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EFFECTS OF TIME OF DAY AND SEASON ON WINTER BIRD COUNTS[1]

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Abstract. We examined the effects of time of day and season on counts of wintering birds in a central Pennsylvania forest. Black-capped Chickadees (*Parus atricapillus*), Tufted Titmice (*Parus bicolor*), and White-breasted Nuthatches (*Sitta carolinensis*) were detected more often in the morning (07:00–10:59) than at other times, whereas White-throated Sparrows (*Zonotrichia albicollis*) were noted more often at midday (11:00–13:59). Numbers of contacts of all species combined were relatively similar between morning and midday but were much lower in the afternoon (≥14:00). Black-capped Chickadees, Tufted Titmice, White-breasted Nuthatches, Golden-crowned Kinglets (*Regulus satrapa*), and White-throated Sparrows were observed more often in early winter (before 19 January) than later in the season. We conclude that winter bird counts can be conducted in both morning and midday hours with little or no qualitative loss of data. In addition, counts should be made in early winter to minimize the effects of food shortages later in winter that may influence avian mortality and movements to feeders.

Key words: Winter bird counts; censusing; diurnal patterns.

INTRODUCTION

Studies of winter bird communities are relatively uncommon compared to those in the breeding season (Kricher 1975). Winter bird communities in northern latitudes generally consist of few species and individuals (e.g., Yahner 1986). Thus, in order to obtain adequate sample sizes of wintering birds to examine, for example, the effects of habitat alterations on avian abundance, the timing of counts becomes an important consideration.

Recommendations for the timing of winter bird counts vary markedly. The Audubon winter-bird population studies (Kolb 1965) suggested that counts can be made throughout the day, whereas Shields (1977) and Kricher (1982) recommended that counts be conducted a few hours after sunrise. Although Kricher (1975, 1982) suggested that winter counts be made from mid-December through mid-March, Kolb (1965) and Conner and Dickson (1980) recommended that counts be restricted from late December to mid-February.

As part of a study dealing with the effects of forest irrigation on avian communities in Pennsylvania (Rollfinke 1988), we compared winter bird counts conducted at different times of day and over the course of winter. Our objective in the present study was to determine the effects of time of day (morning, midday, and afternoon) and season (early, mid-, and late winter) on counts of wintering birds in a Pennsylvania forest.

METHODS

We conducted the study on State Game Lands (SGL) 176, Centre County, Pennsylvania, during winters 1986–1987 and 1987–1988. Overstory trees were 50 to 65 years old and included white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), scarlet oak (*Quercus coccinea*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), and red maple (*Acer rubrum*). Elevation ranged from 360 to 400 m. A portion (200 ha) of SGL 176 has been irrigated with waste water (chlorinated sewage effluent) since 1983, and approximately 5 cm of waste water are applied per week throughout the year via an extensive sprinkler system (see Rollfinke 1988).

We established four replicate transects each in irrigated and adjacent nonirrigated forest. Transects were 250 m in length, and were located at least 50 m from disturbances (i.e., unpaved roads) and habitat edges. All birds heard or seen were counted within a 50-m lateral distance of each

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TABLE 1. Stepwise logistic regression of presence or absence of wintering birds (dependent binary variables) along a transect on time of DAY and winter PERIOD for irrigated transects, nonirrigated transects, and for all transects combined, SGL 176, Centre County, Pennsylvania, with both winters (1986–1987 and 1987–1988) combined. Only significant ($P < 0.05$) independent variables are included in table.

Dependent variable	Independent variable	Improvement in chi-square	df	*P*
Irrigated transects:				
Black-capped Chickadee	PERIOD	10.75	2	0.005
Tufted Titmouse	PERIOD	11.26	2	0.004
White-throated Sparrow	PERIOD	14.18	2	0.001
Nonirrigated transects:				
White-breasted Nuthatch	DAY	11.59	2	0.003
	PERIOD	13.91	2	0.001
Golden-crowned Kinglet	PERIOD	8.20	2	0.017
	DAY	8.46	2	0.015
All transects combined:				
Black-capped Chickadee	PERIOD	13.74	2	0.001
Tufted Titmouse	PERIOD	13.74	2	0.001
	DAY	6.32	2	0.042
White-breasted Nuthatch	PERIOD	12.34	2	0.002
Golden-crowned Kinglet	PERIOD	11.96	2	0.003
White-throated Sparrow	PERIOD	13.17	2	0.001

transect from late December to early March in winters 1986–1987 and 1987–1988. Because our objective was to make relative comparisons between times of day and season rather than absolute density estimates, we chose to use transects of fixed widths over variable-width transects, which adjust for differences in detectability between species (Dickson 1982, Raphael 1987). Transect width was chosen to be 50 m because we believe that most or all birds could be detected within this lateral distance regardless of vegetative structure (Whitcomb et al. 1981, Yahner 1985) and because irrigation pipelines at SGL 176 paralleled our transects at lateral distances of just over 25 m, providing clear visual reference points from which to determine a 50-m distance.

Counts were conducted at least twice per week, resulting in a minimum of 24 counts per winter and were divided equally among three times of day: morning (07:00–10:59), midday (11:00–13:59), and late afternoon (14:00–17:30). The design was such that starting times for each transect and the order in which transects were walked were randomly selected. No counts were conducted during heavy precipitation or high winds. Each winter was divided into three periods: early winter (29 December–18 January), midwinter (19 January–9 February), and late winter (10 February–9 March). Winter counts were limited to late December through early March to avoid late fall or early spring migration or any detection biases created by the onset of territorial song (Robbins 1972). Further, these times represent the maximum extremes suggested by earlier authors (e.g., Kricher 1975).

We used stepwise logistic regression (BMDPLR, Dixon 1985) to predict the presence or absence (binary dependent variable) of wintering birds along transects based on time of day (morning, midday, or late afternoon) and winter period (early, mid-, or late). Observed vs. expected numbers of contacts of eight common species (>90 total contacts each along all transects and in both winters combined), of all species combined, and of all species combined excluding three large Cedar Waxwing (*Bombycilla cedrorum*) flocks were compared among times of day and winter periods using *G*-tests for goodness-of-fit (Sokal and Rohlf 1981).

RESULTS

We observed 16 and 19 species along irrigated transects and 15 and 12 species along nonirrigated transects in the winters of 1986–1987 and 1987–1988, respectively (see Rollfinke 1988; Rollfinke and Yahner, in press). Mean number of contacts for both winters combined was 19.7 birds per 10 ha along irrigated transects (17.0 excluding Cedar Waxwings) and 11.5 birds per

TABLE 2. Total number of contacts per bird species, total number of species, and total number of individuals along irrigated and nonirrigated transects combined, SGL 176, Centre County, Pennsylvania, during three times of day with both winters (1986–1987 and 1987–1988) combined. Expected number of contacts were equal among time periods.

	Time of day		
	Morning (07:00–10:59)	Midday (11:00–13:59)	Late afternoon (14:00–17:30)
Downy Woodpecker	77	78	62
Hairy Woodpecker	39	27	27
Black-capped Chickadee	138[a]	96	65[b]
Tufted Titmouse	50[a]	29	16[b]
White-breasted Nuthatch	56[a]	43	34
Brown Creeper	37	33	30
Golden-crowned Kinglet	78	80	49[b]
White-throated Sparrow	43[b]	74[a]	49
Total no. species	18	18	19
Total no. individuals (all species)	647[a]	549	366[b]
Total no. individuals (excluding waxwings)	551[a]	504	366[b]

[a] Observed number of contacts significantly greater than expected during this time of day compared to others combined; G-test for goodness-of-fit, $G \geq 3.8$, df = 1, $P < 0.05$.
[b] Observed number of contacts significantly less than expected during this time of day compared to others combined; G-test for goodness-of-fit, $G \geq 3.8$, df = 1, $P < 0.05$.

10 ha along nonirrigated transects (11.4 without waxwings).

Presence or absence of White-breasted Nuthatches, Golden-crowned Kinglets, and Tufted Titmice was correlated with time of day (Table 1). We recorded more Black-capped Chickadees, Tufted Titmice, and White-breasted Nuthatches than expected in the morning and more White-throated Sparrows at midday than at other times (Table 2). Golden-crowned Kinglets were detected less often in late afternoon than in either morning or midday. However, contacts of Downy Woodpeckers (*Picoides pubescens*), Hairy Woodpeckers (*Picoides villosus*), and Brown Creepers (*Certhia americana*) were not different among time periods. The highest number of contacts of all species combined was noted in morning, with 15% fewer birds in midday, and 43% fewer birds in late afternoon hours (Table 2), despite lower mean temperatures in morning hours (−6°C in morning, −1° at midday, 1° in late afternoon).

Presence or absence of five common species (Black-capped Chickadee, Tufted Titmouse, White-breasted Nuthatch, Golden-crowned Kinglet, White-throated Sparrow) was associated with winter periods (Table 1). Each of these species was encountered more often in early winter than in other periods (Table 3). Again, presence or absence of Downy Woodpeckers, Hairy Woodpeckers, and Brown Creepers was not correlated with winter periods. Three large flocks of Cedar Waxwings dramatically increased total numbers of contacts of all species combined in midwinter. However, when we excluded this species, 27% fewer resident birds were observed in midwinter and 51% fewer in late winter than in early winter. The total number of avian species declined from 20 in midwinter to only 14 in late winter.

DISCUSSION

Our finding that common wintering birds, with the exception of White-throated Sparrows, were most readily detected in the morning concurs with those of Shields (1977), Conner and Dickson (1980), and Kricher (1982). In contrast, Kolb (1965) suggested that winter birds can be censused at all times of day, and Robbins (1972) found several species to be consistently more conspicuous in afternoon than in morning during winter. Grubb (1978) has shown that activity of birds (and hence conspicuousness) often depends more on weather than on time of day. As Shields (1979) pointed out, however, even if winter bird detectability depends primarily on temperature or light intensity, these winter variables are related directly to time of day.

To our knowledge, no studies have examined the reliability of winter bird counts conducted at midday. We found that counts made at midday (11:00–13:59) gave almost the same number of

TABLE 3. Total number of observed (expected in parentheses) contacts per bird species, total number of species, and total number of contacts of individuals along irrigated and nonirrigated transects combined, SGL 176, Centre County, Pennsylvania, during three winter periods with both winters (1986–1987 and 1987–1988) combined.

	Winter period		
	Early winter (12/29–1/18)	Midwinter (1/19–2/9)	Late winter (2/10–3/9)
Total no. of transect counts	148	138	122
Downy Woodpecker	88 (78.7)	67 (73.4)	62 (64.9)
Hairy Woodpecker	38 (33.7)	29 (31.5)	26 (27.8)
Black-capped Chickadee	162 (108.4)[a]	89 (101.1)	48 (89.4)[b]
Tufted Titmouse	49 (34.5)[a]	37 (32.1)	9 (28.4)[b]
White-breasted Nuthatch	69 (48.2)[a]	31 (45.0)[b]	33 (39.8)
Brown Creeper	41 (36.3)	31 (33.8)	28 (29.9)
Golden-crowned Kinglet	94 (75.1)[a]	70 (70.0)	43 (61.9)[b]
White-throated Sparrow	91 (60.2)[a]	65 (56.1)	10 (49.6)[b]
Total no. species observed	18	20	14
Total no. individuals (all species)	682 (566.5)[a]	604 (528.3)[a]	276 (467.0)[b]
Total no. individuals (excluding waxwings)	682 (515.4)[a]	463 (480.6)	276 (424.9)[b]

[a] Observed number of contacts significantly greater than expected during this time of winter compared to others combined; G-test for goodness-of-fit, $G \geq 3.8$, df = 1, $P < 0.05$.
[b] Observed number of contacts significantly less than expected during this time of winter compared to others combined; G-test for goodness-of-fit, $G \geq 3.8$, df = 1, $P < 0.05$.

total contacts of all species combined as morning counts. If this situation is typical of wintering bird communities in northern latitudes, then winter counts need not be restricted to morning hours (prior to 11:00) but can extend to at least 12:00 or shortly thereafter with little or no qualitative or quantitative loss of data. Such a recommendation would facilitate wintering bird studies that are restricted in numbers of field days due to logistical constraints by increasing the time spent in the field per day and, hence, the amount of area sampled.

Because most wintering birds are nonterritorial, highly transient, and more variable in abundance than breeding birds, a large number of censuses is required to arrive at accurate samples of winter bird communities (Kricher 1982). We contend that presence or absence of all wintering bird species can be detected at any time of day, given adequate numbers of transect counts. However, we also suggest that abundance of individual species may be underestimated despite adequate coverage if counts are conducted late in the day, particularly after 14:00. Although Robbins (1972) suggested a minimum of eight counts to census winter bird populations, we support Kricher's (1982) more conservative recommendation of at least 13 counts.

Winter may be defined as mid-December through mid-March for the purposes of bird counts (Kricher 1982). Several authors, however, recommend that winter bird counts be completed by mid-February, when avian population declines often become noticeable (Kolb 1965, Morse 1970, Conner and Dickson 1980). Kricher (1975) also reported significant declines in avian species richness in a New Jersey oak forest during late winter (February and March). Our results support the recommendation that most counts be conducted from late December through January in order to maximize detection of common forest birds. As winter progresses, birds are less likely to occur in flocks because of local movements to suitable breeding areas (Morse 1970). An additional factor affecting bird numbers in late winter is declining food resources, which influences avian mortality and movements to feeders (Graber and Graber 1979).

In conclusion, we believe that temporal factors should be given serious consideration when conducting winter bird counts. The impact of forest management or other habitat alterations on wintering forest avifauna can be better assessed if counts are made early in the day and season than at other times, especially if time and field personnel are limited.

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