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Original Article

Avian Response to Conservation Buffers in Agricultural Landscapes During Winter

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ABSTRACT Native herbaceous vegetation cover along row-crop field edges (i.e., field buffers) increases breeding densities of many bird species. However, the effect of field buffers on bird species during the non-breeding season is less understood. We compared density, avian richness, and avian conservation value on row-crop fields containing buffers strategically designed for wildlife versus fields without buffers in 3 southeastern U.S. states during winter 2007 and 2008. Fields with buffers were enrolled in U.S. Department of Agriculture, Conservation Reserve Program practice Habitat Buffers for Upland Birds (CP33), which targets restoration of northern bobwhite (*Colinus virginianus*) and other upland bird species. Overall species richness did not differ on fields with buffers versus fields without buffers in 2007, but was 29% greater on fields with buffers in 2008. Swamp sparrows (*Melospiza georgiana*), song sparrows (*M. melodia*), field sparrows (*Spizella pusilla*), and red-bellied woodpeckers (*Melanerpes carolinus*) had greater densities on fields with buffers compared with fields without buffers. Increasing field-buffer width did not result in greater bird densities. Our results suggest a small change in primary land use (≈7%) produced a disproportionate population response by some grassland-dependent and woodland bird species during winter. Because field buffers provide a direct source of winter food and cover resources, they may be a pragmatic means to provide critical non-breeding habitat with little alteration of existing agricultural systems.

KEY WORDS agricultural landscapes, conservation buffers, conservation programs, habitat buffers for upland birds, southeast, targeted conservation, winter birds.

Intensification of agriculture to maximize production has caused a loss of ecological heterogeneity and subsequent decline in abundance and diversity of birds associated with early successional habitats (Benton et al. 2003, Murphy 2003, Newton 2004, Vickery et al. 2004). In the eastern United States, 43% of grassland and 36% of successional-scrub bird species have experienced notable population declines in the past half-century (Sauer et al. 2011). Many of these species have been relegated to habitat remnants within agricultural landscapes for all or part of their life history. Some short-distance migrants (e.g., Savannah sparrow [*Passerculus sandwichensis*], swamp sparrow [*Melospiza georgiana*]) may breed in favorable grassland habitats in northern parts of their range, but experience limited habitat availability upon arrival at their wintering range in the southern United States.

During winter, reduced availability and diversity of food and cover resources combined with unfavorable weather conditions may limit survival and exacerbate declines of overwintering early successional bird populations occupying

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agricultural landscapes (Peach et al. 1999, Atkinson et al. 2002). Conservation actions that promote heterogeneous habitat structure and abundant food resources may be key factors in offsetting declines in some species (Atkinson et al. 2002, Bradbury et al. 2004, Gillings et al. 2005). Converting row-crop field edges to native herbaceous cover may provide increased food and cover for resident and short-distance migratory bird species on their winter range and elicit greater year-round ecosystem gains from conservation actions (Best et al. 1998, Bradbury and Allen 2003).

In row-crop systems, linear strips of uncultivated vegetation (i.e., field buffers) established along field edges increased breeding densities of early successional birds in the United States (Smith et al. 2005*a*, Riddle et al. 2008, Conover et al. 2009) and Europe (Peach et al. 2001, Ewald et al. 2010, Perkins et al. 2011). In the United Kingdom (UK) and the rest of Europe, agri-environment schemes that provide winter food resources positively influenced breeding population trends of several farmland bird species (Gillings et al. 2005). However, knowledge pertaining to abundance, diversity, and habitat relationships of North American birds occupying agricultural landscapes during winter is lacking (Atkinson et al. 2002, Peterjohn 2003) when compared with the UK (Gillings et al. 2008). Moreover, studies of field-buffer effects on birds in North America during winter are of limited spatial extent (Smith et al. 2005*b*, Conover et al. 2007, Blank et al. 2011).

Our objective was to evaluate effects of a targeted field-buffer practice on avian communities in agricultural landscapes during winter. Habitat Buffers for Upland Birds, commonly called practice CP33, is a U.S. Department of Agriculture, Conservation Reserve Program practice that targets recovery objectives of the National Bobwhite Conservation Initiative (Dimmick et al. 2002, U.S. Department of Agriculture 2004, National Bobwhite Technical Committee 2011). This initiative seeks to provide habitat via establishment of native herbaceous vegetation buffers along row-crop field edges for population recovery and restoration of northern bobwhite (*Colinus virginianus*) and other early successional bird species. We compared bird communities and densities during winter on fields with buffers and fields without buffers, and investigated effects of field-buffer width on observed bird densities in 3 states in the southeastern United States to determine the influence of field buffers on species overwintering in agricultural landscapes.

STUDY AREA

We monitored birds during winter on row-crop field edges with CP33 buffers and field edges without buffers in Arkansas, Kentucky, and Mississippi (USA) during 2007 and 2008 (Fig. 1) as part of a larger multi-season national CP33 monitoring program (Evans et al. 2013). Buffers within each field were planted to a mix of native warm-season grasses and forbs (including big bluestem [*Andropogon gerardii*], little bluestem [*Schizachyrium scoparium*], switchgrass [*Panicum virgatum*], Indiangrass [*Sorghastrum nutans*], and seed producing forbs such as partridge pea [*Chamaecrista fasciculata*], blackeyed susan [*Rudbeckia hirta*], coneflower [*Echinacea* spp.], bundleflower [*Desmanthus* spp.], and prairie clover [*Dalea* spp.]), or were naturally regenerated from the seedbank following soil disturbance.

Figure 1. Geographic locations of winter line transects on Conservation Reserve Program practice Habitat Buffers for Upland Birds (CP33) buffered and non-buffered row-crop fields in Arkansas, Kentucky, and Mississippi, USA, 2007–2008.

METHODS

Using a multi-stage sampling design, we selected randomly 120 total landowner contracts (40/state) enrolled in the CP33 buffer practice from the sampling frame of all contracts in each state in 2005. We then chose randomly 1–3 buffered fields/landowner contract in each state. Multiple fields within a single contract were selected for 5 landowner contracts containing multiple buffered fields and were only selected if fields were >500 m apart to avoid overlap of bird detections on transects. Two contracts in Mississippi contained 2 survey fields, and 3 contracts contained 3 survey fields. We paired each selected buffered field with a similarly cropped, row-crop field (located 1–3 km from the corresponding buffered field) to reduce variance associated with landscape context (Burger et al. 2006). Row-crop field interiors were typically planted to soybeans or corn during the growing season, but were post-harvest stubble or bare during winter. A random sample of landowner contracts was collected by the USDA Farm Service Agency national office and landowner contact information and contract details were provided by Farm Service Agency employees at county offices. Landowners responded favorably to requests to monitor both buffered and non-buffered fields, and failure to gain permission to monitor was rarely encountered. Non-buffered fields were frequently under the same ownership as the paired buffered field, but landowners that were not enrolled in CP33 contracts also provided access to non-buffered fields for monitoring. On selected fields, we located randomly a single 200-m line transect on each field along the buffer–non-crop edge for fields with buffers and the crop–non-crop edge for fields without buffers. Transects were placed along the buffer–non-crop edge for fields with buffers, rather than through the buffer center, to ensure comparable sampling between fields with and without buffers (Fig. 2).

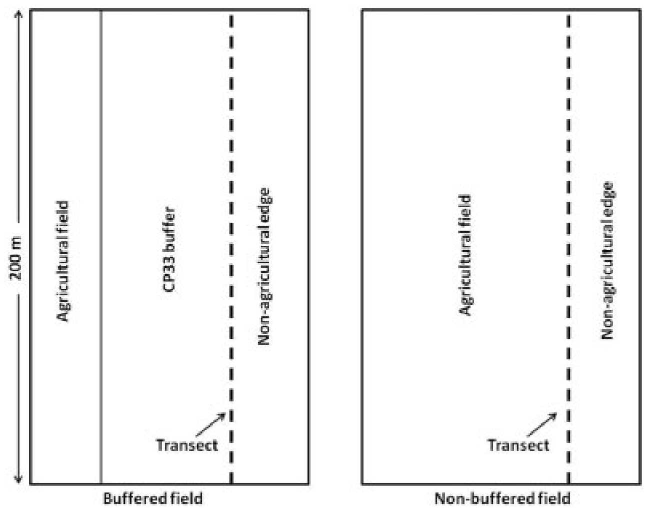

Figure 2. An example of layout design for winter line-transect bird surveys situated parallel to buffer–non-crop edges for buffered survey fields and crop–non-crop edges for non-buffered survey fields. Transects were 200 m in length and edges may or may not have been wooded, and were conducted in fields in Arkansas, Kentucky, and Mississippi, USA, 2007–2008.

Non-agricultural edges were usually wooded, fencerows, or grass (pasture, hay, or grassy ditches).

Basic plumage, decreased vocalization frequency, and secretive nature make most birds difficult to detect during winter (Diefenbach et al. 2003, Peterjohn 2003). We accounted for this presumably reduced "detectability" by using line-transect distance sampling (Buckland et al. 2001). Though 240 (120 buffered, 120 non-buffered) fields were originally selected for surveys, we conducted line-transect surveys from January to March on a subsample of 219 fields (106 pairs of buffered and non-buffered fields, 3 unpaired buffered fields, and 4 unpaired non-buffered fields) in 2007–2008. Landowner termination of buffers after initial study set-up combined with inaccessibility of some fields resulted in the loss of 21 fields and subsequent unbalanced allocation of survey effort. Fields in Arkansas were not sampled in 2008, resulting in 127 total fields (64 non-buffered, 63 buffered) sampled in both years in Kentucky and Mississippi.

We surveyed birds from dawn to dusk on days with no precipitation and winds <6 km/hour. We recorded observations in 1 of 7 distance intervals parallel to the transect centerline (0–10, 10–20, 20–30, 30–40, 40–50, 50–100, >100 m) and assumed 1) all birds on the transect centerline were detected; 2) all birds were recorded at their initial location; and 3) all birds were recorded accurately into appropriate distance intervals (Buckland et al. 2001). We also recorded date, time, observer, weather characteristics (% cloud cover, temp [°F], wind speed [km/hr]) and side of transect centerline (agricultural [buffer, row-crop], non-agricultural [woody, herbaceous]) during each survey (see recommendations in Marques et al. 2007, Rexstad 2007). We measured buffer widths annually on each buffered field at 10 points placed systematically along buffers during the growing season as part of a complimentary vegetation assessment from 2007 to 2008. Management was not allowed on buffers until contract year 4; therefore, buffer widths remained constant year-round prior to 2009.

Data Analysis

Winter bird community.—We evaluated year and stratum-specific (buffered, non-buffered) winter-bird community metrics of species richness and avian conservation value (ACV). We calculated species richness by summing the number of species observed on buffered and non-buffered transects each year. As a weighted index to assess relative conservation value for birds, ACV uses species-specific Partners in Flight "concern scores" that incorporate rankings of relative global abundance, population trend, breeding and non-breeding distribution, and population threats to North American bird species (Carter et al. 2000, Nuttle et al. 2003). To assess ACV, we used weighted ranks (Partners in Flight rank) developed from Partners in Flight concern scores (maintained by the Rocky Mountain Bird Observatory) by Beissinger et al. (2000) and further corrected by Nuttle et al. (2003). We first multiplied species abundance times Partners in Flight rank value to calculate a conservation value for each species observed on each transect. We then summed conservation value scores across species in each community guild to calculate a total ACV score for each buffered and non-buffered transect at 3 levels: over all bird species, a grassland bird guild, and a woodland bird guild. Grassland and woodland guild classifications were defined from expert opinion and published species accounts (e.g., Vickery et al. 1999, Poole 2005). We evaluated species richness and total ACV by year in SAS PROC MIXED (Littell et al. 2006) with stratum type (buffered, non-buffered) as a fixed effect and transect pairs as random effects. Transects that were not paired were excluded from analyses. Species detection probabilities were not incorporated into measures of species richness or ACV.

We evaluated species richness and total ACV differences on 57 fields with buffers <23 m and 55 fields with buffers >23 m (23 m represents the midpoint of the allowable range for CP33 buffers (9–37 m; U.S. Department of Agriculture 2004) by year in SAS PROC MIXED (Littell et al. 2006). We included buffer width (<23 m, >23 m) as a fixed effect and buffered transect as a random effect.

Density.—We evaluated density of overwintering bird species observed on both sides of the transect centerline on fields with buffers versus fields without buffers pooled over all states using Conventional Distance Sampling (CDS) and Multiple Covariate Distance Sampling (MCDS) in Program DISTANCE 6.0 version 2 (Thomas et al. 2010). We also included 3 species groups (wood warblers, raptors, and other sparrows) that were composed of species with similar life-history strategies but for which there were insufficient sample size for individual analysis. Although some bird species may occur in flocks during winter, most bird observations during our surveys were of single individuals and loosely aggregated groups of individuals. We analyzed each observation independently because of general lack of discrete aggregations, and right-truncated observations for each species or group at distances (m) where the probability of detection (g

[w]) <0.1 to avoid biased density estimates from outlier detections (Buckland et al. 2001). We evaluated fits of models of the detection function for each species or species group: uniform (CDS only), half-normal (CDS, MCDS), and hazard rate (CDS, MCDS), with and without series expansion adjustments (cosine, simple polynomial, hermite polynomial; Buckland et al. 2001). We used Akaike's Information Criteria (AIC; Akaike 1973), goodness-of-fit tests and probability density function plots of each candidate model to determine appropriate models of the detection function (Buckland et al. 2001, Marques and Buckland 2003, Pacifici et al. 2008). For each species, if sample size allowed, we used AIC to determine whether the detection function was better estimated over buffered and non-buffered sites combined (i.e., global; assumed equal detectability across treatments) or separately for each treatment type (i.e., stratified; assumed detection function different for buffered and non-buffered fields; Buckland et al. 2001). We selected the model with the lowest AIC if AICs were competing ($\Delta AIC < 2.0$) between global and stratified models and both models had adequate fit (Buckland et al. 2001). We calculated only a global detection function and evaluated type (buffered, non-buffered) as a factor-level (i.e., categorical) covariate in MCDS analysis for species with limited sample size (<40 observations total). We also evaluated factor-level covariates (state, date, year, observer and side of transect centerline [agricultural, non-agricultural]), and continuous weather covariates (% cloud cover, temp, and wind speed) for each species or group for MCDS analysis. We calculated stratum-specific density (D; birds/ha) over all states and years for each species or group under the best approximating model of the detection function. We used density differences on fields with buffers and fields without buffers to calculate simple ($D_{\text{buffered}} - D_{\text{non-buffered}}$) and relative effect size [$(D_{\text{buffered}} - D_{\text{non-buffered}})/D_{\text{non-buffered}}$], and used 95% confidence intervals to determine significance (Gardner and Altman 1989, Sim and Reid 1999).

We also evaluated density differences in relation to buffer width for species or species groups exhibiting ≥100% relative effect size on buffered compared with non-buffered fields. We used the same stratification, detection function, and covariate analysis scheme as above to maintain consistency across analyses, but calculated densities on buffered fields categorized by buffer width (57 fields with buffers <23 m, 55 fields with buffers >23 m). We used density differences on fields containing <23-m-wide and >23-m-wide buffers to calculate simple ($D_{>23\text{m}} - D_{<23\text{m}}$) and relative effect size [$(D_{>23\text{m}} - D_{<23\text{m}})/D_{<23\text{m}}$]. We used 95% confidence intervals on simple effect size to determine significance in relation to buffer width (Gardner and Altman 1989, Sim and Reid 1999).

RESULTS

Winter Bird Community

We recorded 69 and 75 species on fields with buffers and fields without buffers, respectively, from 2007 to 2008. Mean species richness did not differ on fields with buffers and fields without buffers in 2007, but was 29% greater on fields with buffers in 2008 (Table 1). We did not confirm any difference in avian conservation value between fields with buffers and fields without buffers for total species or either species guild, even though ACV for the grassland guild was markedly greater on fields with buffers during both years (Table 1). Species richness and ACV did not differ between fields containing buffers >23 m and <23 m in width (Table 1).

Density

We recorded 16,259 individuals over 70,200 m of transects in 3 states during 2007–2008. The state in which the transects were located was included as a covariate in top models for estimating density of 13 of 20 species or groups, whereas covariates for year and side of transect were each included in top models for 7 species or groups. Weather covariates were each included in top models for ≤3 species or groups.

We observed greater densities of field sparrows (*Spizella pusilla*; relative effect size [RES] = 217%), song sparrows (*Melospiza melodia*; RES = 100%), swamp sparrows (RES = 2,708%), and red-bellied woodpeckers (*Melanerpes carolinus*; RES = 152%) on fields with buffers (Fig. 3; Table 2). We also observed relative effect sizes >100% for Savannah sparrow, slate-colored junco (*Junco hyemalis*), eastern meadowlark (*Sturnella magna*), and American goldfinch (*Carduelis tristis*), as well as the warbler and other sparrow species-groups, but large variances precluded any definitive conclusion regarding their responses. Conversely, we observed greater densities of Carolina chickadees (*Poecile carolinensis*; RES = −61%) on fields without buffers, even though there was actually a greater amount of woody cover in

Table 1. Mean ($\bar{x}$) ± SE winter bird species richness (Rich), total avian conservation value (overall [ACV-O], grassland bird [ACV-G], and woodland bird [ACV-W]), relative effect size {RES = [(buffered–non-buffered)/non-buffered] × 100}, critical value of the F-statistic, and P-value on fields with buffers and fields without buffers in Arkansas, Kentucky and Mississippi, USA, 2007–2008.

		Non-buffered		Buffered				
Year	Metric	$\bar{x}$	SE	$\bar{x}$	SE	RES (%)	F	P-value
2007	Rich	5.571	0.346	5.687	0.34	2.08	0.08	0.778
	ACV-O	27.365	3.877	28.016	3.782	2.38	0.02	0.898
	ACV-G	14.764	3.965	23.772	3.7	61.01	2.85	0.094
	ACV-W	13.24	1.66	9.817	1.697	−25.85	2.65	0.107
2008	Rich	4.142	0.397	5.338	0.397	28.87	6.9	0.011
	ACV-O	29.369	13.561	64.879	13.461	120.91	3.49	0.066
	ACV-G	20.947	14.684	56.309	13.444	168.82	3.15	0.078
	ACV-W	9.422	1.862	11.686	1.749	24.03	0.79	0.378

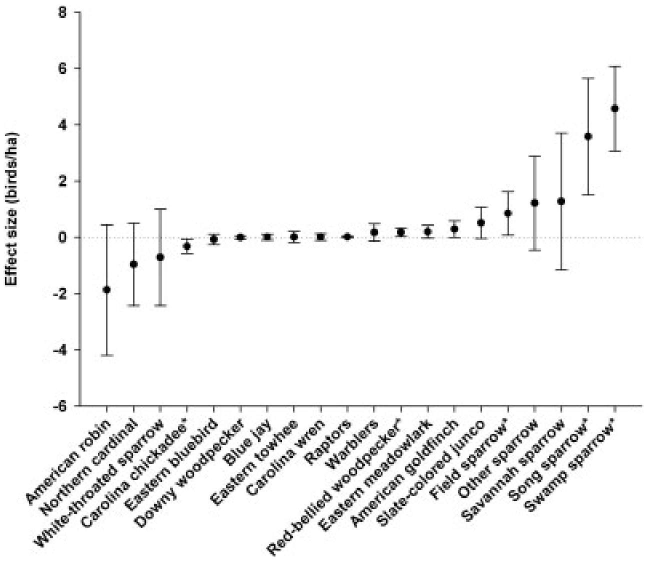

Figure 3. Effect size ($D_{\text{buffered}} - D_{\text{non-buffered}}$) ± 95% confidence interval (CI; birds/ha) for winter bird species in Arkansas, Kentucky, and Mississippi, USA, 2007–2008. Observed 95% CI >0 birds/ha suggests densities were greater on buffered fields for a given species, and 95% CI <0 birds/ha suggests densities were greater on fields without buffers. *Significant difference based on 95% CI on effect size.

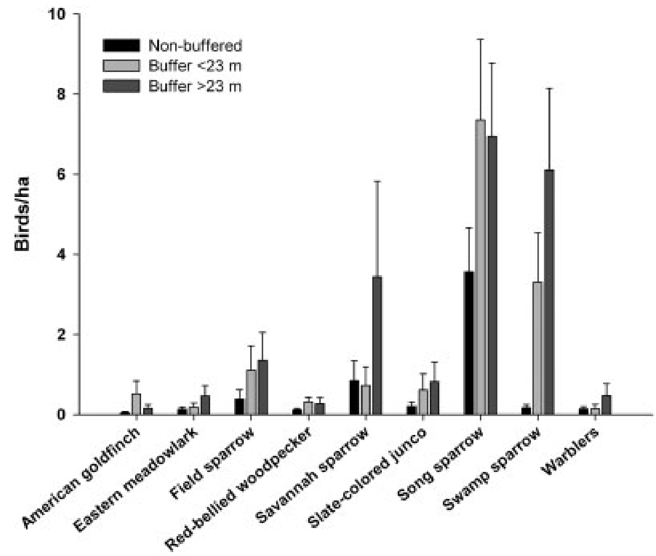

Figure 4. Density ± 95% confidence interval (CI; birds/ha) on Conservation Reserve Program practice Habitat Buffers for Upland Birds (CP33) buffered and non-buffered row-crop fields <23 m and >23 m in width for overwintering bird species or species groups with relative effect size >100% in Arkansas, Kentucky and Mississippi, USA, 2007–2008.

the landscape around fields with buffers compared with fields without buffers (6.2% greater within 500-m and 2% greater within 1,500-m landscapes; Fig. 3; Table 2). Using 95% confidence intervals on mean density estimates, we were unable to ascertain any changes in avian density with respect to width of buffers, although relative effect sizes for wide (>23 m) versus narrow (<23 m) buffers varied among species (Fig. 4).

DISCUSSION

Overwinter survival may be a limiting factor in some early successional bird species (Peach et al. 1999; Siriwardena et al. 2000, 2007), and heterogeneity in habitat structure may be a key factor in offsetting declines in some species in agricultural landscapes (Atkinson et al. 2002, Bradbury et al. 2004). Habitat provided by conservation programs such as the Conservation Reserve Program (Best et al. 1998) and

Table 2. Truncation distance in meters (w), number of observations (n; at truncation distance), density (D) in birds/ha and SE on fields with buffers and fields without buffers; and effect size (ES; $D_{\text{buffered}} - D_{\text{non-buffered}}$), 95% confidence interval (CI) on ES, and relative effect size (RES) {[($D_{\text{buffered}} - D_{\text{non-buffered}}$)/$D_{\text{non-buffered}}$] × 100} for 20 winter bird species/species groups in Arkansas, Kentucky, and Mississippi, USA, 2007–2008.

		Non-buffered			Buffered					
Bird species or group	***w***	***n***	***D***	**SE**	***n***	***D***	**SE**	**ES**	**95% CI ES**	**RES (%)**
Raptors	100	21	0.039	0.012	26	0.050	0.013	0.010	(−0.023 to 0.0440)	25.94
Red-bellied woodpecker (*Melanerpes carolinus*)	100	40	0.115	0.024	61	0.291	0.072	0.176	(0.0266 to 0.3248)	152.43
Downy woodpecker (*Picoides pubescens*)	100	24	0.073	0.027	21	0.065	0.019	−0.008	(−0.071 to 0.0558)	−10.99
Blue jay (*Cyanocitta cristata*)	100	85	0.216	0.038	85	0.219	0.038	0.004	(−0.101 to 0.1090)	1.73
Carolina chickadee (*Poecile carolinensis*)	100	69	0.529	0.119	39	0.204	0.057	−0.326	(−0.583 to −0.067)	−61.48
Carolina wren (*Thryothorus ludovicianus*)	100	35	0.179	0.043	36	0.188	0.041	0.008	(−0.108 to 0.1249)	4.63
Eastern bluebird (*Sialia sialis*)	100	51	0.255	0.085	63	0.179	0.044	−0.076	(−0.262 to 0.1109)	−29.86
American robin (*Turdus migratorius*)	100	950	2.812	1.108	354	0.936	0.421	−1.876	(−4.198 to 0.4471)	−66.71
Warblers	100	20	0.138	0.041	44	0.309	0.152	0.171	(−0.137 to 0.4795)	123.80
Eastern towhee (*Pipilo erythrophthalmus*)	100	44	0.302	0.066	44	0.308	0.075	0.005	(−0.190 to 0.2007)	1.72
Field sparrow (*Spizella pusilla*)	50	44	0.390	0.185	137	1.235	0.346	0.845	(0.0772 to 1.6132)	216.73
Savannah sparrow (*Passerculus sandwichensis*)	50	90	0.841	0.403	222	2.111	1.174	1.269	(−1.163 to 3.7027)	150.92
Song sparrow (*Melospiza melodia*)	50	250	3.562	0.668	726	7.139	0.816	3.577	(1.5106 to 5.6437)	100.43
Swamp sparrow (*Melospiza georgiana*)	40	15	0.169	0.055	414	4.733	0.770	4.565	(3.0520 to 6.0772)	2,707.69
White-throated sparrow (*Zonotrichia albicollis*)	50	239	2.906	0.725	221	2.186	0.490	−0.720	(−2.435 to 0.9955)	−24.77
Other sparrow	40	50	0.806	0.251	123	2.018	0.814	1.212	(−0.457 to 2.8809)	150.24
Slate-colored junco (*Junco hyemalis*)	100	28	0.205	0.082	96	0.715	0.271	0.510	(−0.044 to 1.0653)	248.77
Northern cardinal (*Cardinalis cardinalis*)	100	131	2.038	0.716	129	1.071	0.209	−0.967	(−2.428 to 0.4942)	−47.45
Eastern meadowlark (*Sturnella magna*)	100	68	0.132	0.038	119	0.327	0.110	0.195	(−0.032 to 0.4226)	147.26
American goldfinch (*Carduelis tristis*)	50	7	0.042	0.020	54	0.329	0.148	0.287	(−0.006 to 0.5806)	684.71

European Agri-Environmental Schemes (Bradbury and Allen 2003, Gillings et al. 2005) benefit overwintering avian communities by providing food and cover. In the UK, 5 of 6 species of declining granivorous farmland birds exhibited greater abundance on areas with conservation set-aside land compared with farmland without these conservation lands during winter (Buckingham et al. 1999). Moreover, benefits were increased when practices in the UK targeted provision of wildlife habitat, though most European conservation practices set-aside entire fields (Brickle 1997, Bradbury and Allen 2003, Hinsley et al. 2010).

We found that habitat provided by targeted CP33 field buffers during winter at least doubled density of 4 bird species and was particularly beneficial to grassland-associated species (e.g., Emberizid sparrows). Increased density on fields containing buffers was also observed for other species, including eastern meadowlark, Savannah sparrow, slate-colored junco, American goldfinch, and wood warblers. Despite markedly increased abundances of these species, high variability in encounter rates among transects resulted in confidence intervals on effects size that overlapped 0.0 and precluded a definitive statement of response to buffers. Increased densities and diversity observed in this study may result from increased availability of forage, particularly seeds, in buffered habitats (Robinson and Sutherland 1999) combined with thermoregulatory and security benefits afforded by greater cover. However, although the pairing of fields (i.e., locating non-buffered fields 1–3 km from buffered fields) was intentionally designed to control for excess variation associated with features of the larger landscape, some variation among landscape contexts remained. Adjacent habitats may have influenced selection and buffer use in this study. We recommend future studies control for adjacent habitat types when comparing densities on agricultural fields with and without conservation practices.

Density of red-bellied woodpeckers and warblers doubled on buffered fields; however, the observed effect size may result from a greater percentage cover of woody habitat in the immediate and surrounding landscape (6.2% greater within 500-m and 2% greater within 1,500-m landscapes surrounding buffered fields compared with landscapes surrounding non-buffered fields). Increased densities of these woodland species may simply be a result of greater wooded cover in buffered landscapes; but alternatively, buffers might provide additional foraging opportunities, greater vegetation diversity, or less abrupt edges to existing wooded cover that resulted in increased suitability of this extant habitat (Peak and Thompson 2006). Thus, further investigation into the effects of targeted agricultural conservation practices on non-target species in adjacent or nearby wooded habitat may be warranted.

Although density differences between narrow (<23 m) and wide (>23 m) buffers were not substantiated because of large encounter-rate variability, some species (e.g., Savannah sparrow, swamp sparrow, and eastern meadowlark) appeared to exhibit greater densities in wider buffers during winter (Fig. 4). Further assessment of relationships among winter birds and buffer width is warranted because the evaluation presented here represents a coarse assessment of buffer width and a finer assessment will require a greater sample size. Positive relations with habitat area have been widely documented during breeding season for Savannah sparrows and eastern meadowlarks in the midwestern and northeastern United States (e.g., Herkert 1994, Vickery et al. 1994, Renfrew and Ribic 2008), although some studies reported variable or negative response for Savannah sparrows (see Ribic et al. 2009). During the breeding season, swamp sparrows are not typically considered area-sensitive, but they are influenced by vegetation structure, insofar as to be denoted a "vegetation-restricted species" in the midwestern and northeastern United States (Herkert 1994, Benoit and Askins 2002). Even though few studies have assessed area sensitivity of these species during winter (see Brennan and Kuvlesky 2005), Savannah, song, and swamp sparrow, and eastern meadowlark were among the most abundant species detected along survey transects during winter on large (range = 7–1,214-ha) fields of early successional habitat in the Lower Mississippi River Alluvial Valley (Doster 2005, Twedt et al. 2008). Song sparrows were also found to be greater in density in native-grass filter strips >60 m in width than in strips 30–60 m wide in Maryland, USA (Blank et al. 2011). Overwinter mortality may be more pronounced in linear patches compared with square patches such as fields, remnant grasslands, and wetlands in the Great Lakes region in which the area relationships of swamp sparrows have previously been studied (e.g., Riffell et al. 2001). Sensitivity to patch area during winter may be related to food resources and thermoregulatory and escape cover.

Song sparrow and American goldfinch, which appeared to respond favorably to the presence of buffers but negatively to buffer width during winter, have been shown to be negatively influenced by patch area during the breeding season in the midwestern United States (Herkert 1994). These species may avoid habitats with greater patch area because they perceive reduced availability of edge habitat. Indeed, song sparrow densities associated with field-buffer landscapes (7.1 ± 0.8 birds/ha) were greater than or similar to densities of this species on large fields of early successional habitat in the Lower Mississippi River Alluvial Valley (7.1 ± 2.1 birds/ha, Doster 2005; 1.0 ± 0.2 birds/ha, Twedt et al. 2008).

Results from this assessment of winter bird response to targeted native herbaceous buffer habitats across a large spatial extent were consistent with results from previous studies that were conducted at smaller scales. Previous studies found native herbaceous habitats, similar to those provided by targeted CP33 buffers, increased total avian and sparrow abundance in Maryland, Mississippi, and North Carolina, USA (Marcus et al. 2000, Smith et al. 2005*b*, Conover et al. 2007, Blank et al. 2011), when compared with conventionally cropped non-buffered fields. Response to buffer habitats was positively influenced by buffer width in studies in Maryland (Blank et al. 2011) and Mississippi (Conover et al. 2007). As with our study, woodland and edge species, such as northern cardinal (*Cardinalis cardinalis*), eastern towhee (*Pipilo erythrophthalmus*), and white-throated sparrow (*Zonotrichia albicollis*), did not respond to buffers at the farm scale in Mississippi (Smith et al. 2005*a, b*, Conover et al. 2007). Even so, these studies were inconclusive regarding species richness, diversity, and total ACV, which were not influenced by buffers in some studies (Smith et al. 2005*a, b*) and were greatly influenced by buffers in other studies in Mississippi and Maryland (Conover et al. 2007, Blank et al. 2011). These differences demonstrate the importance of evaluation of avian response to buffer habitats at broad spatial scales. The value of buffers for improving bird habitat during winter may be a function of their landscape context as much as farm or field-level management (Best 2000, Bradbury et al. 2004, Moreira et al. 2005).

MANAGEMENT IMPLICATIONS

This study exemplifies how management that targets restoration of northern bobwhite can positively impact other bird species that share similar habitat requirements. Substantive responses by some overwintering bird species to buffers suggest that policy makers should be cognizant of potential secondary outcomes when conservation practices target specific species or taxa. Depending on target species, establishment of practices such as buffers along row-crop field edges may increase landscape heterogeneity and provide critical overwintering habitat for some species in agricultural landscapes. Benefits of targeted practices will be further enhanced if practices are delivered purposefully and strategically in support of desired landscape conditions.

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