The Journal of Wildlife Management 76(5):907–910; 2012; DOI: 10.1002/jwmg.341

Management and Conservation

Effects of Variable Spring Harvest Regimes on Annual Survival and Recovery Rates of Male Wild Turkeys in Southeast Louisiana

MICHAEL J. CHAMBERLAIN,[1] *Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602, USA*
BLAKE A. GRISHAM,[2] *School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, USA*
JENNIFER L. NORRIS,[3] *School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, USA*
NORMAN J. STAFFORD III, *Louisiana Department of Wildlife and Fisheries, P. O. Box 98000, Baton Rouge, LA 70808, USA*
FREDERICK G. KIMMEL, *Louisiana Department of Wildlife and Fisheries, P. O. Box 98000, Baton Rouge, LA 70808, USA*
MICHAEL W. OLINDE, *Louisiana Department of Wildlife and Fisheries, P. O. Box 98000, Baton Rouge, LA 70808, USA*

ABSTRACT Spring harvest is a primary mortality factor for male eastern wild turkeys (*Meleagris gallopavo silvestris*), but the relationship between spring harvest regimes and annual survival is not well understood. We banded 462 male wild turkeys from 1989 to 2007 in southeastern Louisiana to estimate annual survival and band recovery rates relative to spring harvest. We evaluated these parameters under a liberal harvest season (3-bird limit; 1989–1997) and a reduced conservative harvest season (2-bird limit; 2000–2007). Estimated recovery rates during the liberal season were 0.75 (SE = 0.05) for adults and 0.63 (SE = 0.04) for juveniles, and recovery rates during the conservative season were 0.61 (SE = 0.04) and 0.48 (SE = 0.05) for adults and juveniles, respectively. Annual survival averaged 0.16 (SE = 0.05) and 0.43 (SE = 0.05) for adults and juveniles, respectively, during the liberal season. Conversely, during the conservative season, annual survival averaged 0.31 (SE = 0.05) and 0.56 (SE = 0.05) for adults and juveniles, respectively. Our findings suggest that bag limit reductions combined with a reduction in season length contributed to a 2-fold increase in annual survival for male wild turkeys. We contend that male wild turkeys were likely over harvested on our study area during the liberal harvest season, which contributed to exceptionally low annual survival rates. Managers should attempt to assess survival rates of male wild turkeys in harvested populations to properly manage spring harvest and develop appropriate harvest limits. © 2012 The Wildlife Society.

KEY WORDS harvest regimes, Louisiana, *Meleagris gallopavo*, program MARK, survival, wild turkey.

Eastern wild turkeys (*Meleagris gallopavo silvestris*) are an important game species in North America. Numbers of turkey hunters and turkey harvest continue to increase, despite national trends showing declining numbers of sport hunters throughout the United States (Tapley et al. 2001). Managers are increasingly challenged with selecting harvest regimes that optimize harvest and opportunity in the face of increasing recreational demand, without negatively affecting turkey populations.

Wild turkey populations have historically been harvested under 1 of 3 regimes: 1) harvest of only males during spring, 2) harvest of only males during spring with a limited fall harvest of either sex, and 3) a sustained-yield approach with a spring harvest of males with maximized harvest of either sex during the fall (Healy and Powell 2000). Because wild turkeys are polygynous and males do not contribute to young-rearing, the most conservative approach is harvesting only males during spring. In contrast, regimes that allow harvests of both sex and include a fall harvest are more liberal, and typically increase female mortality (Vangilder and Kurzejeski 1995) and contribute to additive mortality for males (Little et al. 1990, Pack et al. 1999). Although the relationship between harvest mortality and annual survival of wild turkeys is not conclusive (Vangilder 1992, Norman et al. 2004), studies have generally correlated reduced survival of males during spring with harvest (Vangilder 1995, Grisham et al. 2008).

Beyond the harvest regime implemented, length of the harvest season and bag-limit (number of birds harvested per hunter) also are influential components in managing wild turkey populations. Harvest regimes with relatively liberal spring seasons and bag limits (i.e., ≥3 bird season bag and >30 day season length) such as in Wisconsin, Mississippi, Georgia, Louisiana, and Kentucky typically result in annual survival rates for males ranging from 0.16 to 0.50 (Godwin et al. 1991, Ielmini et al. 1992, Paisley et al. 1995, Stafford et al. 1997, Wright and Vangilder 2001). However, harvest regimes with conservative seasons and bag limits (≤2 bird season bag and ≤30 day season) in Minnesota

Received: 20 April 2011; Accepted: 15 November 2011;
Published: 12 January 2012

[1]*E-mail: mchamberlain@warnell.uga.edu*
[2]*Present address: Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409, USA.*
[3]*Present address: Ohio Department of Natural Resources—Wildlife Division, Ashley, OH 43003, USA.*

and Louisiana have resulted in increased survival rates of males (>0.64) (Porter 1978, Grisham et al. 2008).

Prior to 1999, wild turkey harvest regimes in southeastern Louisiana (despite being a spring-only harvest of males) were considered liberal (Kurzejeski and Vangilder 1992) with a 37 day season, 3 bird bag-limit, and no limit on hunter numbers. Stafford et al. (1997) reported high recovery rates of male wild turkeys banded during 1989–1997 (adults = 0.79 and juveniles = 0.65) and low annual survival rates (adults = 0.16 and juveniles = 0.46). These findings strongly suggested that spring harvest was an important source of additive mortality for males in southeast Louisiana. In response to the findings of Stafford et al. (1997), the Louisiana Department of Wildlife and Fisheries (LDWF) instituted a progressively more conservative turkey harvest regime for southeastern Louisiana beginning in 2000. Specifically, LDWF reduced season length and bag-limits to reduce harvest of males and increase the proportion of adult males in the harvested population. We analyzed band return data from a 19-year period that encompassed both aforementioned harvest regimes. Our objective was to evaluate how male survival and band recovery rates were affected by the different spring harvest regimes.

STUDY AREA

Our study area was located in Washington Parish in southeast Louisiana and included the 5,600 ha Ben's Creek Wildlife Management Area (WMA) and approximately 9,100 ha of surrounding private lands. The entire study area was owned and managed by Weyerhaeuser Company, with Ben's Creek WMA being managed for hunting by LDWF. The study area was predominantly (>90%) loblolly pine (*Pinus taeda*) plantations managed for wood fiber production.

METHODS

We live-trapped turkeys from late December–early March in 1989–1994 and in 1997–2007 using rocket nets at permanent bait sites. We banded each captured male with a uniquely numbered United States Geological Survey aluminum butt-end leg band that contained contact information for the LDWF. We aged birds (juvenile, adult) based on feather characteristics of the ninth and tenth primaries (Pelham and Dickson 1992). We released birds immediately at the capture site.

Throughout the duration of our study, the length of the spring hunting season on our study area became more conservative. Hunting seasons on Ben's Creek WMA began the third Saturday in March and extended 37 days during 1989–1994, 23 days during 1995–2004, and 16 days during 2005–2007. Hunting occurred during 37 days on surrounding lands from 1989–1999, and during 30 days thereafter. Season bag limits were 3 birds from 1989–1996 and 2 birds from 1997–2007. We recognize the change in season length on public lands in 2005 and beyond could have influenced our comparisons relative to comparing a liberal to conservative harvest regime, but the shorter season length would only create an even more conservative harvest strategy. Hence, we believe our subsequent inferences and interpretations regarding survival and harvest rates under 2 different harvest regimes are valid.

After turkeys were harvested, they were examined at a mandatory check station operated by LDWF on Ben's Creek WMA. Hunting clubs and LDWF staff recorded biological data (age, harvest location) during our study. Hunting clubs on surrounding private lands maintained their own records on data sheets furnished by LDWF.

Analyses

We grouped each banded male as juvenile or adult during the 2-bird or 3-bird limits (hereafter, conservative and liberal seasons, respectively), thus generating 4 groups of binary covariates based on age and harvest season (juveniles during the liberal season [1989–1997], adults during the liberal season, juveniles during the conservative season [2000–2007], and adults during the conservative season). We used the band recovery model (Brownie et al. 1985) in program MARK (White and Burnham 1999) to model harvest data and determine the best fit model parameters for survival and band recovery estimates. We applied 5 candidate models to determine effects of harvest regime and age on annual survival. Model 1 was $\phi(g)\ p(g)$ where survival (ϕ) and recovery (p) models fit with the grouped (g) covariates of age and harvest regime. Model 2 was $\phi(g)\ p(.)$ where survival estimates were fit with covariates of age and harvest regime and recovery rates were constant. Model 3 was $\phi(.)\ p(g)$ where recovery rates were fit with covariates of age and harvest regime and survival was constant. Model 4 was $\phi(g \times t)\ p(g \times t)$ where both survival and recovery were time, age, and harvest regime specific. Model 5 was $\phi(t)\ p(t)$ where both survival and recovery were time specific.

For analyses that involved age, we also constructed age models in program MARK to designate that after 1 year, juvenile cohorts became adults. We selected the best-fitting model based on Akaike's information criterion (AIC_c), Akaike weights (w_i), chi-square model-fit statistics, and model deviance (Anderson et al. 2001, Anderson and Burnham 2002).

RESULTS

We banded 204 wild turkey males during the liberal hunting seasons (1989–1997) and recovered 137, whereas we recovered 138 of 258 banded males during the conservative hunting seasons (2000–2007). We caught and banded juveniles ($n = 136$) more frequently than adults ($n = 68$) during the liberal hunting seasons, whereas we banded similar numbers of juveniles ($n = 127$) and adults ($n = 131$) during the conservative hunting seasons. However, juveniles ($n = 31$ and 8; liberal and conservative seasons, respectively) were harvested less frequently than adults ($n = 106$ and 130; liberal and conservative limits, respectively).

The model with the lowest AIC_c and highest Akaike weight was $\phi(g)\ p(g)$ with 8 parameters (Table 1). Based on Akaike weights, strong evidence favored the first model ($\phi(g)\ p(g)$; $w_i = 0.90$), indicating that harvest regimes affected age-specific survival and recovery estimates.

Table 1. A priori candidate models used to model survival (ϕ) and recovery rates (p) for adult and juvenile wild turkey males during liberal and conservative harvest seasons on Ben's Creek Wildlife Management Area and adjacent private lands in southeastern Louisiana, 1987–2007. We used 4 covariate groups (e.g., juveniles during liberal season, adults during liberal season, juveniles during conservative season, and adults during liberal season). For each model, we provide the change in Akaike's Information Criteria (ΔAIC_c), Akaike weights (w_i), number of estimable parameters (K), and the deviance (DEV).

Model	ΔAIC_c	w_i	K	DEV
$\phi(g)\ p(g)$[a]	0.00	0.90	8	199.88
$\phi(g)\ p(.)$[b]	5.26	0.07	4	213.38
$\phi(g \times t)\ p(g \times t)$[c]	6.69	0.03	45	122.87
$\phi(.)\ p(g)$[d]	21.49	0.00	4	229.60
$\phi(t)\ p(t)$[e]	29.29	0.00	9	227.09

[a] Survival and recovery rates fit with grouped covariates of age and harvest season (liberal or conservative).
[b] Survival rates fit with grouped covariates of age and harvest season, recovery rates constant.
[c] Survival and recovery rates were time, age, and harvest season-specific.
[d] Recovery rates fit with grouped covariates of age and harvest season, survival rates constant.
[e] Both survival and recovery rates were time-specific.

Annual survival of males during the liberal hunting seasons decreased by 94% (adults) and 30% (juveniles) relative to conservative seasons, and adults had 110% lower annual survival rates than juveniles (Table 2).

Estimated band recovery rates during the liberal seasons averaged 0.75 (SE = 0.05) and 0.63 (SE = 0.04) for adults and juveniles, respectively. Band recovery rates decreased during the conservative seasons to an average of 0.61 (SE = 0.04) and 0.48 (SE = 0.05) for adults and juveniles, respectively.

DISCUSSION

Our results indicate that annual survival rates of male wild turkeys increased with reductions in hunter bag limits and a decrease in season length. The extremely low annual survival rates we observed under a liberal harvest season suggest that males were overharvested on our study area. Band recovery rates during the spring harvest season decreased with a decrease in bag limits and season length, suggesting that harvest was an additive mortality factor for male wild turkeys under a liberal harvest season. However, band recovery rates observed under a more conservative hunting season (2-bird bag limit, approx. 20 day season) were still greater than expected based on previous studies on eastern wild turkeys.

Previous studies have documented lower annual survival for adults than juveniles, regardless of harvest regime (Ielmini et al. 1992, Wright and Vangilder 2001), hence we were not surprised to observe similar results. Adults are typically more susceptible to harvest (Lewis 1980, Ielmini et al. 1992, Wright 1998, Hubbard and Vangilder 2005) and increased mortality of adults due to harvest may skew age classes to younger males (Vangilder 1992), resulting in lower quality spring turkey hunting (Wright and Vangilder 2005). Kurzejeski and Vangilder (1992) suggested that harvesting >25% of adult males shifted the age ratio in favor of juvenile males. The number of adults banded during the liberal season in our study was 50% ($n = 68$ vs. 131) of that banded during the conservative season. When the bag limit was reduced to 2 birds, the number of adults banded ($n = 131$) was similar to the number of juveniles banded ($n = 127$), suggesting that prior to bag limit reductions age ratios were highly skewed toward juveniles. Reducing the bag limit and implementing a more conservative harvest season appears to have helped balance age ratios in the population we studied.

Mean annual survival of adult males in our study was 0.16 and 0.31 during liberal and conservative harvest season, respectively. Regardless of the harvest season, these survival rates are lower than in previous studies throughout the geographic range of the eastern wild turkey (Ielmini et al. 1992, Paisley et al. 1995, Hubbard and Vangilder 2005), with the exception of the 26.2% annual survival rate reported by Wright and Vangilder (2005). Likewise, our estimates of harvest rates for adults and juveniles parallel those of Wright and Vangilder (2005) in Missouri, who found that adult mortality rates during the spring hunting season typically doubled that of juveniles. Notably, the band recovery rates for adult males in our study exceed any in the published literature (Stafford et al. 1997 analyzed data from a portion of the same population discussed herein). Previous authors have suggested that harvest rates considerably less than those we report are likely to eventually result in reduced turkey hunting quality, through reductions in the percentage of adult males in the population (Hubbard and Vangilder 2005).

Vangilder and Kurzejeski (1995) used a simulation model with varying levels of spring harvest to infer effects of variable harvest rates on male turkey populations. With a 45% harvest

Table 2. Annual survival and recovery rates (with SE and 95% CI) for male wild turkeys on Ben's Creek Wildlife Management area and surrounding private lands in southeastern Louisiana, 1989–2007. We evaluated 2 harvest strategies (liberal and conservative hunting seasons).

Parameter	Survival estimate	SE	95% CI	Recovery estimates	SE	95% CI
Liberal season[a]						
Adults	0.16	0.05	0.08–0.28	0.75	0.05	0.63–0.84
Juveniles	0.43	0.05	0.34–0.52	0.63	0.04	0.54–0.71
Conservative season[b]						
Adults	0.31	0.05	0.23–0.40	0.61	0.04	0.52–0.69
Juveniles	0.56	0.05	0.46–0.66	0.48	0.05	0.39–0.57

[a] Three-bird limit per hunter with 37 day (1989–1994) and 23 day (1995–1997) season.
[b] Two-bird limit per hunter with 23 day (1998–2004) and 16 day (2005–2007) season.

rate, annual survival rates of adult and juvenile males were 0.26 and 0.40, respectively. Wright and Vangilder (2005) used the same model reported in Vangilder and Kurzejeski (1995) to calculate the proportion of the prehunt population killed by hunters. The model predicted that with a 45% harvest rate of males, 63% of adult and 32% of juvenile males in the prehunt population were killed; these numbers closely tracked the observed harvest rates based on radio-tracked males in their study (Wright and Vangilder 2005), and are still less than harvest rates on our study area. We agree with Wright and Vangilder (2005), who suggested that harvest rates similar to what we observed are not sustainable and inevitably will result in reductions in hunting quality.

MANAGEMENT IMPLICATIONS

Spring harvest was a primary mortality factor for male wild turkeys in our study.

Although reducing bag limits increased annual survival of males and appeared to balance age ratios within the male population, we offer that the observed rates of survival and recovery are not sustainable without compromising quality of turkey hunting on our study area. We recommend that the LDWF consider further adjustments to the turkey hunting season on our study area to increase survival rates and reduce annual recovery rates. Alternatively, further reducing bag limits to 1 bird has potential to reduce harvest rates, but relationships between reduced harvest rate of turkeys and hunter participation warrant investigation. Reducing the number of hunting days available within the spring season, coupled with a reduction in bag limit, may offer the best opportunity to reduce harvest rates to a sustainable level.

ACKNOWLEDGMENTS

Funding and support were provided by the Louisiana Department of Wildlife and Fisheries, the School of Renewable Natural Resources at Louisiana State University (LSU), the LSU Agricultural Center, and the Warnell School of Forestry and Natural Resources at the University of Georgia. We appreciate the efforts of staff at the Ben's Creek Wildlife Management Area and the many hunters on surrounding private lands that reported harvested birds.

LITERATURE CITED

Anderson, D. R., W. A. Link, D. H. Johnson, and K. P. Burnham. 2001. Suggestions for presenting the results of data analyses. Journal of Wildlife Management 65:373–378.

Anderson, D. R., and K. P. Burnham. 2002. Avoiding pitfalls when using information–theoretic methods. Journal of Wildlife Management 66:912–918.

Brownie, C., D. R. Andersen, K. P. Burnham, and S. Robson. 1985. Statistical inference from band recovery data. United States Fish and Wildlife Service Resource Publications 217, Washington, D.C., USA.

Godwin, K. D., G. A. Hurst, and R. L. Kelley. 1991. Survival rates of radio-equipped wild turkey gobblers in east-central Mississippi. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 45:218–226.

Grisham, B. A., M. J. Chamberlain, and F. G. Kimmel. 2008. Spatial ecology and survival of male wild turkeys in a bottomland hardwood forest. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 62:70–76.

Healy, W. M., and S. M. Powell. 2000. Wild turkey management: planning for the future. Proceedings of the National Wild Turkey Symposium 8:233–241.

Hubbard, M. W., and L. D. Vangilder. 2005. Survival of eastern wild turkey males in the eastern Missouri Ozarks. Proceedings of the National Wild Turkey Symposium 9:361–366.

Ielmini, M. R., A. S. Johnson, and P. E. Hale. 1992. Habitat and mortality relationships of wild turkey gobblers in the Georgia Piedmont. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 46:128–137.

Kurzejeski, E. W., and L. D. Vangilder. 1992. Population management. Pages 166–184 *in* J. G. Dickson, editor. The wild turkey, biology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Lewis, J. B. 1980. Fifteen years of wild turkey trapping, banding, and recovery data in Missouri. Proceedings of the National Wild Turkey Symposium 4:24–31.

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.

Norman, G. W., M. M. Conner, J. C. Pack, and G. C. White. 2004. Effects of fall hunting on survival of male wild turkeys in Virginia and West Virginia. Journal of Wildlife Management 68:393–404.

Pack, J. C., G. W. Norman, C. I. Taylor, D. E. Steffen, D. A. Swanson, K. H. Pollack, and R. Alpizar-Jara. 1999. Effects of fall hunting on wild turkey populations in Virginia and West Virginia. Journal of Wildlife Management 63:964–975.

Paisley, R. N., R. G. Wright, and J. F. Kubisiak. 1995. Survival of wild turkey gobblers in southwestern Wisconsin. Proceedings of the National Wild Turkey Symposium 7:39–44.

Pelham, P. H., and J. G. Dickson. 1992. Physical characteristics. Pages 166–184 *in* J. G. Dickson, editor. The wild turkey, biology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Porter, W. F. 1978. Behavior and ecology of the wild turkey in southeastern Minnesota. Dissertation, The University of Minnesota, Minneapolis, USA.

Stafford, N. J., III, R. M. Pace, III, and M. W. Olinde. 1997. Eastern wild turkey gobbler harvest and physical characteristics in southeastern Louisiana. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 51:381–387.

Tapley, J. L., R. K. Abernethy, and J. E. Kennamer. 2001. Status and distribution of wild turkey in 1999. Proceedings of the National Wild Turkey Symposium 8:15–22.

Vangilder, L. D. 1992. Population dynamics. Pages 144–164 *in* J. G. Dickson, editor. The wild turkey, biology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Vangilder, L. D. 1995. Survival and cause-specific mortality of wild turkeys in the Missouri Ozarks. Proceedings of the National Wild Turkey Symposium 7:21–31.

Vangilder, L. D., and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in northern Missouri. Wildlife Monographs 130.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 Supplement: 120–138.

Wright, G. A. 1998. Turkey hunting data. Kentucky Department of Fish and Wildlife Resources, Federal Aid in Wildlife Restoration Project W-45-30, Annual Report, Frankfort, 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.

Wright, G. A., and L. D. Vangilder. 2005. Survival and dispersal of eastern wild turkey males in western Kentucky. Proceedings of the National Wild Turkey Symposium 9:367–373.

Associate Editor: Bret A. Collier.