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MAXIMIZING DETECTION PROBABILITY OF WETLAND-DEPENDENT BIRDS DURING POINT-COUNT SURVEYS IN NORTHWESTERN FLORIDA

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ABSTRACT.—We conducted 262 call-broadcast point-count surveys (1–6 replicate surveys on each of 62 points) using standardized North American Marsh Bird Monitoring Protocols between 31 May and 7 July 2006 on St. Vincent National Wildlife Refuge, an island off the northwest coast of Florida. We conducted double-blind multiple-observer surveys, paired morning and evening surveys, and paired morning and night surveys to examine the influence of call-broadcast and time of day on detection probability. Observer detection probability for all species pooled was 75% and was similar between passive (69%) and call-broadcast (65%) periods. Detection probability was higher on morning than evening (t = 3.0, P = 0.030) or night (t = 3.4, P = 0.042) surveys when we pooled all species. Detection probability was higher (but not significant for all species) on morning compared to evening or night surveys for all five focal species detected on surveys: Least Bittern (*Ixobrychus exilis*), Clapper Rail (*Rallus longirostris*), Purple Gallinule (*Porphyrula martinica*), Common Moorhen (*Gallinula chloropus*), and American Coot (*Fulica americana*). We detected more Least Bitterns (t = 2.4, P = 0.064) and Common Moorhens (t = 2.8, P = 0.026) on morning than evening surveys, and more Clapper Rails (t = 5.1, P = 0.014) on morning than night surveys. *Received 2 March 2007. Accepted 6 October 2007.*

Maximizing detection probability of rare or inconspicuous birds during point-count surveys is essential so that sufficient individuals are detected to reliably estimate population trends (Lynch 1995). Wetland-dependent birds (i.e., rails and bitterns) are among the most inconspicuous groups of birds in North America. They vocalize infrequently and often occur in isolated wetlands making them difficult to monitor (Bystrak 1981, Gibbs and Melvin 1993). A marsh bird monitoring protocol was developed in 1999 for conducting standardized surveys for wetland-dependent birds across North America (Conway 2007). The protocol instructs surveyors to use call-broadcast after an initial 5-min passive period to increase vocalization probability of birds present during the survey period. However, call-broadcast might interfere with the observer's ability to hear vocalizing birds during the survey (Conway and Nadeau 2006). A decrease in observer detection probability could potentially negate the benefits of increased vocalization probability. Few studies have examined the effects of call-broadcast on observer detection probability and participants using this protocol are not obligated to use methods (i.e., multiple-observer surveys) to account for variation among observers.

Vocalization probability of wetland-dependent birds varies with time of day and diurnal patterns may vary regionally and among species (Conway and Gibbs 2001). Thus, surveyors should identify the optimal time of day to conduct surveys in their region to maximize detection probability. The Standardized North American Marsh Bird Monitoring Protocol (Conway 2007) instructs participants to conduct surveys in the morning or evening when birds are most vocal. Participants using the protocol are not obligated to define which of the two daily time periods is optimal in their region and few participants have attempted to do so. Many species of wetland-dependent birds are known to vocalize at night (e.g., Black Rail [*Laterallus jamaicensis*], Clapper Rail [*Rallus longirostris*], Virginia Rail [*R. limicola*], Yellow Rail [*Coturnicops noveboracensis*], and American Bittern [*Botaurus lentiginosus*]; Reynard 1974, Meanley 1985, Johnson and Dinsmore 1986, Gibbs et al. 1992, Bookhout 1995), yet few studies have attempted to examine the efficacy of night surveys. We compared morning to evening sur-

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veys and morning to night surveys to ascertain the optimal time of day to conduct surveys for wetland-dependent birds in the southeastern United States. Our specific objectives were to: (1) compare observer detection probability between passive and call-broadcast surveys in the context of the North American Marsh Bird Monitoring Protocol, and (2) ascertain the optimal time of day to conduct surveys for wetland-dependent birds in the southeastern United States.

METHODS

Study Area.—All surveys were conducted on the St. Vincent Island (SVI) portion of St. Vincent National Wildlife Refuge (29° 40′ N, 85° 05′ W). SVI is a 4,968 ha forested barrier island in the northeastern Gulf of Mexico bounded by St. Vincent Sound, Apalachicola Bay, and the Gulf of Mexico. Thirty-seven percent of the island is considered suitable habitat for wetland-dependent birds: 308 ha of managed marsh, 67 ha of managed open water, 1,090 ha of estuarine marsh, and 383 ha of estuarine open water (Grace 2000). Palustrine marsh (270 ha) and palustrine scrub (43 ha) wetlands exist on the island, but were not surveyed since few wetland-dependent birds have been detected in these wetland types. We established five survey routes on SVI: three were in managed marshes and two were in estuarine marshes. Vegetation on three survey routes was dominated by *Cladium*. The other two routes were co-dominated by *Typha* and *Juncus* or *Spartina* and *Cladium*. Salinity in the managed marshes increased throughout the study and ranged from 3.1 to 18.5 ppt. Salinity measurements were not available for the estuarine marshes. We established 62 survey points, placing 12–14 points on each survey route. Adjacent points were spaced 200 m apart (400 m on one route to conform to past surveys). We chose an interval of 200 m on the four newly established routes to increase our probability of detecting Black Rails, which are rarely detected beyond 100 m (Conway et al. 2004). Survey points were marked in the field with a portable GPS receiver and with rebar or surveyor tape.

Surveys.—Survey methods followed the Standardized North American Marsh Bird Monitoring Protocol (Conway 2007). We recorded all aural and visual detections of 10 focal species during each minute of both a 5-min passive listening period and a 5-min call-broadcast period at each point. The 10 focal species thought to occur in the area included Pied-billed Grebe (*Podilymbus podiceps*), Least Bittern (*Ixobrychus exilis*), American Bittern, Black Rail, Clapper Rail, King Rail (*Rallus elegans*), Sora (*Porzana carolina*), Purple Gallinule (*Porphyrula martinica*), Common Moorhen (*Gallinula chloropus*), and American Coot (*Fulica americana*). The call-broadcast period was composed of 30 sec of broadcast calls followed by 30 sec of silence for each of five species in the following sequence: Black Rail, Least Bittern, Clapper Rail, Common Moorhen, and Purple Gallinule. We used the standardized call-broadcast recordings for the North American Marsh Bird Monitoring Protocol (Conway 2007) that we obtained from the coordinators of the program. We did not broadcast for all (5 of 10) focal species to limit the duration of the survey at each point. We excluded species of lesser management concern or species commonly detected without the use of call-broadcast. We excluded King Rail from our call-broadcast due to the similarity between King Rail and Clapper Rail calls and because they commonly respond to each others' calls (Conway and Nadeau 2006). Surveys were conducted on days without rain and when winds were <10 km/hr. All calls were broadcast using a Memorex CD player (Model #MD6443SIL) and a Sony SRS-A27 Active Speaker System placed on the ground or bow of the canoe pointed perpendicular to the edge of the marsh. All broadcasts were ~ 90 dB measured 1 m from the speaker. We used a Kestrel 3000 weather anemometer to record temperature and wind speed at the beginning and end of each survey route. We also estimated percent cloud cover at the beginning and end of each survey route. We measured temperature, wind speed, and cloud cover to examine whether differences in detection probability during different periods (morning, evening, and night) were potentially due to differences in weather conditions.

Double-blind Multiple-observer Surveys.—We conducted double-blind multiple-observer surveys at 26 points on two survey routes on 25 June and 5 July 2006. Double-observer surveys require two trained observers. We only had two trained observers and chose each route based on the route observer #1 planned to survey (for the second part of our study) on the day observer #2 was available. Both observers estimated the distance to each bird detected and recorded the call given by each bird. We were able to use these auxiliary data to easily identify (after the survey) which birds had and had not been detected by each observer. The two observers stood side-by-side or sat on opposite ends of a canoe during the surveys. They recorded their data inconspicuously during the survey, by recording their data discreetly and by shielding their data sheets with their clipboard, to not alert the other observer when they detected a bird. They did not discuss their detections until the survey was complete.

We followed Nichols et al. (2000) to estimate observer detection probability for each of two observers (P_1 and P_2) during each of three time periods: (1) the entire survey (passive and call-broadcast combined), (2) the passive period only, and (3) the call-broadcast period only. We averaged P_1 and P_2 to obtain an overall estimate of observer detection probability for each of the three time periods.

Detection Probability During Different Times of Day.—We conducted 144 paired point-count surveys on three survey routes (38 points with 2–6 replicates/point) during both the morning and evening. Paired surveys were conducted on the same day or consecutive days between 31 May and 30 June 2006. Morning surveys were conducted 0.5 hrs before sunrise until no later than 1000 hrs EDT, and evening surveys were conducted 3 hrs before sunset until dark. We also conducted 104 paired point-count surveys on two different routes (26 points with 4 replicates per point) during both the morning and night. Paired surveys were conducted on the same day or consecutive days between 7 June and 7 July 2006. Morning surveys were conducted 0.5 hrs before sunrise until no later than 1000 hrs, and night surveys were conducted between 0100 and 0400 hrs. Paired morning versus evening surveys were conducted on different survey routes than paired morning versus night surveys with the exception of one pair of surveys.

We used paired *t*-tests to compare the mean number of wetland-dependent birds detected (all species pooled) and the mean number of each species detected on each route between morning and evening surveys, and between morning and night surveys. We also used paired *t*-tests to compare temperature, wind speed, and percent cloud cover between morning and evening surveys, and between morning and night surveys.

RESULTS

Double-blind Multiple-observer Surveys.—We detected 5 of 10 focal species during double-blind multiple-observer surveys: Least Bittern, American Bittern, Clapper Rail, King Rail, and Common Moorhen. Observer detection probability for all species pooled across the entire survey (passive and call-broadcast periods combined) was 75%. The observer detection probability was similar for both the passive period (69%) and call-broadcast period (65%).

Detection Probability During Different Times of Day.—We detected 5 of 10 focal species on at least one of the 12 paired morning and evening surveys: Least Bittern, Clapper Rail, Purple Gallinule, Common Moorhen, and American Coot. The mean (± SE) number of birds detected was higher (t = 3.0, P = 0.030) on morning ($\bar{x}$ = 19.8 ± 6.5 birds) than on evening surveys ($\bar{x}$ = 7.8 ± 3.3 birds) when we pooled all species. We detected 106% more Least Bitterns (t = 2.4, P = 0.064) and 170% more Common Moorhens (t = 2.8, P = 0.026) on morning than on evening surveys (Fig. 1A). We did not observe significant differences in the number of individuals detected between morning and evening surveys for Clapper Rail, Purple Gallinule, and American Coot. We did not observe a difference in percent cloud cover (t = 0.8, P = 0.31) or wind speed (t = 0, P = 1.00) between morning ($\bar{x}_{cloud}$ = 19 ± 7%, $\bar{x}_{wind}$ = 1.5 ± 0.1 km/hr) and evening ($\bar{x}_{cloud}$ = 22 ± 8%, $\bar{x}_{wind}$ = 1.5 ± 0.3 km/hr) surveys, but temperature was 8% higher on evening ($\bar{x}_{temp}$ = 28.6 ± 0.5° C) than on morning ($\bar{x}_{temp}$ = 26.6 ± 0.8° C) surveys (t = 3.5, P = 0.017).

We detected 3 of 10 focal species on at least one of the eight paired morning and night surveys: Least Bittern, Clapper Rail, and Common Moorhen. The mean number of birds detected was higher (t = 3.4, P = 0.042) on morning ($\bar{x}$ = 5.5 ± 1.7 birds) than on night surveys ($\bar{x}$ = 1.2 ± 0.6 birds) when we pooled

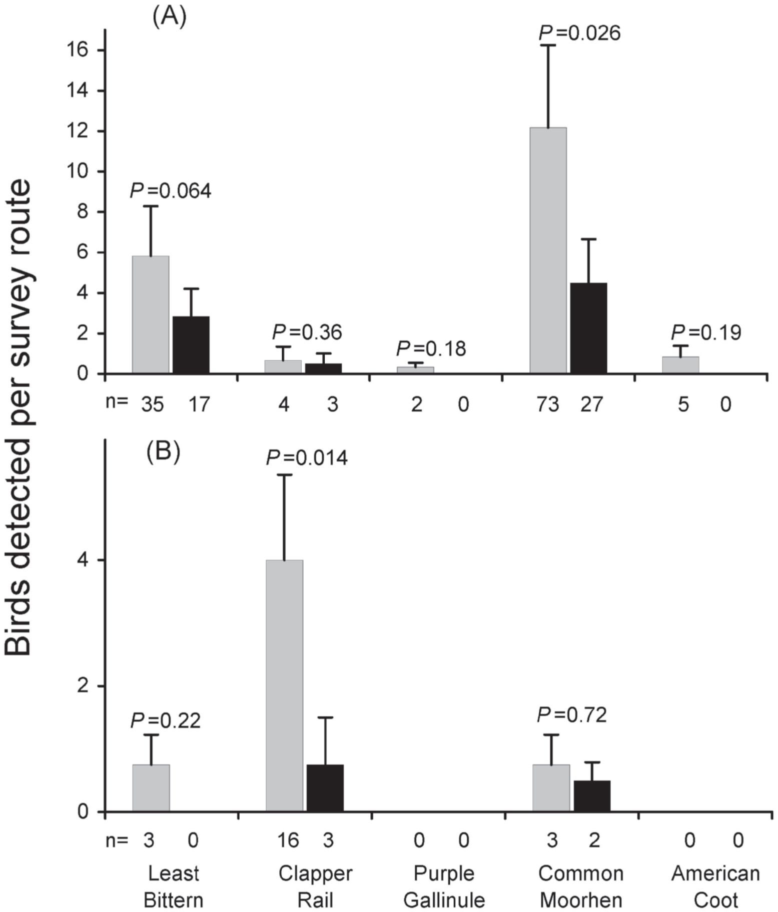

FIG. 1. Mean (± SE) number of wetland-dependent birds detected during (A) six morning (gray) and six evening (black) surveys, and (B) four morning (gray) and four night (black) surveys on St. Vincent National Wildlife Refuge, northwestern Florida, 31 May–7 July 2006. Data in (A) and (B) were from different survey routes and can not be appropriately compared. Sample sizes (*n*) refer to the total number of birds detected.

all species. We detected 433% more Clapper Rails ($t = 5.1$, $P = 0.014$) on morning than on night surveys (Fig. 1B). We did not observe significant differences in number of individuals detected between morning and night surveys for Least Bittern or Common Moorhen. We did not observe a difference in temperature ($t = 0.3$, $P = 0.76$) between morning ($\bar{x}_{temp} = 25.4 \pm 0.7°$ C) and night ($\bar{x}_{temp} = 25.1 \pm 1.3°$ C) surveys. Percent cloud cover ($t = 2.3$, $P = 0.10$) and wind speed ($t = 2.8$, $P = 0.066$) were higher on morning ($\bar{x}_{cloud} = 39 \pm 17\%$, $\bar{x}_{wind} = 2.4 \pm 0.3$ km/hr) than on night ($\bar{x}_{cloud} = 23 \pm 21\%$, $\bar{x}_{wind} = 0.8 \pm 0.5$ km/hr) surveys, however, the differences were only marginally significant.

DISCUSSION

Our results suggest that call-broadcast has little or no negative effect on observer detection probability. These results support use of call-broadcast to maximize detection probability during wetland-dependent bird surveys. Other studies have shown that observer detection probability is higher during the call-broadcast period for Clapper Rails and similar between passive and call-broadcast periods for all other species (Conway and Nadeau 2006). We observed similar patterns although our sample sizes for individual species were small. Our estimate of observer detection probability (75%) is similar to previous estimates (50–75%) for wetland-dependent birds (Conway et al. 2004, Conway and Nadeau 2006). Our results suggest that trained observers are missing 25% of the birds vocalizing during a survey that combines both passive and call-broadcast methodology. Thus, accounting for detection probability during surveys is essential if data will be used to estimate a measure of true abundance. Moreover, our individual estimates of observer detection probability (68 and 82%) differed between our two trained observers. Hence, estimating observer detection probability for each observer is important if data from multiple observers will be used to estimate population trends over time.

We detected more birds on morning surveys compared to both night and evening surveys for all species detected. Higher temperatures in the evening may explain the decrease in the number of wetland-dependent birds detected between morning and evening surveys. Past studies examining the effects of temperature on the detection probability of wetland-dependent birds have reported conflicting results. Previous studies have reported a positive correlation between temperature and detection probability (e.g., Mangold 1974, Tacha 1975, Spear et al. 1999) and others have shown a negative correlation (e.g., Tango et al. 1997). However, authors of these studies failed to account for the correlation between temperature and time of day or time of year (Conway and Gibbs 2001). Future studies that examine how weather affects detection probability need to first control for time of day. Robbins (1981) suggested that extreme heat reduces bird activity in other groups of birds. Higher wind speeds and percent cloud cover in the morning did not make morning less effective than night surveys. Robbins (1981) also reported two peak singing periods for birds (one in the morning and one in the evening) but the peak singing period in the morning was substantially longer. Thus, we may have detected more birds in the morning because we were able to survey more points on a route during the peak singing period.

Our results suggest that surveying in the morning will maximize detection probability of wetland-dependent birds in the southeastern United States. We recommend that further studies be completed in other regions of North America to identify the optimal time of day to conduct surveys. Additional research is needed to examine the efficacy of night surveys for wetland-dependent birds that are rare or not present on SVI (e.g., Black Rail, Yellow Rail, and Virginia Rail).

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