

An aerial photograph of a coastal area. A road runs diagonally from the top left towards the bottom left. A bridge crosses a body of water, extending from the road. The water is a mix of green and brown, indicating different depths or sediment. In the background, there are some buildings and a parking lot. The title text is overlaid on a semi-transparent white box in the upper left portion of the image.

BENTHIC GEOLOGIC HABITAT MAPPING IN SHALLOW LAGOON AND ESTUARINE ENVIRONMENTS

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GEOLOGISTS AND SOIL SCIENTISTS WORKING SIDE BY SIDE: NOT SO CRAZY AFTER ALL!

Low-energy basin
organic silt?

Fluid silt loam?

J. Turenne



BENTHIC GEOLOGIC HABITATS

- What is a habitat?
 - Spatially recognizable area with physical, chemical, and biological characteristics that are distinctly different from surrounding areas.
(Valentine et al., 2005)
- Benthic Geologic Habitat
 - A spatially recognizable area with *geologic characteristics* that are distinctly different from surrounding areas.

BENTHIC GEOLOGIC HABITATS

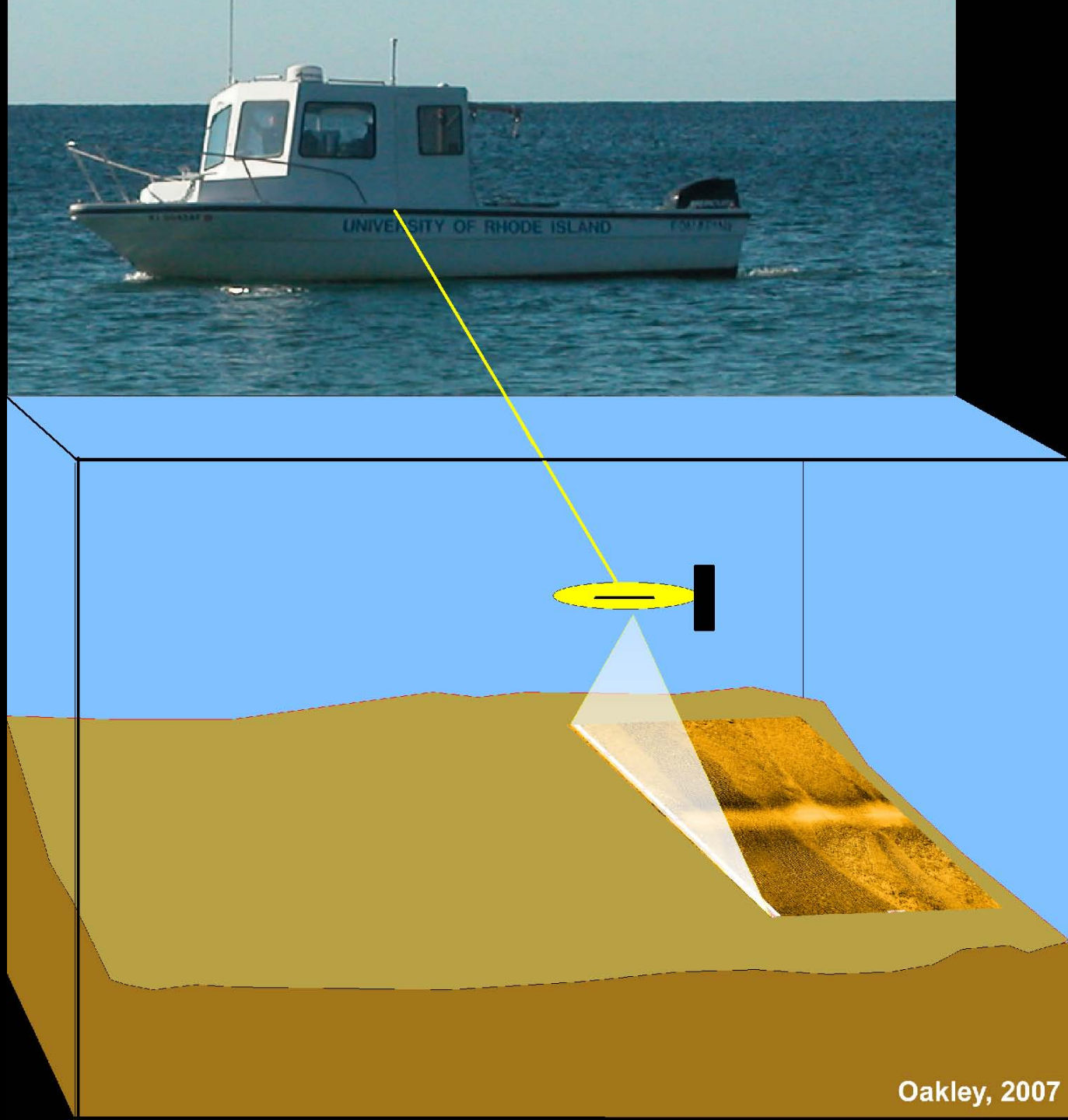
‘Geologic Characteristics’ = Facies

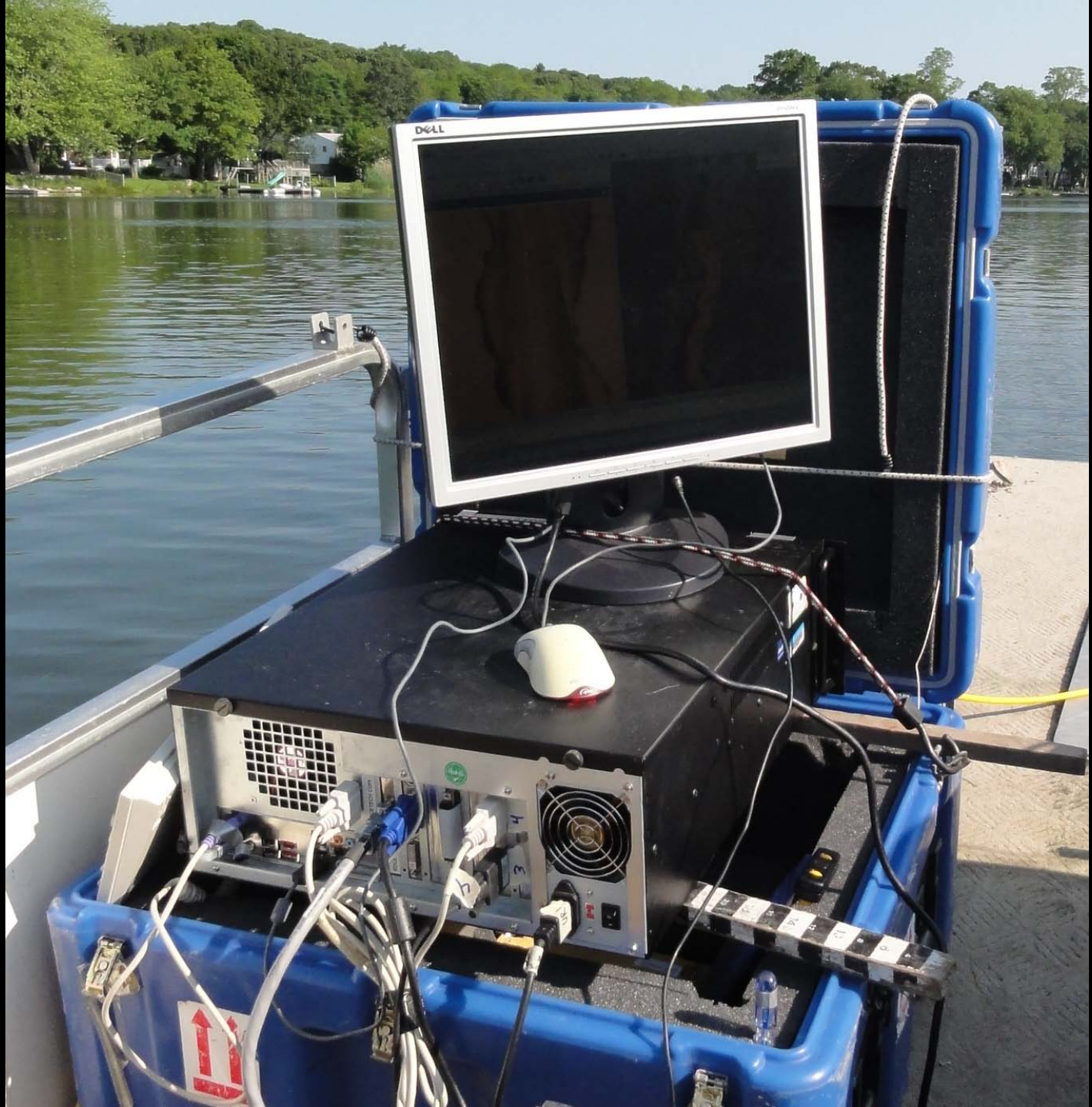
- Particle size, shape, sorting, color, composition and biologic content

The extent of the facies are determined using side scan sonar

Characteristics described from sediment samples, underwater video, etc..

WHAT IS SIDE-SCAN SONAR?







INTERPRETING SIDE-SCAN SONAR DATA

Interpreted based on the texture and intensity of the returning side-scan sonar signal

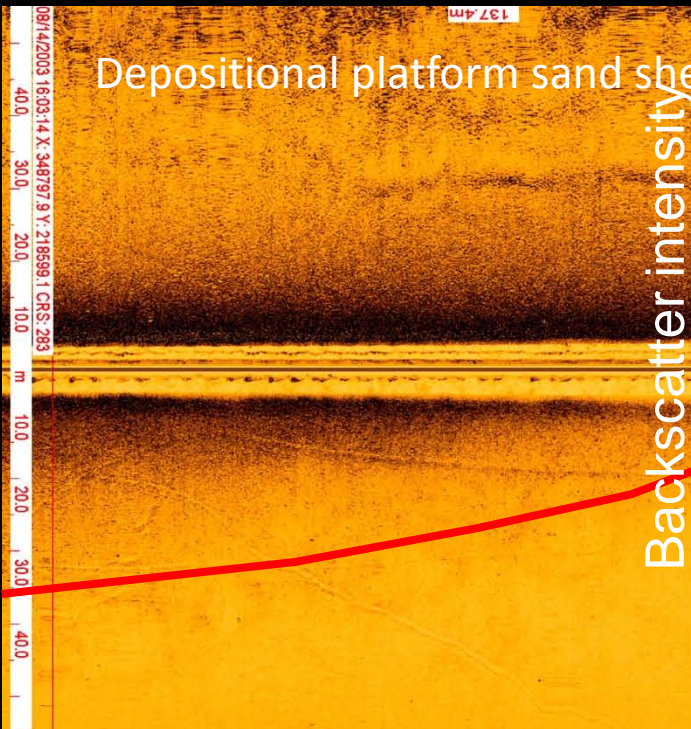
- Intensity

- How light/dark is the image
- Quasi relationship between grainsize and intensity

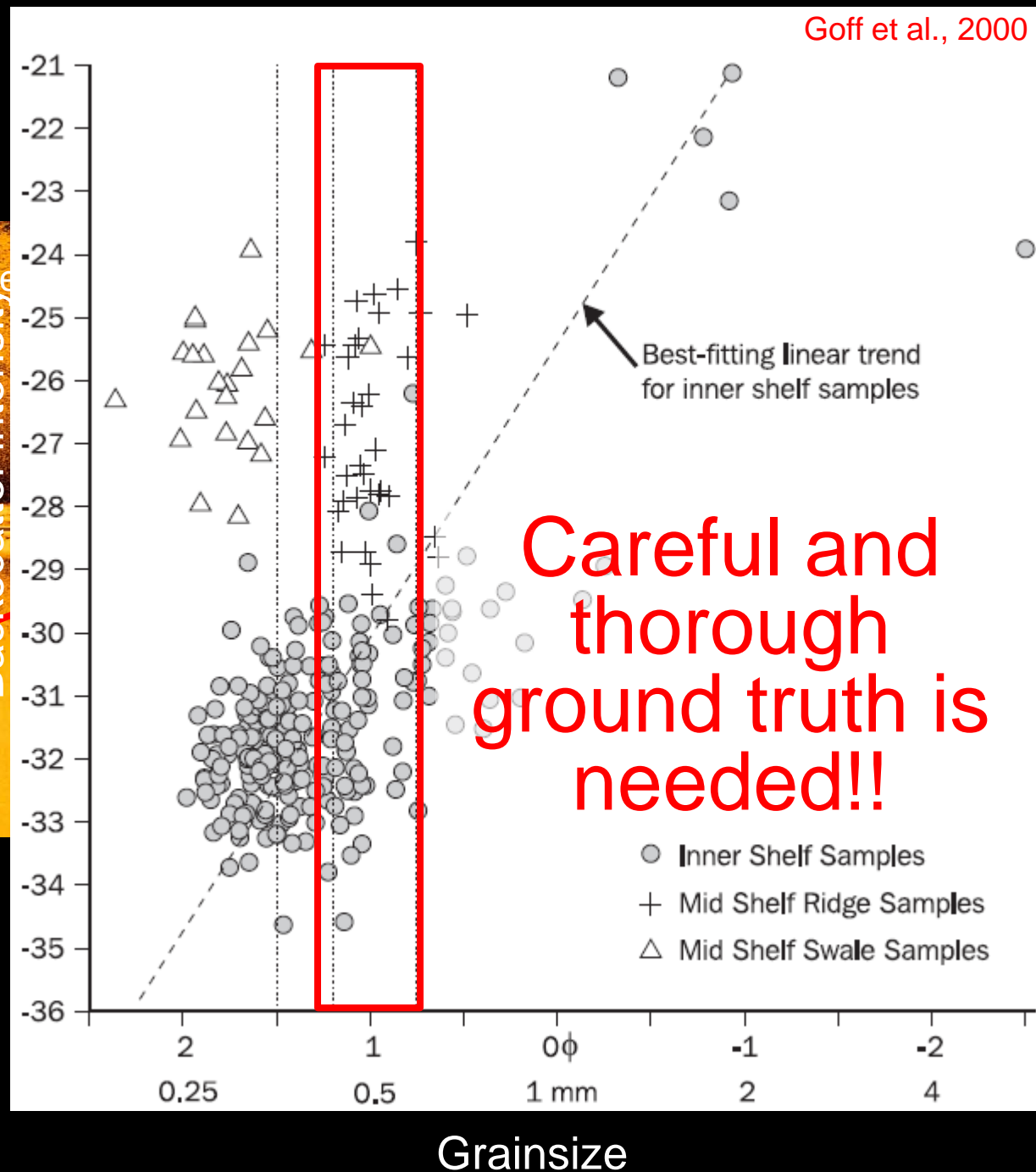
- Texture

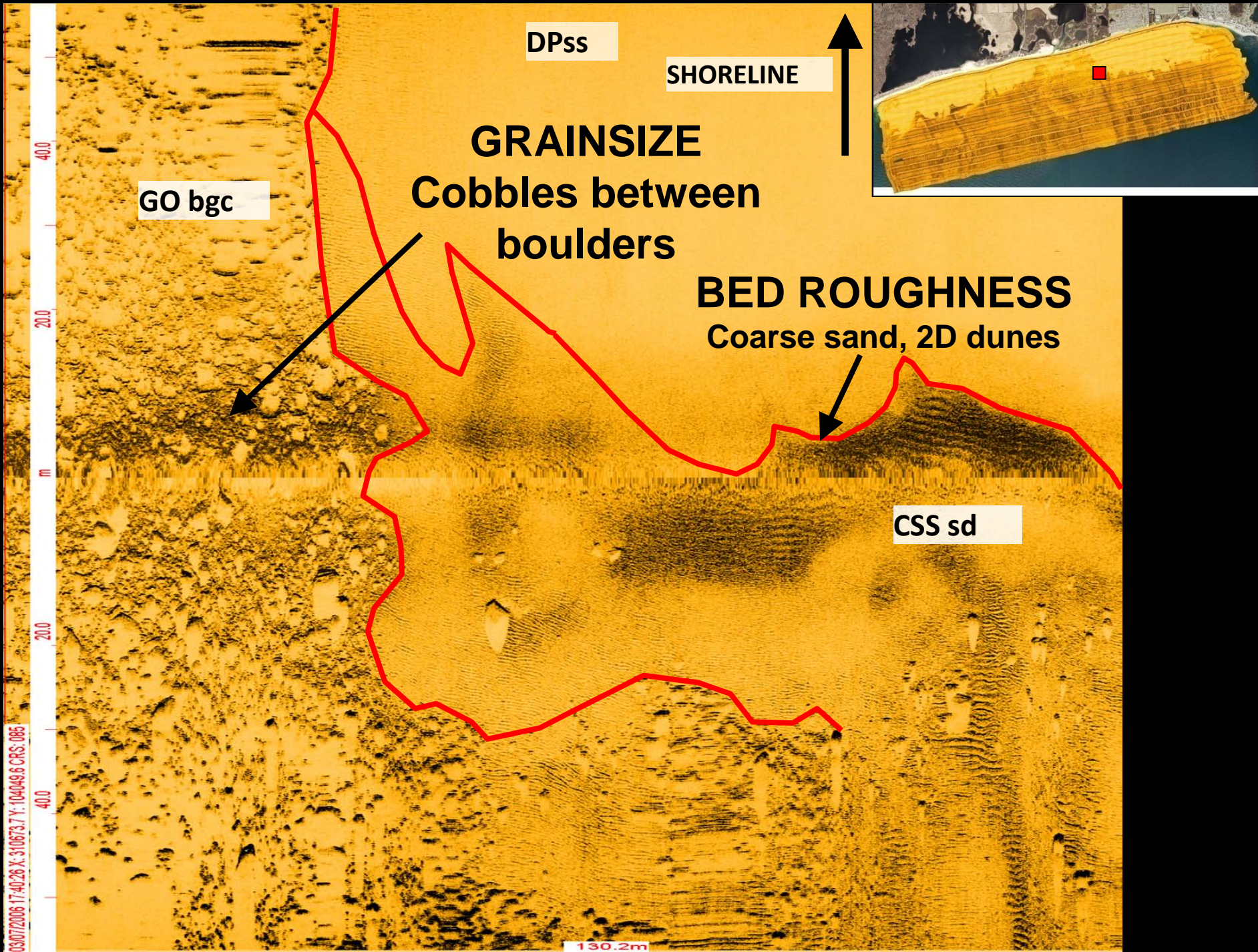
- What is the pattern of the image
- “Geology” (bedforms, boulders etc.)
- “Biology” (Microalgae, SAV)

Intensity of the side-scan signal



“Hard or rough bottoms reflect more energy...”

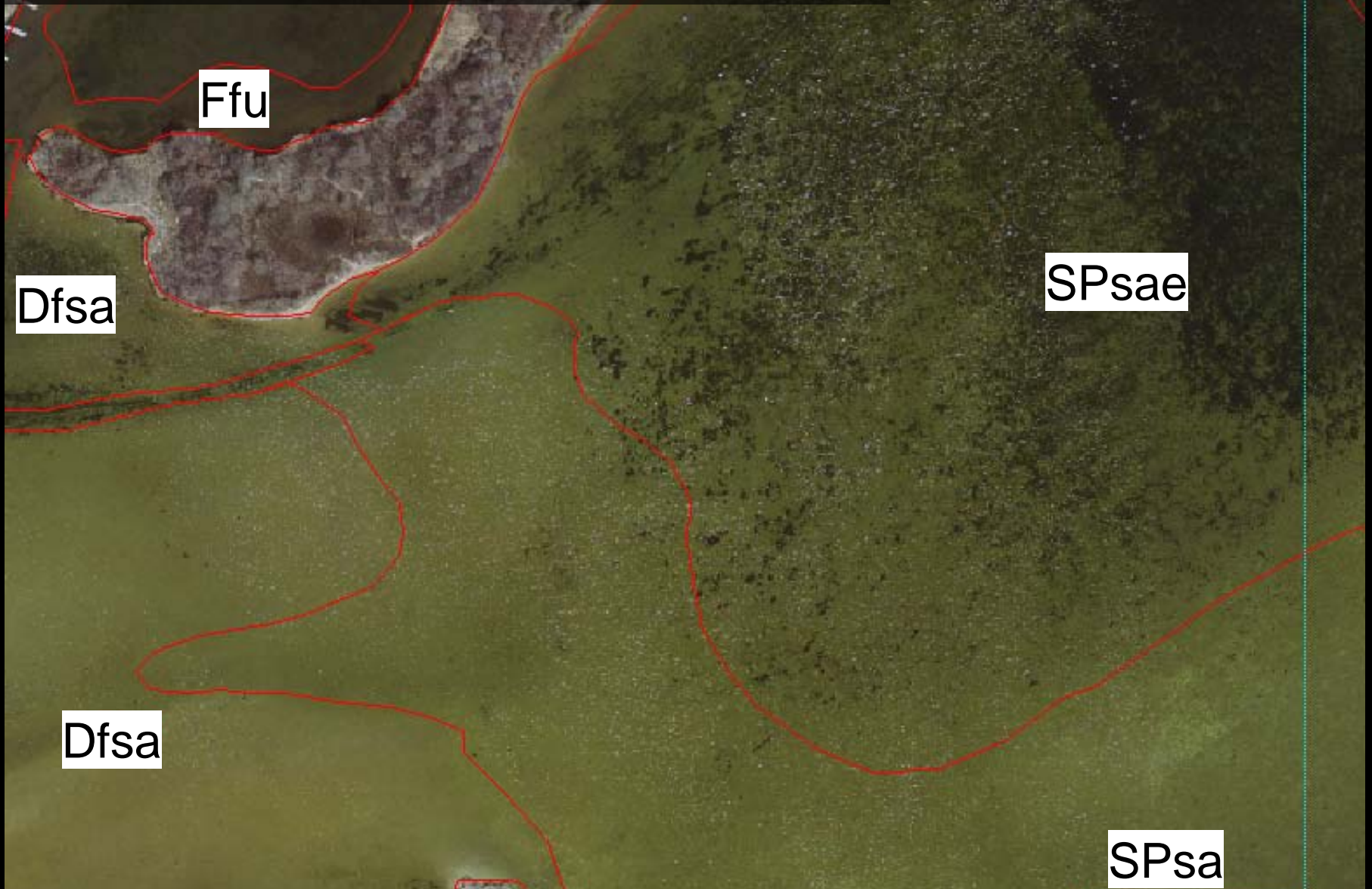




OTHER SOURCES OF IMAGERY

- Aerial imagery serves two purposes:
 - Base map to display data
 - Additional data source for shallow dep. environments
- Digital orthophotographs
- Low-angle oblique photos
- Vertical aerial photos
 - * Know the date of the photos, and low-tide is the best

Digital orthophotography – Green Hill Pond



*Not always a perfect match
If the images are from previous years

COLLECTING GROUND-TRUTH

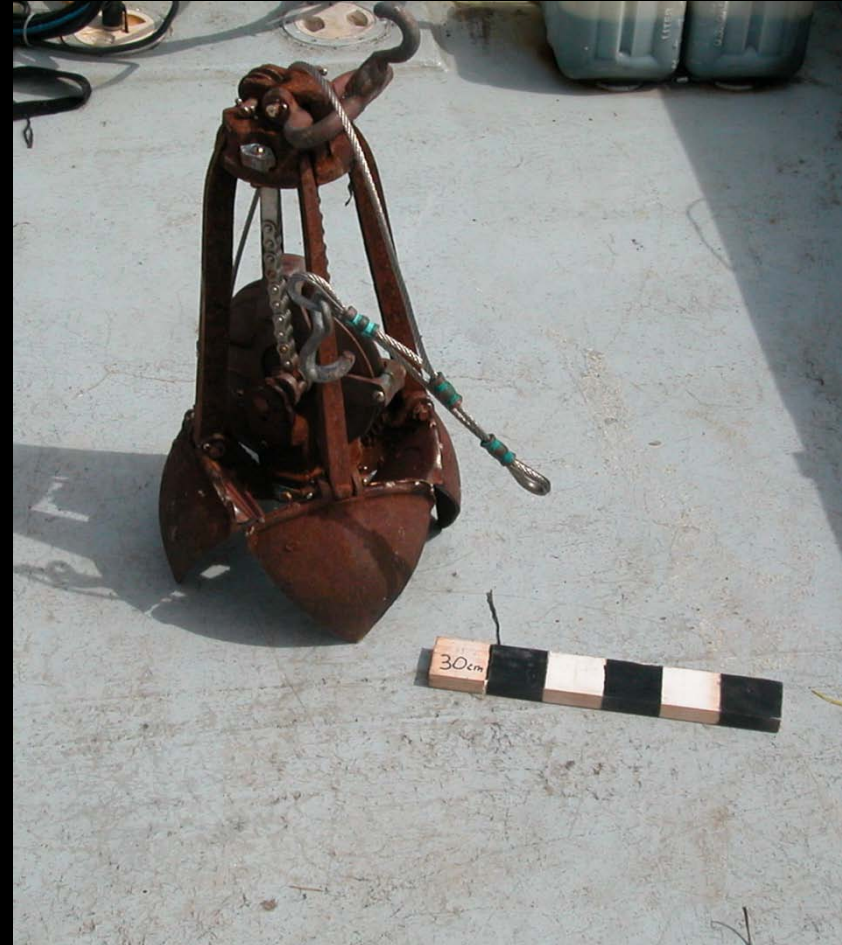
- A side-scan only mosaic is not a geologic map!
- Beware 'Automated interpretations'
- Sources of ground-truth data
 - *Surface sediment grab samples*
 - *Underwater video images*
 - Sediment cores
 - SPI Imagery
 - Direct (Diver) Observation

SURFACE GRAB SAMPLERS

“PETITE” PONAR GRAB:
(Mud and Sand)



Orange Peel Grab:
(Sand and Gravel)

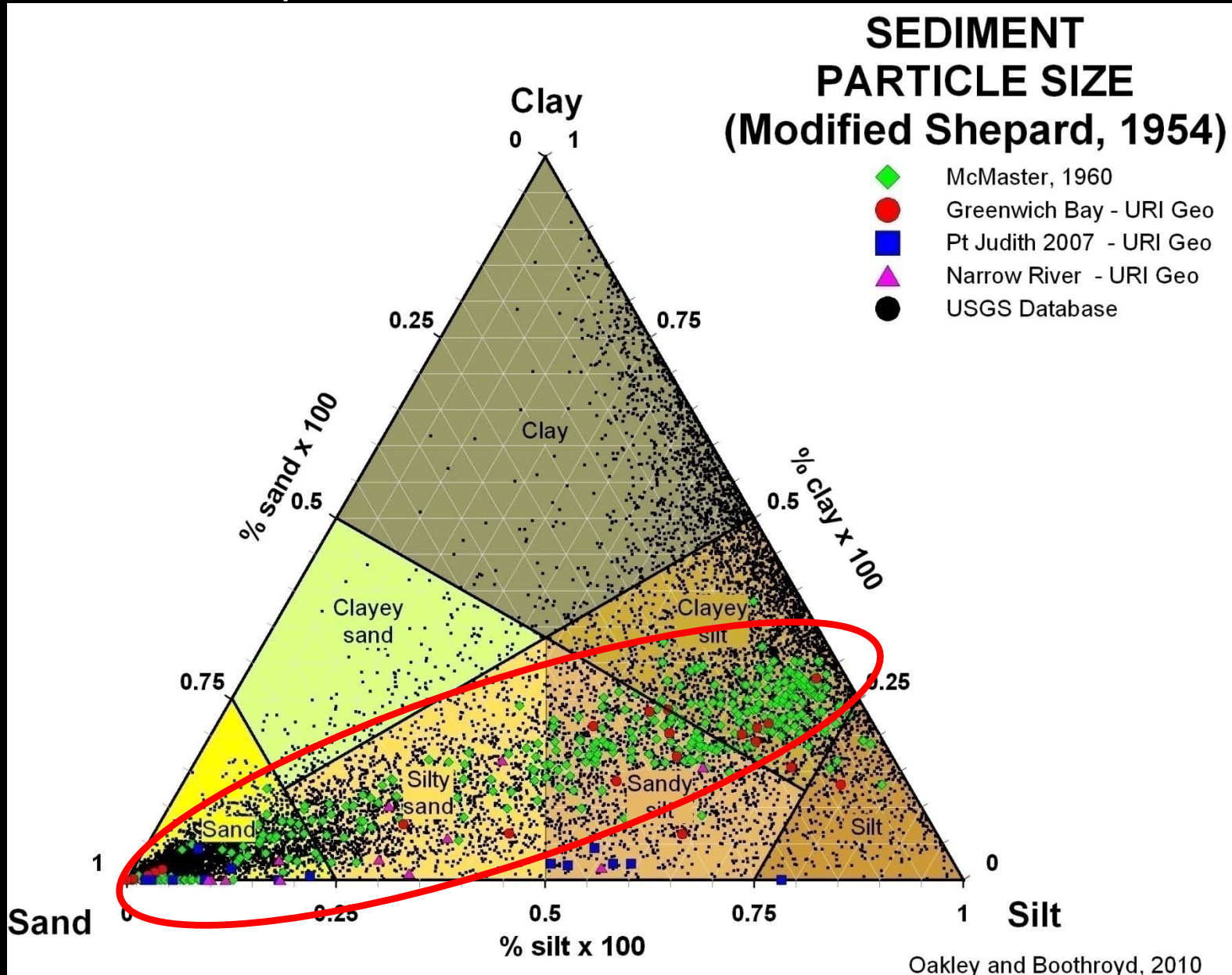


SURFACE GRAB SAMPLE

Upper Pond, Narrow River, RI



CLASSIFYING PARTICLE SIZE: Modified Shepard, 1954



UNDERWATER VIDEO IMAGERY



SeaViewer
Underwater Video Systems

J. Turenne, Photos

Underwater Laser Pointers

N 41 24. 71383
W071 30. 25328

157 deg
0 mph

12:52:36

5 cm

10-08-08

Low-energy basin silt
w/ burrows

Low-energy basin silt w/ shells
Slipper shells, (*Credula fornicata*)

Images collected by URI Geosciences
Oakley and Boothroyd, 2008

N 41 24. 71443
W071 30. 21785

353 deg
0 mph

13:14:24

2 cm

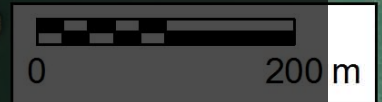
10-08-08

DEPOSITIONAL ENVIRONMENTS

- Place where the geologic processes (Water, wind, ice, humans) work to transport and deposit the sediment
- “Where the sediment ends up”
- Some examples in estuaries and lagoons
 - Low-energy basins, Channels, Tidal deltas Etc.

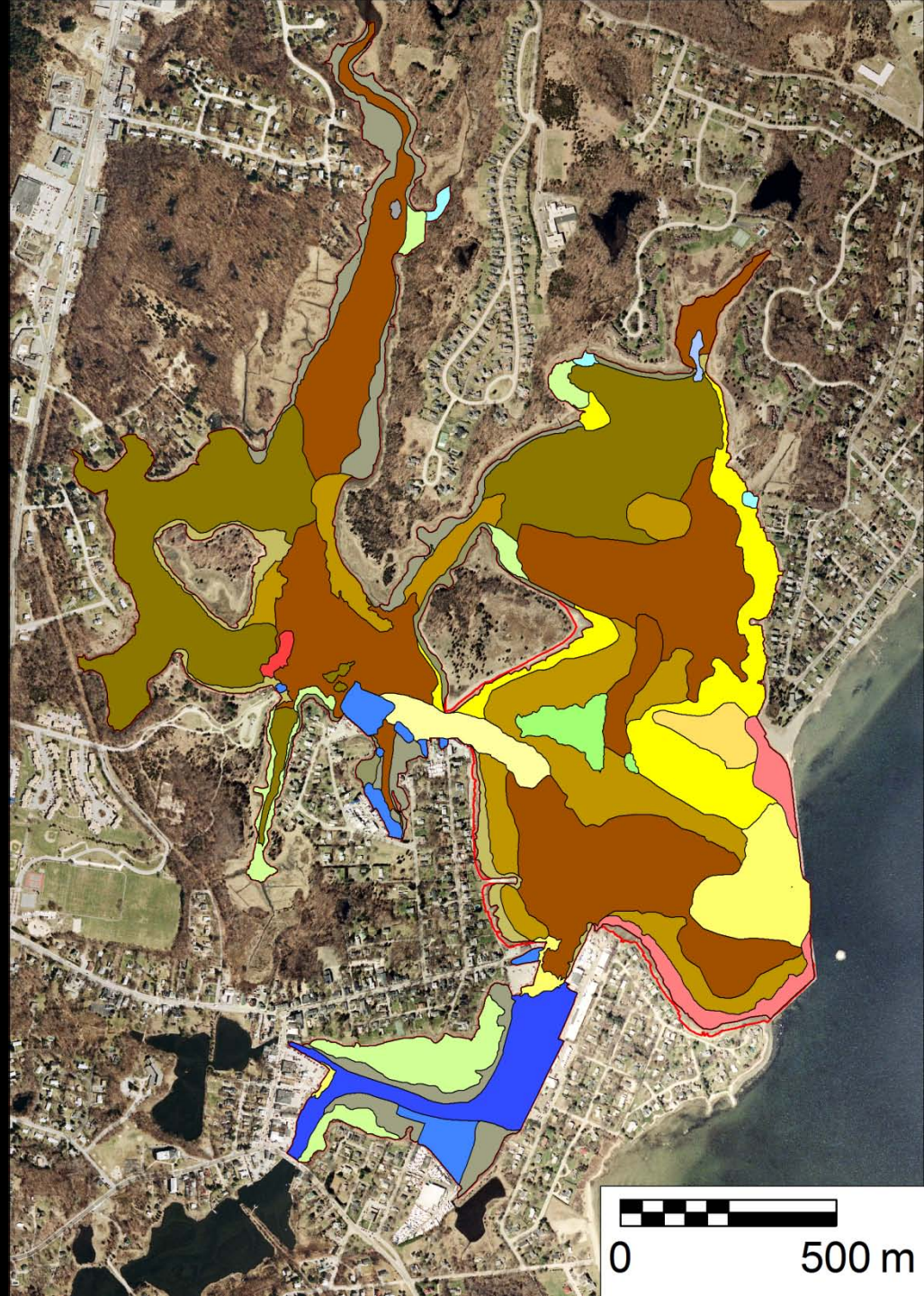
“Benthic Geologic Habitats of Greenwich Bay and Wickford Harbor, Narragansett Bay” (Oakley, Alvarez and Boothroyd, 2011 submitted for publication, J. of Coastal Research)

Stolt et al., 2011 J. of Coastal Research



Interpreting Benthic Geologic Habitats: Wickford Harbor Example

1. Collect and process
Side-scan sonar data
2. Delineate side-scan facies
3. Collect ground – truth data
 - Surface sediment grabs
 - Cores
 - Underwater video
4. Interpret Benthic Geologic
Habitats



WICKFORD HARBOR

Some examples...

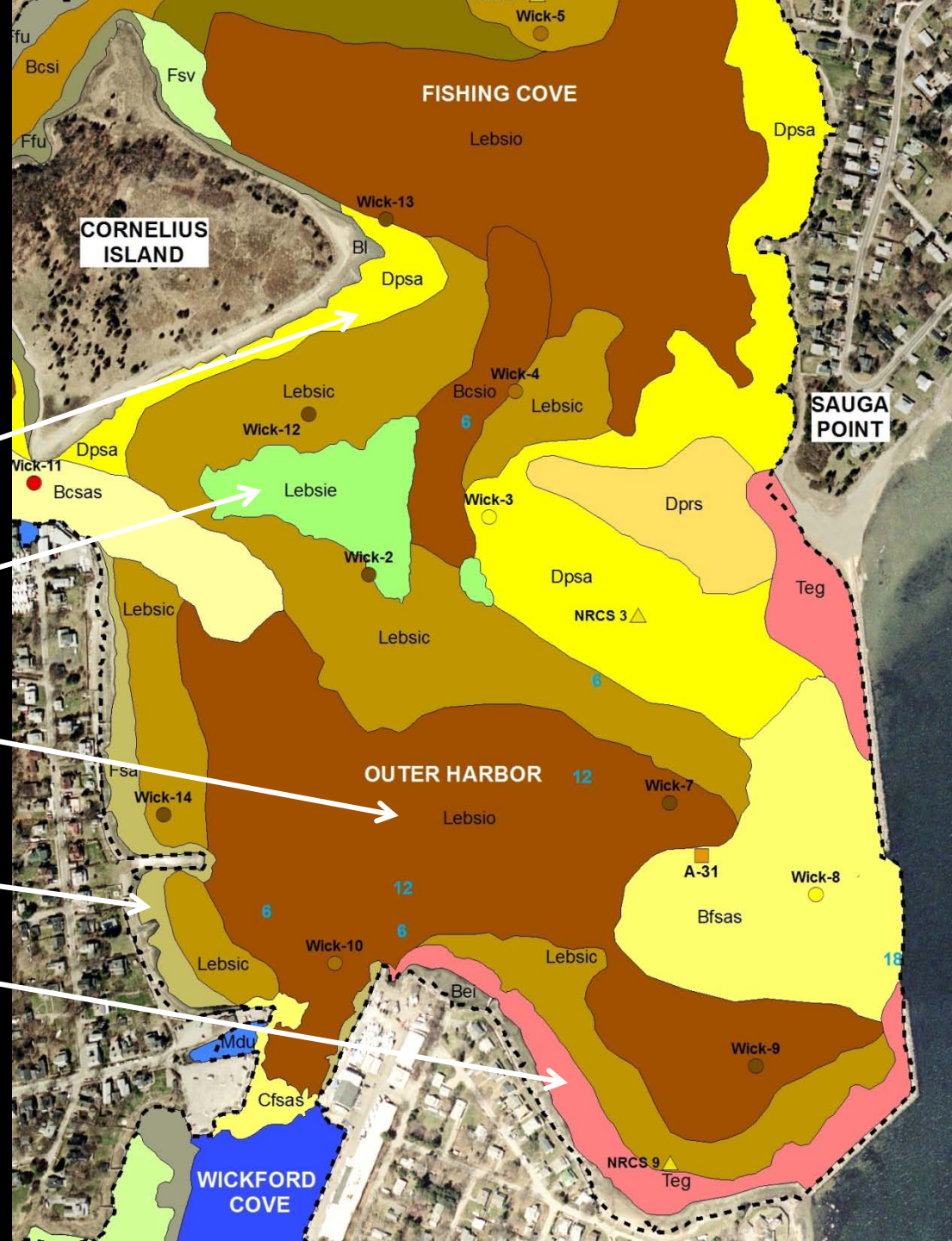
Dpsa – Depositional platform
sand sheet

Lebsie – Low-energy basin
silt w/ eelgrass

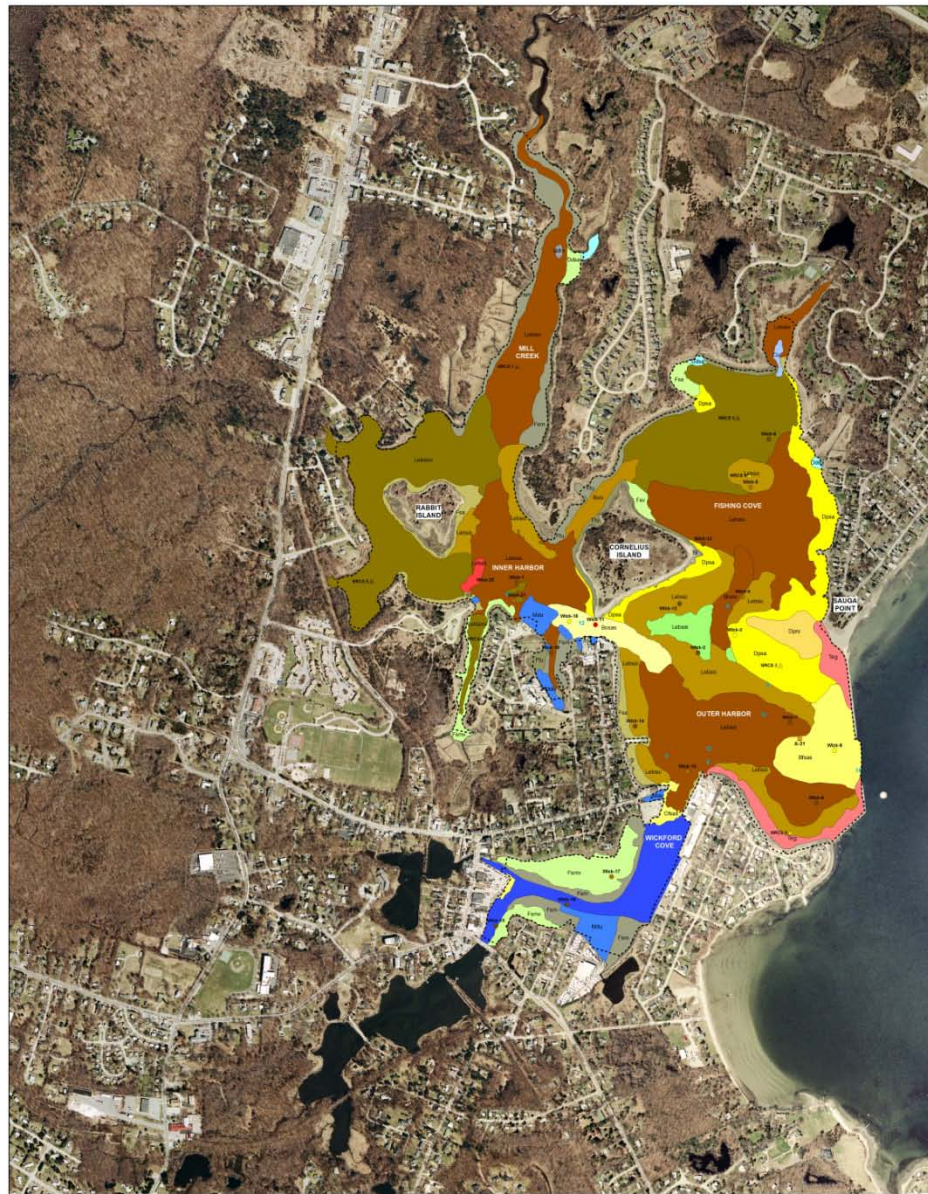
Lebsio – Low-energy basin
organic silt

Fsa – Sand Flat

Teg – Gravel erosional
terrace



WICKFORD HARBOR



Map was either mapping 17 July and August, 2006
by N. Conley, J. Alvarez, M. Sabinovich and W. Payne

The 2002/04 digital orthophoto image was provided by the Rhode Island Department of Transportation via the Rhode Island Geographic Information System

BENTHIC GEOLOGIC HABITATS OF WICKFORD HARBOR, NARRAGANSETT BAY, RHODE ISLAND

by
Bryan Oakley, Jon D. Alvarez and Jon C. Boothroyd

2008

DRAFT: 18 APRIL 2008



- ### EXPLANATION
- #### ESTUARINE BAY FLOOR
- Blue** Bay floor sand sheet - This habitat was mapped at the entrance to the outer harbor, where there is enough wave and tide energy to prevent deposition of fine-grained sediments and organic material. There is a large area of sand sheet in the outer harbor, but it is not mapped as such because it is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet.
- Orange** Low-energy basin coarse silt - This habitat occurs along the shoreline edges of the Outer Harbor low-energy basin. Surface sediment samples from the habitat plot as silt with sandy to silty sand or silty sand with coarse silt. This habitat represents the shallowest reaches of the adjacent sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Outer Harbor low-energy basin. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### Outer Harbor low-energy basin
- Subtidal habitats**
- Orange** Low-energy basin coarse silt - This habitat occurs along the shoreline edges of the Outer Harbor low-energy basin. Surface sediment samples from the habitat plot as silt with sandy to silty sand or silty sand with coarse silt. This habitat represents the shallowest reaches of the adjacent sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Outer Harbor low-energy basin. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### Fishing Cove low-energy basin
- Subtidal habitats**
- Orange** Low-energy basin coarse silt - This habitat was mapped on a slight bathymetric high in Fishing Cove, that likely represents a bathymetric high in the underlying glacial deposit. The slightly higher was energy owing to the bathymetric high of the glacial deposit. This habitat is not mapped as such because it is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Fishing Cove low-energy basin. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### Inner harbor low-energy basin
- Subtidal habitats**
- Orange** Low-energy basin coarse silt - This habitat was mapped on a slight bathymetric high in Fishing Cove, that likely represents a bathymetric high in the underlying glacial deposit. The slightly higher was energy owing to the bathymetric high of the glacial deposit. This habitat is not mapped as such because it is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Inner harbor low-energy basin. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### ESTUARINE CHANNEL
- Blue** Bay channel sand sheet - This habitat was mapped in the channel connecting the inner and outer harbors of the harbor. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet.
- Orange** Low-energy basin coarse silt - This habitat occurs along the shoreline edges of the Estuarine channel. Surface sediment samples from the habitat plot as silt with sandy to silty sand or silty sand with coarse silt. This habitat represents the shallowest reaches of the adjacent sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Estuarine channel. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### ESTUARINE COVE
- Subtidal habitats**
- Blue** Bay channel sand sheet - This habitat was mapped in the channel connecting the inner and outer harbors of the harbor. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet. It is a mixture of sand and silt, and is not a true sand sheet.
- Orange** Low-energy basin coarse silt - This habitat occurs along the shoreline edges of the Estuarine cove. Surface sediment samples from the habitat plot as silt with sandy to silty sand or silty sand with coarse silt. This habitat represents the shallowest reaches of the adjacent sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Estuarine cove. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### ESTUARINE MARGINAL ENVIRONMENTS
- Subtidal habitats**
- Orange** Low-energy basin coarse silt - This habitat occurs along the shoreline edges of the Estuarine marginal environments. Surface sediment samples from the habitat plot as silt with sandy to silty sand or silty sand with coarse silt. This habitat represents the shallowest reaches of the adjacent sand sheet.
- Green** Low-energy basin silt with organic - This habitat, identified by a light, featureless return on the side scan, is distributed in a narrow band along the shoreline edges of the Estuarine marginal environments. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet. It is a mixture of silt and organic material, and is not a true sand sheet.
- #### OTHER MAP SYMBOLS
- SAUGA POINT**
- WMA-1** Surface sediment grain sample - Collected by the University of Rhode Island Department of Oceanography during August 2006. Samples were collected on a Pelagic Force surface sediment grab sampler. Grain size is coarse to fine sand. Samples are described by the nomenclature of Shepard (1964).
- WMA-2** Viscosity location - Collected by the Natural Resources Conservation Service during the summer of 2006. The viscosity location is located in the western portion of the harbor. The location is described by the nomenclature of Shepard (1964) for consistency with the surface sediment grain samples. Grain size is coarse to fine sand.
- A-21** Surface sediment grain sample - Collected by Shepard (1964). Grain size is coarse to fine sand. Samples are described by the nomenclature of Shepard (1964).
- Shepard (1964) sediment sizes**
- Coarsely sediment** - Coarsely sediment
- Fine** - Fine
- Limit of side scan cover** - Data collected during August 2006. Depicted areas outside of the boundary were interpreted from high resolution digital orthophotographs.
- Bathymetry** - Bathymetry - Bathymetry
- Bedrock** - Outcrop exposure of bedrock (Cambrian Rhode Island Formation). Limited to a small extent exposure in the southern portion of Wickford Cove.

BENTHIC GEOLOGIC HABITATS AND SAS

- Mapping is based on different data sets
- BGH's
 - Side-scan, video, grab samples
- SAS
 - Bathymetry, Soil Descriptions
- Map units are typically similar in extent and distribution

BENTHIC GEOLOGIC HABITATS: WICKFORD, RI



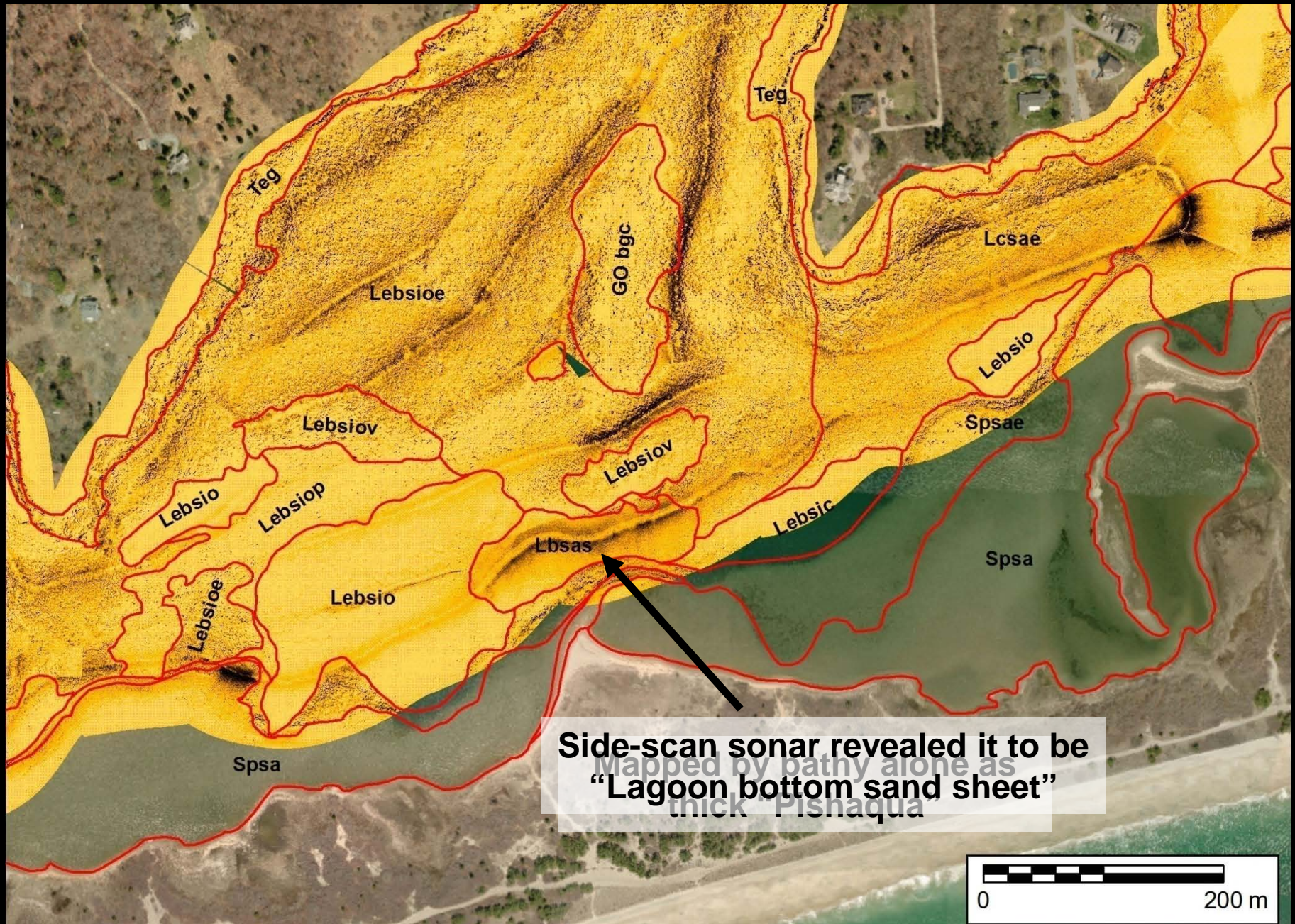
SUBAQUEOUS SOILS: WICKFORD, RI



BENTHIC GEOLOGIC HABITATS AND SAS

- Benefits to SAS mapping
 - Resolution of the data interpreted from side-scan sonar is much higher than SAS data (30cm pixels, < 100m² mmu)
 - Provides a check on the bathymetry driven interpretations
 - Video and grab samples provide some check/additional data on SAS interpretations and presence absence of SAV

Side-Scan Sonar and SAS: Resolution, Resolution, Resolution!



QUESTIONS?

