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BIRD NUMBERS DECLINE IN AN OLD GROWTH FOREST: LONG-TERM TRENDS IN FERNBANK FOREST

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Long-term ecological studies on birds are scarce, with most concluding within 5 years. This long-term study used simple linear regression to examine population trends of avifauna in a small, Piedmont forest in northern Georgia over 12 years. Results indicate that both the numbers of birds and species richness declined during the study, even though forest conditions remained relatively constant. A review of literature revealed 3 potential causes for the decline: disease (West Nile virus), drought, and urban sprawl. This study serves as a call for understanding threats to bird populations in the Piedmont region of Georgia.

Introduction

There have been many studies on the avifauna in eastern deciduous forests of North America, especially in small forest tracts. However, most of these studies have been relatively short-term in scope (<5 years). Sallbanks et al. (2000) reviewed 95 studies published from 1972-1997 that examined relationships between timber harvest and populations of songbirds, and found that 68% of the studies lasted 1-2 years, and only 7% were longer than 4 years. Marzluff et al. (2001) reviewed 101 articles from 1900-2000 that reported empirical research on birds and urbanization, and found that 61% of studies lasted <5 years. Moreover, Kareiva and Anderson (1989) reported that ecological studies in general and studies of birds in particular (Marzluff and Sallabanks 1998) are of notoriously short duration. There are obvious exceptions such as the North American Breeding Bird Survey (BBS), which has run continuously from 1966

to the present (Sauer et al. 2006). The 150-year study of European Blackbirds (*Turdus merula*) is especially notable (Luniak and Mulsow 1988).

I examined population trends of avifauna in a small Piedmont forest in northern Georgia for 12 years to determine if bird populations were changing in the study area. Long-term data may reveal trends that can assist local, state, and federal agencies as they make management and conservation decisions. Moreover, population monitoring plays a critical role in conservation biology by providing information necessary to identify problems at an early stage and to suggest possible solutions (Thomas 1996).

Study Area

This study was conducted in Fernbank Forest, 3.2 km east of Atlanta, Georgia (33°46' N, 84°19' W). Fernbank Forest is an approximately 26-ha tract of relatively undisturbed mature mixed hardwood forest. The dominant trees are oaks (*Quercus* spp.), hickories (*Carya* spp.) and Tulip Poplar (*Liriodendron tulipifera*), with a lesser amount of American Beech (*Fagus grandifolia*) (Skeen 1974). This area is a small remnant of the type of forest vegetation that originally covered the Piedmont physiographic region of the southeastern United States.

Data Collection

I followed the methods of the Monitoring Avian Productivity and Survivorship (MAPS) program (Desante et al. 2005). I distributed 10 permanent sites for mist nets uniformly in the central 10 ha of the study area. I erected one 12-m long, 30-mm mesh mist net at each net site. All 10 nets were operated for 6 h per day, beginning at sunrise, for 9 different days during the breeding season, generally beginning 14 May, and continuing through 8 August. Netting days were ≥1 week apart so birds' habituation to net locations would be limited. To ensure constant-effort comparisons of data, I opened, checked, and closed the nets in the same order on all days of operation. I marked each captured bird with a uniquely-numbered aluminum leg band from the USGS Breeding Bird Laboratory. I recorded band number, species, age, sex, ageing and sexing criteria, date, and net number for each bird captured.

Data Analyses

Mist netting did not occur for 9 days during 2 seasons due to scheduling conflicts or weather. Therefore, I pooled the total number of birds captured from all 10 nets and divided by the number of netting days for each year to yield the average number of birds captured per day. Recaptures within the same year were omitted from analyses so the same bird was not counted more than once in the same year. I used simple linear regression to examine the change in bird numbers over time. I estimated species richness by determining the total number of species captured each year. Tests were considered significant if $P < 0.05$.

Results

I captured 31 different species during the 12-year study (Table 1). The birds captured most often were the Carolina Wren (*Thryothorus ludovicianus*), Northern Cardinal (*Cardinalis cardinalis*), American Robin (*Turdus migratorius*), Wood Thrush (*Hylocichla mustelina*), Blue Jay (*Cyanocitta cristata*), and Tufted Titmouse (*Baeolophus bicolor*). The total captures for the American Robin were skewed because >50% of the records came from one year (1996).

The average number of birds captured per day declined over the 12-year study ($\beta = -0.75$, $R^2 = 0.6503$, $F = 18.60$, $P = 0.001$, Fig. 1). Species richness also declined over the 12-yr study ($\beta = -0.72$, $R^2 = 0.7554$, $F = 30.87$, $P = 0.0002$, Fig. 2). In addition, numbers of Carolina Wrens, Northern Cardinals, Blue Jays, and Wood Thrushes experienced a noticeable decline during the last 4 years of the study (Table 1).

Discussion

Fernbank Forest is unique in that it is the largest "relatively undisturbed" piece of the Piedmont forest in an urban/suburban location (Wilson 1998). Fernbank is not a virgin forest; in fact, few forests in the eastern United States remain intact. However, Fernbank Forest may not have been cut since the 1800s (Skeen 1974). Many of the trees are >30 m in height and measure >1 m in diameter. Increment borings indicate that many of the trees are >200 years old (Skeen 1974, Wilson 1990). Wilson (1998) stated that "this relic forest serves as a baseline to compare human impact on forested ecosystems in the Piedmont

physiographic region." Since 1964, the forest has been enclosed by a 2.4-m high chain-link fence and managed by Fernbank Science Center as part of a lease agreement with the private owner of the property (Wilson 1998). Since that time, there have been few unnatural disturbances to the forest, except for periodic removal of exotic, invasive plant species and an occasional removal of a hazardous tree. Given the relatively undisturbed nature of Fernbank Forest, it is not immediately obvious why the numbers of birds and species richness have declined during the 12 years of this study. Some possibilities include disease, drought, and urban sprawl.

Disease

West Nile virus (WNV) is a mosquito-borne infection that can cause encephalitis and/or meningitis. West Nile virus was first detected in North America during summer 1999 in New York City, New York, when a dead crow (*Corvus* sp.) at the Bronx Zoo was diagnosed with the disease (Steele et al. 2000). Several studies have concluded that WNV has had an impact on bird populations (Rappole et al. 2000, Roberts et al. 2003, Gibbs et al. 2006). No empirical data were collected on numbers of dead birds or incidences of WNV in Fernbank Forest. Studies of the impact of diseases on bird populations, and their responses to disease outbreaks, should be emphasized in future research.

Drought

Georgia suffered one of its worst recorded droughts from 1999 through 2002 (Palmer et al. 2002). Annual rainfall dropped abruptly in the study area during this period, and remained far below average during 2004-2007 (Table 2). Bird numbers declined during this period as well (Table 2). Several studies have shown that drought has an impact on bird abundance (Smith 1982, Faaborg et al. 1984, Blake et al. 1992, George et al. 1992). In addition, analyses of drought patterns coincident with a series of 4 recent outbreaks of WNV indicate that drought conditions may amplify the enzootic cycle for WNV (Epstein and DeFilippo 2001).

Urban Sprawl

Atlanta is currently one of the fastest growing metropolitan areas in the United States and has experienced considerable urban sprawl in the last 3 decades (Kolankiewicz and Beck 2001). Several studies have linked urban sprawl with changes in bird abundance (Vale and Vale 1976, Beissinger and Osborne 1982, Jokimaki and Suhonen 1993, Bolger et al. 1997, Clergeau et al. 2001, Marzluff 2001, Hennings and Edge 2003, Blair 2004). These studies suggest that urbanization affects the heterogeneity of the landscape and the distribution and abundance of birds, as well as the resources upon which birds depend. Given the growth of the urbanized areas in the Atlanta metro area, it is likely that these dynamics are affecting the birds in this region and may account for the population changes observed in Fernbank Forest.

Conclusions

Bird numbers have declined in the study area over the past 12 years even though forest conditions have remained relatively constant. A confluence of factors including disease, drought and urban sprawl may have led to this decline. Overall, this study may best serve as an alarm for changing trends of bird populations in this region.

There are limitations to this study, including the relatively small number of birds captured each year, the relatively small size of the study area, and limitations of the methods. For example, there is no way to draw inferences about canopy dwelling species using ground-based mist-net data. In addition, no empirical data were collected in the study area on the possible causes (disease, drought, and sprawl) for declining bird abundance presented in the paper. Future research considerations should focus on trends of bird abundance on a larger scale and across different habitats with particular reference to disease (WNV), drought, and expanding urban sprawl in northern Georgia, and how these phenomena may be interacting with one another to affect birds.

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Literature Cited

Beissinger, S.R., and D.R. Osborne. 1982. Effects of urbanization on avian community organization. Condor 84:75-83.

Blair, R. 2004. The effects of urban sprawl on birds at multiple levels of biological organization. Ecology and Society 9 [online] URL: http://www.ecologyandsociety.org/vol9/iss5/art2/

Blake, J.G., G.J. Niemi, and J.M. Hanowski. 1992. Drought and annual variation in bird populations: Effects of migratory strategy and breeding habitat. In: J. M. Hagan III and D.W. Johnston, editors. Ecology and conservation of Neotropical migrant landbirds. Washington (DC): Smithsonian Inst. p. 419-429.

Bolger, D.T., T.A. Scott, and J.T. Rotenberry. 1997. Breeding bird abundance in an urbanizing landscape in coastal southern California. Cons. Biol. 11:406-421.

Clergeau, P., J. Jokimaki, and J.L. Savard. 2001. Are urban bird communities influenced by the bird diversity of adjacent landscapes? J. Appl. Ecol. 38:1122-1134.

DeSante, D.F., K.M. Burton, P. Velez, and D. Froehlich. 2005. MAPS Manual: 2005 Protocol. Contribution No. 127 of The Institute for Bird Populations. Point Reyes Station, CA.

Epstein P.R., and C. DeFilippo. 2001. West Nile virus and drought. Global Change and Human Health 2:105-107.

Faaborg, J., W.J. Arendt, and M.S Kaiser. 1984. Avian population fluctuations during drought conditions in Puerto Rico. Wilson Bull. 94:20-30.

George, L.T., A.C. Fowler, R.L. Knight, and L.C. McEwen. 1992. Impacts of a severe drought on grassland birds in western North Dakota. Ecol. Appl. 2:275-284.

Gibbs, S.E.J., M.C. Wimberly, M. Madden, J. Masour, M.J. Yabsley, and D.E. Stallknecht. 2006.. Year Factors affecting the geographic distribution of West Nile virus in Georgia, USA. Vector-Borne and Zoonotic Diseases 6:73-82.

Hennings, L.A., and W.D. Edge. 2003. Riparian bird community structure in Portland, Oregon: habitat, urbanization, and spatial scale patterns. Condor 105:288-302.

Jokimaki, J., and J. Suhonen. 1993. Effects of urbanization on the breeding bird species richness in Finland: a biogeographical comparison. Ornis Fennica 70:71-77.

Kareiva, P., and M. Anderson. 1989. Spatial aspects of species interactions: the wedding of models and experiments. In: A. Hastings, editor. Community ecology. New York (NY): Springer-Verlag; p. 35-50.

Kolankiewicz, L., and R. Beck. 2001. Weighing sprawl factors in large U.S. cities. [online] URL: http://www.sprawlcity.org/studyUSA/USAsprawlz.pdf

Luniak, M., and R. Mulsow. 1988. Ecological parameters in urbanization of the European blackbird. In: L. Tomialojc and F.R. Gehlbach, editors. Avian population responses to man-made environments. Acta XIX Congressus Internationalis Ornithologica, Ottawa, Canada. p. 1787-1793.

Marzluff, J.M. 2001. Worldwide urbanization and its effects on birds. In: J.M. Marzluff, R. Bowman, and R. Donnelly, editors. Avian conservation and ecology in an urbanizing world. Norwell (MA): Kluwer Academic. p. 19-47.

_____, R. Bowman, and R.E. Donnelly. 2001. A historical perspective on urban bird research: trends, terms, and approaches. In: Marzluff, J.M., R. Bowman, and R.E. Donnelly, editors. Avian conservation and ecology in an urbanizing world. Norwell (MA): Kluwer Academic. p. 1-18.

_____, and R. Sallabanks. 1998. Past approaches and future directions for avian conservation biology. In: Marzluff, J.M. and R. Sallabanks, editors. Avian conservation: research and management. Washington (DC): Island Press, p. 5-14.

Palmer, R.N., S.L. Kutzing, and A.C. Steinemann. 2002. Developing drought triggers and drought responses: an application in Georgia. In: Proceedings of the ASCE's 2002 conference on water resources planning and management. Roanoke, VA. Am. Soc. Civil Eng. 9 pp.

Rappole, J.H., S. Derrickson, and Z. Hubalek. 2000. Migratory birds and spread of West Nile virus in the Western Hemisphere. Emerging Infectious Disease 6:319-328.

Roberts, J.F., M.L. Vickers, S.F. Sells, D.L. Watson, S.K. Billings, C.B. Jackson, B.L. Palmer-Ball, Jr., L.R. Harrison, D.C. Bolin, R.C. Giles, and M. Sebastian. 2003. Passive surveillance of West Nile virus from wild birds of Kentucky, 2002. Kentucky Warbler 79:53-59.

Sallbanks, R., E.B. Arnett, and J.M. Marzluff. 2000. An evaluation of research on the effects of timber harvest on bird populations. Wildl. Soc. Bull. 28:1144-1155.

Sauer, J.R., J.E. Hines, and J. Fallon. 2006. The North American Breeding Bird Survey, results and analysis 1966-2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, MD.

Skeen, J. 1974. Composition and biomass of tree species and maturity estimates of a suburban forest in Georgia. Bull. Torrey Bot. Club 101:160-165.

Smith, K. 1982. Drought-induced changes in avian community structure along a montane sere. Ecology 63:952-961.

Steele KE, M.J. Linn, R.J. Schoepp, N. Komar, T.W. Geisbert, R.M. Manduca, P.P. Calle, B. L. Raphael, T.L. Clippinger, T. Larsen , J. Smith, R.S. Lanciotti, N.A. Panella, and T.S. McNamara. 2000. Pathology of fatal West Nile virus infections in native and exotic birds during the 1999 outbreak in New York City. Vet. Pathol. 37:208-214.

Thomas, L. 1996. Monitoring long-term population change: Why are there so many analysis methods? Ecology 77:49-58.

Vale, T.R., and G.R. Vale. 1976. Suburban bird populations in west-central California. J. Biogeography 3:157-165.

Wilson, L.A. 1990. Forest succession. Fernbank Quarterly 15:4-5.

_____. 1998. Fernbank Forest: An urban old-growth forest within the Fernbank complex. Georgia J. Sci. 56:154- 163.

Table 1. There were 789 birds captured from 31 different species during the 12 years of mist-netting in Fernbank Forest, Atlanta, Georgia.

		YEAR												
Species	**Common name**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**Total**
Empidonax virescens	Acadian Flycatcher	0	0	0	1	0	0	0	1	0	0	0	0	2
Setophaga ruticilla	American Redstart	0	0	0	0	0	0	0	0	0	0	1	0	1
Turdus migratorius	American Robin	47	4	14	2	0	1	4	10	1	3	0	0	86
Mniotilta varia	Black-and-white Warbler	2	0	0	0	0	0	0	0	0	0	0	0	2
Dendroica caerulescens	Black-throated Blue Warbler	0	0	0	0	0	0	0	1	0	0	0	0	1
Cyanocitta cristata	Blue Jay	10	8	6	4	3	7	4	11	0	0	1	0	54
Toxostoma rufum	Brown Thrasher	6	4	3	2	1	0	0	5	0	1	0	2	22
Wilsonia canadensis	Canada Warbler	0	0	0	0	1	0	0	0	0	0	0	0	1
Poecile carolinensis	Carolina Chickadee	5	1	5	0	1	0	4	0	1	0	0	0	17
Thryothorus ludovicianus	Carolina Wren	17	20	32	31	19	17	26	20	20	9	11	14	222
Quiscalus quiscula	Common Grackle	0	1	1	0	0	0	0	0	0	0	0	0	2
Oporornis agilis	Connecticut Warbler	0	1	0	0	0	0	0	0	0	0	1	0	2
Picoides pubescens	Downy Woodpecker	2	3	3	2	0	5	5	8	2	3	0	2	33
Pipilo erythrophthalmus	Eastern Towhee	1	1	3	1	0	0	0	3	0	0	0	1	9
Catharus minimus	Gray-cheeked Thrush	0	1	0	0	0	0	0	0	0	0	0	0	1
Dumetella carolinensis	Gray Catbird	1	0	3	1	0	0	0	0	0	1	0	0	6
Picoides villosus	Hairy Woodpecker	0	1	0	0	0	0	2	0	0	1	0	0	4
Wilsonia citrina	Hooded Warbler	0	0	0	0	0	0	0	0	0	0	1	1	1
Oporornis formosus	Kentucky Warbler	2	1	0	0	0	0	0	0	0	0	0	0	3
Cardinalis cardinalis	Northern Cardinal	11	18	14	18	7	15	22	24	12	7	4	11	152
Colaptes auratus	Northern Flicker	1	0	0	1	0	0	0	1	0	0	0	0	3
Seiurus aurocapilla	Ovenbird	1	0	0	0	0	0	0	1	0	0	0	0	2
Melanerpes carolinus	Red-bellied Woodpecker	0	1	0	1	0	1	0	0	0	0	0	0	3
Melanerpes erythrocephalus	Red-headed Woodpecker	0	0	0	0	0	1	0	0	0	0	0	0	1
Catharus ustulatus	Swainson's Thrush	7	3	4	3	0	0	0	0	0	0	0	1	17
Baeolophus bicolor	Tufted Titmouse	7	4	5	1	2	7	5	2	0	0	3	0	36
Catharus fuscescens	Veery	3	2	3	1	1	0	0	0	0	0	0	0	10
Sitta carolinensis	White-breasted Nuthatch	1	0	0	1	0	0	0	0	3	0	0	0	5
Hylocichla mustelina	Wood Thrush	4	7	9	5	6	7	7	7	4	0	1	1	57
Helmitheros vermivorum	Worm-eating Warbler	0	0	0	0	1	0	0	0	0	1	0	0	2
Empidonax flaviventris	Yellow-bellied Flycatcher	0	0	0	1	0	0	0	0	0	0	0	0	1
	Total birds	128	81	105	75	42	61	79	94	43	26	22	33	789
	Total species	19	18	14	17	10	9	9	12	7	8	7	8	

Table 2. Total annual precipitation and average number of birds captured per day in Fernbank Forest, Atlanta, Georgia. The highlighted area represents the drought that occurred in this region of Georgia from 1999-2001.

Year	Average number of birds captured per day	Total annual precipitation[1] (cm)
1996	15.33	113.3
1997	9.00	131.3
1998	11.67	118.4
1999	8.33	98.8
2000	5.25	90.4
2001	6.78	97.5
2002	8.78	121.4
2003	10.44	134.4
2004	4.78	136.1
2005	3.25	143.8
2006	2.44	121.4
2007	3.67	81.3

[1]Precipitation data were downloaded from DeKalb Peachtree Airport, Atlanta, Georgia, which was the nearest weather station with available data.

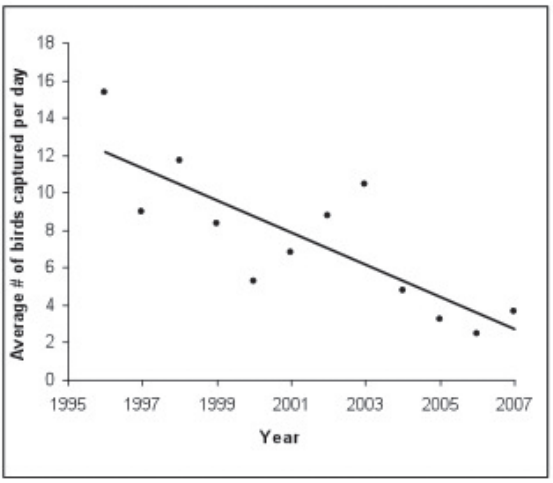

Figure 1. The average number of birds captured per day from 1996-2007 in Fernbank Forest, Atlanta, Georgia, followed a linear regression model ($\beta = -0.75$, $R^2 = 0.65$, $F = 18.60$, $P = 0.001$) that revealed a significant decline in numbers over time.

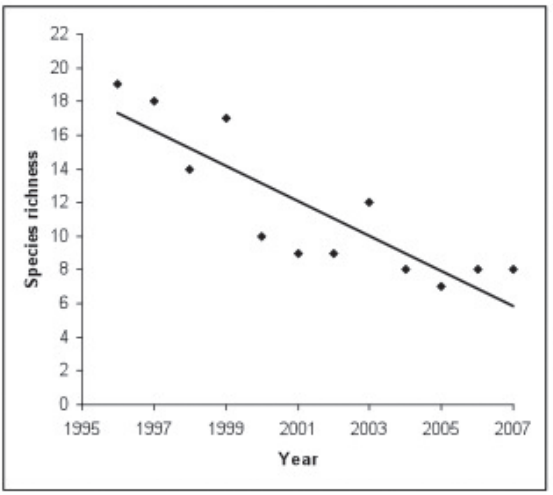

Figure 2. Avian species richness from 1996-2007 in Fernbank Forest, Atlanta, Georgia, followed a linear regression model ($\beta = -0.72$, $R^2 = 0.75$, $F = 30.87$, $P = 0.0002$) that revealed a significant decline over time.