

Survival of Rio Grande Wild Turkeys on the Edwards Plateau of Texas

BRET A. COLLIER,¹ Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

DUSTIN A. JONES,² Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

JODY N. SCHAAP,³ Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

CHARLES J. RANDEL, III,⁴ Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

BEAU J. WILLSEY,⁵ Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

RAY AGUIRRE, Texas Parks and Wildlife Department, Comfort, TX 78013, USA

T. WAYNE SCHWERTNER, Texas Parks and Wildlife Department, Mason, TX 78013, USA

NOVA J. SILVY, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

MARKUS J. PETERSON, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843, USA

ABSTRACT The southeastern portion of the Edwards Plateau of Texas, historically a stronghold of Rio Grande wild turkeys (*Meleagris gallopavo intermedia*), has seen a decline in turkey numbers since the 1970s. Because adult and juvenile survival are key parameters affecting turkey population dynamics, we used radiotagged individuals to compare Rio Grande wild turkey survival in areas of suspected decline versus stable portions of the Edwards Plateau during 2001–2003. Reproductive period (breeding or nonbreeding) had an impact on survival, but differences in age, sex, or region did not influence survival. Model averaged estimates of monthly survival were 0.97 (SE = 0.005) for nonbreeding periods and 0.96 (SE = 0.007) for breeding periods. Our results indicate juvenile and adult survival in the declining areas was similar to survival in the stable areas of the Edwards Plateau. This suggests causes of the decline might be associated with differences during other life-history stages, such as nest success or poult survival, although we cannot rule out the possibility juvenile or adult survival contributed to the decline in the past. This situation demonstrates why wildlife managers should be cognizant of the implications of initiating long-term monitoring programs after changes in population status occur, rather than initiating them in expectation of such changes. (JOURNAL OF WILDLIFE MANAGEMENT 71(1):82–86; 2007)

DOI: 10.2193/2005-751

KEY WORDS abundance, Edwards Plateau, *Meleagris gallopavo intermedia*, population decline, radiotelemetry, Rio Grande wild turkey, survival, Texas.

Restoration of Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) throughout the United States relied on initial translocations from Texas populations (Beasom and Wilson 1992). Historical data suggest Rio Grande wild turkey numbers peaked presettlement at between 1.8 million and 2 million individuals. While Rio Grande wild turkeys were extirpated throughout much of their original range by the 1920s, and the Texas population fell to $\leq 100,000$ individuals (Beasom and Wilson 1992), the stronghold of Rio Grande wild turkeys consistently was the Edwards Plateau of central Texas (Walker 1954, Gould 1975). Since the 1970s, however, surveys by Texas Parks and Wildlife Department (TPWD) biologists and anecdotal observations of private landowners and managers suggested a decline in Rio Grande wild turkey abundance in the southeastern portion of the Edwards Plateau (Fig. 1). Although the historical roadside

survey could have shortcomings, landowner collaborators over the past 30 years have reported a substantial decline in turkeys on winter roost in our study region. Thus, it is unlikely the decline is a result of survey methodology.

A range of factors alter size and structure of Rio Grande wild turkey population over time (Mosby 1967, Beasom and Wilson 1992). Patterns in wild turkey population dynamics have relationships with survival and production (Vangilder 1992, Miller et al. 1998, Hubbard et al. 1999); demographic differences in these life-history traits can influence population dynamics (Suchy et al. 1983, Hubbard et al. 1999). The relationship between demography and population dynamics, however, is not clearly defined because populations can exhibit divergent trajectories with equivalent estimates of survival (Hennen and Lutz 2001). Unfortunately, while the Edwards Plateau is the historic stronghold and geographic center of the Rio Grande wild turkey range, research on turkey life history in this region is limited (Peterson 1998).

Because the mechanism responsible for the apparent decline in Rio Grande wild turkey abundance in the southeastern Edwards Plateau is unknown, TPWD initiated a research program designed to determine which Rio Grande wild turkey demographic parameters differed between stable and declining sites in this region, and what factors influenced variation in these parameters. To achieve this objective, we radiotagged Rio Grande wild turkeys in 2

¹ E-mail: bret@tamu.edu

² Present address: SWCA Environmental Consultants, 4407 Monterey Oaks Boulevard Building 1, Suite 10, Austin, TX 78749, USA

³ Present address: SWCA Environmental Consultants, 4888 Langfield, Suite 300, Houston, TX 77040, USA

⁴ Present address: Sapphos Environmental, Inc., 133 Martin Alley, Pasadena, CA 91105, USA

⁵ Present address: Florida Fish and Wildlife Conservation Commission, 2304 S.W. Main Boulevard Suite 101, Lake City, FL, 32025, USA

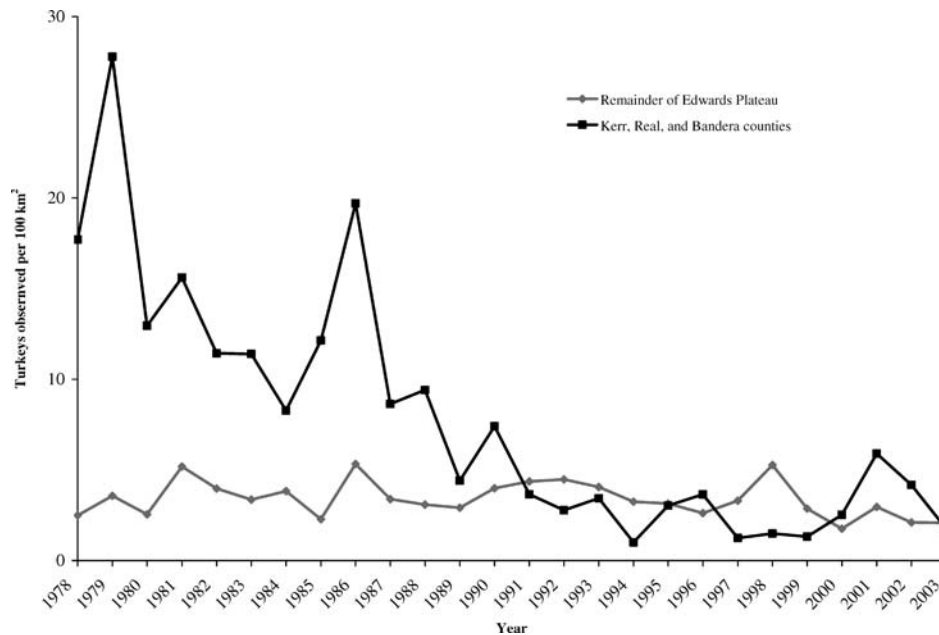


Figure 1. Number of Rio Grande wild turkeys observed per 100 km² by Texas Parks and Wildlife Department biologists during summer production surveys for Bandera, Kerr, and Real counties, and the remainder of the Edwards Plateau, Texas, USA, 1975–1999 (Texas Parks and Wildlife Department, unpublished data). This figure excludes 12 counties in the Edwards Plateau averaging <1 turkey observed per 100 km².

regions of the southeastern Edwards Plateau; one where turkey numbers were declining, and one where there was no trend in turkey abundance. Using these radiotagged individuals, our research objectives were to 1) evaluate survival of Rio Grande wild turkeys in both stable and declining areas of the southeastern Edwards Plateau, and 2) determine whether survival varied between areas, varied by age or sex class, or fluctuated dependent upon seasonal phenology.

STUDY AREA

We conducted our study from January 2001 through August 2003 on 4 research sites on the Edwards Plateau of Texas. We located 2 sites in areas where declines in turkey abundance had occurred (Bandera and Medina counties), and 2 other sites (Kerr and Real counties) were located in areas where there was no trend in abundance (Fig. 2). Each site was characteristic of the Edwards Plateau topography: rolling divides with limestone bedrock and outcrops with rocky soils (Gould 1975). This region previously was a fire-evolved grassland savannah interspersed with live oaks (*Quercus virginiana*) and mesquite (*Prosopis glandulosa*), with Ashe juniper (*Juniperus ashei*) along sheltered outcroppings (Taylor and Smeins 1994). Fire suppression and grazing concomitant with settlement gradually converted the area to brushland and open woodland consisting primarily of live oak mottes and Ashe juniper thickets. Our study sites (private ranches) ranged from 984 ha to 8,858 ha and all had management for native and exotic hunting; livestock grazing occurred on 3 of the sites (Kerr, Medina, Bandera Counties). Limited (≤ 2 hunters/yr) turkey hunting occurred on one study site (Real County), but several properties bordering each site allowed turkey hunting.

METHODS

We captured wild turkeys at each study site from December to March during 2001–2003 using walk-in funnel traps (Davis 1994, Peterson et al. 2003) baited with cracked corn and milo. We aged (juv, ad) and sexed captured individuals according to primary molt pattern and feather coloration (Pelham and Dickson 1992). Juvenile turkeys were 6–10 months of age at capture. We weighed (kg) and fitted each individual with a uniquely numbered TPWD aluminum leg

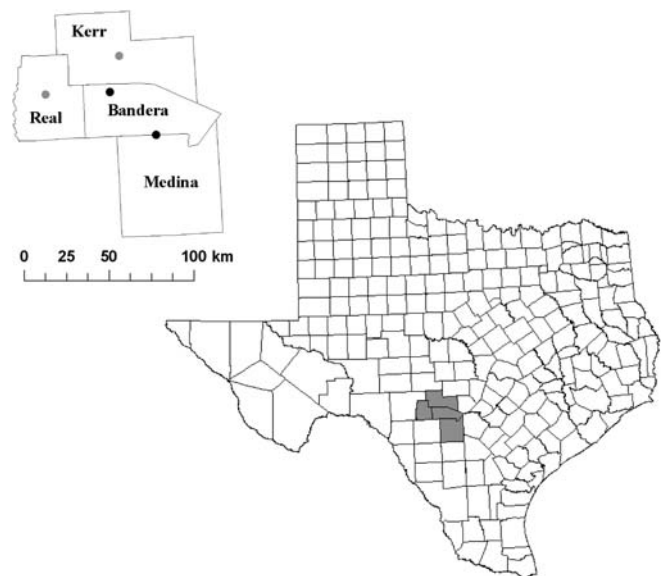


Figure 2. Study area locations for stable sites (gray circles) and declining sites (black circles) in the Edwards Plateau of Texas, USA. Gray areas shown on the state map represent the 4 counties in the southeastern Edwards Plateau where we conducted research on Rio Grande wild turkey survival 2001–2003.

Table 1. Notation and description of candidate models used to estimate survival rates of radiotagged Rio Grande wild turkeys in the Edwards Plateau, Texas, USA, during 2001–2003.

Model notation	Model description
$S_{T2Breeding}$	Survival differs between breeding and nonbreeding seasons
$S_{T2Breeding, Region}$	Survival differs between breeding and nonbreeding seasons and between regions
$S_{T2Breeding, Sex}$	Survival differs between breeding and nonbreeding and between sex
$S_{(.)}$	Constant survival
$S_{(.), Region}$	Survival differs by region, constant within region
S_{Age}	Survival differs between age classes
S_{Sex}	Survival differs between sexes
$S_{T2Breeding, Male(.)}$	Survival differs between breeding and nonbreeding for F, constant survival for M

band. We radiotagged turkeys with mortality-sensitive radiotransmitters (69.0–95.0 g; Advanced Telemetry Systems, Isanti, MN) using a modified backpack harness (Kenward 1987). We tracked radiotagged individuals daily for the first 2 weeks postcapture to evaluate capture-related loss, and we used a minimum 2-week adjustment period (max. 22 d) before we entered turkeys into the survival dataset (Miller et al. 1995, Hubbard et al. 1999). Texas A&M University's Lab Care Committee approved all animal capture protocols (AUP: 2001–119)

We located radiotagged individuals ≥ 3 times per week throughout the study by triangulation or homing and visual observation (White and Garrott 1990) using a vehicle-mounted 4-element Yagi antenna or a 3-element handheld Yagi antenna. Radiotracking increased to ≥ 5 times per week during spring and summer to accurately determine onset of breeding activities and measure nesting success and breeding season mortality. There was no evidence from ground and aerial tracking that radioed individuals moved between study populations, thus we considered each population distinct. Juveniles transitioned to adult age classes at ≤ 6 months postcapture, so we standardized the age transition date, or the median of the reproductive season for Rio Grande wild turkeys in the Edwards Plateau, to 1 June each year. Thus, we censored juveniles from the juvenile at-risk set on 31 May and reentered them as adults on 1 June, creating a 7-month period (Jun–Dec) when there were no juveniles included in the at-risk data set.

We used a staggered-entry (Pollock et al. 1989), known fate design in program MARK (White and Burnham 1999) to evaluate survival of Rio Grande wild turkeys. We defined encounter (sampling) occasions monthly, and we based survival estimates on the best-fitting model as selected in MARK. We used an information-theoretic approach to model selection (Burnham and Anderson 2002) to evaluate factors contributing to variation in survival. Our candidate model set (Table 1) represented survival as a function of some combination of sex, age, region, and time. Because we expected survival to vary between breeding (Apr–Jul) and nonbreeding seasons (Aug–Mar; Ransom et al. 1987, Miller et al. 1995, Hennen and Lutz 2001), we used a 2-period

Table 2. Plausible candidate models used to estimate period (monthly) survival rates of radiotagged Rio Grande wild turkeys in the Edwards Plateau of Texas, USA, 2001–2003.^a

Candidate models	No. of			
	parameters (k)	-2LogL	ΔAIC_c	w_i
$S_{T2Breeding}$	2	734.52	0.00	0.54
$S_{T2Breeding, Region}$	4	731.62	1.11	0.31
$S_{T2Breeding, Sex}$	4	734.24	3.73	0.08

^a Models were ranked by differences in relative Akaike's Information Criterion adjusted for small sample size (ΔAIC_c). w_i indicates Akaike weight.

linear trend to evaluate whether survival fluctuated between breeding or nonbreeding seasons. Willsey (2003) found little evidence for intraregion variation in survival across our study sites, thus we did not consider site as a factor contributing to variation in survival.

RESULTS

We captured 285 Rio Grande wild turkeys between 2001 and 2003; 180 in the stable region and 105 in the declining region. During spring 2001, we radiotracked 13 males and 39 females in the stable region and 3 males and 28 females in the declining region. In 2002, we added 9 males and 17 females in the stable region, as well as 9 males and 23 females in the declining region. In 2003, we added 19 males and 52 females in the stable region, with 12 males and 31 females added in the declining region. We did not include 25 captured individuals in our analysis due to mortality ($n = 3$) or failed transmitters ($n = 22$) within 1 month of capture, and we did not radiotag 5 individuals upon capture. Hunter harvest was limited, accounting for only 5 mortalities (4 during breeding season; spring hunting season) during the study.

The best-approximating model indicated Rio Grande wild turkey survival varied according to a 2-period trend between breeding and nonbreeding seasons across years (Table 2). Model averaged monthly survival estimates for the 2-period trend model indicated survival was slightly higher during nonbreeding (0.97, SE = 0.005) as compared with breeding season periods (0.96, SE = 0.007). Model selection results also suggested support for differences in survival across breeding and nonbreeding seasons between the stable region (nonbreeding 0.97, SE = 0.006; breeding 0.96, SE = 0.007) and declining region (nonbreeding 0.97, SE = 0.006; breeding 0.94, SE = 0.011).

DISCUSSION

Our results indicated variation in Rio Grande wild turkey survival between breeding and nonbreeding seasons; however, differences between period survival estimates (0.01) probably were not biologically significant. The second best-approximating model ($w_2 = 0.31$) indicated support for regional variation in survival, but overlapping confidence intervals precluded biological interpretation of regional differences in survival.

We found little evidence for sex-specific variation, which

supports findings by Miller et al. (1995) and Keegan and Crawford (1999). As the -2 log-likelihoods for the 3 top models differed by ≤ 3 units, we suspect that effects of region and sex were ancillary to the effect of breeding season variation in our model selection results (Burnham and Anderson 2002:131). Estimated annual survival (0.66) based on our period estimates falls within the current range for Rio Grande and eastern (*M. gallopavo silvestrisi*) wild turkeys (Smith-Blair 1993, Roberts et al. 1995, Miller et al. 1998, Keegan and Crawford 1999). However, researchers have reported higher (Ransom et al. 1987, Smith-Blair 1993) and lower (Miller et al. 1995, Hennen and Lutz 2001) survival estimates.

Several authors have found seasonal variation in wild turkey survival (Vander Haegen et al. 1988, Little et al. 1990, Hennen and Lutz 2001). Biologists expect lower survival during spring hunting season for males (Wright and Vangilder 2001) and females due to increased vulnerability associated with reproductive activities (e.g., breeding, nesting, brood rearing; Vander Haegen et al. 1988, Little et al. 1990, Keegan and Crawford 1999). We did not evaluate the effects of reproductive timing on Rio Grande wild turkeys mortality during the breeding season, although research in Kansas and Oklahoma (Miller et al. 1995) found higher mortality for hens on initial nests. Moreover, Randel et al. (2005) speculated that mortality was higher for early nesting juvenile as opposed to adult hens on our study areas.

Although abundance of Rio Grande wild turkeys has declined on the southeastern Edwards Plateau since the 1970s, our results indicate survival is similar for study areas in these 2 regions. Moreover, survival during our study was consistent with estimates from the published literature for both eastern and Rio Grande wild turkeys. These populations could have increasing or decreasing trajectories with survival equivalent to our results, dependent upon other population parameters (Hennen and Lutz 2001). For these reasons, declining turkey abundance in the southeastern versus other portions of the Edwards Plateau probably is associated with differences in other demographic parameters, such as nesting or brood rearing. However, because our study was the first to address Rio Grande wild turkey survival in this region, and since we initiated it long after the decline began, we cannot rule out the possibility that juvenile or adult survival contributed to the decline in the past.

MANAGEMENT IMPLICATIONS

Our results suggest juvenile and adult survival were probably unimportant in the decline of Rio Grande wild turkey abundance in areas of the southeastern Edwards Plateau. Because survival of juvenile and adult Rio Grande wild turkeys was not different between areas of declining and stable turkey abundance in the southern Edwards Plateau of Texas, managers should focus monitoring and research on other demographic parameters that could influence production and dynamics. These include nesting rate, nest survival, brood sex ratio, and sex-specific poult survival. Interpreta-

tion of our results was complicated by the fact that we began monitoring survival after a problem was perceived. This situation demonstrates why wildlife managers should initiate long-term monitoring programs in expectation of changes in population status rather than initiating such programs after obvious deleterious changes occur.

ACKNOWLEDGMENTS

We are grateful to the landowners and land managers who willingly allowed us access to their properties over the course of this study. We are especially indebted to B. Watts, J. Harrell, J. H. Waligura and the Waligura family, and T. Kneese for assistance with study operations on each of the research sites. We are grateful to D. B. Frels, E. F. Fuchs, C. T. Meadows, W. E. Armstrong, D. F. Prochaska, F. O. Gutierrez, M. J. Edinburg, and E. E. Gray at the Kerr Wildlife Management Area for logistical support throughout the course of this research project. We also thank S. L. Locke for assistance with figure creation. The Texas Park and Wildlife Department, the Texas Turkey Stamp Fund, and the National Wild Turkey Federation Texas State Superfund funded this project.

LITERATURE CITED

- Beason, S. L., and D. Wilson. 1992. Rio Grande turkey. Pages 306–330 in J. G. Dickson, editor. *The wild turkey: biology and management*. Stackpole Books, Mechanicsburg, Pennsylvania, USA.
- Burnham, K. P., and D. R. Anderson. 2002. *Model selection and multimodel inference*. Second edition. Springer-Verlag, New York, New York, USA.
- Davis, B. D. 1994. A funnel trap for Rio Grande turkey. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 48:109–116.
- Gould, F. W. 1975. *Texas plants: a checklist and ecological summary*. Texas A&M University, Agricultural Experiment Station, College Station, Texas, USA.
- Hennen, R. S., and R. S. Lutz. 2001. Rio Grande turkey female survival in southcentral Kansas. *Proceedings of the National Wild Turkey Symposium* 8:117–122.
- Hubbard, M. W., D. L. Garner, and E. E. Klaas. 1999. Factors influencing wild turkey survival in southcentral Iowa. *Journal of Wildlife Management* 63:731–738.
- Keegan, T. W., and J. A. Crawford. 1999. Reproduction and survival of Rio Grande turkeys in Oregon. *Journal of Wildlife Management* 63:204–210.
- Kenward, R. E. 1987. *Wildlife radio-tagging: equipment, field technique and data analysis*. Academic Press, London, United Kingdom.
- Little, T. W., J. M. Keinzler, and G. A. Hanson. 1990. Effects of fall either-sex hunting on survival in an Iowa wild turkey population. *Proceedings of the National Wild Turkey Symposium* 6:119–125.
- Miller, D. A., L. W. Burger, B. D. Leupold, and G. A. Hurst. 1998. Survival and cause specific mortality of wild turkey hens in central Mississippi. *Journal of Wildlife Management* 62:306–313.
- Miller, M. S., D. J. Buford, and R. S. Lutz. 1995. Survival of female Rio Grande wild turkeys during the reproductive season. *Journal of Wildlife Management* 59:766–771.
- Mosby, H. S. 1967. Population dynamics. Pages 113–136 in O. H. Hewitt, editor. *The wild turkey and its management*. The Wildlife Society, Washington, D.C., USA.
- Pelham, P. H., and J. G. Dickson. 1992. Physical characteristics. Pages 32–45 in J. G. Dickson, editor. *The wild turkey: biology and management*. Stackpole, Mechanicsburg, Pennsylvania, USA.
- Peterson, M. J. 1998. Review of Proceedings of the Seventh National Wild Turkey Symposium. J. G. Dickson, editor. Stackpole, Mechanicsburg, Pennsylvania, USA. 1996. *Journal of Wildlife Management* 62:816–818.
- Peterson, M. N., R. Aguirre, T. A. Lawyer, D. A. Jones, J. N. Schaap, M. J.

- Peterson, and N. J. Silvy. 2003. Animal welfare-based modification of the Rio Grande wild turkey funnel trap. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 57:208–212.
- Pollock, K. H., S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989. Survival analysis in telemetry studies: staggered entry design. *Journal of Wildlife Management* 53:7–15.
- Randel, C. J., R. Aguirre, D. A. Jones, J. N. Schaap, B. J. Willsey, M. J. Peterson, and N. J. Silvy. 2005. Nesting ecology of Rio Grande wild turkey in the Edwards Plateau of Texas. Proceedings of the National Wild Turkey Symposium 9:in press.
- Ransom, D., Jr., O. J. Rongstad, and D. H. Rusch. 1987. Nesting ecology of Rio Grande turkeys. *Journal of Wildlife Management* 51:435–439.
- Roberts, S. D., J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. *Journal of Wildlife Management* 59:437–447.
- Smith-Blair, A. E. 1993. Rio Grande wild turkey hen habitat and edge use, survival, and reproductive characteristics in the Texas Rolling Plains. Thesis, Texas Tech University, Lubbock, Texas, USA.
- Suchy, W. J., W. R. Clark, and T. W. Little. 1983. Influence of simulated harvest on Iowa wild turkey populations. Proceedings of the Iowa Academy of Science 90:98–102.
- Taylor, C. A., and F. E. Smeins. 1994. A history of land use of the Edwards Plateau and its effect on the native vegetation. Pages 1–8 in C. A. Taylor, editor. Proceedings of the Juniper Symposium. Technical Report 94-2. Texas Agricultural Experiment Station, College Station, Texas, USA.
- Vander Haegen, W. M., W. E. Dodge, and M. W. Sayre. 1988. Factors affecting productivity in a northern wild turkey population. *Journal of Wildlife Management* 52:127–133.
- Vangilder, L. D. 1992. Population dynamics. Pages 144–164 in J. G. Dickson, editor. *The wild turkey: biology and management*. Stackpole, Mechanicsburg, Pennsylvania, USA.
- Walker, E. A. 1954. Distribution and management of the wild turkey in Texas. *Texas Game and Fish* 12:12–14, 22, 26–27.
- White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. *Bird Study* 46(Supplement):120–138.
- White, G. C., and R. A. Garrott. 1990. *Analysis of wildlife radio-tracking data*. Academic Press, San Diego, California, USA.
- Willsey, B. J. 2003. Survival and mammalian predation of Rio Grande turkeys on the Edwards Plateau, Texas. Thesis, Texas A&M University, College Station, Texas, USA.
- Wright, G. A., and L. D. Vangilder. 2001. Survival of eastern wild turkey males in western Kentucky. Proceedings of the National Wild Turkey Symposium 8:187–194.

Associate Editor: Ransom.