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Robert A. Askins
Connecticut College, raask@conncoll.edu

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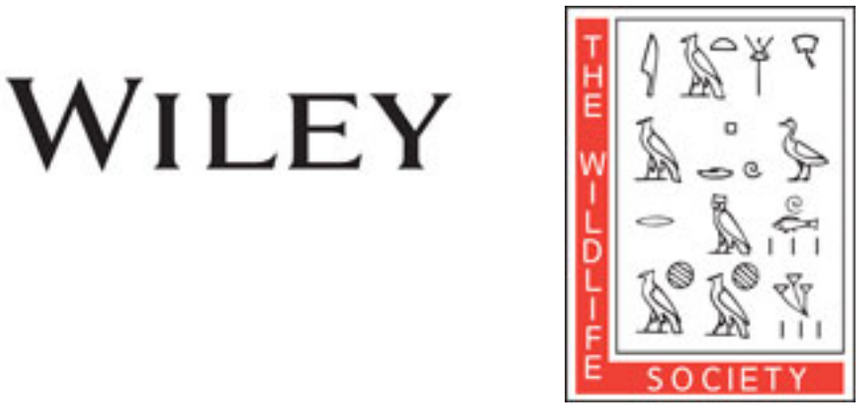

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COMMENTS . . .

OPEN CORRIDORS IN A HEAVILY FORESTED LANDSCAPE: IMPACT ON SHRUBLAND AND FOREST-INTERIOR BIRDS

ROBERT A. ASKINS, ***Department of Zoology, Connecticut College, 270 Mohegan Avenue, New London, CT 06320***

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Studies in eastern North America show that >25 species of forest songbirds tend to be more abundant in large forests than in small, isolated patches of forest (Askins et al. 1987, Robbins et al. 1989, Wilcove and Robinson 1990). Most of these "area sensitive" species are Neotropical migrants. Research on natural nests and experiments with artificial nests both indicate that nest success is low for these species in small forest patches because of parasitism and predation by species that occur most frequently near the edge of the forest (Wilcove 1985, Robinson 1988). In small forest patches even the center of the stand is close to the forest edge, so brood parasitism by brown-headed cowbirds (*Molothrus ater*) and nest predation by raccoons (*Procyon lotor*) and other predators occur throughout the stand. Consequently, fragmentation of temperate-zone forests into small patches is a threat to many species of migratory birds, a group that also is threatened by loss of wintering habitat in the tropics.

Because of the susceptibility of private forest land to subdivision and fragmentation, public forest land is the most likely place to maintain large blocks of continuous forest needed by area-sensitive species (Wilcove 1990). However, logging and road-building in state and national forests breaks the continuity of the canopy. A key question is whether these openings are really comparable to the forest fragmentation found in agricultural or suburban landscapes where forest is restricted to island-like patches surrounded by extensive areas of more open habitat (Thompson et al. 1992). For example, clearcuts are relatively temporary disruptions of the forest canopy, and in large forests they create internal rather than external forest edges. Thus it is not obvious that they would exhibit the high rates of cowbird parasitism and nest predation characteristic of a forest edge abutting a residential area or an agricultural field. Studies of the impact of timber harvesting on forest songbirds indicate that densities of most species are not substantially reduced as a result of moderate clear-cutting in extensively forested landscapes (Derleth et al. 1989, Thompson et al. 1992, Welsh and Healy 1993). However, a conclusive assessment of the influence of clear-cutting and other timber harvesting techniques on forest birds awaits results of studies of the impact of logging on reproductive rates of birds in the surrounding forest.

A potentially more serious problem in public forests is creation of permanent edges within large areas of forest along roads, utility right-of-ways, and other open corridors and clearings (Schonewald-Cox and Buechner 1992). These corridors often connect the forest to open habitat, thus potentially serving as a conduit bringing open-country species such as cowbirds and small predators into the interior of large forests.

EFFECTS OF CORRIDORS ON FOREST SONGBIRDS

Small and Hunter (1988) provided evidence that open corridors result in higher nest predation rates in a region of Maine that is 90% forested and where fragmentation of forest is primarily caused by roads, powerlines, and streams. They found that the predation rate on Japanese quail (*Coturnix coturnix*) eggs placed in artificial nests was greatest in smaller patches of forest unless the forest patch bordered a body of water. They suggested that red fox (*Vulpes vulpes*), striped skunk (*Mephitis mephitis*), and raccoon may use the clearings along powerlines and roads as travel corridors into forest fragments. Although Small and Hunter (1988) did not find a significant relationship between nest predation and distance into the forest from the edge, Chasko and Gates (1982) found that songbird nests in forests adjacent to a 52-m wide powerline corridor in Maryland had lower success rates than nests >45 m from the corridor edge because of higher rates of nest predation, cowbird parasitism, hatching failure, and loss from inclement weather. The relationship between distance to the edge and nest success was not as obvious for a second powerline corridor, which was 46 m wide (Chasko and Gates 1982). Ferris (1979) found that densities of 3 species of forest songbirds were lower close to an interstate highway in Maine than deeper into the forest along a 400-m transect ($P < 0.05$), while edge species were more abundant close to the highway ($P < 0.05$). Hickman's (1990) analysis of bird densities along nature trails and control transects in 3 large forest preserves in Illinois suggested that even extremely narrow corridors (2–3 m wide) may have a negative effect on forest-interior birds. Although forest bird densities were similar along trails and control transects, some edge species were more common along trails ($P < 0.01$). These included blue jays (*Cyanocitta cristata*), which are nest predators, and brown-headed cowbirds, which are brood parasites.

Most studies of forest fragmentation in eastern North America do not provide direct information about how birds are affected by clearcuts or open corridors in a heavily forested landscape. Nearly all of these studies were completed in predominantly agricultural or suburban landscapes where forests are discrete, easily defined patches (Galli et al. 1976, Whitcomb et al. 1981, Ambuel and Temple 1983, Blake and Karr 1984, Lynch and Whigham 1984).

In comparing 4 landscapes in Ontario, Illinois, and Missouri, Freemark and Collins (1992) found that the number of species of forest-interior songbirds increased more rapidly with forest area in the most heavily forested (30% wooded) landscape than in more open, agricultural landscapes (2–22% wooded), indicating that the regional configuration of forest affects the composition of the bird community. Moreover, in a study of 4 landscape types in Sweden, Andrén (1992) found that nest predation rates by corvids (Corvidae) on artificial nests placed in forests increased as the proportion of agricultural land in the surrounding landscape increased from 4% to 80%. Similarly, Hoover and Brittingham (1993) found that the rate of cowbird parasitism on wood thrush nests is lower in the northeastern United States than in regions with a higher proportion of agricultural land (the midwestern and mid-Atlantic states). These studies suggest that forest fragmentation has a greater impact on breeding success of forest songbirds in predominantly agricultural landscapes than in heavily forested landscapes.

Although the effects of forest fragmentation may be greater in agricultural landscapes, Askins et al. (1987) showed that fragmentation by open corridors can have a major effect on forest bird communities in a relatively heavily forested region. They surveyed birds in southeastern Connecticut, a region that is 68% forested (Dickson and McAfee 1988). Large expanses of forest are typically broken only by corridors such as highways and powerline rights-of-way. Residential and commercial de-

velopment tends to follow highways, amplifying the open corridor effect. Because the main goal of this study was to determine whether fragmentation of forests by narrow openings has an impact on bird communities, forest patches were defined as areas of forest separated from other forest by an opening in the canopy ≥10 m (Askins et al. 1987). Birds were surveyed using point counts in 46 forest patches that ranged in size from 1.5–2,600 ha. Three vegetation plots were located within 100 m of each survey point. Although forest fragmentation is caused primarily by open corridors, the abundance and species richness of migratory birds was consistently lower in smaller patches. Multiple regression analysis using forest area and vegetation variables indicated that forest area was the best predictor of the abundance of Neotropical migrants, accounting for 60% of the variability.

Moreover, Askins et al. (1987) found that some species were consistently absent from small forest patches. For example, cerulean warblers (*Dendroica cerulea*) were not detected in forests <647 ha and worm-eating warblers (*Helmitheros vermivorus*) were not detected in forests <23 ha. Similarly, in Maryland and adjacent states, Robbins et al. (1989) did not find cerulean warblers in forests <138 ha or worm-eating warblers in forests <21 ha.

RECOMMENDATIONS CONCERNING OPEN CORRIDORS

These results and the results of experiments with artificial nests (Chasko and Gates 1982, Small and Hunter 1988) suggest that fragmentation of continuous forest into patches can reduce the abundance and diversity of Neotropical migrants even in fairly heavily forested landscapes. If diversity of Neotropical migrants is a management goal, then large blocks of continuous forest should not be segmented with roads and powerlines. Instead of creating the crisscross pattern of open corridors found in many forests, it would be better to consolidate new roads, railroads, and utility right-of-ways into a single open corridor. However, even though narrow corridors seem to have a negative impact on area-sensitive forest birds (Chasko and Gates 1982, Hickman 1990), it is likely that a large, open corridor will have a greater effect than a small corridor. The impact of large corridors could be reduced by locating them along the periphery of the forest whenever possible. In the case of powerline corridors, public safety concerns may dictate that the corridor avoid the forest boundary where it abuts residential or commercial areas, but the center of a forest tract could still be avoided.

Consolidation of corridors along the periphery of forests would help maintain larger areas of continuous forest where Neotropical migrants can breed successfully. It could also provide large roadless areas beneficial to black bears (*Ursus americanus*), other large mammals (Mech et al. 1988, Brocke et al. 1990), and many other species of plants and animals (Bennett 1991).

POPULATION DECLINES IN SHRUBLAND BIRDS

Another benefit of consolidating open corridors would be the creation of larger areas of continuous open habitat that could be used by bird species that are characteristic of early successional habitats and forest edges. Shrubland and thicket specialists would especially benefit from this type of management. Maintenance of habitat for shrubland specialists is an important management goal in eastern North America because many of these species have shown severe population declines. The best evidence for these declines comes from Breeding Bird Surveys (BBS), roadside surveys that are conducted annually on more than 3,000 routes across the United States and Canada (Robbins et al. 1986). Data from these surveys are available from the Breeding Bird Survey database, National Biological Survey. Between 1966 and 1991, 6 species of shrubland specialists—yellow-billed cuckoo (*Coccyzus americanus*),

brown thrasher (*Toxostoma rufum*), golden-winged warbler (*Vermivora chrysoptera*), prairie warbler (*Dendroica discolor*), painted bunting (*Passerina ciris*), and field sparrow (*Spizella pusilla*)—declined ($P < 0.01$) in eastern North America (Askins 1993). Six other shrubland species—Bell's vireo (*Vireo bellii*), chestnut-sided warbler (*Dendroica pensylvanica*), yellow-breasted chat (*Icteria virens*), indigo bunting (*Passerina cyanea*), Bachman's sparrow (*Aimophila aestivalis*), and clay-colored sparrow (*Spizella pallida*)—showed declining population trends that were not significant ($P > 0.05$). Among shrubland specialists, only blue grosbeak (*Guiraca caerulea*) increased ($P < 0.01$), while black-billed cuckoo (*Coccyzus erythropthalmus*), white-eyed vireo (*Vireo griseus*), and mourning warbler (*Oporornis philadelphia*) showed increasing trends that were not significant ($P > 0.05$). Also, long-term monitoring programs at migratory stopover sites in Massachusetts (Hagan et al. 1992) and Ontario (Hussell et al. 1992) independently showed that many species typical of shrubland habitats have declined during the past 20–30 years.

Some species of shrubland birds have declined enough to be included on lists of species of special concern in some northeastern states. For example, yellow-breasted chat was once common in southern New England but is now on endangered species lists for Connecticut and Rhode Island (Ford 1992). Two shrubland species, Bachman's sparrow and golden-winged warbler, are included among species of management concern in the Northeast (Confer 1992, LeGrand and Schneider 1992, Vickery 1992). Equally important, some species that are still common have been declining rapidly on BBS routes in eastern North America. For example, prairie warbler and field sparrow have declined by 2.2% and 3.4% per year, respectively (Askins 1993). If this trend continues, they will soon be included among species of management concern.

These shrubland species probably have declined primarily because of habitat loss. The amount of shrubland habitat has steadily declined in many regions of eastern North America because of residential development (Witham and Hunter 1992) and growth of forest on abandoned farmland (Confer 1992, LeGrand and Schneider 1992). The area covered by sapling and seedling stands that would be used by shrubland birds has declined in New England with a commensurate increase in the area covered by mature forest (Brooks and Birch 1988).

To some extent the decline of shrubland species reflects a shift to conditions more similar to the landscape of eastern North America before extensive clearing of the land for agriculture. Shrubland specialists probably reached atypically high densities during the past century (Morse 1989) when numerous farms were abandoned (Irland 1982), creating large areas of low thicket. Perhaps because of the perception that these open-country birds were absent or rare in eastern North America before European agriculture, declines in grassland and shrubland birds have received considerably less attention than less consistent and less severe declines in forest songbirds (Askins 1993).

However, there is considerable evidence for the existence of open habitats such as grasslands, savannas, open pine barrens, and lowbush blueberry (*Vaccinium angustifolium*) barrens in the northeastern United States at the time of European settlement (Askins 1993). Some of these areas may have been burned regularly by Native Americans (Bromley 1935). These habitats probably supported grassland and shrubland birds. For example, analysis of pollen and charcoal in lake sediments indicates that fire has maintained shrublands dominated by ericaceous shrubs in Maine for at least 825 years (Winne 1988). Currently, sites in Maine with a similar plant community support such shrubland specialists as brown thrashers, indigo buntings, and field sparrows (Vickery 1993).

Although fire may have been locally important along the east coast of North America before European settlement, most of the habitat for shrubland birds was probably created by blowdowns of large stretches of forest caused by windstorms. Based on an analysis of stumps, dead wood fragments, and the mounds and pits created by windthrown trees, Stephens (1956) showed that 4 major episodes of tree uprooting occurred since 1400 in the Harvard Forest in Massachusetts, three of which were associated with recorded hurricanes. In a similar study in New Hampshire, Henry and Swan (1974) showed that the forest had been heavily damaged by fire in 1635 (perhaps following a blowdown caused by a hurricane), a hurricane in 1938, and 3 windstorms in 1898, 1909, and 1921. Although disturbances of this sort were apparently infrequent in some regions of eastern North America, they occurred frequently in other regions (Bormann and Likens 1979).

Destruction of forest by fire or wind may have created large areas of early successional habitat that could be used by shrubland birds in presettlement times. However, fire suppression, reduction of total forest area, and the prevalence of relatively young stands (which may be more resistant to wind damage compared to older stands) all may contribute to a lower frequency of large-scale disturbances today.

The importance of disturbances in sustaining regional biological diversity by creating a "shifting mosaic" of different successional stages has been documented for numerous ecosystems (Hobbs 1987, Hobbs and Gimingham 1987). Management practices that exclude disturbance can lead to loss of species and disruption of ecological processes (Pickett et al. 1992). In many regions natural disturbances such as extensive fires or massive blowdowns of trees no longer occur frequently enough to create sufficient habitat for early successional species (Hobbs 1987), so these species may depend upon artificial disturbances (Pyle 1980). For example, clear-cutting of forests can create favorable habitat for some species of shrubland birds (Conner and Adkisson 1975, Webb et al. 1977, Crawford et al. 1981, Yahner 1993). However, clear-cutting is being replaced with selection cutting in many forests because of concerns about the esthetic and ecological effects of large cuts. As a result, permanent open corridors may become increasingly important for maintaining populations of species that depend on shrubland habitat.

MANAGEMENT OF CORRIDORS FOR SHRUBLAND BIRDS

Like grassland birds, which also have shown population declines in eastern North America (Robbins et al. 1986, Bollinger and Gavin 1992, Askins 1993), shrubland birds depend on habitat disturbance to maintain their habitats. Active management for these early successional species is therefore straightforward, but it is often expensive. Management directed specifically at maintaining habitat for early successional birds is feasible in some situations (Lent and Litwin 1989), but these species probably can be sustained most effectively in areas that are subject to frequent disturbance associated with agriculture, forestry, and maintenance of roads and right-of-ways. Open corridors along roads and utility right-of-ways provide an opportunity for maintaining shrubland habitat.

Consolidation of corridors not only reduces fragmentation of forests, but also may result in better habitat for some shrubland species than narrow corridors can provide. Like many forest species, shrubland species may require a minimum area of appropriate habitat. For example, yellow-breasted chats tend to be absent from shrubland patches <2 ha (Dennis 1958) and golden-winged warblers usually do not nest in patches <10 ha (Confer and Knapp 1981). In a comparison of 4 powerline corridors that differed in width, Anderson et al. (1977) recorded more species of shrubland specialists

on wide corridors (61 and 92 m) than on narrow corridors (12 and 31 m). Brown thrasher and white-eyed vireo were present only on the wide corridors, and yellow-breasted chat and field sparrow were more abundant on these corridors. Other species of birds may be adapted to using forest canopy gaps (Noss 1991), so they would not require large areas of continuous shrubland. In order to develop effective management plans for shrubland birds, the habitat requirements of these species need to be studied more systematically, particularly their response to habitat patches of different sizes, shapes and configurations.

Open corridors often are maintained with mowing or broadcast spraying of herbicide, resulting in a habitat that is suitable for only a few early successional bird species (Bramble et al. 1992). However, many public utilities have shifted to using selective basal spraying of herbicides to remove trees and create relatively stable shrubland or shrub-grass communities (Niering and Goodwin 1974, Bramble et al. 1990). Studies in Connecticut, Pennsylvania, and Maryland indicate that corridors maintained by selective basal spraying of trees can sustain populations of shrubland birds (Chasko and Gates 1982, Askins 1990, Bramble et al. 1992), including many of the species that have shown substantial population declines along BBS routes in eastern North America. Between 1983 and 1989, breeding bird surveys were completed along a 60-m wide powerline corridor in the Connecticut College Arboretum that had been maintained by basal spraying since 1953 (Askins 1990). Breeding pairs of white-eyed vireos, blue-winged warblers (*Vermivora pinus*), chestnut-sided warblers, prairie warblers, and field sparrows were consistently present. The last 3 species have shown declining trends for BBS counts in eastern North America. They also declined or disappeared on an adjacent study area in the Connecticut College Arboretum that had been an old field in 1953 but had grown into a young forest and tall thicket by 1989 (Askins 1990). Bramble et al. (1992) found high densities of blue-winged warblers, chestnut-sided warblers, prairie warblers, field sparrows, and indigo buntings, and lower densities of golden-winged warblers and yellow-breasted chats on powerlines maintained by selective basal spraying in 2 regions of Pennsylvania. Similarly, Chasko and Gates (1982) found nesting yellow-breasted chats, indigo buntings, and field sparrows along a 52-m-wide powerline corridor in Maryland. Moreover, they found relatively high rates of fledging success for nests in the corridor. These studies show that selective removal of trees can result in a diverse shrubland community that will support many species of birds that are typical of early successional habitats, including species that are shrubland specialists.

RECOMMENDATIONS

Early successional bird species can be maintained by careful management of vegetation in nature preserves, but given the expense required for continual vegetation management, this approach will probably not be sufficient. Proper management of open corridors along roads and utility lines can produce appropriate habitat for these species, especially if these corridors are consolidated to produce wide expanses of shrubland habitat to accommodate species such as golden-winged warbler and yellow-breasted chat that apparently require relatively large areas of continuous shrubland. Consolidation of corridors also would reduce the number of openings interrupting large expanses of forest and thus would provide more unbroken forest interior, which is the most productive habitat for many species of migratory birds. Maintenance of appropriate habitat for both shrubland and forest specialists should be an important consideration in forest management plans.

SUMMARY

In eastern North America, remnant patches of forest surrounded by open habitat constitute unfavorable habitat for many species of migratory forest birds because of high rates of

nest predation and cowbird parasitism. Although most evidence for this relationship comes from "forest islands" surrounded by residential or agricultural land, even forest patches isolated from other forests by narrow open corridors such as roads and powerline right-of-ways seem to show this pattern. Productive habitat for migratory birds can be maintained by consolidating corridors and routing them along the periphery of forests to retain as much continuous forest as possible.

Consolidation of open corridors provides another major advantage: the area along the corridor can provide a large area of suitable habitat for early successional birds, especially species that are shrubland or thicket specialists. Populations of many species of shrubland birds have declined in eastern North America as open habitats have been developed or have grown into forest. Right-of-ways and other areas subject to periodic artificial disturbance may become increasingly important to these species, which probably originally depended on habitat created by large-scale natural disturbances such as fires and windstorms. Relatively stable shrublands with a diversity of shrubland plants and birds can be maintained by selectively removing trees with basal applications of herbicide.

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