VirginiaTech
Invent the Future

CSES Crop & Soil Environmental Sciences

Research at Virginia Tech

By
Dr. John M. Galbraith

May 2006

Jim Baker

- Updated the VALUES database in Virginia
  - Dataset of all soil series with soil properties and yields of crops and forages
  - Data is used for land value assessment and for nutrient management planning

- Research is conducted by VA Dept. Health employees supervised by Jim on septic system efficiency and suitability of C horizons for percolation

Dr. Matt Eick and Lucien Zelazny

- P-index for Virginia (progress)

Carl Zipper

- Powell River Research and Education Center Director
  - (With Galbraith and Prisley and Wynne)
  - Carbon sequestration potential for marginal farmland in VA under various future land use scenarios
    - Based on STATSGO and HEL definition
    - Identifies marginal cropland and current land use
    - Identifies buffers around streams in cropland that may be reforested

W. Lee Daniels

- Mineral sand mining reclamation
  - Sand mining removes entire regolith, separates heavy mineral sands, replaces dispersed sediment back into pits.
  - Problems
    - sands and clays (slimes) separated vertically and horizontally in the deposit
    - Topsoil replaced when slimes are still wet or not replaced at all
  - Solutions
    - Work the soil when dry, rip 2 directions, apply phosphorus and lime and seed to a mixture of legumes and nurse crops
    - Second or third year, return to normal cropping and fertilization

W. Lee Daniels

- Mountaintop Mining
  - (With Haering and Galbraith and Thomas) Four articles published on mapping and reclamation of mine soils
  - Recognition of densic horizons and restricted depth classes
  - 2 new series proposed on mined areas
  - Recognition of impeded drainage classes
  - Subsidence interpretations
  - Land use interpretations

W. Lee Daniels

- N-index
  - With Pat Donovan, developing a N-index for soil management in VA

W. Lee Daniels

- Wetlands
  - Working with VDOT to develop an assessment of their wetland mitigation success – 10 pairs of mitigated wetlands-reference wetlands, study near completion
  - Recommendations for reclamation, creation, and mitigation of wetlands for state agencies and consultants

Differential Soil Properties at Fort Lee (Cummings, 1999)

0-15 cm	pH	% C	% N
Reference	4.76	2.89	0.18
Mitigation	5.31	0.82	0.07

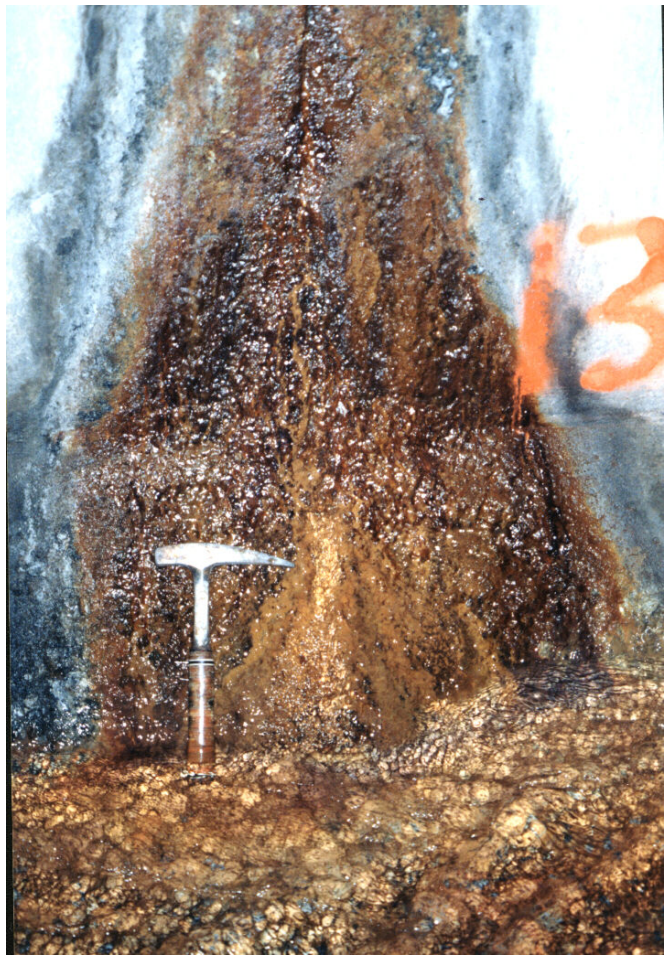
Differential Soil Properties at Fort Lee (Cummings, 1999)

Bulk Density Mg/m^3	Surface (0-15 cm)	Subsurface (70 cm)
Reference	0.71	1.42
Mitigation	1.75	1.71

W. Lee Daniels

- Acid-Sulfate soils
  - Problem
    - Very low pH
    - Poor water quality
    - Corrosion steel and concrete
    - Toxic to fish and microbes
    - Subsidence
  - Solution
    - Identify location of deposits
    - Classify the potential hazards of each deposit

Inside the culvert at Clifton Forge

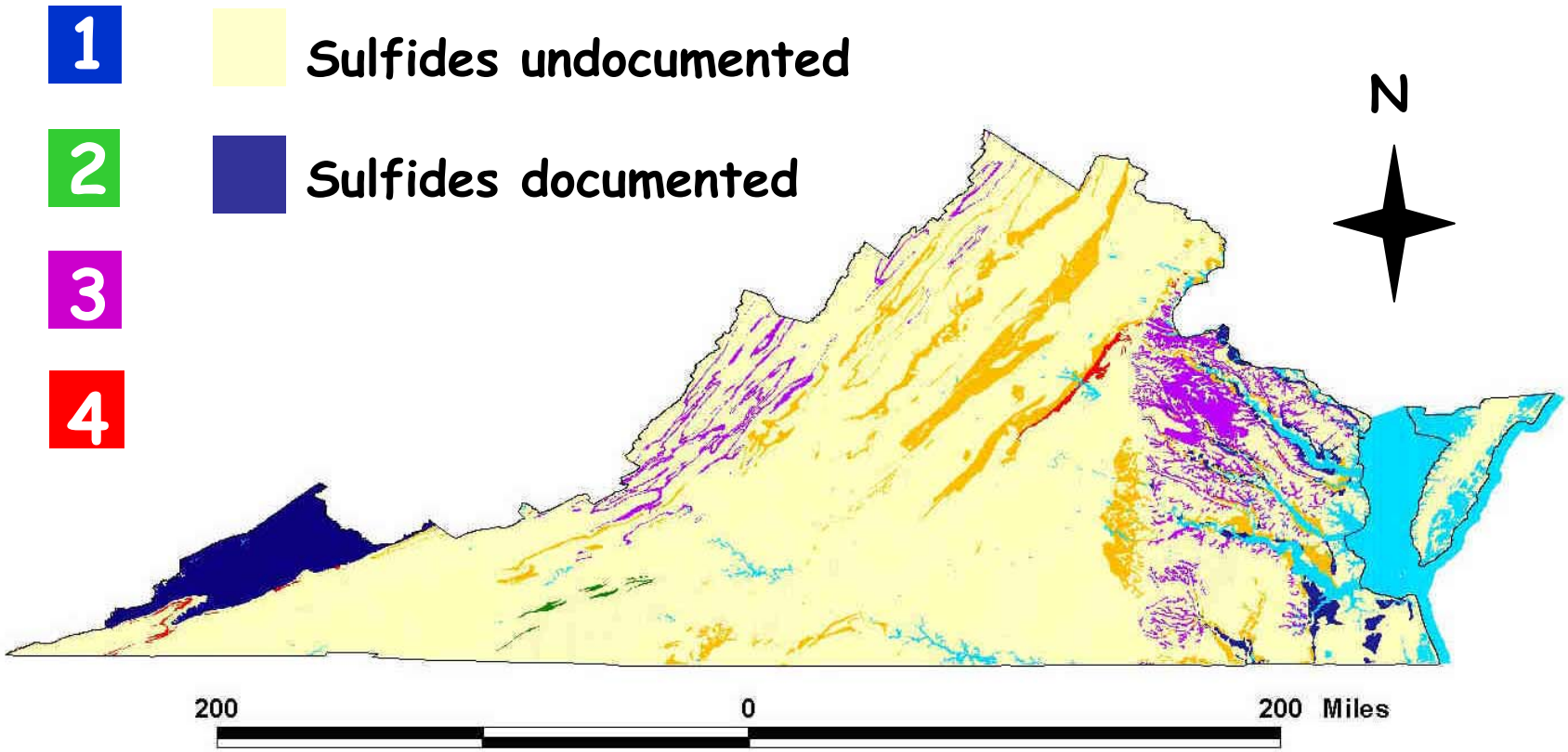


If sulfidic materials can have high pH values, then how do we know how bad they are?

Potential peroxide acidity (PPA) and total-S

- **PPA < 10 Mg $CaCO_3$/1000 Mg material (total-S < 0.2%): can readily be managed.**
- **PPA 10 - 60 Mg $CaCO_3$/1000 Mg material (total-S = 0.2 - 2%): can be remediated with intense management.**
- **PPA > 60 Mg $CaCO_3$/1000 Mg material (total-S > 2%): extremely difficult to remediate.**

Compiling a state-wide sulfide hazard map for Virginia: the final map.



Compiling a state-wide sulfide hazard map for Virginia: the final map.

All formations, based on draft version of digital geologic map of Virginia.

Not characterized

Sulfides not documented.

Sulfides documented. Acid potential unknown.

Characterized

1: PPA < 10; S < 0.5%.

2: PPA < 10; S > 0.5%.

3: PPA 10 - 60.

4: PPA - more than 10% of samples > 60.

John Galbraith

Focus Areas

- Wetlands: Inventory, Soils, Hydrology, and Mitigation
- Mine Soil: Reforestation potential, Mapping, Classification, Interpretation, and Hydrology
- Urban Soil: Mapping, Classification, Interpretation, and Hydrology
- GIS Resource Inventory and Analysis (SOC)
- Decision Support Systems and User Guides

DSS Projects

http://clic.cses.vt.edu/SoilsInfo/

- Va_Septic – based on Soil Data Viewer
- Va_On-site – based on VHD regulations
- SSURGO 2.x User's Guide
- Pasture Land Management System (PLMS)
- Charts for Ver. 5.0 Field Indicators of Hydric Soils (soon to be available at Mid-Atlantic Hydric Soils Committee web site)

John Galbraith

- Andy Jones, Galbraith, Burger, Fox, Zipper
  - Problem – Abandoned mine soils are intentionally compacted, smoothed, seeded to fescue and Sericea lespedeza, and grazed. Native seedlings cannot reestablish.
  - Solution - Identify soils where establishment of trees is economically and environmentally feasible and cost-effective.

Forest Capability Class

- We developed a suitability classification based on B.D., % rocks, pH, E.C., slope, aspect, and rooting depth (water holding capacity)
- Soils can be rated to see if it is economical to plant either hybrid poplar, white pine, native oaks, or if it should be left alone and grazed

Land-use Effects on Growing Season Length Indicators in Southeast Virginia Wet Flats (Great Dismal Swamp)

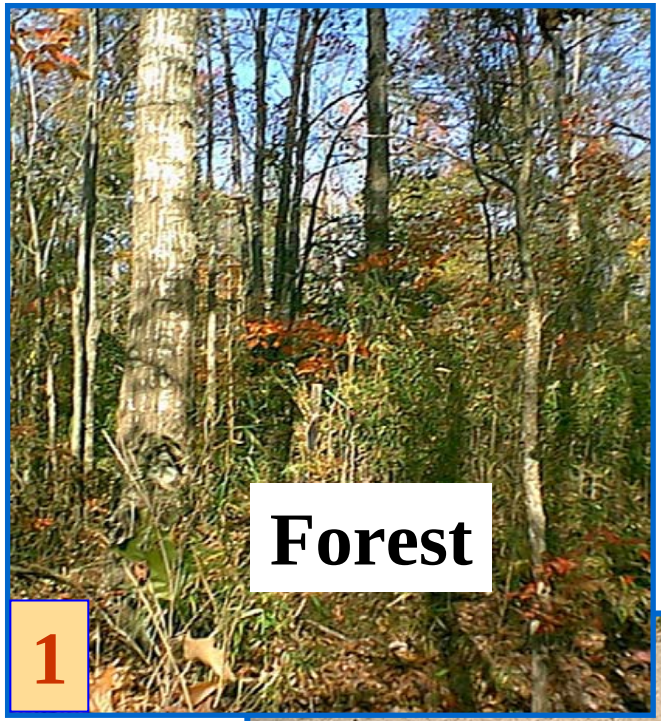
Amanda C. Burdt and John M. Galbraith

– Problem: Growing season misses the seasonal high water table, and the growing season used for regulations is incorrect

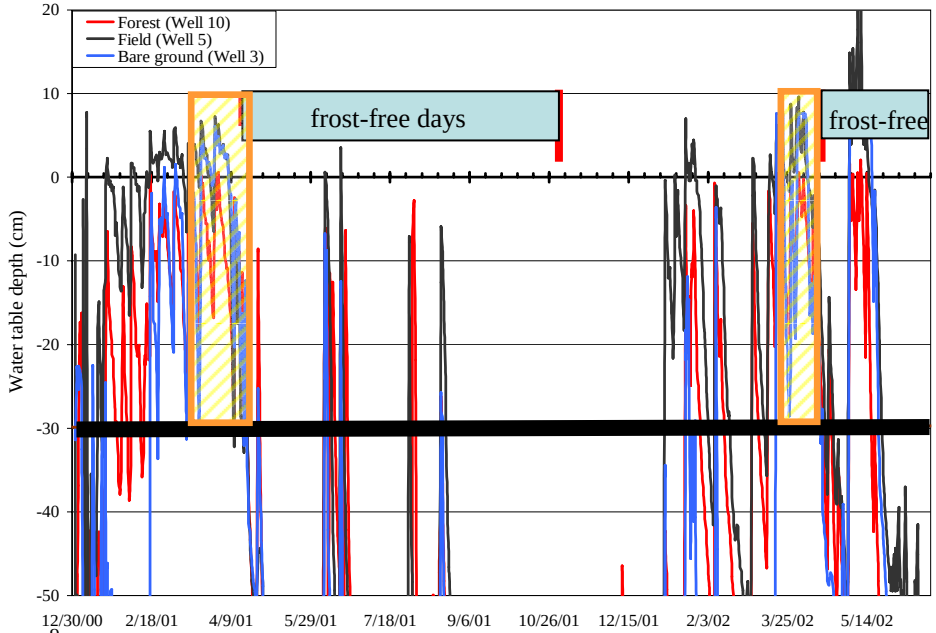
– Solution: Measure hydric soils indicators, soil temperatures, growing seasons, and hydrology under three land uses

(Published 2005)

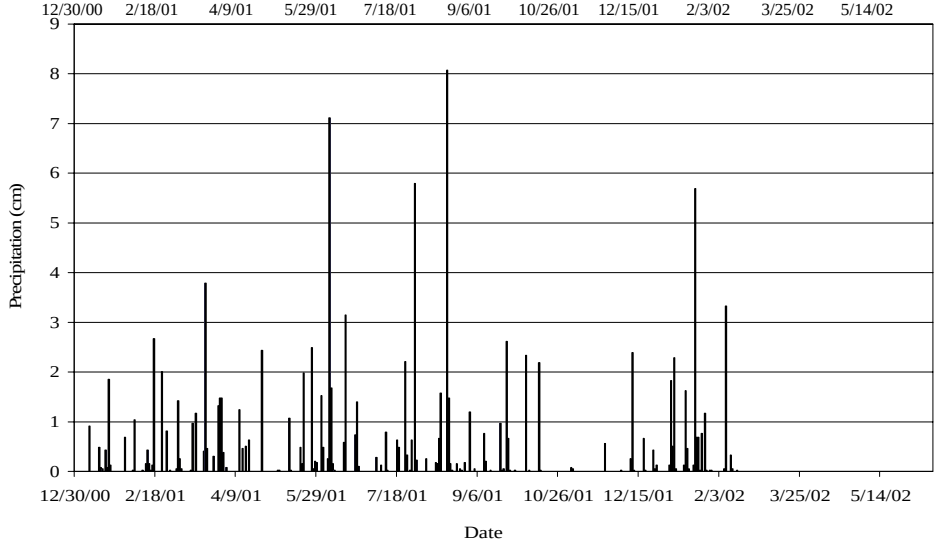
Treatments



Hydroperiod for Hall Property in 2001

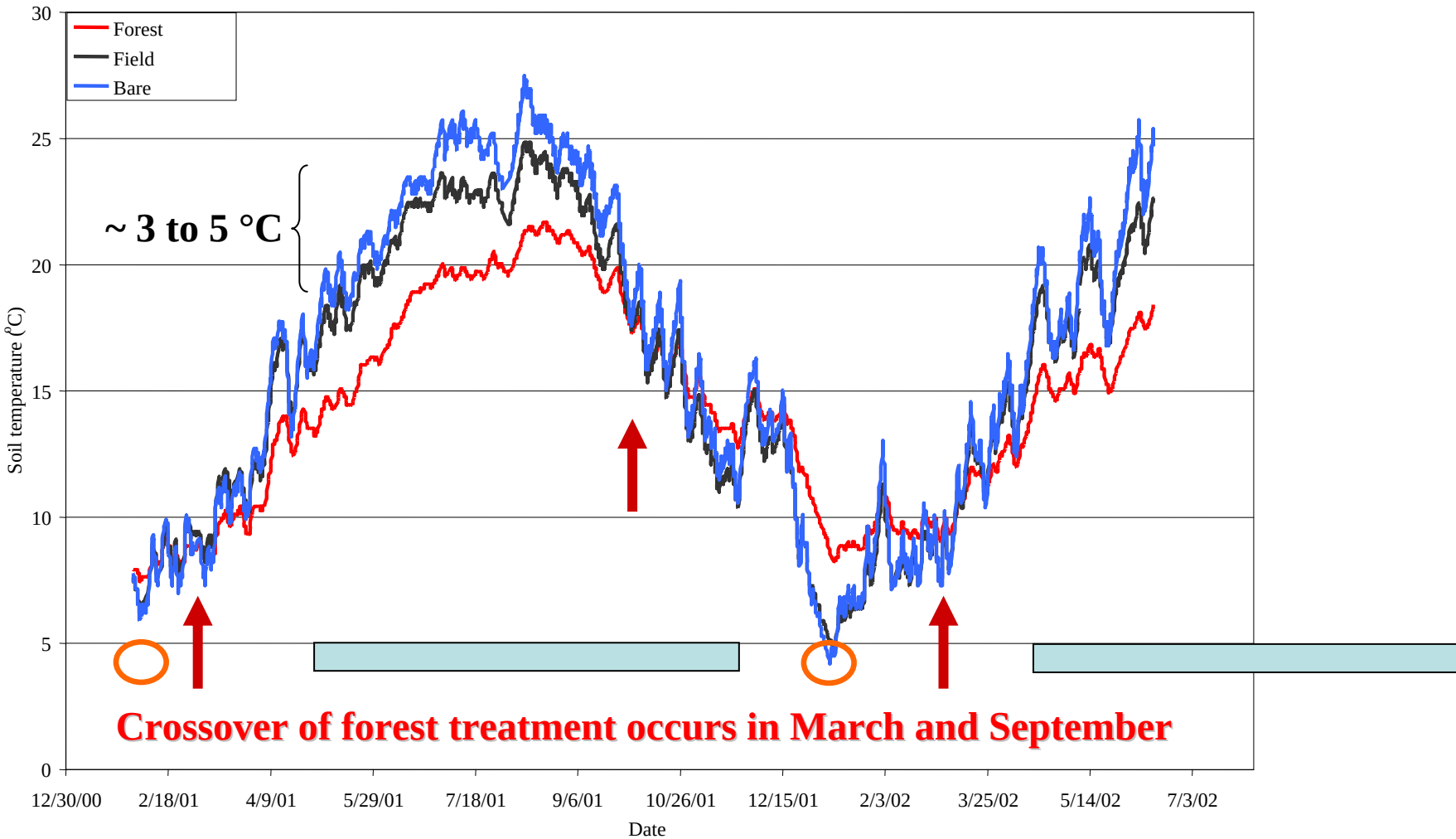


30 cm depth



rainfall

Soil Temperature at 50 cm at Hall



Circles represent times where soil temp. was below 5C. Blue bars are “growing season”

Results and Conclusions

1. For the Great Dismal Swamp Ecosystem in Southeast Virginia, the published frost-free days “growing season” is **March 14 to Nov. 29** (259 days) on the east side and **March 29 to Nov. 7** (222 days) on the west side.

2. We found the growing season measured at 50cm to be year round under forest, and all but one week under early successional (field) and under bare cropland.

3. The coldest days were in the first two weeks of January.

4. The forest soil was warmer and drier than the field which was warmer and drier than the cropland.

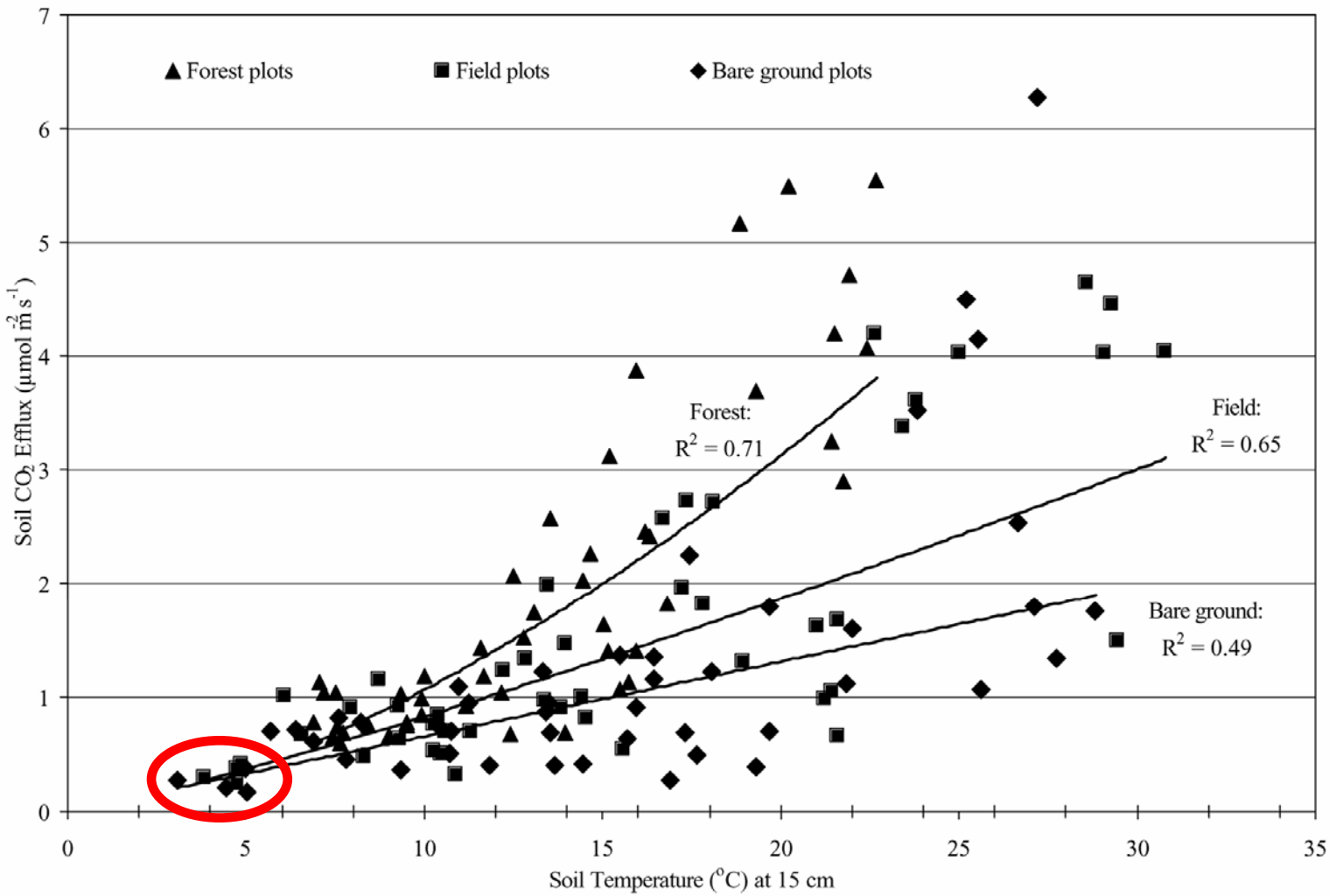
5. A year round growing season should be declared for all thermic wetlands, maybe all mesic wetlands as well. Frigid?

Measuring CO_2 efflux from wetland soils under three land uses

- Problem: Hard to measure soil temperature at 50 cm
- Solution: Measure CO_2 efflux at surface as a measure of biological activity
- Results and Conclusions: CO_2 efflux in Forest > Field > Cropland.
- Could use 5C to estimate base rate of efflux, use that to see when activity was at a minimum.

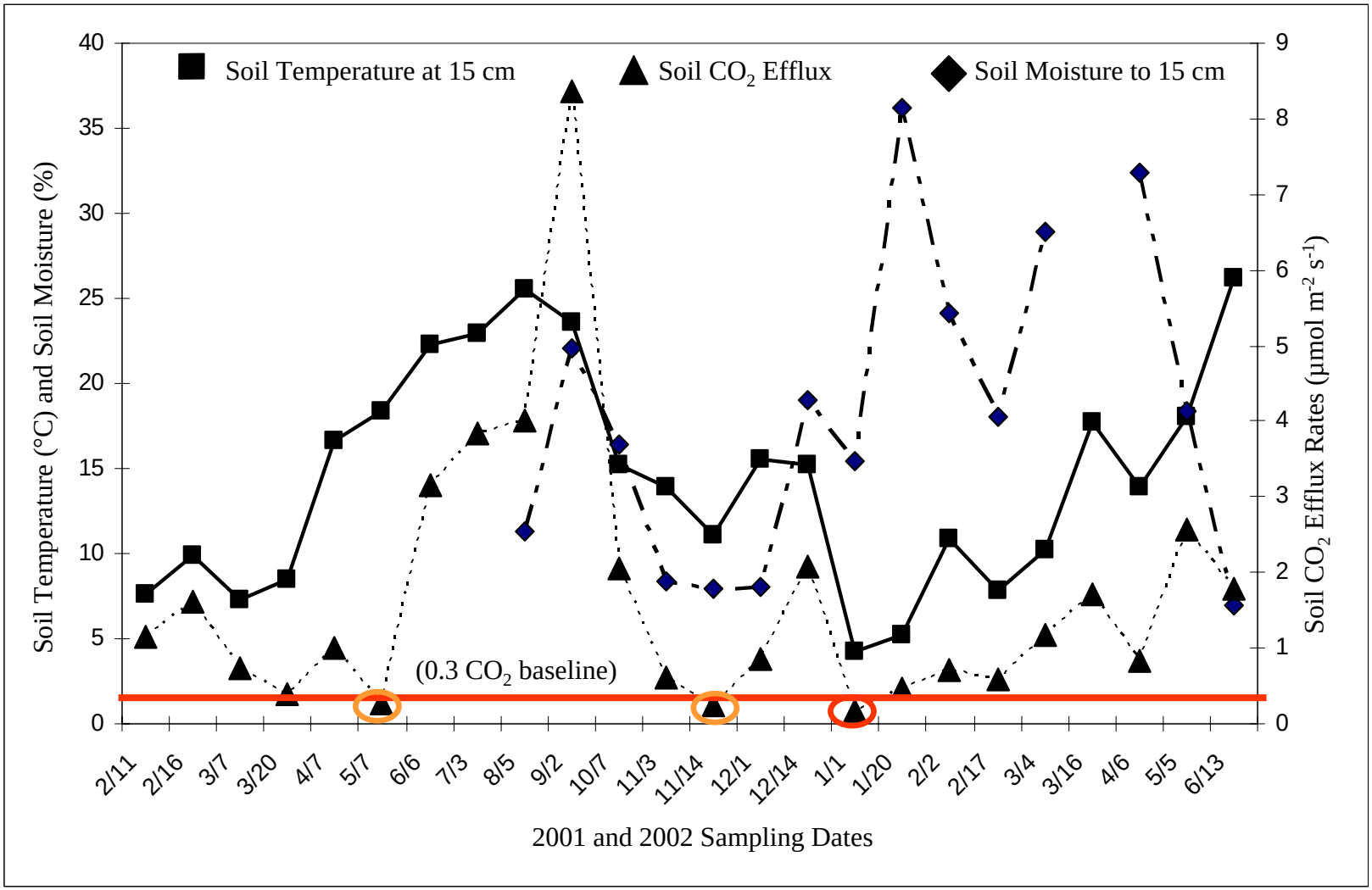
(published 2006)

CO_2 and Soil Temperature Relations – Treatment Differences



Note: The relationships between the natural log of the soil CO_2 efflux rates and measured soil temperature and moisture at 15 cm were analyzed using multiple regression analysis (Neter et al., 1996) using SAS™ software (Statistical Analysis Systems, Cary, NC).

CO_2 and the Baseline in a Forest Plot



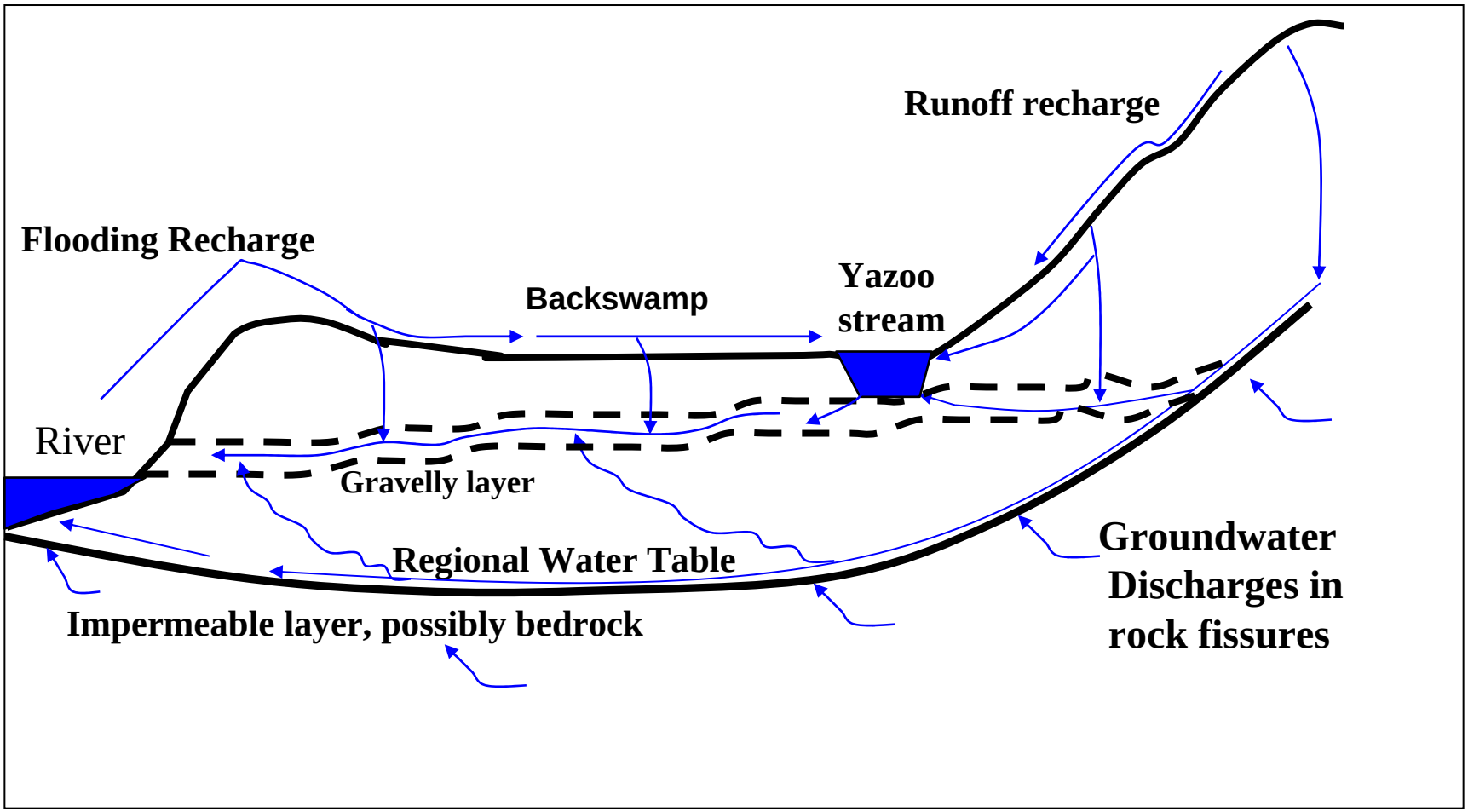
CO2 efflux is dependent on soil temperature and moisture. Red – temperature dip

HGM, Hydrology and Hydric Soil Indicators in Piedmont Slope Wetlands and Wet Floodplains

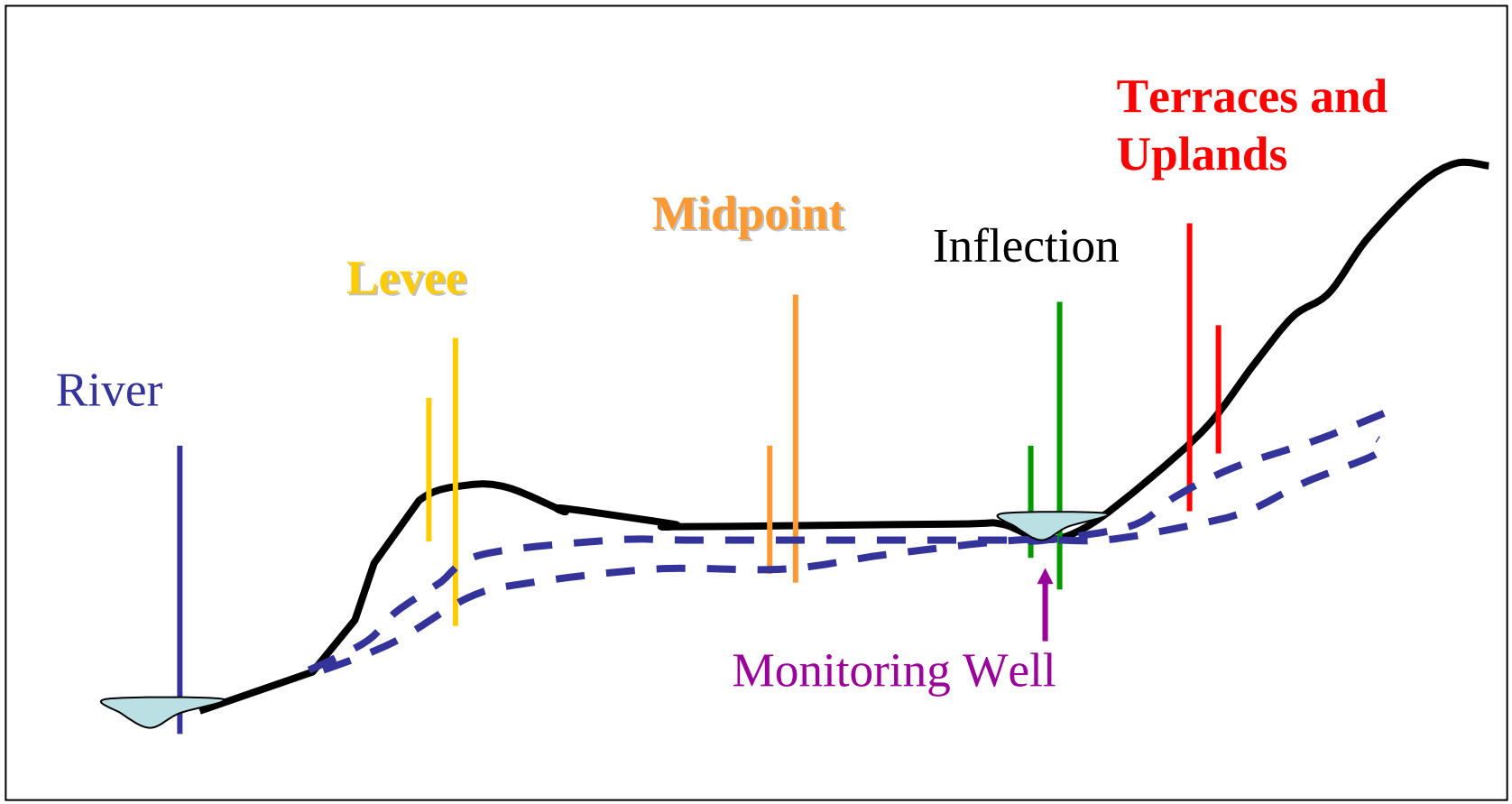
- Problem: Soils at inflection point of hill and in floodplain are wet, don’t always meet an indicator
- Solution: Measure the hydrology and hydric soil technical standard
- Results and Conclusions: Soils are hydric. In backswamps, water may be oxygenated. At the inflection point, water flows through, may take Fe with it. High OC at inflection point masks indicators.

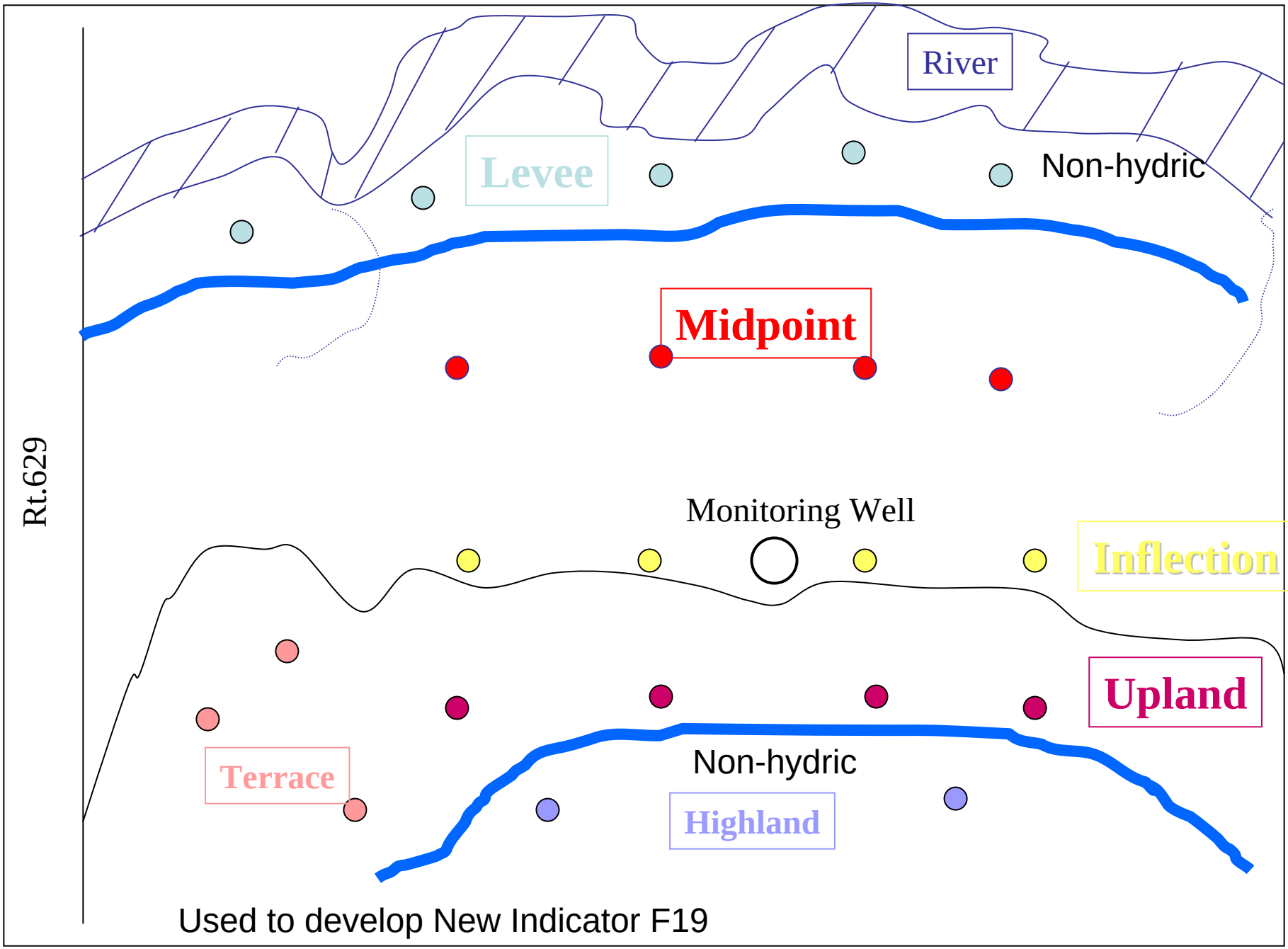
(in publication draft stage)

Discharge in Humid Riverine Systems With Seeps



Study Site:
5 Landscape Positions




River
Levee
Non-hydric
Midpoint
Rt.629
Monitoring Well
Inflection
Upland
Terrace
Non-hydric
Highland
Used to develop New Indicator F19

Using public domain data to predict the occurrence of hydric soil

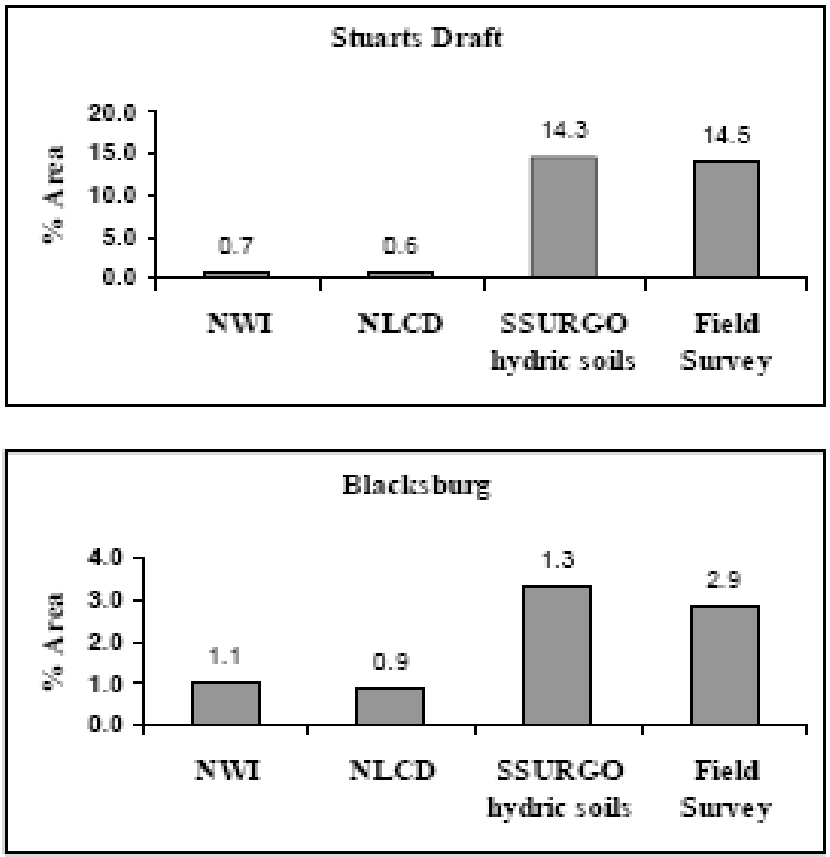


Figure 4.

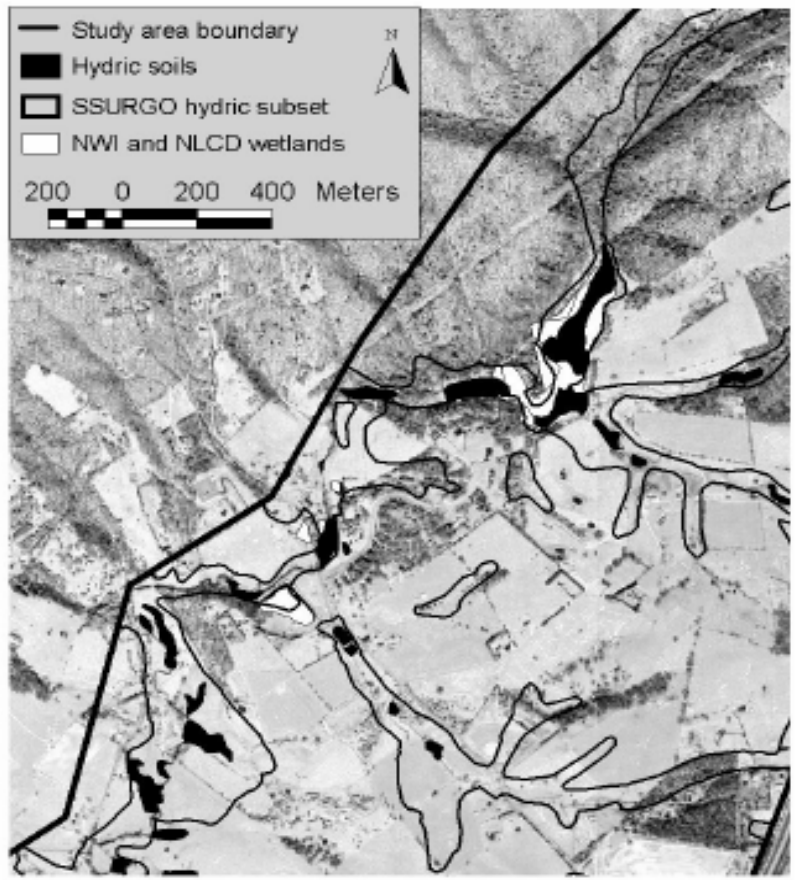


Figure 3.

Published 2004

Integrating National Wetland Inventory maps using Remote Sensing and GIS tools

Eva Pantaleoni and John Galbraith, Virginia Tech

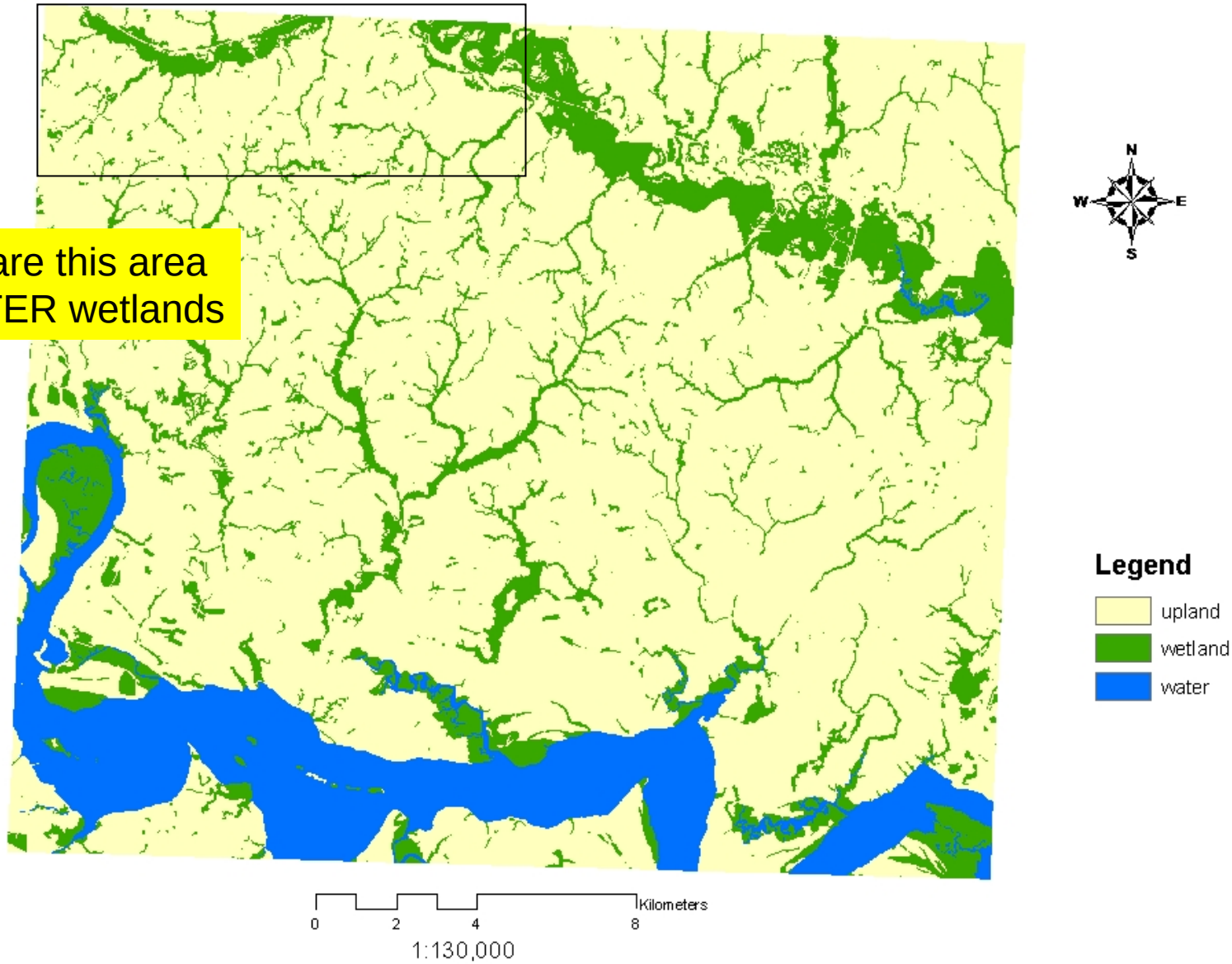
2006

(in progress)

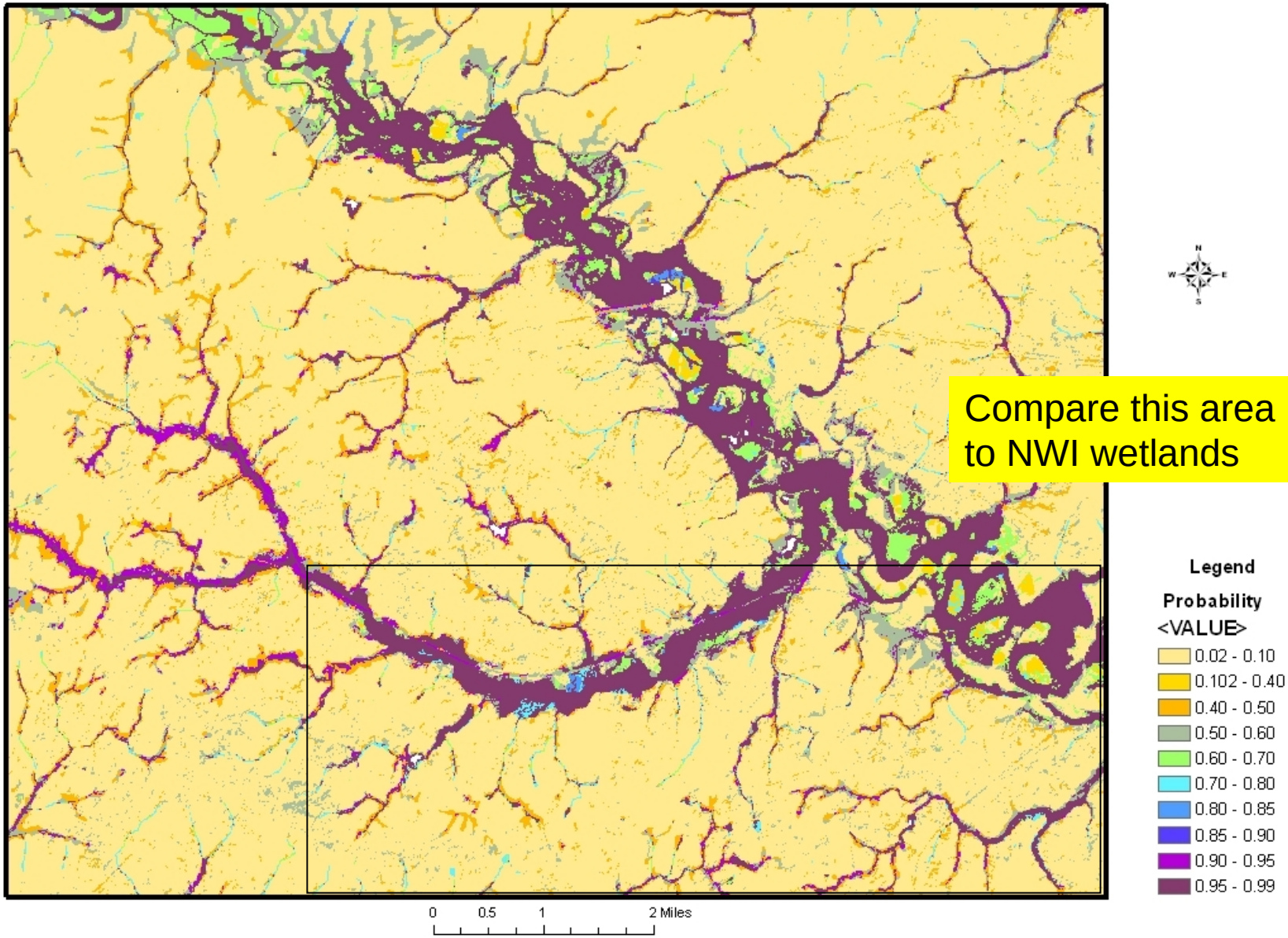
Using Remote Sensing to Improve NWI

- Purpose: To explore the ability of raw ASTER bands and GIS data layers in predicting wetland location using a logistic regression model
- ASTER bands are able to detect wetland with an accuracy of 28% when open water features are not included in the model.
- The model improves significantly when soil, hydrography and elevation data are introduced in the model (accuracy=52% at 0.95 probability level).
- Most of misclassified wetlands were forested wetlands
- Other errors were due to the dry year and georectification problems (pixels did not match)

National Wetland Inventory Map



Wetland Probability Map



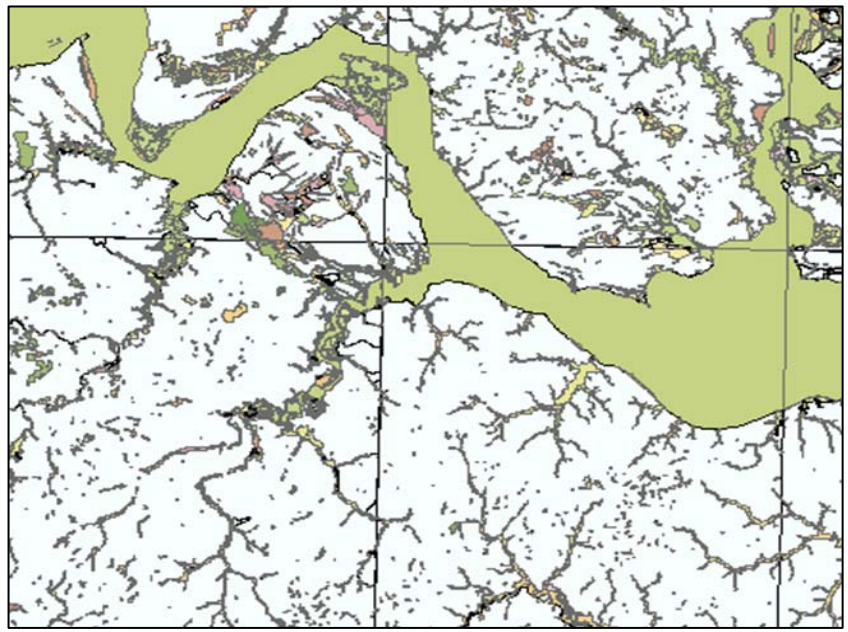
Assessment of National Wetlands Inventory (NWI) Landscape Position Classification System

Alexis E. Sandy and John M. Galbraith

- The National Wetland Inventory (NWI) is a project of the FWS that has produced wetland maps for approximately 90 percent of the coterminous United States (US Fish and Wildlife Service, 2002).

- They are adding hydrogeomorphic and other characteristic descriptors that are needed for assessment of wetland functions

- Updating process is still conducted manually



Functions Implied by Landscape Position Descriptors

- Functions Implied
  - Surface water detention
  - Stream flow maintenance
  - Shoreline stabilization
  - Nutrient transformation
  - Sediment retention

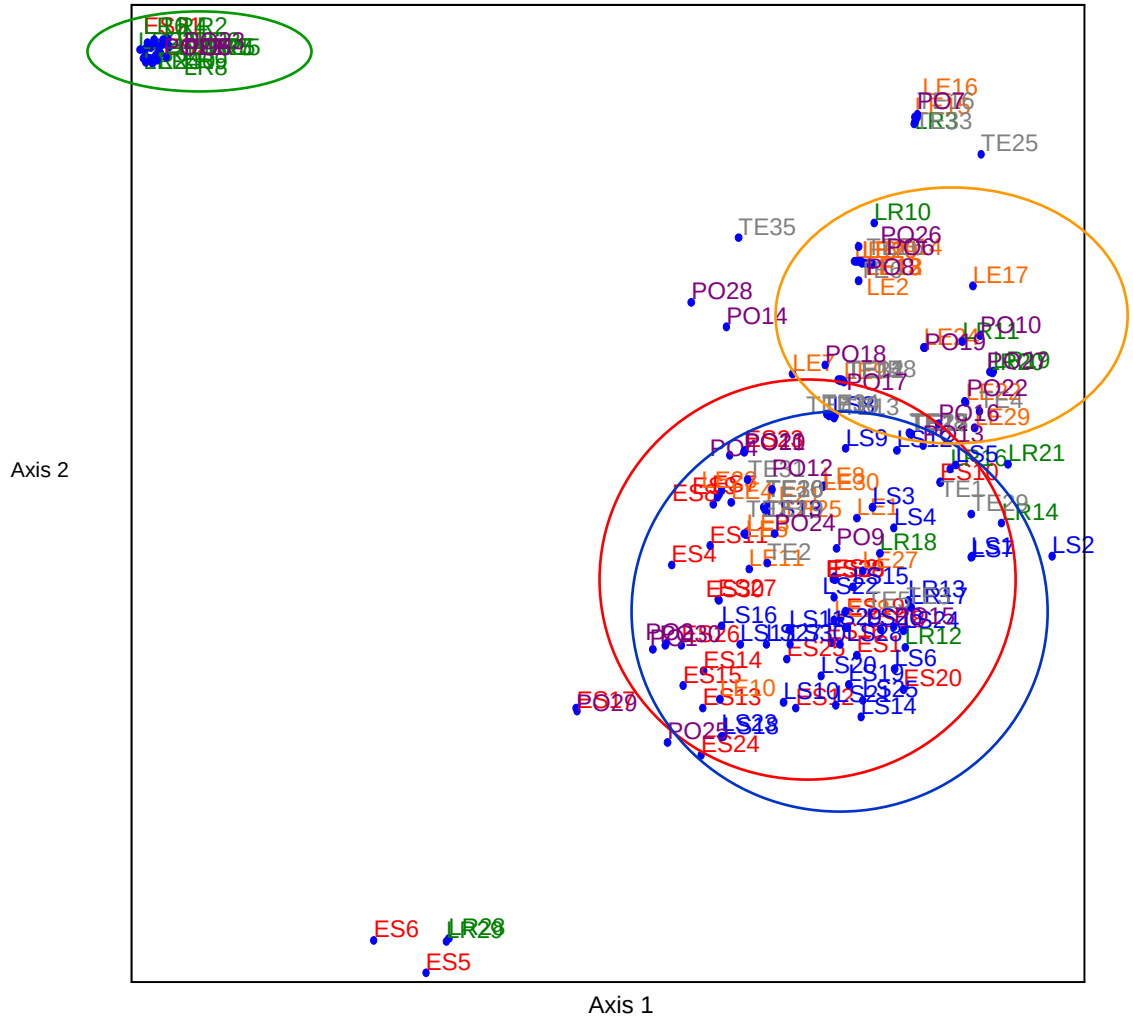
- Procedure: 180 wetlands representing 6 landscape positions were visited and soils, vegetation, and hydrology indicators recorded.
- The data were input to see if they clustered and differentiated enough to be diagnostic for making an automated method to identify the 6 positions.

PRELIMINARY RESULTS: Wetland Plant Status

- Stress = 0.136
- Dimensions = 3

<u>Legend</u>:

ES = Estuarine
LE = Lentic
LS = Lotic
Stream
LR = Lotic River
PO = Pond
TE = Terrene

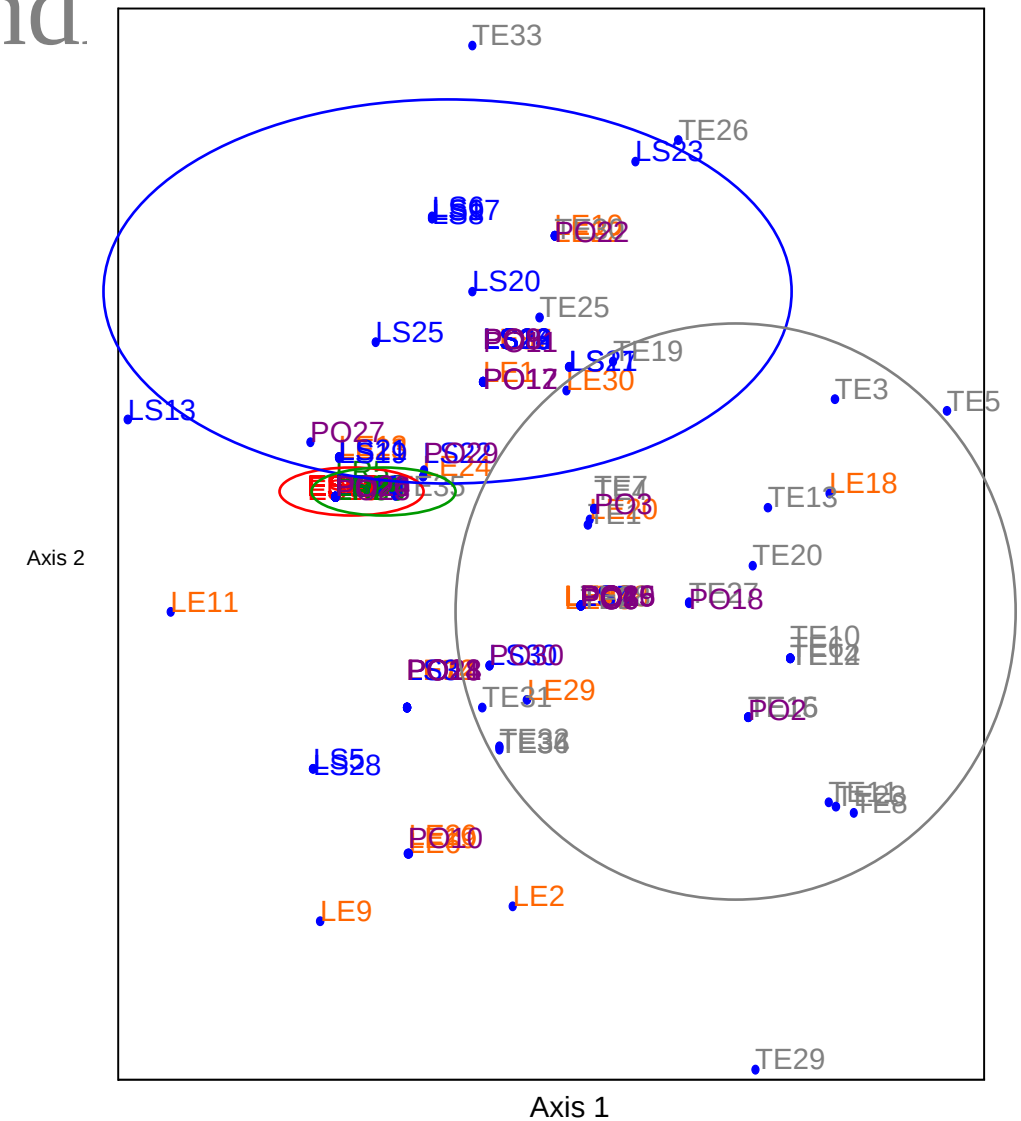


PRELIMINARY RESULTS: Hydrology Primary & Secondary Ind

- Stress = 0.097
- Dimensions = 3

<u>Legend</u>:

ES = Estuarine
LE = Lentic
LS = Lotic
Stream
LR = Lotic River
PO = Pond
TE = Terrene

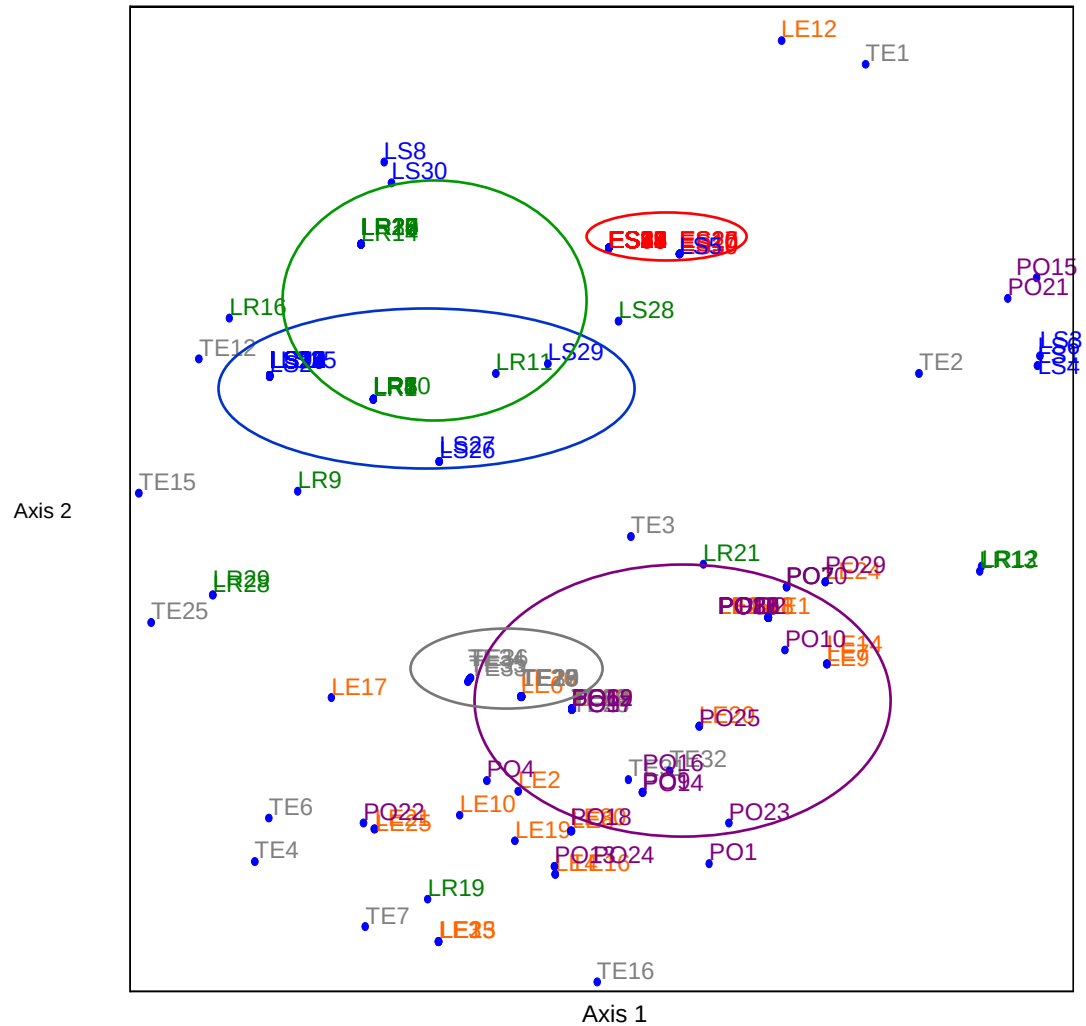


PRELIMINARY RESULTS: Field Hydric Soil Indicators

- Stress = 0.117
- Dimensions = 3

<u>Legend</u>:

ES = Estuarine
LE = Lentic
LS = Lotic
Stream
LR = Lotic River
PO = Pond
TE = Terrene



PRELIMINARY RESULTS

Table I-1. Measures of Kruskal's stress, proportion of variance explained (R2), and orthogonality for dimensions retained for NWI landscape position classes as a result of a Non-metric Multidimensional Scaling (NMS) analysis. Analysis is based on field validated wetland plant occurrence, hydrology primary and secondary indicators, and hydric soil characteristics and field indicators of hydric soil.

	Distance Measure	Axis	Stress†	R^2 Increment	R^2 Cumulative	Axis Pair	r	Orthogonality
								-------%-------
Wetland Plant Indicator Status	Bray-Curtis (Sorenson)	1	0.255	0.660	0.660	1 vs 2	-0.438	80.9
		2	0.190	0.116	0.776	1 vs 3	0.288	91.7
		3	0.136	0.118	0.893	2 vs 3	-0.205	95.8
Hydrology Primary and Secondary Indicators	Jaccard	1	0.344	0.441	0.441	1 vs 2	-0.167	97.2
		2	0.179	0.247	0.687	1 vs 3	0.095	99.1
		3	0.097	0.272	0.960	2 vs 3	-0.130	98.3
Hydric Soil Characteristics and Field Indicators of Hydric Soil	Jaccard	1	0.368	0.237	0.237	1 vs 2	-0.058	99.7
		2	0.185	0.334	0.571	1 vs 3	-0.164	97.3
		3	0.117	0.318	0.889	2 vs 3	0.346	88.0

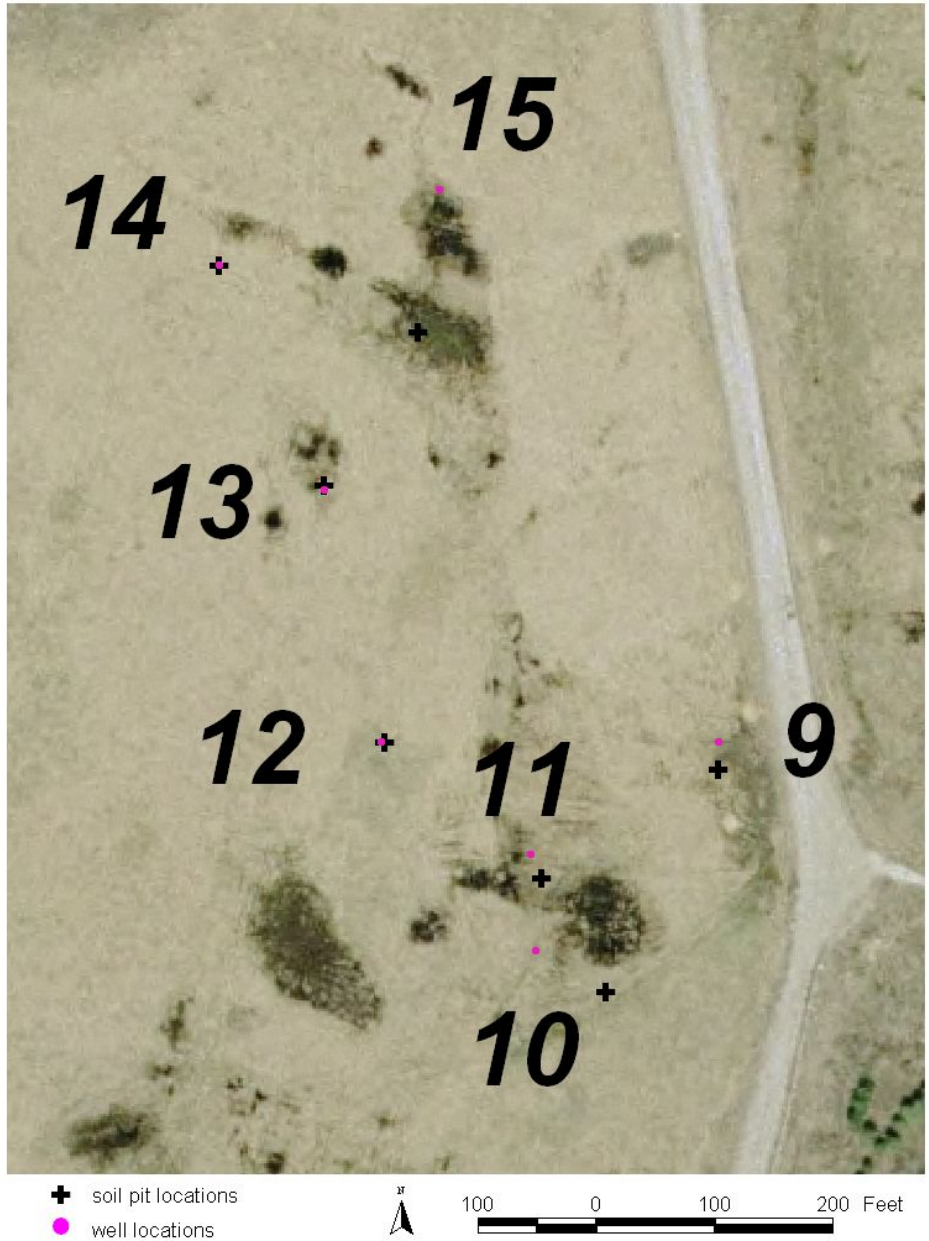
† Kruskal's Stress Measure; stress of 0.20 = poor; 0.10 = fair; 0.050 = good; 0.025 = excellent; 0.000 = perfect.

Other Wetland-related Studies

- Multi-state Problem Red Parent Materials Study
- Multi-state Piedmont Floodplains Indicator Study
- Proposed (Multi-state Young Sandy Dune Soils Indicator) may include use of Lidar and multispectral data to ID and locate sandy wetlands and use of photospectroscopy to ID SOC content in sandy soils
- Eh change/time in-situ study (leave for 4 hrs)
- Impact of roads on wetlands in rural and suburban Virginia Coastal Plain areas
- Using Wetness Index to enhance NHD stream network data in the Ridge and Valley
- Mine Soil Wetlands and Series Drainage Class Study at Powell River

Hydrology and drainage class study for coal mine soils

Neo-wetlands formed in 20 years on mine soil in southwest Virginia. Soils with dense, compacted subsoils perch water on or near the surface, forming wetlands. The soils range from somewhat excessively drained to very poorly drained, yet are mapped as a consociation of excessively drained soils with a few wet spot symbols.



Urban Soils Hydrology Study

- In Fairafx Co., VA we have selected two-three sites where we will install piezometer nests to determine hydrologic drainage patterns in representative urban soils

- Study to begin in 2006

Research Programs

- Wetlands and Stream Ecology

http://clic.cses.vt.edu/soils/wetlands/Wetlands_VT_2006.pdf

- GIS, GPS, and Remote Sensing

http://clic.cses.vt.edu/soils/OGIS.pdf