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WEATHER-DEPENDENT USE OF HABITAT PATCHES BY WINTERING WOODLAND BIRDS

DANIEL R. PETIT[1]

Department of Zoology
The Ohio State University
Columbus, Ohio 44230 USA

Abstract.—Use of three habitat patches by winter birds was assessed under different weather conditions from 15 Nov.–15 Mar. 1982–1985 in southeastern Ohio. All three plots contained mature trees, but the dense coniferous and open coniferous plots were comprised almost entirely of white pine trees and the deciduous plot was a bottomland stand of deciduous hardwoods. Additionally, the dense coniferous plot had a very dense understory (branches and foliage from pine trees), whereas the open coniferous plot was nearly devoid of vegetation below 6 m. During warm (>0 C) and cold/calm (≤0 C, wind velocity <1.0 m/s) weather, there were relatively more birds in the deciduous plot than in either coniferous plot. However, under more severe weather conditions (cold/windy and rainy) there were equal proportions in each of the three habitat types. Based on absolute numbers of birds censused, rather than relative numbers, it appears that birds moved into both coniferous patches during harsh weather conditions. An opposite, but statistically nonsignificant, trend was observed on the deciduous site. These results suggest that wintering woodland birds respond to harsh weather on a short-term basis by moving into habitats that provide greater shelter from the elements. Those movements may have implications for studies based on winter censuses because of the added weather-dependent variability to census numbers.

EL EFECTO DEL CLIMA EN LA UTILIZACIÓN DE HABITAT EN PARCHES POR PARTE DE AVES INVERNALES

Resumen.—El uso de tres parcelas de hábitat por parte de aves invernales fue evaluado bajo diferentes condiciones climatológicas desde nov.-15 a mar.-15 de 1982–1985, en el sureste de Ohio. Las tres parcelas contenían árboles maduros, pero las de coníferos densos y coníferos abiertos estaban compuestas casi todas de pino blanco, mientras que la parcela de árboles deciduos era mayormente un rodal de madera leñosa. La parcela densa de pino tenía un follaje denso de ramas de pino cerca del suelo, mientras que las parcelas abiertas de coníferos estaban casi totalmente desprovistas de vegetación por debajo de los 6 m. Durante climas cálidos (>0 C) y frio/calmado (<0 C, velocidad del viento <1.0 m/s), hubo relativamente más aves en las parcelas de árboles deciduos que en cualquiera de las parcelas de coníferos. Sin embargo, bajo las condiciones climatológicas más severas (frio/viento y lluvioso) hubo proporciones iguales en cada uno de los hábitats. A base de números absolutos de aves contadas, en vez de números relativos, parece que las aves se movieron a ambos parches de coníferos durante condiciones climatológicas más extremas. Una tendencia opuesta, aunque no estadisticamente significativa, fue observada en las parcelas de deciduos. Estos resultados sugieren que las aves invernales responden a climas hostiles, a corto plazo, moviendose a hábitats que proveen mayor resguardo de los elementos. Estos movimientos pueden tener implicaciones en estudios sobre aves invernales que se basen en censos.

Foraging behavior of terrestrial birds wintering at northern latitudes is influenced largely by local weather conditions, such as temperature, wind velocity, and solar radiation (e.g., Alatalo 1982; Grubb 1975, 1977, 1978; Morse 1970). Such alterations in behavior are thought to be induced by thermoregulatory demands of cold, harsh environments (Gates 1969,

[1] *Current address: Department of Zoology, University of Arkansas, Fayetteville, Arkansas 72701 USA.*

Grubb 1975). Research on weather-dependent behavior of birds has concentrated on microhabitat changes within a given vegetation type; for example, vertical movements or branch size selection on trees in mature forests (Alatalo 1982, Grubb 1975). Yet, under some weather conditions, these small-scale responses may be ineffective in reducing loss of body heat. Accordingly, a bird has several "options" to alleviate the thermal stress. It can move into other habitats where protection from the elements is greater or, if inclement weather is prolonged, it can migrate regionally to areas where the climate is more benign. Weather-related regional movements have been documented for a number of winter residents (see discussion in Terrill and Ohmart 1984:435). However, study of more short-term, local movements by birds into habitats that offer greater protection from the elements is lacking. Several authors (e.g., Brawn and Samson 1983, Grubb 1977) have noted, however, that birds on their study plots seemed to prefer certain habitat types with more protection from inclement weather when it was cold and windy. In this study, I assess winter bird use of three distinct habitat patches of mature trees that differ in vegetation composition and structure and ask the question, does weather affect the relative distribution of birds among the three habitat types?

METHODS

The three study plots, each 1.5 ha in area and in close proximity to each other, were located near Greendale in Wayne National Forest, Hocking Co., Ohio. Much of southeastern Ohio forests, such as those containing my study sites, are characterized by oak-hickory associations on ridge tops and slopes, and by beech (*Fagus grandifolia*), yellow poplar (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), white ash (*Fraxinus americana*), maples (*Acer* spp.), and river birch (*Betula nigra*) in the floodplains of rivers and creeks (Gordon 1969). A conspicuous element of the terrain is patches (usually <5 ha) of native and planted pines (mainly *Pinus strobus, P. echinata,* and *P. virginiana*) comprising 10–15% of the forest (Kincaid 1982).

The deciduous plot was a portion of a larger bottomland forest typical of this area (see above). The plot had a canopy 23 m tall and was bordered on all sides by contiguous forest. The other two study sites were patches of nearly pure (>95%) white pine, but each had distinct foliage profiles. The dense coniferous plot, located 100 m N of the deciduous plot, was characterized by relatively short (12 m) trees with foliage and branches extending nearly to the ground. The open coniferous plot was positioned 150 m NE of the deciduous plot and 80 m E of the dense coniferous plot. This coniferous plot differed from the dense coniferous stand by having a taller (23 m) and more open canopy and little foliage below 6 m.

Birds on each plot were censused by three observers between 15 Nov. and 15 Mar. (the "no-leaf" seasons; cf. Berner and Grubb 1985) 1982–1985. Birds on each plot were censused along two parallel transects as the observer walked slowly (2 km/h), counting all birds seen or heard within 25 m of the route. Censuses were usually conducted in the morning and took 30 ± 5 min to complete. All three plots were censused on the same days, either simultaneously or one immediately after the other. Thus, all sites were censused over a 1.5 h period. Because the measurement of interest was *relative* distribution of birds across plots, the experimental design allowed me to control for such confounding effects as time of day, time of year, weather, and total bird densities in the area. The plots were smaller than those typically used in winter bird censuses (Robbins 1981), but were necessary because of the need to ensure that birds were not moving between plots during a given census period and that local weather conditions remained fairly constant. Larger plots take longer to census and, therefore, the probability that individuals were moving between plots would be increased; I was interested in a nearly simultaneous "snapshot" of bird abundance among habitat types. Furthermore, small plots increase the variance of bird abundance estimates, thereby making it more difficult to detect statistical differences between plots.

Before each census in 1982–1983 and 1983–1984, temperature and wind velocity (averaged over a representative 2 min period) (m/s; "Velometer Jr.," Alnor Instrument Co., Niles, Illinois) were measured at a height of 1.5 m at a regular location outside of the plots and at a predetermined location within each plot. In addition, immediately after each sighting of a bird, or during a 2 min period if no birds were sighted, wind velocity was again measured. From these data, then, I calculated a measure of the ability of each plot to serve as a buffer against wind (see Grubb 1978 for a similar technique). For censuses conducted in 1984–1985, wind velocity was estimated based on the Beaufort scale. I also measured precipitation with a rain gauge. If any weather conditions changed markedly from the beginning to the end of the three censuses on a given day, those data were discarded.

Because the experimental design included matched sets ("blocks") of censuses taken under similar conditions, Friedman's nonparametric, analysis of variance (Hollander and Wolfe 1973, Siegel 1956) was used to test the null hypothesis that relative bird abundance did not differ between the three habitat types under a given set of weather conditions. Friedman's test is a form of repeated measures where each "block" (subject) is subjected to all of the treatments under study. The advantage of this type of design is that the between-census variability is partitioned out, such that each census serves as its own control (Neter and Wasserman 1974). Thus, I controlled for extraneous variables, such as time of day, time of year, and total density of birds in the general study area, with this blocked design. Friedman's test was used to test the null hypothesis of no difference in abundance among habitats for each of the following weather conditions: (1) cold/windy (temperature ≤ 0 C, wind velocity outside of plots ≥ 1.0 m/s), (2) cold/calm (≤ 0 C, wind < 1.0 m/s), (3) warm (> 0 C), and (4) rainy (light [0.1–0.4 cm/h] rain falling).

The above results would indicate if the *proportion* of birds in each habitat type varied under different environmental conditions, but would not provide any information as to whether birds showed weather-dependent habitat use (i.e., moved into different habitats) or that individuals in one (or two) plot simply were less detectable under some weather conditions (Robbins 1981). To distinguish between these two possibilities, a Kruskal-Wallis one-way analysis of variance (Siegel 1956) was conducted for each plot to compare bird census numbers across the four weather categories.

RESULTS

The dense coniferous plot provided much refuge from the wind over the range of wind velocities ($\leq$3.0 m/s) measured in this study. On average, that plot reduced wind velocity recorded in open areas by 78%, compared to 55% in the open coniferous plot and 28% in the deciduous plot. During the three winters, 99 censuses were conducted, 33 in each habitat type. Eighteen species were recorded, but the majority (>80%) of individuals were represented by six species: Downy Woodpecker (*Picoides pubescens*), Carolina Chickadee (*Parus carolinensis*), Tufted Titmouse (*P. bicolor*), White-breasted Nuthatch (*Sitta carolinensis*), Brown Creeper (*Certhia americana*), and Golden-crowned Kinglet (*Regulus satrapa*).

Relative distribution of birds across the three plots was non-random during both warm (Friedman's test, $\chi^2 = 7.49$, df = 2, $P < 0.05$) and cold/calm ($\chi^2 = 9.81$, df = 2, $P < 0.01$) weather. In both cases, relative bird abundance was much greater on the deciduous site than on either of the coniferous plots (Fig. 1). During cold/windy ($\chi^2 = 2.03$, df = 2, $P > 0.30$) and rainy ($\chi^2 = 1.90$, df = 2, $P > 0.30$) weather, however, relative bird distribution was similar across the three habitat types (Fig. 1).

Results of Kruskal-Wallis tests showed that absolute numbers of birds censused under different weather conditions differed substantially in both the dense coniferous plot ($\chi^2 = 13.72$, df = 3, $P < 0.01$) and the open coniferous stand ($\chi^2 = 6.26$, df = 3, $P < 0.10$, Fig. 2); more birds were present during cold/windy and rainy weather than during more benign conditions. Conversely, the number of birds occupying the deciduous woodland declined nonsignificantly in response to harsh weather ($\chi^2 = 2.21$, df = 3, $P > 0.50$, Fig. 2).

DISCUSSION

Many bird species are known to make local movements during the winter to areas with more abundant food (e.g., Graber and Graber 1979, Perrins 1966, Van Balen 1980). Results from this study suggest that wintering woodland birds also make short-term local movements into habitat patches that confer greater protection from inclement weather. Specifically, birds moved into the dense coniferous habitat patch and, to a lesser extent, the more open coniferous woodlot during cold/windy and rainy weather. Some of those individuals apparently moved from the surrounding deciduous forest. Although I did not have birds individually marked, on two occasions I observed Golden-crowned Kinglets and Carolina Chickadees flying from the deciduous study area into the dense

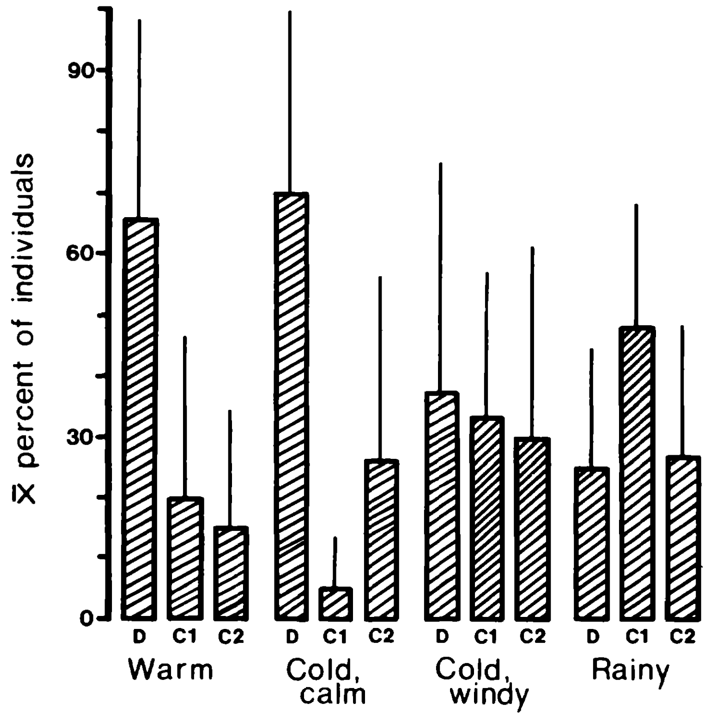

FIGURE 1. Relative distribution of wintering woodland birds across three habitat types under different weather conditions in Hocking County, Ohio. D = Deciduous plot, C1 = Dense coniferous plot, C2 = Open coniferous plot. Vertical lines represent 1 standard deviation.

coniferous plot when it began raining during censuses in the deciduous plot. Birds may have been moving into all three plots from other, more exposed habitats (e.g., upland forests), which could account for the less drastic change in bird numbers on the deciduous plot. Nevertheless, birds clearly moved onto coniferous plots from other areas during the most severe weather. In addition, although the coniferous patches were nearly identical in tree species composition, more birds used the dense plot than the open plot during inclement weather. This disparity can be attributed to the greater protection from wind and rain in the dense stand. More study is needed on the temporal (both daily and diurnal) variation in habitat use by overwintering birds at northern latitudes and how this variation is related to weather. Moreover, in future studies, detailed study of marked birds would provide definitive evidence of weather-dependent patch use.

Robbins (1981) suggested that inclement weather during winter may have a negative impact on the number of birds censused because of its effect on the observer. Although this is probably factual, the effect of

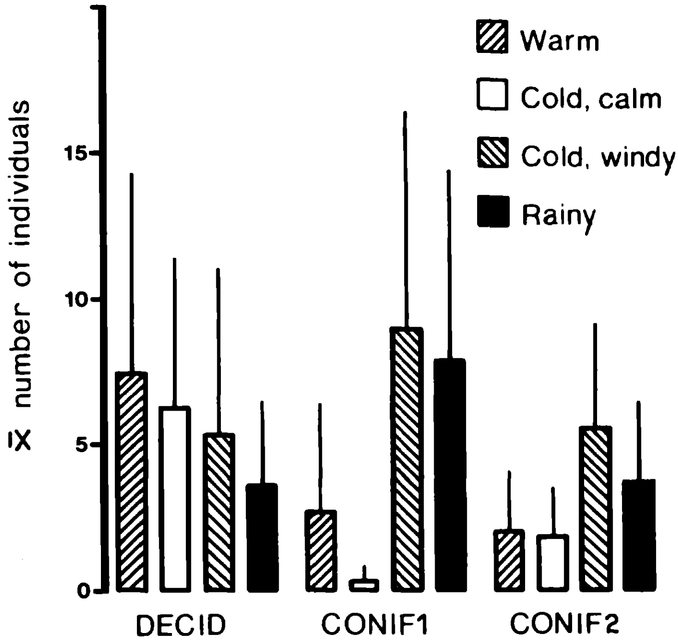

FIGURE 2. Number of wintering woodland birds censused in three habitat types under different weather conditions in Hocking County, Ohio. DECID = Deciduous plot, CONIF1 = Dense coniferous plot, CONIF2 = Open coniferous plot. Vertical lines represent 1 standard deviation.

weather also may be pronounced on birds, which move into habitat types that afford greater protection. Therefore, short-term movements by birds should be considered by researchers conducting winter censuses; those movements may create additional, unwanted variance in count numbers such that trends in habitat use are obscured.

Results of this study also indicate that habitats that are relatively barren of breeding species in summer (e.g., stands of white pine in this study) may be important to some avian species during winter, at least on a short-term basis. Most management plans involving birds concentrate on habitats with high use during the breeding period (Verner et al. 1986); winter use is largely ignored. However, if bird populations are constrained primarily by survival on wintering grounds (e.g., Fretwell 1972), then presence of certain habitat types that offer shelter even on a short-term basis could be important for survival of individuals.

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