Geochemical Patterns in Calcareous Fens of Massachusetts

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What is a Fen?

- A fen is a type of wetland

- Water is supplied by *upwelling groundwater*,
  - not solely from surface sources (i.e. rain, streams, etc.)
- By definition

  - A fen is a wetland whose vegetation, water chemistry, and soil development are influenced in a large way by ground water. (Bedford and Godwin, 2003)

Types of Wetlands

BOG PEATLAND

$$P = ET + Q \pm \Delta S$$

FEN PEATLAND

$$P = ET + Q \pm \Delta S \pm GW$$
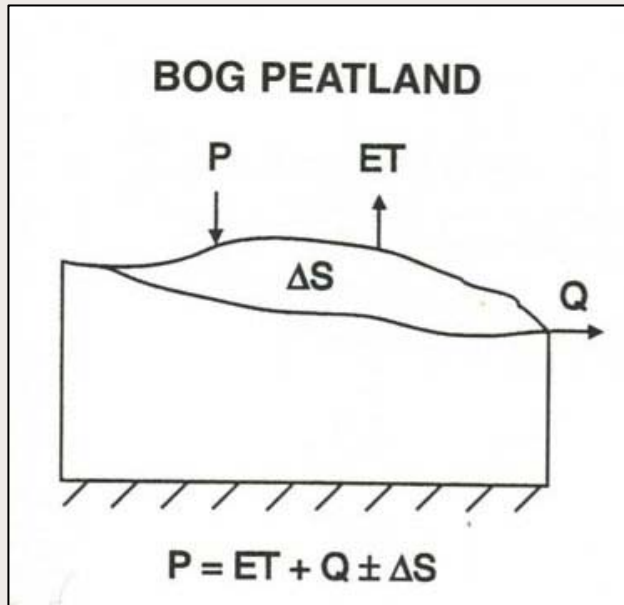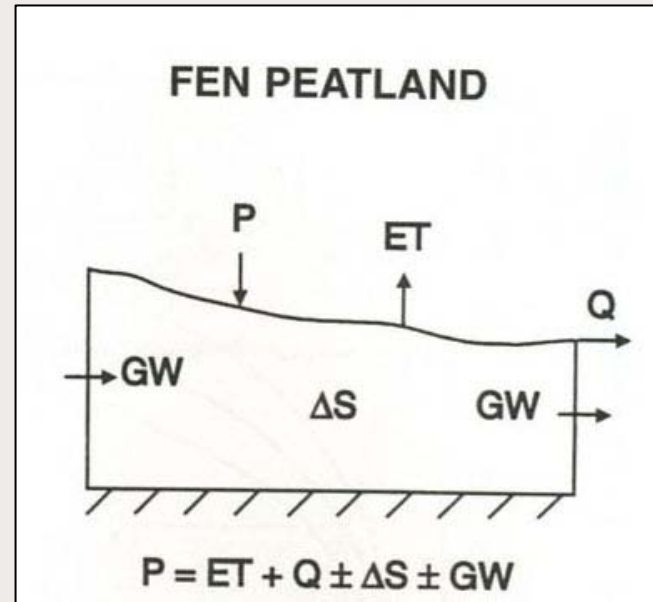
Ombrotrophic

Minerotrophic

(Brooks et al., 1997)

Types of Fens

- Poor Fen
  - Water pH 3.5-5.9
  - Water Ca 1 - 7 ppm
  - Water Mg 0.4 – 2 ppm
- Rich Fen
  - Water pH 6.0 - 8.4
  - Water Ca 7 – 433 ppm
  - Water Mg 2-32 ppm
- Calcareous Fen
  - A specialized form of Rich Fen, waters and soils are rich in Calcium Carbonate (attributable to Limestone or Dolostone bedrock in groundwater path). (Bedford and Godwin, 2003)

Carbonate Bedrock in the US
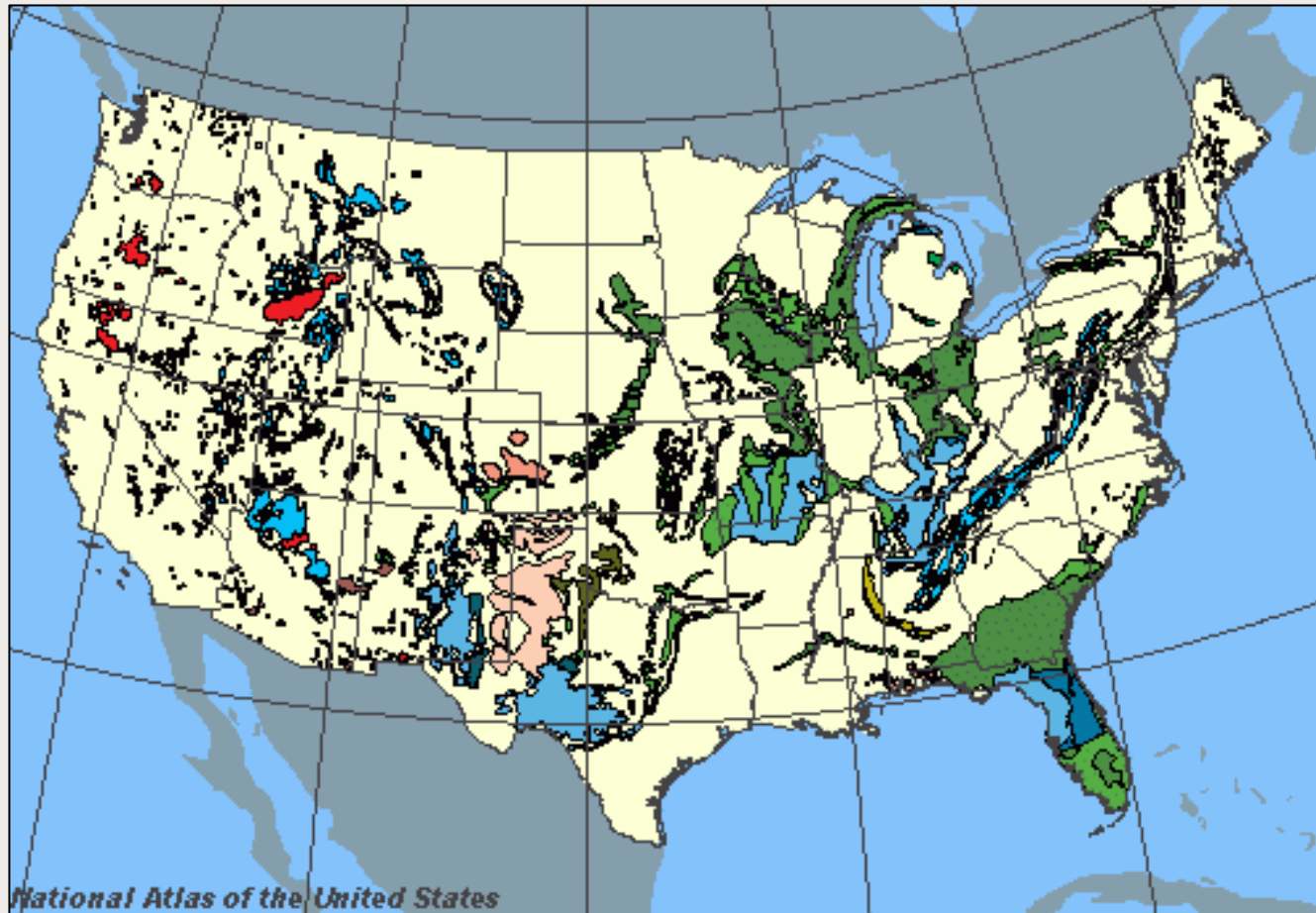
(National Atlas, 2006)

Carbonate Bedrock in the Northeast
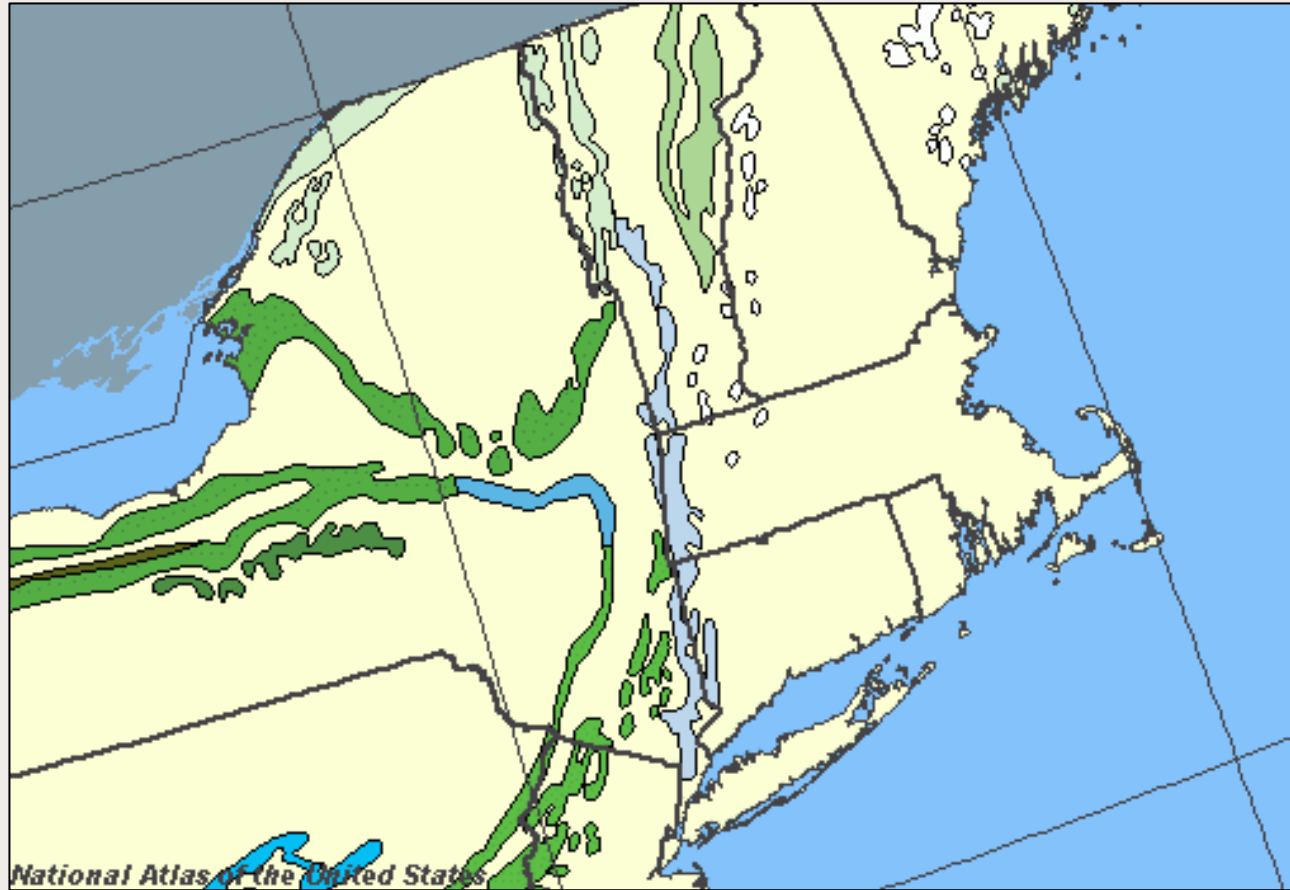
(National Atlas, 2006)

Plant Communities

- Calciphiles
  - Can tolerate and/or thrive on unusually high calcium levels
- Rare occurrences of these favorable conditions = rare occurrences of these plants
- Unique/rare plant assemblages
- Endangered/Threatened Species

Unique Plant Assemblages

Rare Plants

Platanthera huronensis

Calopogon tuberosus

Spiranthes cernua

Study Objectives

- Document unique plant assemblages
- Compare species distributions to environmental calcium levels
  - Develop calcium ranges for select species
  - Compare species tissue calcium to environmental calcium
- Understand the hydrogeochemical cycles in the fens
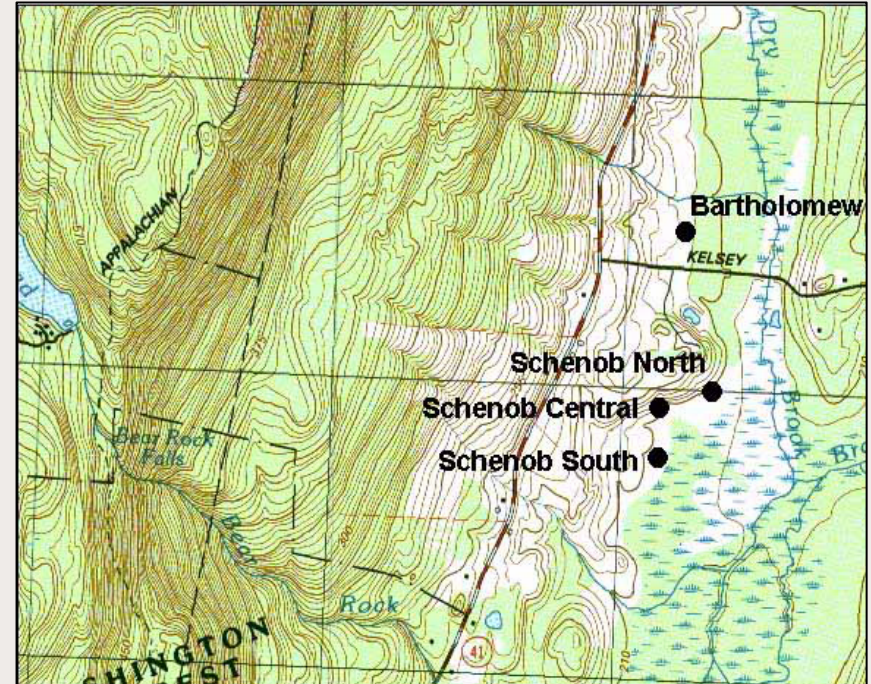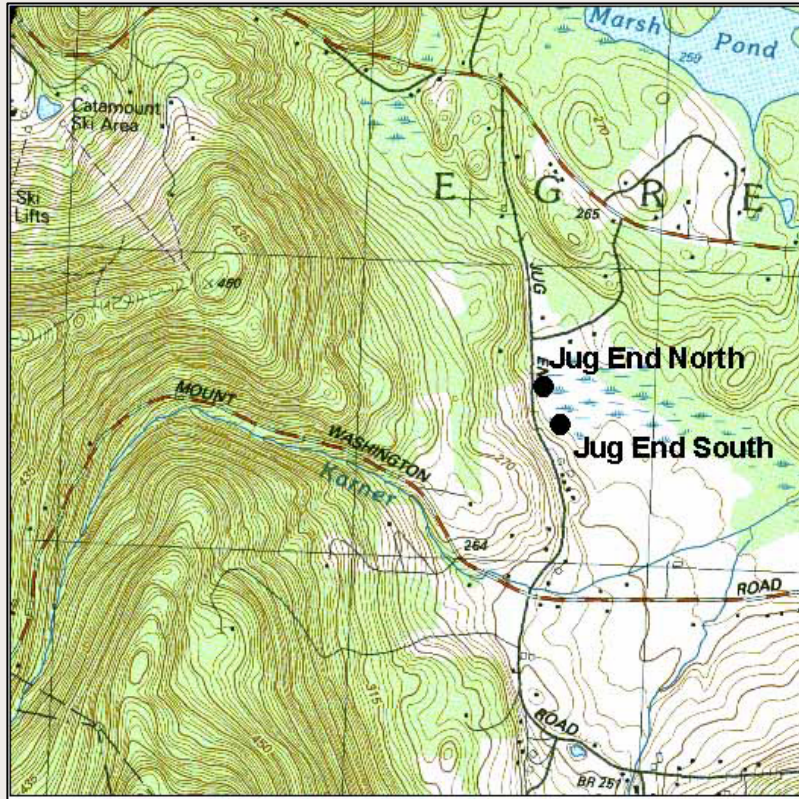 - And how these relate to calcium dynamics and plant distributions

Materials and Methods

- Site Locations
- Study Layout
- Hydrology
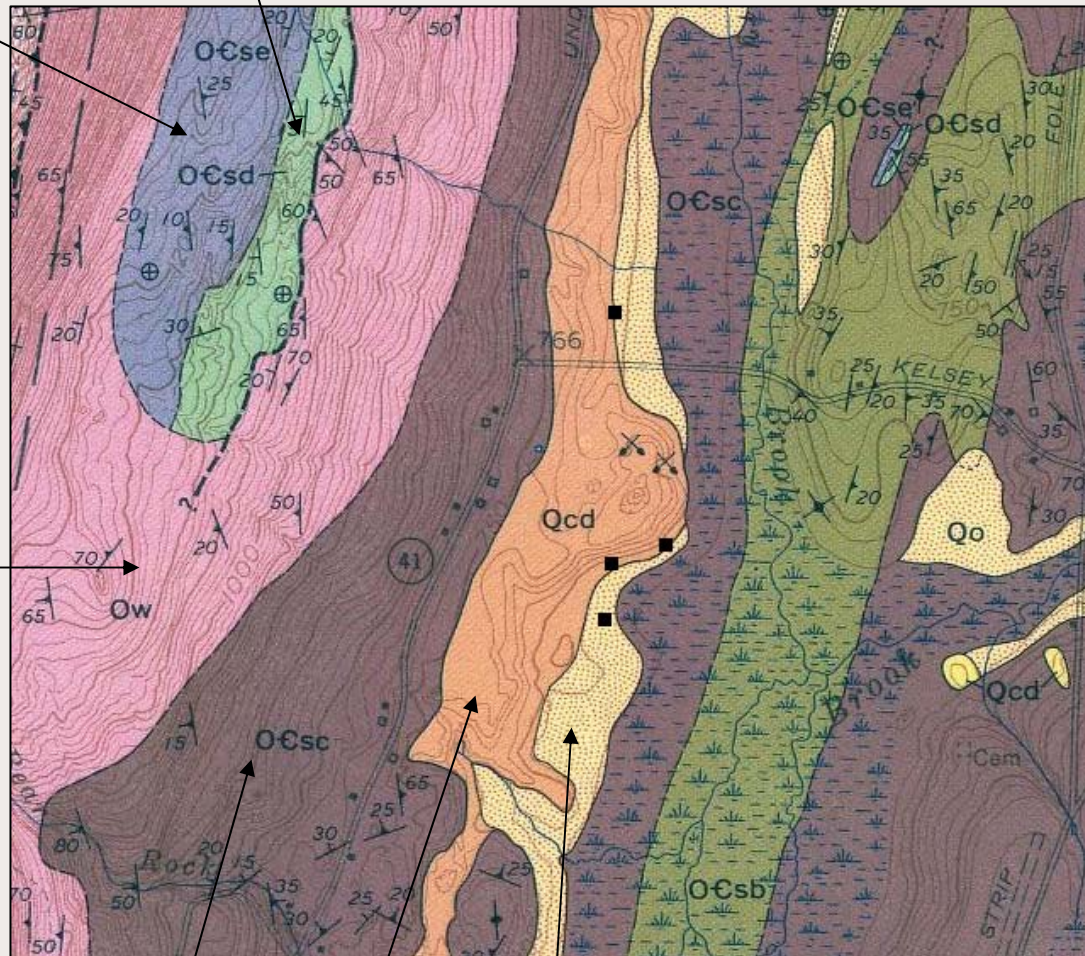- Water Chemistry
- Soils Properties

Site Locations
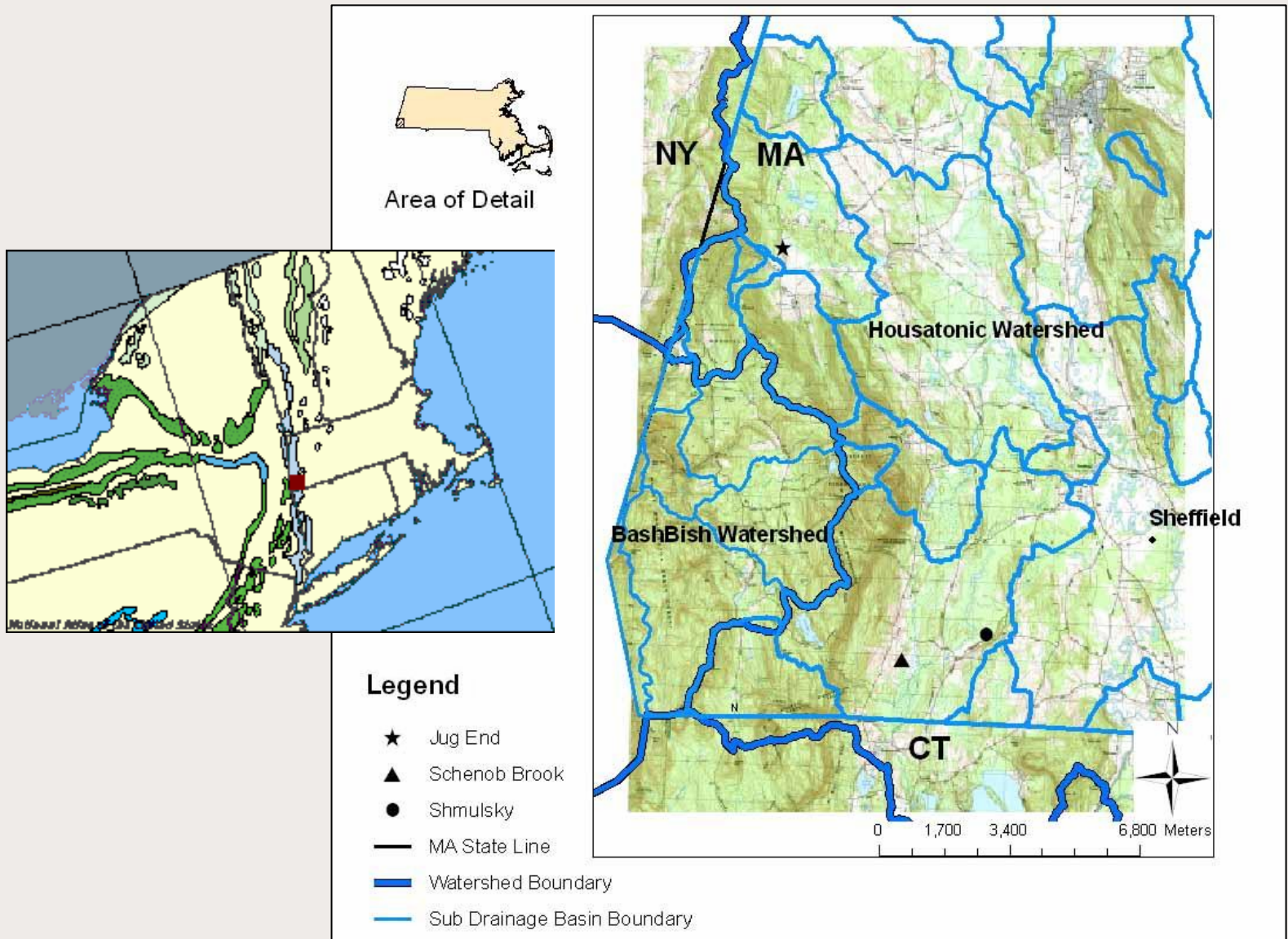
Topographic Setting

Geologic Setting

Study Layout

Geographic Location 1

Site 2

Site 1
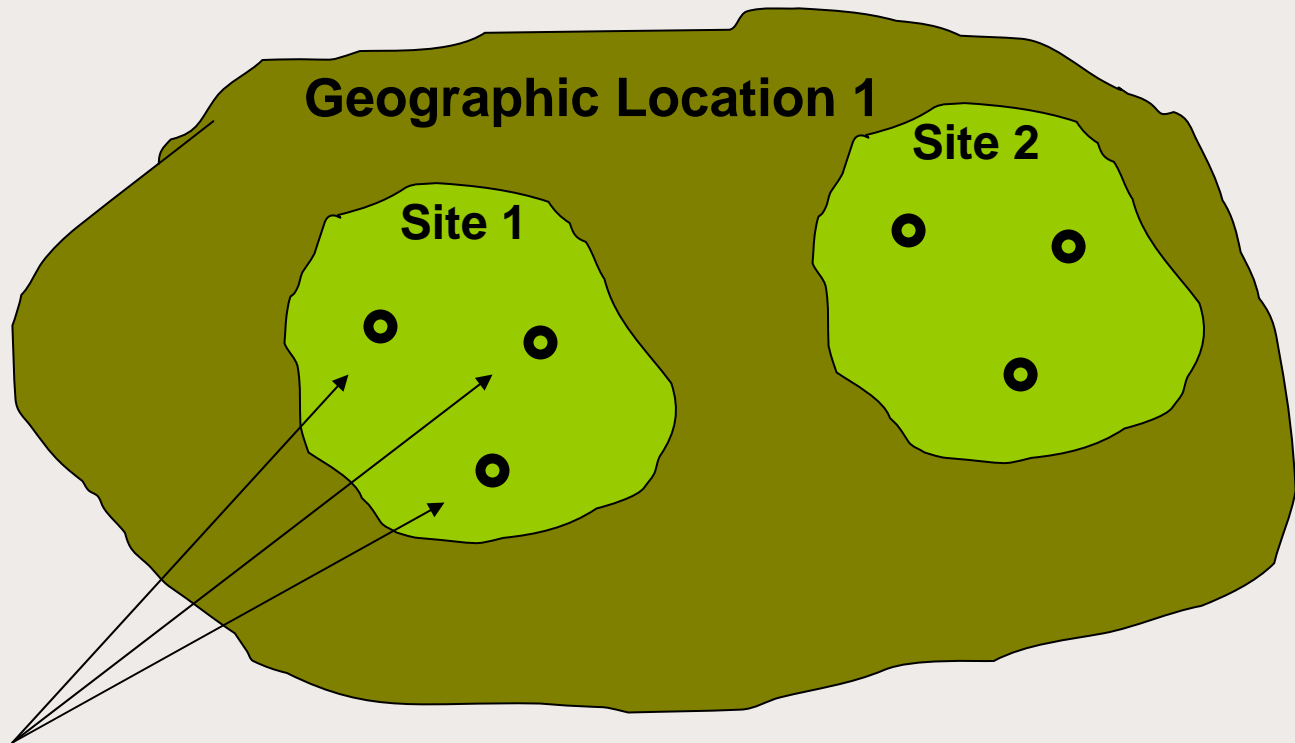
Three replicate sampling stations per site.

Hydrology

piezometers

Sampling station

well

veg plot

2.5m
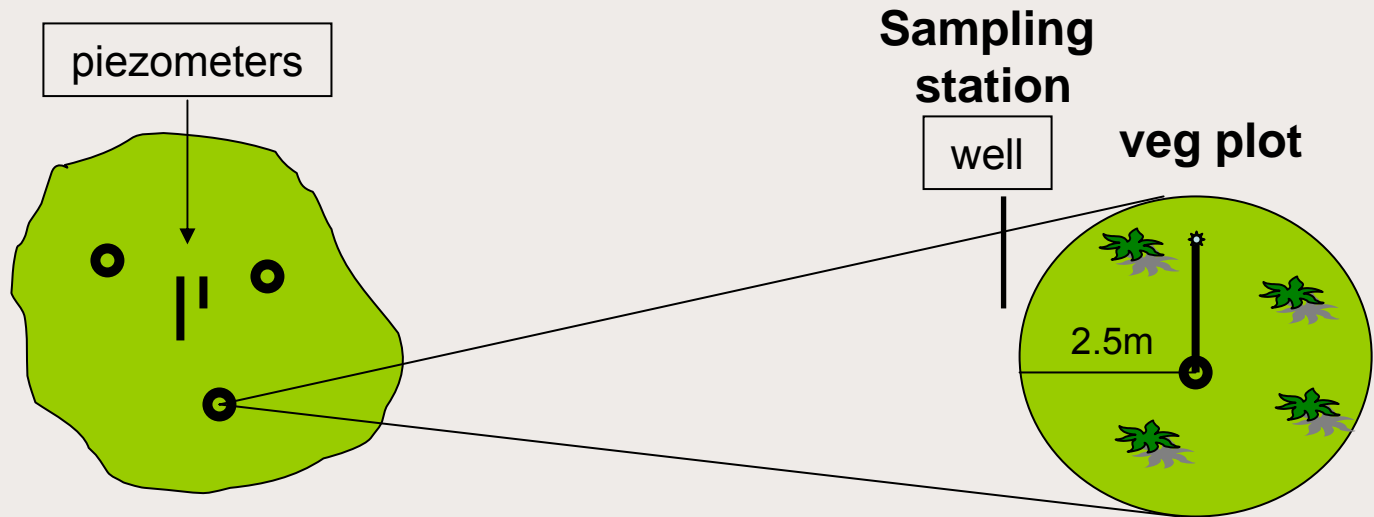
Hydrologic conditions were monitored bimonthly from April to October, 2006

- Wells (at 60cm)

- Nested Piezometers (depth varied)

- α, α dipyridyl was used to identify if reducing conditions were present in surface soils

Water Analysis

- Water was collected from suction lysimeters (at 30cm) and analyzed
  - bimonthly for pH, Calcium, Magnesium
  - monthly for Iron (Total), Nitrogen (NH_4^+), Phosphorus (PO_4^{3-}), and Potassium

Water chemistry was monitored from May to October, 2006
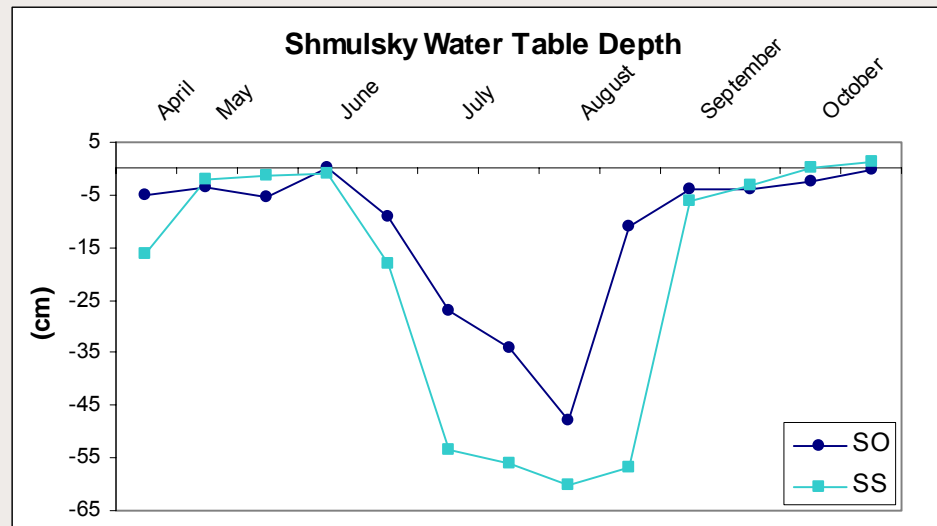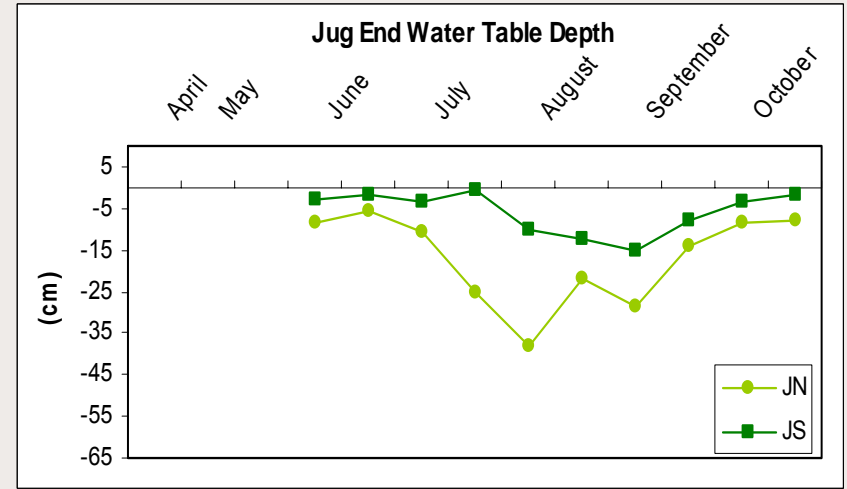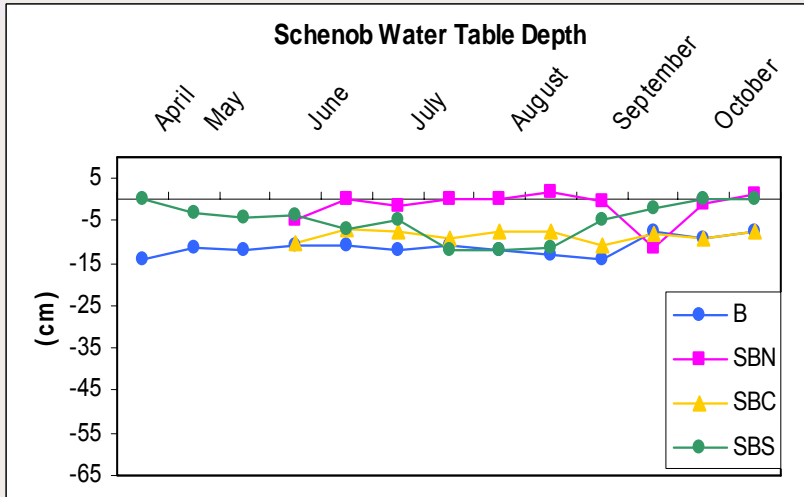
well

lysimeter

2.5m
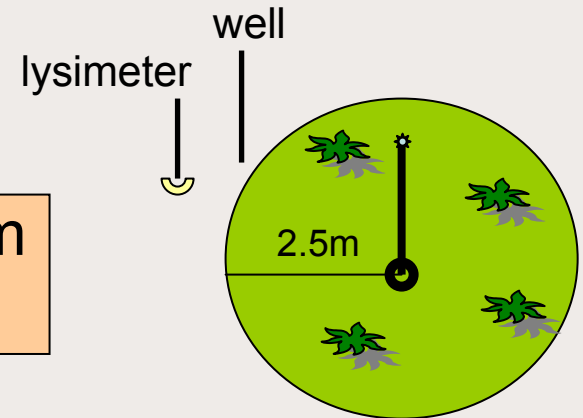
Soil Analysis

- Soil profiles were described (horizons, depth, color).

- Samples were collected from each major horizon in July and analyzed for
  - Exchangeable Calcium, Magnesium, Iron, Phosphorus, Potassium and Total Nitrogen
  - Texture
  - Organic matter
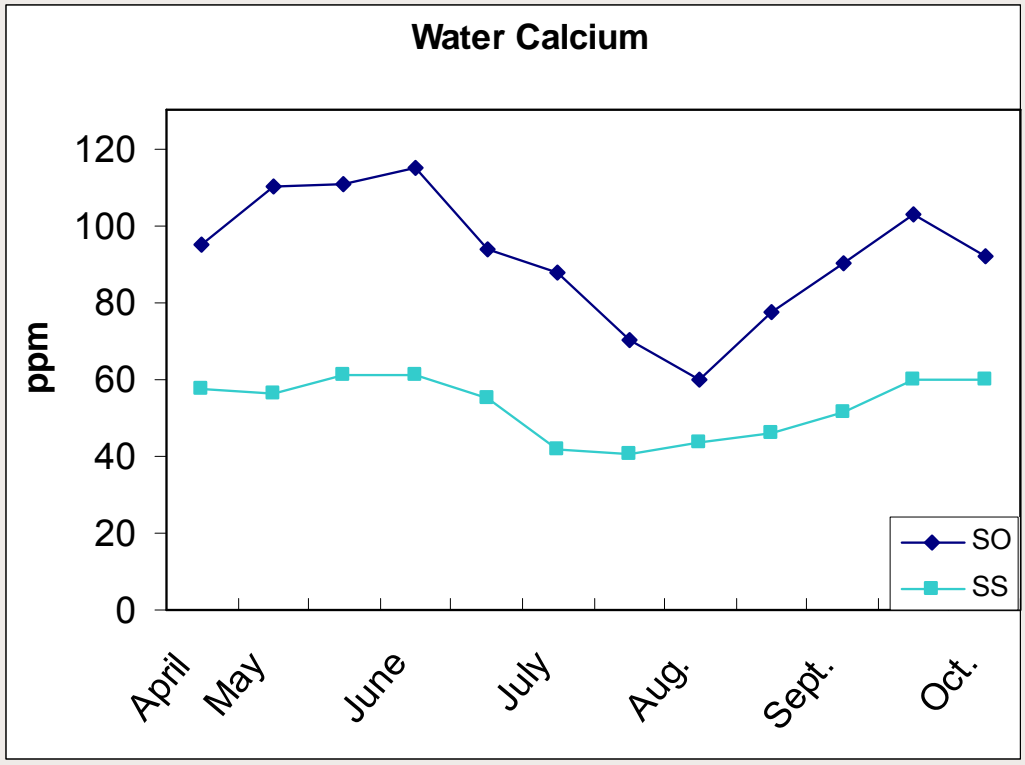 - Carbonates
  - pH

lysimeter   well   soil sample
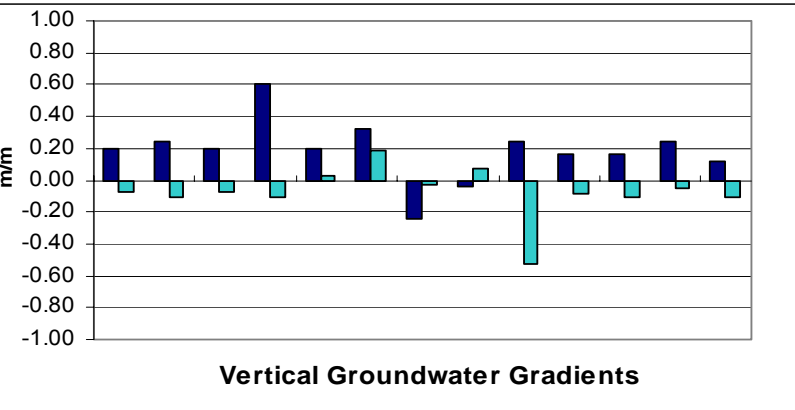
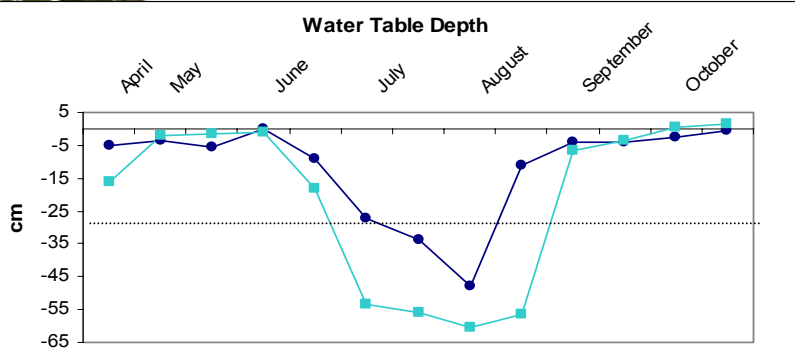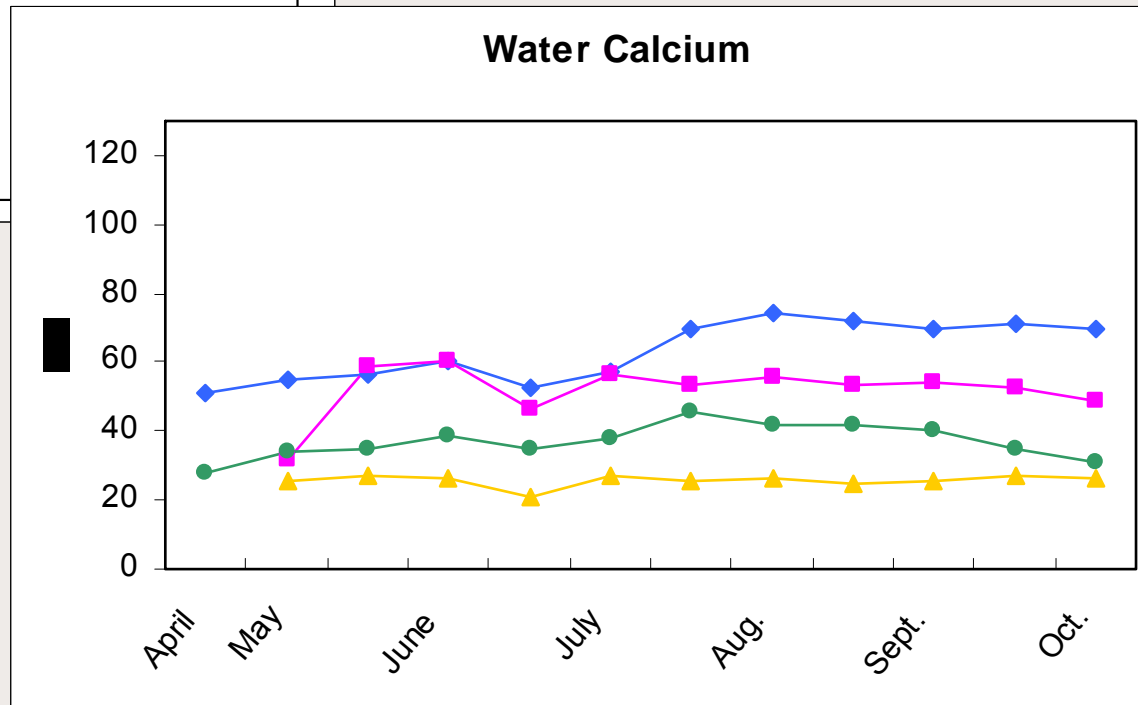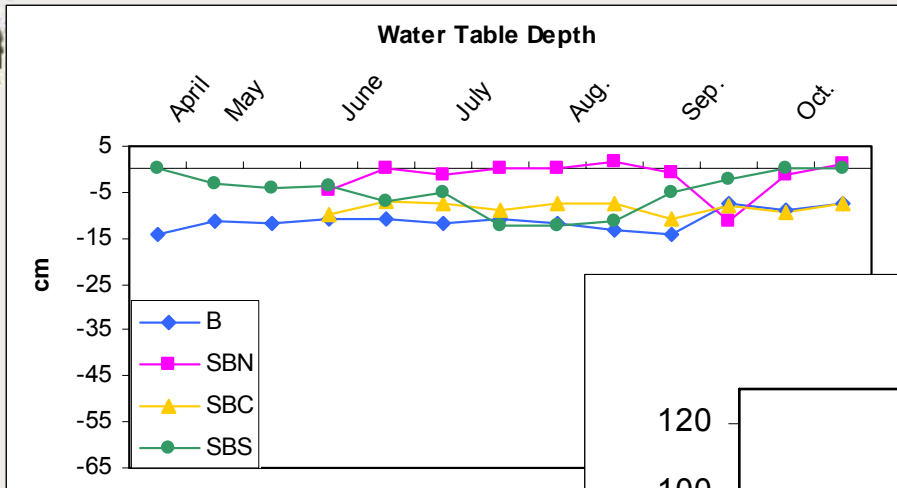2.5m
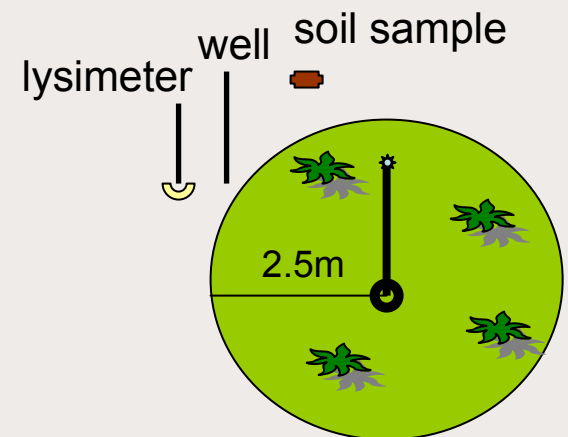
Results: Hydrology Overview

Results: Hydrologic relationships
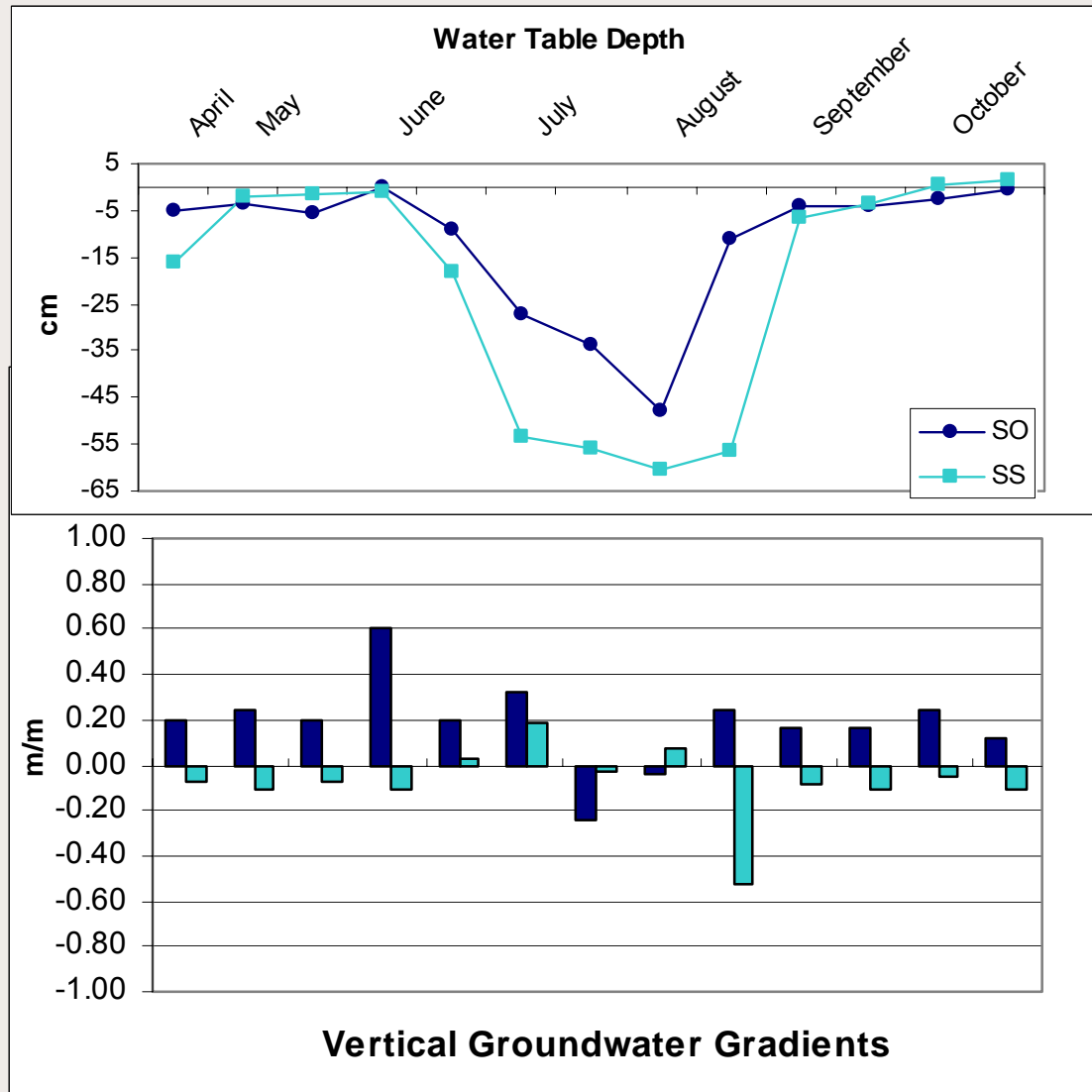
Shmulsky Location

Hydrogeochemical Relationships

Shmulsky Location

Hydrogeochemical Relationships

Water Table Depth

Water Calcium

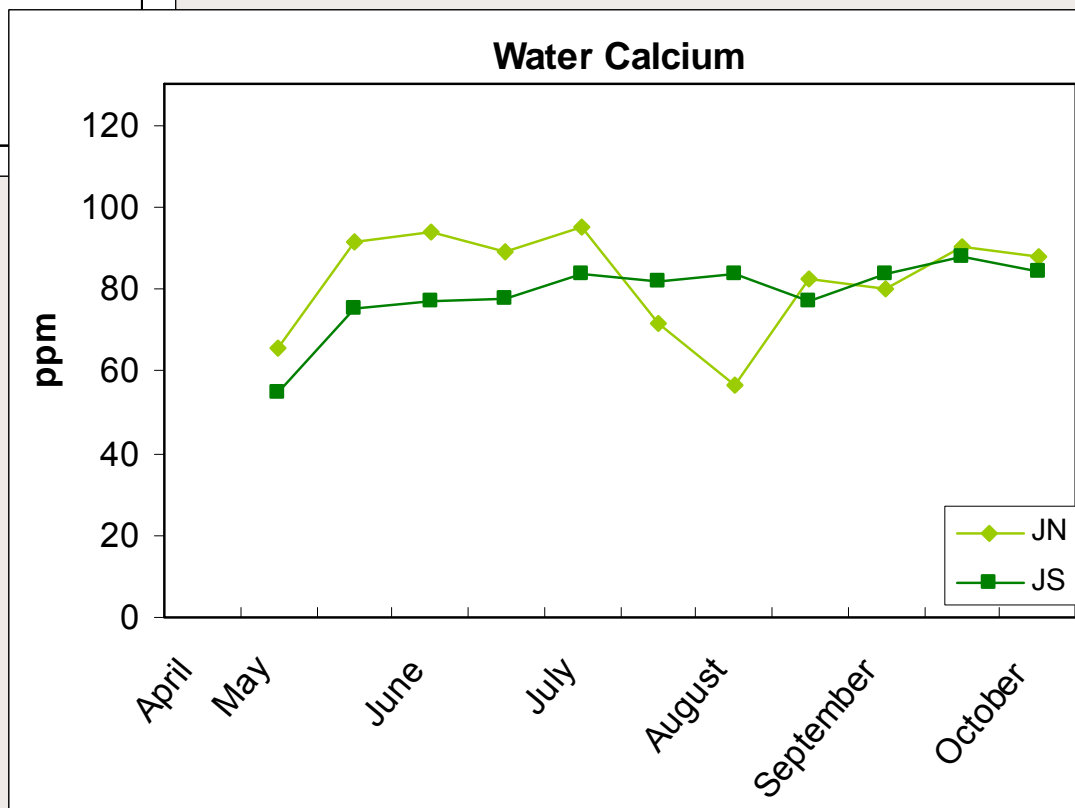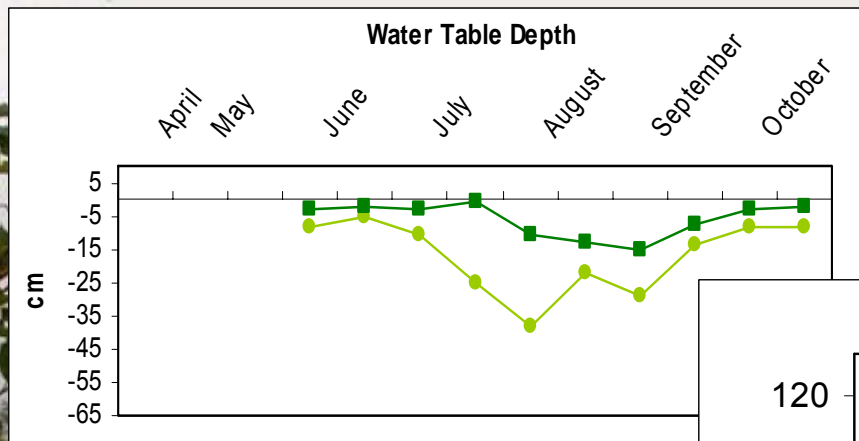## Vertical Gradients

Mostly flow through

Discharge conditions throughout the season

Recharge conditions throughout the season

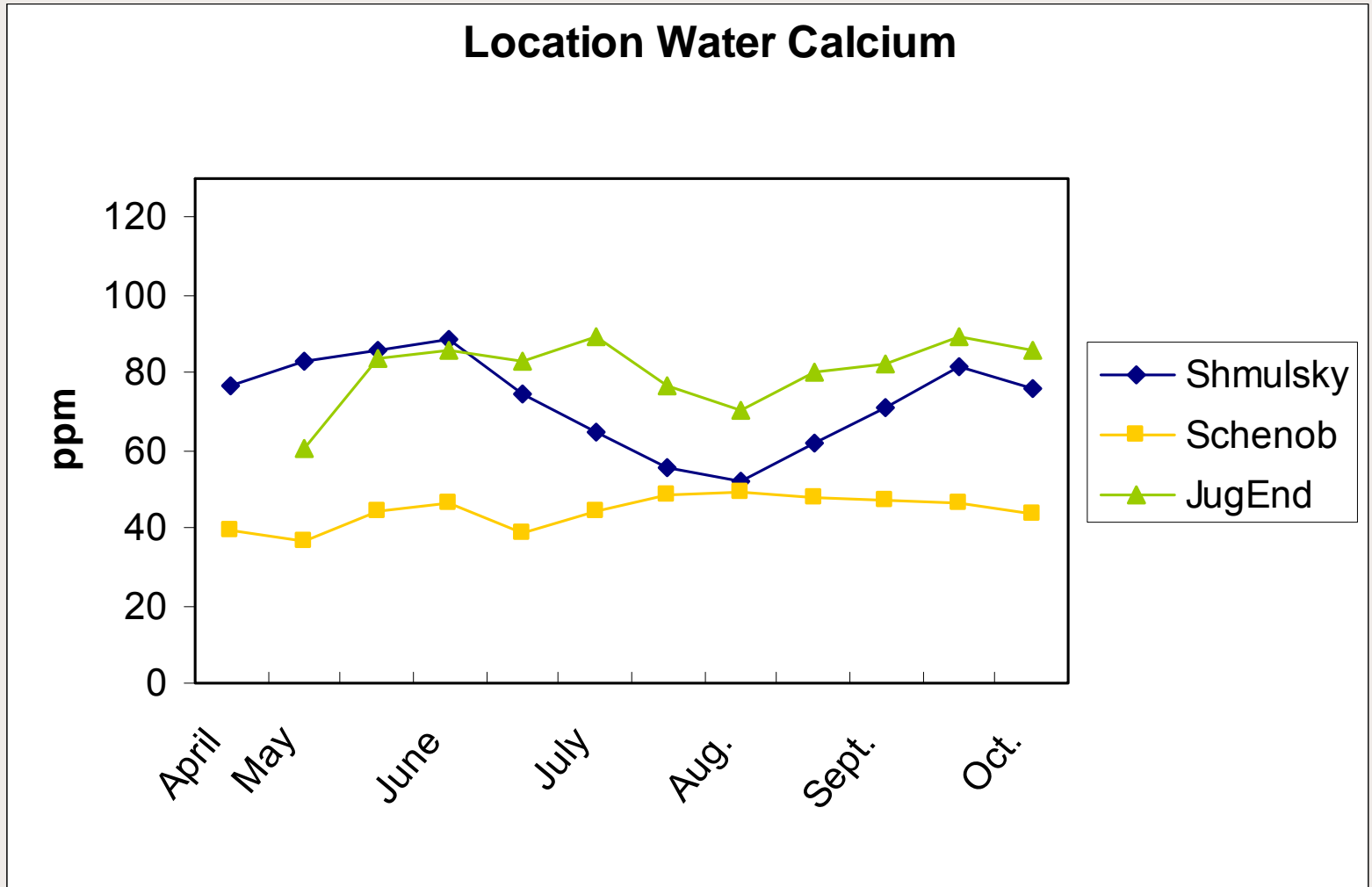Schenob Brook Location

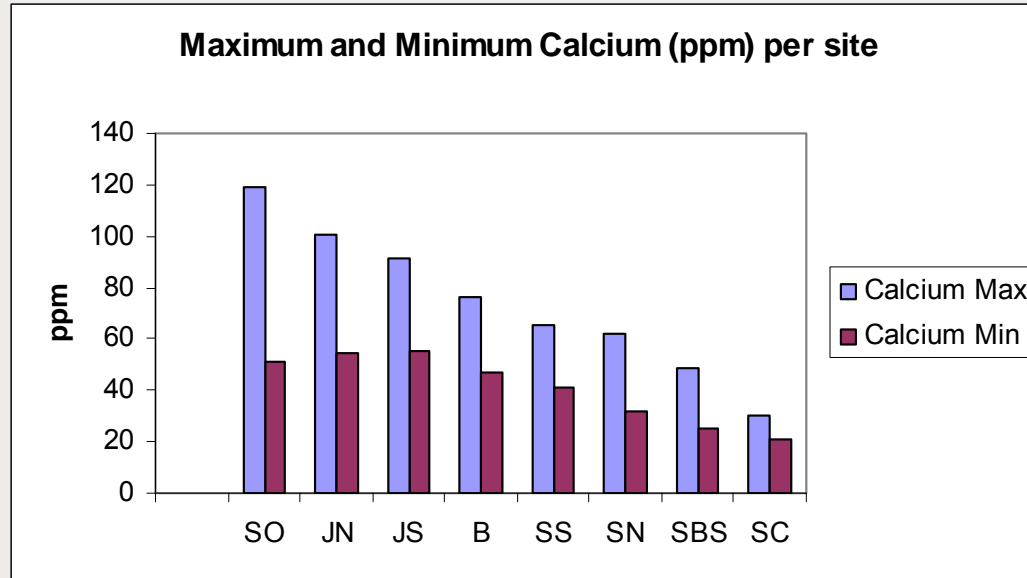# Hydrogeochemical Relationships

Water Table Depth

Water Calcium

Vertical Gradients

■ Flow through

● Flow through with strong recharge in July followed by Discharge.

JN

JS

Jug End Location

Calcium Trends

Future Analysis

Maximum and Minimum Calcium (ppm) per site

Calcium values at all study points ranged from 20-120ppm

- Relate this wide range of fen Calcium values to
  - Species distribution patterns
  - Plant tissue calcium levels by species

Acknowledgements

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- Dr. Allen Barker
- Dr. Lynn Adler
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Questions?