Evaluating 2 Potential Limiting Factors for Relocated Turkeys in Texas

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Abstract: Relocated eastern wild turkeys *(Meleagris gallopavo silvestris)* have been increasing in northern Post Oak Savannah (POS) of Texas. However, it has been difficult to establish populations in the southern POS where mortality is high and reproductive success low. It has been proposed that high spring precipitation and high carnivore numbers account for poor population viability in the southern POS. We found that spring precipitation (1994–1995 nesting seasons) was not above the historic average (1950–1993), nor did unusually high rainfall events occur. These data suggest that spring precipitation might not account for low reproductive success of relocated wild turkeys in southern POS. Furthermore, carnivore indices for northern and southern counties (spotlight census data—7,658 km, 1980–1994) were 74 carnivores/100 km and 51 carnivores/100 km, respectively. We also reject the hypothesis that carnivore numbers were greater in the southern POS than in the northern POS. However, we propose, despite higher carnivore numbers observed in the northern POS, predator efficiency might be greater in the southern POS due to unsuitable nesting and brood-rearing habitat for turkeys.

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Historically, the Pineywoods (PW) and POS regions of eastern Texas supported viable turkey populations (Fig. 1, Newman 1945, Gould 1975, Lincecum and Phillips 1994). In 1942, wild turkey numbers declined to an estimated 100 birds in the PW

and POS due to overharvest and habitat loss. During the 1970s, large numbers of pen-reared wild turkeys were released by the Texas Parks and Wildlife Department (TPWD) in east Texas with poor success (M. J. Peterson, TPWD, unpubl. data). In 1979 and 1980, wild-trapped eastern turkeys from Louisiana and Mississippi were released successfully into 2 sites in the PW (Campo 1983). This demonstrated the importance of using wild-trapped turkeys for the restoration program. Since 1987, TPWD has obtained increasing numbers of wild-trapped eastern turkeys and released them into apparently suitable restoration areas in east Texas. Initial efforts were concentrated in the PW. More recently, these efforts expanded into the POS. During this period, restoration success was variable (M. J. Peterson, TPWD, unpubl. data). Specifically, population surveys indicated increasing turkey numbers in the northern POS (M. J. Peterson, TPWD, unpubl. data) whereas it has been difficult to establish populations in the southern POS (Lopez et al. 1998).

During 1994–1995, a radio-telemetry study conducted to determine survival and reproduction of relocated wild turkeys in the southern POS (Lopez et al. 1998) found high adult mortality and low reproductive success. Opinions by turkey biologists held that high spring precipitation and carnivore numbers account for these results. We evaluated 2 possible causes for these results: (1) spring precipitation during the 1994–1995 nesting seasons in the southern POS was above average or adversely distributed (i.e., were "wet" years) and (2) carnivore numbers were greater in southern POS compared to the northern POS where turkey numbers increased.

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Methods

Study Areas

The POS region of Texas is wedged between the Pineywoods on the east, Blackland Prairies on the west, and Coastal Prairies on the south (Fig. 1, Gould 1975). Annual rainfall is 89–114 cm, with highest rainfall in May (Gould 1975). This area is characterized by open stands of post oak *(Quercus stellata),* blackjack oak *(Q. marilandica),* and black hickory *(Carya texana)* on upland sites. Currently, dense brush understories have increased in southern counties due to long-term, heavy grazing pressure and fire suppression. The primary invasive brush species is yaupon *(Ilex vomitoria),* which is not cold tolerant and is not as prevalent in northern counties (M. J. Peterson, TPWD, unpubl. data). Bottomland species include water oak *(Q. nigra),* willow oak *(Q. phellos),* American elm *(Ulmus americana),* cedar elm *(U. crassifolia),* and overcup oak *(Q. lyrata)* (Allen 1974, Gould 1975). Bottomland habitats are relatively similar to historic conditions (Allen 1974). Four release sites within 100

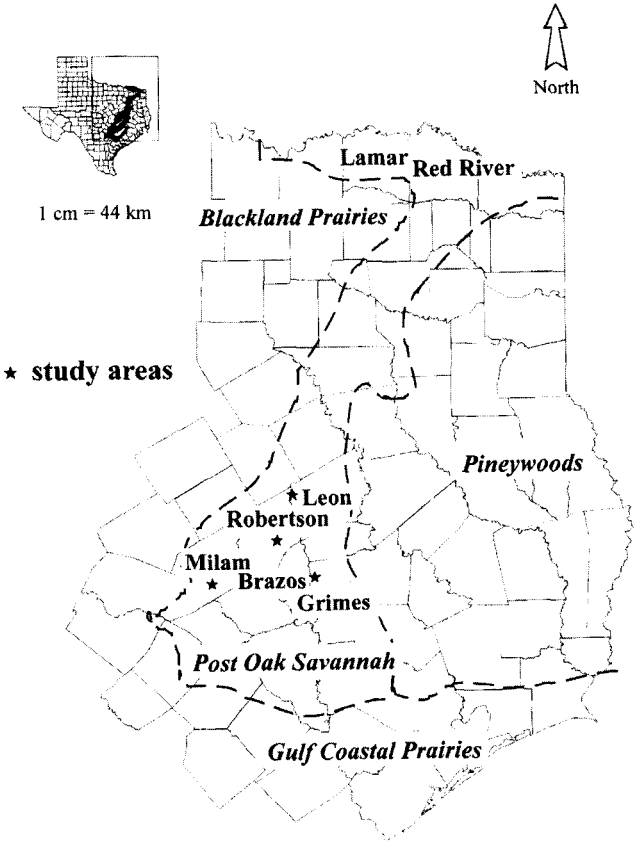

Figure 1. Selected counties used in comparing northern and southern Post Oak Savannah (POS). Ecological regions are denoted by dashed lines (adapted from Gould 1975).

km of Bryan, Texas, were selected by TPWD in the southern POS. These sites were in Robertson, Leon, Milam, and Grimes counties (Fig. 1, Lopez 1996).

Spring Precipitation

We obtained precipitation data from College Station (38 km from TMPA release) (1953–1992), Franklin (16 km from Camp Creek release) (1964–1993), Rockdale (9.6 km from ALCOA release) (1964–1993), and Jewett (29 km from Limestone release) (1950–1988) weather stations. Historical precipitation data (10 Apr–30 May 1950–1993) were compared with rainfall data obtained during the peak nesting season (10 Apr–30 May) from the 4 release sites during 1994–1995 nesting periods (Lopez et al. 1997). The Shapiro-Wilk (W) statistic (SAS Inst. 1985) was used to determine if precipitation was normally distributed. Rainfall events exceeding 0.25 and 2.54 cm were categorized during this period (i.e., number of days in which greater rainfall observed). Total rainfall (cm) also was tabulated.

We compared 1994–1995 precipitation data to historic data using a *Z*-statistic to calculate rainfall probabilities (Ott 1993). We defined an extreme rainfall event (i.e., "wet") as values that fell in the upper quartile. For example, if the historic mean for rainfall events >2.54 cm was 5.2, and the actual number of rainfall events observed during the 1995–1995 nesting season was 6, then a *Z*-value was calculated ($[-u/\sigma$, Ott 1993) and event probability determined from a normal distribution table. Rainfall events (1994–1995) with $P<0.25$ occurred in the upper quartile (i.e., were "wet" years).

Carnivore Numbers

We obtained annual carnivore indices (Texas Parks and Wildl. Dep. 1980–1994) for northern (Lamar and Red River) and southern (Brazos, Burleson, Grimes, Leon, Limestone, Madison, Milam, and Robertson) counties in the POS Region (Fig. 1). These indices (carnivores/100 km by county) were obtained from standardized TPWD spotlight counts along 24.1 km of predetermined road surveyed 1 hour after sunset each June (Texas Parks and Wildl. Dep. 1980–1994). A total of 7,658 km were compared (south 2,153 km, north 5,504 km). Average transect visibility between northern and southern POS was similar and representative of the regions surveyed.

The mean number of carnivores between regions by 5-year period (i.e., 1980–1984, 1985–1989, 1990–1994) was determined and compared using an ANOVA (Ott 1993). The mean number of carnivores between regions during the past 15 years (1980–1994) also was compared using an ANOVA. Carnivores surveyed include raccoon *(Procyon lotor),* opossum *(Didelphis virginiana),* striped skunk *(Mephitis mephitis),* gray fox *(Urocyon cinereoargenteus),* coyote *(Canis latrans),* and bobcat *(Lynx rufus).*

Results

Spring Precipitation

We found historical precipitation data were normally distributed ($W=0.83$). Spring precipitation (1994–1995 nesting seasons) was not different ($P=0.36$–0.48) from historical data (Table 1). Test results suggest rainfall observed during the 1994–1995 nesting season was average.

Carnivore Numbers

The structures of the carnivore communities surveyed in the northern and southern POS were similar (Table 2). Carnivore indices for northern counties were higher than or similar to (1980–1984, $F=2.41$, 1 df, $P=0.129$; 1985–1989, $F=1.34$, 1 df, $P=0.254$; 1990–1994, $F=7.14$, 1 df, $P=0.010$; 1980–1994, $F=11.13$, 1 df, $P=0.001$) carnivore indices for southern counties (Fig. 2).

Table 1. Spring precipitation by amount for the southern Post Oak Savannah,[b] 1950–1995.

Rainfall amount	1950–1993 $\bar{x}$	SD	95% CI	1994 season	1995 season	1994bc z	1995bc z
Alcoa[a]							
Days >0.25 cm	12.1	3.0	1.09	13.0	10.0	0.300 (0.38)	
Days >2.54 cm	5.2	2.1	0.76	4.0	5.0		
Total rainfall (cm)	19.3	8.1	2.95	12.7	19.8		0.062 (0.48)
Camp Creek[a]							
Days >0.25 cm	12.5	3.6	1.31	13.0	9.0	0.139 (0.44)	
Days >2.54 cm	5.3	2.0	0.73	5.0	6.0		0.350 (0.36)
Total rainfall (cm)	19.6	9.1	3.31	17.4	18.1		
Lake Limestone[a]							
Days >0.25 cm	11.0	3.5	1.27	10.0	11.0		
Days >2.54 cm	5.1	1.9	0.69	6.0	5.0	0.053 (0.48)	
Total rainfall (cm)	19.3	8.9	3.24	19.8	19.0	0.062 (0.48)	
TMPA[a]							
Days >0.25 cm	12.8	3.6	1.13	13.0	10.0	0.056 (0.48)	
Days >2.54 cm	4.7	2.0	0.63	4.0	4.0		
Total rainfall (cm)	19.3	8.4	2.64	14.4	16.6		

a. Rockdale weather station (9.6 km from Alcoa release) (1964–1993); Franklin weather station (16 km from Camp Creek release) (1964–1993); Jewett weather station (29 km from Limestone release) (1951–1988); College Station weather station (38 km from TMPA release) (1953–1992).

b. z-value (one-tail) for given year calculated from historical data if 1994 or 1995 event above average.

c. Probability (in parenthesis) of similar ($\geq$) event (1994 or 1995) occurring.

Table 2. Proportion (%) of carnivores surveyed between northern (N = 1,354) and southern (N = 1,878) Post Oak Savannah based on spotlight indices,[a] 1980–1994.

Predator	Northern[b] (%)	Southern[b] (%)
Raccoon	71	72
Virginia opossum	9	6
Skunk	12	13
Fox	1	1
Coyote	5	6
Bobcat	1	1
Other[c]	1	1
Total	100	100

a. Texas Parks and Wildlife Department (1980–1994).

b. Northern=Lamar and Red River counties; southern=Brazos, Burleson, Grimes, Leon, Limestone, Madison, Milam, and Robertson counties.

c. Other includes nest predators occurring in low numbers (e.g., ringtail cat, *Bassariscus astutus*).

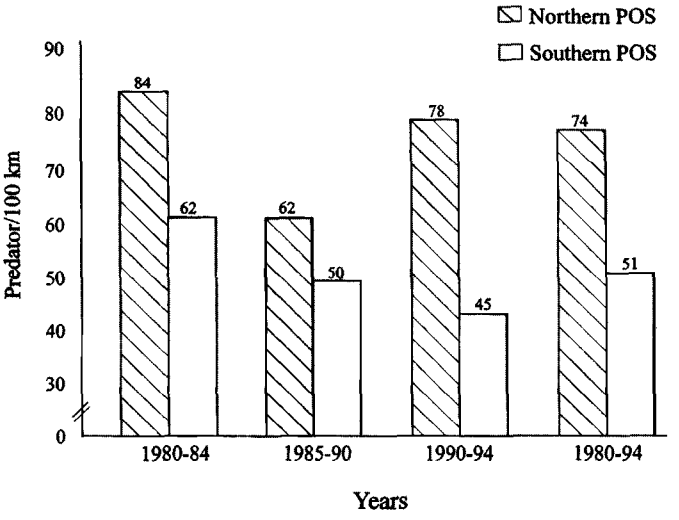

Figure 2. Carnivores seen per 100 km of spotlight road census in southern and northern Post Oak Savannah, 1980–1994.

Discussion

Wildlife managers need to correctly identify factors limiting the success of relocated populations so release site selections can be reevaluated or corrective management efforts made. Some researchers maintain that high spring precipitation might limit wild turkey population growth by increased predation risk to incubating hens (Williams et al. 1968, Speake et al. 1969, Everett et al. 1980). It is hypothesized that spring precipitation increases the ability of predators to smell and detect incubating hens ("wet" hen hypothesis, Healy 1992). Further, Markley (1967) and Healy (1992) suggested spring weather affected hen and poult success when birds were exposed to severe weather patterns (i.e., high rainfall). We found spring precipitation during the 1994–1995 nesting seasons was average (note: precipitation data were normally distributed; therefore, the average also equals the mode or most frequently occurring rainfall event), suggesting such conditions in east Texas are the norm and should be expected in future years. For this reason, we reject the idea that abnormally high spring precipitation during the 1994–1995 nesting seasons was observed. We also suggest the observed reproductive failure in the southern POS was not solely due to climate.

Predation on wild turkeys is well documented (Markley 1967, Speake 1980, Miller and Leopold 1992) and has been reported to depress or limit survival and growth of some populations (Speake 1980, Miller and Leopold, 1992). In our study, we found nearly twice as many carnivores were observed in the northern POS, where turkey populations have been established, than in southern POS where restoration efforts typically failed. Therefore, predation potential in northern POS is similar or

greater than in southern counties. Furthermore, turkey population surveys demonstrated that turkey losses were offset by vigorous recruitment in northern counties (M. J. Peterson, TPWD, unpubl. data), while it was absent (0%) in the southern counties (Lopez et al. 1997). Therefore, we reject the idea that greater carnivore numbers in the southern POS led to reproductive failure on these study areas.

Despite higher carnivore numbers in the northern POS, nest and brood predation might be greater in the southern POS due to unsuitable nesting and brood-rearing habitat. Numerous studies have reported that predator efficiency increases as suitable nesting and/or brood-rearing habitat declines (i.e., predation risk increases where prey are concentrated) (Lack 1968, Bergerud and Gratson 1988, Martin 1993, Badyaev 1995). It is possible that nesting and brood habitat are different between northern and southern POS because of encroaching brush and decreasing native pastureland from north to south (M. J. Peterson, TPWD, unpubl. data). We recommend that data on nesting and brood-rearing habitat availability, in light of carnivore numbers, be compared between northern and southern POS to determine if they can explain differential reproductive success between the 2 areas.

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