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Optimum Timeframes for Detecting Songbird Vocalizations in the Black Hills

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Abstract

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Birds are indicators of vegetation structure and ecological conditions. The singing activity of birds declines during late-morning periods, which can affect estimates of abundance and conclusions regarding vegetative conditions indexed by birds. Therefore, it is important to quantify periods of bird activity so biologists can plan studies. We determined hourly detections from singing males of 22 nongame bird species in ponderosa pine, quaking aspen, and grassland vegetation types in the Black Hills of South Dakota. Detections of 12 of 22 species differed among 1-hr intervals after sunrise. Detections of yellow-rumped warblers, Townsend's solitaires, red-breasted nuthatches, western tanagers, and American robins decreased on count-episodes more than 4 hrs after sunrise. Detections of dusky flycatchers declined on count-episodes more than 3 hrs after sunrise and detections of black-capped chickadees were greatest during the first hour after sunrise and declined afterward. Detections of many other species from songs or calls decreased on count-episodes more than 5 hrs after sunrise. We recommend that bird counts in the Black Hills be completed within 4 hrs after sunrise so estimates of bird abundance are not affected by reduced singing among males.

Keywords: forest birds, detection, hourly variation, methods

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Bird populations serve as indicators of environmental conditions because they have specific requirements (Cody 1985, Martin and Finch 1995) and therefore can be used for monitoring effects of land management activities on other wildlife. However, several factors cause estimates of bird abundance to vary and may lead to inaccurate estimates of populations (Ralph et al. 1993). In most studies, more than 90% of birds are identified by their song or call (Carey et al. 1990). Therefore, if the frequency that birds sing during the day varies, estimates of bird abundance may be biased if data are collected during periods of low singing frequency (Palmeirim and Rabaca 1994, Robbins 1981). Current recommendations are that birds should be counted within 4-5 hrs after sunrise (Ralph et al. 1993, Manuwal and Carey 1991). However, these recommendations were made based on data from different regions and vegetation types than occur in the Black Hills. We conducted this study to determine variation in singing behavior of birds in the Black Hills so managers could effectively devise studies that accurately estimate bird populations.

Study Area

This study was conducted on the Nemo, Harney, Pactola and Spearfish Ranger Districts in the north/central region of the Black Hills National Forest, South Dakota, from 1992 to 1994. The Black Hills encompasses approximately 15,540 km^2 in west-central South Dakota and east-central Wyoming. Elevation ranges from 1450 m to 1770 m. Major forest vegetation types include ponderosa pine (*Pinus ponderosa*)/snowberry (*Symphoricarpos albus*), ponderosa pine/kinnikinnick (*Arctostaphylos uva-ursi*), ponderosa pine/juniper (*Juniperus communis*) and ponderosa pine/bur oak (*Quercus macrocarpa*) (Hoffman and Alexander 1987). Quaking aspen (*Populus tremuloides*) occurs as climax forest vegetation with paper birch (*Betula papyrifera*) in both uplands and in drainages. Wet (subirrigated) and dry (upland) grasslands or meadows are interspersed throughout the area. Most of the ponderosa pine forest has been logged in the past.

Methods

Sampling Design

In 1992, we selected 87, 4- to 32-ha land units (hereafter referred to as stands) managed by the Black Hills National Forest based on vegetation type and structural stage criteria (Buttery and Gillam 1983, Mills et al. 1996) that represented range of vegetation types and structural stages of forest conditions in the Black Hills. Prospective stands were identified using 1:24,000 aerial photographs and stand inventory data (Black Hills National Forest RIS Data, Custer, SD). Forty-eight stands were ponderosa pine (7 stands in each of 6 structural stages and 6 stands in another), 28 stands were quaking aspen (7 stands in each of 4 structural stages) and 11 stands were grasslands. Quaking aspen stands included both uplands and drainages. Vegetation characteristics used for selecting stands were verified in the field prior to counting birds. In 1994, we selected 91 new stands using the same vegetation type and structural stage criteria. Forty-nine of these stands were in ponderosa pine, 28 in quaking aspen and 14 in grasslands.

We marked 3 sites in each stand selected in 1992 and 2 sites in each stand selected in 1994. In ponderosa pine, upland quaking aspen, and dry meadow vegetation types, sites were 150-200 m apart and 150 m from the edge of the vegetation type or structural stage (Manuwal and Carey 1991, Robbins et al. 1989). In drainage quaking aspen and wet meadows, sites were located >150 m apart, in the center of the drainage; these vegetation types are too narrow to locate sites 150 m from an edge.

Bird Counts

At each site, we recorded detections of birds during the breeding season by using a variable circular plot (Reynolds et al. 1980) on 2 consecutive days (one sample session) during 2 sample sessions each year. Each day we counted birds at a site is hereafter

referred to as a count-episode. Bird counts extended from 15 May to 7 July so early and late nesting species were included (Ralph et al. 1993, Robbins et al. 1989). Count-episodes began at sunrise and were completed by 11:45 AM. All observers were experienced and trained for visual and audio identification of birds in the Black Hills and practiced estimating distances before and during bird counts (Verner and Milne 1989). We used 3 observers and each observer visited different sites each sample session. We also reversed the order of daily count-episodes to sites (Gotfryd and Hansell 1985, Verner and Milne 1989). During each count episode, we recorded all birds seen or heard during an 8-minute interval that began upon arrival at the count point (Verner 1988, Ralph et al. 1993). Birds observed while approaching the census point were recorded as observations from the count point. We recorded the time the count began, whether birds observed were within the vegetation type or structural stage being sampled, and the activity of bird. We discontinued bird counts during periods of moderate to heavy rain, when wind velocities exceeded 10 km/hr, or when temperatures were less than 7°C or greater than 24°C (Manuwal and Carey 1991).

Data Analysis

For data analysis, we truncated the data beyond 50 m of the variable plot center; thus, analyses were conducted on detections of birds from a 50-m fixed radius plot and included only birds detected from songs or calls that were in the vegetation type or structural stage identified for sampling. We determined the average number of detections, by species, in 1-hr time periods after sunrise for each stand. The weekly average time of official sunrise was obtained from the local newspaper. We used Kolmogorov-Smirnov tests to determine if the frequency of count-episodes in the seven 1-hr time periods differed among vegetation types and structural stages. Fewer ($p < 0.01$) count-episodes were completed 7 hrs after sunrise in quaking aspen and grasslands than the previous time periods. We determined associations of birds to vegetation types from Mills et al. (1996) and restricted our analyses to data from sites in vegetation types associated with individual species. For example, detections of birds associated with quaking aspen and grasslands were compared for six 1-hr time periods using data from sites in these vegetation types, respectively. However, detections of birds associated with ponderosa pine were compared over seven 1-hr time periods from sites in ponderosa pine.

Homogeneous variances in our data were uncommon, so we selected statistical tests that did not require this assumption. We tested the hypotheses that average detections of birds from songs or calls at sites did not differ among 1-hr intervals after sunrise using Welch's test with Dunnett's T3 multiple comparison procedure. We assigned statistical significance at $\alpha = 0.05$ for all tests. We assumed that the breeding season for birds was sufficiently short that a factor for time during the breeding season was not needed in the analysis.

Woodpeckers have large home ranges, vocalize infrequently, and drum for territorial displays. Most detections of woodpeckers in this study were visual and were not included in our analyses.

Results

Birds Associated With Ponderosa Pine

Differences in detections of yellow-rumped warblers (*Dendroica coronata*) and Townsend's solitaires (*Myadestes townsendii*) were not significant through 4 hrs after sunrise (figures 1A and 1B). Detections of individuals for both of these species declined on count-episodes more than 4 hrs after sunrise. Detections of red-breasted nuthatches (*Sitta canadensis*) and western tanagers (*Piranga ludoviciana*) were stable for the first 4 hrs after sunrise, then declined significantly on count-episodes more than 4 hrs after sunrise (figures 1C and 1D). White-breasted nuthatches (*P. carolinensis*) were associated with the ponderosa pine vegetation type, but no differences in detections by song were noted.

Birds Associated With Quaking Aspen

Dusky flycatchers (*Empidonax oberholseri*) sang infrequently during the first hour after sunrise (figure 2A). Afterward, detections of dusky flycatchers by song increased until 4 hrs after sunrise when significant declines were noted. Significant declines in detections of warbling vireos (*Vireo gilvus*) occurred on count-episodes more than 5 hrs after sunrise. Ovenbirds (*Seiurus aurocapillus*) and common yellowthroats (*Geothlypis trichas*) were also associated with quaking aspen in the Black Hills, but no differences in detections from singing males were noted.

Birds Associated With Grasslands

Detections of vesper sparrows (*Pooecetes gramineus*) and western meadowlarks (*Sturnella neglecta*) from songs or calls did not differ through 5 hrs after sunrise (figures 3A and 3B). Detections of these species were highly variable and declined on count-episodes more than 5 hrs after sunrise. Detections of grasshopper sparrows (*Ammodramus savannarum*) were relatively constant throughout the morning.

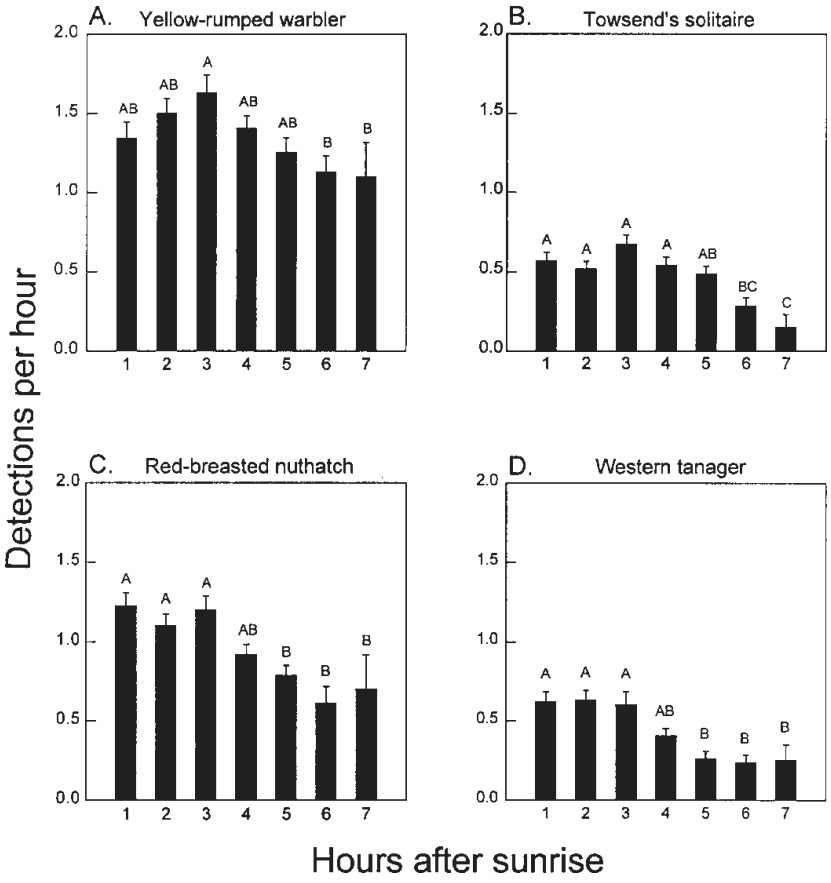

Figure 1—Average number of detections per hour of birds associated with ponderosa pine among seven 1-hr time periods during bird counts in the Black Hills. Standard errors are indicated by error bars. Time periods with different letters are significantly different (α = 0.05) using Dunnett's T3 multiple comparison procedure.

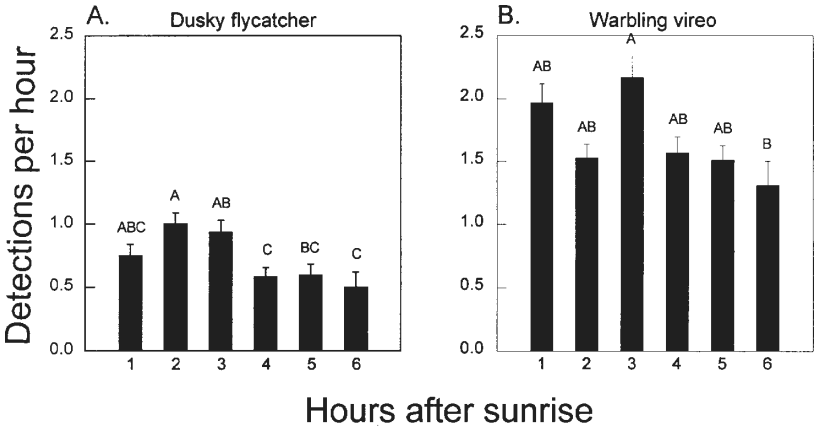

Figure 2—Average number of detections per hour of birds associated with quaking aspen/paper birch among seven 1-hr time periods during bird counts in the Black Hills. Standard errors are indicated by error bars. Time periods with different letters are significantly different (α = 0.05) using Dunnett's T3 multiple comparison procedure.

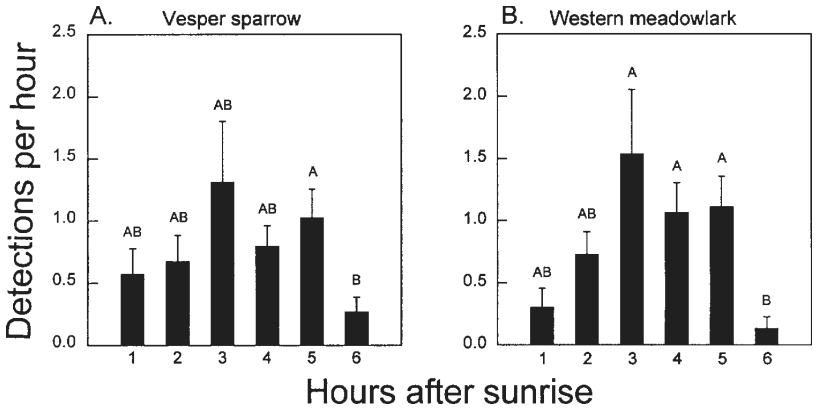

Figure 3—Average number of detections per hour of birds associated with grasslands among seven 1-hr time periods during bird counts in the Black Hills. Standard errors are indicated by error bars. Time periods with different letters are significantly different ($\alpha = 0.05$) using Dunnett's T3 multiple comparison procedure.

Other Forest Birds

Dark-eyed juncos (*Junco hymelis*) were vocal throughout the morning until 6 hrs after sunrise (figure 4A). However, detections of black-capped chickadees (*Poecile atricapillus*) declined steadily throughout the morning with significant declines occurring on count-episodes more than 1 hr and again more than 5 hrs after sunrise (figure 4B). American robins (*Turdus migratorius*) were vocal until 4 hrs after sunrise (figure 4C). Detections of northern flickers (*Colaptes auratus*), downy woodpeckers (*Picoides pubescens*), hairy woodpeckers (*P. villosus*), Swainson's thrushes (*Catharus ustulatus*), mountain bluebirds (*Sialia currucoides*), chipping sparrows (*Spizella passerina*), and brown-headed cowbirds (*Molothrus ater*) did not differ among hourly sampling periods.

Discussion

The conspicuousness of many bird species varies throughout the day owing to changes in activity levels (Palmeirim and Rabaca 1993) and the periods of highest detectability are not the same for all birds (Robbins 1981). Ralph et al. (1993) and Manuwal and Carey (1991) recommend that bird counts should be completed within 5 hrs after sunrise. But Verner and Ritter (1986) found no hourly differences in species abundance measured 4 to 5 hrs after sunrise. Our results support the recommendations of Ralph et al. (1993) and Manual and Carey (1991). Biologists planning studies should note that detections of several birds species declined by more than 50% on count-episodes completed 4 to 5 hrs after sunrise. Bird counts completed more than 4 or 5 hrs after sunrise would underestimate Townsend's solitaires, yellow-rumped warblers, red-breasted nuthatches, western tanagers, dusky flycatchers, black-capped chickadees, and American robins. Vesper sparrows and western meadowlarks would be underestimated on count-episodes completed during early and late in the morning. However, it is possible that our presence during low light conditions of early morning caused these grassland birds to be less vocal. Meadowlarks may be sensitive to observer intrusions as evidenced by lower density estimates closer to count points than 30 to 50 m away (M. Rumble, unpubl. data, Rocky Mountain Research Station, Rapid City, SD).

Fatigue by observers could influence the apparent detection of birds during the late morning. However, we do not believe fatigue was a factor that caused fewer detections of some song birds later in the morning. There were many species that no differences in detectability from songs or calls were evident on count-episodes later in the morning. If observer fatigue had been a factor, most all species should have exhibited declines in detections during late morning count-episodes. Most of the bird species that exhibited declines in detection later in the morning were common and we believe that our ability to detect them from songs or calls was similar throughout the morning.

It is well known that in songbird surveys, even the best surveyors seldom record all of the audible birds (Bart 1985, Robbins and Stallcup 1981). Diurnal variation in detectability of birds is widely acknowledged (Robbins 1981, Skirvin 1981). Detections of birds usually depend on certain attributes of singing and calling (Manuwal and Carey 1991) and bird calls or songs often vary regionally (Carey et al. 1990). Training observers to recognize songs and calls of local birds is important (Verner and Milne 1989).

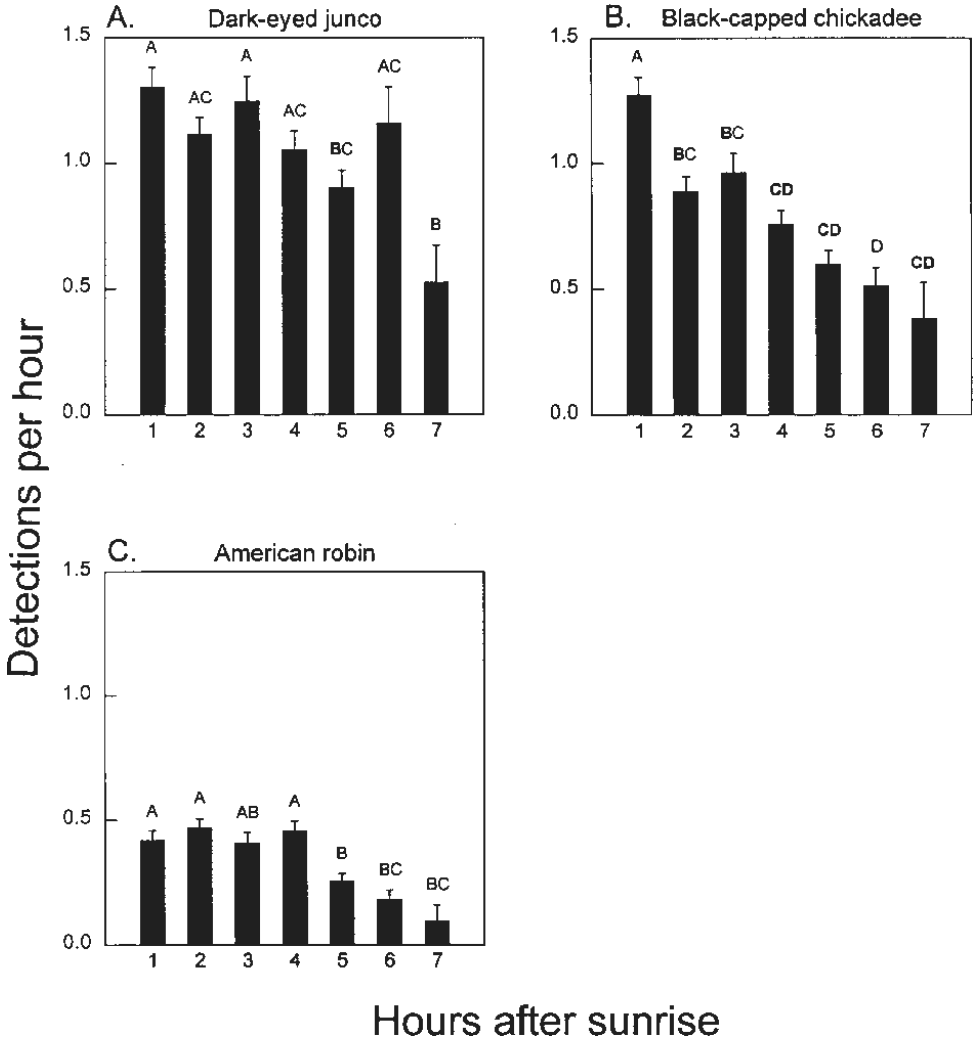

Figure 4—Average number of detections per hour of birds associated with both quaking aspen/paper birch and ponderosa pine among seven 1-hr time periods during bird counts in the Black Hills. Standard errors are indicated by error bars. Time periods with different letters are significantly different ($\alpha = 0.05$) using Dunnett's T3 multiple comparison procedure.

Management Implications

We recommend that study designs for bird counts include the following. Count-episodes should be completed within 4 hrs after sunrise. Some species associated with each of the vegetation type categories were less detectable from songs on count-episodes completed more than 5 hrs after sunrise; thus, their abundance would be underestimated. Multiple count-episodes at a site should include at least 2 consecutive days and the order of sampling should be distributed throughout the daily counting period to minimize effects of time on detectability of birds. Recommendations of other researchers should be followed (e.g., Verner 1985,Verner and Milne 1989).

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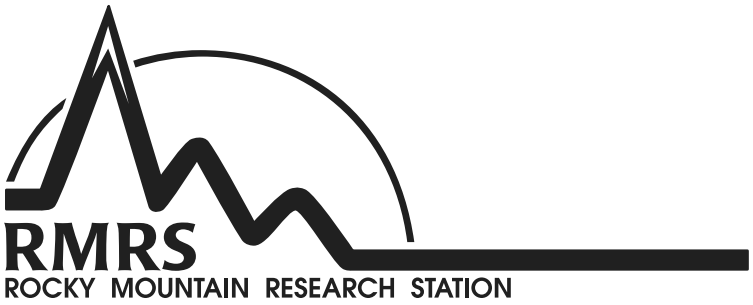

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