Soil Survey Investigations of Freshwater Subaqueous Soils

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Overview:

- Introduction – Statement of Research
- Project Objectives
- Research Methods and Procedures
- Data Analysis
- Summary/Conclusion

Question: Why Study Freshwater Subaqueous Soils?

- There is a growing need for a tool to manage shallow aquatic systems and resources at an ecosystem scale
- Agencies are trying to manage elevated nutrient levels (N & P) and the trophic state of lakes
- There are also issues related to sediment accumulation (including contaminants such as metals, herbicides, and pesticides)

Question: Why Study Freshwater Subaqueous Soils?

- There has been an explosion in the population of invasive species
- Environments should be managed in 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
- contaminants
- flood plain restoration
- WHIP projects
- cultural resources needs
- bathymetry
- river data for dam removal and fish ladders

Why Study Freshwater Subaqueous Soils?

The goal of my study is 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 3 created and 3 natural 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**
- **P, N, and As distribution maps and related interpretations**
- **Relationships between landscape unit/soil type/soil properties and invasive species distribution**

Specific Project Objectives (cont.)

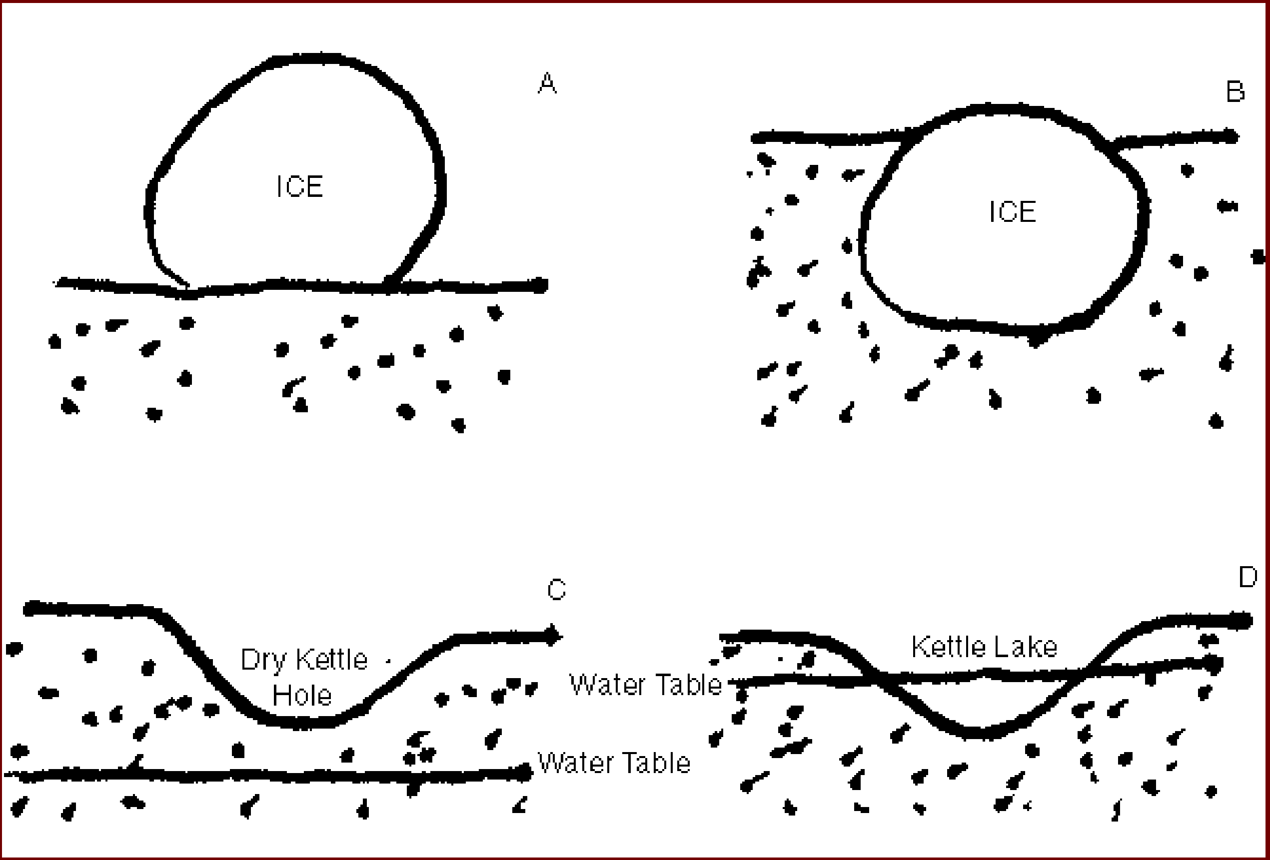
- **Sedimentation rates with interpretations/relationship to land-use-history**
- **Recommendations for changes to Soil Taxonomy**
- **Recommendations for methods and protocols for mapping freshwater subaqueous soils**
- **Recommendations for mapping created and natural freshwater subaqueous soils based on soil-landscape relationships**

3 Created Freshwater Lakes (impound-ments)

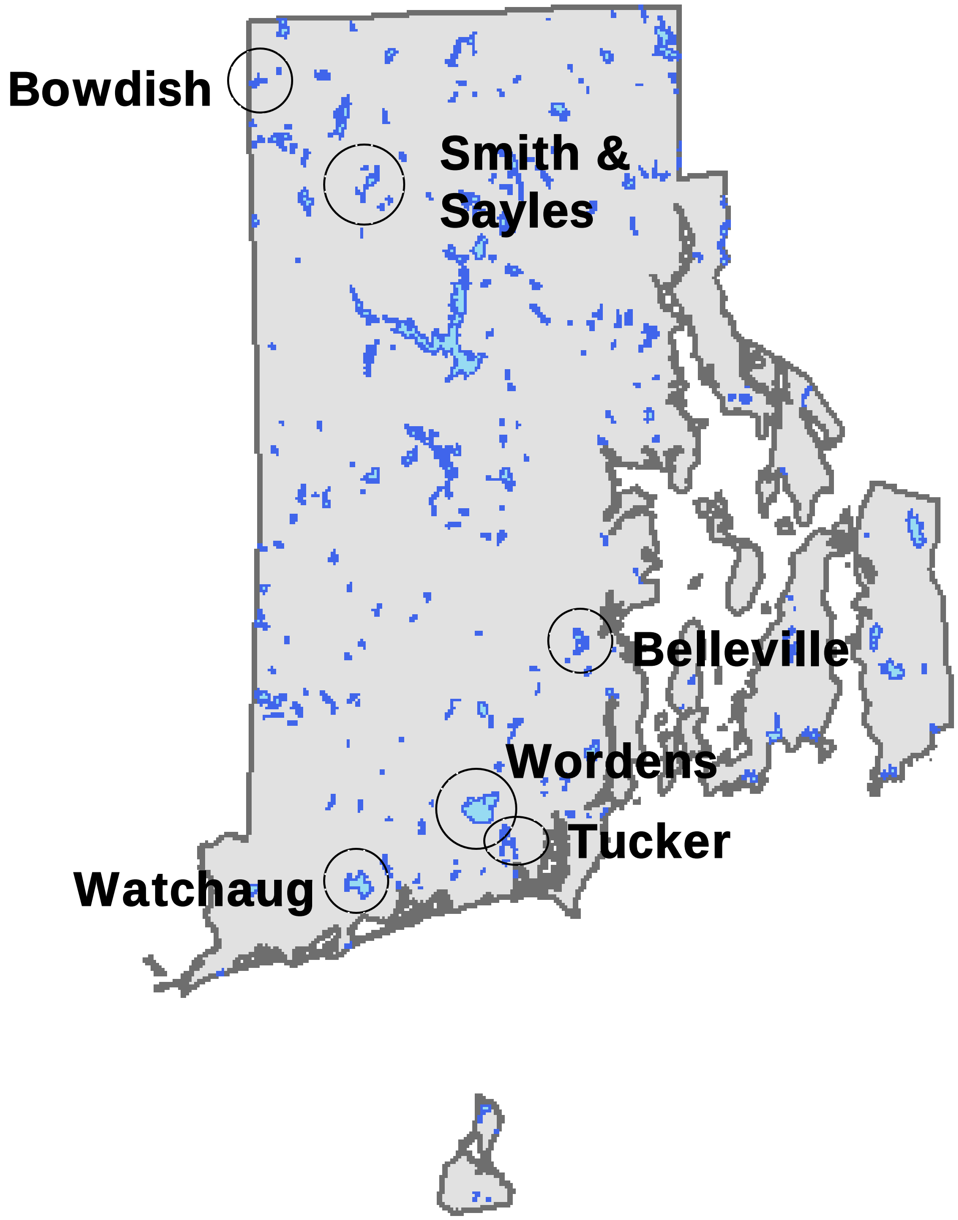
Sorry Dad, but my true passion is for making furnitures, not dams...

Name	Bowdish	Smith-Sayles	Belleville
Area (acres)	126	175	108
Watershed Size (mi^2)	1,478	640	1,366
Maximum Depth	11	11	8
Average Depth	5.6	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	7	32	36
Average Depth	4	11	8



Bowdish
Smith &
Sayles
Belleville
Wordens
Tucker
Watchaug

Research Methods and Procedures:

(Data collection in the field)

- Bathymetric Analysis
- Ground-Penetrating Radar
- Soil Sampling

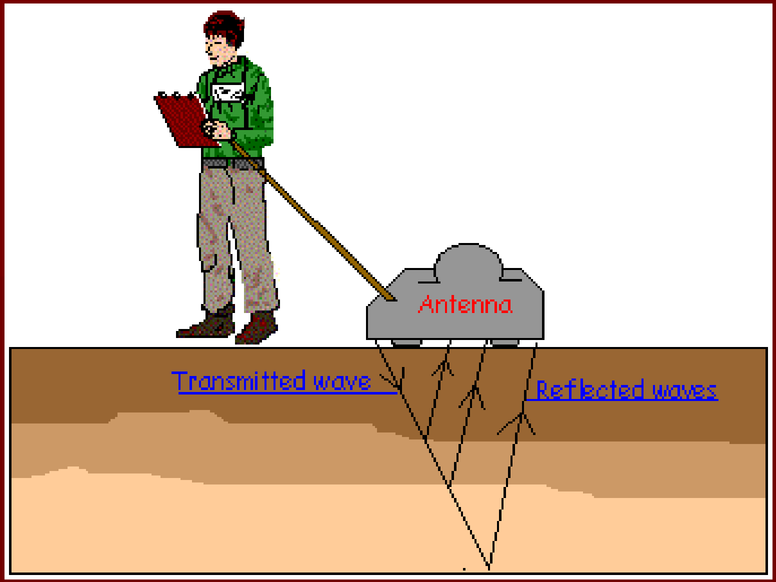
Bathymetry
!

Bathymetric Analysis

- Detailed bathymetric maps of each study area will be created
- Ground-penetrating radar (GPR), surveying rods, fathometer, and GPS used to collect the depth of water and at known locations
- Points taken at 10s intervals traveling at a speed of 4-10kph in track lines 20 to 40 meters apart
- Ground-truthing of data will be conducted to assure accuracy
- This data will help create contour lines and subaqueous soils maps

Ground-Penetrating Radar (GPR)

- Ground penetrating radar utilizes radio frequency waves to detect subsurface features



- GPR's operate at frequencies between 20 and 1000 MHz

- Waves reflect when they encounter a change in the electrical properties of sediment

Fathometer

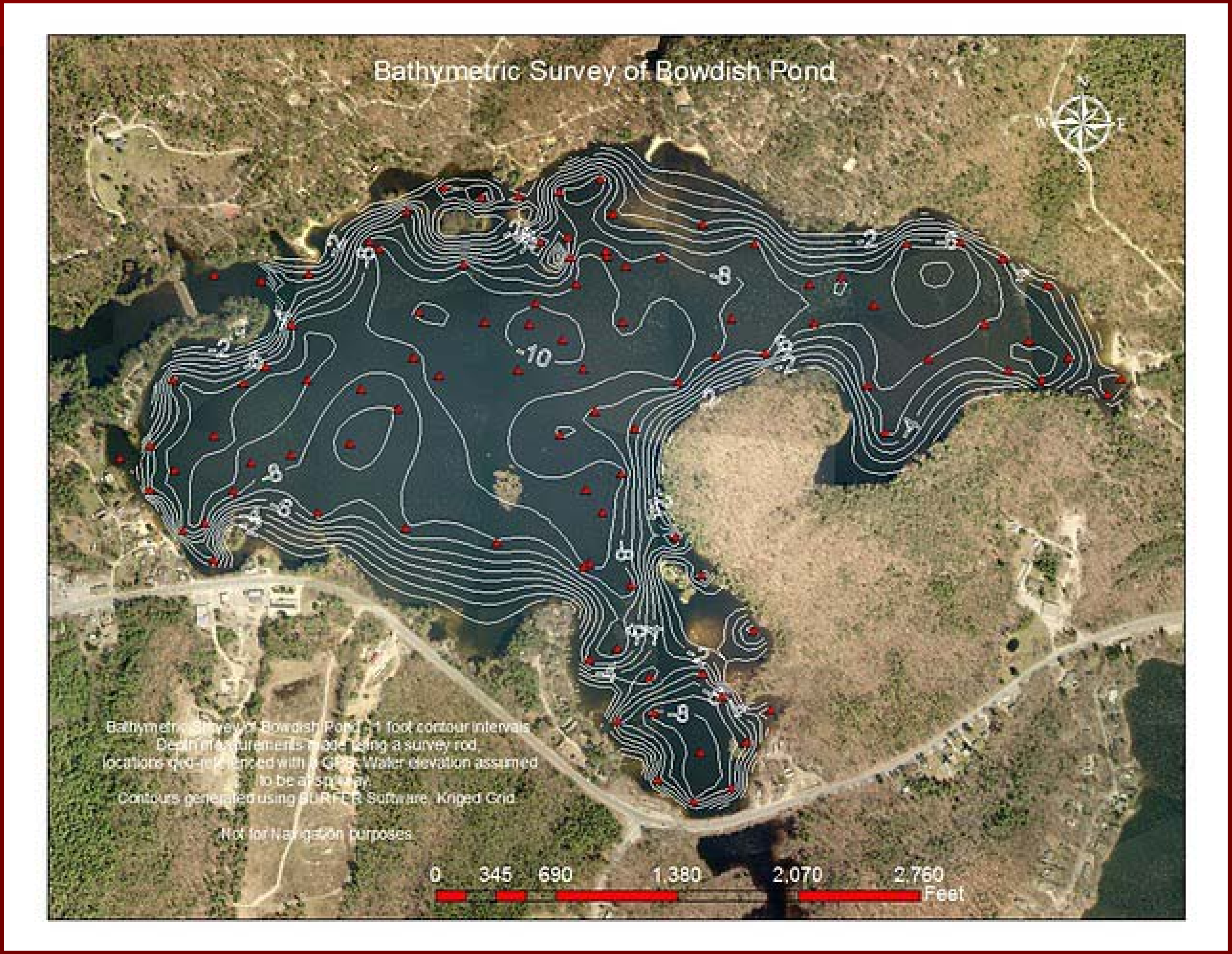
- Fathometers utilize echo-sounding technology to detect the bottom of a water body; this gives us water depth

- Some accuracy problems can occur in densely vegetated lakes; ground-truth!

- Soundings/tracks can be saved directly into the unit

- The unit also acts as a regular GPS unit

Bathymetric Map



Soil Sampling

- Conducted during both winter and summer months
- Soils will be sampled to an average depth of 100-150 cm; water <2.5m deep
- Standard bucket auger, MacCauley peat sampler, or vibracore will be used
- GPS locations!


water
organics
organics

Soil Sampling (cont.)

- All samples will be described following standard procedures (Munsell color, texture, coarse fragments, water depth, etc.)
- Additional samples will be taken as needed with a vibra-corer or MacCauley sampler to further support the statistical analysis and to capture the variability and extent of soil types
- Date of dam completion in each of the impounded systems will mark time zero for soils analysis

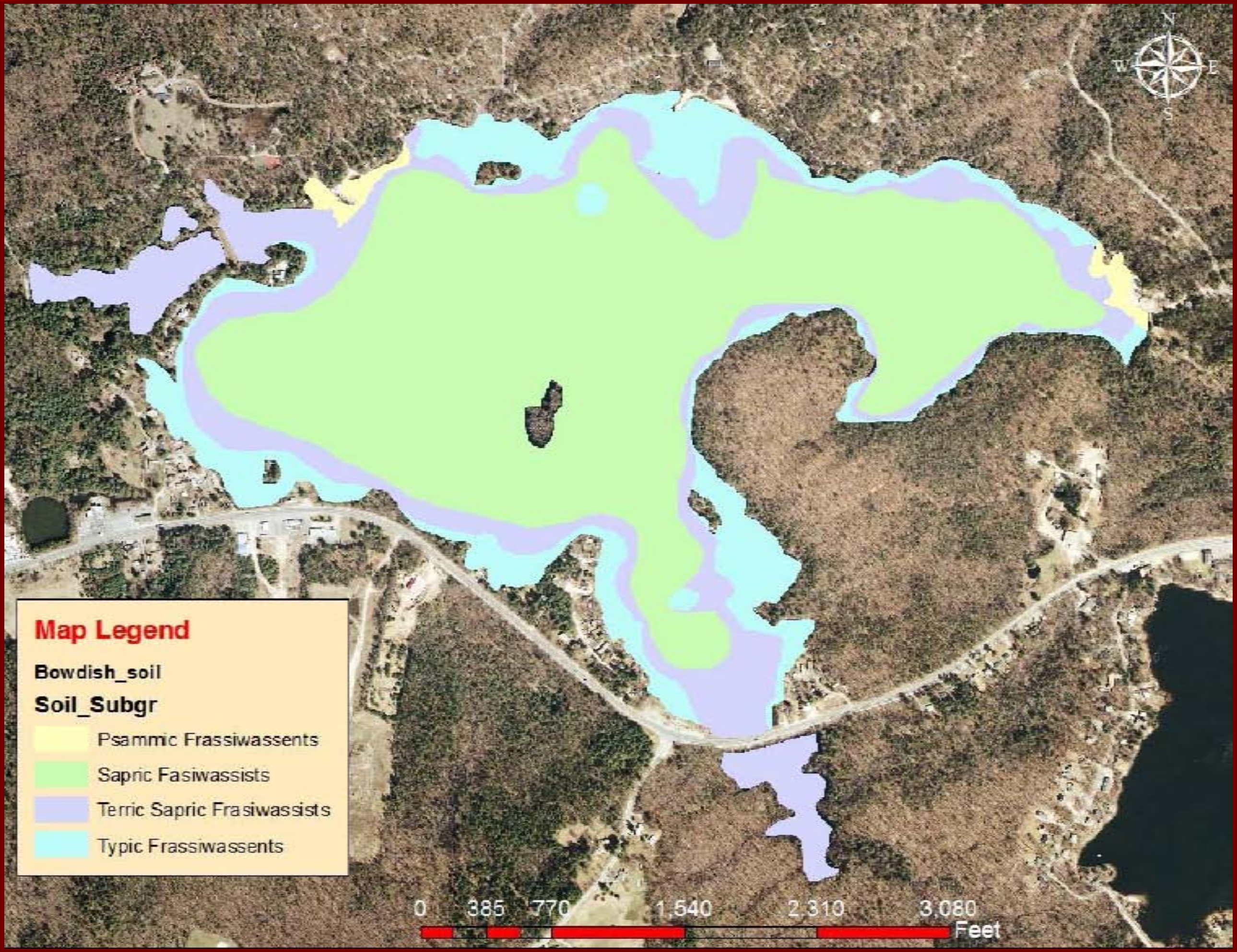
Vibracoring

- A vibra-corer basically “vibrates” an aluminum sampling tube into the soil until the tube is filled with sample, or until refusal occurs

- The sample tube is then pulled from the ground, usually using a winching system

- The tubes are then capped, labeled, and usually kept refrigerated until they are opened for description and analysis

Subaqueous Soils Map



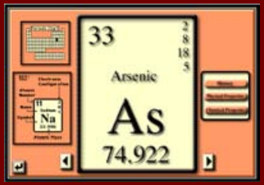
Research Methods and Procedures

(Data analysis in the lab):

- pH and Electrical conductivity
- Particle size distribution (PSD) and percent coarse fragments
- Total Arsenic
- Nitrogen, Carbon, and Phosphorus

pH (soil Reaction)	Electrical Conductivity
pH (soil) – the degree of acidity or alkalinity of a soil	Electrical conductivity (EC) – gives us an indirect measurement of the salt content of a soil
Important for nutrient availability, microbial reactions, and classification	Can affect soil pH, plant growth, and water quality

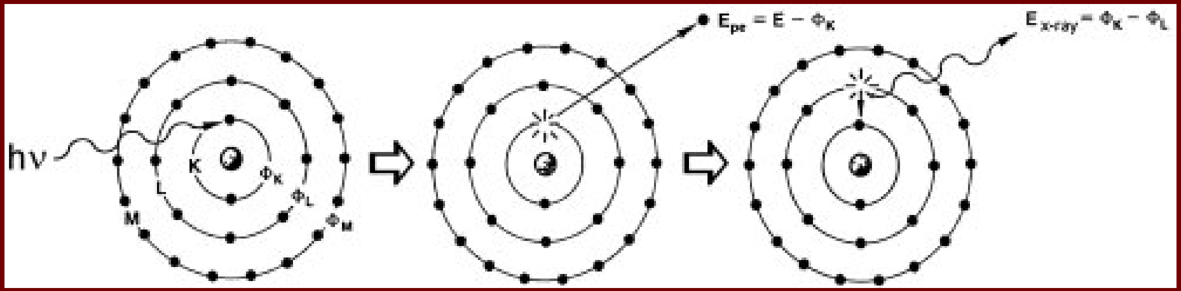
Total Arsenic



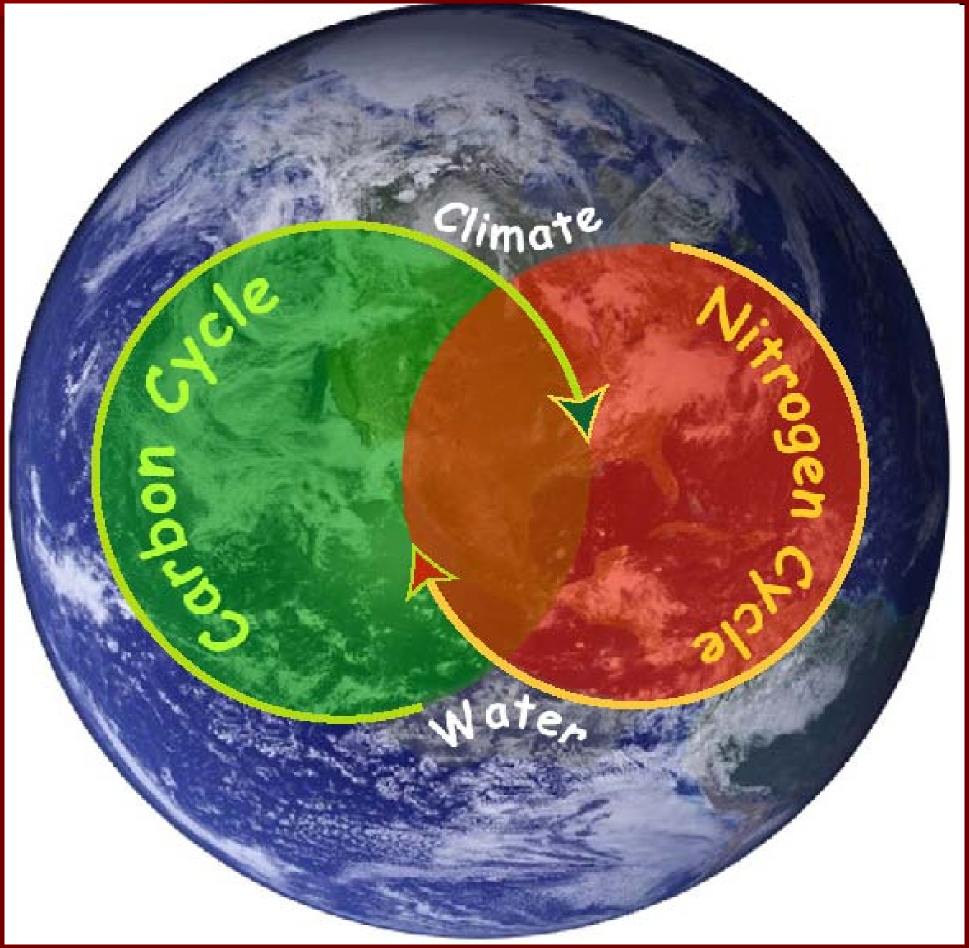
- Arsenic exists in many forms, but its most common sources are fertilizers, animal feed, and through fossil-fuel combustion

- X-ray fluorescence (XRF) – type of elemental analysis that will be used to measure total Arsenic (As) in samples

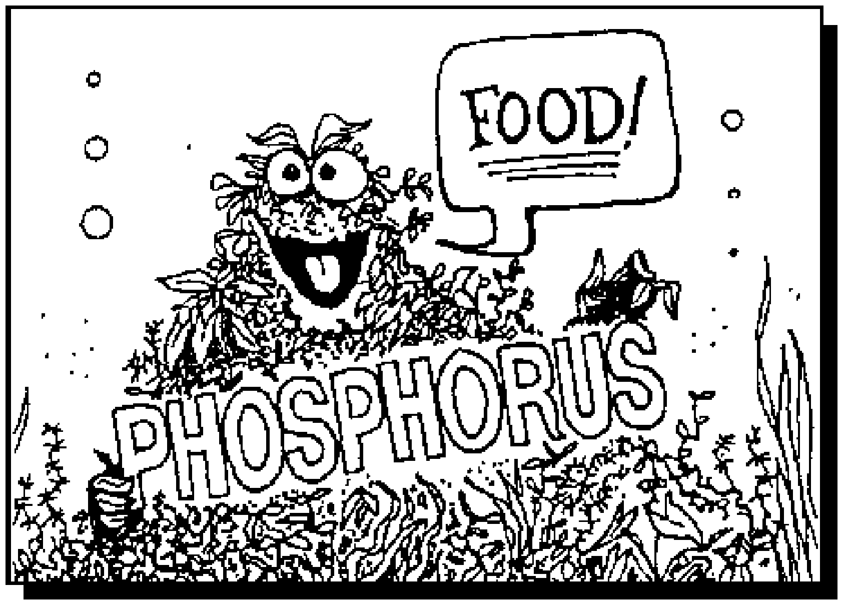
- Arsenic sampling sill serve as a surrogate for a number of contaminants that could possibly accumulate in the subaqueous environment



Total Carbon/Total Nitrogen



- Soil organic Carbon will be determined using the Loss-on-Ignition (LOI) method
- Carbon and Nitrogen Analyzer: used to measure total carbon and nitrogen for each sample collected
- Carbon pools will be determined on an area basis for the upper meter of the soil by summing the carbon stored in each horizon for each soil-landscape unit



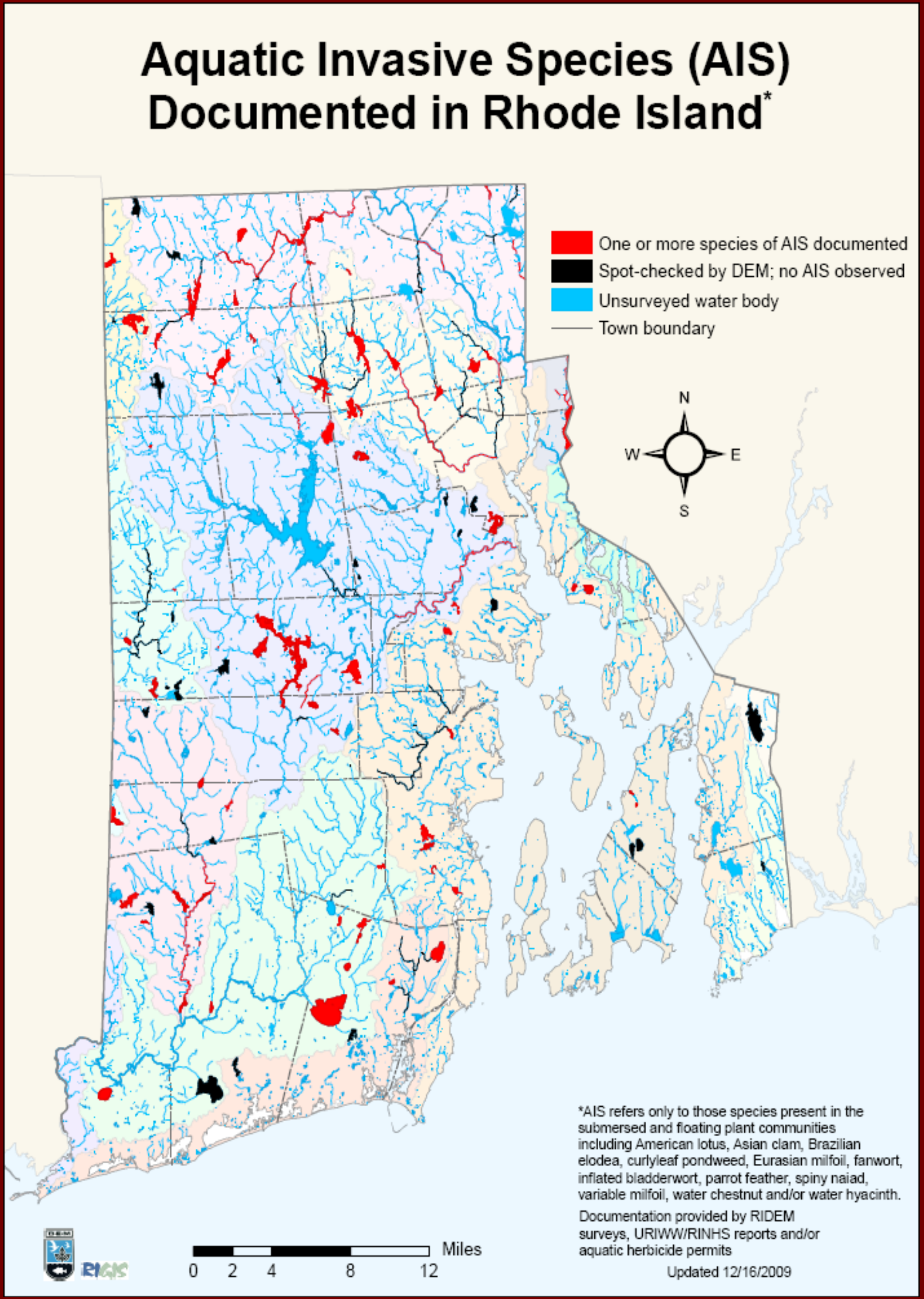
Nutrients accumulate in lakes from many sources:

- Precipitation (rain or snow)
- Erosion
- Surface water run-off
- Storm water
- Leachate from septic systems
- Use of lawn and agricultural fertilizers
- Animal waste

Eutrophication has been linked to a variety of ecological and health problems, ranging from increased growth of undesirable algae and aquatic weeds to fish kills and human illness

Invasive Species

- Water quality and invasive species distribution data are both available for select water bodies in RI
- Invasive species distributions will be 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 species distribution

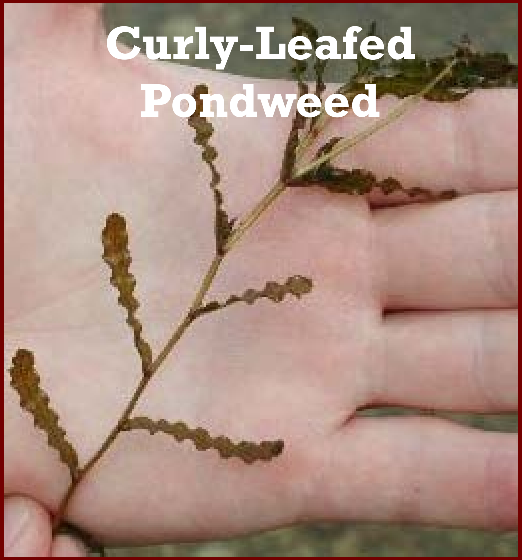


Current Species Observed:

(as of 12/16/2009 (RIDEM)):

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

Invasive Species



Aquatic Species Websites:

- http://www.dem.ri.gov/programs/benviron/water/quality/surfwq/aisindex.htm
- http://des.nh.gov/organization/divisions/water/wmb/exoticspecies/index.htm
- http://www.mass.gov/dcr/watersupply/lakepond/downloads/aquatic_species.pdf

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
- Agencies managing freshwater resources have many unanswered questions regarding water quality, sedimentation, invasive species, nutrient inputs, carbon sequestration, contaminants, conservation, and restoration
- This research is hopefully just a first step in answering some of these questions, and in helping to better understand these very diverse aquatic systems

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