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Temporal Differences in Point Counts of Bottomland Forest Landbirds

Winston Paul Smith[1,3] and Daniel J. Twedt[2]

ABSTRACT.—We compared number of avian species and individuals in morning and evening point counts during the breeding season and during winter in a bottomland hardwood forest in west-central Mississippi, USA. In both seasons, more species and individuals were recorded during morning counts than during evening counts. We also compared morning and evening detections for 18 species during the breeding season and 9 species during winter. Blue Jay (*Cyanocitta cristata*), Mourning Dove (*Zenaida macroura*), and Red-bellied Woodpecker (*Melanerpes carolinus*) were detected significantly more often in morning counts than in evening counts during the breeding season. Tufted Titmouse (*Baeolophus bicolor*) was recorded more often in morning counts than evening counts during the breeding season and during winter. No species was detected more often in evening counts. Thus, evening point counts of birds during either the breeding season or winter will likely underestimate species richness, overall avian abundance, and the abundance of some individual species in bottomland hardwood forests. *Received 15 Nov. 1997, accepted 20 Aug. 1998.*

Improvement and standardization of assessment techniques for monitoring bird populations has received considerable attention (e.g., Ralph et al., 1993, 1995a, b; Hamel et al. 1996). Although most studies of avian population assessment techniques have focused on breeding birds, some have evaluated winter bird populations (Rollfinke and Yahner 1990; Gutzwiller 1991, 1993a, b). Detecting statistically significant changes in avian populations may require an extensive monitoring network (Smith et al. 1993, Hamel et al. 1996). To achieve monitoring objectives using limited resources, protocols that reduce costs and maximize efficiency are required (Smith et al. 1993). Unfortunately, many factors that influence survey efficiency are beyond the control of investigators. For example, detection varies among species, among census techniques (e.g., Grue et al. 1981, Rollfinke and Yahner 1990), and may be influenced by physical or biological factors (Gutzwiller 1993a, b).

If detection probabilities were constant over time, the efficiency of avian surveys could be increased by providing a greater window of opportunity during which surveys could be conducted. However, most species exhibit diel and seasonal variation in detectability. Thus, to optimize sampling effort and reduce sampling variances, monitoring should be focused on periods when species are most frequently detected (Gutzwiller 1993a).

To assess optimal periods of detection, investigators have compared point counts from different times of the morning during the breeding season (Shields 1977, Grue et al. 1981, Robbins 1981, Skirvin 1981) or winter (Gutzwiller 1993a). Only Rollfinke and Yahner (1990), using transect counts, compared morning counts to evening counts during winter. Although birds are generally assumed to

[1] United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, 2770 Sherwood Lane—Suite 2A, Juneau, AK 99801-8545; E-mail: wpaulsmith@aol.com
[2] USGS Patuxent Wildlife Research Center, 2524 South Frontage Road, Vicksburg, MS 39180.
[3] Corresponding author.

be more detectable during morning than during evening, we suspected that some species were equally detectable during both periods. If true, monitoring efforts that focused only on these species could greatly expand the time during which surveys could be conducted. To evaluate the differences in detection of avian species between morning and evening, we conducted paired morning and evening point counts during the breeding season and during winter. In this paper, we report the resulting estimates of avian species richness, overall abundance, and abundance of selected species. We also assess the relationship between detection of individual species and the observed variation between morning and evening counts.

STUDY SITE AND METHODS

Point counts were conducted on the 1050 ha Delta Experimental Forest, near Stoneville, Mississippi (33° 29′ N, 90° 55′ W). Surrounded largely by agriculture, this bottomland hardwood forest was heavily logged from 1910 to 1920 with additional research and commercial harvests continuing though the 1960s. There was no timber harvest on Delta Experimental Forests between the early 1960s and the time of this study.

We conducted morning and evening point counts during the breeding season (30 May–12 June 1991; 8–21 May 1992) and winter (4–14 February 1991; 9–29 January 1992) at 25 stations in each of 4 forest stands. Forest stands were similar in habitat but were subjected to different silvicultural management. We generally followed standardized protocols for conducting point counts (Ralph et al. 1993, Hamel et al. 1996) but used 4-min sampling periods instead of 5-min and 20-m fixed radius circular plots instead of 50-m. We reduced the sampling period based on species detection curves from preliminary survey data and we restricted the plot radius to 20-m because of a concurrent effort to model habitat using these same data. Points were visited so that each visit occurred at a different time during the 3-h periods following sunrise (morning) and preceding sunset (evening). Over the two years of this study, we made a total of 10 morning and 10 evening visits to each of the 4 stands during the breeding season. Within the same time interval, we made a total of 6 morning and 6 evening visits to each stand during winter. Detection probability (Gutzwiller 1993a) was estimated for each species as the proportion of total point counts during which the species was detected. During the breeding season and during winter we compared the number of species and individuals detected during morning and evening visits using a split plot, repeated measures analysis of variance; each stand (an experimental design block) was split into morning and evening treatment periods with visits (dates) constituting the repeated measure. All statistical analysis were performed using the SAS System for Windows (Release 6.11, SAS Institute, Inc., Cary, NC, USA). We subsequently compared the abundance of selected individual species between morning and evening counts using the same experimental design. However, individual species abundances were compared only if the overall variability of the species allowed detection of at least 0.25 individuals when the power of the test ($1 - \beta$) was at least 0.80 with $\alpha = 0.10$ (Hamel et al. 1996). Furthermore, because we conducted multiple tests when comparing individual species, we used Bonferroni's correction which reduced the probability required for significance of these tests to $\alpha \leq 0.006$.

RESULTS

We recorded 57 forest landbird species during the breeding season and 36 species during the winter. More species ($F_{1,3} = 383.35$, $P < 0.01$) and total individuals ($F_{1,3} = 597.38$, $P < 0.01$) were detected in morning counts ($\bar{x} \pm$ SE; 10.05 ± 0.06 species, 11.66 ± 0.08 individuals) than in evening counts ($\bar{x} \pm$ SE; 7.77 ± 0.07 species, 8.46 ± 0.09 individuals) during the breeding season. During winter, we again detected more species ($F_{1,3} = 82.38$, $P < 0.01$) and total individuals ($F_{1,3} = 26.59$, $P = 0.01$) in morning counts ($\bar{x} \pm$ SE; 6.12 ± 0.07 species; 9.36 ± 0.14 individuals) than in evening counts ($\bar{x} \pm$ SE; 4.44 ± 0.08 species, 6.45 ± 0.13 individuals).

During the breeding season, 16 of 57 species met our criteria for comparing morning and evening counts of individual species (Table 1). We detected significantly ($F_{1,3} \geq 46.83$, $P < 0.006$) more individuals during morning counts than during evening counts for four species: Blue Jay (*Cyanocitta cristata*), Tufted Titmouse (*Baeolophus bicolor*), Mourning Dove (*Zenaida macroura*), and Red-bellied Woodpecker (*Melanerpes carolinus*). No significant differences ($P > 0.01$) were detected between morning and evening counts for the other 12 species (Table 1). Of the 11 species eligible for comparison during winter, only Tufted Titmouse was detected significantly ($F_{1,3} = 50.6$, $P < 0.006$) more during morning than during evening. As with the breeding season, the detection of the remaining species did not differ significantly ($P > 0.01$) between morning and evening counts (Table 1).

Detection probability of individual species ranged from less than 0.01 to 0.70 during winter and from less than 0.01 to 0.82 during the breeding season. There was a significant cor-

TABLE 1. Abundance ($\bar{x}$ ± SE) and detection probability of individual species from morning and evening point counts conducted during the breeding season and during winter of 1991 and 1992 on Delta Experimental Forest, Stoneville, Mississippi, USA.

Species	Breeding season			Winter		
	Morning abundance $\bar{x}$ ± SE	Evening abundance $\bar{x}$ ± SE	Detection probability	Morning abundance $\bar{x}$ ± SE	Evening abundance $\bar{x}$ ± SE	Detection probability
Mourning Dove (*Zenaida macroura*)	0.688 ± 0.021[a]	0.412 ± 0.018	0.475[c]	—[b]	—[b]	0.044
Yellow-billed Cuckoo (*Coccyzus americanus*)	0.525 ± 0.020	0.430 ± 0.018	0.419	0	0	0
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	—[b]	—[b]	0.078	0.309 ± 0.024	0.422 ± 0.030	0.227[c]
Red-bellied Woodpecker (*Melanerpes carolinus*)	1.279 ± 0.023[a]	0.865 ± 0.025	0.762[c]	1.208 ± 0.034	0.870 ± 0.030	0.695
Downy Woodpecker (*Picoides pubescens*)	0.468 ± 0.018	0.422 ± 0.019	0.404	0.497 ± 0.020	0.437 ± 0.023	0.400
Northern Flicker (*Colaptes auratus*)	—[b]	—[b]	0.024	0.612 ± 0.022	0.703 ± 0.026	0.396[c]
Great-crested Flycatcher (*Myiarchus crinitus*)	0.247 ± 0.015	0.194 ± 0.013	0.208	0	0	0
Blue Jay (*Cyanocitta cristata*)	0.645 ± 0.022[a]	0.458 ± 0.021	0.456[c]	0.853 ± 0.032	0.235 ± 0.022	0.388
Carolina Chickadee (*Poecile carolinensis*)	0.877 ± 0.029	0.574 ± 0.026	0.528	1.048 ± 0.039	0.750 ± 0.033	0.574
Tufted Titmouse (*Baeolophus bicolor*)	1.203 ± 0.028[a]	0.814 ± 0.029	0.666[c]	0.866 ± 0.034[a]	0.320 ± 0.023	0.423
Carolina Wren (*Thryothorus ludovicianus*)	1.200 ± 0.027	0.822 ± 0.026	0.704[c]	0.655 ± 0.028	0.300 ± 0.021	0.376
Wood Thrush (*Hylocichla mustelina*)	0.383 ± 0.019	0.387 ± 0.019	0.322	0	0	0
American Robin (*Turdus migratorius*)	—[b]	—[b]	0.003	1.276 ± 0.088	0.900 ± 0.050	0.543[c]
White-eyed Vireo (*Vireo griseus*)	0.212 ± 0.014	0.152 ± 0.012	0.168	0	0	0
Red-eyed Vireo (*Vireo olivaceus*)	0.276 ± 0.015	0.134 ± 0.011	0.196	0	0	0
Yellow-rumped Warbler (*Dendroica coronata*)	0	0	0	0.992 ± 0.048	0.717 ± 0.015	0.436
Prothonotary Warbler (*Protonotaria citrea*)	0.246 ± 0.016	0.097 ± 0.010	0.155	0	0	0
Summer Tanager (*Piranga rubra*)	0.331 ± 0.016	0.490 ± 0.020	0.360	0	0	0
Northern Cardinal (*Cardinalis cardinalis*)	1.315 ± 0.025	1.112 ± 0.026	0.819[c]	—[b]	—[b]	0.094
Indigo Bunting (*Passerina cyanea*)	0.536 ± 0.021	0.459 ± 0.020	0.418	0	0	0
White-throated Sparrow (*Zonotrichia albicollis*)	0	0	0	0.127 ± 0.029	0.171 ± 0.036	0.050

[a] Mean number of detection greater ($P < 0.006$) for morning counts than for evening counts.
[b] Morning and evening counts not compared.
[c] Detection probability differs significantly between breeding season and winter (test of difference between two proportions, $z > 1.96$, $P < 0.05$).

relation between detection probability and variation in abundance during the breeding season (r_s = 0.74, $P < 0.01$) but not during winter (r_s = 0.32, $P > 0.05$). Six of 11 species found at our study site throughout the year, Red-bellied Woodpecker, Downy Woodpecker (*Picoides pubescens*), Blue Jay, Tufted Titmouse, Carolina Wren (*Thryothorus ludovicianus*), and Northern Cardinal (*Cardinalis cardinalis*), had greater detection probabilities ($P < 0.05$) during summer (Table 1). Conversely, Red-headed Woodpecker (*Melanerpes erythrocephalus*), Northern Flicker (*Colaptes auratus*) and American Robin (*Turdus migratorius*) had greater detection probabilities during winter.

DISCUSSION

During the breeding season, morning point counts yielded more species and more individuals than did evening counts. Furthermore, when significant differences existed for individual species, morning counts were consistently higher than evening counts. Forest landbirds have long been presumed to be more detectable during early morning than at other times of the day and many observers restrict breeding bird censuses to morning hours (Skirvin 1981). In studies of diel variation (Shields 1977, Skirvin 1981), more species and individuals were detected during the initial 2 h after sunrise than at other times. In floodplain forests, Robbins (1981) found that, although the total number of birds recorded diminished beyond 2 h after sunrise, the number of species detected remained nearly uniform for up to 5 h after sunrise. Although there have been few comparisons of early morning and late evening censuses, Grue and coworkers (1981), working in desert habitats during the breeding season, found more species and individuals during morning point counts than during evening counts. Our data provide further empirical evidence to support presumed temporal differences in avian detections between morning and evening counts during the breeding season.

During winter, we also detected more species and individuals on morning point counts than on evening counts. Rollfinke and Yahner (1990) also reported more species and more individuals on early morning transects than on evening transects during winter. Although we detected only Tufted Titmouse significantly more on morning counts than on evening counts during winter, Gutzwiller (1993a) found that five species had higher detection probabilities on point counts between 07:00 and 13:45 than at other times of the day. Overall, our data suggest that evening point counts during either the breeding season or winter will probably underestimate species richness, overall avian abundance, and the abundance of at least some species in bottomland hardwood forests.

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