Temporal Patterns in use of an Iowa Woodlot During the Autumn Bird Migration

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ABSTRACT.—Migration is an important part of many temperate bird species' annual life history. We used a time-point census method to describe the changes in bird communities during the autumn migration in central Iowa. Site selection within a second-growth forest varied significantly based on diet and migration habits of birds. Temporal changes in individual activity and species presence show preferences that may be related to availability of fruit. We discuss the effect of the invasive shrub *Rosa multiflora* on bird abundances on both temporal and spatial scales.

INTRODUCTION

Nearly 300 species of North American birds engage in some form of seasonal migration, which is considered to be driven by diminishing food availability as winter takes hold in the northern latitudes (Cox, 1985). This mass movement of birds places increasing pressure on the resources within the "stopover" habitats that are visited by migrating birds (Winker *et al.*, 1992), although the requirements of birds using these habitats—as well as the relative importance of specific types of habitat—are not well known (Weisbrod *et al.*, 1993). For example, they may be seeking specific types of food with a particularly high lipid content in an effort to acquire extra body fat to accommodate the energetic demands of long distance, non-stop flight (Snow, 1970; Suthers *et al.*, 2000). Such dietary plasticity has been shown by Parrish (1997) in a study of migrants on Block Island, 19 km off of the coast of Rhode Island, USA; recaptured birds showed increases in body mass, indicating that the site was used for body fat accumulation. Birds can satiate their demand for high-lipid food through the consumption of fruit, leading to important interactions between fruit-producing plants and birds as agents for their dispersal (Snow, 1970; Thompson and Willson, 1979).

An intensification of frugivorous activity during the autumn migration may have important implications for habitat use and responses of birds to habitat change. For example, Suthers *et al.* (2000) showed that both migrant and resident birds, with the exception of the thrushes (Turdidae), preferred shrub lands and avoided areas that have become significantly dominated by a forest canopy in New Jersey, USA. Other studies indicate that birds migrating in the autumn may select their stopover habitats based on the availability of food capable of meeting their high-energy requirements. Additionally, those habitats which satisfy the demands of the migrating birds have been shown to experience a peak in avian activity late in the growing season. Weisbrod *et al.* (1993) used mist net studies along a stretch of the St. Croix River in Wisconsin and reported a peak of migrant birds in late September. Stapanian (1982) described a sharp peak in the mean number of frugivores spanning late September through late October using weekly censuses at his 16 census stations in Kansas, USA, although the distribution of birds at each site was highly variable. Winker *et al.* (1992) used mist nets along the St. Croix River in Minnesota to demonstrate that autumn migrants frequent woodland patches and put an acute seasonal

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demand on the resources within stopover habitats. Echoing Stapanian (1982), this study also suggests that habitat diversity is important in determining the role of stopover forest fragments.

Here we report on changes in avian communities in a second-growth woodlot in central Iowa between July and October 2003. We sought to extend the understanding of temporal changes in the autumn bird migration and its effect on local stopover habitats as called for by Weisbrod *et al.* (1992) and Winker *et al.* (1992). We describe the temporal changes in the avian community of a second-growth forest in Iowa, portions of which were being grazed up until the 1960s and row-cropped as recently as the 1980s. Using a time-point census design, we recorded all birds seen and heard from all levels within the habitat. As in other studies, we expect the composition of the avian communities using the habitats to change during the autumn migration. Specifically, we expect primarily insectivorous species to decrease in abundance as their food becomes scarce, while fruit and seed eating species increase in abundance as they seek foraging opportunities within the woodlot. We also expect species which breed in Iowa to become scarcer as the migration continued, and that this change would correspond to an increase in the abundance of non-resident birds towards the end of the season.

Finally, we hypothesize that within a single woodlot, birds would show a preference between sites that vary in vegetation characteristics. Given the evidence for changing dietary priorities among these birds (Parrish, 1997; Suthers *et al.*, 2000), we expected migrating birds to select those areas with more accessible fruits (Snow, 1970; Whelan and Willson, 1994) and avoid those areas dominated by a forest canopy (Suthers *et al.*, 2000).

<center>METHODS</center>

Study area.—The Conard Environmental Research Area (CERA), Grinnell College's biological field station located near Kellogg, Iowa, is a 148 ha tract acquired as agricultural land in the 1960s that is undergoing woodland, savanna and prairie restoration. We selected six sites within second-growth forest slated for savanna restoration in the near future. Aspect, general location and the edge effect of boundaries were controlled in order to more directly study the impact of vegetation on migration habits. Each of our six sites optimized the following criteria: all are located near the top of north- or northeast-facing ridges, are separated by at least one ridge that was not sampled and are at least 100m from neighboring agricultural areas.

Vegetation characterization.—For the vegetation surveys, we established five 10 m × 10 m plots at each of the six sites and characterized both tree and shrub communities. The first plot was centered around the census point, and the remaining four were placed randomly between 10 m and 50 m away from the census point in the cardinal directions. We counted, identified to species and measured the basal area of every tree greater than 1.5 cm diameter at breast height within each plot.

The invasive *Rosa multiflora*—commonly known as multiflora rose—was clearly the dominant species of the shrub layer, and was the only shrub species considered here. An index system was devised to classify the height and percent cover of multiflora rose in each plot. Height was scored from 1–3 as follows: "1" = less than 0.5 m tall, "2" = 1 m tall and "3" = 2 m tall. Percent cover was scored on a scale of 0–4, representing the number of plot quarters covered by any portion of a multiflora rose plant. For each site we averaged the data from the five plots into a single value.

Bird censuses.—Sampling occurred between 22 July and 21 October 2003 for a total of 18 census days. Beginning in mid-August, we increased from weekly to biweekly counts to

TABLE 1.—Summary of total identifications and species counts for each diet and breeding type category: F = frugivore, I = insectivore, G = granivore and X = omnivore. MB = migrant breeder, RB = resident breeder and NB = non-resident migrant

	Total identifications				Species counts				Total identifications			Species counts		
Site	F	G	I	X	F	G	I	X	MB	NB	RB	MB	NB	RB
1	619	26	25	85	68	2	7	22	360	11	384	45	3	51
2	507	32	29	63	63	8	7	16	310	19	302	38	6	50
3	243	43	51	54	42	8	17	13	138	27	226	32	7	41
4	290	18	78	148	46	8	14	26	213	77	244	25	21	48
5	515	13	30	87	59	3	8	26	186	66	393	28	7	61
6	248	50	51	87	38	10	7	24	104	32	300	16	6	57

increase our accuracy in recording the arrival and departure dates of migrating species (Thomas and Willson, 1979). We identified to species all visualizations and vocalizations (summed as "total identifications" in our analyses) within a 5-min period from a fixed point at each of the six sites (a "time-point census" method). While total identifications did not differentiate between one bird calling 10 times and 10 birds calling once each, we also counted the number of distinct species identified for each day and site (summed as "species count" in our analysis). This measure is a method of expressing how frequently members of a bird classification were observed and may serve as a more conservative measure of frequency than abundance. In order to limit between-site travel time, sites were sampled in the same order between 0750–0950.

Data analysis.—We classified each species of bird into four groups (Table 1) based on literature reports of the birds' diet (Stapanian, 1982; Martin, 1985; Jackson *et al.*, 1996; Suthers *et al.*, 2000), *i.e.*, insectivores, frugivores, granivores and birds whose diets are consistently too omnivorous to fit into one of the three main categories. We also classified species into breeding types based on the breeding location and migration habits of the

TABLE 2.—Summary of major habitat characteristics of six sites within a central Iowa woodlot. Data include mean height and percent cover of multiflora rose, as well as the basal area and total number of individuals for the following groups of trees: all trees, native hardwoods, American Elm and other trees found at the sites. Values for each of the three multiflora rose measurements represents the mean of five sample plots per site and are scored along a categorical index (*see* Methods). Tree data is the sum of five plots per site. Basal area measured as diameter at breast height (cm)

	Multiflora rose		Total trees		Native hardwoods[a]		American elm		Other trees[b]	
Site	*Height (meters)*	*Percent cover*	*basal area (cm)*	*individuals*	*basal area (cm)*	*individuals*	*basal area (cm)*	*individuals*	*basal area (cm)*	*individuals*
1	2.5	1.6	494.4	34	148.3	6	129.9	11	216.2	17
2	2.5	3	698.0	86	59.2	2	455.2	64	183.6	20
3	1.8	2.1	685.4	70	324.0	26	328.9	40	32.5	4
4	1.7	1.9	680.1	53	130.0	8	398.7	34	151.4	11
5	2	1.6	578.4	64	375.0	37	138.9	14	64.5	13
6	1.1	0.6	599.1	39	529.0	20	53.9	10	16.2	4

[a] "Native Hardwoods" includes Burr Oak, Red Oak, Shagbark Hickory, Butternut Hickory, Basswood and Black Cherry

[b] "Other Trees" includes Green Ash, Hackberry, Hawthorn, Osage Orange, Red Elm, Wild Crabapple, White Mulberry and Wild Plum

birds, *i.e.*, migrants that breed locally (MB), non-breeding migrants (NB) and year-long resident breeders (RB).

We performed a repeated measures analysis of variance (ANOVA) on both total identifications and species count. This was used to test the significance of time (day), as well as the interactions between day and breeding type and day and site. Since the data showed some evidence of non-normality and unequal variances, we calculated both the standard and conservative degrees of freedom (Box, 1954).

Using species counts or total identifications leaves us with only one measurement per site/breeding type combination. Having only one measurement per sampling unit does not allow for using the ANOVA table for testing the interaction between site preference and breeding type (Milliken and Johnson, 1984). Following Suthers *et al.* (2000), a chi-square test was conducted to determine if different breeding types have distinct site preferences within a single forest. Finally, we used cubic regression models to express the temporal changes for each diet and breeding type.

RESULTS

Site preferences.—The chi square tests showed significant interactions between breeding types and site using both total identifications ($\chi^2 = 213.94$, df = 10, P < 0.001) and species count ($\chi^2 = 41.22$, df = 10, P < 0.001). This gives strong evidence that various breeding types have distinct site preferences within the woodlot (Table 1). While resident breeders were fairly consistent at each site, migrant breeders preferred sites 1 and 2 while non-breeders preferred sites 4 and 5. The data in Table 1 also gives strong evidence that each diet classification also has distinct site preferences.

We also tested the linear predictive ability of site vegetation on breeding. This involved calculating the correlation of each species count and total identifications of each breeding type against the following vegetation characteristics: height and percent cover of multiflora rose, total tree count and average basal area per square meter (Table 2). These four vegetation characteristics were uncorrelated.

Migrant breeders and height showed strong evidence of a linear relationship ($R^2 = 89\%$, P = 0.005) using species count data (Fig. 1) and some evidence of a linear relationship ($R^2 = 81.2\%$, P = 0.014) using total identifications. Resident breeders and average basal area ($R^2 = 67\%$, P = 0.047) also showed evidence of a negative linear relationship when using total identifications. It is important to note that 24 tests for linear regression were conducted and using the very conservative Bonferroni's correction would not show any of these linear relationships significant at P = 0.05. Using similar methods, testing correlations of diet classifications and vegetation characteristics shows frugivores have a linear relationship with height for both total identifications ($R^2 = 71.5\%$, P = 0.034) and species counts ($R^2 = 85.2\%$, P = 0.009).

Seasonal changes in avian abundances.—Cubic regression models of time and breeding type (Fig. 2) were developed, since the repeated measures ANOVA indicated that different breeding types may have distinct temporal patterns in both total identifications (F = 3.15, P < 0.087) and species counts (F = 4.10, P < 0.05). Figures 2 and 3 show that, in some cases, the cubic model was a much better fit than a linear or quadratic model. In cases where a cubic term is not necessary, the coefficient for the unnecessary term will be close to zero, so cubic models provide essentially the same equations and R^2 values as a lower level model.

Cubic regression models show the total identifications of migrant breeders peaked in late September (Fig. 2a), but migrant breeder species counts showed two notable declines—one between late July and mid August and the other after Sept. 20 (Fig. 2b). Resident breeders had a marked increase in total identifications (Fig. 2).
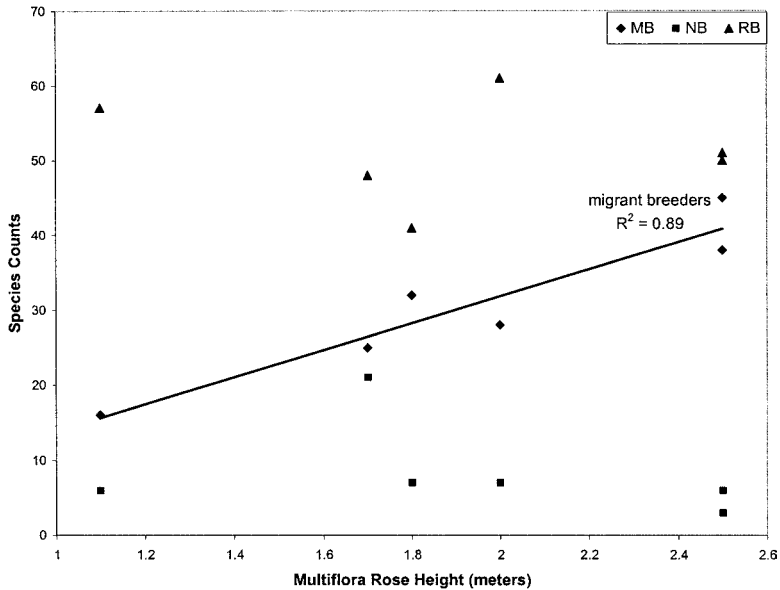
Fig. 1.—Scatter plots show the relationship between species counts and multiflora rose height (*A*). MB = migrant breeders, RB = resident breeders and NB = non-resident migrants. Regression lines shown only for significant relationships (P < 0.1 after Bonferoni's test)

The high rate of co-linearity between breeding type and diets made it difficult to simultaneously analyze both categorizations in an ANOVA. As expected, separate analysis showed very similar results for diet classifications. The temporal patterns of each diet classification showed frugivores tended to be the most abundant group of birds in terms of both total identifications and species counts, and showed peaks in late September (Figs. 3a, 3b).

Discussion

We found significant changes in the composition of bird communities in a second growth forest in Iowa over the course of the fall migration. We were able to identify distinct temporal patterns by classifying species into groups based on diet or breeding type. Insectivores showed a consistent decrease over time. Frugivores tended to be the most abundant group in terms of diet, while resident breeders, which are composed primarily of frugivores and omnivores, were the most abundant in terms of breeding type. In fact, these two groups demonstrated similar trends (Figs. 2, 3).

The cubic model shows a peak in frugivore abundance and frequency late in the season and also indicates an earlier peak in mid-July (Fig. 3). The observation of two peaks is consistent with Thompson and Willson's (1979) report of two peaks in frugivore abundance during an autumn migration at a temperate woodlot. Other studies also note large late-season peaks in frugivores (Stiles, 1980; Parrish, 1997; Suthers *et al.*, 2000).

A period of intense foraging followed the first onset of multiflora rose fruit (16 September; D. McGranahan, pers. obs.), was also characterized by an increase in spatial variability and mixed-flock foraging. Stapanian (1982) reported a patchy distribution of
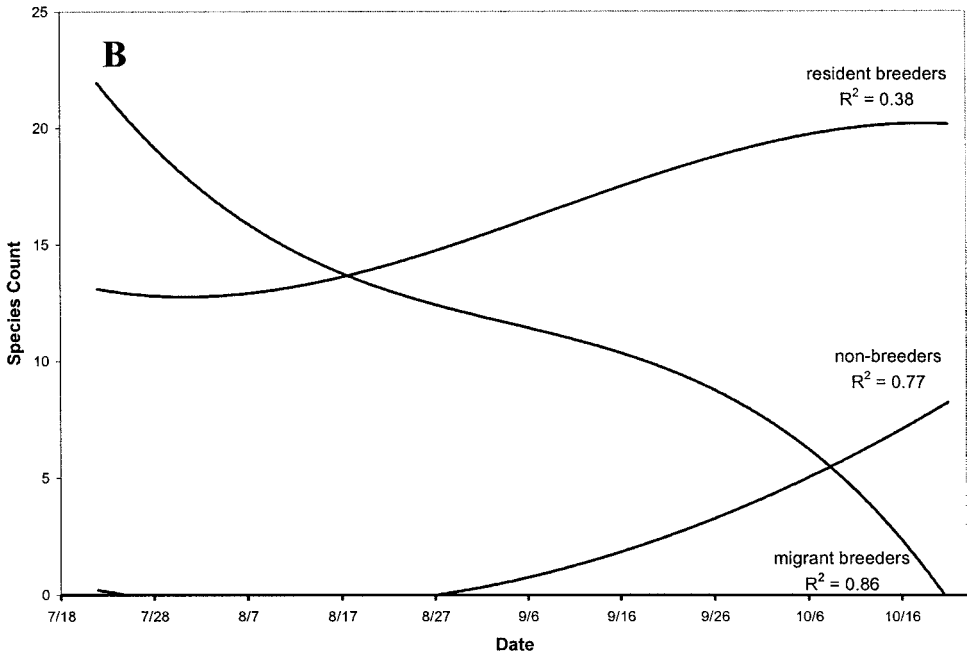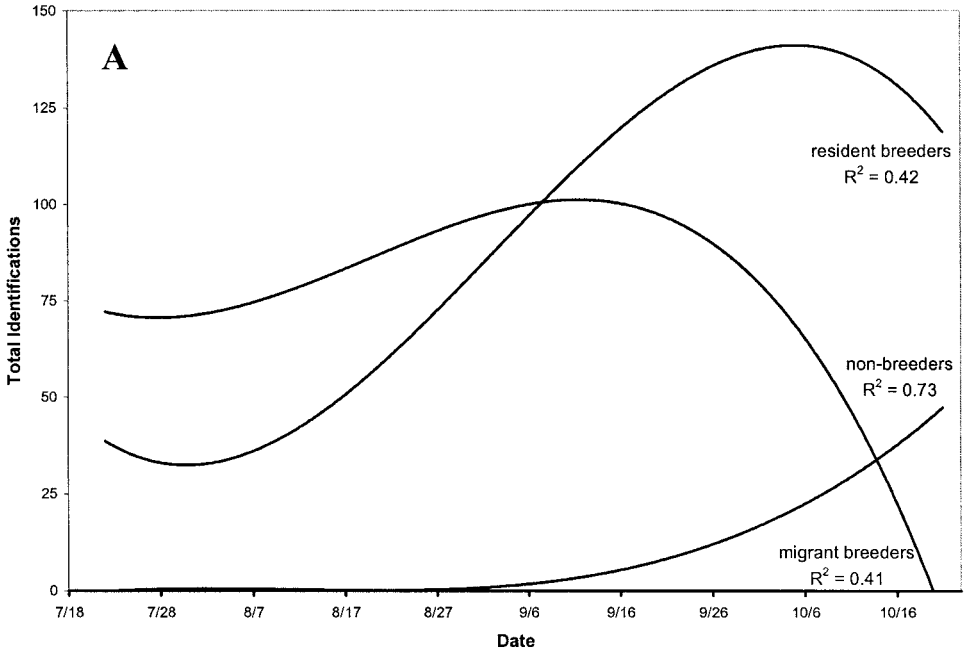
FIG. 2.—Cubic regressions show the change in bird migration strategy and breeding behavior groups over time in total identifications (*A*) and species counts (*B*)
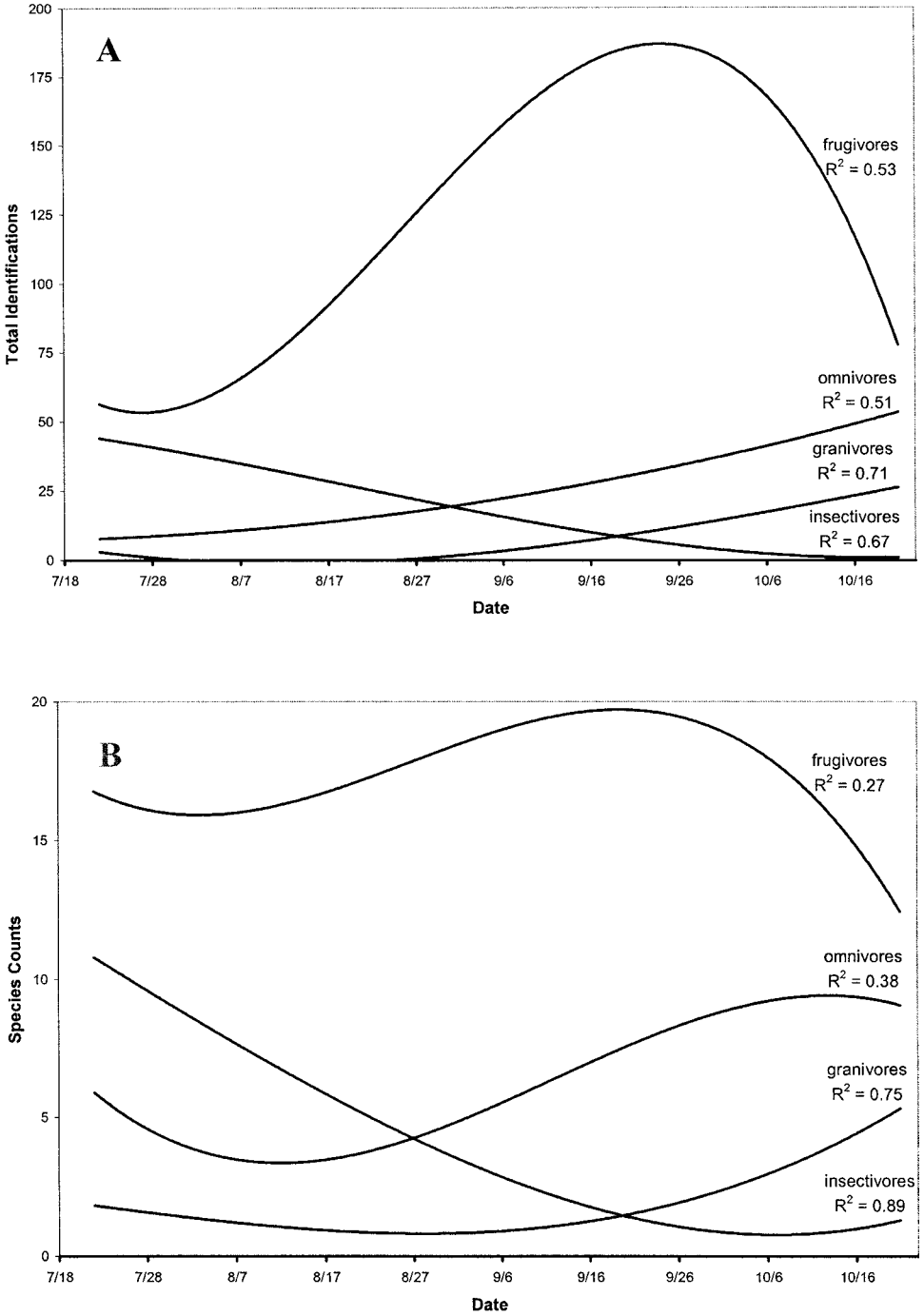
FIG. 3.—Cubic regressions show the change in bird diet groups over time in total identifications (*A*) and species counts (*B*)

TABLE 3.—Bird species that were observed at CERA between 22 Jul. and 21 Oct. 2004, including diet and breeding type assignments: F = frugivore, I = insectivore, G = granivore and X = omnivore. MB = migrant breeder, RB = resident breeder and NB = non-resident migrant

	Species	Diet class	Breeding class
American Goldfinch	*Carduelis tristis*	F	RB
American Redstart	*Setophaga ruticilla*	I	MB
American Robin	*Turdus migrantorius*	F	MB
Baltimore Oriole	*Icterus galbula*	I	MB
Bay-breasted Warbler	*Dendroica castanea*	F	NB
Black-and-white Warbler	*Mniotilta varia*	I	NB
Black-capped Chickadee	*Poecile atricapilla*	X	RB
Blue Jay	*Cyanocitta cristata*	F	RB
Brown Creeper	*Certhia americana*	I	NB
Brown Thrasher	*Toxostoma rufum*	F	MB
Cedar Waxwing	*Bombycilla cedrorum*	F	MB
Common Yellowthroat	*Geothlypis trichas*	I	MB
Dark-eyed Junco	*Junco hyemalis*	F	NB
Eastern Towhee	*Pipilo erythrophthalmus*	F	MB
Eastern Wood-pewee	*Contopus virens*	I	MB
Field Sparrow	*Spizella pusilla*	I	MB
Fox Sparrow	*Passerella iliaca*	F	NB
Golden-crowned Kinglet	*Regulus satrapa*	G	NB
Gray Catbird	*Dumetella carolinensis*	F	MB
Great-crested Flycatcher	*Myiarchus crinitus*	I	MB
Hairy Woodpecker	*Picoides villosus*	X	RB
House Wren	*Troglodytes aedon*	I	MB
Indigo Bunting	*Passerina cyanea*	I	MB
Mourning Dove	*Zenaida macroura*	X	MB
Nashville Warbler	*Vermivora ruficapilla*	F	NB
Northern "Yellow-shafted" Flicker	*Colaptes auratus*	X	MB
Northern Cardinal	*Cardinalis cardinalis*	F	RB
Ovenbird	*Seiurus aurocapillus*	F	MB
Red-bellied Woodpecker	*Melanerpes carolinus*	X	RB
Red-eyed Vireo	*Vireo olivaceus*	I	MB
Red-headed Woodpecker	*Melanerpes erythrocephalus*	X	MB
Red-winged Blackbird	*Agelaius phoeniceus*	F	MB
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	F	MB
White-breasted Nuthatch	*Sitta carolinensis*	G	RB
White-throated Sparrow	*Zonotrichia albicollis*	F	NB
Yellow-bellied Flycatcher	*Empidonax flaviventris*	I	NB
Yellow-bellied Sapsucker	*Sphyrapicus varius*	X	NB
Yellow-rumped Warbler	*Dendroica coronata*	F	NB

frugivores late in the season, sometimes observing 500 birds at one station and zero at another. In New Jersey, Baird (1980) also reported extensive mixed-species flocking late in the migration season and throughout the winter.

We explain the disproportionately large increase in total identifications by acknowledging the foraging behavior of some of the more abundant frugivore species, most notably the American Robin, Northern Cardinal and White-throated Sparrow. These birds often foraged in large flocks among the multiflora rose, at times emitting call notes at the (unrecordable) rate of 2–3 per second (D. McGranahan, pers. obs.). These three birds composed of 24% of

frugivores before fruiting but composed 57% of frugivores after fruiting. The Northern Cardinal, which is also a resident breeder, composed 36% of the frugivore population after fruiting. The impacts of these three birds are much more modest when using species count, since each bird category is only counted once for each site day measurement. During this part of the season, which is generally regarded as an important period of acquiring body fat for many different migrating birds, CERA is primarily providing food for many individual birds that only belong to a few common species.

When species were classified into groups, there was strong evidence of site preference between the six different study sites across the woodland. We attempted to predict site preferences based on the vegetation characteristics of our six sites. The general trend of these data reflects the findings of Suthers *et al.* (2000): migrant breeders tended to prefer areas with taller shrubs and resident breeders preferred areas less basal area. However, no evidence of a relationship was found between migrant breeders and basal area (P = 0.54) and resident breeders and multiflora height (P = 0.4).

When no classification was done, the interaction between temporal patterns and sites was insignificant. This provides additional support that diet and breeding type classifications are proper indicators of site and temporal patterns. Categorization of species allowed us to view strong temporal patterns for insectivores, granivores, non-breeders and migrant breeders. Frugivores and migrant breeders have significant site preferences that are correlated to multiflora rose height. While more work should be done to study appropriate categorizations of birds and what causes their preference for specific sites, there is little doubt a preference does exist.

Two of the major frugivores—the American Robin and the Northern Cardinal—are not typically high priorities for managers of conservation areas such as CERA. These *kulturfolger* species—"culture followers"—are quick to adapt to landscapes altered by humans, including those dominated by exotic food species, often at the expense of the increasingly rare culture-avoiding species, or *kulturmeiders* (Rosenweig, 2003). For example, Hecksher (2004) has documented that nest-site preference in Veery (a migrant breeder at the study site in the mid-Atlantiic piedmont) is associated with higher densities of the same alien shrub, *Rosa multiflora*, and suggests that invasion of this shrub may explain this bird species recent range expansion. We will monitor changes in bird communities as a proportion of our study area is restored to native savannah vegetation, to see whether a reduction in the dominance of exotic food species, like multiflora rose, changes usage by both common species and those in decline regionally.

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