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ESTIMATING NON-BREEDING SEASON BIRD ABUNDANCE IN PRAIRIES: A COMPARISON OF TWO SURVEY TECHNIQUES

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Abstract.—Surveying birds during the non-breeding season in prairie environments can be difficult because birds are less visible and vocal during this period than they are during the breeding season. We compared the effectiveness of using fixed-radius point counts and rope-dragging transects for surveying non-breeding birds and determining their relative abundances in the Florida Everglades, from November 1997 through January 1998. Effort (person work hours) was compared using species-effort and abundance-effort curves. Relative abundances of total birds, American Bittern (*Botaurus lentiginosus*), Sedge Wren (*Cistothorus platensis*), Common Yellowthroat (*Geothlypis trichas*), and Seaside Sparrow (*Ammodramus maritimus mirabilis*) were greater using transects. Abundances of other common species were similar using both techniques. More species were detected on transects than on point counts. When considering effort involved, transects detected more total species, but point counts detected a greater total number of birds. Overall, transects took more effort to cover similar amounts of habitat. Differences in detection using these two techniques may be attributed to species-specific behaviors. Research focused on non-breeding season bird communities should consider using rope-dragging transects in appropriate habitat because point counts may underestimate abundances of some species.

ESTIMANDO LA ABUNDANCIA DE AVES EN PRADERAS DURANTE LA TEMPORADA NO REPRODUCTIVA: UNA COMPARACIÓN DE DOS TÉCNICAS DE MUESTREO

Sinopsis.—Muestrear aves en áreas de praderas durante la temporada no-reproductiva puede ser difícil porque las aves son menos visibles y menos vocales en este período que durante la temporada reproductiva. Comparamos la efectividad de usar conteos de puntos en radios fijos y de transectos arrastrando sogas para monitorear aves que no se reproducen y determinar sus abundancias relativas en la cienagas de Florida entre noviembre del 1997 y enero del 1998. Se comparó el esfuerzo (horas de trabajo por persona) usando curvas de especies-por esfuerzo y de abundancia-por esfuerzo. Las abundancias relativas del total de aves y de *Botarus lentiginosus, Cistothorus platensis, Geothlypis trichas* y de *Ammodramus maritimus mirabilis* fueron superiores al utilizar transectos. Las abundancias de otras especies comunes fueron similares al usar ambas técnicas. Se detectaron más especies en los transectos que en los conteos de puntos. Al considerar el esfuerzo hecho, los transectos detectaron mayor total de especies, pero los conteos de puntos detectaron mayor número de aves. En general, los transectos tomaron más esfuerzo para cubrir cantidades similares de habitat. Las diferencias en detección usando estas dos técnicas puede ser atribuídas a conductas específicas de las especies. Investigación enfocada en las comunidades de aves en período no reproductivo debieran considerar el uso de transectos arrastrando sogas en hábitats apropiados porque los conteos de punto pueden subestimar la abundancia de algunas especies.

Surveying birds during the non-breeding season can be difficult (Smith 1984, Rollfinke and Yahner 1990), especially in prairie environments. Birds are less vocal and visible during this period than during the breeding season (Smith 1984, Gutzwiller 1991). This issue is compounded with

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the secretive nature of many prairie bird species, which generally spend time foraging silently on or near the ground. These birds are difficult to locate except for incidental flushing and rare vocalizations.

Different methods have been used to survey birds during the non-breeding season, including fixed-radius point counts (Hutto et al. 1986), unlimited distance point counts (Gutzweiller 1991), line transects (Shields 1977, Edwards et al. 1981, Robbins 1981a, Best et al. 1998), spot-mapping (Robbins 1972, Robbins 1981b, Smith 1984), and mist-netting (Gram and Faaborg 1997, Whitman et al. 1997, Rappole et al. 1998). Point counts are popular among avian ecologists because time spent surveying can be precisely controlled (as opposed to transects) and a large amount of area can be covered, even through difficult terrain (Dawson 1981, Verner 1985). Transects are usually similar to point counts in effectiveness (Dobkin and Rich 1998), although the movement of observers along a transect may cause birds to move away from the observer (Burnham et al. 1980, Verner 1985). Spot-mapping may yield more accurate abundance estimates than other common techniques, but this technique is more difficult to use in the non-breeding season because birds are generally less territorial (Verner 1985). Mist-netting may be useful in forest environments (Gram and Faaborg 1997), but may underestimate canopy birds (Whitman et al. 1997), and its usefulness for surveying prairie birds may be limited. With the exception of mist-netting, one potential problem with all of these methods is the poor detectability of inconspicuous birds.

We compared the effectiveness of using point counts (points hereafter) and rope-dragging transects (transects hereafter) for surveying non-breeding birds in the freshwater prairie of the Florida Everglades. These two methods differ in how birds are detected during the survey. Point counts use visual and aural cues to passively detect birds (Hutto et al. 1986, Ralph et al. 1993). Rope-dragging is a method commonly used to find grassland bird nests, where a rope or cable is dragged over the ground, flushing females off their nests (Labisky 1957, Higgins et al. 1969). To our knowledge, this technique has not previously been compared with other techniques for surveying birds in prairie environments. Transects potentially flush all birds in a sampling unit, regardless of activity, facilitating detection by observers and enabling density estimates. This may be important for detecting birds that remain quiet and invisible in the presence of an observer (Verner 1985).

STUDY AREA

Ten study sites were chosen within the Everglades National Park, Florida (25°N, 80°W). Sites were selected in conjunction with a larger study of the non-breeding season ecology of Cape Sable Seaside Sparrows (*Ammodramus maritimus mirabilis*; T. F. Dean and J. L. Morrison, unpubl. data). Consequently, all sites had vegetation thought to provide suitable habitat for these sparrows. All sites consisted of seasonally inundated freshwater prairie dominated by muhly grass (*Muhlenberghia filipes*), sawgrass (*Cladium jamaicens*), and black-topped sedge (*Schoenus nigricans*). Sites also contained scattered cypress domes (*Taxodium* spp.), hardwood hammocks, and tree islands. Each site was partially inundated during the study period due to intense precipitation during October and November.

METHODS

We used a split-plot study design to compare point-count and rope-dragging transects. Each of the 10 study sites contained two sampling plots. Each plot contained one transect and three point count locations, totaling 20 transect and 60 point count locations. We placed three points, equally spaced, along each transect, to sample similar habitat and bird communities. To make direct, balanced comparisons, we considered individual sampling units as one transect and the three point count locations along the individual transect (n = 20). For each sampling unit, point counts were conducted within 3 d of the transect survey. Each transect and point count was repeated monthly in November 1997, December 1997, and January 1998. A total of three observers conducted point count and transect surveys. To minimize observer bias, these observers were rotated for each monthly count. We began surveying in November to minimize the number of migrating birds detected and stopped at the end of January when many species initiated breeding behaviors. Surveys were not conducted during periods of precipitation or high wind velocities ($\geq$20 km/h) (Robbins 1981c).

Transects.—Rope-dragging transects were 25 m by 800 m, covering 2 ha of prairie habitat. Transects were placed $\geq$200 m apart. To conduct surveys two observers dragged a 25-m weighted rope along the transect and recorded all birds that flushed from the vegetation. Weights consisted of two plastic, 0.5-liter bottles attached to a 1-m length of nylon rope, and were placed at 1.5-m intervals along the rope. We cut holes in each bottle for water drainage. The purpose of the bottles was to create additional noise and disturbance to the vegetation when dragging the rope, without damaging the habitat. The mean duration ($\pm$SD) for transects was 18.3 $\pm$ 3.5 min. We also recorded the number of times individual birds were reflushed from the vegetation as an index of the efficacy of the transect method for flushing birds. This index was calculated as the number of times a bird was reflushed divided by the total number of times that it could have been potentially reflushed. A bird could be potentially reflushed if, after being flushed, it landed farther down the sampling transect. We assumed a bird was reflushed if it landed farther down the transect and we flushed another individual of the same species in the same area from which it landed. These individuals were only included in estimating the effectiveness of transects.

Point counts.—We conducted 100-m fixed-radius point counts (Hutto et al. 1986), covering 3.1 ha for each point (9.4 ha per sampling unit). A single observer recorded all individuals and species using the prairie, taking care not to count the same individuals more than once. We chose 100-m radii because this appeared to be the greatest distance for accurately detecting birds in this habitat. Each count lasted 10 min. Point locations were ≥200 m apart. Point counts were conducted between sunrise and 3 h after sunrise (generally 0700–1000 h EST), as detection rates may decline after this time period (Ralph 1981). We did not include birds flying over the habitat in any analysis.

Statistical analyses.—We analyzed detection rates by comparing the relative abundance of birds detected between the two techniques and effort involved in detecting both species and individuals. We defined relative abundance as the number of birds detected per hectare surveyed. Effort considered the amount of work per person involved between techniques. Effort for an individual transect included two observers conducting the survey ($\bar{x}$ = 36.6 min/person); effort for point counts included one observer conducting three point count surveys (along the transect), and the time walking between the points within the plot ($\bar{x}$ = 41.9 min/person). Effort was compared in two ways: (1) the number of species detected per person hour of effort (with species-effort curves; Gram and Faaborg 1997, Whitman et al. 1997), and (2) the number of birds detected per person hour of effort (with abundance-effort curves). For analyses of relative abundance, we compared rates for both total birds and individual species. For individual species, we analyzed the six most common species detected; for the other species, we did not have large enough sample sizes to make statistically accurate comparisons ($n < 35$ observations).

Relative abundances of total birds and individual species were analyzed using a split-plot, repeated measures ANOVA design. Each site had two plots, or sampling units. The response variable was the abundance of total birds or individual species. The primary factor of interest was the survey type (transect or point), a second factor was study site, and a third factor was sampling date as the repeated measure. We used the survey type × plot (site) interaction mean-square error term as the error term for the survey type factor. This error term is more conservative than the default error term and explains random variation between survey means over months sampled. To control for type I experimental errors, we used Bonferroni adjustments using an initial value of $\alpha = 0.05$ to determine an adjusted alpha for seven tests conducted ($\alpha' = 0.007$; Sokal and Rohlf 1995). Arithmetic means ±SE are reported.

RESULTS

We detected 672 birds of 20 species during the study period using transects and point counts. We detected 18 species using transects and 16 using point counts. The most common species detected (in decreasing order of abundance) were: Palm Warbler (*Dendroica palmarum*), Common Yellowthroat (*Geothlypis trichas*), Seaside Sparrow, Sedge Wren (*Cistothorus platensis*), American Bittern (*Botaurus lentiginosus*), and Red-winged Blackbird (*Agelaius phoeniceus*).

The relative abundance for total birds detected was greater using transects (Table 1). Abundances of the most common species, including American Bittern, Common Yellowthroat, and Seaside Sparrow, were gen-

TABLE 1. Relative abundances ($\bar{x} \pm$ SE) of the most commonly detected species using rope-dragging transects and point counts in the Everglades National Park, Florida, November 1997–January 1998. Transects and point counts were compared using split-plot, repeated measures ANOVAs. The tests reported are for the factor comparing the type of survey technique used (df = 1, 19).

Species	Relative abundance (No. birds/ha surveyed) Transects	Points	*F*	*P*
American Bittern	0.292 ± 0.050	0.004 ± 0.002	21.65	<0.001
Sedge Wren	0.275 ± 0.082	0.067 ± 0.014	6.98	0.016
Palm Warbler	0.242 ± 0.066	0.326 ± 0.034	1.25	0.277
Common Yellowthroat	0.413 ± 0.063	0.124 ± 0.020	21.19	<0.001
Seaside Sparrow	0.375 ± 0.065	0.030 ± 0.010	28.29	<0.001
Red-winged Blackbird	0.033 ± 0.020	0.094 ± 0.061	0.88	0.359
Total birds	2.000 ± 0.193	0.750 ± 0.102	27.35	<0.001

erally greater using transects (Table 1). Abundance of Sedge Wrens was greater using transects (Table 1); however, this trend was not significant when comparing with the Bonferroni adjusted critical alpha. Point counts did not detect significantly greater abundances for any of the common birds in our study area. There was no evidence for an effect of study site and sampling date on abundance indices for any of the species tested. There were no significant interactions detected for any ANOVA tests.

Based on our sampling unit, the effort involved in point counts ($\bar{x}$ = 41.9 min/person) was slightly greater than that for transect surveys ($\bar{x}$ = 36.6 min/person). The total number of species detected based on species-effort curves was slightly greater for transects (Fig. 1). The total number of birds detected based on effort curves was greater for point counts, primarily due to large numbers of Palm Warblers detected (Fig. 1).

The effectiveness index for rope-dragging transects was consistently high for all species potentially reflushed (89.4%, n = 143). However, the weighted ropes did not reflush all birds. Therefore, it is likely that a small proportion of birds was not detected using transects, or that flushed birds may have moved on the ground away from the transect area.

DISCUSSION

Prairie environments are difficult to survey during the non-breeding season primarily due to bird behaviors in these environments. Most of the species we detected in our study area foraged on or near the ground, either by ground gleaning, or by stalking and striking prey (Ehrlich et al. 1988). Notable exceptions included Palm Warblers, which not only ground glean, but also hawk and hover glean, and Red-winged Blackbirds, which ground glean and hawk prey (Ehrlich et al. 1988). Both Palm Warblers and Red-winged Blackbirds also tend to form small foraging flocks during the non-breeding season in the Everglades. These foraging behaviors generally made Palm Warblers and Red-winged Blackbirds more

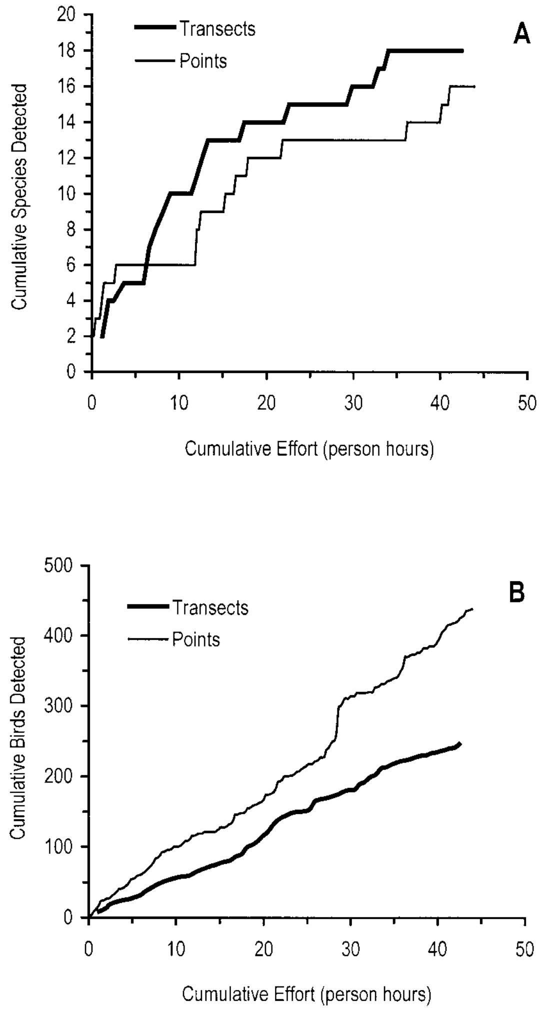

FIGURE 1. The total number of species (A) and total number of birds (B) counted based on effort (person hours) between rope-dragging transects and point counts in the Everglades National Park, Florida, November 1997–January 1998.

conspicuous than other birds in the study area. Differences between the two survey techniques may be attributed to these differences in foraging behaviors. Transects consistently detected greater abundances of solitary, ground-dwelling species (e.g., Seaside Sparrow). Similar abundances were detected with both point counts and transects only for the most conspicuous species, which form foraging flocks and forage higher in the vegetation (e.g., Palm Warbler, Red-winged Blackbird). Point counts consistently did not detect secretive species, which is concordant with other non-breeding season studies (e.g., Rappole et al. 1998).

In our study design, the effort involved in conducting transects and point counts was similar, because we compared series of three points to one transect. However, the effort involved per point (10 min) was much less than the effort involved per transect ($\bar{x}$ = 36.6 min). Moreover, the effort involved to sample similar areas is much greater using transects. Even when considering a smaller radius point count, such as 50 m, the effort involved per hectare surveyed will be greater for transects. Based on effort the total number of species detected was only slightly greater using transects, but the total number of birds detected was much greater for point counts. This may be explained by the greater sampling intensity using point counts in our study, in which we conducted surveys at three times more point count locations (n = 60) than transect locations (n = 20), covering more area (points = 188.4 ha, transects = 40 ha).

Both types of surveys have certain biases and error associated with the assumptions of the techniques. Point counts may bias detection rates of birds based on their foraging substrate and the conspicuousness of their behavior in different habitat types. Birds that sing frequently (even during the non-breeding season) may be accurately detected, but birds that are generally silent may not. Also, during the non-breeding season many species only make call notes, which are more difficult to distinguish than singing birds. Another error involved in point counts is distance estimates, especially for singing and calling birds (Scott et al. 1981).

Rope-dragging transects may have fewer potential biases and errors. Initially, detecting birds that flush from the vegetation may be difficult, but we found that even inexperienced technicians could accurately identify all species within a week. Another potential error in transects is the assumption that all birds are flushed from the vegetation, and all species of bird are equally likely to be flushed. From our observations of birds reflushing when repeatedly dragging a weighted rope over their presumed location, most birds flushed multiple times from the vegetation, but not all birds reflushed. This might have occurred for two possible reasons: birds may have moved along the ground away from the transect area or remained in the area and tolerated the rope moving over them.

Determining which survey technique most accurately detects the true bird community composition is difficult. Our results suggest that while transects generally detected greater abundances of most birds, point counts may underestimate the abundances of some inconspicuous bird species during the non-breeding season in prairie habitats. Results of this study strengthen the view that no single method may adequately detect all species (Conant et al. 1981, Rappole et al. 1998). If projects are targeting specific species, the behaviors of these species should be addressed when determining appropriate survey techniques. Conant et al. (1981) argue that the best method for surveying birds is one that provides the least observer effect. Based on our results and observations using these two techniques, the use of transects seems to have fewer biases and errors in prairie habitat. Because transects require two observers, observer bias may be less than with point counts. Minimizing observer effect when surveying birds is important, however, accurately accessing populations of birds—both in terms of species richness and abundance—should be a key factor when deciding on appropriate survey methods.

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