Above and Below Ground Nutrient Cycling in Northern Prairie Wetlands

Lindsey M. Meyers, Edward S. DeKeyser, Jack E. Norland, Christina L.M. Hargiss, Thomas DeSutter

North Dakota State University

Introduction

- Nutrient storage in wetlands
  - Different than in terrestrial ecosystems
  - Phosphorus, nitrogen, and carbon behave differently in anaerobic conditions
- Wetlands can be a sink for excess nutrients
  - Wetlands termed the ‘kidneys’ of an ecosystem
  - To a certain threshold
  - Nutrient overload can affect the biological integrity and functioning of the wetland
- Types and bioavailability of nutrients dependent upon:
  - Nutrient input/output, nutrient composition, pH, soil properties, types and distribution of different species

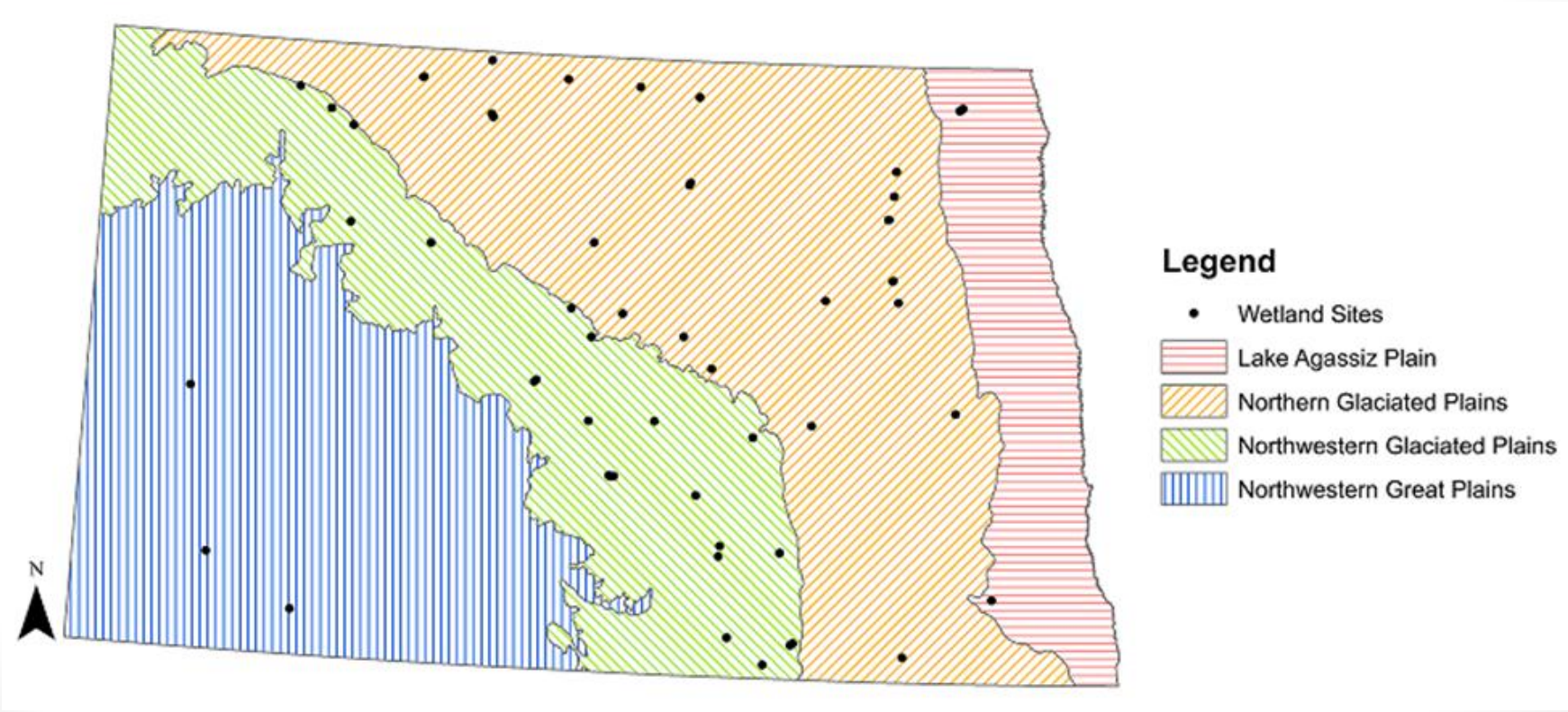
Introduction

- Assess a broad range of wetland types across North Dakota
  - Land use and condition data
  - Measure nutrient storage
  - Compare plant and soil data
- Plant and soil samples
  - Collected in different locations within the wetland
  - Compare different nutrients
  - Different plant types

Methods

- Summer 2011
- 55 sites
- Plant and soil samples
  - Plant: N, C, P analysis (P still being analyzed)
  - Soil: P, Hg analysis (still being analyzed)
- Assessments
  - National Wetland Condition Assessment (NWCA)
  - Index of Plant Community Integrity (IPCI)
  - North Dakota Rapid Assessment (NDRAM)
  - Hydrogeomorphic (HGM) Model

Study Sites


N
Legend
Wetland Sites
Lake Agassiz Plain
Northern Glaciated Plains
Northwestern Glaciated Plains
Northwestern Great Plains

Plant and Soil Samples

- Collected at 3 landscape positions
  - Upland
  - Toe slope
  - Shallow marsh

Plant Samples

- Clipped five 0.25-m^2 quadrats by type of vegetation at each landscape position
  - Warm season grasses
  - Cool season grasses
  - Sedges and rushes
  - Forbs and shrubs
  - Cattails
- Weighed for biomass
- Phosphorus, Nitrogen, and Carbon nutrient analysis

Soil Samples

- Samples for Phosphorus and Mercury content
  - Collected at the same 3 landscape positions
  - Six 500 g soil cores at each position
    - Three from 0-15 cm
    - Three from 15-30 cm

Wetland Assessments

- NWCA
  - Buffer, vegetation, soils, hydrology, water quality, algae, rapid assessment
- IPCI
  - Intense vegetative assessment based on 9 metrics
- NDRAM
  - Rapid assessment of buffer, soil, hydrology, management, vegetation, habitat, and overall condition based on 10 metrics
- HGM Model
  - Functional assessment of buffer, soil, hydrology, landscape and land use

IPCI Metrics

- Species richness of native perennials
- Number of genera of native perennials
- Assemblages: native grass and grass-like species (Poaceae, Cyperaceae, Juncaceae)
- Percentage of annual, biennial, and introduced species
- Number of native perennial species in the wet meadow zone
- Number of species with a C-value ≥ 5*
- Number of species with a C-value ≥ 4 in the wet meadow zone*
- Average C-value*
- Floristic quality index (average C-value multiplied by the square root of the total number of species)*

*C-value, or coefficient of conservatism, ranks native plants on tolerance to disturbance

NDRAM Metrics

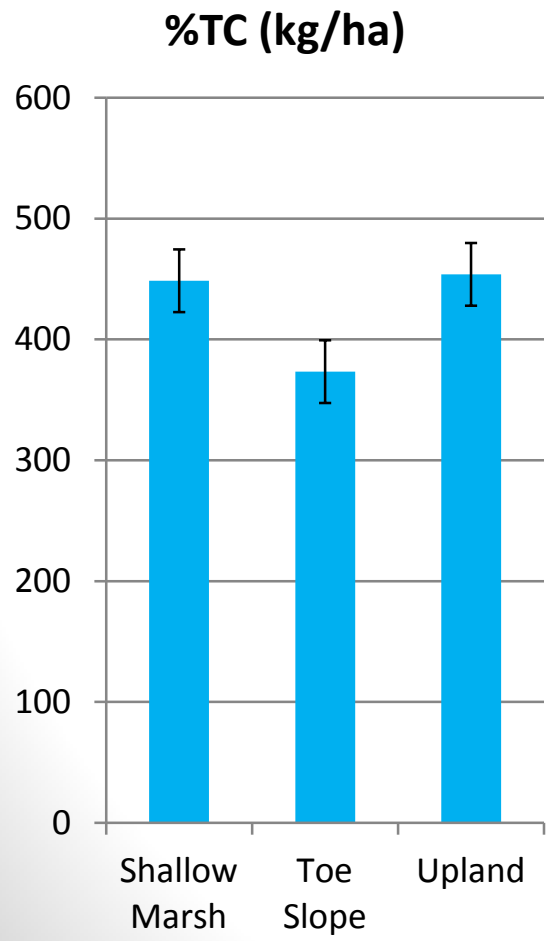
- Average buffer width
- Intensity of surrounding land use
- Substrate/soil disturbance
- Plant community and habitat development
- Habitat alteration and recovery from current and past disturbance
- Management
- Modifications to natural hydrologic regime
- Potential of wetland to reach reference (native) condition
- Cover of invasive species
- Overall condition

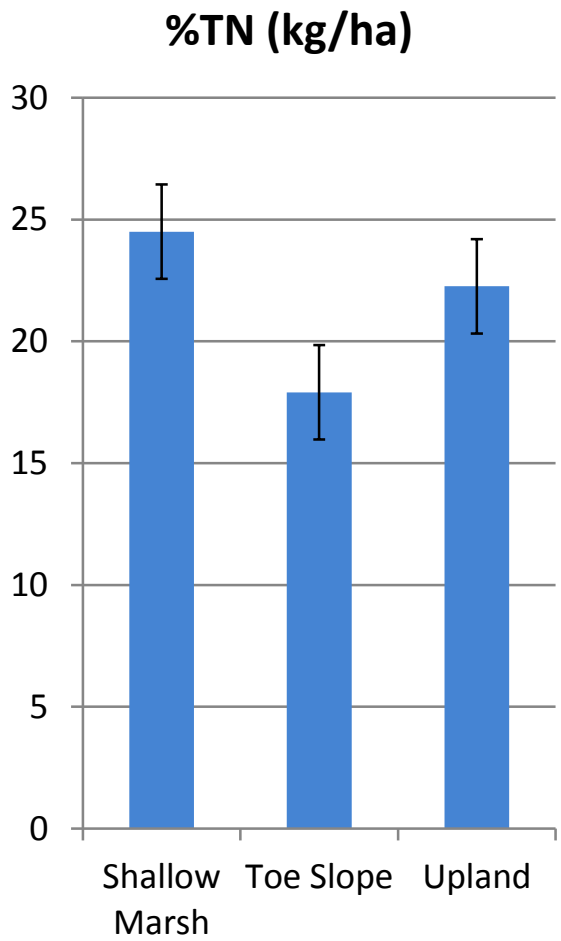
Statistics

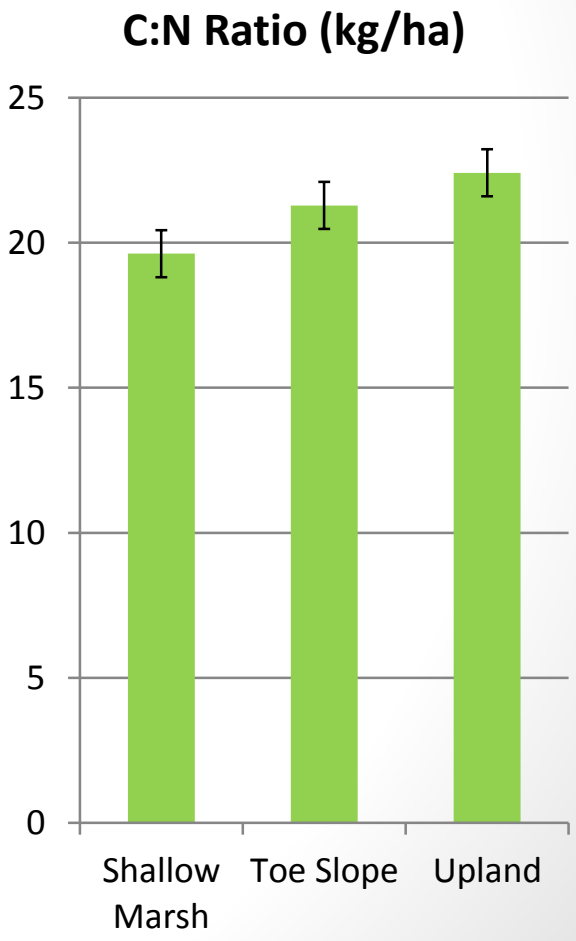
- Multi-response Permutation Procedures (MRPP)
  - Landscape positions (TC, TN, C:N)
    - Upland, toe slope, shallow marsh
  - Plant types (C:N)
    - Cattail, shallow marsh grass/grass-likes, shallow marsh forbs, toe slope grass/grass-likes, toe slope forbs, upland grass/grass-likes, upland forbs
  - Wetland condition for IPCI and NDRAM (C:N)
    - IPCI: good, fair, poor
    - NDRAM: good, fair high, fair low, poor
- Nonmetric Multidimensional Scaling (NMS) correlating C:N ratio
  - IPCI metrics
  - NDRAM metrics

MRPP Landscape Position

- Used Euclidean distance measure and Bonferroni test to adjust for multiple comparisons
- No significant differences for landscape position ($p < 0.05$)

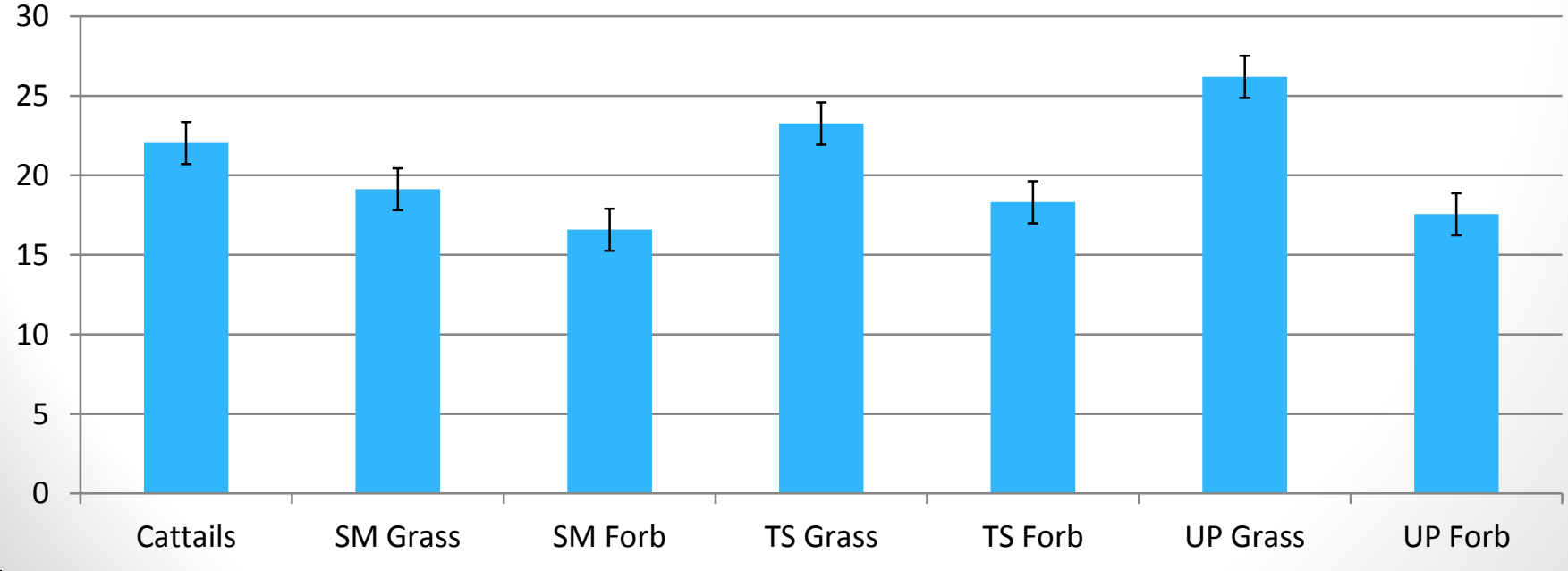






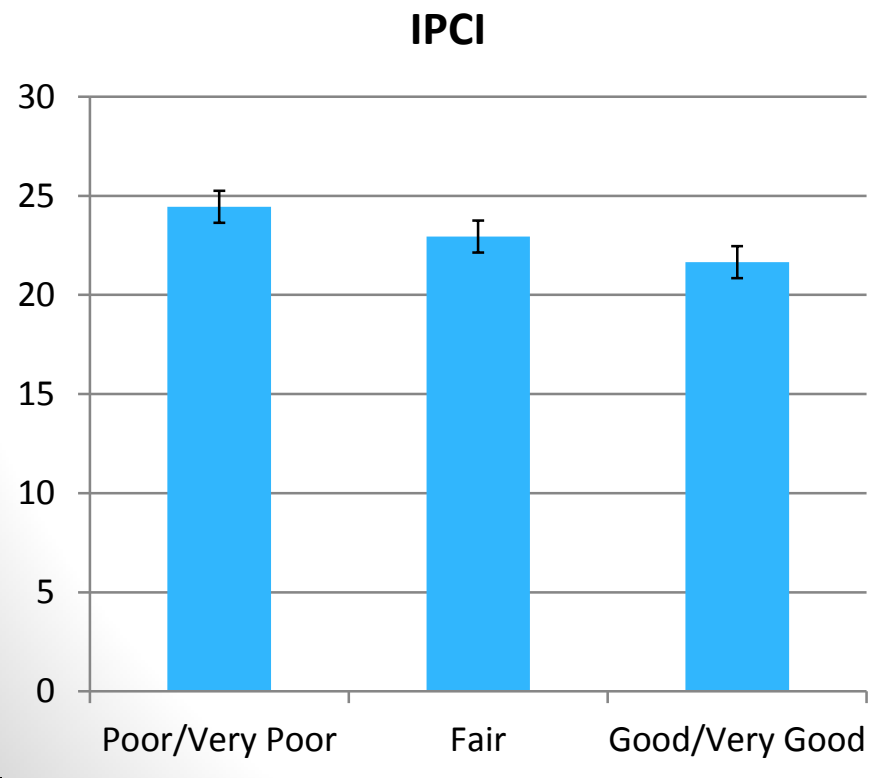
MRPP Plant Type

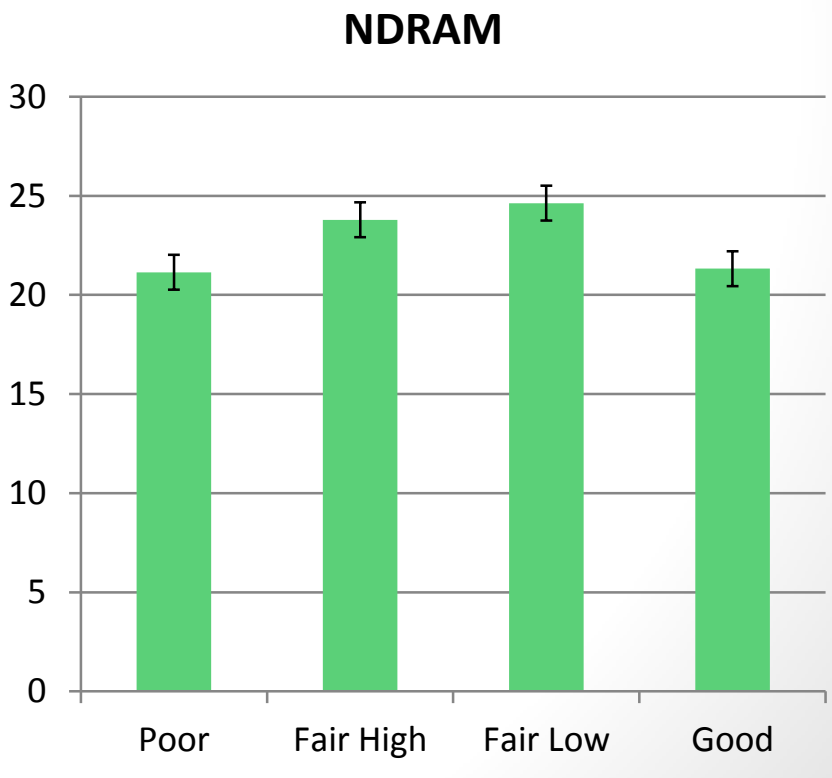
- Used Euclidean distance measure and Bonferroni test to adjust for multiple comparisons
- Significant differences in C:N ratio (kg/ha) for plant type ($p < 0.05$)
  - Shallow marsh grass/grass-likes **<** upland grass/grass-likes
  - Shallow marsh forbs **<** toe slope grass/grass-likes
  - Shallow marsh forbs **<** upland grass/grass-likes
  - Toe slope forbs **<** upland grass/grass-likes
  - Upland forbs **<** toe slope grass/grass-likes
  - Upland forbs **<** upland grass/grass-likes



MRPP Wetland Condition

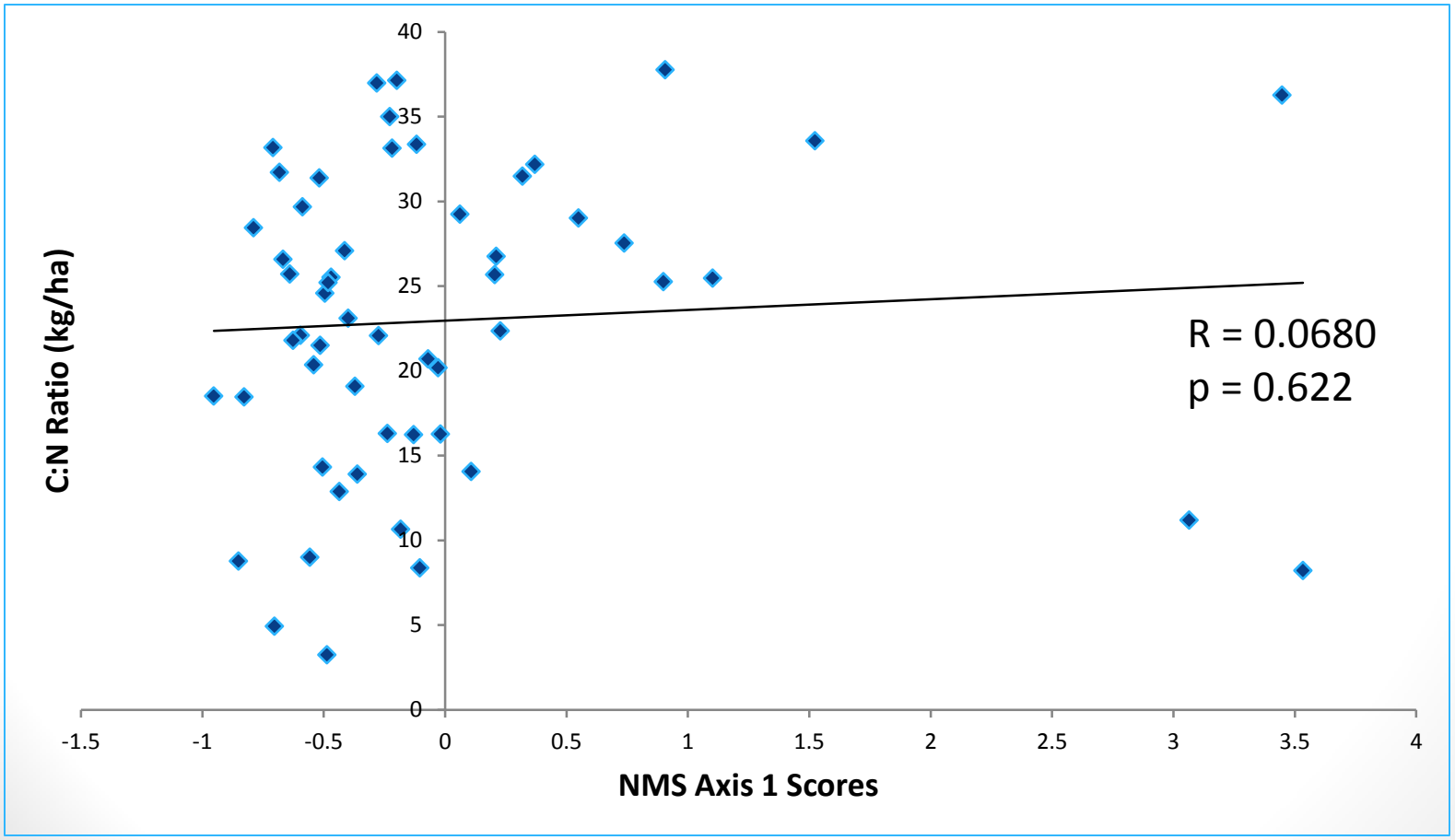
- Used Euclidean distance measure and Bonferroni test to adjust for multiple comparisons
- No significant differences in C:N ratio for wetland condition for either assessment ($p < 0.05$)





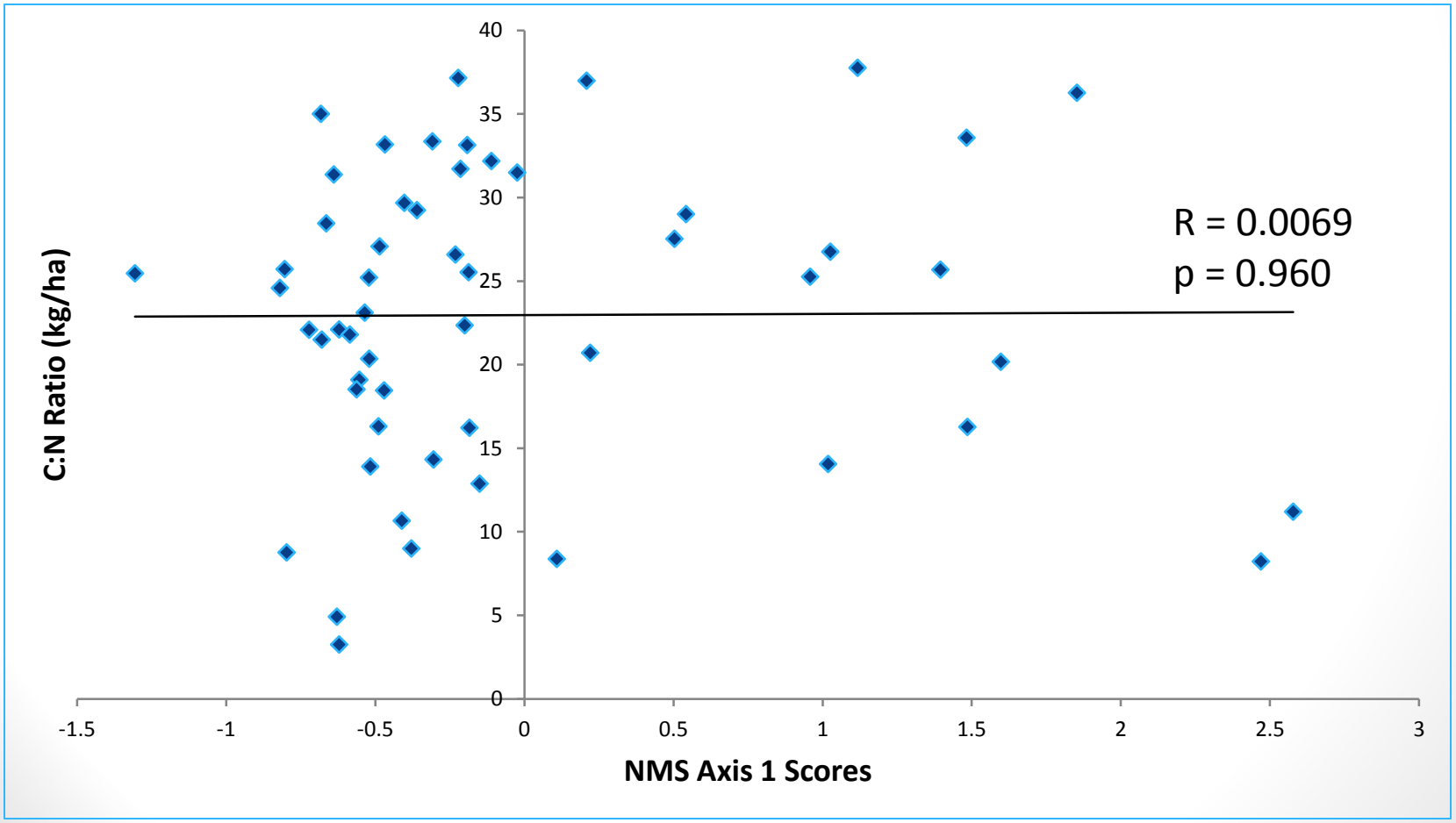
NMS C:N Ratio and IPCI

- Used Relative Euclidean distance measure
- Axis 1 represented 92.4% of the variability in the data
- C:N ratio not significantly correlated to Axis 1



NMS C:N Ratio and NDRAM

- Used Relative Euclidean distance measure
- Axis 1 represented 83.6% of the variability in the data
- C:N ratio not significantly correlated to Axis 1

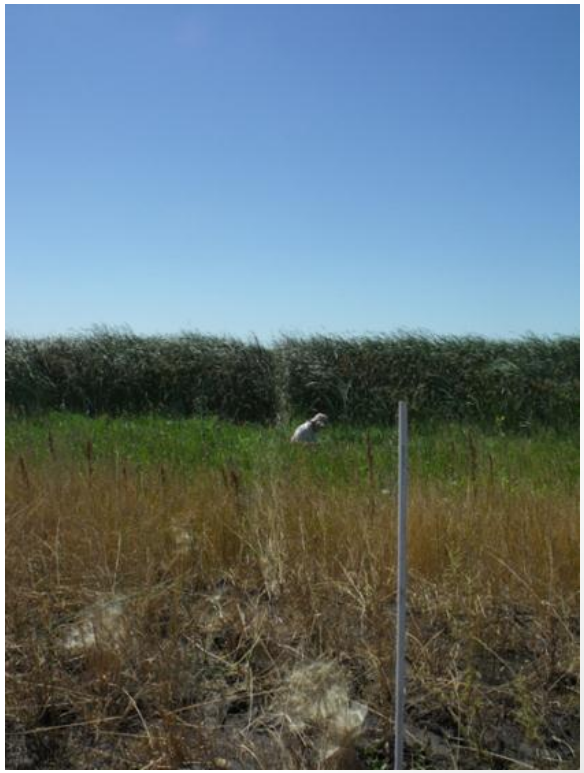


Conclusions

- Total %C, total %N, and C:N ratios in plants are not different in different landscape positions in the wetland
- C:N ratios in plants do not differ for wetland condition
- C:N ratios are different for some plant types
  - Typically, forbs have < C:N ratios than grass/grass-likes particularly when compared with higher landscape positions
- NMS shows IPCI and NDRAM metrics are not correlated to aboveground C:N ratios
- High variability in aboveground C and N even within similar land use settings

Future Analyses

- Make comparisons with plant Phosphorus content
- Correlate with soil data
- Correlate with species level data
- Correlate with NWCA and HGM Model
- Continue running more statistics and models as data becomes available



Thank You!

- Shawn DeKeyser
- Jack Norland
- Tom DeSutter
- Christina Hargiss
- Matt Stasica
- Skye Gabel
- NDSU Soils Lab
- Jessica Meissner
- Patrick Corrigan
- Levi Scheff
- Eva Sebesta

- Funding for this project provided by the ND Department of Health, EPA, and ND Water Resources Research Institute

Questions?