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The Birds of Chichaqua Bottoms Greenbelt (Polk County, Iowa): Patterns of Habitat Use and Implications for Management

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Despite the fact that many birds are believed to be declining as a result of habitat loss and elimination of historic disturbance regimes, few studies have explored how restoration and management of mixed grassland and woodland systems influence bird communities. In this study, we tested whether habitat size, habitat type, and use of prescribed fire as a management tool affected the species richness and composition of bird communities sampled from 22 restored grassland and woodland sites within Chichaqua Bottoms Greenbelt (Polk County, Iowa). In 2004–5 bird communities were sampled by walking transects within each site and recording the presence and abundance of bird species identified by sight or vocalization. A total of 198 bird species was recorded across all 22 transects, and observed species richness was higher in larger habitats and habitats with greater structural complexity. Although habitat type was correlated with significant variation in bird community structure, the use of fire as a management tool did not appear to significantly influence either species richness or community composition of birds. Xeric prairies supported the fewest bird species within the restored landscape, with mesic woodlands and woodland –prairie mosaics supporting the most species. Interestingly, the frequency of site occupancy by Northern Harrier and Henslow's Sparrow was not a function of burn history, and only the Bobolink appeared to be marginally more common in recently burned sites. Thus, we suggest that land managers might benefit from envisioning restoration as a landscape-scale process rather than a site-scale process. Single, isolated restoration sites may never accumulate all bird species that reflect pre-disturbance avifauna. Rather, restoration of individual sites may re-establish meta-communities within a region, with bird species present at only a fraction of all possible sites from year to year.

INDEX DESCRIPTORS: Bird community, ecological restoration, prairie management, prescribed fire.

The prairies and oak woodlands of central North America represent one of the most biodiverse assemblages of vegetation in North America. Habitat loss due to expansion of row crop agriculture, however, has left less than 1% of original prairie and oak savanna systems intact (Rosburg 2001). Correlated with the widespread loss of these habitats, a number of studies have noted diminished populations of grassland and oak savanna bird species (e.g., Herkert 1994, Winter and Faaborg 1999, Johnson and Igl 2001, Davis 2004). While some loss of bird diversity within the central Midwest is directly attributable to the relative paucity of large remnants within highly fragmented landscapes, recent studies also indicate that nest failure, brood parasitism, and changes in the structure of the vegetation within prairies lacking natural disturbance regimes may be as important as loss of habitat area per se (Collins 2000, Herkert et al. 2003, Patten et al. 2005, Winter et al. 2005, Walk et al. 2006). Because the amount of remnant prairie habitat in states such as Iowa is limited to perhaps 0.1%–0.5% of the historical maximum (Smith 1998), ecological restoration of native grassland communities may be among the best strategies ecologists can use to prevent further bird population declines.

Unfortunately, relatively few studies have attempted to address the question of how bird communities respond to prairie restoration. Given the well-established area sensitivities of species such as Henslow's Sparrow (*Ammodramus henslowii*), Grasshopper Sparrow (*Ammodramus savannarum*), Bobolink (*Dolichonyx oryzivorus*), Dickcissel (*Spiza americana*), and Northern Harrier (*Circus cyaneus*) (Winter and Faaborg 1999, Johnson and Igl 2001), it seems clear that larger restorations may avoid problems associated with creating ecological trap habitat in smaller prairie reconstructions (Battin 2004, Shochat et al. 2005). In one of the few comparisons of bird communities in both remnant and restored Tallgrass prairies, Fletcher and Koford (2002) demonstrated that remnants and restorations supported similar densities of breeding bird species, with Grasshopper Sparrows and Savanna Sparrows (*Passerculus sandwichensis*) actually attaining greater numbers in restored grasslands. Many prairie birds also appear to be sensitive to edge effects, with lower densities or decreased nesting success reported adjacent to prairie – matrix habitat interfaces (Fletcher and Koford 2002, Herkert et al. 2003, Martin et al. 2006). Therefore, the shape of a prairie restoration may be as important as the size of the site for grassland bird species.

Management tools used to mimic natural disturbance regimes also may have significant effects on the composition and diversity of bird species in prairie and savannas. Surprisingly, only a small number of studies have considered this question for restored habitats within the highly fragmented Iowa landscape. In a comparison of the effects of burning and mowing on bird communities in western Iowa, Van Dyke et al. (2004) suggested that bird communities appeared resilient to human-imposed disturbance regimes. Unfortunately, few of the sites used in their analysis were particularly species rich, with area-sensitive or regionally-declining species not well represented within the

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entire system. Obviously, mowing and burning both alter the composition and structure of vegetation within tallgrass prairies, and a number of studies have suggested that the timing of a burn is especially important in changing relative dominance of grasses or forbs within restored prairies (Gibson et al. 1993, Howe 1994, Collins 2000). Because a large number of grassland birds are as sensitive to local vegetation structure as they are to patch area (if not more so – see Whitmore 1979, Delisle and Savidge 1997), the use of prescribed burning may still significantly influence bird communities in restored systems (Tucker et al. 2003).

The goal of this study was to survey a large grassland and woodland restoration project in Central Iowa and assess the heterogeneity in bird species composition among different habitats. Specifically, we tested three predictions regarding the variation in bird communities among habitat patches within the large restoration. First, we tested whether larger patches of restored vegetation supported a greater number of bird species. Second, we examined whether bird communities were significantly different between xeric prairies, mesic prairies, and mesic grassland/woodland habitats. Third, we assessed if the use of fire as a management tool was correlated with changes in bird species richness or community composition compared to habitats that were unexposed to fire for at least 5 years. Finally, we use the results obtained here to suggest a strategy for the restoration of heterogeneous habitats in agricultural landscapes of the central Midwest.

MATERIALS AND METHODS

Study site

Chichaqua Bottoms Greenbelt (hereafter, CBG) is a 3,000 ha grassland and woodland nature preserve located in south-central Iowa near the Wisconsin glacial terminus, or the Des Moines Lobe physiographic region (41°46′22N 93°23′06W). Recent glacial history dramatically influenced the geomorphology of the region; CBG occurs within a landscape of poorly drained, shallow wetlands adjacent to broad alluvial bottomlands. Floodplains within CBG are flat lowlands of alluvial soils deposited by glacial meltwater and, more recently, the Skunk River which flows through the center of the preserve. Prior to settlement, the vegetation of CBG was primarily mixed prairie, with mesic grasslands favored in glacial kettles and lowlands and more xeric prairie communities found on sandier soils or aeolian deposits. Draining of wetlands and mesic grassland habitats for row crop agriculture resulted in a loss of 98% of the original vegetation within CBG after settlement, and most prairie habitats currently present at the site reflect active restoration efforts to decrease cover of cool season grasses such as *Bromus inermis* (Leyss) and *Phalaris arundinacea* (L.) and increase the prevalence of conservative Tallgrass prairie grasses, sedges, and forbs (Chichaqua Bottoms Greenbelt Comprehensive Conservation Plan 2004). Wetland habitats throughout the preserve are also the product of restoration activities, including active removal of tile lines, alteration of surface water drainage patterns, and construction of open water wetlands through mitigation. Prescribed burning is the dominant form of disturbance used to manage the vegetation of CBG, with an average of 750 ha burned annually over the last decade. In general, few parcels are burned in consecutive years.

Data collection

To sample bird communities throughout the entire CBG nature preserve, we established a total of 22 monitoring transects through a variety of habitats within the preserve (Fig. 1).

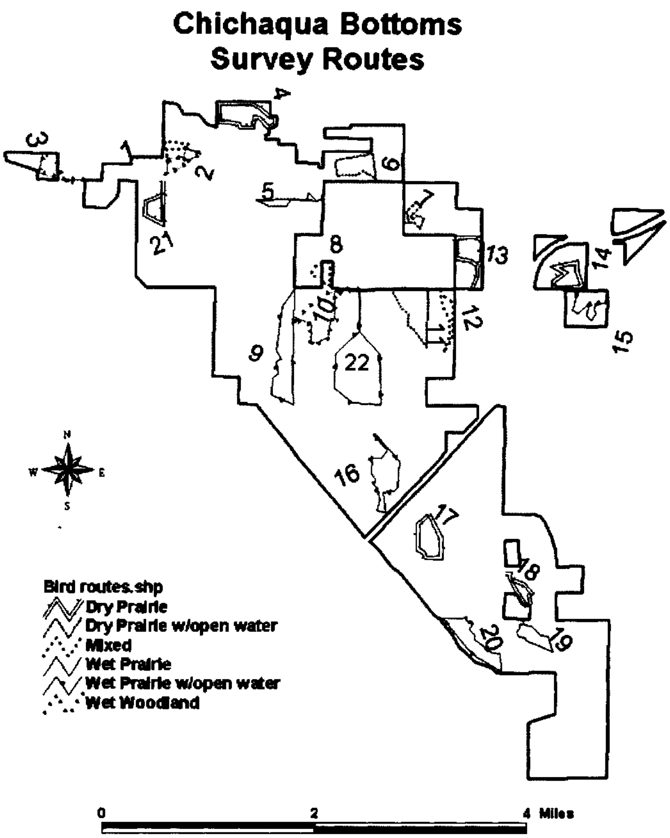

Fig. 1. Map of Chichaqua Bottoms Greenbelt, Iowa (41°46′22N 93°23′06W). The location of the 22 sampling transects are illustrated. Transects are described in Table 1.

Transects were spatially located to sample the range of habitat types present within the nature preserve, and varied in length depending on the size of the patch. Transects ranged in length from 1.21–4.35 km, and was proportional to the overall area (in m^2) of the habitat patch within which a transect occurred (Pearson product moment correlation between patch area and transect length = 0.84, P = 0.001). Transect Average transect length was 2.5 km (Table 1). A total of six habitat types was sampled: dry prairie, wet prairie, wet prairie with open water restoration, dry prairie with open water restoration, wet woodland, and wet prairie with woods. In addition, roughly half of the transects had recent history of prescribed burning (see Table 1). Most burning was conducted in the fall 2003, however, a few sites were managed with fire in either 2001, 2002 or 2004. Those sites considered unburned (see Table 1) had not been managed with fire for ≥ 6 years.

To sample bird communities along each transect, each route was walked twice per month during spring and fall migrations (spring migration: June 2004 and April–May 2005; fall migration: September–October 2004) and once per month during other times. In some rare cases, volunteers were used to walk transects as well. These volunteers were birdwatchers from Des Moines Audubon Society with a history of experience identifying species by sight and sound. When traversing a transect, a slow, steady walking pace was used. We did not use any dedicated point count positions along the transects, rather the observer recorded all species and individuals within ≈25 m from the transect while the route was being walked. Transects were never walked during periods of

Table 1. Habitat and management attributes for 22 sampling transects within Chichaqua Bottoms Greenbelt, Iowa (41°46′22N 93°23′06W). Transects were walked ≈ 2 wks from June 2004–May 2005 to sample bird communities.

Transect	Length (km)	Dominant vegetation[1]	Habitat type	Year burned[2]	Bird richness	Bird abundance
1	3.22	*Acer saccharinum*, *Phalaris arundinacea*, *Pinus banksiana*	Wet prairie & woods	2000	95	1137
2	1.61	*Acer saccharinum*, *Rhamnus cathartica*, *Quercus bicolor*	Wet woods	N/A	63	602
3	1.93	*Acer saccharinum*, *Celtis occedentalis*, *Quercus bicolor*	Wet woods	N/A	68	664
4	2.74	*Andropogon gerardii*, *Sorgastrum nutans*, *Juniperus virginiana*	Dry prairie	2001	78	1621
5	2.25	*Andropogon gerardii*, *Sorgastrum nutans*, *Salix interior*	Wet prairie	2003	42	287
6	1.93	*Andropogon gerardii*, *Schizachyrium scoparium*, *Bouteloua curtipendula*	Dry prairie	N/A	39	342
7	1.45	*Elymus canadensis*, *Phalaris arundinacea*, *Salix* spp.	Wet prairie & water	N/A	77	831
8	1.21	*Acer saccharinum*, *Phalaris arundinacea*, *Salix* spp.	Wet prairie & woods	2003	56	439
9	3.86	*Andropogon gerardii*, *Sorghastrum nutans*, *Populus deltoides*	Wet prairie & water	2003	89	1739
10	3.06	*Platanus occidentalis*, *Fraxinus pennsylvanica*, *Populus deltoides*	Wet woods	N/A	84	1101
11	2.58	*Andropogon gerardii*, *Schizachyrium scoparium*, *Sorgastrum nutans*	Dry prairie & water	2001	91	2058
12	2.09	*Elymus canadensis*, *Populus deltoides*, *Acer negundo*	Wet prairie & woods	N/A	80	1419
13	2.25	*Andropogon gerardii*, *Sorgastrum nutans*, *Elymus canadensis*	Dry prairie	N/A	51	776
14	1.61	*Andropogon gerardii*, *Schizachyrium scoparium*, *Sorgastrum nutans*	Dry prairie	N/A	57	674
15	1.93	*Carex* spp., *Typha angustifolia*, *Helianthus grosseserratus*	Wet prairie & woods	N/A	64	750
16	3.22	*Andropogon gerardii*, *Salix* spp., *Typha angustifolia*	Wet prairie & water	2003	108	2007
17	1.77	*Andropogon gerardii*, *Sorgastrum nutans*, *Elymus canadensis*	Wet prairie	2003	45	700
18	1.45	*Schizachyrium scoparium*, *Koeleria macrantha*, *Bouteloua curtipendula*	Dry prairie	2003	50	461
19	1.77	*Andropogon gerardii*, *Juglans nigra*, *Salix* spp.	Wet woods	2003	82	1619
20	2.82	*Andropogon gerardii*, *Salix* spp., *Acer negundo*	Wet prairie & woods	2003	89	1799
21	1.61	*Andropogon gerardii*, *Sorgastrum nutans*, *Solidago canadensis*	Wet prairie	2003	31	352
22	4.35	*Elymus canadensis*, *Panicum virgatum*, *Typha angustifolia*	Wet prairie & water	2004	120	6698

[1]Dominant vegetation was assessed using visual surveys of percent cover of plants while walking transects.
[2]N/A indicates that the habitat patches was unburned for at least 6 years.

precipitation or when wind speeds exceeded 15 km/hr. Unfortunately, we did not use a formal DISTANCE protocol while walking transects. This limited the subsequent analyses that we were able to perform. For example, we do not have estimates of population size for species of conservation concern.

Data analyses

To test for differences in species richness of birds observed along transects, we developed an analysis of covariance model (ANCOVA) using SAS statistical software (PROC GLM, SAS Institute 2006). Our ANCOVA model included two fixed effects (habitat type, df=4; use of prescribed fire, df=1). Although six total habitat types were sampled in 2004–5, only a single transect (#11, see Table 1) passed through dry prairie with open water restoration. Therefore, we dropped this habitat type from the ANCOVA models. Because the number of species and individuals sampled generally increases with sampling effort, we included transect length as a covariate (df = 1) within the model. Separate models were tested using either bird species

Table 2. Results of ANCOVA models testing whether observed bird species richness or log-abundance were affected by transect length (random variable), habitat type (5 levels: dry prairie, wet prairie, wet prairie & open water, wet prairie & woodland, and wet woodland), or burn treatment (two levels: burned or unburned since 2001). Treatment effects flagged with * were significantly different ($P \leq 0.001$).

Source of Variation	df	Species richness		Log abundance	
		MS	F	MS	F
Transect length	1	1688.35	17.82*	2.26	10.75*
Habitat type	4	816.41	8.62*	0.38	1.75
Burn treatment	1	221.16	2.33	0.26	1.03
Error	14	94.74		0.22	

richness or log-transformed abundance of birds as response variables.

We used non-metric multidimensional scaling (NMDS) to test for differences in bird species composition among either (1) all six habitat types present within Chichaqua Bottoms Greenbelt or (2) the habitats managed with fire and those unburned for ≥ 6 years. A full description of NMDS is given in McCune & Grace (2002), but briefly NMDS seeks to reduce complex multispecies responses to environmental variation by reducing the stress (≈ variation) among sites while creating a smaller set of explanatory variables summarized in ordination axes. Non-metric multidimensional scaling differs from other commonly employed ordination techniques in that NMDS differentiates among sampling units by ranking them according to their pair-wise dissimilarity. We performed NMDS ordination with PC-ORD (version 4, MjM Software Design, California). Bird community data consisted of a species presence – absence matrix, and we used a simple Jaccard Index as a measure of dissimilarity among sites as recommended by Krebs (1999). In addition, we followed the recommendation of McCune & Grace (2002) and used multiple runs of the NMDS algorithm with our real data (100 total runs) to avoid local stress minima, a problem that prevents the ordination from converging on the lowest possible stress value. We used 1000 Monte Carlo simulation runs to evaluate the significance of our final two ordination axes.

Finally, we developed logistic regression models to test whether frequency of occurrence of selected bird species was affected by the use of prescribed fire as a management tool. In order to account for confounding effects of differential sampling effort among the 22 sites, we included transect length as an independent variable in these logistic regressions. Models were developed for bird species that have been identified as either regionally declining or in need of immediate conservation effort by Partners in Flight and the National Audubon Society (Fitzgerald and Pashley 2000). Because some regionally declining bird species were found on < 3 sites through the entire course of this study (e.g., Prothonotary Warbler, Grasshopper Sparrow), we had to pare the entire list of declining species to three that were found on at least five sites in order to construct logistic regressions. These three species were: Northern Harrier, Henslow's Sparrow, and Bobolink. Logistic regressions were performed in SAS (PROC GLM, SAS Institute 2006). Model fit was assessed using the deviance statistic, which is distributed approximately as Chi-square when the model degrees of freedom are large (Piegorsch and Bailer 1997). When using the deviance statistic, goodness-of-fit is interpreted somewhat differently compared to conventional significance tests because the null hypothesis is that the model appropriately describes the variation in the observed data. Thus, large p-values ($P > 0.05$) indicate insufficient evidence for rejecting the null hypothesis that the model fits.

RESULTS

A total of 198 species of birds was detected along transects in the period June 2004–May 2005. Individual transects supported an average of 71 species, although observed species richness varied from a high of 120 along transect 22 and a low of 31 species documented along transect 21 (see Table 1). The most frequently observed bird species across all transects were (in rank order): Red-winged Blackbird (*Agelaius phoeniceus*), American Goldfinch (*Carduelis tristis*), American Robin (*Turdis migratorius*), and Eastern Kingbird (*Tyrannus tyrannus*). In contrast, Black-crowned Night Heron (*Nycticorax nycticorax*), Pileated Woodpecker (*Dryocopus pileatus*), Sandhill Crane (*Grus canadensis*), and Wood Thrush (*Hylocichla mustelina*) were among the species only seen on single transects within the preserve. Cliff Swallows (*Petrochelidon pyrrhonota*), American Tree Sparrows (*Spizella arborea*), Red-winged Blackbirds, and American Goldfinch were the four most abundant species recorded from Chichaqua Bottoms Greenbelt.

Significantly more bird species were observed on longer sampling transects, indicating that some variation in the number of species recorded per transect was a function of habitat size ($F_{1,14} = 17.82$; $P < 0.001$; Table 2). Species richness of birds also varied significantly among the five principle habitat types, but not between sites that were previously burned or unburned (Table 2, Fig. 2a,b). This pattern held when we performed a second analysis using only sites burned in 2003 and 2004. Bird species richness did not appear to be affected by recent burn history ($F_{1,11} = 1.36$; $P = 0.21$). It is important to note, however, that the power of our model to detect effects of burning is somewhat low ($\beta = 0.83$), so lack of an effect of fire must be interpreted with some caution.

The most depauperate habitats were wet and dry prairies, with wet prairies only supporting an average of 40 bird species ($F_{4,14} = 8.62$; $P < 0.001$; Fig. 2a). Habitats associated with open water wetlands supported nearly twice the average number of bird species as mesic or xeric grasslands (Fig. 2a), although this difference was primarily driven by the seasonal presence of migratory waterfowl and shorebirds (final stress of ordination = 38.16 ; $P < 0.001$ for both axes; Fig. 3a). Open wetlands also provided a larger field of view and thus may have increased species' detection probabilities. Wet woodlands and wet prairie – woodland complexes supported similarly rich bird faunas, and NMDS ordination revealed that this larger richness was derived primarily from a larger number of warblers and icterids (Fig. 3a). Patterns in the differences in community composition of birds

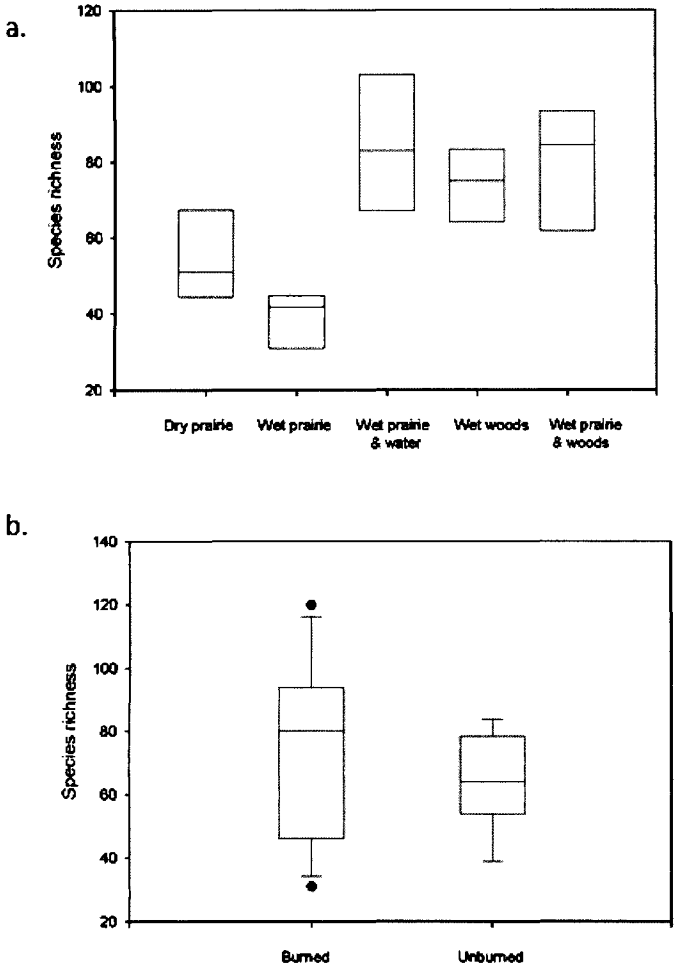

Fig. 2. Box-and-whisker plots of variation in bird species richness (a) among habitat types and (b) between recently burned and unburned habitats within Chichaqua Bottoms Greenbelt, Iowa. Means flagged with differing * are significantly different (P < 0.05).

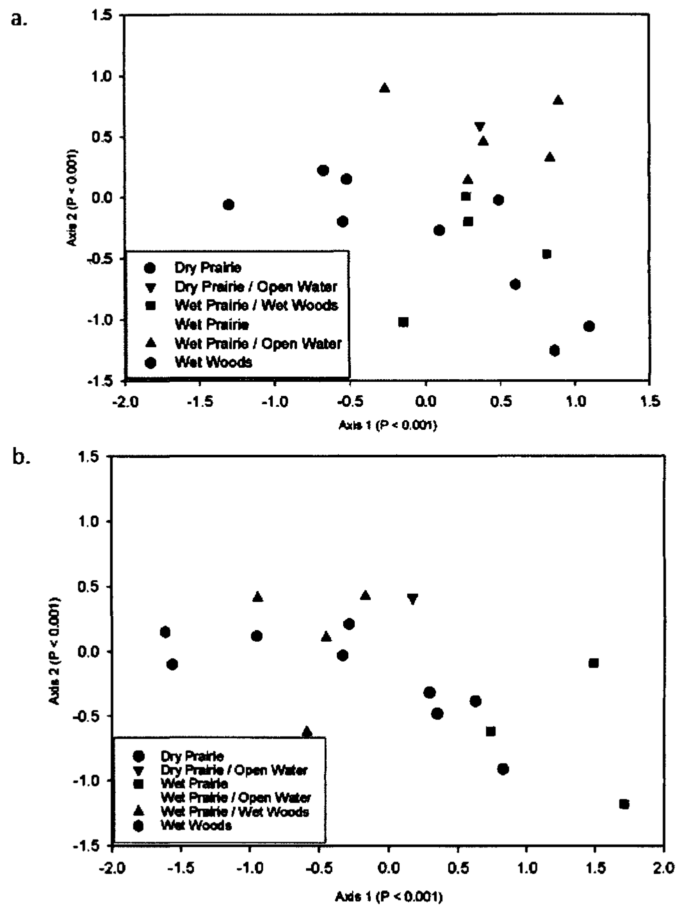

Fig. 3. Non-metric multidimensional scaling ordination of variation in bird community composition among six habitat types within Chichaqua Bottoms Greenbelt, Iowa. In (a) the ordination includes all bird species sampled along the transects, while in (b) all waterfowl, shorebirds, and wading birds have been removed from the data. Site-level groupings are similar in both ordinations. Monte-Carlo tests revealed that the first two axes of both ordinations were significant (P < 0.0001).

among habitat types remained significant when the data was analyzed excluding non-resident waterfowl and shorebirds. NMDS ordination again produced three clusters of bird communities representing grasslands (dry + wet prairie), grasslands with open water, and woodland habitats (final stress = 11.08; P < 0.001 for both axes; Fig. 3b). Finally, although we did not detect a significant effect of prescribed burning on bird richness, we did observe that richness values were twice as variable in burned habitats compared to those that had not been subjected to fire for > 4 years (Fig. 2b). Unburned sites, however, did not appear to support significantly different bird communities when analyzed using NMDS ordination (final stress = 38.16; P < 0.001 for both axes; Fig. 4).

As for species richness, transect length had a significant effect on the abundance of birds sampled over the course of this study (Table 2). Surprisingly, however, bird abundance did not appear to be affected by habitat type or burning treatment (Table 2), which might be expected when each major habitat type supports a few dominant species (e.g., Red-winged Blackbirds in wet prairies or American Goldfinches in dry prairies). In general, logistic model fits for predicting the likelihood of species occurrence as a function of burn history or transect length were poor (Table 3). Logistic regression models for species of conservation concern (Northern Harrier, Henslow's Sparrow, and Bobolink) demonstrated that use of prescribed fire marginally increased the likelihood of occurrence for the Bobolink, with areas burned in 2003 more likely to support the species than those unburned since 2001 (Table 3). Interestingly, the effect of burning was not significant for frequency of occurrence for Henslow's Sparrow, a species known to prefer nesting sites with significant litter accumulation.

DISCUSSION

The largest differences in the bird communities sampled in this study were attributable to differences in the size of the restored habitat and the structure of the vegetation within a given site. As in other studies, more structurally heterogeneous habitats supported a larger number of bird species (e.g., see Wiens 1989). Comparable to Van Dyke et al. (2004), however,

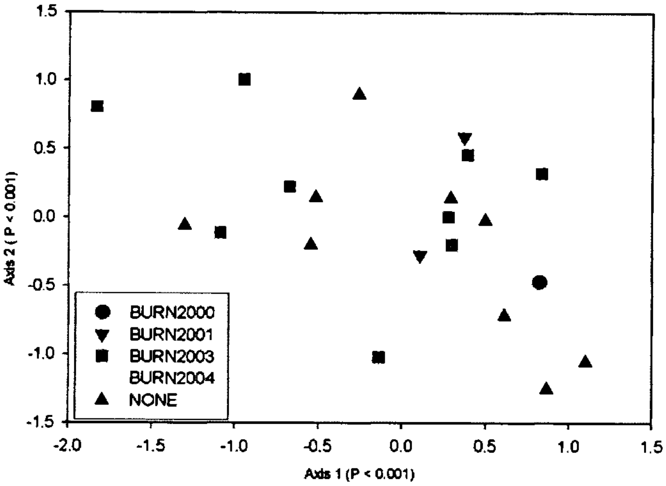

Fig. 4. Non-metric multidimensional scaling ordination of variation in bird community composition among six habitat within Chichaqua Bottoms Greenbelt, Iowa. Although Monte Carlo simulation demonstrated that both axes of the ordination were significant ($P < 0.0001$), burned sites did not possess significantly different bird communities.

the most frequently encountered bird species throughout this restored system were also species that are regionally common throughout the Midwest, especially the Red-winged Blackbird and the American Goldfinch (Kent and Dinsmore 1996). Most bird species that have been identified as declining in the Tallgrass prairie ecoregion (see Partners in Flight 2004) were observed along fewer than three routes over the course of this study, adding further evidence that, at the scale of single management units, restorations tend to re-assemble simplified animal communities relative to Tallgrass prairie remnants (Summerville et al. 2006).

Collectively, however, the 22 sites used in this study contained a large number of native bird species. Given that many of the restored habitats at CBGB were former agricultural fields in the 1980's, the fauna has likely transitioned from being depauperate across the landscape to more diverse overall (Herkert et al. 1994). Thus, although individual prairie sites may be relatively species depauperate, restoration of the entire Chichaqua Bottom Greenbelt region appears to be facilitating bird community re-assembly. This observation is important for several reasons. First, it suggests that land managers might benefit from envisioning restoration as a landscape-scale process rather than a site-scale process – single restoration sites may never accumulate all faunal species that reflect a pre-disturbance steady-state (Summerville et al. 2006). Rather, restoration of individual sites may re-establish meta-communities within a region; species may be present within a fraction of all possible sites from year to year, but environmental stochasticity, poor site fidelity, or changes in vegetation structure may contribute to considerable species turnover within each site. Second, the importance of regional-scale restorations illustrates the value of integrating new restoration projects within the context of pre-existing habitat remnants or older reconstructions (Sheperd and Debinski 2005). Isolated restorations may, in fact, have greater levels of temporal variation in community structure compared to sites that are connected (Summerville et al. 2006). Finally, the regional scale of bird community re-assembly suggests that the long-term success of bird conservation in the Iowan landscape will require greater coordination of preserve management across administrative institutions (Bestlemeyer et al. 2003).

We failed to detect any highly significant effects of prescribed fire on bird communities within Chichaqua Bottoms Greenbelt, regardless of habitat type or burn year. This may not be surprising, given that other studies have suggested that simplified avian communities lacking large populations of regionally declining bird species appear resilient to fire (Van Dyke et al. 2004). Furthermore, because the use of fire in this restored system tends to leave a mosaic of scorched patches and unburned vegetation, the fire regime in this system may not change the overall value of a site for specific birds as long as individual management units are appropriately sized (Byre 1997). For example, Henslow's Sparrow winters in sites burned annually as long as the timing of the burn maximizes the density of forbs and grass seed stalks (Tucker and Robinson 2003). Care still needs to be taken when evaluating how the use of prescribed fire affects bird nesting and fledging success, as burning may both increase food availability and nest predator density within a managed system (Hartung and Brawn 2005, Shochat et al. 2005). Furthermore, data on the impacts of fire on woodland birds are significantly less equivocal. Fire appears to cause significant declines in area-sensitive passerines such as Ovenbird (*Seiurus aurocapillus*), Wood Thrush (*H. mustelina*), and *Empidonax* flycatchers (Blake 2005).

In conclusion, restoring both mesic and xeric grasslands in the agricultural landscape of central Iowa provides suitable habitat for both migratory and resident birds. Species that have been identified as regionally declining (Henslow's Sparrow, Grasshopper Sparrow, Northern Harrier, Bobolink) also seemed capable of utilizing restored habitats within Chichaqua Bottoms Greenbelt.

Table 3. Results from logistic regression model fitting the observed frequency of occurrence among 22 sampling transects for three bird species of conservation concern (Partners in Flight 2004). The three bird species analyzed here were recorded from at least 35% of transects sampled in 2004–5. The overall logistic regression model was only significant for the Northern Harrier and Bobolink but not Henslow's sparrow (Wald χ^2 for N. harrier = 4.41, $P > 0.05$; Wald χ^2 for Bobolink = 2.25, $P > 0.05$). Treatment effects flagged with a * were marginally significant ($P = 0.10$) and those marked with a ** were significant ($P < 0.05$).

		Northern harrier		Henslow's sparrow		Bobolink	
Regression parameter	df	Parameter estimate	Wald χ^2	Parameter estimate	Wald χ^2	Parameter estimate	Wald χ^2
Transect length	1	−1.57	4.20**	0.07	0.003	−0.05	0.001
Burn treatment	1	0.09	0.04	0.33	0.48	0.78	2.56*
Intercept	1	3.78	3.80**	−0.08	0.02	0.26	0.21

Because presence of individuals within a habitat should not be equated with successful nesting (or positive population growth rates), more detailed studies of avian nesting biology are required in restored systems (see Hughes et al. 1999 for a thoughtful discussion of the Dickcissel). Indeed, while the pace of Tallgrass prairie restoration accelerates in highly fragmented regions such as Iowa, one important question remains to be addressed – are we truly restoring high quality habitat for declining bird species or are we merely creating a preserve system of ecological traps? If nest failure due to predation is higher in restored grasslands than in large remnants, preserve managers may find that the control of mesopredators within restored systems will be as critical to bird conservation as managing the structure of the vegetation (Newbury and Nelson 2007, Cox et al. 2012). A more focused study on the breeding birds of Chichaqua Bottoms Greenbelt will be required resolve how ecological restoration affects the demography of Iowa's declining bird species.

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