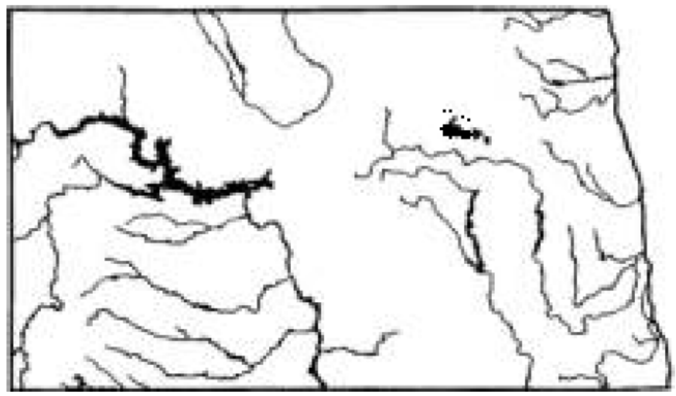

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Abstract

This study seeks to assess and evaluate wetlands across the state of North Dakota with a special emphasis on wetlands in the Prairie Pothole Region (PPR). In the summer of 2011, four assessment and nutrient studies were completed on 55 wetlands. The National Wetland Condition Assessment (NWCA) evaluated vegetative, soil, water, algal, hydrological and buffer wetland characteristics. The NWCA not only included intensive sampling of these biological and physical criteria, but also included a rapid assessment of these criteria. Regional wetland assessments developed for North Dakota were also completed at each site. Each wetland was rapidly assessed using the North Dakota Rapid Assessment Method (NDRAM), plant community composition of each wetland was evaluated using the Index of Plant Community Integrity (IPCI), and functional characteristics of the wetlands were evaluated using the Hydrogeomorphic (HGM) model. At each wetland, live plant and soil samples were collected for nutrient analysis. Additionally, current and future statistical and lab analysis is discussed here. Future sampling is scheduled to take place in the summer of 2012.

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Introduction

Prairie pothole wetlands are important to North Dakota and provide many unique functions and services. These include wildlife habitat and forage, improved water quality, floodwater storage, groundwater recharge, and carbon sequestration (Knutsen and Euliss 2001; Gleason et al. 2008). These services benefit humans as well as the natural system. Because wetland ecosystem services are diverse and at times difficult to measure, currently there is much unknown regarding certain functions of PPR wetlands and what their value is to society.

Historically, the PPR was comprised of short-, intermediate-, and tall-grass prairie with about 20 to 60 % of the landscape containing wetland ecosystems (Seabloom and van der Valk 2003). However, agricultural practices are important in the PPR and have been the main factor in wetland degradation and destruction due to tillage, upland deterioration, sedimentation, agricultural runoff, and drainage (Dahl 1990; Dahl and Johnson 1991). PPR wetland condition in this agricultural landscape can be assessed using plant community, land use, soil, and water data (DeKeyser et al. 2003; Seabloom and van der Valk 2003; Gilbert et al. 2006; Hargiss et al. 2008; Hargiss 2009). As agriculture, climate change, and other impacts increase stress on wetlands, accurate assessment and measurement of wetland functioning is important for land managers, policymakers, and scientists.

Nutrient storage and cycling is another important measure in wetlands in addition to overall quality or condition. Freshwater aquatic systems can be greatly affected by nutrient runoff from adjacent lands (Cooper 1993). Additionally, the amount and type of nutrients stored in wetlands can affect the overall biological community and functioning of the wetland. What types of nutrients and the bioavailability of these nutrients can be dependent upon nutrient input/output, nutrient composition, pH, soil physical and chemical properties, and type and distribution of plant and animal species.

Wetlands are useful buffers and can be sinks for excess nutrients at low concentrations (Howard-Williams 1985). Additionally, nutrient accumulation in wetlands can influence species composition and productivity. How current land use practices in North Dakota PPR affect nutrients in wetlands has not been extensively studied. It is not certain how carbon, nitrogen, and phosphorus are stored in PPR wetlands. Other studies have found that there is a significant increase in phosphorus levels in wetland soils located around agricultural lands (Reddy and DeLaune, 2008). Nutrient pools in wetland soils are variable and mineralization rates can vary considerably between wetland communities (Bridgham et al. 1998). Therefore, data is needed for accurate measurement of nutrients in wetlands and how they may be affected by land use practices.

Objectives

The objectives of this study include:

1) To provide a condition assessment of North Dakota wetlands.
2) Compare methods of the NWCA and the regional assessments.
3) To develop and assess ecosystem services models for wetlands in the PPR of North Dakota.

4) To examine phosphorus and nitrogen isotopes in PPR wetland soils of North Dakota.
5) To examine phosphorus, nitrogen, and total carbon in PPR wetland plants of North Dakota.

Methods

In the summer of 2011, 55 selected sites across North Dakota were assessed with NWCA methods and regional assessment methods. Additionally, at each site plant and soil samples were collected for phosphorus, nitrogen, and total carbon content. Sites were randomly selected by the EPA from the U.S. Fish and Wildlife Service's Status and Trends plots. In the summer of 2012, additional wetlands will be sampled for nutrient analysis and to supplement data needed for the development of ecosystem services models. Two of the 55 wetlands were sampled twice over the summer for the NWCA, also two wetlands were specifically located to be sampled as reference sites, and 52 of the 55 were located within the PPR.

At each site, the NWCA assessment was completed as outlined in the NWCA Field Operations Manual (U.S. Environmental Protection Agency 2011). This included characterization of the wetland buffer, vegetation, soils, hydrology, water quality, algae, and a rapid assessment. The assessment area for each wetland was set up around a GPS point determined from the Status and Trends plots. In areas where this was not practical (water was over 1 m deep, point was located on an upland), the point was allowed to move up to 60 m. The point was not required to be located at the center of the assessment area, but did have to be within the assessment area. The size of a typical assessment area was 0.5 ha with the smallest being 0.1 ha. A standard assessment area is a circle with a 40 m radius, however most assessment areas were modified. Less than 10% of the assessment area can be greater than 1 m deep of water and/or upland. Vegetation, soil, water, and algae samples were taken, stored, and shipped as directed.

Three buffer plots were characterized in each of the four cardinal directions and one buffer plot at the center of the assessment area (Figure 1). The first of the outer buffer plots were located 5 m from the edge of the assessment area. The next two were located 45 and 90 m from the first buffer plot. Each buffer plot was 100-m^2 and natural cover, stressors, and alien species were recorded for each plot.

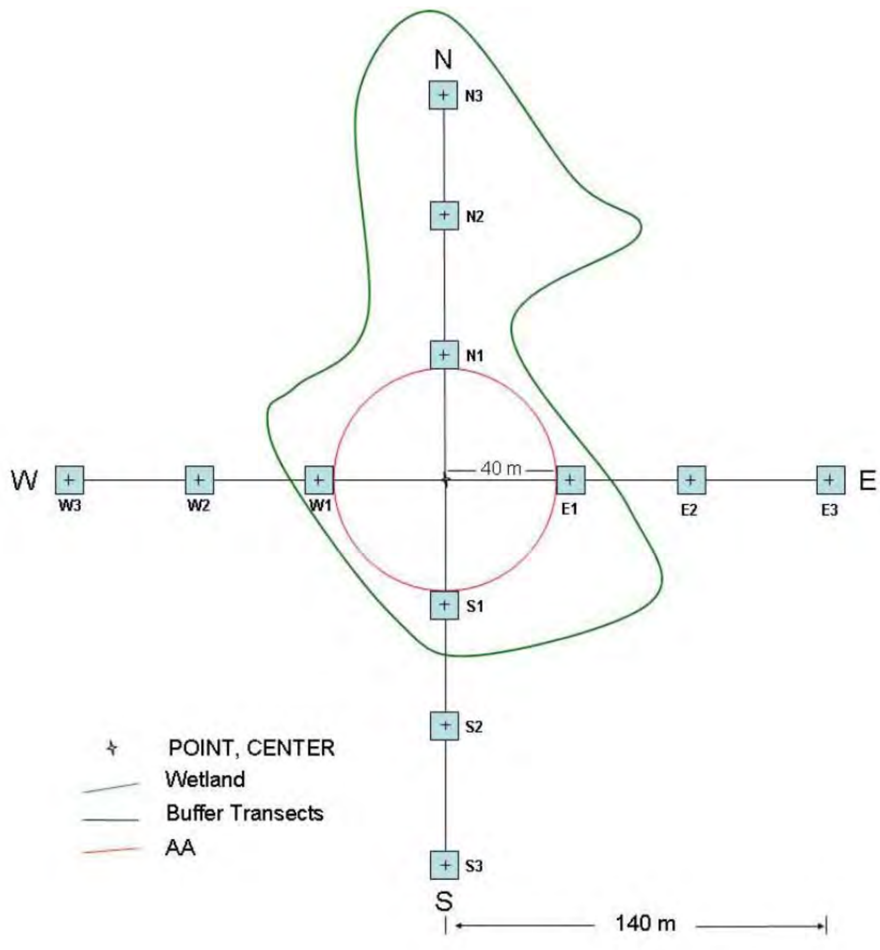

Figure 1. Buffer plots with respect to a standard assessment area (taken from U.S. Environmental Protection Agency 2011). N1, N2, and N3 refer to the first, second, and third buffer plots on the north transect with the east, south, and west transects labeled similarly.

Five 100-m^2 (10m x 10m) plots to assess vegetation were designated in the assessment area according to the shape of the assessment area with one always located 5 m from the center of the assessment area (Figure 2). Plant species presence was recorded in nested 1-m^2 and 10-m^2 quadrats in the southwest and northeast corners of each plot. Percent cover estimates and height classes for all vascular plant species were recorded across the 100-m^2 plot. Percent cover estimates for all nonvascular plant species were recorded across the 100-m^2 plot. Last, counts of live trees by species and diameter class and counts of standing dead trees by diameter class were performed in each plot.

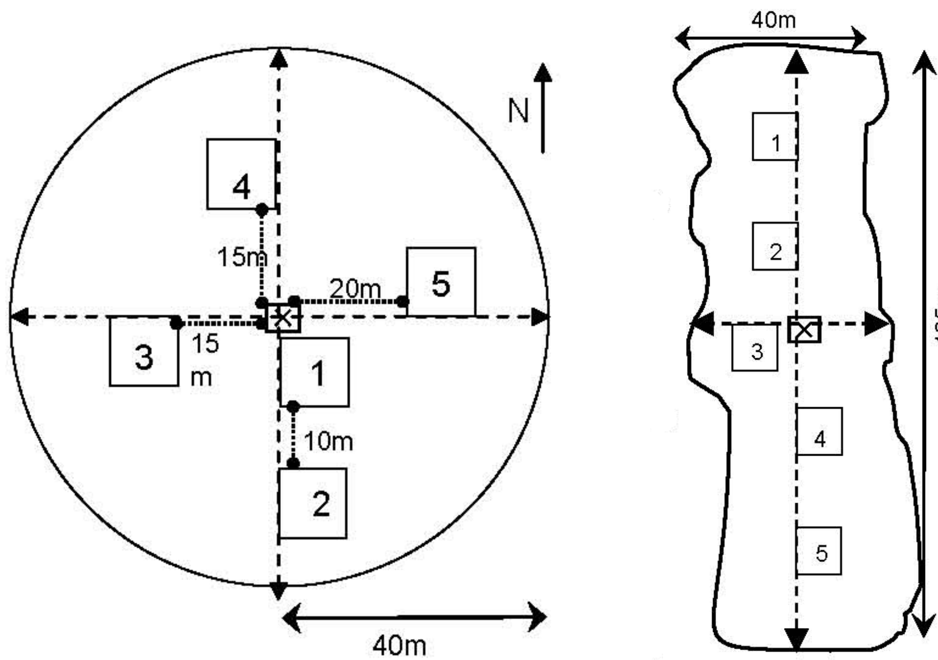

Figure 2. Examples of placement of vegetation plots in a standard assessment area (left) and a nonstandard assessment area (right) (taken from U.S. Environmental Protection Agency 2011).

Four soil pits were dug at the southeast corner of the outer four vegetation plots. Soil pits where water was greater than 0.25 m deep were discarded. Soil profile and physical characteristics and hydric soil indicators were recorded at each of the four soil pits down to 60 cm. Based on the profile characteristics for each pit, one of the four pits was chosen as the most representative for the site. This pit was described down to 125 cm. Additionally, soil isotope and sediment enzyme, bulk density, and soil chemistry samples were taken from this pit.

At each site hydrology was characterized including: identification of water sources, hydrology indicators, and hydrology stressors. Hydrology indicators and stressors were measured only within the assessment area. Also, water quality measurements and samples were taken at wetlands with surface water greater than 15 cm deep. This included: an estimation of the percent of the assessment area covered by surface water and the maximum depth of the surface water, determining characteristics of the assessment area surface water, collecting water chemistry samples, and surface water field probe readings (dissolved oxygen, pH, conductivity, and water temperature). At wetlands with water greater than 15 cm deep, chlorophyll-a samples were taken. Other algal samples were collected depending on presence or absence of epiphytes and sampleable substrate.

The national rapid assessment method (USA-RAM) was completed on all sites. The USA-RAM rapidly assessed the wetland buffer and assessment area. The buffer zone was established as 100 m from the perimeter of the assessment area. Recorded was the percent of the assessment area had the buffer, buffer width, and stresses to the buffer zone. The assessment area was scored on the physical and biological structure (dealing with topographic, patch mosaic, vertical, and plant community complexity) and stressors. Stressors to the assessment area included: alterations to hydroperiod and water quality, habitat/structure alterations, invasive plant species, and vegetative disturbance.

Additionally, three regional wetland assessment methods were performed. The regional methods include: rapid assessment using the NDRAM (Hargiss 2009), intense vegetation assessment utilizing the IPCI (DeKeyser et al. 2003; Hargiss et al. 2008), and a functional assessment using the HGM model (Gilbert et al. 2006). For temporary, seasonal, and small semi-permanent wetlands where the assessment area covered all or most of the wetland zones, the regional assessments were completed as normal. For large semi-permanent, permanent, riparian, and lacustrine wetlands the regional assessments were performed along the assessment area in a linear fashion. This was done so that all assessments (national and regional) were performed on the same part of the wetland.

The NDRAM first records a general site description, map drawing, and basic site information including the type and distribution of vegetation present. Additionally, three metrics are scored that determine the site quality. Metric 1 is worth 20 points and assesses the average buffer width and the intensity of surrounding land use. Metric 2 is worth 57 points and assesses the amount of substrate/soil disturbance, quality of plant community and habitat development, degree of habitat alteration and recovery from current and past disturbances, type of management, extent of modifications to the hydrologic regime, and the potential of the wetland to attain reference condition. Metric 3 is worth 23 points and assesses the extent of invasive plant species and the overall condition for the vegetation of the site. Sites were each ranked in one of four condition groups: Good (69-100), Fair High (53-68), Fair Low (27-52), and Poor (0-26).

The IPCI records the vegetative cover and species composition within each wetland zone. 1 m^2 quadrats were used to estimate percent cover by species (Kantrud and Newton 1996; DeKeyser et al. 2003; Hargiss et al. 2008). Quadrats were placed at equal distributions throughout the center of each wetland zone (Figure 3). Eight quadrats were completed in the low prairie zone, seven in the wet meadow zone, five in the shallow marsh zone, and five in the deep marsh zone. Plants within the 1 m^2 quadrats were considered primary species. Additionally, a list of secondary species was recorded for species found outside of the quadrats. Within each quadrat, estimates of average litter thickness, average water depth, percent cover of standing dead, percent bare ground, and percent open water were also recorded.

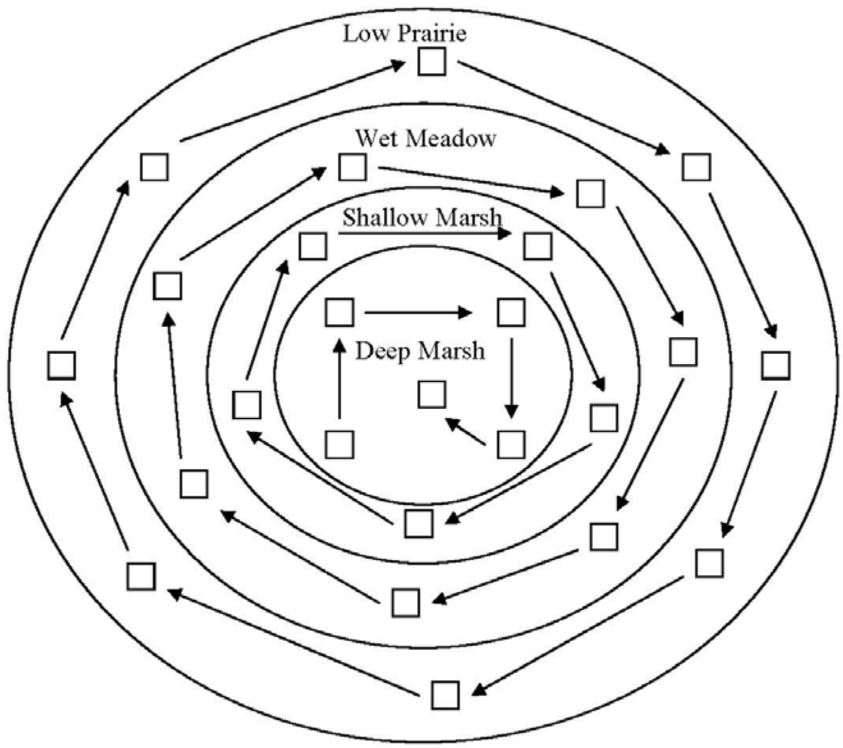

Figure 3. IPCI quadrat distribution for a semi-permanent wetland (taken from Paradeis 2008).

The HGM model assesses wetlands based on data recorded in the field as well as GIS information in order to compare a wetland's function to reference condition (Gilbert et al. 2006). Field data collected at each wetland included: a soil description up to 30 cm at four different soil pits evenly distributed across the wet meadow zone, litter depth at each soil pit, wetland and catchment perimeter and area using a GPS, and land use and buffer zone characteristics.

In addition to the wetland assessments, plant and soil samples were collected for nutrient analysis. At each site, three landscape positions were sampled including the mid-slope, wet meadow zone, and shallow marsh zone. The mid-slope was defined as at least a 1 m elevational rise from the wetland within 50 m of the wetland. Mid-slope landscape positions were not collected in actively cropped areas. Soil samples were collected at three locations per landscape position. The three locations at each landscape position fell within the width of the wetland. Two 500 g soil cores were extracted at each location, one from the top 15 cm and one from 15 to 30 cm deep in the soil horizon, using a small shovel for a total of 18 cores per site. Samples were bagged, labeled, and stored in coolers at the site. Samples were refrigerated until analyzed for phosphorus content. Also, five 0.25 m^2 quadrats of live vegetation were clipped and bagged at each landscape position for a total of 15 quadrats per site. Vegetation in each quadrat was separated into warm season grasses, cool season grasses, sedges and rushes, forbs and shrubs, and cattails. Upon return to NDSU, vegetation samples were dried, weighed for biomass, and ground for phosphorus, nitrogen, and total carbon nutrient analysis.

Future Analysis

Currently, the data collected this summer is in the process of being entered and analyzed. Future statistical analyses include: comparison of wetland assessment methods; modeling of wetland assessment, land use, and/or nutrient pools; and comparisons of how and where nutrients are stored in different wetlands. Analysis of ecosystem services in wetlands, particularly with respect to nutrient cycling, will also be completed. Methods being examined include those used by Clark (2007), Johnston et al. (2008), and Briggs et al. (2009). Comparisons will also be tested for level of disturbance such as farmed, restored, idle, and native (reference condition). Previous wetland data will also be used in analyses.

Additionally, lab analyses on samples collected in the field are being completed. Samples collected for NWCA assessments have been shipped to the NRCS National Laboratory (soil samples from 11 sites) and the North Dakota Department of Health Laboratory (water samples) or are being analyzed by the NDSU Soil Testing Lab (remaining soil samples). Vegetation and soil samples collected for nutrient analysis are being completed by the NDSU Soil Testing Lab using standard methods and procedures as outlined for the North Central Region (North Central Region-13 1998). Soil phosphorus is to be analyzed using two extractions: water soluble extractions to test the amount of phosphorus in solution in the soil and Olsen extractions (bicarbonate extraction) to test the amount of plant available phosphorus in the soil (Olsen et al. 1954). This summer, additional data will be collected on 9 additional wetlands which have been restored. Further analysis and comparisons for the potential of nutrient cycling in restored wetlands will be completed.

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