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Testing the importance of auditory detections in avian point counts

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ABSTRACT. Recent advances in the methods used to estimate detection probability during point counts suggest that the detection process is shaped by the types of cues available to observers. For example, models of the detection process based on distance-sampling or time-of-detection methods may yield different results for auditory versus visual cues because of differences in the factors that affect the transmission of these cues from a bird to an observer or differences in an observer's ability to localize cues. Previous studies suggest that auditory detections predominate in forested habitats, but it is not clear how often observers hear birds prior to detecting them visually. We hypothesized that auditory cues might be even more important than previously reported, so we conducted an experiment in a forested habitat in North Carolina that allowed us to better separate auditory and visual detections. Three teams of three observers each performed simultaneous 3-min unlimited-radius point counts at 30 points in a mixed-hardwood forest. One team member could see, but not hear birds, one could hear, but not see, and the third was nonhandicapped. Of the total number of birds detected, 2.9% were detected by deafened observers, 75.1% by blinded observers, and 78.2% by nonhandicapped observers. Detections by blinded and nonhandicapped observers were the same only 54% of the time. Our results suggest that the detection of birds in forest habitats is almost entirely by auditory cues. Because many factors affect the probability that observers will detect auditory cues, the accuracy and precision of avian point count estimates are likely lower than assumed by most field ornithologists.

SINOPSIS. **Probando la importancia de detecciones auditivas en conteos de punto**

Avances recientes en la metodología para hacer un estimado de la probabilidad de detección durante conteos de puntos sugiere que el proceso de detección toma forma con dos tipos de pistas disponibles para los observadores. Por ejemplo, modelos del proceso de detección, basados en métodos de la distancia de muestreo o tiempo de detección, pueden ofrecer diferentes resultados para pistas auditivas vs visuales. Esto es así porque hay diferencias en los factores que afectan la transmisión de dichas pistas por parte de las aves al observador y diferencias en la habilidad del observador en localizar o dar con dichas pistas. Estudios previos sugieren que las detecciones auditivas predominan en áreas forestadas, pero no esta claro cuantas veces los observadores escuchan al ave previo a observarla. Tenemos como hipótesis que las pistas auditivas pudieran ser aún más importantes que lo previamente informado, por lo que llevamos a cabo un experimento en un hábitat forestado en Carolina del Norte, que nos permitió separar de forma adecuada detecciones auditivas de visuales. Tres grupos, cada uno de tres individuos, llevaron a cabo simultaneamente conteos de punto de radio indefinido por tres minutos en 30 puntos, en un bosque mixto de maderas duras. Uno de los miembros podía observar pero no oir las aves ("sordo"), otro podía oir, pero no observar ("ciego") y el tercero podía hacer ambas cosas. Del total de aves detectadas el 2.9% fueron observadas por los "sordos," 75.1% por los "ciegos" y 78.2% por el que utilizaba ambos sentidos. Las detecciones por lo que podían oir y por los que utilizaban oido y vista fueron similares en el 54% de los casos. Nuestros resultados sugieren que la detección de aves en hábitat forestados se lleva a cabo, principalmente, por pistas auditivas. Dado el caso que muchos factores pueden afectar la probabilidad de que el observador pueda detectar el ave por pistas auditivas, la precisión y exactitud de los estimados de conteos de puntos deben ser más bajos que lo asumido por la mayoría de los ornitólogos.

Key words: auditory, detection probability, point counts, sampling, visual

Point counts are the most widely used method for estimating abundance in avian field studies (Rosenstock et al. 2002). Many factors affect the probability of detecting birds during a count, including time of year (Best 1981), time of day (Robbins 1981a), weather conditions (Robbins 1981b), habitat type (Pacifici et al. 2008), background noise (Simons et al. 2007), species diversity (Schieck 1997), species density (McShea and Rappole 1997), observer hearing ability (Emlen and DeJong 1992), observer skill level (Kepler and Scott 1981), bird pairing status (Gibbs and Wenny 1993), stage of the nesting

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cycle (Wilson and Bart 1985), singing rates (Best 1981), and the presence of an observer (McShea and Rappole 1997).

Methods of estimating detection probabilities on point counts include distance sampling (Buckland et al. 2001), multiple observer methods (Alldredge et al. 2006), time-of-detection methods (Alldredge et al. 2007a), double sampling (Bart and Earnst 2002), and repeated counts (Royle and Nichols 2003, Kery et al. 2005). These methods are applicable to both auditory and visual detections, but their performance will depend on the observation process. If used simultaneously during a count, the two processes may compete for an observer's limited attention. Distance sampling requires observers to accurately estimate the distance to a cue and performs well when visual cues are available. Time-of-detection methods are well suited for auditory cues where such methods can account for differences in detection probability associated with variable singing rates.

A point-count simulation system (Simons et al. 2007) has been used to identify factors affecting detection probabilities on auditory counts (Alldredge et al. 2007b). Findings to date indicate that the difficulty of localizing auditory cues can influence both the bias and precision of point-count-based abundance estimates (Simons et al. 2009). Furthermore, Simons et al. (2009) advise against mixing auditory and visual detections in a single analysis because detection processes vary for different cues. For example, the proportion of birds detected using visual cues will vary with the size, color, and behavior of birds, and with the structure and composition of their habitats. The proportion of birds detected using auditory cues is generally a function of singing rate and song spectral characteristics. The area that can be sampled using visual detection depends on the density of vegetation or other visual obstructions around the sampling point. In most cases, the area sampled using auditory detections is larger because sound travels beyond visual obstacles. Therefore, it is important to understand the relative importance of visual and auditory cues when selecting a method for analyzing point count data.

Auditory detections are reported to comprise 70% of observations in suburban landscapes (Sauer et al. 1994), 81% in tropical forests (Scott et al. 1981), and up to 94% in closed-canopy deciduous forests (DeJong and Emlen 1985). Even in open-grassland habitats, auditory detections often predominate because birds are generally not visible and because song is the best cue available for identifying breeding males (Diefenback et al. 2007). Reported rates of visual and auditory detections in the literature are based on ad hoc methods where observers are asked to indicate the mode of detection for each bird recorded. Our objective was to determine if reported rates of visual detections might be inflated because visual detections are often preceded by auditory cues. We designed a simple experiment to evaluate this question in a forested habitat.

METHODS

Our study was conducted at William B. Umstead State Park in Raleigh, North Carolina (35°51.22′N, 078°44.58′W). Woodlands in the park are classified as Dry-Mesic Oak Hickory Forest type (Schafale and Weakly 1990), and canopy cover ranged from 70 to 100%. Dominant canopy species included loblolly pine (*Pinus taeda*), mixed oaks (*Quercus spp.*), and tulip poplar (*Liriodendron tulipifera*). Little herbaceous and shrub layer vegetation cover was present in drier upland sites (approximately 60% of points), making it possible to see birds at distances of up to 100 m in these areas. At bottomland sites (approximately 40% of points), herbaceous and shrub layer vegetation cover was often dense, limiting visibility to ≤ 20 m in any direction.

Nine experienced observers were divided into three teams of three observers each and conducted counts at a series of 30 points on 15 May 2006 from 08:00 to 12:00. Points were marked with flags and spaced a minimum of 200 m apart. The team members performed simultaneous independent 3-min unlimited-radius point counts (Ralph et al. 1995) at each point. The observers mapped all detections on data sheets, estimating the direction and distance to each bird detected. All teams started at the first point and performed counts at all 30 points in sequence. The teams maintained a separation of approximately 15 min from each other. During each count, one team member was "blinded" to all visual input, one was "deafened" to all auditory input, and the last team member performed the count nonhandicapped. The blinded team members wore a baseball cap fitted with a vinyl face-shield that allowed them to see the ground directly in front of them, but little else. A north-facing arrow was placed at the feet of the blinded observers so that they could maintain their spatial orientation throughout the count. The deafened team member wore earplugs and radio headphones adjusted to produce static noise at a volume sufficient to block all outside sound. This team member stood 3–4 m away from the other two observers during counts to prevent headphone noise from disrupting the hearing of the other two observers. Detection methods were randomized among the team members at each point. The observers changed detection methods before they moved to the next point. They then walked to the next point with their detection handicaps in place, eliminating any bias from hearing or seeing birds prior to starting the next count.

Detections for each observer were compared to determine the total number of individuals and species counted using all methods and the total number of individuals and species in common among observers on each team. We tallied the detections made by each class of observers (deafened, blinded, and nonhandicapped) and compared the percentages of total birds detected with each method. We used a randomized complete-block design ANOVA on the means of the percentages with method as the treatment and teams as blocks (SAS Institute 2006). We also ran a least-squares means test with the Tukey adjustment for multiple comparisons to compare each pair of detection methods. In a further analysis, we calculated the percentage of birds detected by both blinded and nonhandicapped observers. We divided these data into three groups (1–7 birds, 8–10 birds, and >10 birds detected, respectively) to examine how the number of birds detected by both observers varied with the total number of birds detected at a point. We used a one-way ANOVA to compare the mean percentage of birds detected in common by blinded and nonhandicapped observers (JMP 2001). We used a Tukey–Kramer HSD post hoc test to compare the means for each group, adjusting for multiple comparisons and unequal sample sizes at an alpha level of 0.05. Values are reported as means ± SE.

RESULTS

Observers detected 824 birds, with an average of 9.2 birds per point count (range: 1–16). Non-handicapped observers detected 78.2 ± 1.6% of all birds detected, blinded observers detected 75.1 ± 1.7%, and deafened observers detected 2.9 ± 0.7%, and these differences were significant ($F_{2,232} = 1003.9$, $P < 0.0001$). In paired tests, the difference between nonhandicapped and blinded observer detections was not significant ($P = 0.25$), but detections made by deafened observers differed from those of both blinded ($P < 0.0001$) and nonhandicapped observers ($P < 0.0001$). Of 55 species detected, 50 were detected by nonhandicapped observers, 46 by blinded observers, and 18 by deafened observers, respectively.

The mean percentage of birds detected by both blinded and nonhandicapped observers for the three count abundance categories differed significantly ($F_{2,87} = 6.3$, $P = 0.0029$), with 63.5 ± 3.6% ($N = 26$) detected by both during counts where 1–7 birds were detected, 53.3 ± 3.0% ($N = 36$) during counts where 8–10 birds were detected, and 45.9 ± 3.4% ($N = 28$) during counts where >10 birds were detected. The difference in the percentage of birds detected by blinded and nonhandicapped observers during counts where 1–7 birds vs. counts where > 10 birds were detected was significant ($P = 0.0019$). Other differences were not significant (1–7 birds vs. 8–10 birds, $P = 0.08$; 8–10 birds vs. >10 birds, $P = 0.25$).

DISCUSSION

We found that visual detections by deafened observers comprised 2.9% of all detections in forested habitats, a percentage lower than other reported estimates (Scott et al. 1981, DeJong and Emlen 1985, Sauer et al. 1994). This suggests that observers often hear a bird before detecting it visually. In field situations, the percentage of visual detections may be even lower because our deafened observers devoted all of their time to visual scanning, a method almost never used in the field. In our experience, most point-count observers devote little attention to visual scanning because they are either concentrating on auditory cues or recording observations on their data sheets.

Current methods of estimating detection probabilities on avian point counts require observers to localize cues accurately to apply distance (Buckland et al. 2001), time of detection (Alldredge et al. 2007a), or multiple-observer (Alldredge et al. 2006) methods, and they assume that observations reflect the initial detections of any birds recorded. Many factors, including habitat (Pacifici et al. 2008), topography and environmental conditions (Robbins 1981a,b), and the orientation of singing birds (Alldredge et al. 2007c, Simons et al. 2009), may interfere with the ability of observers to accurately localize auditory cues. We found that over 97% of avian detections in forested habitats were based on auditory cues, suggesting that the application of these sampling methods in forested habitats is problematic due to the difficulty of accurately localizing the auditory cues that predominate in these environments (Simons et al. 2009).

Although the mean percentages of birds detected by nonhandicapped and blinded observers in our study were similar, the mean percentage of birds detected by both was approximately 50%. As the total number of birds detected at a point increased, the mean percentage detected in common decreased significantly. Several factors may contribute to this phenomenon, including observer skill, the tendency of observers to tune out or focus on particular species during a count, distraction of observers when focusing on difficult detections or recording data, and variation in the level of certainty individual observers require before recording an observation. The predominance of auditory detections on many avian surveys and the growing body of evidence for numerous sources of measurement error, misclassification error, and bias on the auditory detection process suggest that investigators should use caution when interpreting auditory point-count data. These cautions apply equally to estimates of occurrence, abundance, or species richness. Our finding that over 97% of bird detections in forested environments are based on auditory cues reinforces recent experimental evidence indicating that both the accuracy and precision of avian point-count estimates are lower than assumed by most field ornithologists.

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