Survival and Reproduction of Eastern Wild Turkeys Relocated into the Post Oak Savannah of Texas

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Abstract: Relocated (N = 76) eastern wild turkeys (*Meleagris gallopavo silvestris*) were released into the Post Oak Savannah of Texas in winters 1994 and 1995. Before release, each bird was fitted with a radio transmitter and numbered leg band. Mortality and reproduction were monitored through 1996 to determine survival and reproduction. First-year annual survival rates for gobblers and hens was 0.286 and 0.484, respectively. One of 4 study areas lost all gobblers within the first year. Mammalian predation (63.4%) was the primary cause of mortality. High post-release mortality was attributed to habitat unfamiliarity. Poult survival 2 weeks post-hatch was 0, resulting in the lowest reproductive success reported for this subspecies. Low reproductive success is attributable to unsuitable nesting and brooding habitat.

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In 1942, wild turkey numbers were estimated to be less than 100 birds in the Pineywoods and Post Oak Savannah of eastern Texas (Newman 1945, Gould 1975). Initial restoration efforts within these areas using wild-trapped Rio Grande (*M. g. intermedia*) and pen-raised turkeys were unsuccessful (Newman 1945, Mosby 1975). In the early 1950s, development of the cannon-net technique allowed the efficient

capture and relocation of the eastern subspecies in many state restoration programs. In 1979 and 1980, wild-trapped eastern turkeys from Louisiana were released into 2 sites in the Pineywoods, resulting in a successful release (Campo 1983). This indicated that the Texas Parks and Wildlife Department could use wild-trapped eastern birds for its restoration program. Recent success by Texas Parks and Wildlife Department in obtaining wild-trapped eastern broodstock from other states has accelerated the restoration program in Texas (Campo et al. 1984, Kennamer and Kennamer 1990). Initial restoration efforts were in the Pineywoods and recently these efforts have expanded into the Post Oak Savannah which is the western limit (Fig. 1) of the eastern turkey's historical range (Newman 1945, Gould 1975, Campo et al. 1984).

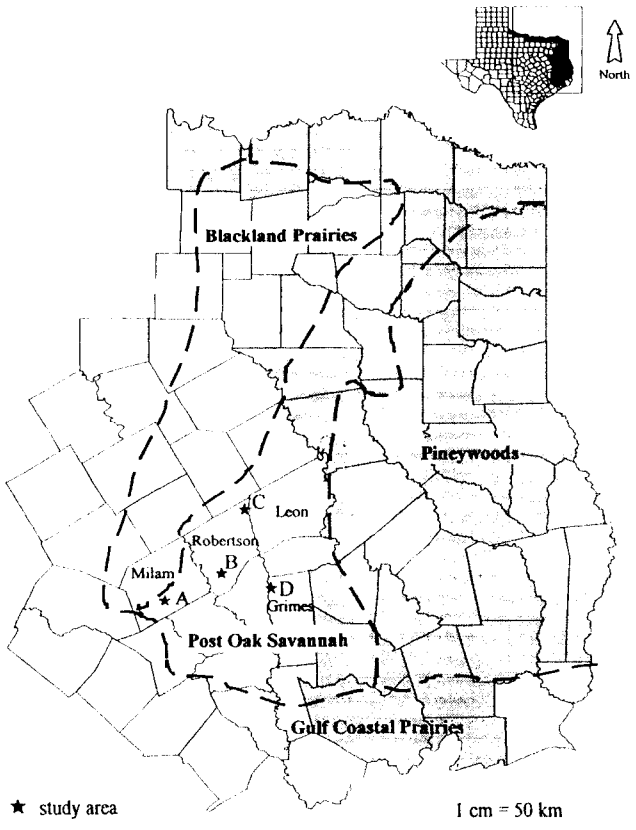

Figure 1. Historical range (shaded) of eastern wild turkeys in eastern Texas by county and study sites: A=Alcoa, B=Camp Creek, C=Limestone, and D=TMPA (adapted from Newman 1945). Ecological regions are denoted by dashed lines (adapted from Gould 1975). *Note:* The division between the range of the Rio Grande and eastern sub-species of wild turkeys is uncertain.

Numerous studies have been conducted on restocked populations within the historical range of the eastern wild turkey (Little and Varland 1981, Vangilder et al. 1987, Miller 1990) including studies in the Pineywoods (Hopkins 1981, Campo 1983). However, studies of the survival and reproduction of eastern turkeys relocated into the Post Oak Savannah are lacking. In addition, restocked birds used in the Pineywoods studies were from southeastern states (Hopkins 1981, Campo 1983), whereas the majority (approximately 88%) of birds currently being released into the Post Oak Savannah (including all birds released in this study) are from Iowa or other mid-western states. These birds were relocated into habitats which are different from their native range or habitat. The objective of our study was to evaluate survival and reproduction of eastern wild turkeys relocated into the Post Oak Savannah.

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Methods

Study Area

The Post Oak Savannah (Fig. 1) is wedged between the Pineywoods on the east, Blackland Prairies on the west, and Coastal Prairies on the south. This area is characterized by open stands of post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*) on upland sites. Currently, dense brush understories have increased due to long-term heavy grazing pressures and fire suppression (Allen 1974). The primary invasive brush species is yaupon (*Ilex vomitoria*), which forms dense understory stands with the majority of the shrub's canopy between 1 and 5 m above ground (J. Yantis, Texas Parks and Wildlife Department, pers. commun.). 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. Four study areas were selected by Texas Parks and Wildlife Department biologists as release sites (selection criteria—landowner cooperation, property size, and general habitat characteristics) within the Post Oak Savannah, and within 100 km of Bryan, Texas, in Robertson, Leon, Milam, and Grimes counties (Fig. 1). These 4 study areas were typified of areas found in the Post Oak Savannah.

Radio Tagging

In winter 1994 (26 Jan), 62 eastern wild turkeys (14 adult males, 32 adult females, 16 juvenile females) were captured and released into 4 study areas under the direction of Texas Parks and Wildlife Department biologists. An additional 14 gobblers (12 adults, 2 juveniles) were released the following year (22 Jan 1995). All birds were fitted with a battery-powered radio transmitter (150–152 MHz, 115 g, Advanced Telemetry Systems, Inc. Isanti, Minn.) and Texas Parks and Wildlife Department numbered leg bands. Radio transmitters were <3% of body mass and equipped with a mortality switch adjusted for 12-hour delay so that no mortality signal was emitted during incubation. Transmitters were attached using a shock-cord harness (Am. Cord & Webbing Co., Woonsocket, R.I.; Williams et al. 1968), and birds were aged and sexed (Pelham and Dickson 1992).

Radio-tagged birds were monitored 2–4 times per week from January 1994–1996 as time permitted via triangulation (White and Garrott 1990). Mortality signals were immediately followed by walk-ins to determine cause of death from evidence at recovery sites. Carcasses with sufficient remains ($N = 2$) were submitted for necropsy to the Texas Veterinary Medical Diagnostic Laboratory, College Station.

Survival

We used the Kaplan-Meier estimator modified for staggered entry (Pollock et al. 1989) to calculate survival rates (S) and distributions by study area, sex, and age-class. Annual survival rates were based on a 365-day period beginning 26 January 1994. Birds surviving more than a year were censored and readmitted the following year. Survival rates and standard errors were calculated using a SAS (SAS Inst. 1985) program (White and Garrott 1990).

We used the log-rank test (Pollock et al. 1989) to determine differences among annual survival distributions by study area, sex, and age-class. Further, differences among annual survival rates by study area, sex, and age-class were tested using a Z-test statistic (Pollock et al. 1989). The experiment-wise error rate ($\alpha = 0.05$) was controlled during multiple comparisons (i.e., study area) by adjusting the error rate to $P = 0.01$ (Ott 1993).

Mortality losses were categorized into groups from field evidence (e.g., carcass condition, tracks, etc.): predation (avian, mammalian), poached, unknown, and other (roadkill, censored, trapstress). Categories were compared ($P = 0.05$) to determine if mortality rates in each group were equal using a Chi-square goodness-of-fit test (Ott 1993).

Reproduction

Reproductive parameters (nest and renest attempts, nest success, hen success, and poult success) were collected using standard methods (Glidden and Austin 1975, Vangilder et al. 1987, Vangilder and Kurzejeski 1995). We defined nest attempts as

the percentage of hens in the population on 1 April which initiated incubation (did not include renests). Renests were the percentage of hens in the population on 1 April which initiated incubation of a second clutch. We defined nest success as the percentage of incubating females which were successful (at least 1 egg hatched). Hen success was defined as the percentage of hens in the population on 1 April which were ultimately successful (at least 1 egg hatched). We defined poult success as the percentage of hatched poults that survived 2 weeks post-hatch. We tested for differences ($P = 0.05$) in nest attempts, nest success, and hen success among years and between age classes using Chi-square tests.

Results

Survival

Forty-one birds (27 females, 14 males) died during our study (26 Jan 1994–1996) with 33 birds surviving. We censored 2 females (1 juvenile, 1 adult) due to transmitter failure. We found first-year annual survival distributions and rates between males ($S = 0.286$, SE = 0.121, $N = 14$) and females ($S = 0.484$, SE = 0.074, $N = 48$) differed (log-rank text, $\chi^2 = 11.752$, 1 df, $P < 0.001$; $Z = 7.625$, $P < 0.001$), with hens having greater survival (Fig. 2). In comparing first-year annual survival distributions and rates for females between study areas, we failed to detect a

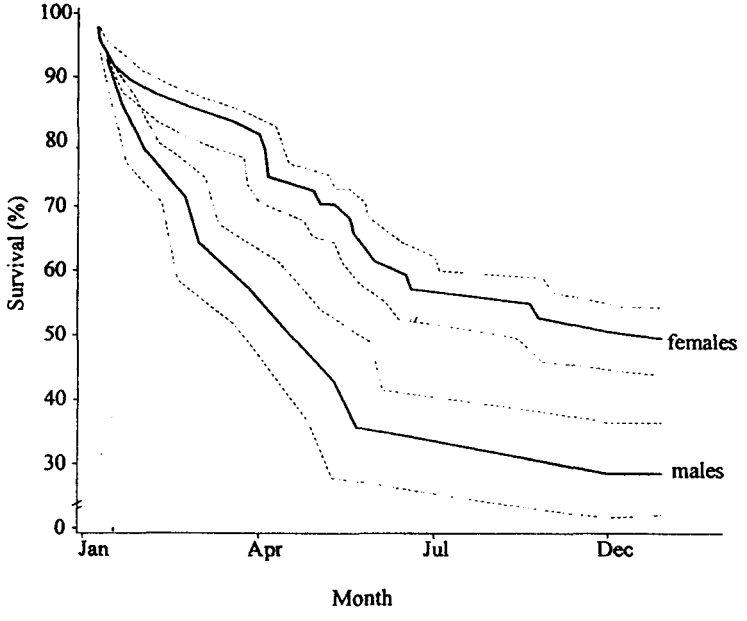

Figure 2. First-year survival of eastern wild turkeys relocated into eastern Texas by sex, 1994–1995. Dashed lines indicate 95% confidence interval.

difference (log-rank text, $\chi^2 = 2.673$, 3 df, $P = 0.445$; $Z = 0.310$–1.734, $P = 0.042$–0.378) with the exception of Alcoa and Texas Municipal Authority ($Z = 2.450$, $P = 0.007$). Male survival between study areas was not compared due to our small sample size. We combined data for further analysis.

In comparing first-year survival distributions and rates by sex and age-class, we failed to detect a difference (log-rank test, $\chi^2 = 3.308$, 2 df, $P = 0.191$; $Z = 1.074$, $P = 0.1423$) in survival distributions and rates between female adults ($S = 0.375$, SE = 0.086, $N = 32$) and males ($S = 0.286$, SE = 0.121, $N = 14$). However, survival rates (Table 1) between female juvenile and female adults, and female juveniles and males differed ($Z = 2.292$, $P = 0.010$, $Z = 2.940$, $P = 0.002$, respectively). In both cases, female juvenile survival was higher. Approximately 48% of adult hens ($N = 12$) released were lost during the nesting season (15 Apr–15 Jun) the first year as compared to no losses for juvenile hens (Fig. 3).

Second-year survival for males ($S = 1.000$) and females ($S = 0.912$) was higher than first-year survival (Table 1). In comparing first-and second-year survival rates and distributions (both sexes combined), a difference (log-rank test, $\chi^2 = 11.752$, 2 df, $P < 0.001$; $Z = 7.625$, $P < 0.001$) was found. We observed higher survival for supplemental (i.e., birds released into areas with birds already present) males ($S = 0.714$, SE = 0.120, $N = 14$) than first-year males ($S = 0.286$, SE = 0.121, $N = 14$) (log-rank text, $\chi^2 = 4.025$, 1 df, $P = 0.045$; $Z = 3.615$, $P < 0.001$), which suggests supplemental releases may increase survival of relocated birds.

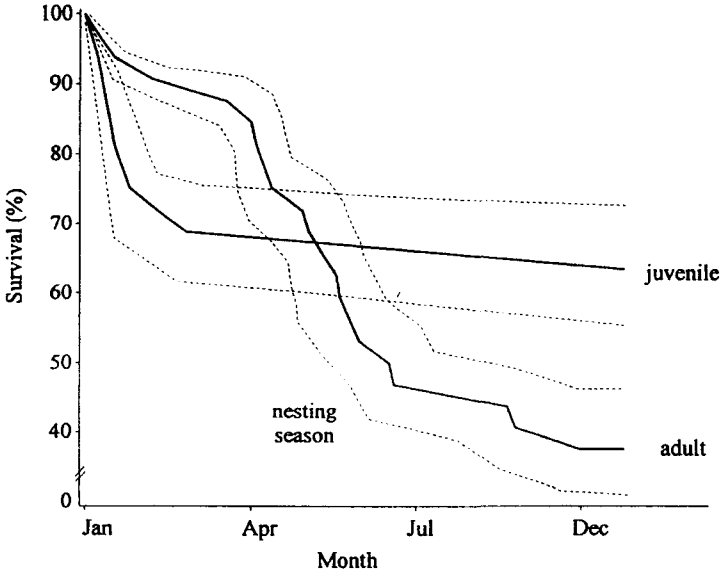

Figure 3. First-year survival of eastern wild turkey hens relocated into eastern Texas by age class, 1994–1995. Dashed lines indicate 95% confidence interval.

Table 1. Kaplan-Meier estimates of annual survival rates (*S*) by study area for relocated wild turkeys in eastern Texas, 26 January 1994–1996.

	Study Area													
	Alcoa			Camp Creek			Limestone			TMPA			Pooled		
	S	SE[a]	*N*	*S*	SE	*N*	*S*	SE	*N*	*S*	SE	*N*	*S*	SE	*N*
First-year															
Females	0.273	0.134	11	0.417	0.142	12	0.500	0.134	14	0.636	0.145	11	0.484	0.074	48
Adult	0.333	0.157	9	0.250	0.153	8	0.556	0.166	9	0.429	0.187	7	0.375	0.086	32
Juvenile	0.000	—	2	0.750	0.217	4	0.400	0.219	5	1.000	—	4	0.625	0.121	16
Males	0.400	0.219	5	0.000	—	3	0.333	0.272	3	0.333	0.272	3	0.286	0.121	14
Total															62
Second-year															
Females	0.667	0.272	3	1.000	—	5	0.857	0.132	7	1.000	—	7	0.913	0.059	22
Males[b]	1.000	—	2			0	1.000	—	1	1.000	—	1	1.000	—	4
Total															26

[a] Lines (—) indicate standard errors could not be calculated due to insufficient sample size or zero mortality.

[b] Male survival estimates do not include supplemental birds released in 1995.

Mammalian predation accounted for most mortality (63.4%, $N = 26$), followed by unknown (14.6%, $N = 6$), poached (9.8%, $N = 4$), censored (4.9%, $N = 2$), roadkill (2.4%, $N = 1$), trap stress (2.4%, $N = 1$), and avian predation (2.4%, $N = 1$). Test results suggest mammalian predation was more frequent ($\chi^2 = 88.435$, 6 df, $P < 0.001$). Suspected predators in most instances were bobcats (*Felis rufus;* $N = 13$) and canids (*Canis* spp.; $N = 6$). No distinction was made in separating domestic and feral canids.

Reproduction

We found no difference in nest attempts (Table 2) among years ($\chi^2 = 1.750$, 1 df, $P = 0.186$) and between age classes ($\chi^2 = 0.040$, 1 df, $P = 0.842$). Mean nest incubation dates were 16 May (range 1 May–6 June) and 8 May (range 23 Apr–19 Jun) for first-and second-year nest attempts, respectively. Due to our high female mortality resulting in a small sample size, nest and hen success could not be compared between years and age classes.

Discussion

Survival

Wild turkeys relocated into the Post Oak Savannah had low first-year survival, particularly males. First-year male survival was lower than reported by Campo et al. (1984) for gobblers relocated (0.712) into the Pineywoods. Three of 4 study areas had ≤ 1 gobbler by the end of the first year, suggesting the number of gobblers released by Texas Parks and Wildlife Department (12 hens/3 gobblers per release site)

Table 2. Reproduction of eastern wild turkeys relocated into the Post Oak Savannah of Texas, April–June 1994–1995.

Year/ Reproductive effort	Juvenile		Adult		Total	
	N	%	*N*	%	*N*	%
First-year						
Total hens (on 1 Apr)	14	100	28	100	42	100
Nest attempts	4	29	14	50	18	43
Renesting attempts	0	0	0	0	0	0
Nest success	1	25	4	29	5	28
Hen success	1	7	4	14	5	12
Poult success[a]	0	0	0	0	0	0
Second-year						
Total hens (on 1 Apr)			22	100	22	100
Nest attempts			10	45	10	45
Renesting attempts			2	9	2	9
Nest success			3	30	3	30
Hen success			3	14	3	14
Poult success[a]			0	0	0	0

a. Poult survival 2 weeks post-hatch.

b. All hens adult in 2nd-nesting season (1995).

may be insufficient for the Post Oak Savannah. We recommend increasing the number of males to 5 (Lopez, unpubl. data) for future releases (suitable sites only).

First-year hen (juvenile and adult) survival ($S = 0.484$) was slightly lower than rates (range 0.580–0.676) reported by Campo et al. (1984) for relocated populations in the Pineywoods. Porter (1978), Vander Haegan et al. (1988), and Little et al. (1990) reported differential survival of adult and juvenile wild turkey hens. In contrast, Kurzejeski et al. (1987), Roberts et al. (1995), Vangilder and Kurzejeski (1995), and Wright et al. (1996) found no difference in survival between adult and juvenile birds. In our study, first-year adult hen survival ($S = 0.375$) was lower than in east Texas (Campo et al. 1984). Conversely, first-year juvenile hen survival ($S = 0.625$) was significantly higher than adult hen survival. The higher survival observed for juvenile hens in our study has not been reported for other southeastern populations; however, this could be attributed to small sizes.

Approximately 48% of first-year adult hen mortality occurred during the nesting season in contrast to 0% for juvenile hens. A combination of factors may explain higher adult hen losses. Increased movements by adults during the nesting season may be costly in terms of energy loss, and may increase bird susceptibility to predation. At the same time, habitat unfamiliarity also may magnify susceptibility to predation (Miller et al. 1985, McGuiness et al. 1990, Miller 1990). Conversely, adult hens are considered to be most vulnerable to predation during egg incubation and 2-weeks post-hatch (Speake et al. 1969). Thus, a higher number of adult hens attempting to nest would make them more susceptible to predation compared to juvenile hens.

We found second-year survival rates for relocated birds to be higher than first-year survival rates. This difference in survival among years suggests habitat unfamiliarity (i.e., predator learning/avoidance) was a major factor influencing survival for relocated turkeys. All birds released during our study were from Iowa or other midwestern states. These birds were relocated into habitats (forested/rangeland) which were much different from their native range or habitat (wooded riparian/agriculture land). Other restocking studies report high post-release mortality (McMahon and Johnson 1980, Miller 1990, McGuiness et al. 1990). In eastern Texas, Hopkins (1981) reported 73% of annual mortality occurred 6 months post-release. In our study, we documented 100% and 79% of male and female annual mortality, respectively, to occur 6 months post-release (85% combined).

Predation was the primary cause of mortality for both males and females in our study (63.4%). We hypothesize wild turkeys are naive to common predators (i.e., bobcats) which are absent or low in density in Iowa farmlands (D. Garner, Iowa Department of Natural Resources, pers. commun.). Furthermore, habitat unfamiliarity and/or poor habitat conditions may have increased risk of predation by increased bird movements. Predation also has been identified as being a major cause of mortality in other studies (Everett et al. 1980, Vander Haegen et al. 1988, Little et al. 1990, Palmer et al. 1993, Vangilder and Kurzejeski 1995). Although poaching has been reported as a major factor in turkey losses (Kurzejeski et al. 1987, Little et al. 1990), it had less impact (10%) in our study. We propose predation to be limiting the survival of relocated birds in the Post Oak Savannah.

We found higher survival for supplemental males than first-year males which suggests supplemental releases may increase survival of relocated birds. The utility of supplemental releases may be beneficial by providing release strategies which may increase the number of birds surviving 1 year post-release thus maximizing the efficiency of wild turkey restoration efforts. For example, if short-term survival increases with the use of supplemental stockings (i.e., more birds surviving to 2nd and 3rd year), and greater reproductive success is observed with these resident birds (>1 year post−release), then reproductive output would be maximized (i.e., higher recruitment/bird released). However, these preliminary findings are restricted to male survival and 1 year of data collection in our study. Information on the effectiveness of supplemental releases for wild turkeys is limited (Campo 1983, Backs and Eisfelder 1990, C. Feuerbacher, TAMU, unpubl. data) and the utility of this stocking strategy warrants further investigation.

Reproduction

Nesting for both adults and juveniles (43%) in our study was lower than rates reported by Campo et al. (1984) (79%–96%) in the Pineywoods. Renesting in our study for first-and second-year birds was 0% and 9%, respectively. Rates were much lower than those (47%) reported by Campo et al. (1984). Lutz and Crawford (1987), however, documented renesting for both adults and juveniles to be 0% for Merriam's wild turkey (*M. g. merriami*) in Oregon.

First-year nest success was 25% (juvenile) and 29% (adult) in our study. Rates were slightly lower than reported by Campo et al. (1984) for restocked populations (40%–46%). Hen success rates (45%–70%) reported by Campo et al. (1984) were higher than those documented in our study (7%–14%). Hens suspected of hatching a clutch ($N = 8$) for both years lost all of their poults within 2 weeks post-hatch. Other studies (Glidden and Austin 1975, Campo et al. 1984) document 2-week post-hatch mortality to be 35%–88% for restocked populations.

We believe suitable nesting and brood habitat may be limited in the Post Oak Savannah, resulting in the high nest predation and low nest/poult success observed in our study. It is hypothesized that predator efficiency increases as suitable nesting and brood habitat declines (i.e., predation risk increases where prey are concentrated: Haensly et al. 1987, Martin 1993, Badyaev 1995). In addition, it also has been suggested that habitat patterns (i.e., small patches, edges) serve as travel lanes for predators (Horkel et al. 1978, Haensly et al. 1987, Martin 1993), which results in higher predation risk.

Historically, the Post Oak Savannah was in constant transition from prairie to savannah to forest as a result of wildfires (Allen 1974). However, within the last 50 years, this open savannah has reverted to dense woodlands with stands of yaupon understories due to fire suppression and heavy grazing (McCaleb 1954, Allen 1974). Typically, the canopy of yaupon is between 1 and 5 m above ground, which would not provide suitable nesting cover or brood habitat. As a result, forested areas have little or no herbaceous understories (height 0–1 m). Moreover, pasturelands are either heavily grazed or mowed for hay during the nesting season. For these reasons, we believe nesting and brood habitat is limited in this area.

Management Implications

The high mortality and low recruitment for relocated wild turkeys observed in our study may explain the variable success in Texas Parks and Wildlife Department's restoration program. In the past, state biologists have preferred adult birds in restoration efforts because of expected higher first-year hen success. However, our results suggest that juvenile hens may be preferred when high-nest predation is expected. Increasing survival of hens to the second year when habitat familiarity improves may increase the cost effectiveness of restoration programs. In addition, supplemental stockings may allow survival of relocated birds to increase. However, increasing reproductive success may be more difficult.

We propose nesting and brood habitat is limiting the growth of our population. We recommend that criteria used in the selection of future release sites should include the amount of suitable nesting and brood habitat available. Plant successional stages (dense lateral and brood cover, height 0–1 m) selected by wild turkeys can be increased and maintained by prescribed fire (3–5 years) and light to moderate grazing practices. Initially, dense yaupon understories may be reduced by mowing, and then maintained with mechanical treatments (i.e., mowing every 2–3 years) or prescribed fire (3–5 years). We recommend such activities should be delayed until after the peak hatching period (mid-June) to avoid disturbing nesting hens.

Overall, we recommend only release sites with suitable nesting and brood-rearing habitat be considered in future releases in the Post Oak Savannah. Stocking of wild turkeys into unsuitable habitat should be avoided.

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