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FOREST FRAGMENTATION AND THE DECLINE OF MIGRATORY SONGBIRDS

by Robert A. Askins

During the summer of 1953 William Niering and Richard Goodwin initiated a study of the birds and vegetation in the Connecticut College Arboretum in New London. They surveyed plants and counted singing birds in two adjacent study sites: a shrubby old field that had been abandoned a few years previously, and an old, but storm-damaged, oak-hemlock forest. Their intent was to monitor the old field as it changed to a thicket and then to a young forest. The oak-hemlock forest would serve as a relatively stable "control," a baseline for comparison. How long would it take before these two distinctly different sites shared similar arrays of plants and animals?

Changes in the birdlife of the old field were predictably dramatic. The Ring-necked Pheasants, American Goldfinches, and Song Sparrows of the open grassland were replaced by Brown Thrashers, Prairie Warblers, Yellow-breasted Chats, and other thicket species, which in turn disappeared as the young forest was colonized by Black-capped Chickadees, Wood Thrushes, and Red-eyed Vireos (Askins 1990). Unexpectedly, the bird community of the mature forest displayed changes that were nearly as dramatic. By the early 1970s many voices had disappeared from the morning chorus of early summer in the forest. Eastern Wood-Pewee, Canada Warbler, American Redstart, and Black-throated Green Warbler were gone; and Red-eyed Vireo and Hooded Warbler had declined precipitously (Butcher et al. 1981). The forest had become more mature as the tree canopy closed, creating what appeared to be a more favorable habitat for at least some of these forest bird species, but they declined nonetheless.

This change was particularly alarming because it paralleled changes at many other forest sites in eastern North America. Many of the same species had declined at four sites near Washington, D.C., two sites in northern New Jersey, and one site in upstate New York (Askins et al. 1990). A particularly severe collapse in the diversity of forest birds was recorded at Greenbrook Sanctuary, a preserve on the Palisades above the Hudson River. Between the late 1940s and the 1980s, the following species disappeared from this study site: Eastern Wood-Pewee, Yellow-throated Vireo, Black-throated Green Warbler, American Redstart, Ovenbird, and Hooded Warbler (Serrao 1985). Most of the species that declined at Greenbrook Sanctuary and the other sites shared two characteristics: they are forest specialists (species that normally nest in the interior of forests, away from open habitats) and neotropical migrants (species that nest in the North American temperate zone and winter in the tropics).

What Caused The Decline?

Initially, these declines were attributed to destruction of winter habitat (Briggs and Criswell 1978; Morton 1980). During the winter neotropical migrants are concentrated in Mexico, northern Central America, and the northern West Indies, regions where forests and other natural habitats have been destroyed at a rapid rate since the late 1940s. Because migratory birds spend more than half of the year in their winter habitats, a severe reduction in the amount of this habitat potentially could have a major impact on their populations.

An alternative explanation emphasized a consistent characteristic of the sites where these declines have occurred; they are relatively small nature preserves or parks, "islands" of woodland in an urban or suburban sea (Whitcomb et al. 1981). In most cases these sites have become increasingly islandlike and increasingly isolated from other forests as residential and commercial areas have spread across the surrounding region. For example, between 1950 and 1985, the period in which forest birds declined at several sites near Washington, D.C., the amount of forest in the four counties surrounding the city was reduced by thirty to forty percent (T.W. Birch, personal communication). As the remaining patches of forest became more isolated, they may have been colonized by fewer birds dispersing from other forests. If a small population on one of these forest islands declined, it would not be replenished by immigrants from other sites (Brown and Kodric-Brown 1977). Consequently, the species restricted to these islands (i. e., the forest specialists) would suffer a high rate of extinction.

During the 1980s it became clear that high extinction rates in small forests had a much more immediate cause than their isolation from other forest bird populations. Although the interior of a small forest patch may look superficially similar to the interior of a large forest, it is a distinctly different, and much more hostile, environment for forest birds. Small forests are readily penetrated by an array of predators that thrive on the forest edge and in the surrounding rural or suburban habitats. Raccoons, feral cats, American Crows, and Blue Jays reach the heart of small forests and prey on the eggs and young of forest birds. Many species of forest birds are particularly vulnerable to these nest predators because they build open-cup nests on the ground or low in the shrub layer. Brown-headed Cowbirds may also be abundant near the forest edge (Brittingham and Temple 1983). They parasitize the relatively accessible nests of forest-interior birds, reducing nest success even further. In a study of six small woodlots in Illinois, Robinson (1988) found that eighty percent of the nests were destroyed by predators and sixty-five percent of the susceptible nests were parasitized by cowbirds. Recently, the reproductive rates of Ovenbirds were determined in a large tract of forest and in eleven small forest patches (fourteen to one hundred and eighty-three hectares) near Hawk Mountain, Pennsylvania (James Bednarz,

personal communication). Apparently because of high predation rates, only six percent of the males in the small forests fledged young. In contrast, fifty-nine percent of the males in the large forest were successful. Moreover, Temple and Cary (1988) showed that nest success rates were substantially lower near the forest edge than in the interior of large forests. Even the center of a small forest patch is close to the forest edge, so there may be no refuge from predators and cowbirds.

Two lines of evidence indicate that the severe population declines that have occurred in small forests are due to problems with the breeding site rather than to destruction of winter habitat. First, the severe declines documented in small forests generally have not characterized populations of neotropical migrants in extensive forests. Wilcove (1988) found no evidence for an overall decline in neotropical migrants in Great Smoky Mountains National Park between 1947 and 1983. Moreover, at two sites in the heavily forested White Memorial Foundation in Connecticut, the abundance of migrants increased significantly between 1965 and 1988 (Askins et al. 1990). In contrast, populations of some migrants declined at a site in the White Mountains of New Hampshire, but this was probably due to changes in forest structure and insect abundance (Holmes and Sherry 1988). Hence the consistent and severe decline of migratory bird populations in small preserves is not apparent in the few large forests where bird populations have been monitored.

The second line of evidence comes from surveys of numerous forests in the same region. Studies in Wisconsin, Maryland, Illinois, Missouri, Ontario, and Connecticut have revealed the same basic pattern: both the diversity and density of migratory forest birds is higher in large forests than in small forests (Askins et al. 1990). For example, Robbins and coworkers (Robbins et al., *Habitat Area*, 1989) surveyed birds in 271 forests in Maryland and surrounding states. All forests were surveyed in the same manner; birds were counted at a single survey point in the interior of the forest. The probability of occurrence was higher in larger forests than in smaller forests for twenty-six species, most of which are neotropical migrants. Moreover, some species, such as Cerulean Warbler and Black-throated Blue Warbler, occurred only in large forests. These results support the contention that small forest patches do not provide favorable breeding habitat for a large number of species of forest migrants.

During the 1970s the Connecticut College Arboretum fit this pattern very well (Butcher et al. 1981); several species of forest migrants had declined and disappeared during the 1960s and 1970s, a period when woods south of the study area were replaced with shopping centers and a highway interchange. When Margaret Philbrick and I revived this census in 1982, we fully expected to find that more species of forest birds had been lost from the study area. During the most recent census, in 1976, Red-eyed Vireo and Hooded Warbler had seemed to be on the verge of disappearing (Butcher et al. 1981). However,

we soon discovered that, far from going extinct at the study site, these species had increased (Askins and Philbrick 1987). Also, Eastern Wood-Pewee, which had disappeared from the site during the 1970s, was again present. The overall density of neotropical migrants had increased, and it remained high through 1991 (although never as high as in the 1950s) (Askins 1990). During the late 1970s and the 1980s, the study site was becoming less isolated due to the growth of forest on abandoned farmland to the west and north, a process that was well documented by the surveys of vegetation and birds in the adjacent old-field study area. Perhaps the bird populations in the forest study area have become buffered from nest predators and cowbirds by the bands of new forest along its western and northern borders.

Have Neotropical Migrants Shown An Overall Decline?

Forest fragmentation has probably resulted in the decline of migratory songbirds in Washington, D.C., northern New Jersey, and other regions where extensive suburban development has occurred during the past four decades. The total amount of forest has progressively increased in other regions of the Northeast, however (Birch and Wharton 1982; Brooks and Birch 1988), and this has probably resulted in a reduction in the amount of forest fragmentation. Hence it is not clear that forest fragmentation would have caused an overall decline in populations of neotropical migrants. Although forest fragmentation may be localized, the effect on bird communities would be highly conspicuous because the rate of fragmentation would be highest in heavily populated regions where observers are concentrated.

Studies in heavily forested areas such as the Great Smoky Mountains do not consistently show that neotropical migrants have declined, but unfortunately only a few long-term censuses have been maintained in such remote areas. A better source of information on general trends in migratory songbird populations is the Breeding Bird Survey (BBS), a system of more than two thousand roadside survey routes in the United States and Canada (Robbins et al. 1986). These routes are surveyed once each breeding season. Between 1966 and 1979, BBS results indicated that the populations of most species of forest migrants were increasing (Robbins et al. 1986), which is opposite to the trend displayed in many small forests during the same period. Between 1978 and 1987, however, most species of migrants that nest in forests were declining (Robbins et al., *Population Declines*, 1989). Population declines were particularly prevalent in species that winter in tropical forests rather than in second-growth habitats, suggesting that destruction of tropical forests caused the declines. Perhaps the dramatic population declines in suburban forests masked the much more subtle, but ultimately more important, declines due to loss of winter habitat.

Additional evidence for a long-term decline comes from the field notes of

Ludlow Griscom and Norman Hill for spring migration in eastern Massachusetts between 1937 and 1989 (Hill and Hagan 1991). Most species of migratory songbirds were detected progressively less frequently during this period. Most disturbing, the total number of migrants detected per hour fell by sixty-four percent between 1954 and 1987. In addition, counts of spring migrants at Long Point, Ontario, indicate that most species of migratory songbirds declined between 1961 and 1988 (Hussell et al. in press).

Although these results are alarming, they do not tell the entire story. Data on spring migrants caught at banding stations at Manomet Bird Observatory in Massachusetts and Powdermill Nature Reserve in Pennsylvania show that capture rates for most species of neotropical migrants have not declined during the past twenty years (Hagan et al. in press). Also the BBS, which covers a greater geographical area than any other monitoring program for breeding birds in North America, shows that densities of most species of forest migrants increased during the first thirteen years of the surveys and declined during the subsequent eleven years. The net result was that few species showed an overall decline between 1966 and 1989 (Sauer and Droege, in press).

Prognosis For The Future

Regardless of whether or not winter habitat destruction has already caused migratory bird populations to decrease, it seems inevitable that it will eventually have this effect. Tropical forests are being destroyed at a rapid, probably accelerating pace, in Mexico and Central America, where a large proportion of neotropical migrants are concentrated during the winter (Gradwohl and Greenberg 1988). Recent studies of migrants in their winter areas have shown that, although most species are found in a range of different habitats, many species achieve their highest densities in rain forest or tropical moist forest. For example, in a study of the distribution of wintering migrants in different habitats on the Yucatan Peninsula, Lynch (1989) found that several species were found primarily in mature moist and semi-evergreen forest. The "forest specialists" included Wood Thrush, Blue-winged Warbler, Black-and-white Warbler, Kentucky Warbler, Hooded Warbler, and Wilson's Warbler. In contrast, some other species that nest in forests were found in a wide variety of winter habitats, from old fields to tall forests. This group included Least Flycatcher, Northern Parula, and Magnolia Warbler. Species in the latter group may not be affected very much by tropical forest destruction because they are frequent in disturbed habitats. This assumes, of course, that the rates of survival for these species are similar in disturbed and undisturbed habitats (Rappole and Morton 1985), a factor about which we have little information. It is clear, however, that the species that concentrate in forests in winter are rapidly losing their preferred habitat in Mexico and Central America. It is difficult to see what would prevent their populations from falling.

In the West Indies observers often find large numbers of wintering warblers in disturbed habitats and gardens. For example, Emlen (1977) found that a number of species, including Yellow-rumped Warbler, Prairie Warbler, Palm Warbler, and Common Yellowthroat, occurred frequently in a wide range of habitats, including open habitats such as marshes and old fields. These species are probably not greatly threatened by habitat change in their wintering area. In contrast, a survey of different habitats in the U. S. Virgin Islands showed that many species were largely restricted to large tracts of woodland in Virgin Islands National Park, and that within these tracts they were concentrated in the relatively tall moist forest on mountain ridges and in deep valleys (Askins et al. in press). In particular, Black-and-white Warblers, American Redstarts, Ovenbirds, and Hooded Warblers were recorded almost exclusively in this habitat. Only Northern Parula and Prairie Warbler were frequent in dry woodland and gardens, and the former was most abundant in moist forest. Mixed flocks with several species of warblers were frequent in canopy and subcanopy of tall moist forest, but infrequent in all other habitats. Thus, most of the species that overwinter in the Virgin Islands would be negatively affected by destruction of moist forest, and in fact these species are substantially less abundant on the heavily developed island of St. Thomas than in the forests of Virgin Islands National Park on St. John (Askins et al. in press).

We still know surprisingly little about the ecology of migratory songbirds in their winter habitats, but there is growing evidence that a large number of species require tropical forests. The future of these species will depend upon whether the rapid conversion of tropical forest to pasture and marginal farmland can be slowed and stopped. Maintaining tropical forests will not only protect the rich diversity of plants and animals of the tropics, but will also help protect a large proportion of the songbirds that nest in the coniferous and deciduous forests of temperate North America.

Protection of lowland rainforests in Guatemala, Belize, and Mexico and mountaintop forests in the West Indies will not be sufficient, however; migratory songbirds also require suitable breeding habitat. Indeed, breeding habitat may have been the limiting factor for migratory birds during the past one hundred to one hundred and fifty years. Between 1800 and 1900, the forests of eastern North America were destroyed at a rapid rate (Terborgh 1989). Most of the tall deciduous forests of the Ohio River Valley were cut, and most of the woodland of southern New England was converted to an open landscape of fields, pastures, and tiny woodlots (Cronon 1983). This marked reduction in the amount of breeding habitat probably left an excess of winter habitat. Perhaps even today tropical countries have not caught up with the North in the destruction of habitat for migratory songbirds (Terborgh 1989).

During this century forests have grown back, as farms were abandoned in many regions of eastern North America. In more heavily settled areas the

regrowth of forests has been counteracted by the fragmentation of forests resulting from the rapid growth of suburban areas. The resulting patches of woodland generally are not favorable habitat for forest-interior birds. Although large areas of Canada, the northern Midwest, and northern New England are heavily forested, and in many cases the forests are becoming more mature and continuous (Brooks and Birch 1988), fragmentation may be important even in these areas. Forestry practices that create a patchwork of small clearings result in a substantial increase in forest edge, probably resulting in higher rates of nest predation and cowbird parasitism for birds in the surrounding forest. These clearings are generally temporary, however. As young forest grows in these areas, the forest edge disappears, and the openings are colonized by forest-interior birds surprisingly quickly (Mauer et al. 1981). In contrast to logging, residential and resort development is a much more serious problem because large forests are permanently fragmented. Widespread development of private forest lands in northern New England could result in an extensive degradation of habitat for migratory songbirds.

What Can Be Done?

Environmental problems such as acid rain, greenhouse warming, and ozone depletion can only be solved through international cooperation. The same is true for conservation of migratory birds. In the long term, many species can only be protected if their winter habitats in the West Indies and in Central and South America are protected. It is therefore crucial for us to support the efforts of conservationists in tropical countries who are working to protect natural habitats.

The prescription of maintaining viable breeding populations of migratory songbirds in the North is relatively simple: avoid fragmenting forests. For example, lumbering could be concentrated into a particular sector of a forest during a particular period, preventing a checkerboard pattern of scattered openings. Houses and resort buildings could be clustered to minimize disruption of continuous forest. Powerlines could be routed along the periphery of a forest rather than through the center. This would require major changes in current land-use practices, which are characterized by sprawling development that ignores the integrity and value of large, uninterrupted expanses of natural habitat.

Amateur ornithologists can make a major contribution not only by helping with efforts to protect winter and breeding habitats, but also by applying their expertise in some of the critical monitoring programs, particularly the BBS and surveys in the interior of large forests that are being initiated in several U. S. states and Canadian provinces. Some national forests have also started monitoring programs that depend on volunteers. The conservation and research efforts for migratory songbirds are being coordinated through the Neotropical

National Fish and Wildlife Foundation. This program involves a partnership among government agencies and private conservation organizations, and should increase the effectiveness of research programs and conservation efforts for migratory birds. Not incidentally, it should demonstrate to people in both the temperate zone and tropics that we can only solve the environmental problems of the Western Hemisphere by working together.

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