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Habitat Requirements of Early Successional Bird Communities: Management Implications for the Mid-Atlantic Region

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EXECUTIVE SUMMARY

Recent concern for the status of North American bird populations has resulted in an escalation of monitoring and management efforts. Although much of this concern has been focused on declining forest-dwelling species, species associated with grass or shrublands have experienced annual population declines that in many cases are equal to or greater than their forest-dwelling counterparts. Declines of many grassland bird species are evident from several geographic areas including the mid-Atlantic region. Although many factors may be involved, the widespread loss and degradation of early successional habitats represents the most plausible explanation for recent declines. If the pattern of land conversion observed over the past 40 years continues into the future at a similar pace, few grasslands will be available to support populations of declining birds. Because of the high concentration of military installations within the mid-Atlantic region, U.S. Department of Defense (DoD) lands may represent the most promising opportunity to sustain early-successional communities. DoD lands are particularly widespread and currently contain some of the most extensive grasslands in the region. Through its partnership with the Partners in Flight initiative, DoD has committed to integrate neotropical migratory bird management efforts into existing natural resource management programs that are consistent with the military mission. This project was initiated to determine habitat requirements for species within the mid-Atlantic region that depend on early successional habitats so that appropriate management recommendations could be formulated.

Both breeding and winter bird communities were sampled within a network of study sites located on the coastal plains of Maryland and Virginia to determine the habitat and area requirements of birds that depend on early successional habitats. A total of 1,182 individuals of 39 species were detected during the breeding season and 1,403 individuals of 46 species were detected during the winter. During both seasons, habitat type and patch size were important determinants of community organization.

The results of this study provide regionalized insights into the habitat requirements of grassland and shrubland birds that are important to the development of appropriate management guidelines. The two most significant findings in this regard are that 1) patch area is an important habitat requirement for obligate grassland birds but not for shrubland birds, and 2) patch occupation by shrubland species is conditional on the availability of woody vegetation while occupation by grassland species is conditional on the absence of woody vegetation. Another important consideration in developing management recommendations is that within the mid-Atlantic region, large and small patches of early successional habitat are not equally abundant. Large patches are relatively rare within the landscape. Because obligate grassland species require large fields and large fields are regionally rare, we recommend that whenever possible fields greater than 10 ha should be managed for grassland species.

Specific Management Recommendations include:

1. Consider patch size in developing site-specific management plans.

2. Manage grassland patches to prevent encroachment by woody vegetation.

3. Manage shrubland patches to maintain a stable area of woody vegetation.

4. Manage both grassland and shrubland patches to maintain or promote vegetation diversity.

5. Conduct management activities just prior to the growing season for both grassland and shrubland patches.

INTRODUCTION

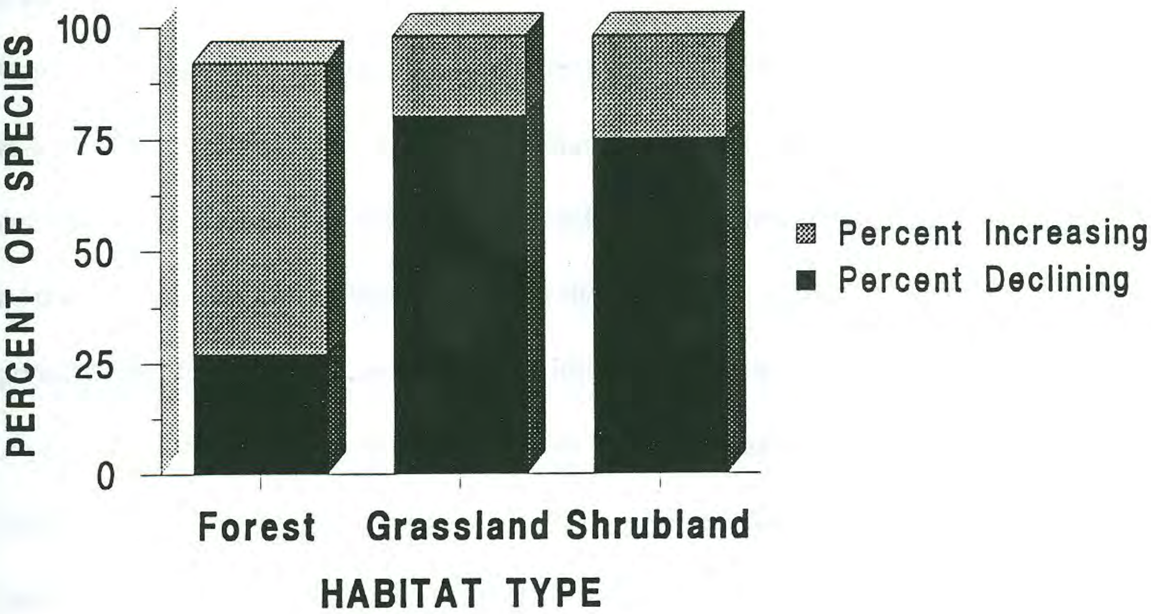
In recent years, concern for the status of many North American bird populations has greatly increased within both the general populous and the scientific community. Much of this concern has been focused on the many species of neotropical migrants (those species that migrate between breeding grounds in the temperate latitudes of North America and wintering grounds in Central and South America and the Caribbean) that have exhibited dramatic population declines in recent decades (sensu Hagan and Johnston 1992). In particular, a great deal of attention has been given to forest-dwelling neotropical migrants. This bird assemblage is very diverse, accounting for 65-85% of birds within the forest ecosystems of North America. Many of these species require interior forest areas and so are especially vulnerable to habitat fragmentation (e.g. Forman et al. 1976, Lynch and Whigham 1984, Blake and Karr 1987, Robbins et al. 1989). Although many forest-dwelling species face significant threats to their survival, they are not the only assemblage of birds that have experienced population reductions. Among others, many populations of grassland birds have undergone significant declines in recent decades (Askins 1993) (see Figure 1).

The species assemblages associated with the gradient of habitats between grasslands and shrublands are generally less diverse than their forest counterparts (Johnston and Odum 1956). These assemblages do contain neotropical migrants but they represent a smaller segment of the overall species when compared to forested habitats. Grasslands and shrublands contain comparatively more temperate migrants (species that migrate relatively short distances to winter in the mid to lower latitudes of North America) and permanent residents (species or populations that are non-migratory).

Figure 1. Percent of species showing declining and increasing population trends between 1966 and 1991 in Breeding Bird Survey results for eastern North America. Results are summarized for three groups of species; forest migrants (forest), grassland specialists (grassland), and shrubland specialists. Figure adapted from Askins (1993).

Figure 1

Population Trends of Forest Migrants, Grassland Specialists, and Shrubland Specialists in Eastern North America



Results from the annual, U.S. Fish and Wildlife Service's breeding bird survey (BBS) suggest that species associated with grasslands or shrublands have experienced annual population declines that in many cases are equal to or greater than those experienced by forest-dwelling birds (Robbins et al. 1986, Askins 1993). Between 1966 and 1979, many grassland birds showed significant population declines (Robbins et al. 1986) a trend that has continued after 1979 (Bollinger and Gavin 1992). Between 1966 and 1991, 28 species associated with grasslands and shrublands in eastern North America showed a negative population trend (17 of which were significant) while only 7 showed a positive trend (Askins 1993) (see species trends in Table 1).

Evidence that grassland bird assemblages are declining extends beyond the BBS results. Long-term studies of grassland habitats in Illinois reveal that while few changes in abundance occurred in the first half of this century (Graber and Graber 1963), dramatic changes have taken place between the late 1950's and the late 1970's (Askins 1993). Over this period, populations of several species including Upland Sandpiper, Bobolink, Dickcissel, Grasshopper Sparrow, Savannah Sparrow, and Henslow's Sparrow have declined between 94 and 98%. Similar declines in breeding populations have also been observed within many northeastern states (Vickery 1992). In a recent analysis of data from two long-term migration banding stations in the northeast, Hagan et al. (1992) show declining capture rates for several early successional species over the past two decades. Using Christmas Bird Count (CBC) data Hagan (1993) also showed a significant decline for several wintering populations of the Rufous-sided Towhee between 1966 and 1990.

Table 1. Population trends of grassland specialists, transitional specialists, and shrubland specialists in eastern North America, between 1966 and 1991[1].

Species	Trend[2]	Statistical significance[3]
Grassland species[4]		
Ringed-necked Pheasant (*Phasianus colchicus*)	-3.5	*
Northern Bobwhite (*Colinus virginianus*)	-3.4	**
Upland Sandpiper (*Bartramia longicauda*)	+2.0	
Burrowing Owl (*Athene cunicularia*)	-5.6	
Horned Lark (*Eremophila alpestris*)	+0.2	
Dickcissel (*Spiza americana*)	-3.6	*
Vesper Sparrow (*Pooecetes gramineus*)	-3.1	**
Lark Sparrow (*Chondestes grammacus*)	-6.7	
Savannah Sparrow (*Passerculus sandwichensis*)	-1.8	**
Grasshopper Sparrow (*Ammodramus savannarum*)	-5.3	**
Henslow's Sparrow (*A. henslowii*)	-4.6	**
Bobolink (*Dolichonyx oryzivorus*)	-0.8	
Eastern Meadowlark (*Sturnella magna*)	-3.5	**
Western Meadowlark (*S. neglecta*)	-8.0	**
Transitional species[5]		
Common Ground-Dove (*Colmbina passerina*)	-4.2	**
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	-1.9	**
Eastern Bluebird (*Sialia sialis*)	+2.0	**
Loggerhead Shrike (*Lanius ludovicianus*)	-3.6	**
American Goldinch (*Carduelis tristis*)	-1.3	**
Shrubland species[6]		
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	+0.9	
Yellow-billed Cuckoo (*C. americanus*)	-1.7	**
Brown Thrasher (*Toxostoma rufum*)	-1.5	**
White-eyed Vireo (*Vireo griseus*)	+0.2	
Bell's Vireo (*V. beli*)	-0.8	
Golden-winged Warbler (*Vermivora chrysoptera*)	-2.4	**
Chestnut-sided Warbler (*Dendroica pensylvanica*)	-0.6	
Prairie Warbler (*D. discolor*)	-2.2	**
Mourning Warbler (*Oporonis philadelphia*)	+0.5	
Yellow-breasted Chat (*Icteria virens*)	-0.9	
Blue Grosbeak (*Guiraca caerulea*)	+2.9	**
Indigo Bunting (*Passerina cyanea*)	-0.5	
Painted Bunting (*P. ciris*)	-2.7	**
Bachman's Sparrow (*Aimophila aestivalis*)	-0.9	
Clay-colored Sparrow (*Spizella pallida*)	-3.1	
Field Sparrow (*S. pusilla*)	-3.4	**

[1]Table adapted from Askins (1990). Data are from the Breeding Bird Survey database, U.S. Fish and Wildlife Service.
[2]Percent change per year.
[3]* - $p < 0.10$; ** - $p < 0.01$. Significance values indicate results from route regression analysis of population trends.
[4]Species that depend on open habitats dominated by grass and forbs, with little woody vegetation.
[5]Species that are primarily found in open grassland with scattered trees and shrubs.
[6]Species that are primarily found in habitats with a dense shrub layer and little or no tree layer.

A number of explanations have been advanced to explain recent declines in early successional species. The most pervasive explanation is that the availability of habitats required to support these species has declined. Several underlying forces have come together to cause observed trends in habitat availability. In many geographic locations throughout the eastern United States loss of habitat has resulted from natural successional processes following the wave of farm abandonment that occurred earlier in the century. For example, in New Hampshire, the proportion of land that was forested declined from an estimated 95% at the time of European settlement to 47% by 1880 as a result of the broad-scale clearing of land for agriculture (Harper 1918, Irland 1982). Subsequent abandonment of farmlands from the mid 1800's into the early 1900's has resulted in colonization of these lands by second-growth forests and a dramatic shift back to forested lands. Within the past 100 years, forest cover has rebounded back to 87% (Frieswyk and Malley 1985). A similar shift in landuse has occurred across many locations in the east.

Within the mid-Atlantic region, landuse changes have generally followed those of other regions in eastern North America. For example, in Virginia open farmland had declined from 9.5 million acres in 1945 to 6.5 million acres by 1978 (U.S. Dept. of Commerce 1980). In addition, only 61% of farmlands were in cropland in 1945 compared to 74% in 1978. Most of the land converted from farmland to other uses over the period was lost from pasture, wild hayfields, and idle areas. The total acreage of these grassland habitats has been reduced by 55% since 1945. Aside from the direct conversion of early successional habitats to other uses, the character of remaining open lands has changed due to shifts in agricultural practices. These shifts have had negative impacts on a number of bird species (Millenbah et al. 1996). For example, a change in several practices used in hay-cropping (e.g. faster rotation to other crops, shift to earlier cropping dates, increase in the use of alfalfa) practices have been suggested to contribute to the decline of bobolink populations in New York (Bollinger and Gavin 1989). In Ohio, intensification of farming has been implicated in the decline of Barn Owls over the past few decades (Colvin 1985). The wide distribution of various livestock species has also influenced the quality of open lands for specific bird species. In a review of the literature, Bock et al. (1992) examined the response of 35 species to grazing intensity. Species examined exhibited the full range of responses. Some species such as Horned Lark, Lark Sparrow, and McCown's Longspur were positively influenced by grazing, while other species such as Savannah Sparrow, Baird's Sparrow, Henslow's Sparrow, and Botteri's Sparrow were negatively impacted. Other species such as Grasshopper Sparrow, Bobolink, and Sprague's Pipit showed a mixed response depending on the habitat being grazed. Within the mid-Atlantic region, pasturelands that remain appear to have been grazed more intensively in recent decades. For example, in Virginia the number of cattle per acre of land has risen 364% since 1945. On balance the combination of these and other landuse changes appear to have reduced both the quantity and quality of habitats required by grassland species.

Changes in landuse patterns are likely to continue well into the future. These changes are likely to be particularly heightened within coastal areas due to the explosive population growth currently occurring within these areas. Greater than 52% of the U.S. human population now lives within 80 km of U.S. coastlines. Concentration of our population along coastlines is projected to continue well into the next century (Cullitan 1989). By 2010, coastal populations will have grown from 80 million to more than 127 million people, an increase of 60%. Due to their broad distribution and abundance in the mid-Atlantic region, government lands now represent one of the most significant means of preserving natural communities.

The U.S. Department of Defense (DoD) controls over 10 million hectares of land within the United States making it the third largest land holder in the federal government (Goodman 1996). Because of the high concentration of military installations within the mid-Atlantic region, DoD lands may represent the most promising opportunity to manage lands for populations of declining species. In 1991, DoD through each of the military services joined the Partners in Flight initiative. Through this partnership, DoD has committed to integrate neotropical migratory bird management efforts into existing natural resource and land management programs that are consistent with the military mission. However, before species may be incorporated into existing management programs it is first necessary to identify habitat requirements so that management objectives may be developed. This project was initiated to determine broad habitat requirements for species within the mid-Atlantic region that depend on early successional habitats. Specifically, our objectives are:

1. to investigate habitat use patterns and species diversity across an early successional gradient in order to assess the benefits of different management scenarios.

2. to determine the area requirements (if any) of early successional species.

3. to evaluate current management practices relative to the habitat requirements of grassland species.

4. to develop guidelines for the conservation of early successional habitats within the mid-Atlantic region.

METHODS

Study Area

This study was conducted on the Coastal plain of Maryland and Virginia (for the purpose of this study the Coastal plain was considered to be all lands east of interstate 95). This physiographic province includes approximately 22,000 km^2. Mean annual precipitation for the region is 108 cm, and mean temperatures range from -2° C in January to 31° C in July (National Oceanic and Atmospheric Administration).

In eastern North America, early successional habitats often exist in a variety of conditions ranging from abandoned agricultural fields to regenerating clearcuts. This project focuses on the gradient of seral stages that arise from farm abandonment (referred to as "oldfield" succession). In the mid-Atlantic region, early stages of oldfield succession proceed from virtually no cover (bare ground) to a nearly continuous stand of woody shrubs and saplings. Between these two extremes are transitional fields that contain a mosaic of open, weedy, and shrubby patches. These three vegetative conditions represent the range of habitat conditions (Figure 2) investigated in this study.

Patch Selection and Description

A simple two-way design was used with vegetation structure (3 levels) and patch size (4 levels) as factors (Figure 3). Vegetation categories were chosen to represent the successional gradient from open grasslands to closed shrublands. Patches were considered to be "grasslands" if they were dominated by mixed grasses and forbs (monoculture patches of

Figure 2. Conceptual diagram of early successional gradient included in the study. Darkened areas represent patches of woody vegetation.

Figure 2

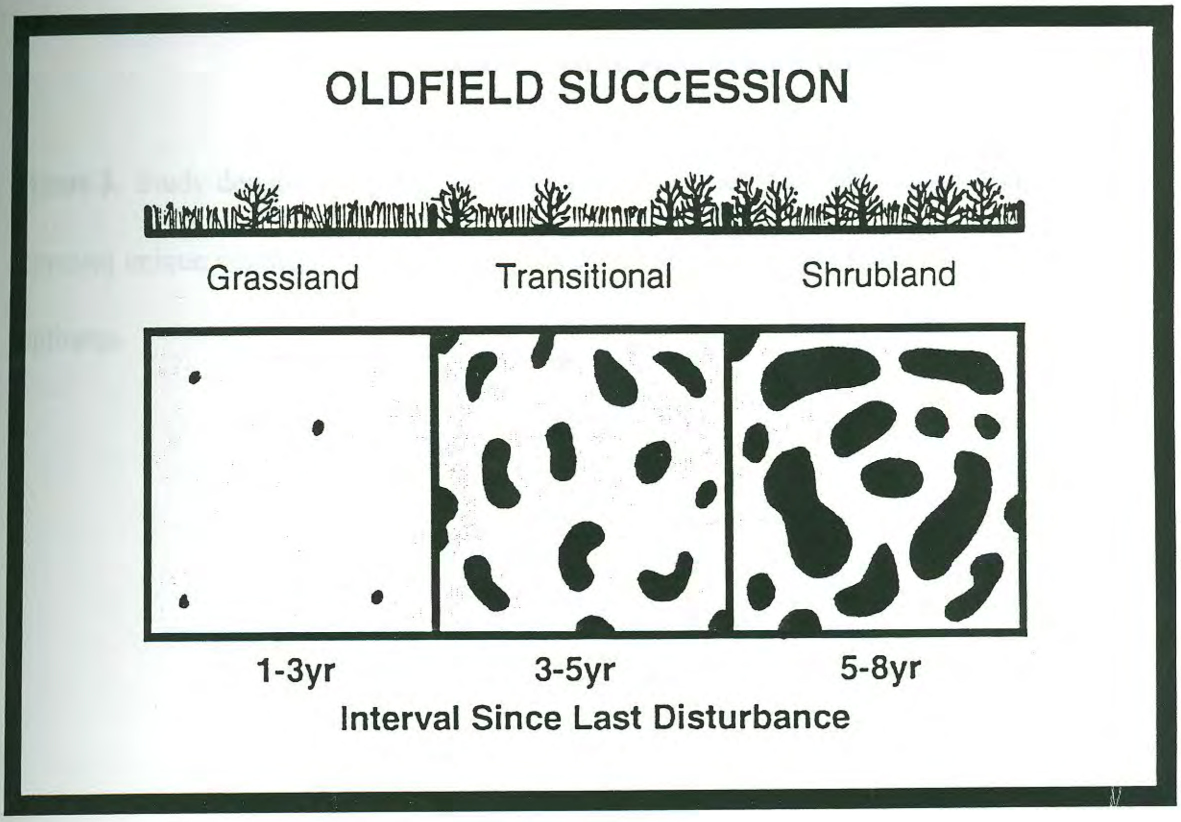
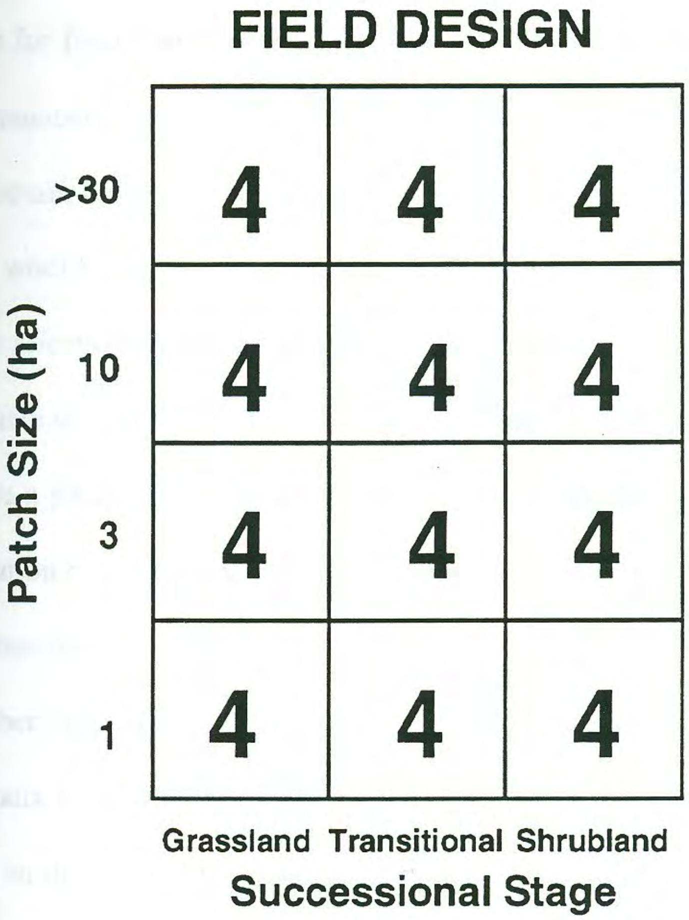

OLDFIELD SUCCESSION
Grassland
Transitional
Shrubland
1-3yr
3-5yr
5-8yr
Interval Since Last Disturbance

Figure 3. Study design including the two factors considered in field work. Cells represent unique combinations of factors. Numbers within cells indicate spatial replicates.

Figure 3

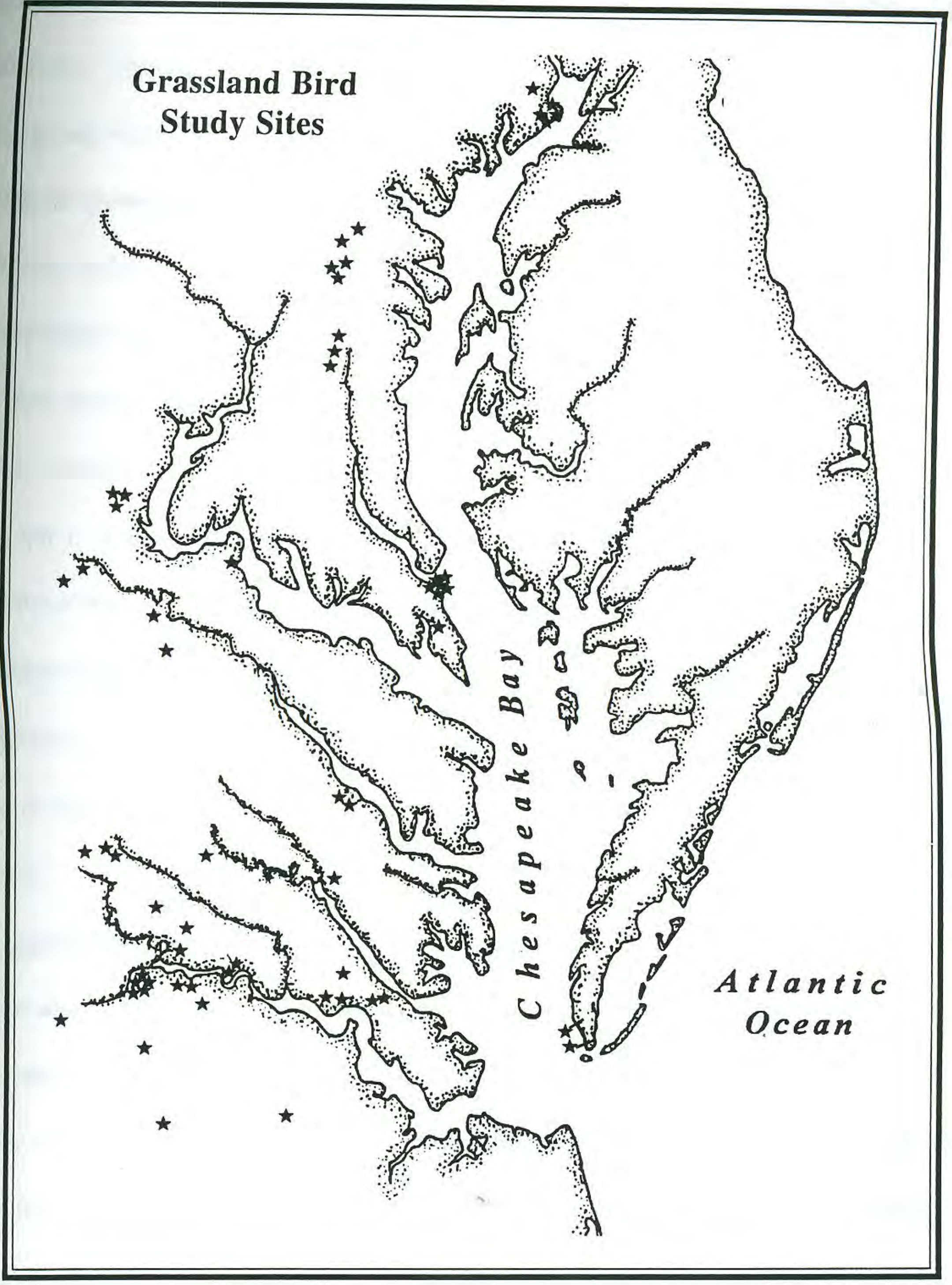

FIELD DESIGN
Patch Size (ha)
>30
10
3
1
4 4 4
4 4 4
4 4 4
4 4 4
Grassland Transitional Shrubland
Successional Stage

fescue and broomsedge were avoided) and less than 10% of the surface area was covered with woody vegetation. Patches were considered to be "transitional" if they contained mixed grasses and forbs and between 10 and 40% of the surface area covered with woody vegetation. Patches were considered to be "shrublands" if the surface area was covered with greater than 40% woody vegetation (woody vegetation was restricted to the shrub or sapling stage). An attempt was made to locate 4 spatial replicates for each of the 12 cells within the field design. A search for field sites was initiated in April of 1995. Efforts were made to include the maximum number of patches located on military installations as possible. However, in order to obtain four replicate patches per cell, other non-military public lands (e.g. state parks, state wildlife management areas, federal wildlife refuges) and private lands were also used. Initial selection of grassland patches to be considered for the study was based on a visual estimate of vegetation structure and size relative to desired categories. A final decision to include a patch within the study was based on confirmation of these factors in addition to consideration of access and location. Figure 4 shows the distribution of study sites used during the breeding and winter seasons.

The actual number of field sites used in the study deviated slightly from the initial field design (see Appendix I for complete listing of field sites). A total of 44 patches (rather than 48) were included in the study during the breeding season (only two replicates each could be found for the >30 ha transitional and shrubland categories). Winter surveys were conducted on the majority of patches utilized during the breeding season. However, the loss of study sites due to land conversions between seasons resulted in the use of alternative sites. A total of 43 patches were included in the study during the winter season (only three

Figure 4. Distribution of study sites (individual stars) on the Coastal Plain of Maryland and Virginia during both field seasons. Refer to Appendix I for details pertaining to individual sites.

Figure 4



replicates of the 10 ha shrubland and two replicates of the >30 ha transitional and shrubland categories could be located for study).

Because a relatively large number of field sites were used with a diversity of management histories, the floristic composition of patches could not be controlled for within the field design. Among grassland patches, a wide variety of native and non-native, perennial grasses were observed. The predominant grass species observed were orchard grass (*Dactylis glomeratus*), Kentucky bluegrass (*Poa pratensis*), foxtail (*Setaria spp.*), soft chess (*Bromus mollis*), various fescue species (*Fetusca spp.*) and to a lesser extent broom sedge (*Andropogon virginicus*) and indian grass (*Sorghstrum nutans*). In addition to the grasses, most patches contained some abundant forb species such as horseweed (*Erigeron canadensis*), common ragweed (*Ambrosia artemisiifolia*), and various goldenrod species (*Solidago spp.*). Transitional and shrubland patches also contained coverage of the grasses and forbs mentioned above but were punctuated to varying degrees by patches of woody plants. Some dominant woody plants observed included blackberry (*Rubus spp.*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), and small saplings (height <1.5 m) of cherry (*Prunus spp.*) red maple (*Acer rubrum*) and sweetgum (*Liquidambar styraciflua*).

Survey Techniques

For many bird species, detectability varies with season. For example, during the breeding season many birds are conspicuous as they defend territories, go through courtship behaviors, and raise young. At this time, males often spend a great deal of time singing to advertise for females or to defend territorial boundaries. In contrast, during the winter months many birds become inconspicuous to avoid predators, rarely sing, and spend the majority of their time searching for food. The marked differences in the detectibility of birds between summer and winter require that different techniques be used to adequately estimate their numbers. For this reason, we employed different field techniques to survey grassland patches during the summer and winter seasons.

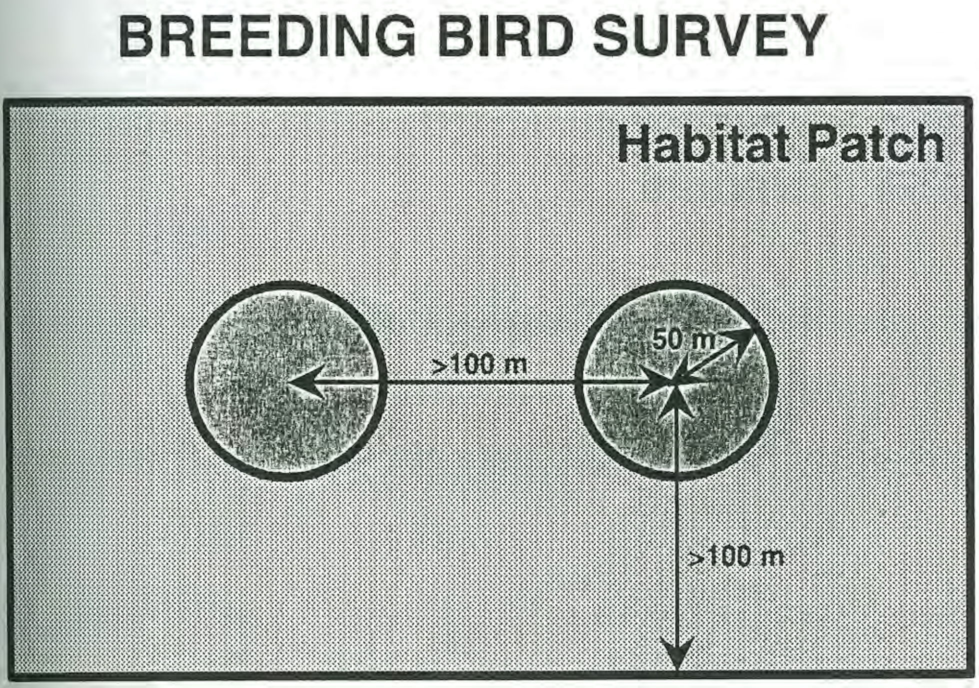
Breeding Season - A stratified point count technique was used to measure bird density and occurrence during the breeding season. Survey plots (point counts) consisted of a 50-m radius circle with a wire flag located at its center. An observer stood at the center of the plot and recorded all birds seen or heard within the grassland patch for a 10 min period. All birds detected were recorded as being either within or beyond the 50 m circle (see Figure 5a). An additional 100 m circle was also used. Birds detected within either the 50 or 100 m survey plots were used to generate density estimates where appropriate. Birds detected outside survey plots were used to assess presence/absence patterns.

Because patch size varied more than thirty fold across the study design, different survey efforts were needed in order to maintain even coverage. A single point count was placed at the center of 1 and 3 ha patches. Two and four point counts were used for 10 and >30 ha patches respectively (see Table 2 for a summary of sampling effort for different patch sizes). When multiple survey points were used in a single patch, they were placed a minimum of 100 m apart and 100 m from the patch edge.

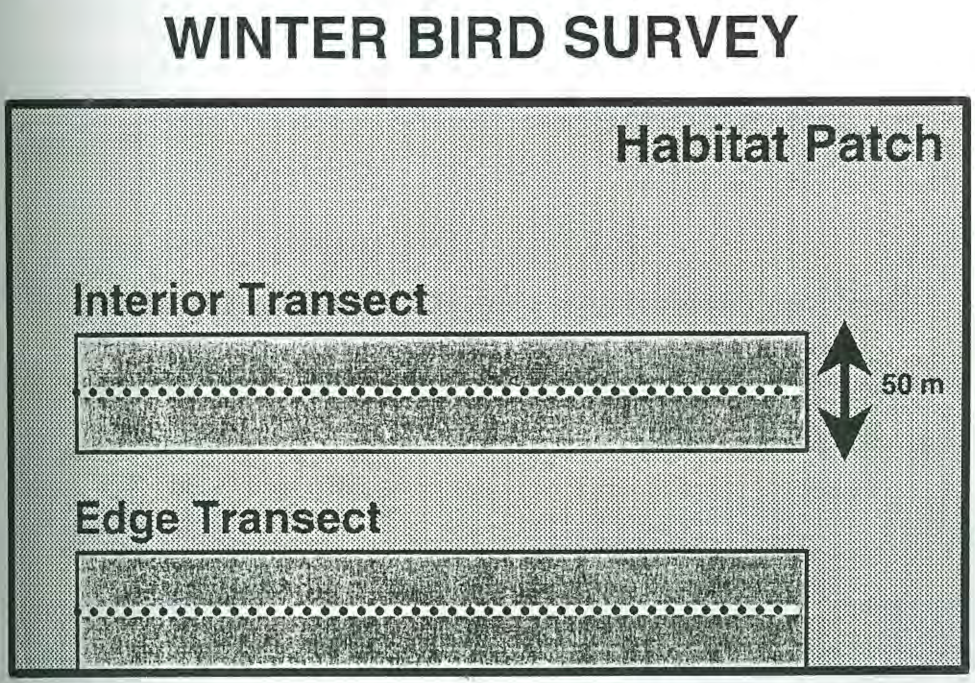
Surveys of breeding birds were conducted between 19 May and 30 June 1995. Surveys were initiated 0.5 hr after sunrise and terminated by 10:00 EST. All patches were surveyed twice during the breeding season. Each patch was surveyed once before a second

Figure 5. (A) Layout of sample plots (point counts) for breeding bird surveys. Circular plots indicate sampling area used for density estimation. (B) Layout of transects used for winter bird surveys. Interior transects passed through the center of study sites; Edge transects were positioned along field edges.

Figure 5


BREEDING BIRD SURVEY
Habitat Patch
>100 m
50 m
>100 m

A.


WINTER BIRD SURVEY
Habitat Patch
Interior Transect
50 m
Edge Transect

B.

Table 2. Description of survey units used to measure bird communities within the range of patch size classes.

Patch Size Class	Point Counts/Patch	Transect Length (m)
1	1	100
3	1	150
10	2	300
>30	4	800

round of surveys was initiated. The order of surveys was changed between rounds such that no patch was surveyed in the same time position twice. Surveys were not conducted during heavy rain or strong wind.

Winter Season - A strip-transect technique was used to measure bird density and occurrence during the winter season. Each transect consisted of a center line bisecting a 50 m wide band of grassland habitat. In order to differentiate between species associated with the edge of grassland patches and those associated with the patch interiors, two types of transects were established ("interior" and "edge") (Figure 5b). Interior transects bisected grassland patches and so passed through the most isolated areas within the patch. Edge transects were established to run parallel and adjacent to the patch edge. Both transect types were established within each grassland patch. In an attempt to maintain comparable coverage of available habitat, transect lengths were increased systematically to accommodate larger patches. Strip transects (1 each for interior and edge types) were 100, 150, 300, and 800 m in length for the 1, 3, 10, and >30 ha patch size categories respectively (see Table 2 for summary of sampling effort with patch size).

In order to survey strip transects, an observer walked a zig-zag search pattern moving back and forth between the lateral transect boundaries. This technique greatly increased detectibility of wintering birds by flushing individuals concealed in dense vegetation. All birds detected were identified to species and recorded based on their location inside or outside of the transect area, as well as, their location relative to the nearest patch edge.

Winter bird surveys were conducted between 25 January and 28 March, 1996. Surveys were initiated 1 hr after sunrise and were terminated before 15:00 EST. All patches were surveyed twice during the winter season. Each patch was surveyed once before a second round of surveys was initiated. Each patch was surveyed once during the "early" period (before 10:00 EST) and once during the "late" period (after 10:00 EST). Surveys were not conducted during heavy rain, strong winds, or when patches were snow covered.

Data Summary and Analysis

For both breeding and winter seasons, survey data was summarized to generate dependent variables over different levels of organization. Community-wide variables included species richness and overall bird abundance. The community was also subdivided into two functional groups including 1) obligate grassland species and 2) facultative grassland species. Obligate grassland species were those species during the breeding or winter season that depend on open grassland exclusively. Facultative grassland species are those species that utilize grasslands but also occur within a broader range of habitats. In addition to the community-wide variables and the functional species groups, individual species were also analyzed when sample size permitted.

Breeding Season - Species richness (total number of species) was used as an estimate of community breadth. Richness values were calculated for each patch based on the accumulated number of species detected (either inside or beyond 50 m radius) during the course of both surveys. Bird density, both for the community as a whole and for individual species, was calculated from the number of birds detected within 50 m survey plots. The survey with the highest number of birds was used for analysis. To avoid pseudoreplication, average density values were calculated for patches with multiple survey plots. Data were standardized to birds/ha for presentation.

Winter Season - As with the breeding season data, species richness was calculated for each patch based on the accumulated number of species during the course of both surveys. Total bird density was calculated for each patch using both transect types combined. Bird density was also calculated for each transect type (interior vs edge) separately. Data were standardized to birds/ha for presentation.

Data Analysis - The effects of habitat type and patch size on dependent bird variables (for both summer and winter) were examined using a two-way analysis of variance (ANOVA) when possible. Variables that did not meet parametric assumptions were transformed using standard transformations. Variables that still did not meet parametric assumptions after transformation were analyzed using nonparametric comparisons. Tukey's honestly significant difference (HSD) test was used for post hoc comparisons to differentiate which factor levels (i.e. habitat type/patch size) were responsible for significant differences in bird variables.

Frequency statistics were used to compare relative habitat use for all common species. During the breeding season, observed incidence rates were compared to those expected based on the area sampled within each habitat type and patch size (50 m radius points were used for 1 ha patches and 100 m radius points were used for patches > 1 ha). During the winter season, observed frequencies of common species were compared to those expected based on the area of band transects sampled within each habitat type and patch size.

RESULTS

Breeding Season

Community-level Patterns - A total of 1,182 individuals of 39 species were detected during breeding season surveys (See Appendix II for a listing of species and their respective abundances). Both habitat type and patch size were found to have a significant effect on total species richness (Table 3). However, a significant interaction term was also detected suggesting that the effect of these two factors was not additive. In order to investigate the effect of this interaction further, a single factor analysis was performed by assessing the variation in one factor while holding the other factor constant. When habitat type was controlled for, average species richness increased significantly with patch size for both transitional and shrubland habitats (Figure 6a). Average species richness for both habitat types increased nearly three fold as patch size increased from 1 to >30 ha. In contrast, average species richness within grassland habitats did not vary significantly with patch size (Figure 6a).

The influence of habitat type on average species richness varied with patch size. For 1 and 3 ha patches, habitat type had no significant influence on average species richness (Figure 6b). In contrast, average species richness for transitional and shrubland patches that were in size classes greater than 3 ha was significantly higher than the same size grassland patches (Figure 6b).

The effect of patch size and habitat type on bird density was variable. Average bird density was significantly influenced by habitat type (Table 4). For all patch sizes combined, bird density increased along the successional gradient (Figure 7a). However, when habitat

Table 3. Results of a two-way ANOVA for species richness during the breeding season. Factors include habitat type (grassland, transitional, and shrubland) and patch size (1, 3, 10, and ≥30 ha).

Source of variation	DF	SS	MS	F	P
Habitat type	2	378.42	189.21	31.49	< 0.001
Patch size	3	236.28	78.76	13.10	< 0.001
Habitat type x patch size	6	126.84	21.14	3.52	< 0.05
Error	32	192.22	6.07		

Figure 6. Average species richness ($\pm$ SD) of habitat type and patch size combinations during the breeding season. Data presented represent species detections from unlimited radius point counts. (A) F-statistics and significance values indicate results from independent one-way ANOVA tests of species richness among patch sizes (1, 3, 10, and $\geq$30 ha) for each habitat type. (B) F-statistics and significance values indicate results from independent one-way ANOVA tests of species richness among habitat types (G = grassland, T = transitional, and S = shrubland) for each patch size.

Figure 6

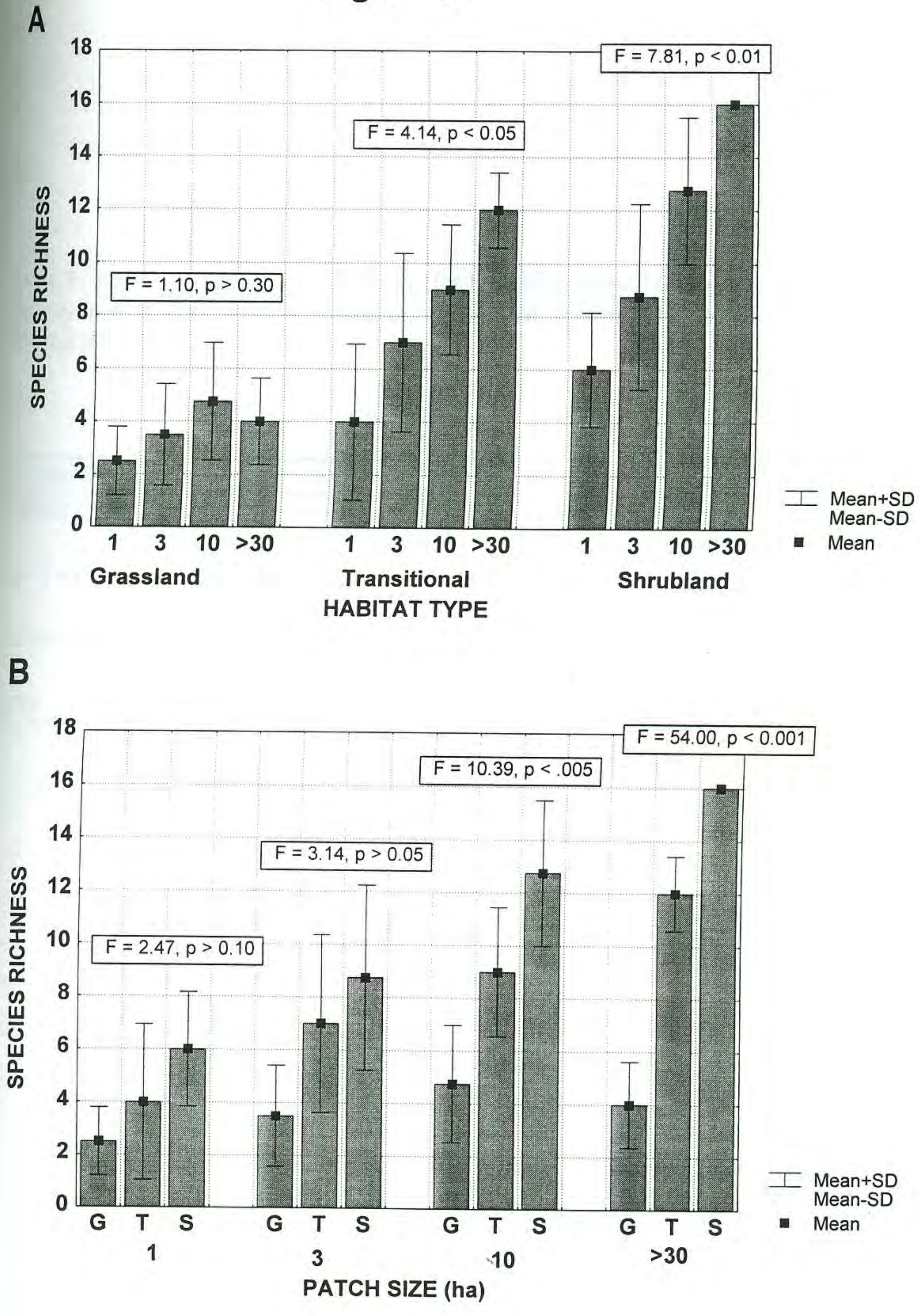
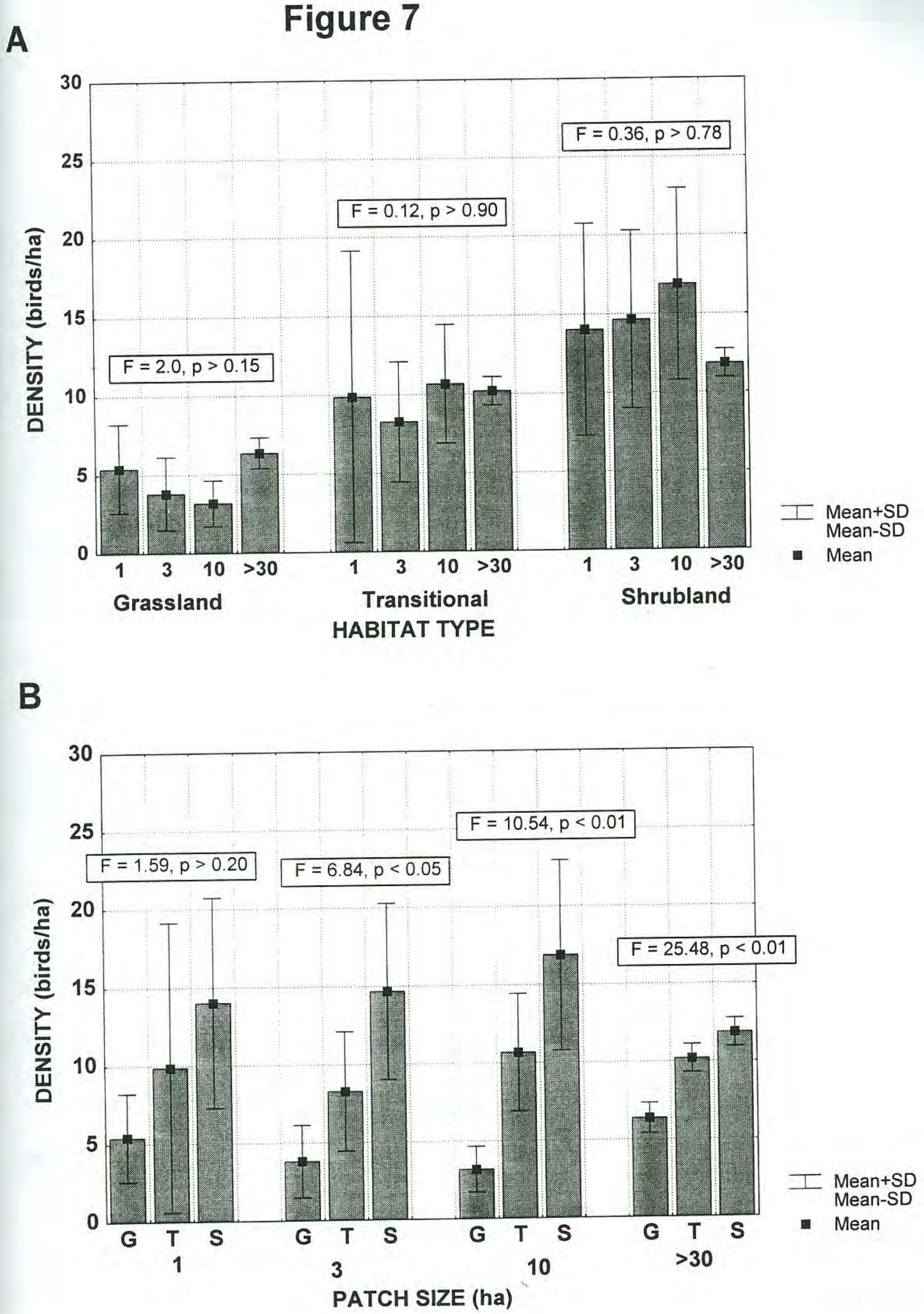

A
F = 7.81, p < 0.01
F = 4.14, p < 0.05
F = 1.10, p > 0.30
SPECIES RICHNESS
1 3 10 >30
Grassland
Transitional
Shrubland
HABITAT TYPE
Mean+SD
Mean-SD
Mean
B
F = 54.00, p < 0.001
F = 10.39, p < .005
F = 3.14, p > 0.05
F = 2.47, p > 0.10
SPECIES RICHNESS
G T S
1
3
10
>30
PATCH SIZE (ha)
Mean+SD
Mean-SD
Mean

Table 4. Results of a two-way ANOVA for total bird density during the breeding season. Factors include habitat type (grassland, transitional, and shrubland) and patch size (1, 3, 10, and ≥30 ha)

Source of variation	DF	SS	MS	F	P
Habitat type	2	411.26	205.63	14.46	< 0.001
Patch size	3	6.78	2.26	0.16	> 0.05
Habitat type x Patch size	6	39.18	6.53	0.46	> 0.08
Error	32	455.36	14.23		

Figure 7. Average total bird density (± SD) of habitat type and patch size combinations during the breeding season. Data presented represent bird detetcions within fixed-radius (50m) point counts. (A) F-statistics and significance values indicate results from independent one-way ANOVA tests of density values among patch sizes (1, 3, 10, and ≥30 ha) for each habitat type. (B) F-statistics and significance values indicate results from independent one-way ANOVA tests of density values among habitat types (G = grassland, T = transitional, and S = shrubland) for each patch size.

Figure 7


A
30
25
20
15
10
5
0
DENSITY (birds/ha)
F = 2.0, p > 0.15
F = 0.12, p > 0.90
F = 0.36, p > 0.78
1 3 10 >30
Grassland
1 3 10 >30
Transitional
1 3 10 >30
Shrubland
HABITAT TYPE
Mean+SD
Mean-SD
Mean
B
30
25
20
15
10
5
0
DENSITY (birds/ha)
F = 1.59, p > 0.20
F = 6.84, p < 0.05
F = 10.54, p < 0.01
F = 25.48, p < 0.01
G T S
1
G T S
3
G T S
10
G T S
>30
PATCH SIZE (ha)
Mean+SD
Mean-SD
Mean

types were combined, average bird density was not found to be influenced by patch size (Figure 7b). Additionally, there was no significant interaction term detected (Table 4) suggesting that the effect of habitat type on density was consistent across patch size categories. Further investigation revealed that significant variation in average bird density across habitat types was due to low density in grassland patches compared to transitional and shrubland patches. Average bird densities within the latter patch types were not significantly different.

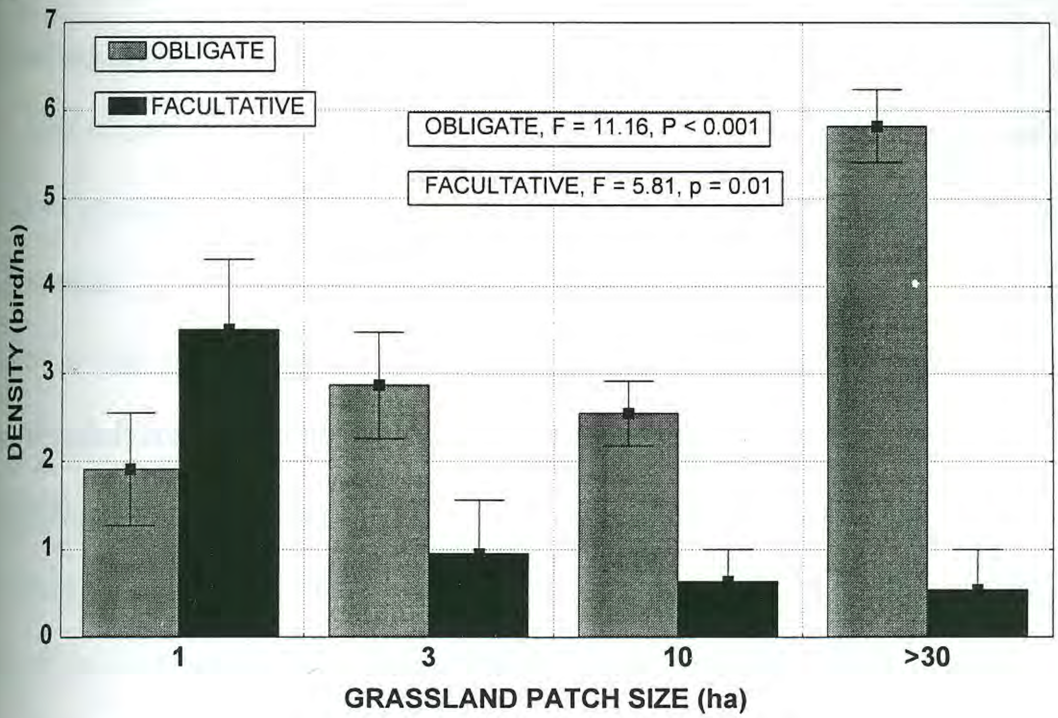
Patch size effected the two functional bird groups (obligate vs facultative grassland species) differently. Within grassland habitats, the density of obligate species increased significantly with patch size (Figure 8a). Average density increased from 1.9 $\pm$ 1.27 (SD) in 1 ha patches to 5.8 $\pm$ 0.83 birds/ha count in 30 ha patches. The increase in density of the Grasshopper Sparrow was the primary cause of this pattern, accounting for 95% of the increase between 1 and >30 ha patches and 67% of the increase between 10 and >30 ha patches. Within the same grassland habitats, the average density of facultative species decreased significantly with patch size (Figure 8a). Average density decreased from 3.6 $\pm$ 1.53 (SD) to 0.5 $\pm$ 0.89 birds/plot for 1 and >30 ha patches respectively. The different responses to patch size shown by the two species groups reflects a shift in community composition with patch size (Figure 8b). Bird communities within small grassland patches are dominated by facultative grassland species whereas large grassland patches are dominated by obligate grassland species.

Within transitional and shrubland habitats, detections of grassland-obligate species were too infrequent to permit quantitative comparisons. Density patterns within these two

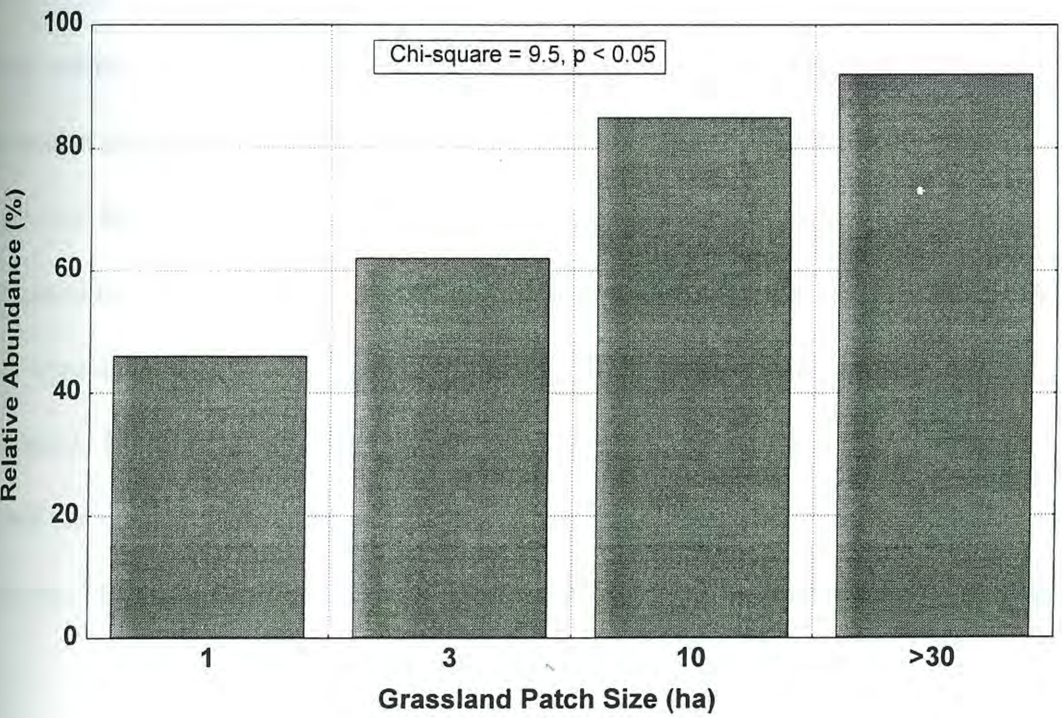
Figure 8. (A) Average density of grassland obligate and facultative species (± SD) in grassland patches during the breeding season. Data presented represent bird detections within fixed-radius (50m) point counts. F-statistics and significance values indicate results of independent one-way ANOVA tests of density values among patch sizes for each functional bird category. (B) Relative abundance of grassland obligate species in respective grassland patch sizes. Percentage values are calculated from bird detections within fixed-radius (50m) point counts. The Chi-square statistic and significance value indicate the result from a test of relative abundances among grassland patch sizes.

Figure 8

A


OBLIGATE
FACULTATIVE
OBLIGATE, F = 11.16, P < 0.001
FACULTATIVE, F = 5.81, p = 0.01
DENSITY (bird/ha)
0
1
2
3
4
5
6
7
1
3
10
>30
GRASSLAND PATCH SIZE (ha)

B


Chi-square = 9.5, p < 0.05
Relative Abundance (%)
0
20
40
60
80
100
1
3
10
>30
Grassland Patch Size (ha)

habitat types were a function of species that depend on shrub cover (shrub-dependent species). Average bird density was not significantly effected by patch size for transitional and shrubland habitats (Figure 8a).

Species-level Patterns - Total species richness values for the three habitat categories were 21 for grasslands, and 29 for both transitional and shrubland habitats. Of the total species detected, 12 species were distributed in all three habitat types and 15 species were distributed in only two habitat types (6 species in grassland and transitional habitats, 9 species in transitional and shrub habitats). The specific distribution of individuals across the successional gradient varied between species (Figure 9). However, all common species except Grasshopper Sparrow and Eastern Meadowlark were detected significantly more in transitional and Shrubland patches than expected by chance (see Chi-square values given in Figure 9). Grasshopper Sparrows and Eastern Meadowlarks showed the opposite pattern and were significantly associated with grassland patches. Although species richness was relatively similar between the three habitat categories, grassland patches were dominated by fewer species than either transitional or shrubland (Figure 10). Only two species (Grasshopper Sparrows and Eastern Meadowlark) accounted for 65% of all birds detected within grassland patches. The majority of detections within both transitional and shrubland habitats were accounted for by the same species. Five species including Common Yellowthroat, Field Sparrow, Red-winged Blackbird, Indigo Bunting, Blue Grosbeak accounted for 68 and 61% of the total birds detected in transitional and shrubland habitats respectively. Detections of grassland-obligate species in transitional habitats was low (7%)

Figure 9. Habitat associations of selected species during the breeding season. Columns indicate percentage values based on the frequency of detections within fixed-radius (100m) point counts for each habitat type. Chi-square statistics and significance values indicate results from tests of the observed distribution of detections in each habitat from an expected even distribution based on the available number of points. A significant test ($p < 0.05$) demonstrates a species affinity for only one or two habitat types. Species names for respective four letter codes are given in Appendix II.

Figure 9

Habitat Associations of Selected Species During the Breeding Season

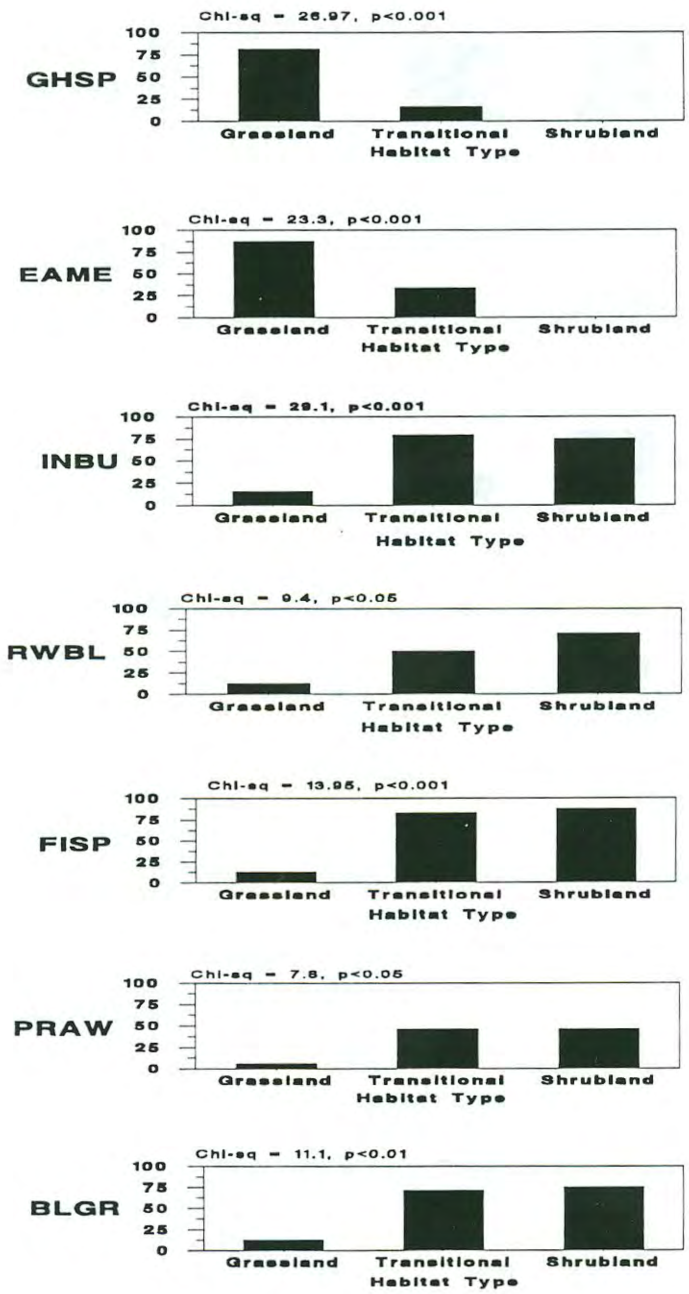


Figure 9

Habitat Associations of Selected Species During the Breeding Season

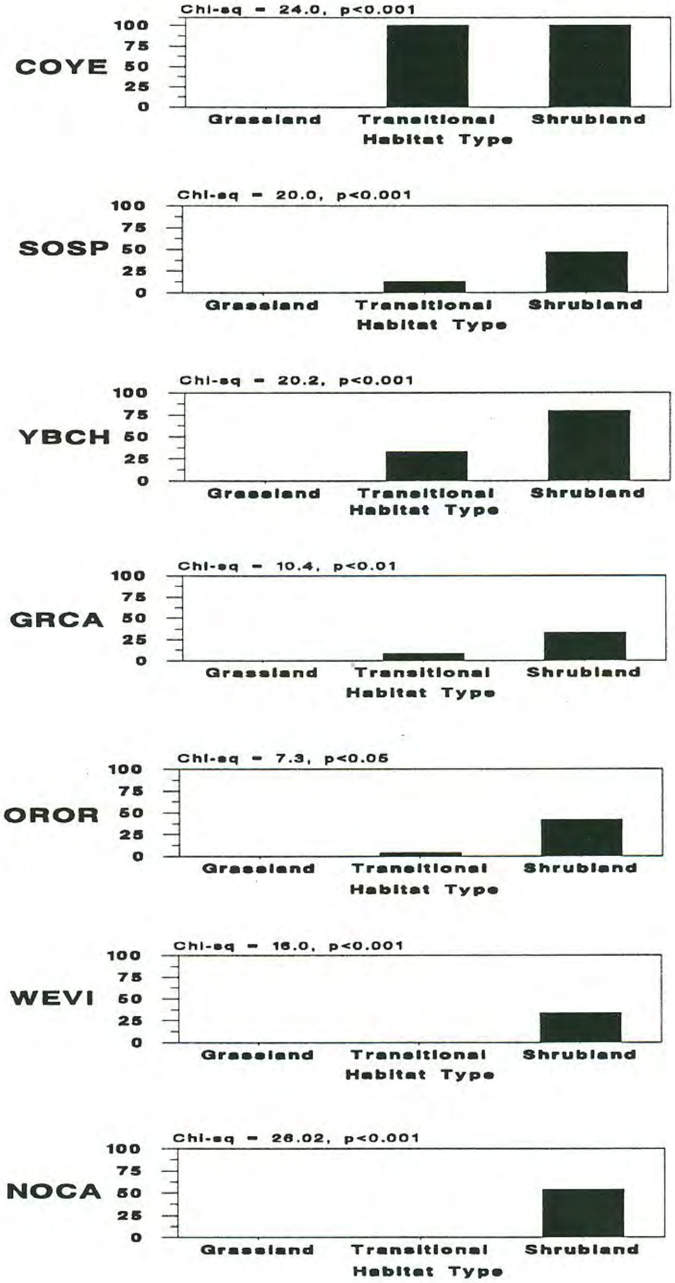
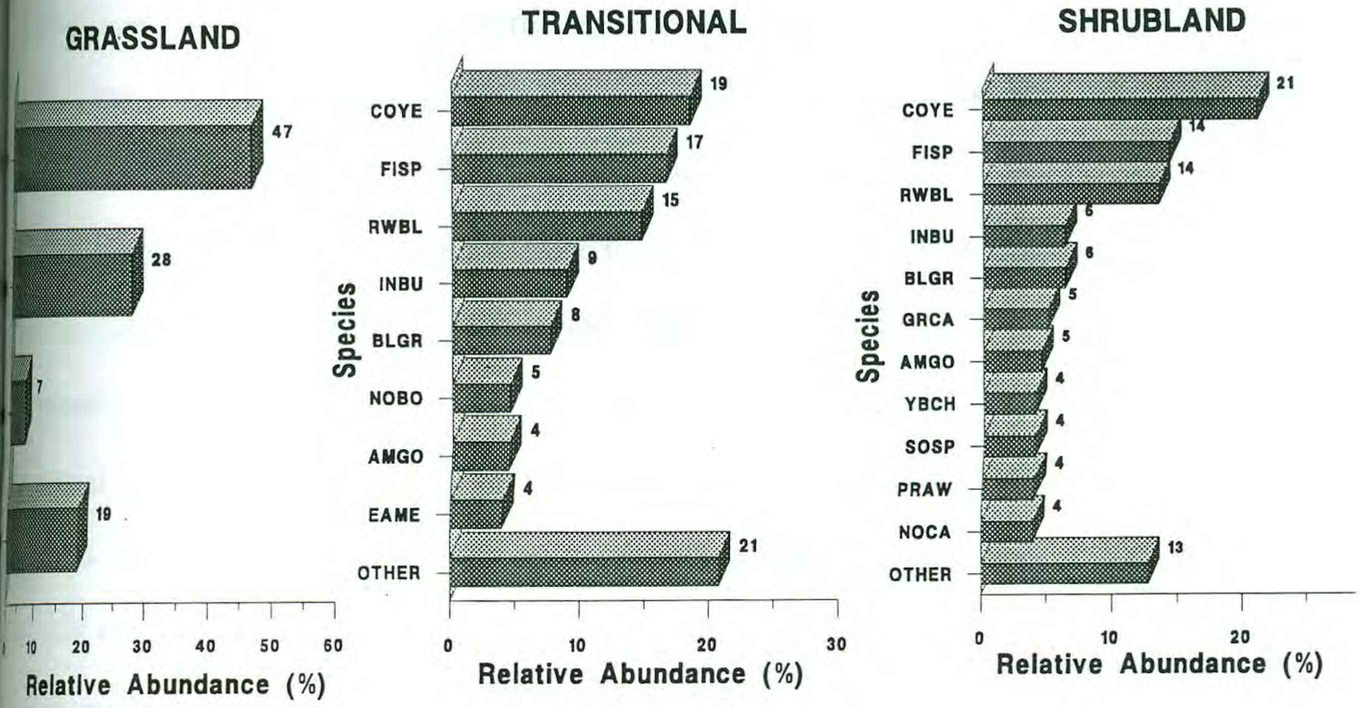


Figure 10. Relative abundance of species in grassland, transitional and shrubland habitats during the breeding season. Percentage values are calculated from fixed-radius (50m) point count data. Species names for respective four letter codes are given in Appendix II.

Figure 10

Relative Abundance of Selected Species for Grassland, Transitional, and Shrubland Habitats



and limited to patches 10 ha and larger. No grassland-obligate species were detected in shrubland habitats.

Winter Season

Community-level Patterns - A total of 1,403 birds of 46 species were detected during winter surveys (See Appendix III for a listing of species and their respective abundances). Average species richness was significantly influenced by habitat type (Table 5). Average species richness also showed a strong increasing trend with patch size but this pattern was not statistically significant (Table 5). However, a significant interaction between habitat type and patch size was detected (Table 5). As was the case for patterns observed during the breeding season, this interaction effect was due to the difference between grasslands and the other two habitat types. Average species richness for birds within grasslands increased significantly with patch size (Figure 11a). In contrast, species richness for birds within transitional and shrubland patches did not increase significantly with patch size (Figure 11a).

The influence of habitat type on species richness varied across patch sizes (Figure 11b). Of all patch size categories, habitat type had a significant effect on species richness for 3 ha patches only (Figure 11b). Within this patch size category, the significant habitat effect was due solely to the difference between grassland patches and the other two habitat types.

Overall bird density was significantly influenced by habitat type (Table 6). Bird density also showed a very strong positive trend with increasing patch size but this pattern was not quite significant (Table 6). However, a significant interaction between habitat type and patch size was detected (Table 6). When habitat types were considered separately, bird

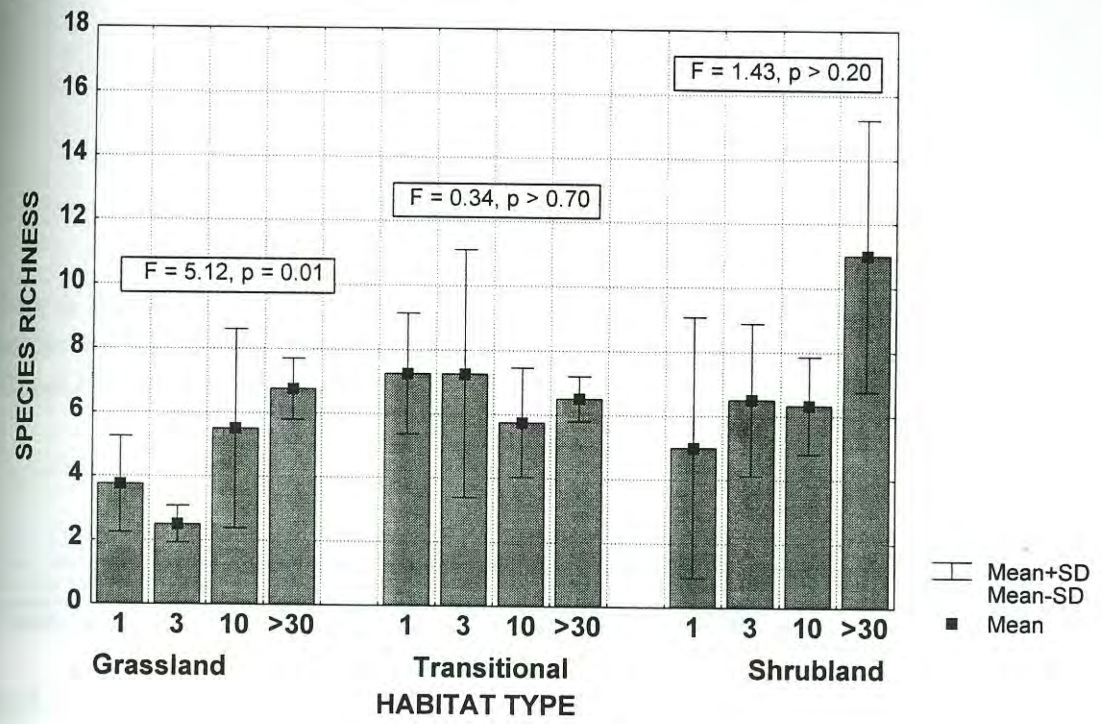
Table 5. Results of a two-way ANOVA for square-root transformed species richness during the winter season. Factors include habitat type (grassland, transitional, and shrubland) and patch size (1, 3, 10, and ≥30 ha).

Source of variation	DF	SS	MS	F	P
Habitat type	2	2.31	1.15	4.43	< 0.05
Patch size	3	1.87	0.62	2.41	> 0.05
Habitat type x patch size	6	4.33	0.72	2.78	< 0.05
Error	31	8.06	0.26		

Figure 11. Average species richness (± SD) for habitat type and patch size combinations during the winter season. Data presented represent bird detections from unlimited-width transects. (A) F-statistics and significance values indicate results from independent one-way ANOVA tests of species richness among patch sizes (1, 3, 10, and ≥ 30 ha) for each habitat type. (B) F-statistics and significance values indicate results from independent one-way ANOVA tests of species richness among habitat types (G = grassland, T = transitional, and S = shrubland) for each patch size.

Figure 11

A


SPECIES RICHNESS
F = 5.12, p = 0.01
F = 0.34, p > 0.70
F = 1.43, p > 0.20
1 3 10 >30
Grassland
Transitional
Shrubland
HABITAT TYPE
Mean+SD
Mean-SD
Mean

B

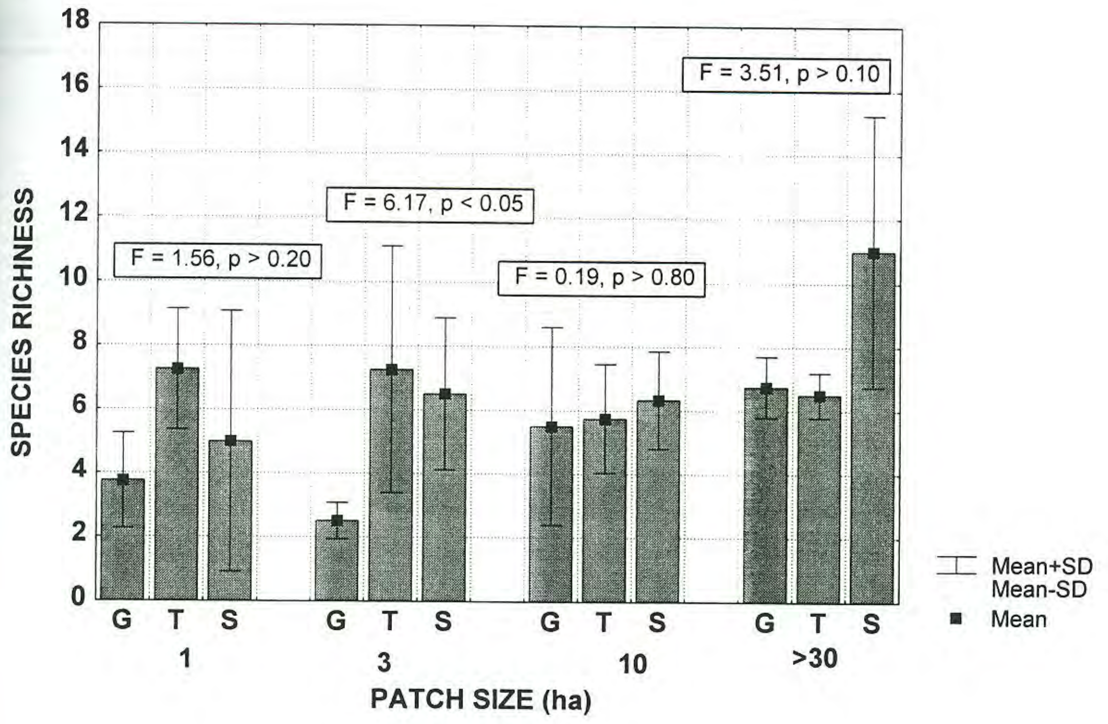

SPECIES RICHNESS
F = 1.56, p > 0.20
F = 6.17, p < 0.05
F = 0.19, p > 0.80
F = 3.51, p > 0.10
G T S
1
3
10
>30
PATCH SIZE (ha)
Mean+SD
Mean-SD
Mean

Table 6. Results of a two-way ANOVA for total bird density during the winter season. Factors include habitat type (grassland, transitional, and shrubland) and patch size (1, 3, 10, and ≥30 ha).

Source of variation	DF	SS	MS	F	P
Habitat type	2	2570.82	1285.41	4.06	< 0.05
Patch size	*3*	*2256.81*	*852.27*	*2.69*	*> 0.05*
Habitat type x patch size	6	4798.39	799.73	2.53	< 0.05
Error	31	9799.13	316.10		

Figure 12. Average total bird density (± SD) of habitat type and patch size combinations during the winter season. Data presented represent bird detections within fixed-width (50m) transects. (A) F-statistics and significance values indicate results from independent one-way ANOVA tests of density values among patch sizes (1, 3, 10, and ≥ 30 ha) for each habitat type. (B) F-statistics and significance values indicate results from independent one-way ANOVA tests of density values among habitat types (G = grassland, T = transitional, and S = shrubland) for each patch size.

density was not significantly influenced by patch size for any habitat type (Figure 12a). When patch sizes were considered separately, habitat type significantly influenced bird density within 1 ha patches only (Figure 12b).

Species-level Patterns - Total species richness values for the three habitat categories were 26 for grasslands, 34 for transitional, and 37 for shrubland habitats. Of the total species detected, 19 were detected in all three habitat types, 28 species were detected in only two habitats. The remaining 18 species were distributed in only one habitat type (six species to one of each of the three habitat types). As with the breeding season, habitat affinities varied between species (Figure 13). However, of the primary species detected only Savannah Sparrow, Eastern Meadowlark, and Eastern Bluebird were significantly more abundant in grassland patches than expected by chance (Figure 13). Remaining species were significantly more abundant in transitional or shrubland patches.

Grassland-dependent species accounted for 33% of the individuals detected in grassland patches but less than 1% of the individuals detected in transitional and shrubland patches (Figure 14). The most frequently detected grassland species were Savannah Sparrows and Eastern Meadowlarks. These two species accounted for 16% of all individuals in grassland patches. The Dark-eyed Junco, Field Sparrow, and Song Sparrow combined accounted for 46 and 52% of the total birds detected in transitional and shrubland patches respectively.

<u>Seasonal Comparisons</u>

Community-level Patterns - Habitat type had an important influence on species richness and total bird density in both seasons. However, patch size was relatively more

Figure 12

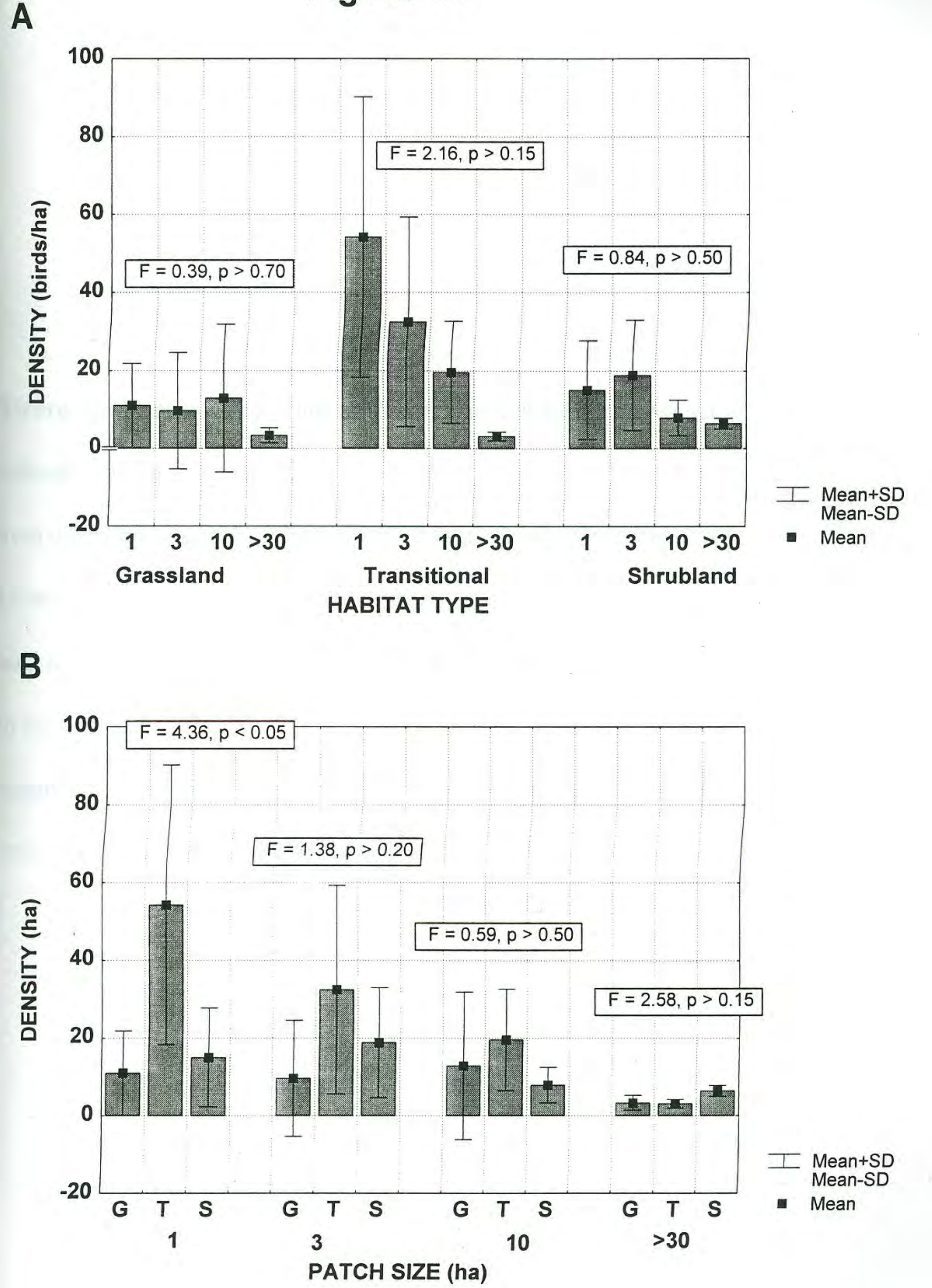

A
100
80
60
40
20
0
-20
DENSITY (birds/ha)
F = 0.39, p > 0.70
F = 2.16, p > 0.15
F = 0.84, p > 0.50
1 3 10 >30
1 3 10 >30
1 3 10 >30
Grassland
Transitional
Shrubland
HABITAT TYPE
Mean+SD
Mean-SD
Mean
B
100
80
60
40
20
0
-20
DENSITY (ha)
F = 4.36, p < 0.05
F = 1.38, p > 0.20
F = 0.59, p > 0.50
F = 2.58, p > 0.15
G T S
G T S
G T S
G T S
1
3
10
>30
PATCH SIZE (ha)
Mean+SD
Mean-SD
Mean

Figure 13. Habitat associations of selected species during the winter season. Columns indicate the percent deviation of the observed distribution of individuals from an expected even distribution across all habitat types based on bird detections within fixed-width (50m) transects. Postive deviations indicate habitats that are overutilized relative to the total area surveyed. Negative deviations indicate habitats that are underutilized relative to the total area surveyed. Chi-square statistics and significance values indicate the results from frequency tests of the above observed and expected distibutions. Species names for respective four letter codes are given in Appendix III.

Figure 13

Habitat Associations of Selected Species During the Winter Season

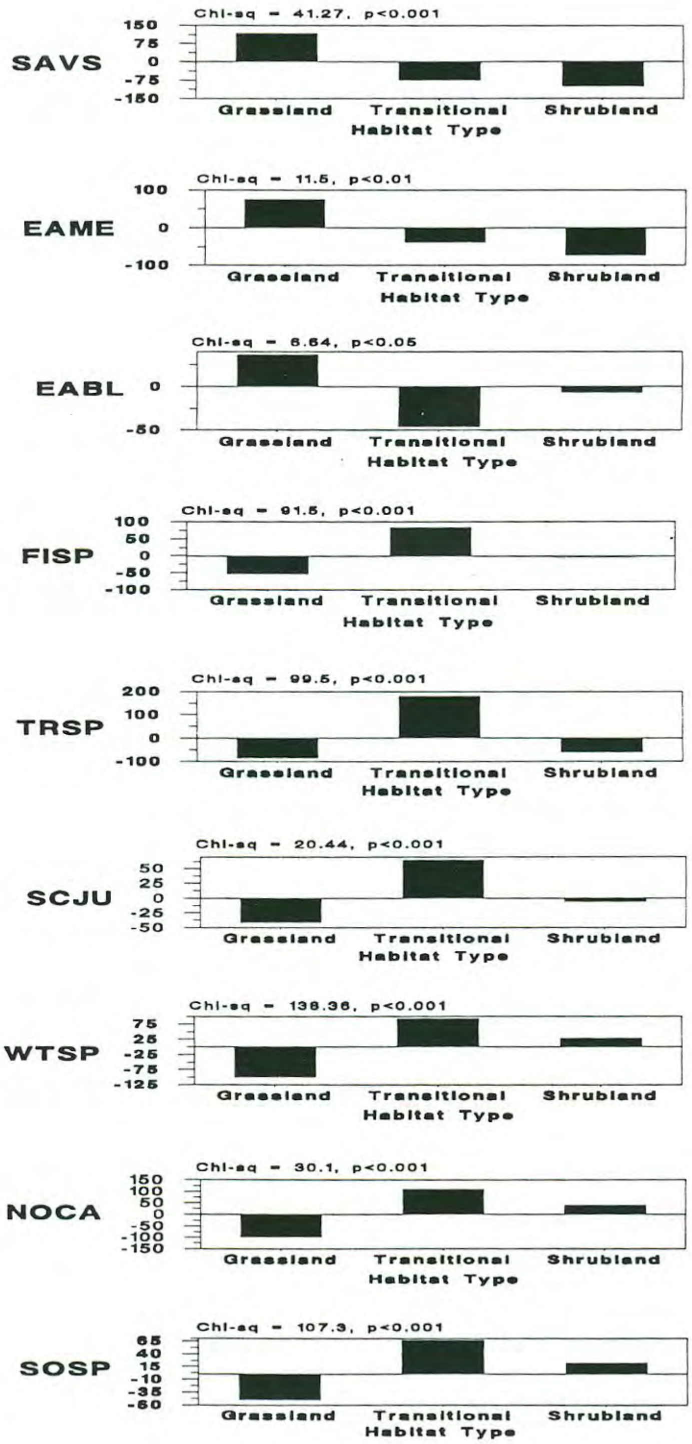
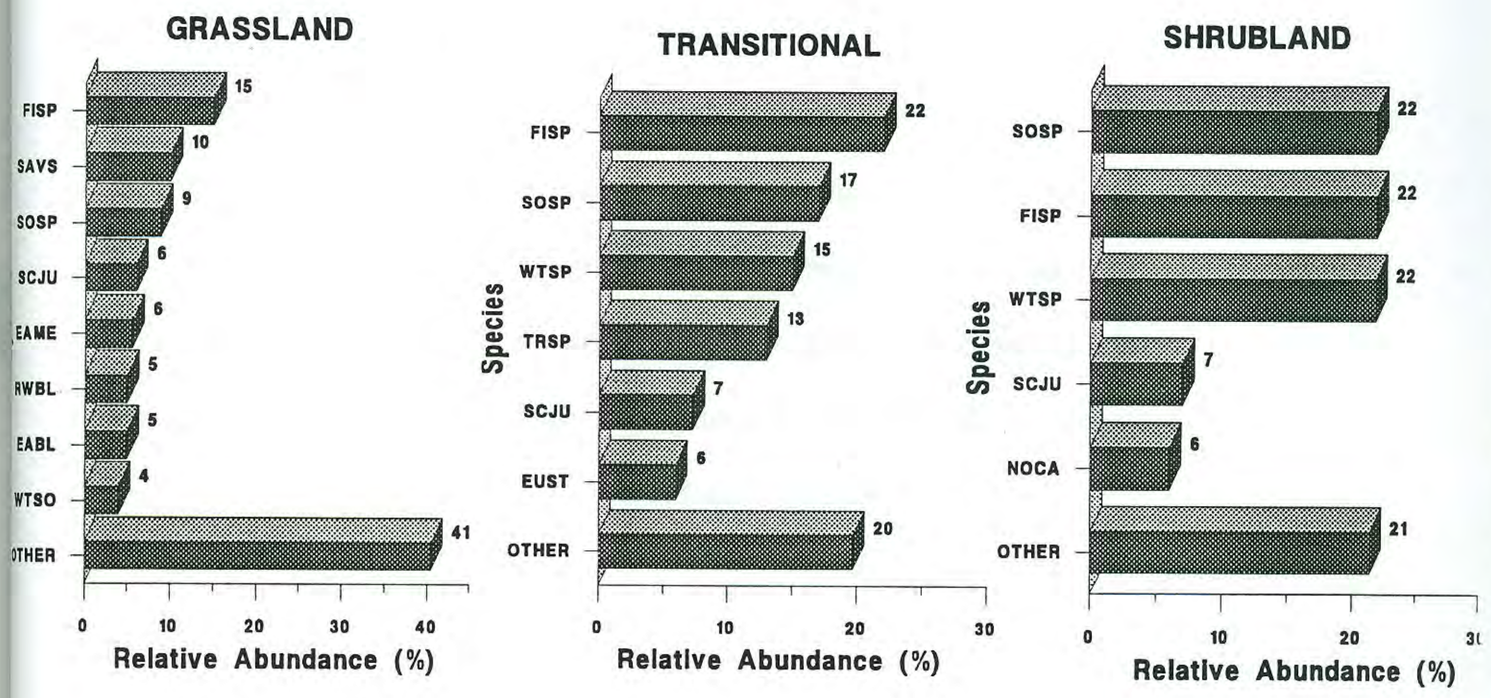


Figure 14. Relative abundance of species in grassland, transitional, and shrubland habitats during the winter season. Percentage values are calculated from fixed-width (50m) transect data. Species names for respective four letter codes are given in Appendix III.

Figure 14

Relative Abundance of Selected Species for Grassland, Transitional, and Shrubland Habitats



important during the breeding season (Tables 3 through 6). Seasonal comparisons of community variables were comparable for each habitat type (Table 7). However, within shrubland patches species richness was higher during the breeding season and within transitional patches bird density was higher during the winter. A dominance index (given in Table 7) calculated for each habitat type and season indicates that the composition of bird communities within grasslands was more even in winter compared to the breeding season. Dominance values for bird communities within transitional and shrubland patches were comparable between seasons (Table 7, Figures 10 and 14).

Species-level Patterns - A number of species detected within experimental patches were present for only one season. Fifteen of these species were present during the breeding season only. All of these species are neotropical migrants that spend the winter months to the south of the mid-Atlantic region. An additional 16 species were detected only during the winter months. All of these species are temperate migrants that breed in the northern latitudes of North America and migrate to the mid-Atlantic region to spend the winter.

Several species were common within experimental patches during both seasons (Appendices I and III). Some of these species showed a shift in the relative use of the three habitats between seasons. For example, both Song and Field Sparrows were limited to transitional and shrubland patches during the breeding season (Figure 9) but were observed in grassland patches during the winter (Figure 13). Similarly, the Eastern Meadowlark showed a proportional shift toward grasslands during the winter season (Figures 9 and 13).

Table 7. Avian community variables for three habitat types during the breeding and winter seasons. Variables presented are calculated from all patch size categories within each habitat type.

Season	Habitat type	Average density (birds/ha) ± SD	Average species richness ± SD	Dominance index[1]
Breeding	grassland	4.6 ± 2.2	3.7 ± 1.8	0.29
	transitional	9.7 ± 5.2	7.4 ± 3.7	0.09
	shrubland	14.7 ± 5.4	10.1 ± 4.3	0.09
Winter	grassland	9.2 ± 12.4	4.6 ± 2.3	0.08
	transitional	30.3 ± 38.8	6.7 ± 2.3	0.13
	shrubland	13.2 ± 10.9	6.7 ± 3.4	0.14

[1]Simpson's index of dominance = $\sum (n_i(n_i - 1)/N_i(N_i - 1))$ where n is the total number of the *i*th species and N is the total number of all species in the *i*th habitat.

grassland conditions that consist of minimal shrub and woody-plant coverage. Many grassland birds have very explicit habitat requirements that may preclude them from using a site after relatively subtle vegetation changes. For example, the Grasshopper Sparrow is most common in grassland areas that have relatively low litter deposition, are dominated by bunch-type grasses, and contain a sufficient amount of bare ground for foraging purposes (Whitmore 1981). Short-term habitat changes such as increasing litter cover and decreasing the availability of bare ground have been shown to lower reproductive success or cause abandonment of breeding sites (Whitmore 1979). The Eastern Meadowlark is most common in grassland habitats with a dense continuous cover of grass, relatively high litter cover, and low percentage of bare ground.

Despite differences in fine-level vegetation requirements, Grasshopper Sparrows and Eastern Meadowlarks responded similarly to habitat succession. Both species declined dramatically from grasslands to transitional patches and were absent altogether from shrubland patches. This result is consistent with previous studies of these species that have shown abandonment of sites when shrub cover increased beyond 35% (Johnston and Odum 1956).

In addition to habitat type, breeding bird communities were also influenced by patch area. Small grassland patches (< 10 ha) were dominated by facultative grassland species, whereas larger patches were predominantly composed of obligate grassland species. Grassland bird communities approached maximum incidence in patches that were approximately 10 ha in area. However, based on density patterns, grassland patches at least 30 ha in area represent a more ideal minimum size. In contrast to bird communities associated with grassland patches, bird communities within transitional and shrubland habitats exhibited little response to patch size. Species associated with these habitats showed high incidence rates within patches as small as 3 ha.

Many grassland birds require a minimum area of contiguous habitat that may help explain a causal relationship between habitat fragmentation and bird declines (Herkert 1991, Askins 1993). Along with an overall loss of area, fragmentation reduces average patch size. As a result, population establishment of area-sensitive species is halted in many small grassland remnants and overall reproductive success diminishes from increased nest predation rates coupled with decreasing grassland area (Johnson and Temple 1986; 1990, Burger 1994).

Area sensitivity is often estimated from incidence functions that represent the probability that a species will occur in a patch of a given size. In grassland birds, estimates of area-sensitivity may be dependent on population levels (Vickery 1995) and should be investigated on a regional scale. However, estimates taken from several studies (Samson 1980, Herkert 1994, Vickery 1995) demonstrate that grassland birds that appear to have large area requirements are among the species showing the highest rates of decline (Herkert 1994).

Patch size has also been linked to productivity in grassland birds. In Minnesota, Johnson and Temple (1986;1990) compared the nesting density and breeding productivity of five grassland species (including the Grasshopper Sparrow) in large (>130 ha) to small (16 - 32 ha) grassland remnants. Nest density and productivity of these species increased with area and distance to grassland edge. Nests in smaller grasslands had lower reproductive success due to increased depredation rates and brood parasitism by Brown-headed Cowbirds.

Burger et al. (1994) showed similar results using artificial nests placed near and far from woody vegetation in Missouri prairie fragments.

In the present study, Grasshopper Sparrows were absent in grassland patches <3 ha in area. Grasshopper Sparrows were consistently detected in 10 ha patches but contained a maximum of only two territorial males. Grasshopper Sparrow density doubled as patch size increased from 10 to 30 ha. Grasshopper Sparrows have been shown to respond strongly to habitat area in other studies. For example, Herkert (1991) showed similar responses in Grasshopper Sparrow densities in Illinois. Samson (1980) found that Grasshopper Sparrows were encountered in less than 30% of grassland patches smaller than 10 ha. Herkert (1994) and Vickery (1995) report that Grasshopper Sparrows were absent from grassland patches < 32 ha in area and only encountered in 50% of patches smaller than 50 ha (Herkert 1994) and 100 ha (Vickery 1995).

In the present study, Eastern Meadowlark density was not influenced by patch size. Although the species is known to be area-sensitive in other locations (Herkert 1994, Vickery 1995), minimum area requirements are typically less than in most other grassland species. In Illinois, Herkert (1994) reported 50% occurrence in patches that were 10 ha in area. In coastal Maine, 50% occurrence was not reached until patch size increased to 100 ha (Vickery 1995). The difference between these incidence rates has been attributed to a lower regional abundance of Eastern Meadowlarks in Maine (Vickery 1995). Differences in incidence rates between this and previous studies may reflect regional differences in population levels (Rosenburg and Wells 1995).

Winter Season

Vegetative structure is one of the primary habitat dimensions that determine community structure in early successional bird communities during winter (e.g. Wiens 1973, Pulliam and Mills 1977, Lima and Valone 1991). This is true to a large extent because predation is one of the principal sources of mortality during winter and many of the early successional passerines use vegetative cover as a means to reduce susceptibility to predators. Within early successional fields, vegetation influences predation risk in two functionally different ways. The first is that dense stands of tall stems (grasses and forbs) provide a "visual refuge" for birds by making it more difficult for predators to detect them. The second is that dense stands of woody vegetation provide a "protective refuge" by making it more difficult for predators to access and extract prey once detected. Dependency on woody vegetation as a protective refuge varies considerably between species (Pulliam and Mills 1977). The influence of this single habitat element is so strong that the addition of even small amounts of woody vegetation has been shown to cause substantial shifts in community composition (Lima and Valone 1991).

Within this study, community and species level patterns were consistent with previous studies that document interspecific variation in dependency on woody vegetation. A clear distinction between grassland bird communities and transitional/shrubland communities was evident across the range of study patches. Species richness increased significantly from grassland patches to transitional patches. From a total of 46 species, only 3 (including Savannah Sparrow, Eastern Meadowlark, and Eastern Bluebird) were commonly associated with grassland patches during the winter. This is compared to over a dozen that were commonly associated with transitional and shrubland patches. This increase in species richness across the successional gradient is in general agreement with the relatively high number of species within the mid-Atlantic region that are cover-dependent compared to those that are independent of cover during the winter months. Transitional and shrubland patches supported very similar bird communities. As during the breeding season, the amount of shrub cover added between transitional and shrubland patches had relatively little influence on the winter bird community.

MANAGEMENT CONSIDERATIONS/RECOMMENDATIONS

The results of this study provide regionalized insights into the habitat requirements of grassland and shrubland birds that are important to the development of appropriate management guidelines. The most significant finding in this regard is that for obligate grassland birds patch area is an important habitat requirement. The few grassland species detected within study sites seem to be confined to fields that are at least 10 ha in area. In contrast, shrubland species do not appear to be sensitive to area. This fundamental difference between the two communities, suggests that patch area should be a primary management consideration. Management activities intended to provide habitat for grassland species should take place within large (> 10 ha) patches only. Patches of any size may be managed for shrubland species.

A second consideration important for the development of management guidelines is that obligate grassland species are sensitive to intrusion by woody vegetation. Within study sites, grassland species were rare when even small amounts of woody vegetation were present. In contrast, most shrubland species require at least 25% coverage of woody vegetation for cover, nesting and foraging substrate. This fundamental difference in habitat preference points to how patches should be managed for the two bird communities. Management for grassland species should utilize techniques that eliminate or prevent establishment of woody vegetation. Management for shrubland species should utilize techniques that promote and maintain shrubs and small saplings. In the latter case, management should seek to sustain shrub coverage but should not allow habitats to progress to the forest stage.

Within the mid-Atlantic region, large and small early successional patches are not equally abundant. Patches large enough to meet the minimum area requirement for obligate grassland species are relatively rare within the landscape. Within this study, the low number of replicates in the larger (> 10 and > 30 ha) patch categories was due to the low availability of large fields. Because obligate grassland species require large fields and large fields are regionally rare, we recommend that whenever possible fields greater than 10 ha should be managed for grassland species. Although viewed on an individual field basis, this strategy may not achieve the maximum diversity of early successional species that may be achieved by managing large patches as shrublands (i.e. shrublands support a greater diversity of bird species than grasslands in the mid-Atlantic region), this strategy will maintain the full complement of early successional species on a regional scale. Similarly, whenever possible, early successional patches smaller than 10 ha should be managed as shrublands. Small patches that are managed as grasslands provide little value to the bird community as a whole since they do not provide habitat for either grassland or shrubland birds.

SPECIFIC RECOMMENDATIONS

Grassland Management

1. Manage grassland patches to prevent encroachment by woody vegetation. Patches should be actively managed at least once per year to retard the development of woody shrubs and saplings. The management area should include the entire surface of the patch. Management options that set back the advancement of woody vegetation include 1) burning, 2) mechanical removal (i.e. mowing, plowing), and 3) spot application of herbicides. These options may be used individually or in combination, depending on the management constraints for each individual patch.

2. Manage grassland patches to maintain or promote vegetation diversity. Management practices that lead to or promote monotypic patches are not recommended. The use of fescue and other sod forming grasses that out compete other native grasses and forbs and form monocultures should be avoided. Where feasible, patches dominated by such grasses should be treated, plowed and replanted with a greater diversity of warm-season grasses and forbs. Most grassland birds prefer a diversity of food plants with different structures. Warm-season bunch grasses are often preferred because they provide interstitial patches of bare ground required for foraging. Forbs should also be maintained or included in seed mixtures. Many grassland birds prefer forbs for song perches and nesting substrates.

3. Conduct grassland management activities just prior to the growing season. Whenever feasible, management activities should be conducted during the spring between early April and mid May. Within the mid-Atlantic region, most grassland birds appear within breeding areas in mid to late May. Breeding activities often extend between late May and mid August. Management activities such as mowing, burning, etc that occur within this time window may destroy nests and/or young and so reduce reproductive success. Similarly, vegetation that is removed after the growing season will not be replaced until the following growing season. Because some grassland species require standing vegetation for cover during winter, removal of this vegetation effectively makes patches unusable during the winter months.

Shrubland Management

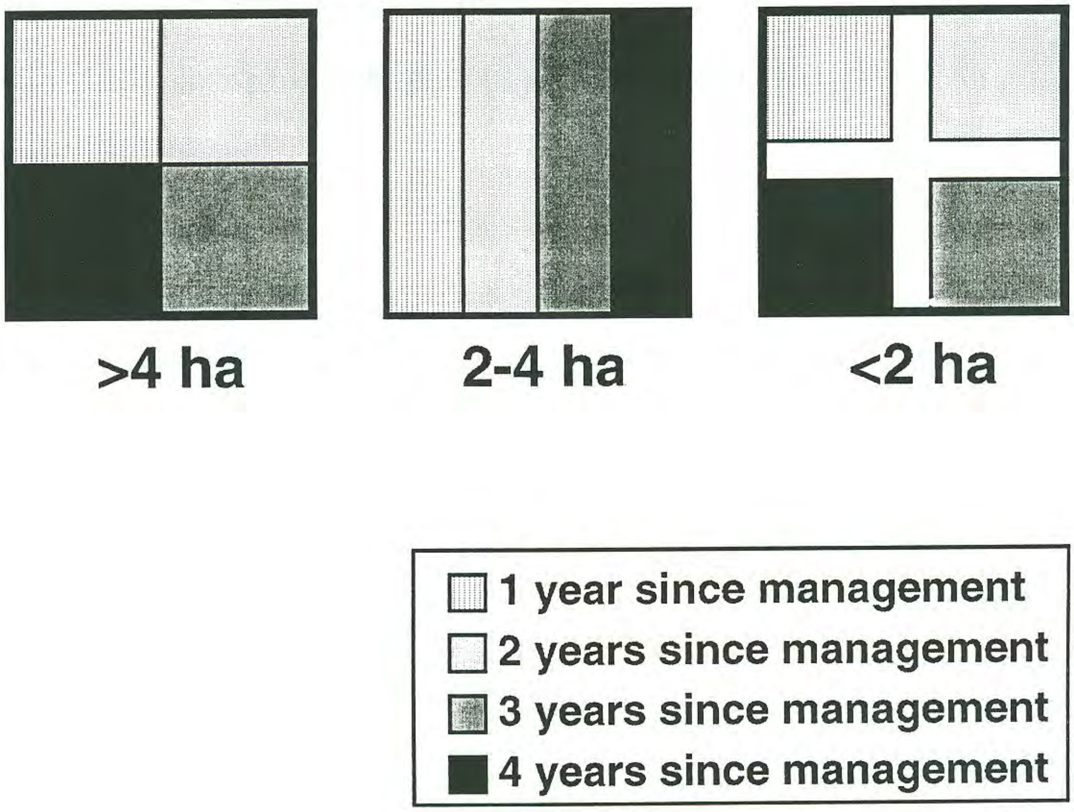
1. Manage shrubland patches to maintain a stable area of woody vegetation. Whenever possible, patches should be actively managed so as to provide a "sustained yield" of early successional, shrubby vegetation while preventing succession from reaching a forest stage. Within the mid-Atlantic region, 4 years typically allows enough time for regrowth of woody vegetation but is not enough time for saplings to get so large that they are difficult to manage. For relatively large shrubland patches, the surface area should be subdivided and managed on a four-year rotation where a different portion of the patch is managed each year (see Figure 15 for rotational scenarios for different size patches). Management options for shrublands include 1) burning, and 2) mechanical removal (i.e. bush hogging, and plowing). Application of herbicides is not recommended except for the control of selected woody species because it often delays or inhibits regrowth.

2. Manage shrubland patches to maintain or promote vegetation diversity. Management practices that lead to or promote monotypic patches are not recommended. The exclusive use of exotic woody plants such as autumn olive, privet, bamboo, etc to provide cover should be avoided. In general, introduced plant species support a less diverse and

Figure 15. Recommended management scenarios for early successional patches of different sizes. Patches that are larger than 4 ha should be quartered for management purposes and managed on a 4-year, staggered rotation. Patches that are between 2 and 4 ha should be divided into 50 m wide strips and managed on a 4-year, staggered rotation. Patches that are less than 2 ha should be left intact and managed once every 4 years. Where several small patches are in close proximity, management years should be staggered. These management scenarios are intended to provide a stable, sustained yield of shrublands that are as large and contiguous as possible.

Figure 15

Management Scenarios
For Patches of Different Size



abundant invertebrate prey base. A mixture of native shrubs and saplings that provide both horizontal and vertical structural diversity should be promoted. During both the breeding and winter seasons, many shrubland bird species prefer a diversity of cover types.

3. Conduct grassland management activities just prior to the growing season. Whenever feasible, management activities should be conducted during the spring between early April and mid May. Within the mid-Atlantic region, most shrubland birds appear within breeding areas in mid to late May. Breeding activities often extend between late May and mid August. Management activities such as mowing, burning, etc that occur within this time window may destroy nests and/or young and so reduce reproductive success. Similarly, vegetation that is removed after the growing season will not be available as cover to species during the winter months.

LITERATURE CITED

Askins, R. A. 1993. Population trends in grassland, shrubland and forest birds in eastern North America. Current Ornithology 11:1-34.

Blake, J. G., and J. R. Karr. 1987. Breeding birds of isolated woodlots: Area and habitat relationships. Ecology 68:1724-1734.

Bock, C. E., V. A. Saab, R. D. Rich, and D. S. Dobkin. 1992. Effects of livestock grazing on neotropical migratory landbirds in western North America. Pp. 296-309 *in* D. M. Finch and P. W. Stangel eds., Status and Management of Neotropical Migratory Birds. USDA Forest Service Gen. Tech. Report RM-229. Fort Collins, Co.

Bollinger, E. K., and T. A. Gavin. 1989. The effects of site quality on breeding-site fidelity of Bobolinks. Auk 106:584-594.

--------------. 1992. Eastern Bobolink populations: ecology and conservation in an agricultural landscape. Pp., 497-506 *in* J. M. Hagan and D. W. Johnston, eds., Ecology and Conservation of Neotropical Migrant Landbirds. Smithsonian Institution, Washington D.C., USA.

Burger, L. D., L. W. Burger, Jr., and J. Faaborg. 1994. Effects of prairie fragmentation on artificial nests. J. Wildl. Manage. 58:249-254.

Colvin, B. A. 1985. Common Barn Owl population decline in Ohio and the relationship to agricultural trends. Journal of Field Ornithology 56:224-235.

Cullitan, T. J., M. A. Warren, T. R. Goodspeed, D. G. Remer, C. M. Blackwell, and

J. J. McDonough, III. 1989. Fifty years of population change along the nation's coasts 1960-2010. Coastal Trends Series, Report No. 2. Rockville, MD: NOAA, Strategic Assessment Branch.

Forman, R. T. T., A. E. Galli, and C. F. Leck. 1976. Forest size and avian diversity in New Jersey woodlots with some land use implications. Oecologia 26:1-8.

Frieswyk, T. S., and A. M. Malley. 1985. Forest statistics for New Hampshire-1973 and 1983. Resource Bulletin NE-88. U.S. Forest Service, Northeast Forest Experiment Station, Broomall, Pennsylvania.

Goodman, S. W. 1996. Ecosystem management at the Department of Defense. Ecological Applications 6:706-707.

Graber, R. R., and J. W. Graber. 1963. A comparative study of bird populations in Illinois 1906-1909 and 1956-1958. Ill. Nat. Hist. Sur. Bull. 28:383-528.

Hagan, J. M., III. 1993. The decline of the Rufous-sided Towhee in the eastern United States. Auk 110:863-875.

-------------, T. L. Lloyd-Evans, J. L. Atwood, and D. S. Wood. 1992. Long-term change in migratory landbirds in the northeastern United States, Evidence from migration capture data. Pp. 115-130 *in* J. M. Hagan III and D. W. Johnston, eds., Ecology and Conservation of Neotropical Migrant Landbirds. Smithsonian Institution, Washington D.C., USA.

Harper, R. M. 1918. Changes in the forest area of New England in three Centuries. Journal of Forestry 16:442-452.

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

--------------. 1991. Prairie birds of Illinois: Population response to two centuries of habitat change. Ill. Nat. Hist. Sur. Bull. 34:393-399.

Irland, L. C. 1982. Wildlands and woodlots: A story of New England's forests. University Press of New England, Hanover, New Hampshire.

Johnson, R. G., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. J. Wildl. Manage. 54:106-111.

--------------. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pp 245-249 *in* J. Verner, M. L. Morrison, and C. F. Ralph, eds., Wildlife 2000, Modeling Habitat Relationships of Terrestrial Vertebrates. Univ. of Wisconsin Press, Madison, WI, USA.

Johnston, D. W., and E. P. Odum. 1956. Breeding bird populations in relation to plant succession on the Piedmont of Georgia. Ecology 37:50-62.

Karr, J. K. 1971. Structure of avian communities in selected Panama and Illinois habitats. Ecological Monographs 41:207-233.

Lima, S. L., and T. J. Valone. 1981. Predators and avian community organization: an experiment in a semi desert grassland. Oecologia 86:105-112.

Lynch, J. F., and D. F. Whigham. 1984. Effects of forest fragmentation on breeding bird communities in Maryland, USA. Biol. Conserv. 28:287-324.

MacArthur, R. H. and J. W. MacArthur. 1966. On bird species diversity. Ecology 42:594-598.

May, P. G. 1982. Secondary succession and breeding bird community structure: patterns of resource utilization. Oecologia 55:208-216.

Millenbah, K. F., S. R. Winterstein, H. Campa III, L. T. Furrow, and R. B. Minnis. 1996. Effects of conservation reserve program field age on avian relative abundance, diversity, and productivity. Wilson Bull. 108:760-770.

Pulliam, H. R., and G. S. Mills. 1977. The use of space by wintering sparrows. Ecology 58:1393-1399.

Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat area requirements of breeding forest birds of the middle Atlantic states. Wildl. Monogr. 103:1-34.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The breeding bird survey: Its first 15 years, 1965-1979. U.S. Dept. Interior Fish Wildl. Serv. Res. Publ. 157:1-196.

Roth, R. 1976. Spatial heterogeneity and bird species diversity. Ecology 57:773-782.

Samson, F. B. 1980. Island biogeography and the conservation of prairie birds. Proc. Amer, Prairie Conf. 7:293-305.

U.S. Dept. of Commerce. 1981. 1978 Census of Agriculture. Vol. 1, Part 46: Virginia state and county data. U.S. Government Printing Office. Washington, DC.

Vickery, P. D. 1992. A regional analysis of endangered, threatened, and special-concern birds in the northeastern United States. Trans. of the Northeast Section, The Wildlife Society 48:1-10.

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 4:1087-1097.

Whitmore, R. C. 1981. Structural characteristics of Grasshopper Sparrow habitat. J. Wildl. Manage. 45:811-814.

--------------. 1979. Short-term change in vegetation structure and its effect on Grasshopper Sparrows n West Virginia. Auk 96:621-625.

Wiens, J. A. 1973. Pattern and process in grassland bird communities. Eco. Monogr. 43: 237-270.

Appendix I. Location and description of study sites.

Location	Tenure[1]	Habitat type[2]	Patch size	Season used[3]
Prince George Co., VA, Route 10	P	G	1	B
Henrico Co., VA, Route 156	P	G	1	B,W
Prince George Co., VA, Routes 460 and 629	P	G	1	B
Prince George Co., VA, I-95	P	G	1	B
Patuxent Naval Air Test Station, MD	F	G	1	W
Patuxent Naval Air Test Station, MD	F	G	1	W
Henrico Co, VA, I-95 and Old Francis Rd.	P	G	1	W
New Kent Co., VA, Route 249	P	G	3	B
National Park Service, Greensprings tract	P	G	3	B,W
Kiptopeke State Park, Northampton Co., VA	S	G	3	W
Hanover Co., VA, Route 643	P	G	3	B,W
Spotsylvania Co., VA, Route 627	P	G	3	B
St. Mary's City, MD, Route 5	P	G	10	B,W
Fort Lee Military Reservation	F	G	10	B
Charles City Co., VA, Shirley Plantation	P	G	10	B,W
Sussex Co, VA, Routes 35 and 627	P	G	10	B,W
Patuxent River Naval Air Test Station, MD	F	G	10	W
Patuxent River Naval Air Test Station, MD	F	G	10	W
Henrico Co., VA, Times Dispatch Road	P	G	10	W
Fort A.P. Hill, VA	F	G	≥30	B,W
West Point Municipal Airport, VA	M	G	≥30	B,W
Aberdeen Proving Grounds, VA	F	G	≥30	B,W
Yorktown Naval Weapons Station, VA	F	T	1	B
Patuxent Naval Air Test Station, VA	F	T	1	B,W
Patuxent Naval Air Test Station, VA	F	T	1	B,W
Patuxent Wildlife Research Center, MD	F	T	1	B
Hanover, Co., VA, Route 360	P	T	1	W
Prince George Co., VA, Bermuda Industrial Park	P	T	1	W
Petersburg Federal Reformatory Prison, VA	F	T	3	B,W
U.S. Naval Surface Weapons Cntr., Dahlgren	F	T	3	W
Quantico Marine Corps Command, VA	F	T	3	B,W
Patuxent Wildlife Research Center, MD	F	T	3	W
Charles City Co., VA, Curles Neck Farm	P	T	3	B,W
Quantico Marine Corps Command, VA	F	T	10	B,W
Camp Peary Naval Reservation, VA	F	T	10	B,W
Essex, Co., VA, Routes 17 and 601	P	T	10	B,W
Aberdeen Proving Grounds, MD	F	T	10	B
Howard Co., MD, Gorman Road, West of I-95	P	T	10	W
Eastern Shore of VA National Wildlife Refuge	F	T	≥30	B,W
Aberdeen Proving Grounds, MD	F	T	≥30	B,W
Prince Georgés Co., MD, Route 301	P	S	1	B,W
James City Co., VA, Gospel Spreading Farms	P	S	1	B
Fort Lee Military Reservation, VA	F	S	1	W
Aberdeen, MD, Route 27	P	S	1	W

Appendix I continued.

Location	Tenure[1]	Habitat type[2]	Patch size	Season used[3]
Prince George Co., VA, River Road	P	S	3	B,W
Spotsylvania Co., VA, Routes 610 and 620	P	S	3	B,W
Yorktown Naval Weapons Station, VA	F	S	3	B,W
Essex Co., VA, Routes 17 and 601	P	S	3	B
Henrico Co., VA, Interstates 64 and 295	P	S	3	W
Quantico Marine Corps Command, VA	F	S	10	B,W
Fort Lee Military Reservation, VA	F	S	10	B
Paxtuxent Naval Air Test Station, MD	F	S	10	B,W
James City Co., VA, Curles Neck Farm, Route 5	P	S	10	B
Pettigrew Wildlife Management Area, VA	S	S	10	W
Prince Georges Co., MD, Route 301	P	S	≥30	B,W
Prince Georges Co., MD, Route 301	P	S	≥30	B,W
Howard Co., MD, Gorman Rd. East of I-95	P	S	≥30	W

[1]F = Federal; M = Municipal; P = private; S = State
[2]G = grassland; T = transitional; S = shrubland
[3]B = breeding season; W = winter season

Appendix II. List of species detected during breeding season surveys. Numbers indicate the total detection of individuals from unlimited radius point count data.

Species	Species code	Functional[1] category	grassland	Habitat type transitional	shrubland
Northern Bobwhite (*Colinus virginianus*)	NOBO	GF	5	21	9
Red-tailed Hawk (*Buteo jamaicensis*)	RTHA	GF	0	1	0
American Kestrel (*Falco sparverius*)	AMKE	GF	0	1	0
Mourning Dove (*Zenaida macroura*)	MODO	GF	2	1	0
Downy Woodpecker (*Picoides pubescens*)	DOWO	GF	0	0	2
Willow Flycatcher (*Empidonax trailii*)	WIFL	GF	0	0	2
Eastern Phoebe (*Sayornis phoebe*)	EAPH	GF	0	1	0
Eastern Kingbird (*Tyrannus tyrannus*)	EAKI	GF	0	3	0
Tree Swallow (*Tachycineta bicolor*)	TRSW	GF	4	0	0
Purple Martin (*Progne subis*)	PUMA	GF	4	2	0
Barn Swallow (*Hirundo rustica*)	BASW	GF	5	4	2
American Crow (*Corvus brachyrhychos*)	AMCR	GF	0	1	0
Blue-gray Gnatcatcher (*Polioptila caerulea*)	BGGN	GF	0	0	2
Eastern Bluebird (*Sialia sialis*)	EABL	GF	1	0	0
American Robin (*Turdus migratorius*)	AMRO	GF	0	1	8
Gray-catbird (*Dumtella carolinensis*)	GRCA	GF	0	1	11
Northern Mockingbird (*Mimus polyglottus*)	NOMO	GF	0	1	2
Brown Thrasher (*Toxostoma rufum*)	BRTH	GF	0	1	3
Eastern Meadowlark (*Sturnella magna*)	EAME	GO	84	11	0
European Starling (*Sturnus vulgaris*)	EUST	GF	54	0	0
White-eyed Vireo (*Vireo griseus*)	WEVI	GF	0	1	6
Yellow Warbler (*Dendroica petechia*)	YEWA	GF	0	0	2
Prairie Warbler (*Dendroica discolor*)	PRAW	GF	3	13	18
Common Yellowthroat (*Geothlypis tristas*)	COYE	GF	2	75	125
Yellow-breasted Chat (*Icteria virens*)	YBCH	GF	0	6	18
American Redstart (*Setophaga ruticulla*)	AMRE	GF	0	0	1
Blue Grosbeak (*Guiraca caerulea*)	BLGR	GF	10	20	26
Indigo Bunting (*Passerina cyanea*)	INBU	GF	12	30	41
Northern Cardinal (*Cardinalis cardinalis*)	NOCA	GF	0	0	15
Rufous-sided Towhee (*Piplio erythrophthalmus*)	RSTO	GF	0	1	3
Song Sparrow (*Melospiza melodia*)	SOSP	GF	1	5	20
Field Sparrow (*Spizella pusilla*)	FISP	GF	9	54	62
Grasshopper Sparrow (*Ammodramus savannarum*)	GHSP	GO	113	8	0
Red-winged Blackbird (*Agelaius phoeniceus*)	RWBL	GF	19	40	76
Brown-headed Cowbird (*Molothrus ater*)	BHCO	GF	3	2	2
Common Grackle (*Quiscalus quiscula*)	COGR	GF	0	16	38
Orchard Oriole (*Icterus spurius*)	OROR	GF	0	3	10
American Goldfinch (*Carduelis tristis*)	AMGO	GF	9	29	13
House Finch (*Carpodacus mexicanus*)	HOFI	GF	0	6	5

[1]GO = grassland obligate; GF = grassland facultative

Appendix III. List of species detected during winter season surveys. Numbers indicate the total detection of individuals from unlimited-width transect data.

Species	Species code	Functional[1] category	Habitat type grassland	transitional	shrubland
American Bittern (*Botarus lentiginosus*)	AMBI	GF	0	1	0
Killdeer (*Charadrius vociferus*)	KILL	GO	2	0	0
Common Snipe (*Gallinago gallinago*)	COSN	GF	5	0	1
American Woodcock (*Scolopax minor*)	AMWO	GF	0	0	3
Northern Bobwhite (*Colinus virginianus*)	NOBO	GF	0	5	0
Northern Harrier (*Circus cyaneus*)	NOHA	GF	2	0	5
Sharp-shinned Hawk (*Accipiter striatus*)	SSHA	GF	0	0	1
Red-shouldered Hawk (*Buteo lineatus*)	RSHA	GF	0	0	1
Red-tailed Hawk (*Buteo jamaicensis*)	RTHA	GF	4	7	3
American Kestrel (*Falco sparverius*)	AMKE	GF	3	2	2
Short-eared Owl (*Asio flammeus*)	SEOW	GF	1	1	0
Mourning Dove (*Zenaida macroura*)	MODO	GF	5	3	3
Belted Kingfisher (*Ceryle alcyon*)	BEKI	GF	1	0	0
Yellow-shafted Flicker (*Colaptes auratus*)	YSFL	GF	2	0	1
Downy Woodpecker (*Picoides pubescens*)	DOWO	GF	0	0	2
Eastern Phoebe (*Sayornis phoebe*)	EAPH	GF	0	0	4
Horned Lark (*Eremophila alpestris*)	HOLA	GO	3	0	0
Blue Jay (*Cyanocitta cristata*)	BLJA	GF	0	1	4
Black-capped Chickadee (*Parus carolinensis*)	CACH	GF	0	0	5
Carolina Wren (*Thryothorus ludovicianus*)	CARW	GF	0	0	2
Ruby-crowned Kinglet (*Regulus calendula*)	RCKI	GF	0	0	1
Eastern Bluebird (*Sialia sialis*)	EABL	GF	18	10	8
American Robin (*Turdus migratorius*)	AMRO	GF	10	17	8
Northern Mockingbird (*Mimus polyglottus*)	NOMO	GF	0	2	2
Brown Thrasher (*Toxostoma rufum*)	BRTH	GF	0	1	1
American Pipit (*Anther rubescens*)	AMPI	GF	55	0	0
Eastern Meadowlark (*Sturnella magna*)	EAME	GF	20	5	2
European Starling (*Sturnus vulgarus*)	EUST	GF	0	45	0
Yellow-rumped Warbler (*Dendroica coronata*)	YRWA	GF	0	5	0
Northern Cardinal (*Cardinalis cardinalis*)	NOCA	GF	0	0	14
Rufous-sided Towhee (*Piplio erythrophthalmus*)	RTSO	GF	0	1	6
Savannah Sparrow (*Passerculus sandwichensis*)	SAVS	GO	37	1	0
Song Sparrow (*Melospiza melodia*)	SOSP	GF	32	119	76
American Tree Sparrow (*Spizella arborea*)	TRSP	GF	7	95	12
Field Sparrow (*Spizella pusilla*)	FISP	GF	56	155	76
Chipping Sparrow (*Spizella passerina*)	CHSP	GF	0	3	0
Dark-eyed Junco (*Junco hyemalis*)	SCJU	GF	26	51	27
White-throated Sparrow (*Zonotrichia albcollis*)	WTSP	GF	17	105	78
White-crowned Sparrow (*Zonotrichia leucophrys*)	WCSP	GF	0	10	2
Swamp Sparrow (*Melospiza georgiana*)	SWSP	GF	0	3	2
Fox Sparrow (*Passerella iliaca*)	FOSP	GF	0	4	3
Rusty Blackbird (*Euphagus carolinus*)	RUBL	GF	21	0	0
Red-winged Blackbird (*Agelaius phoeniceus*)	RWBL	GF	18	5	2
Common Grackle (*Quiscalus quiscula*)	COGR	GF	1	0	0
American Goldfinch (*Carduelis tristis*)	AMGO	GF	0	1	0
House Finch (*Carpodacus mexicanus*)	HOFI	GF	0	14	2

[1]GO = grassland obligate, GF = grassland facultative