BIRD USE OF CONSERVATION RESERVE ENHANCEMENT PROGRAM (CREP) BUFFERS BORDERING ROWCROP FIELDS IN MARYLAND

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ABSTRACT

With the assistance of federal and state conservation programs, landowners have established over 57,000 acres of conservation buffers on the edges of working agricultural lands in Maryland. Most of these buffers are enrolled in Maryland's Conservation Reserve Enhancement Program (CREP), an initiative designed to build on the success of the Conservation Reserve Program (CRP) and to allow the United States Department of Agriculture (USDA) to work in partnership with the state of Maryland. Two types of conservation buffers comprise over 99% of all those in Maryland: Herbaceous filter strips (USDA Cover Type CP21) and riparian forest buffers (USDA Cover Type CP22). In 2004 we began a study to assess the bird use of warm season grass filter strips, cool season grass filter strips, and riparian forest buffers bordering rowcrop fields in Maryland. Birds were surveyed in summer 2004, winter 2005, and summer 2005 in conservation buffers and crop fields without buffers.

Total bird density and species richness were significantly higher in buffers than in crop fields without buffers in summer, but not in winter. Wide buffers had more total species than narrow buffers, but narrow buffers had more total birds and species per area than wide buffers. Bird density and species richness in summer were not significantly different between cool season grass filter strips and warm season grass filter strips. Density of birds was higher in warm season grass filter strips in winter, probably due to the practice of mowing cool season grass filter strips in the fall. Density of grassland-dependent species was much higher in wide filter strips than in narrow filter strips in both seasons. The number of shrubs and small trees, and vertical vegetation density were positively correlated with total bird density, while litter depth was negatively correlated with total bird density. We found evidence of nesting in conservation buffers by 14 species of birds. Eighty-six total nests were found in 2004 and 2005, the majority being red-winged blackbirds (*Agelaius phoeniceus*), indigo buntings (*Passerina cyanea*), and common yellowthroats (*Geothlypis trichas*). Several species of conservation concern were seen in conservation buffers, including northern bobwhite (*Colinus virginianus*), eastern meadowlark (*Sturnella magna*), grasshopper sparrow (*Ammodramus savannarum*), vesper sparrow (*Pooecetes gramineus*), and savannah sparrow (*Passerculus sandwichensis*).

Conservation buffers are used frequently by many species of birds and their installation should be encouraged by state and federal conservation agencies. Our research suggests that generalists, grassland-generalists, and successional/scrub birds are common in Maryland's conservation buffers, but that most conservation buffers in Maryland are too narrow to support a diverse community of grassland-dependent birds. Greater consideration must be given to how conservation buffers should be designed and managed if conservation of grassland-dependent birds is a priority goal of Maryland's CREP.

MANAGEMENT RECOMMENDATIONS

- **State and federal conservation agencies should continue to encourage land owners to install conservation buffers.** This study as well as others have confirmed that conservation buffers are far more useful to breeding birds than are rowcrop fields without buffers. We encountered many farms that had no conservation buffers between rowcrop fields and forested wetlands or drainage ditches. These un-buffered fields are of little value to breeding birds.

- **Leave some cover for wintering birds.** CREP buffers cannot be mowed between April 15 and August 15, and many farm owners choose to mow entire buffers in the fall. The short grass left over after fall mowing leaves poor cover for wintering birds. We recommend that at least a portion of each buffer be left standing in the fall and winter to provide cover for wintering birds.

- **Manage buffers to encourage plant species diversity and structural diversity, and to discourage monocultures.** We found little evidence that a particular grass type (either warm or cool season grasses) is favored by most birds. Instead, most birds respond to vegetation structure. The presence of shrubs and woody plants in buffer habitats increases the vertical structure and heterogeneity of the vegetation, resulting in increased bird species richness and abundance. Overly competitive grasses that reduce plant species diversity and structural diversity, such as switchgrass and orchard grass, should be planted in moderation.

- **Keep litter (i.e. thatch or duff) depth in buffers to a minimum.** Litter depth was negatively correlated with both total bird density and grassland bird density. Managing buffers to have lower amounts of litter depth, and preferably some areas of bare ground, will appeal to most bird species.

- **If conservation of grassland-dependent birds is an objective, we encourage land managers to install whole grassland fields rather than grass filter strips.** Whole fields should be at least 50 ha, and preferably 200 ha, to support a diverse community of grassland birds. If whole grassland fields are not an option, our data suggest that grass filter strips should be a minimum of 75 m in order to attract breeding grassland-dependent birds. However, we acknowledge that this width may not be wide enough to avoid edge effects and to meet the minimum area requirements of some grassland-dependent species.

- **Greater emphasis should be put on building grass filter strips along rowcrop field borders without wooded edges.** Grassland birds avoid wooded edges and have lower nest success along wooded edges due to high rates of predation and brood parasitism. Building filter strips in areas without wooded edges, such as near drainage ditches and roads that are not bordered by trees, would increase the available habitat for grassland birds while reducing deleterious edge effects.

INTRODUCTION

The Conservation Reserve Program (CRP) is a provision of the Food Security Act of 1985 and implemented by the USDA. The CRP offers incentive payments to encourage farm owners to remove highly erodible and environmentally sensitive cropland from production and plant it to grasses, trees, or other approved perennial vegetative cover. The goals of the CRP are to improve water quality, reduce soil erosion, and establish wildlife habitat. By the mid-1990s, over 14 million ha of land had been enrolled in the CRP nationwide.

In 1997, the State of Maryland and the USDA established Maryland's Conservation Reserve Enhancement Program (CREP), an initiative designed to build on the success of the CRP and to allow the USDA to work in partnership with the State of Maryland (USDA-FSA 1997). As of January 2006, there were over 29,000 ha of former cropland enrolled in Maryland's CREP, and nearly 80% of these lands were enrolled as "conservation buffers" (USDA 2006). Conservation buffers are strips of land in permanent vegetation that are generally planted alongside perennial and intermittent streams or forested wetlands. Most of the conservation buffers in Maryland are enrolled under Maryland's CREP, but some buffers are enrolled under CRP or other USDA conservation programs. In this report, the term "conservation buffer" is used to represent buffers enrolled under CREP or CRP.

Two types of conservation buffers comprise over 99% of those in Maryland: Herbaceous filter strips (USDA Cover Type CP21; 70%) and riparian forest buffers (USDA Cover Type CP22; 29%) (USDA 2006). Herbaceous filter strips are usually planted to a mixture of wildflowers and either warm season grasses or cool season grasses. Warm season grasses grow in the summer, set seed in the fall, and then go dormant during winter and spring. Common warm season grasses in filter strips include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), and indian grass (*Sorghastrum nutans*). Cool season grasses grow in the spring, set seed in early summer, and then go dormant until they begin growing again in the fall. Common cool season grasses in filter strips include orchard grass (*Dactylis glomerata*), red fescue (*Festuca rubra*), and sheep fescue (*Festuca ovina*).

Riparian forest buffers are planted to a variety of trees, shrubs, and grasses. Because most of the riparian forest buffers in Maryland were established since 1997 under the CREP, most trees in these buffers are less than ten years old. Often, the trees in riparian forest buffers are planted in rows and are shielded by tree tubes when they are saplings.

It is widely thought that conservation buffers provide valuable habitat for birds (USDA-NRCS 2000). Because filter strips and riparian forest buffers are the predominant conservation buffer types in Maryland, studies of bird use in these habitats are of particular interest. However, we are aware of no studies on bird use in riparian forest buffers, and only three studies in the Midwest on bird use in filter strips (Kammin 2003, Davros 2005, Henningsen and Best 2005). Conflicting results and lack of data applicable to Maryland's conservation buffers make the results of these studies of limited value to land managers in Maryland.

In 2004 we designed a study to assess the value of herbaceous filter strips and riparian forest buffers for breeding and wintering birds in Maryland. The primary objectives of the study were

to evaluate (1) relative bird density and species richness in conservation buffers in Maryland in summer and winter, (2) how vegetation composition and structure in filter strips are related to bird use, (3) how buffer width is related to bird use, and (4) the suitability of conservation buffers as breeding bird habitat for grassland and early successional/scrub species. We believe that the results of this study will be valuable in determining the effectiveness of conservation buffers enrolled in Maryland's CREP and in providing management recommendations designed to meet specific bird conservation objectives.

STUDY AREA

Study sites were located on farms in four counties on Maryland's Eastern Shore: Kent, Caroline, Queen Anne's, and Talbot. We surveyed birds in three types of conservation buffers: Warm season grass filter strips, cool season grass filter strips, and riparian forest buffers. As a control, we surveyed birds in crop fields without buffers, which represented the available habitat to birds before the establishment of a buffer. Buffer type was determined by a combination of reviewing farm plans provided by USDA-NRCS (Natural Resources Conservation Service) offices, visual inspections, or vegetation surveys.

All buffers surveyed were between rowcrops (corn or soy bean) and a deciduous wooded edge (Figure 1). The wooded edge was classified as either a forested wetland ≥ 30 m wide or a hedgerow < 30 m wide. Many buffers were planted with a narrow strip of cool season grasses between the buffer and the adjacent wooded edge, for use as a fire-break or a driving lane. These strips were ≤ 4.6 m wide.

All buffers surveyed were planted between 1997 and 2004. The maximum allowable width of conservation buffers enrolled in the CREP within that time period was 91.4 m, while the minimum allowable width was 7.3 m. Crop fields without buffers were also adjacent to deciduous wooded zones and within the same physiographic region as the buffers. Study sites in crop fields without buffers were located between the wooded edge and 91.4 m out into the crop field (the same distance as the widest allowable buffer). All study sites were > 200 m long, at least 100 m from other study sites, and at least 50 m from an edge where there was a distinct habitat change (roads, pastures, new crop adjacent to the buffer, houses, etc.).

METHODS

Site Width and Length Measurements

Buffer widths were calculated by averaging width measurements taken every 50 m over the length of the buffer. Each width measurement was from the crop edge to the wooded edge. Width measurements were taken using a laser range finder or a tape measure. Buffers were classified as either narrow (< 30 m), medium (30 – 60 m), or wide (> 60 m). The length of each site was determined by measuring the length of a line drawn down the center of each site in ArcView GIS 3.3. The area of each site was calculated by multiplying the site width times the site length. All measurements in ArcView GIS 3.3 were made using a State Plane 1983 projection.

Bird Surveys

We surveyed birds in conservation buffers in summer 2004, winter 2005, and summer 2005 using modified area searches. Techniques differed slightly in summer and winter. During summer surveys, the number of observers was determined by the width of the buffer. In buffers < 60 m wide, two observers walked parallel transect lines down the length of the buffer, each observer covering about 1/2 the width of the buffer. In buffers > 60 m wide, three observers walked parallel transect lines down the length of the buffer, each observer covering about 1/3 the width of the buffer. The distance between observers varied depending on the width of the buffer. During winter surveys, two or three observers, depending on the width, walked parallel transect lines down the length of the buffer, each observer surveying a section approximately 20 m wide. In buffers > 60 m, the observers turned around at the end of the site and surveyed the remainder of the buffer. Observers communicated regularly in order to reduce the risk of double-counting birds. Observers alternated positions relative to the edge of the site in successive surveys to avoid observer bias in a particular position.

Crop fields without buffers were surveyed with the same techniques as those used in the buffers in each season. Birds were surveyed in the crop fields out to 91.4 m from the wooded edge. The distance from the wooded edge to each bird observed was estimated into one of several distance intervals and recorded.

All birds seen or heard within the site were identified to species if possible. Birds were categorized as singing males, non-singing males, females, juveniles, or unknowns. Birds observed foraging in the air above the site or in the branches over-hanging the site were also recorded. Over-hanging branches were included as part of the study site because many birds using buffers use the wooded edges as perches on which to sit or sing. An adult carrying food was considered an indication of the presence of at least one juvenile. Observations of brown-headed cowbird nestlings, fledglings, or eggs were considered an indication of the presence of an adult, female brown-headed cowbird.

Summer surveys were done between 19 May and 22 July in each year. At all buffer sites, we conducted one round of surveys from May – June, and a second round from June – July. Crop fields without buffers were surveyed once each year from May – June, since the corn crops were too tall by July for the observers to conduct a second round of surveys. Summer surveys were conducted from sunrise to 3.5 hrs after sunrise. Winter surveys were conducted twice at each site between 19 January and 10 March. Winter surveys were between one hour after sunrise and one hour before sunset. Surveys were not conducted in rain, fog, falling snow, or wind > 16 km/hr.

All farms had more than one study site (i.e. buffers, crop fields without buffers, or both). For efficiency, we surveyed as many sites on the same farm on the same day as possible. The order that the farms were surveyed was stratified so that farms in close proximity were not all surveyed during the same part of season.

Nest Searching and Monitoring

We conducted nest searching and monitoring in selected filter strips in summer 2005. We randomly selected three narrow, two medium, and two wide filter strips for both warm and cool

season grass filter strips. This yielded 14 filter strips searched total. We conducted one search in late June – early July and one search in mid July – late July. A 300 m section of each filter strip was randomly chosen to nest search (Henningsen and Best 2005). The same section was searched in both nest searching periods. Nest searching was done by 3 to 8 people spaced approximately 2 m apart. Searchers parted vegetation with poles to scan for nests and flushed birds. Starting by the crop edge, we traversed the length of the filter strip and made additional passes until we had searched the entire width. Additional nests that were located opportunistically in filter strips and riparian forest buffers at other times were also monitored. Orange flagging was placed approximately 2 m away from the nest to help with relocation. Nests were considered active until all the young had fledged or the nest failed.

Active nests were checked every 3-4 days (Kammin 2003, Henningsen and Best 2005). We recorded the plant species in which the nest was located, nest height, GPS location, nest contents, and if adult birds were present. Nests were considered successful if at least one of the host young fledged (Henningsen and Best 2005). If the nest was found empty during a visit, the nestlings were of fledging age, and there was no sign of predation, we considered the young to have fledged. If the nest was found empty and the nestlings were not of fledging age, the nest was considered depredated.

Vegetation Surveys

Vegetation surveys in grass filter strips were conducted within five days of each summer bird survey. We measured vegetation composition and structure within 1 m^2 sampling plots. In 2004, sampling plots were placed 50 m apart along transect lines running parallel to the edge of the strip. The number of transect lines established depended on the width of the strip. In filter strips < 45 m wide, one transect line was established down the center of each strip. In filter strips > 45 m wide, each strip was divided into two sections of equal width and length and a transect line was established down the center of each section. In 2005, transects were established in the same way as in 2004, but we switched to a stratified, random sampling design. In filter strips < 45 m wide, plots were located every 50 m at random distances perpendicular to the transect line. In filter strips > 45 m wide, plots were located every 50 m at random distances perpendicular to each transect line and within each section.

We estimated percent cover of grass, forbs, trees, bare ground, standing dead vegetation, and litter within a 1 m x 1 m frame. Percent cover measurements were non-overlapping and summed to 100%. Vertical density was measured by taking Robel pole (Robel et al. 1970) readings at each sampling point in the four cardinal directions. The Robel pole was positioned 1 m from the corner of sampling frame closest to the crop edge. On the second round of vegetation surveys in 2005, we identified each plant within the frame to species and estimated percent cover for each species. Litter depth was recorded at the mid-point of the side of the sampling frame closest to the wooded edge.

Statistical Analyses

All statistical tests were done in SAS (SAS Institute Inc. 2003) and statistical significance was set at $P \leq 0.05$. Total bird densities, species richness, and species densities are assumed to be relative and not actual. Species richness is a measure of the number of species recorded at each

site. Total bird density and species density were calculated by dividing the number of birds counted and the number of species counted by the area of the site, respectively. Means for density and richness were calculated by taking the average of the two surveys within a season. If the site was surveyed in both summer 2004 and summer 2005, the mean across both years was used for statistical tests.

Total bird density, species richness, and species density values were square-root transformed to improve normality and homogeneity of variances. Site type (three conservation buffer types or crop fields without buffers) and buffer width class (narrow, medium, or wide) were considered as separate treatment factors. For comparisons between buffers and crop fields without buffers in summer, only the first round of surveys in each year were used in the analyses because crop fields without buffers were only surveyed once in the first round of each year due to the height of the corn crops. Only observations in crop fields without buffers within 45 m of the wooded edge in summer, and 40 m of the wooded edge in winter, were included in the analyses, to approximate the average buffer width in each season.

Differences among treatments were evaluated with an analysis of variance using Proc Mixed (SAS Institute Inc. 2003). Buffer type, buffer width class, and their interaction were included in the original model as fixed effects. For winter analyses, snow depth was included in the original model as a covariate. Because Canada geese (*Branta candensis*) were only observed during surveys occasionally in winter in large flocks, observations of Canada geese were omitted from means comparison tests to improve homogeneity of variances. Differences between site types and buffer width classes were evaluated using pair-wise contrasts. Trends among individual bird species were analyzed for those species for which there were ≥ 45 observations over both summers. Riparian forest buffers were left out of individual species and guild analyses due to a low sample size for that treatment. Outliers for all statistical tests were removed as necessary to improve normality. Individual species and guild analyses were not done on winter data due to low sample sizes.

Relationships between buffer vegetation characteristics and bird metrics were done using multiple regression. Vegetation and bird data used for regression analyses were from the second round of surveys in 2005 (late June – mid-July). Vegetation data with non-normal distributions were square-root transformed when needed. Correlations between vegetation metrics were evaluated using a Pearson correlation matrix. Following Delisle and Savidge (1997), because no correlations had r values ≥ 0.70, all metrics were included in the original model. Insignificant terms were removed from the model in a backwards step-wise progression, removing the least significant term at each step, until only significant terms remained in the model. Relationships between bird metrics, buffer width, and buffer length were evaluated using the same techniques. Buffer width values were log transformed for the regression analysis.

RESULTS

Study Sites

Mean buffer width and length in summer among the three buffer types were 41.5 m and 480.6 m, respectively (Table 1). Mean buffer width and length in winter among the three buffer types were 33.8 m and 454.5 m, respectively. We went to fewer sites in winter than in summer

because we only did surveys in one winter season, many farms were unavailable in winter due to hunting activities, and because of inclement weather.

Summer

We counted 3,470 birds among 59 species over two summers (Table 2). The most abundant bird species observed in conservation buffers were red-winged blackbirds, indigo buntings, field sparrows (*Spizella pusilla*), and common yellowthroats. Several species of conservation concern were seen during bird surveys, including vesper sparrow, eastern meadowlark, grasshopper sparrow, and northern bobwhite.

Mean total bird density, species richness, and species density by buffer type and buffer width are reported in Table 3. Total bird density (Figure 2) was nearly seven times higher in conservation buffers than in crop fields without buffers ($P < 0.0001$). Species richness (Figure 3) and species density were also significantly higher in conservation buffers than in crop fields without buffers ($P < 0.0001$).

Among conservation buffers, the interaction between width and buffer type was insignificant for both bird density and species richness, therefore the main effects of width and buffer type were considered individually. Bird density was not significantly different among the three conservation buffer types (Figure 4). There were, however, significant differences in total bird density among the three buffer width classes (Figure 5). Narrow buffers had nearly twice the density of birds than in wide buffers ($P = 0.02$), and overall, bird density was lower in wider buffers. Additionally, a regression analysis indicated that bird density was negatively correlated with buffer width ($P = 0.002$). Species richness and density were not significantly different among buffer types. Species richness was significantly higher in wider buffers than in narrow buffers, while species density was significantly lower in wide buffers (Figure 6).

Each bird species was categorized into one of seven guilds. Generalist and grassland-generalist species tended to be common among all buffer types (Figure 7). Grassland-dependent species were the least common birds in conservation buffers. Grassland-dependent, grassland-generalist, and successional/scrub species data were analyzed statistically to look for guild-specific preferences. No guild preferred a particular type of grass filter strip. Successional/scrub species were found in higher densities in narrow filter strips (Figure 8). Three species of grassland-dependent species were seen in grass filter strips: grasshopper sparrow, eastern meadowlark, and ring-necked pheasant (*Phasianus colchicus*). Among these species, only the grasshopper sparrow was seen in any appreciable numbers. Of the 58 grasshopper sparrows recorded in filter strips over two years, all but one were seen in filter strips > 75 m wide. Only two meadowlarks and two pheasants were seen in conservation buffers over two summers, all of which were in buffers > 90 m wide.

Few individual species showed a preference between the two types of grass filter strips (Figure 9). Common grackles (*Quiscalus quiscula*) were found in significantly higher densities in cool season grass filter strips, while common yellowthroats (a grassland-generalist) were found in significantly higher densities in warm season grass filter strips. Only a few species showed preferences among the three types of buffer width classes (Figure 10). Indigo buntings

were found in lower densities in wider buffers. There were higher densities of common yellowthroats in narrow and medium buffers than in wide buffers.

The two filter strip types were similar among most vegetation metrics, but warm season grass filter strips were significantly higher in vertical density, number of grass species, and total number of shrubs (Table 4). Few vegetation characteristics were found to be significant predictors of bird density. The number of shrubs and vertical vegetation density were positively correlated with overall bird density (P = 0.044). Litter depth was negatively correlated with overall bird density (P = 0.033) and grassland bird density (grassland-generalists and grassland-dependent species combined) (P = 0.002) (Figure 11). No vegetation metrics were significant predictors of successional/scrub species as a guild.

We found evidence of nesting in conservation buffers by 14 species of birds. Eight-six total nests were found, the majority being red-winged blackbirds, indigo buntings, and common yellowthroats (Table 5). One wild turkey (*Meleagris gallopavo*) nest was found in a riparian forest buffer and several family groups of northern bobwhites were seen in conservation buffers. Apparent nest success was highest in riparian forest buffers (52%), lower in warm season grass filter strips (44%), and lowest in cool season grass filter strips (21.4%). Apparent nest success in all buffers combined was 41%.

Winter

We counted 3,258 total birds among 26 species during surveys in winter 2005 (Table 2). The most common species in conservation buffers were song sparrows (*Melospiza melodia*), swamp sparrows (*Melospiza georgiana*), white-throated sparrows (*Zonotrichia albicollis*), and field sparrows (*Spizella pusilla*). Several species of conservation concern were seen during winter surveys in buffers, including northern bobwhite and savannah sparrow (*Passerculus sandwichensis*).

Mean total bird density, species richness, and species density by buffer type and buffer width are reported in Table 6. We found no significant differences in total bird density (Figure 12) or species richness between conservation buffers and crop fields without buffers. Total bird density was significantly higher in riparian forest buffers (P = .004) and warm season grass filter strips (P = .047) than in cool season grass filter strips (Figure 13). There were no significant differences in total bird density among the three filter strip width classes. Species richness (Figure 14) and density were higher in riparian forest buffers than in grass filter strips. There were no significant differences in species richness or species density among the three strip width classes.

We recorded only two grassland bird species in conservation buffers in winter. Swamp sparrow (a grassland-generalist) was only found in riparian forest buffers and warm season grass filter strips and was more common in narrow buffers than in wider buffers. Savannah sparrow (a grassland-dependent species) was also only found in riparian forest buffers and warm season grass filter strips and was much more common in wide buffers.

DISCUSSION

Our findings suggest that conservation buffers do provide valuable habitat for birds in Maryland's agricultural landscape. Total bird density was nearly seven times higher in conservation buffers than in crop fields without buffers during the breeding season, and both species richness and species density were significantly higher in conservation buffers. In addition, we found nests of 14 species of birds in conservation buffers. These results indicate that the creation of conservation buffers has achieved some of the wildlife benefits intended by Maryland's CREP.

We are aware of no other studies that have compared the abundance/density and richness of birds in grass filter strips and riparian forest buffers to rowcrop fields. However, our results do agree with the findings of studies that have compared bird abundance and species richness in other conservation buffer types to rowcrop fields (Best 2000). In the Midwest, grassed waterways (USDA Cover Type CP8) appear to be particularly favored by birds, with 48 species recorded using waterways and 11 species known to nest in them (Bryan and Best 1991; 1994). In Mississippi, species richness was greater in agricultural fields with field borders (USDA Cover Type CP33) than in those without field borders during the breeding season (Smith 2004).

High bird abundance/density and species richness does not necessarily indicate quality habitat for birds (Van Horne 1983, Davros 2005). Best (2000) reports that while bird abundance and nest densities in buffers are generally much greater than those in CRP fields, nest success is generally lower in buffers than in CRP fields. Predation is the most significant reason for nest failure in nearly every study of conservation buffers or similar strip-cover habitats. Kammin (2003) reported that 76.4% of all nests found in Illinois filter strips were destroyed by predation, and that nest success for the two most abundant species, red-winged blackbirds and American robins, was only 8% and 6%, respectively. Davros (2005) reported that nest success in Minnesota filter strips ranged from 8.6% in filter strips with more standing dead vegetation and less grass cover, to 34.8% in sites with less standing dead vegetation and more grass cover. Predation in filter strips in Iowa accounted for 62% of nest failures (Henningsen and Best 2005). These results have raised concern that conservation buffers act as reproductive sinks for birds.

We recorded 59 species using conservation buffers during the breeding season. This is more than any other study on bird use in conservation buffers (Best 2000, Kammin 2003, Davros 2005). The number of breeding birds may be higher than other studies because most other studies have focused on one buffer type, while ours focused on filter strips and riparian forest buffers combined. Additionally, we counted birds if they were in overhanging trees along the wooded edge, since most species use trees along the edge as perches. In most other studies of birds in conservation buffers and other strip-cover habitats, birds were recorded only if they were seen in the buffer or strip.

The fact that we did not find a significant difference in bird density among the three buffer types during the breeding season agrees with other studies, particularly those done in grassland habitats. In a study conducted in CRP fields in Nebraska, Delisle and Savidge (1997) did not find differences in total bird abundance between cool season grass fields and warm season grass fields. And Henningsen and Best (2005) found relative bird abundance and relative nest abundance to be similar between cool and warm season grass filter strips in Iowa.

In contrast, we did find significant differences among the three conservation buffer types in winter. Cool season grass filter strips had the lowest values for species richness and species density. These results agree with studies of wintering grassland birds that have reported higher species diversity and avian abundance in warm season grass fields compared to cool season grass fields (Farrand and Ryan 2005). In our study, we believe the major reason why there were fewer birds in cool season grass filter strips has to do with management. Most of the cool season grass filter strips we visited in winter were mowed just after the breeding season, which is allowed under the current rules of Maryland's CREP. Late summer mowing leaves the filter strip short and exposed throughout the winter, providing poor cover for wintering birds. We recommend that at least a portion of each buffer be left standing in the fall and winter to provide habitat for wintering birds.

Vegetation structure and composition is a more important factor for birds than planting mixture (i.e. cool or warm season grasses) (Patterson and Best 1996, Best 2000). The presence of woody plants in strip-cover habitats increases the vertical structure and heterogeneity of the vegetation, resulting in increased species diversity and abundance (Arnold 1983). Grassland birds are influenced by both the ratio of grasses to broad leaved plants and the presence of woody vegetation (Best 2000). In our study, grassland bird density was positively associated with vertical vegetation density, and negatively associated with percent litter depth. However, there is no one formula that suits all grassland species. Bobolinks, for example, prefer less forb cover and more grass cover, while dickcissels prefer the opposite (Patterson and Best 1996). Similarly, dickcissels are associated with tall, dense vegetation while grasshoppers sparrows prefer sparse vegetation with a shallow litter layer (Delisle and Savidge 1997). We recommend that overly competitive grasses that reduce plant species diversity and structural diversity, such as switchgrass and orchard grass, should be planted in moderation in conservation buffers.

All of the buffers in this study were adjacent to a wooded edge. The presence of a woody vegetation adjacent to buffers may decrease grassland bird abundance and species richness, while increasing brown-headed cowbird parasitism (Gates and Gysel 1978, Winter et al. 2000, Davros 2005). Henningsen and Best (2005) reported that bird abundance and species richness were higher in filter strips without woody vegetation nearby than at sites with an adjacent wooded edge. Kammin (2003) found that grassland-dependent species were more abundant in filter strips without adjacent woody vegetation in early summer, late summer, and fall. Grassland-generalist species in this study were more abundant at sites without adjacent woody vegetation in winter, early summer, and late summer, but were less abundant in filter strips without adjacent woody vegetation in the fall.

We found that species richness in summer was highest in the widest buffers. Stauffer and Best (1980) found that bird species richness increased with the width of both wooded and herbaceous riparian habitats. Davros (2005) also reported that filter strip width was positively associated with bird abundance and species richness. In contrast, species density was higher in narrow and medium width buffers than in wide buffers. These results have implications for land managers concerned with resource allocation. While the widest buffers with the largest areas will tend to have more species, species density will tend to be higher in narrow buffers with smaller areas. However, the species composition in buffers of different widths varies greatly.

Grassland-dependent species were found only in wide filter strips in summer, and were much more common in wide filter strips and riparian forest buffers in winter. This is not surprising considering the known preferences of grassland-dependent birds. Several studies have documented a positive relationship between grassland bird abundance and the size of grassland areas (Vickery et al. 1994, Johnson and Igl 1995, Helzer and Jelinski 1999). Vickery et al. (1994) suggested that grasslands need to be approximately 200 ha in area in order to support a diverse grassland bird community. Heltzer and Jelinski (1999) found that perimeter-area ratio of grassland fields was strongly associated with grassland bird richness and probability of occurrence. They concluded that large patches (> 50 ha), with abundant interior areas free from the impacts of edges, was important to the conservation of grassland-dependent birds.

Because most of the filter strips in Maryland are adjacent to wooded edges, we believe that filter strips should be as wide as possible to reduce the chances of deleterious edge effects such as predation and brood parasitism. Nearly all of the breeding grassland-dependent birds recorded during our study were seen in conservation buffers ≥ 75 m wide. We recommend that buffers should be planted at least 75 m wide in order to attract grassland-dependent birds, but we acknowledge that this width may not be wide enough to avoid edge effects and to support a healthy grassland bird community. To further avoid edge effects, we believe that greater emphasis should be put on building filter strips along field borders without wooded edges, such as near drainage ditches and roads that are not bordered by trees. As for width, a simple motto could go a long way to providing quality habitat for grassland birds: The wider the better.

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We are grateful to Dr. Galen Dively for his help with logistics, statistical analyses, and study design. Dr. Bahram Momen also assisted with statistics and study design. Thanks to Maren Gimpel, Jason Guerard, Leanna Kelly, Beth Olsen, Jared Parks, Zack Parks, and Dan Small for their help in the field. We thank the following farms, farm owners, and organizations that allowed us to work on their properties: Ackridge, Aspen Institute, Barnstable Hill, Beachy, Chino, Burgess, Cohey, Cottingham East, Dodd, Gunther, Holsinger, Holt, Hope House, Houghton, Kenzie, Leaverton, Milliken, Murchison, Pickering Creek Audubon Sanctuary, Rash, Rockland, Royal Swan, Ruff, Schwaninger, Stagwell, Sultenfuss, Tuckahoe State Park, Willock, Wye Island NRMA. Chino Farms provided housing for our field staff. The Chesapeake Wildlife Heritage provided technical information and advice. The USDA Natural Resources Conservation Service provided additional funding and technical support for this project.

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Table 1. Study site characteristics

		Width (m)				Length (m)			
Season/Habitat Type	N	Mean	SD	Min	Max	Mean	SD	Min	Max
Summer									
Cool season grass filter strips	17	45.8	33.7	10.1	95.4	585.5	315.5	270	1072
Warm season grass filter strips	40	39.3	29.1	14.3	97.1	457.5	270.9	200	1859
Riparian forest buffers	11	43.1	22.0	14.6	75.0	402.3	169.7	212	797
Crop fields without buffers	25	45	0	45	45	410.4	247.4	200	988
Winter									
Cool season grass filter strips	9	39.0	33.1	13.5	91.4	532.7	369.7	273	1397
Warm season grass filter strips	21	28.6	17.4	13.4	95.3	430.5	111.6	274	729
Riparian forest buffers	13	41.1	21.3	7.6	65.3	447.0	255.7	190	1099
Crop fields without buffers	15	40	0	40	40	433.6	262.1	200	1026

Table 2. Bird species recorded during surveys in 2004 - 2005

Common Name	Scientific Name	Guild[b]	Season
American Crow	*Corvus brachyrhynchos*	Woodland	Year-round
American Goldfinch	*Carduelis tristis*	Generalist	Summer
American Pipit[a]	*Anthus rubescens*	Generalist	Winter
American Redstart	*Setophaga ruticilla*	Woodland	Summer
American Robin	*Turdus migratorius*	Urban	Year-round
American Tree Sparrow	*Spizella arborea*	Successional/scrub	Winter
Bald Eagle	*Aquila chrysaetos*	Other	Summer
Baltimore Oriole	*Icterus galbula*	Successional/scrub	Summer
Barn Swallow	*Hirundo rustica*	Generalist	Summer
Blue Grosbeak	*Passerina caerulea*	Successional/scrub	Summer
Blue Jay	*Cyanocitta cristata*	Urban	Year-round
Blue-gray Gnatcatcher	*Polioptila caerulea*	Woodland	Summer
Brown Thrasher	*Toxostoma rufum*	Successional/scrub	Summer
Brown-headed Cowbird	*Molothrus ater*	Generalist	Summer
Canada Goose[a]	*Branta candensis*	Other	Winter
Carolina Chickadee	*Poecile carolinensis*	Woodland	Year-round
Carolina Wren	*Thryothorus ludovicianus*	Woodland	Year-round
Cedar Waxwing	*Bombycilla cedrorum*	Other	Summer
Chimney Swift	*Chaetura pelagica*	Urban	Summer
Chipping Sparrow	*Spizella passerine*	Urban	Year-round
Common Grackle	*Quiscalus quiscula*	Generalist	Summer
Common Yellowthroat	*Geothlypis trichas*	Grassland-generalist	Summer
Dark-eyed Junco	*Junco hyemalis*	Woodland	Winter
Downy Woodpecker	*Picoides pubescens*	Woodland	Year-round
Eastern Bluebird	*Sialia sialis*	Successional/scrub	Year-round
Eastern Kingbird	*Tyrannus tyrannus*	Generalist	Summer
Eastern Meadowlark	*Sturnella magna*	Grassland-dependent	Summer
Eastern Phoebe	*Sayornis phoebe*	Other	Summer
Eastern Towhee	*Pipilo erythrophthalmus*	Successional/scrub	Year-round
Eastern Tufted Titmouse	*Baeolophus bicolor*	Woodland	Year-round
Eastern Wood-Pewee	*Contopus virens*	Woodland	Summer
Empidonax Sp.	*Empidonax sp.*	Woodland	Summer
European Starling	*Sturnus vulgaris*	Urban	Year-round
Field Sparrow	*Spizella pusilla*	Grassland-generalist	Year-round
Grasshopper Sparrow	*Ammodramus savannarum*	Grassland-dependent	Summer
Gray Catbird	*Dumetella carolinensis*	Successional/scrub	Summer
Great Blue Heron	*Ardea herodias*	Other	Year-round
Great Horned Owl	*Bubo virginianus*	Woodland	Year-round
Great-crested Flycatcher	*Myiarchus crinitus*	Woodland	Summer
Green Heron	*Butorides virescens*	Other	Summer

Hairy Woodpecker	*Picoides villosus*	Woodland	Year-round
Hermit Thrush	*Catharus guttatus*	Woodland	Winter
Horned Lark	*Eremophila alpestris*	Grassland-generalist	Winter
House Finch	*Carpodacus mexicanus*	Urban	Year-round
House Sparrow	*Passer domesticus*	Urban	Year-round
Indigo Bunting	*Passerina cyanea*	Successional/scrub	Summer
Killdeer[a]	*Charadrius vociferus*	Generalist	Winter
Mourning Dove	*Zenaida macroura*	Generalist	Year-round
Northern Bobwhite	*Colinus virginianus*	Generalist	Year-round
Northern Cardinal	*Cardinalis cardinalis*	Successional/scrub	Year-round
Northern Flicker	*Colaptes auratus*	Other	Year-round
Northern Mockingbird	*Mimus polyglottos*	Urban	Year-round
Orchard Oriole	*Icterus spurious*	Generalist	Summer
Purple Martin	*Progne subis*	Other	Summer
Red-bellied Woodpecker	*Melanerpes carolinus*	Woodland	Year-round
Red-eyed Vireo	*Vireo olivaceus*	Woodland	Summer
Red-tailed Hawk	*Buteo jamaicensis*	Woodland	Year-round
Red-winged Blackbird	*Agelaius phoeniceus*	Grassland-generalist	Year-round
Ring-necked Pheasant	*Phasianus colchicus*	Grassland-dependent	Year-round
Ruby-throated Hummingbird	*Archilochus colubris*	Woodland	Summer
Savannah Sparrow	*Passerculus sandwichensis*	Grassland-dependent	Winter
Scarlet Tanager	*Piranga olivacea*	Woodland	Summer
Song Sparrow	*Melospiza melodia*	Grassland-generalist	Year-round
Swamp Sparrow	*Melospiza georgiana*	Grassland-generalist	Winter
Tree Swallow	*Tachycineta bicolor*	Other	Summer
Turkey Vulture[a]	*Cathartes aura*	Other	Year-round
Vesper Sparrow	*Pooecetes gramineus*	Grassland-dependent	Summer
Warbling Vireo	*Vireo gilvus*	Successional/scrub	Summer
White-eyed Vireo	*Vireo griseus*	Successional/scrub	Summer
White-throated Sparrow	*Zonotrichia albicollis*	Successional/scrub	Winter
Wood Thrush	*Hylocichla mustelina*	Woodland	Summer
Wild Turkey	*Meleagris gallopavo*	Generalist	Year-round
Yellow Warbler	*Dendroica petechia*	Woodland	Summer
Yellow-billed Cuckoo	*Coccyzus americanus*	Woodland	Summer
Yellow-breasted Chat	*Icteria virens*	Successional/scrub	Summer
Yellow-throated Vireo	*Vireo flavifrons*	Woodland	Summer

[a] Only seen in crop fields without buffers.
[b] Sources: (Best et al. 1997, McCoy et al. 1999, Kammin 2003, Sauer et al. 2005)

Table 3. Summer bird density, species richness, and species density by habitat type and buffer width

	Summer								
	Total Bird Density (per 100 ha)			Species Richness			Species Density (per ha)		
Habitat Type	Mean	SE		Mean	SE		Mean	SE	
Conservation buffers	1273.6	117.1	a	5.81	0.45	a	4.41	0.40	a
Crop fields without buffers	187.8	32.9	b	1.94	0.31	b	1.22	0.23	b
CSG filter strips	1189.8	290.5	a	4.66	0.69	a	3.19	0.69	a
WSG filter strips	1167.2	131.8	a	5.51	0.56	a	4.51	0.51	a
Riparian forest buffers	1678.1	407.3	a	6.64	1.17	a	4.42	0.79	a
Narrow buffers	1503.2	197.4	a	4.52	0.63	a	5.46	0.59	a
Medium width buffers	1157.3	143.0	ab	6.30	0.83	ab	4.23	0.56	a
Wide buffers	920.4	234.0	b	6.45	0.67	b	1.98	0.30	b

CSG = cool season grass; WSG = warm season grass.
Means in the same column, followed by the same letter, and within the same section (sections are separated by black lines) are not significantly different. Filter strips and riparian forest buffers are types of conservation buffers.

Table 4. Mean vegetation characteristics in grass filter strips[a]

Vegetation Characteristic	CSG (n=16)	WSG (n=20)	F	P
Vertical Density (cm)	49.5	68.1	6.98	0.012
Max Height Live Vegetation (cm)	124.8	131.6	0.68	0.417
Litter Depth (cm)	2.7	3.6	2.27	0.141
Percent Cover of Forbs	34.8	25.8	0.81	0.374
Percent Cover of Grass	38.6	48.1	1.68	0.204
Percent Cover of Litter	18.1	20.5	0.55	0.464
Percent Cover of Standing Dead Vegetation	0.6	1.4	1.56	0.220
Number of Forb Species[b]	4.2	3.9	0.18	0.675
Number of Trees Species[b]	0.5	0.5	0.31	0.584
Number of Grass Species[b]	1.5	2.0	6.85	0.013
Total Number of Shrubs[c]	19.6	105.6	8.77	0.006

CSG = cool season grass filter strip; WSG = warm season grass filter strip.
[a] Data are from vegetation surveys done in late June – mid-July 2005.
[b] Mean species richness from sampling plots.
[c] Number of shrubs or trees taller than the surrounding grass canopy.

Table 5. Number of nests, by species, found in the 3 types of conservation buffers in summer 2004 and 2005.

Species	CSG (n = 17)	WSG (n = 40)	RFB (n = 11)
Blue Grosbeak	0	3	1
Brown Thrasher	0	0	1
Common Yellowthroat	0	8	0
Field Sparrow	1	3	1
Grasshopper Sparrow	0	5	1
Gray Catbird	0	0	1
Indigo Bunting	12	6	1
Northern Cardinal	0	0	1
Northern Mockingbird	0	0	2
Orchard Oriole	0	2	2
Red-eyed vireo	0	0	1
Red-winged blackbird	5	15	11
Song Sparrow	0	1	0
Wild Turkey	0	0	1

CSG = cool season grass filter strip, WSG = warm season grass filter strip, RFB = riparian forest buffer.
Note: This table is not intended for comparisons among buffer types, since the number of study sites within each buffer type differed and nest searching effort was not equal across all sites.

Table 6. Winter bird density, species richness, and species density by habitat type and buffer width

	Winter								
	Total Bird Density			Species Richness			Species Density		
Habitat Type	Mean	SE		Mean	SE		Mean	SE	
Conservation buffers	1074.7	232.9	a	1.79	0.29	a	2.28	0.77	a
Crop fields without buffers	1074.1	507.2	a	1.06	0.30	a	0.74	0.23	a
CSG filter strips	246.9	120.2	a	0.83	0.46	a	0.82	0.58	a
WSG filter strips	1078.1	331.3	b	1.63	0.43	a	2.40	1.22	ab
Riparian forest buffers	1642.3	509.4	b	2.58	0.35	b	2.67	0.59	b
Narrow buffers	1328.8	380.5	a	1.61	0.38	a	3.13	1.31	a
Medium width buffers	678.6	270.3	a	1.72	0.57	a	1.03	0.34	a
Wide buffers	857.3	336.9	a	3.00	0.57	a	1.51	0.60	a

CSG = cool season grass; WSG = warm season grass.

Means in the same column, followed by the same letter, and within the same section (sections are separated by black lines) are not significantly different. Filter strips and riparian forest buffers are types of conservation buffers.

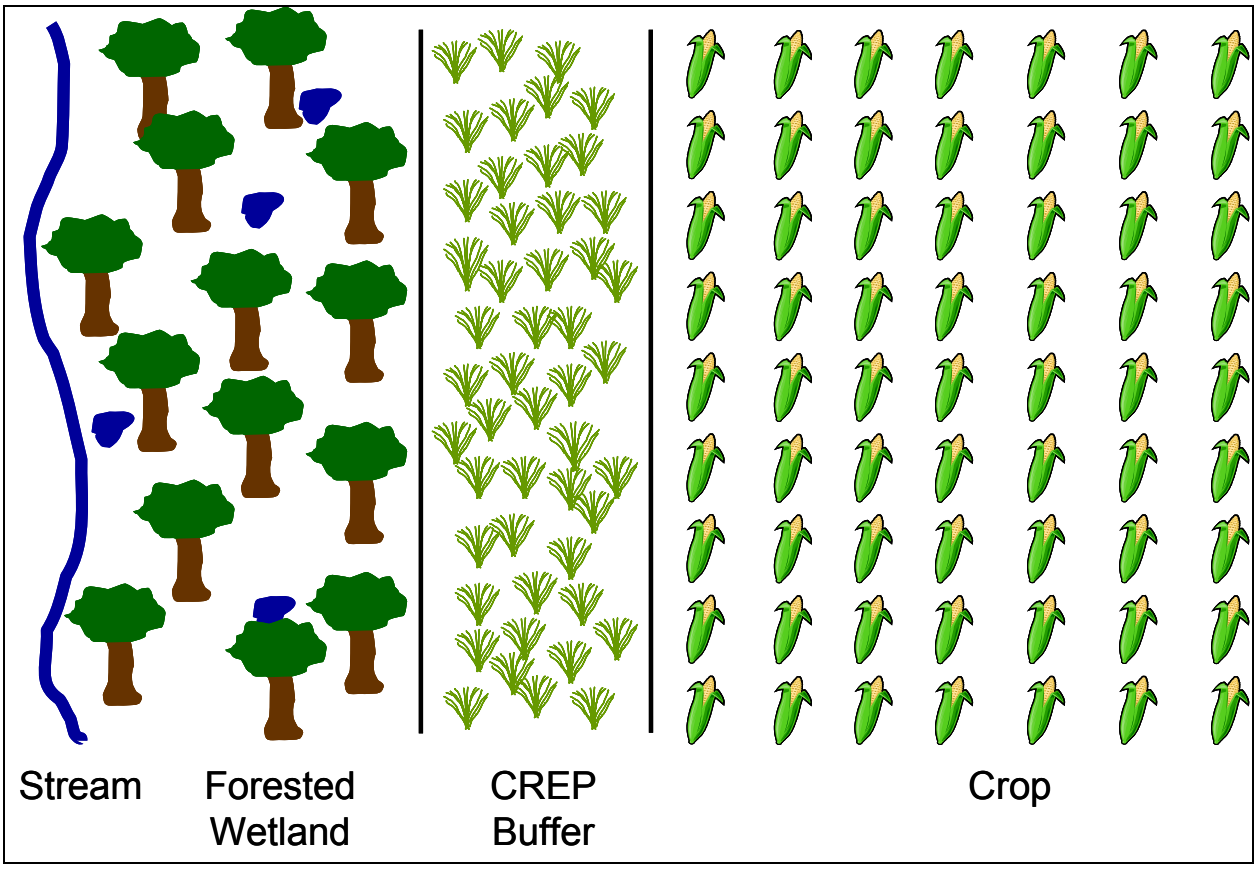

Figure 1. Location of a typical CREP buffer.

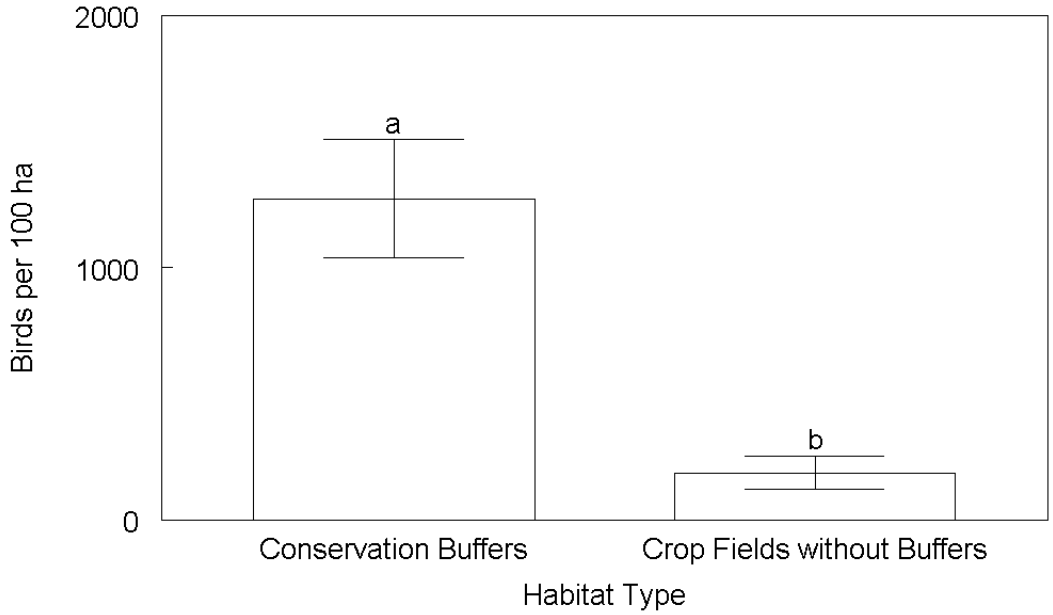

Figure 2. Mean bird density (± 2SE) in conservation buffers and crop fields without buffers in summer. Bars with the same letter above them are not significantly different.

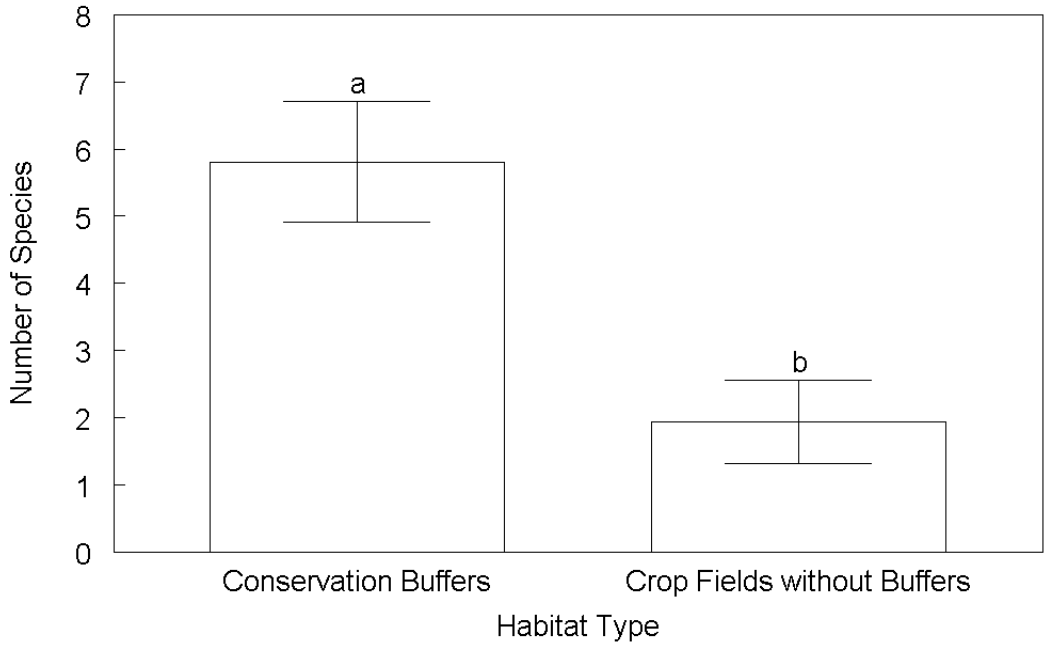

Figure 3. Mean bird species richness (± 2SE) in conservation buffers and crop fields without buffers in summer. Bars with the same letter above them are not significantly different.

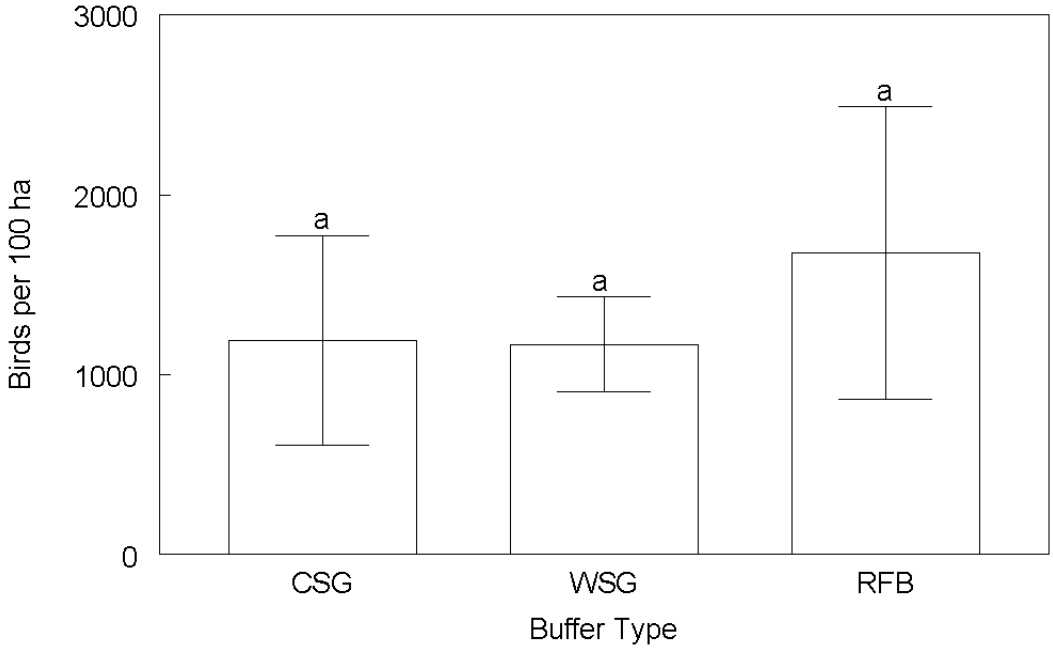

Figure 4. Mean bird density (± 2SE) in three conservation buffer types in summer. CSG = cool season grass filter strip; WSG = warm season grass filter strip; RFB = riparian forest buffer. Bars with the same letter above them are not significantly different.

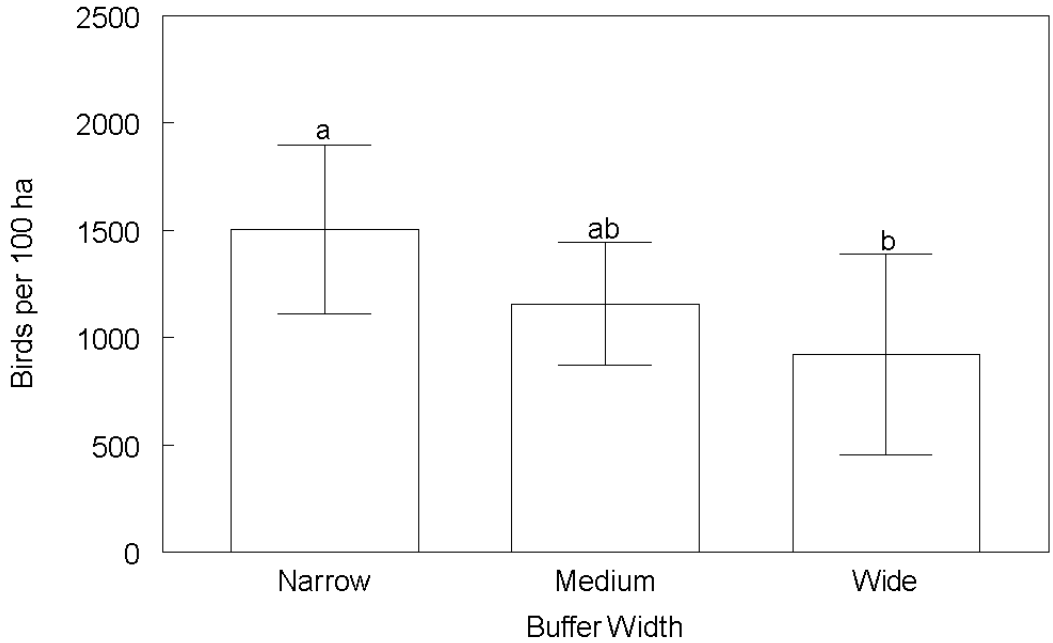

Figure 5. Mean bird density (± 2SE) among three conservation buffer width classes in summer. Narrow = < 30 m; Medium = 30 to 60 m; Wide = > 60 m. Bars with the same letter above them are not significantly different.

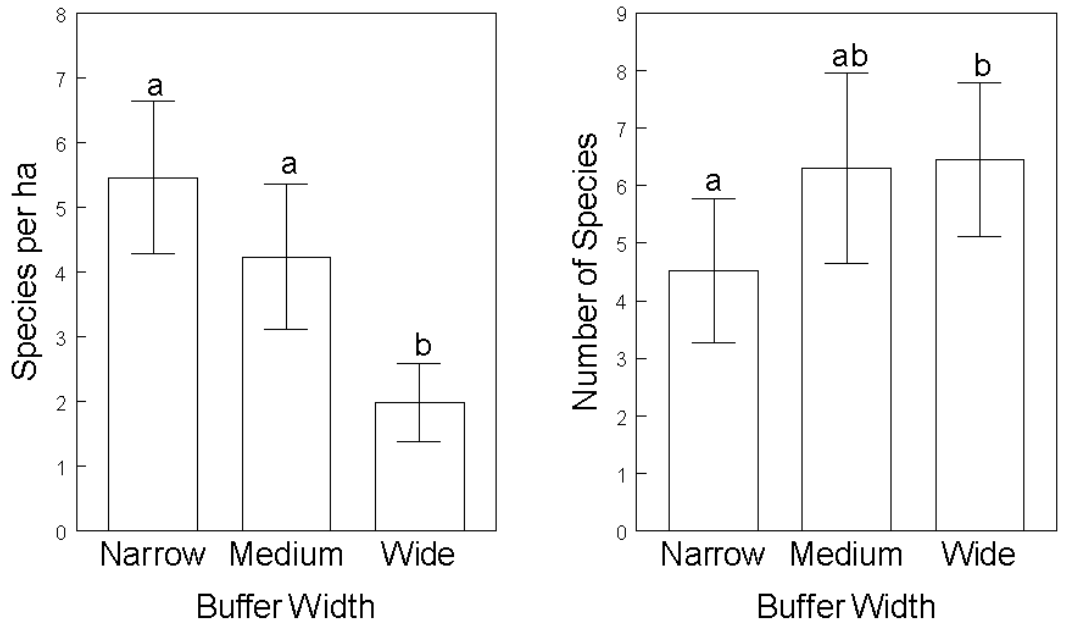

Figure 6. Mean species density (left) and species richness (right) (± 2SE) among three conservation buffer width classes in summer. Narrow = < 30 m; Medium = 30 to 60 m; Wide = > 60 m. Bars with the same letter above them are not significantly different.

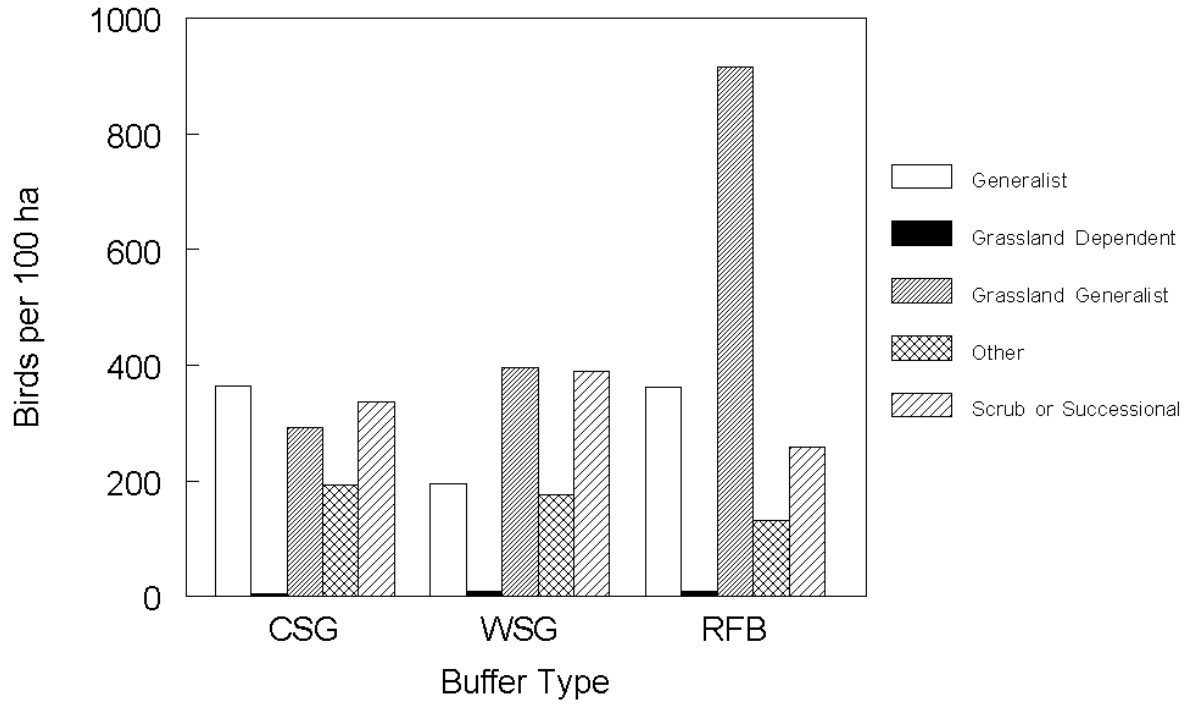

Figure 7. Mean bird density within guilds in summer. CSG = cool season grass filter strip; RFB = riparian forest buffer; WSG = warm season grass filter strip.

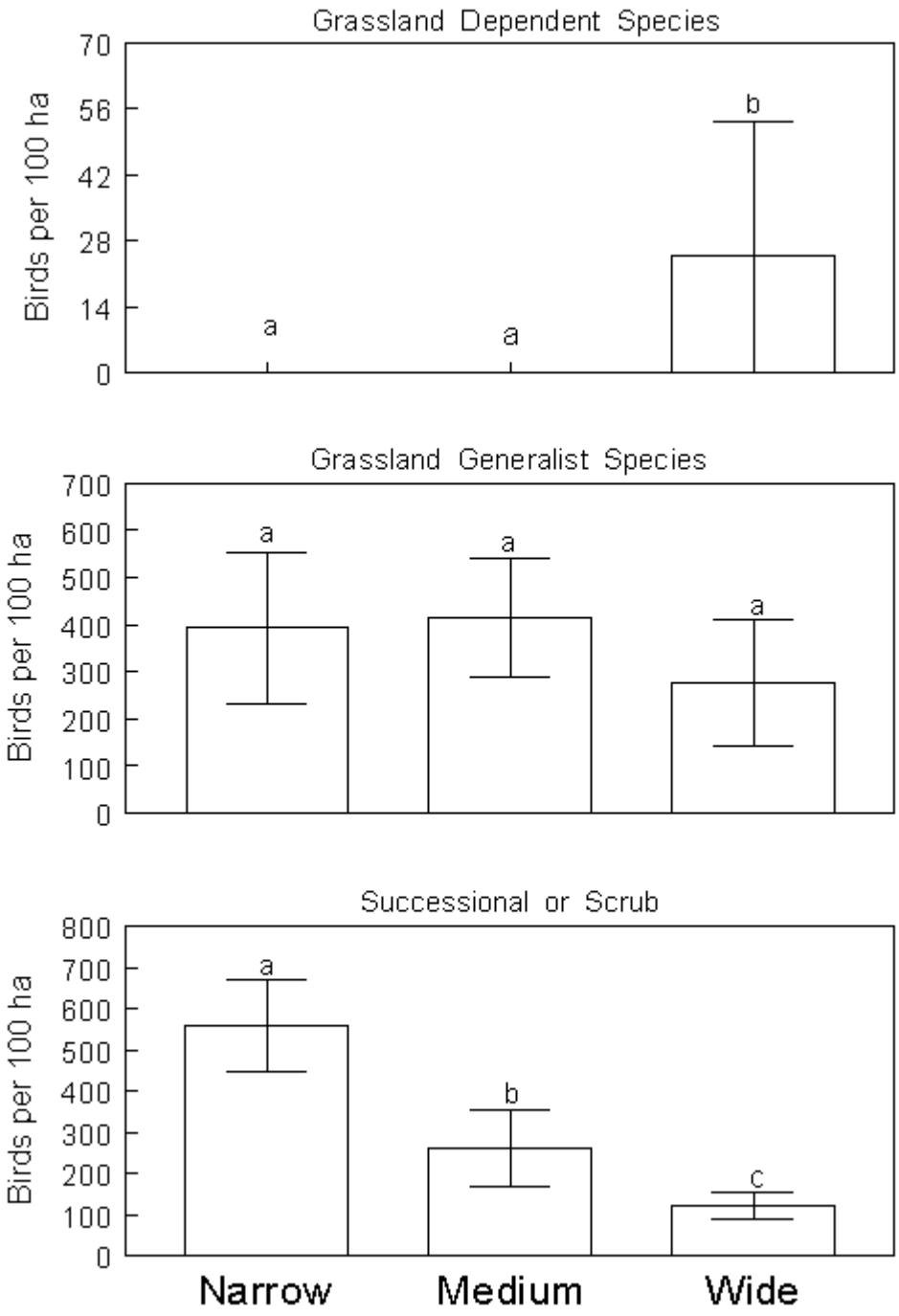

Figure 8. Mean bird density (± 2SE) among three conservation buffer width classes in summer. Narrow = < 30 m; Medium = 30 to 60 m; Wide = > 60 m. Bars with the same letter above them are not significantly different.

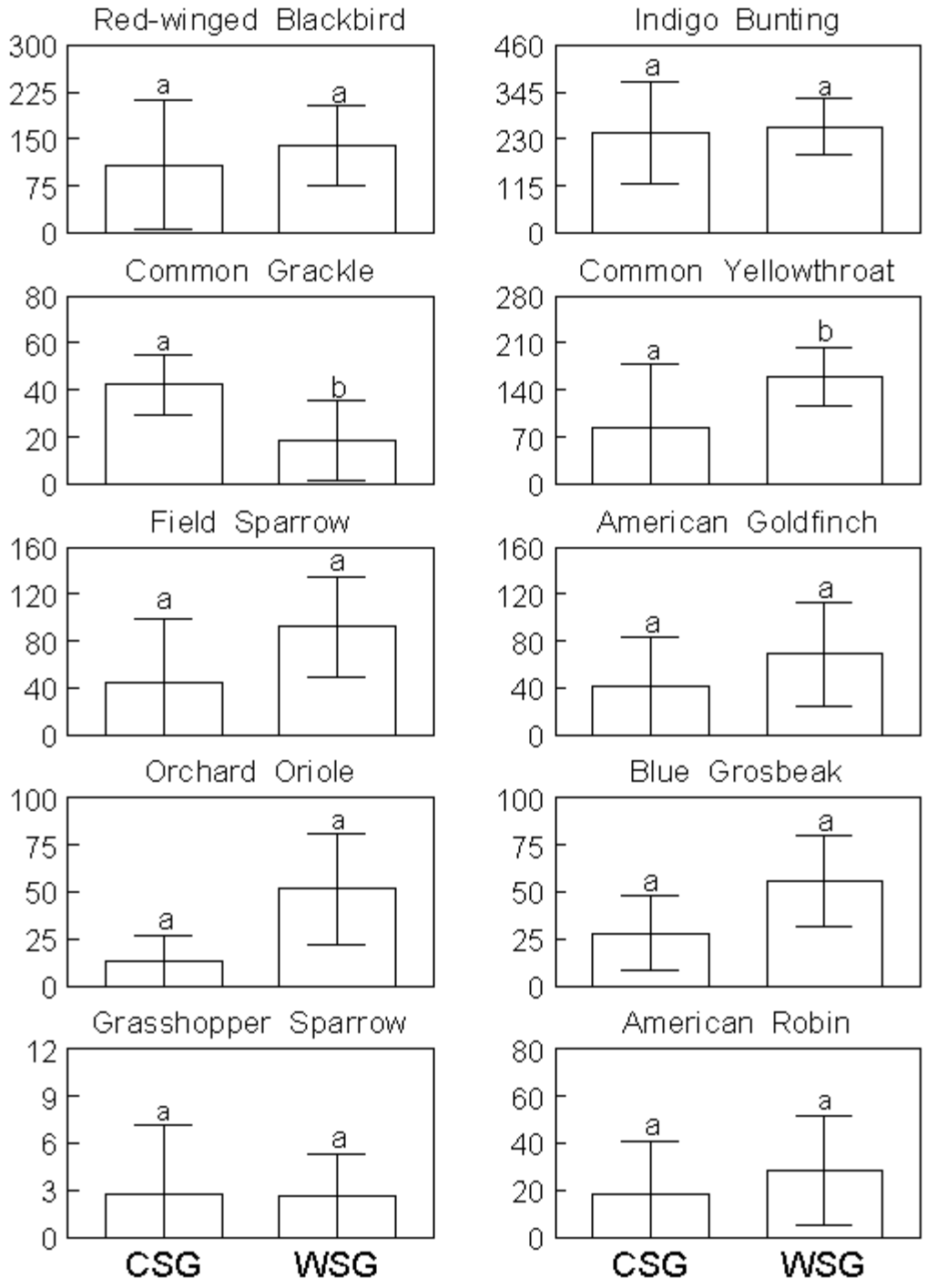

Figure 9. Mean bird density (birds per 100 ha ± 2SE) of the top ten most common species in grass filter strips in summer. CSG = cool season grass filter strip; WSG = warm season grass filter strip. Bars with the same letter above them are not significantly different.

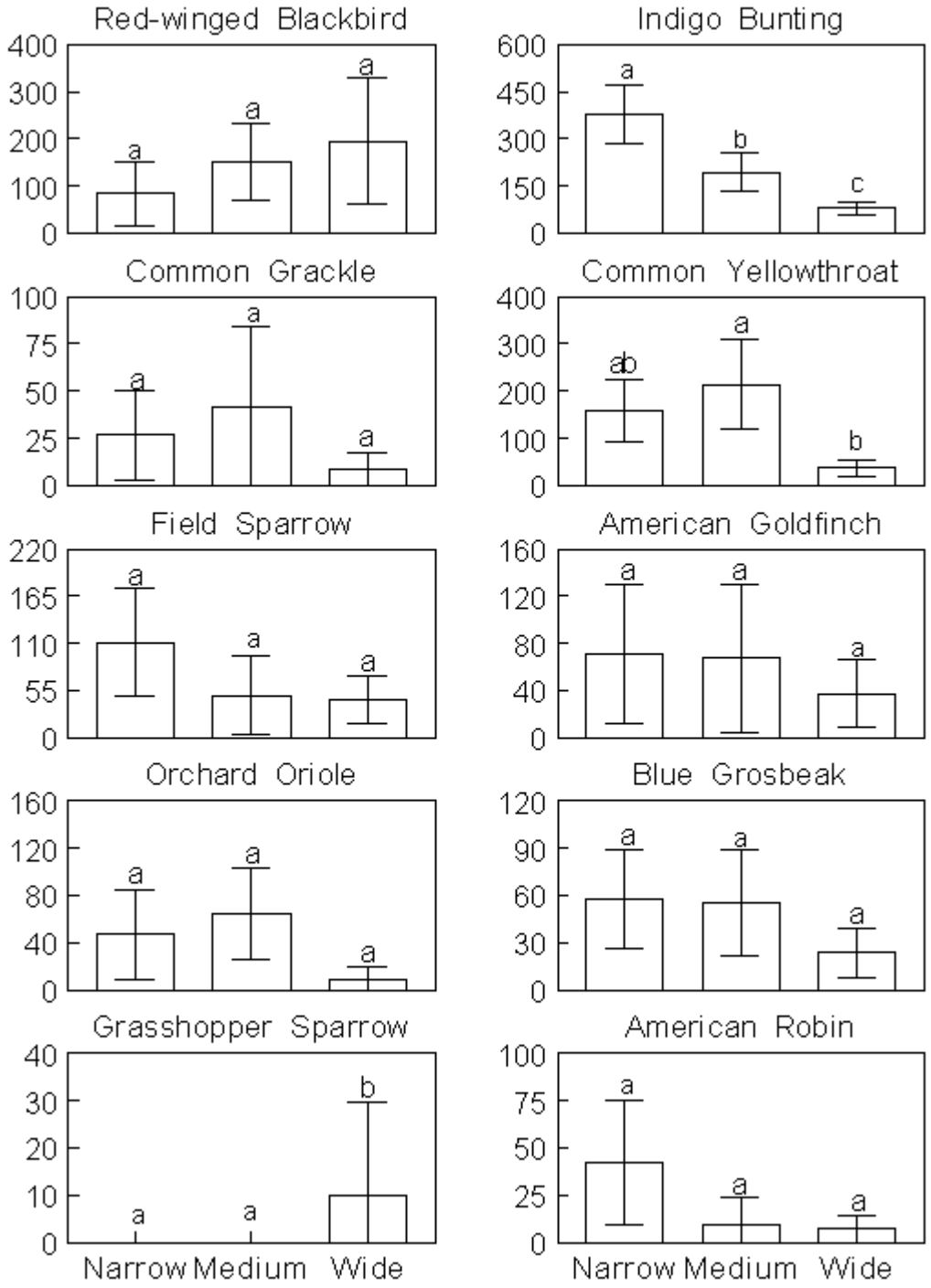

Figure 10. Mean bird density (birds per 100 ha ± 2SE) of the top ten most common species in grass filter strips in summer. Narrow = < 30 m; Medium = 30 to 60 m; Wide = > 60 m. Bars with the same letter above them are not significantly different.

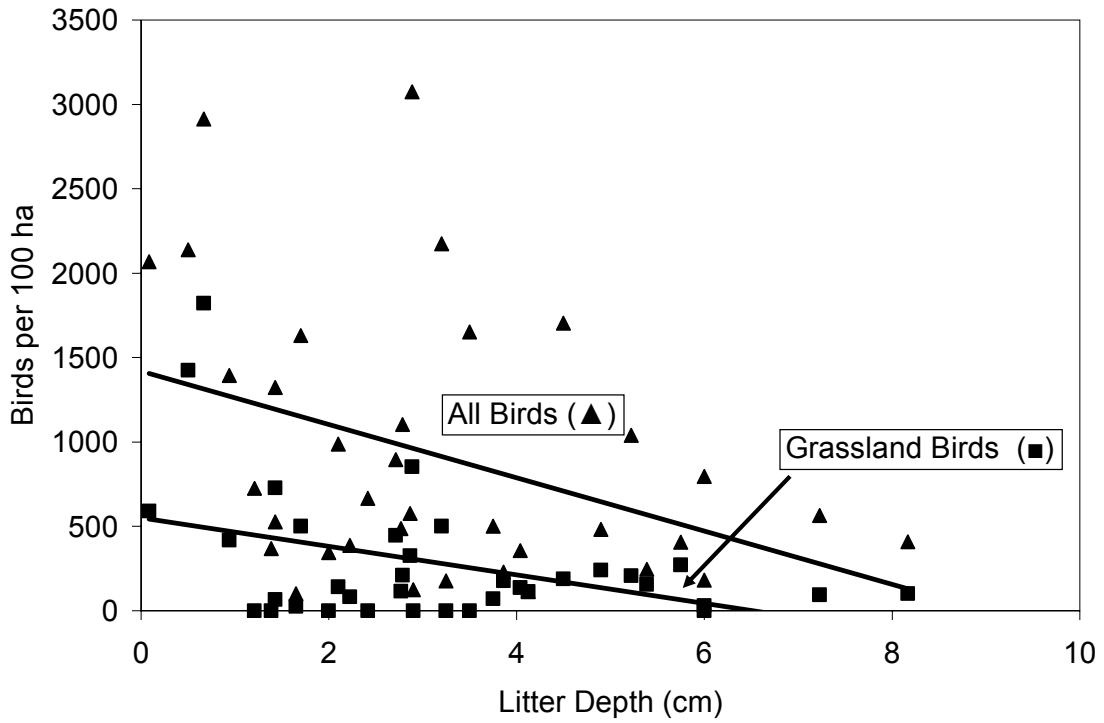

Figure 11. Relationship between bird density and litter depth in grass filter strips.

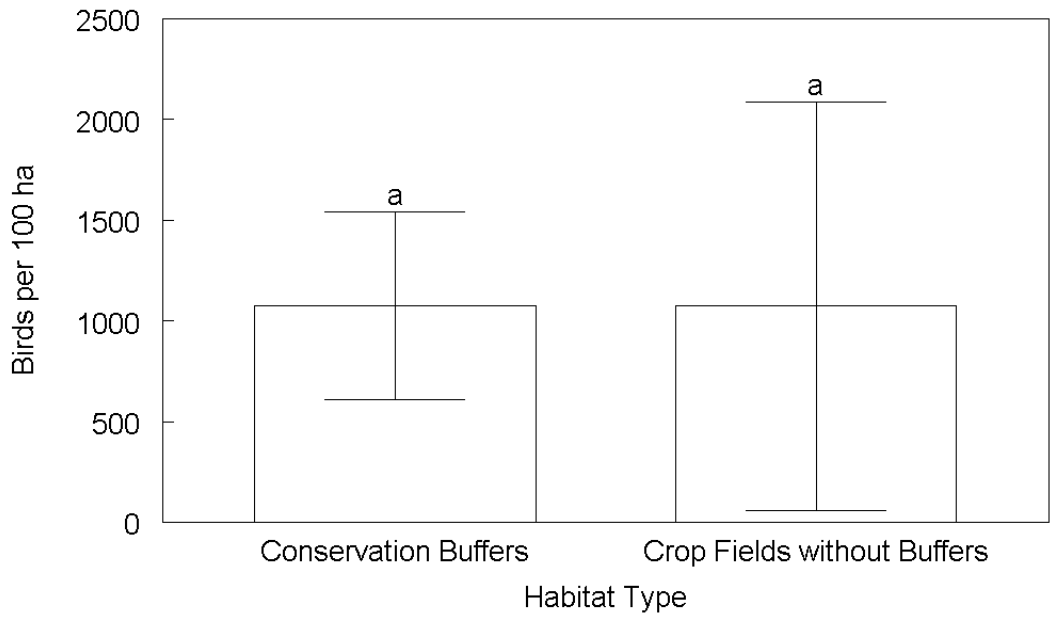

Figure 12. Mean bird density (± 2SE) in conservation buffers and crop field edges without buffers in winter. Bars with the same letter above them are not significantly different.

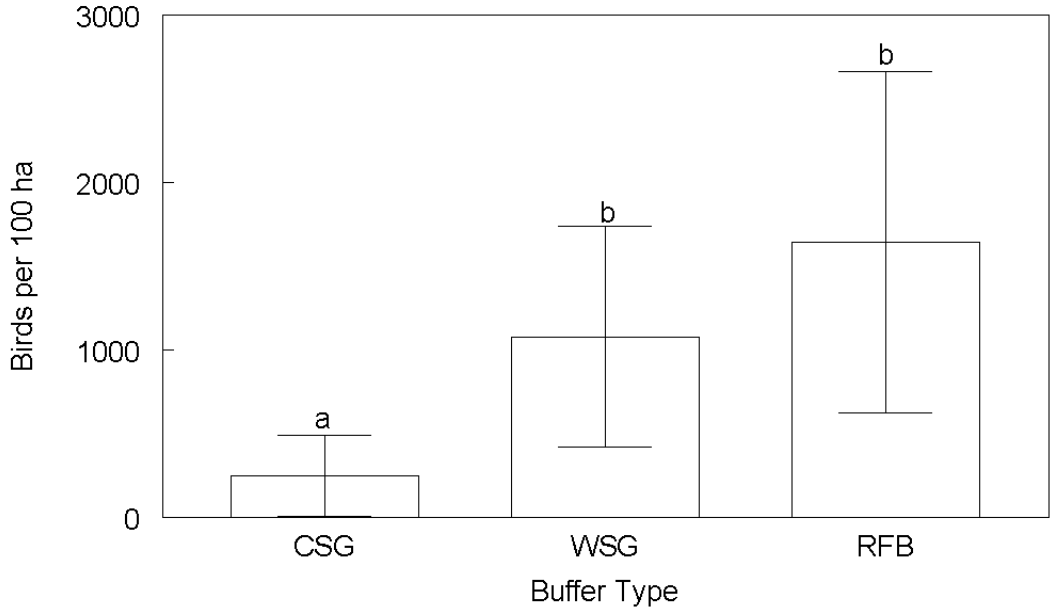

Figure 13. Mean bird density (± 2SE) in three conservation buffer types in winter. CSG = cool season grass filter strip; RFB = riparian forest buffer; WSG = warm season grass filter strip. Bars with the same letter above them are not significantly different.

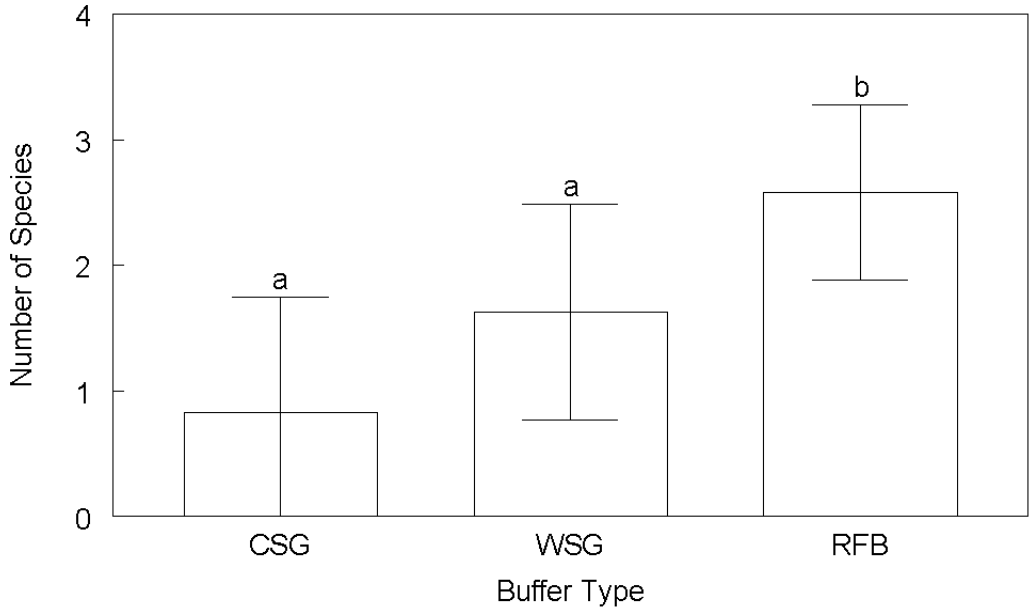

Figure 14. Mean bird species richness (± 2SE) in three conservation buffer types in winter. CSG = cool season grass filter strip; RFB = riparian forest buffer; WSG = warm season grass filter strip. Bars with the same letter above them are not significantly different.