Is Spring Wild Turkey Gobbler Harvest Additive or Compensatory?

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Abstract: We compared survival rates of eastern wild turkey (*Meleagris gallopavo sylvestris*) gobblers in hunted (Crackerneck Wildlife Management Area and Ecological reserve [CWMA]) and unhunted (Savannah River Site [SRS]) populations in South Carolina to assess impact of spring gobbler-only hunts. Annual survival rate of gobblers on SRS (0.71) was greater ($\chi^2 = 5.11$; df = 1; $P = 0.02$) than that of gobblers on CWMA (0.54). Our results indicate that spring gobbler harvests constitute additive mortality to turkey populations. However, even in years when reproductive rates were relatively low, a spring-only gobbler harvest rate of 25% appeared to have a minimal effect on turkey populations.

Key words: eastern wild turkey, *Meleagris gallopavo*, gobbler, survival, harvest, additive mortality, South Carolina

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The effect of regulated hunting on wildlife populations has been a concern of wildlife managers for decades (Burger et al. 1994). For many game species, little is known about the relationship between harvest and natural mortality, which can lead to uncertainty when establishing harvest regulations (Williams et al. 2004). Hunting has often been viewed as a compensatory mortality factor for many wildlife populations (Caughley 1983), meaning that harvest reduces natural mortality rates in populations following the hunt. In some northern bobwhite (*Colinus virginianus*) populations, hunting appears to have a partial compensatory effect on mortality rates (Roseberry 1979, Williams et al. 2004). However, Pollock et al. (1989a) reported an additive effect of hunting on mortality rates for northern bobwhites in a Georgia population. Hunting also acted as an additive mortality component in a population of ruffed grouse (*Bonasa umbellus*) (Small et al. 1991).

For many geographic areas, little is known about wild turkey (*Meleagris gallopavo*) survival rates in hunted populations, and effects of spring gobbler hunting on populations are largely unknown (Kurzejeski et al. 1987, Godwin et al. 1991, Palmer et al. 1993). Survival rates of recently released gobblers in Texas ranged from 0.68–0.71 (Campo et al. 1984, Swank et al. 1985), whereas the gobbler survival rate in a hunted Alabama population was 0.63 (Everett et al. 1980). In contrast, in an intensively hunted population in Iowa, juvenile and gobbler survival rates were 0.38 and 0.33, respectively (Vangilder 1992).

It has long been assumed that spring-only hunting constituted an additive mortality factor in turkey populations (Vangilder 1992). However, this assumption has not been verified through field studies. Several wild turkey population models have been developed that simulate effects of hunting on turkey populations (Lobdell et al. 1972, Suchy et al. 1990, Alpizar-Jara et al. 2001), and all indicate that spring-only gobbler harvests do not affect population growth. Several studies have examined gobbler survival rates before and after implementation of spring-only hunting (Vangilder 1992), primarily on areas with recently established populations. However, to our knowledge, no research has compared gobbler survival between an established, unhunted control population and a similar hunted population. Our objectives were to compare survival rates and causes of mortality of wild turkey gobblers between long-established unhunted and hunted populations in the Coastal Plain of South Carolina to determine whether spring harvest is additive or compensatory.

Study Area

We conducted our study on the U. S. Department of Energy's Savannah River Site (SRS), which comprised approximately 802 km^2 of the upper coastal plain of South Carolina. The SRS had been closed to hunting since 1951 prior to re-establishment of wild turkeys in the region (Moore et al. 2005). In the early 1970s, South Carolina Department of Natural Resources (SCDNR) reintroduced wild turkeys on SRS to establish a source population for future restocking efforts within and outside the state. Therefore,

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the SRS turkey population had been established for >30 years and had never been hunted. Because public access was highly restricted for security purposes, human-induced mortality (except that caused by vehicle collisions) was nearly impossible.

The Crackerneck Wildlife Management Area and Ecological Reserve (CWMA) was a 4400-ha portion of SRS on its western side, operated by the SCDNR. The CWMA initiated spring, gobbler-only hunting in 1983 and the area was open to the public for turkey hunting on Fridays and Saturdays, 1 April-1 May. Hunters were permitted to take juvenile and adult gobblers, and the state limit was five turkeys.

Approximately 90% of the land area of SRS (including CWMA) was in forested cover, managed by the USDA Forest Service on 50- to 120-year rotations. Vegetation types included longleaf pine (*Pinus palustris*), loblolly pine (*P. taeda*), mixed pine-hardwood, upland hardwood, and bottomland hardwood forests, with early successional habitats occurring in rights-of-way and timber regeneration areas. Approximately 12% of the area was in stands less than 10 years old and 31% was in stands exceeding 50 years old (Blake and Bonar 2005). Pine stands were prescribe-burned on a two- to five-year rotation.

Methods

We captured wild turkeys during January-March of 1998–2000 using 9 ×18-m rocket nets (Bailey et al. 1980). We fitted each turkey with a numbered aluminum leg band and a "backpack" harness containing an 80-g radio transmitter equipped with a mortality signal (20-month battery life; Telonics, Mesa, Arizona). Capture and handling techniques were approved by the Clemson University Research Committee (Animal Use Protocol Number 01-003). We monitored turkeys three times weekly with a handheld Yagi antenna and portable receiver until the birds died or the transmitter ceased to function. When we suspected mortality, we located birds and attempted to determine cause of death based on evidence at the mortality site, such as hair, tracks, bite marks, and cache characteristics. We excluded from analyses birds not surviving 14 days post-instrumentation because of the potential for injury or stress resulting from capture.

We calculated annual survival rates for 1998–2000 for gobblers on both areas using the Kaplan-Meier procedure to allow for staggered entry of newly marked animals (Kaplan and Meier 1958, Pollock et al. 1989b). We used the log-rank test (Cox and Oakes 1984, Pollock et al. 1989b) to compare survival rates between hunted and unhunted populations. Except for hunting mortality on the CWMA population, all other mortality factors should have been comparable between the CWMA and SRS populations, because the areas were contiguous and under similar land management; habitat types were comparable and we know of no reason that predator populations should have differed. Therefore, if annual survival rates differed between the two areas, we assumed the difference indicated an additive effect of the spring-only harvests.

We also partitioned mortality rates (Caughley 1977) as $q = u + w$ where u and w were the proportion of a population killed by hunting and natural agents, respectively, and q was the proportion killed by all agents. Values of u and w are not independent. If hunting were banned, w would increase because without hunting some animals that would have been harvested are now at risk from other agents. The problem is relaxed by defining isolated mortality rates as h, the proportion that would die from hunting if no animals died from natural causes and n, the proportion that would die from natural causes if there were no hunting. They are related to total rate of mortality by $q = h + n - hn$. Because no hunting was allowed on SRS, $q = w = n$ for this population. Assuming n for the SRS and CWMA populations were equal allows calculation of h for the CWMA population. If hunting mortality was compensatory, values of q for the SRS and CWMA would be expected to be similar. In contrast, if hunting mortality was additive the value of q for CWMA should be greater than that for SRS.

Results

From January-March 1998–2000, we captured 47 gobblers on SRS including 14 juveniles and 19 gobblers on CWMA including 7 juveniles. We excluded from analyses one adult gobbler on SRS because its death was likely capture-related. Number of gobblers at risk on 1 Apr 1998, 1999, and 2000, respectively, was: 10 (SRS) and 6 (CWMA); 19 (SRS) and 10 (CWMA); and 27 (SRS) and 6 (CWMA). During the study, 19 birds were censored due to transmitter failure or loss of contact. Mean annual survival rate of gobblers on SRS (0.71; SE = 0.01; Figure 1) was greater ($\chi^2 = 5.11$; df = 1; $P = 0.02$) than that of gobblers on CWMA (0.54; SE = 0.09). Bobcats (*Lynx rufus*) were the only confirmed natural predator of gobblers, whereas hunters accounted for nine mortalities on CWMA (Table 1). However, four of the nine hunter-killed birds died after radio transmitters had ceased to function and were therefore excluded from survival analyses. Seven mortalities were attributed to unknown predators because insufficient evidence was present for positive identification. Of these, two occurred on CWMA. We do not believe that these CWMA predation events resulted from hunter crippling, as one occurred on 2 March (prior to hunting season) and one occurred on 28 June (nearly two months after the close of hunting season). On SRS, two gobblers were killed by automobiles.

Total mortality rate (q) from 1998–2000 for the SRS population was 0.383 (18 of 47) and for the CWMA population was

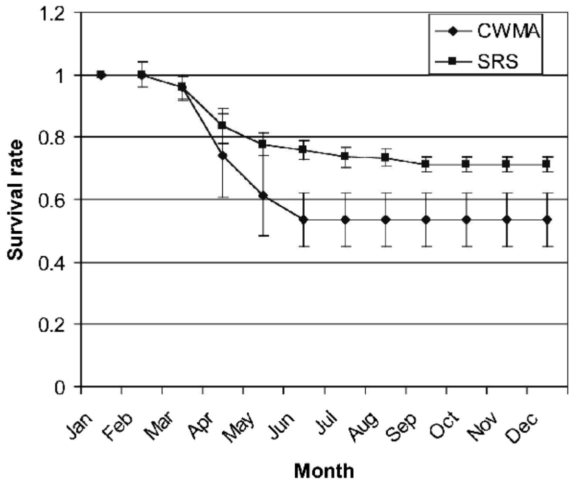

Figure 1. Mean annual survival rates for gobblers on the Savannah River Site (SRS) and Crackerneck Wildlife Management Area and Ecological Reserve (CWMA), South Carolina, 1998–2000.

Table 1. Numbers of mortalities and mortality rates among monitored gobblers (47 on SRS and 19 on CWMA) on the Savannah River Site (SRS) and Crackerneck Wildlife Management Area and Ecological Reserve (CWMA), South Carolina, 1998–2000.

Cause	SRS	CWMA
Bobcat	11 (0.234)	5 (0.263)
Harvest	0	5 (0.263)
Road kill	2 (0.043)	0
Unknown predator	5 (0.106)	2 (0.105)
Total	18 (0.383)	12 (0.632)

0.632 (12 of 19; Table 1). Proportion of monitored birds lost to natural agents was 0.383 (18 of 47) for SRS and 0.368 (7 of 19) for CWMA. Assuming that values of *n* for SRS and CWMA were equal, the value of *h* for CWMA was 0.404.

Discussion

Our analyses indicate that spring-only gobbler hunting constitutes an additive mortality component for the wild turkey population on CWMA. Mortality from natural causes was similar between the two populations (0.383 for SRS versus 0.368 for CWMA) with the addition of hunting as a mortality source at CWMA accounting for the difference in survival rates between the two populations. Because SRS provided a unique opportunity to examine survival rates and causes of mortality in a large, well-established, unhunted wild turkey population, this is the first study to demonstrate that spring-only hunting has a significant additive effect on gobbler survival rates. Previous studies have examined the effect of fall harvest on wild turkey survival rates. However, they only compared addition of a fall harvest to an existing spring harvest and lacked any control populations that were free of hunting. Little et al. (1990) reported that fall gobbler harvest was an additive mortality component for gobbler populations in Iowa. In contrast, in Virginia and West Virginia populations, fall hunting mortality did not appear to be additive for gobblers (Norman et al. 2004).

Several factors should have made it more difficult for us to detect a difference in survival rates between our two populations. First, our sample of marked birds at CWMA was small, resulting in a larger error for that estimate. Second, due to our small sample size, we included juvenile gobblers in our estimates of survival rates. Although the age composition of the two marked populations was approximately similar (30% juvenile for SRS, 37% juvenile for CWMA), inclusion of juvenile gobblers in the CWMA population may have biased our estimate for that area upward (i.e., closer to the un-hunted population), as juvenile gobblers are known to be less susceptible to harvest than adult gobblers (Vangilder 1992). Finally, overall harvest at CWMA (26% of marked gobblers) was low compared to reports from other hunted populations, possibly because hunting at CWMA was limited to two days/week. In other southeastern populations, 29%–44% of marked birds have been reported killed during spring gobbler seasons (Everett et al. 1980, Williams and Austin 1988, Palmer et al. 1990). Despite these considerations, we detected a statistically significant difference in survival rates for the two populations. However, we cannot rule out the possibility that our findings were an artifact of our small sample size. In addition, our treatment populations were not replicated, so our results should be viewed with caution until confirmed with additional research.

Most gobbler predation on SRS (73%) and on CWMA (71%) occurred during spring, coinciding with hunting season. Similarly, Godwin et al. (1991), Holdstock et al. (2006), and Thogmartin and Schaeffer (2000) reported that most natural mortality occurred during spring. Gobblers apparently are at greater risk to predation during mating season when their attention is focused on attracting and mating with hens. Though bobcats were the only confirmed natural predator during the study, coyotes (*Canis latrans*) also may affect gobbler populations on SRS and CWMA. Coyotes were first documented on SRS in 1986 (Mayer et al. 2005) as their range expanded across the Southeast, and the population there was increasing during our study (J. C. Kilgo, USDA Forest Service Southern Research Station, unpublished data). Coyotes have been reported as major wild turkey predators in many other studies (Miller and Leopold 1992) and during a concurrent hen study on SRS, they were responsible for two confirmed hen deaths (Moore 2006). Coyotes likely were responsible for some portion of our unknown gobbler mortalities.

The survival rate of gobblers (0.71) in the long-established, unhunted SRS population was similar to that of newly stocked populations in other areas, whereas the CWMA survival rate (0.54) was in the range of those reported from other hunted populations. In two re-stocked Texas populations, unhunted gobblers had annual survival rates of 0.71 (Campo et al. 1984) and 0.68 (Swank et al. 1985). Reported gobbler survival rates in hunted populations vary greatly geographically, from 0.63 in Alabama (Everett et al. 1980) to 0.36 in Texas and Kansas (Holdstock et al. 2006).

Several population models have been developed to examine potential effects of spring and fall harvests on wild turkey populations. Under the model developed by Vangilder and Kulowiec in Missouri (Vangilder 1992), assuming average recruitment rates and that hunting mortality was additive, population growth was relatively unchanged with spring gobbler harvests of ≤30%. In our study, 26% of marked gobblers on CWMA were harvested by hunters, indicating that harvest at current CWMA levels should be sustainable. If the four hunter-killed, censored birds were included in analyses, harvest mortality at CWMA would have been 47%, much greater than the threshold hypothesized by the Missouri model. Although it is therefore possible that harvest at CWMA approached levels that would affect population size, evidence from SCDNR summer brood surveys during 2000–2002 indicate that the population remained stable (M. B. Caudell, SCDNR, unpublished data) despite poor nesting success in 1999–2000 (Moore 2006). Thus, even in years of relatively low reproductive rates, the population was able to withstand relatively high harvest rates.

Many studies have demonstrated that legal harvest of turkeys can be a primary mortality factor in some areas (Vangilder 1992). Our results indicate that, in addition to being a significant mortality factor, spring gobbler harvests constitute an additive mortality factor in wild turkey populations. However, even in years when reproductive rates are relatively low, spring-only gobbler harvest rates of 30%–40% may have a minimal long-term effect on turkey populations. Due to the polygynous mating system of wild turkeys, timing of spring-only harvests (Beville 1975) could be more important than the level of harvest that occurs during the hunts. If high gobbler harvests occur before the peak of the mating season (Miller et al. 1997), hunting could impact populations by affecting nesting rates and egg fertility (Exum et al. 1987, Vangilder 1992).

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Literature Cited

Alpizar-Jara, R., E. N. Brooks, K. H. Pollock, D. E. Steffen, J. C. Pack, and G. W. Norman. 2001. An eastern wild turkey population dynamics model for Virginia and West Virginia. Journal of Wildlife Management 65:415–424.

Bailey, W. D., D. Bennett, Jr., H. Gore, J. Pack, R. Simpson, and G. Wright. 1980. Basic considerations and general recommendations for trapping the wild turkey. Proceedings of the National Wild Turkey Symposium 4:10–23.

Beville, W. V., Jr. 1975. Setting spring gobbler hunting seasons by timing peak gobbling. Proceedings of the National Wild Turkey Symposium 3:198–204.

Blake, J. I. and R. T. Bonar. 2005. Commercial forest products. Pages 328–338 *in* J. C. Kilgo and J. I. Blake, editors. Ecology and management of a forested landscape. Island Press, Washington, D.C.

Burger, L. W., E. W. Kurzejeski, L. D. Vangilder, T. V. Dailey, and J. H. Schultz. 1994. Effects of harvest on population dynamics of upland gamebirds: are bobwhite the model? Transactions of the North American Wildlife and Natural Resources Conference 59:466–476.

Campo, J. J., C. R. Hopkins, and W. G. Swank. 1984. Mortality and reproduction of stocked eastern wild turkeys in east Texas. Proceedings of the Annual Conference of the Southeastern Association Fish and Wildlife Agencies 38:78–86.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons Ltd., New York, New York.

———. 1983. Harvesting of wildlife: past, present, and future. Pages 3–14 *in* R. McCullough and R. H. Barrett, editors. Game harvest management. Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.

Cox, D. R. and D. Oakes. 1984. Analysis of survival data. Chapman and Hall, New York, New York.

Everett, D. D., Jr., D. W. Speake, and W. K. Maddox. 1980. Natality and mortality of a north Alabama wild turkey population. Proceedings of the National Wild Turkey Symposium 4:117–126.

Exum, J. H., J. A. McGlincy, D. W. Speake, J. L. Buckner, and F. M. Stanley. 1987. Ecology of the eastern wild turkey in an intensively managed pine forest in southern Alabama. Tall Timbers Research Station Bulletin 23, Tallahassee, Florida.

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

Holdstock, D. P., M. C. Wallace, W. B. Ballard, J. H. Brunjes, R. S. Phillips, B. L. Spears, S. J. Demaso, J. D. Jernigan, R. D. Applegate, and P. S. Gipson. 2006. Male Rio Grande turkey survival and movements in the Texas panhandle and southwestern Kansas. Journal of Wildlife Management 70:904–913.

Kaplan, E. L. and E. Meier. 1958. Nonparametric estimation from incomplete observations. Journal of American Statistical Association 53:457–481.

Kurzejeski, E. W., L. D. Vangilder, and J. B. Lewis. 1987. Survival of wild turkey hens in north Missouri. Journal of Wildlife Management 51:188–193.

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.

Lobdell, C. H., K. E. Case, and H. S. Mosby. 1972. Evaluation of harvest strategies for a simulated wild turkey population. Journal of Wildlife Management 36:493–497.

Mayer, J. J., L. D. Wike, and M. B. Caudell. 2005. Furbearers. Pages 366–373 *in* J.C. Kilgo and J.I. Blake, editors. Ecology and management of a forested landscape. Island Press, Washington, D.C.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1997. Chronology of wild turkey nesting, gobbling, and hunting in Mississippi. Journal of Wildlife Management 61:840–845.

Miller, J. E. and B. D. Leopold. 1992. Population influences: predators. Pages 119–128 *in* J. G. Dickson, editor. The wild turkey: biology and management. Stackpole, Harrisburg, Pennsylvania.

Moore, W. F. 2006. Survival, nesting success, and habitat selection in wild turkey populations in the upper coastal plain of South Carolina. Doctoral dissertation. Clemson University, Clemson, South Carolina.

———, J. C. Kilgo, W. D. Carlisle, and M. B. Caudell. 2005. Wild turkey. Pages 359–366 *in* J. C. Kilgo and J. I. Blake, editors. Ecology and management of a forested landscape. Island Press, Washington, D.C.

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.

Palmer, W. E., G. A. Hurst, and J. R. Lint. 1990. Effort, success, and characteristics of spring turkey hunters on Tallahala Wildlife Management Area, Mississippi. Proceedings of the National Wild Turkey Symposium 6:208–213.

———, ———, J. E. Stys, D. R. Smith, and J. D. Burk. 1993. Survival rates of wild turkey hens in loblolly pine plantations in Mississippi. Journal of Wildlife Management 57:783–789.

Pollock, K. H., C. T. Moore, W. R. Davidson, F. E. Kellogg, and G. L. Doster. 1989a. Survival rates of bobwhite quail based on band recovery analyses. Journal of Wildlife Management 53:1–6.

———, S. R. Winterstein, C. M. Bunck, and P. D. Curtis. 1989b. Survival analyses in telemetry studies: the staggered entry design. Journal of Wildlife Management 53:7–15.

Roseberry, J. L. 1979. Bobwhite population responses to exploitation: real and simulated. Journal of Wildlife Management 43:285–305.

Small, R. J., J. C. Holzwart, and D. H. Rusch. 1991. Predation and hunting mortality of ruffed grouse in central Wisconsin. Journal of Wildlife Management 55:512–520.

Suchy, W. J., G. A. Hanson, and T. W. Little. 1990. Evaluation of a population model as a management tool in Iowa. Proceedings of the National Wild Turkey Symposium 6:196–204.

Swank, W. G., D. J. Martin, J. J. Campo, and C. R. Hopkins. 1985. Mortality and survival of wild trapped eastern wild turkeys in Texas. Proceedings of the National Wild Turkey Symposium 5:113–120.

Thogmartin, W. E. and B. A. Schaeffer. 2000. Landscape attributes associated with mortality events of wild turkeys in Arkansas. Wildlife Society Bulletin 28:865–874.

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

Williams, C. K., R. S. Lutz, and R. D. Applegate. 2004. Winter survival and additive harvest in northern bobwhite coveys in Kansas. Journal of Wildlife Management 68:94–100.

Williams, L. E., Jr. and D. H. Austin. 1988. Studies of the wild turkey in Florida. Technical Bulletin 10, Florida Game and Freshwater Fish Commission, Gainesville, Florida.