Soil Survey Investigations of Freshwater Subaqueous Soils

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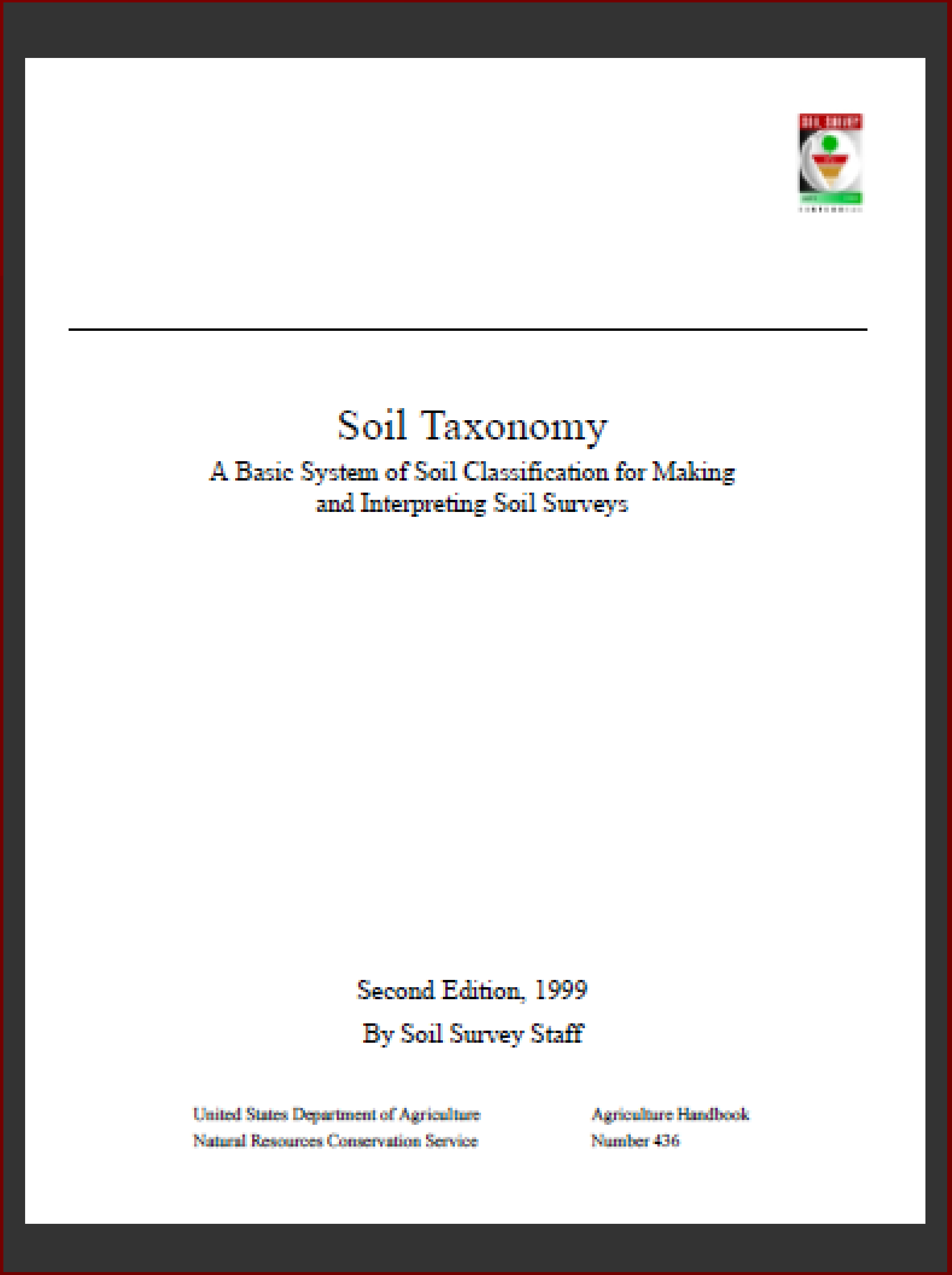
In the second edition of Soil Taxonomy, the definition of soil was changed to accommodate subaqueous soils.

This was done as resource scientists began to recognize the importance of these shallow-water soil resources for their habitats, structure, and associated ecosystem functions.



Soil Taxonomy

A Basic System of Soil Classification for Making and Interpreting Soil Surveys

Second Edition, 1999

By Soil Survey Staff

United States Department of Agriculture
Natural Resources Conservation Service

Agriculture Handbook
Number 436

Question: Why Study Freshwater Subaqueous Soils?

- growing need for a tool to manage shallow aquatic systems and resources at an ecosystem scale
- agencies trying to manage elevated nutrient levels and the trophic state of lakes
- issues related to sediment accumulation
- explosion in the population of invasive plant species
- environments should be managed to ensure long-term sustainability
- previous work mainly focused on coastal (estuarine) subaqueous soils

Requests for Technical Soil Services:

- sedimentation rates and volume of sediment for pond restoration
- engineering calculations for water volume in ponds
- geotechnical data
- contaminant levels
- flood plain restoration
- carbon accounting
- cultural resources needs
- bathymetry
- river data for dam removal and fish ladders

STUDY GOAL

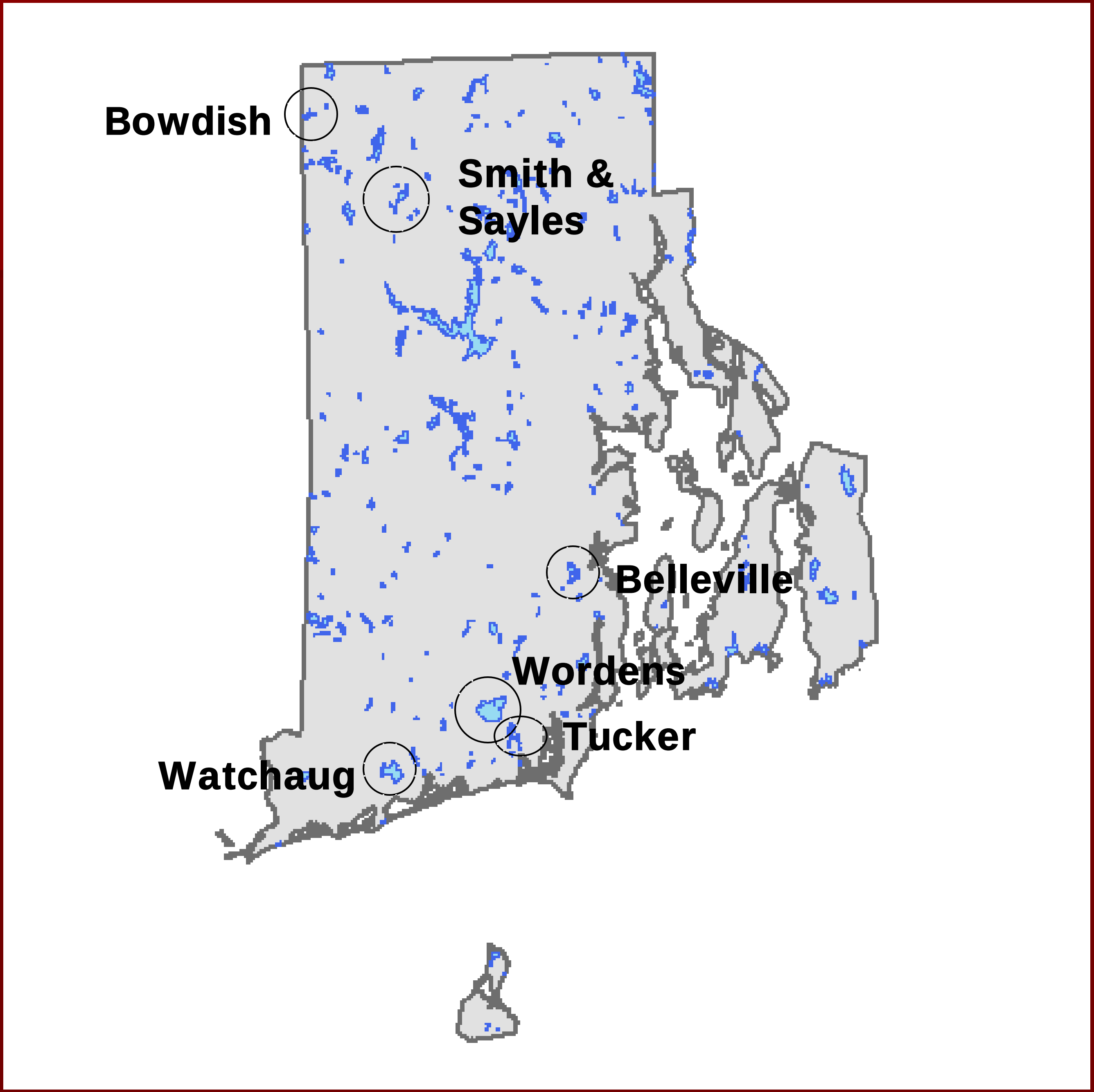
...to begin to develop an understanding of the variations and distributions of freshwater subaqueous soils and to answer some of the commonly asked questions regarding the mapping, classification, and interpretation of these soils.

Specific Project Objectives:

- subaqueous soil maps for 6 freshwater lakes or ponds
- characterization data for the most common soil types in each water body
- carbon pools by area (Mg/ha) for each of the mapping units
- relationships between landscape unit/soil type/soil properties and invasive plant species distribution
- sedimentation rates with interpretations/relationship to land-use-history

Final Recommendations

- changes to Soil Taxonomy
- methods and protocols for mapping freshwater subaqueous soils
- ways to map created and natural freshwater subaqueous soils based on soil-landscape relationships


Bowdish
Smith & Sayles
Belleville
Wordens
Tucker
Watchaug

3 Created Freshwater Lakes (impoundments)

Name	Bowdish	Smith-Sayles	Belleville
Area (acres)	126	175	108
Watershed Size (mi^2)	1,478	640	1,366
Maximum Depth (feet)	10	11	9
Average Depth (feet)	6	5	5
Year Impounded	1850	1865	1800

3 Natural Freshwater Lakes

Name	Worden's	Tucker	Watchaug
Area (acres)	1,043	101	573
Watershed Size (mi^2)	317	317	317
Maximum Depth (feet)	7	32	43
Average Depth (feet)	4	11	8

Research Methods

(field procedures)

- Bathymetric Analysis
- Ground-Penetrating Radar
- Soil Sampling
- Vegetation Mapping

Bathymetric Analysis

- Detailed bathymetric maps of each study area have been created
- Fathometer, surveying rods, and GPS were used to collect the depth of water at known locations
- Points were taken at 10s intervals traveling at a speed of 4-10kph in track lines 20 to 40 meters apart
- This data helped create contour lines and will aid in subaqueous soils map creation
- Some accuracy problems can occur in densely vegetated lakes; ground-truth for accuracy

Ground-Penetrating Radar (GPR)

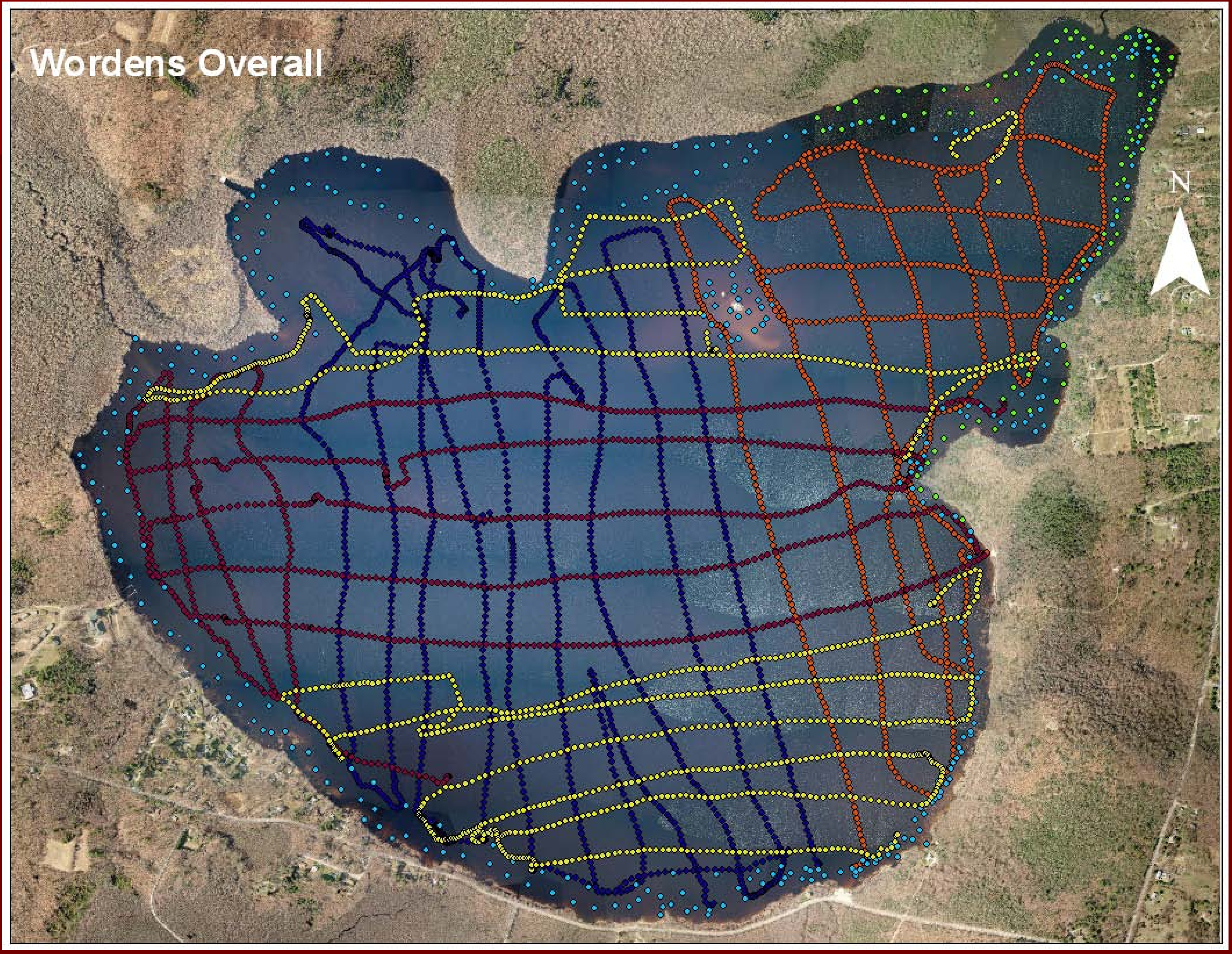
- Ground penetrating radar utilizes radio frequency waves to detect subsurface features
- Waves reflect when they encounter a change in the electrical properties of sediment
- The unit can be pulled across the ice (a flat surface) or behind a boat

Soil Sampling

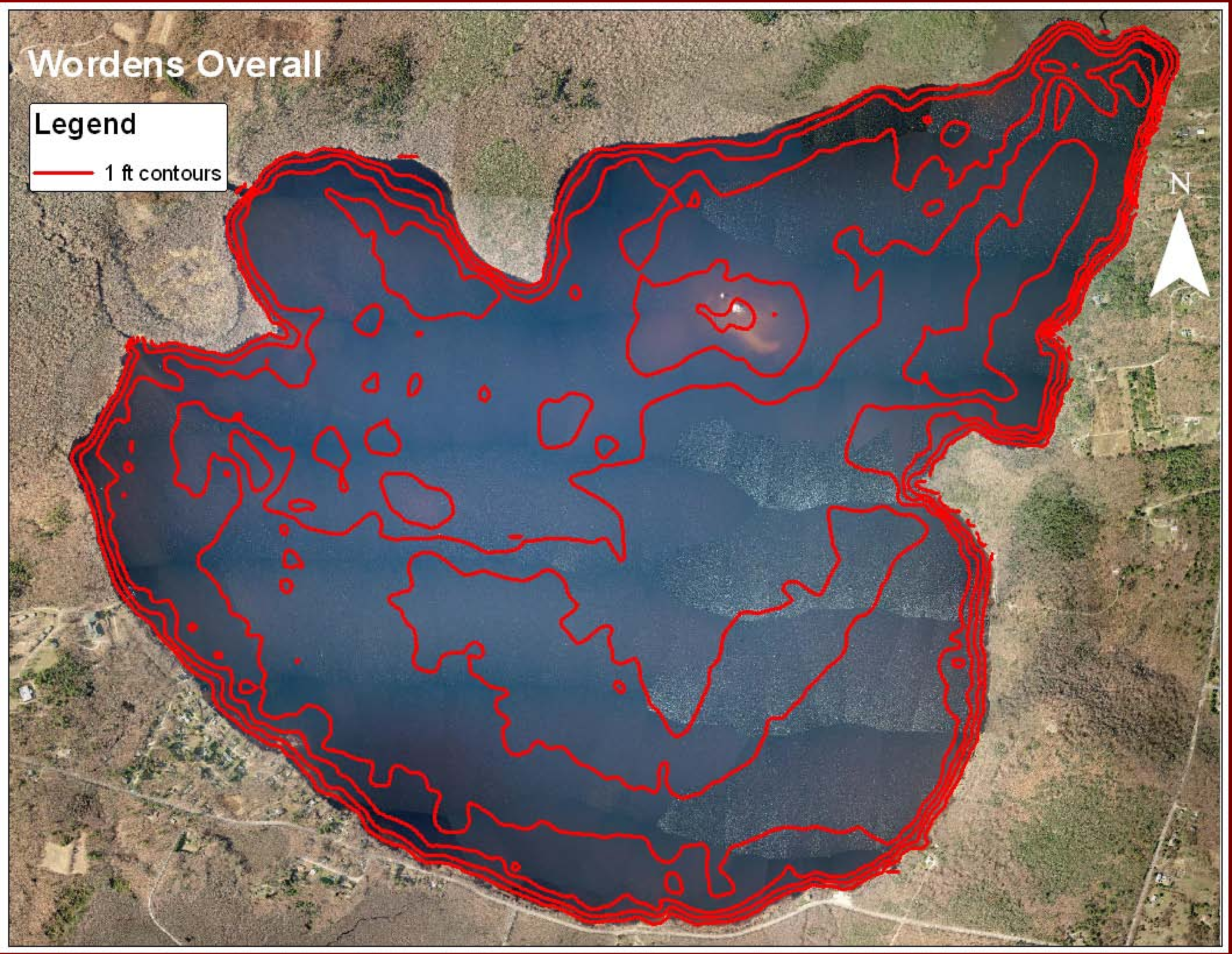
- Conducted during both winter and summer months
- Soils are sampled to an average depth of 100-150 cm; usually in water <2.5m deep
- Standard bucket auger, Macaulay peat sampler, or vibracorer are used to capture the variability and extent of soil types
- All samples are being described following standard procedures

Where I'm at with my research…

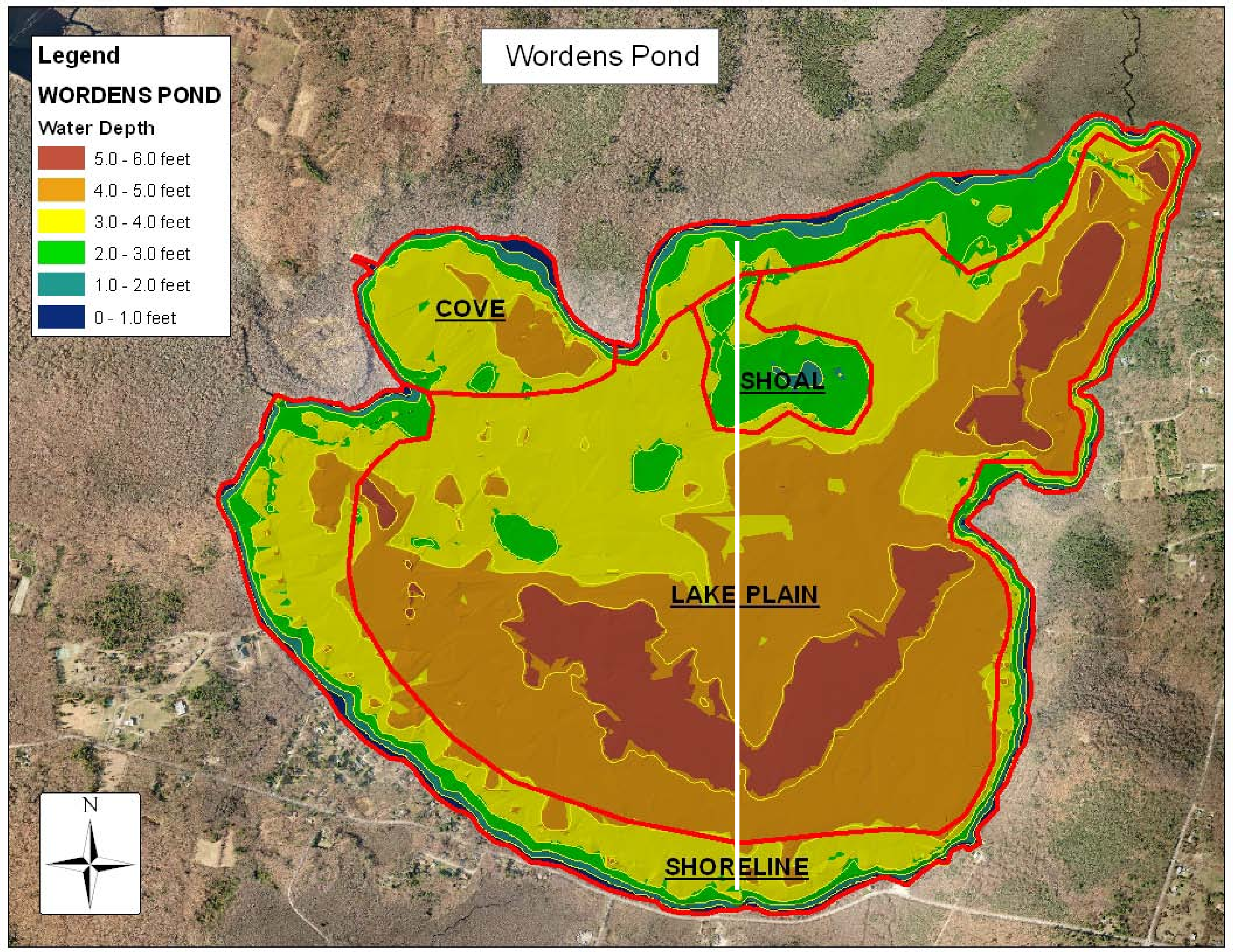
Track Lines



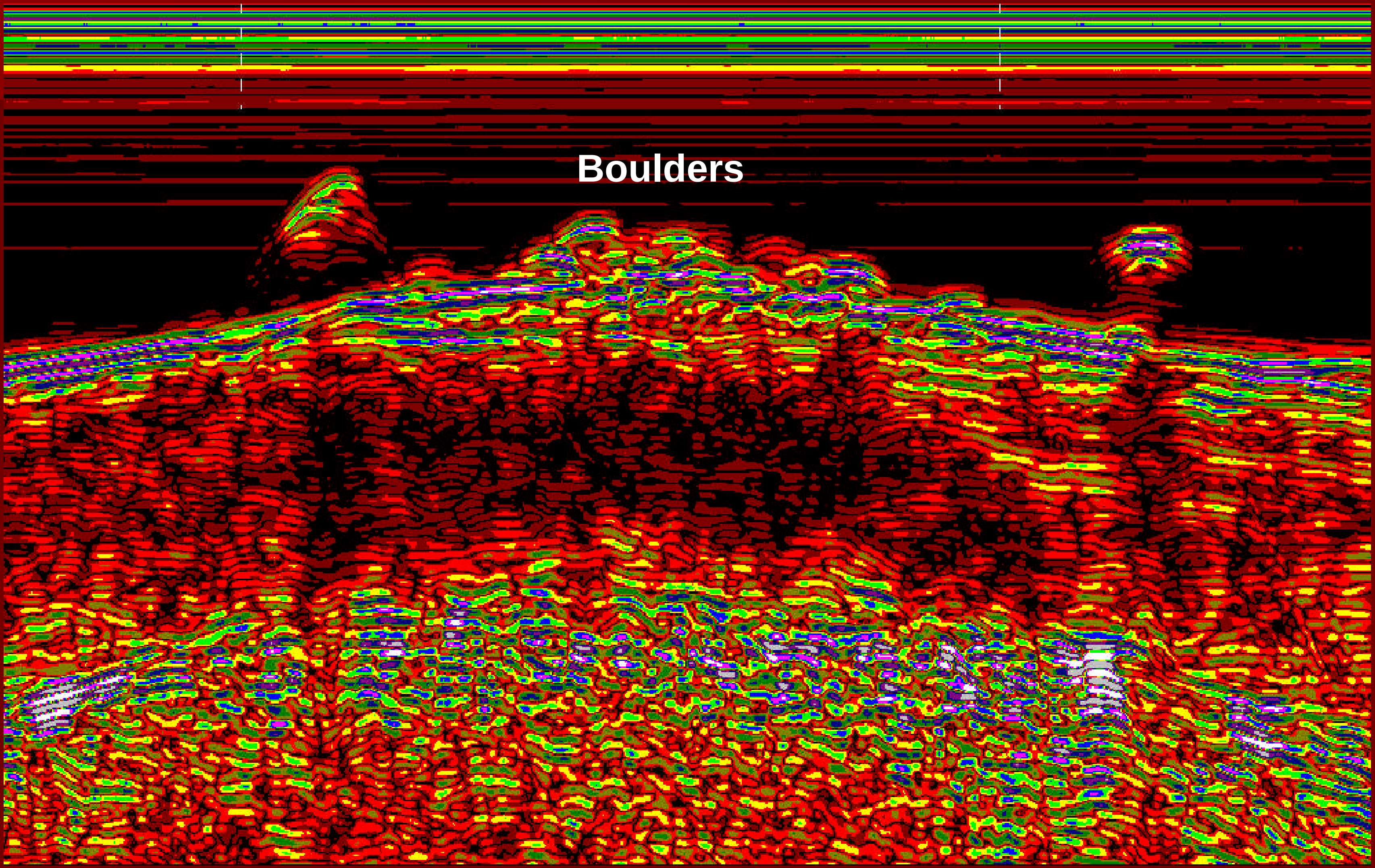
Bathymetric Map of Wordens Pond



Delineated Landscape Units for Wordens Pond



Total length of cross-section shown on page = 12.25 meters



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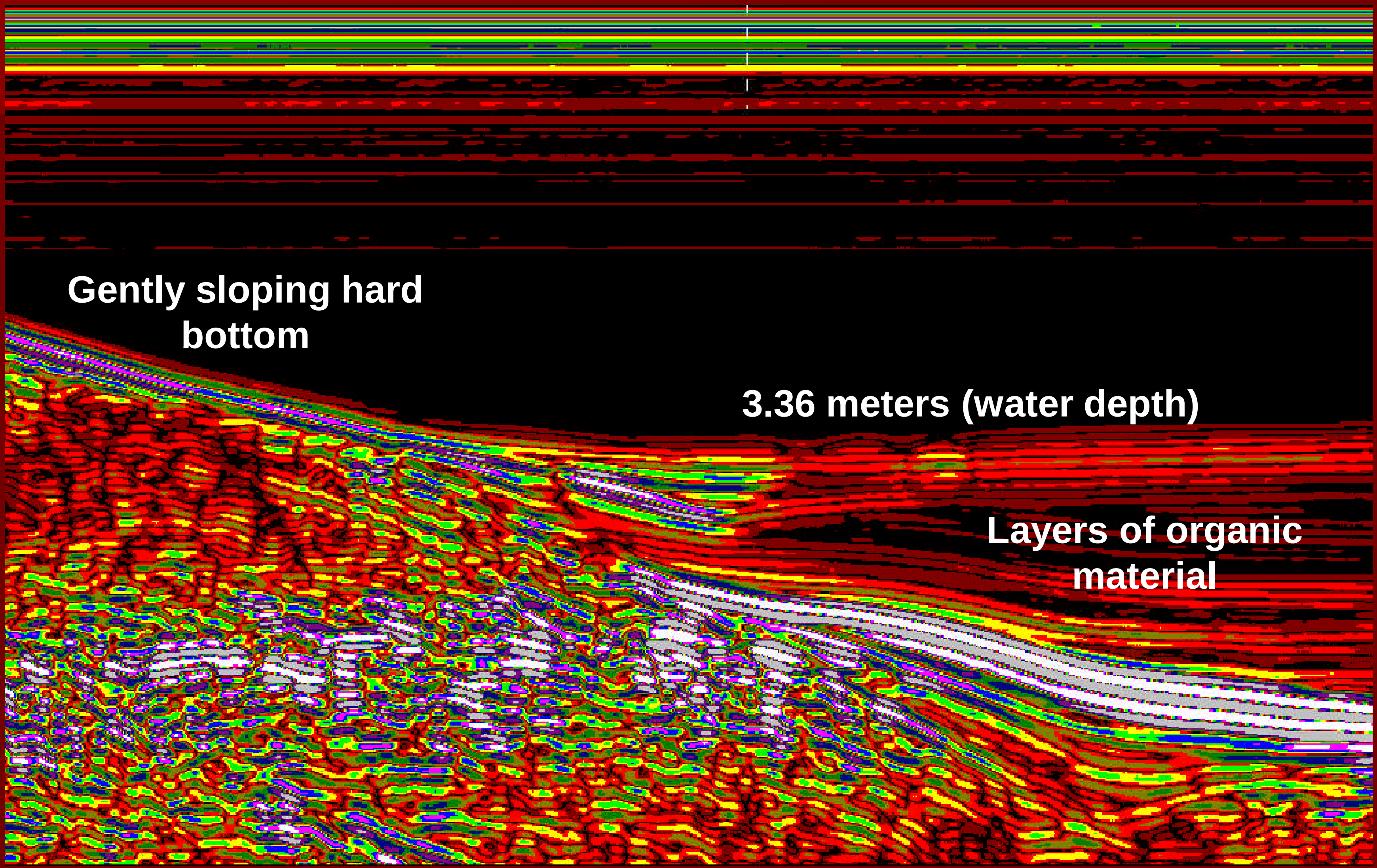
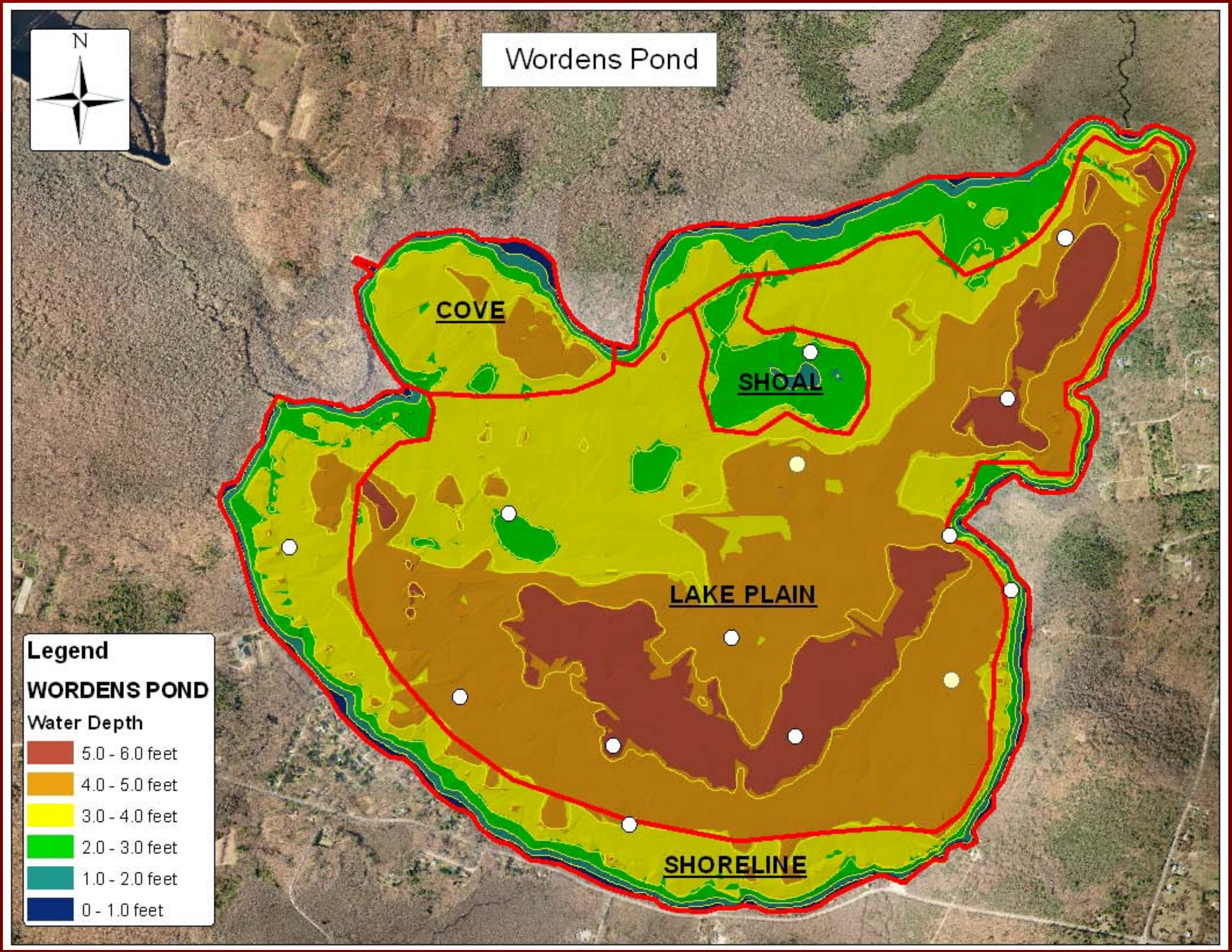
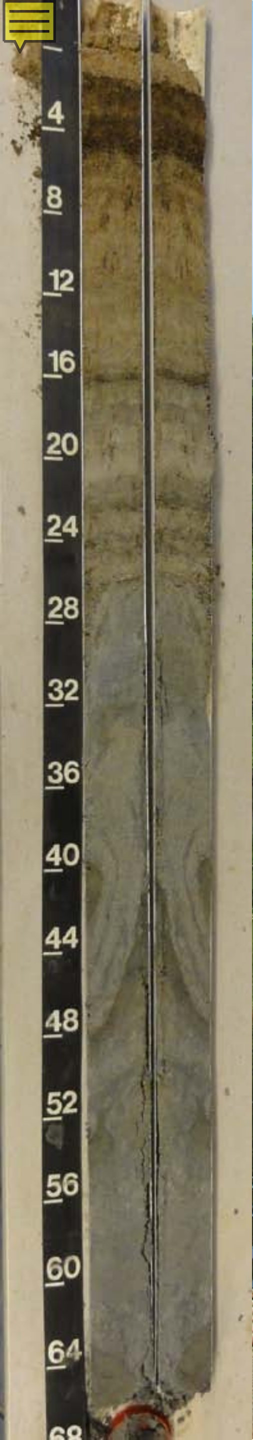


Sample Locations for Wordens Pond

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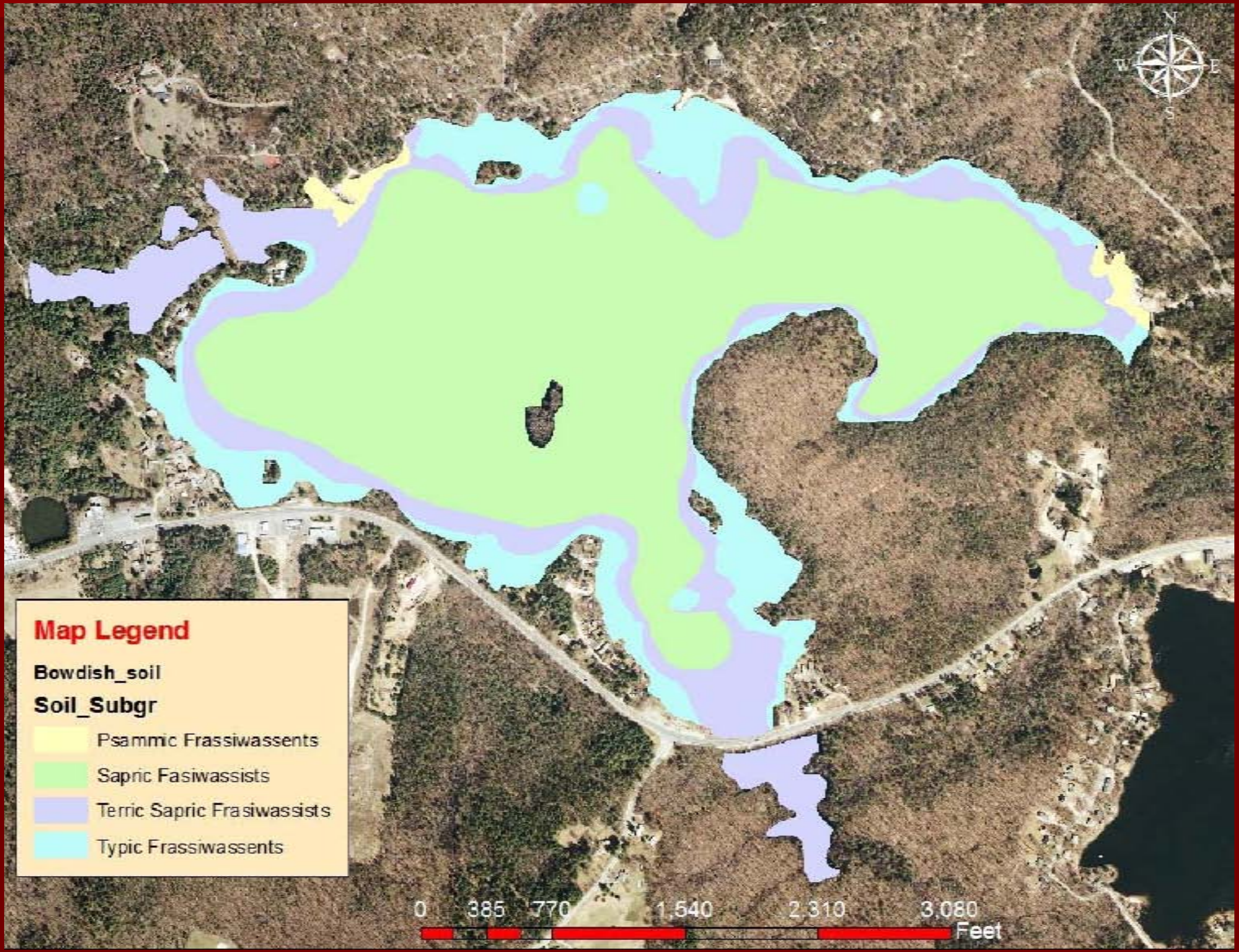
Histosol

Histic epipedon

Opened Vibracore Sample

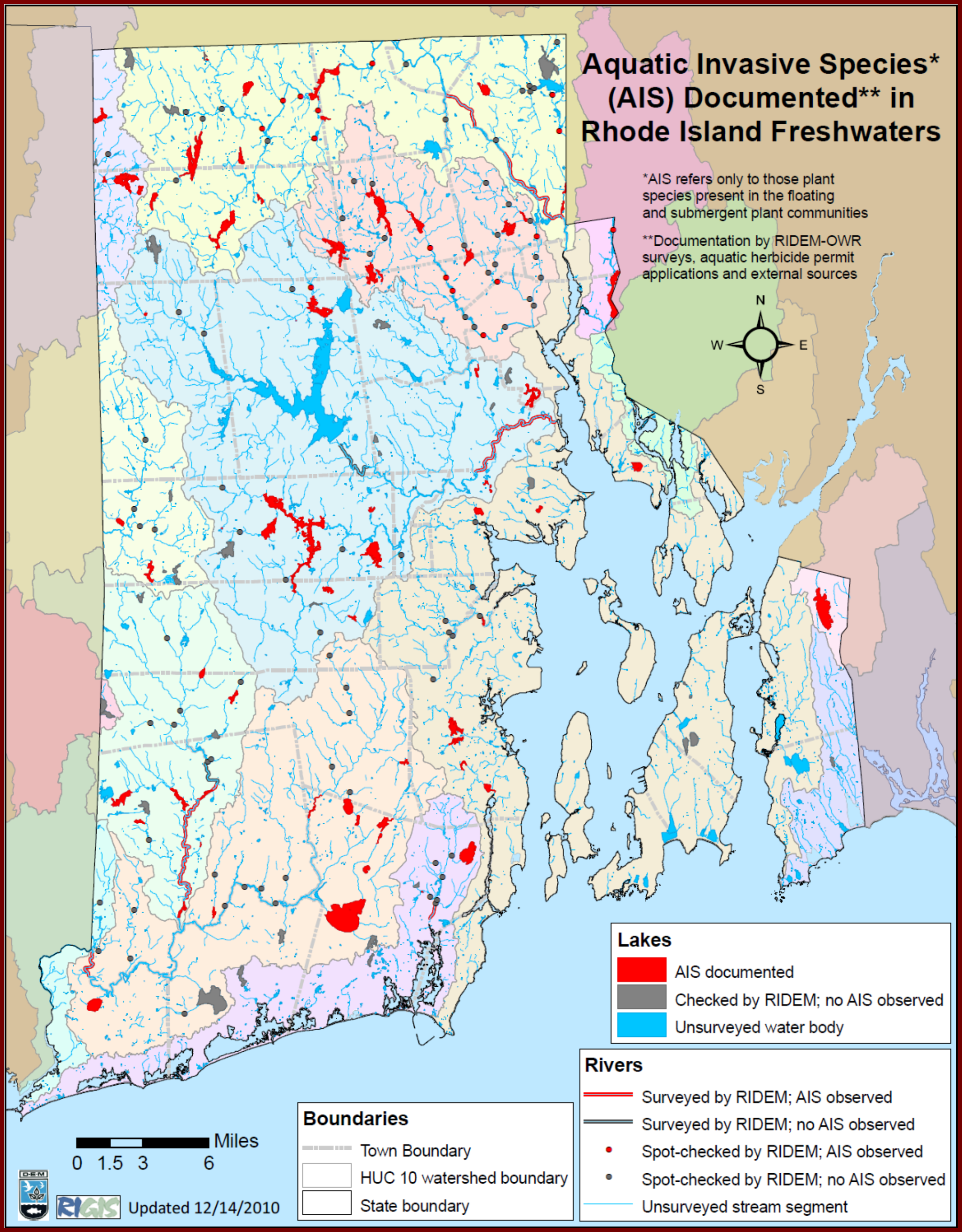
Entirely mineral soil

Final Product: Subaqueous Soils Map!



Vegetation

- Water quality and invasive species distribution data are both available for select water bodies in RI
- Invasive species distributions are being reviewed relative to soil type, landscape unit, and soil characteristics
- The ultimate goal will be to identify soil characteristics that explain the most variability in invasive plant species distribution



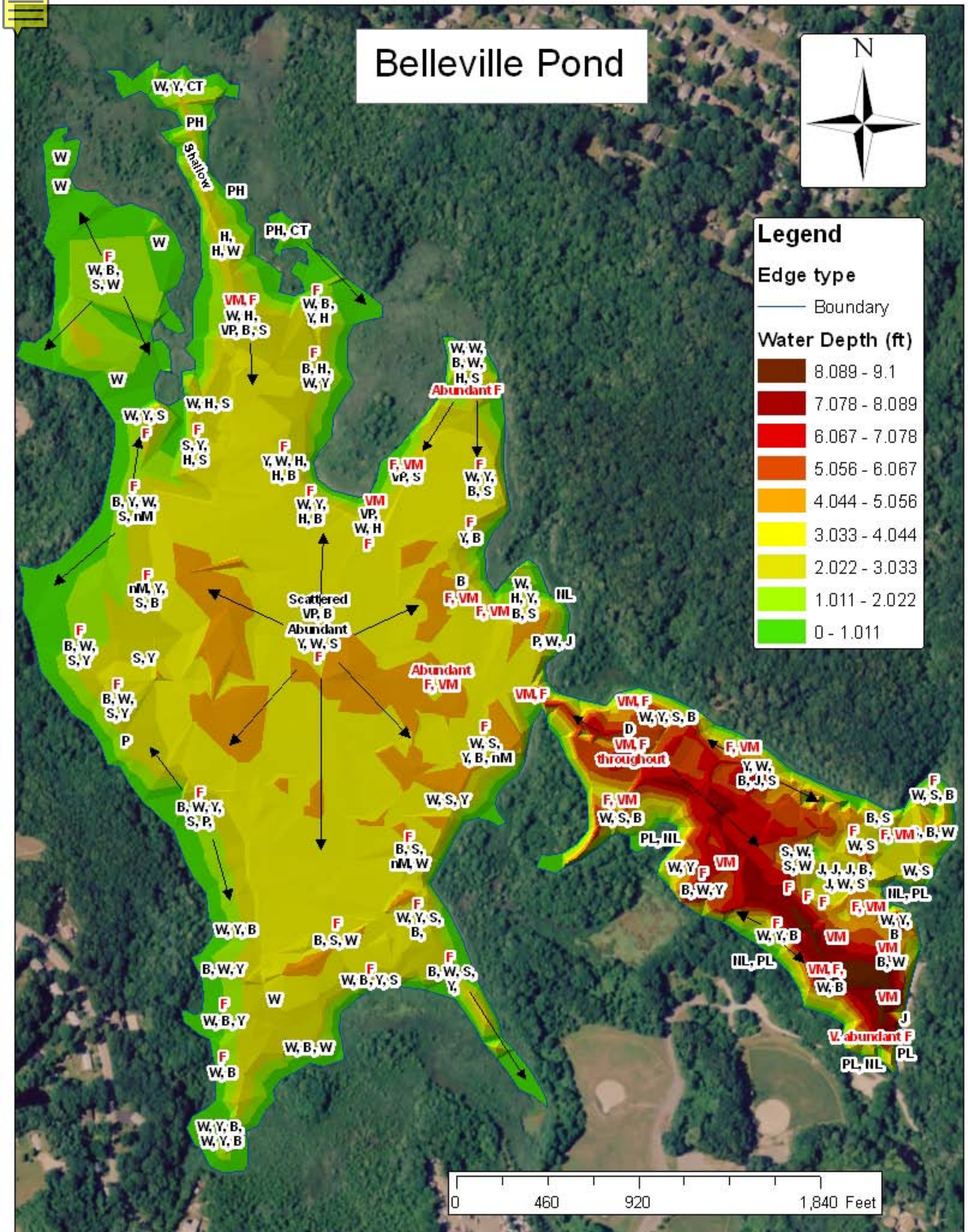
Vegetation Mapping

- Conducted during the summer months of 2010; mainly during the peak of flowering

- We mapped abundance and location of ALL vegetation on all 6 water-bodies

- Location and abundance of invasive plant species was especially noted

- Maps were created in GIS



Vegetation Maps

Identifying the soil characteristics that explain the most variability in invasive plant species distribution will likely be a key management interpretation as we move forward

Current Species Observed:

(as of 12/14/2010 (RIDEM)):

- **Bowdish** – variable watermilfoil and fanwort
- **Smith & Sayles** – variable watermilfoil
- **Belleville** – fanwort, variable watermilfoil, water chestnut
- **Wordens** – fanwort, variable watermilfoil, water hyacinth
- **Tucker** and **Watchaug** - CLEAN

Invasive Species

Water Chestnut

Fanwort

Variable Leaf
Watermilfoil

Lab Analysis

- 1:1 pH and 1:2 $CaCl_2$ pH
- 5:1 Electrical conductivity
- Carbon (loss-on-ignition and C:N analyzer)
- Phosphorus sequential extraction
- Particle size distribution

Soil Organic Carbon Pools

200 - 300 Mg/ha SOC

> 400 Mg/ha SOC

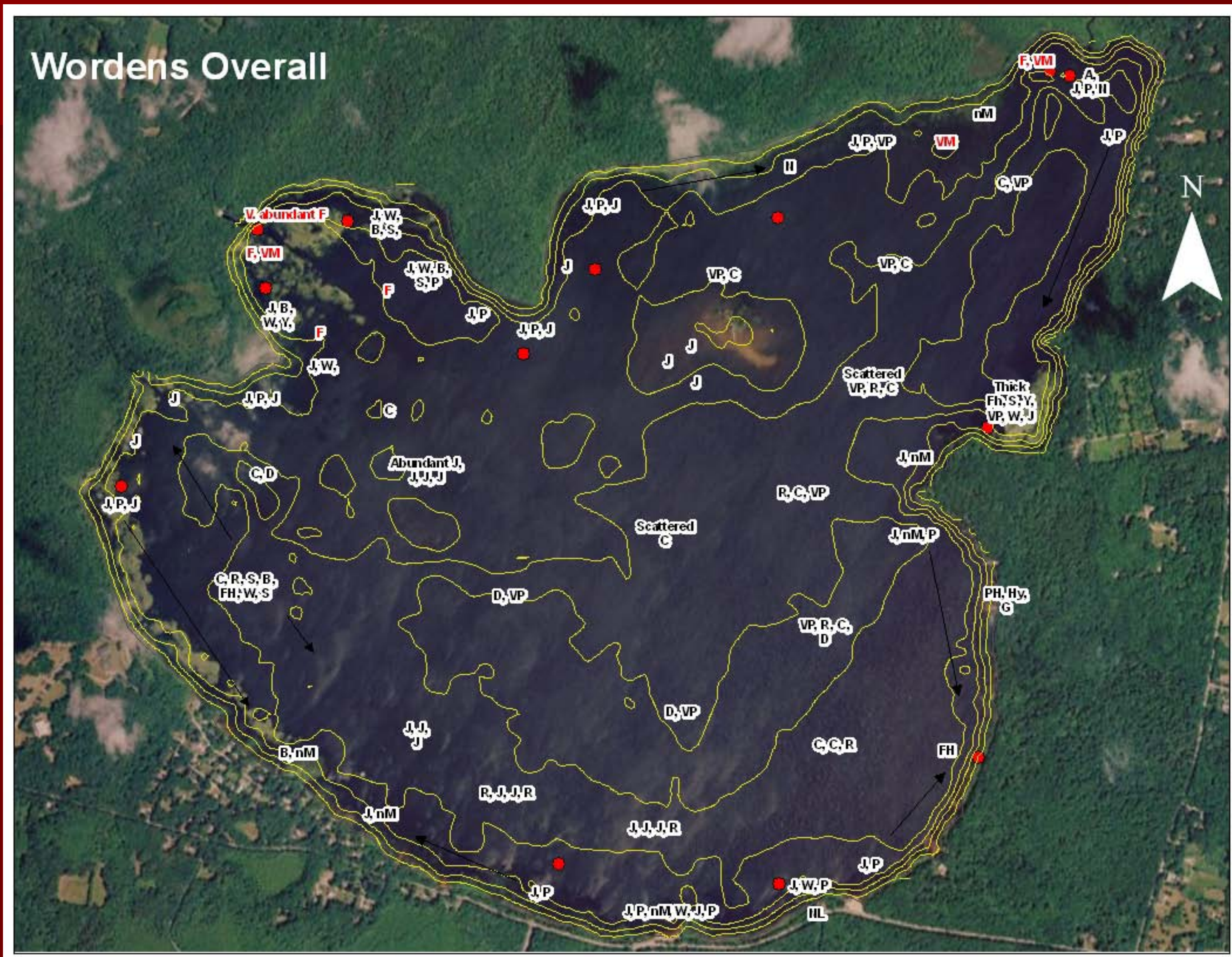
C content (%) x bulk density x horizon thickness

- Something we are thinking about as we progress with this research is the impact of aquatic invasive plant species on the total amount of carbon in any given system.

- Our experiences are suggesting that these plants, although quite a nuisance, may lead to higher carbon sequestration rates than systems without invasive plants.

- In some cases these C accumulations have resulted in the formation of histic epipedons over mineral soils.

P subsamples



Phosphorus sub-sampling was conducted in the four ponds that have documented occurrences of the exotic species Variable milfoil and fanwort

0-5 and 5-10cm samples were collected and bagged for further analysis in the lab (Dissolved-reactive Phosphorus, exchangeable Phosphorus)

Summary/Conclusion

- As subaqueous soil science progresses, a wide range of use and management interpretations are expected to be developed for use with freshwater subaqueous soil maps
- The freshwater subaqueous soil environment is proving to be a significant sink for organic carbon
- Aquatic invasive species have been found to be more dominant in the 3 created freshwater systems, and less prevalent in the 3 natural ponds in my study. We are still investigating the relationship with phosphorus inputs and invasive plants
- Field and lab data are being used to identify and map subaqueous Histosols (Frassiwassists) and Entisols (Frassiwassents)
- 8 additional soil series are being developed as more samples are collected and analyzed, further distinguishing classification differences between organic and mineral subaqueous soils
- This research is hopefully just a first step in helping to better understand these very diverse aquatic systems

Special Thanks To:

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NRCS Natural Resources Conservation Service

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