

BREEDING BIRDS OF A CENTRAL OHIO WOODLOT IN RESPONSE TO SUCCESSION AND URBANIZATION¹

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ABSTRACT. Population densities of breeding birds were surveyed intensively in a formerly grazed 11 ha woodlot near Columbus, Ohio, during 1938-42 and 1979-84. During the years between surveys, canopy cover increased while shrubstory and ground cover were reduced greatly except along two edges. Suburban residential development engulfed most of the surrounding cropland; remaining fields were converted from pasture to intensive cropping (corn, alfalfa, turfgrass).

Changes in avifauna generally reflected these environmental changes. Species typical of open understory (e.g. indigo bunting, *Passerina cyanea*; field sparrow, *Spizella pusilla*) decreased greatly and were confined to edges, while forest-interior species (e.g. acadian flycatcher, *Empidonax virens*; wood thrush, *Hylocichla mustelina*) increased in numbers. "Generalists," forest-edge species often associated with suburban development, also increased (e.g. American robin, *Turdus migratorius*; northern cardinal, *Cardinalis cardinalis*). Raptors decreased, along with some cavity-nesting species (e.g. tufted titmouse, *Parus bicolor*), perhaps in response to reduced availability of nesting sites.

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INTRODUCTION

Fragmentation of previously continuous and relatively uniform ecosystems has been a particularly noticeable aspect of agricultural and commercial development in North America. In the eastern United States, subdivision of extensive deciduous forest into small and relatively isolated woodlots has been demonstrated to exert a considerable effect on bird populations. For example, in New Jersey, Galli et al. (1976) found the number of breeding species closely correlated with area of woodlot, consistent with expectations from the theory of island biogeography (MacArthur and Wilson 1963). The most precipitous declines occurred among forest interior species. Such declines have been documented in many other instances (Butcher et al. 1981, Whitcomb et al. 1981, Aldrich and Coffin 1980, Ambuel and Temple 1982). In most cases a decline in species richness occurred rather rapidly after fragmentation, whereafter the avi-

fauna reached an apparent equilibrium dominated by forest-edge species and permanent residents. Interior species were maintained where isolation was recent (Noss 1981) or where small forest fragments were "subsidized" by replenishment from more extensive forests nearby (MacClintock et al. 1977).

Increasing urbanization has been a component of habitat fragmentation, as suburbs encroach upon woodlands near cities. Effects of urbanization may be indirect (isolating fragments from continuous forest) or direct; presence of open areas near trees encourages nest predation by jays, crows, blackbirds, and squirrels, and parasitism by brown-headed cowbirds (Brittingham and Temple 1983). Domestic and semi-feral pets (primarily house cats) may increase avian mortality, as will greater numbers and activity of rats, raccoons, opossums, and school-age children (Kerlinger and Doremus 1981). Beisinger and Osborne (1982) noted a tendency for urbanization to result in replacement of foliage and bark gleaners by ground feeders, perhaps in response to suburban landscaping around forest fragments, essen-

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tially "flooding" them with species partial to lawns and ornamental shrubbery. A century of such changes may affect avifauna profoundly; of 26 species nesting on 3½ ha in Cambridge, MA, only nine remained a century later, and eight of these were permanent residents (Wolcott 1974). Despite few major environmental changes in the Cambridge study area itself, no permanent resident nested during the 1860s and no neotropical migrant nested during the 1960s.

Changes in avifauna during ecological succession are well-documented and indicate a general trend for species typical of shrub stages to be replaced by those of mature forest as the canopy closes. For instance, Johnston and Odum (1956) found field sparrow, common yellowthroat, yellow-breasted chat, and rufous-sided towhee to be the most abundant species in 20-yr-old shrub communities in Georgia, whereas none occurred in oak-hickory climax aged 150 yr. In a 50-yr study of a formerly-grazed, isolated Illinois woodlot, Kendeigh (1982) noted a similar gradual replacement of shrubstage species though a temporary increase followed elimination of elms due to disease. Several species typical of forest edges (e.g. mourning dove, blue jay, American robin and northern cardinal) persisted at high densities for many years thereafter despite reclosing of the canopy. Kendeigh's study sites were surrounded throughout by agricultural fields.

From 1938 to 1942, breeding birds were censused annually in a woodlot surrounded by agricultural land in central Ohio (Mills 1943). Urbanization and intensified agriculture had completely enclosed the area by the 1960s. The present study reports changes in the avifauna as the result of surveys conducted 1979-1984.

METHODS AND MATERIALS

The study area was a rectangular 11 ha woodlot in the extreme NW corner of The Ohio State University campus, approx. 7½ km NW of the center of Columbus, Franklin Co., Ohio. The woodlot has never been clear-cut, and several old-growth American beeches (*Fagus grandifolia*) aged 200+ yr survive. Surrounding forests were clearcut for lumber

and agriculture in the 19th century, reducing the woodlot to 42 ha by 1870 and 11 ha by 1906. Within the woodlot has occurred selective removal of black walnut (*Juglans nigra*), elm (*Ulmus* spp.), and oak (*Quercus alba* and *Q. borealis*), but the area has been in forest cover continually since colonial times.

The woodlot was grazed routinely 1860-1930, with consequent little forest reproduction then. Photographs from the early 1900s reveal an open, parklike appearance. Grazing was terminated in 1931 and understory succession commenced rapidly aided by numerous plantings by the OSU Department of Forestry. By 1942 there was dense woody understory, mostly of elm. Forestry plantings (for woodlot "improvement") were judged a failure yet some trees persisted, adding diversity. Overstory in 1942 was primarily beech and elm (together 76% of trees over 22 cm dbh), with a lesser proportion of walnut, white ash (*Fraxinus americana*), and sugar maple (*Acer saccharinum*). Surrounding the woodlot on all sides were agricultural fields, grazed or occasionally planted to wheat and corn.

By 1979, a subclimax forest had attained with little shrubstory, and several early-successional tree species reached the canopy. Beech still predominated, with minor representation by white ash, sugar maple, white and red oaks, and black cherry (*Prunus serotina*). Most elms were eliminated by Dutch elm disease in the 1950s, though a few dying trees persisted. Scattered red, scotch, and white pines (*Pinus resinosa*, *P. sylvestris* and *P. strobus*) remained from the forestry experiments of the 1930s. There was moderate human activity spanning education, recreation, and crime all of which retarded understory growth and compacted soil except where poison ivy (*Rhus toxicodendron*) was especially dense.

Agricultural fields (corn, alfalfa, turfgrass) were to the south and east, while residential areas of Columbus and Upper Arlington replaced the former fields north and west for many km². Extensive plantings of shade trees in these neighborhoods have matured to the extent that they superficially resemble the original open woodland.

In the weekly 1938-42 censuses, two or more observers walked through the woodlot for about two hr and noted the location of each bird on a map of the area. During the nesting season at least three additional hr were spent in systematic search for nests, and each location was marked. An active nest, a pair remaining in one location, or a persistently singing male was taken as positive evidence of nesting (Mills 1943).

In 1979-84, at intervals of five to nine days 1 April-1 July (except 1983), I used a modified spot-mapping technique (Kendeigh 1982) to census singing males. I remained at the center of the south portion, then at the center of the north portion, for ½ hr each during which I noted locations of singing males on a map of the woodlot. I then walked for another hour around the periphery, about 10 m inside the border recording any additional birds I had

missed from near the center. Birds noted at the same location on at least six visits were assumed to be nesting. Additional evidence for breeding was presence of an active nest, a parent feeding young, or a juvenile unable to fly. In one case (great horned owl), recently-fledged immatures were seen with adults. An attempt was made to limit visits to calm, clear mornings and to complete each census by 10:30 a.m. Occasional evening forays were made to check for owls. The 1983 censuses began late (June) but were particularly intensive, concentrating on searches for active nests and recently-fledged nestlings.

Data were subjected to Wilcoxon rank-sum test (Hollander and Wolfe 1973) except when breeding was unrecorded during either 1938-42 or 1979-84.

RESULTS

Table 1 summarizes results of the surveys. Table 2 repeats previously-published results of 1938-42 surveys (Blyth et al. 1939, Blyth and Mills 1940, Barry and Mills 1941, 1942) and includes results of 1979-84 surveys. In addition, a single pair of each of four species was recorded but once: red-tailed hawk (*Buteo jamaicensis*) 1939, eastern screech-owl (*Otus asio*) 1942, eastern bluebird (*Siala sialis*) 1939, and American redstart (*Setophaga ruticilla*) 1979. A pair of hooded warblers (*Wilsonia citrina*) reared a cowbird in 1984.

At least one pair of carolina wrens (*Thyrotorus ludovicianus*) was present in the woodlot annually 1973-76. Severe winter weather 1977-78 nearly extirpated the species from central Ohio, and none was observed in the woodlot 1979-84.

DISCUSSION

Surveys 1938-42 involved more observers than 1979-84. Every effort was made to

standardize time of day and weather conditions during surveys 1979-84. Concentration on territorial males plus frequency of visits were expected to reduce error though territorial males do not guarantee that a nest is nearby. These considerations suggest that 1979-84 results, especially 1983, could have underestimated population densities slightly compared to counts from 1938-42.

By the 1930s the woodlot had been isolated from nearby sources of colonists, and had been greatly modified by grazing, for over half a century. The avifauna was dominated by forest-edge and shrubstage species. Only Cooper's hawk and barred owl represented species typical of forest interior. By 1979 these no longer occurred, and they have generally declined in central Ohio according to results of raptor surveys and Christmas bird counts.

Urbanization resulted in increases among several species. Diversified plantings of ornamental shrubbery including evergreens and berry-bushes enhanced numbers of mourning dove, blue jay, American robin, northern cardinal, red-winged blackbird, common grackle, and house sparrow. Some of these are also habitual feeder-visitors whose overwintering survival has increased elsewhere by the propensity of suburbanites to maintain feeders (Graber and Graber 1979). Recent invasions of northern mockingbirds and house finches, both unrecorded in the 1930s, were a further result, in part, of urbanization.

TABLE 1
Breeding birds and species turnover in 11 ha woodlot, Columbus, Ohio, 1938-42 and 1979-84.

	1938	1939	1940	1941	1942	1979	1980	1981	1982	1982	1984
No. of species	30	31	28	29	25	26	24	28	28	25	25
No. of pairs	98	103.5	103	100	101	63	68	71	70	56	61
Species lost from previous year	—	2	3	2	5	—	3	1	1	5	5
Species gained from previous year	—	3	0	3	1	—	1	5	1	2	5

TABLE 2

Breeding pairs nesting in 11 ha woodlot, Columbus, Ohio, during 1938-42 and 1979-83.

Species	Number of breeding pairs												6-yr mean
	1938	1939	1940	1941	1942	5-yr mean	1979	1980	1981	1982	1983	1984	
Cooper's hawk (<i>Accipiter cooperii</i>)	1	0	0	1	0	0.4	0	0	0	0	0	0	0
Ring-necked pheasant (<i>Phasianus colchicus</i>)	1	1	2	2	3	1.8	2	1	1	1	2	0	1.2*
Northern bobwhite (<i>Colinus virginianus</i>)	3	5.5	3	1	1	2.7	0	0	0	0	0	0	0
American woodcock (<i>Scolopax minor</i>)	1	1	0	1	1	0.8	0	0	0	0	0	0	0
Mourning dove (<i>Zenaidura macroura</i>)	1	1	1	1	0	0.8	3	6	4	3	3	3	3.7*
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	2	1	2	1	2	1.6	2	1	1	1	2	1	1.3
Great horned owl (<i>Bubo virginianus</i>)	0	0	0	0	0	0	0	1	0	0	0	1	0.3
Barred owl (<i>Strix varia</i>)	1	1	1	0	0	0.6	0	0	0	0	0	0	0
Ruby-throated hummingbird (<i>Archilochus colubris</i>)	1	1	1	1	1	1.0	0	0	0	0	0	0	0
Downy woodpecker (<i>Picoides pubescens</i>)	1	1	1	1	1	1.0	2	2	2	2	2	2	2.0*
Common flicker (<i>Colaptes auratus</i>)	2	3	1	2	2	2.0	2	2	1	1	1	1	1.3
Eastern wood-pewee (<i>Contopus virens</i>)	1	1	1	1	0	0.8	1	2	3	1	0	2	1.5
Acadian flycatcher (<i>Empidonax virens</i>)	0	0	0	0	0	0	2	1	3	1	1	0	1.3
Alder flycatcher (<i>Empidonax trailii</i>)	1	0	1	1	1	0.8	0	0	0	0	0	0	0
Great crested flycatcher (<i>Myiarchus crinitus</i>)	2	1	2	2	2	1.8	1	2	2	2	1	0	1.3
Blue jay (<i>Cyanocitta cristata</i>)	0	0	0	0	0	0	2	2	2	2	3	2	2.2
American crow (<i>Corvus brachyrhynchus</i>)	2	1	1	2	0	1.2	1	0	0	0	1	0	0.3*
Carolina chickadee (<i>Parus carolinensis</i>)	0	0	0	0	0	0	1	2	1	3	3	2	2.0
Tufted titmouse (<i>Parus bicolor</i>)	2	2	3	2	2	2.2	1	0	1	0	1	0	0.5*
White-breasted nuthatch (<i>Sitta carolinensis</i>)	1	2	1	1	0	1.0	0	0	0	1	1	1	0.5*
House wren (<i>Troglodytes aedon</i>)	0	0	0	0	0	0	2	2	1	2	3	4	2.3
Blue-gray gnatcatcher (<i>Poliophtila caerulea</i>)	1	1	2	0	1	1.0	0	0	0	0	0	0	0
Wood thrush (<i>Hylocichla mustelina</i>)	0	0	0	0	0	0	2	1	4	4	0	3	2.3
American robin (<i>Turdus migratorius</i>)	0	1	0	2	0	0.6	6	7	7	8	5	7	6.7*
Gray catbird (<i>Dumetella carolinensis</i>)	2	3	1	2	2	2.0	1	1	3	1	2	2	1.7
Northern mockingbird (<i>Mimus polyglottos</i>)	0	0	0	0	0	0	0	0	1	1	0	0	0.3
Brown thrasher (<i>Toxostoma rufum</i>)	1	2	1	1	1	1.2	0	0	0	0	0	0	0

TABLE 2 (Continued)

Species	Number of breeding pairs												
	1938	1939	1940	1941	1942	5-yr mean	1979	1980	1981	1982	1983	1984	6-yr mean
European starling (<i>Sturnus vulgaris</i>)	12	10	10	12	12	11.2	4	4	3	4	2	6	3.8*
Red-eyed vireo (<i>Vireo olivaceus</i>)	6	6	6	9	4	6.2	4	7	6	4	1	4	4.3*
Cerulean warbler (<i>Dendroica cerulea</i>)	0	0	0	0	0	0	0	0	1	1	0	0	0.3
Common yellowthroat (<i>Geothlypis trichas</i>)	2	2	4	4	2	2.8	0	0	0	0	0	0	0
Yellow-breasted chat (<i>Icteria virens</i>)	2	2	2	2	2	2.0	0	0	0	0	0	0	0
Northern cardinal (<i>Cardinalis cardinalis</i>)	4	5	2	3	4	3.6	9	10	9	12	11	12	10.5*
Indigo bunting (<i>Passerina cyanea</i>)	6	5	10	8	6	7.0	3	2	4	2	2	2	2.5*
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)	6	7	10	7	8	7.6	0	0	0	0	0	0	0
Field sparrow (<i>Spizella pusilla</i>)	22	22	22	20	21	21.4	0	0	0	0	0	0	0
Song sparrow (<i>Melospiza melodia</i>)	6	9	5	5	13	7.6	3	4	2	1	2	2	2.3*
Red-winged blackbird (<i>Agelaius phoeniceus</i>)	0	0	0	0	0	0	0	0	1	1	0	1	0.5
Common grackle (<i>Quiscalus quiscula</i>)	0	0	0	0	0	0	2	2	2	2	1	2	1.8
Brown-headed cowbird (<i>Molothrus ater</i>)	2	2	3	2	3	2.4	2	1	2	3	1	3	2.0
House finch (<i>Carpodacus mexicanus</i>)	0	0	0	0	0	0	0	0	1	1	2	1	0.8
American goldfinch (<i>Carduelis tristis</i>)	3	2	4	3	5	3.4	2	3	1	2	2	3	2.2*
House sparrow (<i>Passer domesticus</i>)	0	0	0	0	0	0	2	2	1	2	1	2	1.7

*Indicates 1979-84 mean significantly different from 1938-42 mean (Wilcoxon rank-sum test, $p = 0.95$). (Rank-sum statistic calculated only for species breeding in both periods, 1938-42 and 1979-84.)

Change in avifauna associated with forest succession generally agreed with observations of Kendeigh (1982) and Johnston and Odum (1956). The dense undergrowth of 1938-42 gave way to a more mature forest with understory concentrated along south and east edges adjacent to agricultural fields. Decline or disappearance of blue-gray gnatcatcher, brown thrasher, common yellowthroat, yellow-breasted chat, indigo bunting, rufous-sided towhee, field and song sparrows therefore was expected. The latter four are dominant "omnivores" in Illinois forest remnants

<16.8 ha surrounded by agricultural land (Blake 1983). In the present study, indigo buntings and song sparrows nested only along the shrubby eastern edge of the woodlot by 1979. Species increasing as forest matured were: downy woodpecker, acadian flycatcher, eastern wood-pewee, blue jay, carolina chickadee, and wood thrush. An increase in eastern wood-pewee and wood thrush is not typical of smaller woodlots (e.g. Ambuel and Temple 1983); these species generally occur in more extensive forests. Occurrence of long-distance migrants (acadian flycatcher, wood thrush,

and cerulean warbler), in such a small woodlot was an encouraging sign in an otherwise ominous recent decline in populations of neotropical migrants (Whitcomb et al. 1981, Ambuel and Temple 1982).

Despite the changes resulting from urbanization and succession, the numbers of species nesting annually, and their rate of turnover, remained remarkably constant (table 1). However, total nesting pairs declined from 1938-42 to 1979-84, primarily due to the disappearance of towhees and field sparrows. Twelve species nested during all 11 years 1938-42 and 1979-84. Of these, five showed no significant change in numbers. Gray catbirds apparently nested closer to shrubby woodlot edges in 1979-84 than they did 1938-42. There has been continuous forest canopy for over 45 yr, and though the canopy was denser in 1979 than in 1938, yellow-billed cuckoo and great crested flycatcher were unchanged in status. Densities of common flicker and brown-headed cowbird were also unchanged. In 1938 there was nearby grazing, and local populations of cowbirds were already large. Nest parasitism is sometimes an important component of population dynamics of forest birds immediately following fragmentation (Brittingham and Temple 1983).

Of five woodpecker species (common flicker, downy, red-bellied, hairy, and pileated woodpeckers) that nest regularly in more extensive central Ohio forests, only two nested and two more occurred as sporadic visitors to the woodlot during both periods. Also pileated woodpeckers, *Dryocopus pileatus*, were not seen though fresh diggings in 1980 and 1981 attested to their intermittent presence. The absence of diversity among woodpeckers may have resulted in a dearth of suitable nesting and roosting holes for secondary cavity-users. The declines in tufted titmice and white-breasted nuthatches may reflect this though these birds are also somewhat intolerant of woodlots so small regardless of availability of nesting sites (Whitcomb et al. 1981) and are harassed by starlings (Kendeigh 1982). Reduction in nesting

starlings, a trend not evident in most other studies, also may have reflected a lack of suitable cavities.

Overall changes in avifauna were similar to those noted in other small midwestern woodlots (e.g. Kendeigh 1982), though the influence of surrounding suburban development was evident. A few species typical of more extensive forests continued to nest, sometimes intermittently, despite the small size and relative isolation of this woodlot.

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LITERATURE CITED

- Aldrich, J. W. and R. W. Coffin 1980 Breeding bird populations from forest to suburbia after 37 years. *Amer. Birds* 34: 3-7.
- Ambuel, B. and S. A. Temple 1982 Songbird populations in southern Wisconsin forests: 1954 and 1979. *J. Field Ornithol.* 53: 149-158.
- Barry, H. L. and R. H. Mills 1941 A breeding-bird census of a previously grazed beech-maple woodlot in Franklin County, Ohio. *Audubon Mag. Suppl.* 43: 490-491.
- 1942 A breeding-bird census of a previously grazed beech-maple woodlot in Franklin County, Ohio. *Audubon Mag. Suppl.* 44: 24-25.
- Beissinger, S. R. and D. R. Osborne 1982 Effects of urbanization on avian community organization. *Condor* 84: 75-83.
- Blake, J. G. 1983 Trophic structure of bird communities in forest patches in east-central Illinois. *Wils. Bull.* 95: 416-430.
- Blyth, D. D., J. H. Jenkins and D. T. Katz 1939 A breeding bird census of a previously grazed beech-maple woodlot in Franklin County, Ohio. *Bird-Lore Suppl.* 41: 25.
- and R. H. Mills 1940 A breeding-bird census of a previously grazed beech-maple woodlot in Franklin County, Ohio. *Bird-Lore Suppl.* 42: 485.
- Brittingham, M. C. and S. A. Temple 1983 Have cowbirds caused forest songbirds to decline? *BioScience* 33: 31-35.
- Butcher, G. S., W. A. Niering, W. J. Barry and R. H. Goodwin 1981 Equilibrium biogeography and the size of nature preserves: An avian case study. *Oecologia* 49: 29-37.
- Galli, A. E., C. F. Leck and R. T. T. Forman 1976 Avian distribution patterns in forest islands of different sizes in central New Jersey. *Auk* 93: 356-364.

- Graber, J. W. and R. R. Graber 1979 Severe winter weather and bird populations in southern Illinois. *Wils. Bull.* 91: 88-103.
- Hollander, M. and D. A. Wolfe 1973 Non-parametric statistical methods. J. Wiley and Sons, New York. 503 p.
- Johnston, D. W. and E. P. Odum 1956 Breeding bird populations in relation to plant succession on the piedmont of Georgia. *Ecology* 37: 50-62.
- Kendeigh, S. C. 1982 Bird populations in east central Illinois: Fluctuations, variation, and development over a half-century. *Illinois Biol. Monogr.* 52: 1-136.
- Kerlinger, P. and C. Doremus 1981 Habitat disturbance and the decline of dominant avian species in pine barrens of the northeastern United States. *Amer. Birds* 35: 16-20.
- MacArthur, R. H. and E. O. Wilson 1963 An equilibrium theory of insular zoogeography. *Evolution* 17: 373-387.
- MacClintock, L., R. F. Whitcomb and B. L. Whitcomb 1977 Evidence for the value of corridors and minimization of isolation in preservation of biotic diversity. *Amer. Birds* 31: 6-16.
- Mills, R. H. 1943 An ecological study of a central Ohio woodlot. M.S. Thesis. Ohio State Univ., Columbus. 164 p.
- Noss, R. F. 1981 The birds of Sugarcreek, an Ohio nature reserve. *Ohio J. Sci.* 81: 29-40.
- Whitcomb, R. F., C. S. Robbins, J. F. Lynch, B. L. Whitcomb, M. M. Klimkiewicz and D. Bystrak 1981 Effects of forest fragmentation on avifauna of the eastern deciduous forest. *In*: R. L. Burgess and D. M. Sharpe, (eds.), *Forest island dynamics in man-dominated landscapes*. *Ecol. Stud.* #41. Springer-Verlag, New York, NY. p. 125-205.
- Wolcott, C. F. 1974 Changes in bird life in Cambridge, Mass. from 1860 to 1964. *Auk* 91: 151-160.