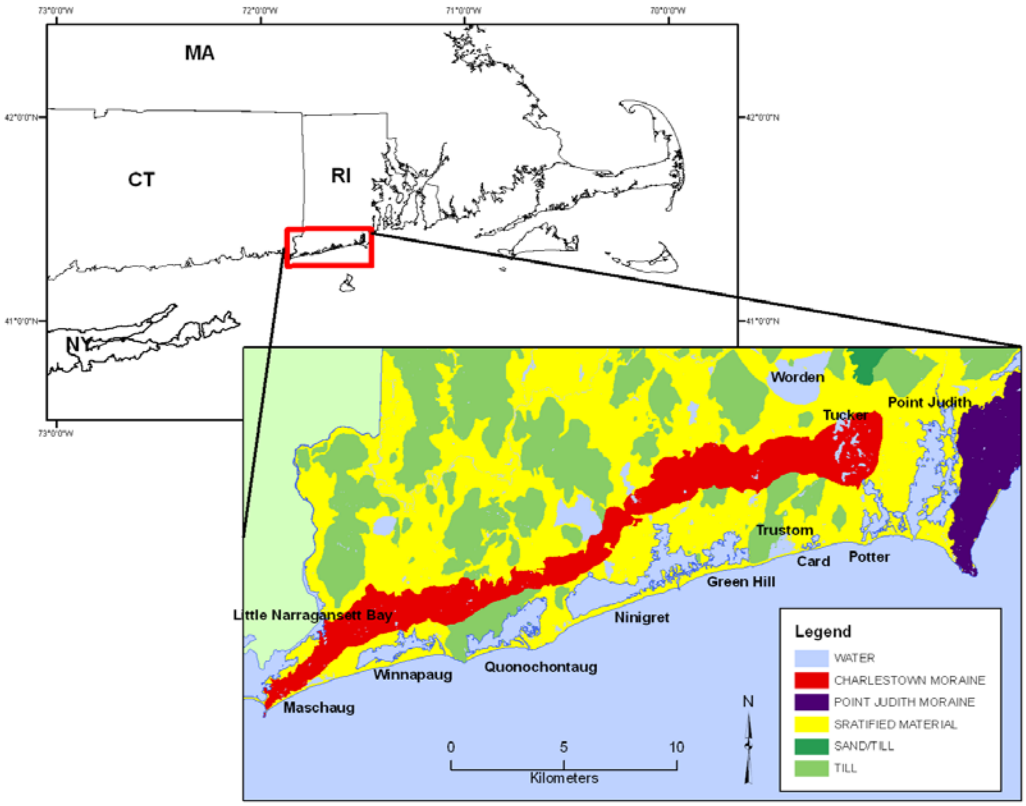
Field Guide:
2nd National Workshop on Subaqueous Soils

Rhode Island
August 9-12, 2010

University of Rhode Island
UNIVERSITY OF MARYLAND
PENNSTATE
NRCS Natural Resources Conservation Service

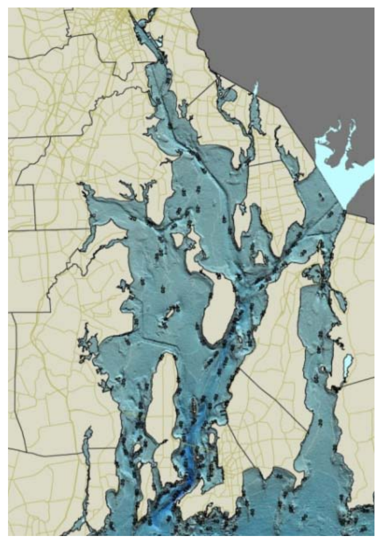
Figure 1: Generalized geology of south coastal Rhode Island



Wednesday, August 11 Field Tour – Eelgrass, Tidal Marshes, and Coastal Mapping – Fort Getty, Jamestown Rhode Island

This tour will provide an overview of the Eelgrass restoration project that the RI NRCS in partnership with Save the Bay has been involved with since 2003. We will also observe some of the coastal mapping of the beaches, dunes, and marshes as part of the RI Coastal Zone Soil Survey. The tour will travel to Ft. Getty in Jamestown RI, this site has been historically used as a transplant donor site for eelgrass, and it is one of the most productive beds in RI and one of the few sites world-wide where seagrass is expanding.
Out tour is located in the 1,000 square mile, Pennsylvanian-aged Narragansett Rift Basin which is a major structural unit in southeastern RI and extends into SE Massachusetts. Excellent outcrops of the stratified rocks will be observed during the trip and in Ft. Getty. The rocks of the Narragansett Basin typically consist of highly folded and fractured, dark colored siltstone, shale, graywacke, argillite, and coarse-grained conglomerate. As we pass Great Marsh in Jamestow we cross the Beaver Head Fault which separates the Pennsylvanian aged rocks to north from the Cambrian age strata to the south, Ft. Getty is also located on the fault.

West Passage, Narragansett Bay: As we pass over the Jamestown Bridge we will cross the west passage of Narragansett Bay, the largest estuary in New England (147 sq. mi). In 1524 Giovanni da Verrazzano soiled into Narragansett Bay and declared the bay a refuge. The average depth in the bay is 26 feet, deepest point is 184 feet in the east passage, tidal range is 4 feet (tidal rise is about 1 ft/100yrs), and 1.8 million people live in the watershed.



Jamestown Central Farming District: As we begin to head south off 138 we drive along a series a drumlins passing approximately 300 acres of farmland that has been protected under easements. On the east side just before the marsh are the Dutra and Neal farms which were protected using FRPP and other easement money in 2008.

Great Marsh: this is the largest tidal marsh on Jamestown; it is owned by the town and managed by the conservation commission. The RI NRCS is currently assisting the town to control the phragmites in the eastern portion of the marsh using WHIP funds. Most of the restoration efforts involve cleaning out the main ditches to improve tidal flushing which has been blocked by the toll booth constructed in the 1960's. To assist with the project a detailed soil map of the marsh was conducted along with monitoring of the soil salinity, water tables, soil temperature and conductivity. An EMI survey was made of the marsh using an EM-38.

2nd National Workshop on Subaqueous Soils

August 8 to 13, 2010, Kingston, RI
Schedule Matrix

	Sunday August 8th	Monday, August 9th	Tuesday, August 10th	Wednesday, August 11th	Thursday, August 12th	Friday, August 13th
Morning	Travel Day	Lecture Session 1	Field Session 2 Group 1: Pedon Descriptions Group 2: Freshwater SAS Group 3: Bathy and Landscapes Group 4: Vibracoring	Field Session 3 Group 1: Freshwater SAS Group 2: Bathy and Landscapes Group 3: Vibracoring Group 4: Pedon Descriptions	Field Session 3 Group 1: Bathy and Landscapes Group 2: Vibracoring Group 3: Pedon Descriptions Group 4: Freshwater SAS	Travel Day
Afternoon		Field Session 1 Group 1: Vibracoring Group 2: Pedon Descriptions Group 3: Freshwater SAS Group 4: Bathy and Landscapes	Lecture Session 2	Lecture Session 3	Lecture Session 4	
Evening				Technical Field Tour/Social		

Group Session Information:

Pedon Descriptions - Group Leaders Mark Stolt and Martin Rabenhorst
At this session participants will review describing subaqueous soil pedons and collecting samples for laboratory analysis. Vibracore samples collected in the other session will be cut open and described using the methodology developed. Pedons will be sampled using field meters, bulk density sampling, and other methods to assist with classification. Each pedon will be entered in a pedon description form and classified to the series (if possible) level.

Freshwater Subaqueous Soils - Group Leaders Patrick Drohan and Jonathan Baaken
This session will visit several fresh water systems currently being mapped and researched. Attendees will learn how these systems are mapped and data collected such as bathymetry, ground-penetrating radar, and sampling. Examples of subaquatic vegetation will be shown to the group including both invasiv and non-invasive SAV.

Bathymetry and Landscapes - Group Leaders Maggie Payne and Mike Bradley
This session will go over methods for bathymetric data including using an RTK GPS to determine NAVD elevation, use of acoustic single beam fathometers, and field techniques for running tracklines. The group will also visit the major landscape units and observe the benthic ecology and soil types.

Vibracoring and Field Mapping tools/techniques - Group Leader Jim Turenne
This session will show the group how to collect vibracore samples and the use of traditional sampling equipment. The point data collection methods used in the field will also be demonstrated.

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Map Unit Symbol	Series Name	Landscape Unit	Description
WPa0	Pishagqua mucky silt loam, 0 to 1 meter water depth		
WPa1	Pishagqua mucky silt loam, 1 to 2 meter water depth		
WPa2	Pishagqua mucky silt loam, 2 to 3 meter water depth		
WPd	Pishagqua mucky silt loam, 2 to 5 meter water depth, dredged	Lagoon Bottom	The Pishagqua series consists of subaqueous soils that are permanently submerged in low enegy depositional basins, estuaries and coastal lagoons. Pishagqua soils formed in silty estuarine deposits greater than 1 meter and often contain sulfidic materials. Slopes range from 0 to 3 percent.
WNa0	Nagunt sand, 0 to 1 meter water depth		
WNd	Nagunt sand, 2 to 5 meter water depth, dredged		
WNs1	Nagunt sand, sloping, 1 to 2 meter water depth	Washover Fan	The Nagunt series consists of subaqueous soils on washover fan flats and flood tidal deltas in coastal lagoons. Nagunt soils are formed in fine sandy to sandy marine deposits that are deposited as a result of washover events and tidal currents. Buried surface horizons and stratification are often identified. Slope ranges from 0 to 3 percent.
WFn0	Fort Neck mucky silt loam, 0 to 1 meter water depth		
WFn1	Fort Neck mucky silt loam, 1 to 2 meter water depth	Shallow lagoon bottom over sand or outwash	The Fort Neck series consist of subaqueous soils in low energy coastal lagoons and channels. The Fort Neck soils are formed in less than 100 cm marine silts over marine sands or stratified sand and gravel. Slope ranges from 0 to 5 percent.
WBn0	Billington silt loam, 0 to 1 meter water depth	Mainland cove	The Billington series consists of subaqueous soils in coves. The Billington soils are formed in marine silts over organic deposits within 100 cm of the soil surface. Slope ranges from 0 to 2 percent.
WWq	Wequetequock silt loam, 0 to 2 meter water depth	Mainland cove	The Wequetequock series consists of subaqueous soils formed in marine silts over organic deposits starting below 100 cm of the soil surface. Slope ranges from 0 to 2 percent.
WNe0	Napatree sand, 0 to 1 meter water depth, bouldery surface		
WNx0	Napatree sand, 0 to 1 meter water depth, extremely bouldery surface	Submerged mainland beach - bouldery phase	The Napatree series consists of subaqueous soils in bouldery, mainland shorelines adjacent to glaciated uplands with numerous boulders and stones. The Napatree soils are formed in sandy marine deposits overlying submerged terrestrial till deposits. Slope ranges from 0 to 6 percent.
WAa0	Anguilla mucky sand, 0 to 1 meter water depth		
WAa1	Anguilla mucky sand, 1 to 2 meter water depth	Submerged mainland beach - sand and gravel phase	The Anguilla series consists of subaqueous soils on mainland shorelines. The Anguilla soils are formed in sandy marine deposits over outwash. Slopes range from 0 to 6 percent.

WMd	Massapog fine sand, 2 to 5 meter water depth, dredged		
WMg0	Massapog fine sand, 0 to 1 meter water depth		
WMgI	Massapog fine sand, intertidal	Flood Tidal Delta; lagoons	The Massapog series consists of subaqueous soils on flood tidal deltas in coastal lagoons. Soils are formed in fine sandy marine overwash deposits, often containing multiple buried surface horizons.
WRh0	Rhodesfolly fine sand, 0 to 1 meter water depth		
WRh1	Rhodesfolly fine sand, 1 to 2 meter water depth	Flood Tidal Delta; open water	The Rhodesfolly series consists of subaqueous soils on flood tidal deltas in open bays. Soils are formed in sandy and gravelly overwash deposits and can contain multiple buried surface horizons.
WMa1	Marshneck loam, 1 to 2 meter water depth	Flood Tidal Delta Slope	The Marshneck series consists of subaqueous soils on flood tidal delta slopes in coastal lagoons and bays. Soils are formed in sandy and loamy marine deposits over silty marine deposits, often representing old lagoon bottom deposits that have been covered by overwash sands. Surface horizons are loamy with high organic matter contents.

Map Unit Symbol	Series Name	Description	Landscape
ShA	Succotash sand, 0 to 3 percent slopes	The Succotash series consists of very deep, moderately well drained soils on that are on back barriers of barrier islands and spits. They are formed in sandy eolian and coastal overwash deposits of marine origin. Saturated hydraulic conductivity is high or very high throughout.	Back barrier dunes
SU	Succotash – Urbanland complex	Moderately well drained sands and impervious land.	Back barrier dunes, developed coastal areas
FtA	Fortress sand, 0 to 3 percent slopes	The Fortress series consists of very deep, moderately well drained soils with rapid permeability. The soil formed in a thick mantle of anthrotransported sandy materials. These soils occur on modified landscapes in and near urbanized areas of the Northeast.	Human altered landscapes
HsB	Hooksan sand, 3 to 8 percent slopes	The Hooksan series consists of excessively drained soils on coastal plains and barrier islands consisting of sandy eolian and marine sediments.	Foredunes
HsC	Hooksan sand, 8 to 15 percent slopes	The Hooksan series consists of excessively drained soils on coastal plains and barrier islands consisting of sandy eolian and marine sediments.	Dune crests
HU	Hooksan – Urbanland complex, 1 to 8 percent slopes	Excessively drained coastal sands and impervious land.	Foredunes and dune crests that are developed.
Mk	Matunuck mucky peat	The Matunuck series consists of very deep, very poorly drained soils formed in thick sand deposits. They are in tidal marshes subject to inundation by salt water twice daily. Matunuck soils typically have very dark gray mucky peat surface horizons over gray sand C horizons.	Tidal marshes with 8 - 16 inches of organic surface
Pw	Pawcatuck mucky peat	The Pawcatuck series consists of very deep, very poorly drained soils formed in organic deposits over sandy mineral material. They are in tidal marches subject to inundation by salt water twice daily. Slope ranges from 0 to 1 percent. Permeability is moderate to rapid in the organic layers and very rapid in the underlying mineral sediments.	Tidal marshes with 16 - 50 inches of organic surface

Ip	Ipswich mucky peat	The Ipswich series consists of very deep, very poorly drained soils formed in thick organic deposits. They are on level tidal marshes subject to inundation by salt water twice daily. Saturated hydraulic conductivity is moderately high to very high.	Tidal marshes with >51 inches of organic surface
Sa	Sandyhook mucky sand	The Sandyhook series consists of very deep, very poorly drained soils with rapid permeability. The soil formed in thick sandy sediments subject to tide flooding adjoining beaches along the Atlantic coast. The soils are nearly level to gently sloping.	Tidal marshes and coastal Phragmites marshes with less than 8 inches of organic surface
Ba	Beaches, sandy	Beaches composed primarily of sandy surface textures, includes areas of gravelly surfaces (<3 inches). Unit goes from MLLW to vegetated dune including swash zone.	Beaches
Bax	Beaches, boulder surface	Beach areas with > 15% cover of boulders (>25 inches)	Till Headlands, shorelines
Baz	Beaches, cobble surface	Beach areas with > 15% cover of cobble and stones (3 to 25 inches)	Beaches
BiB	Bigapple sand, 0 to 8% slopes	The Bigapple series consists of very deep, well drained or excessively drained soils. The soil formed in a thick mantle of anthrotransported soil material from dredging activities in coastal waterways and rivers. The anthrotransported material is thicker than 40 inches and occurs on modified landscapes in and near major urbanized areas of the Northeast.	Human altered landscapes
UrS	Urban land, 0 to 3 percent slopes, sandy substratum	>90% pavement over coastal sands.	Coastal urban land; typically beach parking lots

Field Bathymetry Process

For tidally influenced waters:
Tide data collection:

1: Deploy tide gauges

-Tide gauges deployed to record water depth every 6 minutes during the time that surveys are being conducted.

-Be sure tide gauges will be submerged the entire time that you are collecting data.

-Tide gauges should be no more than 3 km apart. More gauges are necessary in areas with restricted tidal flows where there is a greater tidal lag

-Collect 1 month of tidal data if possible to calculate mean sea level for the area.

2: Record elevation of tide gauges

-Using RTK GPS or surveying from a known benchmark, determine elevation of tide gauge pressure sensor in NAVD88. The OPUS solution can be used to obtain the NGS datum information (NAVD-88 and NAD-83).

Depth data collection:

1: Set fathometer offset

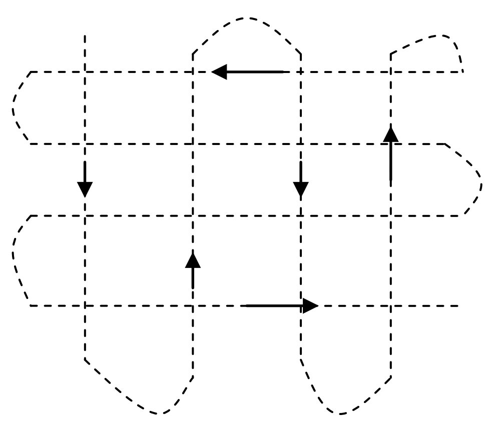
-Determine fathometer offset at trolling speed so that fathometer readings match manually measured depth readings.

2: Collect data in tracks

-Set fathometer to collect data every 5 seconds

-Travel at a speed of 3-5 mph in tracks approximately 100 meters apart.

-Aim for complete coverage of area by crossing at right angles to original tracks.



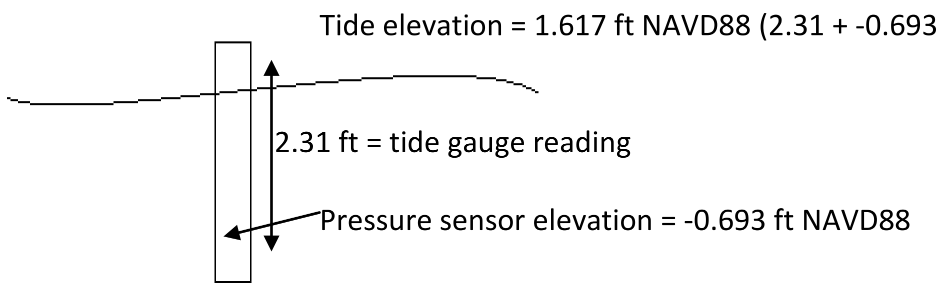
Track lines should cross at right angles and be evenly spaced

Data Download and Processing

1: Download tide data and correct to NAVD88

-Download tide gauge info and put in Excel spreadsheet

-Add tide gauge readings to surveyed elevation of tide gauge to get the elevation of the tide above or below zero in NAVD88



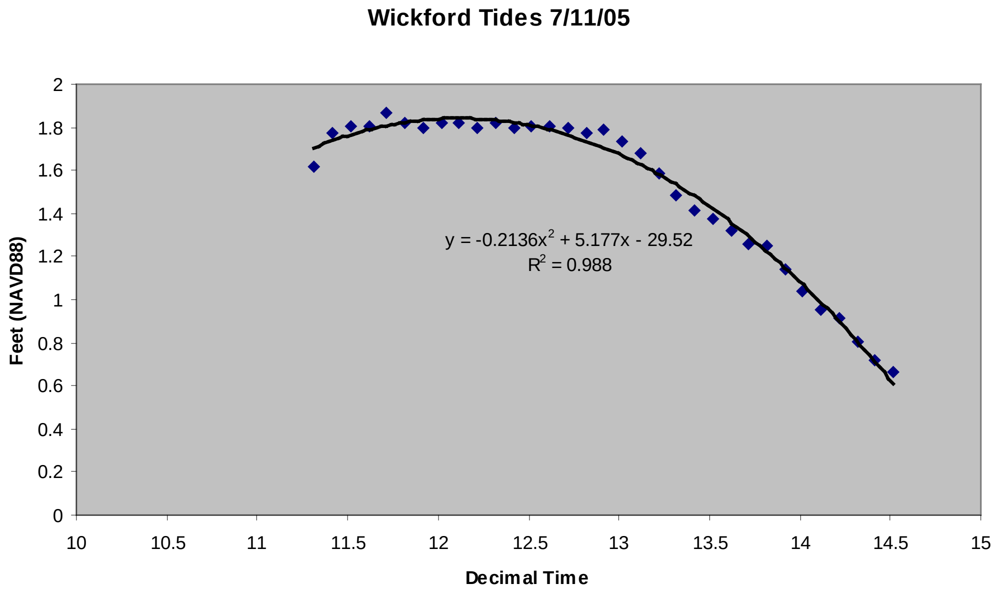
time	tide gauge reading (ft)	decimal time	RTK tide gauge elevation	total tide elevation (NAVD88)
11:19:03	2.31	11.32	-0.693	1.617
11:25:03	2.47	11.42	-0.693	1.777
11:31:03	2.5	11.52	-0.693	1.807
11:37:03	2.5	11.62	-0.693	1.807
11:43:03	2.56	11.72	-0.693	1.867
11:49:03	2.51	11.82	-0.693	1.817
11:55:03	2.49	11.92	-0.693	1.797
12:01:03	2.51	12.02	-0.693	1.817
12:07:03	2.51	12.12	-0.693	1.817
12:13:03	2.49	12.22	-0.693	1.797

2: Graph corrected tide data

-Convert times for tide gauges and mapping depths to decimal hours using equation (time-INT(time))*24=decimal time. (time = select the box that says the time of the reading)

-Graph the decimal time and the water depth from the corrected tide gauge information as an x-y graph.

-Add a polynomial trendline and get the equation of the line.



3: Download tracklog data

-Download fathometer data and open in Excel

-Select depth column and format cells to contain 1 decimal place

4: Correct tracklog data for tide

-Use the equation of the trendline and plug in decimal times of each depth reading from the fathometer. This will give you the approximate tide height above or below zero NAVD88 at that time.

-Subtract this correction number from the depth reading from the fathometer. The result is the corrected depth readings in feet below NAVD88.

Y_PROJ	X_PROJ	depth reading (ft)	Date	Decimal time	tide correction equation = tide elevation at each time y = -0.2136x2 + 5.177x - 29.52	correct depth y = depth reading - tide correction
179313	343306	17.16	7/11/2005	11.11	1.630	15.53
179244	343355	17.78	7/11/2005	11.11	1.631	16.15
179173	343401	17.68	7/11/2005	11.11	1.633	16.05
179064	343433	16.63	7/11/2005	11.12	1.635	14.99
178412	342965	4.82	7/11/2005	11.50	1.768	3.05

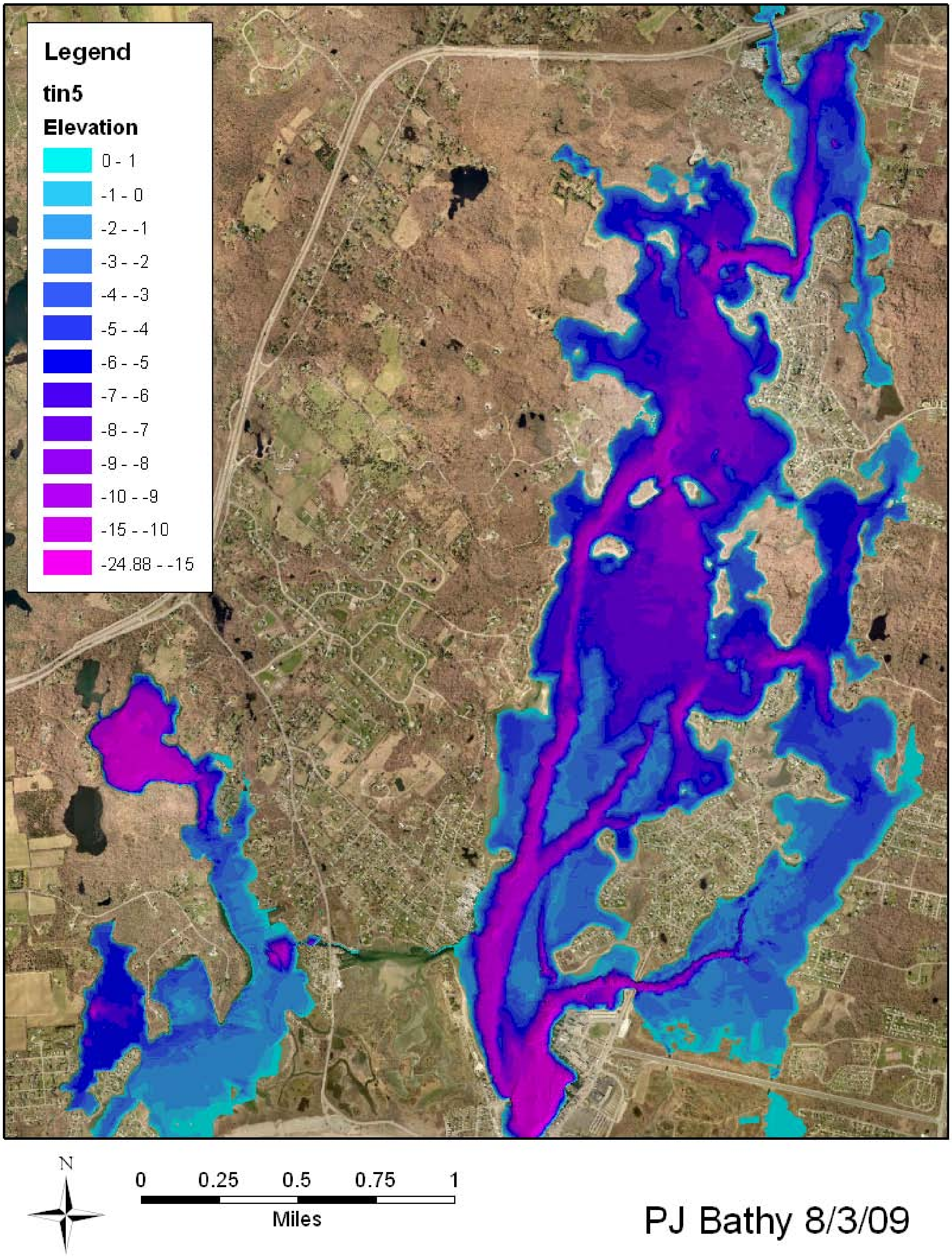
178446	342960	5.48	7/11/2005	11.51	1.769	3.71
178474	342983	6.46	7/11/2005	11.51	1.770	4.69
178511	342986	7.12	7/11/2005	11.52	1.771	5.35
178554	342986	7.64	7/11/2005	11.52	1.772	5.87
178598	342981	7.87	7/11/2005	11.52	1.773	6.10
178642	342970	8.01	7/11/2005	11.53	1.774	6.24
178695	342965	8.40	7/11/2005	11.53	1.775	6.62
178757	342957	8.66	7/11/2005	11.54	1.776	6.88
178810	342949	8.83	7/11/2005	11.54	1.777	7.05
178850	342933	8.63	7/11/2005	11.55	1.778	6.85
178905	342892	6.23	7/11/2005	11.55	1.780	4.45
178956	342845	7.64	7/11/2005	11.55	1.781	5.86
179015	342803	7.32	7/11/2005	11.56	1.782	5.54
179080	342765	6.99	7/11/2005	11.56	1.783	5.21

For inland waters:

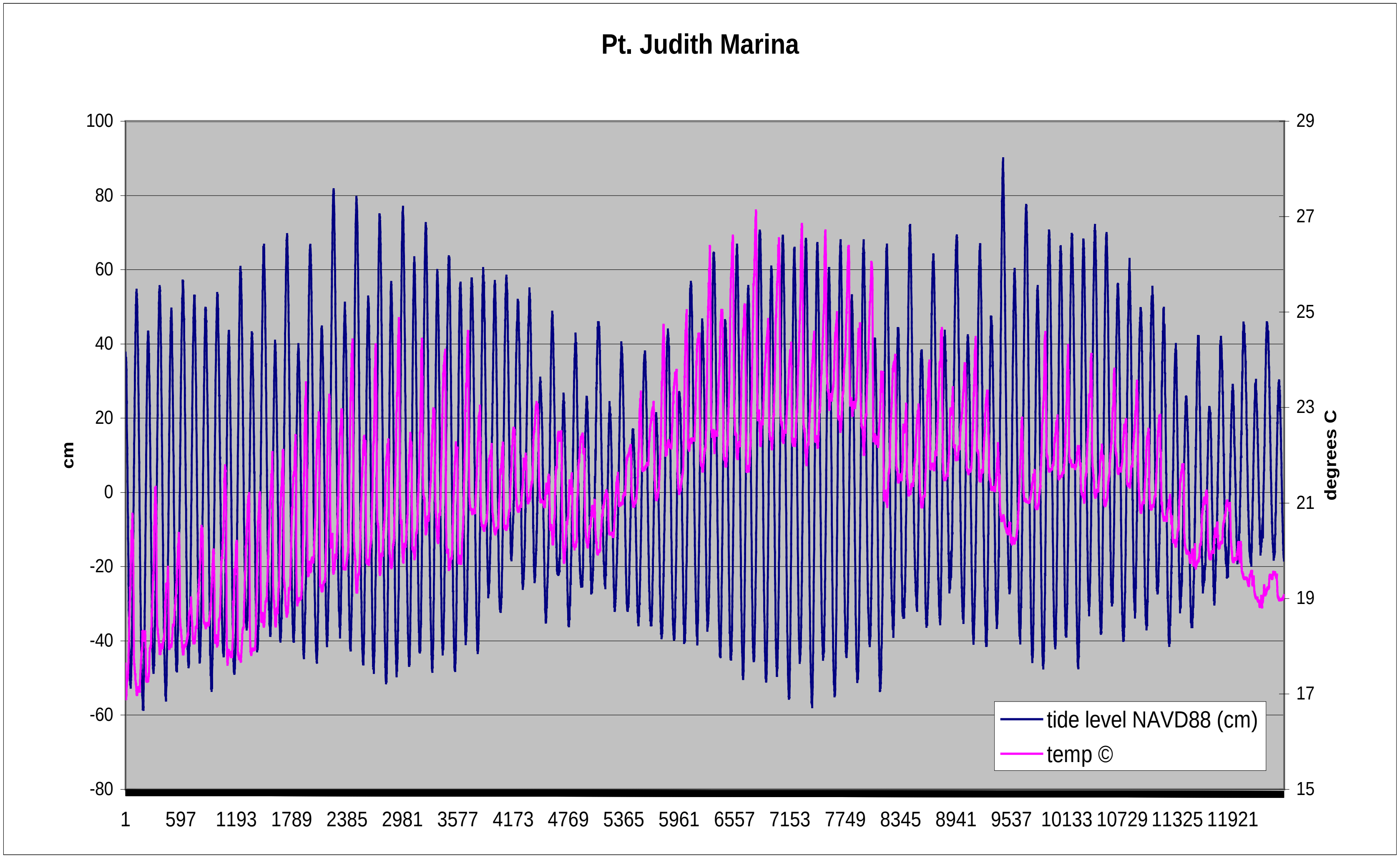
Follow the same process as tidally influenced water, but there is no need to record tidal cycles. Elevation of the water surface at the time of fathometer surveys should be recorded using a RTK GPS or surveyed from a known benchmark. Depth can be recorded relative to water level, however, if bathymetry is meant to be tied into elevation of surrounding land, data can be reported in NAVD88. If the water body elevation (soil) is controlled by a dam the elevation of the spillway should also be recorded to determine the maximum water level.

Tools

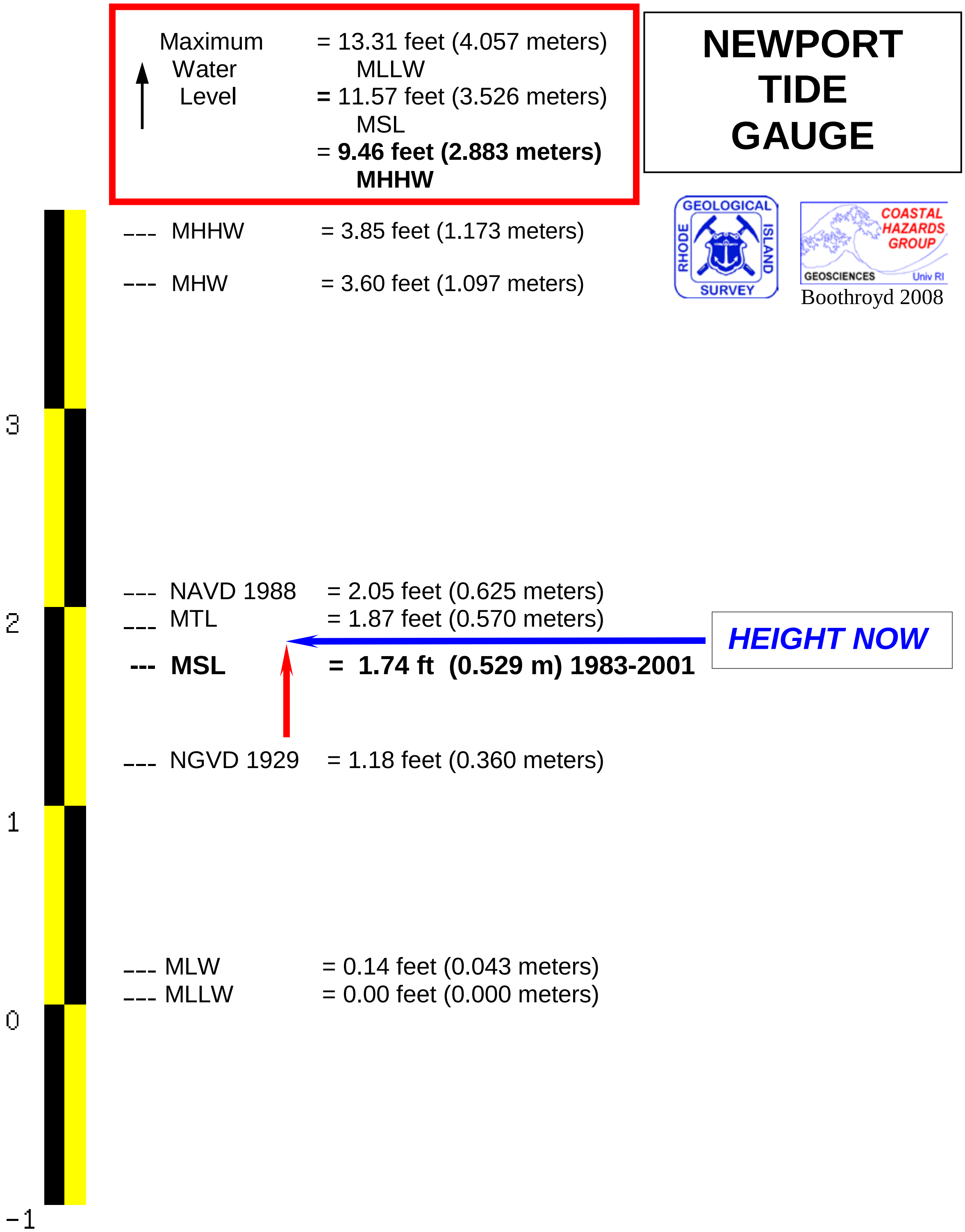
Sounder/Chartplotter with GPS and dual frequency transducer
  Garmin GPSmap Chartplotter $550
  or
Survey grade Fathometer (e.g. Hydrobox - http://www.syqwestinc.com/)
  approximately $3,000 to 5,000
Tide gauges
  Solinst levelogger and barrologger $500 each
RTK GPS or Survey Equipment (RTK GPS runs $20 to $50,000 range)



PJ Bathy 8/3/09



Tide data and water temperature data for Point Judith Pond at Point Judith Marina collected 7/2/2007 through 8/23/2007.



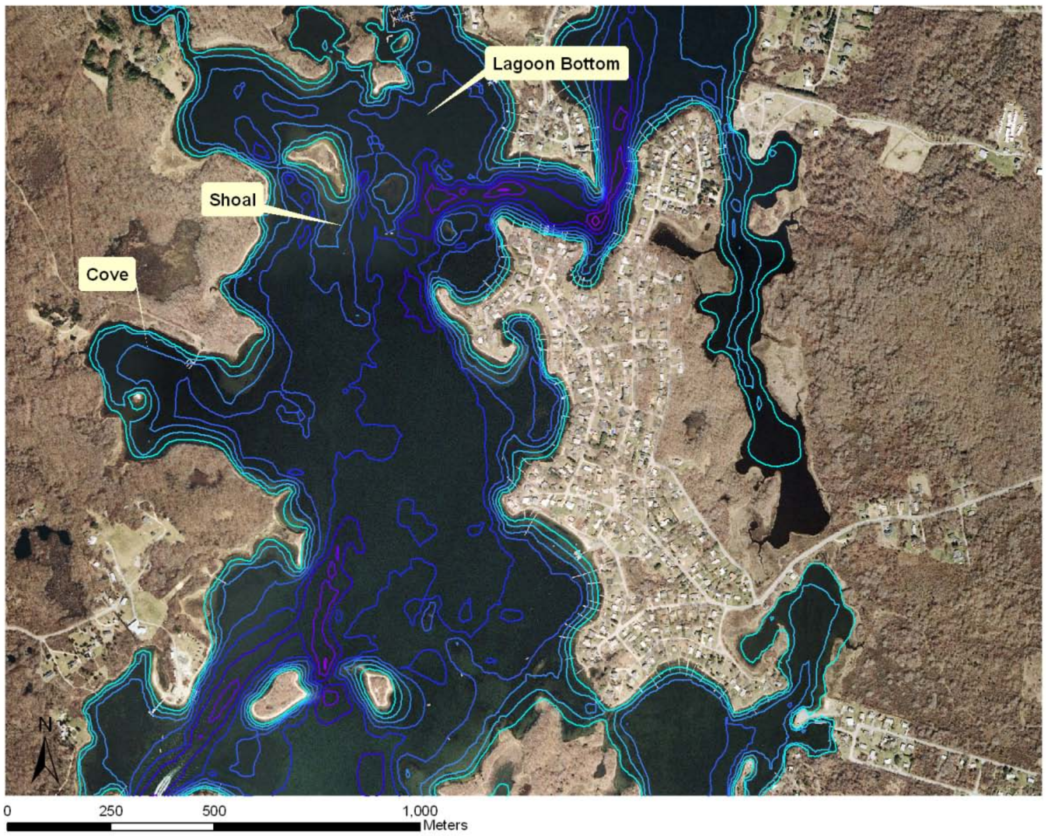
The NAVD 1988 and NGVD 1929 elevations related to MLLW were computed from Bench Mark, 845 2660 TIDAL 6, at the station.

Displayed tidal datums are MEAN HIGHER HIGH WATER (MHHW), MEAN HIGH WATER (MHW), MEAN TIDE LEVEL (MTL), MEAN LOW WATER (MLW), AND MEAN LOWER LOW WATER (MLLW) referenced on 1983-2001 Epoch.

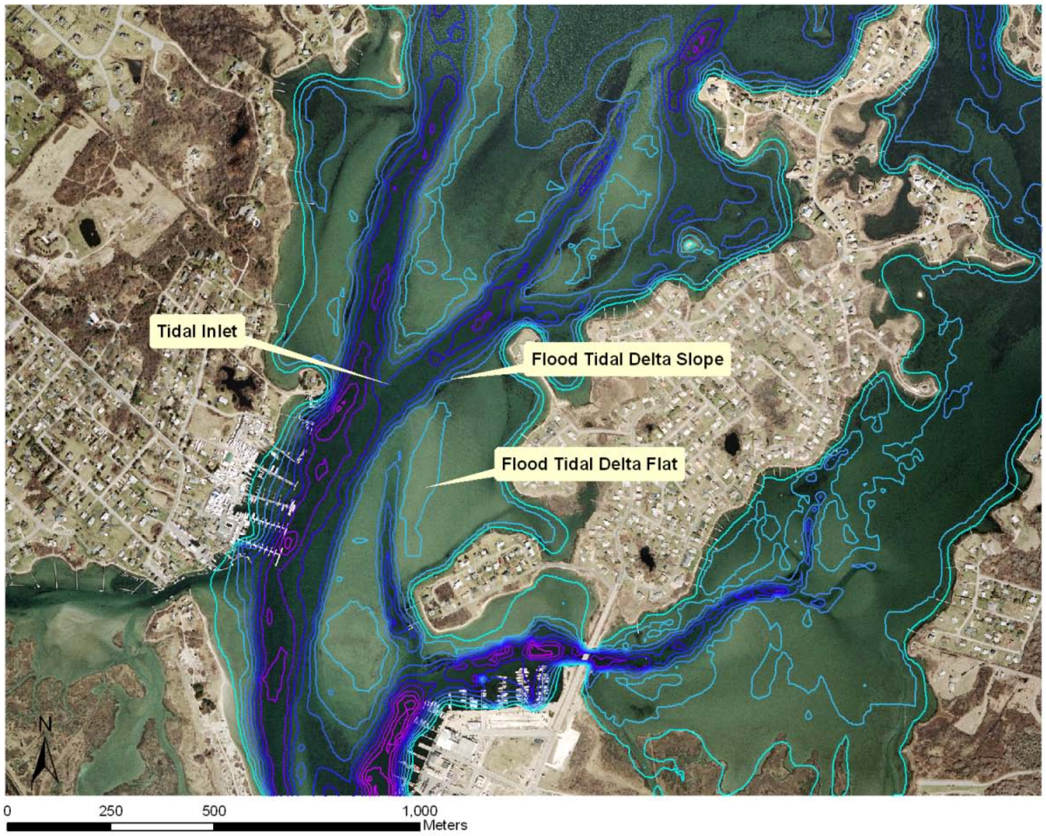
adapted from www.ngs.noaa.gov/cgi-bin/ngs_opsd.prl?PID=LW0493

Subaqueous Landscapes in Point Judith Pond:

***Subaqueous Landscapes:** Permanently submerged areas that are fundamentally the same as subaerial (terrestrial) systems in that they have a discernable topography composed of mappable, subaqueous landforms.



***Lagoon Bottom:** The nearly level or slightly undulating central portion of a submerged, low-energy, depositional estuarine basin (McGinn, 1982) characterized by relatively deep water (1.0 to >2.5 m). Compare – Bay Bottom.
***Shoal:** A natural, subaqueous ridge, bank, or bar consisting of, or covered by, sand or other unconsolidated material, rising from the bed of a body of water (e.g. estuarine floor) to near the surface. Compare – Dredge-deposit Shoal, Reef. (modified from Jackson, 1997)
***Mainland Cove:** A subaqueous area adjacent to the mainland or a submerged mainland beach that forms a minor recess or embayment within the larger basin. Compare – Cove, Barrier Cove.



***Flood-Tidal Delta:** A largely subaqueous (sometimes intertidal), crudely fan-shaped deposit of sand-sized sediment formed on the landward side of a tidal inlet (modified from Boothroyd et al., 1985; Davis, 1994; Ritter et al., 1995). Flood tides transport sediment through the tidal inlet and into the lagoon over a flood ramp where currents slow and dissipate (Davis, 1994). Generally, flood-tidal deltas along microtidal coasts are multi-lobate and unaffected by ebbing currents (modified from Davis, 1994). Compare – Flood-Tidal Delta Slope.

* **Flood-Tidal Delta Flat:** The relatively flat, dominant component of the flood-tidal delta. At extreme low tide this landform may be exposed for a relatively short period (modified from Boothroyd et al., 1985).

* **Flood-Tidal Delta Slope:** An extension of the flood-tidal delta that slopes toward deeper water in a lagoon or estuary, composed of flood channels, inactive lobes (areas of the flood-tidal delta that are not actively accumulating sand as a result of flood tides), and parts of the terminal lobe of the flood-tidal delta (modified from Boothroyd et al., 1985).

***Tidal Inlet:** Any inlet through which water alternately floods landward with the rising tide and ebbs seaward with the falling tide (Jackson, 1997). Compare – Inlet, Relict Tidal Inlet.

* 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.

Glacial geology and depositional history of Point Judith Pond, Rhode Island

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ABSTRACT
The Quaternary geology of the Point Judith Pond area in Rhode Island is complex due to the location at the intersection of two ice lobes during the most recent advance of the Laurentide ice sheet into southern New England. This area is on the boundary between two geologic quadrangle maps that were mapped at different times by different geologists and the two maps do not agree on the origin of the glacial material surrounding Point Judith Pond. Based on current geologic theory and evidence from soil parent material mapping, the materials in and around Point Judith Pond are dominated by ice-marginal fluvial deposits that were deposited around stagnant ice blocks. Debris flow till is also common in this area as ice blocks melted and till material was deposited along with stratified material. Additionally, there is little information on the sediment facies that exist within the basins of the pond that may help in determining the geology of the surrounding area and the geologic history of these deeper basins. Bathymetric mapping, along with 79 vibracores, peat cores, and auger borings were conducted throughout Point Judith Pond in an effort to map the glacial surface and post-glacial deposition within Point Judith Pond. Where these samples included glacial material or contact with fresh water marsh material these cores can help to determine the Pleistocene topography prior to inundation with salt water and the rate of deposition since that time.

INTRODUCTION
Coastal Rhode Island contains multiple coastal lagoons, called coastal or salt ponds in local terminology. These lagoons are located landward of barrier spits and are underlain by Pleistocene-age glaciofluvial and till material (Boothroyd et al., 1985). Point Judith Pond is unique among the Rhode Island coastal ponds in that basin was formed by the flooding of ice-block basins and the bathymetry is controlled by this the Pleistocene topography (Boothroyd et al., 1985; Figure 1). The surficial geology of the Point Judith Pond area in Rhode Island is complex due to the location at the intersection of two ice lobes (Shafer and Hartshorn, 1965). Shafer (1961) mapped most of the area surrounding Point Judith Pond as undifferentiated ice contact deposits consisting mostly of glaciofluvial material. Kaye (1960), on the other hand, mapped the majority of the area surrounding the pond as ablation moraine complex.

GENERAL GEOLOGY
The Late Quaternary glacial sediment that is evident today in Rhode Island is the result of the most recent advance and retreat of the Laurentide Ice sheet. During ice retreat, multiple moraine sequences were formed throughout the southern portion of the state (Shafer and Hartshorn, 1965; Figure 2). The Point Judith Pond area lies at the boundary between two ice lobes of the Laurentide Ice sheet; the Rhode Island-eastern Connecticut lobe (CRI) and the Narragansett Bay lobe (NB) (Boothroyd and Sirkin,

2002). The Charlestown moraine, which lies parallel to the south coast of Rhode Island, indicates a recessional position for the CRI lobe. The Point Judith moraine, to the east of Point Judith Pond, represents the western edge of the NB lobe that retreated up Narragansett Bay (Shafer, 1961). It is believed that the Narragansett Bay lobe retreated more slowly than the ice to the west because the ice was thicker in the lower elevations of the Narragansett Basin (Boothroyd and August, 2008). The interaction between these two lobes of ice is what formed the complex geology in and around Point Judith Pond.

Sources of glacial material

A large volume of ice marginal stratified deposits can be deposited in a short period of time from material derived from beneath and within the ice (Gustavson and Boothroyd, 1987). In the Point Judith Pond area, it is possible to determine the source of much of the stratified material because the pond exists within Permian and younger bedrock, but is just south and west of the Narragansett Basin, which consists of Pennsylvanian aged bedrock of the Rhode Island Formation (Hermes et al., 1994). The two major sources of glacial meltwater within the Point Judith Pond area came from the Pettaquamscutt Cove valley within the Rhode Island Formation and the Saugatucket River valley within the Esmond Igneous Suite. The large percentage of Pennsylvanian aged rocks within the deposits in the Point Judith Pond area indicate that alluvial deposits east and directly south of Silver Lake are derived from the Pettaquamscutt Cove valley, while smaller percentages within deposits to the west indicate that these are derived from the Saugutucket River valley system (Shafer, 1961). These two morphosequences are mapped as the same age deposits, as these two valleys drained at similar times.

Ice Block Basins

The basins that form the depressions that make up Point Judith Pond result from detached ice blocks within and alluvial fan as per Koteff and Pessl (1981). An unusually large amount of ice blocks likely remained in the Point Judith Pond area due to the proximity to the topographically low Rhode Island Sound. The Narragansett Bay lobe of the Laurentide ice sheet was thicker and remained longer to the east of Point Judith Pond behind the Point Judith moraine than the ice to the north and west (Boothroyd and August, 2008). As these ice blocks remained as the ice retreated to the northwest and large amounts of sands and gravels were deposited in an alluvial fan surrounding these blocks. As the ice blocks melted, stratified sands and gravels were left in the surrounding area with slumping and debris flow occurring as material shifted off of the melting ice (Benn and Evans, 1998). Typical of ice-marginal deposits, the resulting deposits are seen in the form of a complex combination of stratified sands and gravels interbedded with debris flow till (Shafer, 1961; Shaw, 1972).

Kingston Quadrangle

The mismatch between the Kingston and Narragansett Pier Quadrangles in the unit to the west of Point Judith Pond is an indication of the complexity of the deposits in this area (Kaye, 1954; Shafer, 1961). The two morphosequences from the Pettaquamscutt Cove and Saugutucket River valley sequences that are mapped within the Narragansett Pier Quadrangle are combined as one unit in the Kingston Quadrangle and mapped as ablation moraine complex (Kaye, 1960; Shafer, 1961). Although there is a significant amount of ablation till material in this area, evidence suggests that these deposits are dominated by alluvial fan deposits from fluvial deposition. Soil mapping in the area indicate stratified material as a parent material to the west of the pond and on most of the islands within Point Judith Pond. Northwest of the pond, soils are mapped with ablation till parent materials, indicating that this area may contain more areas of debris flow till or be more influenced by the Charlestown moraine formation (U.S. Department of Agriculture, Natural Resources Conservation Service, 2008; Figure 3). Further study would have to be done in the Kingston Quadrangle in order to continue the delineation of the origin of the deposits to the west of Point Judith Pond.

SUBAQUEOUS GLACIAL AND ORGANIC MATERIALS

In order to achieve a more complete image of the glacial geology of the Point Judith Pond area, we investigated the subaqueous bathymetry and depth to glacial materials within the basins of Point Judith Pond. Bathymetry data from NOAA 1948 surveys were combined with single-beam sonar soundings collected in Upper Pond and Bluff Hill Cove in order to create contours of the depth of the pond. During the summers of 2007 and 2008, 79 vibracores, peat sampler cores, and auger borings were taken throughout the pond to a depth of 40 to 350 cm below the sediment surface. These samples were described according to National Soil Survey protocols (Soil Survey Division Staff, 1993) and the depth to parent material and organic matter was recorded where it was found (Figure 4). Two transects were modeled here for comparison of current water depth and depth to glacial or organic contact (Figure 5).

Bathymetric surveys show that the contours within Point Judith Pond have much less relief than that of the surrounding terrestrial landscape (Figure 4). Average depth of the pond is calculated to be approximately 1.8 meters (Boothroyd et al., 1985). The lack of relief within the pond is due to the marine sedimentation that has occurred since the time of marine inundation of low-lying coastal lands in Rhode Island. Prior to marine inundations however, many deep basins contained freshwater lakes, ponds, and marshes. It is estimated that it was not until approximately 4000 years BP that many of the coastal lagoons were inundated with marine waters (Boothroyd et al., 1985; Hubney, 2006). The rapid rate of deposition within marine waters accounts for the infilling of glacial basins and the lack of relief in most of Point Judith Pond.

Nine out of 79 sampling sites encountered glacial material within the sampling depth. The depth to contact ranged from 36 to 170 cm below the sediment surface or approximately 93 to 308 cm below mean low water (MLW). Mean sampling depth was 154 cm below the sediment surface. The majority of samples in which glacial material was encountered within the sampling depth were very close to the shore, while most samples within the central part of the basins contained very deep marine deposits. This indicates that the topography of the land prior to inundation in the Point Judith Pond consisted of equal or greater relief than the surrounding land, supporting the theory that the basins were formed in alluvial fan deposits with embedded ice blocks.

Glacial material found at the base of the vibracores was described as stratified material in all cores. The material contained coarse sand with multiple pebble sized gravels. Vibracores and auger borings did not penetrate very far into the glacial materials because of the gravelly nature of these deposits. Although all glacial material was described as stratified material, it was difficult in many cores to determine if deposits were stratified fluvial deposits or debris flow till due to the small sample size (3 inch cores), the very gravelly nature of the sediment that often resulted in core refusal, and the fact that the focus of descriptions were on the upper layers of sediment rather than the glacial material. Lodgement till, however, was not encountered in any cores.

Submerged peat deposits

Organic material in the form of fresh water cedar swamp deposits were encountered in 15 of the 79 samples taken in Point Judith Pond. The depth to organic contact ranged from 20 to 260 cm below the sediment surface and -101 to -478 cm elevation (NAVD88). Cores with organic deposits were also encountered near the shore, most often in small coves. Some of these peat deposits are over 1 meter in thickness. After glacial retreat and prior to marine inundation, the ice block basins likely contained fresh water and swamps, which formed these organic deposits. Sea level was 120 meters lower than present day sea level at the time of glacial retreat from southern New England, leaving the Point Judith basins either dry or containing lakes or ponds. No evidence of laucustrine deposits were found in any core samples, leading to the conclusion that peat deposits were formed in isolated depressions at the margins of the larger depressions. The lack of organic deposits near the central parts of the Point Judith Pond basins indicate that ice blocks may have remained in the large basins for a significant amount of time while the cedar swamps developed in shallower basins where ice had already melted away. Research in the Pettaquamscutt River Estuary to the north of Point Judith Pond has shown that freshwater swamps existed in this area beginning approximately 19,000 years BP (Hubney, 2006). Freshwater remained in these basins until sea level rise inundated the basins with salt water. In the Pettaquamscutt River, the date of inundation of the basins is calculated to be 975 years BP (Hubney, 2006). Studies in other coastal ponds on the south shore of Rhode Island have resulted in much earlier dates of marine inundation of approximately 4,000 years BP (Boothroyd et al., 1985). Inundation of the Point Judith Pond basins likely occurred at some point between these two dates. Further research and dating of organic material is necessary to pinpoint the date of inundation.

CONCLUSIONS

The glacial geology of the Point Judith Pond area in Rhode Island is a large ice-marginal fluvial deposition. Large ice blocks from the Narragansett Bay lobe of the Laurentide Ice sheet were left in what are now the basins of Point Judith Pond and smaller blocks created the kettle basins to the west of the pond. Ice margins at Pettaquamscutt Cove and retreating up the Saugutucket River valley provided the source for a large amount of fluvial material that skirted these ice blocks and the valley edge along the Point Judith Moraine to the east. Upon melting, the ice blocks left a hummocky topography with a large percentage of debris flow till interbedded with fluvial deposits. Small depressions within the topography were ideal locations for the formation of cedar swamps, which thrived until marine waters inundated the deep basins of Point Judith Pond. The subaqueous topography was quickly filled in with marine sedimentation, forming the relatively shallow basin that we see today in Point Judith Pond.

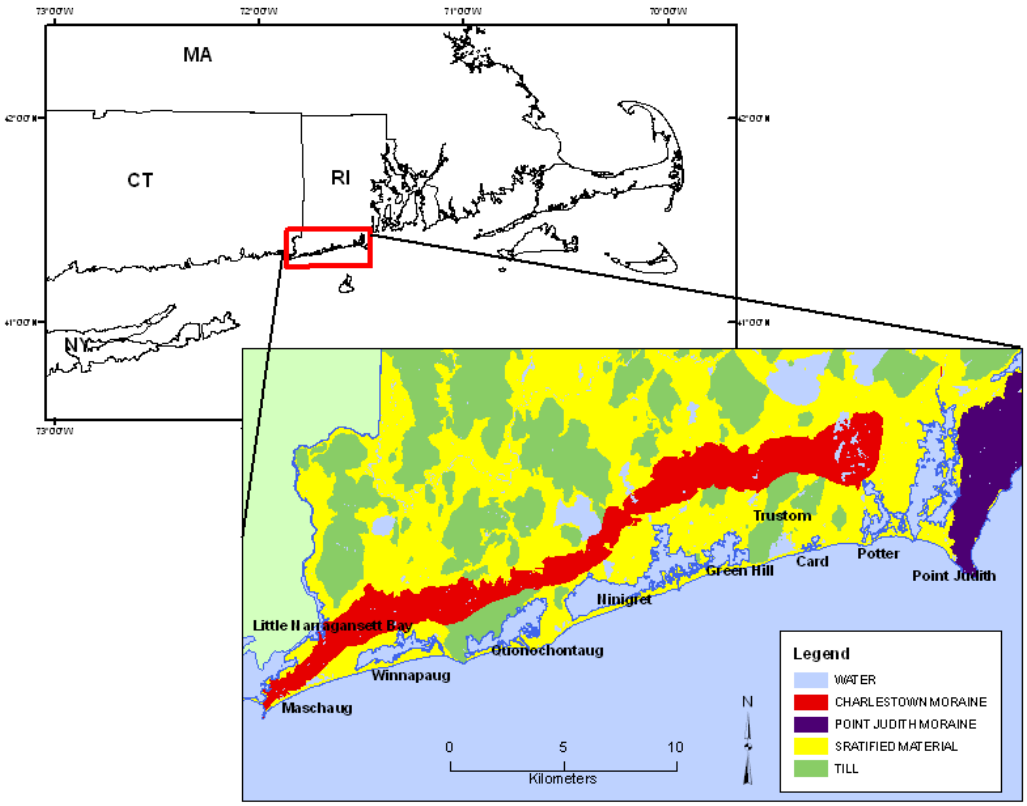


Figure 1. Location of coastal ponds of Rhode Island with general glacial features of Southern Rhode Island.

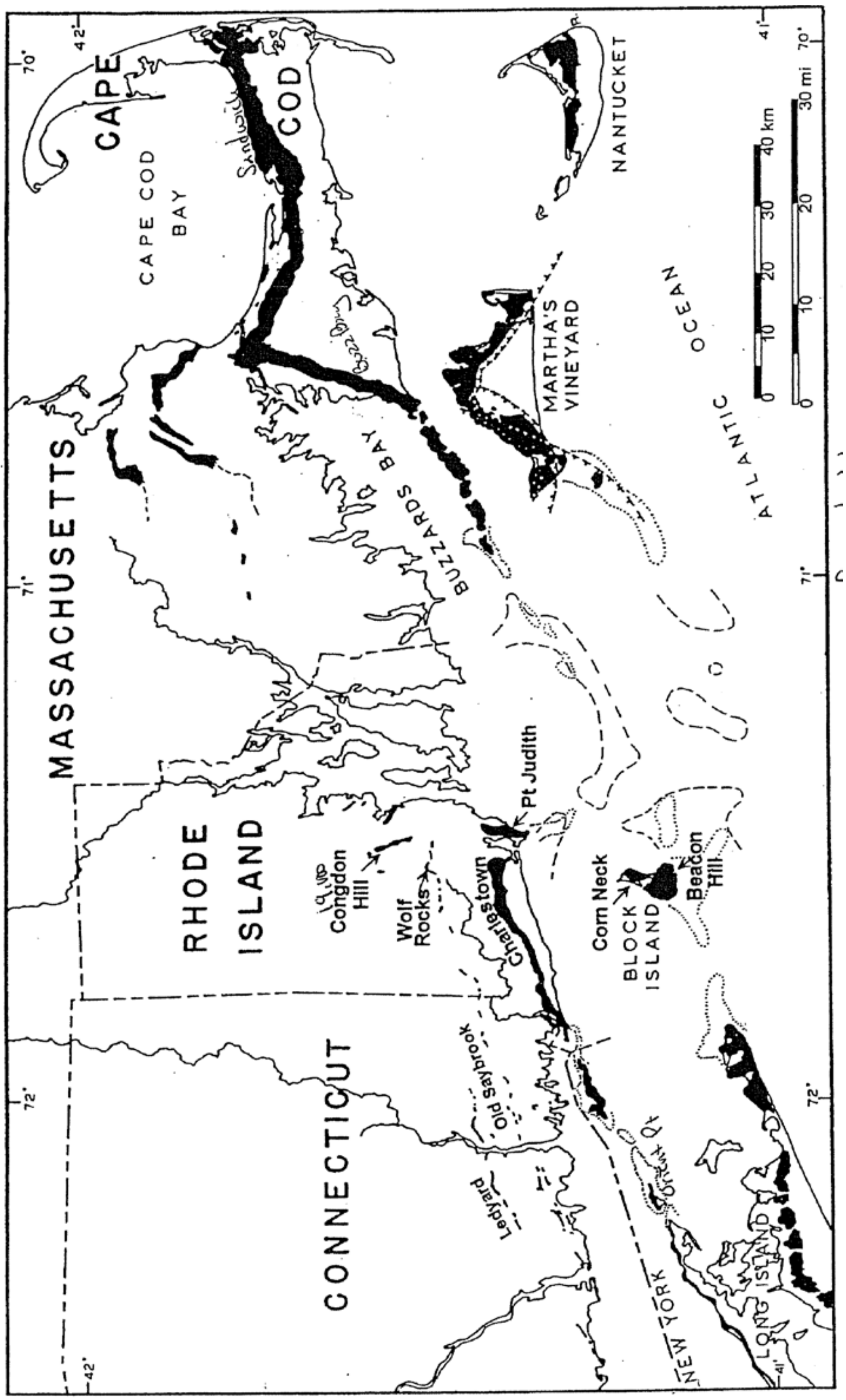


Figure 2. End moraines of southeastern New England from Shafer and Hartshorn (1965) and Sirkin (1982).

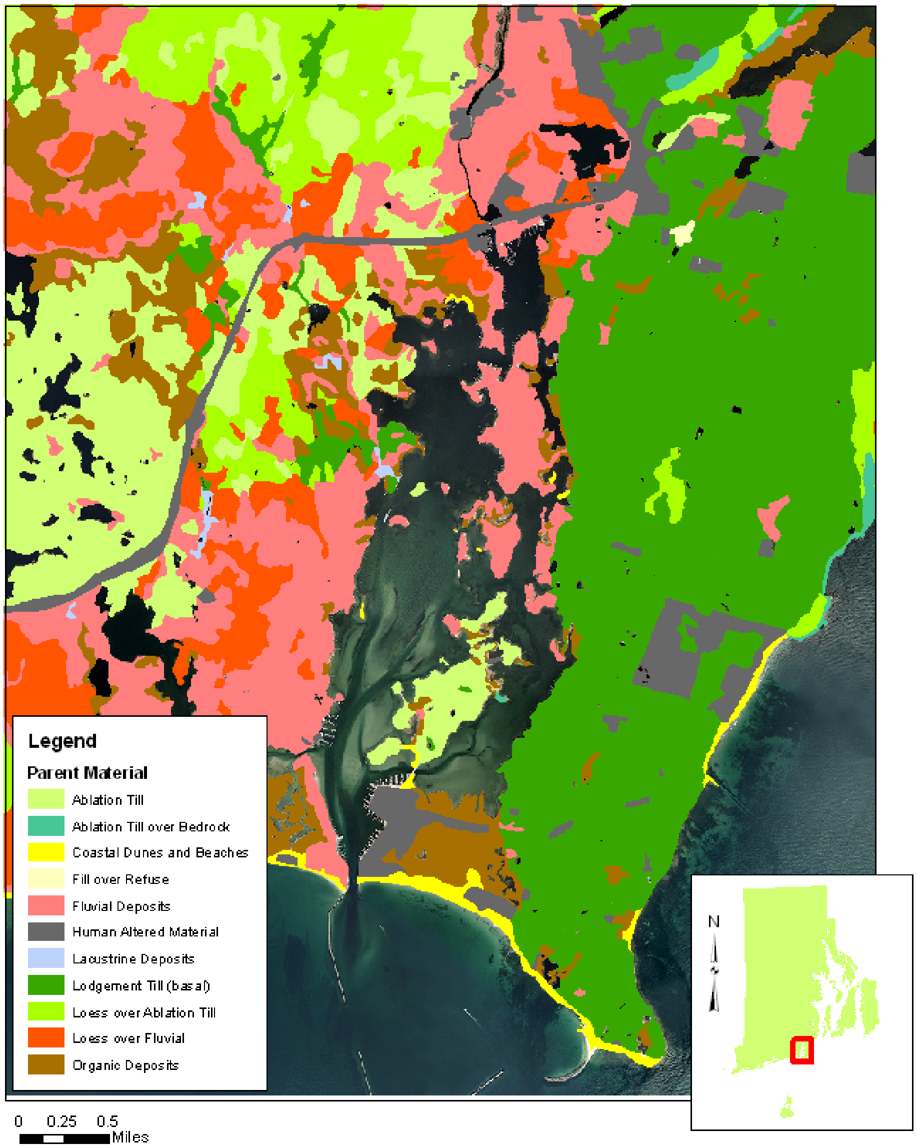


Figure 3. Parent material of soils from Soil Survey map of Rhode Island.

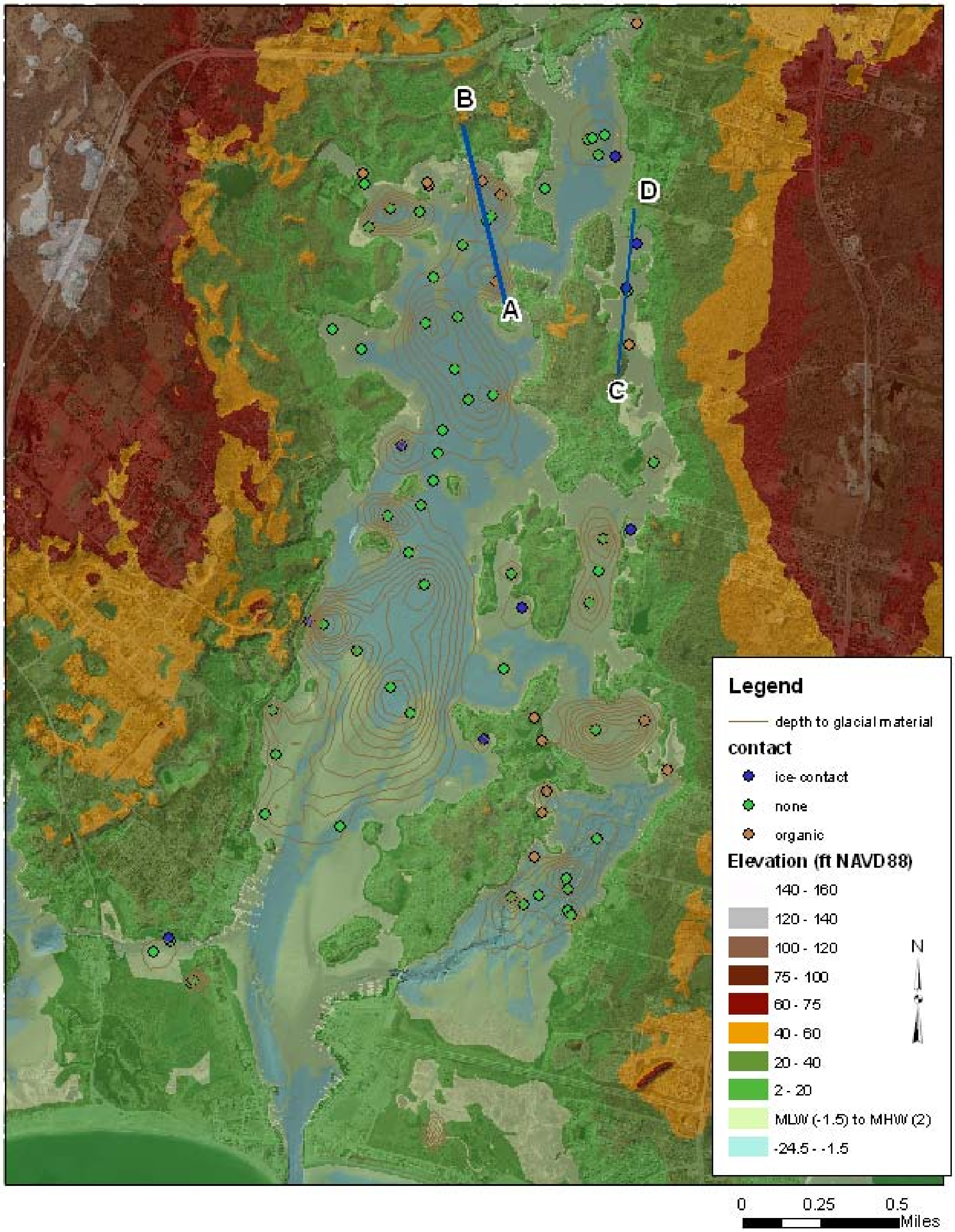
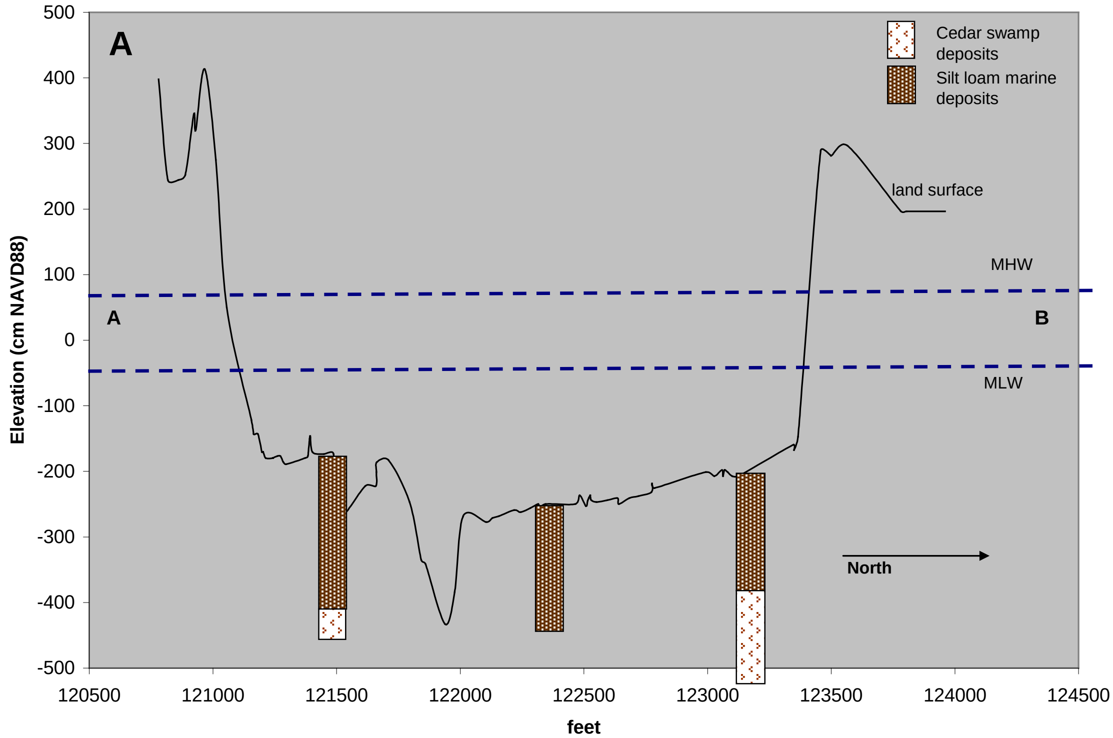


Figure 4. Depth to glacial contact or organic materials in vibracores and auger borings in Point Judith Pond. Contours in 25 cm intervals. Glacial contact is either till or fluvial materials, organic contact is freshwater peat, and no contact indicates neither glacial nor organic contact was reached within core.



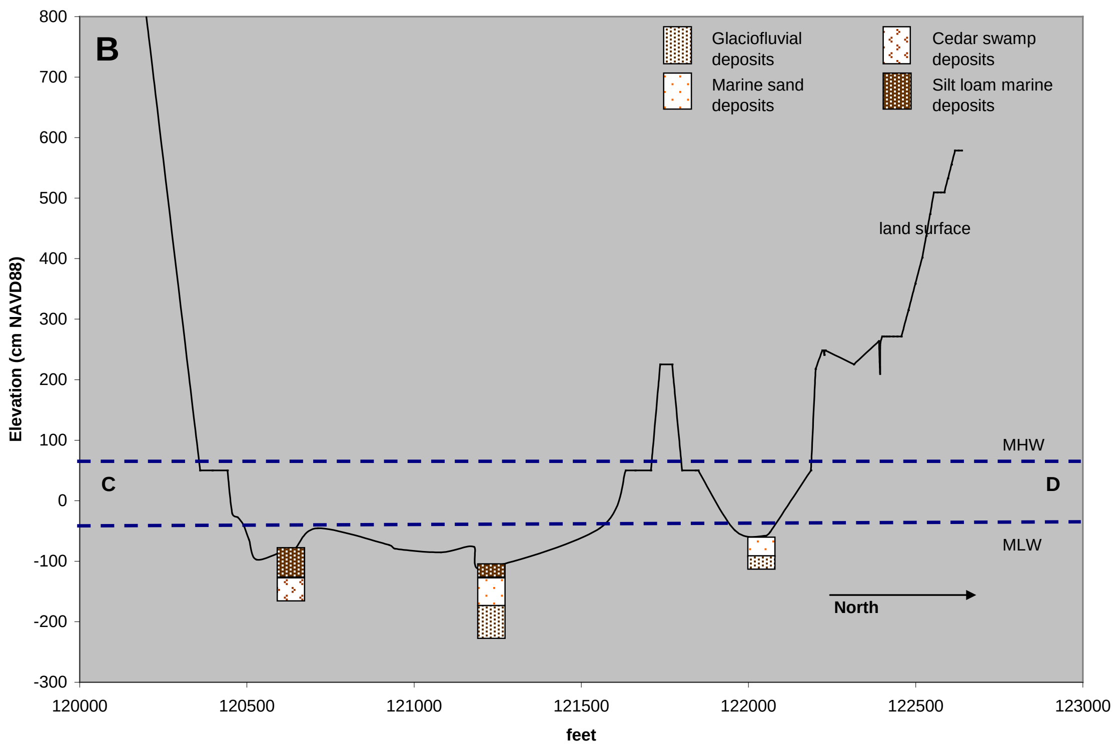


Figure 5. Transect core facies. (A) In transect A-B, marine silts dominate the surface and organic cedar swamp deposits are found at approximately 3.5 meters below MLW. (B) In transect C-D, marine silts form a very thin surface layer and glacial material is found at one meter below the MLW.

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Describing Subaqueous Soils

Standard descriptive terminology as outlined in the Soil Survey Manual (1993), and horizon designations outlined in the Keys to Soil Taxonomy (2003), should be used to describe the subaqueous soils. Some terminology and definitions that are important to consider in describing subaqueous soils are described below.

n-value (fluidity)

Fluidity is described in the field using a palmful of soil squeezed in the hand. Approximate n-value is assigned based on the fluidity.

Nonfluid (n-value = 0) – No soil flows through the fingers with full compression

Slightly fluid (n-value <0.7) – Some soil flows through fingers, most remains in the palm, after full pressure.

Moderately fluid (n-value = 1) – Most soil flows through fingers, some remains in palm, after full pressure.

Very fluid (n-value >1) – Most soil flows through fingers, very little remains in palm, after gentle pressure.

Odor

Sulfide odor is described as strong, moderate, weak, or none immediately after soil is exposed to air.

Reaction to hydrogen peroxide

Sulfidic materials accumulate within a soil that is permanently saturated, generally with brackish water. The sulfates in the water are biologically reduced to sulfides as the materials accumulate. Sufidic materials commonly accumulate in coastal marshes near the mouth of rivers that carry noncalcareous sediments, but they may occur in freshwater marshes if there is sulfur in the water.

Monosulfides, often in the form of Fe(II) monosulfides, are visible in reduced soil as a dark black color. When a sulfidic soil is oxidized, either in place due to oxidized water conditions, or when the soil is drained, Fe(III) is formed, and the typical black color is lost, leaving a gray or brown color (Lyle, 1983). An example of a common monosulfide oxidation reaction:

$$FeS + O_2 + H_2O = Fe(OH)_3 + H^+ + SO_4$$

Sulfidic materials are typically determined in the laboratory using incubation pH measurement in which a soil is kept in incubation for 8 weeks and the initial and final pH measurements are made. Hydrogen peroxide has also been used in determination of the presence of reduced sulfides in soil samples with pH measurements made after complete oxidation with H_2O_2 (Finkelman and Giffin, 1986; Jennings et al., 1999). Hydrogen peroxide speeds up the natural oxidation reaction and can be represented in the following reaction:

$$FeS + H_2O_2 = Fe(OH)_3 + H^+ + SO_4 + H_2O$$

In the field, the application of 3% hydrogen peroxide solution enables determination of the presence of reduced sulfides as monosulfides are oxidized and quickly change color upon exposure to peroxide. Presence of sulfide is defined as an immediate (within 10 seconds), discernable color change upon addition of H_2O_2, as seen below.

Horizon Designations:

A horizons: “Mineral horizons that formed at the surface or below an O horizon, that exhibit obliteration of all or much of the original rock structure, and that show one or more of the following: (1) an accumulation of humified organic matter intimately mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons (defined below) or (2) properties resulting from cultivation, pasturing, or similar kinds of disturbance.” (SSM)

Subaqueous soils are often described with an A horizon at the surface if that horizon shows a darker color due to an accumulation of organic matter. Some subaqueous soils are described without an A horizon if there is no obvious accumulation of organic matter such as in a very active flood tidal delta landform. Buried A horizons (Ab) are commonly described when a soil is interpreted to have had a stable surface long enough to accumulate organic matter, and was subsequently buried with mineral material. These horizons are identified by a darker color.

B horizons: “Horizons that formed below an A, E,, or O horizon and are dominated by obliteration of all or much of the original rock structure and show one or more of the following:

1. illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;
2. evidence of removal of carbonates;
3. residual concentration of sesquioxides;
4. coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron;
5. alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or
6. brittleness." (SSM)

Subaqueous soils very rarely are described with B horizons. In cases where a submerged soil is present, a B horizon may be described within the buried soil profile.

C horizons or layers: "Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. The material of C layers may be either like or unlike that from which the solum presumably formed. The C horizon may have been modified even if there is no evidence of pedogenesis." (SSM)

Transitional Horizons: AC and CA horizons are described in subaqueous soils. These transitional horizons are formed between surface A horizons and subsurface C horizons and have qualities of both master horizons.

g Strong gleying: "This symbol is used to indicate either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved a reduced state. Most of the affected layers have chroma of 2 or less and many have redox concentrations. The low chroma can be the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed." (SSM)

The subscript g is used in subaqueous soils for those horizons with a value of 4 or more moist *or* 6 or more dry and a chroma of 2 or less.

Use of discontinuity: "A discontinuity is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons formed and/or a significant difference in age, unless that difference in age is indicated by the suffix "b." Symbols to identify discontinuities are used only when they will contribute substantially to the reader's understanding of relationships among horizons. Stratification common to soils formed in alluvium is not designated as discontinuity, unless particle size distribution differs markedly (strongly contrasting particle-size class, as defined by Soil Taxonomy) from layer to layer even though genetic horizons have formed in the contrasting layers." (SSM)

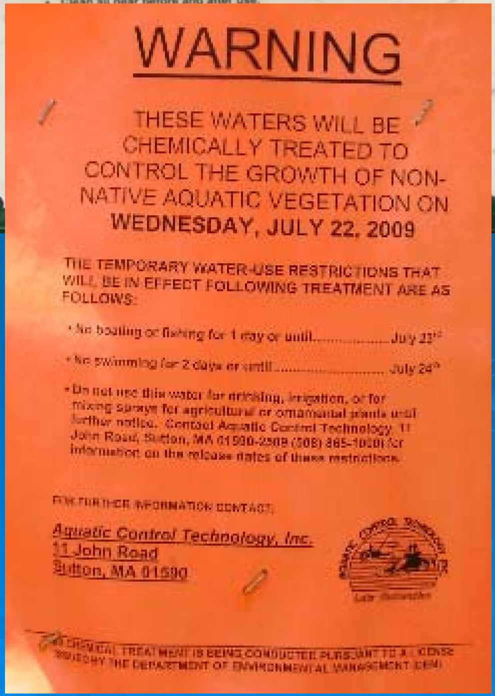
Discontinuities in subaqueous soils are described when there is a significant change in particle-size that indicates that the material was deposited by a different process. Important examples are a discontinuity at the change from material deposited in a marine environment to older material deposited on land and later inundated. Deposits of similar particle size from multiple overwash events behind a barrier are not described as discontinuities.

si-sulfidic (proposed subordinate distinction – 2010): This symbol indicates the presence of sulfides in mineral or organic horizons. Sulfidic horizons typically have dark colors; values <4, and chromas <2. These horizons typically form in coastal environments that are permanently saturated (tidal marshes or estuarine subaqueous soils) and have a source of sulfur to form sulfides. Such horizons may have a sulfidic odor when first exposed to air. Sulfidic horizons may also be geologic in origin. Examples include coal deposits or coastal plain deposits such as glauconite that have not been oxidized because of thick overburden.

Freshwater Subaqueous Soils

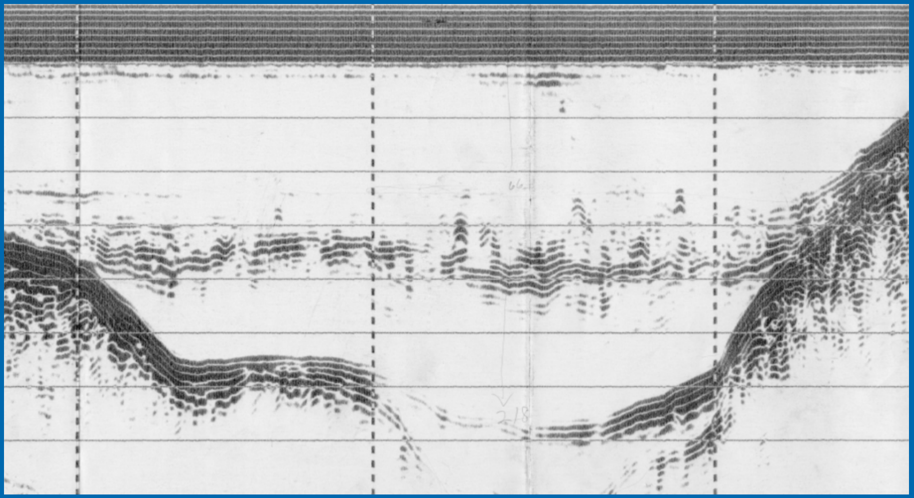
Jim Turenne, RI NRCS

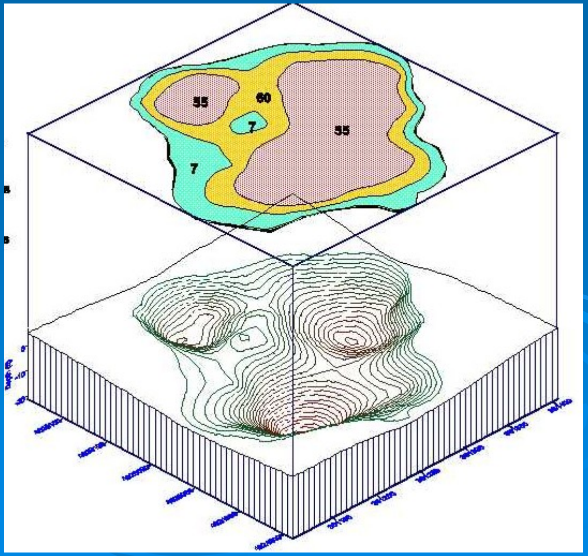
http://nesoil.com/sas



Need for freshwater SAS data

- Pond restoration – Grafton Pond, MA.
- Nutrient input/hydrologic conditions.
- Dam Removal – Lime Pond, Saw Mill Pond
- Invasive control (BMP) – Bowdish, 3 other.
- Peat thickness and volume – SE MA.
- Potential fuel source (84,000,000 cubic ft Bowdish)



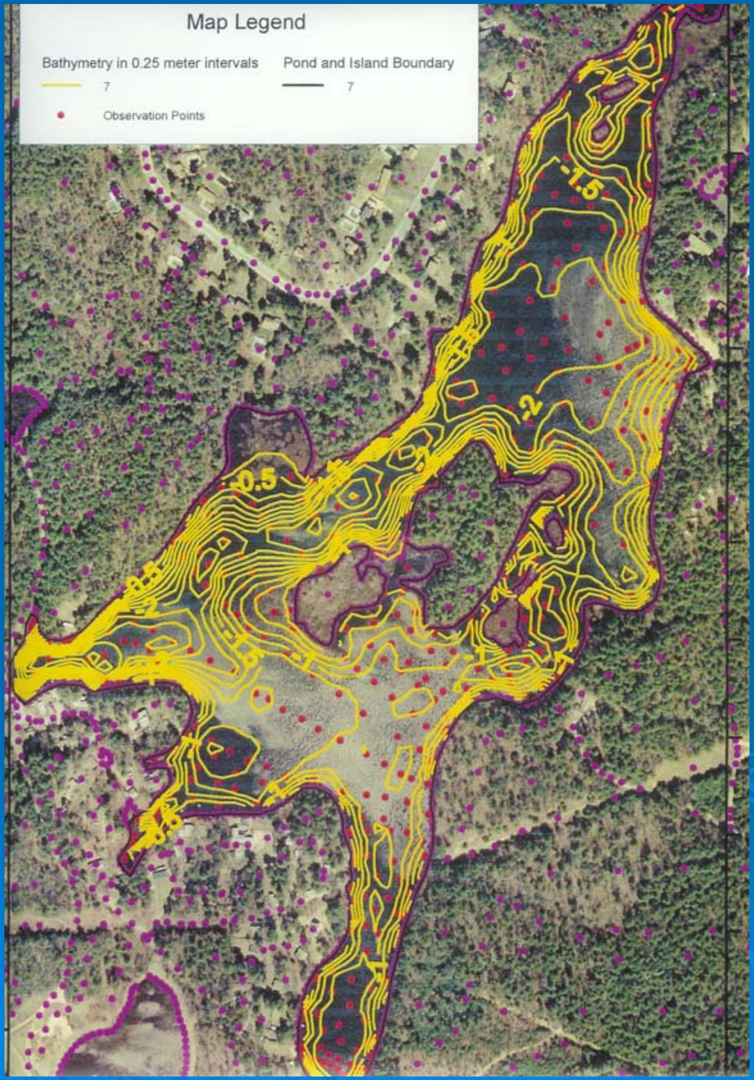


Classification- needs more input

- **Wassists** - are subaqueous Histosols. Defined as Histosols that have a positive water potential at the soil surface for 90% of each day. These soils are the second suborder to classify out under Histosols after Folists. The formative element Wass is derived from the German (Swiss) word “wasser” for water.
- BBA. 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. **Frasiwassists**
- **Wassents** - are subaqueous Entisols. Defined as Entisols that have a positive water potential at the soil surface for 90% of each day. These soils are the first suborder to classify out under Entisols. The formative element Wass is derived from the German (Swiss) word “wasser” for water.
- **Key to Great Groups**
- LAA. 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. **Frasiwassents**

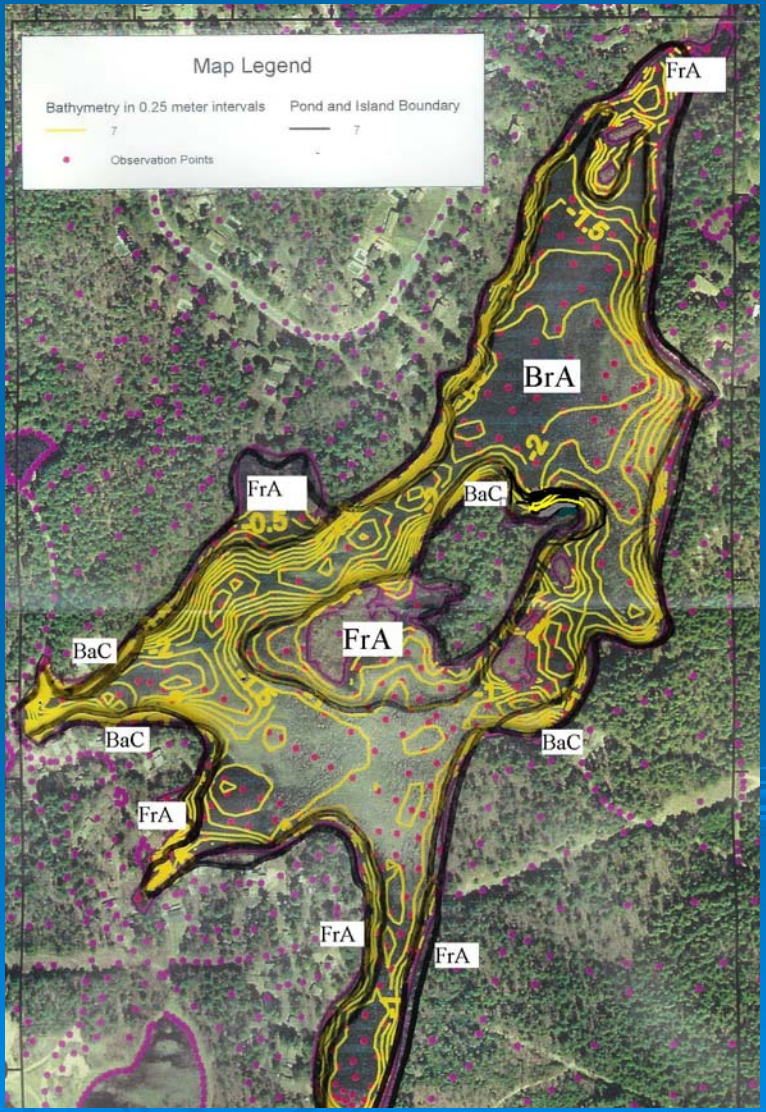
Mapping Protocol

- 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



Mapping Protocol

- Series and map unit phases need to be developed.
- Organic – dysic/euic, decomposition, terric types.
- Mineral – particle family, parent material, surface.
- Interps needed.



Imagery / Pictomery

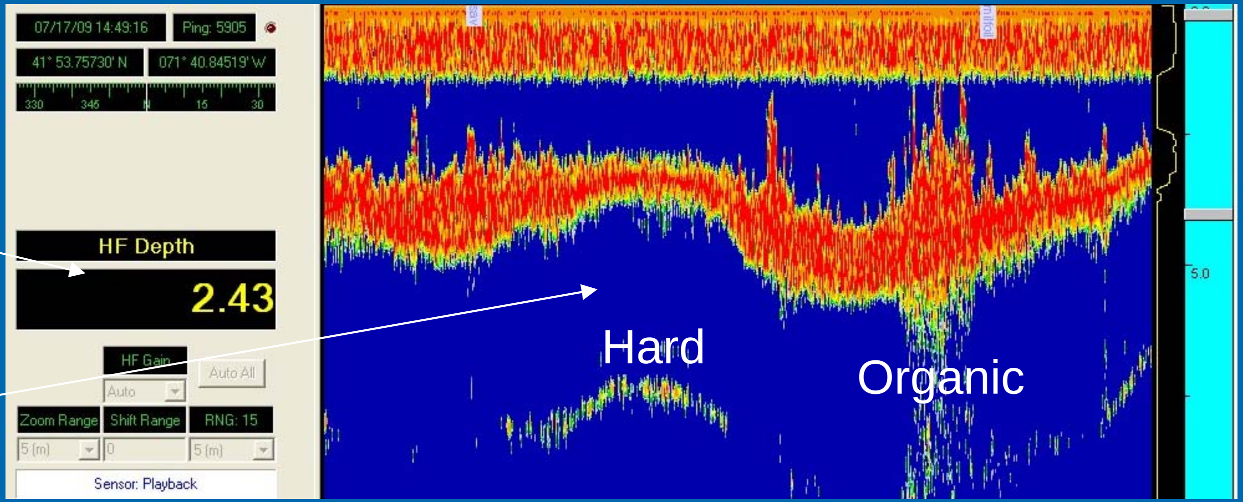
Acoustic Map

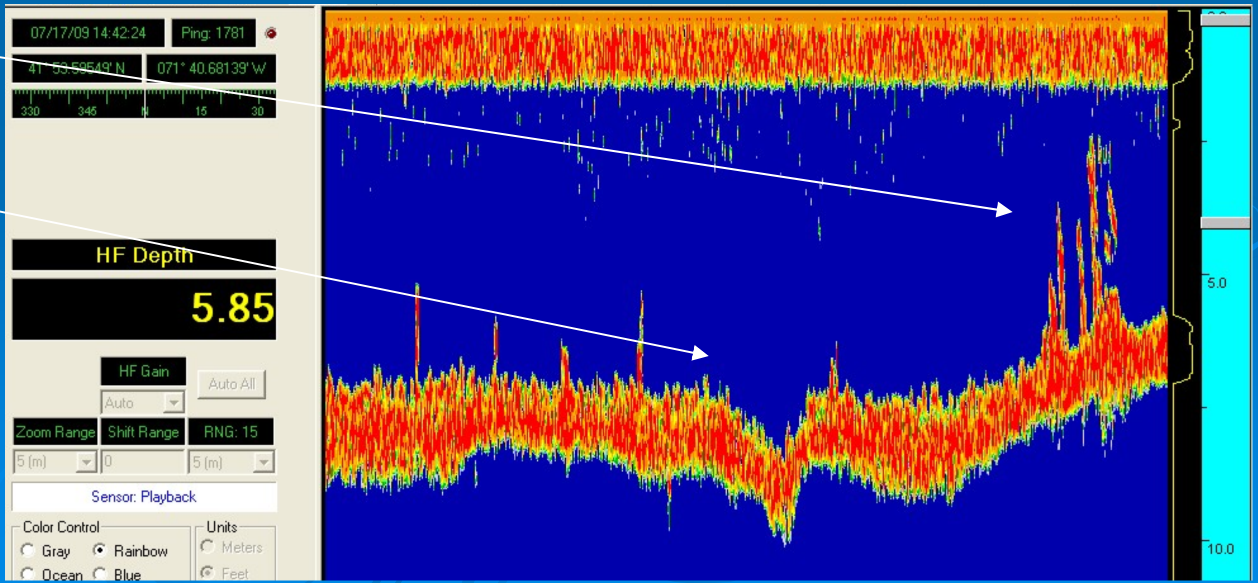
Survey Grade Fathometer (detailed bathymetry)

Bottom type mapping.

SAV, boulders, stumps.

Submerged stream channels

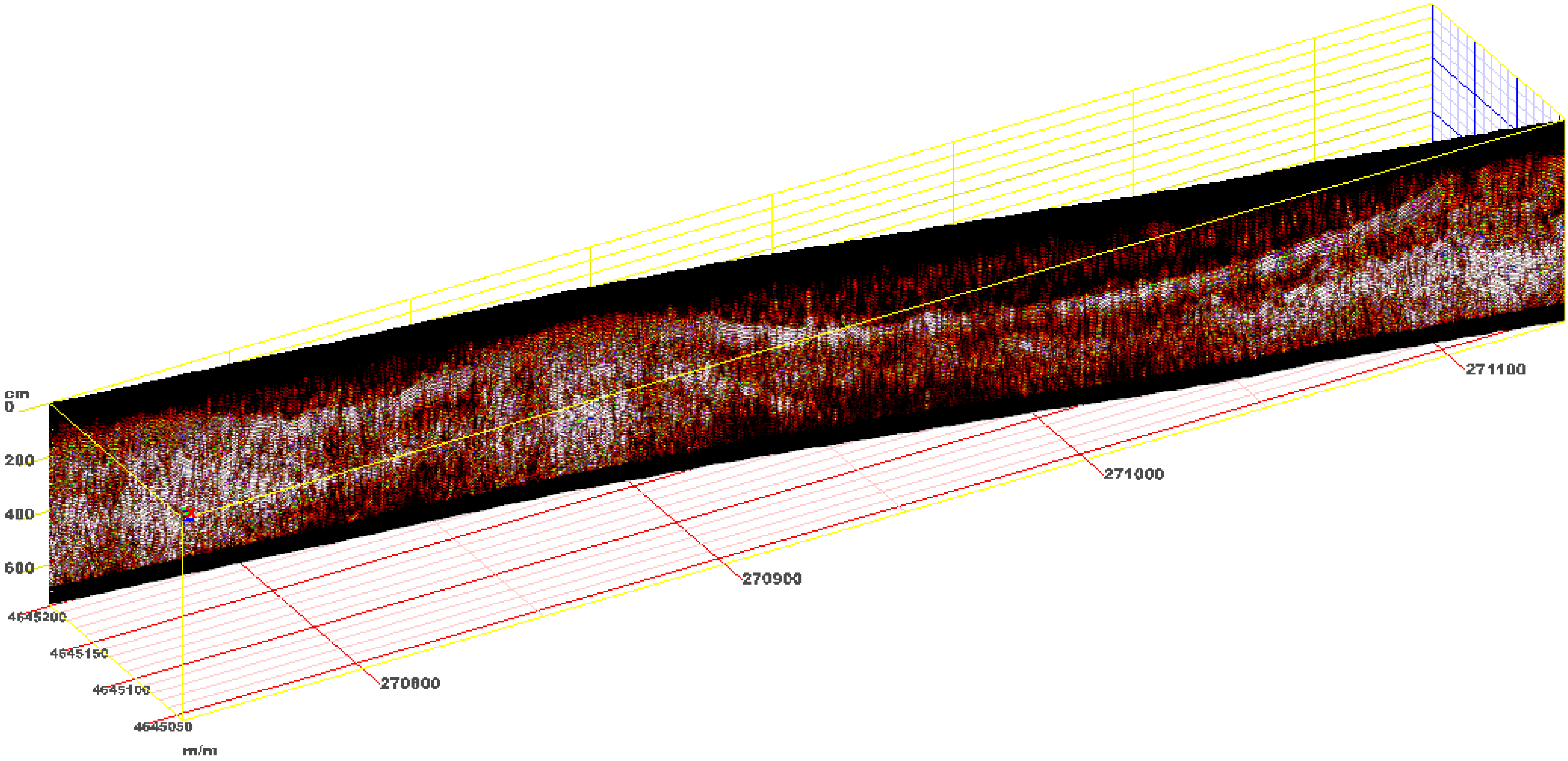




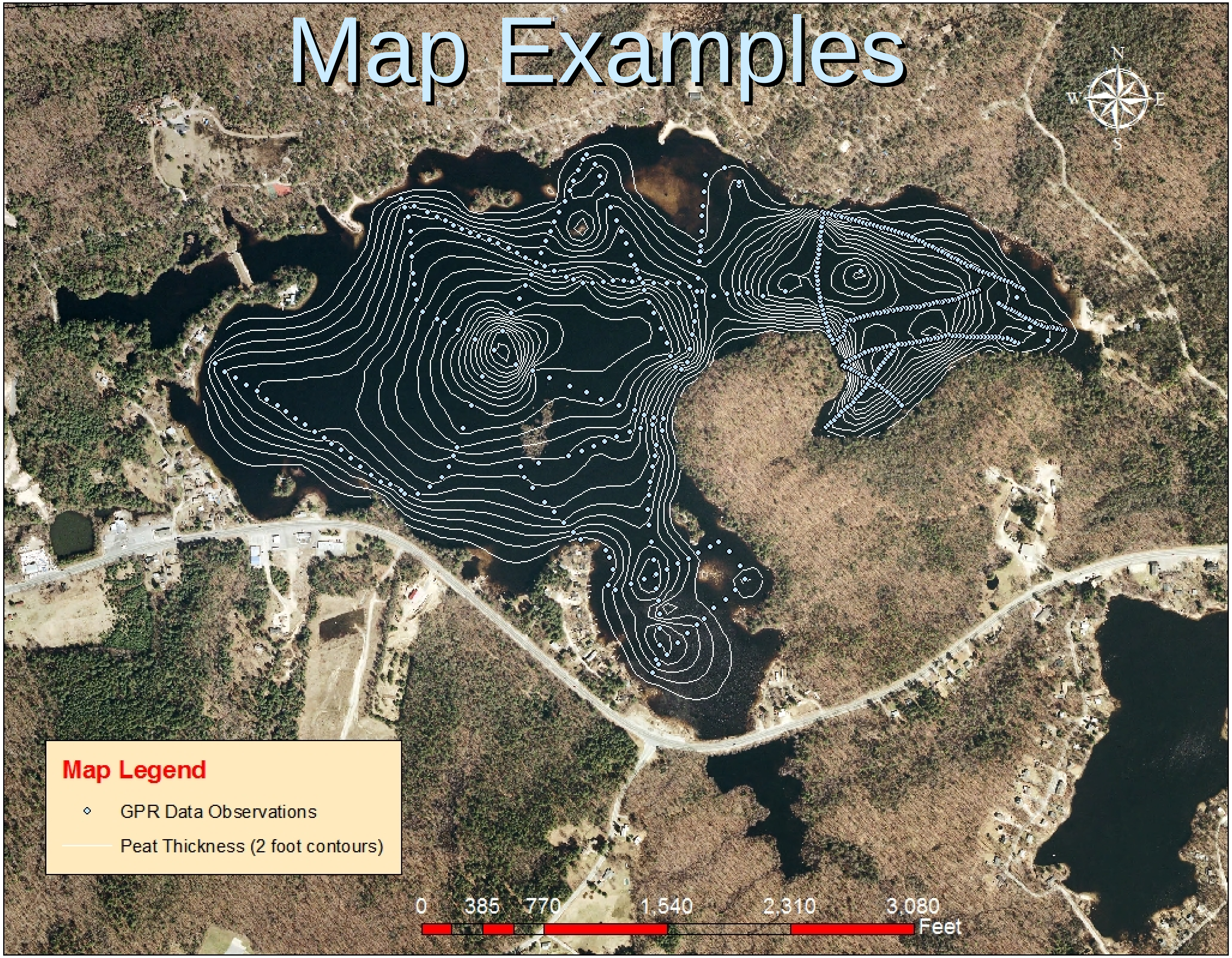
On Bowdish Pond

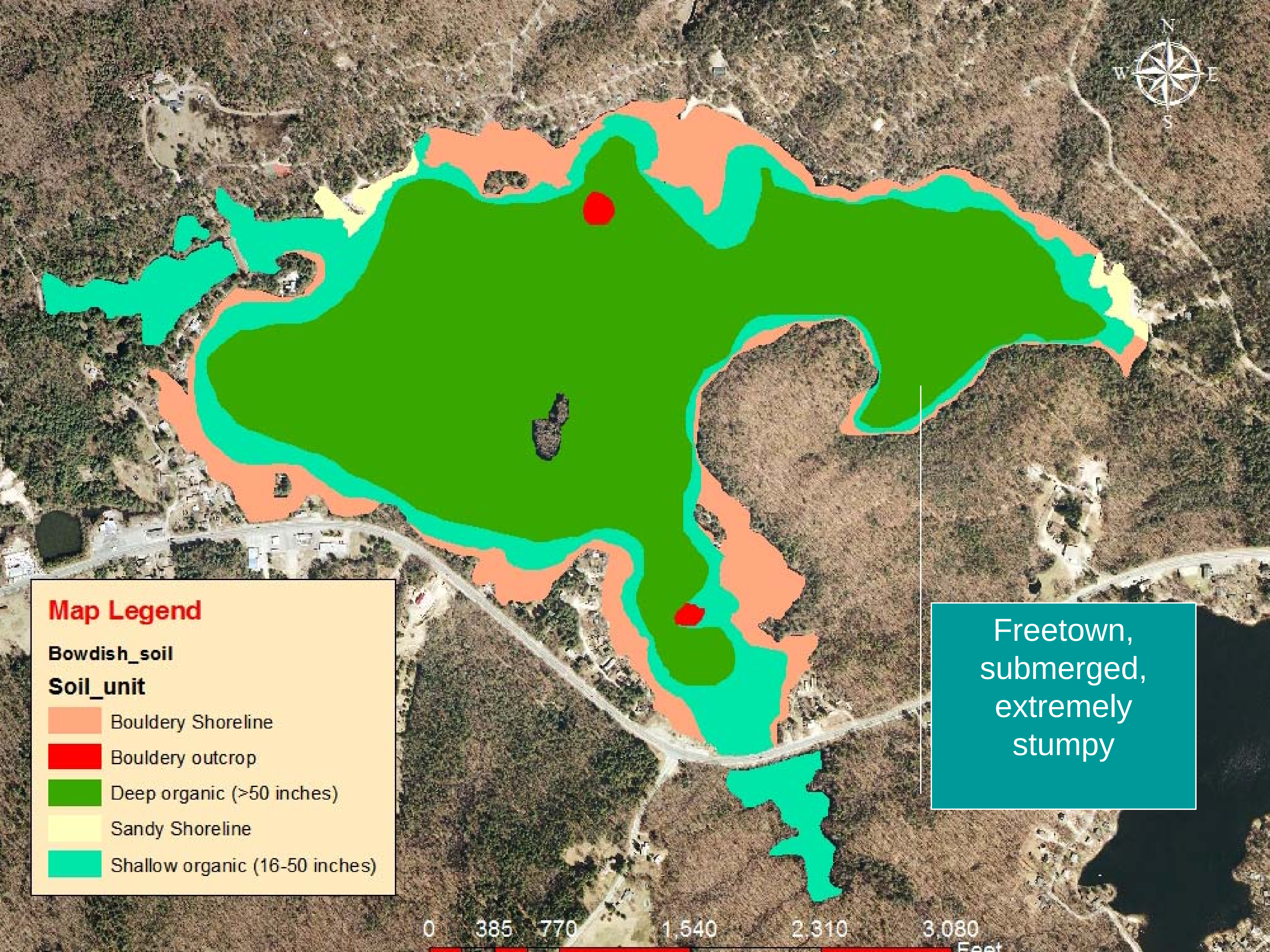
- 250 acre pond in NW RI.
- NRCS partnering with DEM for Invasive Study on Ponds (EQIP).
- Need baseline bathy and soil mapping – no data.
- Used GPR to profile pond in winter 09.
- Bathy being collected now.

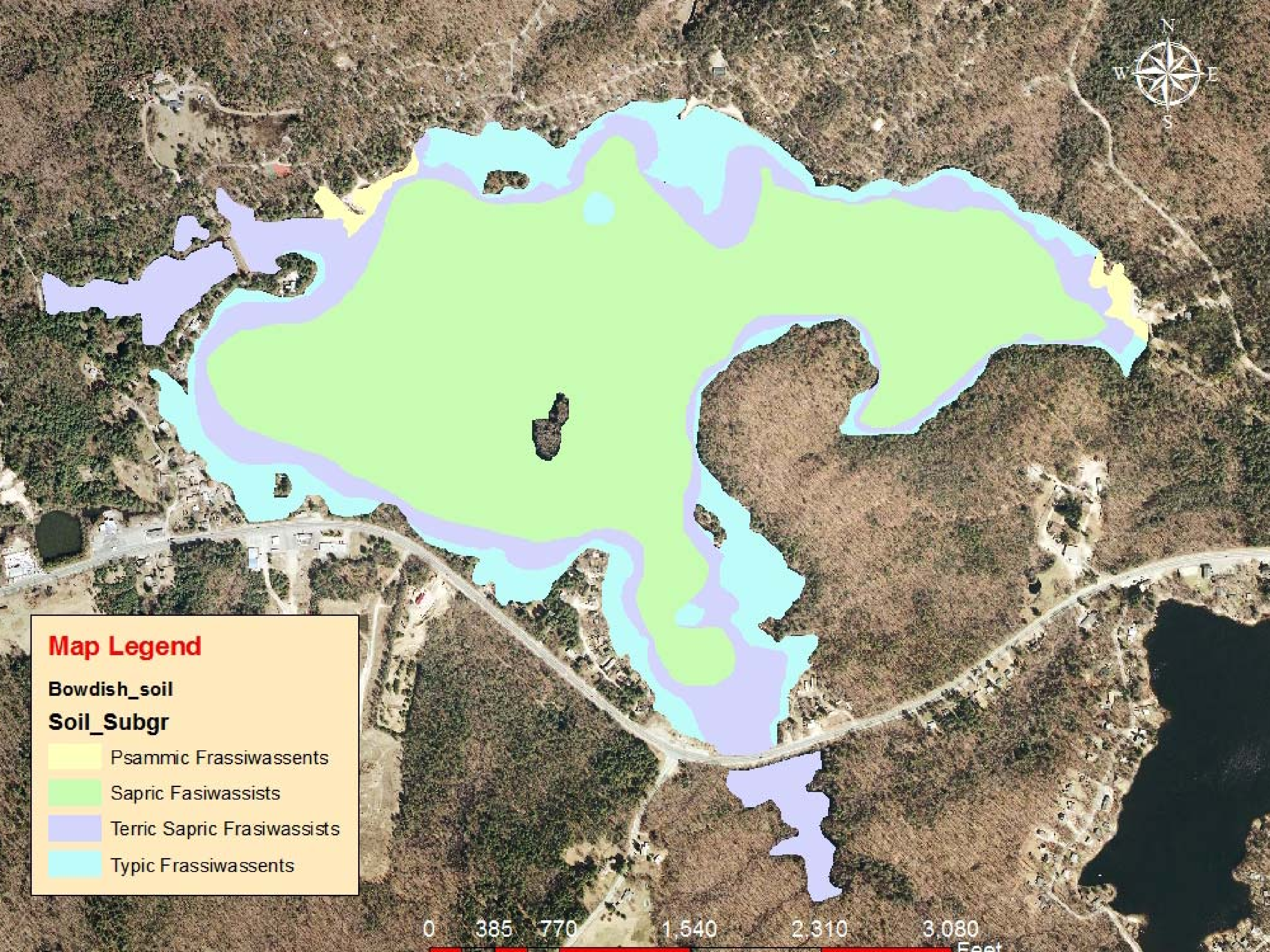
GPR / GPS Interface – Google Earth



Map Examples




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)
0
385
770
1,540
2,310
3,080
Feet
Freetown, submerged, extremely stumpy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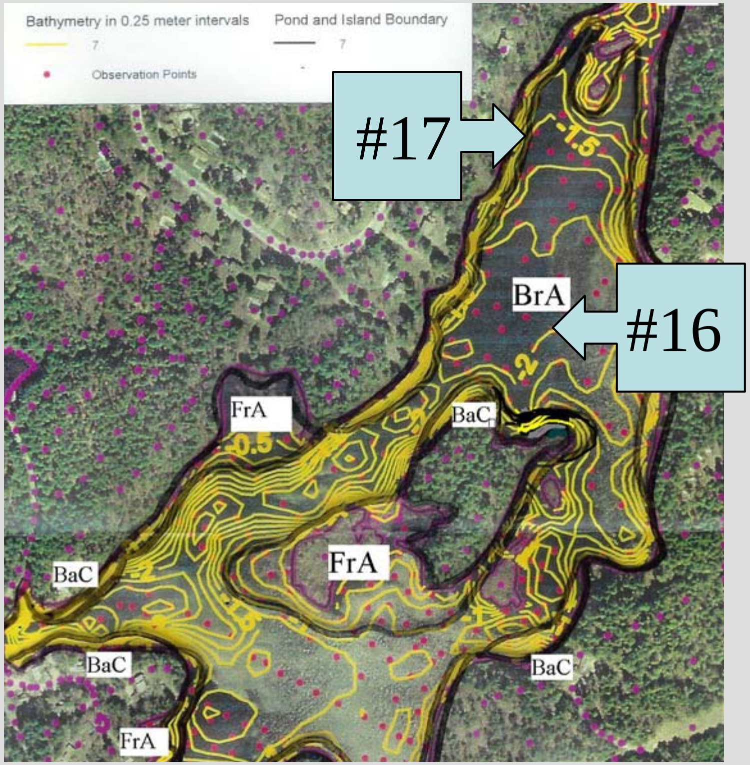
Map Legend
Bowdish_soil
Soil_Subgr
Psammic Frassiwassents
Sapric Fasiwassists
Terric Sapric Frasiwassists
Typic Frassiwassents
0
385
770
1,540
2,310
3,080
Feet

Submerged #18

Mapped As Fresh (FrA)

Terrestrial #19

Mapped as Carver (252)



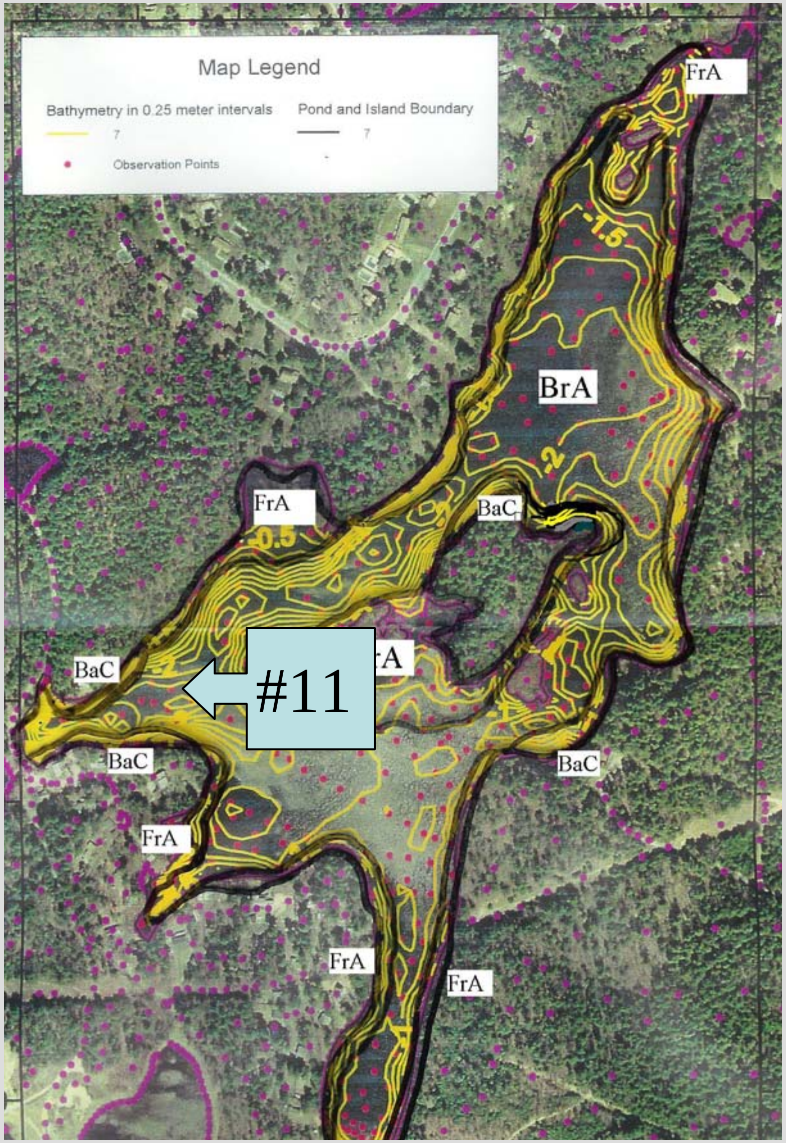
16 Fluvaquent Halposaprist

#17 Typic Haplosaprist

#16 #17

Sample 16

Oa 0-15
C 15-17
Oe 17-23
Oa2 23-30
C2 30-34
Oe2 34-36
C3 36-38
2C 38-44
2Oa 44-125
2Oa2 125-135

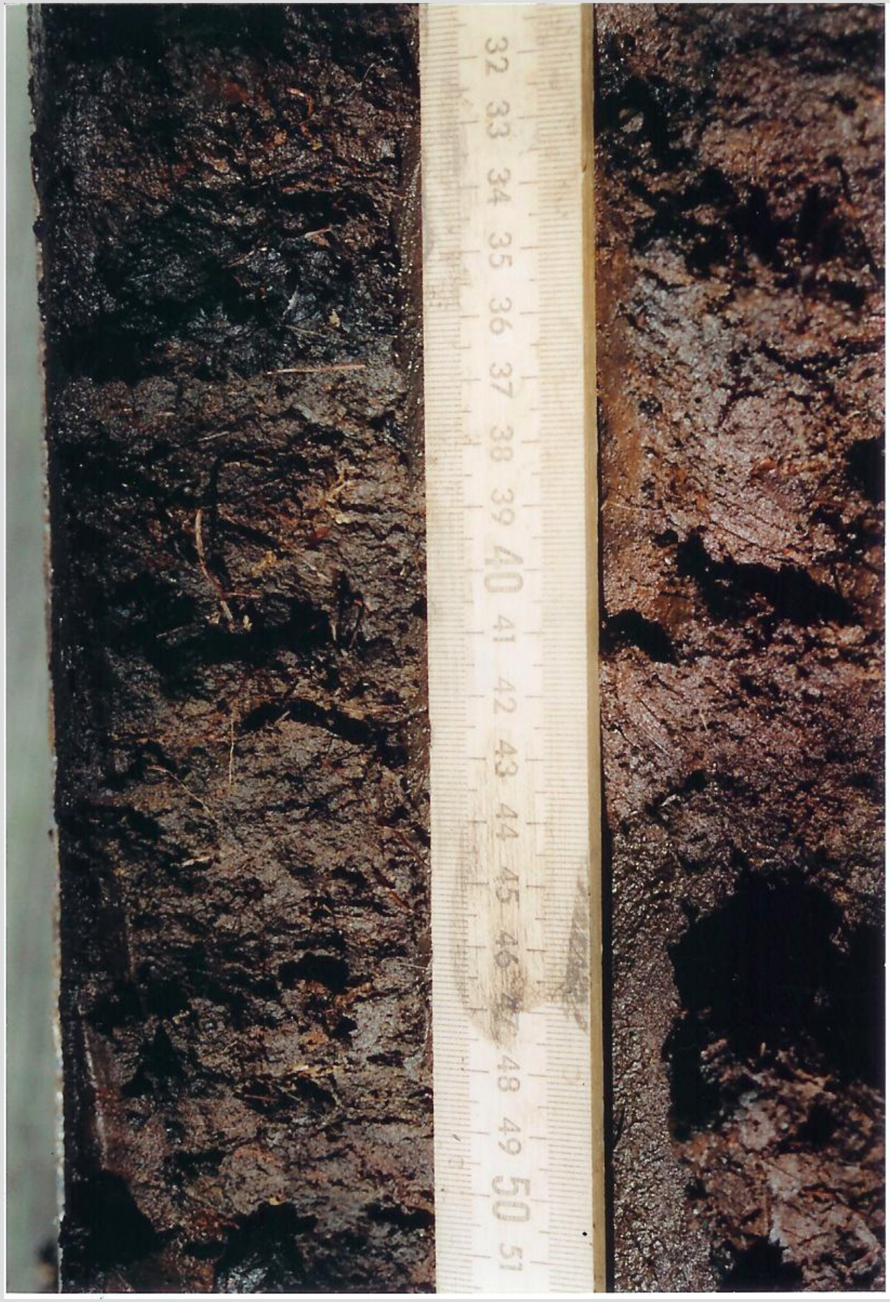


#11

Typic Haplosaprist

Organic
Staining
At 80 cm

Burrage Pond Organic Deposits



Using Ground-Penetrating Radar (GPR) for collecting subaqueous soil data in fresh-water environments (Frasiwassents and Frasiwassists).

Background: GPR technology has been used for soil survey inventory since 1978. It is the premiere geophysical tool for providing high-resolution imagery of subsurface features and has many applications to soils survey. Information about GPR can be found at: http://nesoil.com/gpr/. One of the current uses of GPR is to provide bathymetric and subsurface information for subaqueous fresh water soils (sorry GPR does not work in saline subaqueous soils). New GPR units have the advantage of interfacing the data output with a GPS so maps of interfaces can be easily incorporated to a GIS or displayed on internet mapping products such as Google Earth.

Survey Procedure: Where applicable, the best time to conduct GPR surveys on water bodies is during winter months while the ponds are frozen. This makes transecting and ground-truthing much easier and typically gives a better image. In areas where this is not possible the GPR is typically towed in a rubber raft behind a boat.

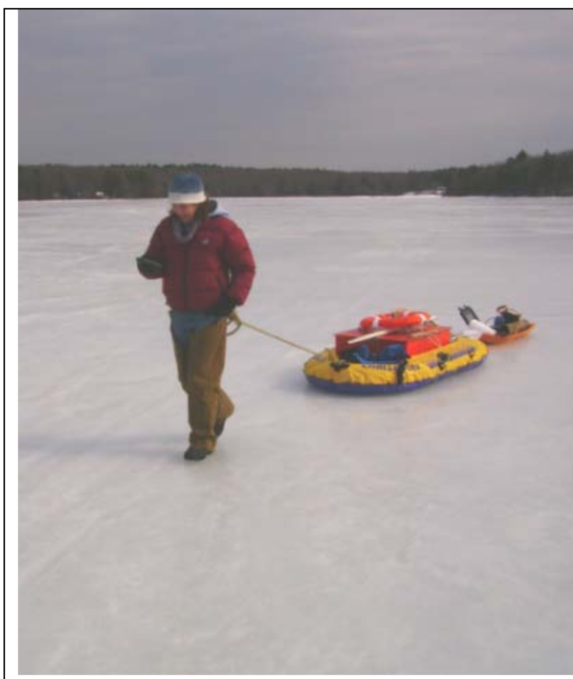
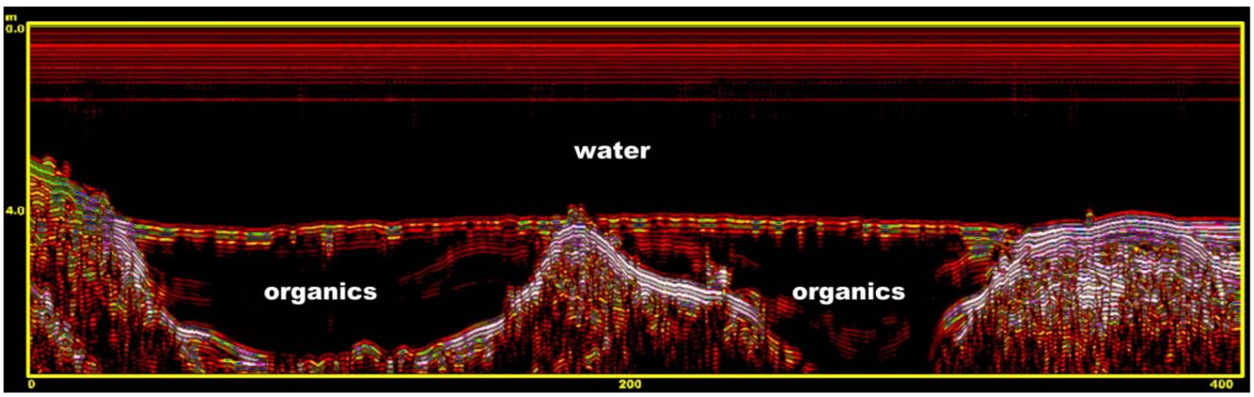


Photo left: GPR survey on ice – Bowdish Reservoir.
Photo top: GPR survey on water – Burrage Pond.

Radar Data: Depth of penetration for the GPR is limited by several factors including salinity, pH, conductivity, antenna frequency, and type of subsurface material. In New England depth of penetration through the water column is between 20 and 30 feet using a 120 MHz antenna.

The radar typically is capable of displaying the depth to the water/soil interface (bathymetry) and provides information about the soils below the interface. In many low-energy areas the soils are organic material (Frasiwassists) and the GPR is excellent for providing information on the thickness of the organic material. Uses of this data have been for determining volume of "soft sediment" in ponds for dredging calculations. This data is also useful for carbon sink estimations, for example the GPR survey of the 250 ac Bowdish Reservoir determined peat thickness to be 45 feet in some areas and most of the pond was greater than 10 feet of peat. The volume of this basin was estimated at 84,000,000 cubic feet. The GPR can also provide information about the subsurface of mineral soils (Frasiwassents) also, such as if the material is stratified, till, or bedrock along with the bottom type – bouldery, stumpy, etc.



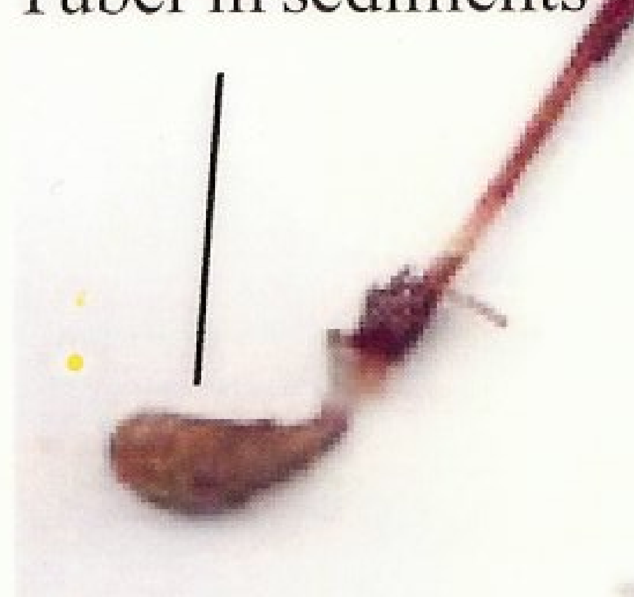
Example of a radar profile across Tucker Pond.

Hydrilla Look-Alikes

These plants all look very much alike. If you see anything that looks like the plants below, always contact NH DES for positive identification.
If you see these please call DES at 603-271-2248 or mail specimens to Limnology Center, NH DES, 6 Hazen Drive PO Box 95, Concord, NH 03302-0095

Hydrilla- EXOTIC
Hydrilla verticillata

Tuber in sediments



Leaves in 3s or 5s whorled around stem with curling tips, very toothed or serrated on edges

Brazilian elodea- EXOTIC
Egeria densa

Leaves in 4s or 8s whorled around stem with broader leaves, slighty toothed at edges

Waterweed- NATIVE
Elodea nuttalii

Leaves in 3s whorled around stem with narrow leaves, no teeth on margins of leaf

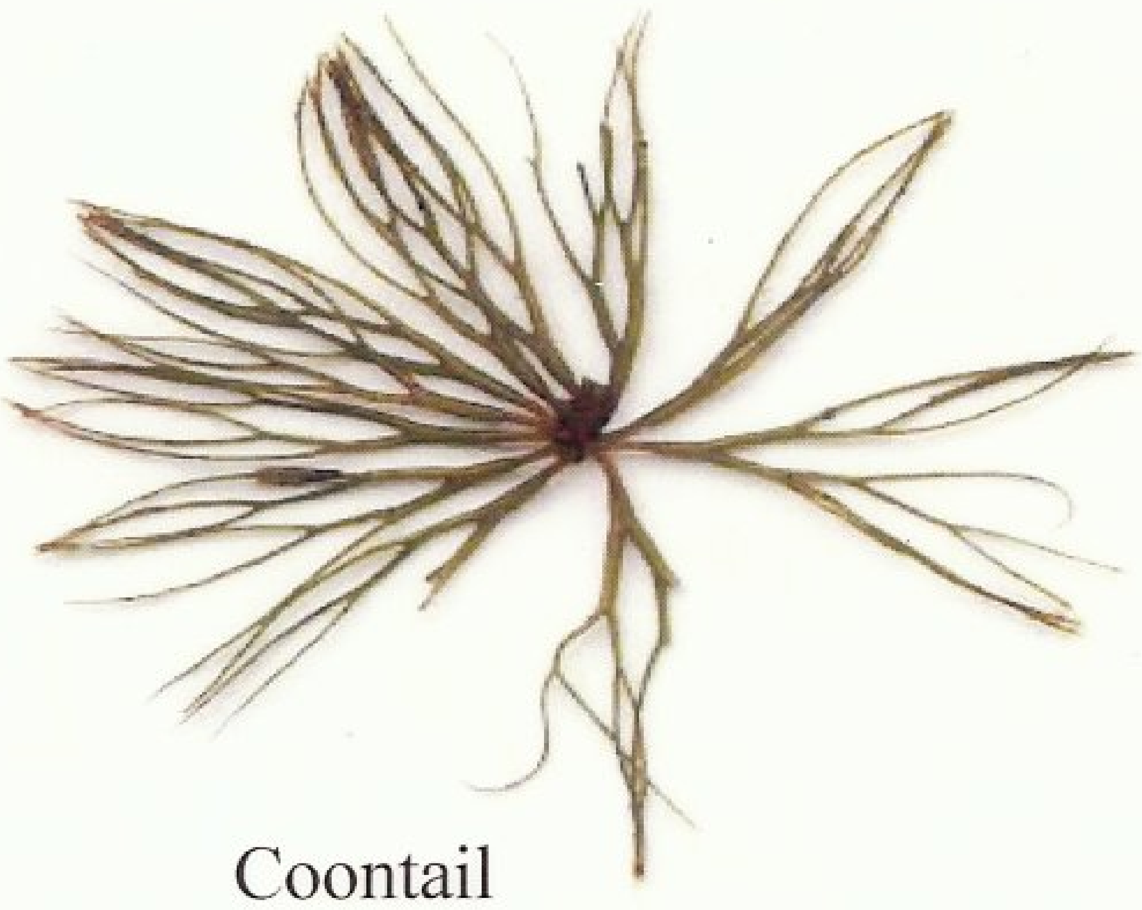
Waterweed- NATIVE
Elodea canadensis

Leaves in 3s whorled around stem with broader leaves, no teeth on margins of leaf

Look-alike Native and Exotic Aquatic Plants

Look-Alike Submerged Plants with Feathery Leaves

Fanwort
Cabomba caroliniana
EXOTIC!



Coontail
Ceratophyllum
Native

Eurasian milfoil
Myriophyllum spicatum
EXOTIC!

Bladderwort
Utricularia
Native

Variable milfoil
Myriophyllum heterophyllum
EXOTIC!

Waterweed
Elodea
Native

Native milfoil
Myriophyllum humile
Native

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
60 Quaker Lane, Suite 46
Warwick, Rhode Island 02886

Phone: 401.828.1300
Fax: 401.828.0433

NRCS partners with Save The Bay and the University of Rhode Island to restore Eelgrass Habitats

With funding through the Wildlife Habitat Incentive Program, Natural Resources Conservation Service (NRCS), Save The Bay, and the University of Rhode Island-Graduate School of Oceanography (URI GSO) began a week-long effort of transplanting and seeding thousands of eelgrass *(Zostera marina*) plants in Narragansett Bay. One acre of eelgrass beds were restored during this effort. The project is using recent advances in underwater seeding and whole plant transplanting techniques. Eelgrass is an under water marine flowering plant or "seagrass" and provides important ecological services to bays and coasts worldwide. Eelgrass beds are a primary source of food and shelter for many types of marine life, including economically important finfish and shellfish species, such as the bay scallop. The restoration conducted at Fogland Point and Poplar Point builds on the work completed earlier this year and will incorporate recent advances in eelgrass seeding techniques. The eelgrass beds that have been restored are now full of life with creatures such as seahorses, flounders, tautog, crabs and many types of bait fish

Tying eelgrass to TERF frame

Eelgrass seeding sled is connected to the pump and seed/gel reservoir by a reinforced tube.

As part of this federal, state and local partnership, the team will be using URI GSO's innovative creation, an eelgrass seeding machine, to sow hundreds of thousands of eelgrass seeds under water. The seeding machine acts as an underwater planting device where seeds are injected in a nutritive gelatinous matrix, pumped into the tines of the planting sled and injected just below the sediment surface. The seeding machine uses the same technology the food industry employs to inject jelly into donuts. Additionally, whole eelgrass plants, collected from a designated donor site, are also being planted within the restoration area using the TERF tm (Transplanting Eelgrass Remotely with Frames) methodology. This approach allows eelgrass shoots to be tied directly to weighted lobster pot modified frames. Eelgrass shoots are gingerly 7tied to TERF tm frames with dissolvable crepe paper and are then deployed by divers. Weeks later, the TERF tm frames are removed once shoots have rooted into the sediment.

Eelgrass habitat is vitally important to the Rhode Island economy due to its role in supporting fish, shellfish, and other wildlife. The tragic loss of eelgrass over the past century demands that we work together to restore this important species. NRCS is proud to support this unique partnership of volunteers, marine scientists and local citizens.

Best estimates indicate that the majority of historic eelgrass beds in Narragansett Bay are gone today. Only 100 acres of eelgrass remain. Hundreds of acres of Narragansett Bay could once again support eelgrass habitat following full-scale transplanting activities and water quality restoration.

TERF frame (100 plants) deployed during the Eelgrass Restoration Project

Vibracoring 101

Introduction:

Just as in terrestrial soils, different subaqueous soil types require different sampling tools. The McCauley peat corer is the preferred tool for description and characterization in highly fluid (high n-value) and organic soil materials. Samples collected with a peat sampler, however, are often small (half cores with a 3 cm diameter). It may be necessary to take multiple adjacent samples for characterization purposes if a McCauley peat sampler is employed because materials with a high n-value often has a small dry mass. High n-value materials can also be collected in a core barrel using a piston sampler. This type of sampler is an open tube or core barrel with a rubber plug inside the barrel that rises up as the barrel is pushed into the soil. The plug maintains a short, nearly air-tight space just above the sample to minimize disturbance, while the suction minimizes compaction.

Bucket augers are used for collecting field note descriptions, transects, and field mapping in areas of non-fluid soils (sandy to gravelly areas) and for locating areas for collecting full vibra-core samples. Using a bucket auger in shallow water can be extremely labor intensive and is generally limited to coring to approximately 50 to 70 cm, below this depth suction makes retrieving the sample difficult.

For both of the traditional hand tools above it is useful to have multiple extensions available for the various water depths. The best type to use are the augers that have the "quick release" system rather than the threaded screw systems as these become difficult to add extensions and often freeze up with rust. If available stainless augers will last longer but are more expensive. A 4 inch diameter regular bucket auger works best but having several auger types is also helpful along with a dutch auger. For the McCauley a 50 cm length blade works well but a 1 m blade, while a lot heavier, will cut the number of samples needed in half. Another useful tool is to have two rubber rings on each extension (a garden hose gasket works fine). These are used to slide to the water level to mark your current depth, this will help determine you next sampling interval for a complete sample.

Vibracoring:

Vibracore sampling is the most effective approach to obtain minimally disturbed samples of less fluid material for detailed description and sampling of typical pedons. A vibracore rig consists of an engine (minimum 5.5 hp, best is 8 hp), a cable, and vibrating head (2.5 in or bigger). The engine creates a high frequency, low amplitude vibration. The vibration is transferred through a cable to the vibracore head that is bolted to the top of core barrel or tube. These vibrators are made for vibrating concrete for removing bubbles before setting. The vibration essentially liquefies the soil materials, enabling the core barrel to penetrate into the soil materials.

Core barrels are generally made out of 7.5 to 10 cm inside diameter aluminum pipe (irrigation pipe). Some barrels are made out of polycarbonate (these are clear and light, but also 6 to 7 times more expensive than aluminum). Core barrel lengths should be as long as the soil to be sampled, plus water depth, and an extra 50 or 60 cm. Sources of core barrels may be found from irrigation supply companies, another potential source is to talk with your NRCS planners and engineers to see if they know of farms that have them stockpiled and available to buy. Many farms are switching from aluminum to plastic irrigation and are looking to scrap their old tubes. Prices for new tubes runs $2-3/foot, best o buy in 30 foot sections and cut in half for use.

The vibracore head is bolted to the core using either heavy-duty U-bolts or a custom welded fitting. The attachment must be very secure, as the vibration tends to loosen bolts and cause slippage if not properly tightened. Vibracore heads are usually custom made by a fabricator, depending on the boat platform you will either need to have a head that runs parallel to the core (if moon-pool space is limited) or perpendicular if you have more space, the later setup appears to create the strongest vibrations and works best. If no head is available attaching the head directly to the barrel using u-clamps works but often comes loose and dents the barrel.

Step by Step Procedure:

Step 1: Preparation - Define the area to be cored, select the best location for the map unit, determine proper tide conditions (outgoing or low tide for deep areas, high tide for shallows). A checklist of equipment needed for the coring day is highly recommended; forgetting one piece of equipment can cause delays. Extra equipment and tools should be brought along as dropping stuff overboard is inevitable. A heavy duty magnet is good to have onboard along with diving equipment in case equipment is dropped overboard.

Step 2: Secure Vessel – Once you are at the site to be cored you must get the coring vessel secured so it will not move. There are several ways to keep the boat from drifting around; first is to have the boat face the wind or flowing water direction. Two bow anchors are needed to be dropped in a Y-pattern and a stern anchor set. Keeping the engine in reverse also works well if no stern anchor is available. Other options are to use steel rods drilled into the soil from the bow and stern or have a person in the water holding the boat still.

Step 3: Core Preparation – Once the vessel is secure mark the waypoint location with a GPS and determine the water elevation (depth) with a survey rod. The core should then be cut to the proper length to allow the proper amount of soils to be sampled, an additional 5-7 feet of core barrel should be added for core settlement, tide changes, and to have some of the core above the water for retrieval. Once the core barrel is cut it should be measured and the total length noted on the core form.

Step 4: Coring – Once the core is attached to the core head and you are ready to begin the vital next step is SAFTEY. Anyone on board the vessel needs to have a hard hat, gloves, shoes (no open toes), and is paying attention to the coring operation. The core barrel and head are inserted into the moon pool and positioned straight. The engine operator then turns on the engine and the core is vibrated into the soil. In some cases the vibracoring may require weight to be applied to get through some soil layers. People may need to stand on the head and top of core or pull ropes down. If the core won't budge any deeper turn off the engine and note refusal on the log.

Step 5: Retrieving the Core - Once a core is vibrated into the soil to a satisfactory depth, the amount of soil compaction (referred to as "core rot") within the core is measured, this is done to be able to provide corrections for depths to layers and bulk density measurements. This is done by measuring the length from the top of the core barrel to the soil surface outside of the core as well as inside the core using a sinker attached to a rope. The difference in length is the amount of compaction or settling that occurred in the sample during vibracoring. See the log sheet at end of this document. Once these measurements are made it is time to pull the core. The core barrel is filled to the top with water and a cap is screwed to the top as tight as possible to create suction. Pulling the core out of the soil is done using either a chain-fall or a power winch, using a come-along is not recommended. Make sure your straps are strong enough to pull the cores out. Once the core is almost out of the soil a person with a bottom cap needs to be ready to quickly seal the bottom of the core as the final section is pulled onto the boat. Remove the vibracore head assembly.

Step 6: Completing the core – Once the core is on the deck of the boat and the bottom cap is duct taped shut, the core is ready to be cut. Place the weighted string into the core to determine the soil surface and mark that level on the core. Using a large pipe-cutter or hack saw cut the barrel a few inches above the soil surface – use caution when cutting the core, one person needs to grab the top section and one the bottom, gloves should be worn as the cores are very sharp. Once cut place something in the core to protect the surface (a "whacky noodle" works best) and attach the top cap and duct tape it shut. Using a sharpie label the core with the pedon ID, Waypoint, date, and an arrow indicating the surface. Cores are then stored upright on board the sampling vessel and then transferred to cold storage (4C). Cores are kept refrigerated until they can be opened and sampled.

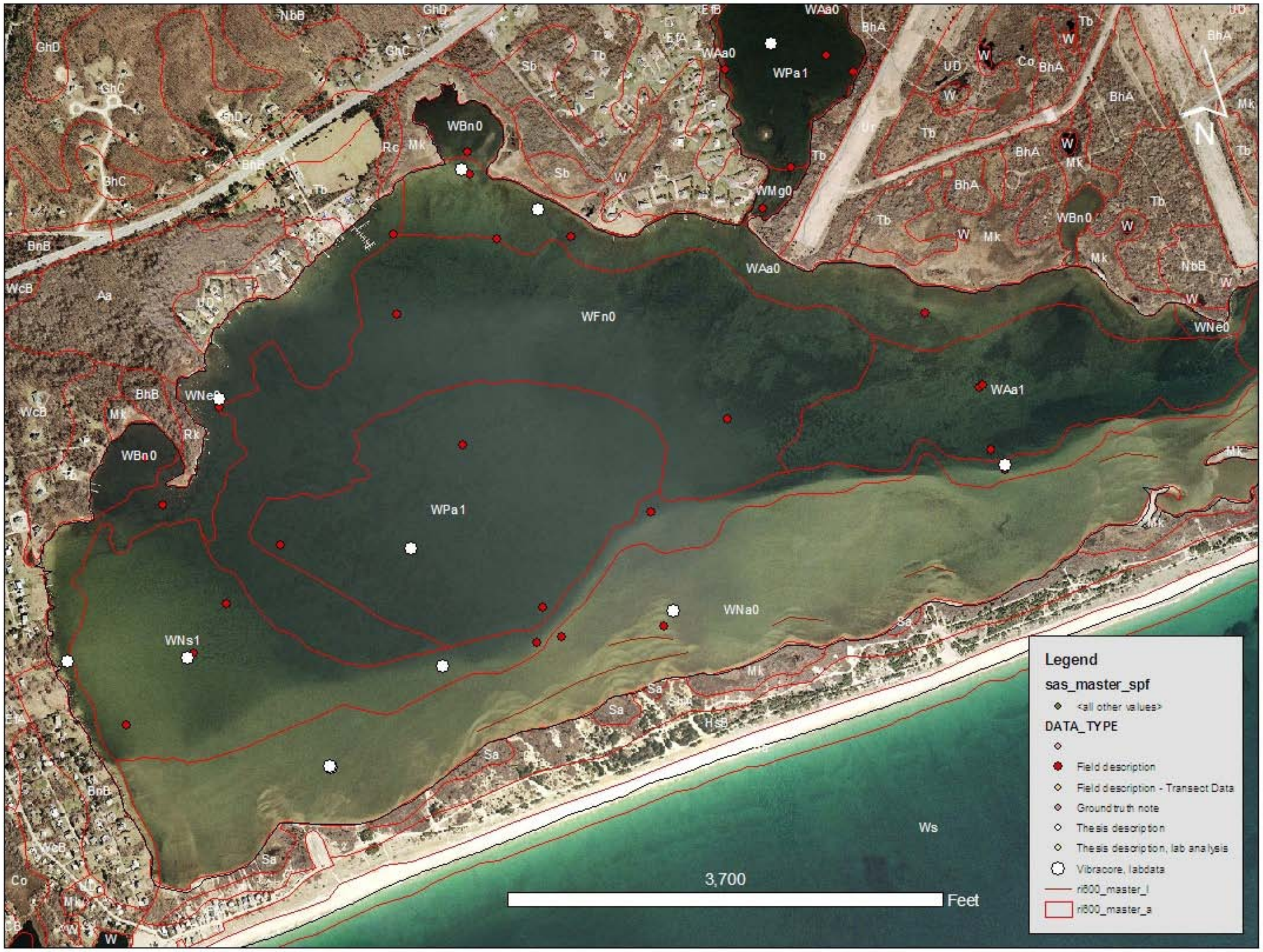
Tools/Sources:

5.5 HP. GAS VIBRATOR - 14 FT. SHAFT - 2-1/2" HEAD $2,500 (2007)
http://www.improvedconstructionmethods.com/dreyer_gasoline_concrete_vibrators.htm
Tripod (search rescue tripod in Internet) $1,290
Chain fall $250
Plastic caps for cores (EC-64?) http://www.caplugs.com

List of Equipment Used:

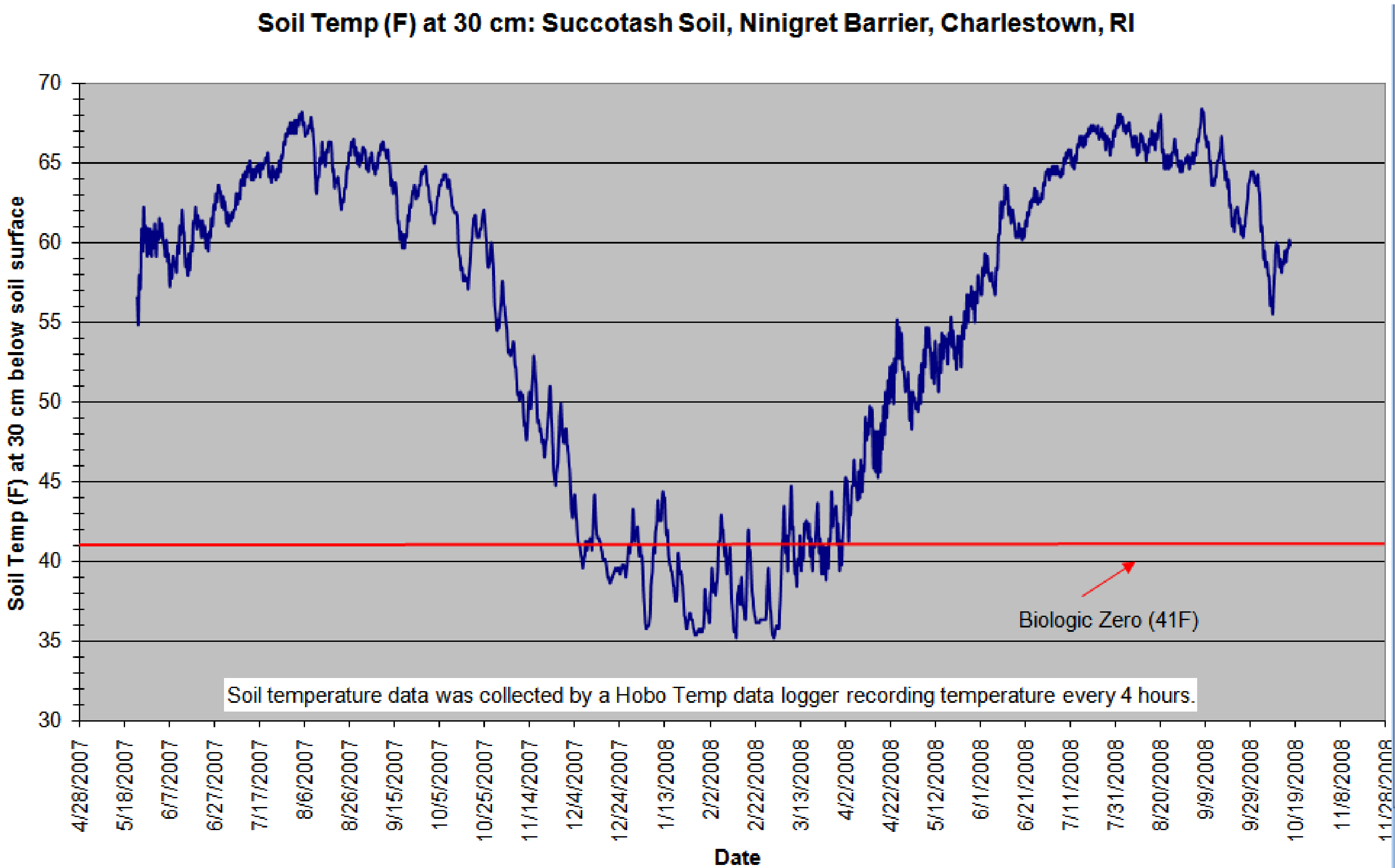
Engine and Shaft	Straps	Sharpie
Vibracore head	Core catcher	Duct Tape (lots)
Tripod	Bolts and nuts (spares)	Screw Cap
Chainfall \ Power Winch	Hard Hats	Core barrels
Bucket for water	Caps (two per core)	GPS
Survey Rod	Anchors (3)	First aid kits

Example of Vibracore Log Sheet:



WPa1
WBn0
WFn0
WNe0
WAa0
WAa1
WMg0
WNa0
WNs1
Ws
3,700
Feet
N
Legend
sas_master_spf
<all other values>
DATA_TYPE
Field description
Field description - Transect Data
Ground truth note
Thesis description
Thesis description, lab analysis
Vibracore, labdata
ri600_master_l
ri600_master_a


WNs1
Bedforms
N
Sa
WNa0
Sa
ShA
Sandyhook soils - VPD, tidal flooding
Succotash soils, MWD
Sa
Ba
Hooksan - ED soils on foredunes, formed in eolian and/or washover deposits.
Beaches, sandy
Ws
Fortress - MWD, HTM soils
830
Feet



Soil Temp (F) at 30 cm: Succotash Soil, Ninigret Barrier, Charlestown, RI
Soil Temp (F) at 30 cm below soil surface
70
65
60
55
50
45
40
35
30
Biologic Zero (41F)
Soil temperature data was collected by a Hobo Temp data logger recording temperature every 4 hours.
4/28/2007
5/18/2007
6/7/2007
6/27/2007
7/17/2007
8/6/2007
8/26/2007
9/15/2007
10/5/2007
10/25/2007
11/14/2007
12/4/2007
12/24/2007
1/13/2008
2/2/2008
2/22/2008
3/13/2008
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
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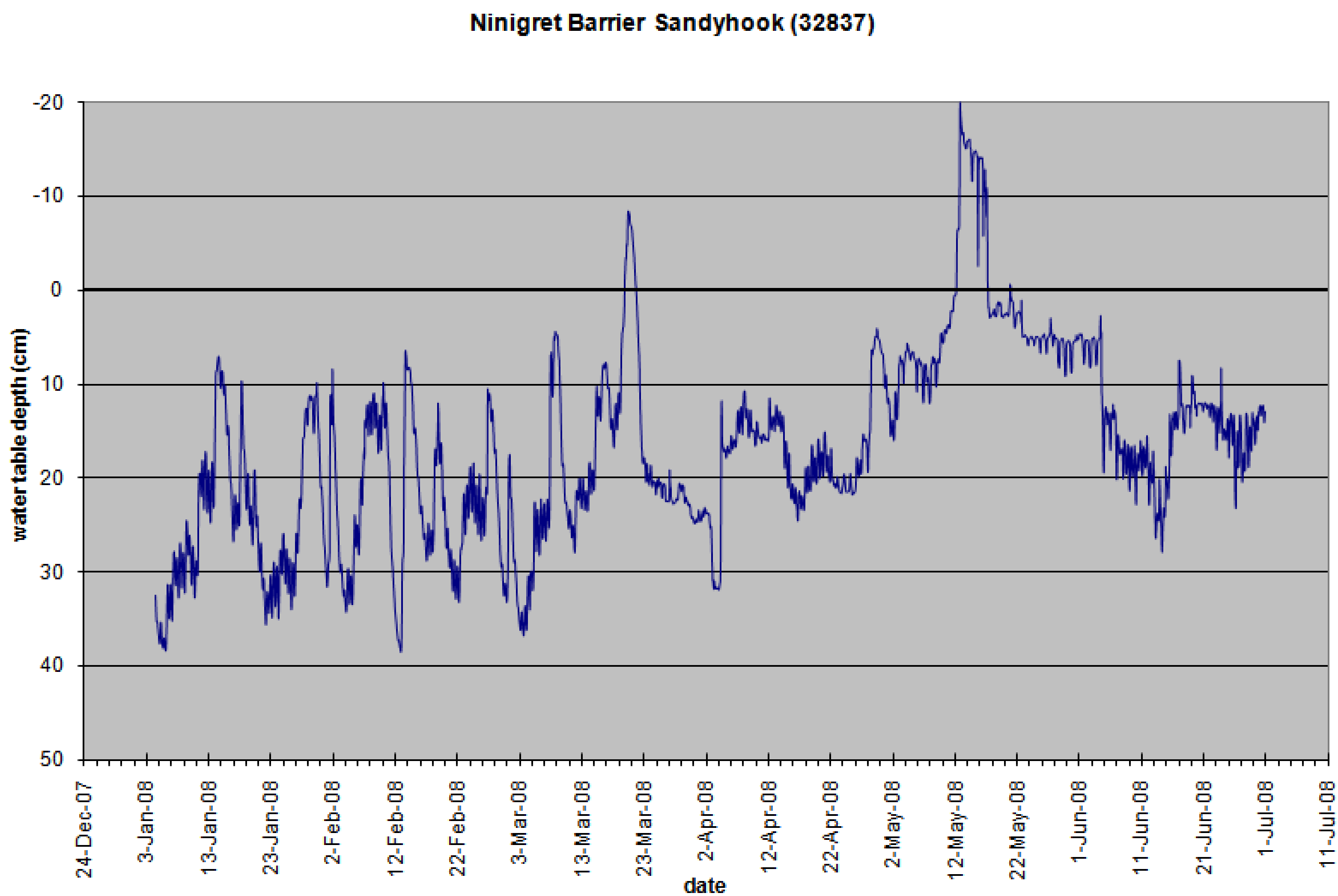
10/19/2008
11/8/2008
11/28/2008
Date


Ninigret Barrier Sandyhook (32837)
water table depth (cm)
-20
-10
0
10
20
30
40
50
24-Dec-07
3-Jan-08
13-Jan-08
23-Jan-08
2-Feb-08
12-Feb-08
22-Feb-08
3-Mar-08
13-Mar-08
23-Mar-08
2-Apr-08
12-Apr-08
22-Apr-08
2-May-08
12-May-08
22-May-08
1-Jun-08
11-Jun-08
21-Jun-08
1-Jul-08
11-Jul-08
date

Site Number:		Mapping Unit:		Description	
Date:		Location Description:			
Start Time:		Water Depth (ft/m):			
End Time:		Temp (F/C)			
Surveyors:		Bottom Type:			
Waypoint:		SAV cover:			
GPS		Observation Method:			
UTM Easting:		Site Notes:			
UTM Northing:					

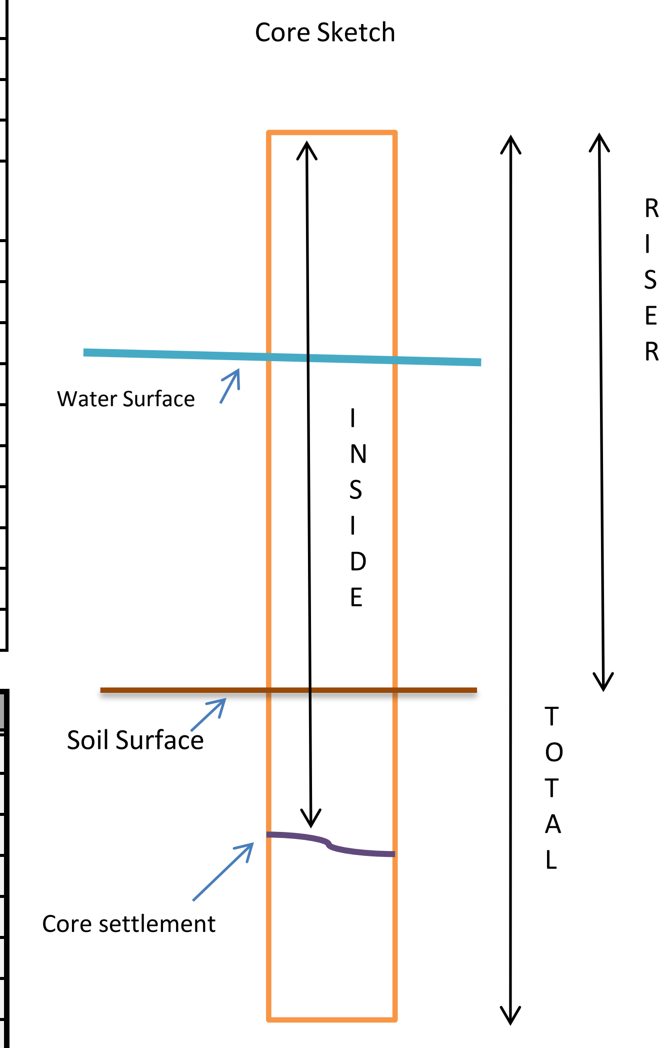
Water Column measurements:			
	Surface	Mid	Bottom
pH			
DO (mg/l)			
salinity (ppt)			
temp (F/C)			

Horizon	Depth (cm)	Boundary Dist.	Field Texture Class	fluidity (n-value)	Munsell Color (Matrix)	Coarse frags (%)	Shell frags (%)	H_2S odor	Peroxide Color change	Notes	Origin

Notes:

Vibracore Log Sheet

Site		
Pedon ID (YYYYSIFIPS###)		
Date/Time		
Series		
Map Unit		
Location		
Waypoint		
GPS		
Lat		
Lon		
UTM Easting		
UTM Northing		
UTM Zone	19	
Datum		
Water Depth (unit)		
Tide		



CORE LOG		
a) Total Core Length		Length before coring
b) Riser Length		After coring length of riser
c) Inside length		Sinker measurement
d) Measure core settlement		=c-b
Final core length		After core is completed
Where core is stored		
Date described		

NOTES:

Eelgrass Restoration in Narragansett Bay, RI

SAVE THE BAY®

NARRAGANSETT BAY

Marci Cole Ekberg
Wenley Ferguson

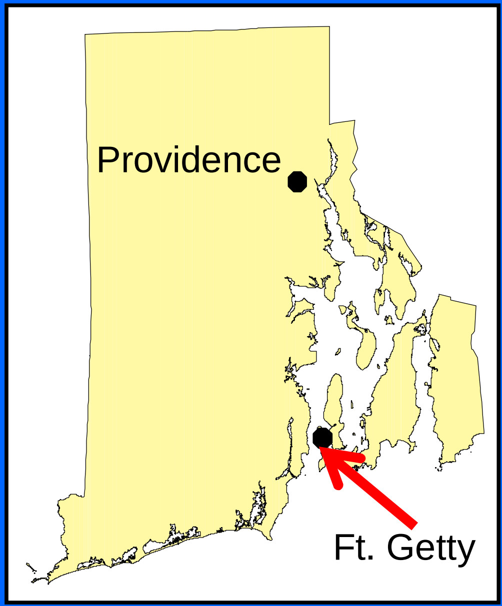
NRCS Natural Resources Conservation Service

NOAA

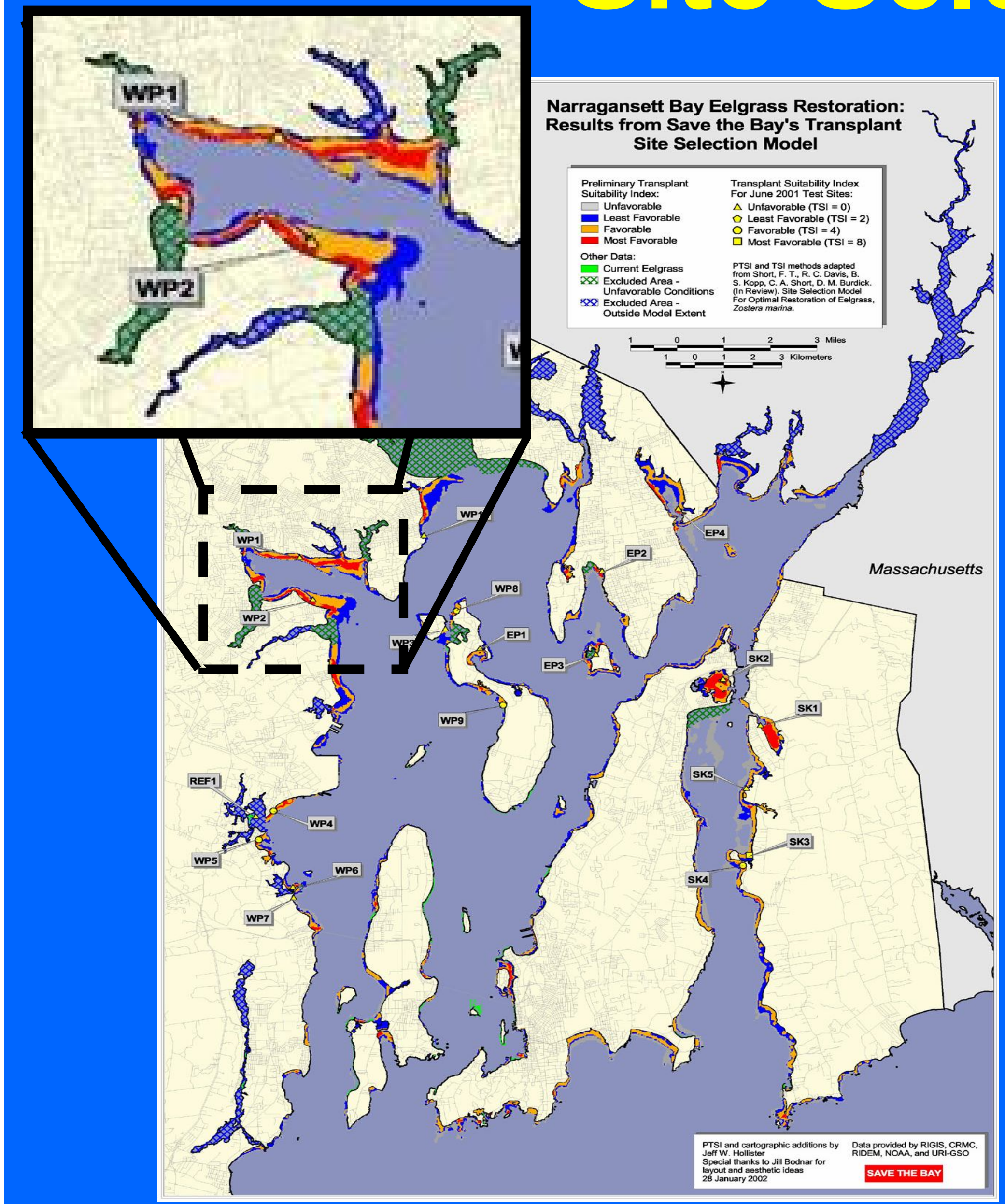
RESTORE AMERICA'S ESTUARIES

Background

- Save The Bay began bay-wide eelgrass restoration in 2001
- The first large-scale transplant was conducted in 2002 with 22,000 shoots
- Save The Bay planted approximately 110,000 shoots a year
- Techniques and use of volunteers have changed over the years to increase transplant survival and efficiency



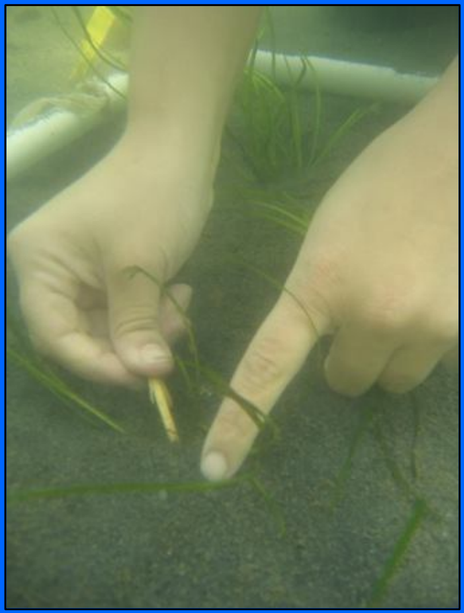
Site Selection



- Transplant Site Selection Model adopted from Short et al. 2002
- Model includes depth, light, temp, historic distribution
- Test-transplant follows site selection
- Successful test transplants (greater than 50% survival) are then scaled up

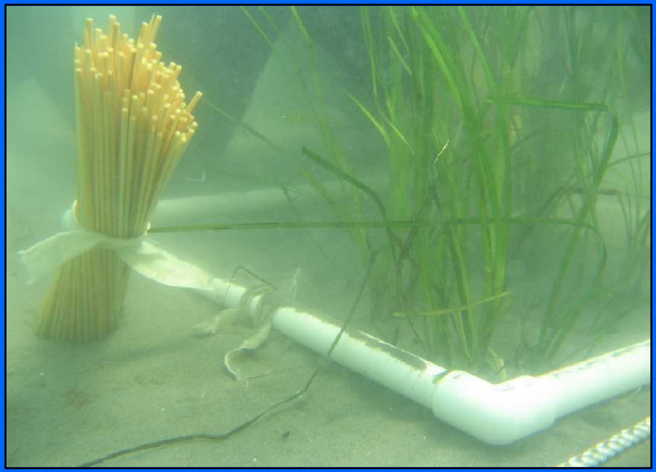
Harvest Methods

- Divers use trowels to remove eelgrass from sediment
- Kayakers transport catch-bags to shore
- Volunteers count and bundle eelgrass

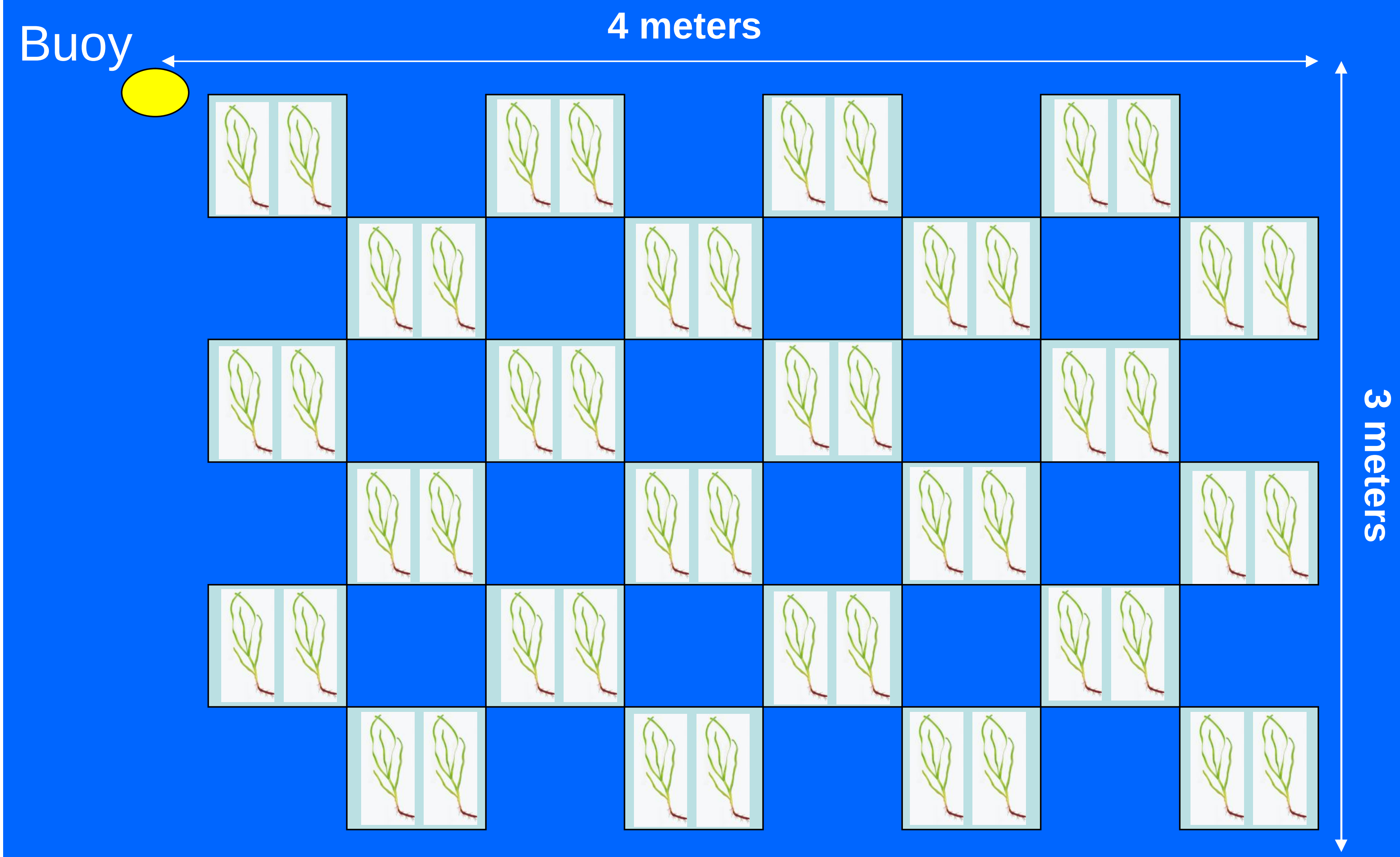


Hand Planting

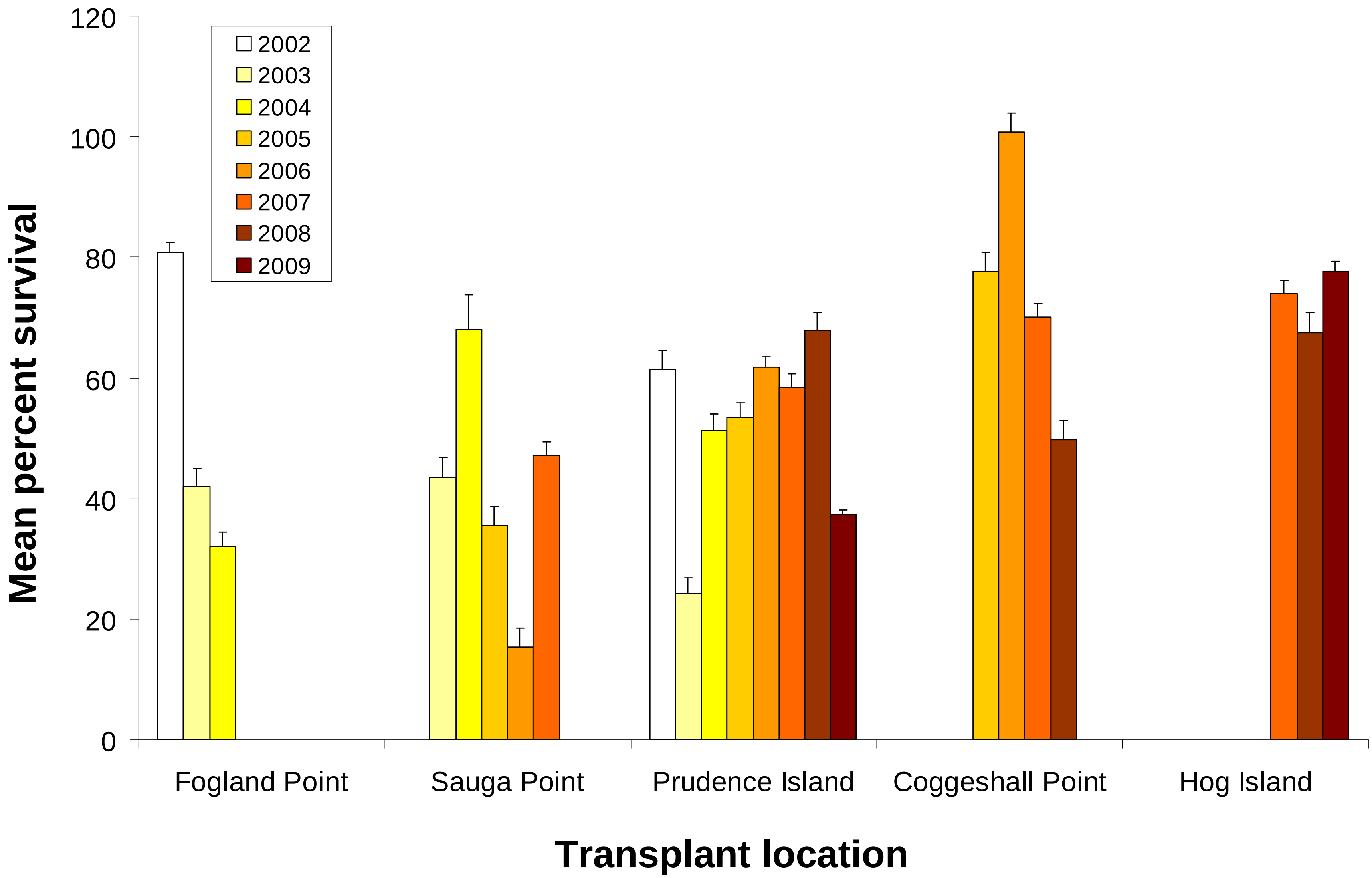
- Adapted from Horizontal Rhizome Method (Davis and Short, 1997)
- Method has been used since 2003
- Hand transplanting using soaked bamboo skewers as bio-staples
- 50 shoots planted within 0.25 m^2 quadrat



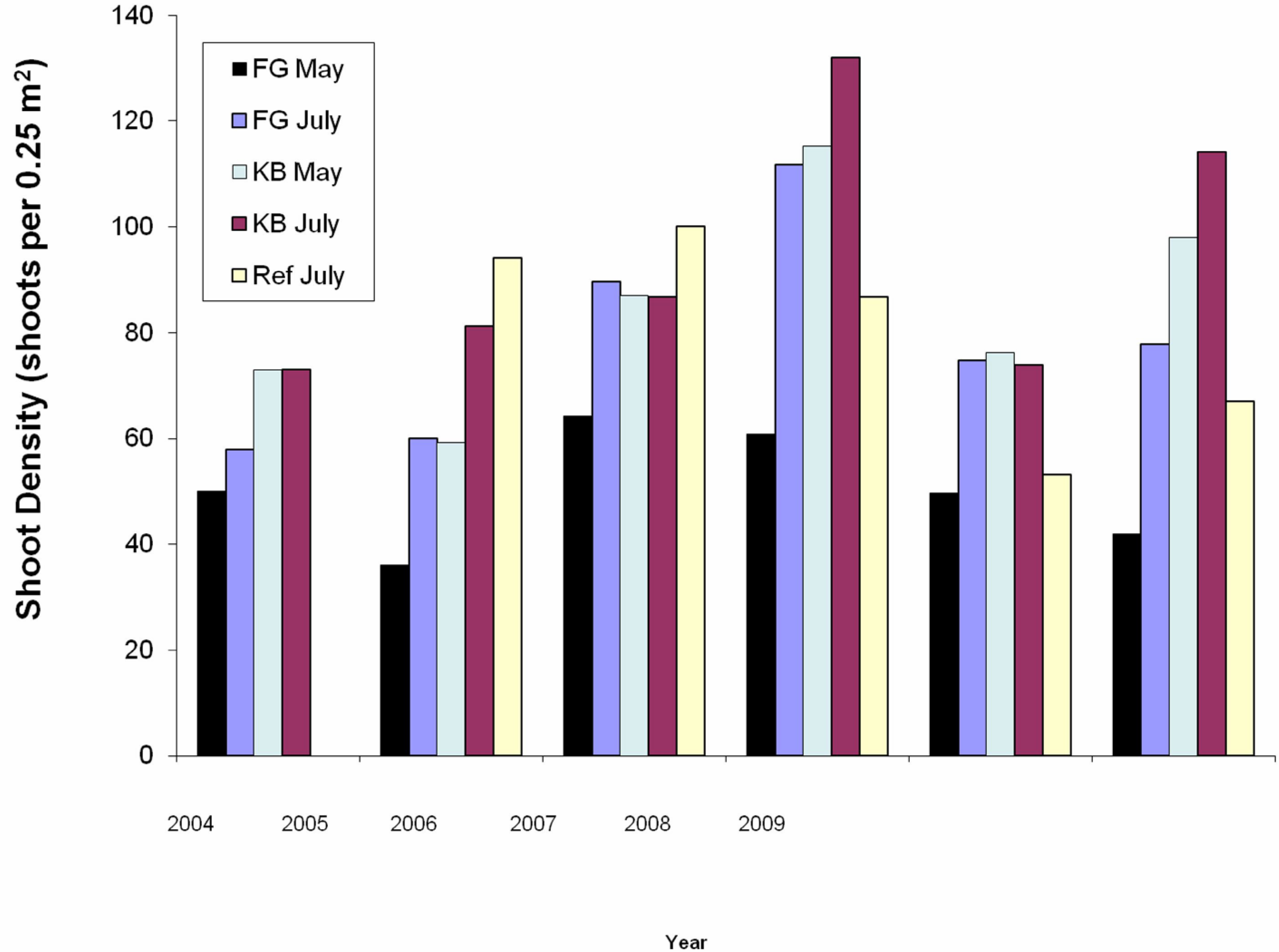
Checkerboard Pattern



- 24 Quadrats spaced Corner to Corner
- 1,200 shoot per checkerboard plot

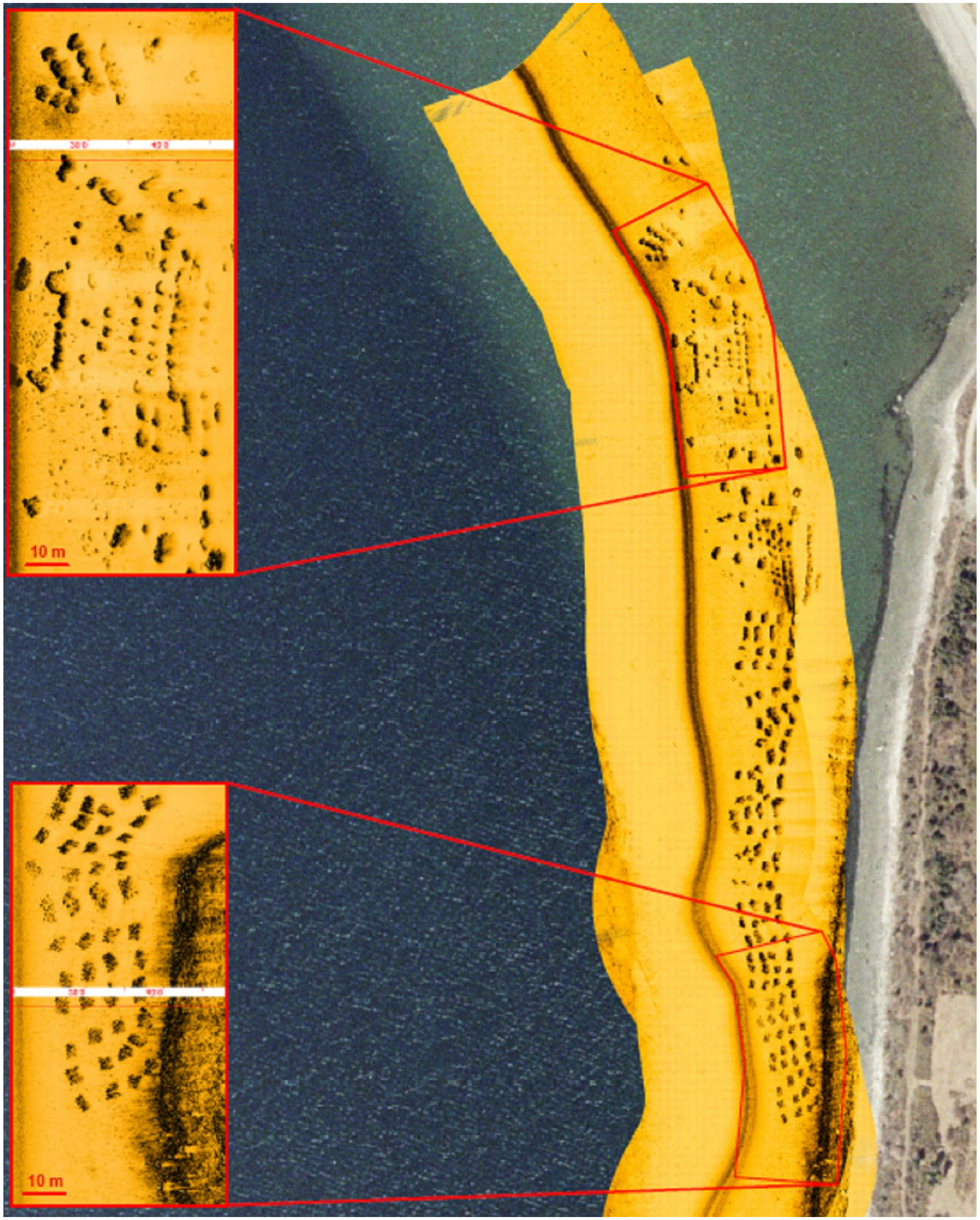


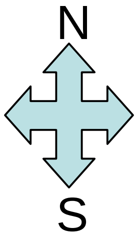
- High variability in shoot survival between growing seasons in the Bay
- Shoot survival varies between transplant sites
- Success of a site cannot be determined over one growing season



Shoot Density (shoots per 0.25 m²)
140
120
100
80
60
40
20
0
FG May
FG July
KB May
KB July
Ref July
2004
2005
2006
2007
2008
2009
Year

Prudence Island Transplants 2002-2009





SAV Mapping 2006

- Mapped eelgrass in Narragansett Bay and Block Island
- 10 years since previous effort
- Identified 466 total acres of eelgrass
- Funded by the Estuarine Reserves Division of NOAA, RI CRMC, NRCS, the NOAA Community-Based Restoration Program Partnership with Restore America's Estuaries, and the Town of New Shoreham
- Efforts underway to secure funding for another mapping effort in 2011, with goal to collect data every 5 yrs

Future of Eelgrass

- Continue test transplants to monitor changes in water quality and identify new sites for transplanting
- Conduct advocacy to reduce nitrogen loading to the Bay from point and non-point sources

Questions?