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IOWA FARMED WETLANDS

Monitoring the Wildlife, Hydrology and Water Quality of Drained Wetlands of the Des Moines Lobe, Northern Iowa: Introduction to Special Feature

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Abstract
The vast majority of prairie-pothole wetlands in a region that extends from northcentral Alberta in Canada to central Iowa in the United States have been drained to facilitate agricultural crop production. However, many of these drained wetlands continue to pond surface water immediately following snowmelt or heavy rains, making them too wet to provide a consistent crop and yet too dry to function as normal wetlands. These systems which we label "drained wetlands" were the subject of a four-year monitoring study (2011–2014) funded by the U.S. EPA that focused on monitoring the wildlife value, hydrology and water quality of drained wetlands of the Des Moines Lobe. Herein we describe highlights from the various monitoring components of the multi-year study and introduce a collection of five papers begins to describe the ecosystem value and complexity of these under-studied wetland systems.

Keywords Prairie pothole · Des Moines lobe · Iowa · Tile drainage · Sheetwater · Water quality

Introduction

Extending from the Canadian provinces of Alberta, Saskatchewan, and Manitoba through northern Montana, north and eastern North Dakota, eastern South Dakota, and western Minnesota, the 700,000 km^2 prairie pothole region (PPR) terminates with the Des Moines Lobe in central Iowa (Fig. 1; Miller et al. 2009). Within this vast region exist millions of pothole depressions (Winter and Rosenberry 1998; van der Valk and Pederson 2003; Johnson et al. 2008; Roth and Capel 2012). In Iowa alone, the retreat of the Wisconsin-age Des Moines Lobe approximately 12,000 years B.P. (Prior 1991) left a landscape that once contained an estimated 1.4 million ha of prairie-pothole wetlands (Miller et al. 2009).

However, installation of artificial drainage systems by Euro-American settlers in the late 1800s to early 1900s drained most of these wetlands (Kanwar et al. 1983; Zucker and Brown 1998). In the PPR of Iowa, approximately 95 to 99% were drained; only 12,140 ha of Iowa's original wetland area remains today (Bishop et al. 1998). The easiest to drain were shallow pothole depressions that ponded water only temporarily; these wetlands were the first to be converted to agricultural crop production (Miller et al. 2009). Historically, these drained pothole wetlands were cropped with rotations of corn andsod-based crops including oats, other small grains, and alfalfa. However, since the 1950's soy has largely replaced other crops and now alternates with corn as the dominant "row crop" grown in the state.

Today, these "drained" wetlands are the most prevalent wetland category on the Des Moines Lobe landscape. Although many drained wetlands have one or more layers of drainage tile installed beneath them to keep them sufficiently dry for crop production, snowmelt or heavy rains can temporarily pond in these landscape depressions (Fig. 2). The result is that many are often too wet to yield a consistent crop and yet too dry to function as a normal wetland (Fig. 3).

What to Call them?

For purposes of implementing the 1985 Food Security Act, wetlands were defined in the Act's wording and it established

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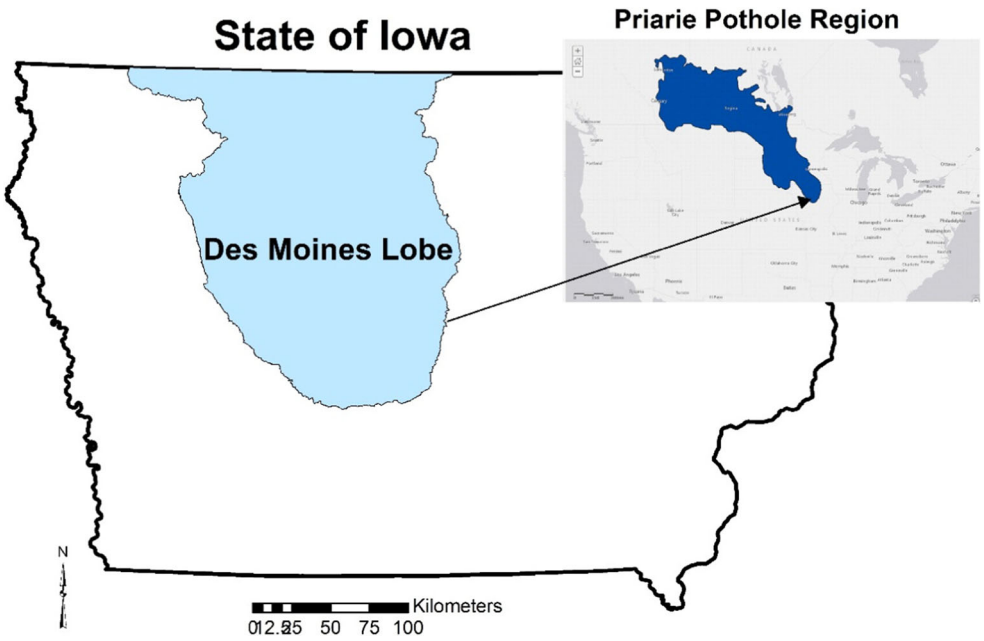

Fig. 1 Location of the prairie pothole region in the midcontinent of North America and its southern termination as the Des Moines Lobe in Iowa

financial penalties for altering wetlands (known as the "swampbuster" provisions of the Food Security Act). In defining wetlands, the Act established four categories related to those on agricultural lands: a) wetlands, b) prior-converted wetlands, c) converted wetlands and d) farmed wetlands. "Wetlands" are areas that meet specific hydrology, plant, and soil criteria representative of wetland habitats. "Prior-converted wetlands" are wetlands that were converted to arable land prior to 1985, whereas "converted wetlands" are wetlands that were converted to arable land after 1985. Farmed wetlands are areas that have the hydrology and soil characteristics of wetlands but are used to produce a crop. Continued farming of "farmed wetlands" is allowed under the Food Security Act, but crop production cannot be facilitated by new drainage. Since the Food Security Acts implementation in 1985, amendments and court rulings have attempted to clarify these definitions, and identify program oversight responsibilities and jurisdictions.

With these definitions in mind, sometimes it is difficult to state with confidence whether a drained and cropped pothole wetlands isindeed a "farmed wetlands" "prior converted" or "converted" wetland. Clearly, definitions matter when dealing with federal legislation and therefore terminology should not be used carelessly. For this reason, we have chosen to use the term "drained wetlands" (which could also be described as "partially converted" wetlands)to describe these drained and cropped pothole wetlands that temporarily hold water. Using the term "drained wetland" as we have done in many of our studies, avoids a definition linked to official FSA connotations

Fig. 2 Ponded water in drained wetlands of Iowa's prairie pothole region after a heavy rain temporarily backed up the drain tile in early May, 2005. Photo courtesy of Guy Zenner, Iowa DNR Waterfowl Biologist (retired)

Fig. 3 Bird use of temporarily ponded water in a drained prairie pothole wetland

yet provides a descriptive name that is easily understandable. For others, using the term "partially converted" might be preferred. In the wildlife literature there is a history of referring to such wetlands as "sheetwater wetlands" (e.g., LaGrange and Dinsmore 1989) and we adopted that terminology in describing the wildlife component of our study.

U.S. EPA-Funded Monitoring Project

Very little information documents the ecosystem value of drained wetlands in terms of wildlife, water quality, and key hydrological attributes. In 2011, scientists from the Iowa Department of Natural Resources, Iowa State University, and University of Iowa received the first of two consecutive multi-year U.S. EPA Region VII Wetland Program Development Grants to evaluate such wetlands of northern Iowa. The projects were implemented during a four-year monitoring period (2011–2014) and focused on three main objectives: 1) assess the value of partially converted wetlands for wildlife, 2) measure surface-water quality of partially converted wetlands, and 3) evaluate their hydrological functioning. A fourth objective focused on modeling hydrological connectivity was added later.

The value of this four-year effort was to provide natural resource agencies, conservation organizations, and agricultural groups with the information needed for a better understanding ecosystem services provided by partially converted wetlands across this region. Information gained provides for an improved understanding of ecological implications of policy decisions related to large scale tile/drainage issues, wetland restoration priorities, and water-quality priorities.

Overview of the Special Feature

Monitoring of drained wetlands in the Des Moines Lobe of Iowa was conducted between 2011 and 2014.The results from several of these studies are reported in this special feature of *Wetlands*. The paper by Murphy and Dinsmore (2017) describes the diversity and abundance of waterbirds using drained wetlands in spring migration. During the 4-year study they sampled 1913 unique wetlands and tallied 14,968 individuals of 53 waterbird species. The best represented groups were waterfowl and shorebirds, with waterfowl dominating the abundance in early spring (March–April) and shorebirds more prevalent in May.Overall, Murphy and Dinsmore (2017) highlight the widespread use of these drained PPR wetlands by waterbirdsduring spring migration anddiscuss the importance of wetland size as a predictor of use.

Groundwater hydrology and quality of drained wetlands of the PPR are poorly understood and the paper by Schilling et al. (2017) describes water-table fluctuations and groundwater nutrient concentrations at eight drained wetland sites. They report that water table depths were greatly influenced by the presence of subsurface drainage tile in the drained potholes. Although ponding was observed in the depressions on occasion, it appeared to be from precipitation or snowmelt runoff and only rarely due to groundwater rise. Elevated concentrations of NO_3-N and PO_4-P were measured in shallow groundwater beneath the drained wetlands and Schilling et al. (2017) noted that the nutrient concentrations were similar in magnitude to those typically measured in subsurface tiles in central Iowa.

Hydrologic connectivity within a topographically-defined, drained and farmed, prairie- pothole complex was explored in a paper by Arenas-Amado et al. (2017). Using a physically-based surface and groundwater model (HydroGeoSphere; Panday and Huyakorn 2004) they report that hydrologic connectivity among three pothole depressions was rarely established during a six-year simulation period due to extensive subsurface drainage. The use of coupled surface-subsurface flow models like the one reported in Arenas-Amado et al. (2017) was considered by Golden et al. (2014) to be the analytical tools needed to answer important questions related to hydrologic connectivity among wetland sites.

Papers by Evelsizer and Skopec (2017) and Skopec and Evelsizer (2017) report on the occurrence and concentrations of nutrients and pesticides and neonicotinoids in ponded surface water within these drained wetland systems. Nutrient concentrations in drained wetlands were found to be several orders of magnitude higher than in reference and restored wetlands in the region (Skopec and Evelsizer 2017). The paper by Evelsizer and Skopec (2017) reports that concentrations of commonly used herbicides (Acetochlor and Atrazine), neonicotinoids (Clothianidin and Thiamethoxam), and persistent degradates were detected in many drained wetlands sites. Information on surface water quality in these drained wetland sites of the PPR is needed to make informed conservation and land-use policy decisions.

In addition to the papers included in the special feature, other studies associated with the project were published elsewhere. Studies by Streeter and Schilling (2015, 2017) characterized shallow soil properties of drained and farmed wetlands of the PPR and estimated the changes to soil properties that may occur within 30 years of wetland restoration. Then (2016) developed a spreadsheet-based daily water budget model to evaluate how soil infiltration rate, catchment-to-pothole ratio, and the presence of a surface intake potentially impacted ponding depth and duration of a drained and farmed pothole in Hamilton County, Iowa.

Overall, this collection of papers begins to describe the ecosystem value and complexity of these understudied wetland systems. We hope that this special feature can serve as a catalyst for future work in drained wetlands of the PPR.

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