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A CENSUS OF A BREEDING BIRD POPULATION IN A VIRGIN SPRUCE FIR FOREST ON MT. GUYOT, GREAT SMOKY MOUNTAINS NATIONAL PARK

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INTRODUCTION

There is no true timberline in the Southern Appalachians. The spruce-fir forests that crowned the crests of this chain of mountains bisecting much of the eastern United States have been reduced to a remnant by the activities of man. More than ninety percent of the virgin spruce stands of these mountains have been lost due to lumbering and fires (Stupka, 1963). The unspoiled Canadian Zone forests of Mt. Guyot and the other high mountains within the boundaries of the Great Smoky Mountains National Park are unique in eastern North America, both their fauna and flora. Not every species of bird found in the boreal spruce-fir forests of northern Maine and western Ontario are to be found there. Indeed, many characteristics of the forests of the north are rare in the spruce-fir of these southern highlands, but enough boreal species inhabit the biome to make it the only clearly-defined "life zone" in these mountains. In these high-altitude forests many Canadian Zone birds nest in the southernmost extension of their breeding range in the Eastern United States.

The Balsam Woolly Aphid (*Chermes picea*) was accidentally introduced from Europe into New England in 1908. It has since spread to eastern Canada, the Pacific Northwest, and to the Southern Appalachians. In 1957 it was discovered in North Carolina, and in 1963 on Mt. Sterling in the Great Smoky Mountains National Park.

Because of its exceedingly high reproductive capacity and the absence of natural predators the aphid represents a very serious threat to many species of fir trees in this country. A heavy stem infestation can kill a tree within two years (United States Departments of Agriculture and Interior, 1964). In the Great Smoky Mountains National Park, Fraser Fir (*Abies fraseri*) forms al-

most pure stands above 6,000 feet altitude. Should this species be destroyed, the vegetation of these mountain highlands would undergo dramatic changes which would soon be followed by equally intense changes in the kinds of animals living in this biome.

PURPOSE OF THE STUDY

The uppose of this study was to determine as accurately as possible the density of the bird populations in a virgin spruce-fir forest before changes in the forest resulting from aphid damage could occur. Accounts of the kinds of birds to be found in the spruce-fir biome are numerous. Some taken in the Southern Appalachians date almost one hundred years ago (Brewster, 1886). These reports give excellent records of the numbers of species to be found, but none gives the numbers of individuals of each species, the density, to be expected for a given unit of measure of spruce-fir forest.

A knowledge of the approximate avian population is of importance for several reasons: 1) As far as can be determined from the literature search, there are no records of population censuses taken in a virgin spruce-fir forest. The study is, therefore, unique. 2) Should the aphid continue to spread unchecked, there will occur many changes in the flora and fauna of the area. 3) Records of the present population densities are needed as a basis for comparison for ecological studies which might be undertaken at some future date.

THE AREA

The area chosen for study was a sample plot established in the spruce-fir forest on Mt. Guyot in Great Smoky Mountains National Park. Mt. Guyot is the second highest mountain in the Park and the third highest point in the Eastern United States, reaching an altitude of 6,621 feet above sea level at 35°43' N., 83°16' W. (USGS map NI 17-1). It is located on the boundary of Haywood County, North Carolina and Sevier County in East Tennessee. The mountain is accessible by United States Highway 441 and by Tennessee Highways 32 and 73. Only foot trails enter the mountain itself. A base camp from which the census was conducted was established at Tricorner Knob, a permanent shelter on the Appalachian Trail.

The study plot was a sixty-acre L-shaped grid divided into forty squares 256 feet on a side, each square having an area of one and one-half acres. Elevation of the plot varied from 5,760 to 6,000 feet. The climate at this elevation is similar to that found farther to the north. The average annual precipitation is about 38 inches. The average temperature in January is equivalent to that in Central Ohio while the average July temperature is duplicated along the southern edge of Hudson Bay in Canada (U.S. Dept. of Commerce, Weather Bureau, 1962). During the period of the census, 17 June, 1967, to 27 June, 1967, the average daily noon temperature at Tricorner Knob was 58°F.

The dominant plant association is the spruce-fir forest of the Canadian Zone biome. Because of their remoteness from easily accessible areas, the forests of Mt. Guyot were not logged before the national park was established. The forests that exist on the mountain at present are magnificent virgin remnants of those that once extended northward from the Southern Appalachians into Canada.

There was no edge or ecotone in the study area. The forest surrounding the grid was the same for miles in all directions being broken only by an occasional windfall. The uniformity of the area is an important factor. Uniform habitats typical of large regions are particularly desirable and at least one-half the value of each count depends upon it (Hall, 1964).

A survey of the forest crown vegetation on the census area was made. Its composition was found to be as follows: Fraser Fir 80%, Red Spruce (*Picea rubens*) 16%, and Yellow Birch (*Betula lutea*) 4%. (For a complete description of vegetation see Alsop, 1968.) Due to the shallowness of their root systems many trees are blown over during periods of strong winds leaving a mass of roots, soil, and matted vegetation standing almost vertically at the butt of the trunk. At least two species of birds, the Winter Wren (*Troglodytes troglodytes*) and the Slate-colored Junco (*Junco hyemalis*), were found to use these upturned tangled masses for nesting sites.

THE STUDY

Because many birds pass through the Great Smokies in the course of their spring migration, the end of the second week of June was chosen as a favorable time to begin the census. At this time no migrants are likely to be found in the spruce-fir forests and most of the passerine birds in residence in these high elevations are involved in some phase of their nesting activities during this period.

In order to minimize error in the conversion of the numbers of territorial males on the plot to a basis of the number of males per hundred acres the plot was made as large as possible. It was felt that sixty acres could be covered by the observer in one census trip before the birds' activity began to decline. Coverage of an area this large by a single observer was possible largely due to the restriction of the environment to a single uniform type and to the persistence of the birds' activity during most of the day at this altitude.

When the grid was established, with the recording stations at the intersections of the grid lines, a map was made of it for each species recorded on or over the study area (for a more detailed description of the methods and materials used see Alsop, 1968). These were used to plot the location of each contact and to establishing the number of territorial males using the area.

At each station, as soon as the time and station number were recorded, birds were counted by sight and sound for three minutes. During this time all the birds contacted were recorded. This was done even though the population density would be based on males only, to gain a knowledge of all the birds that occurred on the census area regardless of their status. No contacts made while moving from one station to the next were recorded.

Contacts were scored in three ways using the symbols *se* for seen, *si* for heard singing, and *b* for heard calling only. This procedure was used because it was felt by the observer that a singing bird was probably a male advertising his territory and was therefore more important, from the standpoint of the census results, than a bird detected only by his call notes. In the same manner a bird scored as singing was given priority over one actually seen. The type of contact was followed with an estimate of the distance, in feet, from the observer to the bird. The bird's direction in relation to that of the observer was plotted using a compass.

A special effort was made to record the locations of males of the same species singing simultaneously. This information was much more helpful than clusters of records of singing observations from a series of days because the birds were known to be two different individuals, a fact that enabled me to draw a territorial line between them on a map. During each count special notations were made of birds that flew over the area such as Chimney Swifts (*Chaetura pelagica*), Broad-winged Hawks (*Buteo platypterus*), and Ravens (*Corvus corax*). Noted also were the locations of immature birds and birds whose actions indicated a nest might be close by. In all, nine counts were made during the morning hours and six in the afternoon for a total of fifteen.

TABLE 1
THE POPULATION DENSITY OF MID-JUNE BREEDING BIRDS OF THE
MT. GUYOT SPRUCE-FIR FOREST

Species	Number of males per 60 acres	Number of males per 100 acres
Slate-colored Junco (<i>Junco hyemalis</i>)	46	76
Golden-crowned Kinglet (<i>Regulus satrapa</i>)	30	50
Winter Wren (<i>Troglodytes troglodytes</i>)	20	33
Veery (<i>Hylecichla fuscescens</i>)	20	33
Black-throated Blue Warbler (<i>Dendroica caerulescens</i>)	14	23
Solitary Vireo (<i>Vireo solitarius</i>)	9	15
Black-throated Green Warbler (<i>Dendroica virens</i>)	7	11+
Brown Creeper (<i>Certhia familiaris</i>)	6	10
Red-breasted Nuthatch (<i>Sitta canadensis</i>)	5	8
Robin (<i>Turdus migratorius</i>)	5	8
Black-capped Chickadee (<i>Parus atricapillus</i>)	4	6+
Hairy Woodpecker (<i>Dendrocepes villosus</i>)	2	3
Blackburnian Warbler (<i>Dendroica fusca</i>)	2	3
Totals	170	281

TABLE 2

A COMPARISON OF THE NUMBERS OF MALE BIRDS PER HUNDRED ACRES ON MT. GUYOT AND MT. MITCHELL

Species	Plot Census	Strip Census	Plot Census
	Mt. Guyot	Mt. Mitchell	Mt. Mitchell
	Alsop, 1967	Alsop, 1967	Adams, 1959
Slate-colored Junco (<i>Junco hyemalis</i>)	76	24	65
Golden-crowned Kinglet (<i>Regulus satrapa</i>)	50	13	50
Winter Wren (<i>Troglodytes troglodytes</i>)	33	22	35
Veery (<i>Hylocichla fuscescens</i>)	33	12	+
Black-throated Blue Warbler (<i>D. caerulescens</i>)	23	0	0
Solitary Vireo (<i>Vireo solitarius</i>)	15	3	40
Black-throated Green Warbler (<i>Dendroica virens</i>)	11+	3	75
Brown Creeper (<i>Certhia familiaris</i>)	10	0	+
Red-breasted Nuthatch (<i>Sitta canadensis</i>)	8	1+	20
Robin (<i>Turdus migratorius</i>)	8	4	15
Black-capped Chickadee (<i>Parus atricapillus</i>)	6+	0	0
Hairy Woodpecker (<i>Dendrocoptes villosus</i>)	3	0	+
Blackburnian Warbler (<i>Dendroica fusca</i>)	3	0	35
Song Sparrow (<i>Melospiza melodia</i>)	0	6	0
Chestnut-sided Warbler (<i>Dendroica pensylvanica</i>)	0	8	0
Canada Warbler (<i>Wilsonia canadensis</i>)	0	1+	1
Catbird (<i>Dumetella carolinensis</i>)	0	1+	0
Totals	281	94	340

This method of plotting the birds contacted on maps to determine the number of territorial males present, the Williams spot-mapping method, is very well adapted for most species of small passerine birds. The method is not used to determine the territorial boundaries, but to determine the number of territories present.

Twenty-four species of birds were found on or flying over the Mt. Guyot study plot. Of these twenty-four, thirteen were thought to be breeding birds or territory holders at the time of the census. These thirteen species were represented by one hundred-seventy territorial males, an average of 2.8 territorial males per acre (Table 1).

A trip was made to Mt. Mitchell in North Carolina to see the effects of the Balsam Woolly Aphid and to conduct a brief census of a bird population in a disturbed habitat for comparison with the Mt. Guyot study. It can be assumed from the close proximity of Mt. Guyot to Mt. Mitchell (they are about fifty-five statute miles apart and of similar elevations) that the forests and the birds found on both were originally identical. This can be further

substantiated by the records of early naturalists such as Brewster (1886). Today they are quite different. The forests on Guyot are in their primitive condition; those of Mt. Mitchell have been logged, burned, infested, and left to the ravages of the winds except for some Fraser Fir at the very summit which now face the threat of the aphid. Adams (1959) conducted a breeding bird census on Mt. Mitchell.

On 1 and 2 July, 1967, I conducted two strip censuses to get an index of the relative abundance of the breeding birds there. I was looking for the absence of species recorded on Mt. Guyot and the occurrence of any birds that had not been observed there whose presence could be tied to the ecological changes in the vegetation on Mt. Mitchell. The result of these counts and a comparison with those of Adams' on Mitchell and mine on Guyot are shown in Table 2.

The most dramatic differences in the avifauna were the absences of the Black-throated Blue Warbler (*Dendroica caerulescens*), Brown Creeper (*Certhia familiaris*), and Black-capped Chickadee (*Parus atricapillus*) on Mt. Mitchell as these were common in the spruce-fir of Mt. Guyot. Similarly, the Song Sparrow (*Melospiza melodia*) and the Chestnut-sided Warbler (*Dendroica pensylvanica*) were plentiful on Mt. Mitchell, but the Song Sparrow was never recorded on Mt. Guyot and only one Chestnut-sided Warbler was a visitor to the study plot.

The strip censuses taken on Mt. Mitchell also indicate decreases in the populations of Solitary Vireos (*Vireo solitarius*), Black-throated Green Warblers (*Dendroica virens*), Red-breasted Nuthatches (*Sitta canadensis*), Robins (*Turdus migratorius*), and Blackburnian Warblers (*Dendroica fusca*). Possibly the bird that has benefited the most by the changes in Mt. Mitchell's vegetation is the Song Sparrow. This seems to be a "disaster" species in the higher elevations of the Southern Appalachians. It extends its range to the very peaks of these mountains when sufficient damage has been done to the vegetation to establish the open second-growth areas it prefers.

SUMMARY

The introduction of the European Balsam Woolly Aphid into the United States poses a threat to the Fraser Fir of this country. A census was conducted in the virgin spruce-fir forests of Mt. Guyot in the Great Smoky Mountains National Park using a spot-mapping method to determine the absolute breeding bird population on a sixty-acre plot before ecological changes were brought about by aphid destruction. The results of this census were compared to findings of other investigators in similar biomes. A trip was made to, and a strip census was conducted on, Mt. Mitchell where the forests have undergone dramatic changes due to the destruction of the trees by man and aphid infestation. The findings on Mt. Mitchell were compared to those of Mt. Guyot to see if any changes in the avifauna could be linked directly to the aphid.

This research was important not only in providing a basis for comparison by future investigators, but also in that censuses in undisturbed spruce-forests are few in general and unique in the Southern Appalachians.

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