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Avian Response to Field Borders in the Mississippi Alluvial Valley

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By

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Dramatic alterations have occurred on agricultural landscapes throughout North America, reducing the quantities of herbaceous habitat that once dominated field margins. A concomitant decrease of grassland bird populations paralleled these modifications. Conservation buffers, in the form of field borders, are a method of habitat establishment that effectively balances wildlife and landowner needs. Recent popularity of field borders led to their establishment throughout the southeastern US despite a paucity of knowledge regarding avian response to management regimes.

This research evaluated wintering and breeding avian communities, as well as nesting ecology in response to field border establishment. Results indicated that birds utilize field borders for various life history requirements. Field borders provided enhanced avian benefits over traditional farm practices; and borders of widths >10 m were superior nesting habitat than more narrow borders. Based on these results, we strongly recommend field border establishment to enhance ecosystem integrity on farm landscapes.

DEDICATION

The contents of this manuscript are in memory of my friend, Wrangler. I dragged Wrang to Mississippi under the promise of returning to the north woods that he loved so much, but failed to uphold my end of the bargain.

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CHAPTER I

INTRODUCTION

The majority of native grassland habitat throughout North America has been eradicated through conversion to agriculture (Samson and Knopf 1994, Noss et al. 1995). This conversion has resulted in the dependence of many grassland birds on farmlands to satisfy life history requirements (Hunter et al. 2001). Although agricultural regions once provided relatively hospitable habitat for grassland birds, recent alterations of agricultural practices, as row-crop monoculture plantings and larger farm fields, have resulted in the reduction of strip-cover habitat that once proliferated on farm-field margins in North America (Best 1983, Rodenhouse et al. 1995). This removal of strip-cover habitat translated to a loss of environmental resources (food supply, nesting sites, song perches, and escape cover) utilized by farmland birds (Rodenhouse et al. 1993). Many grassland birds responded with precipitous population declines (Herkert 1995, Warner 1994, Murphy 2003). Such landscape modifications would likely have resulted in positive and negative responses for certain species of any taxon due to diverse life-history strategies. However, the grassland bird group experienced mostly negative effects and currently has the fewest species with increasing population trends of any avian guild and the most species in decline (Peterjohn and Sauer 1999).

In 1985, the Conservation Reserve Program (CRP) was initiated through the Food Security Act (FSA) to enhance soil and water quality. Wildlife habitat was added to the

CRP through multiple farm bills, thereby increasing the importance of wildlife conservation associated with CRP habitat establishment. While grassland fields established under the CRP provided habitat for numerous grassland birds, some species, such as the Dickcissel (*Spiza americana*) and Northern Bobwhite (*Colinus virginianus*), continued to decline (Ryan et al. 1998, McCoy et al. 1999). The National Conservation Buffer Initiative was developed to establish conservation buffers that improve soil and water quality, protect biodiversity, and enhance fish and wildlife habitat. Recently, the USDA announced the availability of a new buffer practice, CP33 Habitat Buffers for Birds (e.g., field borders), under the continuous CRP. This practice is appealing to landowners for its ability to balance the needs of wildlife and farmers. Field borders are defined as enhanced, non-crop strips of vegetation typically established adjacent to existing field margin habitat, such as fencerows or drainage ditches (Marcus et al. 2000, Smith 2004). Field borders and similar linear habitats benefit avian communities by providing nesting habitat, foraging habitat, movement corridors, roosting sites, and escape cover (Puckett et al. 1995, 2000; Marcus et al. 2000, Smith 2004).

However, despite recent conservation efforts to promote field borders, relatively few studies have evaluated avian response to their vegetative and structural dynamics (Marcus et al. 2000, Smith 2004). Research on field borders is also limited by the examination of narrow (<10 m) border widths (Marcus et al. 2000, Smith 2004). Furthermore, no studies have investigated avian nesting ecology or reproductive parameters in field borders. As field borders represent linear, edge habitat, such an evaluation is important to determine the potential negative edge effects on birds (Gates and Gysel 1978, Ratti and Reese 1988, Paton 1994). Edge effects of concern include increased nest predation from enhanced nest predator abundances and activity levels, and brood parasitism rates by Brown-headed Cowbirds (*Molothrus ater*; Gates and Gysel 1978, Major et al. 1999, Woodward et al. 2001, Renfrew et al. 2005). Additionally, such linear, edge habitat may not be ideal for many area-sensitive species that exhibit edge aversion behavior (Johnson and Temple 1986, Winter and Faaborg 1999). Increased border width may lessen edge effects experienced by birds inhabiting field borders and provide habitat for area-sensitive species by reducing the perimeter to edge ratio and increasing habitat area (Helzer and Jelinski 1999). Wider borders may also provide greater benefits for wildlife through enhanced vegetative heterogeneity (Petrides 1942, Rodenhouse and Best 1983) and nest-site diversity (Shalaway 1985, Martin 1993).

The principal objectives of this study were to evaluate potential benefits provided to breeding and wintering avian communities relative to field border structural and vegetative dynamics in the Mississippi Alluvial Valley. Evaluation of this research was executed and presented as three individual components, the response of (1) wintering avian communities, (2) breeding avian communities, and (3) avian nesting ecology to field border width and vegetative characteristics. Collectively, these components form one cohesive body of research that provides a distinctive evaluation on the influence of field border dynamics on avian communities. Results from this research may provide evidence for an effective management regime applicable to field border establishment and maintenance by wildlife managers associated with agricultural landscapes.

Literature Cited

Best, L. B. 1983. Bird use of fencerows: implications of contemporary fencerow management practices. Wildlife Society Bulletin 11:343-347.

Gates, J. E. and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59:871-883.

Helzer, C. J. and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448-1458.

Herkert, J. R. 1995. An analysis of midwestern breeding bird population trends: 1966-1993. American Midland Naturalist 134:41-50.

Hunter, W. C., D. A. Buehler, R. A. Canterbury, J. L. Confer, and P. B. Hamel. 2001. Conservation of disturbance-dependent birds in eastern North America. Wildlife Society Bulletin 29:440-455.

Johnson, R. G. and S.A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies *in* Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. Eds. J. Verner, M.L. Morrison and C.J. Ralph. University of Wisconsin Press, Madison, Wisconsin.

Major, R. E., F. J. Christie, G. Gowing, and T. J. Ivison. 1999. Elevated rates of predation on artificial nests in linear strips of habitat. Journal of Field Ornithology 70:351-364.

Marcus, J. F., W. E. Palmer, and P. T. Bromley. 2000. The effects of farm field borders on over-wintering sparrow densities. Wilson Bulletin 112:517-523.

Martin, T. E. 1993. Nest predation and nest sites: new perspectives on old patterns. BioScience 43:523-532.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger, Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530-538.

Murphy, M. T. 2003. Avian population trends within the evolving agricultural landscape of Eastern and Central United States. Auk 120:20-34.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. United States Department of the Interior National Biological Service Biological Report 28, Washington, D.C., USA.

Paton, P. W. C. 1994. The effect of edge on avian nest success: how strong is the evidence? Conservation Biology 8:17-26.

Peterjohn, B. G. and J. R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology 19:27-44.

Petrides, G. A. 1942. Relation of hedgerows in winter to wildlife in central New York. Journal of Wildlife Management 6:261-280.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr., and T. L. Sharpe. 1995. Bobwhite nesting ecology and modern agriculture: field examination with manipulation. Proceedings from the Annual Conference of the Southeastern Association of Fish Wildlife Agencies 49:507-517.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr., and T. L. Sharpe. 2000. Effects of Filter Strips on Habitat Use and Home Range of Northern Bobwhites on Alligator River National Wildlife Refuge. Quail IV: Proceedings of the Fourth National Quail Symposium Pp. 26–31.

Ratti, J. T. and K. P. Reese. 1988. Preliminary test of the ecological trap hypothesis. Journal of Wildlife Management 52:484-491.

Renfrew, R. B., C. A. Ribic and J. L. Nack. 2005. Edge avoidance aby nesting grassland birds: a futile strategy in a fragmented landscape. Auk 122:618-636.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor, and E. K. Bollinger. 1993. Effects of temperate agriculture on neotropical migrant landbirds, p. 280-295. In: D. M. Finch and P. W. Stangel (eds.). Status and management of neotropical migratory landbirds. USDA Forest Service General Technical Report TM-229, Fort Collins, CO.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor, and E. K. Bollinger. 1995. Effects of agricultural practices and farmland structures in Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Eds. T. E. Martin and D. M. Finch. Oxford University Press, New York.

Ryan, M. R., L. W. Burger, Jr., and E. W. Kurzejeski. 1998. The impact of CRP on avian wildlife: a review. Journal of Production Agriculture 11:61-66.

Samson, F. B. and F. L. Knopf. 1994. Prairie conservation in North America. Bioscience 44:418-421.

Shalaway, S. D. 1985. Fencerow management for nesting birds in Michigan. Wildlife Society Bulletin 13:302-306.

Smith, M. D. 2004. Wildlife habitat benefits of field border management practices in Mississippi. Doctoral Dissertation, Mississippi State University, 2004.

Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: future shock for midwestern birds? Conservation Biology 8:147-156.

Winter, M. and J. Faaborg. 1999. Patterns of area sensitivity in grassland nesting birds. Conservation Biology 13:1424-1436.

Woodward, A. A., A. D. Fink, and F. R. Thompson, III. 2001. Edge effects and ecological traps: effects on shrubland birds in Missouri. Journal of Wildlife Management 65:668-675.

CHAPTER II

WINTERING BIRD RESPONSE TO FIELD BORDERS IN THE MISSISSIPPI ALLUVIAL VALLEY

The majority of native grassland habitat throughout the United States has been converted to agricultural uses (Noss et al. 1995). Additively, the lack of intact native grasslands in North America resulted in the dependence of many grassland birds on these agricultural landscapes for habitat (Hunter et al. 2001). For nearly two centuries, however, agricultural growth positively influenced certain bird species through geographic range expansion (Hurley and Franks 1976). However, recent technological advancement and intensification has reversed the benefits previously provided by this expansion (Vickery et al. 1999, Murphy 2003) through such practices as “clean farming” techniques and larger contiguous farm fields, which frequently lead to a reduction of weedy and shrubby habitat in agricultural regions (Best 1983). As a result, grassland birds are now declining more precipitously than any other avian guild and have the fewest species with increasing population trends in North America (Herkert 1995, Peterjohn and Sauer 1999). For example, from 1966 to 1979, the ratio of grassland birds with negative vs. positive population trends was 3:1, but this ratio worsened substantially (15:1) from 1980 to 2003 (Sauer et al. 2004).

The effects of this grassland-habitat loss in the United States have been well documented for Midwestern breeding birds (Herkert 1994, Herkert et al. 1996), where over 99% of native tall grass prairie has been destroyed (Noss et al. 1995). Of primary concern for these birds should be their over-wintering population ecology, when the vulnerability of birds to resource fluctuations can lead to a population bottleneck (Payne and Wilson 1999). In the southeastern U.S., this should be of particular interest as wintering avian communities are primarily composed of temperate, short-distance migrant sparrows with declining populations (Sauer et al. 2004). However, there has been a paucity of research on grassland birds in relation to their use of wintering grounds in the southeastern U.S. (Marcus et al. 2000, Peterjohn 2003, Smith 2004), where the conversion of native habitats to agriculture has been severe (Noss et al. 1995). An understanding of the response by grassland birds to loss and establishment of wintering habitats is therefore essential to their conservation.

In the MAV physiographic region, native habitats have endured severe levels of eradication, primarily from conversion to agriculture (Noss et al. 1995, Rudis 2001). Such drastic habitat conversions in the MAV have likely resulted in grassland bird dependence locally on agricultural landscapes; hence, creation of suitable habitat on these farms may help stabilize avian population declines associated with habitat degradation. The majority of over-wintering sparrows in the MAV have experienced negative population trends throughout North America since 1980. Such declines include species as the Field Sparrow (*Spizella passerina*, -2.56 %/year), Vesper Sparrow (*Poecetes* *gramineus*, -0.86 %/year), Savannah Sparrow (*Passerculus sandwichensis*, -0.78 %/year), Song Sparrow (*Melospiza melodia*, -0.27 %/year), White-throated Sparrow (*Zonotrichia albicollis*, -0.60 %/year), White-crowned Sparrow (*Zonotrichia leucophrys*, -0.04 %/year), Dark-eyed Junco (*Junco hyemalis*, -1.52 %/year), and Eastern Towhee (*Pipilo erythropthalmus*, -0.98 %/year). However, not all species have declining populations (Fox Sparrow; *Passerella iliaca* 0.14 %/year and Swamp Sparrow; *Melospiza georgiana*, 1.59 %/year; Sauer et al. 2004).

The Conservation Reserve Program (CRP) was established under the 1985 Food Security Act to reduce soil erosion, and it was widely conjectured that the CRP might facilitate stability of grassland bird population declines as a secondary benefit of habitat establishment (Young and Osborn 1990, Johnson and Schwartz 1993, Reynolds et al. 1994, Ryan et al. 1998). In 1997 the USDA amplified assistance to grassland-edge birds with the National Conservation Buffer Initiative (NCBI), which was designed to provide cost-share incentives that promote establishment of conservation buffers by private landowners. Types of buffer habitat included grassed waterways, filter strips, contour buffers, windbreaks, riparian buffers, fencerows, cross-wind trap strips, living snow fences, shelterbelts, and field borders among others. The objectives for these buffers were to improve soil, air and water quality, conserve biodiversity, beautify the landscape, and enhance fish and wildlife habitat (Best 2000). Field borders are non-crop, herbaceous buffers located along field margins, and typically incorporated with a pre-existing field margin feature (Marcus et al. 2000, Smith 2004). Establishment protocols of field borders are typically designed using Northern Bobwhite (*Colinus virginianus*) as the keystone species. Field borders and similar linear habitat have successfully provided nesting habitat, foraging habitat, movement corridors, and escape cover to many avian species (Puckett et al. 1995, Marcus et al. 2000, Puckett et al. 2000, Smith 2004), while substantially reducing soil erosion into riparian zones adjacent to row-crop fields (T. Cooke unpubl. data). Furthermore, Smith (2004) found the escape cover provided by field borders indirectly benefited birds by increasing their use of adjacent crop fields in close proximity, thereby allowing access to waste grain.

In the Southeast, the concept of field border establishment was popular among agricultural producers because they minimally impact on crop production when located along a wooded edge (Davison 1941, Dambach 1945), reduce the incursion of invasive weeds into crop fields, and harbor insects with agronomic benefits (Marshall and Moonen 2002). In the MAV, agricultural producers are especially partial to field borders as potential habitat for local populations of Northern Bobwhite. The conceptual popularity of field borders may result in their widespread establishment in the near future, heightening the need for an understanding of proper management and establishment regimes. Knowledge of field border value to avian communities in the non-breeding season is limited to Marcus et al. (2000) and Smith (2004). However, both of these studies only address avian use of narrow field borders (<10 m). Research on similar linear habitats found that greater widths may have escalated benefits for species associated with grassland habitat (Rodenhouse and Best 1983, Warner 1992). Despite these potential benefits, we know of no studies that evaluated the impacts of a width component for linear, herbaceous habitat to wintering birds. However, research during the breeding season suggests increased width of habitat will reduce the perimeter to area ratio and provide more herbaceous habitat at greater distances from wooded field margins, which may increase the quality of habitat for birds (Helzer and Jelinski 1999, Woodward et al. 2001). Wide borders will retain the edge habitat preferred by cover-dependent species (Schneider 1984), as well as provide habitat for edge-averse species by providing a transitional habitat zone, as opposed to an abrupt wooded-farm field edge (Johnson and Temple 1986, Helzer and Jelinski 1999). Increased width also has the simple effect of increasing habitat area. Hence, a reasonable increase of border width may optimize field-border management protocols and as such, evaluation should be a priority.

During the non-breeding season field borders can provide substantial conservation benefit, as most birds inhabiting agricultural field edges in the Southeast are sparrows (Marcus et al. 2000), of which several are either species of concern or have declining populations (Peterjohn and Sauer 1999). Although open fields and short grass are suitable habitat for wintering birds, such as the Horned Lark (*Eremophila alpestris*) and longspurs (*Calcarius* spp.), field borders provide the enhanced vertical cover preferred by most sparrows (Grzybowski 1983), yet is extremely scarce in the MAV. Furthermore, field borders may provide food and cover resources, which have been suggested to limit winter densities of sparrows (Davis 1973, Jansson et al. 1981, Lima 1990, Watts 1990).

As the programmatic opportunities to implement field borders continues to increase, researchers must determine the conservation efficacy of field borders and provide wildlife managers with a strategy for proper establishment and maintenance. Such information would be invaluable in developing and refining NCBI practice standards. Primary objectives of this study were to assess avian community (abundance, richness, and conservation value) and sparrow response to narrow and wide field border habitat on agricultural production farms in the MAV during the non-breeding season. We hypothesized that (1) narrow-bordered field margins would receive increased bird use (particularly cover-dependent sparrows) than non-bordered margins; (2) border width would positive relate with community measurements and sparrow densities, and (3) wide borders would enhance spatial movement by sparrows into adjacent agricultural fields, thereby increasing access to forage resources crucial to survival in late-winter months.

Methods

Study Site

This study was conducted on six farms in Sunflower County, Mississippi during the winters (February) of 2003 and 2004. Historically, this region was bottomland-hardwood forest; hence, field borders are not restoration of native habitat, but opportunistic exploitation to replace grassland habitat lost elsewhere in the country. All farms were located in the MAV, with the two most distant farms 12 km apart. Our study farms were representative of the MAV landscape, dominated by large fields (171.14 $\pm$ 34.20 ha) of intensive agricultural production, with primary crops of soybean (58%, *Glycine* sp.) cotton (16%, *Gossypium* sp.), and milo (10%, *Sorgum* sp.). This agricultural landscape is fragmented by wooded fencerows and drainage ditches, and has nominal topographical relief. Throughout winter, fields were void of vegetative cover except sparse, short stubble in some fields. Soil associations on the farms were mostly Dundee silt loam or Forestdale silt loam. These are stratified alluvium soils of fine to coarse texture that were washed in by the Mississippi River and have poor to moderate drainage, and vary widely in acidity levels (Powell et al. 1952).

Experimental field borders were established in the spring of 2002 and were located between a wooded field margin (typically fencerow) that enclosed a drainage ditch and an agricultural field. The field border population was randomly selected from a pre-determined sample population of all potential habitats on selected farms. Control (non-bordered) field margins were located in similar conditions, but represented "ditch to ditch" row-cropping techniques and contained no herbaceous buffer. All borders were approximately 400 m in length and were planted with a mixture of indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), partridge pea (*Chamaecrista fasciculata*), and kobe lespedeza (*Lespedeza striata*). Despite plantings, the floral composition of field borders were also dominated by horsetail (*Conyza canadensis*), seashore vervain (*Verbena litoralis*), bermuda grass (*Cynodon dactylon*), johnson grass (*Sorghum halepense*), goldenrod

(*Solidago* spp.), common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*Ambrosia trifida*), poison ivy (*Toxicodendron radicans*), curly dock (*Rumex crispus*) and *Rubus* spp. Farm operators were requested not to disturb (mow, burn, apply chemicals, drive on, or disk) field borders during the study. However, this failed to prevent some border destruction, which resulted in a reduced sample size from 2003 to 2004. Hence, border treatments on field margins were non-bordered (2003: n = 19; 2004: n = 17), narrow-bordered (2003: mean = 8.5 m, SE = 1.8 m, n = 38; 2004: mean = 7.3 m, SE = 2.2 m, n=26), and wide-bordered (2003: mean = 32.7 m, SE = 9.0 m, n = 6; 2004: mean = 29.7 m, SE = 10.2 m, n = 6). The influence of field borders on birds was evaluated in the three field margin regions (adjacent row crop field, wooded edge, and field border zone; FBZ). The FBZ was a 10 m area adjacent to the wooded edge and represented either an experimental border vegetation or, for non-bordered margins, traditional "ditch to ditch" row-crop practices. The agricultural field region encompassed three-10 m distance bands adjacent to the FBZ. The wooded edge region was two-10 m distance bands adjacent to the FBZ, typically in an old fencerow.

Community Assessment

The avian community was censused during February of 2003 and 2004 using line-transect survey techniques (Buckland et al. 2001). Each transect was surveyed over 200 m, with a 100 m buffer on both sides to reduce overlap of previously counted birds. Transect lines were located between the agricultural field and FBZ. Transects were evenly paced for 10 minutes to ensure the entire transect received equal census time and one person censused >90% of transects to minimize observer bias. Surveys were conducted from 0700 to 1000 (three hours post-sunrise, Central Standard Time) on days with no precipitation and wind <12 km/hr. Flyover observations were not included, as their presence was not likely associated with field border presence. We recorded all bird observations within 10 m perpendicular bands relative to each local field margin region and field border treatment.

Statistical Analyses

Community metrics of avian response to field border treatments included avian richness, abundance, sparrow abundance, and total avian conservation value (TACV; Nuttle et al. 2003). Analyses did not include individuals located in the wooded edges of wide borders due to inconsistent width of wooded edges adjacent to some borders. Community metrics were analyzed with a repeated measures analysis of variance (ANOVA) using PROC GLM (SAS Institute, Inc. 2003) to test for differences between border treatments. Fixed main effects were community metrics for border treatments with year as the repeated effect. In addition to these metrics, we also estimated sparrow density (birds/ha) within the 10 m FBZ and 30 m into adjacent agricultural fields. The nature of these survey conditions permits the reasonable assumption of a 100% detection probability, thereby eliminating the need to calculate detection functions (Diefenbach et al. 2003). Sparrow density estimates were analyzed for combined years using an

ANOVA, as no year effects existed amongst all plots ($F_{1,110} = 0.016$, $P = 0.900$). Diversity indices were not used to avoid potentially ambiguous interpretations of community comparisons amongst treatments (Hurlbert 1971, Gotelli and Entsminger 2001).

TACV is a community metric that calculates the relative conservation value of experimental field borders by multiplying species' abundances by their Partners in Flight (PIF) conservation priority ranks (Carter et al. 2000, Nuttle et al. 2003). We applied PIF ranks for wintering birds in the MAV (http://www.rmbo.org/pif/scores/scores.html). PIF ranks were calculated based upon breeding and wintering distributions, relative abundance, potential threats to breeding and wintering habitats, population trend, and physiographic-specific area importance value (Carter et al. 2000). Unidentified birds were not assigned a PIF rank, however, unidentified sparrows were assigned a rank of two, as all sparrows besides Chipping Sparrow (*Spizella passerina*), which was rarely observed, had a rank ≥ 2. Species-specific TACV scores were summed within each transect to produce a cumulative conservation score for each field margin region per border treatment.

Results

We recorded 59 bird species and 4,083 individuals over 22.4 km of line-transects during 2003 and 2004 winters. The five most abundant birds were Mourning Dove (*Zenaida macroura*; 17.5%), European Starling (*Sturnis vulgaris*; 15.5%), Red-winged

Blackbird (*Agelaius phoeniceus*; 6.7%), Common Grackle (*Quiscalus quiscula*; 6.4%), and Northern Cardinal (*Cardinalis cardinalis*; 5.9%). The most abundant sparrows were Song Sparrow (*Melospiza melodia*; 5.0%), White-throated Sparrow (*Zonotrichia albicollis*; 4.4%), and Swamp Sparrow (*Melospiza georgiana*; 3.1%). The most common birds in the FBZ were Song Sparrow (19.0%), Swamp Sparrow (13.9%), Northern Cardinal (11.4%), Mourning Dove (10.5%), and White-throated Sparrow (9.1%).

We detected no notable differences among avian richness or abundance, respectively, for field border treatments in the adjacent wooded edge ($F_{2,42}$ = 0.620, P = 0.543; $F_{2,42}$ = 0.200, P = 0.819) or agricultural field ($F_{2,42}$ = 2.320, P = 0.111; $F_{2,42}$ = 0.870, P = 0.425) regions (Table 2.1). However, bordered-margins did have significantly higher richness and abundance within the FBZ (Table 2.1). Furthermore, TACV was significantly higher for bordered than non-bordered margins in the agricultural field and FBZ, however these trends appeared to be dominated by avian communities in wide field borders (Table 2.1). Sparrow abundance within the FBZ and agricultural field of narrow (2003: mean = 4.368, SE = 1.485; 2004: mean = 3.579, SE = 1.330) and wide-bordered (2003: mean = 18.333, SE = 10.913; 2004: mean = 4.667, SE = 2.687) field margins was significantly greater than non-bordered (2003: mean = 1.200, SE = 0.521; 2004: mean = 3.300, SE = 1.913) margins ($F_{2,42}$ = 4.89, P = 0.011; Figure 2.1).

Overall sparrow densities within the FBZ and adjacent crop field were comparable for non- (4.389 / ha $\pm$ 2.950 SE) and narrow-bordered (7.516 / ha $\pm$ 2.212 SE) treatments ($F_{1,98}$ = 0.719, P = 0.399). Wide-bordered margins however, had significantly higher sparrow densities (32.333 / ha ± 8.73 SE) than both non-bordered ($F_{1,48}$ = 5.771, *P* = 0.020) and narrow-bordered ($F_{1,76}$ = 6.805, *P* = 0.011) field margins. Increased border width corresponded with greater sparrow densities observed 20 m into adjacent agricultural fields; however, few birds ventured farther than 20 m beyond the field border edge regardless of treatment (Figure 2.3). An evaluation of sparrow abundances within 10 m increments adjacent to the wooded edge revealed a significant relationship between spatial habitat use by sparrows and border treatment. Narrow borders supported substantially greater densities of sparrows within the FBZ than non-bordered ($F_{1,98}$ = 3.873, *P* = 0.052), but not in the adjacent agricultural field (10m: $F_{1,98}$ = 0.169, *P* = 0.682; 20m: $F_{1,98}$ = 0.406, *P* = 0.526; 30m: $F_{1,98}$ = 1.245, *P* = 0.267). Wide borders had significantly greater sparrow densities than non-bordered margins in all distance bands (FBZ: $F_{1,48}$ = 13.523; *P* = 0.001; 10m: $F_{1,48}$ = 3.413, *P* = 0.071; 20m: $F_{1,48}$ = 4.831, *P* = 0.033) except 30m ($F_{1,48}$ = 0.005, *P* = 0.947). Densities were also significantly enhanced in most distance bands for wide borders than narrow (FBZ: $F_{1,76}$ = 7.203, *P* = 0.009; 10m: $F_{1,76}$ = 4.729, *P* = 0.033; 20m: $F_{1,76}$ = 8.004, *P* = 0.006; 30m: $F_{1,76}$ = 2.936, *P* = 0.091). Spatial use of adjacent crop fields was overall considerably greater for sparrows inhabiting wide-bordered regions up to the 30 m distance band, where sparrow density equalized for all treatments due to a paucity of birds (Figure 2.3).

Species-specific densities for sparrows generally experienced significant enhancement from non- to narrow and narrow to wide-bordered field margins (Figure 2.2). Song ($F_{2,42}$=5.130, *P* = 0.009) and Swamp ($F_{2,42}$ = 3.400, *P* = 0.040) Sparrows had substantially higher densities within the FBZ for both narrow and wide-bordered margins than non-bordered, whereas White-throated Sparrows remained uninfluenced ($F_{2,42}$ = 0.110, P = 0.900) by field border presence (Figure 2.2).

Table 2.1 Community Metrics in Field Margin Regions

Richness, abundance, and total avian conservation value in the field border zone (FBZ; 10 m region adjacent to wooded edge), agricultural field, and wooded edge habitat regions associated with non-, narrow, and wide-bordered field margins in the Mississippi Alluvial Valley from 2003-2004.

Community Measure	Year	Border Treatment	FBZ				Agricultural Field				Wooded Edge			
			mean	SE	$F_{2,42}$[a]	*P*	mean	SE	$F_{2,42}$	*P*	mean	SE	$F_{2,42}$	*P*
Richness	2003	Non	1.684	0.325			1.053	0.259			5.579	0.542		
		Narrow	1.921	0.231			1.711	0.282			5.789	0.420		
		Wide	4.500	1.335			1.833	0.601			4.333	1.202		
	2004	Non	2.471	0.625			0.882	0.319			5.176	0.530		
		Narrow	2.962	0.452			0.654	0.207			6.000	0.605		
		Wide	3.500	0.428	4.240	0.021	2.167	0.601	2.320	0.111	3.500	1.025	0.620	0.543
Abundance	2003	Non	2.211	0.815			2.000	0.616			20.526	5.597		
		Narrow	4.895	1.216			17.632	10.697			2.260	2.325		
		Wide	14.500	5.328			16.500	12.228			15.000	5.983		
	2004	Non	2.235	1.960			10.000	6.117			12.450	3.031		
		Narrow	4.615	1.657			4.423	2.374			12.026	2.325		
		Wide	10.333	4.529	3.900	0.028	22.333	15.194	0.870	0.425	21.889	18.687	0.200	0.819
TACV	2003	Non	4.368	1.628			8.474	2.054			48.526	13.558		
		Narrow	7.763	1.935			26.658	6.045			58.868	14.564		
		Wide	20.500	6.791			36.833	16.404			23.333	8.815		
	2004	Non	6.471	3.920			20.177	7.927			37.294	9.402		
		Narrow	7.923	3.091			17.769	7.498			41.923	7.060		
		Wide	19.833	9.280	4.420	0.018	64.667	41.639	5.750	0.006	79.000	63.032	1.030	0.365

[a] F-test and *P* values are associated with field border treatment as main effect in repeated measures ANOVA, not individual means per year.

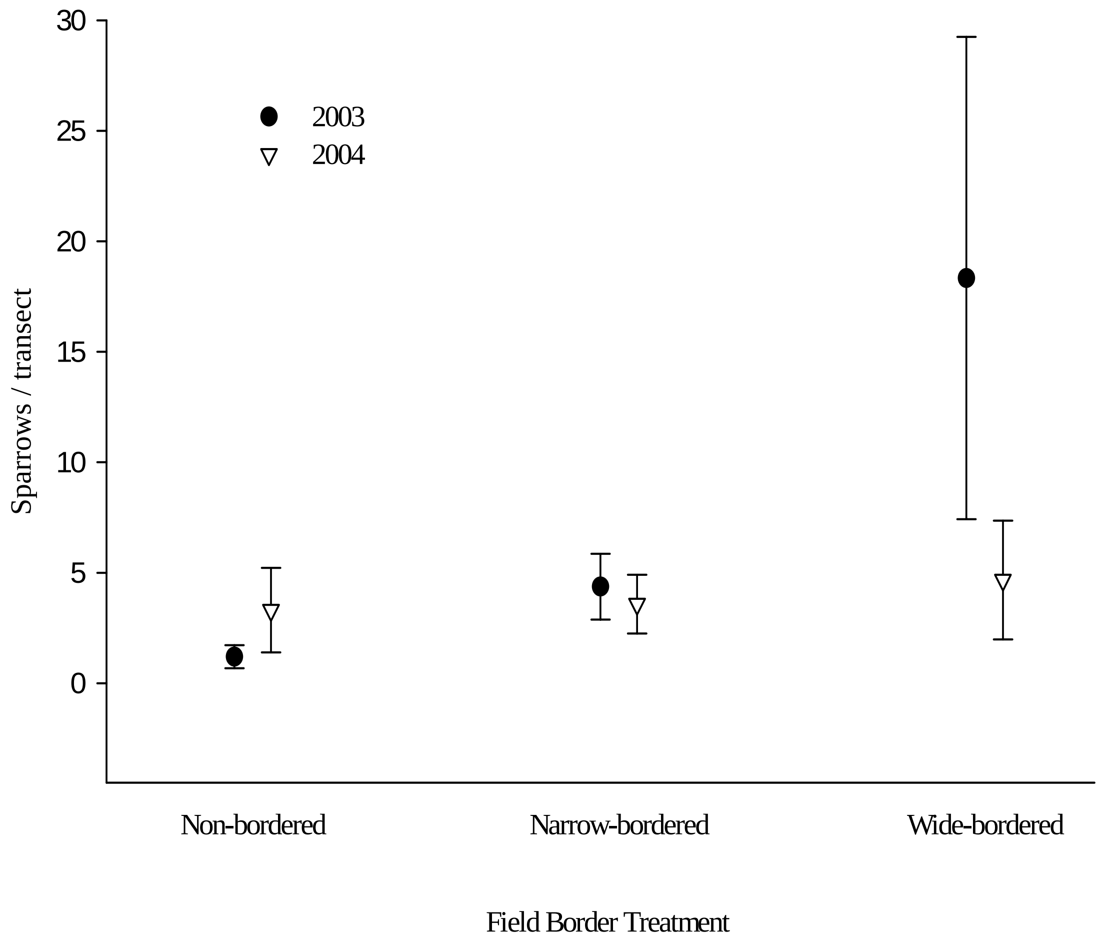

Figure 2.1 Sparrow Abundance

Sparrow abundances within the FBZ and agricultural field regions of non-, narrow and wide-bordered field margins in the MAV during 2003 and 2004.

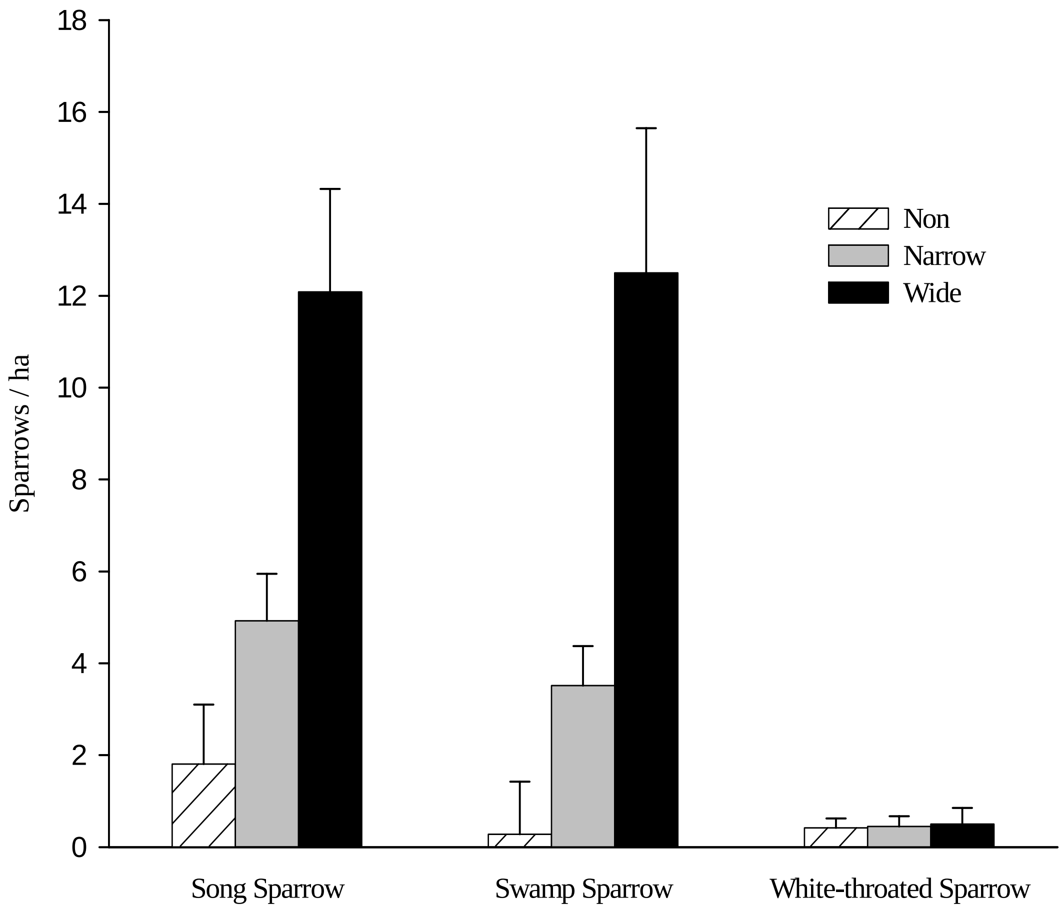

Figure 2.2 Species-specific Sparrow Densities

Sparrow densities within the field border zone (FBZ; 10 m adjacent to wooded edge) of non-, narrow, and wide-bordered field margin treatments during 2003 and 2004.

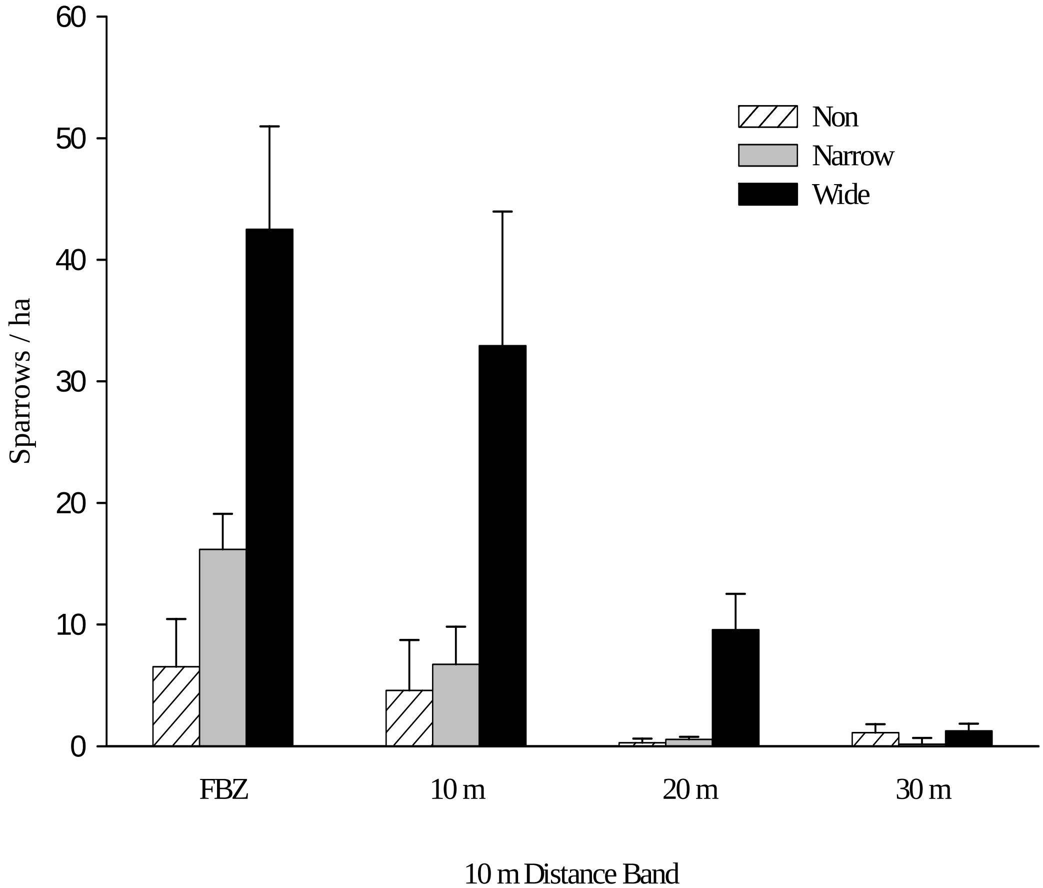

Figure 2.3 Spatial Use of Field Margins

Overall sparrow densities in the field border zone (FBZ; 10 m region adjacent to the wooded edge), and 3-10 m distance bands into the agricultural field for non-, narrow, and wide-bordered field margins during 2003 and 2004.

Discussion

Alterations in agricultural practices and technology commonly proceed in apathy of their impacts on wintering birds. The aftermath of these alterations generally include habitat loss or degradation (Best 1983) and have been found to coincide with declining grassland bird populations throughout North America (Peterjohn and Sauer 1999). The USDA has advocated the integration of herbaceous field borders to enhance the quantity and complexity of early successional habitat in farm landscapes to promote long-term population stability for declining avian species. Field borders represented a large majority of early-successional habitat on the agricultural farms we investigated and provided foraging and escape habitat for many wintering sparrows. The seed resources that field borders provide are an important source of energy for many ground-foraging, over-wintering sparrows (Falls and Kopachena 1994, Mowbray 1997, Arcese et al. 2002). Based on this research, we advocate the establishment of field borders on production farms as valuable habitat for foraging, roosting, escape cover, and maintenance activities of wintering grassland birds in the MAV.

This study confirmed our prediction that narrow field borders positively influence over-wintering sparrows in the southeast (Marcus et al. 2000, Smith 2004). Specifically, narrow-bordered margins appeared to provide superior habitat than non-bordered margins for wintering sparrows. However, aside from sparrows, we failed to document significant benefits of narrow borders to the avian community. There was little response of avian richness, abundance, or TACV to the presence of narrow borders compared with traditional farming practices for birds inhabiting adjacent wooded edges.

Furthermore, our data revealed the augmented benefits to wintering birds through increased field border width. Wide-bordered field margins represented a considerable enhancement over traditional “ditch to ditch” cropping techniques as well as narrow-bordered margins for the wintering avian community, and in particular, sparrows. Although wide borders had less influence on avian richness, their substantial enhancement of abundance and TACV confirms their benefits for avian conservation. Although the increased TACV score for wide borders may relate somewhat to avian abundance, it was largely influenced by enhanced abundances of priority sparrow species, thereby providing a more accurate indication of field border value.

We did not document any attraction of edge-averse species to field borders, regardless of width. We suspect that field border location, on wooded edges in a matrix of vast un-vegetated fields, precluded their appeal to edge-averse birds. As such, field border benefits are mostly exploited by edge-associated and habitat generalist species. Such species-specific responses to field border presence corresponded with the cover-dependency of each species. Song, Swamp, and White-throated Sparrows were all common on field edges and are somewhat dependent on brushy and/or woody cover (Falls and Kopachena 1994, Mowbray 1997, Arcese et al. 2002). White-throated Sparrows were unresponsive to field borders, largely remaining within the wooded edge regardless of border treatment. This was somewhat expected, as the hesitancy of White-throated Sparrows to venture from cover has been previously documented (Schneider 1984). Song and Swamp Sparrows occurred in bordered margins at significantly higher densities than non-bordered and both species had substantially increased densities in wide than narrow field borders. This is encouraging from a conservation standpoint as Swamp Sparrows are classified by Partner's in Flight as a species of high regional concern in the MAV (http://www.rmbo.org/pif/pifdb.html).

Sparrow spatial-use of agricultural fields was greater adjacent to wide borders than narrow or non-bordered. This enhanced spatial utilization suggests wider borders provided higher quality escape cover and allowed birds to forage more effectively in agricultural fields. This effect is also probably related to the increased distance of agricultural fields from wooded edges when adjacent to wide field borders. This allowance of birds to venture farther from the border edge could provide them with substantially increased foraging benefits, as agricultural fields provide a large amount of food in the form of waste grain (Warner et al. 1989). The ability of birds to safely access waste grain within 20 m adjacent to a 400 m long field border would provide an additional 8,000 m^2 of forage space per border. Such supplemental forage resources may represent the difference between survival and death for many sparrows in late-winter months, when food supply is a primary limiting factor (Jansson et al. 1981). We suggest that further investigations identify minimal field border width to experience this effect, forage resource quality in these areas, and the associated risk of predation.

Proper management of field borders is crucial to maintain the integrity of herbaceous vegetation and resultant avian benefits. Maintenance of borders should occur through periodic disturbance regimes (e.g., fire, mowing, and disking) approximately every 3–5 years, dependent on vegetative density and utilization by the avian community (Vogl 1974). Additionally, we recommend application of disturbance regimes to occur in a rotational pattern to prevent widespread simultaneous elimination of herbaceous habitat on a farm. This is especially important if executed during late-winter or early-spring months, when reduced food supply and added forage demands of the impending migration may reduce bird survival. Another consideration for adequate maintenance of these borders relates to row crop orientation during the growing season. We noticed that field borders adjacent to perpendicularly oriented rows were frequently damaged when used as a turn row and therefore, recommend that immediately adjacent rows be oriented parallel with borders to both prevent turn row damage and provide a herbicide lane for farmers to prevent potential incursion of weeds into crop fields. Despite a limited sample size, there was convincing evidence of the benefits of wide field borders for wintering birds, and we therefore recommend field border establishment at widths greater than 10 m.

With the growing popularity of field border habitat, knowledge of avian response is increasingly important. However, there remains a paucity of literature on the value of such resource management systems and over-winter farmland bird conservation. Fortunately, this research gap is slowly becoming recognized and addressed (Herkert et al. 1996, Marcus et al. 2000, Peterjohn 2003, Smith et al. in review). This study demonstrated that field borders are extremely valuable wintering avian habitat in the MAV. Furthermore, benefits provided to all birds, but particularly sparrows, are soundly enhanced with increased border width. Future research on field borders should focus on the identification of an optimal width threshold for maximization of both wildlife habitat and economic benefits of agricultural producers. Resultant management regimes would efficiently enhance the value of such habitat for wintering avian communities without impeding landowner economic profit. The incorporation of herbaceous field borders into agricultural systems may have large environmental and sociological impacts. Their potential to represent a rare equilibrium between the needs of agricultural producers and wildlife is reassuring, as this connection is increasingly urgent with the continued expansion of human populations and food requirements worldwide (Robertson and Swinton 2005).

Literature Cited

Arcese, P., M. K. Sogge, A. B. Marr, and M. A. Patten. 2002. Song Sparrow (*Melospiza melodia*). The Birds of North America, no. 704.

Best, L. B. 1983. Bird use of fencerows: implications of contemporary fencerow management practices. Wildlife Society Bulletin 11:343-347.

Best, L. B. 2000. The value of buffer habitats for birds in agricultural landscapes. Pp. 75-94 *in* A Comprehensive Review of Farm Bill Contributions to Wildlife Conservation (W.L. Holman, Ed.). USDA/NRCS/WHMI.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling. Oxford University Press, New York.

Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: The partners in flight approach. Auk 117:541-548.

Davis, J. 1973. Habitat preferences and competition of wintering Juncos and Golden-crowned Sparrows. Ecology 54:174-180.

Davison, V. E. 1941. Wildlife Borders—An Innovation in Farm Management. Journal of Wildlife Management 5:390-394.

Diefenbach, D. R., D.W. Brauning, and J.A. Mattice. 2003. Variability in grassland bird counts related to observer differences and species detection rates. Auk 120:1168-1179.

Falls, J. B. and J. G. Kopachena. 1994. White-throated Sparrow (*Zonotrichia albicollis*). The Birds of North America, no. 128.

Gates, J. E. and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59:871-883.

Gotelli, N. J. and G. L. Entsminger. 2001. EcoSim: Null models software for ecology. Version 7.0. Acquired Intelligence Inc. & Kesey-Bear. http://homepages.together.net/~gentsmin/ecosim.htm

Helzer, C. J. and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448-1458.

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

Herkert, J. R. 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. Pp. 89-116 *in* Management of agricultural landscapes for the conservation of Neotropical migratory birds (F. R. Thompson, III, Ed.). General Technical Report NC-187. U.S. Forest Service, St. Paul, Minnesota.

Hunter, W. C., D. A. Buehler, R. A. Canterbury, J. L. Confer, and P. B. Hamel. 2001. Conservation of disturbance-dependent birds in eastern North America. Wildlife Society Bulletin 29:440-455.

Hurlbert, S. H. 1971. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54:187-211.

Hurley, R. J. and E. C. Franks. 1976. Changes in the breeding ranges of two grassland birds. Auk 93:108-115.

Jansson, C., J. Ekman, and A. von Bromsson. 1981. Winter mortality and food supply in tits Parus spp. Oikos 37:313-322.

Johnson, D. H. and M.D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conservation Biology 7:934-937.

Johnson, R. G. and S.A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tall grass prairies *in* Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. Eds. J. Verner, M.L. Morrison and C.J. Ralph. University of Wisconsin Press, Madison, Wisconsin.

Lima, S. L. 1990. Protective cover and the use of space: different strategies in finches. Oikos 58:151-158.

Marcus, J. F., W. E. Palmer, and P. T. Bromley. 2000. The effects of farm field borders on over-wintering sparrow densities. Wilson Bulletin 112:517-523.

Marshall, E. J. P. and A. C. Moonen. 2002. Field margins of northern Europe: their functions and interactions with agriculture. Agriculture, Ecosystems, and Environment 89:5-21.

Mowbray, T. B. 1997. Swamp Sparrow (*Melospiza georgiana*). The Birds of North America, no. 279.

Murphy, M. T. 2003. Avian population trends within the evolving agricultural landscape of eastern and central United States. Auk 120:20-34.

Noss, R. F., E.T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. United States Department of the Interior National Biological Service Biological Report 28, Washington, D.C., USA.

Nuttle, T., A. Leidolf, and L. W. Burger Jr. 2003. Assessing conservation value of bird communities with Partners in Flight-based ranks. Auk 120:541-549.

Payne, R. J. H. and J. D. Wilson. 1999. Resource limitation in seasonal environments. Oikos 87:303-314.

Peterjohn, B. G. 2003. Agricultural landscapes: can they support healthy bird populations as well as farm products? Auk 120:14-19.

Peterjohn, B. G. and J. R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology 19:27-44.

Powell, J. C., W. E. Keenan, W. A. Cole, L. C. Murphree, D. A. Yost, J. J. Pitts, and R. H. Wells. 1952. Soil survey of Sunflower County, Mississippi. USDA Soil Conservation Service. Mississippi Agricultural Experiment Station. Pp. 45.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr., and T. L. Sharpe. 1995. Bobwhite nesting ecology and modern agriculture: field examination with manipulation. Proceedings of the Annual Conference for the Southeastern Association of Fish Wildlife Agencies 49:507-517.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr. and T. L. Sharpe. 2000. Effects of Filter Strips on Habitat Use and Home Range of Northern Bobwhites on Alligator River National Wildlife Refuge. Quail IV: Proceedings of the Fourth National Quail Symposium Pp. 26–31.

Reynolds, R. E., T. L. Shaffer, J. R. Sauer, and B. G. Peterjohn. 1994. Conservation reserve program: benefit for grassland birds in the Northern Plains. Transactions of the North American Wildlife and Natural Resources Conference 59:328-336.

Robertson, G. P. and S. M. Swinton. 2005. Reconciling agricultural productivity and environmental integrity: a grand challenge for agriculture. Frontiers in Ecology and the Environment 3:38-46.

Rodenhouse, N. L. and L. B. Best. 1983. Breeding ecology of Vesper Sparrows in corn and soybean fields. The American Midland Naturalist 110:265-275.

Rudis, V. A. 2001. Composition, potential old growth, fragmentation, and ownership of Mississippi Alluvial Valley bottomland hardwoods: a regional assessment of historic change in Bottomland hardwoods of the Mississippi Alluvial Valley: characteristics and management of natural function, structure, and composition. Eds. P. Hamel and T. Foti. Fayetteville, Arkansas.

Ryan, M. R., L. W. Burger, and E. W. Kurzejeski. 1998. The impact of CRP on avian wildlife: a review. Journal of Production Agriculture 11:61-66.

SAS Institute, Inc. 2003. Version 9.1 SAS Institute, Inc., Cary, North Carolina, USA.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966 - 2003. Version 2004.1. USGS Patuxent Wildlife Research Center, Laurel, MD. Online at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html (accessed 15 May 2005).

Schneider, K. J. 1984. Dominance, predation, and optimal foraging in White-throated Sparrow flocks. Ecology 65:1820-1827.

Smith, M. D. 2004. Wildlife habitat benefits of field border management practices in Mississippi. Doctoral Dissertation, Mississippi State University, 2004.

Vickery, P. D., P. L. Tubaro, J. M. Cardosa DA Silva, B. G. Peterjohn, J. R. Herkert, and R. B. Cavalcanti. 1999. Conservation of grassland birds in the western hemisphere. Studies in Avian Biology 19:2-26.

Vogl, R. J. 1974. Effects of fire on grasslands. Pp. 139-194 *in* T. T. Kozlowski and C. E. Ahlgren, eds. Fire and ecosystems. Acad. Press, New York, N.Y. 542pp.

Warner, R. E., S. P. Havera, L. M. David, and R. J. Siemers. 1989. Seasonal abundance of waste corn and soybeans in Illinois. Journal of Wildlife Management 53:142-148.

Warner, R. E. 1992. Nest ecology of grassland passerines on road rights-of-way in central Illinois. Biological Conservation 59:1-7.

Watts, B. D. 1990. Cover use and predator-related mortality in Song and Savannah Sparrows. Auk 107:775-778.

Woodward, A. A., A. D. Fink, and F. R. Thompson, III. 2001. Edge effects and ecological traps: effects on shrubland birds in Missouri. Journal of Wildlife Management 65:668-675.

Young, C. E. and C. T. Osbord. 1990. Costs and benefits of the Conservation Reserve Program. Journal of Soil and Water Conservation 45:370-373.

CHAPTER III

EFFECTS OF FIELD BORDER HABITAT ON BREEDING BIRDS

Grassland avian species have endured significant population declines and as a group, have the fewest species with increasing population trends of any avian guild (Peterjohn and Sauer 1999). Such declines are the likely result of extensive loss and degradation of native grassland habitats mostly throughout the mid-west United States (Johnson and Schwartz 1993, Noss et al. 1995, Herkert et al. 1996), as well as the conversion of alternative grassland habitat, such as hayfields and pastures, to row-crop monoculture fields (Herkert 1994). Grassland bird populations remained stable between the 1920's and 1950's, when diversified farming was common (Warner 1994). However, modern farming has applied intensive cropping practices that parallel the declines of many grassland bird populations (Herkert 1995, Warner 1994). For example, advancements in agricultural technology have instigated "clean farming" techniques, which frequently lead to a reduction of weedy and shrubby habitats in agricultural regions (Best 1983). Over the past few decades, these reductions have resulted not only in a loss of strip cover habitat, but also an increase in crop field sizes (Rodenhouse et al. 1995). This loss of strip cover in agricultural landscapes may be debilitating to farmland avian communities, which exploit it for food, nesting sites, song perches, and cover (Rodenhouse et al. 1993).

The Conservation Reserve Program (CRP) was initiated through the Food Security Act in 1985 and represents a multi-faceted approach to habitat establishment. The widespread establishment of grassland habitat through the CRP has benefited many grassland birds, however, there remained substantial room for improvement (Ryan et al. 1998). For example, populations of some species that were declining before (1966-1985) CRP initiation, such as the Dickcissel (-2.87 %/year, *Spiza americana)* and Northern Bobwhite (-2.08 %/year, *Colinus virginianus*), have continued to decline (Ryan et al. 1998, McCoy et al. 1999). This lack of positive response by certain species has resulted in alternative habitat establishment approaches, such as the National Conservation Buffer Initiative (NCBI). The NCBI focuses on utilizing programs such as the CRP to establish conservation buffers, a form of strip cover, for soil and chemical retention in fields, improving soil and water quality, protecting biodiversity, and enhancing fish and wildlife habitat in agricultural regions (http://www.nrcs.usda.gov/feature/buffers).

One method of buffer establishment through the NCBI is CP33-Habitat Buffers for Upland Birds (e.g., field borders). Field borders are enhanced linear strips of herbaceous vegetation (Marcus et al. 2000) and have more flexibility of establishment location relative to other types of conservation buffers (e.g., riparian buffers must be placed on the down slope side of a field). Field borders and similar habitat benefit the avian community by providing nesting habitat, foraging habitat, roosting sites, movement corridors, and escape cover (Puckett et al. 1995, Marcus et al. 2000, Puckett et al. 2000, Smith 2004). Similar linear habitat has also shown to harbor enhanced avian abundances (Best et al. 1995). In agricultural landscapes, field borders may be particularly beneficial for birds on wooded field edges, where avian abundances are typically highest (Best et al. 1990). Located adjacent to agricultural fields, they may also increase the suitability of such fields for wildlife use (Puckett et al. 2000). Field borders have also been found to enhance herbaceous species diversity throughout a farm (Moonen and Marshall 2001). This enhanced diversification of vegetative structure and composition may positively influence farmland avian communities (Rotenberry 1985, Bryan and Best 1994). Furthermore, field borders may provide direct economic benefit to landowners by harboring insects with agronomic benefits (Marshall and Moonen 2002) and preventing the incursion of invasive weeds into crop fields when sown with perennial grasses (Davison 1941, Marshall and Moonen 2002). Field borders have not always been popular because they take land out of production, however, they are becoming more widely accepted by landowners due to the incentives associated with Continuous signup CRP and their minimal economic impact when placed on field margins (Davison 1941, Dambach 1945). In the MAV, landowner acceptance of field borders frequently stems from their concern for Northern Bobwhite populations, having seen them nearly extirpated from the area. This concern is reinforced by Breeding Bird Survey data, which estimates Northern Bobwhite populations to have declined in the MAV at –1.93 %/year and –5.83 %/year from 1966 to 1980 and 1980 to 2003, respectively (Sauer et al. 2004).

Despite the increasing popularity and establishment of field borders, there have been relatively few studies assessing their value (Marcus et al. 2000, Smith 2004). Furthermore, there remains a knowledge gap on avian response to increased border width. This must be addressed as recent findings on the value of edge habitat for wildlife have disrupted previous notions that edges were indefinitely suitable wildlife habitat (Gates and Gysel 1978, Ratti and Reese 1988, Paton 1994). Wider borders may benefit birds by providing habitat farther from the wooded edge, as habitat suitability can decrease for some species with proximity to an edge (Gates and Gysel 1978), whereas others may have reduced abundances near edges or avoid them entirely (Johnson and Temple 1986). Increased grassland area of wide borders may attract such area-sensitive species that exhibit edge aversion behavior, thereby broadening the spectrum of potential species able to exploit field border habitat (Herkert 1994, Vickery et al. 1994). Previous studies on width of linear habitat have documented wider fencerows with greater wildlife appeal due to increased vegetative heterogeneity (Rodenhouse and Best 1983). Additionally, increased width for road rights-of-way habitat positively influenced avifaunal density and diversity (Warner 1992).

The primary objective of this study was to evaluate the influence of field borders on the breeding avian community. Specifically, we investigated the impact of increased border width and vegetative physiognomy and composition on avian abundance, richness, and standardized conservation value. Based on previous strip cover and grassland habitat research, we hypothesized that (1) avian abundance and field border width would correspond positively, (2) avian richness would have a positive relationship with border width, and (3) area-sensitive grassland birds would be more abundant in wide borders.

Methods

Study Site

This study was conducted on six farms in Sunflower County, Mississippi during three consecutive breeding seasons (May-July of 2002–2004). This region had negligible topographical relief and was historically bottomland-hardwood forest; hence, herbaceous field borders do not constitute restoration of native habitat. All farms were located within 16 km of one another and were representative of the MAV landscape, being dominated by intensive agricultural production fields of cotton (*Gossypium* sp.) and soybean (*Glycine* sp.). All agricultural fields were under conventional or conservation tillage regimes and should not inflict bias on avian community patterns (Castrale 1985). The landscape was predominantly agricultural row-crop fields fragmented by wooded fencerows and riparian zones (e.g., drainage ditches, rivers, and streams). Soil associations on the farms were primarily Dundee silt loam or Forestdale silt loam. These are stratified alluvium soils of fine to coarse texture that were washed in by the Mississippi River, have poor to moderate drainage, and vary widely in acidity levels (Powell et al. 1952). Average precipitation over the three study years was higher during June (20.1 cm) than in May (8.7 cm) or July (10.1 cm). Average summer rainfall was also lower during 2002 (19.1 cm) than either 2003 (39.2 cm) or 2004 (58.5 cm).

Experimental field borders were established between a wooded field margin (typically an old fencerow) that enclosed a drainage ditch, and an agricultural row-crop field. All borders were approximately 400 m in length, but varied in width (narrow vs.

wide-bordered). Control (non-bordered) field margins located on comparable field margins and contained no herbaceous buffer. This was representative of traditional farming practices in the MAV, where fields were planted with row-crops from “ditch to ditch” with clean farming techniques. Farm operators were requested not to disturb (mow, burn, treat with chemicals, drive on, or disk) field borders during the study. However, this failed to prevent some border destruction, which resulted in a substantially reduced sample size after the first year. Hence, field margin treatments included non-bordered (2002: n = 19; 2003: n = 21; 2004: n = 21), narrow-bordered (2002: mean = 10.0 m, SE = 0, n = 38; 2003: mean = 8.5 m, SE = 1.8 m, n = 27; 2004: mean = 7.3 m, SE = 2.2 m, n = 24), and wide-bordered (2002: mean = 34.4, SE = 6.8 m, n = 8; 2003: mean = 32.7 m, SE = 9.0 m, n = 7; 2004: mean = 29.7 m, SE = 10.2 m, n = 11) margins.

Community Assessment

The avian community was censused during the breeding seasons (May–July) of 2002–2004 using line-transect surveys (Buckland et al. 2001). Each transect was surveyed for 10 minutes over a 200 m distance, with a buffer ≥100 m between other transects. Transects were paced evenly to ensure the entire transect received equal census time. One individual censused >95 % of transects to reduce potential observer bias. Line-transect surveys were conducted within three hours post-sunrise (CST) on days with no precipitation and wind <12 km/hr. Surveys were initiated during late-May, after spring migration had ceased and were conducted three times (May, June, and July) each breeding season. Flyover observations were not included, as their presence was not likely associated with field border presence. We recorded all birds in 3-10 m parallel distance bands adjacent to line-transects to estimate avian response in field margin regions (agricultural field, FBZ, and wooded edge) relative to border treatment (non-, narrow, and wide). The FBZ was 10 m adjacent to the wooded edge and consisted of herbaceous vegetation for narrow and wide-bordered margin treatments, whereas it represented traditional "ditch to ditch" farming practices on non-bordered margins. The agricultural field encompassed 30 m of row-crops adjacent to the FBZ. The wooded edge was 20 m adjacent to the FBZ and was typically composed of old fencerow. We restricted observations within 30 m of the border to focus on the avian community associated with field border presence. Count data consisted of the maximum abundance of each species found per field margin over all three surveys. This technique reduced the potential of omitting species not present during some surveys and maintained our ability to document species composition and abundance per border without bias.

Vegetation Surveys

We sampled 7 vegetation plots at random locations in each field border. Vegetation surveys were conducted during the middle of each month in the breeding season (May, June, and July) from 2002–2004, totaling three surveys each season. Vegetation plots were circular and 8 m in diameter. Variables measured within plots include vegetative composition (percentages of forb, grass, row-crop, and woody cover) and vertical cover. Vertical cover was calculated at each plot using a modified Robel pole that measured effective height of the vegetation (Robel et al. 1970, Renken and

Dinsmore 1987). Measurements on the pole were recorded from each cardinal direction at a distance of 4 m and height of 1 m. The height on the modified Robel pole where vegetation completely obstructed visibility was recorded to the nearest centimeter and the average provided an indice of vertical cover for each plot. Vegetative composition proportions (forb, grass, row-crop, and woody cover) were visually estimated in four quadrants of the circular plot. Some field borders were sprayed with herbicide to prevent the domination of invasive species (e.g., johnson grass, *Sorghum halepense*) however, the effect of herbicide applications were trivial relative to total vegetative composition and structure, and did not appear to influence avian habitat use. Experimental field borders were planted in spring 2002 with a mixture of indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), partridge pea (*Chamaecrista fasciculata*), and kobe lespedeza (*Lespedeza striata*). Despite plantings, the floral composition of field borders were commonly dominated by horsetail (*Conyza canadensis*), seashore vervain (*Verbena litoralis*), bermuda grass (*Cynodon dactylon*), johnson grass, goldenrod (*Solidago* spp.), common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*Ambrosia trifida*), poison ivy (T*oxicodendron radicans*), curly dock (*Rumex crispus*), and *Rubus* spp. Vegetative comparisons among border width treatments were analyzed for May of 2004, as this time period represents the site-selection phase of breeding birds for mature (three years old) field borders.

Statistical Analyses

Avian community measurements included richness, abundance, and total avian conservation value (TACV; Nuttle et al. 2003) in each field margin region. TACV was calculated by multiplying the abundance for each species observed by their respective Partners in Flight priority rank (http://www.rmbo.org/pif/scores/scores.html). Priority ranks were calculated based upon breeding and wintering distribution, relative abundance, potential threats to breeding and wintering habitat, population trend, and physiographic-specific area importance value (Carter et al. 2000). These numbers were then summed across all species to produce a TACV score for the treatment-habitat region combination of interest. We applied PIF scores reported for birds in the Mississippi Alluvial Valley during the breeding season. Unidentified birds were not assigned a PIF rank, and were excluded from subsequent analyses.

We detected a year effect on abundance, thus analyzed the avian community with a repeated measures analysis of variance (ANOVA) using PROC GLM (SAS Institute, Inc., 2003) to test for differences of species-specific abundances, overall abundance, species richness, and TACV among margin treatments, with year as the repeated time effect. However, we report species-specific mean abundances for combined years to include all experimental borders, as some were eliminated from repeated measures tests due to sample size differences between years. Species-specific abundances are reported for the FBZ and agricultural field regions, but not for the wooded edge due to the influence that woody vegetation has on the avian community compared to herbaceous strip cover (Arnold 1983). Due to the variation of habitat types included in line-transects and limitation of distance bands, we include no observations beyond 30 m of the transect line. This permits the reasonable assumption of a 100% detection probability with minimal bias, eliminating the need for detection functions (Diefenbach et al. 2003). We also tested for an influence of adjacent crop type, as it has been known to influence avian use of strip cover habitat (Shalaway 1985). Diversity indices were not used, as they can provide ambiguous interpretations and are not recommended for accurate community comparisons (Hurlbert 1971, Gotelli and Entsminger 2001).

Field border characteristics were modeled using multiple linear regression in PROC REG (SAS Institute, Inc., 2003) to test for influence of explanatory variables (border width, % grass cover, % forb cover, % woody cover, and vertical cover) on avian community response variables (abundance, richness, and TACV) within the border and adjacent agricultural field. All vegetative percentage measurements (grass cover, forb cover, and woody cover) were adjusted with an arcsine square root transformation to stabilize variance in the model. Vegetative cover and avian richness were modeled with a simple linear regression using PROC REG (SAS Institute, Inc., 2003). Vegetative differences among field-border width treatments were investigated using an ANOVA.

Results

We documented 78 avian species and counted 15,390 total birds in and around agricultural field margins in the MAV during the summers of 2002-2004. The most common birds observed were Red-winged Blackbird (*Agelaius phoeniceus*; 30.0%), Northern Cardinal (*Cardinalis cardinalis*; 9.6 %), Common Grackle (*Quiscalus quiscula*;

7.5 %), Mourning Dove (*Zenaida macroura*; 5.4 %), Indigo Bunting (*Passerina ciris*; 4.9 %), Blue Jay (*Cyanocitta cristata*; 4.9 %), Dickcissel (*Spiza americana*; 4.5 %), and Carolina Wren (*Thryothorus ludovicianus*; 4.3%). We counted 31 species and 590 total birds within the FBZ. The most common birds within the FBZ included Red-winged Blackbird (44 %), Northern Cardinal (14.4 %), Dickcissel (11.1 %), Indigo Bunting (7.1 %), and Mourning Dove (7.1 %). Red-winged Blackbird, Dickcissel, Mourning Dove, Indigo Bunting, and Northern Cardinal abundances were significantly enhanced in bordered margins (Table 3.1). However, Common Grackle abundance did not differ significantly among treatments (Table 3.1).

There was no influence of adjacent crop type on avian abundance ($F_{6,491} = 1.64$, $P = 0.135$) except for wheat (other crop = 14.43, SE = 0.74, wheat = 36.17, SE = 6.73; $F_{1,502} = 10.30$, $P = 0.001$), which resulted in significantly increased abundance. Field borders adjacent to wheat fields were excluded from further analyses to avoid bias. Multiple linear regression of field border characteristics provided a relatively poor explanatory model within the field border and adjacent crop field ($R^2 = 0.277$, 0.097, 0.285) for abundance, richness, and TACV, respectively. Border width was the only factor in each model that significantly influenced ($P < 0.05$) all community measures, with more influence on abundance ($t_{1,68} = 3.74$, $P < 0.001$) and TACV ($t_{1,68} = 3.86$, $P < 0.001$) than richness ($t_{1,68} = 2.11$, $P = 0.039$). Effective vegetative height (narrow = 75.65, SE = 1.67, wide = 82.79, SE = 2.29; $F_{1,268} = 6.35$, P=0.012) and forb cover (narrow = 43.04, SE = 1.68, wide = 52.25, SE = 2.29; $F_{1,268} = 10.50$, $P = 0.001$) were significantly greater in wide than narrow field borders, indicating greater vegetative heterogeneity in wide borders. Grass cover did not differ between treatments (narrow = 49.27, SE = 1.76, wide = 47.14, SE = 2.41; $F_{1,268} = 0.51$, $P = 0.476$), however, agricultural crop invasion was much more prevalent in narrow field borders (narrow = 4.693, SE = 0.68, wide = 0.00, SE = 0.98; $F_{1,268} = 16.80$, $P < 0.001$).

Avian abundance ($F_{2,47} = 13.22$, $P < 0.001$), richness ($F_{2,47} = 11.03$, $P < 0.001$), and TACV ($F_{2,47} = 14.25$, $P < 0.001$) were significantly higher within the FBZ for narrow and wide-bordered margins compared with non-bordered margins, with considerably enhanced abundance and TACV in wide borders than narrow (Figures 3.1-3.3). Significant increases for abundance ($F_{2,47} = 5.35$, $P = 0.008$; $F_{2,47} = 3.91$, $P = 0.027$), richness ($F_{2,47} = 3.75$, $P = 0.031$; $F_{2,47} = 5.41$, $P = 0.008$), and TACV ($F_{2,47} = 5.99$, $P = 0.005$; $F_{2,47} = 4.27$, $P = 0.020$) were also observed in the adjacent agricultural field and wooded edge, respectively (Figures 3.4-3.9). Again, there was a trend of enhanced abundance and TACV for wide borders than narrow in the agricultural field region (Figures 3.4 and 3.6). These increases suggest the beneficial influence of field borders on surrounding habitats. Repeated measures ANOVA revealed a year effect for abundance ($F_{1,47} = 4.36$, $P = 0.042$), richness ($F_{1,47} = 4.36$, $P = 0.042$), and TACV ($F_{1,47} = 12.91$, $P = 0.002$) in the agricultural field. However, year had relatively little influence on abundance ($F_{1,47} = 4.03$, $P = 0.050$; $F_{1,4\ 7} = 0.36$, $P = 0.547$), richness ($F_{1,47} = 0.82$, $P = 0.371$; $F_{1,47} = 0.51$, $P = 0.479$), and TACV ($F_{1,47} = 3.38$, $P = 0.072$; $F_{1,47} = 0.10$, $P = 0.757$) in the FBZ and wooded edge, respectively. This may be associated to differences in row-crop field composition between years.

Table 3.1 Species-specific Abundances

Mean abundances and standard errors (SE) of the five most common species (ranked in descending order in wide borders) in the FBZ and adjacent crop field per field margin treatment in the MAV during 2003 and 2004.

Species[a]	Non-bordered		Narrow-bordered		Wide-bordered		$F_{2,47}$	*P*
	Mean	SE	Mean	SE	Mean	SE		
Red-winged Blackbird	1.57	0.75	6.20	0.62	14.17	2.05	7.46	0.002
Dickcissel	0.07	0.17	1.10	0.14	2.78	0.51	8.75	<0.001
Mourning Dove	0.31	0.14	0.64	0.13	2.39	0.48	8.37	<0.001
Common Grackle	0.13	0.24	0.80	0.20	1.50	0.34	0.53	0.590
Indigo Bunting	0.13	0.09	0.45	0.08	0.44	0.11	3.99	0.030
Northern Cardinal	0.26	0.14	0.73	0.11	0.28	0.15	3.86	0.030

[a] Refer to text for scientific names.
Note: This table includes data from transects excluded from the repeated measures ANOVA.

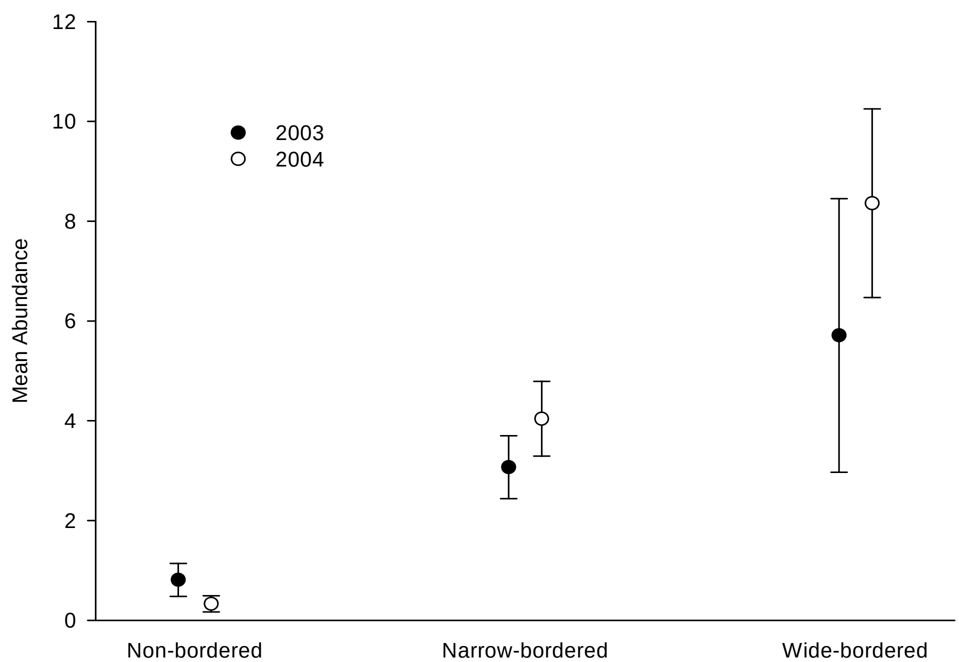

Figure 3.1 Avian Abundance in the FBZ

Total mean avian abundances for field border treatments in the field border zone (FBZ).

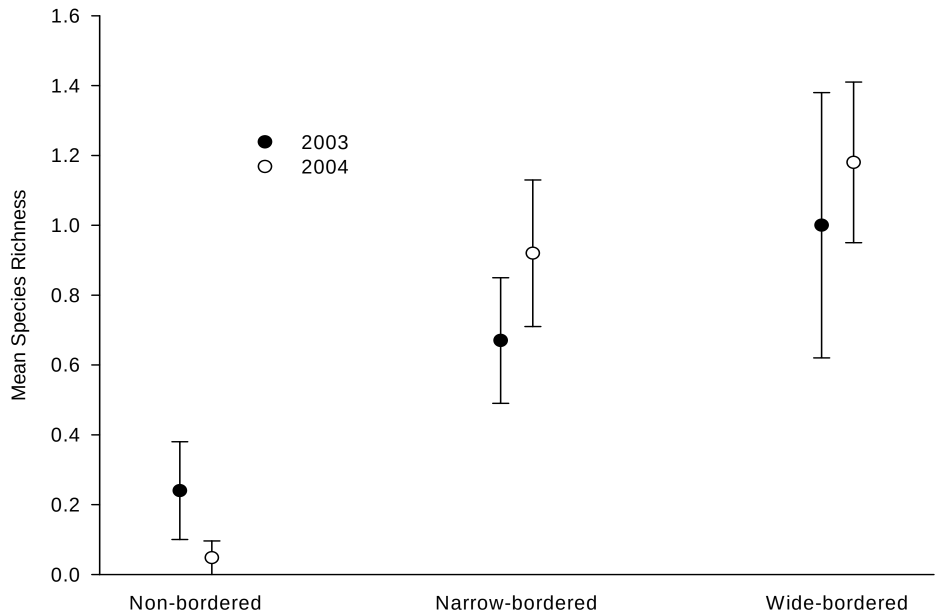

Figure 3.2 Avian Richness in the FBZ

Total mean avian richness for field border treatments in the field border zone (FBZ).

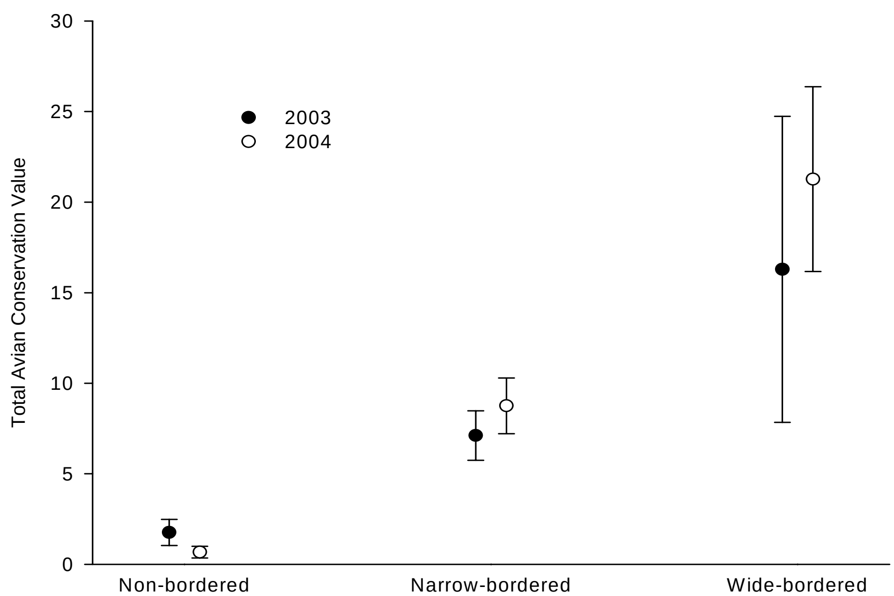

Figure 3.3 TACV in the FBZ

Total avian conservation value (TACV) for field border treatments in the field border zone (FBZ).

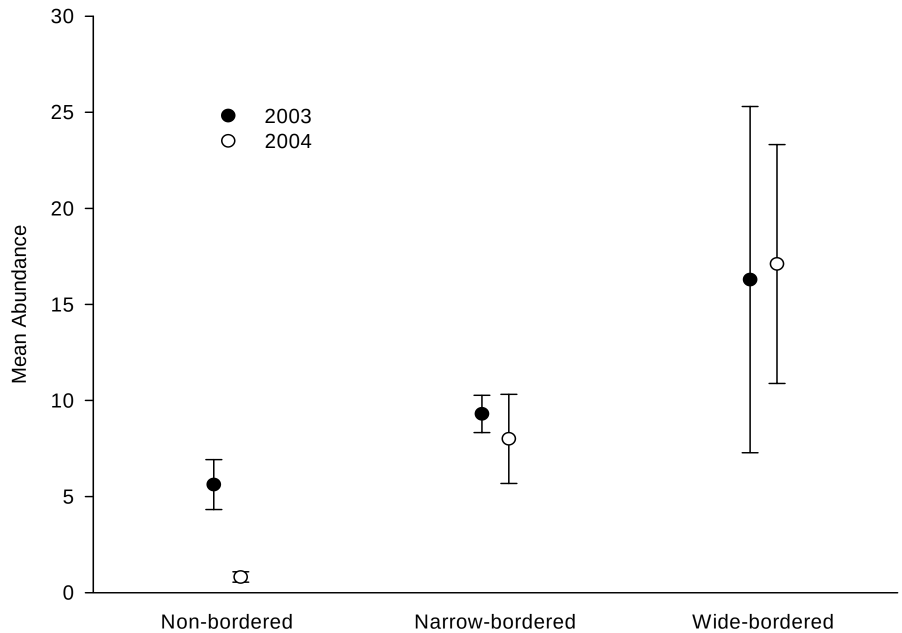

Figure 3.4 Avian Abundance in the Agricultural Field

Total mean avian abundance for field border treatments in the agricultural field.

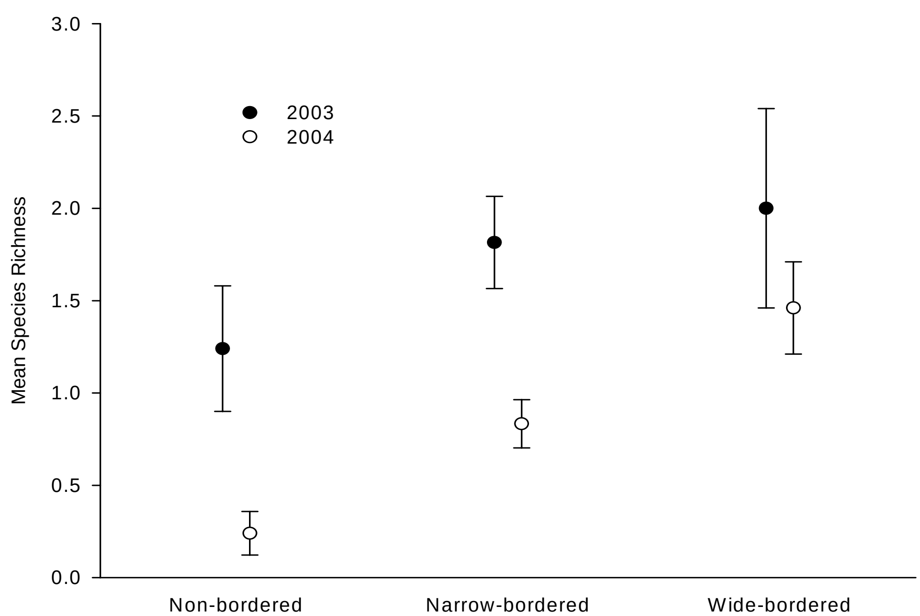

Figure 3.5 Avian Richness in the Agricultural Field

Total mean avian richness for field border treatments in the agricultural field.

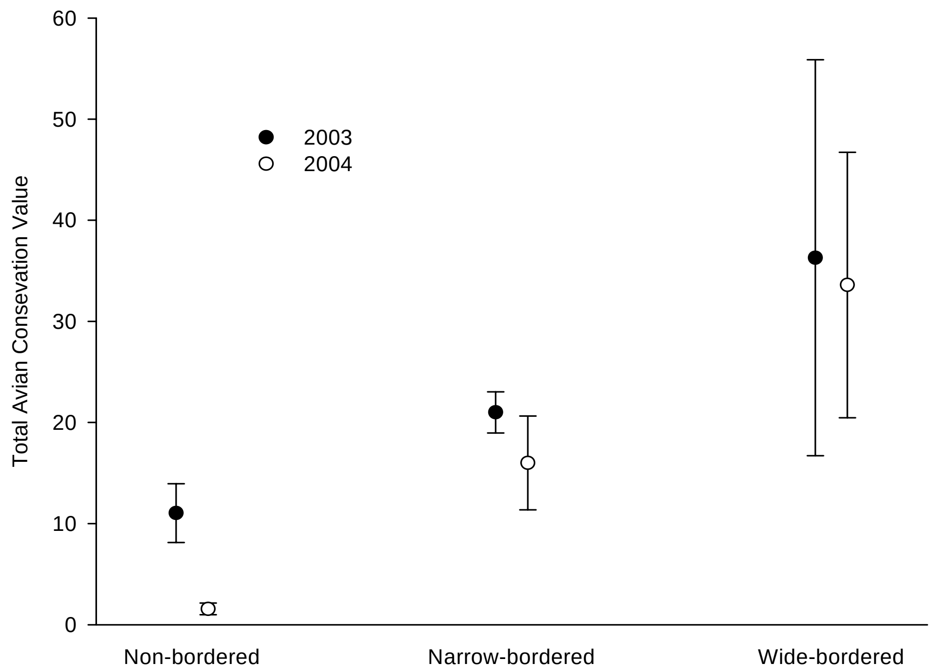

Figure 3.6 TACV in the Agricultural Field

Total avian conservation value (TACV) for field border treatments in the agricultural field.

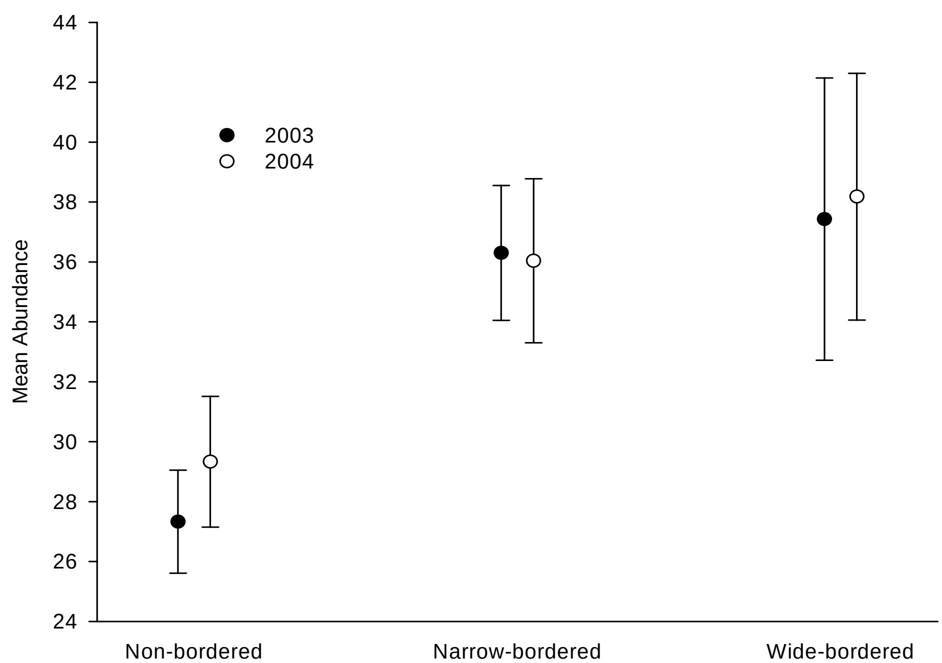

Figure 3.7 Avian Abundance in the Wooded Edge

Total mean avian abundance for field border treatments in the wooded edge.

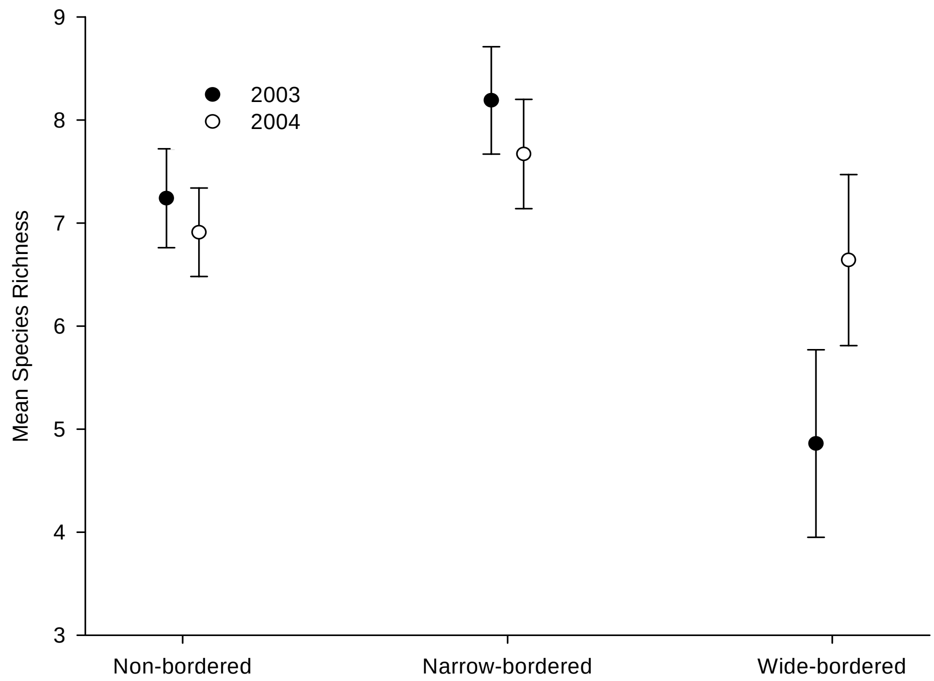

Figure 3.8 Avian Richness in the Wooded Edge

Total mean avian richness for field border treatments in the wooded edge.

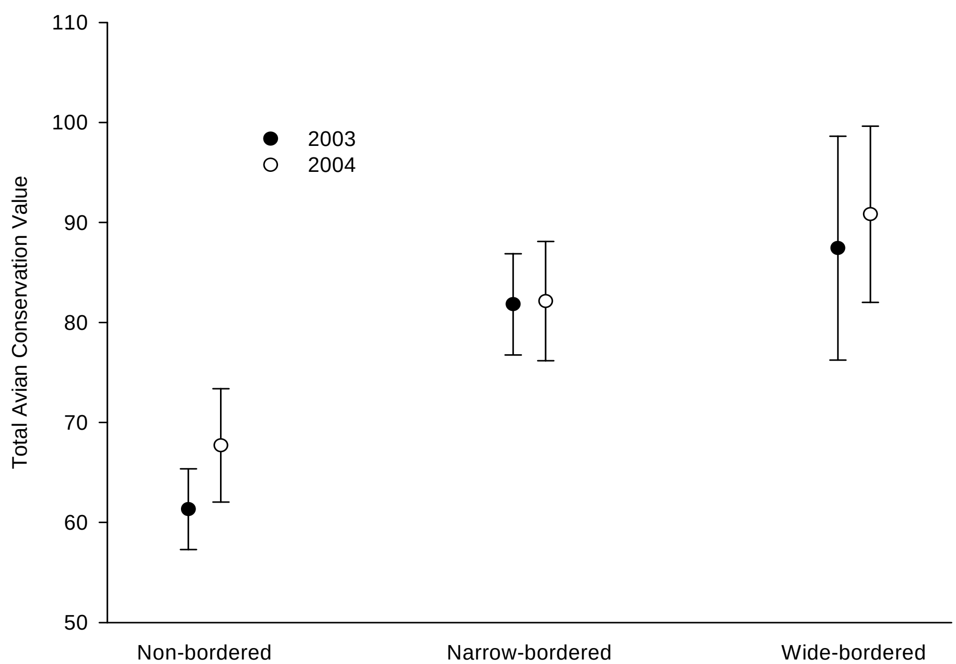

Figure 3.9 TACV in the Wooded Edge

Total avian conservation value (TACV) for field border treatments in the wooded edge.

Discussion

Species-specific Response

All avian species frequently observed inhabiting agricultural field margins in the MAV were positively influenced by field border presence. Red-winged Blackbird, Dickcissel, Mourning Dove, Indigo Bunting, Northern Cardinal, and Common Grackle all experienced greater than twofold abundance increases in narrow vs. non-bordered field margins. The intensive use of field border habitat by these species is encouraging for avian conservation as Dickcissel (-3.68 %/year), Mourning Dove (-2.34 %/year), and Red-winged Blackbird (-2.51 %/year) all have strongly declining populations (1980-2003) throughout Mississippi (Sauer et al. 2004). The inclination that Dickcissel had for field border habitat is reassuring, as they are a species of high conservation concern (http://www.rmbo.org/pif/pifdb.html), and the large-scale destruction of their populations in Venezuela has no visible end (Basili and Temple 1999).

Field borders appear to enhance the suitability of wood lines on an agricultural field margin by providing herbaceous habitat suitable for foraging, nesting, and maintenance activities, rather than an abrupt crop-wooded edge. Northern Cardinal and Indigo Bunting, albeit primarily forest species, their abundances were greater in bordered margins. The more woodland-oriented species (e.g., Northern Cardinal and Indigo Bunting) responded similarly to wide and narrow field borders and likely benefit most from field border habitat nearest the wooded edge. Although habitat similar to field borders was found to benefit Northern Bobwhite (Puckett et al. 2000), this study area did not have adequate populations to detect any trends.

Red-winged Blackbird, Dickcissel, and Mourning Dove abundances were at least two times greater in wide-bordered margins than narrow. These species probably benefit more from larger field borders, as they are more apt to exploit forage and nest-site resources throughout the entire plot, rather than being area-restricted near the wooded edge. Increased Dickcissel abundance in wide borders was not expected, as they are not considered an area-sensitive species (Herkert 1994). We propose their preference for wide borders may be a bi-product of nest-site suitability, however, mechanisms for this pattern should be investigated further. Wide borders also had greater vegetative cover, and higher proportion of forbs than grasses, thereby enhancing forage resources (Robel and Harper 1965). Additionally, the vegetative integrity of wide field borders was more resilient relative to narrow borders, which were prone to crop invasion, accidental herbicide application, and utilization as a turn row by tractors. These vegetative components may have influenced abundance responses of Red-winged Blackbird and Dickcissel, as both were previously found to prefer tall, dense cover and forb-dominated grassland habitats (Bryan and Best 1994).

Community Response

Avian communities inhabiting farmland in the MAV responded positively overall to the implementation of field borders on agricultural-wooded field margins. Avian richness, abundance, and TACV were significantly greater in narrow than non-bordered margins within both the FBZ and adjacent crop field. Community metrics in wooded edges were less influenced by field border presence. However, when adjacent to narrow borders they experienced greater TACV and abundance, which suggests narrow field borders may benefit birds in all adjacent habitat types. This positive response of bird abundance and richness likely reflects increased vegetative structural diversity and floral composition in narrow than non-bordered margins. Additionally, the increase in TACV confirms the benefit of narrow field borders to the overall conservation strategy in agricultural landscapes.

Wide-bordered margins supported substantially greater avian abundance and TACV in the FBZ and adjacent agricultural fields. Field border width did not significantly impact richness of avian communities on field margins during either year. The significant increase of abundance in wide compared to narrow field borders may have resulted from the enhanced vegetative structural diversity and increased cover experienced in wide borders. It is also probable, however, that avian response to wider borders is resultant of increased grassland area and reduced coverage by row-crop monoculture fields.

Multiple linear regression models revealed field border width as the most influential variable on avian community metrics, especially for abundance and TACV. The failure of our model to explain much variability of avian field-margin use insinuates the presence of important unmeasured variables. We suspect landscape composition may be a primary variable our model lacked, as Donovan et al. (1997) found that landscape composition and local-scale characteristics are both influential factors on community structure. We recommend this be analyzed in greater detail in future studies. Furthermore, it is not surprising that local-scale characteristics, such as vegetative composition, did not comprehensively explain avian habitat use of field borders as the MAV is mostly devoid of early successional habitat; thus birds likely employ a less restrictive behavioral disposition toward habitat selection in such an agricultural-dominated landscape.

Management Implications

Emergence of NWSG, partridge pea, and kobe lespedeza occurred hesitantly during the first year, therefore immediate results should not be anticipated. The vegetative cover thickened considerably over the following two years until grasses became nearly impenetrable by year three in some borders. We therefore recommend a maintenance regime be implemented during winter between the third and fifth year post-establishment, in accordance with Vogl (1974). Such disturbances (e.g., burning, mowing, or disking) are necessary not only to prevent a digression of habitat quality caused by disproportionately high vegetative density, but also to reduce encroachment of woody vegetation and thereby maintain the vigor and structural heterogeneity of the herbaceous field border. Mowing may be an effective management regime, however, should not occur until mid to late-August, once nesting has subsided and bird use of borders decreases (Bryan and Best 1991), yet there is still enough time in the growing season for field border vegetation to regenerate, providing birds that over-winter with adequate forage and cover. Further evaluation of vegetative response in field borders to varying disturbance regimes is necessary. Borders of evenly balanced forb and grass composition may not require disturbance implementation as frequently as grass-dominated borders, as they better maintained vegetative heterogeneity over the three years of the study. Additionally, we recommend execution of maintenance regimes in a cyclic rotation that permits some population of field borders on a farm to remain undisturbed each year, thereby providing cover for over-wintering birds (Smith et al. 2005 in review) and nesting substrate for early arrivals in the breeding season (Best 1986, Murray and Best 2003).

The decline of grassland birds in North America has remained an issue deserving of attention since the degradation of native-grassland habitat initiated (Herkert et al. 1996, Peterjohn and Sauer 1999). The NCBI promotes establishment of strip-cover habitats as conservation buffers. Such buffer habitat can improve farmland health through the retention of soil and chemicals in fields, hindering incursion of invasive weeds into crop fields, and harboring agronomically beneficial insects (Davison 1941, Marshall and Moonen 2002). Furthermore, we found that buffer habitat in the form of field borders can have substantial benefits for farmland avian communities. Farmland-integrated habitat, such as field borders, are of increasing importance with the enhanced strain on natural resources from worldwide food demands and expanding human populations (Tilman et al. 2002, Robertson and Swinton 2005). Field borders may be an excellent example of suitable conservation buffer habitat, as they effectively balance wildlife and landowner needs, and are becoming increasingly popular and established (http://www.nrcs.usda.gov/feature/buffers). Results from this study suggest field borders provide quality avian habitat in agricultural-dominated landscapes. We propose field borders, especially of widths that exceed 10 m may increase the ecological integrity and sustainability of agricultural landscapes and their incorporation into farmland resource management systems should be standard practice.

Literature Cited

Arnold, G. W. 1983. The influence of ditch and hedgerow structure, length of hedgerows, and area of woodland and garden on bird numbers on farmland. Journal of Applied Ecology 20:736-750.

Basili, G. D. and S. A. Temple. 1999. Winter ecology, behavior, and conservation needs of Dickcissels in Venezuela. Studies in Avian Biology 19:289-299.

Best, L. B. 1983. Bird use of fencerows: implications of contemporary fencerow management practices. Wildlife Society Bulletin 11:343-347.

Best, L. B., R. C. Whitmore, and G. M. Booth. 1990. Use of cornfields by birds during breeding season: the importance of edge habitat. American Midland Naturalist 123:84-99.

Best, L. B., K. E. Freemark, J. J. Dinsmore, and M. Camp. 1995. A review and synthesis of habitat use by breeding birds in agricultural landscapes of Iowa. American Midland Naturalist 134:1-16.

Brawn, J. D., S. K. Robinson, and F. R. Thompson, III. 2001. The role of disturbance in the ecology and conservation of birds. Annual Review of Ecology and Systematics 32:251-276.

Bryan, G. G. and L. B. Best. 1991. Bird abundance and species richness in grassed waterways in Iowa rowcrop fields. American Midland Naturalist 126:90-102.

Bryan, G. G. and L. B. Best. 1994. Avian nest density and success in grassed waterways in Iowa rowcrop fields. Wildlife Society Bulletin 22:583-592.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling. Oxford University Press, New York.

Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: The partners in flight approach. Auk 117:541-548.

Castrale, J. S. 1985. Responses of wildlife to various tillage conditions. Transactions of the North American Wildlife Natural Resources Conference 50:142-156.

Dambach, C. A. 1945. Some biologic and economic aspects of field border management. Transactions of the North American Wildlife Conference Pp. 169-184.

Davison, V. E. 1941. Wildlife Borders—An Innovation in Farm Management. Journal of Wildlife Management 5:390–394.

Diefenbach, D. R., D. W. Brauning and J.A. Mattice. 2003. Variability in grassland bird counts related to observer differences and species detection rates. Auk 120:1168-1179.

Donovan, T. M., P. W. Jones, E. M. Annand, and F.R. Thompson III. 1997. Variation in local-scale edge effects: mechanisms and landscape context. Ecology 78:2064-2075.

Gates, J. E. and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59:871-883.

Gotelli, N. J. and G. L. Entsminger. 2001. EcoSim: Null models software for ecology. Version 7.0. Acquired Intelligence Inc. & Kesey-Bear. http://homepages.together.net/~gentsmin/ecosim.htm

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

Herkert, J. R. 1995. An analysis of midwestern breeding bird population trends: 1966-1993. American Midland Naturalist 134:41-50.

Herkert, J. R., D. W. Sample, R. E. Warner. 1996. Management of Midwestern grassland landscapes for the conservation of migratory birds. Pp. 89-116 in Management of agricultural landscapes for the conservation of Neotropical migratory birds (F. R. Thompson, III, Ed.). General Technical Report NC-187. U.S. Forest Service, St. Paul, Minnesota.

Hurlbert, S. H. 1971. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54:187-211.

Johnson, R. G. and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies *in* Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. Eds. J. Verner, M.L. Morrison and C.J. Ralph. University of Wisconsin Press, Madison, Wisconsin.

Johnson, D. H. and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conservation Biology 7:934-937.

Marcus, J. F., W. E. Palmer, and P. T. Bromley. 2000. The effects of farm field borders on over-wintering sparrow densities. Wilson Bulletin 112:517-523.

Marshall, E. J. P. and A. C. Moonen. 2002. Field margins of northern Europe: their functions and interactions with agriculture. Agriculture, Ecosystems, and Environment 89:5-21.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger, Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530-538.

Moonen, A. C. and E. J. P. Marshall. 2001. The influence of sown margin strips, management and boundary structure on herbaceous field margin vegetation in two neighbouring farms in southern England. Agriculture, Ecosystems, and Environment 86:187-202.

Murray, L. D. and L. B. Best. 2003. Short-term bird response to harvesting switchgrass for biomass in Iowa. Journal of Wildlife Management 67:611-621.

Noss, R. F., E.T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. United States Department of the Interior National Biological Service Biological Report 28, Washington, D.C., USA.

Nuttle, T., A. Leidolf and L. W. Burger Jr. 2003. Assessing conservation value of bird communities with Partners in Flight-based ranks. Auk 120:541-549.

Paton, P. W. C. 1994. The effect of edge on avian nest success: how strong is the evidence? Conservation Biology 8:17-26.

Peterjohn, B. G. and J. R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology 19:27-44.

Powell, J. C., W. E. Keenan, W. A. Cole, L. C. Murphree, D. A. Yost, J. J. Pitts, and R. H. Wells. 1952. Soil survey of Sunflower County, Mississippi. USDA Soil Conservation Service. Mississippi Agricultural Experiment Station. Pp. 45.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr., and T.L. Sharpe. 1995. Bobwhite nesting ecology and modern agriculture: field examination with manipulation. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 49:507-517.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr. and T. L. Sharpe. 2000. Effects of Filter Strips on Habitat Use and Home Range of Northern Bobwhites on Alligator River National Wildlife Refuge. Quail IV: Proceedings of the Fourth National Quail Symposium Pp. 26–31.

Ratti, J. T. and K. P. Reese. 1988. Preliminary test of the ecological trap hypothesis. Journal of Wildlife Management 52:484-491.

Renken, R. B. and J. J. Dinsmore. 1987. Nongame bird communities on managed grasslands in North Dakota. Canadian Field-Naturalist 101:551-557.

Robel, R. J. and W. R. Harper. 1965. Energy content and retention by ragweed and sunflower seeds during fall and winter. Transactions of the Kansas Academy of Science 68:401-405.

Robel, R. J., J. N. Briggs, J. J. Cebula, N. J. Silvy, C. E. Viers, and P. G. Watt. 1970. Greater Prairie Chicken ranges, movements, and habitat usage in Kansas. Journal of Wildlife Management 34:286-306.

Robertson, G. P. and S. M. Swinton. 2005. Reconciling agricultural productivity and environmental integrity: a grand challenge for agriculture. Frontiers in Ecology and the Environment 3:38-46.

Rodenhouse, N. L. and L. B. Best. 1983. Breeding ecology of Vesper Sparrows in corn and soybean fields. American Midland Naturalist 110:265-275.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor, and E. K. Bollinger. 1993. Effects of temperate agriculture on neotropical migrant landbirds, p. 280-295. In: D. M. Finch and P. W. Stangel (eds.). Status and management of neotropical migratory landbirds. USDA Forest Service General Technical Report TM-229, Fort Collins, CO.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor, and E. K. Bollinger. 1995. Effects of agricultural practices and farmland structures in Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Eds. T. E. Martin and D. M. Finch. Oxford University Press, New York.

Rotenberry, J. T. 1985. The role of habitat in avian community composition: physiognomy or floristics? Oecologia 67:213-217.

Ryan, M. R., L. W. Burger, Jr., and E. W. Kurzejeski. 1998. The impact of CRP on avian wildlife: a review. Journal of Production Agriculture 11:61-66.

SAS Institute, Inc. 2003. Version 9.1. SAS Institute, Inc., Cary, North Carolina, USA.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966-2003. Version 2004.1, USGS Patuxent Wildlife Research Center, Laurel, MD.

Shalaway, S. D. 1985. Fencerow management for nesting birds in Michigan. Wildlife Society Bulletin 13:302-306.

Smith, M. D. 2004. Wildlife habitat benefits of field border management practices in Mississippi. Doctoral Dissertation, Mississippi State University, 2004.

Tilman, D., K. G. Cassman, P. A. Matson, R. Naylor, and S. Polasky. 2002. Agricultural sustainability and intensive production practices. Nature 418:671-677.

Vickery, P. D., M. L. Hunter, Jr., and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.

Vogl, R. J. 1974. Effects of fire on grasslands. Pp. 139-194 in T. T. Kozlowski and C. E. Ahlgren, eds. Fire and ecosystems. Acad. Press, New York, N.Y.

Warner, R. E. 1992. Nest ecology of grassland passerines on road rights-of-way in central Illinois. Biological Conservation 59:1-7.

Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: future shock for midwestern birds? Conservation Biology 8:147-156.

CHAPTER IV

GRASSLAND AVIAN NESTING ECOLOGY IN FIELD BORDERS

Land-use alterations and agricultural advances (machinery, herbicides, pesticides, and transgenic crops) have appreciably reduced and fragmented suitable grassland habitat that is crucial for wildlife (Herkert 1994, Noss et al. 1995). This loss of habitat may be linked to the survival of grassland-nesting birds; a guild that has been undergoing precipitous population declines (Warner 1994, Herkert et al. 1996, Winter and Faaborg 1999). Additive problems for grassland birds include the reduction of habitat quality in the presence of exotic grasses, unnecessary mowing, and rapid rates of succession (Burger 2000). To counter the negative effects of habitat loss on wildlife, habitat-based programs, such as the Conservation Reserve Program (CRP) offer private landowners financial incentive for enrollment. Recently, the National Conservation Buffer Initiative (NCBI) was established to promote the application of conservation buffer management practices through such programs. Some types of conservation buffers include filter strips, contour buffers, riparian buffers, grassed waterways, field windbreaks, shelterbelts, living snow fences, contour grass strips, cross-wind trap strips, alley cropping, herbaceous wind barriers, and field borders. Conservation buffers are placed along streams, field margins, or within the field to increase sediment retention in crop fields, improve soil and water quality, enhance fish and wildlife habitat, and protect biodiversity (Best 2000, http://www.nrcs.usda.gov/feature/buffers). In the Mississippi Alluvial Valley (MAV), the negative effects of habitat loss and fragmentation from agricultural practices, such as row-crop monocultures and "clean farming" (Best 1983) are severe. NCBI practices may therefore have the potential to greatly benefit grassland avian communities in the MAV, where early-successional habitat is scarce.

Field borders (classified in the NCBI as CP33-Habitat Buffers for Upland Birds) are enhanced linear strips of non-crop, herbaceous vegetation (Marcus et al. 2000) and consequently, are popular with landowners and agriculture producers because they can be established throughout a farm without the specific location restrictions imposed on other buffer types (e.g., riparian buffers must be along riparian zones), and accompany incentives through continuous signup CRP. Agricultural producers commonly establish field borders along a wooded field margin, where inherently lower crop productivity and net profit exists compared to field interiors (Davison 1941, Dambach 1945). Field borders represent herbaceous strip-cover habitat that is paramount to the survival of many birds via nesting cover, escape cover, loafing and roosting sites, and foraging habitat (Marcus et al. 2000, Puckett et al. 2000, Smith 2004). This efficacious balance of economic and environmental benefit has instigated increased popularity of field borders, which may potentially lead to their implementation in agricultural landscapes at relatively large scales. However, the majority of field-border research has focused on community measures (Marcus et al. 2000, Smith 2004) or high-profile species (Northern Bobwhite; *Colinus virginianus*; Puckett et al. 2000), and thus does not constitute a comprehensive assessment. To avoid caveats of improper management caused by potentially misleading habitat quality indicators, it is imperative to obtain a thorough understanding of avian nesting ecology in field borders (Van Horne 1983, Vickery et al. 1992).

Among the potential pitfalls associated with habitat establishment near ecotones are edge effects. Edge effects of primary concern for breeding birds include enhanced rates of nest predation and brood parasitism (Gates and Gysel 1978). Nest predation is a primary cause for nest failure in passerines (Ricklefs 1969, Martin 1993) and therefore the principal factor in assessing the conservation value of field borders. Narrow, linear strips of habitat are frequently associated with elevated nest predator abundance, activity rates, and search efficiency (Major et al. 1999, Woodward et al. 2001). Linear habitat can also act as travel corridors for mammalian predators (Fritzell 1978), whom frequently prey opportunistically on avian nests (Angelstam 1986, Vickery et al. 1992). The susceptibility of avian nests to predation may be even greater due to their location in a fragmented, agricultural landscape (Saracco and Collazo 1999, Winter et al. 2000, Chalfoun 2002, Roos 2002). An increase of brood parasitism rates with proximity to a wooded edge could further inhibit nesting success (Johnson and Temple 1990). In a review of edge effects, Paton (1994) documented a 50 m edge proximity threshold, where nests located within 50 m of a wooded edge experienced elevated edge effects. Our primary concern therefore lies in the severity of edge effects and their potential to render field borders as population sinks (Gates and Gysel 1978, Heske et al. 1999), particularly because field borders and similar habitat are rarely wider than 10 m (Puckett et al. 2000, Marcus et al. 2000, Smith 2004). Such a result would inhibit field border value and compromise their benefits for grassland avian conservation.

Less consistent results exist for edge effects in habitat with subtler, more transitional ecotones (Yahner et al. 1989, Saracco and Collazo 1999, Fleming and Giuliano 2001). Agricultural fields farmed with traditional row-crop techniques have abrupt, non-transitional edges at the field margin ecotone. Wide field borders may benefit birds by reducing the abruptness of such an edge by increasing the core amount of herbaceous habitat, thereby reducing the perimeter to area ratio (Helzer and Jelinski 1999). Linear habitat width and vegetative structure and composition are positively related (Petrides 1942, Rodenhouse and Best 1983), which could increase nest densities and reduce nest predation pressure by providing enhanced nest site diversity (Shalaway 1985, Martin 1993). Wider borders will also represent a larger contiguous area of herbaceous habitat than narrow borders, which may provide attractive nest sites for area-sensitive grassland birds (Helzer and Jelinski 1999, Winter and Faaborg 1999). Consequently, wider borders may have enhanced suitability and attractiveness for birds by reducing the intensity of edge effects and increasing vegetative heterogeneity, however, further investigation of edge effect discrepancies within close proximity (<50 m) of edges remains necessary (Paton 1994).

Avian habitat selection and use of field borders may also depend upon suitable vegetative structure and composition (Best 2000). Areas planted with native warm-season grasses (NWSG), as opposed to permitting the encroachment of exotics, provide increased wildlife value (Burger 2000), especially for Northern Bobwhite (Washburn et al. 2000). Additionally, these perennial grasses are ideal for the NCBI, as they can reduce invasibility of field margin flora into crop fields (Davison 1941, Marshall and Moonen 2002) and maximize sediment retention (T. Cooke unpubl. data). In Mississippi, NWSG plantings represent only 0.2% of land restored through the CRP (Burger 2000). Habitat established with NWSG is typically species poor because weed suppression requires herbicide application. This may not be ideal for many avian species, as Best (1983) reported a positive correlation between diversity of vegetative composition and structure with avian diversity. A balanced variety of forbs and grasses may also enhance suitability of habitat for birds by increasing vegetative heterogeneity (Wiens 1969). Furthermore, linear habitat of heterogeneous vegetative structure can yield higher nest densities and enhanced nesting success (Shalaway 1985). Erect residual vegetation is particularly crucial as nesting habitat in agricultural landscapes early in the season when crop fields do not offer adequate cover (Best 1986). Vegetation may also have a temporal influence on nesting success. As certain grassland-edge species are known to prefer tall, dense vegetation (Bryan and Best 1994), their nest success may increase later in the season when vegetative cover is greater and more preferred nesting conditions exist, but not necessarily. However, Grant et al. (2005) revealed a trend of enhanced nest success for grassland birds during the peak of nest initiation.

The growing popularity of field borders may result in their increased proliferation throughout southeastern agricultural landscapes. The potential for such an agricultural conservation movement heightens the demand for an ecological assessment to ensure field border management protocols provided to wildlife managers and private landowners are beneficial for farmland avian communities. Objectives of this study acknowledge that successful field border implementation relies on private landowner interest and minimal impact of economically valuable agricultural land. We therefore attempt to identify field border variables that maximize avian reproductive benefit and retain landowner appeal. In an attempt to evaluate a realistic range of field borders likely to be established by agricultural producers, the border width component of this study focuses on a small spatial scale (<50 m). This report evaluated the response of breeding birds to field border width and vegetative composition and structure to ascertain missing links of proper field border management. Additionally, we analyzed years individually to assess potential changes occurring over the initial three years post-establishment of field borders. We hypothesized that (1) nesting density would increase across the initial three years post border-establishment concomitantly with vegetation growth, (2) nesting success would be higher late in the breeding season from an increase of vegetative cover, (3) wide field borders would have greater vegetative heterogeneity and cover than narrow borders, (4) nesting density and success would relate positively to border width and vegetative cover, and (5) species richness of nesting birds would be enhanced in wide borders due to increased vegetative heterogeneity and total area.

Methods

Study Site

Our study site was located in the southern region of Sunflower County in northwest Mississippi, USA, which is located in the MAV (Bird Conservation Region 26, Physiographic Area 05). The MAV has little topographical relief and being historically bottomland hardwood forest, field borders do not represent native habitat. Currently, agricultural row-crop and catfish farms, fragmented by a network of drainage ditches, streams, wood lines, and fencerows, dominate the MAV landscape. Soil associations on the farms were primarily Dundee silt loam or Forestdale silt loam. These are stratified alluvium soils of fine to coarse texture that were washed in by the Mississippi River, have poor to moderate drainage, and vary widely in acidity levels (Powell et al. 1952). Average precipitation over the three of study was highest during June (20.1 cm) than in May (8.7 cm) or July (10.1 cm). Average summer rainfall was also lower during 2002 (19.1 cm) than 2003 (39.2 cm) or 2004 (58.5 cm).

Avian nesting ecology was investigated for non- (control), narrow, and wide-bordered field margins during the summers of 2002–2004. Non-bordered margins represented traditional farming practices in the MAV, which was either a dirt farm road or "ditch to ditch" row-crops, and were assessed in a "field border zone" (FBZ) that was 10 m immediately adjacent to a farm-field margin. Narrow-bordered margins were initially established at widths of 10 m, while wide borders represented various widths >15 m. All borders were established during the spring of 2002, however, the vegetation emerged successively over three years. Field borders were located in areas of similar local-scale features to minimize bias (Donovan et al. 1997). All borders were on a field margin, situated between a large (mean = 171.14 $\pm$ 34.20 ha) row-crop field and a wood line that had a riparian zone (e.g., drainage ditch, river, or stream) within it. Adjacent crop fields were typically soybean (*Glycine* sp., 58%), cotton (*Gossypium* sp., 16%), or milo (*Sorghum* sp., 10%). All row-crop fields appeared to endure similar tillage regimes, and should not contribute bias on avian community patterns (Castrale 1985).

Experimental field borders were planted in early spring 2002 with a mixture of indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), partridge pea (*Chamaecrista fasciculata*), and kobe lespedeza (*Lespedeza striata*). Despite plantings, the floral composition of field borders was commonly dominated by horsetail (*Conyza canadensis*), seashore vervain (*Verbena litoralis*), bermuda grass (*Cynodon dactylon*), johnson grass (*Sorghum halepense*), goldenrod (*Solidago* spp.), common ragweed (*Ambrosia artemisiifolia*), giant ragweed (*Ambrosia trifida*), poison ivy (*Toxicodendron radicans*), curly dock (*Rumex crispus*) and *Rubus* spp. Across the three years of the study, sample size and width of field borders decreased over time from either withdrawal of landowner interest or tillage encroachment. All borders of respective width treatments were lumped together for statistical analyses, as the intrusion of wild vegetation equalized the vegetative composition of planted treatments. Hence, field margin treatments included non-bordered (2002: n=19; 2003: n=21; 2004: n=21), narrow-bordered (2002: mean=10.0 m, SE=0, n=38; 2003: mean = 8.5 m, SE = 1.8 m, n=27; 2004: mean=7.3 m, SE=2.2 m, n=24), and wide-bordered (2002: mean=34.4, SE=6.8 m, n=8; 2003: mean=32.7 m, SE=9.0 m, n=7; 2004: mean=29.7 m, SE=10.2 m, n=11) margins.

Nesting Ecology

Nest searches were conducted during the 2002–2004 breeding seasons (15 Apr to 31 July). All field borders were searched on a weekly rotation for active nests, as artificial nests may not provide accurate estimations on nesting success (Moore and Robinson 2004). Non-bordered margins were searched less intensively (once every three weeks) to minimize damage to agricultural crops. Nest searches entailed pacing systematically through each border, while searching the vegetation meticulously and flushing birds using sticks. The location of each nest was mapped using compass bearings from landmarks, and marked inconspicuously on the ground with field tape at least 5 m away to prevent attracting predators to nests with visual cues. All nests were monitored evenly (every 2–4 days) to avoid observer influence on success (Bart and Robson 1982). Nests were monitored until fledging or inactive status was confirmed. We determined nest activity status by observing a flushing female or an increase in number of host (as opposed to Brown-headed Cowbird (*Molothrus ater*)) eggs. Nests were categorically separated into time periods (time 1 = 20 April–15 May, time 2 = 16 May–June, time 3 = 16 June–01 August) based on even nest sample sizes to investigate nest survival temporally across the breeding season.

Nest-site variables included distance to wooded and agricultural-field edges, percent nest concealment from directly above, nest height, and a vegetation survey. Nest searches and checks were conducted with extreme care to avoid the trampling of vegetation or creating dead end trails that may interfere with the natural outcome of a nest (Martin 1993). We determined fate for nests with unobserved outcomes when apparent clues existed, such as fledgling presence, broken eggshells, and nest condition/disturbance within the nest and nearby surrounding area for any clues (i.e., eggshells or predator tracks) or disturbances. Nest age was used to assist fate decisions, and was determined by candling eggs during incubation or observing feather growth of nestlings. A nest was considered successful if it produced at least one fledgling. Nest failures were classified as abandoned, depredated, and either weather or human-induced.

Vegetative Assessment

We sampled a minimum of seven vegetation plots at random locations within each field border, with the number of plots proportional to individual border area. Vegetation surveys were conducted thrice each breeding season, during mid-May, mid-June, and mid-July from 2002–2004. Vegetation plots consisted of an 8 m (diameter) circular area. Within each plot, vegetative composition (% forb cover, % grass cover, % woody cover, and litter), species richness, and vegetative cover (vertical) were quantified. Vertical cover was calculated at each plot using a modified Robel pole that measured effective height of the vegetation (Robel et al. 1970, Renken and Dinsmore 1987). Measurements on the pole were recorded from each cardinal direction at a distance of 4 m and height of 1 m. The height on the density board where vegetation obstructed visibility was recorded to the nearest centimeter and the average provided an indice of vertical cover and biomass (Robel et al. 1970). Identical vegetation surveys were conducted at nests, with the nest acting as the centroid of the plot. Nest vegetation surveys were executed after nests were no longer active to minimize disturbance. Some field borders were sprayed with herbicide to prevent domination by invasive species however, herbicide applications were infrequent and appeared trivial relative to total vegetative composition and structure.

Statistical Analyses

We estimated daily survival rates (DSR) for nests using Mayfield calculations (Mayfield 1961, 1975) within each border category. DSR was only calculated for categories that had a minimum sample of 20 nests (Hensler and Nichols 1981). Standard errors were computed for DSR estimates (Johnson 1979). Nest survival estimates were compared across field border treatments using Program CONTRAST (Hines and Sauer 1989). Vegetative measurements were compared across months and years as a repeated measurement using PROC GLM (SAS Institute, Inc. 2003) to track the vegetative succession of field borders over three years post-establishment.

We categorized adjacent crop field type dependent on whether they provided the avian community with cover, food and cover, or neither. Only wheat fields appeared to influence birds by providing a food source to birds during the breeding season, as seed maturation on other crops occurred in the end of summer or early fall.

Results

Nesting Ecology

We found 434 nests of eight bird species in narrow and wide field borders over three breeding seasons (2002–2004). The majority of nests were found in the incubation (n = 234; 54%) and laying or construction stages (n = 151; 35%), whereas few were found in the nestling stage (n = 48; 11%). As few nests were found in the nestling stage, it seems reasonable that our efforts revealed most of the nesting that occurred within field borders. Red-winged Blackbird (*Agelaius phoeniceus*) and Dickcissel (*Spiza americana*) represented 78% (n = 337) and 19% (n = 84) of nests found in borders, whereas Northern Cardinal (*Cardinalis cardinalis*), Blue Grosbeak (*Guiraca caerulea*), Yellow-billed Cuckoo (*Coccyzus americana*), Indigo Bunting (*Passerina cyanea*), Mallard (*Anas platyrhynchos*), and Northern Mockingbird (*Mimus polyglottus*) together accounted for the remaining 3% (n = 13). Mourning Dove (*Zenaida macroura*), Eastern Towhee (*Pipilo erythropthalmus*), Indigo Bunting, and Northern Cardinal frequently nested in the brushy vegetation of adjacent fencerows. Nest initiation occurred relatively consistently for Dickcissel and Red-winged Blackbirds from early-May through late-June (Figure 4.1).

Only 20 nests were found in 2002, however, nesting increased considerably in 2003 (n = 183) and 2004 (n = 231). In accord, field borders experienced substantial annual increases in total nest density from 2002 (0.8 nests/ha) to 2003 (8.84 nests/ha) and 2004 (19.74 nests/ha). Coinciding with this density increase, nests experienced a concomitant decrease in proportion of fledged nests (2002: 35.0%, 2003: 26.4%, 2004: 18.2%) and increase in relative nest predation (Table 4.1; Figure 4.2). Not a single nest was found in any control borders during all years, although birds were commonly observed carrying nesting material into agricultural fields adjacent to field borders. Seventy-eight percent (n = 334) of all nests failed, of which the main causes were predation (89%, n = 297) and abandonment (7%, n = 23; Table 4.1). No nests experienced brood parasitism by Brown-headed Cowbirds in 2002 and six percent of broods were parasitized in both 2003 and 2004 (Table 4.1). Of 283 total fledglings over 2003 and 2004, only three were cowbirds. Dickcissel was the host to only four cowbird eggs, yet two (50%) survived to fledge. Red-winged Blackbirds were less hospitable, with only one of 15 eggs (7%) fledging successfully.

Both Dickcissel and Red-winged Blackbird DSR decreased from 2003 to 2004 (Table 4.2). There was a slight temporal trend of increasing DSR within the 2003 and 2004 breeding seasons for Dickcissel (time 1 = 0.8936, SE = 0.0264, time 2 = 0.9145, SE = 0.0238, time 3 = 0.9440, SE = 0.0184; $\chi^2 = 2.67$, df = 2, $P = 0.264$), and a significant temporal trend for Red-winged Blackbirds (time 1 = 0.9012, SE = 0.0161, time 2 = 0.9093, SE = 0.0088, time 3 = 0.9328, SE = 0.0107; $\chi^2 = 77.86$, df = 2, $P < 0.001$; Figure 4.3). These increases of DSR across the season temporally corresponded with vegetative cover increases (Figure 4.4).

Field Border Width

Wide field borders had significantly greater vertical cover than narrow borders in 2003, but they were similar in 2004 (Table 4.4). Narrow field borders had a significantly greater proportion of grass cover over combined years, whereas forbs dominated vegetative composition in wide borders during both years (Table 4.4). Nest site-selection of both Dickcissel and Red-winged Blackbirds followed this trend, being located in areas of significantly greater overall cover and forb cover, while apparently avoiding sites dominated by grass cover (Table 4.5). Both Dickcissel ($\chi^2 = 91.7$, df = 1, $P < 0.001$) and Red-winged Blackbird ($\chi^2 = 249.2$, df = 1, $P < 0.001$) non-randomly selected for nest-site locations in wide field borders. While Red-winged Blackbirds utilized the narrow borders as nesting habitat (n = 44, 5.31 nests/ha), Dickcissels largely avoided them (n = 3, 0.37 nests/ha). Significantly higher nest densities existed in wide than narrow borders during 2003 ($F_{1,40} = 31.06$, $P < 0.001$) and 2004 ($F_{1,21} = 21.99$, $P < 0.001$). Overall nest densities were 2.9 and 28.2 nests/ha for narrow and wide borders, respectively. Nest density increased significantly between 2003 and 2004 for narrow borders ($F_{1,53} = 6.48$, $P = 0.014$), but not wide ($F_{1,11} = 0.30$, $P = 0.602$; Table 4.3).

Red-winged Blackbirds had considerably higher nest survival in wide (DSR = 0.9235, SE = 0.0101) than narrow (DSR = 0.9038, SE = 0.0279) borders in 2003 ($\chi^2 = 0.441$, df = 1, $P = 0.507$). However, this trend reversed in 2004 (narrow: DSR = 0.9383, SE = 0.0147; wide: DSR = 0.9020, SE = 0.0100; $\chi^2 = 4.169$, df = 1, $P = 0.0412$) indicating stochasticity of nest success estimates among years. Dickcissel and Red-winged Blackbirds both experienced notable declines of nest survival in wide borders (2003 vs. 2004), however, Red-winged Blackbird nesting survival simultaneously experienced a significant increase in narrow borders (Table 4.2). Additionally, relative predation rates were consistently higher in wide vs. narrow borders in 2003 (68% vs. 43%) and 2004 (75% vs. 61%).

Richness of nesting species documented in field borders did not differ per width treatment. We found Dickcissel, Indigo Bunting, Northern Cardinal, Red-winged Blackbird, and Northern Mockingbird to nest in both narrow and wide field borders, suggesting borders mostly provide suitable nest-sites for grassland-edge associated species regardless of border width. Species found to nest only in wide borders were Blue Grosbeak and Yellow-billed Cuckoo. However, these are both edge species and not likely nesting in wide borders for their increased area.

Table 4.1 Nest Outcome by Year

Total nests and nest density per year including fates and outcome in field borders.

					Nest outcome (%)[a]					
Year	# Field borders	Active nests (n)	Total area	Nests/ha	Successful	Depredated	Abandoned	Weather	Machinery	Cowbird Parasitism[b]
2002	46	20	24.6	0.81	7 (35)	9 (45)	1 (5)	0	1 (5)	0
2003	42	183	20.7	8.84	48 (26)	118 (65)	9 (5)	5 (3)	3 (2)	10 (6)
2004	23	231	11.7	19.74	42 (18)	168 (73)	14 (6)	4 (2)	3 (1)	14 (6)
Total		434			97 (22)	297 (69)	23 (5)	9 (2)	7 (2)	24 (6)

[a] Includes nests with discernible cause of failure.

[b] Includes all parasitized nests, not only those resulting in failure.

Table 4.2 Nest Success in Field Borders

Nest success estimates for Dickcissel and Red-winged Blackbirds in field borders during 2003-2004.

		2003					2004				
Species	Border Type	n[b]	Exposure Days	DSR	DSR SE	Mayfield Survival[c]	n[b]	Exposure Days	DSR	DSR SE	Mayfield Survival
Dickcissel	Overall[a]	43	373.5	0.9277	0.0165	0.2400	37	254.5	0.9020	0.0221	0.1400
Red-winged Blackbird	Narrow	19	145.5	0.9038	0.0279	0.01195	33	372.5	0.9383	0.0147	0.2623
	Wide	116	1006.5	0.9235	0.0101	0.1880	151	1149	0.9020	0.0100	0.1140
	Overall	135	1152	0.9210	0.0095	0.1776	184	1521.5	0.9110	0.0084	0.1400

[a] Nest success results for Dickcissel are reported for wide borders, as they rarely nested in narrow borders
[b] n values may vary from totals due to missing nest survival data
[c] Mayfield estimates indicate percent nest success and for the incubation and nestling periods combined (Mayfield 1975)

Table 4.3 Nest Totals per Field Border Treatment

Nest totals, density and total area for each field border treatment from 2002 to 2004.

	2002					2003					2004				
Border Type	# of Borders	Nests (n)	Area (ha)	Mean Width (m)	Nests / ha	# of Borders	Nests (n)	Area (ha)	Mean Width (m)	Nests / ha	# of Borders	Nests (n)	Area (ha)	Mean Width (m)	Nests / ha
Non-bordered	21	0	8.4	10	0	21	0	8.4	10	0	21	0	8.4	10	0
Bordered	38	1	16.0	10	0.1	37	9	10.0	8.5	0.9	18	38	6.2	7.9	6.1
Wide-bordered	8	19	8.6	35	2.2	5	174	7.3	31.9	23.8	5	193	5.8	33.4	33.3

Table 4.4 Vegetation in Field Borders by Year

Vegetative characteristics among field border types during 2003 and 2004.

Year	Treatment (n)	Vertical Cover		% Grass		% Forb	
		mean	SE				
2003	Wide	62.80	2.78	41.69	2.04	56.88	1.91
	Narrow	29.86	1.61	57.58	1.18	30.72	1.11
	$F_{1,40}$		2.531		0.139		2.122
	P		0.112		0.710		0.146
2004	Wide	54.23	1.50	44.32	1.42	55.56	1.40
	Narrow	58.17	1.70	53.03	1.18	40.18	1.17
	$F_{1,34}$		0.036		0.046		11.35
	P		0.849		0.830		0.001
Both	Wide	57.46	1.73	43.33	1.19	56.05	1.15
	Narrow	42.47	1.22	55.55	0.84	34.93	0.81
	$F_{1,46}$		1.279		5.543		14.066
	P		0.258		0.019		< 0.001

Table 4.5 Nest-site Vegetation

Nest-sites in field borders contained significantly greater amounts of forb and overall vertical cover than at random, but avoided dense grass cover.

Species	Survey Site (n)	Vertical Cover		% Grass		% Forb	
		mean	SE	mean	SE	mean	SE
Red-winged Blackbird	Nest (337)	117.268	2.180	28.136	1.602	68.528	1.607
	Random (1628)	37.399	0.805	51.816	0.584	39.970	0.587
	$F_{1,1963}$	1181.709		192.858		278.613	
	P	<0.001		<0.001		<0.001	
Dickcissel	Nest (84)	104.885	4.265	24.317	3.187	71.280	3.189
	Random (1628)	37.399	0.791	51.816	0.591	39.970	0.591
	$F_{1,1710}$	242.035		71.971		93.204	
	P	<0.001		<0.001		<0.001	

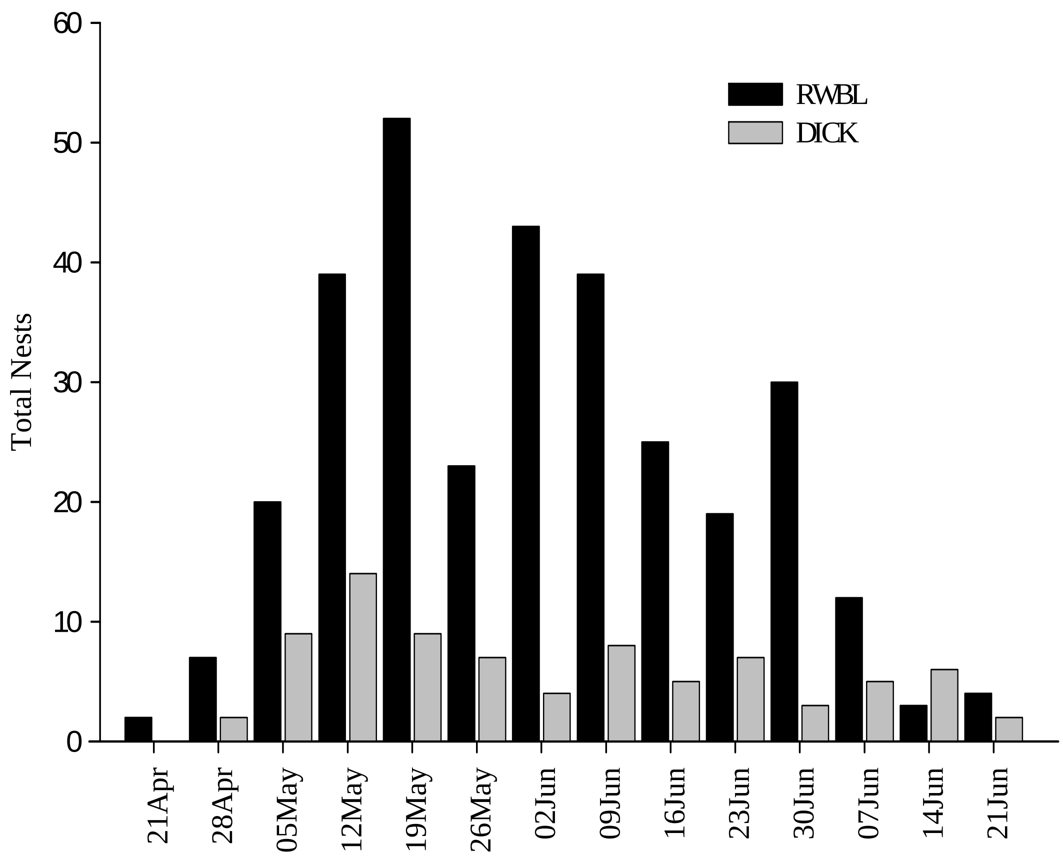

Figure 4.1 Temporal Distribution of Nest Initiation Abundance

Nest initiation weekly throughout the breeding seasons of 2003 and 2004 for Dickcissel and Red-winged Blackbird combined.

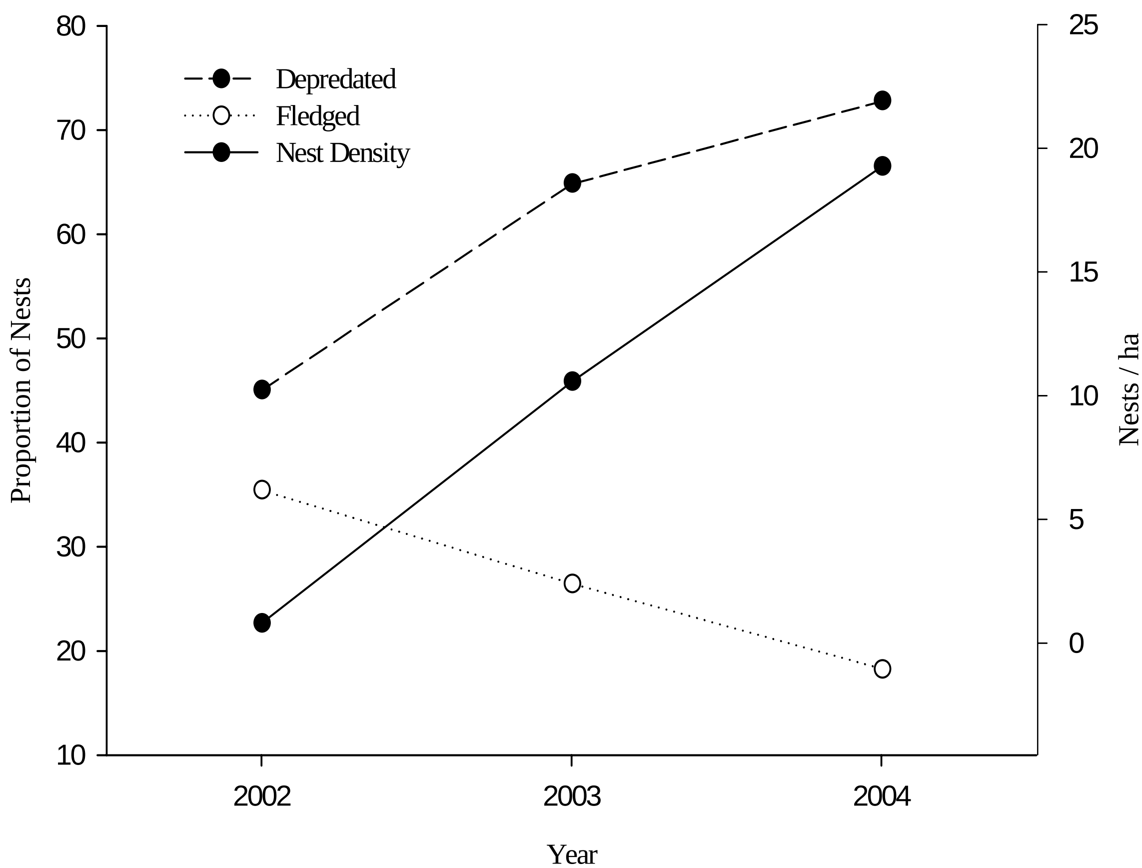

Figure 4.2 Ecology of Nest Survival and Density

Total nesting density (nests/ha), proportion of fledged nests, and proportion of depredated nests in narrow and wide field borders from 2002-2004 in the MAV.

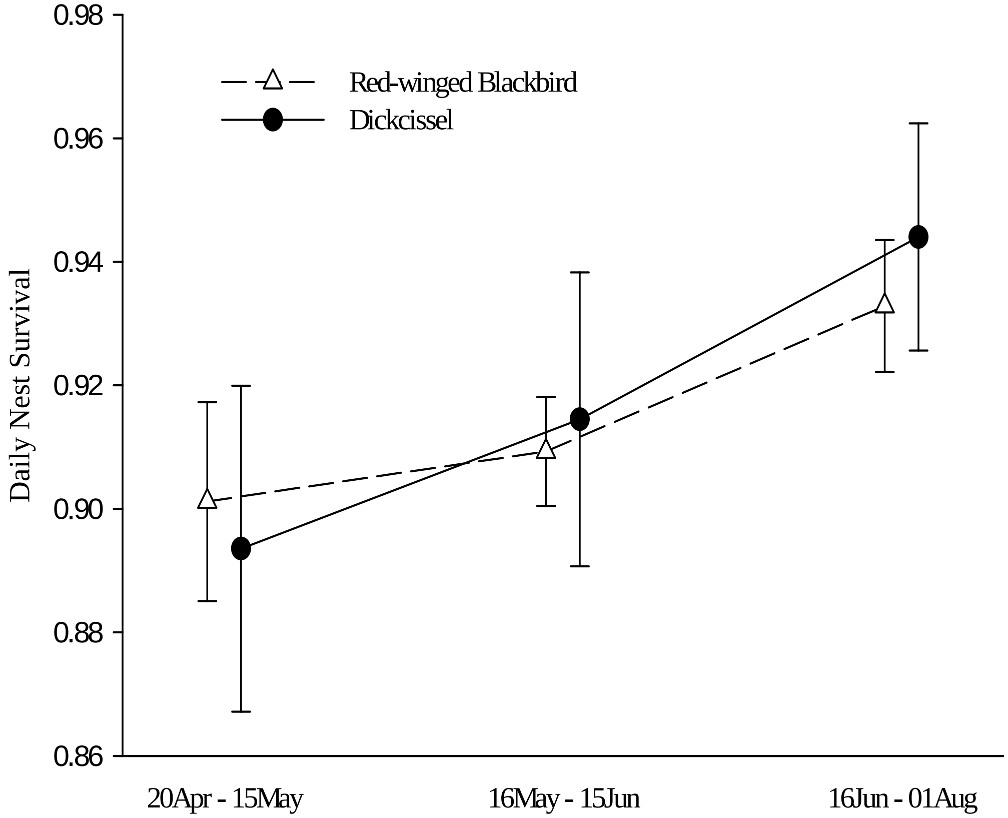

Figure 4.3 Daily Nest Survival

The daily nest survival of Dickcissel and Red-winged Blackbirds over three time periods within the breeding seasons during 2003 and 2004 combined.

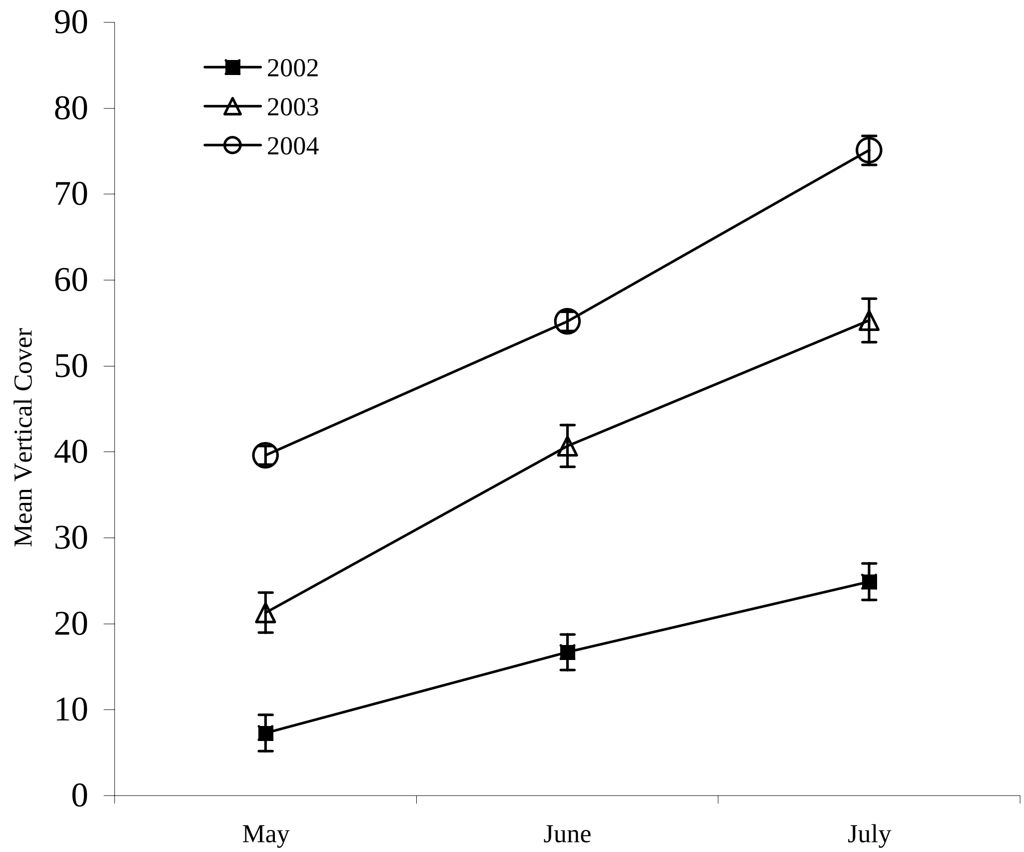

Figure 4.4 Vegetative Cover Within Seasons

The amount of mean vertical vegetative cover over three vegetation surveys (one per month) per border from 2002-2004.

Discussion

Field borders that were located between a wooded fencerow and agricultural row-crop field provided attractive nesting habitat for Red-winged Blackbirds and Dickcissel. Despite their benefiting a paucity of nesting avian species, their exploitation by nesting Dickcissels is encouraging, as they are a species of high conservation concern (http://www.rmbo.org/pif/pifdb.html). Furthermore, field borders were found to attract relatively high nest densities compared with other linear, herbaceous habitats.

Vegetation

During the initial three years post-establishment, the vegetative succession of field borders underwent noteworthy changes (see Figure 4.4). During the first breeding season, field borders were relatively bare of vegetation, hence, failed to attract much nesting activity. This may have related to the relatively xeric conditions our field site experienced that year, and may not accurately represent vegetative emergence elsewhere. Vegetation emerged more rapidly in the late summer/early fall of 2002 and remained throughout the winter to provide crucial standing substrate for wintering birds and early nesting attempts in 2003. Vegetative cover continued to increase throughout the breeding seasons of 2003 and 2004. This increase coincided temporally with an increase in nesting density across years, supporting our first prediction. The steady increase of nest density suggests that vegetative quality and nesting value of field borders may not have maximized by the third year post-establishment. Furthermore, this indicates that suitability of field borders as nesting habitat may depend in part, on vegetative cover. Additionally, increases in vegetative cover paralleled concomitant increases of nesting survival across temporal periods within each season.

Heterogeneity of vegetation was considerably greater in wide borders, which yielded a higher percent composition of forbs, whereas narrow borders were more dominated by grasses. Increased forb cover may enhance the attractiveness of wide borders for nesting habitat, as forbs generally represent higher quality forage resources than grasses (Robel and Harper 1965) and greater structural diversity. Wide field borders also experienced increased vertical cover compared to narrow borders; which, along with greater forb cover, represented increased suitability as nesting habitat for Dickcissels and Red-winged Blackbirds (Bryan and Best 1994, Zimmerman 1999). Furthermore, both species also selected nest-sites for greater vertical cover than found at random in borders (see Table 4.5).

Nesting Ecology

Irrespective of width, all field borders represented substantial improvements as avian nesting habitat over traditional “ditch to ditch” farming methods. Although birds are known to utilize crops for nesting habitat (Basore et al. 1986), we failed to locate a single nest in the non-bordered margins. This lack of nesting activity in non-bordered margins demonstrates the attractiveness of field borders for nesting birds despite their close proximity to a wooded edge (Paton 1994). While this may insinuate that field borders represent attractive nesting habitat for birds, it remained important to evaluate the suitability of such habitat relative to their potential to represent population sinks (Gates and Gysel 1978, Heske 1999). Narrow-bordered margins had minimal appeal as nesting habitat for most species; however, they may be beneficial for species nesting in adjacent habitats by providing nesting material and cover. The only species we found to readily utilized narrow borders for nesting were Red-winged Blackbirds.

Wide field borders were considerably more attractive as nesting habitat than narrow borders, supporting nearly ten times the nesting density each year, therefore substantiating prediction four. However, increased width failed to attract local area-sensitive species. Grasshopper Sparrows (*Ammodramus savannarum*) were occasionally documented as transient visitors in adjacent weedy soybean fields, but failed to approach the wooded edge enough to utilize field borders. Field border habitat located away from a wooded edge may provide beneficial habitat, as certain species (not necessarily edge averse species) have greater nest densities and success at >50 m from wooded edges (Jensen and Finck 2004), and should be further evaluated. Furthermore, field border width did not apparently impact richness of nesting species as Dickcissel, Indigo Bunting, Northern Cardinal, Red-winged Blackbird, and Northern Mockingbirds used both narrow and wide borders. Wide borders did attract Blue Grosbeak and Yellow-billed Cuckoo, however; only one and two nests were found, respectively. The apparent abundance of birds nesting in the brushy vegetation of adjacent fencerows and in row-crop fields indicates field borders indirectly enhanced nesting suitability of adjacent habitats. Nesting attempts in agricultural fields appeared to receive considerably more nesting activity, as birds were commonly observed transporting nesting material from field borders into row-crop fields. We suspect the lack of nesting activity in non-bordered margins therefore related to a combination of proximity to wooded edge and less desirable nesting vegetative substrate. Wide-bordered margins experienced considerably higher nest-densities than narrow borders and were attractive to Dickcissel, a species that has continued to decline after CRP initiation (McCoy et al. 1999, Peterjohn and Sauer 1999).

Previous studies that documented nest density for linear, herbaceous habitat includes 10.9 nests/ha in Iowa grassed waterways (Bryan and Best 1994), 11.8 nests/ha in Iowa roadsides (Camp and Best 1994), and 8.89 nests/ha in road rights-of-way plots in Illinois (Warner 1992). This study documented a nest density of 33.3 nests/ha in wide field borders and 6.1 nests/ha for narrow during 2004 (see Table 4.3). The density estimate for wide borders greatly exceeds that of most linear habitat, excepting Michigan fencerows (43.5 nests/ha), which incorporated a woody vegetative component and included colonial nesting species (Shalaway 1985). Although nesting density in narrow borders was lower than most reported, they were comparable. Therefore, it appears that field borders in the MAV represent a very successful example of how border establishment may dramatically improve an agricultural landscape for nesting birds.

Predation, which appeared to be conducted primarily by medium-sized mammals and snakes, exerted the most influence on nest survival. However, we recognize that identification of predators from nest remains is not always reliable (Lariviere and Messier 1997). We documented one particular event with a motion-sensitive camera where a single raccoon (*Procyon lotor*) was photographed at a nest that was found torn down onto the ground the following day. Subsequent events of similar depredation appearance occurred in the same region of the same field border over the next two days, which resulted in the loss of an estimated 23 nests, most of which were Red-winged Blackbird. Therefore, we propose that predator activity rates and/or abundances may be tightly related to avian nesting survival in field borders and should be considered in management decisions (Gates and Gysel 1978). However, the removal of these nests from Mayfield estimates had no impact on test significance.

We found the period of greatest nest success for both Dickcissel and Red-winged Blackbird was late in the breeding season when relatively few nests were active (see Figure 3.3), supporting prediction two. Relative nest predation increased with nest density across years (see Figure 4.2). This increase of nest predation may be a cause for alarm, as predation effects can continue to intensify over time if predators recognize high-density nest patches (Lariviere and Messier 1998). Increased nest predation may also indicate a temporal aspect of nest predation; particularly as mammals that are typically opportunistic nest predators can exhibit nest-searching behavior in areas of high nest densities (Nams 1991). We recommend further evaluation on density-dependent nest predation in field borders to confirm its occurrence and identify potential mechanisms.

We found no relationship of nest success with field border width, and overall nesting success in field borders was variable among years. Mayfield estimates of Dickcissel nest success in our field borders during 2004 (14.0%) were comparable to estimates in Kansas CRP fields (13.2% and 14.9%; Hughes et al. 1999) as well as old fields (14.3%) and prairies (15.2%) in Kansas (Zimmerman 1982). Dickcissel nest success in field borders during 2003 (24.0%) was similar to that found in Iowa grassed waterways (22.0%; Bryan and Best 1994), which is relatively high, indicating the reproductive benefits field borders may provide for this species. Red-winged Blackbird nest success was relatively consistent between 2003 (17.8%) and 2004 (14.0%), and is within the range of success estimates found in other linear habitat, such as Iowa grassed waterways (8.4%; Bryan and Best 1994) and Iowa roadsides (26.0%; Camp and Best 1994). Therefore, nesting success of Dickcissel and Red-winged Blackbird were comparable to other known estimates and probably do not represent a population sink of concern for these species. However, nesting success in large grass fields of similar vegetative composition was considerably greater than field borders for Dickcissel (29.7%) and Red-winged Blackbird (27.6; McCoy et al. 1999).

Management Implications

Row-crop farming in the MAV is commonly executed “ditch to ditch” and provides little early successional habitat suitable for nesting by farmland birds. Relative to these practices, establishing field borders of any treatment is likely to benefit the avian community in some manner. If a pre-determined amount of space on a farm is to be allocated for field borders, we advocate the establishment of few wide over many narrow borders, as they represented superior nesting habitat. Additionally, we propose that field borders be planted with more forb cover than grass as birds appeared to prefer greater forb cover, while avoiding regions of dense grass cover (see Table 4.5). Recommended management regimes for similar habitat incorporate the application of a disturbance regime during spring every 3-5 years (Vogl 1974) to properly maintain early successional habitat. We believe that disturbance management of field borders should occur similarly, as vegetative cover was extremely thick in many borders by the third year post-establishment. Furthermore, we suggest that such disturbances are not applied to all field border habitat on a farm simultaneously, but executed in rotational fashion (e.g., manage 1/3 of borders on a farm annually in a three-year rotation) to maintain areas of standing residual vegetation for early nesting attempts (Best 1986). Future research on field border management should focus on the influence of adjacent habitat, landscape context, and identifying a threshold width to optimally balance suitability of habitat for nesting birds and cropland area. Additionally, different vegetative plantings should be investigated, as such may influence avian nesting ecology (McCoy et al. 2001).

Advances in agricultural technology have vastly reduced the amount of suitable nesting grassland habitat, which has paralleled grassland bird population declines (Warner 1994, Herkert et al. 1996). Current farming practices in the MAV are representative of this trend, leaving little suitable nesting habitat for grassland birds during the breeding season. The NCBI has advocated establishment of field borders for soil retention, improving water quality, and enhancing wildlife habitat (http://www.nrcs.usda.gov/feature/buffers). The herbaceous vegetation of field borders represent habitat that is extremely scarce in this region, and may be crucial to breeding birds. Field borders also represent a currently popular form of buffer establishment, as they minimally impact agricultural productivity, especially when placed along field margins (Davison 1941, Dambach 1945). While field borders may provide suitable nesting, foraging, and escape habitat for grassland birds (Marcus et al. 2000, Puckett et al. 2000, Smith 2004), previous research has not addressed the effects of field borders on nesting ecology of passerines. An understanding of these effects is pertinent in determining the quality of such linear, edge habitat and its susceptibility to edge effects (Gates and Gysel 1978), especially in an agricultural matrix (Saracco and Collazo 1999). This study found that field borders provided attractive nesting habitat and maintained relatively high nest survival rates for farmland-edge birds in the MAV.

These results, to our knowledge, represent the only investigation on the effects of field borders and their dynamics on avian nesting ecology. While the current acceptance of field borders by landowners is encouraging, proper management decisions will prove vital to their future success. Field borders are a quality component to establishing sustainable resource management systems on agricultural farms, and we strongly advocate their integration in such landscapes.

Literature Cited

Angelstam, P. 1986. Predation on ground nesting birds' nests in relation to predator densities and habitat edge. Oikos 47:365-373.

Bart, J. and D. S. Robson. 1982. Estimating survivorship when the subjects are visited periodically. Ecology 63:1078-1090.

Basore, N. S., L. B. Best, and J. B. Wooley, Jr. 1986. Bird nesting in Iowa no-tillage and tilled cropland. Journal of Wildlife Management 50:19-28.

Best, L. B. 1983. Bird use of fencerows: implications of contemporary fencerow management practices. Wildlife Society Bulletin 11:343-347.

Best, L. B. 1986. Conservation tillage: ecological traps for nesting birds? Wildlife Society Bulletin 14:308-317.

Best, L. B. 2000. The value of buffer habitats for birds in agricultural landscapes. Pp. 75-94 in A Comprehensive Review of Farm Bill Contributions to Wildlife Conservation (W.L. Holman, Ed.). USDA/NRCS/WHMI.

Bryan, G. G. and L. B. Best. 1994. Avian nest density and success in grassed waterways in Iowa rowcrop fields. Wildlife Society Bulletin 22:583-592.

Burger, L. W., Jr. 2000. Wildlife responses to the Conservation Reserve Program in the southeast. Pp. 55-74. in A comprehensive review of farm bill contributions to wildlife conservation (W. L. Holman, Ed.). USDA/NRCS/WHMI.

Camp, M. and L. B. Best. 1994. Nest density and nesting success of birds in roadsides adjacent to rowcrop fields. American Midland Naturalist 131:347-358.

Castrale, J. S. 1985. Responses of wildlife to various tillage conditions. Transactions of the North American Wildlife Natural Resources Conference 50:142-156.

Chalfoun, A. D., F. R. Thompson III, M. J. Ratnaswamy. 2002. Nest predators and fragmentation: a review and meta-analysis. Conservation Biology 16:306-318.

Dambach, C. A. 1945. Some biologic and economic aspects of field border management. Transactions of the North American Wildlife Conference pp. 169-184.

Davison, V. E. 1941. Wildlife Borders—An Innovation in Farm Management. Journal of Wildlife Management 5:390–394.

Donovan, T. M., P.W. Jones, E. M. Annand, and F.R. Thompson III. 1997. Variation in local-scale edge effects: mechanisms and landscape context. Ecology 78:2064-2075.

Fleming, K. K. and W. M. Giuliano. 2001. Reduced predation of articifial nests in border-edge cuts on woodlots. Journal of Wildlife Management 65:351-355.

Fritzell, Erik K. 1978. Habitat use by prairie raccoons during the waterfowl breeding season. Journal of Wildlife Management 42: 118-127.

Gates, J. E. and L. W. Gysel. 1978. Avian nest dispersion and fledging success in field-forest ecotones. Ecology 59:871-883.

Grant, T. A., T. L. Shaffer, E. M. Madden, and P. J. Pietz. 2005. Time-specific variation in passerine nest survival: new insights into old questions. Auk 122:661-672.

Helzer, C. J. and D. E. Jelinski. 1999. The relative importance of patch area and perimeter-area ratio to grassland breeding birds. Ecological Applications 9:1448-1458.

Hensler, G. L. and J. D. Nichols. 1981. The Mayfield method of estimating nesting success: a model, estimators and simulation results. Wilson Bulletin 93:42-53.

Herkert, J. R., D. W. Sample, R. E. Warner. 1996. Management of Midwestern grassland landscapes for the conservation of migratory birds. Pp. 89-116 in Management of agricultural landscapes for the conservation of Neotropical migratory birds (F. R. Thompson, III, Ed.). General Technical Report NC-187. U.S. Forest Service, St. Paul, Minnesota.

Heske, E. J., S. K. Robinson, and J. D. Brawn. 1999. Predator activity and predation on songbird nests on forest-field edges in east-central Illinois. Landscape Ecology 14:345-354.

Hines, J. E., and J. R. Sauer. 1989. Program CONTRAST - A General Program for the Analysis of Several Survival or Recovery Rate Estimates. US Fish & Wildlife Service, Fish & Wildlife Technical Report 24, Washington, DC.

Hughes, J. P., R. J. Robel, K. E. Kemp, and J. L. Zimmerman. 1999. Effects of habitat on Dickcissel abundance and nest success in Conservation Reserve Program fields in Kansas. Journal of Wildlife Management 63:523-529.

Jensen, W. E. and E. J. Finck. 2004. Edge effects on nesting Dickcissels (Spiza Americana) in relation to edge type of remnant tallgrass prairie in Kansas. American Midland Naturalist 151:192-199.

Johnson, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651-661.

Johnson, R. G. and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. Journal of Wildlife Management 54:106-111.

Lariviere, S. and F. Messier. 1997. Characteristics of waterfowl nest depredation by the Striped Skunk (*Mephitis mephitis*): can predators be identified from nest remains? American Midland Naturalist 137:393-396.

Lariviere, S. and F. Messier. 1998. Effect of density and nearest neighbours on simulated waterfowl nests: can predators recognize high-density nesting patches? Oikos 83:12-20.

Major, R. E., F. J. Christie, G. Gowing, and T. J. Ivison. 1999. Elevated rates of predation on artificial nests in linear strips of habitat. Journal of Field Ornithology 70:351-364.

Marcus, J. F., W. E. Palmer, and P. T. Bromley. 2000. The effects of farm field borders on over-wintering sparrow densities. Wilson Bulletin 112:517-523.

Marshall, E. J. P. and A. C. Moonen. 2002. Field margins of northern Europe: their functions and interactions with agriculture. Agriculture, Ecosystems, and Environment 89:5-21.

Martin, T. E. 1993. Nest predation and nest sites: new perspectives on old patterns. BioScience 43:523-532.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bulletin 73:255-261.

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bulletin 87:455-466.

McCoy, T. D., M. R. Ryan, E. W. Kurzejeski, and L. W. Burger, Jr. 1999. Conservation Reserve Program: source or sink habitat for grassland birds in Missouri? Journal of Wildlife Management 63:530-538.

McCoy, T. D., M. R. Ryan, and L. W. Burger, Jr. 2001. Grassland bird conservation: CP1 vs. CP2 plantings in Conservation Reserve Program fields in Missouri. American Midland Naturalist 145:1-17.

Moore, R. P. and W. D. Robinson. 2004. Artificial bird nests, external validity, and bias in ecological field studies. Ecology 85:1562-1567.

Murray, L. D. and L. B. Best. 2003. Short-term response to harvesting switchgrass for biomass in Iowa. Journal of Wildlife Management 67:611-621.

Nams, V. O. 1991. Density-dependent predation by skunks using olfactory search images. Oecologia 110:440-448.

Paton, P. W. C. 1994. The effect of edge on avian nest success: how strong is the evidence? Conservation Biology 8:17-26.

Peterjohn, B. G. and J. R. Sauer. 1999. Population statues of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology 19:27-44.

Petrides, G. A. 1942. Relation of hedgerows in winter to wildlife in central New York. Journal of Wildlife Management 6:261-280.

Powell, J. C., W. E. Keenan, W. A. Cole, L. C. Murphree, D. A. Yost, J. J. Pitts, and R. H. Wells. 1952. Soil survey of Sunflower County, Mississippi. USDA Soil Conservation Service. Mississippi Agricultural Experiment Station. Pp. 45.

Puckett, K. M., W. E. Palmer, P. T. Bromley, J. R. Anderson, Jr. and T. L. Sharpe. 2000. Effects of Filter Strips on Habitat Use and Home Range of Northern Bobwhites on Alligator River National Wildlife Refuge. Quail IV: Proceedings of the Fourth National Quail Symposium 26–31.

Renken, R. B. and J. J. Dinsmore. 1987. Nongame bird communities on managed grasslands in North Dakota. Canadian Field-Naturalist 101:551-557.

Ricklefs, R. E. 1969. An analysis of nesting mortality in birds. Smithsonian Contributions to Zoology 9:1-48.

Robel, R. J. and W. R. Harper. 1965. Energy content and retention by ragweed and sunflower seeds during fall and winter. Transactions of the Kansas Academy of Science 68:401-405.

Robel, R. J., J. N. Briggs, J. J. Cebula, N. J. Silvy, C. E. Viers, and P. G. Watt. 1970. Greater Prairie Chicken ranges, movements, and habitat usage in Kansas. Journal of Wildlife Management 34:286-306.

Rodenhouse, N. L. and L. B. Best. 1983. Breeding ecology of Vesper Sparrows in corn and soybean fields. The American Midland Naturalist 110:265-275.

Roos, S. 2002. Functional response, seasonal decline and landscape differences in nest predation risk. Oecologia 133:608-615.

SAS Institute, Inc., 2003. Version 9.1 SAS Institute, Inc., Cary, North Carolina, USA.

Saracco, J. F. and J. A. Collazo. 1999. Predation on artificial nests along three edge types in a North Carolina bottomland hardwood forest. The Wilson Bulletin 111: 541-549.

Shalaway, S. D. 1985. Fencerow management for nesting birds in Michigan. Wildlife Society Bulletin 13:302-306.

Smith, M. D. 2004. Wildlife habitat benefits of field border management practices in Mississippi. Doctoral Dissertation, Mississippi State University, 2004.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47:893-901.

Vickery, P. D., M. L. Hunter, Jr., and J. V. Wells. 1992. Is density an indicator of breeding success? Auk 109:706-710.

Vogl, R. J. 1974. Effects of fire on grasslands. Pp. 139-194 in T. T. Kozlowski and C. E. Ahlgren, eds. Fire and ecosystems. Acad. Press, New York, N.Y.

Warner, R. E. 1992. Nest ecology of grassland passerines on road rights-of-way in central Illinois. Biological Conservation 59:1-7.

Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: future shock for midwestern birds? Conservation Biology 8:147-156.

Washburn, B. E., T. G. Barnes, and J. D. Sole. 2000. Improving Northern Bobwhite habitat by converting tall fescue fields to native warm-season grasses. Wildlife Society Bulletin 28:97-104.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs 8:1-93.

Winter, M. and J. Faaborg. 1999. Patterns of area sensitivity in grassland-nesting birds. Conservation Biology 13:1424-1436.

Winter, M., D. H. Johnson, and J. Faaborg. 2000. Evidence for edge effects on multiple levels in tallgrass prairie. Condor 102:256-266.

Woodward, A. A., A. D. Fink, and F. R. Thompson, III. 2001. Edge effects and ecological traps: effects on shrubland birds in Missouri. Journal of Wildlife Management 65:668-675.

Yahner, R. H., T. E. Morrell, and J. S. Rachael. 1989. Effects of edge contrast on depredation of artificial avian nests. Journal of Wildlife Management 53:1135-1138.

Zimmerman, J. L. 1982. Nesting success of Dickcissels (*Spiza americana*) in preferred and less preferred habitats. Auk 99:292-298.

CHAPTER V

CONCLUSIONS

The primary objectives of this research were to evaluate the response of breeding and wintering avian communities to field border dynamics in an agricultural landscape. Results from this study revealed the substantial avian benefits provided by field borders. Field border habitat generally housed greater avian richness, abundance, and avian conservation value over traditional “ditch to ditch” row-crop practices. Furthermore, field borders were particularly valuable if established at widths that exceed 10 m and when vegetative composition was dominated by forbs.

During the non-breeding season, avian communities associated with field borders were primarily composed of sparrows. The effects of border treatment were species-specific, dependent on the life history strategy of each species. Extremely cover-dependent sparrows, such as the White-throated Sparrow, were typically uninfluenced by field border presence and mostly remained within the wooded edge. Habitat-generalists, such as Song and Swamp Sparrows, utilized bordered-margins significantly more than non-bordered margins. Increased border width revealed substantially enhanced spatial use of adjacent agricultural fields by sparrows, suggesting an improved quality of escape cover that allowed birds to venture farther from field edges in search of food. Such an increase in foraging space during winter could provide access to vast amounts of waste grain resources that are crucial for survival; especially during late-winter when food becomes scarce but energy demands remain high. Wider borders also experienced significantly higher conservation values for the overall avian community.

During the breeding season, nearly all species that commonly inhabit field edges had significantly greater abundances on bordered-margins. Avian richness, abundance, and conservation value were higher in bordered field margins and adjacent agricultural fields regardless of width. The adjacent wooded edge also benefited during the breeding season, as avian conservation values were higher when located adjacent to a field border. One species of particular conservation concern to benefit greatly from field borders was the Dickcissel. However, Dickcissel appeared to benefit mostly from wide borders and were not abundant on narrow-bordered margins. Vegetative variables were fairly poor predictors of avian community response to field borders, and we suggest that future studies focus on landscape composition.

Field borders appeared to be suitable nesting habitat, although at our field site they mostly attracted Dickcissel and Red-winged Blackbirds. Nesting birds displayed extreme preference for wide border nest-sites, and resultant nesting density was comparatively high (33.3 nests/ha) for similar linear habitat. Furthermore, Dickcissel and Red-winged Blackbird nest success estimates were comparable to other studies, suggesting field border habitat does not likely represent an ecological trap. Nesting ecology within field borders was also related to vegetative characteristics. Nest-site selection within narrow and wide borders favored increased forb composition over grass and greater vertical cover.

Based on this research, we advocate field border establishment at widths exceeding 10 m whenever possible. However, narrow borders also provided benefit to the avian community largely through enhanced forage opportunities. Additionally, borders should be established with diverse vegetation to increase forb cover and structural heterogeneity. Recommended management regimes include a disturbance (mowing, burning, or disking) every 3-5 years to maintain the integrity of early successional vegetation in the borders. Furthermore, we propose that these disturbances be executed in cyclic fashion (1/3 of borders on a farm per year) to leave standing vegetation for early nesting attempts the following breeding season. Future studies should focus on evaluating (1) field border widths >10 m to define a threshold width greater that optimizes the balance between avian nesting benefit and landowner economical gain, (2) avian nesting ecology and community response to field borders away from wooded edges, (3) assessing field border avian benefits in alternative geographic locations, and (4) identifying an effective disturbance management regime.

Field borders provided birds with the herbaceous vegetation that is typically extremely sparse in agricultural landscapes. Overall, field borders were extremely beneficial to wintering and breeding avian communities, and represented an effective balance between wildlife and agricultural needs. The implementation of field borders into farmlands will enhance the sustainability and ecological integrity of said farm, which is increasingly necessary with the growing food demands from expanding human populations.