A COMPARISON OF FOREST INTERIOR NEOTROPICAL MIGRANT BIRD POPULATIONS IN TWO NEW JERSEY FORESTS

Ted Floyd

Introduction

During 1989-1990, I conducted breeding bird censuses of two deciduous forests (the Institute Woods and the Baldpate Mountain Woods) in Mercer County, New Jersey. Both forests are situated within a highly disturbed and densely populated agricultural and residential region, and neighboring forest islands are small, isolated, and internally fragmented. Despite their unfavorable location both forests have been shown to have considerable environmental value, especially for breeding and migrating birds (Boyle 1986, Floyd 1990, Harding and Harding 1980, Leck 1975, Stiles 1991, and Tramer 1969).

I was especially interested in the subset of forest breeding birds that includes forest interior specialists and neotropical migrants. These species have been undergoing recent steady declines (Robbins *et al.* 1989), and fragmentation of breeding habitat is suspected to be a major underlying cause of these declines (Whitcomb *et al.* 1981). The objectives of my study were as follows: (1) to document overall levels of species richness and population density of breeding birds in the Baldpate Mountain Woods and the Institute Woods; (2) to compare patterns of territory distribution of forest interior specialist neotropical migrant bird species in the two forests.

Study Sites

I. The Institute Woods. The 155 hectare (ha) Institute Woods is located at 40°19'37"N 74°40'13"W. It is bordered to the north by the open parkland of the Princeton Battlefield State Park and the Institute for Advanced Study, to the east by the flood plains of the Charles Rogers Wildlife Refuge, to the south by the Canal Pointe housing development, and to the west by soybean and corn fields. The forest is all second growth. Small portions have been free of extensive anthropogenic disturbances since before 1727, and the youngest portions of the forest were abandoned from agriculture as recently as 1940 (Horn 1986).

Canopy coverage is nearly continuous within the Institute Woods. A 5-10 meter (m) wide stream, running east-west through the southern portion of the forest, creates moderate openings in the canopy at places, and an 8 m wide sewer line right-of-way running east-west through the

center creates a narrow gap. Otherwise, occasional tree falls and two narrow fire breaks cause minor discontinuities in the canopy. The terrain is level, sloping slightly southeastward. The well-drained upland portions of the forest drain into the poorly drained flood plain along the forest's southeastern edge. Soil quality is good throughout the forest.

Mature hickories (*Carya*, spp.), oaks (*Quercus*, spp.), and Tuliptrees (*Liriodendron tulipifera*) are common canopy trees throughout the Institute Woods, although these are being replaced by American Beech (*Fagus grandifolia*), Red Maple (*Acer rubrum*), and Sugar Maple (*A. saccharum*). Poison Ivy (*Rhus radicans*), American Bittersweet (*Celastrus scandens*), grapes (*Vitis*, spp.), Virginia Creeper (*Parthenocissus quinquefolia*), and honeysuckles (*Lonicera*, spp.) also contribute significantly to the forest canopy biomass.

At the midstory layer, Flowering Dogwood (*Cornus florida*) is prevalent. Otherwise, this forest tier is comprised of subcanopy saplings and vines. The shrub layer is at places dense and impenetrable. Common Spicebush (*Lindera benzoin*) is abundant on moist soil, and viburnums (*Viburnum*, spp.) are well represented on well-drained soil. Numerous additional native and exotic shrubs are less common. Floor cover is variable. Spring ephemerals are abundant in season. Otherwise, floor cover is irregular throughout the forest.

II. The Baldpate Mountain Woods. The 509 ha Baldpate Mountain Woods is located at 40°19'40"N 74°52'30"W. It is bordered to the north and east by rural portions of Hopewell Township and Pennington Borough, to the southeast by a mixture of upland habitats in Washington's Crossing State Park, to the southwest by residential Titusville, and to the west by the Trap Rock Company quarry. The forest is all second growth. Small portions have undergone recent selective logging, and small portions of the forest edge were reclaimed from agriculture as recently as 1960. Otherwise, nearly all of the forest has been free of extensive anthropogenic disturbances since 1890 (Stiles 1991).

Canopy coverage is nearly continuous within the Baldpate Mountain Woods. However, there are 5 major clearings, ranging in area between 5-24 ha, within this forest. In addition, a 100 m wide power line right-of-way, running east-west through the northern portion of the forest, creates a continuous gap. (Total forest area of 509 ha excludes such clearings and gaps.) The terrain is hilly in places, and drainage is moderate. Soil quality is good throughout the forest.

Mature Tuliptrees are the dominant canopy tree. Hickories and oaks are also common. American Beech, Red Maple, and Sugar Maple are less common, although present throughout the forest. Poison Ivy,

American Bittersweet, grapes, Virginia Creeper, and honeysuckles also contribute significantly to the forest canopy biomass.

At the midstory layer, Sassafras (*Sassafras albidum*) and Flowering Dogwood are prevalent. Otherwise, this forest tier is comprised of subcanopy saplings and vines. The shrub layer is dense and impenetrable throughout the forest. Common Spicebush is abundant, and Sassafras and viburnums are also common. Numerous additional native and exotic shrubs are less common. Floor cover is generally dense, but patchy in places.

Methods

I completed a 100 ha breeding bird census of the Institute Woods between 9 June 1989 and 18 June 1989, essentially in accordance with standard breeding bird census methods (Hall 1964, Van Velzen 1972). The census area was subdivided into 400 different 0.25 ha quadrats, and the approximate center of each bird's territory was mapped to one of these 400 quadrats. Because of the large census area, it was not possible to meet the 8-12 minutes (min) per ha recommended censusing speed (see Engstrom and James 1984). Instead, I censused 50 ha each visit, with an average censusing speed of 4-5 min per ha. I made 10 such visits, between 0530 and 1030, during the period 9 June 1989 - 18 June 1989. Because rapid censusing can result in inaccurate results (Engstrom and James 1984), I made 10 additional visits between 19 June 1989 and 28 June 1989, during each of which 10 ha were intensively searched for any breeders that might have been previously overlooked. "Confirmed" breeding criteria of the *Breeding Bird Atlas of Pennsylvania* (Brauning 1992) were employed during these visits. Total census time was about 100 hours (hr).

In the Baldpate Mountain Woods, I completed a 7000 m transect census of singing males between 13 June 1990 and 22 June 1990. Average censusing speed was 500 m per hr. Three visits each were made to every portion of the census area, which consisted of 10 completely non-overlapping footpaths, varying in length between 200 and 1200 m. It was necessary to census from paths, because of regulations restricting entry to the forest. Approximately 2100 m were censused each morning starting at 0530. Total census time was 42 hr. Additional census time was contributed by the Friends of Hopewell Valley Open Space, which conducted a general biological inventory of the forest during 1990. Where applicable, bird data from this biological inventory were checked with mine.

In both forests, I recorded the number of all pairs of birds per 100 ha (*i.e.*, per 1 km^2), and for forest interior neotropical migrants I also recorded the location ("edge" or "core") of each pair. Forest core was

classified as the region of a forest more than 100 m from the forest boundary, and forest edge was classified as the region of a forest within 100 m of the forest boundary. Classification of habitat use and migration strategy was based on Askins *et al.* (1987), Rappole *et al.* (1983), and Whitcomb *et al.* (1981). In the Institute Woods, I censused exactly 100 ha, but in the Baldpate Mountain Woods, I conducted linear transects. Thus, to compare directly with the Institute Woods, it was necessary to interpolate the Baldpate Mountain Woods census data to 100 ha, using published estimates of maximum radii of vocal detectability (Whitcomb *et al.* 1981). The correction formula for any given species is: $N_{100}=N_s/(0.014R)$, where N_s denotes the number of singing males recorded, R denotes the maximum radius of vocal detectability, and N_{100} denotes the interpolated number of pairs per 100 ha. The constant (0.014) is equal to transect width (7000 m) times 2 (to convert R into a diameter of vocal detectability) divided by 10,000 (to convert m^2 to ha).

I compared my census results with averages from the 10 1983 Breeding Bird Censuses of Piedmont deciduous forest reported in the 1984 volume of *American Birds* (the last volume of *Am. Birds* in which Breeding Bird Census results are published).

Results

There were 517 pairs of breeding birds per 100 ha in the Institute Woods, 712 pairs of breeding birds per 100 ha in the Baldpate Mountain Woods, and 783 pairs of breeding birds per 100 ha in the average of 10 Breeding Bird Censuses of Piedmont deciduous forests.

Census results were partitioned according to migration strategy and habitat preference (see Table 1). The Institute Woods contained 86% as many permanent residents and short distance migrants and 86% as many edge tolerant individuals as did the Piedmont average. However, the Institute Woods contained only 49% as many neotropical migrants and 21% as many forest interior specialists as did the Piedmont average. Most notably, the Institute Woods contained only 15% as many neotropical migrant forest interior specialists as did the Piedmont average.

In the Baldpate Mountain Woods, there were 77% as many permanent residents and short distance migrants and 95% as many edge tolerant individuals as in the Piedmont average. The Baldpate Mountain Woods contained 103% as many neotropical migrants and 83% as many forest interior specialists as did the Piedmont average. Lastly, the Baldpate Mountain Woods contained 90% as many neotropical migrant forest interior specialists as did the Piedmont average.

In the Institute Woods, 68% of the census area was classified as forest "core" (region of forest more than 100 m from the forest edge), but 27 of 30 (90%) breeding pairs of forest interior neotropical migrants bred within this forest region. The null hypothesis of random territory use by forest interior neotropical migrants was thus rejected ($p=0.005$, 1-tailed cumulative binomial; see Table 2a). Within the forest core, forest interior neotropical migrants occurred at a density of 40 pairs per 100 ha.

In the Baldpate Mountain Woods, 277 of 329 (84%) breeding pairs of forest interior neotropical migrants bred within the forest core region. This region comprised 83% of the census area. The null hypothesis of random territory use by forest interior neotropical migrants was upheld ($p=0.67$, 1-tailed cumulative binomial; see Table 2b). Within the forest core, forest interior neotropical migrants occurred at a density of 185 pairs per 100 ha.

Discussion

Numerous studies have documented the scarcity or absence of forest interior neotropical migrants in forest islands (*e.g.*, Forman *et al.* 1976). This pattern has been attributed to a number of causes, foremost among which is increased incidence of nest predation and parasitism along the forest edge (*e.g.*, Brittingham and Temple 1983). Thus, in small forests, which contain relatively more edge than do large forests, breeding densities of forest-inhabiting neotropical migrants are predicted to be low. Specifically, Temple (1986) has shown that forest interior neotropical migrant breeding densities are better predicted by forest "core" area (area of forest more than 100 m from the forest edge) than by total area.

I analyzed breeding bird censuses of two large deciduous forests, in the particular context of the distribution and density of forest interior specialist neotropical migrants. Partitioning census results according to habitat type and migration strategy was instructive. In particular, the Institute Woods and Baldpate Mountain Woods contained similar densities of permanent residents and short distance migrants and edge-tolerant species. However, the Baldpate Mountain Woods contained twice as many neotropical migrants and four times as many forest interior specialists (per unit area) as did the Institute Woods. And in a comparison of censuses of forest interior specialist neotropical migrants, the Baldpate Mountain Woods contained more than six times as many of these birds (per unit area) as did the Institute Woods.

It was also interesting to compare breeding densities within the "core" regions of both forests. Forest interior neotropical migrants bred at a density of 40 pairs per 100 ha within the Institute Woods core, but

forest interior neotropical migrants bred at a density of 185 pairs per 100 ha within the Baldpate Mountain Woods core. Thus, even within the Institute Woods core, breeding densities of forest interior neotropical migrants were considerably lower than within the Baldpate Mountain Woods core. Furthermore, the spatial distribution of forest interior neotropical migrants differed significantly between the two sites. In the Institute Woods, forest interior neotropical migrants bred within the forest core more often than expected by chance, while in the Baldpate Mountain Woods no such pattern of territory use was evident.

At the level of analysis of whole-community species richness or population density, the Institute Woods and Baldpate Mountain Woods appeared to have supported fairly similar avifaunas. But by expanding my analysis of census results to consider species composition and distribution, I have shown that the Institute Woods and Baldpate Mountain Woods supported considerably different avifaunas. The Institute Woods contained a very low number of neotropical migrant forest interior specialists, whose breeding territories were aggregated in the forest's core. In contrast, the Baldpate Mountain Woods contained a moderate number of neotropical migrant forest interior specialists, whose territories occurred along the forest edge as well as within its core.

Census results from the Institute Woods and the Baldpate Mountain Woods highlight the need to look beyond simple measurements of species richness or population density in breeding bird censuses. In particular, whole-community statistics of richness or density may mask important patterns of species composition or territory distribution with a forest. For example, Blake and Karr (1984) provide data which show that management decisions would differ considerably according to the choice of statistics used. The present study emphasizes the importance of breeding bird censuses that are sufficiently large to permit a fine-grained analysis of territory distribution and species composition of bird communities of special concern.

Acknowledgments

This study was part of my undergraduate senior thesis at Princeton University, which was patiently advised by Henry Horn. I thank Margaret Brittingham for helpful comments on an earlier draft of this manuscript.

Literature cited

Askins, R.A., J.F. Lynch, and R. Greenberg. 1990. Population declines in migratory birds in eastern North America. *Curr. Ornithol.* **9**:1-57.

Blake, J.G. and J.R. Karr. 1984. Species composition of bird communities and the conservation benefit of large versus small forests. *Biol. Conserv.* **30**:173-187.

Boyle, W.J. 1986. *A Guide to Bird Finding in New Jersey*. Rutgers Univ. New Brunswick NJ.

Brauning, D.W. ed. 1992. *Atlas of Breeding Birds in Pennsylvania*. Univ. of Pittsburgh. Pittsburgh PA.

Brittingham, M.C. and S.A. Temple. 1983. Have cowbirds caused forest songbirds to decline? *BioScience* **33**:31-35.

Engstrom, R.T. and F.C. James. 1984. An evaluation of methods used in the Breeding Bird Census. *Am. Birds* **38**:19-23.

Floyd, T. 1990. *The Edge Effect on Forest Breeding Bird Community Structure*. Princeton Univ. undergraduate thesis. Princeton NJ.

Forman, R.T.T., A.E. Galli, and C.F. Leck. 1976. Forest size and avian diversity in New Jersey woodlots with some land use implications. *Oecologia* **26**:1-8.

Hall, G.A. 1964. Breeding Bird Census: why and how. *Aud. Field Notes* **18**:413-416.

Harding, J.J. and J.J. Harding. 1980. *Birding the Delaware Valley Region*. Temple Univ. Philadelphia PA.

Horn, H.S. 1986. *Overview of the Institute Woods*. Privately circulated manuscript. Dept. Biol. Princeton Univ. Princeton NJ.

Leck, C.F. 1975. *Birds of New Jersey*. Rutgers Univ. New Brunswick NJ.

Rappole, J.H., E.S. Morton, T.E. Lovejoy, and J.L Ruos. 1983. *Nearctic Avian Migrants in the Neotropics*. US Dept. Interior Fish Wildl. Serv. Washington DC.

Robbins, C.S., J.R. Sauer, R.S. Greenberg, and S. Droege. 1989. Population declines in North American birds that migrate to the neotropics. *Proc. Natl. Acad. Sci. USA* **86**:7658-7662.

Stiles, E.W. 1991. *The Baldpate Mountain Project*. Green Trust Local Program Application. NJ Dept. Environ. Protection. Trenton NJ.

Temple, S.A. 1986. Predicting impacts of habitat fragmentation on forest birds: a comparison of two models. Pp. 301-304, in J. Verner, M.L. Morrison, and C.J. Ralph, eds. *Wildlife 2000: Modeling Habitat Relationships of Terrestrial Vertebrates*. Univ. Wisconsin. Madison WI.

Tramer, E.J. 1969. Mixed hardwood forest Breeding Bird Census. *Aud. Field Notes* **23**:705.

Van Velzen, 1972. Breeding Bird Census instructions. *Am. Birds* **26**:1007-1010.

Whitcomb, R.F., C.S. Robbins, J.F. Lynch, B.L. Whitcomb, M.K. Kliemkiwicz, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pp. 125-205, *in* R.L. Burgess and D.M. Sharpe, eds. *Forest Island Dynamics in Man-Dominated Landscapes*. Springer-Verlag. New York NY.

Editor's Note: Ted Floyd is a Doctoral candidate at Pennsylvania State University and the Allegheny County compiler for *Pennsylvania Birds*.

Table 1. Breeding bird densities (pairs per 100 ha) partitioned by habitat type (columns) and migration strategy (rows) in the Institute Woods (IW), Baldpate Mountain Woods (BM), and Piedmont Average (PA).

	Field + Edge	Edge + Interior	Forest Interior	Total
Permanent Residents				
IW	2	182	21	205
BM	1	130	13	144
PA	19	185	27	231
Short Distant Migrants				
IW	56	51	0	107
BM	30	104	0	134
PA	29	96	7	132
Neotropical Migrants				
IW	10	165	30	205
BM	22	227	185	434
PA	17	197	206	420
Totals				
IW	68	398	51	517
BM	53	461	198	712
PA	65	478	240	783

Design of table is based on Whitcomb *et al.* (1981).

Table 2a. Territory use by forest interior neotropical migrants in the Institute Woods. Number of pairs.

SPECIES	EDGE	CORE	TOTAL
Veery (*Catharus fuscescens*)	0	3	3
American Redstart (*Setophaga ruticilla*)	0	2	2
Ovenbird (*Seiurus aurocapillus*)	0	10	10
Louisiana Waterthrush (*Seiurus motacilla*)	0	2	2
Scarlet Tanager (*Piranga olivacea*)	3	10	13
Total (percent)	3 (10%)	27 (90%)	30 (100%)
Percent of census area	32%	68%	100%

Birds classified as forest interior neotropical migrants were concentrated in the forest core ($p=0.005$, 1-tailed cumulative binomial).

Table 2b. Territory use by forest interior neotropical migrants in the Baldpate Mountain Woods. Number of pairs.

SPECIES	EDGE	CORE	TOTAL
Veery	10	64	74
Black-and-white Warbler (*Mniotilta varia*)	3	18	21
American Redstart	1	3	4
Worm-eating Warbler (*Helmitheros vermivorus*)	3	14	17
Ovenbird	20	91	111
Kentucky Warbler (*Oporornis formosus*)	3	26	29
Hooded Warbler (*Wilsonia citrina*)	5	20	25
Scarlet Tanager	7	41	48
Total (percent)	52 (16%)	277 (84%)	329(100%)
Percent of census area	17%	83%	100%

The null hypothesis of random territory use by forest interior neotropical migrants was upheld ($p=0.67$, 1-tailed cumulative binomial).

Pesticide Research Laboratory
Pennsylvania State University
University Park, PA 16802