

Breeding Bird Censuses at the Coweeta Hydrologic Laboratory:

A Comparison of 1967 and 1993

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ABSTRACT

Eight breeding bird censuses were conducted at Coweeta Hydrologic Laboratory in 1967 and repeated in 1993. Four of the census plots ("control plots") were forested in both years; the other plots had been manipulated in various ways between 1957 and 1964, and in 1967 contained dense low woody vegetation with no canopy. Between 1967 and 1993 the manipulated plots underwent succession, and dense low growth was replaced by forest with a more open understory.

Three control plots showed marked declines in some species, of which the Wood thrush and Northern ovenbird showed the largest decreases. Small apparent decreases occurred in Black-and-white and Canada warblers, Veery and Rose-breasted grosbeak. The fourth control plot experienced the death of many canopy trees; thus changes in its avian community were difficult to interpret.

Most changes in bird populations on the manipulated plots could be attributed to the development of a canopy layer and the thinning of the understory. Most prominent among these changes were declines of Chestnut-sided warblers, Gray catbirds and Rufous-sided towhees, and increases of Northern ovenbirds, Red-eyed and Solitary vireos and Worm-eating and Black-throated blue warblers. Increases in the ovenbird compensated for its reduced abundance on the control plots.

Overall, five of the eight plots had fewer species and none had more in 1993 vs. 1967. All eight plots had lower total avian densities in 1993. Some neotropical migrant birds were less numerous in 1993 despite apparent gains in suitable forest habitat at Coweeta. Most prominent among these ^{are} Wood thrush, Eastern wood-pewee and Canada and Black-and-white warblers. However, most other neotropical migrants have apparently at least held their own during the past 26 years.

These censuses represent only two isolated seasons. In the absence of data for the intervening years, it is not possible to say whether the differences observed represent long-term trends or mere short-term oscillations. These censuses must be repeated in subsequent years to resolve this question.

INTRODUCTION

In 1967 I conducted eight breeding bird censuses at the Coweeta Hydrologic Laboratory, as part of an investigation of global patterns of species diversity in avian communities (Tramer 1969, 1974). This report compares my 1967 data with censuses of the identical plots conducted in 1993. I suggest that these comparisons are of interest for three reasons:

(1) Plant communities on four of my census plots were manipulated in various ways during the decade 1957-1967; changes in breeding bird populations as my plots recovered from those disturbances have not been assessed.

(2) The other four plots, whose vegetation has not been disturbed by humans since early lumbering activity, may reveal changes in bird populations resulting from events extrinsic to Coweeta. In this context, neotropical migrants are of particular interest because of growing concern over their apparent general population declines (Robbins, et al. 1989). Deforestation of tropical wintering areas and fragmentation of temperate zone breeding habitats are the suspected causes of these declines (Whitcomb, et al. 1981, Terborgh 1989, Askins, et al. 1990). Because Coweeta's forest cover is maturing and has remained unfragmented for

many decades, and because the total forest cover in the Nantahala Mountains has remained fairly stable in recent years, I suggest that Coweeta's forest birds have not experienced the reductions in breeding habitat observed elsewhere. Therefore trends in forest bird populations at Coweeta should reflect causes other than fragmentation of suitable habitat.

(3) As part of the long-term ecosystem research effort at Coweeta, my censuses provide the early data points in what will hopefully be a record of breeding bird populations extending for many decades, if not centuries, into the future.

STUDY AREAS

The same eight plots were censused in both 1967 and 1993 (see Table 1). As mentioned above, four are "control" plots whose vegetation has not been subject to disturbance by humans since logging was last conducted, probably in the 1920s (W. Swank, pers. communication). These were chosen to represent four different forest types in the Coweeta basin, Oak-hickory forest, Pitch-pine/oak ridgetop, Cove hardwood forest, and Northern hardwoods forest. Three of these plots appeared little changed between 1967 and 1993, [an impression supported by long-term

vegetation data gathered by Coweeta personnel (Table 2)]. However, the Pitch pine/oak community suffered the loss of about 80% of its Pitch pines (*Pinus rigida*) during the late 1980s due to the combined effects of drought and the southern pine beetle (*Dendroctonus frontalis*). Many of these pines remained as standing dead snags during the 1993 census.

Of the four censuses on manipulated watersheds, Watershed 1 was planted in White pine (*Pinus strobus*) in 1957. During my 1967 visit the pines formed a dense thicket less than 2 m in height. By 1993 the pines had attained heights of 15 m or more; a dense carpet of pine needles had developed and an understory layer was lacking except for scattered young rhododendrons (*Rhododendron maximum*) and a few deciduous saplings.

Other manipulated plots are located on watersheds 13 and 28. In 1967 the northern half of WS 13 formed a "low-elevation coppice" plot, where woody plants had been felled in 1963. Part of WS 28 was a "high-elevation coppice" plot, which had undergone similar treatment. Both of these plots were dense deciduous thickets in 1967. Since then they have been allowed to grow back into forest, and in 1993 were covered by pole- to medium-sized trees with a well-developed canopy (height 15-20 m) and patchy understory of saplings and rhododendron thickets.

The final plot, also located on watershed 28, is a thinned cove forest from which all species except young tuliptrees (*Liriodendron tulipifera*) were removed in 1963. In 1993 this plot looked very similar to the coppiced portion of watershed 28, except for the thicker and taller tulip-trees emerging above the tops of the trees coppiced 30 years before.

Census plots ranged in size from 5.67 to 15 ha (14-37 acres).

PROCEDURES

Bird censuses employed the spot-mapping technique (Williams, 1936). Maps used in 1967 were traced, providing identical maps for use in 1993. During each visit to a site, locations of all birds were noted on these maps. After four censuses had been conducted at each site, a master map was made by overlaying individual census maps and identifying apparent breeding territories from spatial overlap of birds seen or heard on sequential visits. Routes through each plot were chosen so that the investigator passed within 60 m of every spot in the plot; these routes were virtually identical in 1967 and 1993.

In 1967 censuses were conducted on 22 days between June 11 and July 9. In 1993, due to other obligations, the censuses were conducted within a narrower time interval (June 15-23). Only one or two censuses

were conducted on a given day in 1967, but in 1993 three or four censuses were run each day. Staggering the times of each census revealed that time of day had no effect on the numbers of birds seen or heard.

Arbitrarily, a species was counted as breeding on the plot if it was encountered on at least two of four visits. Although calling males were the most frequent evidence of a species' presence, females and recently fledged young were encountered as well, and accounted for about 15-20% of all bird observations.

RESULTS

The most striking result is an apparent decline of total bird species and numbers since 1967. The decline is not restricted to neotropical migrants, but seems to affect components of the short-range migrant and resident (non-migrant) avifauna as well. Five of the eight plots had fewer species than in 1967, and none had more. Total number of individuals present was lower in all eight censuses, in one case by more than 50%. There was no clear trend in species diversity (as measured by the Shannon Weiner formula).

Control Plots: In general, plots that were forested in 1967 and have remained essentially undisturbed since then experienced only moderate

changes in their bird populations. Highlights for each plot are as follows:

The oak-hickory plot (WS 2) had a rather sparse bird fauna in both years (Table 3). The Wood thrush (*Hylocichla mustelina*) and the Northern ovenbird (*Seiurus aurocapillus*) were among the most numerous species in 1967 but were not detected in 1993, whereas the opposite held for the Scarlet tanager (*Piranga olivacea*). The Worm-eating warbler (*Helmitheros vermivorus*) was more abundant in 1993. Total number of species and individuals and the Shannon-Weiner species diversity index were quite similar in both years.

The pitch pine/oak community censuses (Table 4) were quite different. Fifteen species were encountered in both years, but only eight were present in both 1967 and 1993, so turnover in species composition was nearly 50%. However, four of the seven species "missing" in 1993 occurred nearby or were classed as non-breeding visitors, so caution should be exercised in assessing the significance of this apparent change. The Rufous-sided towhee (*Pipilo erythrophthalmus*) was the most abundant species on the plot in 1967, but in 1993 it was seen only once and is assumed to have been a vagrant. The Hooded warbler (*Wilsonia citrina*) has apparently increased, and is now the most numerous species

on the plot.

In 1993, the cove hardwood forest plot (lower portion, WS 27) contained no Wood thrushes or Rose-breasted grosbeaks (*Pheucticus ludovicianus*), both fairly numerous in 1967, and lacked three other species represented in 1967 by a single pair. Carolina chickadees (*Parus carolinensis*) and single pairs of American crows (*Corvus brachyrhynchos*) and Dark-eyed juncos (*Junco hyemalis*) were additions in 1993. In other respects the censuses were similar; Canada warbler (*Wilsonia canadensis*) and Black-throated blue warbler (*Dendroica caerulescens*) were the most abundant species in both years, and the abundances of eight other species were either the same or changed by just a single pair (Table 5).

In the northern hardwoods forest (top of WS 27), dominant species in both years included the Veery (*Catharus fuscescens*), Black-throated blue warbler and Dark-eyed junco. Nine species were present in both years in abundances that differed by not more than one pair. However, the Northern ovenbird was reduced from four pairs to one, and the Wood thrush was absent in 1993. The number of species and individuals on this plot was much less in 1993 (Table 6).

Manipulated plots: In each case, dense low thicket growth has been

replaced by forest cover with a well-developed canopy. This change in vegetation structure has led to the replacement of birds of dense undergrowth by forest canopy species. With the exception of the thinned cove plot on WS 28, the Shannon-Weiner diversity index changed relatively little because declines in species richness were offset by increased evenness of relative abundances. Increased evenness was due to the loss of undergrowth species (Catbird, Chestnut-sided warbler (*Dendroica pensylvanica*) and Towhee) that had attained very high densities in 1967 when favorable habitat was present.

In the white pine planting (WS 1) tree-dwelling species have replaced species of the understory; only one species recorded in 1967 (Hooded warbler) was still present in 1993. The plot contained fewer individual birds in 1993 than in 1967. Aside from one territorial male Hooded warbler, all birds present in 1993 were of species not dependent on the presence of an understory layer (Table 7).

The low elevation coppiced plot (WS 13) has also undergone a replacement of undergrowth species by forest canopy species (Table 8). Only two species were recorded in both years, the Worm-eating and Hooded warblers. The former species has increased markedly, whereas

the latter is well-represented in both censuses.

The high-elevation coppice (WS 28) also changed markedly (Table 9). Five species were recorded in both 1967 and 1993; of these, the abundances of Winter wren (*Troglodytes troglodytes*) and Dark-eyed junco have changed little. The Veery and Black-throated blue warbler were more abundant in 1993, whereas the Canada warbler has decreased.

Finally, the thinned tuliptree cove on WS 28 also experienced considerable change (Table 10). In 1967 this plot supported by far the most diverse avian community at Coweeta. However, in 1993 only ten species were encountered, and the total number of birds present had declined by 33%. The Black-throated blue warbler, most abundant species in 1967, tied with the Red-eyed vireo (*Vireo olivaceus*) as the most numerous species in 1993. However, other 1967 dominants, including the Towhee, Chestnut-sided warbler and Catbird, were absent. The Northern ovenbird was much more numerous in 1993, and four pairs of Solitary vireos (*Vireo solitarius*) had invaded the plot.

Changes in neotropical migrants. Abundances of neotropical migrants, given as both crude numbers and as percentages of the total breeding avifauna, are presented for the "control" plots in Table 11.

Abundances of four species were divided arbitrarily, with half being attributed to the neotropical migrant pool and half to the short-range migrant/resident pool, because substantial numbers winter in both the neotropics and the southeastern U.S. Species treated in this way are Whippoorwill (*Caprimulgus vociferus*), Blue-gray gnatcatcher (*Polioptila caerulea*), Solitary vireo and Northern parula (*Parula americana*).

Crude densities of neotropical migrants were lower in 1993 on all four control plots, although on the lower elevation plots (oak-hickory, pitch pine/oak ridge) the difference is very small. As percentages of the total avifauna, neotropical migrants decreased in the two higher elevation plots (cove and northern hardwoods), but on the oak-hickory and pitch pine/oak plots the percentage of neotropical migrants was slightly higher in 1993. Crude densities of other birds (short range migrants + resident species) also declined slightly on three of the four plots; i.e., except for the cove hardwood forest, there was *not* a reciprocal change in the densities of neotropical migrants vs. other species (Table 11).

Apparent changes in the abundances of neotropical migrants varied from species to species. Combining the results for all four "control" plots, the Wood thrush declined from 8 to 0 pairs, the Northern ovenbird

from 9 to 4, the Rose-breasted grosbeak (*Pheucticus ludivicianus*) from 4 to 1, the Veery and Black-and-white warbler (*Mniotilta varia*) from 7 to 4, and the Canada warbler from 5 to 2. Ignoring changes of less than two pairs as probably insignificant, apparent increases are few and small in magnitude. They are: Black-throated blue warbler (10 pairs to 12), Worm-eating warbler (3 to 5) and Hooded warbler (5 to 7).

Although many changes in bird populations on the manipulated plots may simply reflect changes in vegetation structure, it is useful to examine the abundances of neotropical migrants there as well, to see if patterns observed on manipulated plots contradict any of the apparent declines found on control plots. This is the case for the Northern ovenbird, which increased on the manipulated plots from 2 to 14 pairs, more than offsetting the apparent decline in ovenbirds on control plots. For the Veery the results are ambiguous; the number of pairs on manipulated plots increased from 4 to 5, but an increase in Veeries would be expected as those plots develop a multilayered forest with a closed canopy. Other changes in neotropical migrants mirror those on the control watersheds, and some may reflect real declines. For example, despite the maturation of forest cover on the manipulated watersheds, the Black-and-

white warbler, Canada warbler, Rose-breasted grosbeak and Eastern wood-pewee (not recorded at all in 1993) were less numerous than in 1967.

DISCUSSION

The data presented here involve only two breeding seasons, and without data for the intervening years one cannot discount the possibility that the differences between 1967 and 1993 represent annual oscillations rather than long-term trends. Some of the most profound changes are undoubtedly due to canopy development and thinning of the undergrowth on coppiced plots. Examples include the loss of Gray catbirds, Chestnut-sided warblers, Rufous-sided towhees, Yellow-breasted chats and Brown thrashers. However, when changes due to successional maturation of manipulated plots are discounted, the 1993 data still show lower population densities for many species in many plots.

Only continued monitoring of the Coweeta avifauna will reveal whether the declines seen in 1993 are "real" --- i.e., reflecting a long-term directional change --- or not. Species that should be watched especially closely are the Wood thrush, Veery, Eastern wood-pewee, Rose-breasted grosbeak, and members of the subfamily Parulinae (wood warblers). These are neotropical migrants whose abundances may have

changed substantially, even on plots whose vegetation structure has remained relatively stable.

Some apparent shifts in bird populations also deserve study. The shift of Northern ovenbirds from older forest plots to the newly-forested coppice areas is interesting; it may reflect higher primary productivity of the vegetation in younger forest, an intriguing hypothesis but difficult to test.

The apparent absence of Wood thrushes from my census plots and from forest interior areas of Coweeta generally in 1993 is also curious, because a Wood thrush held territory in the treeline behind Coweeta dormitory, and other wood thrushes were singing from small forest fragments lining the road out to U.S. 441. Early stages of a species' decline involve its disappearance from suboptimal habitat. If the Wood thrush is indeed declining at Coweeta, my 1993 observations suggest that its preferred habitat may be the forest edge or small forest fragment rather than the deep forest interior, an idea at odds with the accepted view of the habitat requirements of this species.

Table 1. Features of bird census plots at Coweeta Hydrologic Laboratory

Plot name	Location	Elevation (m)	Size (ha)
<u>"CONTROL" PLOTS:</u>			
1. Oak-hickory	Watershed 2 below logging road	720-860	5.7
2. Pitch pine/oak	Ridge above dormitory	720-785	8.1
3. Cove hardwoods	Watershed 27 below Stewart Trail	1065-1160	6.9
4. Northern hardwoods	Top of watershed 27	1380-1465	6.5
<u>MANIPULATED PLOTS:</u>			
5. White pine planting	Watershed 1 below logging road	720-840	10.1
6. Low elevation coppice	Watershed 13, northern half	750-880	8.9
7. High elevation coppice	Watershed 28	1180-1240	11.3
8. Thinned cove	Watershed 28	1095-1150	15.0

Table 3. 1967 and 1993 Breeding Bird Censuses, Oak-hickory Forest Plot

Apparent number of breeding pairs (see Procedures)

SPECIES	1967	1993
Whippoorwill (<i>Caprimulgus vociferus</i>)	-	1
Hairy woodpecker (<i>Picoides villosus</i>)	-	1
Pileated woodpecker (<i>Dryocopus pileatus</i>)	v.	1
Blue jay (<i>Cyanocitta cristata</i>)	1	v.
Carolina chickadee (<i>Parus carolinensis</i>)	1	v.
Tufted titmouse (<i>P. bicolor</i>)	1	1
Wood thrush (<i>Hylocichla mustelina</i>)	3	-
Solitary vireo (<i>Vireo solitarius</i>)	v.	1
Red-eyed vireo (<i>V. olivaceus</i>)	1	2
Northern parula (<i>Parula americana</i>)	1	-
Black-throated green warbler (<i>Dendroica virens</i>)	-	1
Black-and-white warbler (<i>Mniotilta varia</i>)	2	1
Worm-eating warbler (<i>Helminthos vermivorus</i>)	1	3
Northern ovenbird (<i>Seiurus aurocapillus</i>)	2	-
Hooded warbler (<i>Wilsonia citrina</i>)	3	3
Canada warbler (<i>W. canadensis</i>)	1	-
Scarlet tanager (<i>Piranga olivacea</i>)	-	2
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)	1	-
Number of species	12	11
Number of pairs	18	17
Shannon-Weiner diversity index	1.03	0.99

v. = visitor

Table 4. 1967 and 1993 Breeding Bird Censuses, Pitch pine/Oak Plot

SPECIES / pairs	1967	1993
Mourning dove (<i>Zenaida macroura</i>)	-	1
Whippoorwill	-	1
Ruby-throated hummingbird (<i>Archilochus colubris</i>)	-	1
Common flicker (<i>Colaptes auratus</i>)	-	1
Eastern wood-pewee (<i>Contopus virens</i>)	1	-
Blue jay	2	-
Carolina chickadee	1	1
Tufted titmouse	-	2
Carolina wren (<i>Thryothorus ludovicianus</i>)	-	1
Blue-gray gnatcatcher (<i>Poliopitila caerulea</i>)	1	v.
Brown thrasher (<i>Toxostoma rufum</i>)	2	-
American robin (<i>Turdus migratorius</i>)	-	1
Red-eyed vireo	2	1
Yellow-throated warbler (<i>Dendroica dominica</i>)	1	1
Prairie warbler (D. discolor)	1	-
Black-and-white warbler	1	1
Worm-eating warbler	2	2
Northern ovenbird	1	-
Hooded warbler	2	4
Northern cardinal (<i>Cardinalis cardinalis</i>)	1	1
Indigo bunting (<i>Passerina cyanea</i>)	1	1
Rufous-sided towhee	5	v.
Number of species	15	15
Numbers of pairs	24	20
Shannon-Weiner diversity index	1.11	1.14

Table 5. 1967 and 1993 Breeding Bird Censuses, Cove Hardwoods Plot

Number of apparent breeding pairs		
SPECIES	1967	1993
Blue jay	1	1
American crow (<i>Corvus brachyrhynchos</i>)	-	1
Carolina chickadee	-	1.5
Tufted titmouse	1	1
Winter wren (<i>Troglodytes troglodytes</i>)	1	2
Wood thrush	3	-
Veery (<i>Catharus fuscescens</i>)	1	-
Solitary vireo	3	2
Red-eyed vireo	1	2
Northern parula	1	-
Black-throated blue warbler (<i>Dendroica caerulescens</i>)	5	8
Black-and-white warbler	2	1
Northern ovenbird	2	3
Canada warbler	6	4
Scarlet tanager	3	2
Northern cardinal	1	-
Rose-breasted grosbeak (<i>Pheucticus ludovicianus</i>)	2	-
Rufous-sided towhee	1	-
Dark-eyed junco (<i>Junco hyemalis</i>)	-	1
Number of species	16	13
Number of apparent pairs	34	29.5
Shannon-Weiner diversity index	1.11	1.00

Table 6. 1967 and 1993 Breeding Bird Censuses, Northern Hardwoods Plot

SPECIES	Number of apparent breeding pairs	
	1967	1993
Ruby-throated hummingbird	1	-
Yellow-bellied sapsucker (<i>Sphyrapicus varius</i>)	1	-
Downy woodpecker (<i>Picoides pubescens</i>)	-	1
Hairy woodpecker	1	1
Blue jay	2	1
Tufted titmouse	1	-
White-breasted nuthatch (<i>Sitta carolinensis</i>)	-	1
Winter wren	1	-
Wood thrush	2	-
Veery	6	4
Solitary vireo	2	3
Chestnut-sided warbler	1	-
Black-throated blue warbler	5	4
Black-and-white warbler	2	1
Northern ovenbird	4	1
Canada warbler	4	2
Scarlet tanager	2	1.5
Rose-breasted grosbeak	2	1
Rufous-sided towhee	1	1
Dark-eyed junco	4	4
Number of species	18	13
Number of apparent pairs	42	26.5
Shannon-Weiner diversity index	1.17	1.06

Table 7. 1967 and 1993 Breeding Bird Censuses, White Pine Planting

SPECIES	Number of apparent breeding pairs	
	1967	1993
Downy woodpecker	-	1
Blue jay	-	1
Carolina chickadee	-	1
Carolina wren	1	-
Solitary vireo	-	3
Red-eyed vireo	-	2
Chestnut-sided warbler	8	-
Black-throated green warbler	-	3
Prairie warbler	1	-
Hooded warbler	3	1
Yellow-breasted chat (<i>Icteria virens</i>)	2	-
Northern cardinal	1	-
Indigo bunting	1	-
Rufous-sided towhee	10	-
Number of species	8	7
Number of apparent pairs	27	12
Shannon-Weiner diversity index	0.72	0.79

Table 8. 1967 and 1993 Breeding Bird Censuses, Low Elevation Coppice

SPECIES	Number of apparent breeding pairs	
	1967	1993
Wild turkey (<i>Meleagris gallopavo</i>)	-	1
Downy woodpecker	-	1
American crow	-	1
Carolina chickadee	-	1
Tufted titmouse	-	1
Carolina wren	1	-
Brown thrasher	2	-
White-eyed vireo (<i>Vireo griseus</i>)	1	-
Red-eyed vireo	-	1
Golden-winged warbler (<i>Vermivora chrysoptera</i>)	1	-
Chestnut-sided warbler	4	-
Black-and-white warbler	-	1
Worm-eating warbler	1	4
Northern ovenbird	-	1
Canada warbler	1	-
Hooded warbler	4	4
Yellow-breasted chat	2	-
Scarlet tanager	-	2
Northern cardinal	1	-
Rufous-sided towhee	6	-
Number of species	11	11
Number of apparent pairs	24	18
Shannon-Weiner diversity index	0.885	0.95

Table 9. 1967 and 1993 Breeding Bird Censuses, High Elevation Coppice

SPECIES	Number of apparent breeding pairs	
	1967	1993
Ruby-throated hummingbird	1	-
Downy woodpecker	-	1
Blue jay	-	1
Winter wren	1	2
Gray catbird	10	-
Veery	1	3
Solitary vireo	-	2
Red-eyed vireo	-	8
Chestnut-sided warbler	8	-
Black-throated blue warbler	3	8
Black-and-white warbler	1	-
Worm-eating warbler	1	-
Northern ovenbird	-	5
Canada warbler	5	2
Scarlet tanager	-	2
Indigo bunting	2	-
Rufous-sided towhee	6	-
Dark-eyed junco	2	3
American goldfinch (<i>Spinus tristis</i>)	2	-
Number of species	13	11
Number of apparent pairs	43	37
Shannon-Weiner diversity index	0.96	0.93

Table 10. 1967 and 1993 Breeding Bird Censuses, Thinned Tuliptree Cove

SPECIES/pairs	1967	1993
Downy woodpecker	1	-
Yellow-shafted flicker	1	-
Eastern wood-pewee	2	-
American crow	-	1
Carolina chickadee	1	1
Winter wren	1	2
Carolina wren	1	-
Gray catbird	4	-
Veery	3	2
Solitary vireo	-	4
Yellow-throated vireo	1	-
Red-eyed vireo	4	9
Golden-winged warbler	1	-
Chestnut-sided warbler	7	-
Black-throated blue warbler	8	9
Black-and-white warbler	3	-
Northern ovenbird	2	8
Louisiana waterthrush (<i>Seiurus motacilla</i>)	1	-
Canada warbler	3	-
Scarlet tanager	1	1
Rose-breasted grosbeak	1	-
Indigo bunting	2	-
Rufous-sided towhee	7	-
Dark-eyed junco	5	4
American goldfinch	1	-
Number of species	23	10
Number of apparent pairs	61	41
Shannon-Weiner diversity index	1.24	0.73

Table 11. Abundances and percentages of neotropical migrants (NM) and short-range migrants plus resident (SRM+R) species in breeding bird communities on control census plots, 1967 and 1993.

Plot		Number of pairs		Percentage of census	
		1967	1993	1967	1993
Oak-hickory	NM	13.5	13	75	76
	SRM+R	4.5	4	25	24
Pitch pine/oak	NM	12.5	11.5	52	58
	SRM+R	11.5	8.5	48	43
Cove hardwoods	NM	27	21	79	71
	SRM+R	7	8.5	21	29
Northern hardwoods	NM	30	16	71	60
	SRM+R	12	10.5	29	40

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