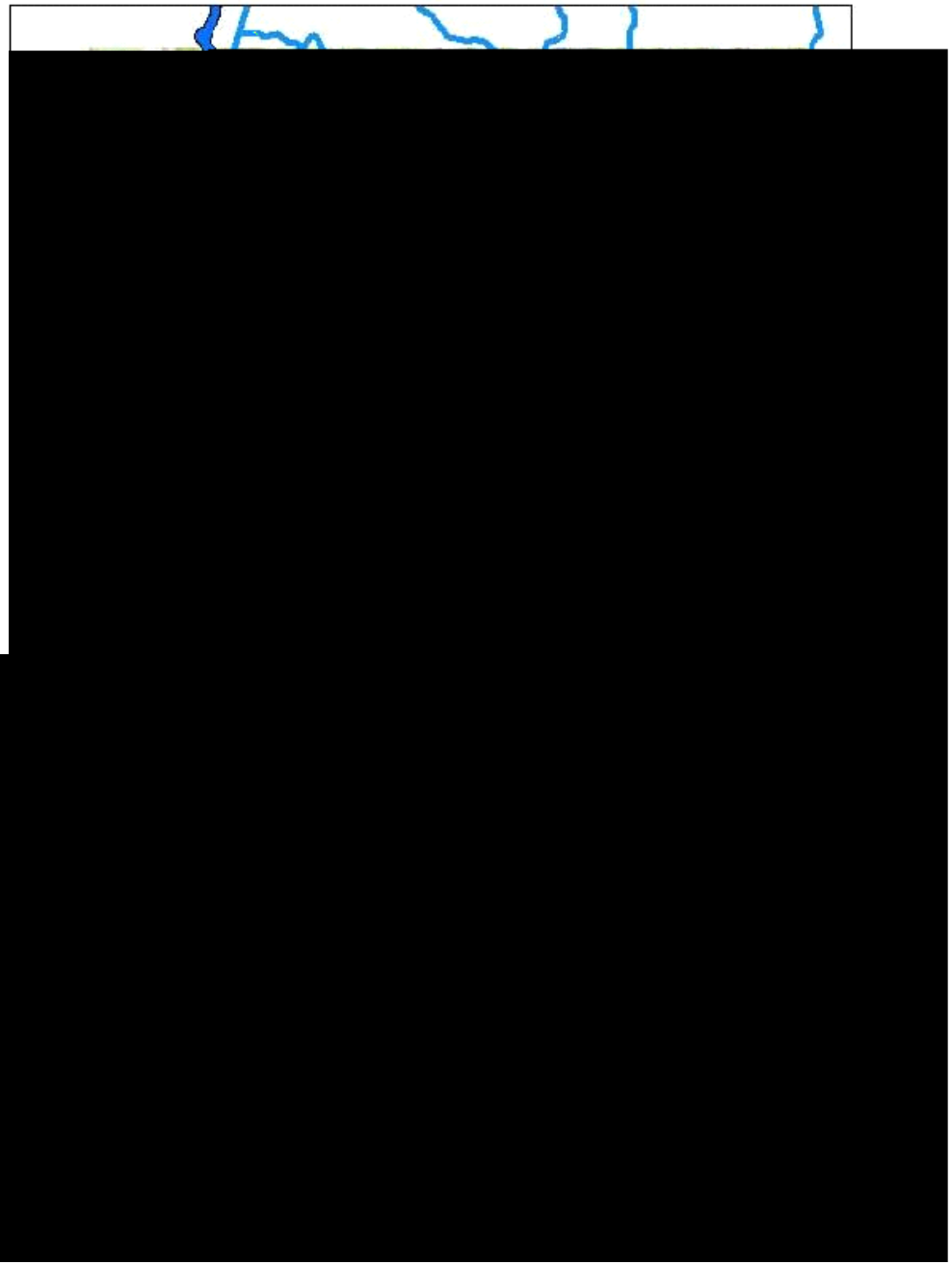
Hydropedology: NE 1021

On going studies conducted at the University of Massachusetts Amherst

HYDROLOGY, GEOCHEMISTRY, & SOILS OF CALCAREOUS FENS

J. Morgan



Introduction

- **Evaluated the hydrologic factors that exist in calcareous fens.**
- **Documented the level of calcium enrichment and pH that occurred in eight study sites across the three geographic locations.**
- **The hydrology and geochemistry were compared to examine the relationship between the two.**

Materials and Methods

Hydrologic Measurements

- nested piezometers (100 cm and 150 cm)
- 5-cm diameter PVC well (screened from 0-60 cm)
- suction lysimeter (30 cm depth; 0.1 MPa air entry value)

Materials and Methods

Water Chemical Analysis

One sample each month was analyzed for nutrients:

- orthophosphate - Ascorbic Acid method (SM 4500-P.E)
- ammonium - Nessler's method (SM 4500-NH_3.C)
- total iron - Ferrover method (SM 3500-Fe.D)

Materials and Methods

Water Chemical Analysis

After nutrient analyses the remaining sample was acidified (with 1μL 1.0 M HNO_3) stored at 4°C. Additional analysis was for:

- calcium (3500-Ca.B)
- magnesium (3500-Mg.B)
- potassium (3500-K.B).

Soil Analysis

Samples were characterized physically and chemically for the uppermost horizons

- **Particle size analysis (pipette method)**
- **Bulk density (core method)**
- **Percent organic matter (loss on ignition)**
- **pH (water method)**
- **Exchangeable calcium, magnesium, and potassium (ammonium acetate method)**
- **Extractable phosphorus and iron (AB-DTPA method)**
- **Total nitrogen (Dumas method)**

Results & Discussion

Vertical groundwater gradients at locations:

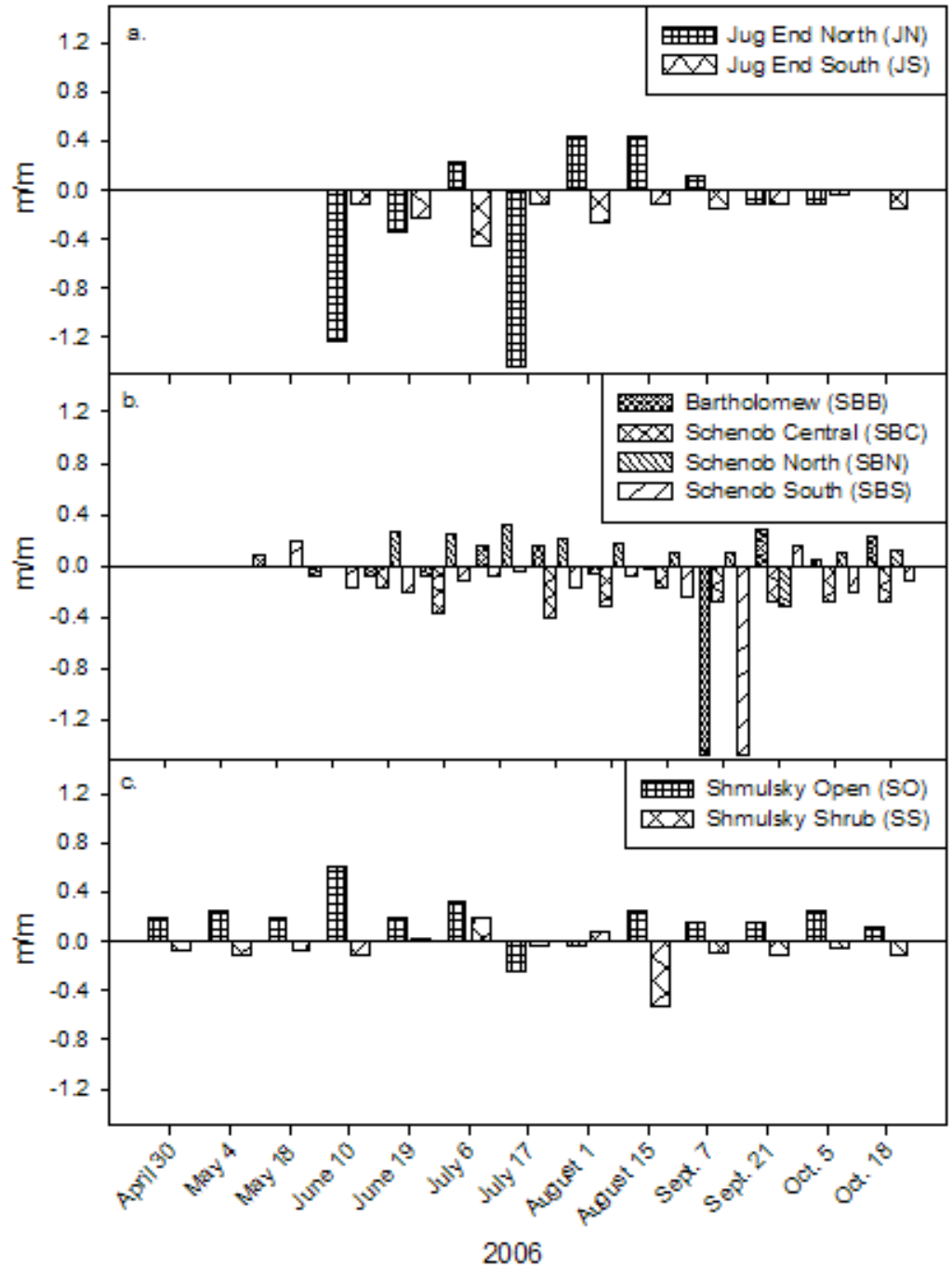
a) Jug End,

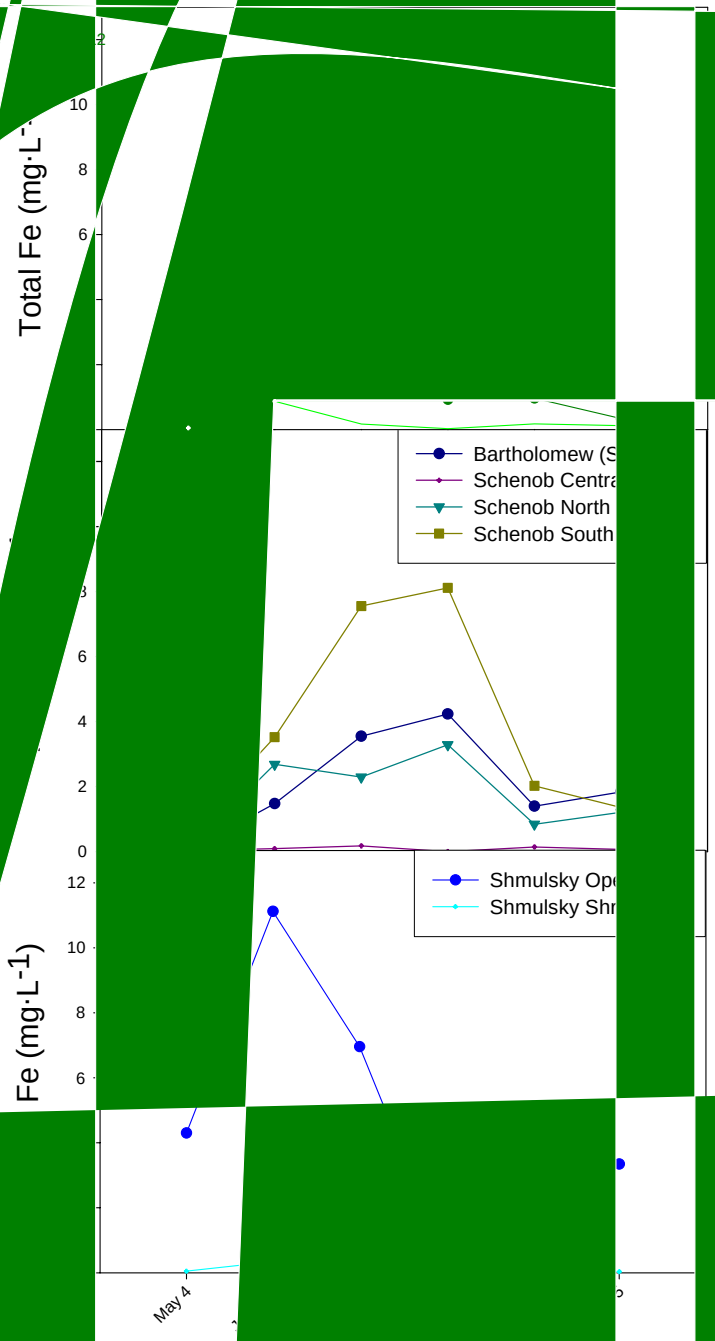
b) Schenob Brook,

c) Shmulsky.

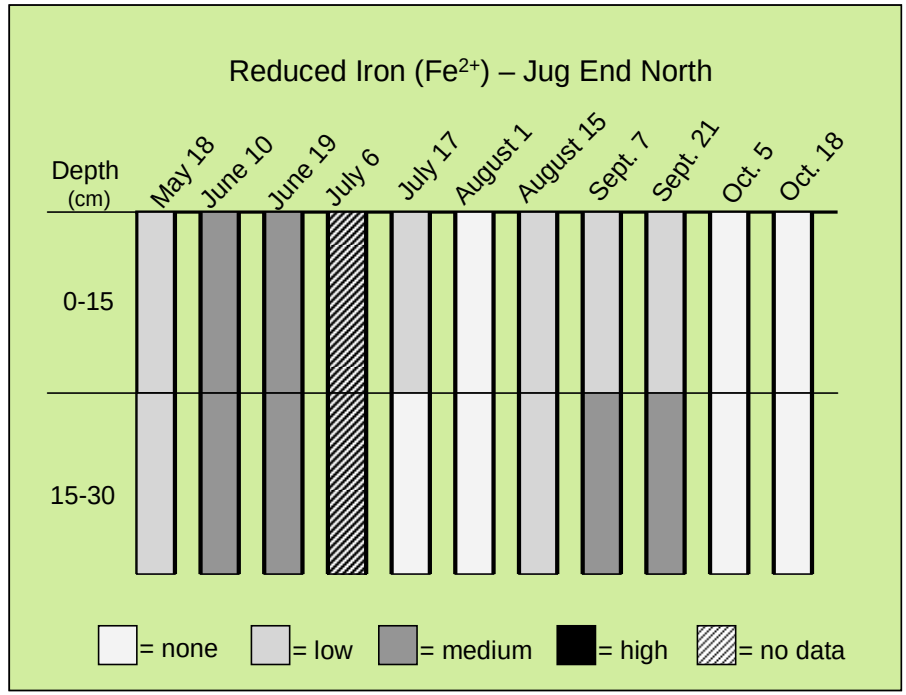
Values greater than zero represent discharge conditions; values less than zero represent recharge conditions.

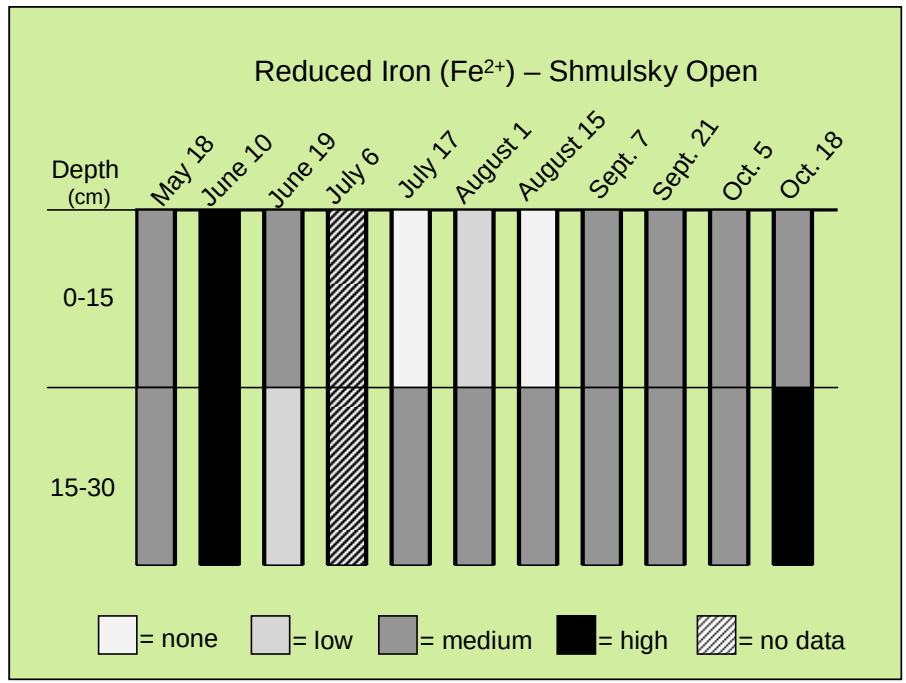
Each bar represents one pair of piezometers at a central location in each site.




Total Fe (mg·L-1)
Fe (mg·L-1)
Bartholomew (S
Schenob Centra
Schenob North
Schenob South
Shmulsky Ope
Shmulsky Shr
May 4

Results & Discussion





Results of α, α-dipyridyl assessment of redox status of surface soil horizon. Presence of reduced iron indicates anaerobic conditions.

Soil physical and chemical properties for the 8 study sites. Data are the mean of 3 soil samples collected from 3 soil pits at each site.

Location	Site	pH	Organic Matter	Total N	AB-DTPA Extractable Elements (pH 7.6)		Exchangeable cations (NH_4OAc, pH 7)			
					P	Fe	Ca	Mg	K	Fe
			% by wt.	---------- mg kg^{-1} ----------						
Jug End	JN	7.3 ab	14.0 bc	5646 bc	1.1 a	99.0 cd	3132 b	335.7 cd	39.6 a	0.7 a
	JS	7.5 a	11.1 c	4653 c	1.3 a	63.9 bd	2649 b	289.7 d	31.5 a	0.8 a
	Mean	7.4 A	12.5 A	5150 A	1.5 A	81.5 A	2891 A	312.7 A	35.6 A	0.7 A
Schenob Brook	SBB	7.0 abc	17.1 bc	7630 abc	2.0 a	137.5 bcd	3914 b	459.8 bcd	59.1 a	1.4 a
	SBC	6.8 abc	10.6 c	3620 c	2.1a	89.4 cd	2483 b	335.2 cd	41.9 a	2.8 a
	SBN	6.4 bc	51.1 a	14843 a	2.5 a	267.0 ab	7968 a	1204.1 a	90.8a	3.7 a
	SBS	6.1 d	35.0 ab	14323 ab	4.2 a	401.3 a	5232 a	780.9 b	216.6 a	6.8 a
	Mean	6.5 B	26.6 B	10104 B	2.7 B	222.3 B	4900 B	695.0 B	104.7 B	3.7 B
Shmulsky	SO	6.4 bc	26.1 abc	10513 abc	1.8 a	162.7 abc	4907 b	681.8 bc	36.4 a	1.3 a
	SS	6.8 abc	13.9 bc	6246 abc	1.3 a	127.1 bcd	2926 b	401.4 cd	34.8 a	1.1 a
	Mean	6.6 B	20.0 AB	8380 AB	1.2 A	144.9 B	3916 AB	541.6 B	35.6 A	1.2 B

Means with different letters are significantly different by Tukey's Test (p=0.05). Uppercase letters represent differences among locations and lowercase letters represent differences among the eight sites.

Seasonal range and seasonal mean of water magnesium, calcium, and Ca/Mg ratio for the eight study sites.

Location	Site Code	Seasonal Calcium Range	Seasonal Mean Calcium	Seasonal Magnesium Range	Seasonal Mean Magnesium	Seasonal Ca:Mg Range	Seasonal Mean Ca:Mg
		---------- mg L^{-1} ----------					
Jug End	JN	37.0-112.5	82.1 ab	30.0-60.5	42.5 ab	1.41-2.31	1.91 ab
	JS	47.3-95.0	78.9 ab	32.0-59.0	44.1 ab	1.39-2.13	1.78 bc
	Location mean:		80.5 A		43.3 A		1.85 A
Schenob Brook	SBB	42.5-78.5	63.2 bc	17.3-42.5	29.1 c	1.96-2.60	2.12 q
	SBC	16.3-37.8	25.7 e	9.3-30.0	16.2 d	1.41-1.82	1.62 cd
	SBN	22.0-73.5	52.0 cd	14.8-42.0	32.7 bc	1.41-1.93	1.55 cd
	SBS	22.5-52.5	36.9 de	15.3-37.5	24.8 cd	1.29-1.69	1.47 d
	Location mean:		44.4 B		25.7 B		1.69 B
Shmulsky	SO	38.0-133.5	92.0	23.0-70.0	54.0 a	1.49-2.01	1.71 bcd
	SS	33.5-74.5	52.9	25.0-46.5	32.4 bc	1.27-1.91	1.63 bcd
	Location mean:		72.4 A		43.2 A		1.67 C

Means with different letters are significantly different by Tukey's Test (p=0.05). Uppercase letters represent differences among locations and lowercase letters represent differences among the eight sites.

Conclusions

- **Significant differences in water and soil calcium, magnesium, and pH were observed among study sites and among locations**
- **Differing trends in water table depth and vertical groundwater gradients.**

Conclusions

- **Water table depth and vertical groundwater gradients could not be correlated to each other as it was determined that sites were receiving water through different mechanisms (directly upwelling or lateral flow from upwelling zones).**
- **The level of upwelling seemed to control the average water calcium level, but the fluctuation in the water table seemed to govern how that calcium varied across the season.**

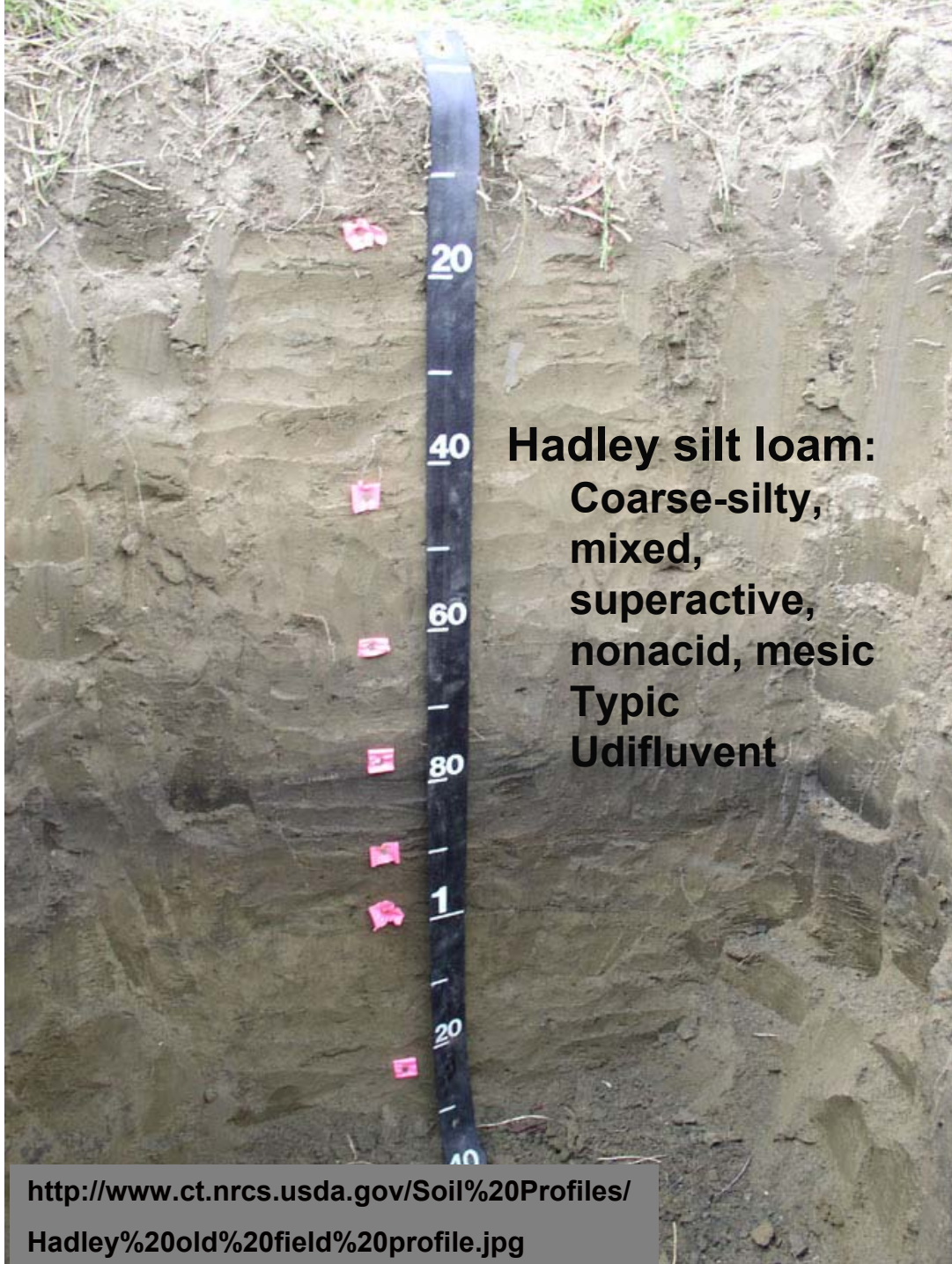
Investigation of Hadley Soils

M. Nowak

http://www.olturtlefarm.com/images/man_with_lettuce.png

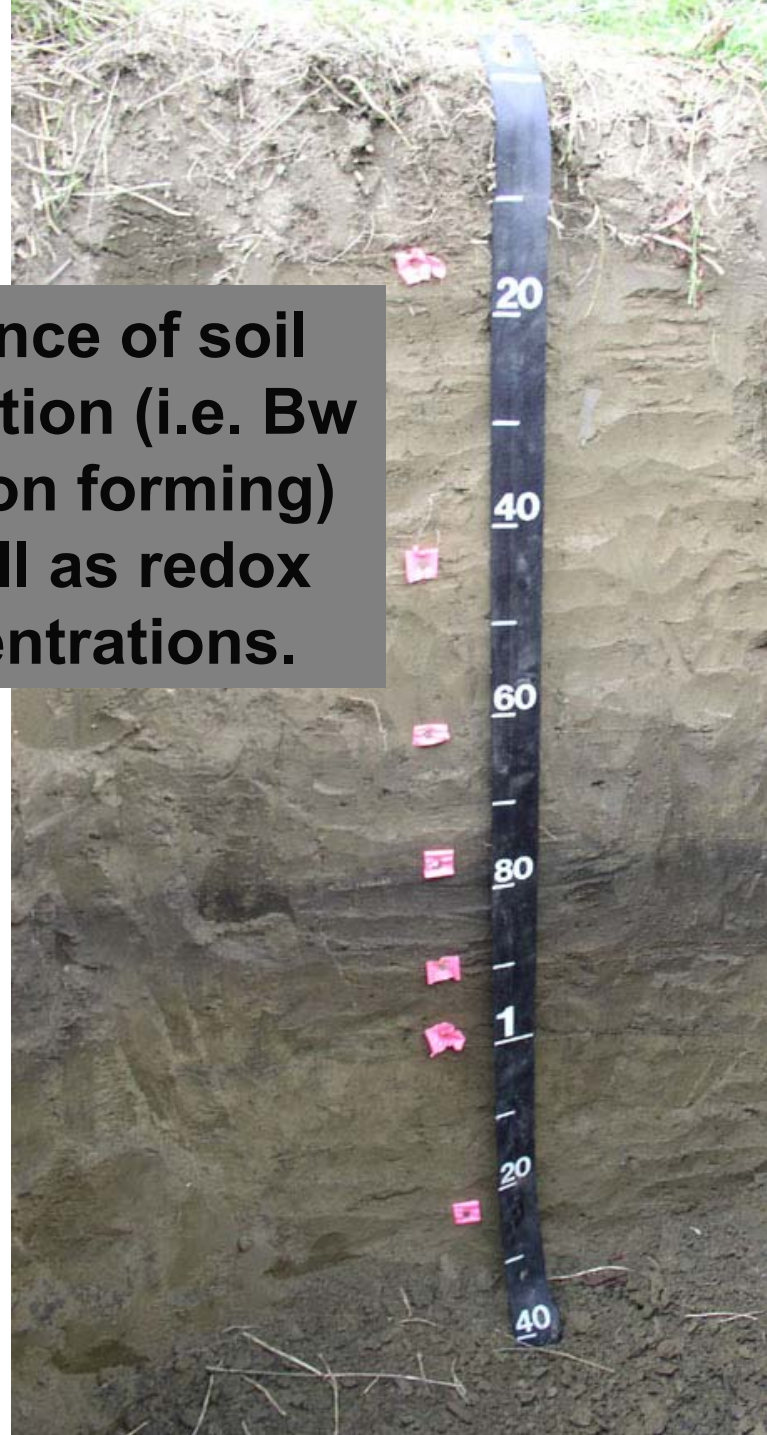
Hypothesis

Much of the area mapped as Hadley silt loam (Entisols) has undergone enough soil formation to be considered Inceptisols.



http://www.ct.nrcs.usda.gov/Soil%20Profiles/Hadley%20old%20field%20profile.jpg

Evidence of soil formation (i.e. Bw Horizon forming) as well as redox concentrations.



Soil Iron

Primary coloring agent of subsoil

Quantitative analysis can determine:

- **Relative soil age**
- **Conditions of soil formation**
- **Mineral transformations**
- **Alternating reducing/oxidizing conditions**

Laboratory Analysis

Procedures designed to target specific fractions of soil Fe

- **Total or free Fe oxide**
  - **Dithionite-citrate extraction**
- **Poorly crystalline or amorphous Fe oxide**
  - **Ammonium oxalate extraction**
- **Organically bound Fe oxide**
  - **Sodium pyrophosphate extraction**

Particle Size Analysis*

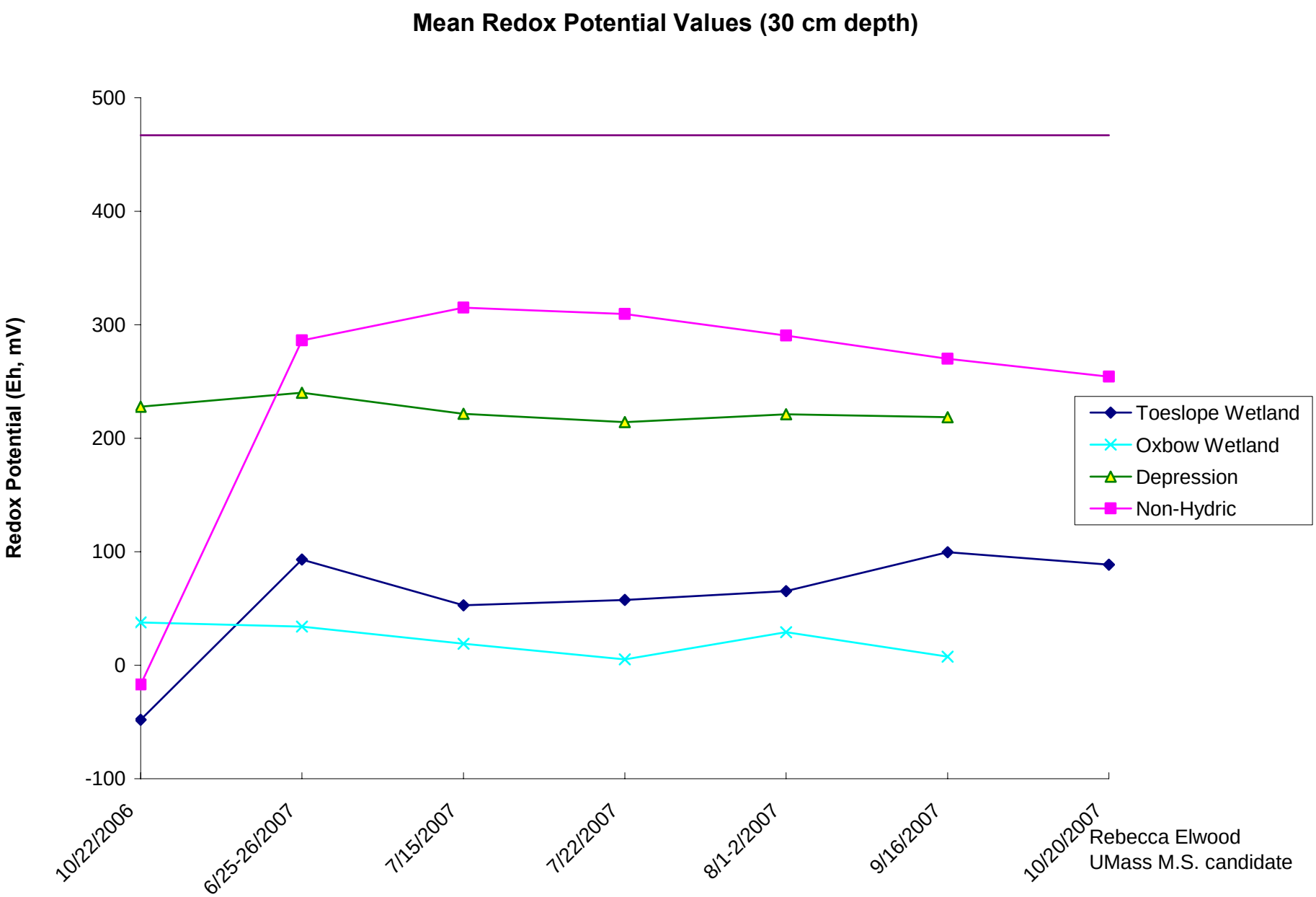
	Silt Content	Clay Content
Average	42.5%	4.9%
Maximum	77.1%	20.5%
Minimum	13.4%	0.5%
Median	37.8%	3.7%

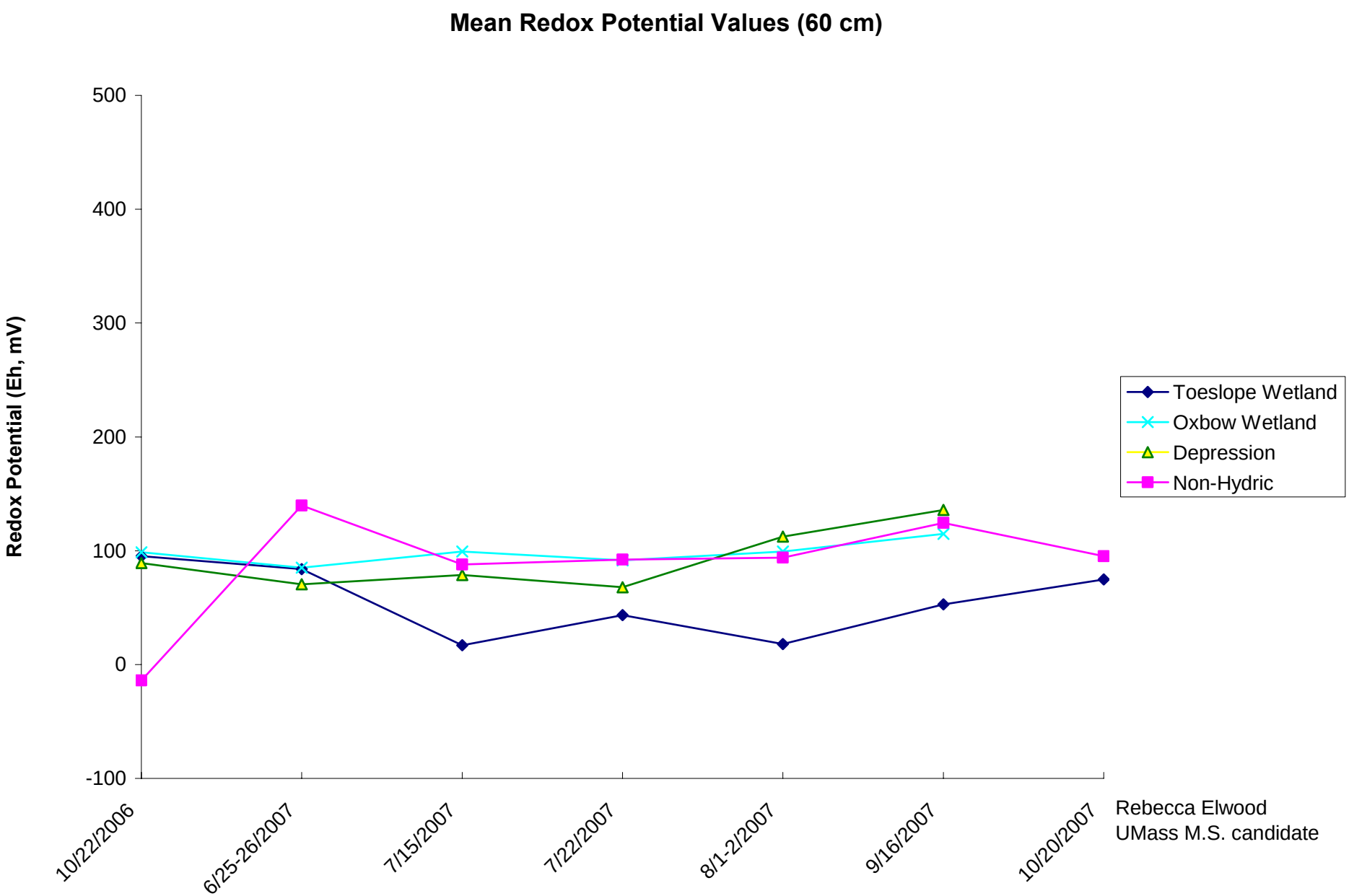
* 38 of 92 samples analyzed – of the 25 profiles, most samples currently analyzed are C Horizons

Riparian Zone Investigation Guilford, CT

Rebecca Elwood

- **Wells, piezometers, and redox probes were placed in six locations along an approximately 100-meter transect.**
- **The riparian zone is a mixed hardwood area containing a toe slope wetland at the base of an approximately 15%, slightly convex slope and an oxbow wetland.**
- **Between the two wetland areas is a section of subtle ridge and swale topography. The surrounding land contains common outcrops of gneiss and schist.**


Mean Redox Potential Values (30 cm depth)
Redox Potential (Eh, mV)
500
400
300
200
100
0
-100
10/22/2006
6/25-26/2007
7/15/2007
7/22/2007
8/1-2/2007
9/16/2007
10/20/2007
Toeslope Wetland
Oxbow Wetland
Depression
Non-Hydric
Rebecca Elwood
UMass M.S. candidate


Mean Redox Potential Values (60 cm)
Redox Potential (Eh, mV)
500
400
300
200
100
0
-100
10/22/2006
6/25-26/2007
7/15/2007
7/22/2007
8/1-2/2007
9/16/2007
10/20/2007
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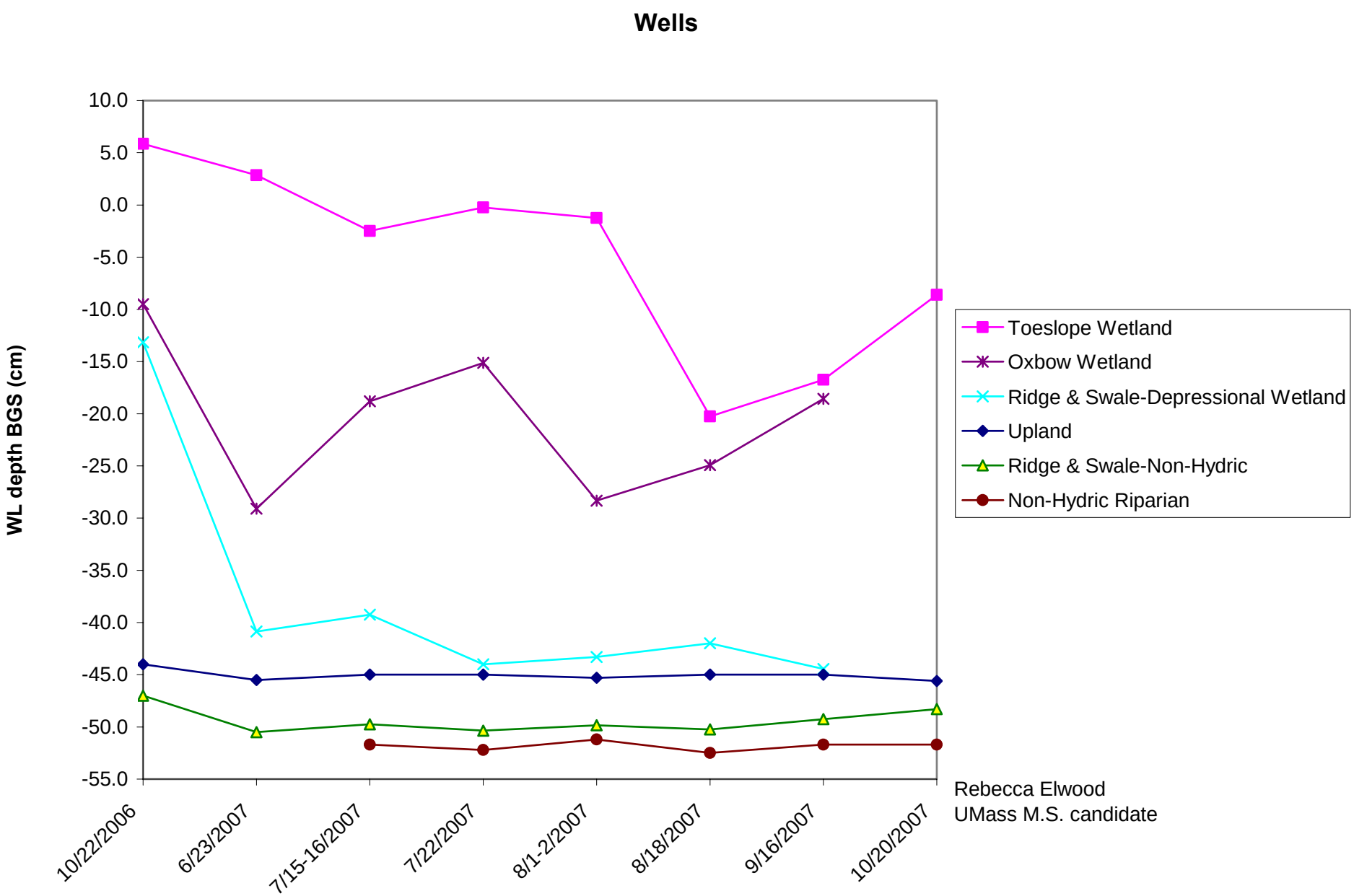
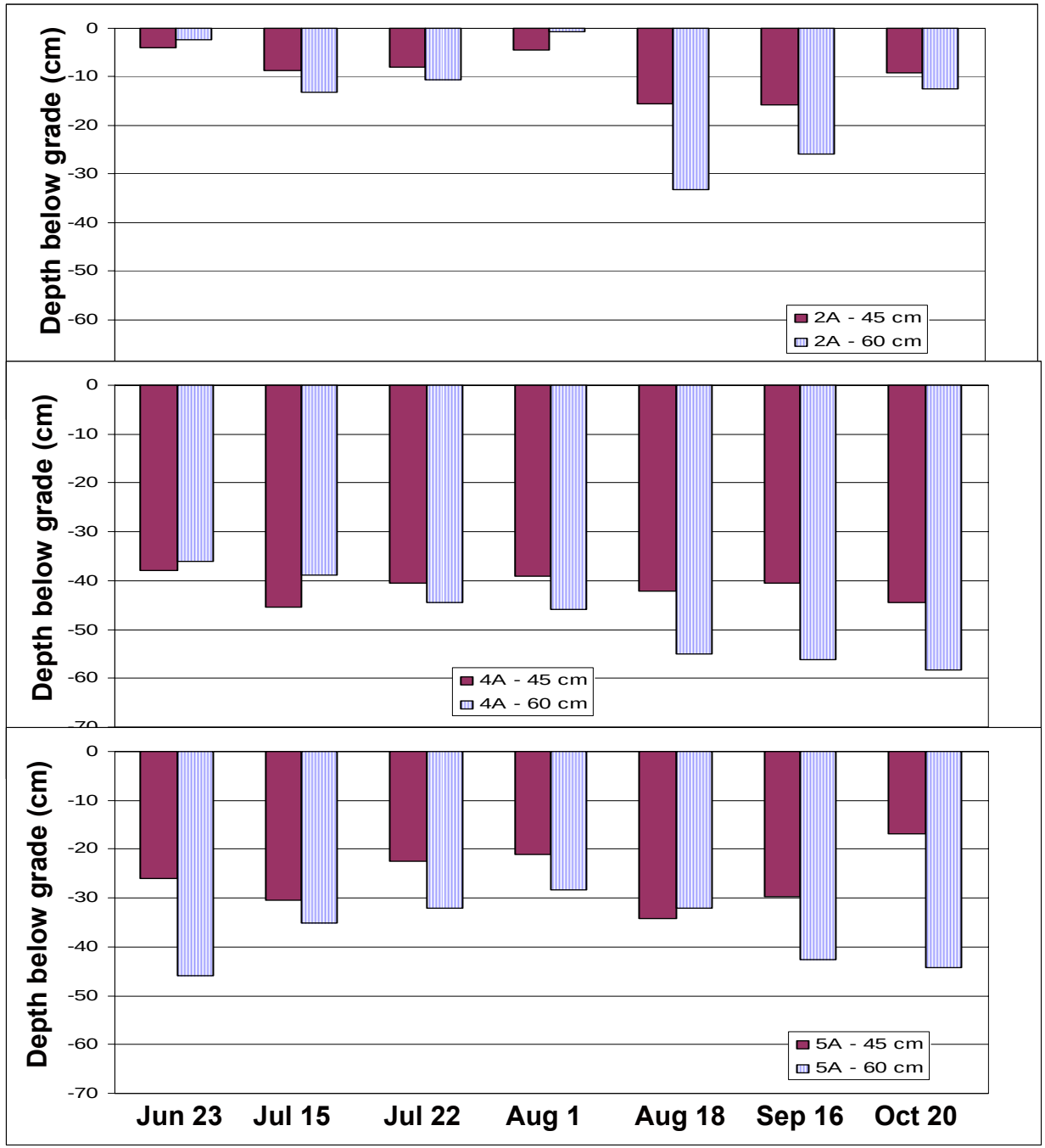


Rebecca Elwood
UMass M.S. candidate

Piezometer Data

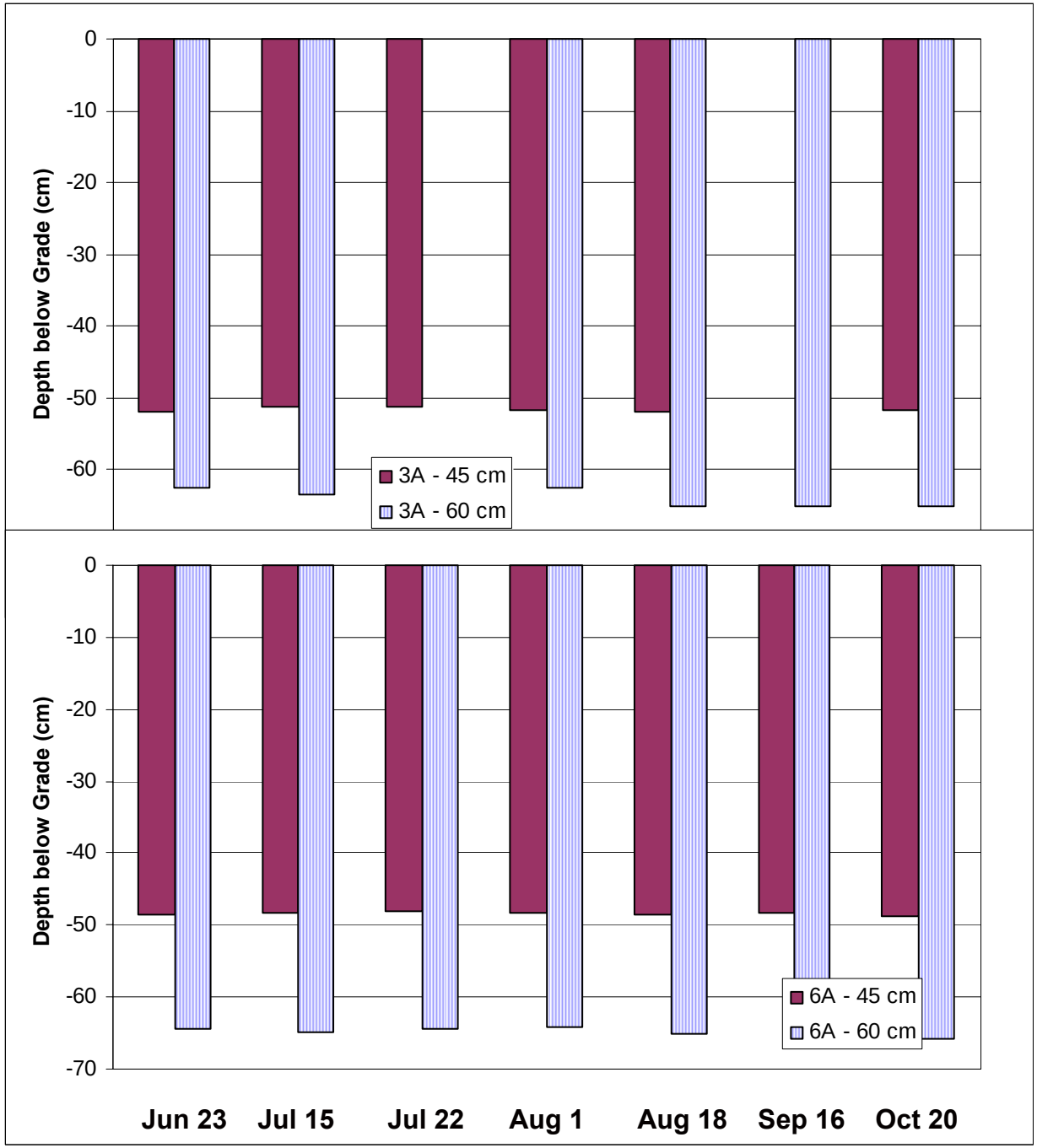


Station 2 =Toeslope wetland

Station 4 = Ridge & swale depressional wetland

Station 5 = Oxbow wetland

Piezometer Data



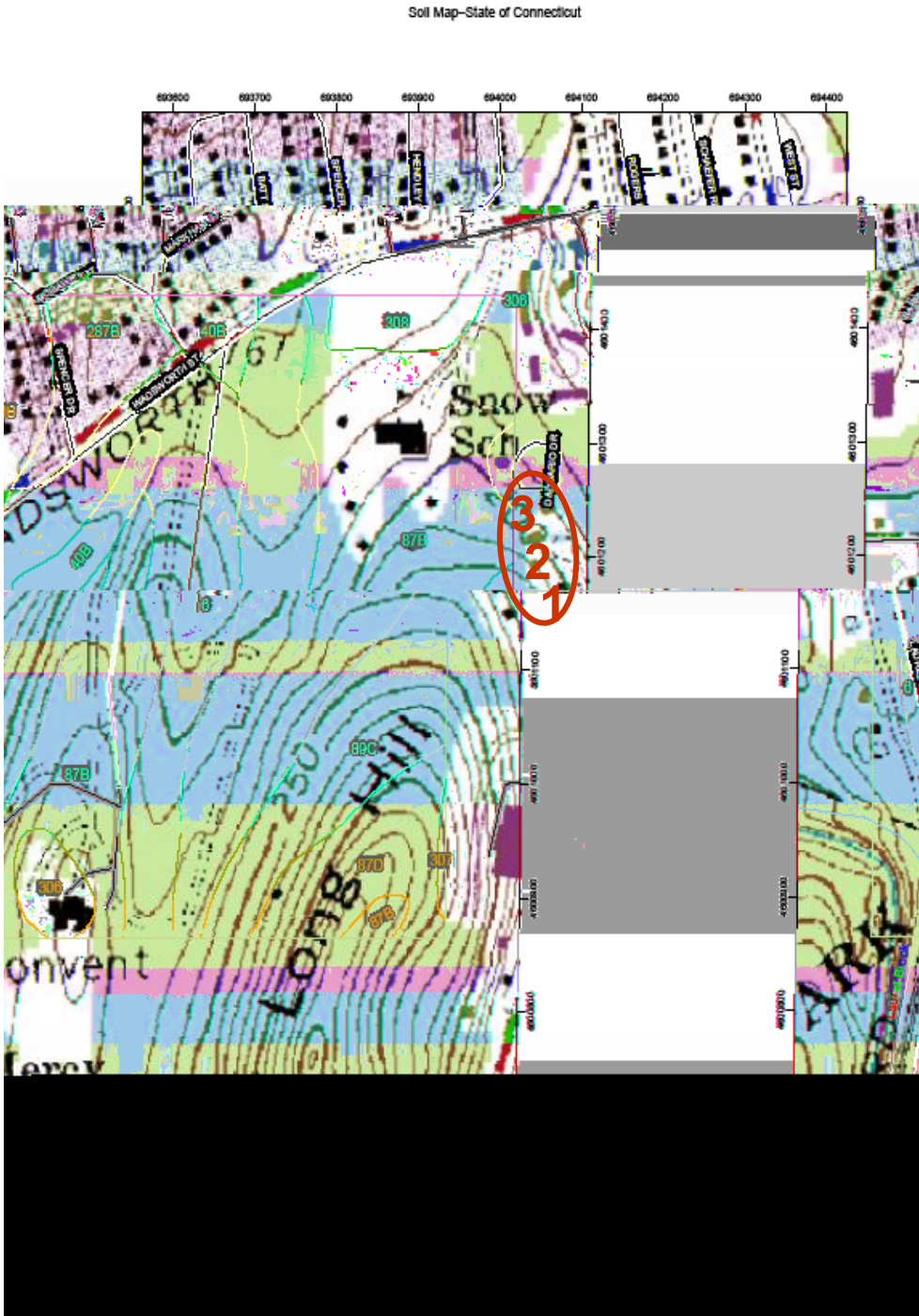
Station 3 = Ridge & swale non-hydric

Station 6 = Non-hydric riparian

Red Soils – Wadsworth Mansion Site Middletown, CT

Site is located on the grounds of the Wadsworth Estate

- Wilbraham silt loam – Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
- Menlo muck – coarse-loamy, mixed, active, mesic Typic Endoaquolls



Well

Installed at all sites

(50 – 55 cm)

Piezometers

Installed at site 1

(30 & 60 cm)

Redox Probes

Installed at all sites

(25 & 50 cm)

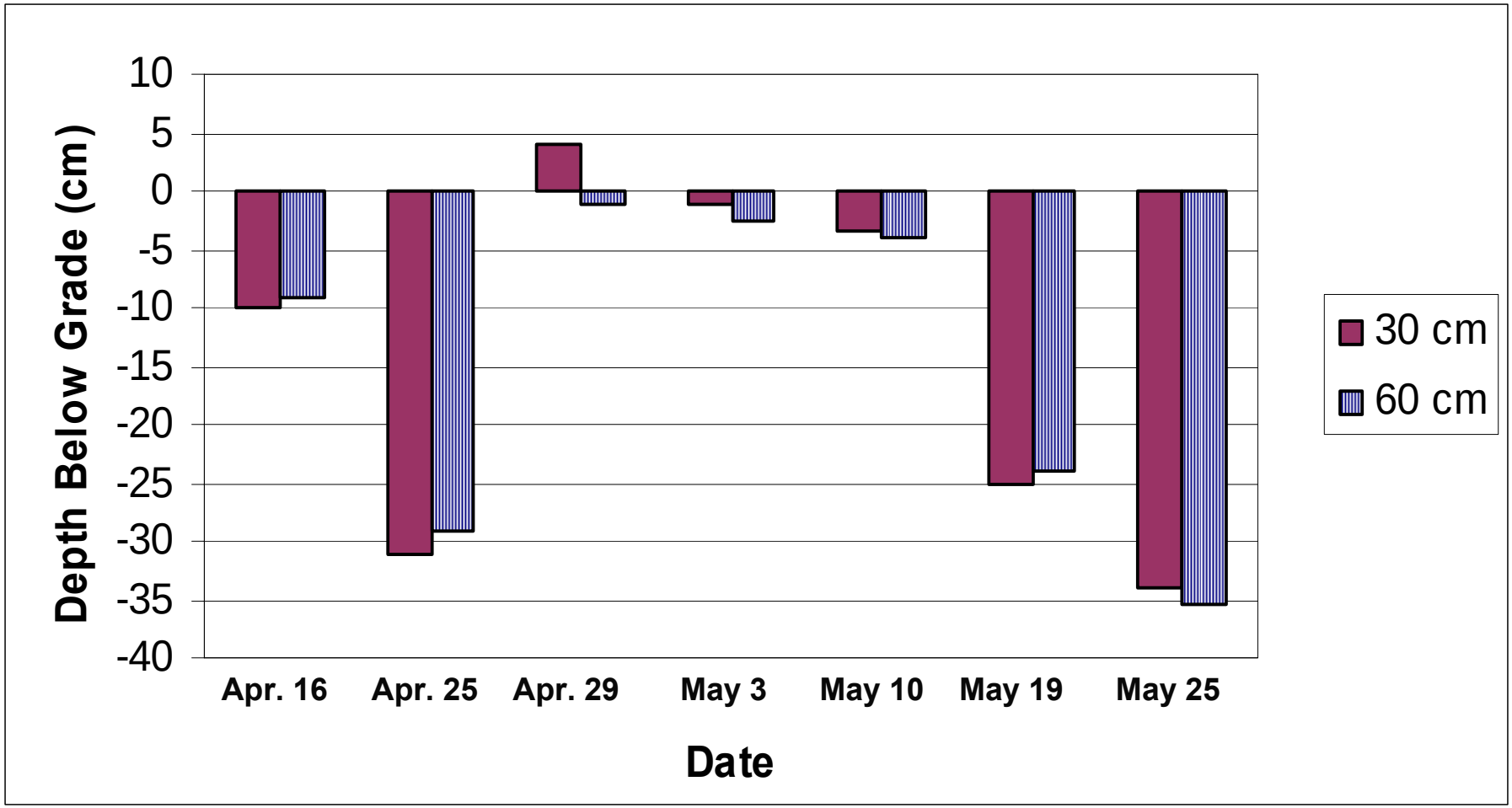
Iris Tubes

Installed at sites

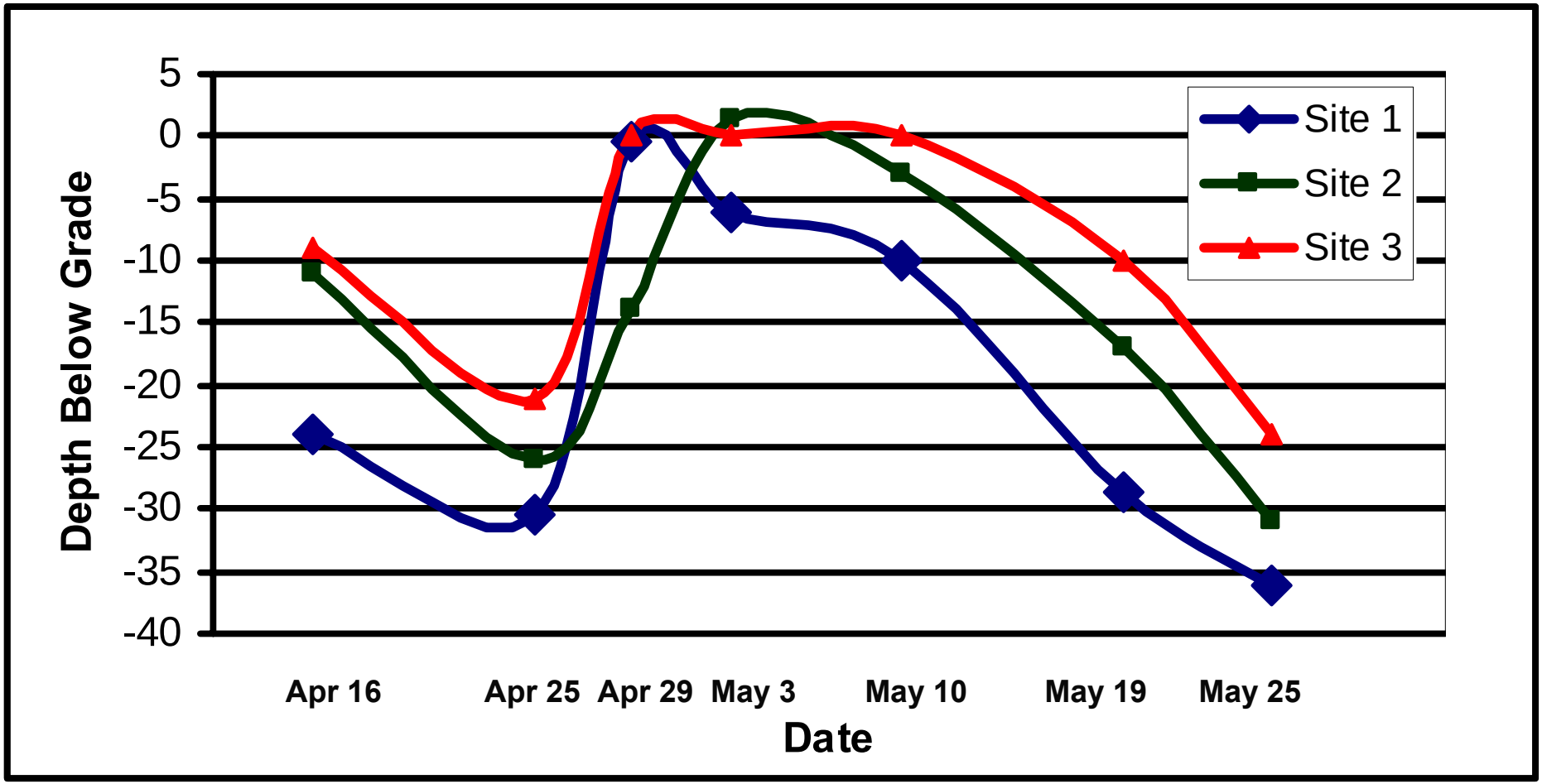
1 and 3

Measurements began in April, 2008

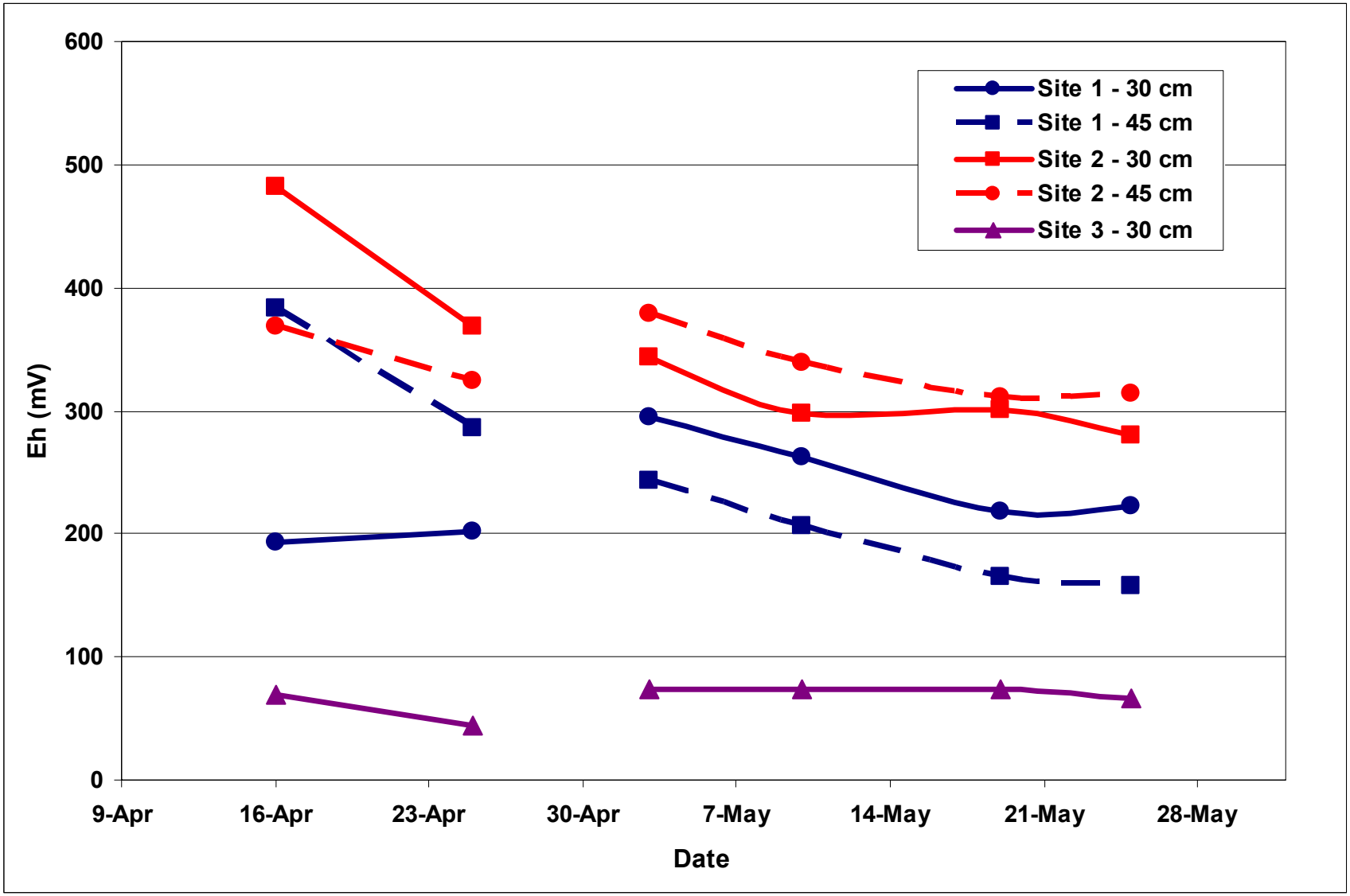
Piezometer Data



Well Data


Depth Below Grade
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Site 1
Site 2
Site 3
Apr 16
Apr 25
Apr 29
May 3
May 10
May 19
May 25
Date

Redox Data



Data are the mean of 5 redox probes