Distribution, Fidelity, and Abundance of Rio Grande Wild Turkey Roosts in the Texas Coastal Sand Plains

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Abstract: Sustainable management of wild turkeys (*Meleagris gallopavo*) requires information on distribution and abundance across the range. Techniques for surveying wild turkey populations in Texas are constrained by land access issues, requiring integration of landowners and managers into monitoring activities. We evaluated the use of 1) aerial surveys for estimating the distribution of Rio Grande wild turkeys (*M. g. intermedia*) relative to roosting habitat, and 2) multiple-observer roost counts for estimating local turkey abundance and roost-site fidelity within the Texas coastal sand plain. Double observer surveys indicated that detection probabilities varied little between observers, with detection rates typically exceeding 0.80. Estimated roost-site fidelity was 0.84 with roost-level detection ranging between 0.69 and 0.79. Based on these data, aerial distributional surveys conducted at the physiographic region scale combined with abundance monitoring using multiple-observer roost counts on a random sample of private lands within the region should provide a framework for long-term monitoring of Rio Grande wild turkeys in Texas and other semiarid regions of the United States.

Key words: abundance, aerial surveys, distribution, occupancy, Rio Grande wild turkey, roost surveys

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Long term data on the distribution and abundance of wildlife provides baseline data required to drive conservation and management actions. However, wildlife biologists are continually challenged by a variety of constraints when developing monitoring strategies (Pollock et al. 2002). In addition to logistical and monetary restrictions, property access restrictions complicate monitoring (Thompson et al. 1998). Thus monitoring programs must accommodate restrictions in sample allocation.

Before European-American settlement of the western United States, Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) were distributed throughout the south-central United States (Kansas, Oklahoma, Texas, New Mexico) and northern Mexico, and numbers probably exceeded 1.8 million individuals (Glazener 1967). A combination of overhunting, heavy livestock grazing, and habitat conversion to cropland during the 1800s led to a precipitous decline in Rio Grande wild turkey numbers, with strongholds remaining in the Edwards Plateau and South Texas Plains ecoregions of Texas; <100,000 individuals remained by 1900 (Texas Game, Fish and Oyster Commission 1929, 1945; Gore 1969). Active regulatory and conservation efforts began in the early 1900s; and in the 1930s Rio Grand wild turkeys were translocated from populations in Texas strongholds to other areas that appeared suitable.

Rio Grande wild turkeys exhibit annual aggregations during fall and winter where both sexes concentrate into large groups that often exceed 100 individuals (Thomas et al. 1966, Cook 1973). Typically, these phonologically-driven concentrations occur in the same general areas with birds returning to roost sites annually for many years (Thomas et al. 1966, Cook 1973). Thus, winter roost locations represent important habitat components for Rio Grande wild turkeys as large flocks forage and rest within relatively close proximity of these roosts (Crockett 1973, Guthrie et al. 2011). Roost-use phenology has been useful for collecting garnering data on Rio Grande turkey populations at the local scale, typically via roost surveys conducted by wildlife biologists or landowners (Cook 1973, Butler et al. 2006).

Although roost surveys can be conducted effectively and efficiently for Rio Grande wild turkeys in Texas (Cook 1973, Butler et

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al. 2006), little effort has focused on identifying or evaluating the relationship between general roost characteristics and local turkey distribution, roost fidelity, or abundance. Data on these relationships are required to identify the most applicable sampling frame for monitoring wild turkey populations in Texas. The purpose of our study was to evaluate aerial surveys for use in monitoring Rio Grande wild turkey distribution and abundance in the south Texas coastal sand plains. Hence, we estimated turkey distribution using an aerial survey and occupancy modeling and estimated local abundance and roost sight fidelity using double observer roost surveys.

Study Area

We conducted our research in the coastal sand plains of Texas (Diamond et al. 1987) in Brooks and Kenedy counties. Our study site was privately owned and managed for native and exotic wildlife, hunting, and rotational cattle grazing through a combination of burning (~4 yr rotation), mechanical, and chemical treatments which led to more woody vegetation than was present historically (Lehmann 1969), primarily in the form of live oak (*Quercus fusiformis*) mottes (clumps of live oak ranging from 0.5 to 300 ha in size) interspersed in mesquite (*Prosopis glandulosa*) savannah and mixed brush scrubland (Scifres 1980). Live oak mottes provide nearly all turkey roost habitat in this portion of the coastal sand plains (Cook 1973, Litton and Harwell 1995). Grass species included big bluestem (*Adropogon gerardii*), little bluestem (*Sorghastrum nutans*), eastern gammagrass (*Tripsacum dactyloides*), bufflegrass (*Pennisetum cilare*), and King Ranch bluestem (*Bothriochloa ischaemum*).

Methods

Data Collection

During 2007 and 2008, we conducted three replicated aerial surveys (three surveys conducted three times) on a randomly sampled set of fixed-width transects ($n=24$; 3 km x 1 km in 2007 along a north-south axis, 1 km x 1 km in 2008) to estimate Rio Grande wild turkey distribution. Transect width was based on a pilot survey conducted in our study region during 2007 and from sightability estimates for Rio Grande wild turkeys from aerial surveys conducted by Beasom (1970) in this same Texas physiographic region. We flew transects in a Cessna 172 fixed-wing aircraft (USA Flights, Kingsville, Texas) at 75 to 100 m above the ground at approximately 200 km per hour using one observer on each side of the aircraft. We collected data on presence/absence, total number of flocks seen, number of birds per flock, and flock location in Universal Transverse Mercator coordinates (UTM). Using ArcMap 10 and 2008 NAIP imagery we hand-delineated oak mottes and removed all areas <2 ha, which were too small to be consistent roosting habitat (Haucke 1975). We ground-truthed our hand-delineated oak motte habitat and accurately classified oak mottes >95% of the time. For each transect, we created a set of spatial covariates including size of nearest oak motte, distance to nearest oak motte, and oak motte density in each sampling unit for use in predicting turkey distribution relative to roosting habitat.

During December–February, we conducted roost counts for roosts identified from our aerial surveys, historical roost sites identified by wildlife biologists, and roosts identified during a concordant radiotelemetry study on Rio Grande wild turkeys on our study site. Once a roost was identified via radio-telemetry and/or visual observation >3 times, to ensure that the roost site was not an artifact of bird location (Chamberlain et al. 2000), we conducted double observer roost surveys (Cook and Jacobson 1979, Nichols et al. 2000) using two camouflaged observers concealed in vegetation within 75 m of the roost and separated by at least 10m to ensure sampling independence. During each roost survey, each observer independently counted the number of unique individuals seen approaching or leaving each roost site. We conducted morning roost surveys beginning at sunrise and continuing until all birds had departed the roost, and evening surveys beginning 0.5 hr before sunset until dark.

We evaluated roost-level fidelity by conducting occupancy surveys at six randomly selected roosts using three replicated surveys on four consecutive days within a week. Because roosts were located within close proximity we were able to survey multiple roosts for occupancy within a given night. We used morning and evening surveys, but did not conduct morning surveys on the same roosts where evening surveys were conducted the previous night because presence/absence already was known. However, we conducted morning surveys followed by evening surveys regardless of occupancy during the morning survey.

Analysis

We predicted Rio Grande wild turkey distribution using single season occupancy models implemented in MARK (White and Burnham 1999). We developed a set of predictive models for transect occupancy and used Akaike's Information Criterion (AIC) to select the best fitting models given the data using the R (R Development Core Team 2011) package RMark (Laake and Rexstad 2009) to interface MARK (White and Burnham 1999). Our model set incorporated spatial and temporal parameters for the occurrence process, and observer-level variation in detection rates. We treated our 2007 surveys as a pilot study to ensure our sampling methodology was appropriate, and although we provide detection parameter estimates from the 2007 and 2008 surveys, we based our distribution predictions on aggregated 2008 survey data.

We estimated roost abundance and observer-specific detection probabilities with DOBSERV (Nichols et al. 2000, Hines 2000), using AIC to determine which models that differentiated between locations (roosts) and observer's best fit the data. We estimated roost fidelity using occupancy modeling in MARK (White and Burnham 1999). We used a single-species, single season (standard) occupancy modeling approach, and constrained our modeling to a simple constant model for occupancy and detection rates because 1) sites surveyed were at known roosts, so there was no sampling uncertainty regarding whether or not sites were used, 2) there were no biologically relevant factors we believed would adequately represent the inherent factors driving roost occupancy over the short time frame of our study, and 3) we had no expectation that detection rates would vary by roost location.

Results

Observers made 355 observations of Rio Grande wild turkey flocks during aerial surveys across both years of the study. Detection probabilities for individual surveys ranged between 0.24 and 0.30 across years (Table 1). The best fitting model for the occurrence probability (ψ) given the 2008 data was an additive model including the size of nearest oak motte and the distance to that motte (Table 2); however, models that incorporated distance to the nearest oak motte as interactive effects, or not at all, also were plausible (Table 2). Using the model that incorporated an additive effect, including the size and distance to the nearest oak motte, we predicted potential turkey distribution at the local study site scale (Figure 1) and across the range of similar coastal sand plains habitat (Figure 2).

We used seven different observers during our abundance and fidelity surveys, three in 2007, and four in 2008, with two observers overlapping both years. We conducted 100 double observer roost surveys with counts ranging from 0 to 183 individuals on 14 confirmed Rio Grande wild turkey roosts in live oak mottes concentrated in the northern and central portions of our study area. Detection probabilities varied little among roosts (Table 3), with detection rates of the primary observer exceeding 0.80 (Table 4). Observers overlapping both years of the study had similar detection probabilities (0.90 and 0.87, respectively). A naïve fidelity estimate for our study was 0.72 (presence at 72 of 100 roost surveyed) with estimated roost site fidelity of ≈0.84 and estimated detection ranging between 0.69 (SE = 0.11) and 0.79 (SE = 0.09)

Table 1. Detection probabilities of replicated (three replicates) Rio Grande wild turkeys aerial grid occupancy surveys in south Texas during January–February, 2007 and 2008.

	Detection probability	SE	95% CI
Survey 1 – 2007	0.28	0.058	0.18–0.41
Survey 2 – 2007	0.27	0.036	0.21–0.34
Survey 3 – 2007	0.24	0.031	0.18–0.31
Survey 1 – 2008a	–	–	–
Survey 2 – 2008	0.30	0.072	0.18–0.45
Survey 3 – 2008	0.30	0.083	0.16–0.48

a. The initial survey of 2008 had too few detections to independently estimate a survey-specific detection estimate.

Table 2. Model selection criteria for Rio Grande wild turkey aerial survey conducted in the Texas coastal sand plain during 2008 used to predict potential distribution relative to roosting habitats. Model parameters for the underlying detection model (p) and occurrence model (ψ) include a constant detection (.) as well as effects of distance from nearest motte (Dist) and size of nearest motte (Size).

Model	k	AIC_c	ΔAIC_c	w_i
p(.), ψ(Dist + Size)	4	394.73	0	0.425
p(.), ψ(Dist + Size + Dist * Size)	5	395.39	0.664	0.305
p(.), ψ(Size)	3	395.64	0.909	0.269
p(.), ψ(Dist)	3	406.58	11.85	0.001
p(.), ψ(Dist*Size)	3	417.92	23.18	0

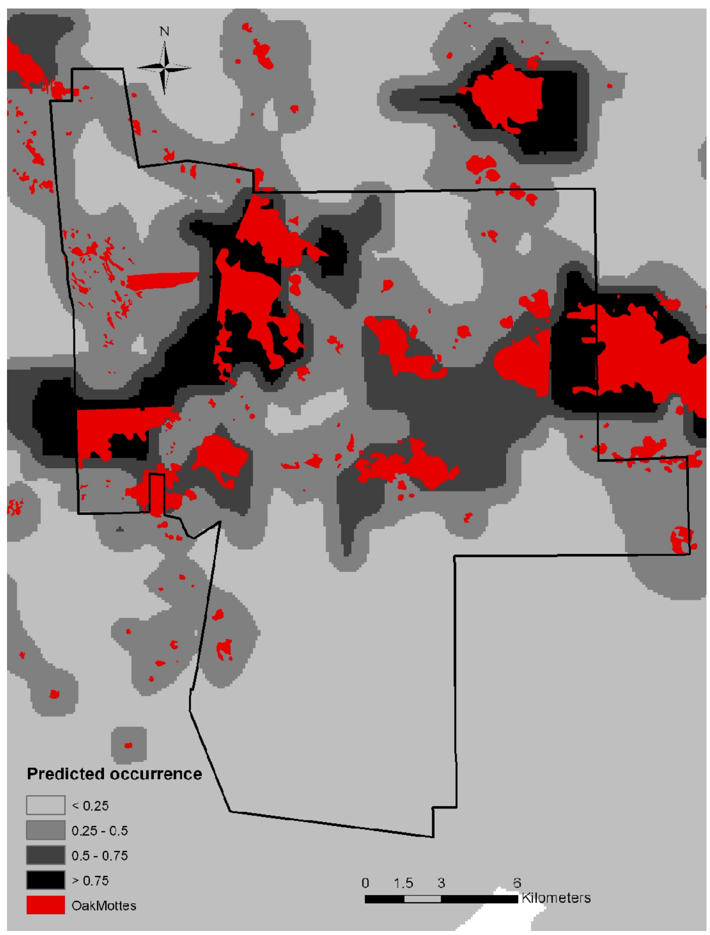

Figure 1. Predicted occurrence probabilities for Rio Grande wild turkeys relative to roosting habitat within our study area based on aerial surveys conducting during 2007 and 2008 in the coastal sand plains region of Texas.

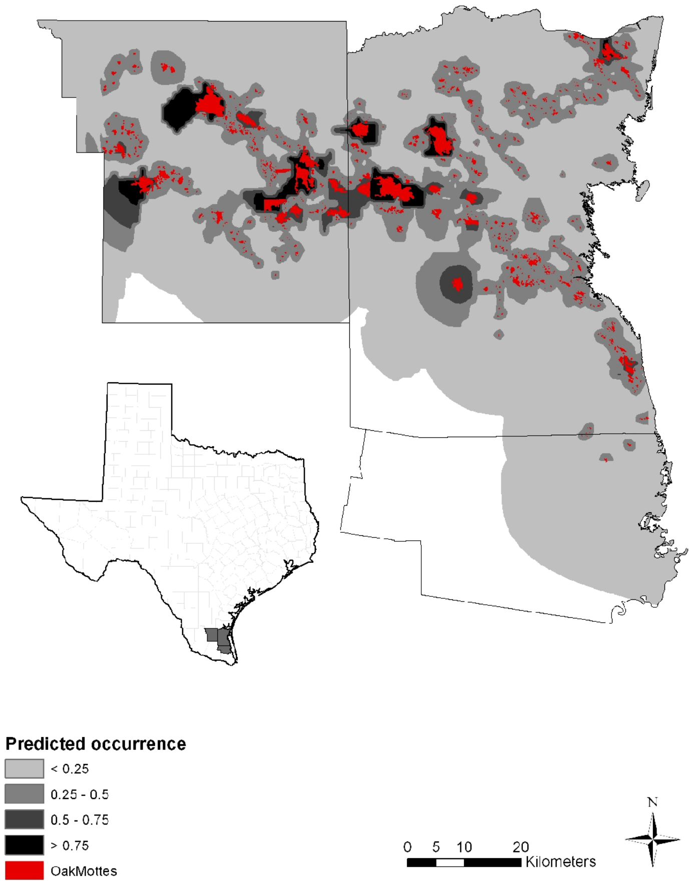

Figure 2. Regional prediction of occurrence probabilities for Rio Grande wild turkeys relative to roosting habitats across the coastal sand plains region of Texas.

Table 3. Estimated detection probability (*P* (SE)), total count (number counted), and estimated roost-level abundance for Rio Grande wild turkey roost surveys during 2007–2008 in the Texas coastal sand plain.

		Detection Probability			Abundance					
Roost	Year	*n* Counted	*P*	SE	Estimated abundance	SE	Lower CL	Upper CL	*n* Counts	Mean birds / Count
1	2007	104	0.938	0.0000	110.91	2.71	107.29	118.51	3	36.97
	2008	172	1.000	–	172.00	–	–	–	4	43.00
2	2007	–	–	–	–	–	–	–	3	
	2008	134	0.991	–	135.25	–	–	–	3	45.08
3	2007	270	0.991	0.0040	272.61	1.97	270.70	279.71	5	54.52
	2008	61	0.987	0.0076	61.83	1.04	61.13	66.54	4	15.46
4	2007	–	–	–	–	–	–	–	3	
	2008	25	1.000	–	25.00	–	–	–	5	5.00
5	2007	–	–	–	–	–	–	–	0	
	2008	29	0.998	0.0018	29.04	0.20	29.00	30.38	3	9.68
6	2007	253	0.991	0.0030	255.32	1.71	253.64	261.44	5	51.06
	2008	426	0.998	0.0007	426.91	1.00	426.16	431.23	6	71.15
7	2007	160	0.994	0.0033	160.99	1.13	160.17	165.93	5	32.20
	2008	125	0.995	0.0026	125.67	0.88	125.09	129.78	5	25.13
8	2007	513	0.998	0.0010	514.16	1.19	513.22	519.09	6	85.69
	2008	12	0.998	0.0010	12.03	0.17	12.00	13.14	3	4.01
9	2007	360	0.579	0.0000	621.09	21.22	582.70	666.11	3	207.03
	2008	300	0.996	0.0014	301.19	1.18	300.24	306.01	3	100.40
10	2007	–	–	–	–	–	–	–	1	
	2008	49	1.000	–	49.00	–	–	–	3	16.33
11	2007	74	0.955	0.0174	77.52	2.39	75.06	85.74	3	25.84
	2008	23	0.999	0.0010	23.01	0.11	23.00	23.74	3	7.67
12	2007	120	0.981	0.0100	122.36	1.99	120.56	129.91	4	30.59
	2008	26	0.980	0.0164	26.53	0.86	26.06	30.90	3	8.84
13	2007	–	–	–	–	–	–	–	0	
	2008	54	1.000	–	54.00	–	–	–	4	13.50
14	2007	–	–	–	–	–	–	–	0	
	2008	66	0.997	0.0024	66.21	0.05	66.01	69.00	3	22.07

Discussion

Based on our aerial survey data, Rio Grande wild turkeys exhibited a predictable occurrence relative to availability of roosting habitats within our study site in the coastal sand plains of south Texas, so these data can appropriately be used to better inform sampling structures for monitoring wild turkey populations (Thompson et al. 1998, Morrison et al. 2008). Because Rio Grande wild turkeys were closely tied to the distribution of roosting habitats, stratified random sampling that emphasizes potential roost sites (i.e., oak mottes) would greatly reduce the spatial area to be surveyed. For example, the total area of the south Texas coastal plains evaluated during this study was ~750,000 ha (Figure 2). If we focused survey efforts on areas within1 km of a potential roost sites (i.e., oak mottes) during morning hours when turkeys were near the roosts, we would reduce the area surveyed by 80%, leaving only 150,000 ha to be surveyed. Moreover, based on the predictions of our distribution models, we could preferentially survey areas with ≥0.50 probability of occurrence (Figure 2) during winter months, reducing the required survey area by >95% (to 40,000 ha), thus ensuring substantive reductions in survey cost (Butler et al. 2007). This reduction in survey area is likely to hold for Rio Grande wild turkeys in other semiarid regions, because riparian corridors account for nearly all roosting cover used during the winter in these physiographic regions (Crockett 1973, Haucke 1975, Erxleben et al. 2010).

Table 4. Mean observer detection probability of Rio Grande wild turkeys during independent double-observer roost count surveys in the Texas coastal sand plain, 2007–2008.

Observer	*n* of Counts	Detection Probability	SE
1	28	0.904	0.006
2	14	0.875	0.009
3	8	0.799	0.021
4	9	0.938	0.011
5	2	0.981	0.006
6	7	0.906`	0.013
7	2	0.952	0.047

Our multiple-observer roost surveys determined that few Rio Grande wild turkeys were missed on our south Texas study area (detection rates 0.79–0.98). When we considered the observational data collected by both observers, detection probabilities for Rio Grande wild turkeys during roost surveys was >0.90. In one case an observer had a restricted view of the survey area, but overall our results indicate that detection rates of turkeys was high during roost surveys. Thus, repeated multiple-observer roost count data, even when uncorrected for detection probability, would likely represent an accurate estimate of the number of turkeys using that roost (Johnson 2008). Because roost counts are efficient for surveying Rio Grande wild turkeys (Cook 1973, Butler et al. 2006, 2007), and detection probabilities are high for roost surveys, adequately trained private land managers could provide high quality multiple-observer roost count data (Locke et al. 2011). Moreover, because Rio Grande wild turkeys exhibit consistent seasonal aggregations at historic roost sites during the fall and winter, these aggregations represent the optimal time for conducting surveys (Cook 1973; Butler et al. 2006). As our results indicate that detection rates for roost abundance surveys are high, survey data collected by citizen scientists should result in information on roost occupancy, fidelity, and abundance which, when collected under an appropriate sampling design can be used to monitor local and regional trends in Rio Grande wild turkey populations in Texas (Locke et al. 2011).

Monitoring wildlife populations is essential to management; thus, application of techniques that are inexpensive yet provide precise and unbiased data are required by regulatory agencies and private land owners. Because the majority of Texas (>95%) is privately owned, aerial surveys provide a viable methodology for estimating the distribution of Rio Grande wild turkeys over large spatial areas. Although species distribution typically does not need to be determined annually (Thompson et al.1998), the frequency of distribution surveys required depends upon the magnitude of change that regulatory agency personnel wish to detect (Butler et al. 2006, 2007). Further research should delineate this relationship for Rio Grande wild turkeys in the Texas coastal sand plain. Regardless, distributional surveys conducted at the physiographic region scale combined with abundance monitoring using multiple-observer roost counts on a random sample of private lands within the region should provide a framework for long-term monitoring of Rio Grande wild turkeys in Texas and other semiarid regions of the United States.

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