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Study Design and Methods for a Wetland Condition Assessment on U.S. Fish and Wildlife Service Fee-Title Lands in the Prairie Pothole Region of North Dakota, South Dakota, and Montana, USA

Open-File Report 2019–1118

U.S. Department of the Interior
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Contents

Acknowledgments iii
Abstract 1
Introduction 1
    Prairie Pothole Region 2
    Wetland Ecosystem Services 2
    Wetland Assessments 2
    Purpose and Scope 3
Methods 3
    Study Area 5
    Selection of Sample Sites 5
    Results of Wetland Selection 6
    Field Sampling Methods 6
    Wetland Condition Assessment 7
Summary 10
References Cited 10
Appendix 1 16
References Cited 16
Appendix 2 17
Appendix 3 24
References Cited 24

Figures

1. Map showing the Prairie Pothole Region in Canada and the United States and focal subregions in the United States 4
2. Diagram showing the generalized quadrat layout for the low-prairie, wet-meadow, and shallow-marsh zones of seasonally ponded potholes 8

Tables

1. Description of spatial data layers used during the selection of study sites 5
2. Criteria used to assess Prairie Pothole Region wetlands for inclusion in the wetland condition assessment 7
3. Metric value ranges for condition scores of 0, 4, 7, and 11 based on the Index of Plant Community Integrity 9
4. Score ranges for each wetland condition category for temporarily and seasonally ponded potholes 9

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Area	
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	acre
square meter (m^2)	10.76	square foot (ft^2)
square kilometer (km^2)	0.3861	square mile (mi^2)

Datum

Horizontal coordinate information is referenced to the World Geodetic System 1984 (WGS 84) / Universal Transverse Mercator Coordinate System zone 13 North (UTM 13N).

Abbreviations

FWS	U.S. Fish and Wildlife Service
IPCI	Index of Plant Community Integrity
NDRAM	North Dakota Rapid Assessment Method
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
PPR	Prairie Pothole Region
WPA	Waterfowl Production Area

Study Design and Methods for a Wetland Condition Assessment on U.S. Fish and Wildlife Service Fee-Title Lands in the Prairie Pothole Region of North Dakota, South Dakota, and Montana, USA

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Abstract

The U.S. Fish and Wildlife Service (FWS) manages wetlands and grasslands for wildlife habitat throughout the central North American Prairie Pothole Region (PPR). PPR wetlands, or potholes, are widely recognized as critical habitats for North American migratory waterfowl, waterbirds, and other wildlife. Potholes also provide other ecosystem services such as carbon sequestration, flood mitigation, filtration of pollutants, groundwater recharge, nutrient retention, and recreational opportunities. Wetland condition assessments have been completed nationally at coarse scales, but focused, regionwide assessments of the biological condition of potholes managed by the FWS are lacking. Therefore, FWS personnel require information pertaining to the biological condition and status of wetlands on FWS fee-title lands in the PPR to support management, restoration, and acquisition efforts. The biological condition of wetlands typically is reflected by their plant communities, and these communities correspond to past and current management and anthropogenic disturbances; thus, plant communities are a suitable surrogate of wetland condition.

This report describes the study design, selection of sample sites, and field survey methods for a wetland condition assessment for FWS fee-title lands in the PPR of North Dakota, South Dakota, and Montana. Various spatial databases were gathered (for example, National Wetlands Inventory) to identify and assess potholes on FWS fee-title lands and to facilitate the selection of study sites. A spatially balanced, site-selection process resulted in the inclusion of 125 temporarily and 125 seasonally ponded potholes distributed across the area of interest; the first 100 for each classification were considered the primary study sites, whereas the remaining 25 were considered an oversample to replace those deemed not appropriate for sampling by field crews. Study sites were within native prairie and reseeded grasslands on FWS National Wildlife Refuges and Waterfowl Production Areas and are distributed among the primary physiographic subregions of the PPR: the Glaciated Plains, Missouri Coteau, and Prairie Coteau; a small number of sites also are within the Lake Agassiz Plain and Turtle Mountains. Site assessment protocols, vegetation survey methods, data analyses, and condition categories (for example, poor, good, very good) for the wetland assessment are based on the North Dakota Rapid Assessment Method and an Index of Plant Community Integrity developed for potholes. Results of the wetland condition assessment will aid FWS staff in assessing past and current management and help to identify priority areas for future management and acquisition.

Introduction

The mission of the U.S. Fish and Wildlife Service (FWS) National Wildlife Refuge System (NWRS) is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (U.S. Fish and Wildlife Service, 2008, p. 4). To fulfill this mission, FWS personnel require relevant and timely scientific data to support management, restoration, and acquisition efforts. National-level assessments typically provide overarching results at coarse scales (U.S. Environmental Protection Agency, 2016a, b) but generally do not provide requisite information for addressing regional-level management needs. Therefore, targeted studies are necessary to answer specific questions at local to regional scales (for example, Wetland Management District). In 2014, a team of FWS managers and biologists formed a working group to identify and prioritize science needs associated with wetlands of the Prairie Pothole Region (PPR). One of the primary concerns noted by this team was the spread of invasive plants

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(for example, *Typha* species [cattail], *Phalaris arundinacea* [reed canarygrass]) into PPR wetlands (for example, Bansal and others, 2019). In situations where these plants displace diverse vegetation communities and form dense stands, the wetland may be less attractive to breeding waterfowl and other wetland-dependent birds and wildlife. In 2015, the working group organized a workshop to learn more about the current state of knowledge pertaining to wetlands in the PPR. During this workshop, it was determined that information relating to the current ecological condition of temporarily and seasonally ponded wetlands on NWRS lands was needed to support management and conservation.

Prairie Pothole Region

The PPR covers about 770,000 square kilometers (km^2) of central North America, including parts of Montana, North Dakota, South Dakota, Minnesota, and Iowa in the United States and Alberta, Saskatchewan, and Manitoba in Canada (Dahl, 2014; Gleason and Tangen, 2014). The PPR is distinguished by high densities of small, depressional, mineral-soil wetlands, hereafter referred to as "potholes." More than 60 percent of the pothole area in the United States has been lost to anthropogenic disturbance since European settlement, yet recent (circa 2009) estimates indicate that more than 2.6 million potholes remain, comprising roughly 26,000 km^2 of wetland habitat throughout the PPR (Pennock and others, 2010; Dahl, 2014; Tangen and others, 2015). About 90 percent of pothole waterbodies are categorized as temporarily and seasonally ponded, and the remaining 10 percent consist of semipermanently ponded and saturated basins (Niemuth and others, 2010; Dahl, 2014).

The NWRS manages nearly 2,800 km^2 of fee-title lands in the PPR of North Dakota, South Dakota, and Montana (Dixon and others, 2019). Fee-title lands are lands where the FWS has acquired or purchased most or all of the rights to a tract of land. In the PPR, fee-title lands consist of National Wildlife Refuges (NWRs) and Waterfowl Production Areas (WPAs). NWRs consist of lands and waters managed for the conservation of wildlife, whereas WPAs are lands purchased to provide habitat for, and improve production of, migratory birds such as waterfowl. In recent years, the FWS has taken on several efforts to restore and reconstruct grasslands in the PPR (for example, Gannon and others, 2013; Igl and others, 2018; Dixon and others, 2019); however, wetlands have received less focus. Many potholes have been restored from a cropland setting to a grassland setting through various land acquisitions (for example, WPAs) and conservation programs. However, research indicates that plant communities of restored wetlands commonly differ from native prairie wetlands that have not been directly affected by tillage (for example, Galatowitsch and van der Valk, 1996; Seabloom and van der Valk, 2003; Aronson and Galatowitsch, 2008; Paradeis and others, 2010; Smith and others, 2016). A national wetland condition assessment based on a vegetation index indicated that 80 percent of wetland area in the Interior Plains (which partially overlays the PPR) was in good or fair condition, whereas 19 percent was in poor condition (U.S. Environmental Protection Agency, 2016b). However, a more focused assessment indicated that more than 80 percent of prairie wetlands in eastern Minnesota were categorized as poor or fair based on plant community attributes (see Minnesota's Intensification Project, U.S. Environmental Protection Agency, 2016b).

Wetland Ecosystem Services

Potholes provide a range of ecosystem services that includes wildlife habitat, carbon sequestration, flood mitigation, filtration of pollutants, groundwater recharge, nutrient retention, and recreational opportunities (Winter and Rosenberry, 1995; Knutsen and Euliss, 2002; Euliss and others, 2006; Gleason and others, 2008; Badiou and others, 2011; Gleason and others, 2011). In the drier, western parts of the PPR, potholes also can be an important water source for domestic livestock. Although potholes are particularly well known for providing breeding, brood-rearing, and migration stop-over habitats for most of North American migratory waterfowl (Batt and others, 1989), potholes also provide key habitats for other wildlife including mammals, game and non-game birds, reptiles, amphibians, and honeybees and native pollinators (Kantrud and others, 1989; Otto and others, 2016; Igl and others, 2017; Smart and others, 2017). Biodiversity (for example, plants, wildlife), hydrology (for example, drainage, water inputs), and soils (for example, sedimentation) of prairie potholes typically are affected to varying degrees by land-use and climate change (Euliss and Mushet, 1996; Gleason and Euliss, 1998; DeKeyser and others, 2003; Gleason and others, 2003; van der Kamp and others, 2003; Balas and others, 2012; Werner and others, 2013); consequently, the provisioning of ecosystem services also can be affected.

Wetland Assessments

The societal value of wetlands is widely recognized and generally is linked to the ecological condition or quality of a wetland. Wetland condition typically is determined based on biotic communities, water quality, hydrologic functions, and degree of anthropogenic disturbance (for example, drainage, sediment loads). Potholes in the PPR have been the subject of numerous ecological and water-quality assessments based on vegetation (Stewart and Kantrud, 1972; DeKeyser and others, 2003; Hargiss and others, 2008), aquatic invertebrates (Tangen and others, 2003; Hanson and others, 2005; Anteau and others, 2011; Preston and others, 2018), birds (Kantrud and Stewart, 1984; Fredrickson and Reid, 1988; Igl and others, 2017), fish (Zimmer and others, 2000, 2002; Hanson and others, 2005; Herwig and others, 2010), amphibians (Hossack and others, 2018; Smalling and others, 2019), water chemistry (Goldhaber and others, 2011; Euliss and others, 2014; Post

van der Burg and Tangen, 2015; McMurry and others, 2016; Schwarz and others, 2018), and soils (Martin and Hartman, 1987; Richardson and others, 1994; Gleason and Euliss, 1998; Euliss and others, 2006). The biotic characteristics and abiotic environments of potholes, however, are highly dynamic spatially and temporally; therefore, interpretation of such assessments should consider factors such as physiographic region (landscape) or wetland classification (period of inundation, water chemistry), hydrology (for example, recharge, discharge [Euliss and others, 2004; Hayashi and others, 2016]), and vegetation cycle (for example, regenerating marsh [van der Valk and Davis, 1978]). Studies also must be placed within the context of the current weather and long-term climate, which affects the water balance of potholes (Hayashi and others, 2016).

Water-quality sampling can be useful for assessing aquatic systems through identification of elevated or harmful levels of metals, nutrients, or agrichemicals (Windham-Myers and others, 2014; McMurry and others, 2016; Schwarz and others, 2018). Accordingly, water-quality assessments of potholes can be informative but have limitations because potholes commonly are dry and the concentration of water-quality parameters can vary widely, within and among years, because of concentration and dilution associated with precipitation, runoff, and evapotranspiration (Euliss and others, 2014; Hayashi and others, 2016). Connection to groundwater (for example, recharge, discharge), which varies greatly among potholes, also can have a considerable effect on water chemistry (Goldhaber and others, 2011; Euliss and others, 2014). Various biotic indices (for example, Index of Biotic Integrity; Karr, 1981) have been developed by comparing communities (for example, invertebrates) across an observed disturbance gradient (Burton and others, 1999; Gernes and Helgen, 2002), and these indices have been used to assess the ecological condition of aquatic systems. Biotic indices incorporating invertebrates have been effectively developed in a variety of aquatic systems, but aquatic invertebrates of potholes have indicated limited utility for wetland assessments because of their tolerance for harsh and variable environments (Tangen and others, 2003; Batzer, 2013; Gleason and Rooney, 2017; Preston and others, 2018). Invertebrates also can be arduous to identify and quantify; many are mobile (that is, able to fly), and community composition can be temporally variable and affected by biotic interactions (Hanson and others, 2005). Wetland vegetation provides habitat and food for a wide variety of birds, invertebrates, and other wildlife, and vegetation is closely coupled with wetland characteristics such as soils, hydrology, and water chemistry; thus, plant communities are well suited to function as indicators of wetland condition. Plant communities have been promising indicators of ecological condition and disturbance (Kantrud and Newton, 1996; Lopez and Fennessy, 2002; DeKeyser and others, 2003; Mack, 2007; Hargiss and others, 2008; Wilson and Bayley, 2012), although results of vegetation studies must be placed within the context of the current climate and abiotic environment (Kantrud and Newton, 1996; Euliss and others, 2004; Euliss and Mushet, 2011). Various assessment methods have been established for potholes (DeKeyser and others, 2003; Gilbert and others, 2006; Hargiss and others, 2008), but few regional assessments of wetlands have been completed (for example, Kantrud and Newton, 1996; Aronson and Galatowitsch, 2008; Hargiss and others, 2017).

Purpose and Scope

Studies have indicated that plant communities of reseeded (that is, previous cropland seeded to grassland) pothole catchments differ from those of native prairie and that these communities can be affected by anthropogenic activities (DeKeyser and others, 2003; Seabloom and van der Valk, 2003; Aronson and Galatowitsch, 2008; Paradeis and others, 2010; Smith and others, 2016). Pothole plant communities also can vary naturally along with climate and hydrologic characteristics (Euliss and others, 2004; Mushet and others, 2018), and studies have demonstrated that changes to plant communities can affect wildlife, particularly birds (Igl and others, 2017). Thus, the provisioning of ecosystem services, such as wildlife habitat, by potholes on NWRS lands may be diminished because of current or previous management and land-use practices; therefore, a regional wetland assessment is needed to determine wetland condition and to facilitate management strategies to improve the functioning of degraded potholes. Such an assessment also could help the FWS prioritize sites for management, acquisition, and establishment of conservation easements.

This report describes the study design, selection of sample sites, and field survey methods for a wetland condition assessment on FWS fee-title lands in the PPR of North Dakota, South Dakota, and Montana. Potholes were selected from native prairies and reseeded grasslands of the Glaciated Plains, Missouri Coteau, Prairie Coteau, Lake Agassiz Plain, and Turtle Mountain subregions of the PPR (fig. 1). Wetland plant communities will be used as a surrogate for wetland condition and will be assessed using an Index of Plant Community Integrity (IPCI) developed specifically for PPR wetlands. The overall condition of each site also will be assessed using a rapid assessment method for potholes. The study design and sample selection were completed during 2019 and the field study will be completed by researchers from North Dakota State University during 2020–21. Funding for the field study has been obligated by the FWS to North Dakota State University according to cooperative agreement number F19AC00885.

Methods

The methods section describes the study area and site-selection methodology and results. Field sampling methods, including a rapid site assessment and vegetation survey, are referenced and explained. Analytical methods and scoring criteria for the wetland condition assessment also are detailed.

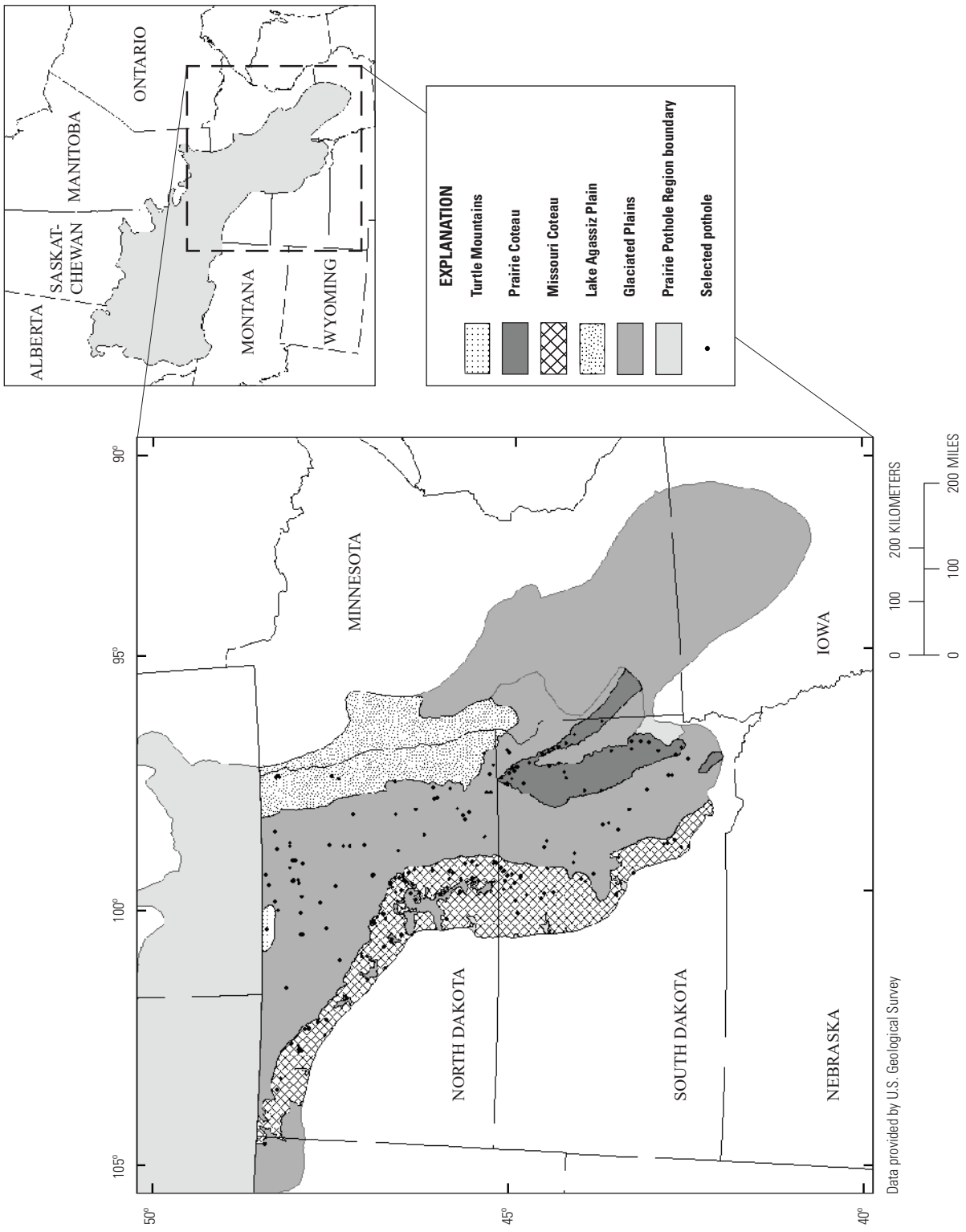

Figure 1. The Prairie Pothole Region in Canada and the United States and focal subregions in the United States.

Study Area

The study will be completed on NWR and WPA lands throughout the PPR of North Dakota, South Dakota, and Montana (fig. 1). Here, a brief description of the PPR is provided; comprehensive descriptions (for example, wetlands, geology, hydrology, soils, biota) can be obtained from a wide variety of published sources (for example, Rothrock, 1943; Stewart and Kantrud, 1971; Stewart and Kantrud, 1972; Kantrud and others, 1989; van der Valk, 1989; Richardson and others, 1994; Euliss and others, 1999; Bluemle, 2000; Euliss and others, 2004; Gleason and others, 2008; Goldhaber and others, 2011; Dahl, 2014; Hayashi and others, 2016). The PPR was formed about 12,000 years ago during the Pleistocene glacial retreat. Ice masses incorporated within glacial till melted, resulting in the formation of closed depressions underlain by low-permeability soil (Johnson and others, 2008). As these shallow basins collected water, they developed into a wide variety of prairie potholes distinguished by unique hydrologic, biotic, chemical, and physical characteristics. Potholes typically are characterized or classified based on water permanence (for example, seasonally or semipermanently ponded) and vegetation zonation, and most (about 90 percent) of them are typified by temporarily or seasonally ponded water regimes with two to three vegetation zones (Stewart and Kantrud, 1971; Niemuth and others, 2010; Dahl, 2014); the focus of this wetland condition assessment is on temporarily and seasonally ponded potholes.

In addition to considering wetland classification, studies commonly attempt to reduce variability by incorporating subregion into study designs and analyses (for example, Euliss and others, 2006; Gleason and others, 2008). Within the PPR, the Glaciated Plains physiographic subregion in the east is a gently sloping, rolling landscape, whereas the Missouri Coteau and Prairie Coteau subregions to the west and south are hummocky plains of glacial sediment. The Lake Agassiz Plain and Turtle Mountains are prevalent areas within the Glaciated Plains (Rothrock, 1943; Kantrud and others, 1989; Bluemle, 2000; Gleason and others, 2008). These subregions span the climate and land-use gradient that characterizes the PPR and generally differ based on topography; hydrology; and, commonly, land use (for example, proportion of cropland or grassland/pasture). The criteria used in this study to delineate these subregions are provided in appendix 1.

Selection of Sample Sites

Spatial data layers were acquired and imported into a geographic information systems environment to delineate political (States), regional (ecoregions), and FWS fee-title-land (NWR, WPA) boundaries. Additionally, FWS National Wetlands Inventory data were obtained to identify and classify wetlands. Descriptions and sources of the various data layers are presented in table 1.

Table 1. Description of spatial data layers used during the selection of study sites.

[FWS, U.S. Fish and Wildlife Service; HAPET, Habitat and Population Evaluation Team; NWI, National Wetlands Inventory; NWR, National Wildlife Refuge; WPA, Waterfowl Production Area; NWRS, National Wildlife Refuge System; PPR, Prairie Pothole Region; USGS, U.S. Geological Survey; EPA, U.S. Environmental Protection Agency]

Variable extracted	Data source	Description
Wetland polygons and attributes	FWS Region 6 HAPET; https://www.fws.gov/mountain-prairie/refuges/hapet.php	NWI data (https://www.fws.gov/wetlands/Data/Data-Download.html) were modified to combine contiguous polygons (that is, wetland zones) that represent an individual wetland into a single polygon classified based on the most permanent zone (for example, seasonally or semipermanently ponded). A description of these data is provided by Tangen and others (2014).
NWR and WPA property boundaries	FWS National Cadastral Data; https://www.fws.gov/gis/data/national/index.html	NWRS boundary data for managed lands, including NWRs and WPAs.
Extent of native prairie	FWS NWRS	Polygons delineating the extent of native prairie on NWRS lands. Native prairie lands were identified based on historical records and input from NWR staff.
PPR polygon	USGS ScienceBase Catalog; https://www.sciencebase.gov/catalog/item/54aeaef2e4b0cdd4a5caedf1	PPR boundary.
Ecoregion boundaries	EPA; https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states	Level III and IV ecoregion boundaries.

The selection of potholes for field sampling was constrained to include only potholes entirely within the boundaries of NWR and WPA lands distributed throughout the PPR of North Dakota, South Dakota, and Montana (FWS Mountain-Prairie Region). Site selection was further constrained to include only temporarily and seasonally ponded potholes, which were delineated and classified based on wetland polygons from a modified National Wetlands Inventory geodatabase (table 1). A total of 125 temporarily and 125 seasonally ponded potholes were selected from this constrained population. The selection of potholes followed the approach used for the U.S. Environmental Protection Agency's National Wetland Condition Assessment (U.S. Environmental Protection Agency, 2016b). Specifically, a generalized random tessellation stratified sampling design was used to generate a randomly selected but spatially balanced distribution of sampled potholes stratified by hydrologic regime (that is, temporarily and seasonally ponded) and sample year (year 1 and 2) (Stevens and Olsen, 2004; Stevens and Jensen, 2007). Spatially balanced designs for populations that are unevenly distributed across the landscape are more efficient than simple random sampling (Dunn and Harrison, 1993). Sites were selected using the "spsurvey" package (Kincaid and Olsen, 2019) in R (R version 3.0.1; R Core Development Team, Vienna). The distribution of selected potholes was the result of a selection of potholes on FWS fee-title lands regardless of State, Wetland Management District, physiographic subregion, or land-use history (that is, native prairie or reseeded grassland). After the initial random selection of potholes, a team of experts from the FWS, U.S. Geological Survey, and North Dakota State University inspected each pothole visually using aerial imagery. Based on this visual inspection, potholes that did not meet predefined selection criteria (table 2) were removed from the primary sample population and replaced with potholes from an oversample population, which also were visually inspected. Of the 250 selected potholes, the first 100 chosen for each wetland classification represent the primary sample sites, and the remaining 25 represent an oversample population to be used when the primary sites are deemed not appropriate for sampling by field crews.

Results of Wetland Selection

Of the 250 potholes that were selected, 157, 91, and 2 were in North Dakota, South Dakota, and Montana, respectively, which reflects the abundance of potholes in each State. Potholes were distributed among the 5 overarching physiographic subregions as follows: 83 in the Glaciated Plains, 122 in the Missouri Coteau, 36 in the Prairie Coteau, 8 in the Lake Agassiz Plain, and 1 in the Turtle Mountains (fig. 1). A total of 176 and 74 potholes were within native prairie and reseeded grasslands, respectively. Information detailing the selected potholes is presented in appendix 2.

Field Sampling Methods

An overall site assessment will be completed using the North Dakota Rapid Assessment Method (NDRAM) for wetlands (Hargiss, 2009; Hargiss and others, 2017). The NDRAM method determines wetland condition based on data describing buffers and surrounding land use (metric 1), hydrology and habitat alteration (metric 2), and vegetation (metric 3). To use the NDRAM, a surveyor travels around the wetland; completes a site description; and records requisite information pertaining to vegetation, land use and management, and hydrology. Metric scoring options and criteria, along with a general description and field data form, are presented in appendix 3 and detailed by Hargiss (2009). For metric 1, a site is assigned as many as 20 points based on average buffer width and intensity of surrounding land use. For metric 2, sites are assigned as many as 57 points based on soil disturbance, habitat conditions, management, hydrologic effects, and the site's potential to obtain conditions similar to minimally disturbed reference sites. For metric 3, sites are assigned as many as 23 points based on the vegetation community (appendix 3). The NDRAM scores each metric numerically through a narrative categorization of the present and past stressors and trends toward recovery. The total NDRAM score (0–100) is categorized as good (69–100), fair high (53–68), fair low (27–52), and poor (0–26).

Field vegetation surveys will be completed during the summer months when most plants are expected to have germinated and should be suitable for identification by field crews. Plant survey and inventory procedures will follow the quadrat method of DeKeyser and others (2003) and Hargiss and others (2008). Upon arrival at a site, the primary vegetation zones will be delineated; temporarily and seasonally ponded potholes typically have two and three zones, respectively (Stewart and Kantrud, 1971). Both wetland classes have an exterior low-prairie zone and an interior wet-meadow zone (central zone for temporarily ponded potholes); seasonally ponded potholes also have a central, shallow-marsh zone. For seasonally ponded potholes, eight 1-square meter (m^2) quadrats will be evenly distributed throughout the low-prairie zone, seven quadrats in the wet-meadow zone, and five quadrats in the shallow-marsh zone. For temporarily ponded potholes eight 1-m^2 quadrats will be evenly distributed throughout the low-prairie zone and seven quadrats in the wet-meadow zone. Quadrats will be centered in the interior and exterior vegetation zones and oriented in a spiraled pattern in the central vegetation zone (DeKeyser and others, 2003; Hargiss, 2009; fig. 2). If open water is present in the central zone, quadrats will be distributed proportionally to the area of open water and emergent vegetation following DeKeyser and others (2003) and Hargiss (2009). Plant species within each quadrat will be identified, and the areal cover percentage of each species will be estimated. In addition to the primary species within the

Table 2. Criteria used to assess Prairie Pothole Region wetlands (potholes) for inclusion in the wetland condition assessment. Criteria are presented separately for the completed site-selection process and for the forthcoming field study. "Action" specifies whether the criteria resulted in, or will result in, the pothole being removed or retained for the study. "Oversample potholes" refers to potholes from the oversample populations that were used, or will be used, to replace those potholes that were excluded from the study.

[NWI, National Wetlands Inventory; FWS, U.S. Fish and Wildlife Service]

Criteria	Description	Action
	Site selection	
Nonpothole	Wetlands from the NWI that were determined not to be potholes were excluded and replaced with an oversample pothole; examples include roadside ditches, prairie streams, artificial wetlands (for example, stock ponds), and permanent lakes.	Removed.
Classification	If temporarily or seasonally ponded potholes from the NWI were identified as semipermanently or permanently ponded or lacustrine during the site-evaluation process, the pothole was replaced with an oversample pothole.	Removed.
Connected	Potholes that were within, or partially connected to, other systems (for example, prairie streams, larger wetlands) were removed and replaced with an oversample pothole.	Removed.
Disrupted hydrology	Potholes with visible disruptions to their hydrology were removed and replaced with an oversample pothole. Examples of disrupted hydrology included ditches, dams, or "splitting" of a pothole by a road.	Removed.
FWS boundary	Potholes that were not completely within the FWS property boundary were removed and replaced with an oversample pothole.	Removed.
	Field study	
Nonpothole	Wetlands from the NWI that are determined not to be potholes will be excluded and replaced with an oversample pothole; examples include roadside ditches, prairie streams, artificial wetlands (for example, stock ponds), and permanent lakes.	Removed.
Classification	If potholes identified as temporarily ponded during the site-selection process are identified by field crews as seasonally ponded, or vice versa, the field classification will be documented and the wetland will be sampled based on its NWI classification determined during site selection.	Retained
Classification	If potholes identified as temporarily or seasonally ponded during the site-selection process are identified as semipermanently or permanently ponded during field sampling, the field classification will be noted and the pothole will be replaced with an oversample pothole.	Removed.
Split	Potholes identified in the field to be distinct wetland basins, but mapped by the NWI as two or more distinct potholes, will be sampled as a single pothole.	Retained
Connected	Potholes that are within, or partially connected to, other systems (for example, prairie streams, larger wetlands) will be removed and replaced with an oversample pothole.	Removed.
Disrupted hydrology	Potholes with visible disruptions to their hydrology will be removed and replaced with an oversample pothole. Examples of disrupted hydrology include ditches, dams, or "splitting" of a pothole by a road.	Removed.
Management	Potholes within units that are actively managed through cropping where the vegetation is affected or difficult to identify will be removed and replaced with an oversample pothole.	Removed.
Access	When a pothole is difficult to access, the field-crew leader will have the discretion to replace that pothole with an oversample pothole to save time and increase efficiency. Examples of when this may occur include muddy roads, long distances from access roads, and the need to cross or navigate around private lands.	Removed.

sample quadrats, secondary species identified between, but not within, the quadrats will be recorded (Hargiss and others, 2008). The percentage of standing dead vegetation, percentage of open water, percentage of bare ground, litter thickness, and water depth within each quadrat also will be recorded. For this study, litter thickness refers to the thickness (from soil surface) of dead plant material from previous years that is not attached to the ground.

Wetland Condition Assessment

Using the IPCI, nine plant community attributes, or metrics, will be used to determine the condition of each pothole (Hargiss and others, 2008). Scores for these nine metrics will be assigned to each pothole based on criteria presented in table 3. Metric scores will be presented and summed, and the condition of each pothole will be classified as very poor, poor,

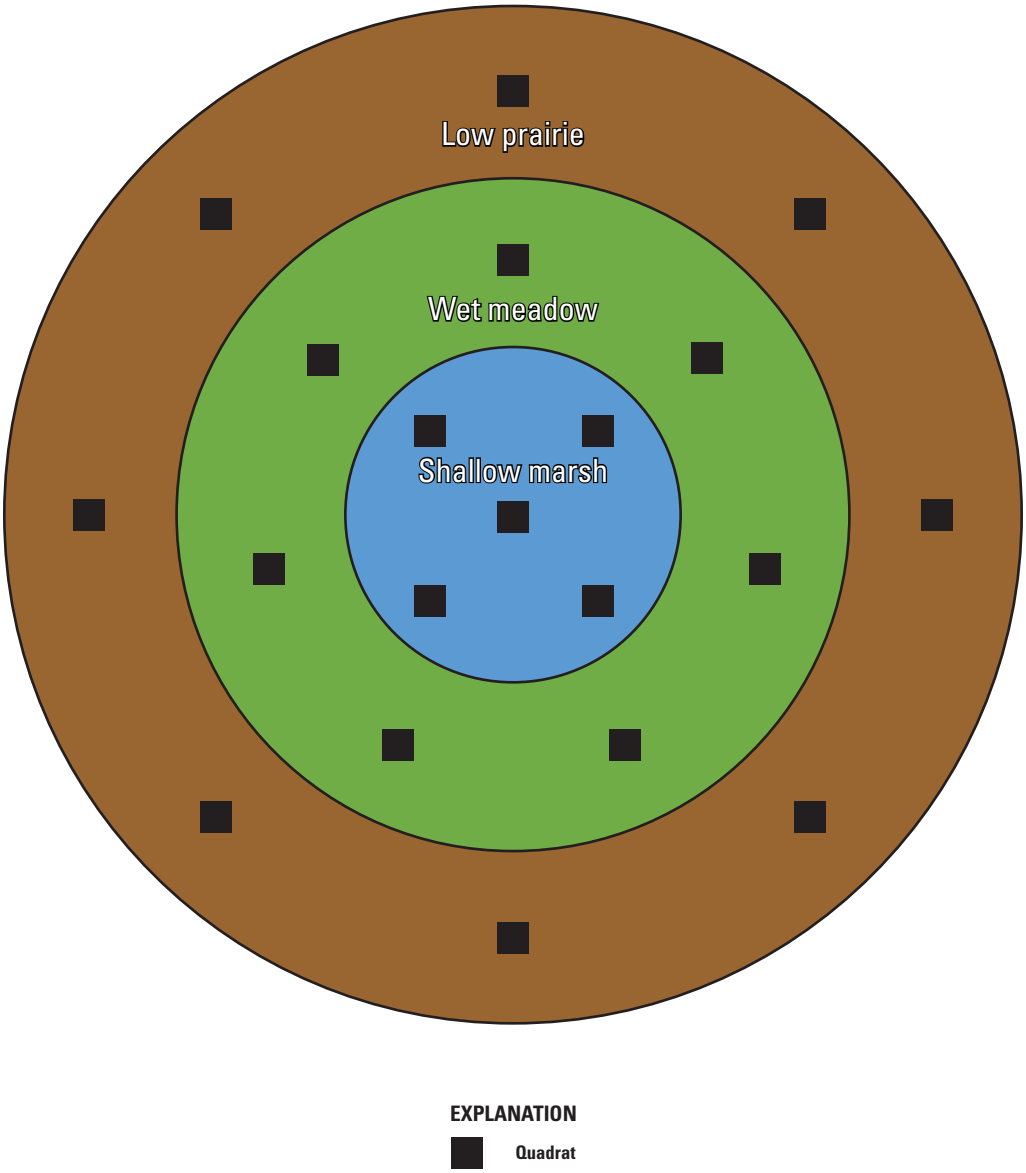

Figure 2. Generalized quadrat layout for the low-prairie, wet-meadow, and shallow-marsh zones of seasonally ponded potholes (modified from DeKeyser and others, 2003; Hargiss, 2009). Temporarily ponded potholes have a similar layout but will include only the low-prairie zone and an interior wet-meadow zone.

fair, good, or very good based on the ranges of IPCI scores presented in table 4. Metric value ranges and IPCI condition ranges are based on those of Hargiss and others (2008). The 9 IPCI metrics and 5 condition categories will be summarized by pothole classification and by various spatial categories such as land cover (native prairie, reseeded grassland), physiographic subregion, and vegetation zone (for example, wet meadow, shallow marsh).

Primary and secondary species-cover data will be analyzed to provide insight pertaining to the composition of major vegetation community zones (for example, wet meadow, shallow marsh) of temporarily and seasonally ponded potholes following Smith and others (2016). The multiresponse permutation procedure with the relative Sørenson distance measure will be used to compare wetland plant communities among pothole classes and zones. Species data will be transformed using the arcsine square root transformation if needed to meet the assumptions of normality (McCune and Mefford, 1999; McCune and others, 2002). Pairwise comparisons will be done among subregions, classes, and zones, and the probability (p) values will be corrected for multiple comparisons using the Bonferroni correction (Rice, 1990).

Table 3. Metric value ranges for condition scores of 0, 4, 7, and 11 based on the Index of Plant Community Integrity. Ranges for temporarily and seasonally ponded potholes were based on tables 1 and 2 of Hargiss and others (2008). Coefficients of conservatism were obtained from the Northern Great Plains Floristic Quality Assessment Panel (2001).

[≥, greater than or equal to; C, coefficient of conservatism; FQI, floristic quality index]

Metric	0	4	7	11
Temporarily ponded				
Species richness of native perennials	0–16	17–23	24–40	≥41
Number of genera of native perennials	0–11	12–19	20–26	≥27
Number of native grass and grass-like species	0–8	9–10	11–15	≥16
Percentage of annual, biennial, and introduced species	≥41.1	35.1–41.0	27.1–35.0	0.0–27.0
Number of native perennial species in wet-meadow zone	0–7	8–10	11–13	≥14
Number of species with C value ≥5	0–4	5–11	12–16	≥17
Number of species in the wet-meadow zone with C value ≥4	0–3	4–9	10–12	≥13
Average C value	0.00–2.50	2.51–3.57	3.58–4.58	≥4.59
FQI	0.00–13.60	13.61–21.70	21.71–27.20	≥27.21
Seasonally ponded				
Species richness of native perennials	0–19	20–31	32–41	≥42
Number of genera of native perennials	0–14	15–24	25–32	≥33
Number of native grass and grass-like species	0–6	7–10	11–17	≥18
Percentage of annual, biennial, and introduced species	≥41.1	30.8–41.0	21.1–30.7	0.0–21.0
Number of native perennial species in wet-meadow zone	0–8	9–16	17–24	≥25
Number of species with C value ≥5	0–7	8–17	18–26	≥27
Number of species in the wet-meadow zone with C value ≥4	0–4	5–9	10–16	≥17
Average C value	0.00–2.60	2.61–3.12	3.13–3.52	≥3.53
FQI	0.00–10.00	10.01–16.11	16.12–22.99	≥23.00

Table 4. Score ranges for each wetland condition category for temporarily and seasonally ponded potholes. Score ranges were determined from appendices A and B of Hargiss and others (2008).

[--, no range]

Wetland condition	Score range	
	Temporarily ponded	Seasonally ponded
Very poor	--	0–19
Poor	0–33	20–39
Fair	34–66	40–59
Good	67–99	60–79
Very good	--	80–99

Nonmetric multidimensional scaling will be used to indicate relations among wetland sites in species space. Species will be correlated with the nonmetric multidimensional scaling axes, and those possessing a Pearson correlation coefficient with an absolute value greater than 0.4 will be considered significant drivers of the axis and examined more extensively.

Summary

U.S. Fish and Wildlife Service (FWS) personnel tasked with restoring and managing wetlands in the Prairie Pothole Region (PPR) of North Dakota, South Dakota, and Montana have identified information pertaining to the biological condition of these wetlands, known as potholes, as an information need. The biological condition of wetlands typically is reflected by their plant communities, and these communities correspond to past and current management and anthropogenic disturbances; thus, plant communities are a suitable surrogate of pothole condition. With this report, the design and methodology of a wetland condition assessment for temporarily and seasonally ponded potholes are described and will be used to guide a subsequent field study.

A spatially balanced, site-selection process resulted in the inclusion of 250 temporarily and seasonally ponded potholes distributed across FWS fee-title land in the PPR; the first 200 were considered the primary study sites, whereas the remaining 50 were considered an oversample to replace those deemed not appropriate for sampling by field crews. Study sites were within native prairie and reseeded grasslands on FWS National Wildlife Refuges and Waterfowl Production Areas and are distributed among the primary physiographic subregions of the PPR: the Glaciated Plains, Missouri Coteau, and Prairie Coteau; a small number of sites also are within the Lake Agassiz Plain and Turtle Mountains. To assess the condition of potholes, plant communities will be inventoried and assessed using the North Dakota Rapid Assessment Method and Index of Plant Community Integrity to categorize the condition of potholes as good, fair high, fair low, or poor (North Dakota Rapid Assessment Method) or very poor, poor, fair, good, or very good (Index of Plant Community Integrity). Results of the wetland condition assessment will aid FWS staff in assessing past and current management and help to identify priority areas for future management and acquisition.

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Appendix 1

Potholes selected for the wetland condition assessment are distributed among the primary physiographic subregions of the Prairie Pothole Region: the Glaciated Plains, Missouri Coteau, and Prairie Coteau; a small number of sites also are within the Lake Agassiz Plain and Turtle Mountains. These subregions span the climate and land-use gradient that characterizes the Prairie Pothole Region and generally differ based on topography; hydrology; and, commonly, land use (for example, proportion of cropland or grassland/pasture). The criteria used in this study to delineate these subregions are provided in table 1.1.

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Table 1.1. U.S. Environmental Protection Agency (EPA) level III and IV ecoregions (U.S. Environmental Protection Agency, 2013a, b) used to define the five overarching physiographic subregions used for this study.

Physiographic subregion	EPA level III ecoregion	EPA level IV ecoregion
Glaciated Plains	Northern Glaciated Plains	Drift Plains End Moraine Complex Glacial Lake Basins Glacial Lake Deltas Glacial Outwash James River Lowland Northern Black Prairie Prairie Coteau Tewaukon/Big Stone Stagnation Moraine
Lake Agassiz Plain	Northern Glaciated Plains	Beach Ridges and Sand Deltas Glacial Lake Agassiz Basin Saline Area
Turtle Mountains	Northern Glaciated Plains	Turtle Mountains
Prairie Coteau	Northern Glaciated Plains	Prairie Coteau
Missouri Coteau	Northwestern Glaciated Plains	Collapsed Glacial Outwash Coteau Lakes Upland Glaciated Dark Brown Prairie Missouri Coteau Missouri Coteau Slope Northern Missouri Coteau Southern Missouri Coteau Southern Missouri Coteau Slope

Appendix 2

A total of 250 temporarily and seasonally ponded potholes were selected for inclusion in the wetland condition assessment. Potholes were within native prairie and reseeded grasslands of North Dakota, South Dakota, and Montana. Potholes are distributed among five overarching physiographic subregions of the Prairie Pothole Region. Information detailing the selected potholes is presented in table 2.1.

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.

[ObjectID, unique numeric identifier; class, pothole classification; cover_type, specifies whether a pothole is within reseeded grassland (REST) or native prairie (NP); State and region, identify the state and physiographic subregion; point_X and point_Y, the latitude and longitude of the pothole; SEAS, seasonally ponded; MC, Missouri Coteau; TEMP, temporarily ponded; GP, Glaciated Plains; LAP, Lake Agassiz Plain; TM, Turtle Mountains; PC, Prairie Coteau]

ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
23111	SEAS	NP	Montana	MC	561459.2531	5414744.222
23086	TEMP	NP	Montana	MC	560118.0845	5415208.541
10674	TEMP	NP	North Dakota	GP	982429.581	5299259.391
140	TEMP	NP	North Dakota	GP	918125.6934	5432756.078
1150	SEAS	REST	North Dakota	GP	925079.1087	5398364.21
2576	SEAS	REST	North Dakota	GP	979239.2335	5349380.227
6261	SEAS	REST	North Dakota	GP	1067469.644	5122460.182
9653	SEAS	REST	North Dakota	GP	863119.2388	5345870.752
10941	SEAS	REST	North Dakota	GP	876646.8329	5282198.948
92	SEAS	REST	North Dakota	GP	932237.0729	5437655.315
844	SEAS	REST	North Dakota	GP	944230.4392	5403623.919
1273	SEAS	REST	North Dakota	GP	954274.4846	5399988.58
4490	SEAS	REST	North Dakota	GP	1041090.947	5168007.468
6243	SEAS	REST	North Dakota	GP	1092381.874	5124570.228
7863	SEAS	REST	North Dakota	GP	778292.4528	5398670.465
517	SEAS	REST	North Dakota	GP	968982.149	5423881.59
1755	SEAS	REST	North Dakota	GP	922960.33	5389321.113
3144	SEAS	REST	North Dakota	GP	979572.2617	5329451.186
4976	SEAS	REST	North Dakota	GP	1037453.534	5150536.617
5791	SEAS	REST	North Dakota	GP	1004429.745	5126964.133
6019	SEAS	REST	North Dakota	GP	1067272.818	5127869.496
6300	SEAS	REST	North Dakota	GP	1067200.074	5122029.274
6576	SEAS	REST	North Dakota	GP	1105092.203	5120426.509
7449	SEAS	REST	North Dakota	GP	884378.785	5417959.841
7481	SEAS	REST	North Dakota	GP	884192.6547	5417722.998
8737	SEAS	REST	North Dakota	GP	882289.5825	5384373.879
8758	SEAS	REST	North Dakota	GP	852741.8237	5381835.158
9826	SEAS	REST	North Dakota	GP	821530.0304	5324833.053
11091	SEAS	REST	North Dakota	GP	941545.4841	5283604.563
11121	SEAS	REST	North Dakota	GP	941685.3474	5283252.875
1204	TEMP	REST	North Dakota	GP	925303.4587	5398113.523
2390	TEMP	REST	North Dakota	GP	898627.7372	5356801.138
3500	TEMP	REST	North Dakota	GP	1027658.873	5256005.42
3762	TEMP	REST	North Dakota	GP	1067966.923	5204595.889
3798	TEMP	REST	North Dakota	GP	1053296.234	5202004.281
5813	TEMP	REST	North Dakota	GP	1005062.364	5126752.245
802	TEMP	REST	North Dakota	GP	973749.0958	5406561.122
1689	TEMP	REST	North Dakota	GP	928713.0309	5391441.03
1969	TEMP	REST	North Dakota	GP	952070.1651	5386447.602
3275	TEMP	REST	North Dakota	GP	1024140.723	5317450.489
3572	TEMP	REST	North Dakota	GP	1035938.983	5227425.814
3613	TEMP	REST	North Dakota	GP	1002179.03	5214227.324

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.—Continued

[ObjectID, unique numeric identifier; class, pothole classification; cover_type, specifies whether a pothole is within reseeded grassland (REST) or native prairie (NP); State and region, identify the state and physiographic subregion; point_X and point_Y, the latitude and longitude of the pothole; SEAS, seasonally ponded; MC, Missouri Coteau; TEMP, temporarily ponded; GP, Glaciated Plains; LAP, Lake Agassiz Plain; TM, Turtle Mountains; PC, Prairie Coteau]

ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
3890	TEMP	REST	North Dakota	GP	1053642.228	5198903.742
4698	TEMP	REST	North Dakota	GP	1032252.572	5160048.211
4802	TEMP	REST	North Dakota	GP	1027204.614	5157283.671
7312	TEMP	REST	North Dakota	GP	895996.1252	5422011.727
7498	TEMP	REST	North Dakota	GP	883607.8351	5417537.065
10910	TEMP	REST	North Dakota	GP	877410.6729	5282729.167
12714	TEMP	REST	North Dakota	GP	978215.1208	5249748.767
352	TEMP	REST	North Dakota	GP	992704.9706	5429108.838
842	TEMP	REST	North Dakota	GP	978263.5299	5406373.897
1019	TEMP	REST	North Dakota	GP	926658.623	5399174.262
1056	TEMP	REST	North Dakota	GP	925967.2942	5398927.972
1265	TEMP	REST	North Dakota	GP	954888.447	5400077.35
1432	TEMP	REST	North Dakota	GP	927507.8578	5397001.193
1629	TEMP	REST	North Dakota	GP	955129.0259	5396620.881
1772	TEMP	REST	North Dakota	GP	923347.5052	5389168.988
2818	TEMP	REST	North Dakota	GP	923237.1684	5336610.968
3240	TEMP	REST	North Dakota	GP	979802.2714	5320115.468
4226	TEMP	REST	North Dakota	GP	1068911.857	5180698.806
6230	TEMP	REST	North Dakota	GP	1092933.853	5124778.069
7509	TEMP	REST	North Dakota	GP	883897.0557	5417469.926
8871	TEMP	REST	North Dakota	GP	905558.526	5383639.495
8918	TEMP	REST	North Dakota	GP	853753.2773	5378978.122
11090	TEMP	REST	North Dakota	GP	941430.4252	5283622.772
2473	TEMP	REST	North Dakota	GP	988396.2173	5359523.615
659	SEAS	NP	North Dakota	LAP	1068100.547	5426368.202
584	TEMP	NP	North Dakota	LAP	1069205.341	5430091.029
3064	TEMP	NP	North Dakota	LAP	1071609.543	5341465.316
490	SEAS	REST	North Dakota	LAP	1067994.838	5432284.103
2729	SEAS	REST	North Dakota	LAP	1075639.378	5352123.522
5865	TEMP	REST	North Dakota	LAP	1119334.639	5134914.883
2629	TEMP	REST	North Dakota	LAP	1075041.974	5353437.808
3476	TEMP	REST	North Dakota	LAP	1072926.05	5260504.209
7273	SEAS	NP	North Dakota	MC	636323.4229	5402532.919
7583	SEAS	NP	North Dakota	MC	652531.6462	5398077.292
8307	SEAS	NP	North Dakota	MC	691994.5788	5374579.295
8520	SEAS	NP	North Dakota	MC	695479.7918	5373827.321
9118	SEAS	NP	North Dakota	MC	724402.3784	5361764.215
12879	SEAS	NP	North Dakota	MC	861921.4046	5238303.127
7259	SEAS	NP	North Dakota	MC	636132.8975	5402640.289
7604	SEAS	NP	North Dakota	MC	652965.1707	5397893.871
7984	SEAS	NP	North Dakota	MC	701464.1214	5386047.925
8217	SEAS	NP	North Dakota	MC	694056.2266	5375277.392

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.—Continued

[ObjectID, unique numeric identifier; class, pothole classification; cover_type, specifies whether a pothole is within reseeded grassland (REST) or native prairie (NP); State and region, identify the state and physiographic subregion; point_X and point_Y, the latitude and longitude of the pothole; SEAS, seasonally ponded; MC, Missouri Coteau; TEMP, temporarily ponded; GP, Glaciated Plains; LAP, Lake Agassiz Plain; TM, Turtle Mountains; PC, Prairie Coteau]

ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
8414	SEAS	NP	North Dakota	MC	696080.995	5374420.284
8958	SEAS	NP	North Dakota	MC	722467.6101	5368178.915
9121	SEAS	NP	North Dakota	MC	722883.0258	5361665.993
12866	SEAS	NP	North Dakota	MC	861130.1313	5238308.088
14749	SEAS	NP	North Dakota	MC	888421.692	5175061.969
8212	SEAS	NP	North Dakota	MC	698755.275	5375657.679
8371	SEAS	NP	North Dakota	MC	692308.9724	5374380.156
8434	SEAS	NP	North Dakota	MC	693431.9298	5374149.24
8441	SEAS	NP	North Dakota	MC	694451.9858	5374190.773
8681	SEAS	NP	North Dakota	MC	693211.4139	5370518.191
13285	SEAS	NP	North Dakota	MC	878017.0766	5235273.699
14798	SEAS	NP	North Dakota	MC	845473.3225	5145025.938
8388	TEMP	NP	North Dakota	MC	692788.6645	5374335.59
9522	TEMP	NP	North Dakota	MC	715825.3092	5338478.42
12933	TEMP	NP	North Dakota	MC	862163.2046	5237972.313
8433	TEMP	NP	North Dakota	MC	692558.6753	5374081.436
4587	SEAS	REST	North Dakota	MC	942636.7168	5157429.205
4804	SEAS	REST	North Dakota	MC	966033.647	5152507.726
11542	SEAS	REST	North Dakota	MC	814751.6026	5258476.81
12445	SEAS	REST	North Dakota	MC	939757.9085	5252301.024
12566	SEAS	REST	North Dakota	MC	920363.2307	5249610.862
13589	SEAS	REST	North Dakota	MC	936034.9628	5235891.261
4096	SEAS	REST	North Dakota	MC	943213.2207	5174030.545
5298	SEAS	REST	North Dakota	MC	965248.3263	5135644.698
5327	SEAS	REST	North Dakota	MC	943299.5259	5132126.085
6433	SEAS	REST	North Dakota	MC	969432.1006	5111596.146
6578	SEAS	REST	North Dakota	MC	971979.1915	5110363.903
11087	SEAS	REST	North Dakota	MC	879010.1439	5278809.511
11605	SEAS	REST	North Dakota	MC	814256.7885	5257572.036
11707	SEAS	REST	North Dakota	MC	882144.4387	5261497.106
12788	SEAS	REST	North Dakota	MC	939987.481	5245269.796
13270	SEAS	REST	North Dakota	MC	937501.9637	5240114.846
13634	SEAS	REST	North Dakota	MC	936054.3003	5235340.492
14018	SEAS	REST	North Dakota	MC	932294.6009	5226139.312
14088	SEAS	REST	North Dakota	MC	911981.5356	5220445.713
4189	SEAS	REST	North Dakota	MC	955405.5057	5172907.618
4307	SEAS	REST	North Dakota	MC	952301.7043	5169645.657
5133	SEAS	REST	North Dakota	MC	946754.834	5141169.082
5177	SEAS	REST	North Dakota	MC	969640.9052	5142257.198
9615	SEAS	REST	North Dakota	MC	737666.9754	5337838.625
9983	SEAS	REST	North Dakota	MC	768147.6362	5309713.589
10453	SEAS	REST	North Dakota	MC	832435.2105	5293745.627

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.—Continued

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ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
11435	SEAS	REST	North Dakota	MC	888255.6925	5266419.728
11470	SEAS	REST	North Dakota	MC	844214.7259	5262221.211
12091	SEAS	REST	North Dakota	MC	852025.9365	5252331.672
12101	SEAS	REST	North Dakota	MC	850418.998	5252152.621
13422	SEAS	REST	North Dakota	MC	937666.4402	5237364.522
13468	SEAS	REST	North Dakota	MC	938981.4663	5237112.115
14050	SEAS	REST	North Dakota	MC	953173.4464	5225716.152
4873	TEMP	REST	North Dakota	MC	941361.2317	5146902.973
6547	TEMP	REST	North Dakota	MC	943574.7345	5108439.103
10513	TEMP	REST	North Dakota	MC	828798.8557	5292531.774
11835	TEMP	REST	North Dakota	MC	815403.9749	5254644.443
13616	TEMP	REST	North Dakota	MC	936137.1677	5235589.362
4130	TEMP	REST	North Dakota	MC	953215.4751	5174358.719
4488	TEMP	REST	North Dakota	MC	922934.1372	5159201.703
5130	TEMP	REST	North Dakota	MC	946359.7019	5141201.811
6316	TEMP	REST	North Dakota	MC	942589.6757	5112482.68
6666	TEMP	REST	North Dakota	MC	971116.1927	5108758.589
13004	TEMP	REST	North Dakota	MC	923703.3687	5242129.549
13221	TEMP	REST	North Dakota	MC	941886.8512	5241045.189
13612	TEMP	REST	North Dakota	MC	937353.5603	5235713.171
13798	TEMP	REST	North Dakota	MC	948264.5725	5232945.296
13873	TEMP	REST	North Dakota	MC	920734.2743	5228349.047
4548	TEMP	REST	North Dakota	MC	927830.7531	5157446.82
6535	TEMP	REST	North Dakota	MC	970413.4838	5110636.544
9378	TEMP	REST	North Dakota	MC	733717.8456	5350643.388
11181	TEMP	REST	North Dakota	MC	875587.1205	5277351.819
11471	TEMP	REST	North Dakota	MC	888936.9212	5265681.603
11532	TEMP	REST	North Dakota	MC	888288.059	5264321.207
12199	TEMP	REST	North Dakota	MC	932088.5144	5256694.573
13621	TEMP	REST	North Dakota	MC	934780.0477	5235423.718
14026	TEMP	REST	North Dakota	MC	932591.4493	5225990.135
14590	TEMP	REST	North Dakota	MC	953143.0236	5198722.058
6991	SEAS	REST	North Dakota	TM	856801.1763	5431491.793
15675	SEAS	NP	South Dakota	GP	1127656	5102126.515
20791	SEAS	NP	South Dakota	GP	1106713.857	4862600.354
21153	SEAS	NP	South Dakota	GP	1032475.002	4957923.879
21725	TEMP	NP	South Dakota	GP	1056147.373	4922090.909
21542	TEMP	NP	South Dakota	GP	1026126.33	4934516.173
21720	TEMP	NP	South Dakota	GP	1056105.167	4922146.938
21121	TEMP	NP	South Dakota	GP	963734.6731	4967399.237
21386	TEMP	NP	South Dakota	GP	1026447.029	4936451.895
17858	SEAS	REST	South Dakota	GP	996401.6512	5041236.21

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.—Continued

[ObjectID, unique numeric identifier; class, pothole classification; cover_type, specifies whether a pothole is within reseeded grassland (REST) or native prairie (NP); State and region, identify the state and physiographic subregion; point_X and point_Y, the latitude and longitude of the pothole; SEAS, seasonally ponded; MC, Missouri Coteau; TEMP, temporarily ponded; GP, Glaciated Plains; LAP, Lake Agassiz Plain; TM, Turtle Mountains; PC, Prairie Coteau]

ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
20436	SEAS	REST	South Dakota	GP	1084448.752	4896696.399
15822	TEMP	REST	South Dakota	GP	1123032.114	5099490.704
19179	TEMP	REST	South Dakota	GP	989755.3037	4996920.618
20672	TEMP	REST	South Dakota	GP	1107386.736	4868633.509
18116	TEMP	REST	South Dakota	GP	1004349.192	5036729.875
19162	TEMP	REST	South Dakota	GP	978220.736	4996408.8
21222	TEMP	REST	South Dakota	GP	1034681.322	4949741.926
21779	TEMP	REST	South Dakota	GP	1055294.576	4920662.912
19180	TEMP	REST	South Dakota	GP	989642.2867	4996934.426
22415	TEMP	REST	South Dakota	GP	1131069.841	4842030.398
22010	SEAS	NP	South Dakota	MC	1010918.98	4869222.243
22252	SEAS	NP	South Dakota	MC	1008244.663	4843894.194
20984	SEAS	NP	South Dakota	MC	955227.6817	4985242.38
21294	TEMP	NP	South Dakota	MC	938415.186	4932838.506
22157	TEMP	NP	South Dakota	MC	1016510.253	4853538.276
22611	TEMP	NP	South Dakota	MC	1019558	4823603.171
21016	TEMP	NP	South Dakota	MC	952401.3816	4977654.583
21290	TEMP	NP	South Dakota	MC	938046.2489	4932901.807
21307	TEMP	NP	South Dakota	MC	934485.5765	4931909.121
21509	TEMP	NP	South Dakota	MC	987698.759	4931935.045
22040	TEMP	NP	South Dakota	MC	1012271.798	4863846.083
15171	SEAS	REST	South Dakota	MC	933572.5294	5095561.12
15156	SEAS	REST	South Dakota	MC	957647.448	5097560.901
16188	SEAS	REST	South Dakota	MC	942873.7321	5079413.785
16198	SEAS	REST	South Dakota	MC	919624.061	5077444.5
16888	SEAS	REST	South Dakota	MC	954100.2702	5071039.098
17695	SEAS	REST	South Dakota	MC	924342.6053	5040560.353
14988	SEAS	REST	South Dakota	MC	963186.2393	5102021.86
15026	SEAS	REST	South Dakota	MC	964085.0509	5101686.739
15324	SEAS	REST	South Dakota	MC	960123.2696	5095207.55
15930	SEAS	REST	South Dakota	MC	956140.0706	5084903.288
22737	SEAS	REST	South Dakota	MC	1022701.45	4814193.27
15403	TEMP	REST	South Dakota	MC	945144.4799	5092646.048
16801	TEMP	REST	South Dakota	MC	953648.6498	5071942.66
15406	TEMP	REST	South Dakota	MC	946526.7532	5092750.068
16871	TEMP	REST	South Dakota	MC	952791.9926	5071147.904
17264	TEMP	REST	South Dakota	MC	927991.5342	5061381.805
18499	TEMP	REST	South Dakota	MC	935026.9822	5023332.251
15500	TEMP	REST	South Dakota	MC	952674.968	5091683.134
15880	TEMP	REST	South Dakota	MC	937793.7871	5084374.493
16389	TEMP	REST	South Dakota	MC	902294.2994	5073619.578
16776	TEMP	REST	South Dakota	MC	951661.9984	5071996.678

Table 2.1. Description of potholes selected for inclusion in the wetland condition assessment.—Continued

[ObjectID, unique numeric identifier; class, pothole classification; cover_type, specifies whether a pothole is within reseeded grassland (REST) or native prairie (NP); State and region, identify the state and physiographic subregion; point_X and point_Y, the latitude and longitude of the pothole; SEAS, seasonally ponded; MC, Missouri Coteau; TEMP, temporarily ponded; GP, Glaciated Plains; LAP, Lake Agassiz Plain; TM, Turtle Mountains; PC, Prairie Coteau]

ObjectID	Class	Cover_type	State	Region	Point_X[1]	Point_Y[1]
17844	TEMP	REST	South Dakota	MC	931904.4913	5036600.156
18110	TEMP	REST	South Dakota	MC	966314.0216	5034113.251
21803	TEMP	REST	South Dakota	MC	968236.4875	4910208.565
22427	TEMP	REST	South Dakota	MC	1010242.166	4833142.332
16446	SEAS	NP	South Dakota	PC	1104226.631	5087883.199
18565	SEAS	NP	South Dakota	PC	1132127.685	5035787.358
18920	SEAS	NP	South Dakota	PC	1142160.132	5018059.072
20139	SEAS	NP	South Dakota	PC	1150666.238	4924405.921
16143	SEAS	NP	South Dakota	PC	1102961.245	5092545.193
16264	SEAS	NP	South Dakota	PC	1098274.76	5089747.448
17193	SEAS	NP	South Dakota	PC	1081569.122	5075701.757
17463	SEAS	NP	South Dakota	PC	1111075.855	5068746.001
17966	SEAS	NP	South Dakota	PC	1123995.551	5049587.789
18331	SEAS	NP	South Dakota	PC	1127588.064	5041673.701
18527	SEAS	NP	South Dakota	PC	1133691.251	5036722.617
18682	SEAS	NP	South Dakota	PC	1135584.142	5029824.918
19263	SEAS	NP	South Dakota	PC	1153852.24	5006782.211
20468	SEAS	NP	South Dakota	PC	1150365.689	4898162.555
17392	SEAS	NP	South Dakota	PC	1112122.018	5069755.047
15626	TEMP	NP	South Dakota	PC	1080381.414	5099699.021
17871	TEMP	NP	South Dakota	PC	1124872.617	5050785.266
18925	TEMP	NP	South Dakota	PC	1094393.166	5014467.672
15629	TEMP	NP	South Dakota	PC	1079398.988	5099563.373
17917	TEMP	NP	South Dakota	PC	1123973.759	5050083.464
18740	TEMP	NP	South Dakota	PC	1135583.581	5028393.606
18719	TEMP	NP	South Dakota	PC	1112886.627	5027206.619
18350	SEAS	REST	South Dakota	PC	1108291.6	5039986.8
16607	SEAS	REST	South Dakota	PC	1104370.866	5085790.826
19660	SEAS	REST	South Dakota	PC	1079526.043	4962876.565
16023	SEAS	REST	South Dakota	PC	1087858.305	5093592.498
18843	SEAS	REST	South Dakota	PC	1101813.164	5018065.966
20556	TEMP	REST	South Dakota	PC	1138865.629	4884170.627
19410	TEMP	REST	South Dakota	PC	1077810.793	4987200.946
19839	TEMP	REST	South Dakota	PC	1134548.584	4952552.621
20315	TEMP	REST	South Dakota	PC	1151141.346	4910092.844
20870	TEMP	REST	South Dakota	PC	1135729.38	4859102.686
15823	TEMP	REST	South Dakota	PC	1095823.545	5097437.629
19733	TEMP	REST	South Dakota	PC	1176123.557	4967415.786
20166	TEMP	REST	South Dakota	PC	1139899.163	4922855.497
20945	TEMP	REST	South Dakota	PC	1146531.44	4851351.509

[1]Coordinate system: World Geodetic System 1984, Universal Transverse Mercator Coordinate System zone 13 North.

Appendix 3

This appendix contains general information describing the North Dakota Rapid Assessment Method (NDRAM), along with the field form presenting requisite information for completing the NDRAM (fig. 3.1). The field form was reproduced, with permission, from (Hargiss, 2009). The NDRAM was created to rapidly assess temporarily, seasonally, and semipermanently ponded wetlands in the Prairie Pothole Region based on plant communities (Hargiss, 2009; Hargiss and others, 2017). Before using the NDRAM, field personnel will be trained in an NDRAM field training course provided by personnel from North Dakota State University. This training course describes the NDRAM, how to identify significant characteristics of the wetland, and the basic plant community information required to properly complete the NDRAM. The NDRAM can be used by anyone who has completed the short field course. Within the attached NDRAM field form, the cover type figure was reproduced from (Stewart and Kantrud, 1971).

Figure 3.1. North Dakota Rapid Assessment Method field form [GPS, global positioning system; N, north; W, west; %, percent; m, meter; <, less than; ft, foot; >, greater than; pts, points; CRP, Conservation Reserve Program]. Available for download at https://doi.org/10.3133/ofr20191118.

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