Changes in forest bird species composition caused by transmission -line corridor cuts

Migrants lose — edge and grassland species gain in dramatic changes

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INTRODUCTION

MANY OF THE FORESTS of the world are now crisscrossed and bisected by many roadways and energy-transmitting facilities. The corridors that cut through our forest destroy old wildlife habitats and create new ones. Anderson *et al.* (1977) showed that transmission-line corridors wider than 61 m create grassland/shrub habitats within the forest. Narrow corridors (30.5 m) add greater edge to the forest, attracting a larger variety of species than is found in the deciduous forest communities. Wider corridors have even more species because grassland bird species become established.

To document the bird species changes that occurred in a 45 m transmission-line corridor cut through an eastern deciduous forest in the United States, a census was made of sites along a proposed transmission-line corridor from the Sequoyah Nuclear Electrical Generating Facilities 16 km east of Soddy-Daisy, Tennessee, to Franklin, Tennessee. Four sites were censused. Two were located off the Sequoyah access road; 2.15 km and 6.1 km east of the junction of U.S. 27 and Daisy Mountain Road. The other two sample sites were 2.3 km and 6.3 km west of the same junction (Fig. 1).

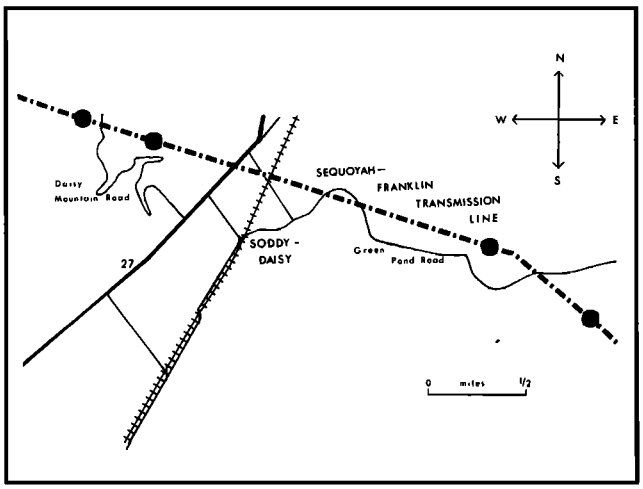

Figure 1. Dark dots indicate four study sites along Sequoyah-Franklin transmission line near Soddy Daisy, Tennessee.

METHODS

THE METHOD OF JAMES AND SHUGART (1970) was used to sample vegetation at each of the four sites. Transects were established along the proposed right of way and 10 sample points were established on each transect.

Bird populations were sampled along those transects by walking to each of the 10 sample points and stopping at each for 10 minutes. All birds seen or heard within a distance of 30 m from the center of the point were recorded. Four censuses of breeding birds were made on each of the study sites during June 1973 (Fig. 2). The transmission-line corridor was cut in February and March 1974 (Fig. 3). Subsequently, four June Breeding Birds Censuses were made in each of the years 1974 through 1977, in the same manner as in 1973 on each of the study sites. Since the corridor was 45 m wide, birds were censused on the entire corridor, the edge of the corridor, and 7.5 m into the forest on either side of the corridor. When it was not clear whether birds near the boundary of the census strip were within the census tract, verification was made by pacing the distance from the edge of the transmission-line corridor. All Breeding Bird Censuses were conducted between the hours of 0600 and 0900 and 1700 and 1900 hours.

Figure 2. Entrance to study site 2.3 km west of the Daisy Mountain Road/U.S. 27 junction in Soddy Daisy, Tennessee, prior to construction of transmission line right of way June 1973. Deciduous forest was dense throughout study area.

RESULTS

Vegetation. The eastern deciduous forest through which the transmission-line corridor was cut consisted of a mixed group of trees, dominated by White Oak (*Quercus alba*), Short-leaf Pine (*Pinus echinata*), Black Oak (*Q. velutina*), and Mockernut Hickory (*Carya tomentosa*). Tree species diversity was high because few rare species were encountered (Table 1). The transmission-line corridor was cut in the mixed mesophytic forest region of the Cumberland and Allegheny Plateau known as the Cliff Section (Braun, 1972). Most of the trees were less than 15 cm dbh (Table 1) and the canopy was dense, shading at least 75% of the area. The ground cover was variable, depending on slope and previous timber cutting practices.

Bird Populations. Bird species diversity calculated from bird population censuses on the four study sites was 1.92 (Table 2) in 1973. The diversity of bird species in the eastern deciduous forest 120 km to the north in Anderson County, Tennessee, was 2.85 (Anderson *et al.*, 1977). The fact that the corridor passes

Table 1 Vegetation profile of four study sites before tranmission line corridor

	Study area			
	1	2	3	4
Trees/ha	684	368	551	548
Tree sp. diversity H*(H/HMAX)	2.04(.71)	2.29(.87)	2.46(.91)	2.3(.87)
Tree basal area/ha	164	189	173	173
Tree relativity				
Density/ha (dbh)				
7.5 - 15 cm	151	37	135	124
15 - 23 cm	72	114	82	86
23 - 38 cm	22	81	17	27
38 - 53 cm	2	15	12	7
> 53 cm				2
Canopy cover (%)	75	77	95	80
Ground cover (%)	41	35	26	84
Shrubs/ha	2346	3112	2606	2095

*$H = -\sum_{1}^{s} p_i \log_e p_i$, where s = number of species and pi the proportion of the total individuals belonging to each species.

through an area already disturbed by roadways, farmland, and homesites may account for this difference in diversity. The sample taken in Anderson County was in a much larger tract of forest.

The transmission-line corridor was cut in February and March 1974. In June of that year, the bird population decreased in species diversity (Table 2) (from 1.92 in 1973) to 1.78 (significant at the .01 level by an analysis of variance test). The corridor had a ground cover of short grasses and sedges. The area sampled consisted of the open transmission-line corridor (grassland habitat) and forest edge (edge habitat). The 7.5 m of forest in the sample was considered edge rather than forest habitat. Thus, following the cut, samples were taken on the two habitat types — grassland and edge.

Table 2. Bird species diversity associated with transmission-line corridors in eastern U.S. deciduous forest

Study Area		YEAR 73[1]	74	75	76	77
	H	1.70	1.61	1.68	1.72	1.56
1	HMAX[2]	1.79	1.79	2.08	1.95	1.90
	%	.95	.90	.81	.88	.82
	H	1.96	1.83	1.61	1.60	1.64
2	HMAX	2.20	1.95	1.95	1.79	1.79
	%	.89	.95	.84	.88	.92
	H	1.79	1.59	1.69	1.50	1.61
3	HMAX	1.95	1.61	1.79	1.79	1.77
	%	.92	.96	.95	.84	.91
	H	2.23	2.09	1.84	1.68	1.60
4	HMAX	2.40	2.20	2.08	1.79	1.79
	%	.93	.95	.88	.94	.89
	MEAN DIVERSITY					
	H	1.92	1.78	1.71	1.62	1.60
	HMAX	2.09	1.89	1.97	1.83	1.81
	%	.92	.94	.87	.88	.89

[1]Diversity before cut

[2]HMAX = $\log_e$ number of species

Seven species of breeding migrants that held territories in the forest before the cut were not observed in the area sampled. Of these, the Yellow-billed Cuckoo (*Coccyzus americanus*), Red-eyed Vireo (*Vireo olivaceus*), Kentucky Warbler (*Oporornis formosus*), Scarlet Tanager (*Piranga olivacea*), and Summer Tanager (*Piranga rubra*) are neotropical migrants. The Blue-gray Gnatcatcher (*Polioptila caerulea*) migrates to the southern United States and the Gulf coast and the Pine Warbler (*Dendroica pinus*) migrates to the coastal plain of the United States.

The numbers of resident Blue Jays, Carolina Chickadees, Tufted Titmice, and Wood Thrushes present in the forest declined following the cut (Table 3). Carolina Chickadee populations fluctuated somewhat in the following years. Both Cardinals and Rufous-sided Towhees were present in the study area prior to the cut and remained at fairly stationary population levels following corridor construction.

Table 3. Populations pre- and post-transmission-line corridor construction

Species	Number per 100 hectare Before cut	After cut
Blue Jay (*Cyanocitta cristata*)	34	17
Carolina Chickadee (*Parus carolinensis*)	51	17
Tufted Titmouse (*Parus bicolor*)	51	34
Wood Thrush (*Hylocichla mustelina*)	34	17
Cardinal (*Cardinalis cardinalis*)	17	17
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	17	17

The seven migrant species were neither observed in Spring 1974 nor any subsequent year of the study. However, six species: Field Sparrow, Bobwhite, Brown Thrasher, Eastern Kingbird, Indigo Bunting, and Blue Grosbeak, were not observed in the deciduous forest before the cut, but were seen in the transmission-line corridor and edge (Table 4). These new species, with the exception of Bobwhite which was seen only in 1974 and 1975, were seen in each subsequent year of observation.

The new species undoubtedly found particular components of the newly created habitat required to survive either in the corridor or in the edge. Observation of Field Sparrows per 100 hectares increased from 17 in the 1974 census to 34 in 1975. This species was found commonly on grassland shrubs and edge. It places its nest in grass, sorrel, or cover just above ground level in bushes and young trees (Johnston, 1947). The crucial factor with this population appears to be the availability of shrubs, trees, fences or other objects higher than the surrounding vegetation. From these posts, the male kept watch on

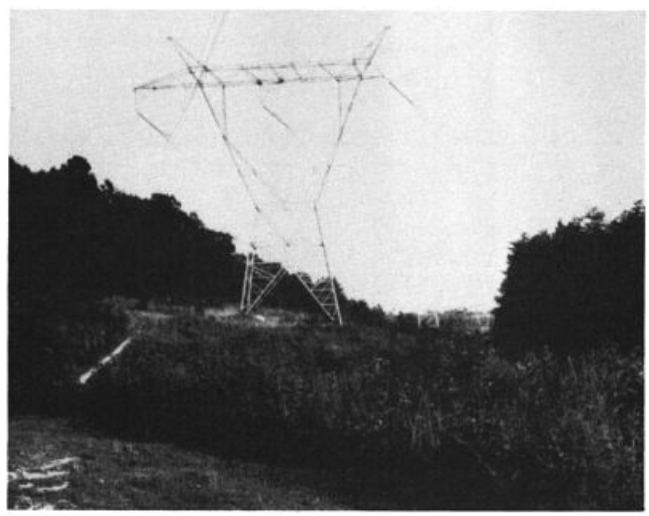

Figure 3. Study site 2.3 km west of the Daisy Mountain/U.S. 27 junction in Soddy Daisy, Tennessee, June 1975.

the nest, chirping when intruders approached Field Sparrows also require a high grass density, high litter cover, and a fair amount of litter on the ground (Whitmore, unpub. ms.). As the grass began to thicken and many more shrubs emerged, the population of Field Sparrows would be expected to decline; this appeared to happen when dense shrubs were found in 1976 and 1977.

Brown Thrashers were found most often in the shrubs along the edge of the transmission-line corridors; they were uncommon in the forest interior. The preferred habitat of Brown Thrashers (Bent, 1948) are these edge areas. Thus, the corridors enhanced the population of this species.

Eastern Kingbirds were observed flying in the corridors and perching on transmission-line towers as well as trees along the corridor edge. According to Tyler (1942) this species nests in the wooded edge of open fields and roadways, so the transmission-line corridors provided an increase in the habitat for Eastern Kingbirds.

Indigo Buntings were seen commonly along the transmission-line corridors perched on grasses and shrubs in the corridor or sitting on trees in the edge. They were also observed in the dense thickets that formed the edge between the corridors and the forest interior. This species appeared to benefit by habitat disturbances that created increased edge with open fields nearby. Yahner and Howell (1975) indicated that the Indigo Bunting is an important species in disturbed deciduous forest. The species increases on deciduous forest sites altered by strip-mining. Whitmore (unpub. ms.) showed that this species spends over 80% of its time in vegetation taller than 500 cm Apparently a tall, open perch is required by the singing male.

Blue Grosbeaks were common along the corridor edge or perched on towers in the center. Very few were observed on the grass in the corridor itself. Those on the edge generally were seen higher in shrubs and trees than the Indigo Bunting.

During the 1975-77 observation periods (the second, third, and fourth breeding seasons following the corridor cut), American Goldfinch, Mourning Dove, Barn Swallow, Common Flicker, and Red-tailed Hawk were observed.

American Goldfinches were seen flying through the corridor and perching on grass and shrubs. Groups were seen on the towers and the trees bordering the corridor. The goldfinch is known to move indiscriminately around many open areas during June (Tyler, 1968). The corridors opened pathways through the deciduous forest, and provided new areas for movement for this species. Since nesting occurred later in the summer, no information on the effect of nesting was obtained for the goldfinch.

Mourning Doves were seen perched on the transmission wires and on the trees along the corridor edge. They were observed in the low thickets and brush of the edge habitat. Calls were commonly heard in the morning.

Barn Swallows were observed flying along the corridor, particularly in the evening. In most instances they appeared to be hawking insects. No Barn Swallow nests were observed, but the new corridors appeared to provide ideal feeding areas for birds that nested on nearby buildings and bridges.

Common Flickers were seen at times in some dead tree branches along the edge of the corridor. Several pairs were observed nesting in trees killed by the construction activity, but left standing.

Red-tailed Hawks observed along the corridor were seen perched on the transmission-line towers or flying in the corridor. Several Red-tailed Hawks were observed capturing small rodents in the corridor

Only 36% of the bird species colonizing the newly cut corridors were migrants (Table 4). The new habitat provided nesting sites, cover, and feeding areas for those birds that moved into the area. Most of the species that disappeared from the region were canopy-foraging species. Yellow-billed Cuckoo, Red-eyed Vireos, Scarlet and Summer tanagers foraged in the mid-canopy region of the deciduous forest whereas Kentucky Warbler was found on the ground and low shrubs under the forest canopy. Blue-gray Gnatcatchers and Pine Warblers were most commonly observed in the upper one-third of the deciduous forest canopy.

Table 4. New bird species found on transmission-line corridors

Species	*Years following clearing when observed*
Red-tailed Hawk (*Buteo jamaicensis*)	2, 3, 4
Bobwhite (*Colinus virginianus*)	1, 2,
Mourning Dove (*Zenaida macroura*)	2, 3, 4
Common Flicker (*Colaptes auratus*)	2, 3, 4
*Eastern Kingbird (*Tyrannus tyrannus*)	1, 2, 3, 4
*Barn Swallow (*Hirundo rustica*)	2, 3, 4
Brown Thrasher (*Toxostoma rufum*)	1, 2, 3, 4
*Indigo Bunting (*Passerina cyanea*)	1, 2, 3, 4
*Blue Grosbeak (*Guiraca caerulea*)	1, 2, 3, 4
American Goldfinch (*Spinus tristis*)	2, 3, 4
Field Sparrow (*Spizella pusilla*)	1, 2, 3, 4

*Migrant (4/11 = 36%)

DISCUSSION

BIRDS, LIKE MOST LIVING ORGANISMS, are restricted in distribution to their adaptive peaks, thus occupying only habitat where they are most fit to survive (Svärdson, 1949; Hilden, 1965). Birds have the instinctive ability to select habitat in which their parents are successful (Lack, 1933). Often specific features of the habitat can be correlated with the presence of breeding bird species (Karr and Roth, 1971; Anderson and Shugart, 1974). Communities of birds therefore evolve in different natural communities as a result of competition by species that select the area to feed and reproduce. Such communities are generally stable aggregations of organisms that conform to the natural stage of succession in the vegetation.

The stability associated with normal successful deciduous forest sequence where species of birds can remain constant for 20-50 years is interrupted in construction of transmission-line corridors by a rapid successional sequence. This new successional sequence is accelerated through maintenance of the corridors by cutting the vegetation every 4-6 years. The result is a dramatic change in bird populations.

The implications of transmission-line corridor cuts through the eastern deciduous forests are sometimes considered beneficial to bird life owing to increased edge effect. Although benefits are difficult to document, and quantify, there is a variety of side effects. The number of species tends to increase but the number of migrant species decreases (Table 2). The stability of the natural system decreases owing to corridors maintenance This decrease in stability causes a decrease in diversity (Table 2). An analysis of variance test indicated that the decrease in diversities from 1974 to 1977 is significant at the .05 level. The new species using the transmission-line corridors are resident

species in the region of the corridor. However, these species capitalize on short-term changes in the environment The new species are associated with the grassland and edge habitats.

Grassland species are known to show a great fluctuation in population density. Wiens (1974), for example, discussed instability of birds in a climax grassland habitat in Texas. Brewer and Swander (1977) showed shifting patterns of occupancy including shifts in territory, location, and changes in population size, even within a breeding season, in some grassland and forest edge species. They suggest that grassland birds have a more flexible system of habitat occupancy than do forest birds because of the magnitude of change associated with the grassland habitat.

SINCE TRANSMISSION-LINE right of ways create grassland communities that are undergoing succession that would normally lead to a state similar to the surrounding forest, it can be expected that the birds should follow typical successional sequences associated with each area. Johnston and Odum (1956) showed that bird species density and numbers increased in a successional sequence from bare ground to mixed forest on the piedmont regions of Georgia. This sequence is interrupted by a lower bird species density in young forests. Furthermore, they pointed out that birds act as an important agent in disseminating seeds in all stages of succession, but most particularly in the shrub stage. Thus, the natural successional sequence of which birds are a part is disrupted in transmission-line corridors, and bird communities that develop in these areas are likely to be less stable than those of forest communities.

A number of studies have been conducted to document the value of edge habitat to birds. Lay (1938) showed the increase in birdlife in a mixed Texas forest where small clearings were established. Hager (1960) showed that logging in a western Douglas-fir forest increased the density of bird populations along the edge within three years after cutting. Johnston (1947) indicated that the forest edge was a distinct community because it was inhabited by species that in part displayed adjustments to the particular niche unique to forest edge.

Such studies indicate that transmission-line corridor construction might lead to an increased number of bird species. These corridors create new communities that, when considered with the total bird population of the deciduous forest, could result in a greater variety and diversity of birds in a region. Land use planners and managers must, however, consider the total region when considering the impact of habitat disturbances on avifauna. As indicated in the present study, the primary species lost from an area are migrants, and the ones that appear in the newly created edge and grassland habitats are resident species often associated with unstable habitats. Planners must address the question associated with maintaining the total forest community. The smallest size of habitat able to support deciduous forest bird communities must be considered. In addition, the "search" area of some larger birds, particularly raptors, must be evaluated. Also, the whole question of wintering habitat must be examined before conclusion can be reached regarding the impact of transmission-line corridors on avian communities.

SUMMARY

A BEFORE AND AFTER study conducted for five years in a deciduous forest community in eastern Tennessee showed that all bird species lost from the habitat as a result of cutting a transmission-line corridor were migrants whereas only 36% of the replacement species were migratory. Although two of the species observed in the area following the cut were nomadic, most were attracted by features such as singing posts and grassland habitat. Bird species diversity decreased significantly in each of the four years following the cut.

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LITERATURE CITED

ANDERSON, S. H. & H. H. SHUGART (1974). Habitat selection of breeding birds in an east Tennessee deciduous forest. *Ecology* 55 828-837.

ANDERSON S. H., K. MANN, & H. H. SHUGART (1977). The effect of transmission-line corridors on bird populations. *Am. Midl. Natr* 97:216-221.

BENT, A. C. (1948). *Life histories of North American nuthatches, wrens, thrashers, and their allies.* Smithsonian Inst. Bull. 195, Washington, D.C. 475 pp.

BRAUM, E. L. (1972). *Deciduous forests of eastern North America* Hafner, New York. 596 pp.

BREWER, R. & L. SWANDER (1977). Life history factors affecting intrinsic rate of natural increase of birds of the deciduous forest biome. *Wilson Bull.* 89:211-232.

HAGAR, D. C. (1960). The interrelationship of logging, birds and timber regeneration in the Douglas-fir region of northwestern California. *Ecology* 41:116-125.

HILDEN, O. (1965). Habitat selection in birds. *Ann. Zool. Fennici* 2 53-75.

JAMES, F. C. & H. H. SHUGART, JR. (1970). A quantitative method of habitat description. *Aud. Field Notes* 24:727-736.

JOHNSTON, D. W. & E. P. ODUM (1956). Breeding bird populations in relation to plant succession on the piedmont of Georgia. *Ecology* 37:50-62.

JOHNSTON, V. R. (1947). Breeding birds of the forest edge in Illinois *Condor* 49:45-53.

KARR, J. R. & R. R. ROTH (1971). Vegetation structure and avian diversity in several new world areas. *Amer. Natur.* 105:423-435.

LACK, D. (1933). Habitat selection in birds with special reference to the effect of afforestation on the Breckland avifauna. *Jour. Anim Ecol.* 2:239-262.

LAY, D. W. (1938). How valuable are woodland clearings to birdlife? *Wilson Bull.* 45:254-256.

SVARDSON, G. (1949). Competition and habitat selection in birds *Oikos* 1:157-174.

TYLER, M. W. (1942). Eastern Kingbird. In *Life histories of North American flycatchers, larks, swallows and allies,* by A. C. Bent Smithsonian Inst. Bull. 179, Washington, D.C. pp. 11-29.

TYLER, M. W. (1968). Eastern American Goldfinch. In Bent's *Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows and their allies,* ed. by O. L. Austin, Part 1, U S National Museum Bull. 237. Smithsonian Inst. Press. Washington, D.C. pp. 447-467.

WHITMORE, R. C. (unpublished manuscript). Comparative ecology of sparrows on reclaimed surface-mines in West Virginia.

WIENS, J. A. (1974). Climatic instability and the "ecological saturation" of bird communities of North American grassland. *Condor* 76 385-400.

YAHNER, R. H. & J. C. HOWELL (1975). Habitat use and species composition of breeding avifauna in a deciduous forest altered by strip mining. *Jour. Tennessee Acad. Sci.* 50:142-147.

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