The Journal of Wildlife Management 75(8):1807–1811; 2011; DOI: 10.1002/jwmg.231

Note

Retention of Butt-End Aluminum Leg Bands by Wild Turkeys

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ABSTRACT We examined retention of butt-end aluminum leg bands on Rio Grande wild turkeys (*Meleagris gallopavo intermedia*) captured in Texas and Kansas, USA, 2000–2009. We examined 187 recaptured or harvested radiotagged wild turkeys to determine band retention and modeled band retention with Program MARK. We did not detect differences in band retention among age and gender classes or that band retention probability was time dependent. We estimated monthly probability of band retention was 0.990 (SE = 0.002). Band retention probability was 0.971 (SE = 0.006) at 3 months post-banding and 0.864 (SE = 0.028) at 15 months post-banding. Butt-end aluminum leg band retention was not 100% for wild turkeys marked during our work; however, our band retention rates were 3.7–5.7 times greater than described previously. © 2011 The Wildlife Society.

KEY WORDS aluminum, banding, butt-end band, Kansas, leg band, *Meleagris gallopavo*, retention, ringing, Texas, wild turkey.

Butt-end aluminum leg bands have been used in band-recovery studies for decades (Seber 1970, Pollock et al. 1989, White and Burnham 1999, Norman et al. 2004, Zimmerman et al. 2009). Information from band recoveries are used by wildlife managers to monitor population parameters such as survival and harvest rates without equipment and labor expenses associated with radiotelemetry (Hoenig et al. 2005). Though few wild turkey (*Meleagris gallopavo*) studies have used band-recovery models to estimate survival and harvest rates (Lewis 1980, Vangilder and Kurzejeski 1995, Norman et al. 2004), band recovery may be a useful technique for wild turkey population monitoring and management. However, band loss between marking and recovery can bias estimates of population parameters (Brownie et al. 1985, Hoenig et al. 2005, Diefenbach et al. 2009). Recent evidence from the northeastern United States suggested butt-end aluminum leg band retention in eastern wild turkeys (*M. g. silvestris*) was ≤0.233 at 15 months post-banding (Diefenbach et al. 2009). Our objective was to examine retention of butt-end aluminum leg bands by Rio Grande wild turkeys (*M. g. intermedia*) in Texas and Kansas, USA.

Received: 3 August 2010; Accepted: 23 March 2011;
Published: 27 September 2011

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STUDY AREA

We captured, marked, and monitored Rio Grande wild turkeys at 3 study sites in the Texas Panhandle, 4 study sites in the Edwards Plateau of central Texas, 2 study sites in South Texas, and 1 in southwestern Kansas. Research at study sites in the Texas Panhandle and Kansas was conducted by investigators from Texas Tech University (TTU; Holdstock et al. 2006, Butler et al. 2007*c*, Hall et al. 2007, Erxleben et al. 2011), whereas research in the Edwards Plateau and South Texas was conducted by investigators from Texas A&M University (TAMU; Collier et al. 2007, 2009; Erxleben et al. 2011).

The Texas Panhandle and Kansas sites were located within the southern Great Plains of the United States. Throughout this region, woodland cover primarily occurred in riparian areas and windbreaks. Common woody species were cottonwood (*Populus deltoides*), western soapberry (*Sapindus drummondii*), hackberries (*Celtis* spp.), elms (*Ulmus* spp.), osage-orange (*Maclura pomifera*), honey mesquite (*Prosopis glandulosa*), saltcedar (*Tamarix* spp.), Chickasaw plum (*Prunus angustifolia*), sand sagebrush (*Artemisia filifolia*), Russianolive (*Elaeagnus angustifolius*), skunkbush sumac (*Rhus aromatica*),

and shinnery oak (*Quercus havardii*; Spears et al. 2007; Butler et al. 2007*a*, *b*; Erxleben et al. 2010, 2011). The Texas Panhandle study sites were located on Wildlife Management Areas and private ranches in Cottle, Hemphill, Collingsworth, and Donley counties, Texas, USA (Butler et al. 2007*a*, *b*). The southwestern Kansas study site was located on a National Grassland and private ranches in Morton, northwestern Stevens, and southern Grant counties, Kansas, USA; northern Cimarron County, Oklahoma, USA; and southeastern Baca County, Colorado, USA. Primary land uses on the southern Great Plains were cattle ranching interspersed with center-pivot agriculture, dry-land agriculture, and oil and natural gas development (Brunjes 2005).

The south Texas study sites were located on the Central Rio Grande Plains (Natural Resources Conservation Service 2006). These study sites were on the La Copita Ranch owned by Texas A&M University and a privately owned ranch northwest of San Diego, Texas, USA in Duval County (Guthrie et al. 2011). The landscape consisted of a thornscrub and grassland mosaic (Northup et al. 2005) and drainages were dominated by honey mesquite, hackberry, and Texas persimmon (*Diospyros texana*; Archer 1990). The Edwards Plateau study sites were located on private ranches in Bandera, Kerr, Medina, and Real counties, as well as the Kerr Wildlife Management Area in Kerr County, Texas, USA. Common woody species included Texas live oak (*Q. fusiformis*), Ashe's juniper (*Juniperus ashei*), and honey mesquite (Randel 2003). Across the region, cattle grazing and wildlife ranching were widespread land uses (Erxleben et al. 2011).

METHODS

As part of a larger research effort, we captured wild turkeys using rocket nets, drop nets, and walk-in traps during January through March 2000–2009 (Glazener et al. 1964, Bailey et al. 1980, Davis 1994, Peterson et al. 2003). We trapped during 2000–2005 at the Texas Panhandle sites; 2000–2001 and 2003–2004 at the southwestern Kansas site; 2001–2007 at the Edwards Plateau sites; and 2007–2009 at the south Texas site. We determined age (yearling or adult) based on characteristics of the ninth and tenth primaries and rectrice length (Petrides 1942, Pelham and Dickson 1992). Yearling turkeys were 6–10 months of age at capture. We attached a backpack-style radiotransmitter (69–110 g; Advanced Telemetry Systems, Isanti, NM or AVM Instruments, Colfax, CA) using 3.2-mm nylon over-braid rubber harness cord. We banded each radiotagged wild turkey with a uniquely numbered butt-end aluminum leg band (size 8 for females and size 9 for males; National Band and Tag, Newport, KY). We purchased bands labeled with Texas Parks and Wildlife Department contact information and radiotransmitters labeled with researcher contact information so hunters could report harvested wild turkeys. Capture and handling of Rio Grande wild turkeys was approved by the TTU Animal Care and Use Committee (protocol no. 02266-09) or TAMU's IACUC (AUP: 2001-119 and 2007-204).

When we recaptured radiotagged wild turkeys, we determined band retention. If band loss had occurred, we fitted a new band. We interviewed hunters who harvested radiotagged wild turkeys and determined if harvested birds retained their bands at harvest. We used the nest survival model in Program MARK to examine models of band retention (White and Burnham 1999, Dinsmore et al. 2002). We used month as our time interval and our time origin for each wild turkey was the month of first capture. For each wild turkey, we included covariates to describe age at banding (yearling or adult), gender of the wild turkey, and number of months since banding (time dependent covariate). This time covariate was used to model potential changes in monthly band retention probability through time. We developed 7 a priori candidate models (Table 1) and used second-order Akaike's Information Criterion (AIC_c) to evaluate evidence for each model (Anderson and Burnham 2002, Burnham and Anderson 2002, Forster and Sober 2004). We considered models plausible if the difference in AIC_c compared to lowest AIC_c of the model set (Δ_i) was ≤ 2 and the 85% confidence interval of parameter (β) estimates did not overlap 0 (Burnham and Anderson 2002, Arnold 2010). We considered models in which we grouped age–gender classes into 4 groups (adult male [AM], adult female [AF], yearling male [YM], or yearling female [YF]) and 3 groups (AM, YM, or F). We selected the most plausible model of monthly band retention and used the delta method to estimate appropriate sampling variance associated with monthly estimates of band retention (Powell 2007).

Table 1. Candidate models of Rio Grande wild turkey butt-end aluminum leg band retention ($n = 187$) in Texas and Kansas, USA, 2000–2009. For each model, we provide $-2 \times$ log-likelihood (-2LL), number of parameters (K), second-order Akaike's Information Criterion (AIC_c), difference in AIC_c compared to lowest AIC_c of the model set (Δ_i), and AIC_c weight (w_i).

Model[a]	−2LL	K	AIC_c	Δ_i	w_i
S(.)	123.332	1	125.335	0.000	0.380
S(time)	122.966	2	126.972	1.637	0.167
S(gender)	123.272	2	127.278	1.944	0.144
S(age)	123.323	2	127.330	1.995	0.140
S(age–gender classes, 3 groups)	122.412	3	128.424	3.090	0.081
S(age + gender)	123.266	3	129.278	3.944	0.053
S(age–gender classes, 4 groups)	122.073	4	130.093	4.759	0.035

[a] Covariates used to model band retention were gender (F = 0, M = 1), age (yearling [Y] = 0, adult [A] = 1), and time = no. of months since banded (time dependent covariate). We also considered models in which we grouped age–gender classes into 4 groups (AM, AF, YM, or YF) and 3 groups (AM, YM, or F).

We determined force in Newtons (N) required to open our butt-end aluminum leg bands after they had been opened once (i.e., bands placed on wild turkeys were opened, placed on a leg, and closed). We estimated force (N = mass [kg] × 9.8 m/s^2 [standard gravity]) with a spring scale (Pelouze 7820 Vertical 100 kg Hanging Scale; Forestry Suppliers, Inc., Jackson, MS). We opened size-8 bands to 9 mm (female) and size-9 bands to 11 mm (male) based on least tarsal diameters reported in Leopold (1944). We compared force required to open the 2 sizes of bands using a 2-sample *t*-test (Zar 1999). We also compared force required to open bands purchased in 2005 (new bands) and bands purchased before 2001 (exact purchase date unknown; old bands) using a 2-sample *t*-test (Zar 1999).

RESULTS

We examined 187 recaptured or harvested radiotagged Rio Grande wild turkeys (41 in southwestern Kansas, 109 in the Texas Panhandle, 18 in south Texas, and 19 in the Edward's Plateau) for band retention. Recaptures occurred between 1 and 62 months after initial capture and banding. We observed no band loss in the Edward's Plateau and south Texas sites, but 9 wild turkeys lost their band in southwestern Kansas (AM = 0; AF = 5; YM = 1; YF = 3) and 11 lost their band in the Texas Panhandle (AM = 4; AF = 2; YM = 2; YF = 3). For the 20 wild turkeys that lost their band, the number of months between the last time they were known to still retain their band and the time they were recovered without their band ranged from 1 to 47 months ($\bar{x}$ = 15.6 months). This interval was ≤14 months for 16 of the 20 wild turkeys (80%) that lost their band. We recaptured or recovered wild turkeys 2–62 months ($\bar{x}$ = 12.2 months, n = 169) post-banding that had retained their band.

We evaluated 7 a priori candidate band-retention models in Program MARK using the nest survival model. We found 4 models appeared competitive (Table 1). Our best model (AIC_c weight [w_i] = 0.380) indicated band retention was not influenced by number of months since banding (time), age at banding, or gender (model *S*(.) in Table 1). Although, the time model appeared plausible (Δ_i = 1.637, w_i = 0.167), the effect of time was not different from 0 (odds ratio = 1.015, β = 0.015, SE = 0.026, 85% CI = −0.023 to 0.053). The gender model appeared plausible (Δ_i = 1.944, w_i = 0.144), but the effect of gender was not different from 0 (odds ratio = 1.122, β = 0.115, SE = 0.472, 85% CI = −0.563 to 0.794). Similarly, the age model appeared plausible (Δ_i = 1.945, w_i = 0.140), but the effect of age at banding was not different from 0 (odds ratio = 0.957, β = −0.044, SE = 0.459, 85% CI = −0.705 to 0.618). Therefore, we considered the *S*(.) model to be our best model of band retention (Table 1). Predictions using the *S*(.) model indicated the monthly probability of butt-end aluminum leg band retention was 0.990 (SE = 0.002) for Rio Grande wild turkeys. We estimated the probability of band retention was 0.971 (SE = 0.006) at 3 months post-banding (approximate beginning of first spring hunting season) and 0.864 (SE = 0.028) at 15 months post-banding (approximate beginning of second spring hunting season; Table 2).

Table 2. Estimated proportion ($\hat{p}$) of butt-end aluminum leg bands retained by Rio Grande wild turkeys in Texas and Kansas, USA, 2000–2009. Predictions based on model *S*(.).

No. months post-banding	$\hat{p}$	SE	95% CI	
			LCL	UCL
3	0.971	0.006	0.959	0.984
10	0.907	0.020	0.868	0.946
15	0.864	0.028	0.808	0.919
22	0.806	0.039	0.730	0.883
27	0.768	0.045	0.679	0.857
34	0.717	0.053	0.613	0.822
39	0.683	0.058	0.569	0.797
51	0.607	0.068	0.475	0.740
58	0.567	0.072	0.426	0.708

We estimated 178.0 N (n = 10, SE = 3.27) of force were needed to open size-8 bands 9 mm and 158.9 N (n = 12, SE = 3.05) of force were needed to open size-9 bands 11 mm (t_{20} = 4.251, P < 0.001). We estimated more force was required to open new size-9 bands ($\bar{x}$ = 158.9 N, n = 12, SE = 3.05) than old bands ($\bar{x}$ = 141.2 N, n = 5, SE = 1.83; t_{15} = 3.590, P = 0.003).

DISCUSSION

We estimated butt-end aluminum leg band retention of 0.864 (SE = 0.028) at 15 months post-banding for Rio Grande wild turkeys, which was much higher than estimates from Diefenbach et al. (2009) on eastern wild turkeys in the northeastern United States (AM = 0.152, YM = 0.233). Leg bands used by Diefenbach et al. (2009) were made by the same manufacturer and were the same size as ours. Perhaps the double marking procedure used by Diefenbach et al. (2009) resulted in greater loss of bands since the riveted bands could provide a leverage point for opening the butt-end bands. Regardless, band loss will result in biased estimates of survival and harvest rates from band-recovery models (Brownie et al. 1985, Nelson et al. 1980, Hoenig et al. 2005).

Increases in band retention from the levels observed by Diefenbach et al. (2009) to the levels we observed would still result in biased estimates, though the magnitude of bias would be reduced (Nelson et al. 1980). Nelson et al. (1980) estimated relative bias in annual survival estimates obtained from band-recovery models using a band retention function similar to ours. Nelson et al.'s (1980) simulated band retention function assumed approximately 60% retention at 5 years and we estimated 55.6% (SE = 0.073) band retention at 5 years. Assuming annual survival of 35%, Nelson et al. (1980) found estimates of annual survival would be biased by −4% to −6%.

Previous research has only examined band loss in male wild turkeys (Diefenbach et al. 2009). We used size-8 bands on female wild turkeys and size-9 bands on male wild turkeys. Though size-8 bands were stronger than size-9 bands, we did not observe differences in band retention between the genders. We also observed older bands were weaker than newer

ones. However, we did not observe a relationship between the number of months since banding and monthly band retention probability. Since few wild turkeys live beyond 5 years of age, we believe this short duration mitigates potential problems from bands weakening with age.

The use of double banding (banding both legs) is one technique available to correct for band loss (Seber 1982, Seguin and Cooke 1983, Spendelow et al. 1994, Rivalan et al. 2005, Diefenbach et al. 2009). However, this technique assumes the probability of band loss is independent between bands when animals are double-banded (Seber 1982). Since this assumption is often violated (Siniff and Ralls 1991, Diefenbach and Alt 1998, Bradshaw et al. 2000, Rivalan et al. 2005), double banding is probably not a good solution to band loss in wild turkey populations. Perhaps correction factors for band loss could be developed from radiotelemetry-based studies such as ours. Further, future band-recovery programs should use riveted bands, but the assumption used by Diefenbach et al. (2009) that retention of riveted bands is 100% still requires verification.

Butt-end aluminum band loss appears to be quite variable in wild turkeys. Though our sample size was low ($n = 37$), we observed no band loss at the Edward's Plateau and south Texas study sites. We cannot explain why Rio Grande wild turkey band retention at those sites were not roughly equivalent to other sites as methods for banding were the same between all study sites. Additionally, tarsal diameters may differ among the subspecies, but we cannot explain why our band retention at 15 months post-banding was 3.7–5.7 times greater than band retention observed in the northeastern United States by Diefenbach et al. (2009). Since many wild turkey populations are tagged with butt-end bands and current band-recovery programs are reliant on those data, further study is needed to understand potential differences in band retention among wild turkey subspecies and geographic regions. The results of Diefenbach et al. (2009) leave managers little choice but to discard all data from band-recovery programs that have used butt-end bands, but our results suggest data obtained from those banding programs could still be viable for population monitoring.

MANAGEMENT IMPLICATIONS

Band-recovery programs should be used cautiously in wild turkey populations if butt-end leg bands are used since band retention was quite variable among subspecies and geographic regions and band loss was >0%. However, small biases of −4% to −6% may be tolerable for large-scale band-recovery studies (Nelson et al. 1980). Correction factors for band loss could be developed from radiotelemetry-based studies, but subspecies and geographic variation may limit applicability of derived correction factors. Therefore, the best way to remove potential biases from wild turkey band-recovery studies resulting from band loss may be to eliminate the use of butt-end aluminum leg bands and use permanent locking leg bands or other permanent marks assuming 100% band retention can be verified.

ACKNOWLEDGMENTS

This study was funded by Texas Parks and Wildlife Department, Texas Tech University, National Wild Turkey Federation, Texas State Chapter of the National Wild Turkey Federation, and Dr. Donald and Sammie Bricker Foundation. We thank researchers from Texas A&M University and Texas Tech University for allowing use of their data for these analyses. We offer many thanks to the numerous graduate students, technicians, volunteers, and wildlife professionals who helped with trapping wild turkeys over the years. We thank A. J. Escobar and J. D. Guthrie for querying our databases for this analysis. This is Texas Tech University, College of Agricultural Science and Natural Resources technical publication T-9-1215.

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Associate Editor: L. Wes Burger.