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Winter foraging guild structure and habitat associations in suburban bird communities

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ABSTRACT

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Winter bird communities were compared in three suburbs over 5 years: MT, a 70-year-old area of large houses and planted mature trees, primarily oaks (*Quercus*) and elms (*Ulmus*); YT, a 15-year-old area also built upon former open agricultural land with young planted trees, primarily maples (*Acer*); OP, a 15-year-old area in which houses were built within a second-growth oak–pine (*Quercus–Pinus*) woodland. Winter bird surveys were conducted each year for 5 years (1976–1980) during January. The total number of species across suburban types was 32; total abundance was higher ($P<0.05$) in MT and YT than in OP. Species richness was similar in each suburban type. Seedeaters and omnivorous ground-foragers dominated the avifaunas of MT and YT, comprising 86% and 92% of their respective avifaunal abundances. Insectivores comprised 14% of the avifauna in OP, but less than 4% and 1%, respectively, in MT and YT.

All significant correlations (r) between ground foragers and measures of tree cover were negative; positive relationships existed between lawn area and distance to the nearest forest fragment. All significant correlations between numbers of insectivores and measures of tree cover were positive. Even though MT contained the largest trees and the greatest tree species and shrub richness, habitat conditions for insectivorous birds were poor in this mature, planted habitat compared with those in OP, built in remnant natural woodland.

INTRODUCTION

Urban and suburban bird communities reach their highest densities in winter in eastern North America (Erskine, 1975; Freedman and Riley, 1980; DeGraaf and Wentworth, 1981). Suburbs have replaced forests and agricultural land in many regions; suburban avifaunas are in many respects quite different from those in comparable rural environments, yet they still provide rich recreational and biological resources. Most studies of urban or suburban habitats tend to group these habitats for comparison with rural or natural habitats. Thus, the general effects of urbanization on birds have been described: urban areas tend to have very high densities of relatively few species (Erz, 1966; Lancaster and Rees, 1979; Jones, 1981) and ground-nesting and native cavity-nesting species are usually absent (Geis, 1974; DeGraaf, 1978). In North America, the breeding populations of insectivorous neotropical migrants decline as urbanization proceeds (Walcott, 1974), and city avifaunas become dominated by starlings (*Sturnus vulgaris*), house sparrows (*Passer domesticus*), and rock doves (*Columba livia*) — seedeaters and ground-foraging omnivorous species that seem to fare well in cities everywhere (Emlen, 1974; Johnson and van Druff, 1987).

Suburbs generally represent a middle habitat condition between natural and urban environs, and have great potential for supporting quite varied bird communities. The breeding bird communities of three types of suburbs have been compared: analyses of habitat structure showed that maturity of shrubs was more important than numbers of shrubs, and that planted trees, regardless of maturity or abundance, were not substitutes for natural forest stands as habitat for most insectivorous birds (DeGraaf and Wentworth, 1986).

What are the habitat values of various suburban types, as revealed by their avian guild structures, to birds in winter? The objectives of the present study were to describe the winter guild structures of winter birds in three types of suburbs, and to determine the physical characteristics of the suburban types that affect use by winter birds.

STUDY AREAS

Three types of suburban neighborhoods were selected in Amherst (population 25 000), a university town in western Massachusetts. Each area was visually homogeneous; all were comprised of single-family dwellings on lots of 0.5–1.0 ha.

The oldest area (MT) was built about 70 years ago on open land and now consists of large houses along streets shaded by mature trees. Lawns are of moderate size; mature trees and shrubs characterize the landscape. Street trees are large, and include pin oak (*Quercus palustris*), American elm (*Ulmus americana*), and sugar maple (*Acer saccharum*).

The second area (YT) was a relatively new suburb built in the mid-1960s on open land from which an old apple orchard had been cleared. The landscape is quite open and exposed; lawns occupy most of the lots, and shrubs and trees are small. The few tall trees are fast-growing varieties, such as silver maple (*Acer saccharinum*) and Lombardy poplar (*Populus italica*). Street trees, still small, are primarily Norway maple (*Acer platanoides*).

The third area (OP) also was built in the mid-1960s, but differs greatly from YT in that houses were built in a second-growth oak–pine woodland. Dominant tree species are red oak (*Quercus rubrum*), black oak (*Quercus velutina*), red maple (*Acer rubrum*), and white pine (*Pinus strobus*). Small clearings were made for the houses; lawns are small and landscaping typically involves foundation plantings. The general appearance is one of houses in a park-like, uneven-aged forest, with forest litter and small lawns comprising the ground cover.

METHODS

Birds were counted during each January from 1976 to 1980. Twenty contiguous 1-ha square plots, located along streets, were established in each suburb. Ten counts (one per day) of all birds seen or heard were made on each plot by walking a 100-m street transect in 4 min between 07:30 and 10:30 EST on clear, calm mornings. The order in which transects were surveyed was randomized. Plots were delineated on aerial photographs (1:4800) that were used during all counts to determine bird locations with respect to plot boundaries.

Vegetation measurements included the diameter at breast height (DBH), total height, and height to crown of all deciduous and coniferous trees, height of deciduous and coniferous shrubs, and areas of lawn and herbaceous growth on each 1 ha plot. Tree heights were measured with an altimeter; heights of shrubs were measured with a range pole. Occupants of all dwellings on plots were asked whether they maintained bird feeding stations. The number of dwellings on plots and the distance from plot centers to the edge of the nearest forest fragment of 0.5 ha or larger were taken from the aerial photographs. Values for 22 habitat components were derived from measurements made in the field and on photographs. Values were calculated for coniferous and deciduous tree and shrub densities, numbers of tree and shrub species, and coniferous:deciduous ratios for trees and shrubs.

The avian communities are described in

TABLE 1

Abundances[1] of winter birds in three types of suburbs, Amherst, MA 1976–1980

Species[2]	Foraging guild	Suburb type			Significance[3]
		MT	YT	OP	
Seed-eating ground foragers					
Ring-necked pheasant (*Phasianus colchicus*)	123	0.48	–	–	
Mourning dove (*Zenaida macroura*)	123	19.68	29.60	2.00	**
Northern cardinal (*Cardinalis cardinalis*)	123	12.24	3.20	0.08	**
American tree sparrow (*Spizella arborea*)	123	5.84	14.64	0.16	**
Song sparrow (*Melospiza melodia*)	123	0.24	1.36	–	**
White-throated sparrow (*Zonotrichia albicollis*)	123	15.68	2.48	0.72	**
Dark-eyed junco (*Junco hyemalis*)	123	9.04	11.92	6.88	
Brown-headed cowbird (*Molothrus ater*)	123	–	2.48	–	
Purple finch (*Carpodacus purpureus*)	123	1.84	0.88	2.00	
House finch (*Carpodacus mexicanus*)	123	7.76	7.68	0.48	
Common redpoll (*Carduelis flammea*)	123	–	0.16	–	
American goldfinch (*Carduelis tristis*)	123	27.92	15.44	10.16	*
Evening grosbeak (*Cocothraustes vespertinus*)	123	54.48	44.56	7.52	**
House sparrow (*Passer domesticus*)	123	41.36	27.60	2.08	**
Seed-eating crown gleaners					
Pine grosbeak (*Pinicola enucleator*)	132	3.76	0.96		
Pine siskin (*Carduelis pinus*)	132	29.04	28.80	3.04	**
Frugivorous crown foragers					
Northern mockingbird (*Mimus polyglottos*)	233	2.40	3.44	–	**
Cedar waxwing (*Bombycilla cedrorum*)	233	–	4.48	–	
Insectivorous bark excavators					
Pileated woodpecker (*Dryocopus pileatus*)	311	–	–	0.48	*
Insectivorous bark gleaners					
Downy woodpecker (*Picoides pubescens*)	312	2.72	0.40	3.04	**
Hairy woodpecker (*Picoides villosus*)	312	0.56	0.56	1.28	
Red-breasted nuthatch (*Sitta canadensis*)	312	0.32	–	0.89	*
White-breasted nuthatch (*Sitta carolinensis*)	312	9.36	1.52	12.40	**
Brown creeper (*Certhia americana*)	312	6.24	–	1.04	
Omnivorous ground foragers					
Rock dove (*Columba livia*)	423	–	0.08	–	
Blue jay (*Cyanocitta cristata*)	423	27.44	33.12	23.36	
American crow (*Corvus brachyrhynchos*)	423	0.48	0.88	0.40	
European starling (*Sturnus vulgaris*)	423	43.12	77.28	3.12	**
Common grackle (*Quiscalus quiscula*)	423	0.48	–		
Omnivorous crown foragers					
Tufted titmouse (*Parus bicolor*)	433	2.16	1.12	9.44	**
Black-capped chickadee (*Parus atricapillus*)	433	31.60	6.80	44.32	**
Carnivore ground hawker					
Sharp-shinned hawk (*Accipiter striatus*)	554	0.08	–	0.08	

[1]The average number of individuals of a species detected per suburb (200 m transect total) per year.
[2]Common and scientific names from the check-list of the American Ornithologists' Union (1983).
[3]Significance levels (ANOVA): $^{*}P<0.05$; $^{**}P<0.01$.

terms of their species compositions and guild structures. Guilds are functional groups of species with similar habitat-use patterns (Salt, 1953; Root, 1967; Holmes et al., 1979). For this analysis, I used a three-digit foraging scheme similar to Willson's (1974) classification, but used categories that reflect winter diets and feeding behavior (DeGraaf et al., 1985). Primary food habit is described as: (1) seedeater; (2) frugivore; (3) insectivore; (4) omnivore; (5) carnivore. Foraging substrate is described as: (1) bark; (2) ground; (3) crown; (4) air. Foraging behavior is described as: (1) bark excavator; (2) gleaner; (3) forager; (4) hawker. Thus, a three-digit code describes the major food, foraging substrate, and feeding behavior of a species.

RESULTS

Thirty-two bird species were found in winter in the three suburbs. Total number of individuals were higher ($P<0.05$) in MT and YT than in OP; species richness was similar in each suburban type: MT and YT each contained 26 species, and OP contained 24 (Table 1). Feeding stations were maintained at 75% of dwellings in MT, 30% in YT, and 78% in OP; no correlations between numbers of feeding stations and numbers of birds per guild were found. However, habitat structure was different in the three suburbs and their winter avifaunas varied accordingly.

Habitat Structure

The most wooded suburb, OP, had the greatest densities of trees and coniferous shrubs, and the highest values for mean height to tree crown, shrub species richness, and the lowest area of lawn. Naturally, OP also had the lowest mean distance from plot center to the nearest forest fragment. MT contained the largest trees,

TABLE 2

Ranked means of habitat values in three suburbs (after DeGraaf and Wentworth, 1986)

Habitat variable	MT	YT	OP	Significance[1]
Deciduous tree DBH[2] (TDDIAM)	1	3	2	**
Deciduous tree height (TDHT)	1	2	1	**
Deciduous tree height to crown (TDHTC)	2	3	1	**
No. of deciduous trees (TDNUM)	2	3	1	**
Coniferous tree DBH (TCDIAM)	1	3	2	**
Coniferous tree height (TCHT)	1	2	1	**
Coniferous tree height to crown (TCHTC)	2	3	1	**
No. of coniferous trees (TCNUM)	2	3	1	**
Deciduous shrub height (SDHT)	2	–	–	–
No. of deciduous shrubs (SDNUM)	1	3	2	**
Coniferous shrub height (SCHT)	–	–	–	–
No. of coniferous shrubs (SCNUM)	1	3	2	**
Coniferous:deciduous tree ratio (TCDRATI)	–	–	–	–
Coniferous:deciduous shrub ratio (SCDRATI)	2	1,2	1	*
Area of 'weedy' growth (AHERB)	1	2	2	**
Area of lawn (AMOW)	2	1	3	**
No. of dwellings (NHOMES)	–	–	–	–
Woodlot distance (WOODLOT)	1	2	3	**
No. of tree species (NSPT)	1	2	3	**
No. of shrub species (NSPS)	1	2	1	**
Total number of trees (TTNUM)	2	3	1	**
Total number of shrubs (RSNUM)	1	2	1	**

[1]Duncan's new multiple range test: *$P<0.05$; **$P<0.01$; –, no significant differences among suburbs.
[2]Diameter at breast height.

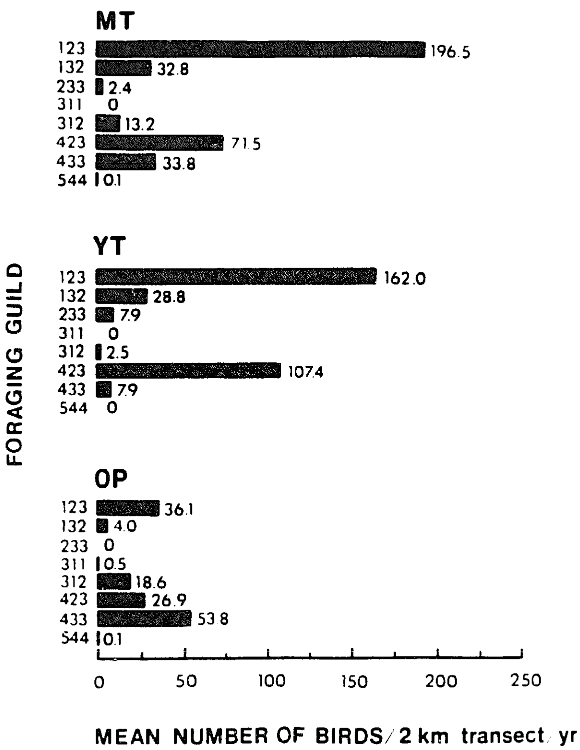

Fig. 1. Winter bird abundance by foraging guild in three suburban types in Amherst, MA, during January, 1976–1980.

both deciduous and coniferous, the greatest tree species richness, and the largest area of herbaceous "weedy" growth. MT had intermediate values for tree density and lawn area. YT had the lowest values for all measured tree and shrub variables, the smallest area of herbaceous weedy growth, and the largest lawn area (Table 2).

Foraging Guilds

MT and OP each supported seven foraging guilds and YT supported six (Table 1).

Ground-foraging seedeaters and omnivores dominated the avifaunas of MT and YT, comprising 86% and 92% of their respective avifaunal abundances. Insectivores comprised 14% of the avifauna in OP, but less than 4% and 1%, respectively, in MT and YT (Fig. 1).

Guild/Habitat Relationships

When winter foraging guild distributions are considered in terms of habitat structure, several general patterns emerge. All significant relationships between ground-foraging seedeaters and omnivores and measures of tree cover are negative (Table 3). Furthermore, numbers of individuals in those two guilds are not associated with woodlots; rather they are correlated with increasing distance to the nearest forest fragment, and are positively correlated with lawn area.

TABLE 3

Correlation (r) between habitat components and winter bird abundances by foraging guilds in suburban Amherst, MA, 1975–1980

Habitat component[1]	Winter foraging guild							
	123	132	233	311	312	423	433	544
TDDIAM		+			+		+	
TDHT	–	+	–	(+)	+	–	+	
TDHTC	–		–	+	+	–	+	
TDNUM	–	+	(–)		+	–	+	
TCDIAM		+			+	(–)	+	
TCHT					+	–	+	(+)
TCHTC	–		–	+	+	–	+	
TCNUM	–		–		(+)	–	+	
SDHT					(–)		–	
SDNUM					+		+	+
SCHT					(–)			
SCNUM	–		(–)		+	(–)	+	+
TCDRATI								
SCRATI	–		–					
AHERB								
ALAWN	+	–	+	–	–	+	–	
NHOMES	(+)		(+)					
FORFRAG	+	–	+	(–)		+	–	
NSPT	+		(+)	–	(–)	(+)	(–)	
NSPS				(+)	+		+	(+)
TTNUM	–		–		+	–	+	
TSNUM					+		+	+

[1]See Table 2 for names of habitat components.
Correlations in parentheses are significant at $P < 0.05$, others at $P < 0.01$.

By contrast, all correlations significant between numbers of insectivores and crown-foraging omnivores and measures of tree cover are positive (Table 3).

DISCUSSION

Suburbs vary in avian composition, depending largely upon the degree to which their habitats differ from natural habitats; in essentially forested regions, such as New England, suburbanization generally results in a decline of insectivorous species in the breeding season (DeGraaf and Wentworth, 1986). In winter, bark-gleaning insectivores were slightly more abundant than in the breeding season — 4.25 pairs per 40 ha (DeGraaf and Wentworth, 1981) vs. 11.44 birds per 40 ha in the present study — over the same 60 plots. Seedeaters are about five times more abundant in winter than in the breeding season (DeGraaf and Wentworth, 1981), primarily in the more open habitats in MT and YT, which were built on agricultural land and in which the trees were planted.

The only guilds that were correlated ($P<0.05$) with numbers of houses were ground foragers, which increased in abundance as house density increased (Table 3).

Those suburbs with lower tree densities (MT and YT) had higher total numbers of winter birds. Higher total abundances of winter birds in habitats with relatively low tree density have been reported for urban forest fragments in winter (Tilghman, 1987) and for forests in Kentucky, where more species were found in disturbed forests with scattered cutting than in a nearby uncut forest (McComb and Moriarty, 1981).

The reasons for high bird abundance or diversity in suburbs with fewer trees and in relatively sparsely stocked forests and urban forest fragments are probably different. however. Enhanced development of the understory layer beneath open canopies attracts additional forest birds, especially early successional species, but in suburban habitats, neither shrub height nor density were consistently greater in more open suburbs. Ground-feeding seedeaters and omnivores which commonly occur in flocks, occurred in greater numbers in the more open suburban types (Table 1) where the area of herbaceous (weedy) growth was greater (Table 2).

Avifaunal quality (the number of species, especially uncommon species) is important to urban and suburban residents (Dagg, 1970; Brown and Dawson, 1978; Yeomans and Barclay, 1981; Witter et al., 1981). The proportion of insectivorous species has been used as a measure of avifaunal quality (Walcott, 1974). In the present study, only the suburb built within existing woodland contained an appreciable proportion of insectivorous species. No matter how mature, planted environments did not produce habitat as attractive to insectivorous birds as did the suburb in remnant natural woodland.

Suburbs vary in their winter avian composition depending upon whether they were built on open agricultural land and hence, contain high proportions of planted woody vegetation, or were built within remnant natural woodland. In forested regions, suburbanization generally results in a decline of insectivorous species, but suburban development in deserts (Emlen, 1974) or in shrublands or steppes (Guthrie, 1974) generally results in an increase in such species because of the growth and proliferation of artificially watered woody vegetation. Within otherwise forested regions, the richness and evenness of distribution of suburban bird species in the breeding season increase with vertical complexity of vegetation (Linehan et al., 1967; Gavareski, 1976) and total amount of woody vegetation (Goldstein et al., 1986) just as they do in "natural" habitats. In winter, the suburb built in remnant woodland (OP) had an avifauna quite different (fewer seedeaters and omnivores and more insectivores) than either of the suburbs built on former agricultural land (MT and YT), even though MT contained larger trees, more shrubs, and greater species richness of trees and shrubs than OP. The total number of birds is lower, but the quality of suburban winter avifaunas, as measured by the proportion of insectivores, is higher in suburbs that contain remnant woodlots. As in the breeding season, planted trees and shrubs, no matter how mature, are not as attractive to insectivorous birds as remnants of natural woodland.

At the scale of individual house lots or residential grounds, plant species composition is a key determinant of the breeding or wintering avifauna. The food and cover values of plant species for birds have been recognized for a long time (e.g. Martin et al., 1951; Terres, 1968; DeGraaf and Witman, 1979). At the neighborhood or subdivision scale, the overall form or structure of the vegetation seems to be more important than its species composition to birds (DeGraaf, 1986). Features such as fields and woodlots are important to high bird species richness in the larger landscape; the overall landscape must support a diverse avifauna from which the greatest variety may be attracted through selection of plant materials to smaller sites.

Urbanization need not eliminate insectivorous forest birds if fragments of native woodland are retained where possible.

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