Population decline of neotropical migrants in an Appalachian forest

Is the clearing of tropical forest causing a decline in Appalachian migrants?

George A. Hall

ARE THE NUMBERS OF land bird species whose home is in the Neotropics, but who migrate into the Temperate Region to breed declining? This question is currently uppermost in the minds of many ornithologists and birders alike (*e.g.*, Terborgh 1980). How often do we hear "I don't see as many warblers these days as I used to see," or "The places I bird haven't changed in 20 years, but there aren't as many birds there as there once were." Such anecdotal information is available in abundance, but are there hard data to accompany these sorts of opinions? These speakers probably forget that perhaps they don't go into the field as much as they used to, and that maybe they don't hear or see as well as they used to. Lacking quantitative vegetational analysis how can anyone say a habitat hasn't changed?

Censuses taken over many years in the Washington, D.C., area have shown declines in many neotropical migrants (Criswell 1975). Here the decline has been attributed to "habitat fragmentation" (Whitcomb 1977). Each species has a minimum or critical area of contiguous habitat below which it cannot maintain a viable population. This effect is of importance for those species whose habitat is characteristically the forest interior. There is considerable evidence supporting this theory, although the critical areas for most species are not, as yet, clearly known.

Possibly of greater importance is the progressive deforestation taking place in the American tropics. As described by Terborgh (1980), forest land in Middle America is being cleared at such a rate that the primary forest will be completely gone by the end of this century. Since the densities of wintering birds are much greater than the summer densities, the clearing of one acre of tropical forest is the equivalent of removing five to six acres of breeding habitat (*loc. cit.*).

This paper concerns a study area which probably comes as close as possible to having been unchanged for more than 35 years. Since the study area is only a part of a much larger tract of similar forest, habitat fragmentation is probably unimportant. The Cheat Mountains in Randolph and Pocahontas Counties, West Virginia, are well known to much of the birding community. On Shaver's Mountain of that system three Breeding Bird Censuses have been carried out periodically for 35 years (see Censuses 27, 75, and 81 this issue). One of these, in a stand of second-growth spruce on Gaudineer Knob, has been the subject of an intensive annual study for 22 consecutive years (Hall *in press*).

This paper concerns a tract of virgin Red Spruce-Northern Hardwoods forest in which the trees are approximately 250-300 years old. The surveyor for the land company that purchased a large tract on this mountain failed to correct for the difference between true and magnetic North, and a triangular wedge of approximately 150 acres was overlooked. Therefore this area was not logged when the surrounding forest was cut in the early years of this century. The resulting "virgin" stand not only served as a seed source to reforest the surroundings, but has come down to us in an essentially unchanged state and serves as an example of what much of the Appalachian montane forest was originally like. This stand represents the transition forest between the pure Red Spruce (*Picea rubens*) forest which was present above 4000 feet and the Northern Hardwoods forest which covered the lower slopes.

STUDY AREA AND METHODS

THE STUDY AREA LIES at an elevation of 4000± feet on a steep slope Red Spruce trees up to four feet dbh constitute about 50% of the stand. Other trees of approximately the same age are Yellow Birch (*Betula alleghaniensis*), American Beech (*Fagus grandifolia*), and Sugar Maple (*Acer saccharum*). There is a moderate amount of young growth of spruce, Red Maple (*A. rubrum*) and Striped Maple (*A. pensylvanicum*) Hobblebush (*Viburnum alnifolium*) is the only prominent shrub. The ground cover consists largely of several fern species and Common Wood Sorrel (*Oxalis montana*). At most places the undergrowth is

Virgin Spruce-Northern Hardwoods Forest (Census 75). Photo/A. R. Buckelew, Jr.

not dense enough to preclude easy movement through the area, although movement is hampered by the steep slope. There is a small system of trails in part of the area.

The appearance of this area has changed little superficially in the 35 years of study. The young spruces and maples of the understory have grown taller, but this is hardly noticeable under the towering height of the old trees. From time to time one of the old trees has died, and there are numerous dead trees in the area. The only major change that has occurred is the occasional blowdown of a dead or living tree. This produces a temporary opening in the canopy which grows into a somewhat denser patch of ferns and herbs. Such openings have been transitory and the gaps are soon filled.

The forest was censused by Robert Stewart and John Aldrich (1949) in 1947. Members of the Brooks Bird Club of West Virginia followed up this count in 1948 and have censused the tract every five years since (DeGarmo 1948, 1953; Hall 1958; Baker *et al.* 1964; Anderson *et al.* 1968; Phillips 1974, 1979; and Eddy 1984 (Census 75).

The statistical significance of the trends was tested by using the Spearman Rank Correlation test.

RESULTS

A TOTAL OF 35 SPECIES has been listed as contributing numerically to the population of this study plot in the nine censuses, but the maximum number in any one year has been 28. Nineteen of these species are neotropical migrants and all but two of them are on Terborgh's (1980) list of forest interior species that are particularly endangered by deforestation in the tropics. The maximum number of these migrants in any one year has been 16.

Table 1. Species Numbers and Densities (singing-males/100 acres) in Virgin Spruce-Northern Hardwoods forest

	*Total Species**	*Neo-tropical Species*	*Total Density*	*Density of Neo-tropical Species*
1947	25	14	325	238
1948	27	14	376	243
1953	28	16	369	238
1958	18	9	233	119
1964	13	8	288	175
1968	17	9	373	181
1973	15	8	273	105
1978	15	8	253	164
1983	15	8	273	150

*The non-neotropical species were (average density, males/100 acres): Yellow-bellied Sapsucker (*Sphyrapicus varius*) (0.39); Downy Woodpecker (*Picoides pubescens*) (0.39); Hairy Woodpecker (*P. villosus*) (3.88); Northern Flicker (*Colaptes auratus*) (0.11); Pileated Woodpecker (*Dryocopus pileatus*) (0.33); Blue Jay (*Cyanocitta cristata*) (1.88); Black-capped Chickadee (*Parus atricapillus*) (5.33); Red-breasted Nuthatch (*Sitta canadensis*) (8.50); White-breasted Nuthatch (*S. carolinensis*) (1.11); Brown Creeper (*Certhia americana*) (11.22); Winter Wren (*Troglodytes troglodytes*) (13.44); Golden-crowned Kinglet (*Regulus satrapa*) (32.77); Hermit Thrush (*Catharus guttatus*) (1.55); American Robin (*Turdus migratorius*) (3.64); Dark-eyed Junco (*Junco hyemalis*) (28.63); and Purple Finch (*Carpodacus purpureus*) (4.33).

The number of species on the plot has declined significantly over the years ($r_s = 0.75$, $p < 0.025$) (Fig. 1). The number of neotropical species has also declined significantly ($r_s = 0.83$, $p < 0.01$) (Fig. 1b). The decrease was largely the result of the disappearance of marginal species, and no principal species has been lost. This suggests that perhaps these marginal species moved into this area, a suboptimal habitat for them, when the optimum habitat was full, but that perhaps today the optimal habitat is not full. However, some of this decline is the result of censusing a 15-acre plot in recent years, rather than a 30-acre one as in the early years.

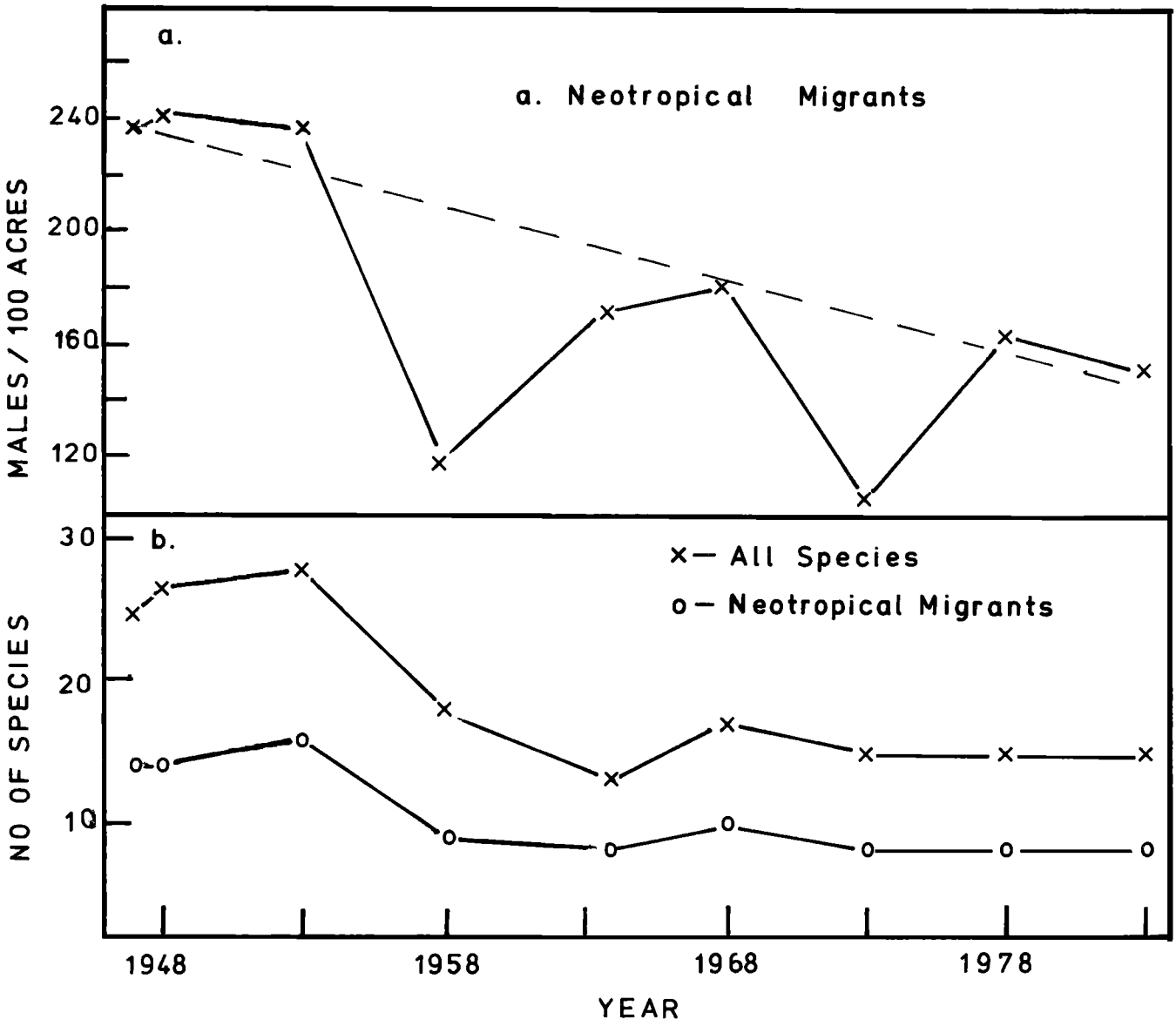

Fig. 1a. Density (singing males/100 acres) of neotropical migrants. 1b. Number of species on the study area.

Five species, Northern Parula (*Parula americana*), Black-and-white Warbler (*Mniotilta varia*), American Redstart (*Setophaga ruticilla*), Worm-eating Warbler (*Helmitheros vermivorus*), and Mourning Warbler (*Oporornis philadelphia*) have occurred only once, with very low densities, and none can be said to truly belong in this habitat. Five species, Eastern Wood-Pewee (*Contopus virens*), Veery (*Catharus fuscescens*), Wood Thrush (*Hylocichla mustelina*), Ovenbird (*Seiurus aurocapillus*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*), were present for a few of the early years of the study, but have since dropped out. None of these ever had populations greater than one male on the study area. No neotropical species shows the opposite tendency, that of being absent in the early years and then colonizing the area.

The density of singing males, which was extremely high originally, has also decreased. However, this decline was not statistically significant. On the other hand, the density of neotropical migrants has declined significantly ($r_s = 0.70$, $p < 0.025$) (Fig. 1a). The 1958 point seems to be too low to be accounted for by the normal variation in the data. The individual species plots also show anomalously low populations in 1958. Everyone who worked in these mountains in that year found all birds to be in low numbers. The spring of 1958 was very cold and very wet, with late freezes and snowfalls. It was thought at the time that there was heavy mortality among spring migrants. Quite a different reason accounts for the low population in 1973. In June of 1972 Hurricane *Agnes* swept up the Piedmont region bringing torrential rains and flooding east of this study area. On this mountain there was a series of four or five days of abnormally cold weather, with rain and fog, and possibly even snow. It is quite probable that essentially no young warblers were raised that year on the mountain, and that there was also adult mortality. Without these two years the trend is significant at a higher level ($r_s = 0.90$, $p < 0.005$).

Swainson's Thrush (*Catharus ustulatus*) and the Scarlet Tanager (*Piranga olivacea*) have been present in most years, but never with densities greater than that of one male on the study tract. Interestingly, both were absent in the low year of 1958. The Red-eyed Vireo (*Vireo olivaceus*) likewise was never a very important member of this community, but has been present in all but one year. The Canada Warbler (*Wilsonia canadensis*) was missing in one year, but in 1948 and 1953 populations were moderately high Dur-

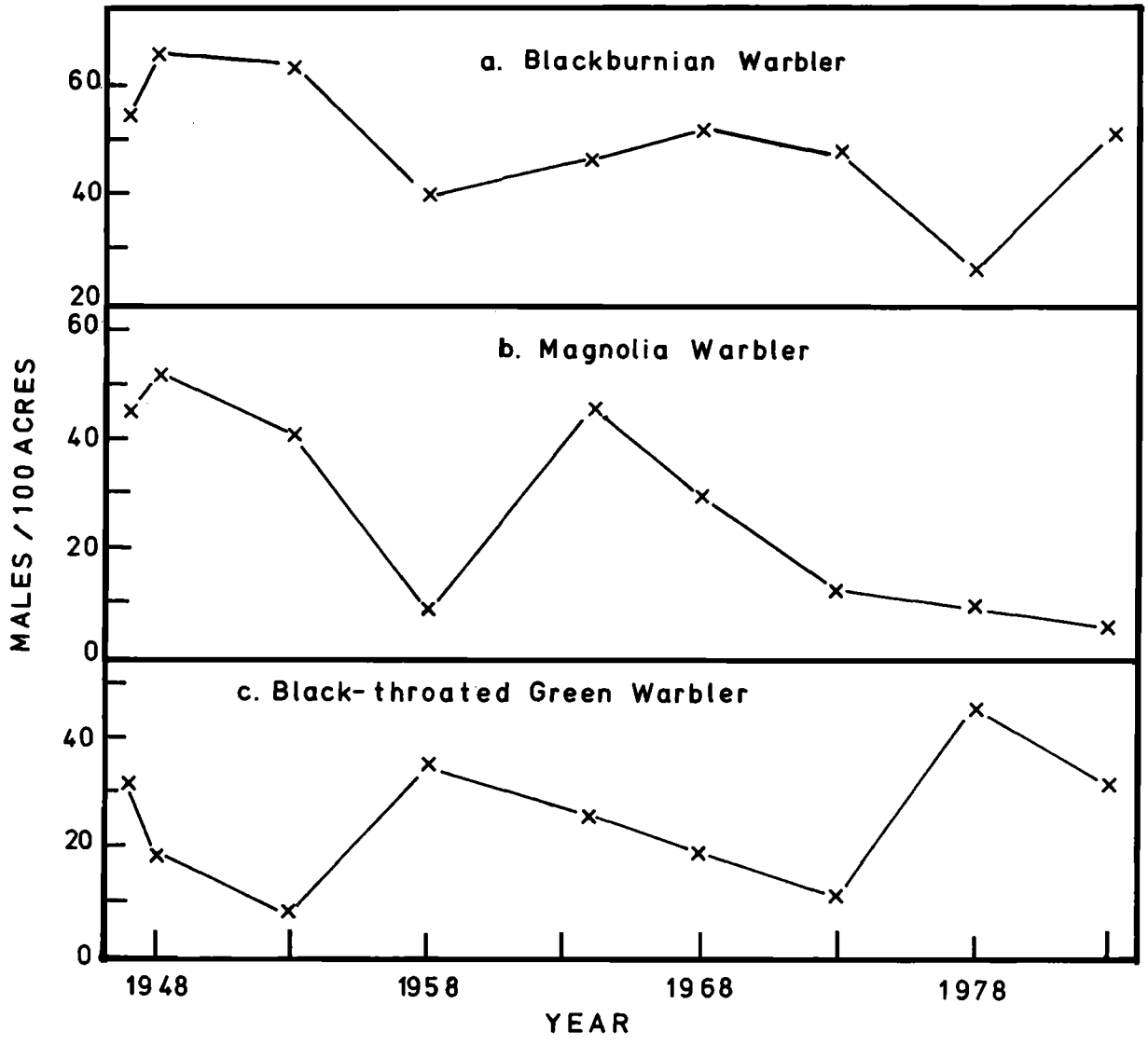

Fig 2a. Density (singing males/100 acres) of Blackburnian Warblers. 2b. Density (singing males/100 acres) of Magnolia Warblers. 2c. Density (singing males/100 acres) of Black-throated Green Warblers.

ing the winter of 1947-48 an ice and wind storm caused several blowdowns with the result that a few openings were made in the canopy. The Canada Warbler, and to a lesser extent the Magnolia Warbler (*Dendroica magnolia*), responded to this with increased numbers. As the openings closed, the Canada Warbler declined until it was again a minor species.

Of the species which have been present every year, the Solitary Vireo (*Vireo solitarius*), which has always been more abundant here than the Red-eyed Vireo, has gradually declined from a density of 26 males/100 acres to 8 males/100 acres, except for an interesting peak of 27 in 1978 The population was high that year, but the extreme figure may represent an erroneous value. The trend is not significant

The Black-throated Blue Warbler (*Dendroica caerulescens*) has maintained an essentially constant number, 20-37 males/100 acres, except for the two anomalous years—1958, when there were only 7, and 1973, when it was absent.

The Black-throated Green Warbler (*Dendroica virens*) has shown a small positive trend in numbers but detailed examination of the data shows that this species oscillates in numbers, with an indefinite period (Fig. 2c). This fluctuation is noticeable throughout these mountains.

The Magnolia Warbler had high populations in the early years, even when there were no openings in the canopy, but it has declined markedly since 1968 (Fig. 2b). The overall decline is statistically significant ($r_s = 0.72$, $p < 0.025$). The population in a nearby census area had declined at about the same time, but there the decline has been attributed mostly to the growth of the young spruce trees (Hall *in press*). This was no doubt true in the early years of that study, but it now appears that this species has undergone a major decline in population in the last 15 years.

The Blackburnian Warbler (*Dendroica fusca*) has generally been the most abundant species on the study area, with densities ranging from 27 to 66 males/100 acres (Fig. 2a). The downward trend is significant ($r_s = 0.69$, $p > 0.025$).

The Golden-crowned Kinglet (*Regulus satrapa*) is not a neotropical migrant and has shown an increase throughout the southern part of its breeding range in recent years. Perhaps this species is moving into niches vacated by the declining warblers. The density increased from 16 males/100 acres to 60 in 1973, but then in 1978 there was a sharp decrease to 33 The winters of 1976-77 and particularly 1977-78 were extremely cold, with ab-

Virgin Spruce-Northern Hardwoods Forest (Census 75). Photo/A. R. Buckelew, Jr.

normally low temperatures going far south into the winter range of the kinglet. The species experienced heavy winter mortality and was very scarce for a number of years. Although by now populations are back to the earlier values in other areas on this mountain, this increase did not show up in the 1983 census on the study plot.

DISCUSSION

THE DATA PRESENTED HERE indicate that both the number of species and the population of the neotropical migrants on this virgin tract have indeed declined over the years of study. Examination of the numbers for individual species show small and often insignificant declines, but in aggregate these amount to a decided and significant decrease. The precise reason, or reasons, for this cannot be assigned. There has been no fragmentation of this habitat. These forest-inhabiting birds are not likely to have been adversely affected by pesticide treatments, either on the wintering or breeding grounds, nor is cowbird parasitism a serious problem in this forest. The most likely cause would seem to be removal of the tropical forest.

It should be noted, however, that a superficial examination of the data do not necessarily lead to this conclusion. Besides using statistical techniques in treating the data, it is also necessary to have a full understanding of the general history of the study area, and, most importantly, to know the climatological history of the region.

There are some general points to be learned from this study. The results in 1958 and 1973 would indicate that the total bird population of an area in these mountains is highly sensitive to climatic and weather factors; indeed, in the Appalachian boreal forest the concept of an equilibrium population, so dear to the hearts of ecological theorists, is meaningless.

Much of present-day ecological theory has been drawn from data that were collected in only one or at most two years. Such short-term data can readily lead to erroneous conclusions. What sort of conclusions could be drawn, for example, from the 1958 data alone? Ideally such studies should be made over many years and should be coupled with a thorough understanding of the general history of the study area. Unfortunately this is not practical when the research is being carried out by students seeking graduate degrees.

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—Division of Forestry
(Mail Address
Department of Chemistry,
P. O. Box 6045),
West Virginia University
Morgantown, WV 26506-6045