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Department of Horticultural Science
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The Role of Plant Species Diversity to Improve Nongame Migratory Bird Habitats in Restored Prairie Pothole Wetlands (US)

Allyz Kramer

Introduction

The decline of native grasslands exceeds those reported for any other major ecosystem in North America (Herkert *et al.*; 1996, Herkert, 1995). Breeding Bird Surveys (BBS) have indicated consistent declines of bird populations throughout the grassland regions of the continental U.S. (Herkert, 1994; Herkert, 1995; Igl and Johnson, 1997; Fletcher and Koford, 2003), with breeding birds of the grassland regions declining more in the last 30 years than any other group of North American birds [Knopf (1994), Peterjohn and Sauer (1999), *in* Ribic and Sample (2001); Herkert, 1995]. The decline in grassland birds can be partially attributed to severe habitat loss and fragmentation of the regional landscape (Herkert *et al.*, 1996). Other issues surrounding population declines in breeding birds of the grassland regions have been suggested such as reproductive failure due to habitat degradation, mowing and haying regimes, habitat loss in winter grounds (Herkert *et al.*, 1996), conversion to woody vegetation (Igl and Johnson, 1997), other land use conversions, or a combination of these factors.

An analysis of breeding bird population trends in the American midcontinent from 1966 – 1993 (Herket, 1995) suggested that when native prairie was converted to secondary grasslands (e.g., hayfields, pastures), a spatial buffer remained as habitat for breeding birds. It is believed that birds breeding in the American midcontinent have evolved to respond to environmental dynamics, including plasticity in their behavior for locating habitat (Igl and Johnson, 1997). However, with further fragmentation of land and conversions to alternative uses (presumably to row-crops), secondary grassland habitats that originally provided a spatial buffer for breeding birds are declining (Herkert, 1994). Another grave concern for breeding birds is that over-wintering habitats are also in decline. Short-distance migrants that over-winter in the southeast U.S. have experienced similar grassland habitat fragmentation and conversion to row-crops (Herkert *et al.*, 1996) that has been experienced in the northern Great Plains.

Habitat lost for wetland birds in the prairie pothole region (PPR) in North America is of particular interest. Breeding bird surveys in the North American grassland regions suggest that wetland bird populations are relatively abundant, but this data may be misleading (Herkert, 1995). The results of these surveys suggested that relative abundance of wetland birds in the region “may be good,” however these patterns were largely driven by populations of a few species such as the Canada goose, ring-billed gull, and sandhill crane that are showing regional population increases (Herkert, 1995).

Plant species assemblage in the low, wet prairie and sedge meadow (herein referred to as “WP/SM”) margins of prairie pothole wetlands is thought to influence a specific guild of nongame avifaunal species for nesting and foraging during the breeding season. How nongame avifaunal species utilize restored prairie potholes and the fringe WP/SM habitats is of interest. A list of nongame avifaunal specialists associated with WP/SM habitats is provided in Table 1. This paper focuses on the current research on breeding bird diversity of WP/SM guild avifaunal species in the PPR of the American midcontinent with particular focus on restored prairie potholes in Iowa, Minnesota, and North and South Dakota. The results of these findings may influence a paradigm shift in how restorations are completed in the region when goals include improving avifaunal species assemblages.

Prairie Pothole Wetlands

The PPR roughly encompasses 782,000 km^2 (300,000 $miles^2$) (van der Valk, 1989; Mitsch and Gosselink, 1993) from north-central Iowa, southwest and west-central Minnesota, eastern South and North Dakota, the northern-tier of Montana, and on into the southern Canadian prairie provinces of Manitoba, Alberta, and Saskatchewan (Figure 1). The prairie pothole landscape was created during the last glacial recession approximately 12,000 years ago (van der Valk, 1989) leaving behind a pockmarked landscape with millions of relatively shallow depressions providing catchment of snow and seasonal runoff (Figure 2). This region was rich in wet, mesic, and dry prairie grasslands prior to settlement in the 1800s. However, due to the nature of the interspersed wet and dry zones, it would have been nearly impossible for settlers to setup traditional agricultural methods without drainage of wet areas.

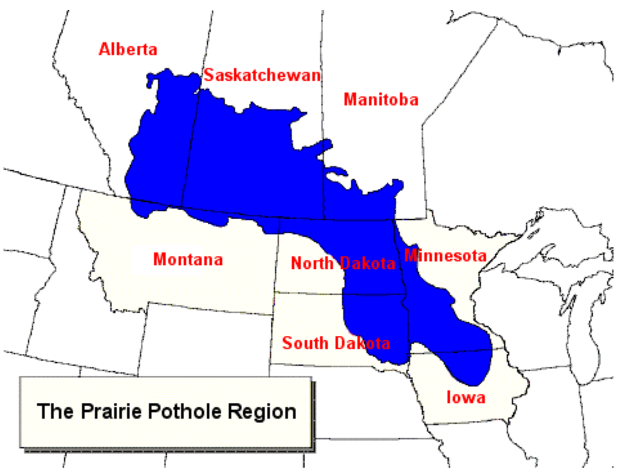

Figure 1. Prairie pothole region of North America. (Source: U.S. Fish and Wildlife Service, Kulm Wetland Management District, 2003.)

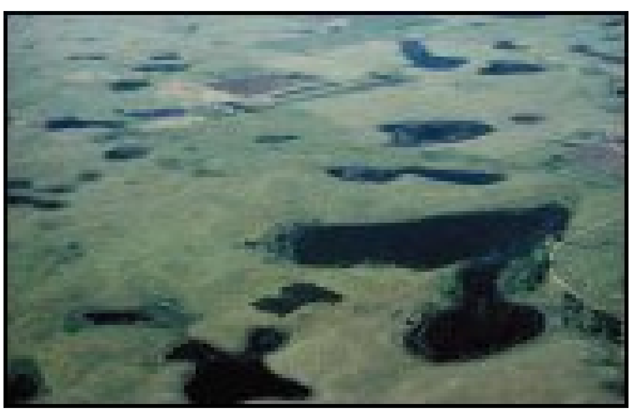

Figure 2. The prairie pothole region in North Dakota. (Source: Northern Prairie Wildlife Research Center, U.S. Geological Survey, 2003.)

Table 1. Nongame Breeding Bird Specialists in U.S. Prairie Pothole Wetlands that Require Wet Prairies, Sedge Meadows, and Shallow Emergent Vegetation.[1]

COMMON NAME	SCIENTIFIC NAME	PROTECTION STATUS[2] AND STATE
RAILS		
Sora	*Porzana carolina*	none
King rail	*Rallus elegans*	E (MN), E (IA), R (SD)
Virginia rail	*Rallus limicola*	none
HERONS		
American bittern	*Botaurus lentiginosus*	none
Least bittern	*Ixobrychus exilis*	R (SD)
SHOREBIRDS		
Wilson's phalarope	*Phalaropus tricolor*	T (MN)
WRENS		
Marsh wren	*Cistothorus palustris*	none
Sedge wren	*Cistothorus platensis*	none
SPARROWS		
Henslow's sparrow	*Ammodramus henslowii*	E (MN), E (IA), R (SD)
LeConte's sparrow	*Ammospiza lecontei*	R (SD)
Swamp sparrow	*Melospiza georgiana*	none
Savannah sparrow	*Passerculus sandwichensis*	none
Clay-colored sparrow	*Pizella pallida*	none
WARBLERS		
Common yellowthroat	*Geothlypis trichas*	none
PERCHING BIRDS		
Bobolink	*Dolichonyx oryzivorus*	none

Footnotes:

[1] Source: Adapted from Galatowitsch and van der Valk (1994), Fairbairn and Dinsmore (2001), Ratti *et al.* (2001), Delphey and Dinsmore (1993).

[2] Minnesota's List of Endangered, Threatened, and Special Concern Species (1996); Iowa's Threatened or Endangered Species (2002); Threatened or Endangered Animals Tracked by the South Dakota Natural Heritage Program (2002). [North Dakota does not have an endangered species act, rather separate statutory provisions authorizing listing and establishment of management programs (N.D. Century Code §20.1-02-05). The state does not list any species itself (N.D. Administrative Code §30-04-01).]

Key:

E = Endangered, with full protection under Minnesota Endangered Species Act or Iowa Threatened or Endangered Species Law.

T = Threatened, with full protection under Minnesota Endangered Species Act or Iowa Threatened or Endangered Species Law.

R = Rare in South Dakota and tracked by the South Dakota Dept. of Game, Fish & Parks Natural Heritage Program.

Legislation in the mid-1800s included the U.S. Swamp Lands Acts, which promoted drainage of the PPR. This was followed by the Homestead Act of 1862, which fueled the expansion of settlements westward, including railroads, stagecoach lines, roads, and improved river transportation (van der Valk, 1989). It is estimated that approximately 38% (2.2 million hectares) of prairie pothole wetlands have been drained or otherwise eliminated (Delphey and Dinsmore, 1993 *in* Dahl, 1990). In Iowa alone, approximately 90% of the prairie pothole wetlands have been eliminated since settlement (Delphey and Dinsmore, 1993 *in* Dahl, 1990). Iowa State Census Reports (1925, *in* Galatowitsch, 1994) indicated that by 1925 less than 1% of land in north-central Iowa was classified as "rough swamp land." The negative effects of these extensive drainage efforts were becoming apparent in the early part of the century where wells were drying up and wildlife populations were declining (Flickinger, 1904, and Birdsall, 1915, *in* Galatowitsch, 1994).

With the focus on draining and settling this landscape, the ecological ramifications of these practices were not a priority. However, by the 1960s and 1970s there was recognition, particularly by resource managers, of the ecological functions and inherent values to humans and wildlife that these prairie wetlands provided. For example, the PPR is a major flyway for the myriad of migratory birds making their way north to breeding grounds and south to over-winter. Estimates as high as 50-70% of all waterfowl produced in North America are thought to come from the PPR (Mitsch and Gosselink, 1993).

Restoration Efforts

Several conservation programs focused on restoring wetland habitat were initiated in the 1980s, such as the Conservation Reserve Program (CRP) of the 1985 Food Security Act (Farm Bill), the North American Water Management Plan, Wetland Reserve Program, and other state or local legislation (e.g., Reinvest in Minnesota – RIM) [Galatowitsch, 1994; Ratti, *et al.*, 2001; Madsen (1988) *in* Delphey and Dinsmore, 1993; VanRees-Siewert and Dinsmore, 1996]. The past few decades of wetland restoration in the PPR of the U.S. has focused on restoring hydrology for improving populations of waterfowl, a goal largely driven by organizations such as Ducks Unlimited and the U.S. Fish and Wildlife Service (USFWS). For example, approximately 3,600 hectares (8,896 acres) of wetland have been restored in Iowa by the North American Waterfowl Management Plan's Prairie Pothole Joint Venture (Zohrer, 1996, *in* Fairbairn and Dinsmore, 2001). In addition, the Natural Resource Conservation Service (NRCS) has restored or is in the process of restoring 31,000 hectares (76,602 acres) of wetlands on privately owned land through its CRP (Fairbairn and Dinsmore, 2001). Galatowitsch and van der Valk (1994) reported that within the first four years of implementation of the NRCS's CRP, over 1,800 prairie pothole wetlands had been restored in the southern PPR alone (i.e., that region of north central Iowa, southwest and south-central Minnesota, and extreme east-central South Dakota).

Studies in the PPR have shown that waterfowl quickly colonized wetlands in central Minnesota and northeast South Dakota once hydrology has been restored (VanRees-Siewert and Dinsmore, 1996; LaGrange and Dinsmore, 1989). Observations made by LaGrange and Dinsmore (1989) in four restored prairie potholes in Iowa showed quick colonization of bird species upon only restoring hydrology. However, these observations consisted of only 11 avifaunal species, of which five were waterfowl species and four species could be considered marsh generalists (e.g., yellow-headed blackbird, red-winged blackbird, killdeer, and spotted sandpiper). Only two of the 11 species (common yellowthroat and song sparrow) that were observed by LaGrange and Dinsmore (1989) could be considered breeding specialists (Table 1) that require specific vegetation assemblages. Delphey and Dinsmore (1993) concluded that waterfowl nesting pairs were not significantly different between restored or natural prairie potholes. VanRees-Siewert and

Dinsmore (1996) studied breeding bird use in Iowa within 40 prairie pothole wetlands that had hydrology restored for one to four years. They found that overall species richness of waterfowl was not significant between restored or natural prairie wetlands in their study in Iowa (VanRees-Siewert and Dinsmore, 1996). The wetlands that had only been restored for approximately one year had less vegetation established than those wetlands that had been restored for four years. VanRees-Siewert and Dinsmore (1996) concluded that overall bird species richness did not vary with wetland age, however there was a correlation between breeding bird species richness with percent emergent vegetation coverage. This was likely attributed to one- and two-year old wetlands having more mudflats and open water versus older wetlands having more well developed stands of emergent vegetation (VanRees-Siewert and Dinsmore, 1996).

These studies suggest that although breeding birds quickly colonize prairie potholes with restored hydrology, there may be a gap in overall breeding bird species richness due to the lack of fringe grassland (i.e., wet prairie, sedge meadow) transition zones. To further qualify this assertion, Delphey and Dinsmore (1993) completed a comparison study of 18 restored and 11 natural prairie potholes in Iowa for breeding bird assemblages. The restored basins relied on drainage cessation for return of hydrology; biotic recolonization depended completely on natural processes. The natural wetlands had WP/SM vegetative zones between the aquatic and terrestrial (upland) zones, whereas restored wetlands had much more abrupt transitional zones between aquatic and terrestrial zones. Delphey and Dinsmore (1993) observed greater breeding bird species richness in natural wetlands versus restored wetlands, including larger numbers of common yellowthroats, swamp sparrows, and red-winged blackbirds in natural wetlands. This was presumably due to the presence of WP/SM zones in natural wetlands, versus WP/SM being distinctly absent at the restored sites.

In a follow-up study completed by Dault (2001), wetlands that were between 4-12 years post-restoration in northwestern Iowa resulted in less total bird species richness than observed in their natural counterparts. Overall, Dault (2001) did not find a significant difference in total bird species richness in old (8-12 years post-restoration) and young (4-6 years post-restoration) restored wetlands. However, Dault (2001) seldom observed secretive species (i.e., American and least bitterns, soras, and Virginia rails) in restored wetlands, which may have accounted for the difference in breeding species richness between old restored and natural wetlands (for at least the normal water level year of this study). When these four secretive species were removed from Dault's (2001) 1999 statistical analysis, there were no significant differences in breeding species richness in natural and restored wetlands. Bitterns, sora, and rail require tall, thick wet meadow zones for nesting, foraging, and protection. Dault (2001) indicated that natural wetlands had greater percentages of wet meadow zones than both young and old restored sites, and natural wetlands generally had more dominant emergent and wet meadow species than restored sites. Dault (2001) concluded that with time, restored wetlands may support an increasingly diverse breeding bird population; however restored sites may not provide the variety of breeding niches that natural wetlands offer.

Habitat Considerations

Several bird species (Table 1) are dependent on particular vegetation assemblages around prairie pothole wetlands. However a number of these species, including sora, Virginia rail, marsh wren, common yellowthroat, and swamp sparrow, along with yellow-headed blackbird and red-winged blackbird have been observed in lower than expected abundance in restored prairie potholes (Delphey, 1991, *in* Galatowitsch and van der Valk, 1994). Several analogies have been offered, including low plant species diversity; low numbers of macroinvertebrates as a food source (Galatowitsch and van der Valk, 1994); limited area (size) of fringe grassland habitats, which can encourage nest predation (Brown and Dinsmore, 1986; Naugle *et al.*, 1999); lack of nearby habitat (fragmentation) (Naugle *et al.*, 2001), and the overall small size of restored wetlands (Brown and Dinsmore (1986).

Vegetation

With the improvement of waterfowl production in the region, more current research has been focused toward whether restored prairie potholes also provide habitat for other avifaunal species. Research suggests that restoring native vegetation provides a critical link in improving nesting habitat for other breeding bird species besides waterfowl. With restoration foci on hydrology, little effort in restoration has been directed toward restoration of surrounding vegetation. LaGrange and Dinsmore (1989) found some reliability in existing seedbanks in colonizing emergent wetland plants in restored prairie potholes, although the dominant vegetation in these restored basins was from windblown seed sources (*Typha* spp.). Wienhold and van der Valk (1989, *in* Galatowitsch and van der Valk, 1996a) found that seeds from bulrushes (*Scirpus validus* and *S. fluviatilis*) can persist in cultivated and drained prairie pothole wetlands. However, efficacy of these seed sources declines as cultivation and drainage is prolonged (Galatowitsch and van der Valk, 1996a) and the seedbank is eventually depleted from the soil. Where restored wetlands are rather isolated or disconnected from natural wetland systems, seed dispersal is unlikely unless through windblown sources or waterfowl dispersal (Galatowitsch and van der Valk, 1996b).

In prairie pothole restorations focused primarily on reestablishing hydrology, what results are semi-permanent and ephemeral basins with areas of open water and pioneer emergent vegetation such as cattails (*Typha* spp.). Although seeds from emergent species may persist in disturbed wetlands, the seeds that would create the typical surrounding WP/SM zones appear to be absent in the seedbank. Furthermore, propagule sources for WP/SM species are often extirpated from nearby wetlands or otherwise limited by dispersal barriers (Mulhouse and Galatowitsch, 2003). This is confirmed by the fact that fringe areas of wet meadow and wet prairie are commonly colonized with more aggressive pioneer species, such as the invasive reed canary grass (*Phalaris arundinacea*) rather than desired sedges (*Carex* spp.) or other native graminoids (see Figure 3). To further illustrate this point, van der Valk *et al.* (1999) completed a study of *Carex* seed efficacy in sedge meadows of the American Midwest and concluded that few, if any, *Carex* seeds are viable in seedbanks. This indicates that these seeds may be rather short-lived, and natural sedge meadows likely maintain themselves through vegetative or clonal growth (van der Valk *et al.*, 1999). This knowledge is critical when initiating restoration of prairie potholes, since these vegetative realms appear to provide a necessary link between the aquatic and terrestrial zones in the landscape for breeding bird specialists (see Table 1). These specific “sedge meadow guild species” (Galatowitsch, 1994) are dependent on and may only occur in the tall, sedge meadow grasses (Herkert *et al.*, 1994) and low prairie margins along emergent and ephemeral prairie pothole marshes. The lack of WP/SM habitats in restored prairie potholes may deter these avifaunal guild species from colonizing regardless of the hydrology restoration. For secretive species such as rails and bitterns, dense meadow and stands of emergent vegetation are required for secluding their nesting and breeding habitats (Galatowitsch, 1994). VanRees-Siewert and Dinsmore (1996) suggest similar findings where sora, Virginia rail, American and least bitterns (and black tern) did not nest in restored wetlands initially, but were observed the following three years presumably due to vegetation finally being established.

Figure 3. A prairie pothole wetland that developed a monoculture of reed canary grass rather than the diversity of vegetation usually found in nondisturbed wetlands. (Source: Northern Prairie Wildlife Research Center, U.S.Geological Survey, 2003.)

Wetland Area, Adjacent Habitat, and Landscape Connectivity

As discussed previously, breeding birds require vegetation structure for nesting and food, as well as other natural history requirements (Fairbairn and Dinsmore, 2001). However other factors affecting wetland bird assemblages have received research attention. Naugel *et al.* (1999) and Brown and Dinsmore (1986) have described minimum habitat area requirements for breeding wetland birds. This is particularly important during site selection for restorable basins, which should be focused more at the local watershed scale for locating groupings of restorable basins. Brown and Dinsmore (1986) and Naugle *et al.* (2001) observed greater species richness in groups of wetland basins than in functionally isolated basins. Fairbairn and Dinsmore (2001) and Dault (2001) observed that the characteristics of wetland basin complexes also attribute to bird species richness in the PPR. Furthermore, wetland complexes are more likely to offer suitable habitat to a broader range of birds in any given year regardless of water level conditions (i.e., drought years) (Dault, 2001). The proximity of restorable basins to adjacent habitats is critical in improving ecological function of prairie pothole wetlands when considering requirements of several WP/SM avifaunal guild species.

In a study on marsh size and isolation on 30 Iowa prairie marshes (Brown and Dinsmore, 1986), breeding bird species richness increases were significant with increased marsh size. However, the rate of increase (slope) of species richness eventually decreased as marshes become larger (suggesting a curvilinear relationship). Brown and Dinsmore (1986) also found that isolation of wetland basins affects bird species richness, although isolation may not be as important as marsh size. For the guild avifaunal species described in Table 1, Brown and Dinsmore (1986) found that swamp sparrows were dependent on marsh size, where a significant increase in frequency was observed when marsh size was at least 5 hectares to greater than 20 hectares. Other guild species possibly area-dependent were marsh wren, least bittern, and American bittern. Virginia rail and sora were apparently area-independent in the study completed by Brown and Dinsmore (1986). This suggests that wetland restorations should include basins with a complex of sizes that could provide nesting habitat for the diverse assemblage of guild species described in Table 1.

Naugle *et al.* (2001) described wetland bird use in South Dakota prairie potholes from a landscape level, where suitability of larger wetlands (>0.5 hectares) for breeding birds decreased when smaller wetlands (<0.5 hectares) were removed from the surrounding landscape. This could be explained by the natural history of some breeding birds that utilize multiple localized wetlands for foraging and nesting, or where some guild species (e.g., Wilson's phalarope) were more likely to inhabit wetlands with untilled surrounding landscapes. The small seasonal basins in the study by Naugle *et al.* (2001) showed greater usage by Wilson's phalarope and Virginia rail than compared to semi-permanent wetlands. The study by Naugle *et al.* (2001) also confirmed that vegetative coverage increased nongame bird species presence, conversely more open water settings with less vegetative cover increased waterfowl usage in marshes. Small seasonal basins in South Dakota are more than six (6) times as abundant as semi-permanent wetlands (Naugle *et al.*, 2001), which suggests that restoration and preservation efforts should perhaps be focused on landscape connectivity and continuity with particular consideration of small wetlands.

The Future in Prairie Pothole Wetland Restoration

Although agriculture remains the primary land use in the PPR, there is ever more focus on restoring the native pothole wetland and grassland landscape for ecological and societal benefits. Bird population densities are often compared between restored and native habitats to determine if restored areas provide suitable habitat as exemplified in historic native ecosystems (Fletcher and Koford, 2003). These studies provide data on the efficacy of breeding bird species relative to restoration sites to improve future restoration decisions and design goals (Fletcher and Koford, 2003).

Prairie pothole restorations typically have focused on functional replacement of hydrology alone, with revegetation of sites by natural biotic processes. Unfortunately, many of these prairie potholes have been drained and cultivated for long enough that the original seedbank has been desiccated. The diverse assemblage of WP/SM species does not appear to reestablish in prairie potholes without supplemental seeding and/or propagules, therefore, revegetation is often driven by pioneer species that tend colonize in monotypic stands (e.g., cattails, reed canary grass). Low vegetative diversity or narrow fringes of WP/SM habitat appear to limit breeding avifaunal guild species from using these habitats. As Delphey and Dinsmore (1993) concluded, recovery of the breeding bird communities in restored prairie potholes will most likely depend on reestablishment of WP/SM habitat.

Restorations in the PPR that are particularly small may be limited by their conservation benefit since these areas generally lack the grassland bird species in greatest need of conservation (Herkert *et al.*, 1994). If restored wetlands in the PPR are still disconnected from adjacent pothole wetlands and associated grasslands (whether restored or native), the overall ecological benefit of the restored site may be rather low. Dault's (2001) study indicated that the area of semi-permanent wetlands and number of marshes within 1,500 meters of each restoration site was most often correlated to estimates of bird species richness and actual bird species occurrences and densities. Restorations should be concentrated in the landscape in a way that provides a variety of marsh sizes and types (permanent, semi-permanent, seasonal, and temporary) proximal to each other. This may be particularly important during drought years where at least some wetlands will likely maintain water levels suitable for breeding marsh birds (Dault, 2001). Furthermore, planting and seeding WP/SM species should be a primary focus in restoring prairie potholes particularly in sites that may be limited by other environmental factors (e.g., unsuitable water regimes or soil conditions, or heavy plant/litter layer) (Galatowitsch *et al.*, 1999).

If the goal of prairie pothole restoration is to improve ecological diversity of avifaunal species in the region, restoration efforts must include improving plant species diversity in the associated WP/SM habitats. Deliberate reintroduction of native dominant graminoids (Mulhouse and Galatowitsch, 2003), as well as other WP/SM seed and/or propagules is necessary in overcoming the lags observed when restored basins are left to recolonize naturally (Galatowitsch *et al.*, 1999). Without an effort to restore zones of native graminoids and forbs, pioneer species such as cattails and reed canary grass quickly colonize providing habitat for more avifaunal generalists (e.g., red-winged blackbirds, cowbirds, grackels) rather than the avifaunal specialists (Table 1) that depend on WP/SM habitats. The most efficient management of habitat for sensitive bird species is to concentrate on retaining those areas still intact and with the most acreage to offer, and with the best management opportunities (Herkert *et al.*, 1996). Areas that are well suited for establishing networks of restored pothole wetlands along with the associated wet prairie, sedge meadow, and/or upland prairie should be priority restoration sites.

Literature Cited

Birdsall, B.P. 1915. History of Wright County, Iowa: its peoples, industries and institutions. B.F. Bowen and Company, Indianapolis, Indiana.

Brown, M., and J.J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50: 392-397.

Dahl, T.E. 1990. Status of prairie pothole wetlands in the United States. U.S. Fish and Wildlife Service, National Wetlands Inventory, St. Petersburg, FL, USA.

Dault, R.E. 2001. Long-term effects of wetland restoration on bird communities in the Prairie Pothole Region of northwestern Iowa. M.S. Thesis, Iowa State University, Ames. 107 pps.

Delphey, P.J. 1991. A comparison of the bird and aquatic macroinvertebrate communities between restored and natural Iowa prairie wetlands. M.S. Thesis, Iowa State University, Ames.

Delphey, P.J., and J.J. Dinsmore. 1993. Breeding bird communities of recently restored and natural prairie potholes. Wetlands 13(3): 200-206.

Fairbairn, S.E., and J.J. Dinsmore. 2001. Local and landscape-level influences on wetland bird communities of the prairie pothole region of Iowa, USA. Wetlands 21(1): 41-47.

Fletcher, R.J., and R.R. Koford. 2003. Changes in breeding bird populations with habitat restoration in northern Iowa. American Midland Naturalist 150(1): 83-94.

Flickinger, R.E. 1904. *The Pioneer History of Pocahontas County, Iowa, from the Time of Its Earliest Settlement to the Present Time.* Sanborn Publishers, Fonda, Iowa.

Galatowitsch, S.M., and A.G. van der Valk. 1994. Restoring Prairie Wetlands: An Ecological Approach. Iowa State University Press, Ames, IA, USA.

________. 1996(a). Characteristics of recently restored wetlands in the prairie pothole region. Wetlands 16(1): 75-83.

________. 1996(b). The vegetation of restored and natural prairie wetlands. Ecological Applications 6(1): 102-112.

Galatowitsch, S.M., R. Budelsky, and L. Yetka. 1999. Revegetation strategies for northern temperate glacial marshes and meadows, pps. 225-241. *In:* W. Streever (ed.). An International Perspective on Wetland Rehabilitation. Kluwer Academic Publishers. Netherlands.

Herkert, J.R. 1994. The effects of habitat fragmentation on Midwestern grassland bird communities. Ecological Applications 4(3): 461-471.

________. 1995. An analysis of Midwestern breeding bird population trends: 1966-1993. American Midland Naturalist 134:41-50.

Herkert, J.R., D.W. Sample, and R.E Warner. 1996. Management of Midwestern grassland landscapes for the conservation of migratory birds, p. 89-116. *In:* F.R Thompson, III (ed.). Management of Midwestern landscapes for the conservation of migratory birds. United States Department of Agriculture North Central Forest Experiment Station General Technical Report 187, St. Paul, Minnesota, USA.

Hickman, S. 1994. Improvement of habitat quality for nesting and migrating birds at the Des Plaines River wetlands demonstration project. Ecological Engineering 3(4): 485-494.

Igl, L.D., and D.H. Johnson. 1997. Changes in breeding bird populations in North Dakota: 1967 to 1992-1993. The Auk 114 (1): 74-92.

Iowa's Endangered and Threatened Plant and Animal Species. 2002. Iowa's Endangered and Threatened Species Law. Iowa Administrative Code [571], Chapter 77. Online Publication: http://www.iowadnr.com/other/files/chapter77.pdf.

Iowa State Census Reports. 1925. State of Iowa Historical Society files. Des Moines.

Knopf, F.L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biology 15: 247-257.

LaGrange, T.G., and J.J. Dinsmore. 1989. Plant and Animal Community Responses to Restored Iowa Wetlands. Prairie Naturalist 21(1): 29-48.

Madsen, C.R. 1988. Wetland restoration in western Minnesota, pps. 92-94. *In* J. Zelazny and J.S. Feierabend (eds.). Increasing our wetland resources. National Wildlife Federation, Washington, DC, USA.

Minnesota Statutes, Section 84.0895. 1996. Minnesota's Endangered Species Statute.

Mitsch, W.J., and J.G. Gosselink. 1993. Wetlands. 2nd Edition. Von Nostrand Reinhold. New York. 722 pps.

Mulhouse, J.M, and S.M. Galatowitsch. 2003. Revegetation of prairie pothole wetlands in the mid-continental US: twelve years post-reflooding. Plant Ecology 169: 143-159.

Naugle, D.E., K.F. Higgins, S.M. Nusser, and W.C. Johnson. 1999. Scale-dependent habitat use in three species of prairie wetland birds. Landscape Ecology 14(3): 267-276.

Naugle, D.E., R.R. Johnson, M.E. Estey, and K.F. Higgins. 2001. A landscape approach to conserving wetland bird habitat in the prairie pothole region of eastern South Dakota. Wetlands 21(1): 1-17.
North Dakota Administrative Code. 2003. Rare and Endangered Animals. Chapter 30-04-01. Online Publication: http://www.state.nd.us/lr/information/acdata/html/30-04.html.

North Dakota Century Code. 2003. Game and Fish Department. Chapter 20.1-02-05. Online Publication: http://www.state.nd.us/lr/cencode/T201C02.pdf.

Northern Prairie Wildlife Research Center. 2003. U.S. Geological Survey. Jamestown, North Dakota. Online Publication: http://www.npwrc.usgs.gov/index.htm

Peterjohn, B.G., and J.R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996, p. 27-44. *In:* P.D. Vickery and J.R. Herkert (eds.). Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Ratti, J.T., A.M. Rocklage, J.H. Giudice, E.O. Garton, and D.P. Golner. 2001. Comparison of avian communities on restored and natural wetlands in North and South Dakota. Journal of Wildlife Management 65(4): 676-684.

Ribic, C.A., and D.W. Sample. 2001. Associations of grassland birds with landscape factors in southern Wisconsin. American Midland Naturalist 146: 105-121.

South Dakota Game, Fish and Parks. 2002. Rare, Threatened, and Endangered Animal Species Tracked by the South Dakota Natural Heritage Program. Online publication: http://www.state.sd.us/gfp/DivisionWildlife/Diversity/index.htm.

U.S. Fish and Wildlife Service. 2003. Kulm Wetland Management District. Kulm, North Dakota. Online Publication: http://kulmwetlands.fws.gov/pothole.html

van der Valk, A.G., T.L. Bremholm, and E. Gordon. 1999. The restoration of sedge meadows: seed viability, seed germination requirements, and seedling growth of *Carex* species. Wetlands 19(4): 756-764.

VanRees-Siewert, K.L., and J.J. Dinsmore. 1996. Influence of wetland age on bird use of restored wetlands in Iowa. Wetlands 16(4): 577-582.

Wienhold, C.E., and A.G. van der Valk. 1989. The impact of duration of drainage on the seed banks of northern prairie wetlands. Canadian Journal of Botany 67: 1878-1884.