Hostile Landscapes and the Decline of Migratory Songbirds

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Between 1949 and 1987, forest birds suffered severe population declines in the 67 hectares of oak forest at Greenbrook Sanctuary, a nature reserve on the Hudson River in New Jersey (*1*). The veery, black-and-white warbler, and worm-eating warbler declined by more than 50 percent, and several species common at the beginning of the study (yellow-throated vireo, black-throated green warbler, American redstart, ovenbird, and hooded warbler) disappeared entirely from the site by the 1980s. Similar population declines occurred in various species of vireos, warblers, thrushes, and flycatchers at eight other sites in the eastern United States that were assessed by intensive Breeding Bird Censuses (*1*).

Bird populations can be indicators of environmental change; for example, the pervasive and insidious effects of DDT on natural food webs first became evident because of the reproductive failures in peregrine falcons and other birds (*2*). What environmental change caused forest birds to disappear from the carefully protected natural areas used for these censuses? A report in this week's issue of *Science* (*3*) by Robinson and co-workers provides an answer.

Nearly all of the species showing severe declines share two characteristics: They are long-distance migrants, breeding in the north temperate zone and spending the winter in the tropics, and they are forest specialists that generally do not nest in nonwooded habitats. These two common denominators generated two competing hypotheses: The declines may result from destruction of tropical winter habitat or, alternatively, from degradation of forests used for nesting in the north.

Although the populations of some species of migrants that spend the winter in tropical forests may be diminishing slowly because of conversion of winter habitat to farmland and pasture (*4*), this process does not explain the much more rapid declines at the Breeding Bird Census sites. Significantly, all of these sites are in relatively small patches of forest, wooded islands surrounded by residential neighborhoods or farmland (*1*). Forests larger than 100 hectares do not show the consistent, catastrophic loss of forest migrants exhibited by these small forests (*1*, *5*). An initial hypothesis attributed the loss of species from these small forest "islands" to the same processes that are thought to determine the number of species on oceanic islands: Small populations on an island are prone to extinction, and the isolation of the island reduces the chances that a population will be rescued by immigrants of the same species, or that lost species will be replaced with new species that have dispersed from other sites (*6*). However, fieldwork showed convincingly that forest birds in these small forests have a more severe problem than those created by small populations and isolation. Compared to the interior of large forests, small forests are an unfavorable environment for nesting because of parasitism by cowbirds and the loss of eggs and nestlings to predators.

The key to this problem is the forest edge, the often sharp boundary between the woodland and surrounding pasture, cropland, or residential areas. Small mammalian predators, such as raccoons and feral cats, and egg-eating birds like American crows and blue jays concentrate their hunting along the forest edge (*5*, *7*). The brown-headed cowbird also tends to be most common near the forest edge (*5*, *7*). The female cowbird lays her eggs in the nests of other species, reducing their reproductive success because the host parents are diverted into feeding cowbird nestlings while their own young starve. Both cowbirds and nest predators are most active in the forest within 100 to 200 meters of the forest edge, so the interior of the forest represents a relatively safe haven for nesting (*8*). In a small forest, however, most or all of the potential nesting habitat may be within 100 meters of the forest edge, leading to low reproductive success.

Not surprisingly, comparisons of forests in the same region show that both the density and the number of species of forest migrants are substantially lower in small forests than in large forests (*1*). Moreover, the census sites that exhibited severe population declines are all small enough so that most bird nests are vulnerably close to the forest edge. Specifically, some of these sites recently have been engulfed by suburban development, probably leading to an increase in the density of nest predators and cowbirds (*1*).

Small forests are unfavorable for nesting not because of the habitat characteristics of the forest itself, but because of the characteristics of the surrounding landscape or "matrix." If the matrix has few nest predators or cowbirds, then nest success will be similar for large and small forests. Conversely, if there are feedlots that attract cowbirds or garbage cans that attract raccoons near a small forest, then nest success may be low. Several studies suggest that the severity of predation and parasitism in small forests varies among landscapes. For example, in small woodlots in Illinois, nest

Dangerous edges. The patches of forest in this landscape contain appropriate nesting habitats for forest birds, but many species may nevertheless have low reproductive rates because of the proximity of the forest edge, which increases predation and parasitism. [Photo by Deanna Dawson]

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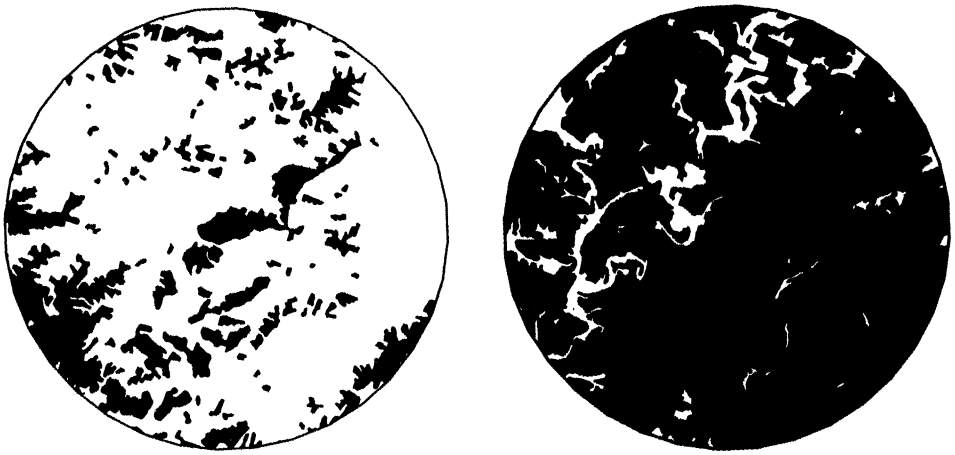

Forest fragmentation. Computer-interpreted maps of two landscapes in Missouri that differ greatly in the proportion of forested (green) and nonforested (white) land. These are two of the circular study plots analyzed in (*3*). Radius, 10 km.

predation and cowbird parasitism are so high for wood thrushes that not enough young are produced to sustain the population (*9*). In Pennsylvania, wood thrushes also have low nesting success in small forests, but this is almost entirely due to nest predation; cowbird parasitism is rare (*10*). In contrast, wood thrushes in a small forest in Delaware produce enough young in most years to replace themselves because of low rates of both parasitism and predation (*11*). Also, the relation between forest area and the number of species of forest migrants varies regionally: The reduction in the number of species in small forests tends to be more severe in agricultural landscapes than in more heavily forested landscapes (*12*).

Although previous studies have suggested a relation between nesting success and the amount of nonforested habitat in the regional landscape, Robinson and colleagues (*3*) now report the first conclusive test of this hypothesis. Five groups of researchers determined rates of nest predation and cowbird parasitism in nine landscapes in the midwestern United States. Forest cover in these landscapes varied in a smooth gradient from 6 to 95 percent. Using standardized measures of predation and parasitism rates, the researchers showed that study areas in landscapes with little forest cover are population "sinks" where reproduction is too low to sustain the population. These populations must depend on dispersal of birds from "source" populations that produce more young than they need to perpetuate themselves. Heavily forested landscapes have low enough rates of predation and parasitism to generate this surplus.

These results have broad implications. Extensive, continuous forests should be preserved not only because they contain a diverse assemblage of forest migrants, but also because they are the source of immigrants that sustain populations of forest migrants in other regions where the forest cover has been disrupted. Insectivorous birds (most of which are migrants) can prevent outbreaks of leaf-eating insects in forests (*13*), so a major decline in migrants could affect the health and stability of forests. More generally, this study shows that conservation efforts must be planned at the scale of the regional landscape. No matter how carefully they are protected, small nature preserves may progressively lose their most distinctive species if they are surrounded by a hostile landscape.

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