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EFFECTS OF URBANIZATION ON AVIAN COMMUNITY ORGANIZATION

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ABSTRACT.—The avian community of a mature residential area was studied and compared with an undisturbed climax beech-maple forest. Urbanization was presumed to be responsible for decreasing species richness and diversity, increasing biomass and density, and favoring dominance by a few species. Foraging guilds shifted from forest insectivores that were canopy foliage gleaners or bark drillers to urban ground gleaners. Analyses of habitat structure showed that although urban foliage height diversity was like that of the forest, the urban area contained only one-third of the total percent vegetative cover. As compared to the forest, urban vegetative cover was: (1) significantly less in all but the middle layer; (2) replaced by man-made structures, ground cover and ornamental vegetation in the low and middle layers but dominated the high layer; and (3) highly discontinuous, existing as isolated strata. Differences in avian community organization between the forest and urban area are discussed in relation to urban habitat manipulation and population-suppressing factors.

Bird communities of residential and urban areas contain higher bird densities than outlying natural areas (Graber and Graber 1963, Emlen 1974), with only forest edge communities supporting greater densities in temperate zones. In addition to the factors controlling natural communities (Lancaster and Rees 1979), the diversity of birds in urban areas is affected by the age of the neighborhood (Lucid 1974), type of housing (Geis 1974), and degree of urbanization (Batten 1972).

Few studies have compared the avifauna of cities with that of outlying natural areas and have measured habitat structure in both communities. The difficulties arise in selecting comparable study areas and quantifying the synthetic urban habitat in relation to natural parameters. In this study, we determined how urbanization affected avian community organization by comparing the ecological characteristics of the birds of a mature residential area with those of the regional vegetative climax, an outlying forest.

STUDY AREAS

For the forest samples, we chose two 6.1-ha control sites in Hueston Woods State Park, Preble County, 7 km north of Oxford, Butler County, Ohio. They comprised a relatively uniform mature beech-maple forest (a remnant of the original forest cover of southwestern Ohio) and have been described vegetatively as being in a state of dynamic equilibrium (Vankat et al. 1975). Site 1 was established and described in 1973 and has been censused annually for breeding birds (Adams 1974, Beissinger and Adams 1974, Waterhouse 1975, Zuck et al. 1977, Beissinger and Adams 1978). Site 2 was established in April 1976 (Beissinger 1977).

Oxford, Ohio is a college town of 30,000 residents. In 1810 the tall trees covering the site were first cut in order to build cabins; however, early town planners left many large trees standing (McGinnis 1930:80). Two 6.1-ha study sites were established in April 1976 within Oxford's oldest residential area. They represent mature residential communities: most homes are over 50 years old; the area is highly vegetated including many old trees, and the neighborhood is stable with few habitat changes having occurred within the past 25 years. The streets are lined with tall shade trees (mostly maples, *Acer* spp.). Typically, each residence is fronted by a dense lawn, bordered by ornamental shrubs and backed by lawns, play areas or gardens. Each block is traversed by paved or unpaved alleys. Most of the dwellings are detached single units though many are occupied by more than one household. Housing density is approximately 12 lots per hectare. See Beissinger (1978) for further descriptions of the town.

METHODS

In each study site, two transects were established and, at 10-m intervals, 30 sampling points were located randomly on either side of each transect (after Wiens 1969:23). At each sampling point, the presence or absence of cover and physiognomic type were determined for a series of levels (ground, 0.15–0.92 m, 0.92–1.83 m, 1.83–2.75 m, 2.75–3.66 m, 3.66–4.58 m, 4.58–9.15 m, 9.15–18.30 m, and greater than 18.30 m) by standing a 5-m aluminum rod (2.54 cm in diameter) and recording the type of cover it touched. For heights greater than 5 m, data were gathered using a sighting device (Emlen 1967) and by visually estimating an extension of the rod. Foliage profiles (MacArthur and MacArthur 1961) were developed for each study site. Percent vegetative cover was calculated as the percentage of points ($n = 60$) with vegetation present, and summed for a site total.

Only resident bird species that regularly used the resources of Hueston Woods or Oxford for foraging or nesting from 2 May to 2 July 1976 were included (Appendix). Spot mapping (Williams 1936) was used to estimate populations of territorial species. Densities of non-territorial species were sampled by direct counts (Graber and Graber 1963). As compared to the forest, the distance from which an observer detected a bird visually or auditorily was much less in the town. Thus, coordinated teams of six observers were used to obtain "instant" population counts of non-territorial birds in Oxford in addition to direct counts. In these instantaneous transect counts, observers used the direct counting technique along an assigned alley or transect. An entire urban study site could be transected by a team of observers in approximately 5 min. Censuses were conducted from 06:00–08:00 and 19:00–21:00. Each study site was censused by Beissinger once weekly for nine weeks by spot mapping and direct counting. Instantaneous transect counts were conducted twice in each of the two urban sites.

Foraging guilds were assigned from field data gathered in May 1977. In Oxford, where many species remained visible while feeding for long periods of time, foraging height and behavior were recorded using the focal point sampling technique (Altmann 1974) at 15-s intervals for a maximum of 2 min per individual. The dense foliage in Hueston Woods prevented the use of the focal point sampling technique since birds seldom were seen for more than several seconds. Instead, foraging height and behavior for individuals were tallied solely by frequencies observed.

Each species was assigned a three-digit number (ABC; Willson 1974) to designate a three-dimensional foraging guild based on (A) primary food habits, (B) foraging stratum preference, and (C) foraging behavior (see Appendix). Information in Martin et al. (1951) was used to define three basic feeding types: (1) seedeater, greater than 65% of the diet is plant material; (2) insectivore, greater than 65% of the diet is insect material; and (3) omnivore, less than 65% of the diet is plant or insect material.

Foraging stratum and foraging behavior were determined from observation and supplemented with data from Willson (1974) for rare species. Height categories for foraging stratum were matched with layer divisions determined by habitat sampling. Categories were: (1) ground; (2) low, 0.15–0.92 m; (3) middle, 0.92–4.58 m; (4) high, greater than 4.58 m; and (5) above canopy. Behavioral categories included: (1) bark drill; (2) bark glean; (3) ground glean; (4) perched-foliage glean; (5) hover-foliage glean; (6) sally; and (7) aerial sweep.

Foliage height diversity and bird species diversity were calculated using the Shannon-Weaver (1949) formula ($H' = -\Sigma\, p_i \log_e p_i$) and the general diversity term ($1/\Sigma\, p_i^2$; Levins 1968, MacArthur 1972) where p_i was the proportion of observations (individuals or foliage contacts) in the "i^{th}" category. These indices complement each other: the Shannon-Weaver index is affected most by rare species; the general diversity term by dominant species (Peet 1974). The latter provides a good alternative to the information-theory based H′, the mathematical and biological basis of which has been questioned (Goodman 1975). Evenness (Pielou 1966) of bird distribution and abundance also was calculated ($J' = H'/H_{max}$).

Statistical analyses of community characteristics were conducted with a Student's *t*-test (Remington and Schork 1970). A Mann-Whitney *U*-test (Conover 1971) was used when assumptions of normality were violated. Significance levels were designated as significant ($P < 0.05$) and marginally significant ($0.05 < P < 0.10$). However, the presence or absence of statistical significance at times must be interpreted cautiously in view of the small sample sizes involved: two replicates of each community type.

RESULTS AND DISCUSSION

HABITAT STRUCTURE

From the analysis of foliage profiles (Fig. 1), the eight height intervals sampled were reconstructed and grouped into three layers: low (0.15–0.92 m), middle (0.92–4.58 m), and high (greater than 4.58 m). These strata best reflect the herbaceous, shrub, and canopy layers of Hueston Woods. Well developed herbaceous and canopy layers were found for Hueston Woods. Site 2 contained a more developed herbaceous layer but a less developed shrub layer than Site 1. Cattle grazed in much of Site 2 about 40 years ago and may account for these differences. The foliage profile for Oxford (Fig. 1) showed little layering in the lower height intervals but did indicate a modestly developed canopy. Oxford's relict canopy rarely extended above 18 m as compared to the 27–40 m canopy of Hueston Woods.

Vegetative volume was examined for the three reconstructed layers in terms of percent vegetative cover (Table 1). Oxford averaged 7.2, 2.1, and 3.1 times less vegetation than Hueston Woods for the low, middle, and high layers, respectively; and 3.2 times less for total percent vegetative cover. Significant differences were found in all but the middle layer. However, no significant difference was found between foliage height diversity in Hueston Woods and Oxford (Table 1). Thus, while vegetative volume differed greatly between the forest and urban areas, structural complexity was equivalent.

Field observations disclosed that vegetation in residential areas occurred in small patches. These patches were in the form of trees, shrubs or herbaceous plants, each of which appeared as a vertically isolated stratum lacking other vegetation above or below. To compare the vertical isolation of vegetative layers between communities, a measure of vertical continuity was calculated (Table 2). Urban Oxford averaged 1.5 times less vegetation appearing in two or more layers and 2.6 times less in all three layers as compared to Hueston Woods. These differences were significant for the categories of two or more ($t = 6.4$, $P < 0.012$) and all three layers ($t = 2.9$, $P < 0.05$), indicating that habitat structure in Oxford lacked vertical continuity and consisted primarily of isolated strata. This may be the result of large openings in Oxford's canopy and isolated plantings of landscape shrubs. Horizontal habitat heterogeneity (Roth 1976) was not quantified; however, the horizontal patchiness of vegetation in our urban areas was readily visible compared to the beech-maple forest.

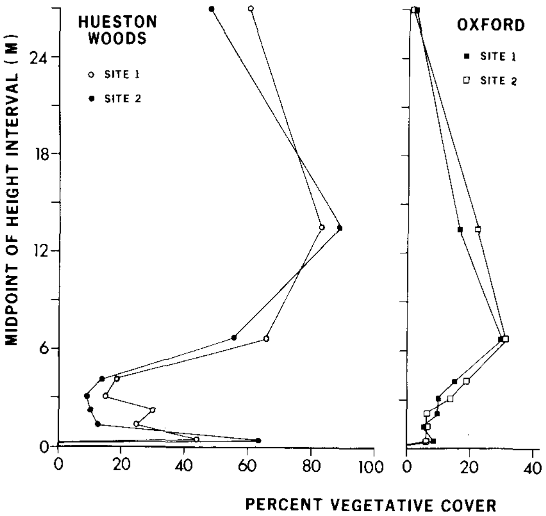

FIGURE 1. Foliage profiles for Hueston Woods and urban Oxford, Ohio.

Percent occurrence of the major physiognomic features of urban Oxford and Hueston Woods were compared. Forest litter (44%) was the dominant ground cover in Hueston Woods while dense grass lawns (20%) followed by cement or paved roads (15%) and buildings (13%) dominated Oxford. Herbaceous plants and broad-leafed trees and shrubs were more important features in Hueston Woods than Oxford in the low (28% vs. 3%) and middle (17% vs. 7%) strata. Broad-leafed trees dominated the high (65%) and middle (15%) layers of Hueston Woods. In Oxford, broad-leafed foliage dominated the high layer (17%) but buildings were the most important feature in the middle layer (12%). Ornamental shrubs and trees outnumbered native shrubs and trees 6:1 in the low layer of Oxford but represented less than half the vegetative cover of the middle layer and were practically non-existent in the high layer. Telephone lines and cars represented less than 1% of the cover in Oxford. In summary, man-maintained ground cover, vegetation, and structures dominated the low

TABLE 1. Percent vegetative cover and foliage height diversity of Hueston Woods and urban Oxford, Ohio.

	Percent vegetative cover				Foliage height diversity	
Area	Low	Middle	High	Total	H'	$1/\Sigma p_i^2$
Hueston Woods						
Site 1	43.3	61.7	98.3	203.3	0.919	2.201
Site 2	65.0	33.3	95.0	193.3	0.902	2.112
Oxford						
Site 1	8.3	20.0	30.0	58.3	0.923	2.333
Site 2	6.7	25.0	33.3	65.0	0.882	2.244
P[a]	.025	.112	.001	.001	.753	.171

[a] Statistical significance based on Student's t-test for Hueston Woods vs. Oxford.

TABLE 2. Frequency and percent of vertical continuity (n = 60) of vegetative cover in Hueston Woods and urban Oxford, Ohio.

Area	Number of layers		
	1 or more	2 or more	All 3
Hueston Woods			
Site 1	60 (100)[a]	45 (75.0)[b]	12 (20.0)[b]
Site 2	60 (100)	50 (83.3)	9 (15.0)
Oxford			
Site 1	21 (35.0)	11 (52.4)	2 (9.5)
Site 2	24 (40.0)	12 (50.0)	1 (4.2)

[a] Values in parentheses are percentage of points with vegetative cover present.

[b] Percentages for two or more and all three layers were calculated by dividing the number of points with vegetative cover present by the number of points with vegetative cover present in one or more layers.

and middle layers of Oxford while native vegetation dominated the high layer. Only native vegetation and ground cover were present in Hueston Woods.

AVIAN DENSITY AND DIVERSITY

Bird population density estimates for both census techniques used in urban Oxford are compared in Table 3. Instantaneous transect counts consistently detected more individuals than direct counts; this difference was significant or marginally significant in 6 of 12 cases. Thus, the average value of two instantaneous transect counts was chosen as a population estimate for non-territorial species in Oxford. Emlen (1974) also found that direct counts by a single observer tended to underestimate population densities in urban areas. Population estimates for each species in both study areas are appended.

We chose to use different census methods for the town and the forest in order to obtain the most accurate assessment of the avian populations possible. This resulted in difficulties comparing census counts between communities. For instance, some young birds could have been included in the urban instantaneous transect counts whereas counts in the forest were confined mostly to spot mapping of adults (mostly males). As the above results of census counts indicate, no single technique alone is adequate and the use of different census methods (hence, lack of strict comparability) may be an inevitable cost of obtaining accurate bird population measurements in both urban and natural study areas. Despite census data that are not completely comparable, our counts do serve as a strong basis for the following discussion of the general characteristics of these two avian communities.

Oxford supported an average of nearly 1,500 individuals per 40 ha (Table 4). Densities are similar to those reported for residential areas in Poland (Tomialojc 1970) but higher than other North American towns (Graber and Graber 1963, Woolfenden and Rohwer 1969, Emlen 1974, Campbell and Dagg 1976). Oxford's high densities of birds may be attributed to the age and stability of the study areas which probably resulted in more vegetation regrowth, more colonization by urban species, and more complete synanthropy (the independent settling of wild species in human habitations; Tomialojc 1970) than other urban areas studied.

Oxford averaged 1.3 times more individuals than Hueston Woods (Table 4) but the difference was not significant. Avian biomass was significantly greater in the town, averaging twice as much as the forest. Starlings and House Sparrows comprised 45.5% of the individuals as well as 35% of the biomass in Oxford. The six most abundant species composed 78% of the individuals and 83.5% of the biomass of the urban sites, but represented only one-third of the bird species. In contrast, the six most abundant species in Hueston Woods accounted for only 48.5% of the individuals and merely 21% of the biomass. Dominance by a few species that can rapidly colonize and reproduce in artificial habitats is characteristic of urban bird communities in North America (Woolfenden and Rohwer

TABLE 3. Comparison of means (±SE) for census techniques of non-territorial species in Oxford, Ohio for direct count (D.C.; n = 5) and instantaneous transect count (I.T.C.; n = 2).

Species	Site 1			Site 2		
	D.C.	I.T.C.	Mann-Whitney *U*-test	D.C.	I.T.C.	Mann-Whitney *U*-test
Mourning Dove	16.2 ± 1.2	22.0 ± 1.0	0.0**	11.6 ± 1.2	13.0 ± 0.0	3.0
Chimney Swift	11.5 ± 0.5[a]	15.0 ± 2.0	0.0*	12.0 ± 4.4[b]	17.0 ± 1.0	2.0
Blue Jay	4.0 ± 0.8	4.0 ± 1.0	4.5	4.0 ± 0.5	4.5 ± 1.5	4.0
Starling	45.2 ± 2.9	49.5 ± 4.5	3.5	32.6 ± 3.8	39.5 ± 5.5	2.0*
House Sparrow	41.2 ± 2.4	71.0 ± 10.0	0.0**	22.8 ± 1.5	44.5 ± 10.5	0.0**
Common Grackle	17.2 ± 0.5	21.0 ± 3.0	1.5*	6.4 ± 1.0	12.5 ± 5.5	2.5

[a] n = 2.

[b] n = 3.

* $P < 0.10$; ** $P < 0.05$.

TABLE 4. Community characteristics of the avifaunas of Hueston Woods and urban Oxford, Ohio. Student's *t*-test statistic is for Hueston Woods vs. Oxford.

	Hueston Woods		Oxford		
	Site 1	Site 2	Site 1	Site 2	t
No. species	30	25	20	17	3.09*
No. individuals	188	153	250	198	−1.71
No. individuals/40 ha	1,253	1,020	1,667	1,320	
Biomass (g)	5,736	4,455	15,445	12,657	−5.85*
Bird species diversity					
H′	3.133	3.009	2.301	2.381	9.89**
$1/\Sigma p_i^2$	18.116	16.722	6.662	7.871	11.00**
Evenness J′	0.896	0.924	0.768	0.824	3.64*

* $P < 0.05$; ** $P < 0.005$.

1969, Emlen 1974, Lancaster and Rees 1979) and Europe (Tomialojc 1970).

Fourteen species were present in both Oxford and Hueston Woods (Appendix). Four (Gray Catbird, Starling, House Sparrow, and Song Sparrow) were edge species found near the lake edge of Hueston Woods Site 1 and are not usually associated with mature forests. Of the 10 remaining species, only the Cardinal showed no appreciable density differences between urban and forest areas. Geis (1974) also found no effects on Cardinal populations due to urbanization in Columbia, Maryland. The Chimney Swift and House Wren had urban populations with densities 5.3 times and 3 times greater than in the forest. Both species are hole-nesters and have grown in numbers in other urban areas (Geis 1974). However, the densities of seven species were lower in the town than the forest: urban densities of the Common Flicker, Downy Woodpecker, and Carolina Wren were slightly lower (0.5–0.6 times less) while urban densities of the Eastern Wood Pewee, Carolina Chickadee, Tufted Titmouse, and White-breasted Nuthatch were much lower (3–8 times). Six of these seven species were insectivorous canopy feeders, generally associated with forests.

The urban community supported nine fewer species than the forest (Appendix). This 28% decline in species richness was significant (Table 4) and similar to a 33% decrease reported for a desert-urban comparison (Emlen 1974). The loss of 18 species and the addition of 7 (Appendix) is attributable to urbanization in Oxford. Bird species diversity in Oxford was similar to values reported for residential areas in Europe (Batten 1972, Huhtalo and Jarvinen 1977) and North America (Emlen 1974, Lucid 1974, Lancaster and Rees 1979), but significantly less than in Hueston Woods (Table 4). Evenness of species was higher in Oxford than other urban areas (Emlen 1974, Lancaster and Rees 1979) but significantly less than Hueston Woods, reflecting a lack of species balance in the urban community.

FORAGING GUILDS

Urban study sites supported densities of omnivores and seed-eaters that were 6.2 and 175.4 times greater than the forest (Fig. 2). Omnivores dominated urban Oxford, composing 59% of the total biomass. Seed-eaters accounted for nearly one-third of the biomass in Oxford but only a few vagrant House Sparrows were found in Hueston Woods. Insectivore species slightly outnumbered omnivores in urban Oxford but composed only 7% of the total biomass, a 6.2-fold decrease in biomass and a 2.6-fold decrease in species as compared with Hueston Woods.

Birds in the town foraged primarily on the ground and secondarily in the canopy while those in the forest foraged in the canopy with secondary utilization of the ground (Fig. 2). Despite the secondary usage of high vegetation by urban birds, 12 of 16 canopy and 2 of 4 middle feeding forest species were not found in Oxford as bird biomass was 6.7 times less for high and 49 times less for middle feeders than in the forest. Although ground feeders dominated Oxford, comprising 93% of the total biomass, four of five non-edge forest species (Wood Thrush, Louisiana Waterthrush, Kentucky Warbler and Rufous-sided Towhee), which usually feed and nest near the ground, were absent from the urban area.

In terms of foraging manner, Oxford was dominated by ground gleaners, which composed half of the species and 93% of the total biomass (Fig. 2). Foliage gleaners (perched and hover) accounted for nearly a quarter of the urban species but less than 1% of the total biomass. Feeding behaviors were more evenly exploited in Hueston Woods by foliage gleaners, bark drillers and ground gleaners. Urban biomass was greater for ground gleaners (12.4 times) and aerial sweepers (5.3 times) but less

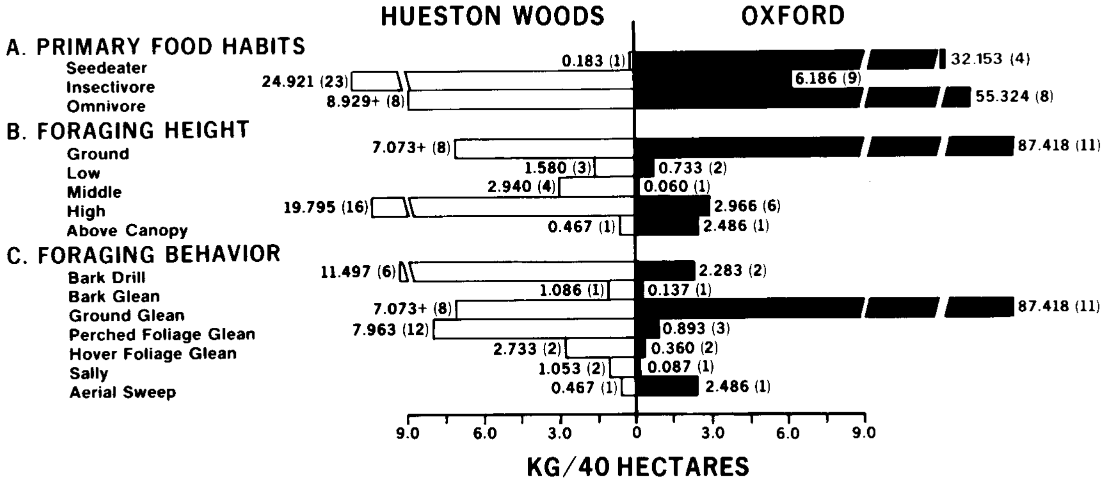

FIGURE 2. Primary food habits, foraging height, and behavior preferences for the bird communities of Hueston Woods and urban Oxford, Ohio. Study site values were pooled for biomass (number of species) and standardized to 40-ha units. Pluses acknowledge the addition of cowbirds to the biomass.

for bark drillers (5 times), perched-foliage gleaners (8 times), hover-foliage gleaners (4.5 times), and sallyers (12.2 times). Hueston Woods supported populations and biomass 7 times greater than Oxford of species whose foraging manner required elevated perches.

FACTORS INFLUENCING URBAN COMMUNITY STRUCTURE

Bird species diversity theoretically should increase with habitat diversity (MacArthur and MacArthur 1961). The vertical distribution of foliage cannot account for the decreased species diversity found in Oxford. However, the volume of foliage was significantly less in the town for all layers and may be a critical resource that limits food density and diversity, nest placement, and predator avoidance and escape. Hooper et al. (1975) and Thomas et al. (1977) noted the influence of vegetative cover, particularly shrub and canopy layers, on the diversity of birds in suburban areas. Oxford's modest canopy and shrub layer did not support many insectivorous species, especially those that fed on plant surfaces. In addition, the lack of low vegetative cover probably deterred colonization by low-dwelling forest species.

The type of vegetative cover also influences avian communities. In Oxford, ornamental trees, often fruit bearers, provided differential sources of food for omnivorous and seed-eating birds. However, these non-native trees support fewer species of insects than native trees (Southwood 1961), increasing the handicap of being an insectivore in an urban area.

Habitat patchiness may be an important factor affecting bird species diversity in urban areas (Hohtola 1978). Vegetative cover in Oxford existed as isolated strata with little vertical continuity between layers. Canopy- and shrub-dwelling passerines select distinctive profiles or patches of vegetation (James 1971, Whitmore 1975). The reduction of such species in Oxford may be due partly to the lack of suitable vegetative patches. Where suitable patches do exist in urban areas, they are likely to be smaller than the threshold size required by many bird species.

The patch repeated most often in Oxford was dense grass lawns. Suburban lawns have higher net productivity and food utilization by birds than other grassland habitats, and act as areas of concentrated food supply capable of supporting high densities of birds (Falk 1976). Flock-feeding species that forage on dense lawns are assured of repeatedly finding suitable foraging patches and food items. Because of the increased visibility afforded by lawns, the probability of detecting and escaping predators increases. In addition, ground birds use less energy walking than flying birds in other strata (Kendeigh 1972), adding to the relative advantage of being a ground-foraging urban bird. Thus, it is not surprising that ground-gleaning species dominate urban bird communities such as Oxford.

It is difficult to measure the effects of human disturbances such as motor vehicle traffic, domestic predators, pedestrians, and noise upon the avifauna of towns. In the regulation of urban bird community structure, human disturbances may multiply and influence the effects of other population-suppressing factors. Emlen (1974) suggested that suppressive factors may have eliminated two ground-dwelling species from his urban study area. Four ground-dwelling forest species from Hueston Woods were replaced in Oxford by seven other ground-foraging species that were able to adapt to human disturbances, find suitable cover, and nest above the ground.

Suppressive factors probably discourage some species from reinvading urban habitats. Successful synanthropic species may be those that are least affected by suppressive factors. Sixteen of 17 synanthropic species in Oxford were arboreal nesters; those that occurred in highest densities (e.g., Common Grackle, Cardinal, American Robin) fed on the ground using lawns, whereas those that fed on plant surfaces (e.g., Eastern Wood Pewee, Carolina Chickadee) were able to colonize only in small numbers.

CONCLUSIONS

The synergism of habitat structure and population-suppressing factors in urban areas creates prime habitat for only a few bird species. These species dominate urban communities and often are considered undesirable or pests. Manipulating urban habitats so that these species are less favored may be possible. The use of certain construction modes can decrease House Sparrow and Starling dominance in towns (Geis 1974). Our study suggests that vegetative cover in urban areas should be increased, not by isolated plantings of landscape shrubs, but by recreating or preserving natural islands of complete habitat profiles consisting of vegetative cover in each layer. Thomas et al. (1977) have determined species-specific habitat profiles but no estimates of threshold sizes for habitat islands are known. Human disturbance and predation from domestic animals may be mitigated by a series of interconnected islands. Increasing vegetative cover in urban areas may increase the number of bird species, support larger populations of insectivores, and perhaps create suitable habitat for some ground nesters.

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APPENDIX. Density (no./6.1 ha), biomass (g), and foraging guild (see Methods for definition of categories) for the birds of Hueston Woods and Oxford, Ohio. For species that altered foraging strategy between communities, guild numbers are listed as Hueston Woods/Oxford. Bird weights were obtained from Stewart (1937), Baldwin and Kendeigh (1938), Roberts (1955) and specimens from the Hefner Museum, Miami University, Oxford, Ohio. Pluses acknowledge the presence of an undetermined cowbird population.

	Density (biomass)				
	Hueston Woods		Oxford		Foraging guild
Species	Site 1	Site 2	Site 1	Site 2	
Bobwhite (*Colinus virginianus*)	0 (0)	0 (0)	2 (187)	0 (0)	113
Rock Dove (*Columba livia*)	0 (0)	0 (0)	0 (0)	5 (1,090)	113
Mourning Dove (*Zenaida macroura*)	0 (0)	0 (0)	22 (3,243)	13 (1,916)	113
Yellow-billed Cuckoo (*Coccyzus americanus*)	2 (116)	2 (116)	0 (0)	0 (0)	244
Chimney Swift (*Chaetura pelagica*)	3 (70)	3 (70)	15 (350)	17 (396)	257
Ruby-throated Hummingbird (*Archilochus colubris*)	0 (0)	0 (0)	2 (6)	4 (12)	335
Common Flicker (*Colaptes auratus*)	4 (524)	4 (524)	2 (262)	2 (262)	241
Pileated Woodpecker (*Dryocopus pileatus*)	2 (624)	2 (624)	0 (0)	0 (0)	241
Red-bellied Woodpecker (*Melanerpes carolinus*)	4 (270)	6 (405)	0 (0)	0 (0)	341
Red-headed Woodpecker (*M. erythrocephalus*)	6 (411)	4 (274)	0 (0)	0 (0)	241
Hairy Woodpecker (*Picoides villosus*)	2 (144)	0 (0)	0 (0)	0 (0)	241
Downy Woodpecker (*P. pubescens*)	4 (107)	6 (161)	4 (107)	2 (54)	241
Great Crested Flycatcher (*Myiarchus crinitus*)	2 (62)	4 (124)	0 (0)	0 (0)	246
Acadian Flycatcher (*Empidonax virescens*)	20 (240)	20 (240)	0 (0)	0 (0)	235
Eastern Wood Pewee (*Contopus virens*)	6 (78)	4 (52)	2 (26)	0 (0)	246
Blue Jay (*Cyanocitta cristata*)	0 (0)	0 (0)	5 (428)	5 (428)	313
Carolina Chickadee (*Parus carolinensis*)	8 (96)	12 (144)	4 (48)	0 (0)	234/244
Tufted Titmouse (*P. bicolor*)	12 (269)	6 (135)	2 (45)	2 (45)	244/245
White-breasted Nuthatch (*Sitta carolinensis*)	8 (163)	8 (163)	2 (41)	0 (0)	242
House Wren (*Troglodytes aedon*)	2 (23)	0 (0)	4 (45)	2 (23)	224
Carolina Wren (*Thryothorus ludovicianus*)	8 (152)	8 (152)	4 (76)	4 (76)	224
Gray Catbird (*Dumetella carolinensis*)	2 (71)	0 (0)	4 (142)	4 (142)	313
American Robin (*Turdus migratorius*)	0 (0)	0 (0)	22 (1,613)	24 (1,760)	313
Wood Thrush (*Hylocichla mustelina*)	4 (195)	0 (0)	0 (0)	0 (0)	213
Blue-gray Gnatcatcher (*Polioptila caerulea*)	18 (180)	16 (160)	0 (0)	0 (0)	245
Starling (*Sturnus vulgaris*)	9 (672)	0 (0)	50 (3,733)	40 (2,986)	313
Yellow-throated Vireo (*Vireo flavifrons*)	2 (39)	4 (78)	0 (0)	0 (0)	244
Red-eyed Vireo (*V. olivaceus*)	20 (330)	12 (198)	0 (0)	0 (0)	244
Cerulean Warbler (*Dendroica cerulea*)	12 (102)	4 (34)	0 (0)	0 (0)	244
Louisiana Waterthrush (*Seiurus motacilla*)	0 (0)	2 (30)	0 (0)	0 (0)	213
Kentucky Warbler (*Oporornis formosus*)	6 (88)	4 (59)	0 (0)	0 (0)	224
House Sparrow (*Passer domesticus*)	2 (55)	0 (0)	71 (1,965)	45 (1,246)	113
Common Grackle (*Quiscalus quiscula*)	0 (0)	0 (0)	21 (2,709)	13 (1,677)	313
Brown-headed Cowbird (*Molothrus ater*)	+	+	0 (0)	0 (0)	313
Scarlet Tanager (*Piranga olivacea*)	2 (48)	2 (48)	0 (0)	0 (0)	244
Cardinal (*Cardinalis cardinalis*)	12 (508)	10 (424)	8 (339)	10 (424)	313
Indigo Bunting (*Passerina cyanea*)	4 (49)	6 (73)	0 (0)	0 (0)	334
Song Sparrow (*Melospiza melodia*)	2 (40)	0 (0)	4 (80)	6 (120)	334/313
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	0 (0)	4 (167)	0 (0)	0 (0)	313