

The Territory Distribution of Breeding Songbirds in the Roemer Arboretum, Geneseo, NY

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Abstract - The distributions of male songbird territories and their relationship to breeding habitats were recorded for the Roemer Arboretum, Geneseo, NY. Birds were observed from March 26, 2000 to May 9, 2000 to determine the size, location and number of territories. Territories were recorded using a geographic information systems (GIS) map that characterized vegetative features of the arboretum. Territory areas for each species were measured and treated as the observed territory size. Territory sizes and breeding habitats were compared to documented studies from the literature. The territory sizes were measured for 18 species of birds. Territory sizes for eight species of birds were similar to sizes documented in the literature. The territory sizes for three species were smaller than those documented in the literature. Six other species were found to not be territorial based on observed locations and densities.

Habitats seem to be influential in the distribution of territories in the arboretum, as territories are not randomly dispersed but clumped in relation to their preferred breeding habitats. This study did not find any apparent deviation in territory size or habitat preference from the literature that could not be attributed to the length of observation of this study.

Key words: bird, distribution, territory, habitat relationships, GIS

Introduction

One objective in ecology is to understand community structure. Bird communities in particular have received intense study (e.g. Holmes 1990a; Chamberlain and Fuller 1999) as birds are easily observed, identified, and have affinities to specific plant communities during the breeding season (Holmes 1990b). These communities are dynamic and stochastic systems that react to numerous ecological factors. Habitat use, territoriality, and the relative densities of species are examples of several parameters that determine how species are spatially distributed (Wiens 1989a). By mapping these distributions and habitat affinities we can begin to analyze and understand the distribution of species within their environment (Lenton et al. 2000).

Mapping the distribution of territories is useful for understanding patterns in biodiversity (Lenton et al. 2000). These maps assist conservationists and landscape ecologists in deciding what land features to preserve to retain species richness (Whitham and Kimball 1996). Technology such as GIS can help to improve our understanding of species distribution in space and appropriate habitat areas for species by analyzing spatial relationships with digital maps. Com-

binning this technology with multiple point locations for singing males can be used to estimate bird territory sizes. These data will help to develop new models that apply a spatially explicit method for predicting distributions based upon habitat characteristics (Tucker et al 1997).

Territory sizes

Male songbirds establish summer breeding territories that creates competition for limited resources. Competition occurs in response to limiting factors such as food or females or when food preferences between birds overlap (Wiens 1989a). Territoriality and aggression manifest as vocal and visual displays between male songbirds. The ecological requirements of these different species result in the partitioning of resources and habitats (Wiens 1989a). The relative strengths of competition and dominance between species vary and influence territory sizes (Wiens 1989b). Each bird species has an ecologically important territory size (Table 1). However, these territories are stochastic and influenced by weather and habitat alterations and annual fluctuations in habitat selection (Haila et al 1996). Therefore, territory sizes

Table 1- Documented territory sizes for songbirds. T-nest= territorial only in immediate area around nest; V= variable territory size to none; NT= not territorial

Species	Territory size (ha)	Source	Location
Blue-jay	NT	Cohen, 1977	
Black-capped chickadee	1.3 -5.3	Odum 1941; Brewer 1983	
White-breasted nuthatch	20.0	Butts, 1931	
Northern Mockingbird	1.01 - 1.27	Michener and Michener 1935; Laskev 1935	California/ Tennessee
American Robin	0.11-0.21	Howell 1942	New York
Eastern Bluebird	2.1	Krieg 1971	New York
Cedar Waxwing	NT	Saunders 1911	
European Starling	T-nest	Kessel 1957	
Yellow Warbler	0.043	Hobson and Sealy 1989	Manitoba
Blue-winged warbler	NA		
Baltimore Oriole	T-nest	Clawson 1980	
Northern Cardinal	0.21-2.60	Kinser 1973; Gutfried 1976	S. Indiana
House Finch	NT	Thompson 1960	
American Goldfinch	V	Middleton 1979	
Eastern Towhee	V: 1.2-2.6	Morimoto and Wasserman 1991	Massachusetts
Chipping Sparrow	0.2-1.0	Albrecht and Oring 1995	
Field Sparrow	0.31-1.62	Best 1977	Illinois
White-throated Sparrow	0.99	Tuttle 1993	
Song Sparrow	0.19-0.59	Nice 1937	

are dynamic and dependent on the vegetative compositions or as species interactions change (Holmes 1990a).

Bird-habitat relationships

The distributions of local bird populations are highly dependent on plant communities (Chamberlain and Fuller 1999; Haila et al 1996). The distribution of bird territories has been suggested to be influenced by available resources within their habitats (Wiens 1989a). Studies have shown that the relationship between birds and vegetation can display patterns of community structure (Cody 1981; Holmes 1990b; Karr 1990). The spatial arrangement of habitats within landscapes may have a strong influence on the abundance, distribution, and dynamics of populations (Chamberlain and Fuller 1999). Most species exhibit

a well-defined habitat preference (Karr 1990a). Thus, the relative area of habitat occupied by songbirds and their distributions may be important when explaining patterns of population dynamics.

Aspects of habitats, such as area, foliage profile or patches in a heterogeneous landscape, also affect the spatial distribution of necessary resources. These habitat characteristics also can have an influence on relative territory sizes. For example, Karr et al. (1990b) have suggested that differences in the territory sizes and abundances of neotropical birds are directly related to habitats. Therefore, analyzing habitat affinities can help explain the arrangement and size of bird territories (Holmes 1990). This combination of territory distribution, size and habitat affinities will provide a more accurate depiction of the ecological parameters affecting the community.

Methods

Study Site

Birds were observed in the SUNY Geneseo Roemer Arboretum, a triangular eight-hectare area located in Geneseo, NY (42°47'20" N, 77°49'25" W). The area was abandoned as pasture approximately 40 years ago. The dominant trees are white ash (*Fraxinus americana*), black walnut (*Juglans nigra*), red cedar (*Juniperus virginiana*) and white oak (*Quercus alba*). Dominant shrubs include buckthorn (*Rhamnus cathartica*) and red-panicked dogwood (*Cornus stolonifera*). Approximately, one hectare of the arboretum is managed and contains a collection of non-native saplings. Roadways border two of sides of the area, which receive considerable use. The third side of the arboretum is bordered by large cultivated lawns, parking lots and dormitories.

Identifying Male Songbirds

The locations of singing male songbirds were recorded from the morning of March 26, 2000 to May 9, 2000. Observations were conducted approximately three times per week. The locations of the singing males were estimated and mapped on a GIS (Arc-View) map that characterized the habitat types of the arboretum.

Analysis of Territory Sizes and Locations

Estimated locations of each bird observation were mapped with GIS and grouped by species. Convex hulls were created that connected each of the observed locations. The areas of the convex hulls were treated as the observed territory size (hereafter known as OTS). Only the species recorded four times or more were considered for analysis. Territories were determined if a pattern in singing activity was detectable. Species were determined to be non-territorial if a territory could not be detected, i.e. no discernable pattern of singing activity. Singing activity does not necessarily mean that a male is declaring its territory, but announcing its status as a suitable mate (Wiens 1989b). The OTSs were determined between species by the distribution of singing males. If two males of the same species were recorded singing in separate

sections of the arboretum on the same day and time, two separate territories were assumed. Territory sizes documented in the literature (Table 1) were then compared to the OTSs found in this investigation. One potential problem of not identifying individual birds is the possibility of double counting a bird on a single day, erroneously increasing the number of observations.

To analyze the spatial relationships of territories, a nearest neighbor analysis was conducted for the field sparrow using the methods developed by Clarks and Evans (1954) to determine if male singing activity was clumped, random, or uniformly distributed in the arboretum.

Bird-habitat relationships

Plant communities were grouped into five distinct plant associations: 1) trees 2) shrubs 3) open 4) managed and 5) undefined (Figure 1). The bird-habitat relationships were investigated by relating the location of the bird observed relative to the vegetative composition of the arboretum. The percentage of birds either present or absent in each type of vegetation was graphed. As with measuring

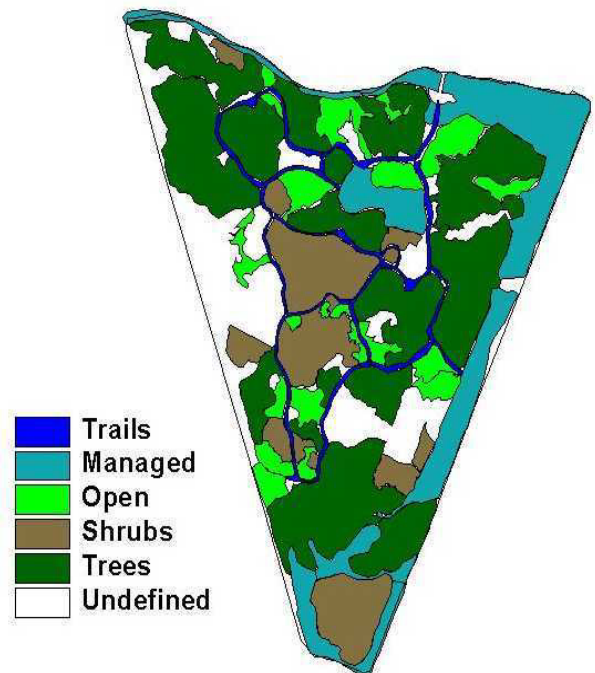


Figure 1- Habitat features used to analyze bird-habitat relationships in the Roemer Arboretum.

the OTS, only birds observed four times or more were considered for analysis. The observed habitats were compared to those documented in the literature (Table 2).

Results

Analysis of Territory sizes and Locations

The nearest neighbor analysis for the field sparrow indicated an index of aggregation of 0.718. The z-value of -2.75 was above the critical z value ($|z| > 1.96$) indicating that the pattern deviates significantly from random and has a clumped distribution.

A total of 27 different species of singing male songbirds were consistently recorded in the Roemer Arboretum from March 26, 2000 to May 9, 2000 (see Appendix A). A total of 18 species were observed more than four times, the minimum number of observations required to determine a territory area (see Methods). I also found that the observed territory size (OTS) of eight species was consistent with territory sizes documented in the literature (Table 3). The OTS of the black-capped chickadee and white-breasted nuthatch were distinguish-

able (2.155 ha and 0.33 ha, respectively; Figure 2). The northern mockingbird and American robin were also found to have territories within the arboretum (0.82 ha and $0.29 + 0.12$ respectively; Figure 3).

The OTS of the yellow warbler was measured at $0.04 + 0.02$ ha (Figure 4). The northern cardinal, house finch, and eastern towhee had measurable territories ($0.29 + 0.19$ ha, 1.02ha, and 0.07ha respectively; Figure 5). The territories of the chipping sparrow and the field sparrow were recorded at $0.06 + .02$ ha and $0.20 + .22$ ha respectively (Figure 6). The OTS of the white-throated sparrow and the song sparrow were measured at 0.11ha and $0.49 + 0.13$ ha respectively (Figure 7).

Five non-territorial species were found to be non-territorial in this study. This includes the blue jay, european starling, cedar waxwing, baltimore oriole, and American goldfinch. These species have been documented in the literature as either being not territorial or territorial only in the immediate

Table 2- Documented breeding habitats for songbirds

Species	Habitat Preference During Breeding Season	Source
Blue-jay	mixed forest edges/woodlands	Graber et al., 1987
Black-capped chickadee	mixed deciduous woodlands/ open woods	Smith, 1993
White-breasted nuthatch	woodland edges/mature forests	Peck and James, 1987
Northern Mockinobird	short grassy areas	Roth, 1979
American Robin	short grassy areas/mixed trees and shrubs	Hamel, 1992.
Cedar Waxwing	shrubs/ small trees/ avoids forest interior	Palmer-Ball, 1996.
European Starling	open country/s hort grassy fields	Feare, 1984.
Yellow Warbler	deciduous thickets/s hrubs	Dunn and Garrett, 1997.
Blue-winged warbler	not available	
Baltimore Oriole	scattered trees/aspen	Sibley, 1993.
Northern Cardinal	small shrubs/trees	Dow, 1969.
House Finch	small conifers near human settlements	Hill, 1993.
American Goldfinch	weedy fields/ early successional areas /low vegetation	Middleton, 1979
Eastern Towhee	edge dense shrub/tree cover/open canopy	Morimoto and Watterson, 1991..
Chipping Sparrow	shrubs/ forests bordering open grassy areas	Middleton, 1998.
Field Sparrow	woodland edges/successional old fields	Peterjohn and Rice, 1991.
White-throated Sparrow	open forest/low dense vegetation	Falls and Kopachena, 1994.
Song Sparrow	notfound	

Table 3- Number and area of observed bird territories.
 T-nest= territorial only in immediate area around nest
 V= variable territory size to none
 ND = no detectable territory

Species	Observed territory size (OTS) (ha)	Total # Territory Observed	Total Sample Size (N)
Blue-jay	ND	-	4
Black-capped chickadee	2.155	1	11
White-breasted nuthatch	0.335	1	4
Northern Mockingbird	0.821	1	4
American Robin	0.296 ± 0.120	5	47
Cedar Waxwing	ND	-	4
European Starling	ND	-	27
Yellow Warbler	0.04 ± 0.026	4	22
Blue-winged warbler	ND	-	12
Baltimore Oriole	ND	-	10
Northern Cardinal	0.294 ± 0.193	2	10
House Finch	1.02	1	5
American Goldfinch	ND	-	33
Eastern Towhee	0.078	1	8
Chipping Sparrow	0.060 ± .02	2	23
Field Sparrow	0.209 ± .223	4	26
White-throated Sparrow	0.11	1	6
Song Sparrow	0.493 ± 0.132	2	15

area of its nest. However, the house finch has been documented as not being territorial, but was found to have a territory in this study (see Table 3). In addition, the blue-winged warbler was determined not to be territorial in this study, but a documented territory size was not found in the literature to compare our

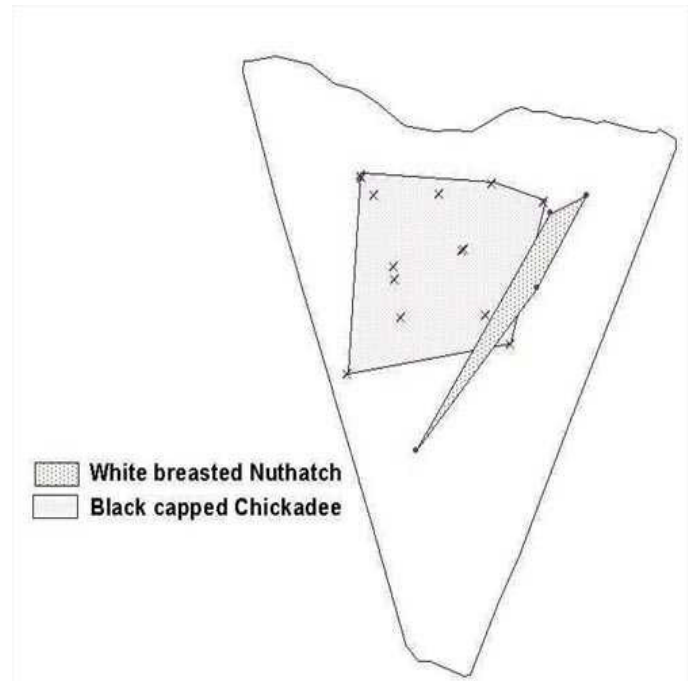


Figure 2- Observed territory sizes for the white-breasted nuthatch and the black-capped chickadee.

results.

Three bird species were determined to have a smaller OTS than previously documented. This includes the white-breasted nuthatch, whose observed OTS of 0.335ha was less than the documented 20.0 ha (Butts 1931); eastern towhee, whose OTS of 0.078 ha

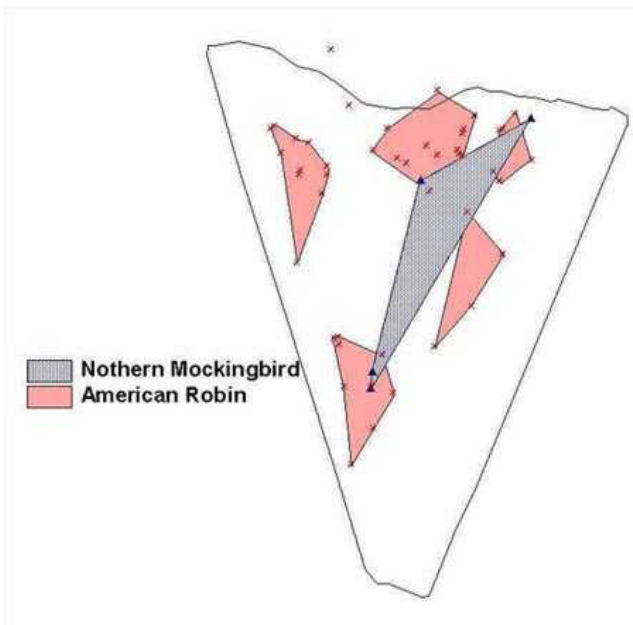


Figure 3- Observed territory sizes for the northern mockingbird and the American robin.

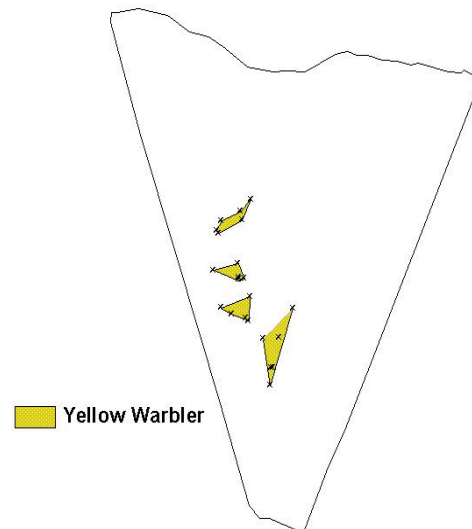


Figure 4- Observed territory sizes for the yellow warbler.

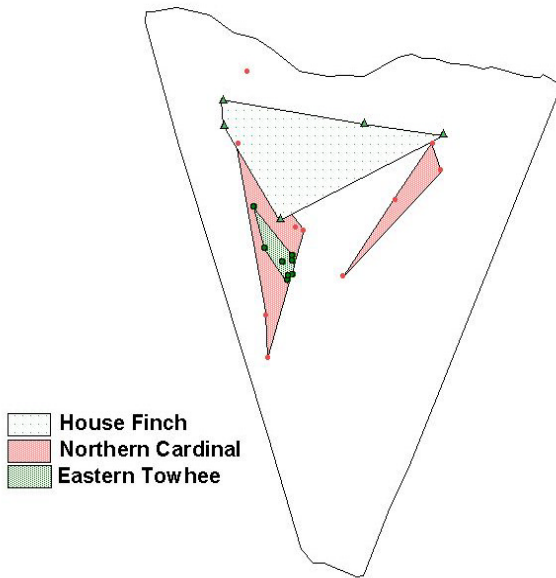


Figure 5- Observed territory sizes for the northern cardinal, house finch and eastern towhee.

was less than the documented 1.2-2.6 ha (Morimoto and Wasserman 1991); and the white-throated sparrow, a OTS of 0.11 ha compared to 0.99 (Tuttle 1993; see Table 2).

Bird-habitat relationships

The bird-habitat relationships were determined for the eighteen species of singing males

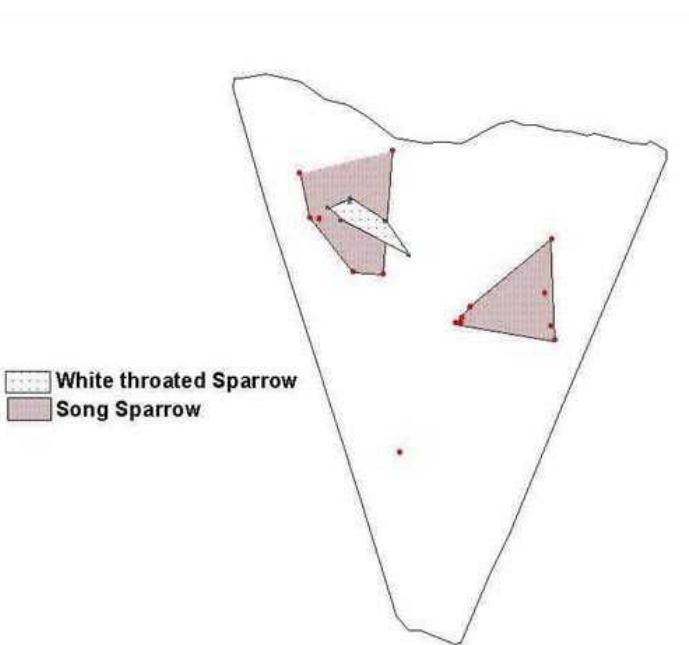


Figure 7- Observed territory sizes for the white-throated sparrow and song sparrow.

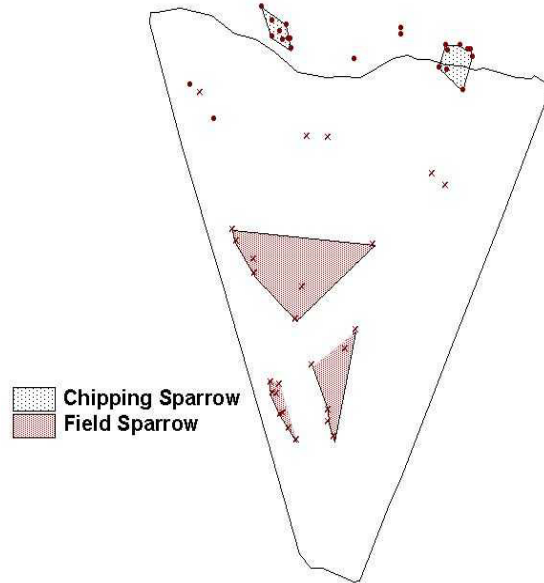


Figure 6- Observed territory sizes for the chipping sparrow and field sparrow.

observed more than four times (see Methods). The most important results were that the habitat types observed for each species were consistent with the documented habitat types recorded in the literature (see Table 2). The blue jay, black-capped chickadee and the white-breasted nuthatch were predominately found in trees (Figure 8). Both the blue jay and black-capped chickadee were observed in shrubs (25% and 29% respectively).

The American robin and the cedar waxwing were observed predominately singing in trees (Figure 9). However, the northern mockingbird was found singing within managed (50%) sections of the arboretum, in addition to trees and shrubs (Figure 9).

The European starling was found to prefer trees during the breeding season, while observed less in shrubs (7%) and managed (22%) sections of the arboretum (Figure 10). Trees and shrubs comprised the majority of the observed areas for both the yellow warbler and blue-winged warbler (Figure 10). The yellow warbler was found in a mixture of shrubs and trees (41% and 27% respectively). In addition, the baltimore oriole was primarily found singing in trees of the arboretum.

The northern cardinal and house finch were both found to prefer areas of the arboretum with high densities of trees (Figure 11), and low shrubs.

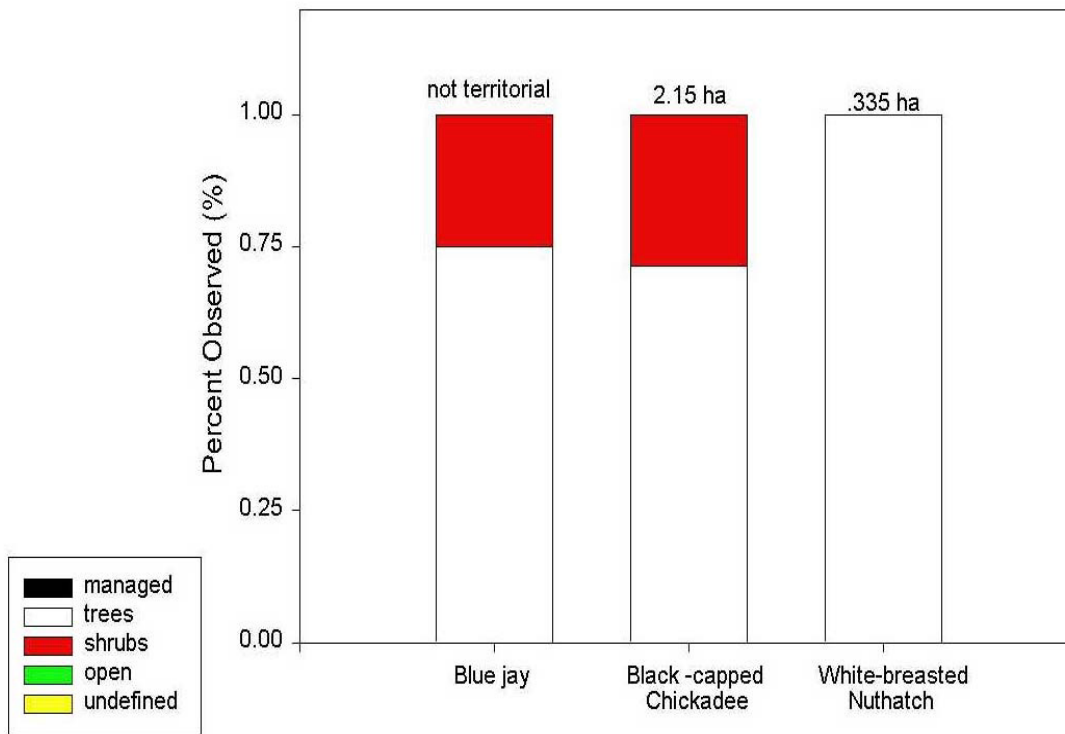


Figure 8- Bird-habitat relationships for the blue jay, black-capped chickadee and white-breasted nuthatch. Numbers over bars indicate total territory area observed.

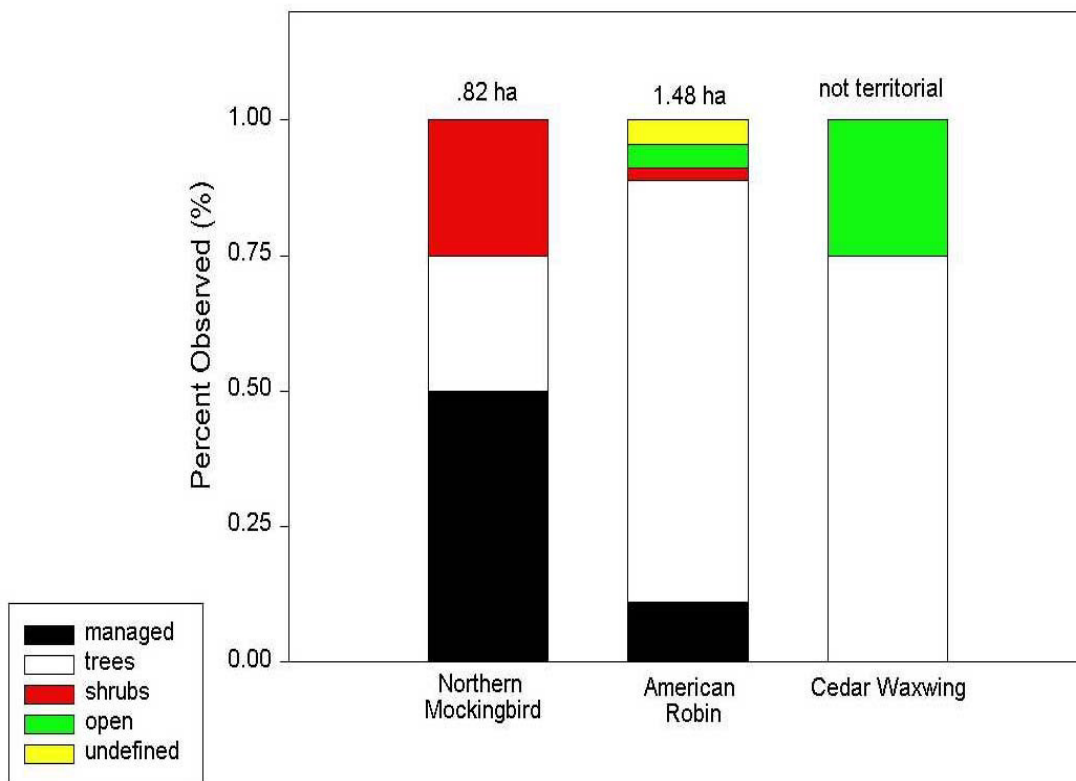


Figure 9- Bird-habitat relationships for the northern mockingbird, American robin and cedar waxwing. Numbers over bars indicate total territory area observed.

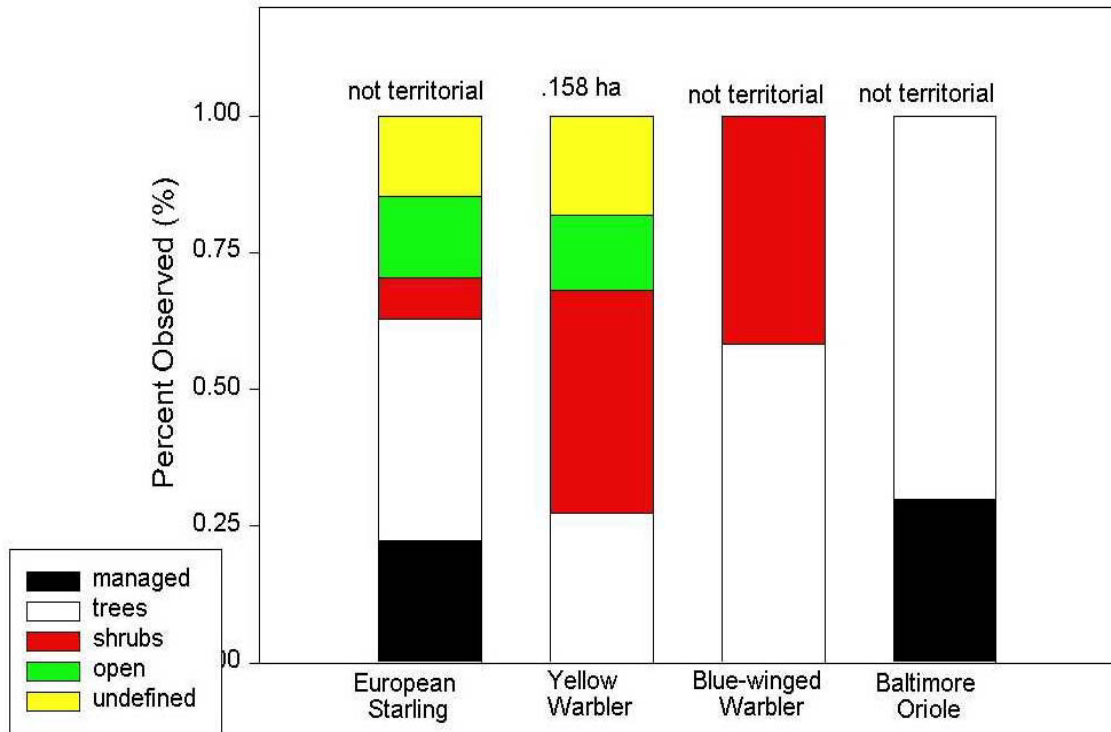


Figure 10- Bird-habitat relationships for the European starling, yellow warbler, blue-winged warbler and baltimore oriole. Numbers over bars indicate total territory area observed.

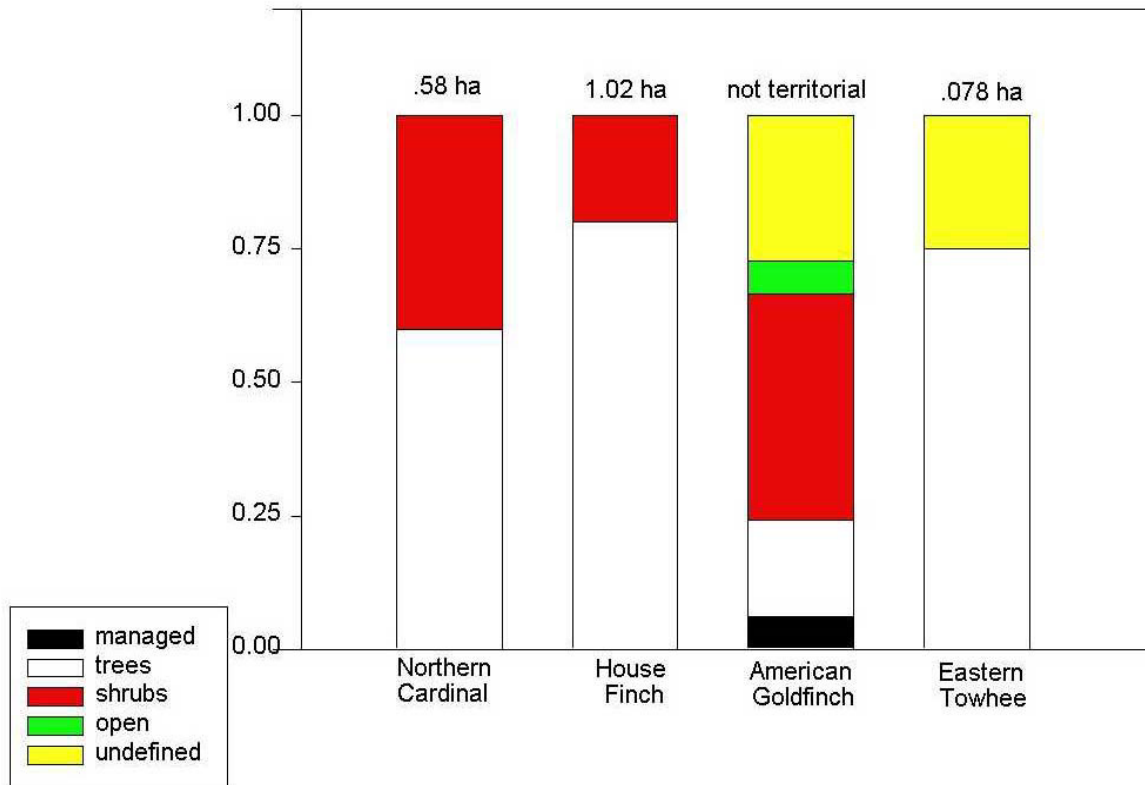


Figure 11- Bird-habitat relationships for the northern cardinal, house finch, American Goldfinch and eastern towhee. Numbers over bars indicate total territory area observed.

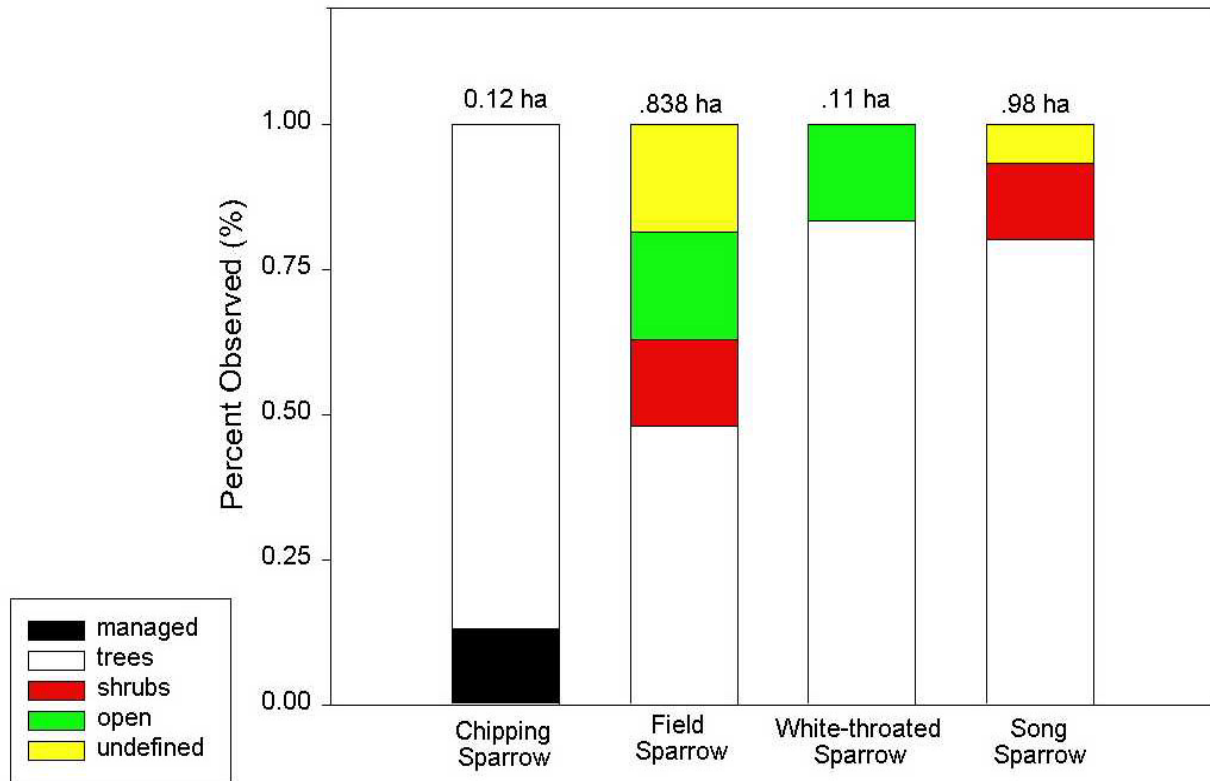


Figure 12- Bird-habitat relationships for the chipping sparrow, field sparrow, white-throated sparrow and song sparrow. Numbers over bars indicate total territory area observed.

The house finch was mainly observed in shrub areas (42%), while also observed in trees (18%), open (6%), and undefined (27%) areas. The American goldfinch was found in a wide variety of habitats with shrubs, trees, and undefined areas consisting of the vegetation. The eastern towhee was found singing in the tall white ash trees within the arboretum (Figure 11).

The chipping sparrow, field sparrow, white-throated sparrow, and song sparrow were found to prefer areas of trees within the arboretum (Figure 12). The field sparrow displayed the most amount of variation, with shrubs (15%), open (19%), and undefined (19%) areas comprising its territories (Figure 12).

Discussion

This study documents the presence or absence of territories for 18 species of birds within the arboretum. The majority of the territory sizes observed were consistent with the literature. The territories in the arboretum suggest that there is a relationship between territory distribution and vegetation structure as most

territories were observed within a section of the arboretum, rather than being dispersed randomly throughout (see nearest neighbor analysis for the field sparrow). This suggests that habitat structure have an influence on the dispersion of territories. Evidence has shown that the presence or abundance of a plant species may be critical in determining what bird species will be present (Wiens 1989). Conservation of specific habitats may help to increase the abundance of a particular species. However, the classification of habitat quality in this study should be reconsidered and re-measured. The habitat features used may have been too generalized or incompletely sampled to relate bird species to their preferred habitats.

One factor that might have influenced the results was the time of year the birds were observed. By extending the observation period through mid-summer, the number of birds observed would probably increase, as would the

number and area of territories. The territory areas that were underestimated such as the white-breasted nuthatch, eastern towhee, and the white-throated sparrow would likely increase with the extended observation time. In addition, the singing activity of the house finch may have been misidentified as a territory, since the house finch has been documented as not being territorial in previous studies. This also could be corrected with a longer observation period.

The location of the arboretum may have had an impact on the distribution of territory sizes. The arboretum is located between two active farmlands, and birds observed such as the eastern towhee, Baltimore oriole and orchard oriole may have been passing through the arboretum, or only used the arboretum as part of its entire territory. Also, since the arboretum is open to public use, breeding densities may have been effected. Both Fernandez-Juricic (2000) and Gutzwiller et al. (1997) reported that breeding bird densities declined with pedestrian traffic. This effect also may apply to vehicular traffic on either side of the arboretum that may have reduced breeding and territory establishment by disturbing the populations.

The problem of double-counting birds should be addressed in future studies. Birds should be identified individually instead of by species. This would eliminate the problem of possibly counting one bird twice in one day.

Finally, the size of the arboretum may have influenced this study. The dispersion of territories detected within the arboretum, while influenced to an extent by the variability of habitat, ultimately depends on the scale examined (Holmes, 1990). Being only eight-hectares in size, the arboretum may have been too small to address territorial requirements of certain species. For example, the white-breasted nuthatch requires a breeding territory of 20 ha (Butts 1931), while only found to be 0.335ha in this study.

This study was aimed at providing a short-term glimpse at the distribution of birds. These patterns are expected to change with space and time as the environment within the arboretum and species dominance changes. Though short-term investigations cannot record the dynamics of resource use and space boundaries (Wiens 1989b), they can provide a basis for future studies. It is intended that these results be used as a comparison for future research on

the composition of the bird community in the Roemer Arboretum.

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Appendix A- Species names for all birds observed in the Roemer Arboretum from March 26 to May 9, 2000.

Species	Scientific Name
American Woodcock	<i>Scolopax minor</i>
Mourning Dove	<i>Zenaida macroura</i>
Downy Woodpecker	<i>Picoides pubescens</i>
Blue-jay	<i>Cyanocitta cristata</i>
Black-capped chickadee	<i>Poecile atricapillus</i>
White-breasted nuthatch	<i>Sitta carolinensis</i>
Northern Mockingbird	<i>Dumetella carolinensis</i>
Gray Catbird	<i>Mimus polyglottos</i>
Brown thrasher	<i>Toxostoma rufum</i>
American Robin	<i>Turdus migratorius</i>
Eastern Bluebird	<i>Sialia sialis</i>
Hermit thrush	<i>Catharus guttatus</i>
Cedar Waxwing	<i>Bombycilla cedrorum</i>
European Starling	<i>Sturnus vulgaris</i>
Yellow Warbler	<i>Dendroica petechia</i>
Blue-winged warbler	<i>Vermivora pinus</i>
Orchard Oriole	<i>Icterus spurius</i>
Baltimore Oriole	<i>Icterus galbula</i>
Brown-headed cowbird	<i>Molothrus ater</i>
Northern Cardinal	<i>Cardinalis cardinalis</i>
House Finch	<i>Carpodacus mexicanus</i>
American Goldfinch	<i>Carduelis tristis</i>
Eastern Towhee	<i>Pipilo erythrophthalmus</i>
Chipping Sparrow	<i>Spizella passerina</i>
Field Sparrow	<i>Spizella pusilla</i>
White-throated Sparrow	<i>Zonotrichia albicollis</i>
Song Sparrow	<i>Melospiza melodia</i>