Space Use, Daily Movements, and Roosting Behavior of Male Wild Turkeys During Spring in Louisiana and Texas

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Abstract: Because wild turkeys (*Meleagris gallopavo*) are an important game species and turkey hunter numbers are increasing, the need for better information on how turkeys use their environment is critical. With the recent advent of GPS technology suitable for use on wild turkeys, we are now able to collect data on a scale not previously possible. We used backpack style GPS units to detail home range and core area sizes, daily movement distances, and roosting characteristics of male Eastern (*M. g. silvestris*) and Rio Grande (*M. g. intermedia*) wild turkeys in Louisiana and Texas. Mean home range size was larger in Louisiana (383 ha) than in Texas (270 ha), and mean distance between consecutive roost sites was farther in Louisiana (803 m) than in Texas (211 m). However, average daily distance traveled was shorter in Louisiana (3725 m) than in Texas (4608 m). The mean distance between consecutive roost sites was 803 m in Louisiana and 211 m in Texas. Our findings suggest that space use and daily movements of male wild turkeys vary little from Eastern to Rio Grande, but that roosting habits and movements associated with roosting differ strongly. Managers should recognize that availability of roost sites may greatly influence daily movements and behavior of Rio Grande wild turkeys but may have limited impacts on Eastern wild turkeys.

Wild turkey populations have increased in North America since the 1940s and huntable populations exist in every state except Alaska (Kennamer 2000). According to the National Wild Turkey Federation (NWTF 2003), there has been over $2 billion in economic impact directly related to the management and pursuit of wild turkeys in the United States. Effective management of wild turkey populations requires an understanding of how they use their environment, particularly during times of the year when turkeys are hunted. Home ranges and core areas of individual turkeys are highly variable, and many studies have detailed spring home range size of male eastern wild turkeys (Kelley et al. 1988, Godwin et al. 1995, Miller et al. 1997) with results ranging from 95 ha in South Carolina to 768 ha in Louisiana (Brown 1980, Grisham et al. 2008). Published home range estimates for male Rio Grande turkeys are sparse: Philips (2004) noted that annual home ranges for males in the Texas Panhandle averaged 974 ha.

Daily movements and roosting ecology of wild turkeys have not been extensively researched. Godwin et al. (1994) reported that adult males moved an average of 2,492 m during a morning observation period and that distances moved during spring (when hunting occurred) were greater than during fall and winter. From a management perspective, daily movements, and especially extensive movements that take individuals beyond management area boundaries, are important for managers on public and private lands. Likewise, selection of quality roost sites is key to wild turkey survival because roosts provide protection from inclement weather and predation (Porter 1978, Kilpatrick et al. 1988) and roost sites may be a limiting factor to turkey distributions in otherwise suitable habitats (Kilpatrick et al. 1988, Rumble 1992, Swearingin et al. 2010). Chamberlain et al. (2000) found that female turkeys in Mississippi did not increase or decrease movements just prior to roosting and concluded that female movements throughout the day may be influenced by known roosting locations or that they simply roosted in the nearest suitable location at the end of the day. Daily movement characteristics associated with selection of roost sites by males are poorly understood, although previous work has assessed general roost ecology (Holdstock et al. 2007). Eastern wild turkeys are known to use the same roost sites for multiple nights seasonally (Kilpatrick et al. 1988), but they typically do not use the same roost site on consecutive nights (Healy 1992). Hoffman (1991) found that average distances between roosts used on consecutive nights by males were >1000 m, and previously used roost sites were reused only 19% of the time. They also found that no single roost site was used more than four times. Conversely, Rio Grande turkeys often show strong fidelity to roost sites (Beasom and Wilson 1992).

Previous studies assessing space use, movements, and roosting behavior of male wild turkeys have used locations collected via very high frequency (VHF) transmitters and often contained high levels of locational error (Thogmartin 2001, Montgomery et al. 2011). However, the advent of GPS transmitters designed for wild turkeys has allowed acquisition of more spatially and temporally accurate data. Guthrie et al. (2011) found that mean error for static tests across three landscapes for GPS units was 15.5 m, and that spatial accuracy provided a substantial improvement to assess habitat use and movement patterns of wild turkeys over traditional VHF telemetry. Therefore, we used GPS technology to describe space use and varying aspects of roosting behavior for male eastern and Rio Grande wild turkeys. Our objectives were to describe four aspects of male turkey movements during the spring hunting and reproductive season: sizes of home ranges and core areas, daily movement distances, distances between consecutive roost sites, and frequency of roost site reuse. We predicted that male Rio Grande turkeys would maintain larger spring home ranges and core area sizes than male Eastern wild turkeys. Likewise, we predicted that male Rio Grande turkeys would exhibit larger daily movements than Eastern males. However, we predicted that distances between consecutive roosts would be shorter for Rio Grande males, and that they would reuse roosts more frequently than Eastern males.

Study Area

We conducted research on four study sites. The primary study area was the 2390 ha Tunica Hills Wildlife Management Area (WMA) located in West Feliciana Parish, Louisiana. Tunica Hills was divided into two tracts, the North Tract (949 ha) and the South Tract (1440 ha). The South Tract was the site of most trapping and monitoring activity along with several adjacent tracts of private land. Tunica Hills was owned and operated by the Louisiana Department of Wildlife and Fisheries and was located at the southernmost edge of the loess blufflands. Tunica Hills and surrounding private lands were composed of dissected uplands characterized by steep bluffs, ravines and rugged hills. Forest types were primarily upland hardwoods. Common overstory species included American beech (*Fagus grandifolia*), various oaks (*Quercus* spp.), hickories (*Carya* spp.), yellow-poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum var. rubrum*), and loblolly pine (*Pinus taeda*). Understory plants included oak leaf hydrangea (*Hydrangea quercifolia*), two-wing silverbell (*Halesia diptera*), pawpaw (*Asimina triloba*), muscadine grape (*Vitis rotundifolia*), flowering dogwood (*Cornus florida*), and sweetleaf (*Symplocos tinctoria*).

Tunica Hills was open to recreational activities including hunting, trapping, hiking and sightseeing, biking, and horseback riding. Hunting was allowed during specified seasons for white-tailed deer (*Odocoileus virginianus*), wild turkey, and small game animals. Turkey hunting was regulated with a season structure that allowed for a lottery system and a one-week hunt open to the public. The turkey season included a one-day youth hunt, followed by three weekends (Saturday and Sunday only) of lottery hunting limited to 15 hunters. After the last Sunday of lottery hunting, the WMA was open to the public for seven days.

Mosher Hill Hunting Club (hereafter Mosher) was a 2500-ha property owned by Weyerhaeuser Company and was leased to a private hunting club. Located in Washington Parish, Louisiana, the property was located east of Hwy 25 and south of Franklinton. Mosher bordered the Bogue Chitto River to the east and the Bogue Chitto State Park to the north. Mosher was located in the Lower Coastal Plain region and consisted mostly of well drained, sandy soils. Forest cover was primarily loblolly pine (*Pinus taeda*) managed intensively for fiber production. The area also contained small drainages and low areas with hardwood forests consisting of water oak (*Q. nigra*), green ash (*Fraxinus pennsylvanica*), sweet bay (*Magnolia virginiana*), southern magnolia (*M. grandiflora*), wild azalea (*Rhododendron canescens*), and red bay (*Persea borbonia*).

Located in West Baton Rouge Parish, Louisiana, Double D hunting club (hereafter Double D), was a 688-ha privately-owned hunting club. Double D was approximately 5 km north of Interstate 10 in the floodplains between the Mississippi and Atchafalaya rivers. The property was classified as bottomland hardwoods and contained a mix of roadways, gas pipelines, and food plots. Due to a closed canopy and prolonged seasonal flooding, much of the midstory and understory was sparse. Overstory species included water oak, nuttall oak (*Q. nuttalii*), overcup oak (*Q. lyrata*), eastern cottonwood (*Populus deltoides*), American sycamore (*Platanus occidentalis*), bitter pecan (*Carya × lecontei*), sweetgum (*Liquidambar styraciflua*), and sugarberry (*Celtis laevigata*). Midstory and understory species included red mulberry (*Morus rubra*), boxelder (*Acer negundo*), roughleaf dogwood (*Cornus drumondii*), trumpet creeper (*Bignonia capreolata*), and poison ivy (*Toxicodendron radicans*).

Located northwest of San Diego, Texas, Temple Ranch was located in the eastern portion of the Central Rio Grande Plains ecoregion in southern Texas. Temple Ranch consisted of 5,261 ha and was intensively managed for hunting white-tailed deer and northern bobwhite (*Colinus virginianus*) with limited amounts of hunting for wild turkey (Byrne et al. 2014). Temple consisted of thornscrub parklands with a well-defined mosaic of shrub clusters scattered throughout low-succession grasslands (Northrup et al. 2005). Closed-canopy woodlands were limited to riparian zones and were intermittently present in the clay loam drainages along San Diego Creek. These woodlands consisted of honey mesquite (*Prosopis*

glandulosa), hackberry (*Celtis occidentalis*), and Texas persimmon (*Diospyros texana*). Grassland herbaceous species included coastal sandbur (*Cenchrus incertus*), thin paspalum (*Paspalum setaceum*), red gramma (*Bouteloua trifida*), and fringed signal grass (*Urochloa ciliatissima*) (Guthrie et al. 2011, Byrne et al. 2014).

Methods

We captured male eastern wild turkeys using rocket nets during January–March 2012 on Tunica Hills and adjacent private lands. In 2013, trapping expanded to Mosher and Double D hunting clubs. Once captured, birds were fit with backpack style GPS units. All GPS units were attached to birds using 3-mm shock cord backpack style. Birds were banded with aluminum rivet bands on their right tarsus between the foot and spur. We estimated age (adult or juvenile) based on development and barring of 9th and 10th primary feathers. In Texas, we trapped male Rio Grande wild turkeys in March 2009 using drop nets as part of ongoing research being conducted by Texas A&M University in cooperation with Texas Parks and Wildlife Department. Once captured, each male was similarly banded with an aluminum leg band and a micro-GPS unit, and released at the capture site. Capture and handling protocols were approved by the University of Georgia Institutional Animal Care and Use Committee (Permit A2011 07-003-R1) and Texas A&M University Animal Care and Use Protocol (SPR-0608-078).

All GPS units were either produced by Sirtrack Wildlife Tracking Solutions (Sirtrack Wildlife Tracking Solutions, Havelock North, New Zealand) or MiniTrack Backpack GPS units (Biotrack Ltd., Wareham, Dorset, United Kingdom). Sirtrack units were approximately 10×4 cm and data were recovered after unit retrieval. Biotrack units measured approximately 7.5×2.5 cm and data could be remotely downloaded. GPS units were programmed to record one location at 1200 hours and one at 2400 hours daily from deployment (January and February) until 10 March when the schedule switched to one location every 15 minutes during daylight hours and one location at 2400 hours. This schedule continued until 30 April and coincided with peak breeding dates and all hunting and was designed to provide fine scale movement data associated with a larger project on male wild turkey behavior (Gross 2014). Beginning 1 May, the units recorded one location at 1200 hours weekly to provide coarse location data until the following March when the data acquisition schedule was repeated.

We evaluated home-range and core area sizes, linear distance traveled per day, and roosting activities during the breeding season (1 March through 31 May). This time period also coincided with all hunting activity on each field site. We used a dynamic Brownian bridge movement model (dBBMM; Kranstauber et al. 2012) to calculate seasonal utilization distributions (UDs) for all males.

This model created UDs based on the animal's estimated movement path instead of individual locations, which accounted for temporal autocorrelation and is appropriate when estimating home range sizes using large quantities of spatial data. The dBBMM is an improved version of the Brownian Bridge Movement Model (Horne et al. 2007) because it allows the Brownian motion to change along the movement path as movements change, resulting in a more accurate utilization distribution (Kranstauber et al. 2012). Using the program R version 3.1.0 (R Development Core Team 2013) and the package "move" (Kranstauber and Smolla 2013), we derived 95% and 50% contours from the calculated UDs to represent home ranges and core areas, respectively. We used a margin size of 11 and a window size of 31 and, based on GPS testing conducted by Guthrie et al. (2011), we used a GPS location error of 18 m for all birds.

To determine daily distance traveled and distance between consecutive roost sites, we used the "XY to Line" tool in ArcGIS 10.0 (ESRI 2011). For daily distance traveled, we used each recorded location to create a total daily movement path and then calculated total linear distance. To assess distances between consecutive roosts, we extracted all roost sites and measured the linear distance between roost locations for consecutive days. We considered a roost site to be reused if an individual roosted within 40m of a previous roost site (approximately 2x the estimated GPS error).

Results

We captured 19 males across the three field sites from 2012 to 2013 in Louisiana and 8 males during 2009 in Texas. Of the 27 birds captured, 26 were fit with GPS units. In Louisiana, 13 units were recovered through hunter harvest or researcher efforts. In Texas, 5 units were successfully recovered using walk-in traps. We calculated spring home range and core area sizes for 18 male wild turkeys (13 in Louisiana; 5 in Texas). Mean home range size in Louisiana (eastern wild turkey) was 383 ± 55 ha (mean ± SE; range 141–740 ha) with a mean core area of 56 ± 8 ha (range 19–102 ha). Mean home range size of males in Texas (Rio Grande wild turkey) was 270 ± 15 ha (range 226–319 ha) with a mean core area of 26 ± 7 ha (range 15–52 ha).

Mean daily distance traveled (Table 1) and mean distance between consecutive roost sites (Table 2) for males in Louisiana was 3725 ± 199 m (range: 131–7751 m) and 803 ± 83 m (range 3–4350 m), respectively. In Texas, the mean daily distance traveled was 4608 ± 516 m (range: 484–11,581 m), whereas the mean distance between consecutive roost sites was 211 ± 40 m (range: 1–3,261 m). The frequency at which males were found at previously-used roost sites (Table 3) averaged $28.2\% \pm 2.5\%$ in Louisiana and $87.6\% \pm 3.0\%$ in Texas.

Table 1. Mean daily distance traveled (m) with associated standard error for individual male wild turkeys in Louisiana (La) and Texas (Tx) from 2009–2013.

State	Bird #	n[a]	x̄	SE	Max[b]	Min[b]
La	1	33	4541	178.4	6426	2657
La	2	49	4611	142.3	6831	2820
La	3	50	4165	146.5	6619	2423
La	4	51	4134	126.3	6011	1459
La	5	16	3499	229.0	5218	2212
La	6	53	3316	151.6	6333	1260
La	7	28	3833	129.7	5393	2765
La	8	46	2301	137.6	6288	1049
La	9	26	4699	302.9	7751	1576
La	10	34	3719	109.7	5280	2670
La	11	50	3038	147.3	5988	1103
La	12	39	2885	93.7	4200	131
La	13	40	3688	171.9	6579	2196
Mean			3725 ± 199			
Tx	1	68	3261	160.3	7509	618
Tx	2	79	5786	196.8	11111	2645
Tx	3	61	5799	246.3	11581	1464
Tx	4	68	4401	188.4	9864	1063
Tx	5	80	3791	129.9	6056	484
Mean			4608 ± 516			

a. n = Number of days analyzed for daily distance estimates

b. Max = The maximum linear distance traveled (m) for individual turkeys on a single day. Min = The minimum linear distance traveled (m) for individual turkeys on a single day.

Table 2. Mean distance between consecutive roost sites (m) with associated standard errors for male wild turkeys in Louisiana and Texas from 2009 to 2013.

State	Bird #	n[a]	x̄	SE	Max[b]	Min[b]
La	1	32	961	145.25	2612	38
La	2	49	979	107.48	2589	16
La	3	50	777	104.54	3548	7
La	4	51	809	66.78	1856	43
La	5	16	678	145.78	1847	80
La	6	53	1314	121.78	3467	13
La	7	28	607	75.71	1730	66
La	8	46	509	87.10	3315	8
La	9	26	1393	216.94	4350	46
La	10	34	581	52.53	1168	52
La	11	50	699	82.97	1918	3
La	12	39	339	42.85	1075	10
La	13	40	789	107.40	2509	4
Mean			803 ± 83			
Tx	1	68	288	63.06	2527	2
Tx	2	79	235	68.20	2967	2
Tx	3	61	87	33.09	1452	3
Tx	4	68	292	62.10	2528	2
Tx	5	80	215	71.94	3261	1
Mean			211 ± 40			

a. n = Number of days analyzed for distance between consecutive roost estimates.

b. Max = Maximum distance between consecutive roost sites (m) for individual turkeys on a single day. Min = Minimum distance between consecutive roost sites (m) for individual turkeys on a single day.

Table 3. Number and percentage of re-used and consecutively used roost sites for individual male wild turkeys in Louisiana (La) and Texas (Tx) from 2009 to 2013.

State	ID	n[a]	Re-used[b]	Consecutive[c]	% Re-used	% Consecutive
La	1	31	5	1	16.1%	3.2%
La	2	56	20	3	35.7%	5.4%
La	3	70	20	5	28.6%	7.1%
La	4	76	19	1	25.0%	1.3%
La	5	39	4	1	10.3%	2.6%
La	6	52	16	7	30.8%	13.5%
La	7	35	8	0	22.9%	0.0%
La	8	49	19	5	38.8%	10.2%
La	9	53	15	1	28.3%	1.9%
La	10	47	21	10	44.7%	21.3%
La	11	45	11	1	24.4%	2.2%
La	12	62	20	7	32.3%	11.3%
La	13	41	12	4	29.3%	9.8%
Mean	–	50.4	14.6	3.5	28.2%	69.0%
Tx	1	68	59	42	86.8%	61.8%
Tx	2	79	72	63	91.1%	79.7%
Tx	3	61	57	48	93.4%	78.7%
Tx	4	68	52	40	76.5%	58.8%
Tx	5	80	72	65	90.0%	81.3%
Mean	–	71.2	62.4	51.6	87.6%	72.1%

a. n = Number of roost events analyzed for estimates of roost site selection.

b. Re-used = Number of times an individual returned to the same roost site.

c. Consecutive = Number of times an individual returned to the same roost site on consecutive nights.

Discussion

Male wild turkeys in Louisiana had an average spring home range size of 383 ha, ranging from 141 to 740 ha, with a core area of 56 ha ranging from 19–102 ha. Our estimates of spring home ranges were smaller than those reported by Grisham et al. (2008), who reported a spring home range size of 768 ha and a core area of 116 ha, but larger than the spring home range estimates from Brown (1980). However, our estimates are similar to Rauch et al. (2010) who reported home ranges of 410 ha during spring hunting seasons in West Virginia. Notably, we used a technique for estimating home range sizes in wild turkeys that has not previously been used (but see Byrne et al. 2014), so comparisons of our results to other studies should be made with this forethought. Nevertheless, the larger ranges in birds monitored in Louisiana indicates a high degree of variability among turkeys; the wide variability in space use estimates for individual birds in Louisiana was not present in our sample of birds from Texas. Likewise, we estimated spring home ranges for male Rio Grandes in Texas to be 270 ha, with core areas averaging 26 ha. To our knowledge, these are the first reported home range estimates for male Rio Grande turkeys during spring. Not surprisingly, these estimates were smaller than the 974-ha annual home range reported by Phillips (2004), because

our estimates accounted for a shorter time period and did not include seasonal changes or dispersal.

Daily distance traveled for birds in Louisiana was 3,725 m and in Texas was 4,498 m. Similarly, Godwin et al. (1994) reported morning and afternoon movement distances of 2,492 m and 2,457 m respectively for males in Mississippi based on hourly telemetry locations during half-day observation periods. Godwin et al (1994) also noted two previous studies, Martin (1984) and Smith et al. (1989), who reported considerably shorter daily distances traveled in Texas and Louisiana. However, Martin (1984) and Smith et al. (1989) estimated distances traveled by using considerably fewer telemetry locations than Godwin et al. (1994) and our study. Therefore, the findings of Godwin et al. (1994) are most comparable to our work, and collectively, these studies suggest that males have fairly consistent distances that they move daily. The 17% larger distances moved by Rio Grande males was likely due to the more open, grassland habitats they inhabited, as well as the distribution of resources (i.e., foraging sites, roosts) within those habitats.

We reported an average distance of 803 m and 211 m between consecutive roost locations for males in Louisiana and Texas, respectively. Our findings for males in Louisiana (eastern wild turkeys) are similar to Hoffman (1991) who reported distances between consecutive roosts to be 1,074 m for male Merriam's wild turkey (*Meleagris gallopovo merriami*) in Colorado. However, our estimate for Rio Grandes in Texas was considerably lower. Holdstock et al. (2006) reported that the distance between successive roost sites was 1,342 m for male Rio Grandes in Texas and Kansas, but they did not calculate distances between each consecutive roost event. Rather, they measured distances between roosting areas where an individual would leave a known roosting area and relocate to another roosting area, not the distance between each morning and afternoon roost.

Eastern and Rio Grande wild turkeys appeared to behave differently in regard to roosting habits as shown by our marked differences in distance between consecutive roosts. Furthermore, eastern wild turkeys reused previous roost sites 28% of the time with consecutive occurrences being rare (7%). However, Rio Grande males in Texas showed a much greater degree of roost site fidelity using previous roost sites almost 88% of the time, with consecutive occurrences exceeding 72%. These results are not surprising due to the limited availability of roosts that Rio Grande males face within their range, and hence the necessity to use roosts in the same location night after night (Beasom and Wilson 1992).

Information detailing daily movements of males is sparse in the published literature, with most work focusing on seasonal movements. Our findings, coupled with previous reports on daily movements (Godwin et al. 1994, Holdstock et al. 2006) indicate that wild turkeys may move considerable distances in a single day. These movements should be considered when developing management strategies, especially on smaller lands where daily movements may take individuals well beyond artificial boundaries. For example, Godwin et al. (1990) found that 34% of male wild turkeys on Tallahala Wildlife Management Area in Mississippi had ≥50% of their telemetry locations off of the area during four spring hunting seasons. In addition, long distance movements may reduce survival because of an increased susceptibility to predation (Stenseth and Lidicker 1992, Holdstock et al. 2006) and increased energy demands (Shields 1987). However, our findings indicate that males are intensively using their home ranges and core areas during spring and that these large daily movements may not increase their spring ranges. Male daily movements during spring are related to breeding behavior (Davis 1973, Godwin et al. 1990) and Kelley et al. (1988) suggested that males will travel greater distances during the spring in search of females. The smaller spring home ranges for Rio Grande males compared to eastern males is likely due to their dependence on fewer roost sites. However, our data indicate that Rio Grande males traveled farther distances per day, but within smaller home ranges than their eastern counterparts. We hypothesize that these individuals were required to move more to find necessary resources, such as suitable foraging sites and potentially access to females, but were also constrained to a relatively smaller home range because of their dependence on available roost sites.

Brown (1980) described variation in previous home range studies and cited differences in data collection and analysis, as well as habitat and individual characteristics as reasons for this variability. Recent developments in GPS technology (Guthrie et al. 2011), as well as creation of methods to analyze these data, such as the dynamic Brownian bridge movement model (Kranstauber et al. 2012), have helped reduce bias associated with the collection and analysis of home range data. Most previous studies used data collected via VHF telemetry or field observations of turkey locations and were analyzed with methods such as Minimum Convex Polygons (MCPs) or Kernel Density estimators. While these studies and methods have provided the framework for wild turkey research, the progression of technology has allowed us to capture and detail data on space use and movements unlike before. We offer that the estimates of space use, daily movements, and roosting behavior reported herein likely represent the most spatially and temporally precise estimates available under the current technology.

Acknowledgments

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