Using Soil, Vegetation and Succession Dynamics to Determine Restoration of Ecological Functions in Created Palutrine Forested Wetlands.

James Perry, PWS and Sean Charles
ASA Nov. 17, 2015

VIMS | William & Mary
Virginia Institute of Marine Science

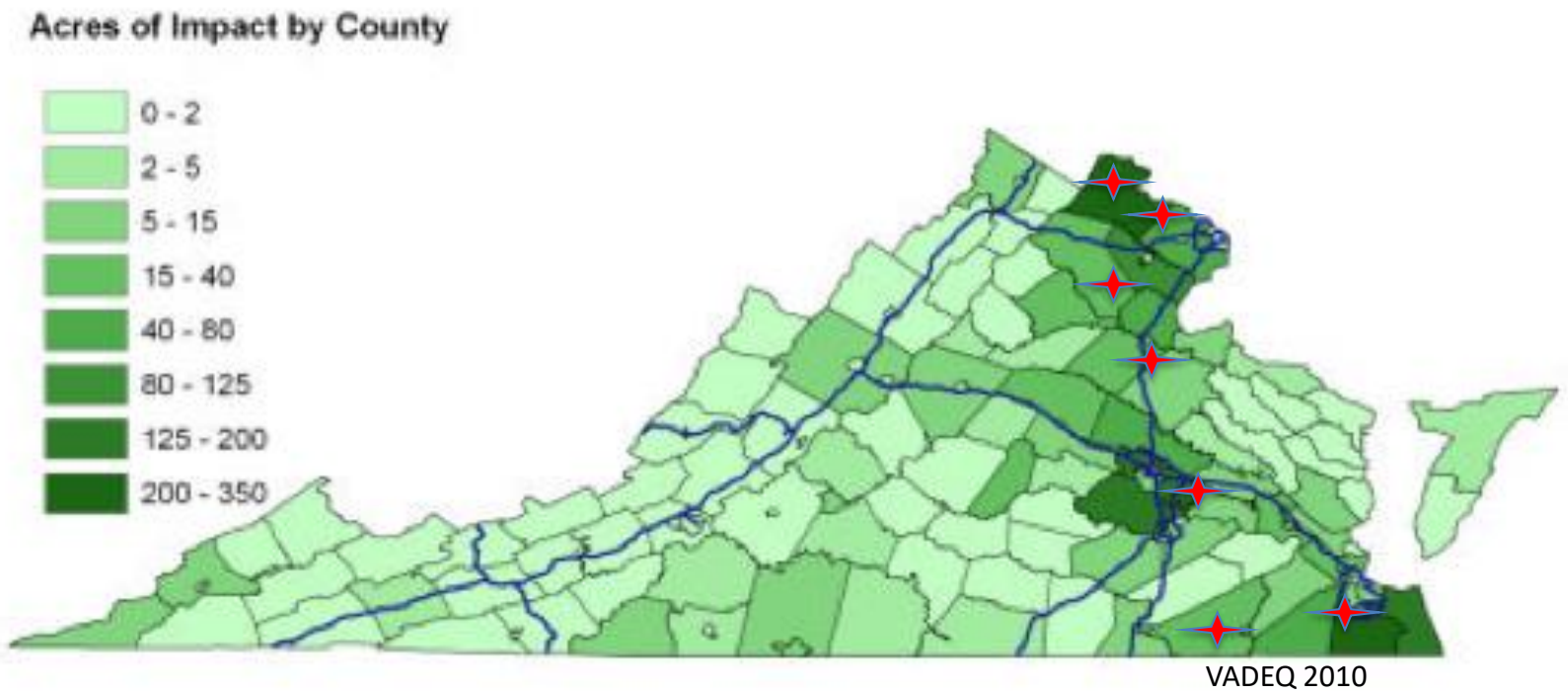
- Successful Mitigation “Provides a habitat that is functionally equivalent to the one that will be lost” (Zedler 1996)

- Wetland Functions (NRC 1995).
  - Short term water storage
  - Long term water storage
  - Transformation and cycling of elements
  - Retention and removal of elements
  - Accumulation of organic matter
  - Accumulation of inorganic sediments
  - Maintenance of a characteristic plant community
  - Maintenance of a characteristic energy flow

Question: Do created/restored wetlands maintain plant communities functionally equivalent to natural wetlands within 20 years, and if not, are they on an appropriate trajectory to do so eventually.

- H_1 Created and reference wetlands will be different in terms of floristic quality and basal area.
- H_2 Created wetlands of ~10 and ~20 years post creation will be different in terms of floristic quality and basal area.
- H_3 Created wetlands soil and vegetation will change over 8 years since they were last monitored and will be more like reference sites.

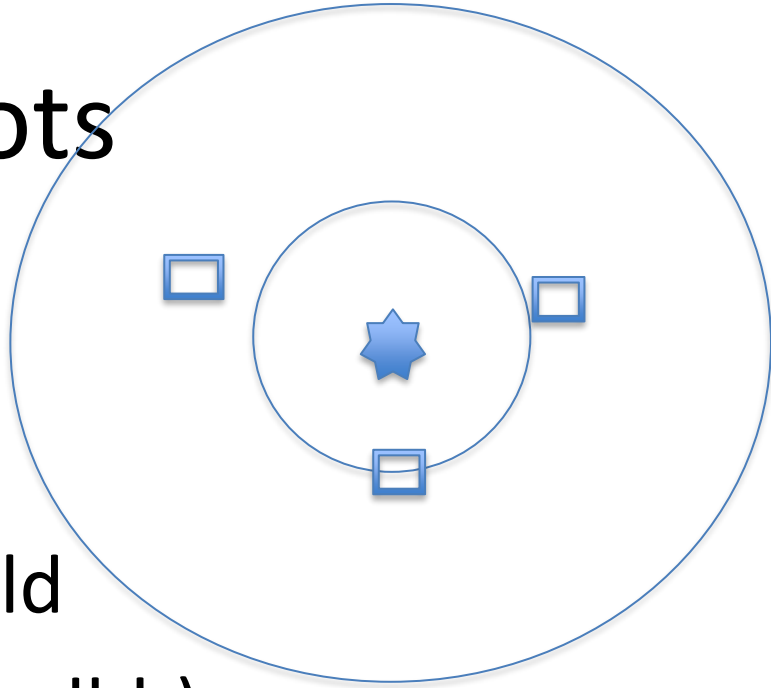
Permitted Wetlands and Open Water Impacts (2001-2009)



VADEQ 2010

- Created Forested Wetlands (CFWs): VDOT mitigation sites
  - Age class 1: 3 sites 10.7 ± 0.9 (11 years old)
  - Age class 2: 4 sites 20.3 ± 0.9 (20 years old)
    - tree-tis?
- Natural Reference Wetlands (NRWs): 4 sites (82 years old)

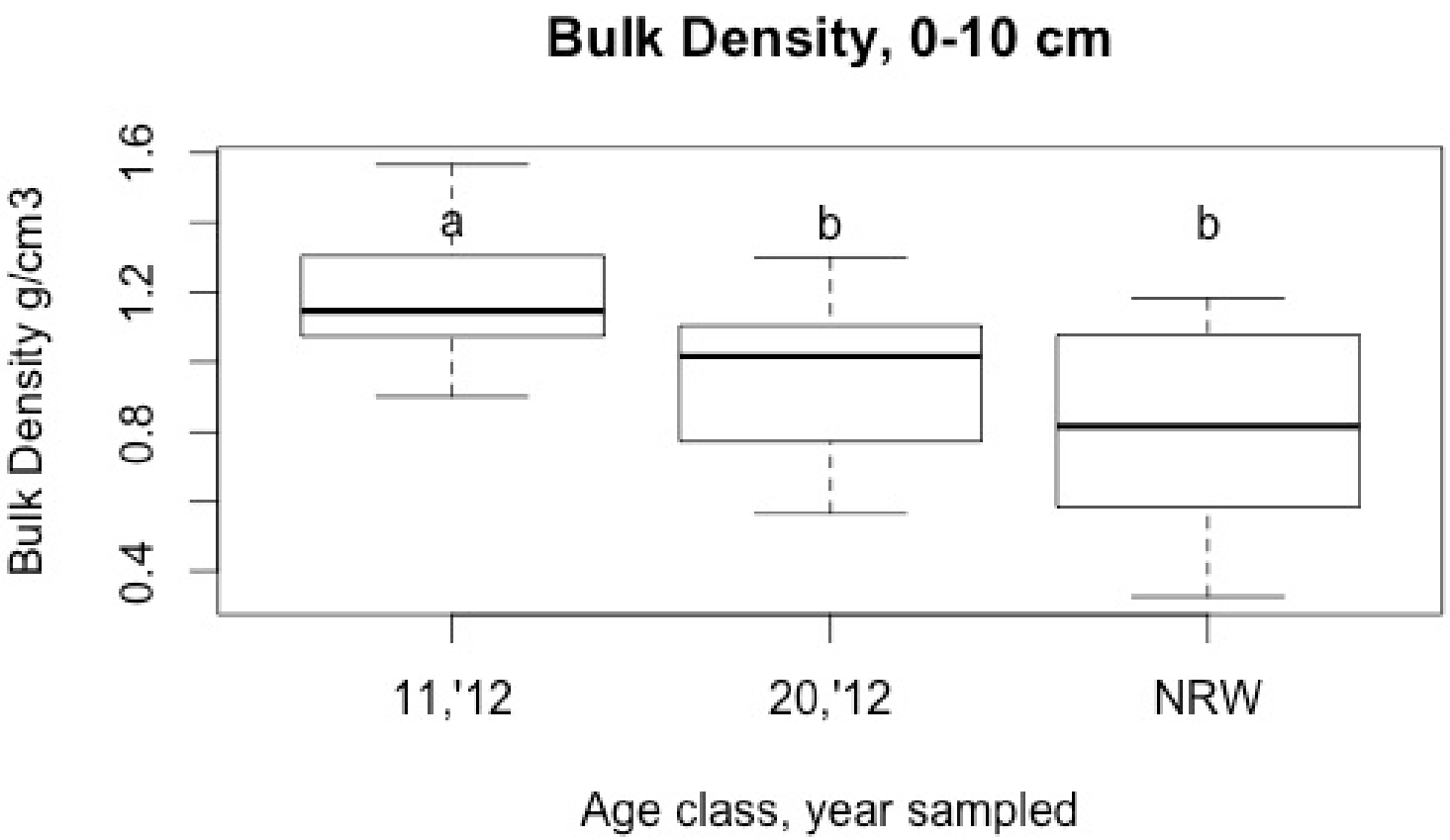
Sample Plots

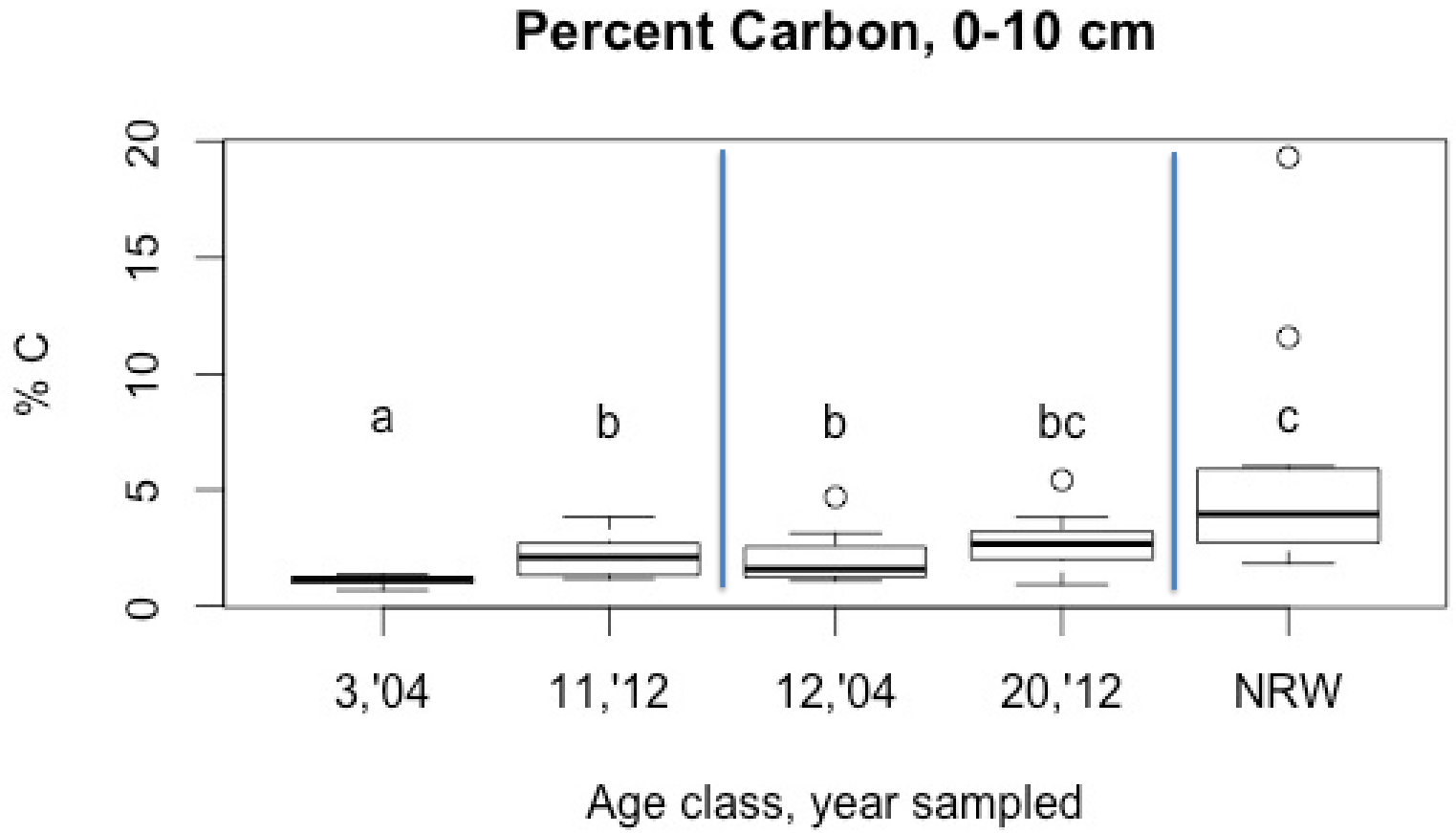


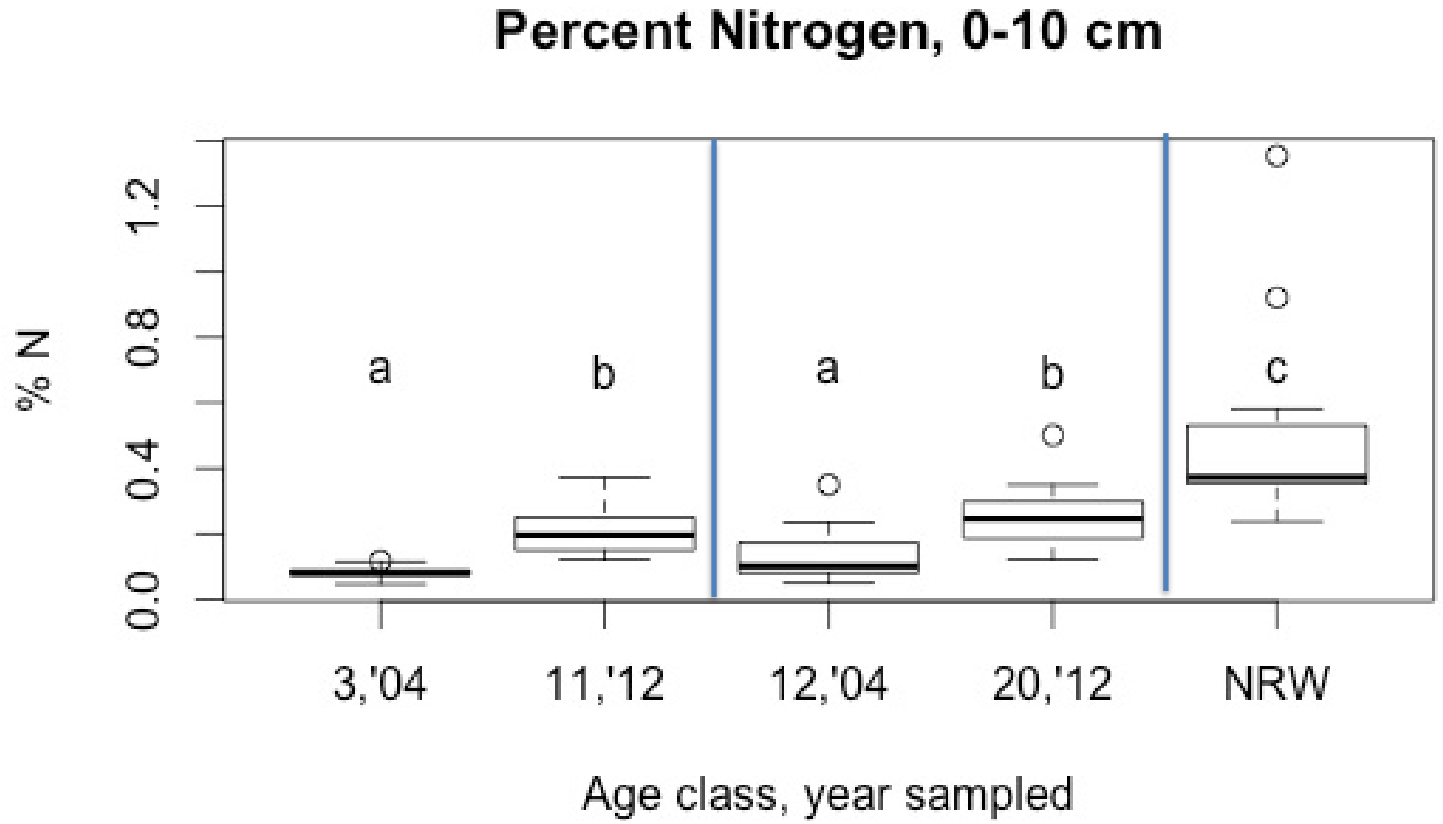
- 1 30-cm soil core
- 18 inch core to analyze for

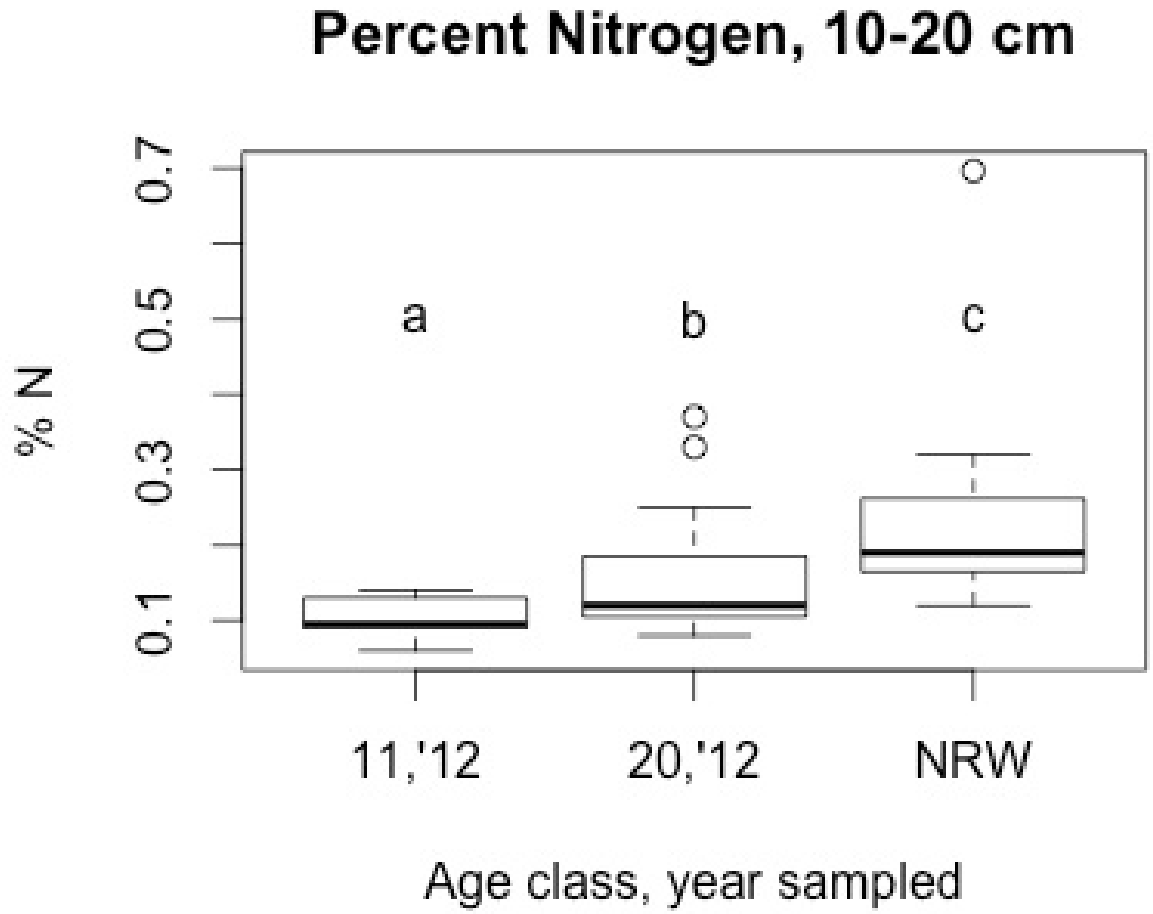
hydric soil indicators in the field

- 11.3 m radius (trees > 10 cm dbh)
  - Identify, Count, dbh
- 5 m radius (woody species > 1m < 10 cm dbh)
  - Identify, count, cover, dbh for tree species >2.5 cm
- 3 1-m^2 herbaceous plots
  - Identify, cover, density


Bulk Density, 0-10 cm
Bulk Density g/cm3
0.4
0.8
1.2
1.6
a
b
b
11,'12
20,'12
NRW
Age class, year sampled


Percent Carbon, 0-10 cm
% C
0
5
10
15
20
a
b
b
bc
c
3,'04
11,'12
12,'04
20,'12
NRW
Age class, year sampled


Percent Nitrogen, 0-10 cm
% N
0.0
0.4
0.8
1.2
a
b
a
b
c
3,'04
11,'12
12,'04
20,'12
NRW
Age class, year sampled

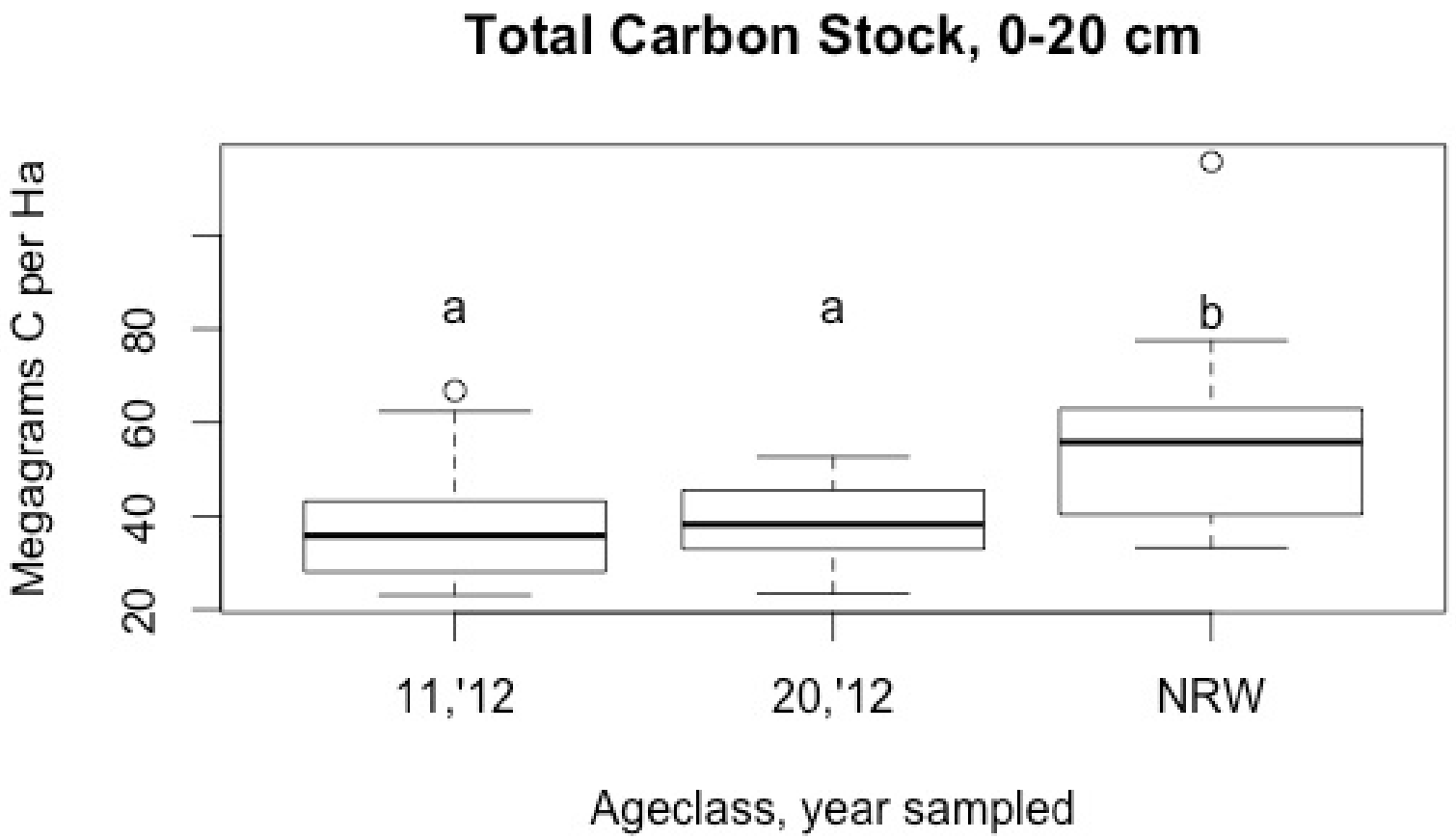

Percent Nitrogen, 10-20 cm
% N
0.1
0.3
0.5
0.7
a
b
c
11,'12
20,'12
NRW
Age class, year sampled

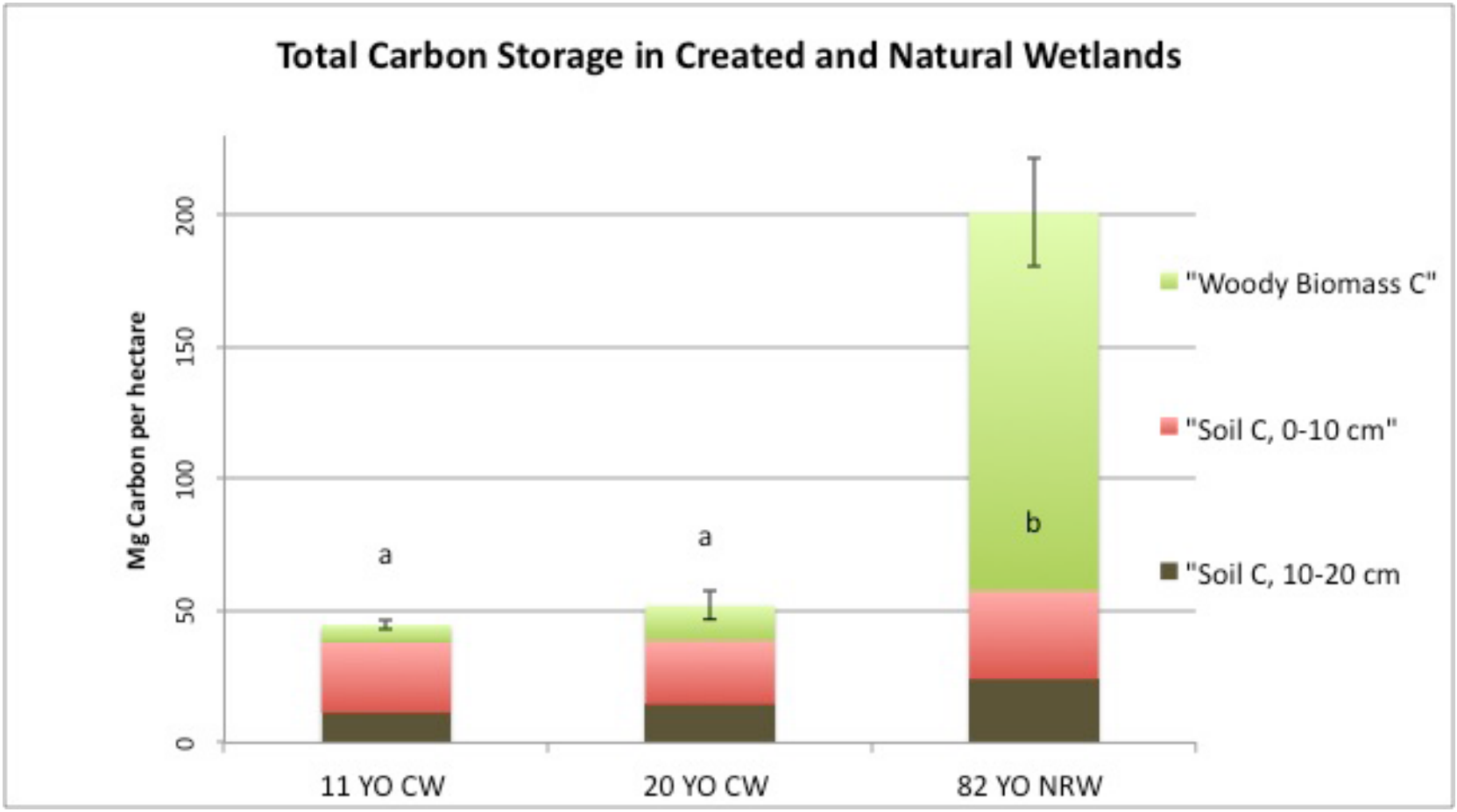
C:N, C:P and N:P ratios in the top 10 cm of CFWs developed to statistically similar levels to NRWs within 20 years

Soil edaphic parameters appear to indicate a trend toward maturation of ecological functions

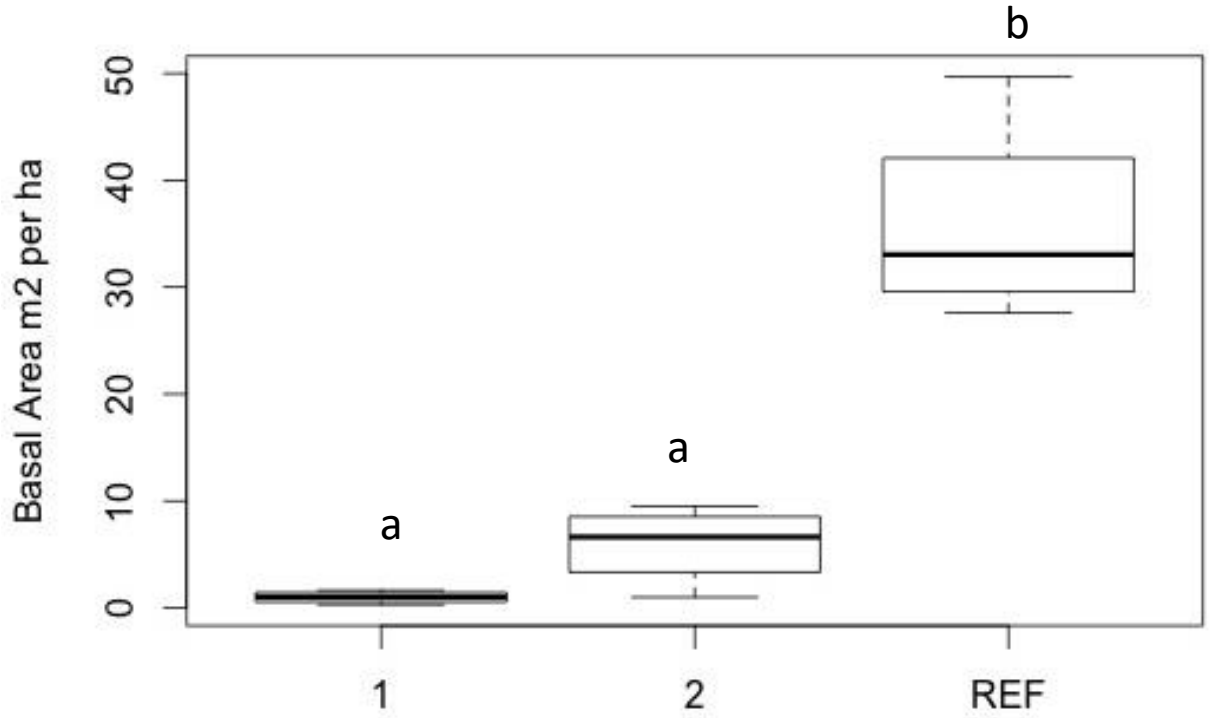
- Bulk density
- Carbon accumulation
- %C
- %Nitrogen

… add in Vegetation




Total Carbon Storage in Created and Natural Wetlands
Mg Carbon per hectare
0
50
100
150
200
a
a
b
11 YO CW
20 YO CW
82 YO NRW
"Woody Biomass C"
"Soil C, 0-10 cm"
"Soil C, 10-20 cm

Basal Area of trees ≥10 cm DBH by age class



All age classes include 2 sites from the Piedmont and 2 from the Coastal Plain

Age 1: average age: 11.5 years

Dominant Trees: Salix nigra (IV = 70.4)

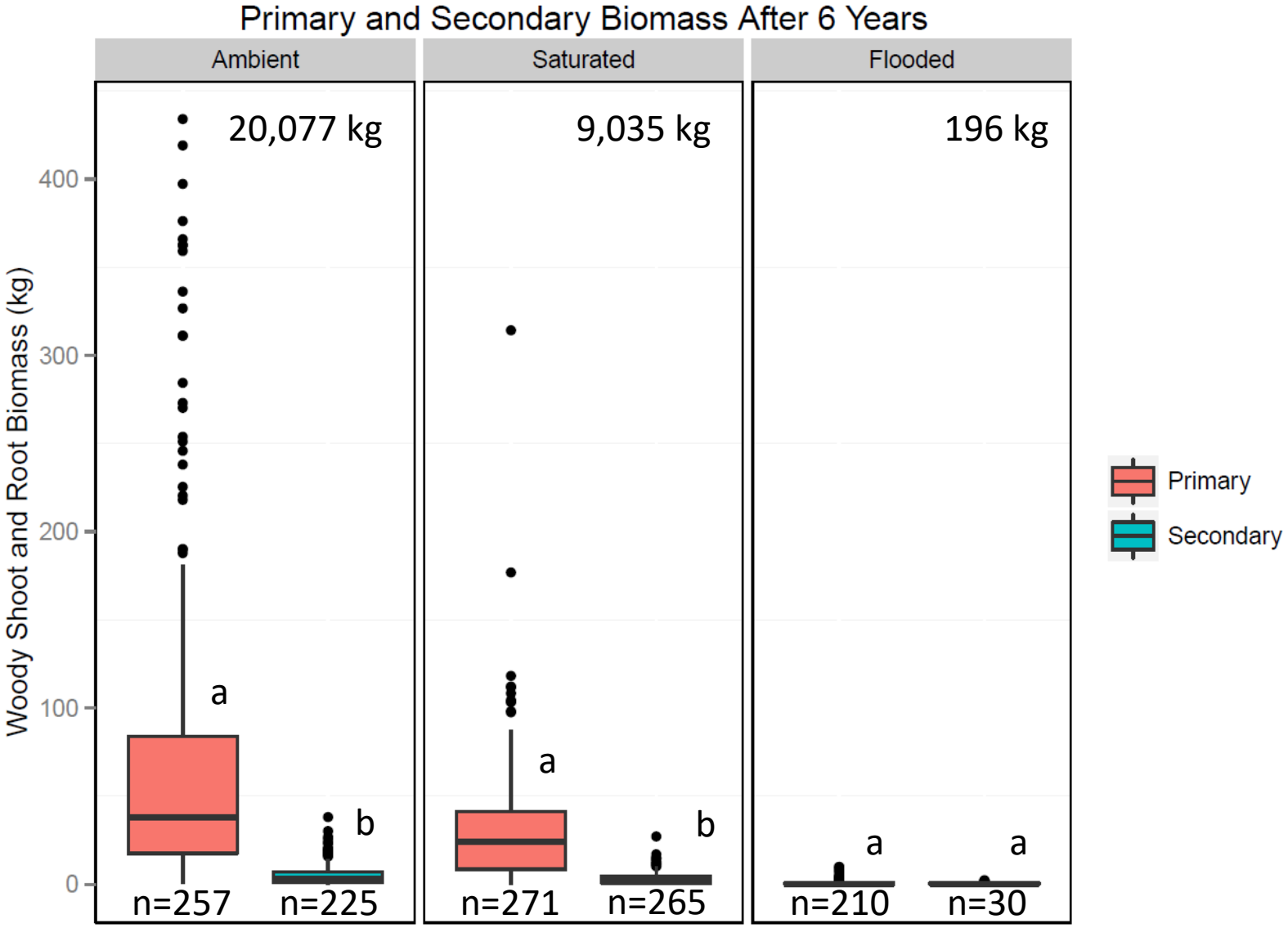
Age 2: average age: 21 years

Dominant Trees: Salix nigra (37.3), Pinus taeda (21.9)

Reference sites: average time since major disturbance (79 years)

Dominant Trees: Acer rubrum (35.5), Fraxinus pennsylvanica (16.9)


Cells
Flooded
Saturated
Ambient
Legend
Cell Boundaries
N



- AMB>SAT>FLD
- PRI>SEC (AMB & SAT)

Soils in the saturated cell of the experimental wetland met wet criteria in years 2, 4, and 5, but not in year 6, were mixed in year 7.

However, since we knew drainage and pumping numbers, we knew we had wetland hydrology in the root zone of Saturated Cell.

Soil edaphic parameters appear to indicate a trend toward maturation of ecological functions.

Vegetation does not indicate that created sites are trending toward meeting lost ecological functions!

- Low biomass;
- More invasive species;
- Lower FQI;
- Lower plant species diversity.

… we need to be careful when using soil parameters to measure replacement of ecological functions.

… we should consider the “big picture”, that is: soils, vegetation and hydrology.

Acknowledgements

VIMS | William & Mary
Virginia Institute of Marine Science

Wetland Studies and Solutions, Inc.®

Peterson Family Foundation

Virginia Department of Forestry