31. Brown-headed Cowbird Parasitism of Migratory Birds: Effects of Forest Area and Surrounding Landscape

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Abstract

Fragmentation of eastern deciduous forests has decreased available habitat for forest-breeding birds, and it may have increased exposure of individuals to predators and brood parasites. Although predation and parasitism by Brown-headed Cowbirds are commonly cited as explanations for the population declines of many bird species, little empirical support exists for these contentions, especially for cowbird parasitism.

Nests of Acadian Flycatchers (N = 358) and Wood Thrushes (N = 329) were monitored during 1993 to determine occurrence of cowbird parasitism in seven forest sites in northeastern Ohio and eleven forest sites in central Maryland and Washington, D.C. Forest patches varied in area from 20 to more than 500 ha and were categorized as surrounded primarily by either agricultural land or urban development. Overall parasitism frequencies were similar for both species in both Ohio and Maryland, but some patterns differed between the host species. Frequency of parasitism on Acadian Flycatchers was significantly and inversely related to size of forest fragments, a trend that also was apparent within each region and in both types of landscapes. These patterns were less apparent for Wood Thrushes. Landscape type played little role in the probability of parasitism for both species. These results support the hypothesis that in some species, individuals breeding in small forest fragments are more susceptible to cowbird parasitism than individuals occupying unbroken forest.

Introduction

Removal and conversion of native vegetation types in North America has resulted in the decline of local and regional wildlife populations through direct displacement or mortality of individual animals. Whereas alteration of pristine habitats is universally recognized as one cost of economic expansion and human population growth, land-use planners, resource managers, and private citizens historically have attempted to mitigate those impacts by creating reserves and parks. Those habitat remnants have ameliorated many of the direct detrimental consequences of habitat loss on wildlife populations by providing, for example, large tracts for area-sensitive mammals, snags for cavity-nesting birds, or refugia for small prey species. However, wildlife ecologists recognize that indirect and cumulative effects of habitat and landscape fragmentation also can contribute substantially to local population extinctions. For instance, whereas small forest reserves may provide suitable breeding habitat for some species of ground- and shrub-nesting birds, extirpation of large predators from those reserves could "release" populations of small- to medium-sized predators and omnivores (e.g., Fonseca and Robinson 1990). Increased numbers of small predators could reduce the nesting success of ground- and shrub-nesting birds (Wilcove and Robinson 1990). Understanding such indirect effects on population viability may help to manage wildlife in disturbed landscapes.

Direct loss of habitat alone cannot account for shrinking populations of neotropical migratory landbirds during the past 25 years (Holmes et al. 1986, Sauer and Droege 1992, Whitham and Hunter 1992). Declines of many of these species may be a consequence of cumulative degradation of habitats and indirect effects of habitat alteration such as increased nest predation. Another indirect effect of habitat disruption, elevated access of the parasitic Brown-headed Cowbird to open and fragmented eastern forests, has been implicated in local and regional declines of many migratory bird species (Mayfield 1965, Brittingham and Temple 1983, Böhning-Gaese et al. 1993).

Although Brown-headed Cowbirds have clearly increased the probability of extinction for several endangered songbirds with highly restricted ranges (Mayfield 1977, Grzybowski et al. 1986), definitive evidence of such an effect for migratory birds as a group is lacking. In fact, the widely presumed relationship between parasitism frequency and forest fragmentation was generally unsubstantiated when the authors of this volume assembled to report on their research in 1993. Furthermore, the loss of eggs or nestlings to predators is usually several times greater than that attributable to cowbird parasitism (Martin 1993), raising doubts over the contribution of cowbird parasitism to declines of songbirds. On the other hand, range expansion of cowbirds since the early 20th century (Part I, this volume) could have upset the population dynamics of migratory birds, stimulating the declines observed in the latter half of the century (May and Robinson 1985). In response to dwindling migratory bird populations, federal, state, and nongovernmental agencies have launched research and management initiatives to explore the ecological effects of cowbird parasitism.

In 1993, we commenced a study in Ohio, Maryland, and the District of Columbia to investigate the influences of forest size, nesting microhabitat, landscape features, and geographic region on reproductive success of forest-breeding birds. Brown-headed Cowbird nest parasitism is a major aspect of the study. The purpose of this chapter is to assess the relationship between two aspects of the physical environment (forest patch size and composition of the surrounding landscape) and nest parasitism levels in Acadian Flycatchers (*Empidonax virescens*) and Wood Thrushes (*Hylocichla mustelina*) breeding in forest fragments within highly managed landscapes.

Study Sites and Methods

Eighteen forest fragments were selected in the Coastal Plain and Western Shore physiographic regions of Maryland (see Figure 1 in Robbins et al. 1989) and District of Columbia (hereafter, Maryland; $N = 11$), and in the Allegheny Plateau and Ohio Hills regions (see Figure 1 in Bystrak 1981) of northeastern Ohio ($N = 7$). Fragments ranged from 20 to more than 500 ha and were located in either predominantly agricultural-rural ($N = 10$) or urban ($N = 8$) landscapes. Landscapes were defined according to the land uses within 5 km of each site. Urban sites were located within metropolitan areas surrounding Washington, D.C., and Cleveland and Akron, Ohio, where urban and suburban development are extensive (often over 50% of the matrix). Agricultural-rural landscapes contained less than 1% of the numbers of buildings found in urban areas and were dominated by agricultural fields and forest patches.

Generally, forests had not been harvested for approximately 80–150 years. Canopy trees in several fragments were at least 200 years old. Nearly all plots were located in parks and reserves, but human impacts were restricted to small foot trails in areas where we searched for nests. Based on tree species composition, each plot was loosely characterized as either a beech-maple or oak-hickory association. Ohio sites, located in Cuyahoga, Medina, Summit, and Ashland counties, were composed predominantly of beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), white oak (*Quercus alba*), red oak (*Q. rubra*), wild cherry (*Prunus serotina*), and white ash (*Fraxinus americana*). Maryland sites were located in Montgomery, Prince Georges, and Anne Arundel counties, as well as in the District of Columbia. Vegetation composition in Maryland was similar to that of Ohio, although tulip trees (*Liriodendron tulipifera*) and oaks (e.g., chestnut oak, *Q. velutina*, and red oak) were often more dominant in Maryland.

On each site, searches for nests were restricted to a predefined plot covering 20–40 ha (determined by fragment size and homogeneity of vegetation). Typically, at least one side of a plot abutted a forest-edge interface. Nests were located between May and July during searches conducted every 3–5 days per plot. Active nests (containing live eggs or young, or with obvious signs of adult activity such as nest building) were also monitored at similar intervals. Plastic flagging was placed more than 10 m away from active nests in cases where nests would be difficult to relocate because of a lack of natural landmarks.

Analyses in this chapter were restricted to Acadian Flycatchers and Wood Thrushes because of small sample sizes for other species. Five sites were discarded in analyses for Wood Thrushes because nest contents were positively known for fewer than five nests. In all statistical analyses, each site (as opposed to individual nests) was treated as an independent replicate. Difference in parasitism levels between Wood Thrushes and Acadian Flycatchers was assessed with the Wilcoxon matched-pairs signed-ranks statistic (T), which controlled for species-specific differences in distribution across sites. For each species, nonparametric Mann-Whitney U-tests (Z approximation) were used to evaluate differences between parasitism frequency in large (> 400 ha) and small (< 130 ha, mean = 65 ha) fragments, in urban and agricultural landscapes, and in Ohio and Maryland. The relationship between fragment area and parasitism frequency was assessed with Spearman's rank correlation coefficients (r_s). A critical probability level of .10 rather than .05 was set for significance in all statistical tests because of the value of minimizing Type II errors in conservation-related hypothesis testing (Askins et al. 1990).

Results

Acadian Flycatchers and Wood Thrushes nested on 18 and 17 plots, respectively. However, numbers of Wood Thrush nests were sufficient for statistical analyses on only 13 sites. Totals of 358 Acadian Flycatcher and 329 Wood Thrush nests were located, but only 70% of the nests of each species were used in statistical analyses because of uncertainty over the occurrence of parasitism in the other nests. In the following analyses, numbers of nests with known contents for each plot averaged 17 for Wood Thrush (median = 12, range = 5–74) and 14 for Acadian Flycatcher (median = 10, range = 5–49).

Overall, 10.7% of all Acadian Flycatcher and 21.7% of all

Wood Thrush nests were parasitized. Parasitism frequencies did not vary by region for either species (Acadian Flycatcher, $Z = 0.56$, $P = .57$; Wood Thrush, $Z = 0.63$, $P = .53$), although for both species the average parasitism frequency was slightly greater in Maryland (Figure 31.1).

Effects of Surrounding Landscape

Although parasitism was slightly more prevalent in urban areas compared with agricultural areas for both Acadian Flycatchers ($Z = 1.26$, $P = .22$) and Wood Thrushes ($Z = 0.43$, $P = .67$), landscape type played only a minor role in overall probability of parasitism in 1993 (Figure 31.1).

When analyses were restricted by region, parasitism of Acadian Flycatchers was slightly more frequent in urban landscapes in both Maryland (mean parasitism frequency in agricultural areas = 13%, urban = 22%; $Z = 0.84$, $P = .40$) and Ohio (agricultural = 10%, urban = 15%; $Z = 0.55$, $P = .58$). For Wood Thrushes, however, this relationship was not evident in either Maryland (agricultural = 19%, urban = 22%; $Z = 0.13$, $P = .90$) or Ohio (agricultural = 14%, urban = 0%: 0 of 5 nests from 2 plots).

Effects of Forest Fragment Size

Parasitism frequencies were five times greater on Acadian Flycatchers breeding in small forest fragments compared with large forests ($Z = 2.82$, $P < .01$; Figure 31.1a). Wood Thrushes, however, displayed a much weaker relationship with fragment size ($Z = 0.73$, $P = .47$; Figure 31.1b). However, the overall correlation between fragment area and parasitism frequency was significant for both Acadian Flycatchers ($r_s = -0.725$, $P < .01$, $N = 18$) and Wood Thrushes ($r_s = -0.506$, $P = .08$, $N = 13$).

In both Ohio ($Z = 2.07$, $P = .03$) and Maryland ($Z = 1.65$, $P = .10$), Acadian Flycatchers suffered greater cowbird parasitism in small forest fragments than in large forests. That trend was apparent, but nonsignificant, for Wood Thrushes in Ohio ($Z = 1.22$, $P = .22$); thrushes in Maryland were parasitized nearly equally often in large and small fragments ($Z = 0.12$, $P = .90$). Correlation analysis supported the relationship between parasitism and fragment area for Acadian Flycatchers in both Ohio ($r_s = -0.675$, $P = .09$, $N = 7$) and Maryland ($r_s = -0.811$, $P < .01$, $N = 11$; Figure 31.2a). Negative relationships between those two variables were also observed for Wood Thrushes in Ohio ($r_s = -0.778$, $P = .22$, $N = 4$) and, to a much lesser extent, in the 9 forest fragments in Maryland ($r_s = -0.247$, $P = .52$; Figure 31.2b).

The negative relationship between fragment size and parasitism frequencies in Acadian Flycatchers was apparent in both agricultural ($Z = 2.24$, $P = .02$) and urban ($Z = 2.18$, $P = .03$) landscapes. For Wood Thrushes breeding in agricultural areas, parasitism frequencies in small fragments (23%) were twice as high as those in large fragments (11%),

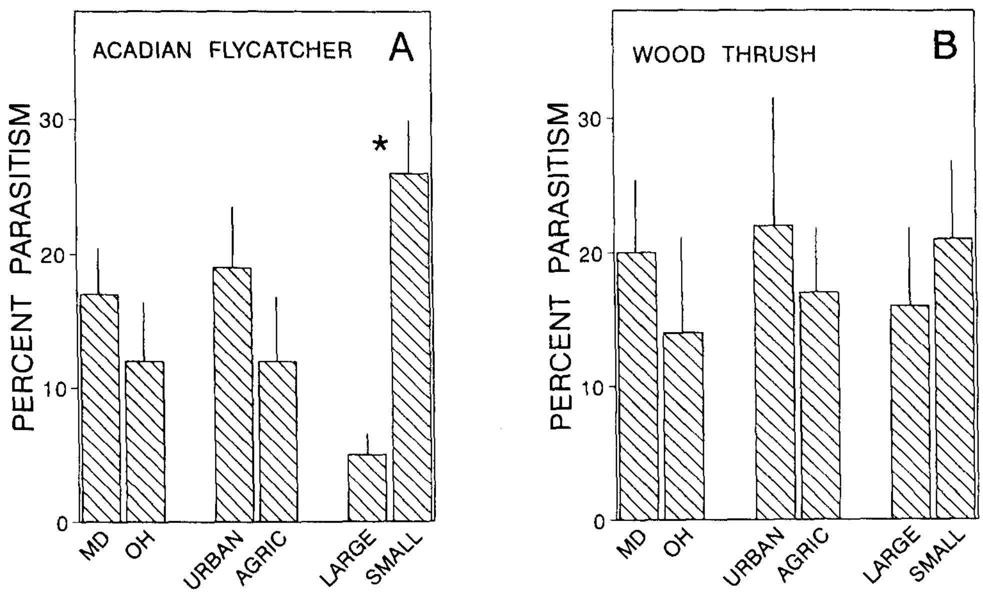

Figure 31.1. Average percentage of parasitism of (A) Acadian Flycatchers and (B) Wood Thrushes in different regions, landscapes, and fragment sizes. Bars represent mean values from study sites, vertical lines signify standard errors, and the asterisk indicates a significant ($P < .10$) difference.

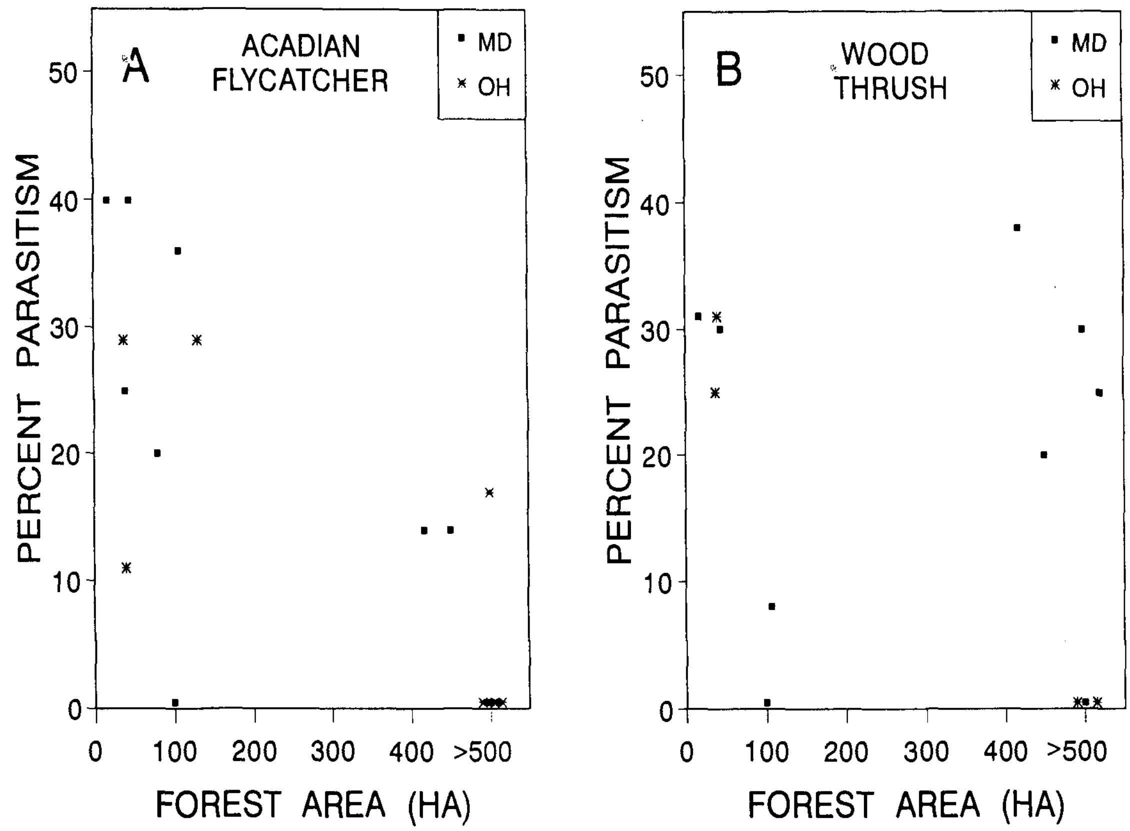

Figure 31.2. Relationship between frequency of parasitism and fragment size for (A) Acadian Flycatchers and (B) Wood Thrushes breeding in forest remnants in Ohio and Maryland.

although this difference was not significant ($Z = 1.41$, $P = .16$). Sample sizes for Wood Thrushes in urban fragments were too small for statistical analyses.

Discussion

Frequencies of parasitism in both Acadian Flycatchers and Wood Thrushes here were generally consistent with levels of parasitism observed elsewhere for these species in the eastern U.S. (e.g., Walkinshaw 1966, Hoover and Brittingham 1993, Roth and Johnson 1993; Dowell et al., Chapter 29, this volume). However, results from this study should be interpreted cautiously because local parasitism frequencies can vary substantially among years (Petit 1991, Roth and Johnson 1993).

The slightly higher frequencies of parasitism in Maryland than Ohio for both species contrast with the conclusion of Hoover and Brittingham (1993), who suggested that there is a negative relationship between parasitism level and distance from the Great Plains. However, parasitism levels in both areas were lower overall than levels found in fragmented landscapes in the midwestern U.S. (Robinson et al. 1995; Donovan et al., Chapter 30, this volume).

Parasitism levels for both Acadian Flycatchers and Wood Thrushes were clearly influenced more by the area of a forest fragment used for breeding than by either geographic region or surrounding landscape. Thus, dissection of forest habitat results in increased brood parasitism of forest-dwelling birds. Increased parasitism levels in relatively small forest fragments have important ramifications for design of forest reserves. The question of the value of small versus large reserves was initially evaluated during the 1970s SLOSS (single large or several small) debate over reserve design (Simberloff and Abele 1976, Whitcomb et al. 1976). Reserve size is now incorporated into algorithms used for identification of critical areas for preservation of species diversity (Margules et al. 1988), using simple presence or absence of species as a function of forest area. The fact that the presence of a species may not necessarily indicate a suitable local environment for reproduction has only recently begun to be incorporated into management and conservation plans (Martin 1992). Acadian Flycatchers and Wood Thrushes do not exhibit strong forest-area sensitivity (Robbins et al. 1989). Breeding populations of such species in small woodlots and forest fragments in eastern North America may experience low reproductive success due to area- and edge-related factors, including cowbird parasitism (e.g., Roth and Johnson 1993). Such potential sink populations (Pulliam 1988) may be maintained only by immigration from areas with successful reproduction. Although the impact of cowbird parasitism on Acadian Flycatchers and Wood Thrushes was minor in relation to losses from nest predation (L. Petit and D. Petit unpubl. data), larger forest reserves may enhance reproductive success of some forest birds through both reduced predation and reduced parasitism (Robinson et al. 1995).

Nevertheless, the effect of forest fragment area on probability of parasitism was weak for Wood Thrushes breeding in eastern Maryland. Likewise, in an investigation conducted over several years in Maryland, Dowell et al. (Chapter 29, this volume) also found that forest area apparently had little influence on parasitism frequencies of Wood Thrushes. Other factors, such as microhabitat surrounding a nest (Petit and Petit unpubl. manuscript), distance to a canopy opening (Brittingham and Temple 1983), or relative abundances of different hosts, may influence probability of parasitism more strongly. These factors deserve further attention.

Landscape type had little effect on parasitism frequencies, although they were generally higher in urban areas. However, when all nests of Acadian Flycatchers (as opposed to replicate plots) were summed by landscape type, nests in urban areas suffered much higher parasitism (21%) than nests in agricultural areas (6%; log-likelihood ratio test, $G = 12.65$, $P < .01$). Cowbirds are attracted to feeding sites in agricultural fields and human settlements (Robinson et al. 1993), so that parasitism frequencies in habitats near these areas are inflated. Within urban areas, grassy lawns, golf courses, recreation areas, and high densities of songbird feeders probably provide good feeding sites for cowbirds. Our results indicate that one cost of a large cowbird population in highly urbanized areas is reduced nesting success of the avian hosts in urban parks and reserves.

The impact of Brown-headed Cowbird parasitism on small birds has been suspected for more than a century (Friedmann 1929, Mayfield 1965). However, organized avian monitoring programs and the resulting discoveries of shrinking migratory bird populations and expanding numbers of Brown-headed Cowbirds (Part I, this volume) have only recently led wildlife ecologists to study those trends. Although it is easy to presume that anthropogenic activity is harmful to wildlife populations, well-designed scientific study is indispensable for advancement of viable and long-term conservation strategies. In our study, the presumed relationship between fragment area and frequency of cowbird parasitism was confirmed for the Acadian Flycatcher and, to a lesser extent, for the Wood Thrush. For several other species breeding on these study sites, however, fragment size had little apparent influence on probability of parasitism (L. Petit and D. Petit unpubl. data). Thus, as for many ecological phenomena, explanations are neither obvious nor simple. Wildlife and resource managers, as well as researchers, should not be content with current knowledge of cowbird-host relationships. Rather, we need to know the impact of Brown-headed Cowbirds relative to other sources of mortality to understand songbird population dynamics in fragmented landscapes.

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