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REPRODUCTIVE PARAMETERS OF RIO GRANDE WILD TURKEYS ON THE EDWARDS PLATEAU, TEXAS

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Abstract: Rio Grande wild turkey (*Meleagris gallopavo intermedia*) abundance has declined in portions of the Edwards Plateau of Texas since the late 1970s. Because reproductive performance influences population dynamics, our objectives were to evaluate how hen reproductive activities varied between areas of stable and declining populations. We evaluated productivity metrics of 304 radiotagged Rio Grande wild turkey hens over 7 reproductive seasons (2001–2007) from areas with stable and declining populations on the Edwards Plateau. First, we evaluated the influence of temporal variation on nest survival using data collected during the entire study. Second, based on intensive reproductive ecology work during 2005–2007, we evaluated impacts of nest- and hen-specific information ($n = 162$) on nest survival. Nest survival during 2001–2007 varied temporally within years following a consistent trend associated with nest initiation dates. We found a 2-period trend best fit the data where daily nest survival varied between the first 20 days of the breeding season (0.92, SE = 0.02, 95% CL = 0.88–0.94) and the last 97 days of the breeding season (0.94, SE = 0.005, 95% CL = 0.93–0.95). Hen nesting rates were variable among years in stable versus declining sites with 78%, 85%, and 94% attempting to nest in the stable region and 67%, 46%, and 87% attempting to nest in the declining region during 2005–2007, respectively. Using data on nest- and hen-specific covariates, daily nest survival increased as hen age increased and the percentage of hens attempting to nest increased. We suggest that nest survival was not related to declines in wild turkey abundance and that any perceived declines were likely a function of variation in production potential (percentage of hens nesting), nesting rates, and nesting hen survival.

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Rio Grande wild turkey (*Meleagris gallopavo intermedia*) numbers in North America were estimated at 1.8–2 million individuals prior to European settlement (Beasom and Wilson 1992). By the 1940s, populations in Kansas and Oklahoma disappeared and ≤100,000 remained in Texas (Walker 1950, Beasom and Wilson 1992), with strongholds in the Edwards Plateau centered on Kerr County (Walker 1954). Since the 1970s, portions of the southeastern region of the Edwards Plateau experienced further declines in Rio Grande wild turkey abundance (Collier et al. 2007). Although the mechanisms that caused this decline are unknown, multiple factors such as natality, mortality, and emigration potentially could have caused numerical and structural changes within these populations (Everett et al. 1980, Collier et al. 2007).

Monitoring and predicting trajectories of wildlife populations are of great concern for managers and often require estimates of parameters for management planning and monitoring. Underlying most monitoring programs are evaluations of how changes in natality and mortality influence population dynamics (Williams et al. 2002). Frequently, natality is identified as the most important characteristic underlying population vitality and potential yield (Dasmann 1964). Thus, identifying processes that cause variation in reproductive patterns is central to understanding population processes.

Frequently in avian studies, reproductive ecology research focuses on estimation of nest success and nest survival (Dinsmore et al. 2002, Shaffer 2004). Nest survival is one determinant of recruitment in populations; however, prediction of annual production necessitates use of a variety of factors in addition to nest survival (Thompson et al. 2001), including estimates of nesting rate, clutch size and nesting attempt, egg hatchability, and poult survival. In addition, factors such as breeding chronology (Vangilder et al. 1987) and environmental variation (Schwertner et al. 2007, Collier et al. 2009) can influence recruitment and, thus, affect long-term population viability (Everett et al. 1980, Reagan and Morgan 1980).

Recent research on the Edwards Plateau showed nesting habitat and vegetative characteristics to be similar between regions of stable and declining Rio Grande wild turkey populations (Randel et al. 2007), and work by Collier et al. (2007) indicated that adult and juvenile survival was similar between regions, but there was evidence of inter-annual variation in female breeding-season survival between stable and declining sites (Collier et al. 2009). Work by Dreibelbis et al. (2008) concordant with our study found that nest predation (>60%) and nest abandonment (>15%) rates were consistent across our study areas.

Thus, we hypothesized that the combined impact of breeding season mortality, low nest success, and poor offspring recruitment could underlie the changes in population size of Rio Grande wild turkeys on the southeastern Edwards Plateau of Texas. Thus, our research focused on evaluating reproductive parameters that may cause natality differences between regions. Here, we report estimates of reproductive parameters and predictions for offspring recruitment for populations of Rio Grande wild turkeys in Texas characterized by 2 distinct trends in abundance.

STUDY AREA

We conducted research on the Edwards Plateau of Texas from January 2001 through July 2007 on 4 study areas, 2 in Kerr and Real Counties (stable populations) and 2 in Bandera and Medina Counties (declining populations; Fig. 1). Our study sites primarily were working rangelands managed for native and exotic game species ranging in size from 984 ha to 8,858 ha. Stable areas included a privately owned working cattle ranch (4,843 ha) along with the Kerr Wildlife Management Area (2,627 ha) along the North Fork of the Guadalupe River approximately 20 km northwest of Hunt, Texas, and a privately owned game ranch (984 ha) located along the Frio River in Real County approximately 9.5 km north of Leakey, Texas. Declining areas included a corporately owned cattle ranch (8,858 ha) located along the Medina River in Bandera County approximately 18.8 km northwest of Medina, Texas, and a privately owned working cattle ranch (2,910 ha) located in Bandera County approximately 17 km south of Bandera, Texas.

Each site was characteristic of the Edwards Plateau topography, with flat to rolling divides usually with shallow soils and limestone bedrock (Gould 1975). Average precipitation ranged from 35 cm/yr in the western portion to 85 cm/yr in the eastern portion of the plateau (Riskind and Diamond 1988). The climax vegetative community included various species of bluestem (*Andropogon* spp.), gramas (*Bouteloua* spp.), and panicum (*Panicum* spp.), in addition to mid- and overstory species of Ashe juniper (*Juniperus ashei*), live oak (*Quercus virginiana fusiformes*), and shinnery oak (*Q. pungens vaseyana*; Gould 1975). Livestock grazing occurred on all sites except for

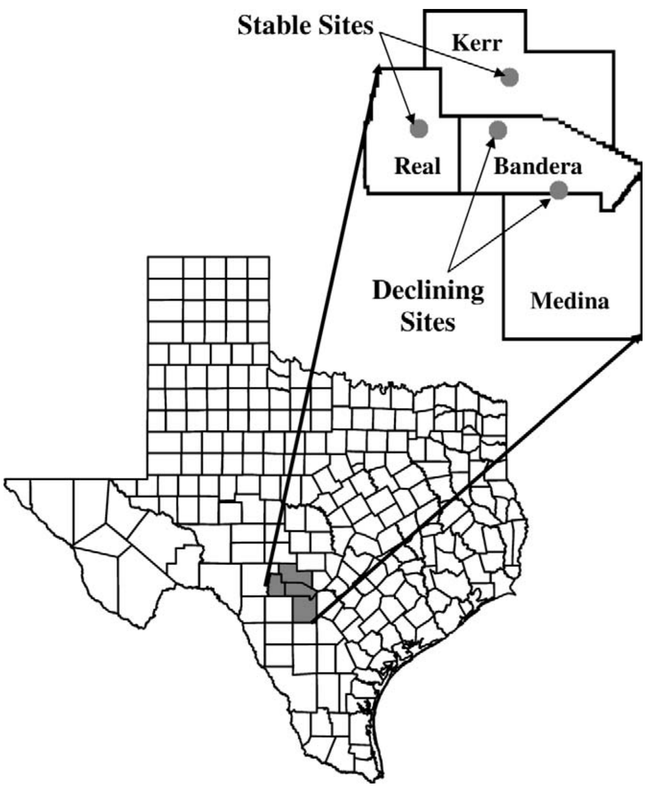

Figure 1. Location of study sites for Rio Grande Wild Turkey project in Edwards Plateau, Texas, USA, 2001–2007.

our Real County site, and supplemental feeding for both native and exotic game species occurred on the stable sites.

METHODS

Data Collection

We captured Rio Grande wild turkeys during January–March 2001–2007 using drop nets (Baldwin 1947, Glazener et al. 1964) or walk-in funnel traps (Davis 1994, Peterson et al. 2003) baited with shelled whole corn and milo. We aged and determined sex of captured Rio Grande wild turkeys (Pelham and Dickson 1992), classifying juveniles as those individuals that hatched the previous year (6–10 months old; Collier et al. 2007). We banded each individual with a unique Texas Parks and Wildlife Department aluminum leg band and fitted each with a backpack-style radiotransmitter (Advanced Telemetry Systems, Isanti, Minnesota, USA).

We monitored hens $\geq$3 times weekly to determined initiation of nesting and incubation by hen movement patterns (Ransom et al. 1987, Paisley et al. 1998, Nguyen et al. 2004). We located nests $<$1 day after we suspected hens had begun incubating to determine nest location (Universal Transverse Mercator), initiation date, and approximate nest age by floating eggs (Westerskov 1950). Nest age could be determined accurately to within 1–2 days. We monitored nesting hens by triangulation $\geq$3 times weekly from a distance of $\geq$100 m to prevent further disturbance to the nesting area, and assumed if hen locations remained constant, nests still were active. We defined the active nesting period as 39 days; the sum of the average number of eggs in a clutch (11) and the 28-day incubation period (Melton 2007).

We determined nest fate only when the hen was no longer in the general area of the nest. We classified nests as successful if $\geq$1 egg hatched and unsuccessful if depredated (nest or eggs exhibited obvious signs of disturbance or destruction), or abandoned (hen left the nest area and eggs remained unhatched). We defined hen success as a hen successfully hatching a brood regardless of the number of nesting attempts in that year. We recorded the fate of abandoned nests after 2 weeks of the nest being unattended and dated the fate to the earliest date of abandonment. If abandonment occurred between the initial visit and the first revisit (usually $<$3 days later), we assumed it was abandoned due to investigator disturbance and did not include those nests in analysis.

Data Analysis

We combined nests monitored over 7 nesting seasons (2001–2007) into groups (region and yr, i.e., group 1 = 2001 Stable). Because of low nest numbers due to drought conditions during 2002–2004, we combined those nesting years into 1 group/region for analysis, resulting in 10 groups. We standardized 2 April as day 1 of the nesting season and considered 28 July the last day of the nesting period. Because data collection was intensive during 2005–2007, we developed and modeled 2 independent data sets (see Melton 2007 for details). First, using data collected between 2001 and 2007, we developed candidate models that represented the daily nest survival rate as a function of inter- and intra-year variation. Based on our experience tracking hens during 2001–2007, we partitioned the breeding season into several temporal frames based on temporal patterns within nest initiation dates (e.g., Hartke et al. 2006; Fig. 2).

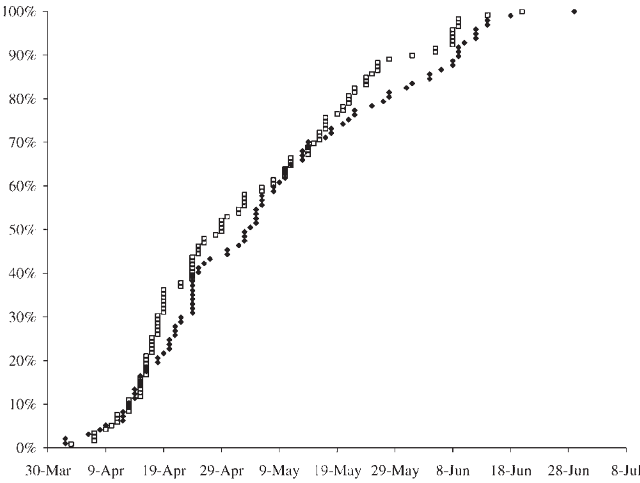

Figure 2. Date of Rio Grande wild turkey nest initiation for stable and declining regions denoted by squares and diamonds, respectively, and graphed by cumulative percent on the Edwards Plateau, Texas, 2001–2007. Note the inflection point at approximately 20 April when the majority of initial nesting attempts have occurred and renesting activities begin.

Next, using data from our intensive study of hen reproductive ecology (2005–2007), we modeled daily nest survival as a function of nest- and hen-specific covariates we hypothesized affected nest survival, and considered additive and interactive relationships between individual covariates. Each nest was described by 6 individual covariates: age cohort (juv, ad), hen age since capture (1–5), prior nesting (hen nested the yr before), prior success (hen successfully hatched a nest the yr before), nest attempt, and percentage of the radiotagged population attempting to nest relative to all radiotagged hens, and 2 interactions; hen age since capture by percentage population attempting to nest and nest attempt by age cohort We conducted all nest survival analysis using Program MARK (White and Burnham 1999).

RESULTS

Summary of Reproductive Metrics

We captured and radiomarked 304 Rio Grande wild turkey hens over 7 seasons; 170 in the stable region and 134 in the declining region. Hen mortality, transmitter failure, or land access issues prevented us from monitoring 43 individuals during the reproductive season. We monitored 104 hens for 1 nesting season, 94 hens for 2 nesting seasons, 43 hens for 3 nesting seasons, 16 hens for 4 nesting seasons, and 4 hens for 5 nesting seasons. During the 7 nesting seasons, we monitored 244 nests; 42 in 2001, 40 in 2002–2004, 44 in 2005, 47 in 2006, and 71 in 2007.

Of the 244 nests, 136 nests were in the stable region and 108 in the declining region. Initial nest attempts ranged from 2 April to 30 May and renest attempts ranged from 20 April to 2 July, with 50% of all nesting attempts occurring before 26 April. Forty-six (19%) nests successfully hatched, 29 (12%) were abandoned (either due to investigator disturbance or for unknown reasons), and 169 (69%) were depredated.

For the hens studied during the intensive reproductive ecology study (2005–2007), nest rate was fairly constant in the stable region, but showed more annual variation in the declining region (Table 1). Renesting rate was higher in stable than declining regions during 2005–2007, respectively (Table 1). We found little variation in the range of first nest-incubation initiation dates among years; 11 April to 29 May for 2005 ($n = 31$), 11 April to 24 May for 2006 ($n = 34$), and 2 April to 30 May for 2007 ($n = 38$). For all years combined, 78% of hens initiated nests in the stable region and 63% initiated nests in the declining region before 25 April (overall median of study). Initiation of renest attempts varied widely and ranged from 20 April to 2 July. Hatching dates ranged between 1 May and 4 June for initial nests and between 19 May and 27 July for renest attempts.

From 2005 to 2007, we obtained data from 162 nests, including 103 initial and 59 renesting attempts over the course of the study. Nest success varied between regions; 18 of 102 nests were successful in the stable region, and 7 of 60 were successful in the declining region as hen success also varied regionally, being more constant in the stable region (Table 1). Clutch sizes averaged 10.9 (SD = 3.44, range = 2–26) in the stable region and 10.8 (SD = 2.73, range = 2–17) in the declining region. Average time spent incubating before an event (i.e., hatch or nest depredation) was 15 days (range = 3–32) for the stable region and 18 days (range = 3–39) for the declining region. Predation was the primary cause of nest failure, accounting for 65 and 67% of loss in the stable and declining regions, respectively.

Nest Survival

For the 7 yr of nesting data, nest survival was consistent between 2 temporal periods within a year, the first 20 days of the nesting season, and the lasts 97 days of the nesting season. Model-averaged daily nest survival was similar for both periods (0.92 [SE = 0.02, 95% CL = 0.88–0.94] and 0.94 [SE = 0.005, 95% CL = 0.93–0.95]), respectively. We found some evidence of model selection uncertainty as models accounting for variation between 2007 and all other years, as well as a 3-period temporal model, also showed some support. However, our nest survival estimates showed little variation between 2007 (0.93, SE = 0.01, 95% CL = 0.90–0.94) and between 2001 and 2006 (0.94, SE = 0.01, 95% CL = 0.93–0.95). Models for nest- and hen-specific covariates indicated an interaction between hen age and percent attempting to nest was the best fitting model given the data. Our results indicated that daily nest survival increased as hen age increased and percent attempting to nest increased (Table 2).

DISCUSSION

Our data are consistent with the hypothesis that declining Rio Grande wild turkey abundance observed in the southeastern Edwards Plateau likely was caused by lower production potential (nest rate, renest rate, nest success, and hen success). We found lower production potential in declining regions than in stable regions each year. We documented 17% and 12% nest success over the course of our study in the stable and declining regions,

Table 1. Reproductive parameters (% [*n*]) of Rio Grande wild turkeys monitored on the Edwards Plateau, Texas, USA, 2005–2007.

Demographic parameter	Site	Yr			Combined
		2005	2006	2007	
Nest rate	Stable	78 (32)	85 (27)	94 (18)	86%
	Declining	67 (9)	46 (24)	87 (24)	67%
Renest rate	Stable	47 (19)	53 (19)	80 (15)	60%
	Declining	20 (10)	20 (10)	74 (19)	38%
Nest success	Stable	19 (36)	15 (34)	19 (32)	17%
	Declining	13 (8)	7 (13)	13 (39)	12%
Hen success	Stable	28 (25)	21 (24)	35 (17)	27%
	Declining	17 (6)	9 (11)	24 (21)	17%

Table 2. Daily nest survival estimates for Rio Grande wild turkey nest characterized by hen age (in yr) and percent of the population attempting to nest on Edwards Plateau, Texas, USA, 2005–2007.

Hen age	% Attempting		
	20	60	100
1	0.911 (95% CI = 0.88–0.94)	0.915 (95% CI = 0.89–0.93)	0.920 (95% CI = 0.90–0.93)
2	0.913 (95% CI = 0.88–0.93)	0.921 (95% CI = 0.90–0.93)	0.929 (95% CI = 0.91–0.94)
3	0.915 (95% CI = 0.89–0.93)	0.927 (95% CI = 0.91–0.94)	0.938 (95% CI = 0.91–0.95)
4	0.917 (95% CI = 0.89–0.93)	0.933 (95% CI = 0.91–0.95)	0.945 (95% CI = 0.91–0.97)
5	0.920 (95% CI = 0.90–0.93)	0.938 (95% CI = 0.91–0.95)	0.952 (95% CI = 0.90–0.98)

respectively. For a 3-yr period (2001–2003), Randel et al. (2007) estimated nest success in the Edwards Plateau at 35% across both stable and declining regions. Cook (1972) estimated Rio Grande wild turkey nest success at 39% on the Edwards Plateau from 1968 through 1971. However, the methods (incidental locations) used by Cook (1972) to locate nests could have limited detectability of depredated nests, thus leading to overestimates of nest success. Both Reagan and Morgan (1980) and Hohensee and Wallace (2001) estimated nest success of 23% and 35%, respectively, in Texas (Edward Plateau and Rolling Plains, respectively), while Schmutz and Braun (1989) found 50% nest success for Rio Grande wild turkeys outside their original range in Colorado. Thus, Rio Grande wild turkey nest success from our study was significantly lower than most published estimates.

During our study, 2002–2006 were drought years, while 2001 and 2007 were characterized by unusually wet spring and summers (Collier et al. 2009). We recorded higher nest success, more renesting attempts and higher hen success during 2007 for both stable and declining regions. Recent work by Collier et al. (2009) found that hens nesting in stable areas had significantly higher breeding season survival than those in declining areas (88% vs. 67%, respectively). However, Collier et al. (2009) found no effect of drought on breeding season survival for females in our study region, but speculated that increased precipitation would lead to increased reproductive activities and, thus, potentially lead to reduced hen survival because exposure to predation during nesting activities would increase concomitant with increased reproductive activities. Hohensee and Wallace (2001) noted poor nest productivity during years characterized by less precipitation, while Beasom and Pattee (1980) speculated soil moisture related to late summer and early autumn rainfall was a key factor determining Rio Grande wild turkey production. Further, Schwertner et al. (2007) found the cumulative effects of precipitation over several months, rather than during any given month, was the best predictor of wild turkey production on the Edwards Plateau. Although a complex suite of weather variables undoubtedly influence annual wild turkey production (Porter and Gefell 1996), precipitation-driven dynamics of Rio Grande wild turkeys assuredly is important in semiarid regions such as the Edwards Plateau of Texas. Because of the environmental impacts on Rio Grande reproductive parameters in semiarid regions, it is important that studies encompass representative high and low annual variation in precipitation. Results of our study suggested lower reproductive parameters than other studies; however, most (2 of 3) years of our study took place during drought conditions.

Predation was the primary cause of nest failure in our study (Dreibelbis et al. 2008), accounting for two-thirds of total nest lost in the stable and declining regions. Cook (1972) noted nest predation accounted for 44% of all Rio Grande wild turkey nest failures on the Edwards Plateau, whereas Reagan and Morgan (1980) documented that 56% of nests were predated. We found little difference in predation rates between regions; however, because two-thirds of nest failed due to predation, nest predation may be more important than previously documented.

MANAGEMENT IMPLICATIONS

We suggest the decline in abundance of Rio Grande wild turkeys on the southeastern Edwards Plateau likely is due to a combination of lower breeding potential and high nest predation rates (Dreibelbis et al. 2008). Because the semiarid environment in Texas is stochastic, Rio Grande wild turkey populations likely will continue to undergo boom–bust cycles, but the bust years could be dampened via habitat maintenance. The oak–juniper savannah of the Edwards Plateau is a disturbance-maintained environment (Fuhlendorf et al. 2008); thus, we suggest that land management practices that increase useable nesting cover, such as brush management and prescribed fire, would reduce both hen predation rates and nest loss and, hence, assist with limiting the negative effects of environmental variation.

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