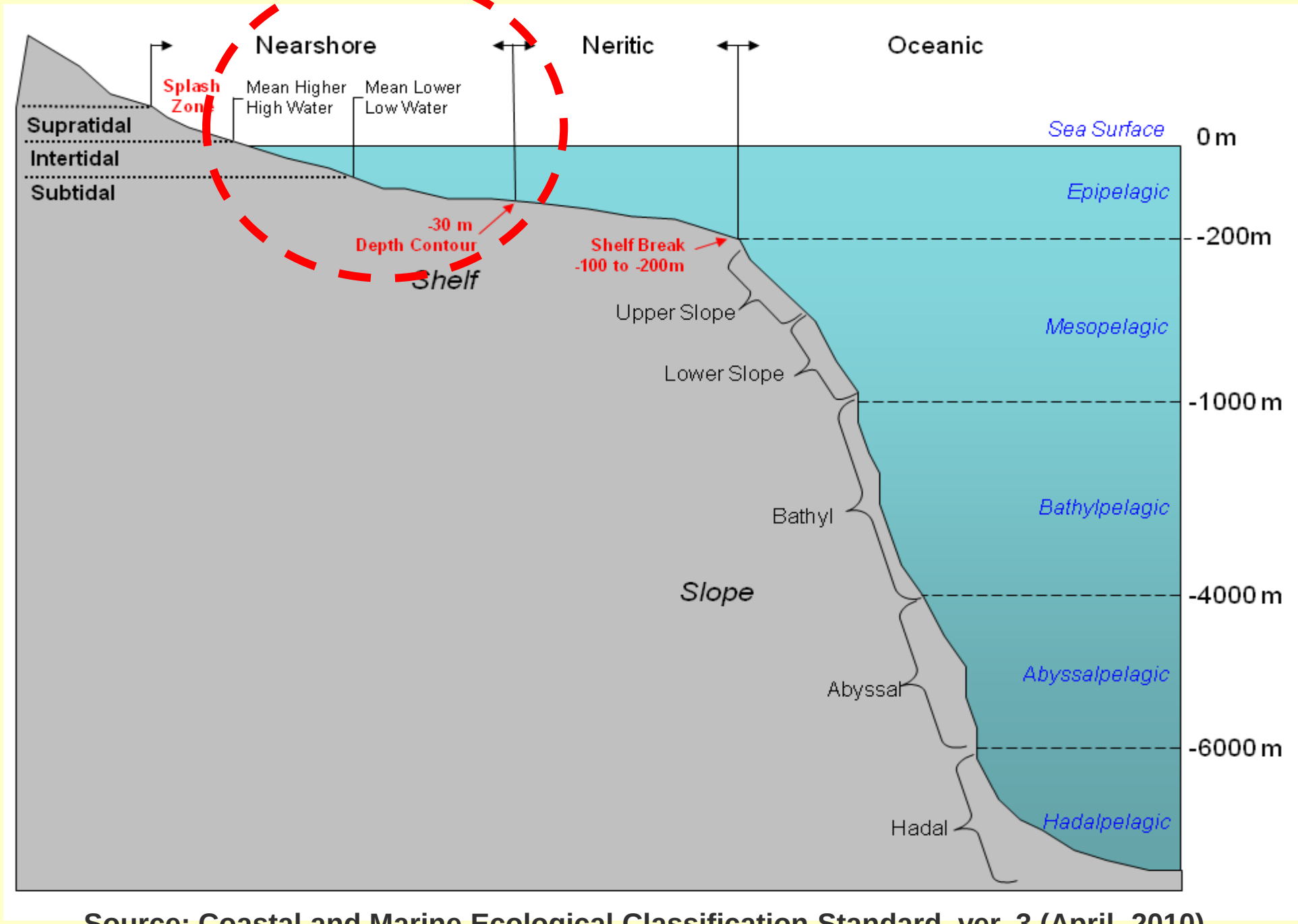
source: Christopherson (2000) *Geosystems*

Pt. Reyes, CA



Coastal Marine Ecological Classification Standard (CMECS)

- ver. 3 *(draft 2010)*



Source: Coastal and Marine Ecological Classification Standard, ver. 3 (April, 2010)

Landscape: ***shore complex*** **Landform:** ***beach***

ST Marks Light house, Wakulla Co., FL

Landforms: ***mangrove swamp, island***

Babeldauhpt Is., Palau

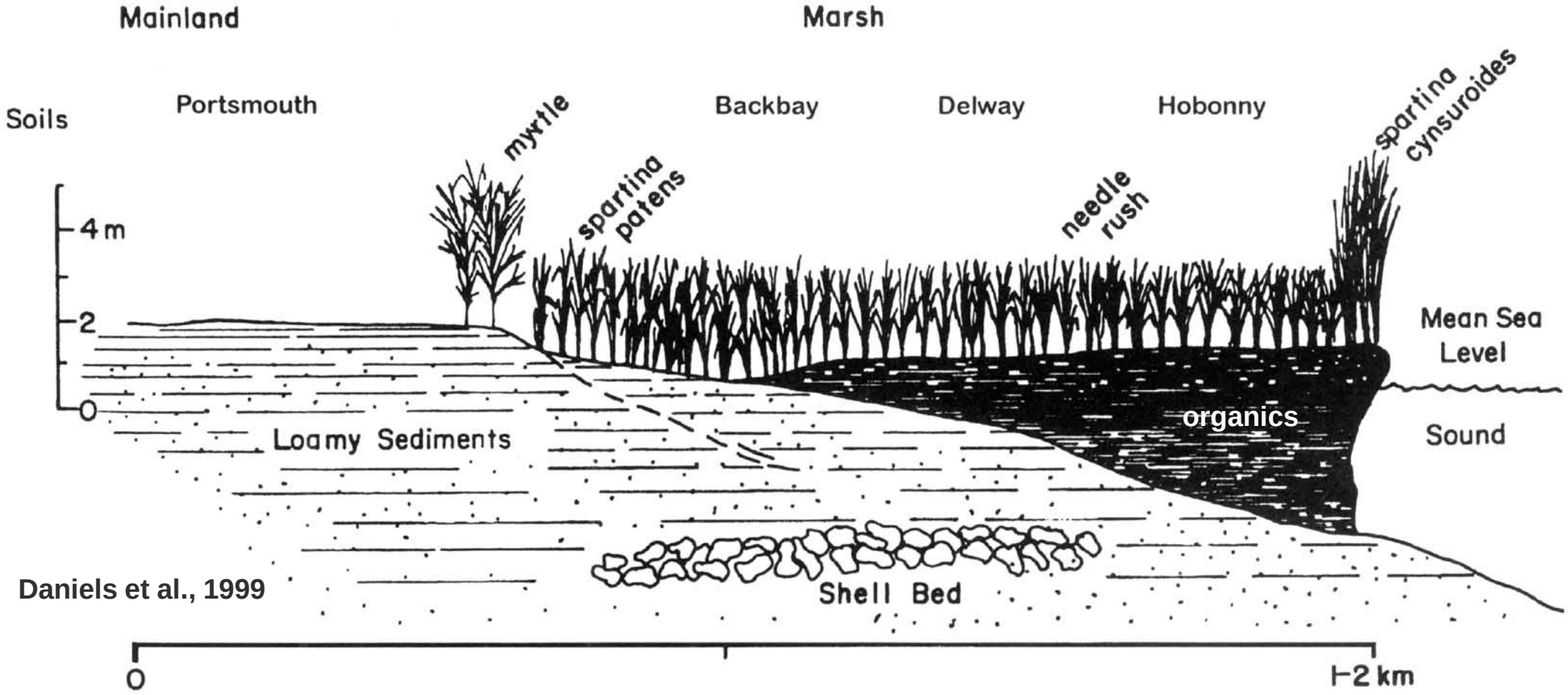
Landform: ***mangrove swamp***

southern FL

Soil: Lignumvitae **PM: coastal marl** **FL**

Estuarine / Lagoon Environment

Landscape: ***shore complex, coastal plain*** **; Landform:** ***marsh, lagoon*** **(lagoonal facies)**



Daniels et al., 1999

Graphics: soil distribution across a landscape; major soils, stratigraphy (PM), topography, dominant or key vegetation species (vs. veg. community types), scales

Daniels et al., 1999

Map

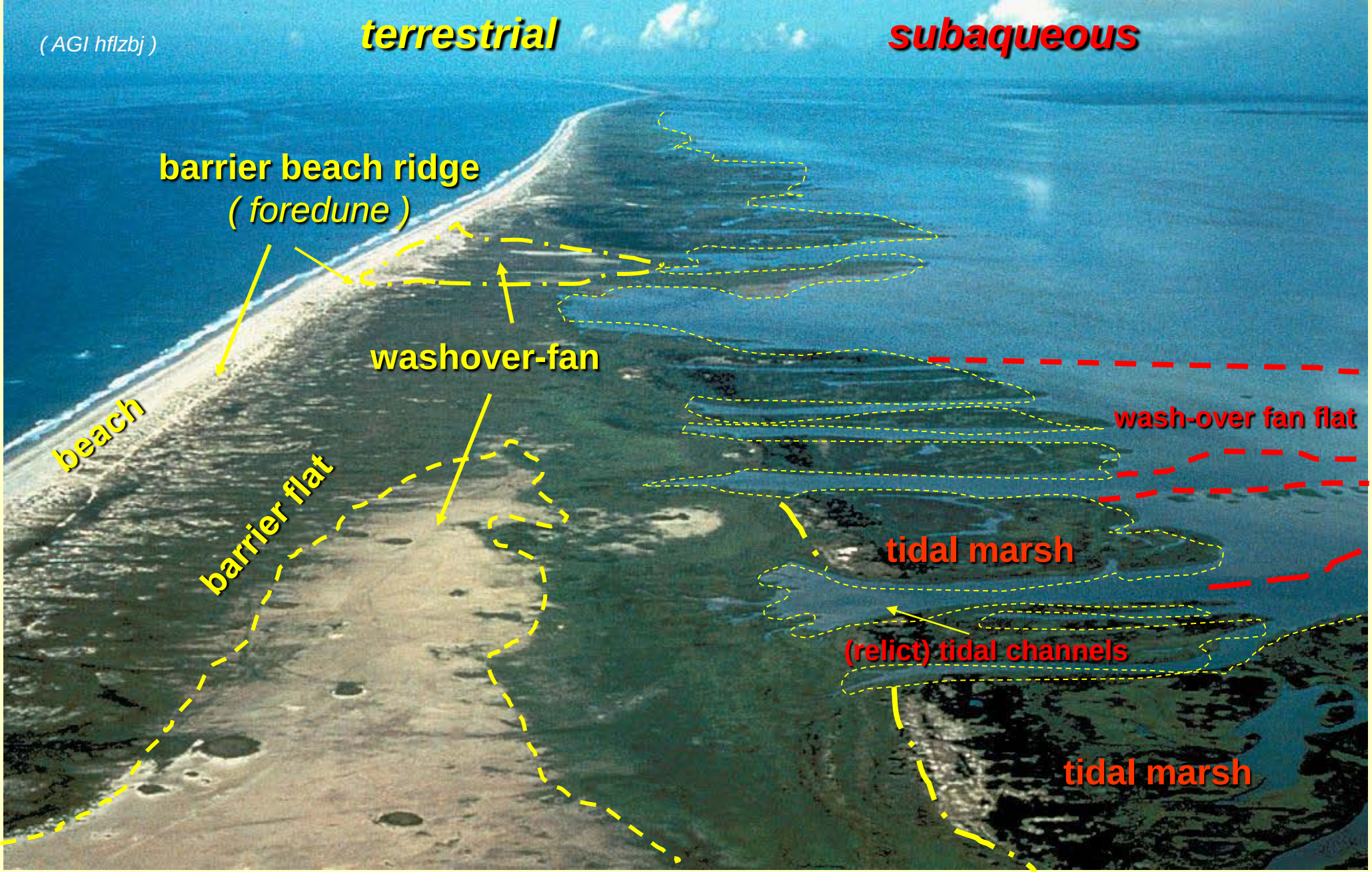
Unit #	Name
3	beach - foredune complex
4	Bohicket soils, low
10	dredge spoil
21	Newhan fine sand
w	water

Brunswick Co.,

Soil Survey
Outer Banks, NC

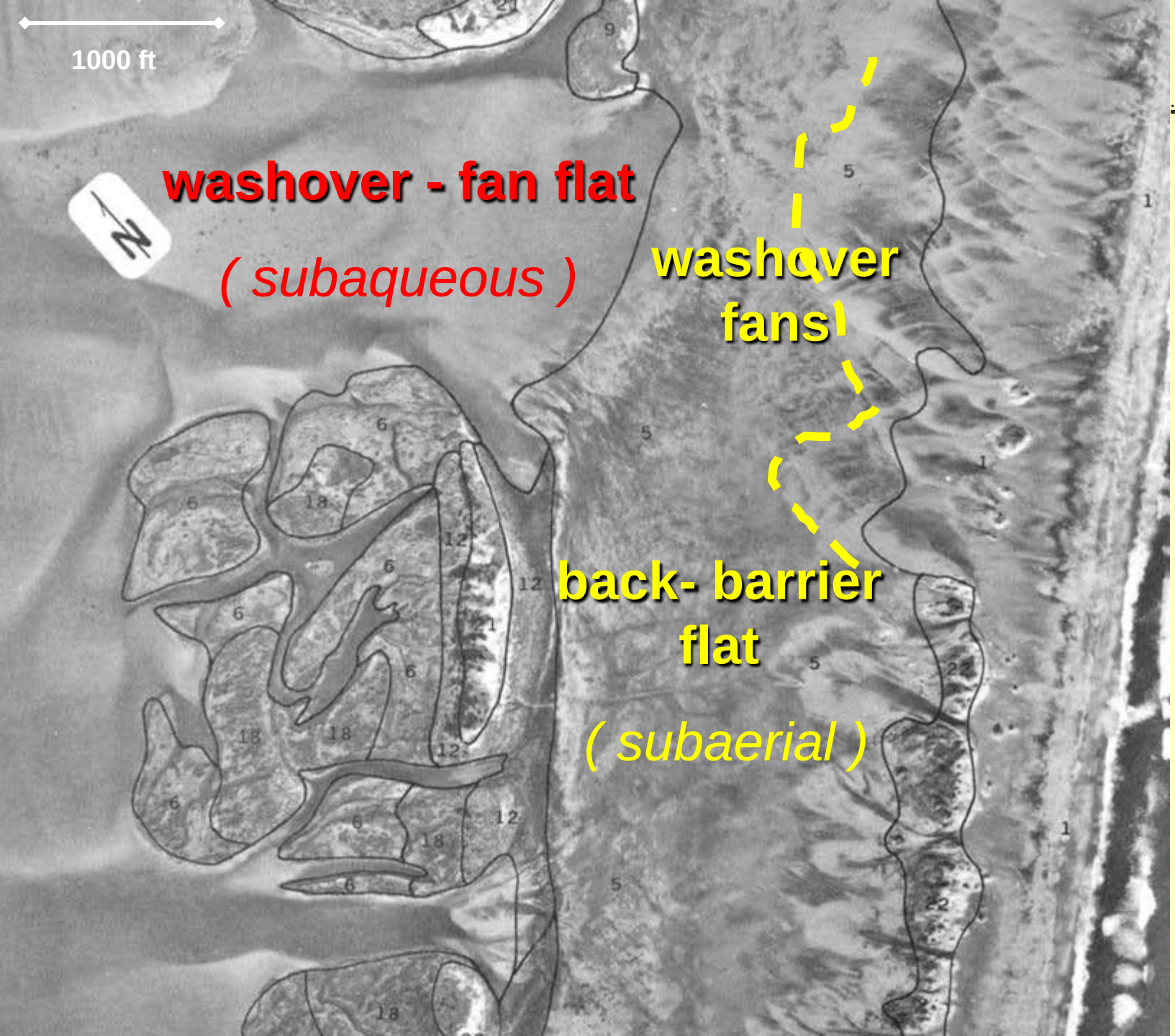
Landscape: ***barrier island*** **Landforms:*****beach, berm, overwash fan, relict overwash fans***

north Core Banks Is, NC



Landscape: ***barrier island*** **Landforms:** ***beach, berm, washover fan, washover fan flats***

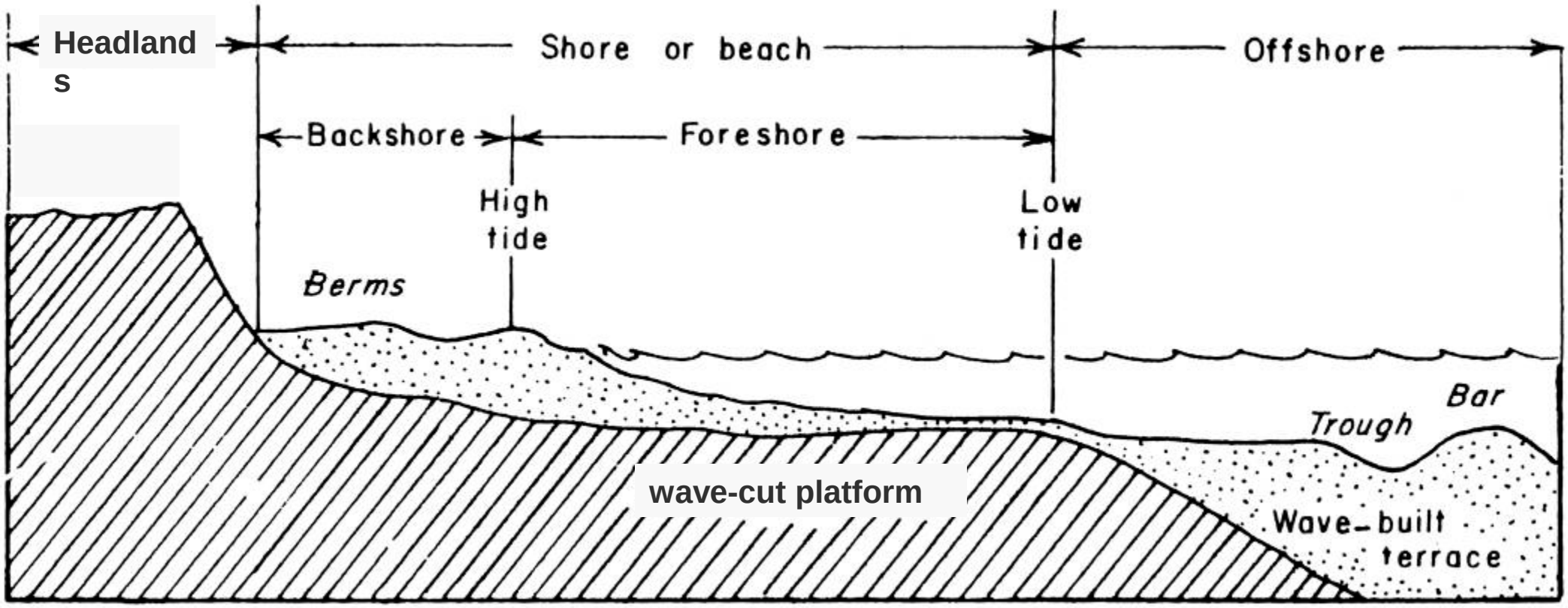
N34.75 Lat, W76..25 Lon north Core Banks Is, NC



Map Unit #	Name
1	beach, occas. flooded
5	tidal flats
6	Carteret soils, low
9	Corolla-Duckston complex
12	Duckston fine sand
18	Carteret, high
21	Newhan fine sand
22	Newhan-Corolla complex
w	water

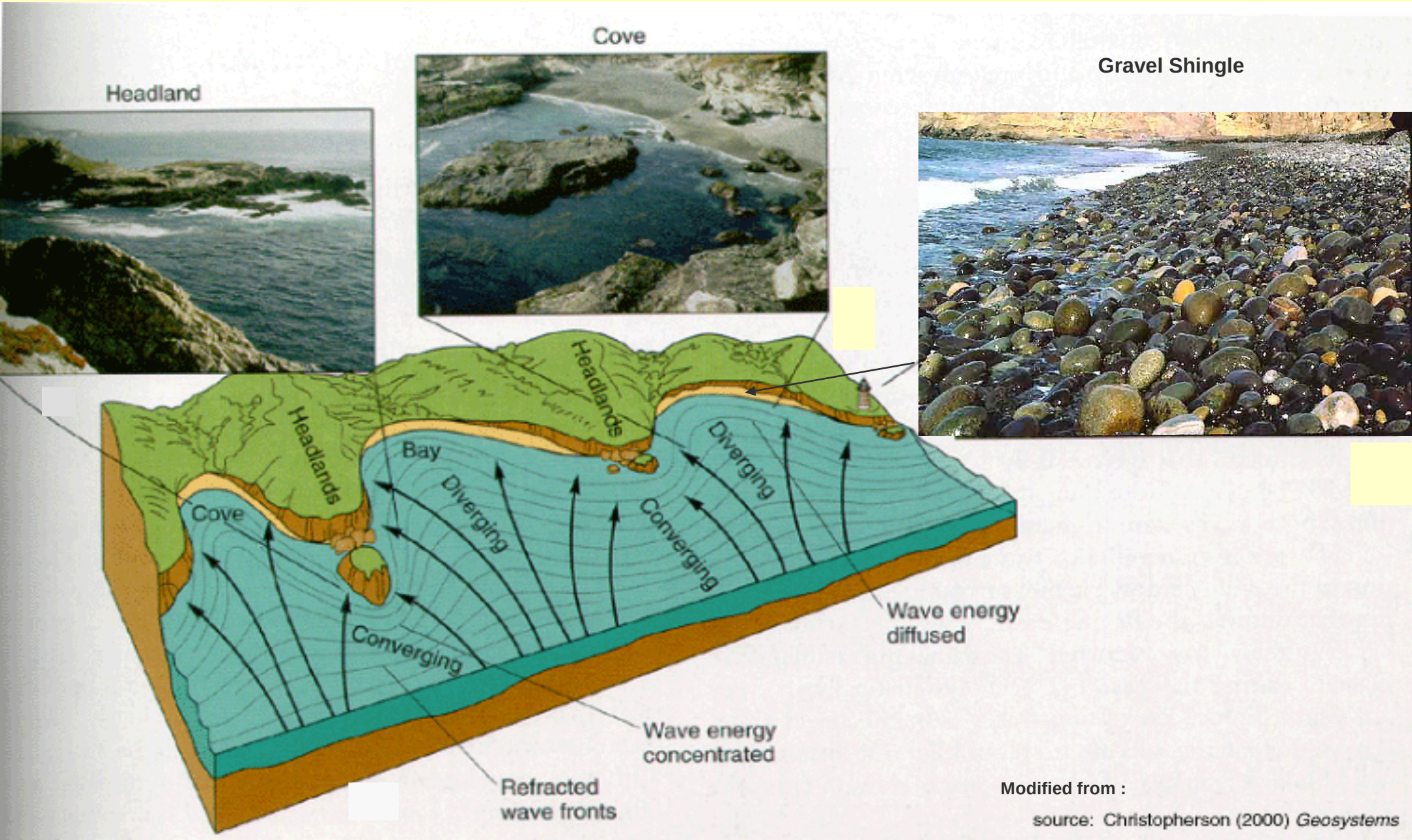
Carteret Co.,
Soil Survey of
Outer Banks, NC,
SCS,1977

General shore features of rocky coasts



Modified from Fairbridge, 1968

Rocky Coasts



Modified from :

source: Christopherson (2000) *Geosystems*

Landscape: *shore complex* Landforms: coastal *headlands, cliff, wave-cut platform*

Anthropogenic Materials / Sediments, Landforms

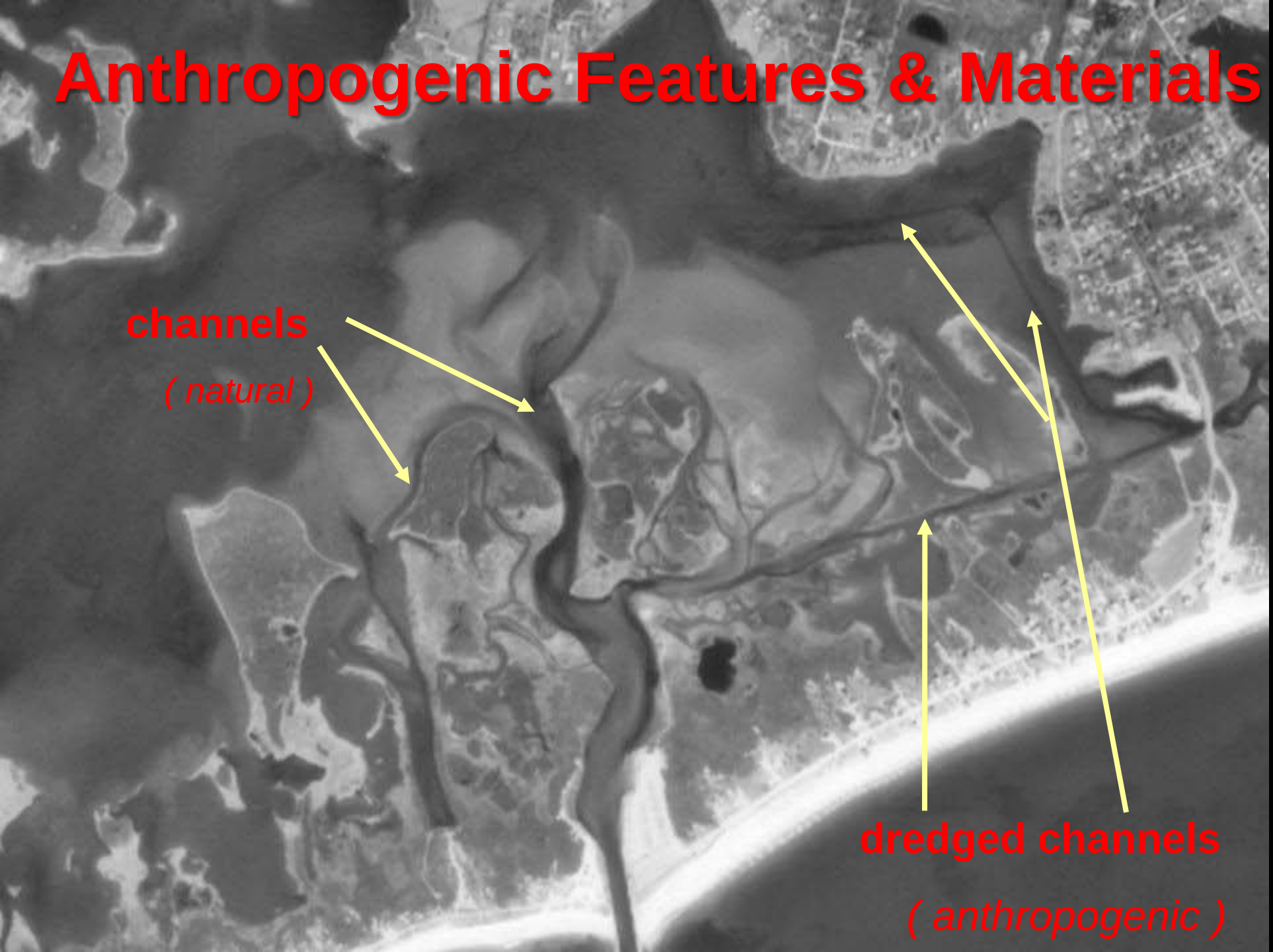
Sediments / deposits

- dredge spoils

Landforms

- dredge channel
- dredge-deposit shoal
- dredge spoil bank
- filled marshland

Anthropogenic Features & Materials



Stolt,
RI

Map

Unit #	Name
6	Carteret soils, low
10	dredge spoil
18	Carteret soils, high
w	water

dredge spoils (PM)
dredge spoil bank
(dredge spoil shoal)
(filled marshland)

Pender Co.,

Soil Survey Outer Banks, NC

SCS, 1977

Freshwater Subaqueous Features

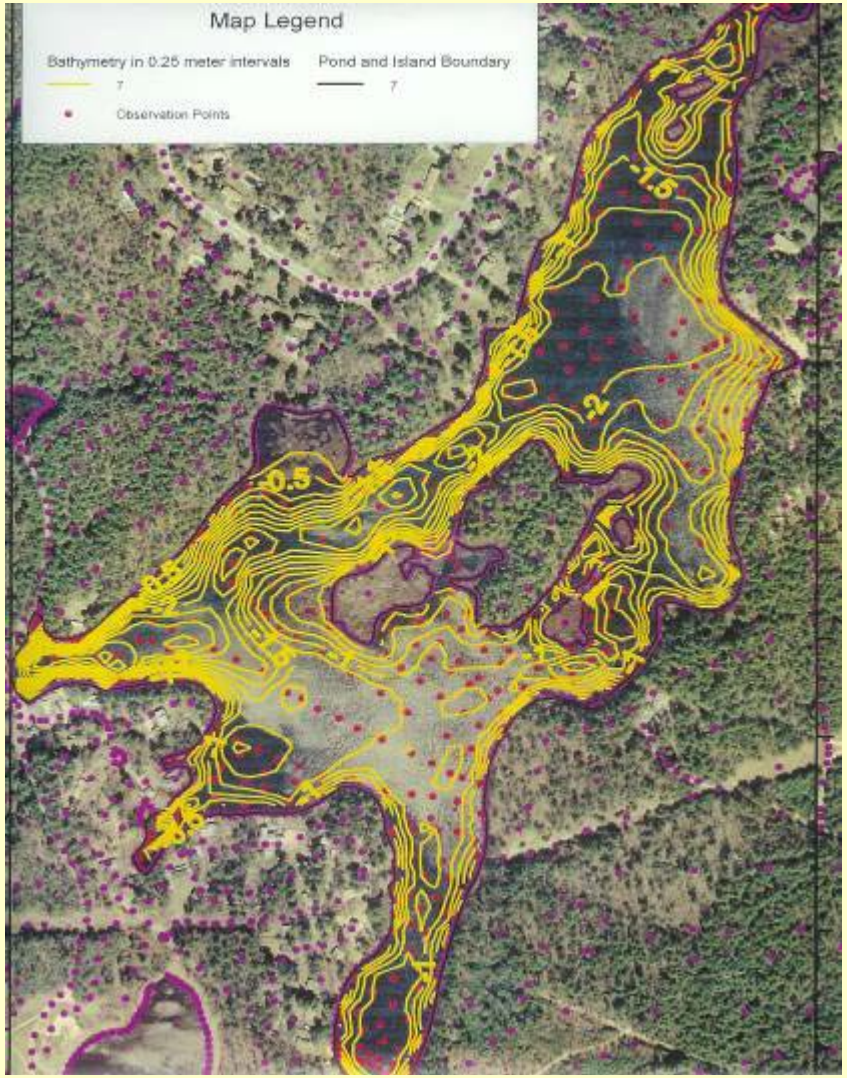
- **Largely ‘undeveloped’.**
- **Lacustrine vs. Coastal Marine / Estuarine**

similarities & differences

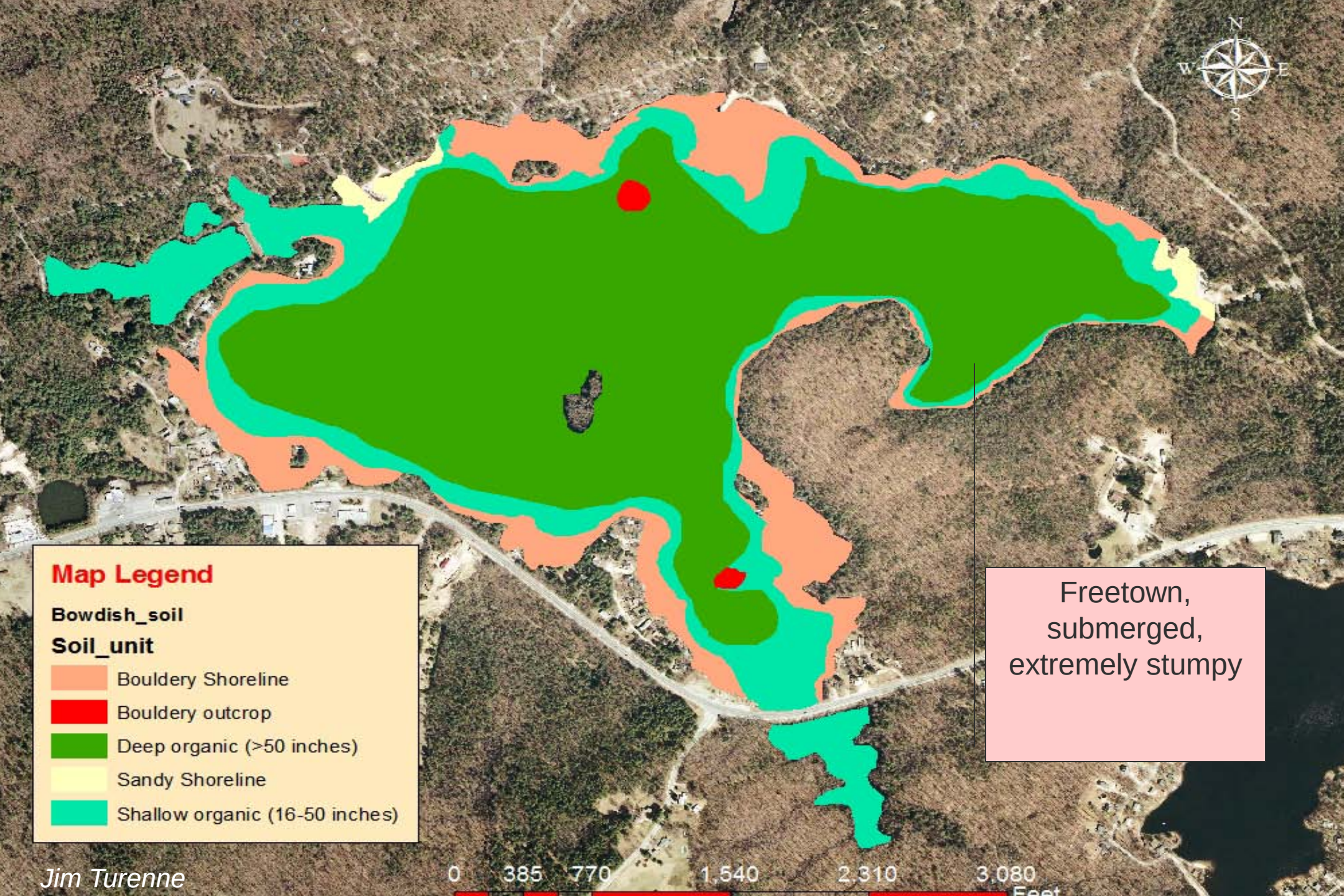
e.g (waterlain deposition) (energies of systems)

Mapping Protocol

- Similar to Sub-tidal – no tide correction but need surface/spillway ele.
- Need to develop landscapes but similar to salt water.
- Use GPR in winter or ice for sub-bottom and bathy.
- Core and soil data same as sub-tidal



Jim Turenne


N
W
E
S
Map Legend
Bowdish_soil
Soil_unit
Bouldery Shoreline
Bouldery outcrop
Deep organic (>50 inches)
Sandy Shoreline
Shallow organic (16-50 inches)
Freetown, submerged, extremely stumpy
Jim Turenne
0
385
770
1,540
2,310
3,080
Feet

Map Examples

Jim Turenne

Work in Progress

- Utilitarian ‘Landform’ terms (esp. freshwater / lacustrine, anthropogenic features).
- Corresponding sediment (regolith?) info & terms.
- Landscape (soilscape) models - both generalized (facies??) and specific (case studies).