

Wild Turkey Nesting Ecology in the Lower Coastal Plain of South Carolina

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Abstract: A population of eastern wild turkeys (*Meleagris gallopavo silvestris*) was studied in the lower coastal plain of South Carolina to determine if intensively managed short-rotation pine plantations have a detrimental effect on reproductive success. Reproductive parameters including nesting chronology, nest success, hen success, clutch size, and hatchability were estimated from 50 radio-instrumented hens monitored during 1988–1990. Predation during nesting and brooding periods was the major cause of nest and adult hen losses (55%). However, illegal kills were as high (45%). Median dates for incubation initiation and hatching were 8 May and 3 June, respectively. Nest success (% hatched ≥ 1 egg) was 57.9%. Proportion of hens in the population expected to produce poults was 50%. Clutches averaged 9.8 eggs with 82% hatchability. Number of poults produced/hen averaged 4.0. Nest sites were located in all stand types in proportion to their availability. Stand age or basal area did not affect nest site selection. Most nests (61%) occurred in stands controlled burned within 2 years and 62% of nests were located within 30 m of a road, trail or firebreak. Reproductive parameters were similar to values reported in other studies and did not indicate a negative effect from intensive forest management practices.

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Wild turkey populations in the southeastern United States may be limited by conversion of natural stands of hardwoods and pine to short-rotation pine

(*Pinus* spp.) plantations. Such conversion has been the topic of much concern (McDowell 1956, Lay 1959, Stoddard, 1963, Shaffer and Gwynn 1967). Mosby (1975) attributed the decline of wild turkey populations on some areas in Alabama to industrial pine monocultures. These short-rotation, intensively managed pine plantations were not considered capable of supporting huntable wild turkey populations (Bailey and Rinnell 1967, Holbrook 1973, Mosby 1975). However, others report some pine forests on the southeastern United States are capable of supporting viable turkey populations (Speake et al. 1975, Hurst and Dickson 1992). Even though wild turkeys are adapted to more habitat types and are more tolerant of man's activities than first thought (Hurst and Dickson 1992), potential impacts to turkey populations and habitat could be substantial as conversion of natural pine and mixed hardwood-pine forests to short rotation pine plantations continues. Abundance of wild turkeys in the future will depend on an improved understanding of effects of various silvicultural practices on wild turkey productivity.

Our objective was to examine reproductive parameters for a population of wild turkey hens located in intensively managed short-rotation pine plantations in the lower coastal plain of South Carolina. We report timing of reproductive effort and describe reproductive success during 1988–1990.

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Methods

We studied turkeys on the Oswald Tract, a 5,363-ha forest owned and managed by Westvaco Corporation, located in the southeast corner of South Carolina's lower coastal plain. The tract is intensively managed for softwood fiber on 25–30 year rotations. Most land (4,579 ha) is in pine production, with 4,047 ha in plantations of loblolly pine (*P. taeda*) ranging in age from 1–36 years. Natural pine stands cover 532 ha (10%) and consist of loblolly pine, slash pine (*P. elliotii*) and longleaf pine (*P. palustris*). Natural hardwood stands occupy 288 ha (5%). The remaining 496 ha (9%) are openings including stands that have been harvested but not replanted, roads, ditches, food plots, and maintenance areas.

Terrain is flat with slopes generally <2%. Elevation ranges from 24–30 m above sea level. Soils range from very poorly drained to excessively well drained with most being somewhat poorly drained (Stuck et al. 1980). Climate is classified as subtropical, with long hot summers and short mild winters. Average annual daily high temperature is 25.1 C and ranges from 16.8 C in January to 33.1 C in July. Annual precipitation averages 125 cm, with about 75% occurring between April and June.

Corridors of mature pines are maintained around young pine plantations and several small openings and roads were planted in bahia grass (*Paspalum*

notatum) or rye (*Specale cereale*). Six hunting clubs lease land on the area with deer and turkey as the primary game species.

Trapping occurred during 01 January–5 March from 1988–1990. Turkeys were captured using rocket-projected netting (Dill and Thornsberry 1950, Bailey et al. 1980). Captured turkeys were sexed, aged as adult or yearling (Mosby and Handley 1943), weighed, leg-banded, and fitted with a multi-purpose radio-transmitter (Everett et al. 1978, Nenno and Healy 1979). Yearlings were birds hatched the previous year. All birds were released within 1 hour of capture. Methods were reviewed and approved by the Clemson University Animal Research Committee (Protocol No. 347).

Signals were monitored using a multi-channel receiver coupled with a hand-held yagi antenna. Incubation, roosting and mortality could be inferred from an increase in signal pulse rate from a motion sensor within the transmitter activated whenever the transmitter had been stationary for a minimum of 15 minutes.

Hens were located twice weekly until early spring. Birds were located twice/day, 3–5 days/week as nesting season approached to determine approximate date of incubation initiation for each hen. We avoided flushing early incubating hens. After 3 weeks of incubation, we approached nests to pinpoint nest locations. Using telemetry, nests were located by taking compass readings to incubating hens from points close to nests (50m). Nests were approached once during the latter stage of incubation when the hen was off the nest. We also tried to visually locate hens on nests before hens flushed; however, if hens flushed, eggs were counted and investigators quickly left the area. Nest checks were made early in the day to allow flushed hens sufficient time to return to nests. Using telemetry, nesting hens early in incubation were checked ≥ 3 times/week. Late incubating hens (>20 days) were checked daily to determine hatching dates. Immediately after hatching, the nest site was examined to determine hatching success. Nest initiation dates were determined by counting total number of eggs present in each nest, assuming 1.5 days per egg laid (Mosby and Handley 1943), and back-dating (number of days required to lay the clutch) from date of incubation initiation. Nests lost to predation or abandonment were examined to determine possible causes. Whenever possible, hens that died were recovered and necropsied to determine cause of death.

Because nesting wild turkeys do not begin incubation until all eggs are laid, lack of movement as indicated by the motion sensing transmitter was indicative of incubation rather than egg laying. Thus, nests lost before initiation of incubation were not detected; therefore, nest totals reported may be lower than actually occurred.

Hen success was defined as number of successful hens/total number of hens monitored. A successful hen was defined as hatching at least 1 egg. Total hens included unsuccessful nesters as well as hens that did not attempt to nest. Nest success was defined as proportion of nests surviving to hatch and hatchability was defined as proportion of eggs from successful nests that hatched.

Habitat characteristics of each nest site were measured after hens left nesting sites. Habitat types around nests were determined from forest stand maps and ground reconnaissance. Basal area (m^2/ha) was calculated from diameter measurements of trees >12.5 cm diameter at breast height (dbh) within a 0.04-ha circular plot centered around the nest site. Distances to openings were measured from each nest. Openings included roads, trails, firebreaks, or foodplots. A burning history of each stand, supplied by Westvaco, was reviewed to determine the time from nesting to the last burn.

Results

Mortality

We monitored 50 wild turkey hens from 1988 through 1990 (44 adults and 6 yearlings). During 1988 and 1989, poaching was a serious problem on the study area. Known illegal kills included 7 birds in 1988 (1 hen and 6 gobblers) and 9 birds (8 hens and 1 gobbler) in 1989. Nine transmitted hens were killed illegally (18%); three were incubating eggs. Only 1 gobbler was known to be taken illegally in 1990.

Eleven hens, all adults, were lost to predation (22%). Two of the 11 (18.2%) were lost to predation prior to nesting. Three (27.3%) were taken by predators during nesting season. Two were killed while incubating. The third may have initiated egg laying; however, incubation was not detected.

Six of the 11 hens (54.5%) were lost to predation after successfully hatching broods. Four were taken by predators <2 weeks after hatching and 1 was taken approximately 1 month after hatching. All 5 of these broods were assumed to have perished. The sixth hen was taken in mid-October and was not considered a brood related mortality. Eight of 11 hens (72.7%) were taken during nesting ($N = 3$) and the brood rearing season ($N = 5$).

Nesting

After 4 mortalities and 2 hens leaving the study area, 44 hens (39 adults, 5 juveniles) were monitored at the beginning of nesting season. Of these, 36 (81.8%) initiated incubation.

Thirty-six birds were responsible for 40 nests including 4 renests. Twenty-nine nests were located (26 initial and 3 renests). All hens flushed once after 3 weeks of incubation resumed incubation on the same day with no apparent effect on nesting success. One nest was located shortly after the clutch had hatched and the hen and poults left the area. Two nests were located after hens were accidentally flushed by researchers, 1 that had been flushed twice in the fourth week of incubation and 1 in the first week of incubation. Both abandoned the original nests but subsequently renested. Eleven nests were not located. Four hens abandoned nests for unknown reasons before location, 3 hens were poached while incubating, 3 abandoned apparently from free ranging dogs, and 1 nest hatched before the exact nest site was located.

Nesting Chronology

Assuming eggs were laid at the rate of 1 egg/1.5 days, initiation of first nests (egg laying) ranged from 15 March through 23 May with a median date of 24 April ($N = 26$). One hen began laying in March (3.8%), 15 started during April (57.7%), and 10 in May (38.5%). Incubation initiation ranged from 9 April to 7 June with a median date of 7 May. Incubation of 7 nests (26.9%) began in April, 18 (69.2%) in May, and 1 began during the first week of June. Hatching dates, based on a 27-day incubation period, ranged from 6 May to 4 July with a median date of 3 June. Renests (second incubated nests) ranged from 20 June to 26 July. Peak hatching occurred from the last week in May through the second week in June (61.5%, $N = 16$). Therefore, nesting season occurred from 15 March and extended through the hatching date of the last renesting on 26 July.

Nest Success

Number of Hens Nesting.—Thirty-five of 39 adults (89.7%) initiated incubation compared to 1 of 5 (20%) yearlings (Table 1). Annual rates for adult hens

Table 1. Nesting success for wild turkeys monitored during the breeding and nesting periods in intensively managed pine plantations in the coastal plain of South Carolina, 1988–1990.

	Year			Total
	1988	1989	1990	
<i>N Hens</i>				
Adults	10	14	15	39
Yearlings	0	0	5	5
Total	10	14	20	44
<i>Hens nesting^a</i>				
Adults	10	13	12	35
Yearlings	0	0	1	1
Total	10	13	13	36
<i>% Nesting^b</i>				
Adults	100.0	92.9	80.0	89.7
Yearlings	0.0	0.0	20.0	20.0
Total %	100.0	92.9	65.0	81.8
<i>Hens Successful^c</i>				
Adults	5	7	10	22
Yearlings	0	0	0	0
Total	5	7	10	22
<i>% Successful</i>				
Adults	50.0	50.0	66.7	57.8
Yearlings	0.0	0.0	0.0	0.0
Total %	50.0	50.0	50.0	51.2

^aNumber of hens that initiated incubation.

^bNumber of hens that hatched at least 1 egg.

^cPercentage = hens successful/total hens monitored.

ranged from 80.0% in 1990 ($N = 15$) to 100.0% ($N = 10$) in 1988. No yearling hens were monitored in 1988 or 1989. In 1990, when 5 yearling hens were monitored, only 1 of 5 (20.0%) was detected nesting compared to 12 of 15 adults (80.0%) for that year.

Fifty percent of all hens ($N = 22$) were successful in hatching eggs (Table 1). Hatching success was higher for adult hens with 22 of 39 (56.4%) adults hatching clutches compared to 0 of 5 yearlings. For each year, 50% or more of adult hens succeeded in hatching a clutch of eggs.

Percentage of nests surviving to hatch eggs was 57.9% (Table 2). Success rates ranged from 41.7% for 1988 to 76.9% for 1990. Because only 1 yearling nested, nest success rate for adults at 59.5% was only slightly higher than the total. Adult success rate for initial nests was 63.6% (21 of 33) and re-nest success was 25.0% (1 of 4).

Clutch Size and Hatchability.—Clutch size averaged 9.8 eggs for all years (Table 2). Clutch size ranged from 2 to 17 eggs. Grouping all successful nests together, 82.2% of eggs produced hatched (Table 2). Hatchability ranged from 68.4% in 1988 to 90.6% in 1989.

Eggs Hatched per Hen.—Eggs hatched/hen was calculated as number of hatched eggs (poults produced) divided by total number of hens available to nest at the beginning of nesting season. Mean number of eggs hatched/hen (adult and yearling) ranged from 3.4 in 1989 to 4.6 in 1990 with an average of 4.0 for all years (Table 2). Number of poults produced/adult hen ranged from 3.4 in 1989 to 6.1 in 1990. Overall, adult hens averaged hatching 4.5 eggs/hen compared to 0.0 for yearling hens.

Nest Losses.—Fifteen of 38 nests (39.5%) were lost from abandonment or nest and/or hen predation. Free-ranging dogs destroyed 3 nests. A raccoon (*Procyon lotor*) destroyed 1 nest, a gray fox (*Urocyon cinereoargenteus*) destroyed 1 nest and an unidentified predator destroyed the other nest. Four nests were lost probably from some type of disturbance; these hens unexpectedly moved from the vicinity of nesting sites. None of these 4 nests were located, therefore nest predation was not confirmed. Five hens were killed while incubating nests. Predators killed 2 hens and poachers killed 3 nesting hens. Two hens abandoned their initial nests after being inadvertently flushed by researchers. These were deleted from nesting totals. Both hens re-nested and these nests were included in nesting totals.

Renesting.—Four of 7 hens (57.1%) survived initial nest losses and re-nested. All were adults but only 1 was successful in its second attempt at hatching eggs. One second nest was abandoned for unknown reasons, 1 was destroyed by raccoons, and 1 had infertile eggs. One yearling and 2 other adults were not detected incubating a second nest after losing their initial nest. Comparing the 3 hens whose initial nests and second nests were located, showed that initial nests averaged more eggs (12.7) than the second nests (8.0). Clutch size was larger in first nests than in re-nests in 6 of 7 studies of eastern wild turkeys (Vangilder 1992).

Table 2. Nest success of wild turkeys monitored during the nesting period in intensively managed pine plantations in the coastal plains of South Carolina, 1988–1990.

	Year			Total
	1988	1989	1990	
<i>N Nests</i>				
Adults	12 ^a	13	12 ^b	37
Yearlings	—	—	1	1
Total	12	13	13	38
<i>Nests successful^c</i>				
Adults	5 ^d	7	10	22
Yearlings	—	—	0	0
Total	5	7	10	22
<i>% Nests successful^e</i>				
Adults	41.7	53.8	83.3	59.5
Yearlings	—	—	0.0	0.0
Total %	41.7	53.8	83.3	57.9
<i>Mean eggs/nest</i>				
Adults	10.1	7.6	10.8	9.8
Yearlings	—	—	—	—
Total	10.1	7.6	10.8	9.8
<i>Mean eggs hatched/hen</i>				
Adults	3.6	3.4	6.1	4.5
Yearlings	—	—	0.0	0.0
Total	3.6	3.4	4.6	4.0
<i>Hatchability %</i>				
Adults	68.4	90.6	82.9	82.2
Yearlings	—	—	0.0	0.0
Total %	68.4	90.6	82.9	82.2

^aIncludes 3 renests.

^bIncludes 1 reneest.

^cNumber of nests that hatched at least 1 egg.

^ePercentage = Number of nests successful/number of nests.

^dTotal hens = 43; 38 adults and 5 yearlings.

Nesting Habitat

We located 39 nests in 4 major habitat types: pine plantations ($N = 30$), natural pine stands ($N = 3$), natural hardwood stands ($N = 3$) and non-forested stands ($N = 3$). Pine plantations were delineated into 4 age classes and all types tested to determine if any one type was used more or less than expected (Neu et al. 1974, Byers et al. 1984). All types were selected in proportion to their availability with no one type being used more or less than expected ($X^2 = 5.01$, $df = 7$, $P = 0.658$).

Basal areas at nest sites ranged from 0.0 m²/ha in clearcuts, forest openings, young pine plantations, and clearcuts to 38.6 m²/ha in a 46-year-old hardwood stand. Ten nests were in stands with basal areas <14.3 m²/ha, 6 were in stands with basal areas between 11.5 and 23.0 m²/ha, and 23 were in stands with basal areas >23.0 m²/ha. There was, however, no detectable selection by hens for any of these 3 basal area categories ($X^2 = 4.59$, $df = 2$, $P = 0.101$).

Thirty-five nests (89.7%) were in stands subjected to periodic controlled burning. Of these, 13 nests (33.3%) were located in stands that had been burned <1 year before nesting, 11 (28.2%) were in stands burned 1 to 2 years before nesting, 2 (5.1%) were in stands that were burned 2–3 years before nesting and 9 (23.1%) were in stands burned >3 years before nesting. Four nests (10.3%) were in unburned stands.

Most hens selected nest sites near some type of forest opening, primarily roads or trails. Of the 29 nests located, 18 (62.1%) were <30 m from a road or trail. Nine (31.0%) were between 30 to 100 m from a road or trail. Only 2 nests (6.9%) were >100 m from any type of opening.

Discussion

Trends in forest use show a steady decline in natural pine and mixed pine-hardwood forest whereas, areas in intensively managed pine plantations are projected to double by the year 2030 (U.S. For. Serv. 1988). Turkeys living in these intensively managed pine forests may be subject to higher rates of mortality than other populations. Because of the high population levels of small mammals within young pine plantations (Atkeson and Johnson 1979), there also exists high populations of predators (Baker and Brooks 1981, Kenward et al. 1981). Relatively high rates of predation reported from similar habitats in south Alabama (Exum et al. 1987) supports the high predation theory. In our study, 22% ($N = 11$) of hens monitored died from natural mortality. Most mortality occurred during the nesting and brood rearing season when hens are most susceptible to predation (Everett et al. 1980, Campo et al. 1984, Kurzejeski et al. 1987). Suspected predators included bobcat (*Felis rufus*) ($n = 4$), gray fox ($n = 1$), great horned owl (*Bubo virginianus*) ($n = 1$) and dogs (*Canis* spp.) ($n = 1$). Causes of 4 mortalities could not be determined.

Extensive road systems required for intensive forest management may contribute to higher poaching rates for turkey populations in these forests (Bailey and Rinell 1967, Holbrook and Vaughan 1985a). In our study, the extensive road system located on this area likely contributed to the high number of hens killed illegally. Eighteen percent of hens monitored during this study were taken illegally, accounting for 45% of total hen mortality. On several occasions, probable poachers were observed driving around locked gates and 1 poacher was observed shooting a turkey from a vehicle. Poaching decreased only after the public was informed of the seriousness of the problem and an increase in law enforcement. This study also demonstrated the need to control access on roads, including installing gates and barricades which can prevent illegal entry. Loss of 6 of 17 (35.3%) nests and 3 incubating hens from poachers and dogs emphasizes the need for control of both illegal entry and free-ranging dogs.

Thirty-five of 39 adult hens (89.7%) initiated incubation. Twenty-two were successful in hatching eggs. The nesting hen success rate for adults was 62.9%. These rates are higher than rates reported in other studies of eastern turkeys in similar habitats (Exum et al. 1987, Everett et al. 1980, Campo et al. 1984, Hon

et al. 1978). Only 1 of 5 yearlings initiated incubation and it was unsuccessful. Even though we were able to monitor yearling hens for only 1 nesting season, the low nesting rate (1 of 5) agrees with findings from other studies in the Southeast (Still and Baumann 1990, Cobb 1990, Davis 1992). However, other studies have reported high yearling nesting rates (Speake et al. 1969, Glidden and Austin 1975, Everett et al. 1980).

Nest success of turkeys within intensively managed, short rotation pine plantations was 58.3% for first nests for all hens and 60.0% for first nests of adults. These success rates were higher than those reported in other studies and habitat types. In 2 studies in east-central Mississippi, hatching success did not exceed 47.6% (Seiss et al. 1990, Smith et al. 1990). A review of 5 other studies showed that success of first nests ranged from 30.7% to 62.0% (Vangilder 1992) with only one study, which contained both eastern and Merriams (nest success = 62.0%), exceeding the rate reported in our study. However, clutch size was slightly lower than those reported in 6 of 7 studies of the eastern wild turkey reviewed by Vangilder (1992).

Hens nested within a wide spectrum of habitat types from clearcuts to pine plantations to natural hardwood stands without any detectable preference for any type. However, 30 of 39 nest sites were located within pine plantations. In our study, 67% of nests occurred in stands burned ≤ 3 years before nesting. In South Georgia, 82% of nests ($n = 23$) were in vegetation burned within 2 years. In Alabama, 89% of hens preferred nest sites in vegetation unburned for ≥ 3 years (Exum et al. 1987). In Mississippi, there was no preference/avoidance for nesting detected for time since burning in mature pine stands (Seiss et al. 1990). Nesting rates, nest success, clutch sizes, hatchability, and nesting habitats were comparable to other studies in similar habitat types (Seiss et al. 1990, Sisson et al. 1990) and do not appear to be as adversely impacted by highly intensive-short rotation pine management as practiced on this area.

Poult mortality was high as 5 of 22 (22.7%) successful hens were lost to predation within 1 month of hatching poults. Poult counts were low in 1988 when no poults were observed with monitored hens after 15 June. In 1989 poult counts were higher as several hens were observed with poults throughout the summer and trapping on the area the following winter consisted of 27% yearlings. Seven of 10 hens in 1990 were successful in carrying broods through summer months.

Data from our study support the conclusions of Hurst and Dickson (1992) who reviewed several studies of wild turkeys using pine plantations. They concluded that wild turkey populations could be maintained in areas of pine plantations if practices to accommodate turkeys were implemented. Practices such as prescribed burning every 3 years and thinning at regular intervals encourage growth of herbaceous and woody groundcover resulting in habitat conditions suitable for nesting and brood rearing (Smith et al. 1990, Sisson et al. 1990). Other practices such as streamside management zones and corridors around plantations serve as travel lanes and provide stand and age diversity (Holbrook

et al. 1985b, Burk et al. 1990). Planting road banks and openings provide supplemental forage, especially during colder months. Without question, the wild turkey is more adaptable than originally thought; however, with the expansion of the area in pine plantation management in the Southeast, increased predation and poaching losses should be considered in management plans.

Literature Cited

- Atkeson, T. D. and A. S. Johnson. 1979. Succession of small mammals on pine plantations in the Georgia Piedmont. *Am. Midl. Nat.* 101:385–392.
- Bailey, R. W. and K. T. Rinell. 1967. Management of the eastern turkey in northern hardwoods. Pages 261–301 in O. H. Hewitt, ed. *The wild turkey and its management*. The Wildl. Soc., Washington, D.C. 589pp.
- Bailey, W., D. Dennett, Jr., H. Gore, J. Pack, R. Simpson, and G. Wright. 1980. Basic considerations and general recommendations for trapping the wild turkey. *Proc. Natl. Wild Turkey Symp.* 4:10–23.
- Baker, J. A. and R. J. Brooks. 1981. Raptor and vole populations at an airport. *J. Wildl. Manage.* 45:390–396.
- Burk, J. D., G. A. Hurst, D. R. Smith, B. D. Leopold, and J. G. Dickson. 1990. Wild turkey use of streamside management zones in loblolly pine plantations. *Proc. Natl. Wild Turkey Symp.* 6:84–89.
- Byers, C. R., R. K. Steinhorst, and P. R. Krausman. 1984. Clarification of a technique for analysis of utilization—availability data. *J. Wildl. Manage.* 48:1050–1053.
- Campo, J. J., C. R. Hopkins, W. G. Swank. 1984. Mortality and reproduction of stocked eastern turkeys in East Texas. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 38:78–86.
- Cobb, D. T. 1990. Impacts of unnatural, asynchronous river flooding on the habitat use and population dynamics of a wild turkey population along the Roanoke River, North Carolina. Ph.D. Diss., N.C. State Univ., Raleigh. 152pp.
- Davis, J. R. 1992. Nesting and brood ecology of the wild turkey in the mountains of western North Carolina. Ph.D. Diss., Clemson Univ., Clemson, S.C. 173pp.
- Dill, H. H. and W. H. Thornsberry. 1950. A cannon-projected net trap for capturing waterfowl. *J. Wildl. Manage.* 14:123–127.
- Everett, D. D., D. W. Speake, and W. M. Maddox. 1980. Natality and mortality of a north Alabama wild turkey population. *Proc. Natl. Wild Turkey Symp.* 4:117–126.
- , ———, ———, and R. E. Hawkins. 1978. Multi-purpose radio-transmitters for studying mortality, natality, and movements of eastern wild turkey. *Proc. Internatl. Symp. on Biotelemetry* 4:155–158.
- Exum, J. H., J. A. McGlincy, D. W. Speake, J. L. Buckner, and F. M. Stanley. 1987. Ecology of the wild turkey in an intensively managed pine forest in southern Alabama. *Tall Timbers Res. Sta. Bull. No. 23.* 70pp.
- Glidden, J. W. and D. E. Austin. 1975. Natality and mortality of wild turkey poults in southwestern New York. *Proc. Natl. Wild Turkey Fed.* 3:48–54.
- Holbrook, H. L. 1973. Management of wild turkey habitat in southern forest types. *Proc. Natl. Wild Turkey Symp.* 2:245–252.
- Holbrook, H. T., M. R. Vaughan, and P. T. Bromley. 1985a. Influence of roads on turkey mortality. *J. Wildl. Manage.* 49:611–614.

- , ———, and ———. 1985b. Wild turkey management on domesticated pine forests. *Proc. Natl. Wild Turkey Symp.* 5:253–258.
- Hon, T. D., P. Belcher, B. Mullis, and J. R. Monroe. 1978. Nesting, brood range, and reproductive success of an insular turkey population. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 32:137–149.
- Hurst, G. A. and J. G. Dickson. 1992. Eastern turkey in southern pine-oak forest. Pages 265–285 in J. G. Dickson, ed. *The wild turkey—biology and management*. Stackpole Books. Harrisburg, Pa. 463pp.
- Kenward, R. E., V. Marestrom, and M. Karlbom. 1981. Goshawk winter ecology in Swedish pheasant habitats. *J. Wildl. Manage.* 45:397–408.
- Kurzejeski, E. W., L. D. Vangilder, and J. B. Lewis. 1987. Survival of wild turkey hens in north Missouri. *J. Wildl. Manage.* 51:188–193.
- Lay, D. W. 1959. Brief summary of turkey range management. *Proc. Natl. Wild Turkey Symp.* 1:97–100.
- McDowell, R. D. 1956. Productivity of the wild turkey in Virginia. *Virginia Comm. Game and Inland Fish. Tech. Bull.* 1. 44pp.
- Mosby, H. S. 1975. The status of the wild turkey in 1974. *Proc. Natl. Wild Turkey Symp.* 3:22–26.
- and C. D. Handley. 1943. *The wild turkey in Virginia: its status, life history, and management*. Va. Comm. Game and Inland Fish. Richmond. 281pp.
- Nenno, E. S. and W. M. Healy. 1979. Effects of radio packages on behavior of wild turkey hens. *J. Wildl. Manage.* 43:760–765.
- Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization—availability data. *J. Wildl. Manage.* 38:541–545.
- Seiss, R. S., P. S. Phalen, and G. A. Hurst. 1990. Wild turkey nesting habitat and success rates. *Proc. Wild Turkey Symp.* 6:18–24.
- Shaffer, C. H. and J. V. Gwynn. 1967. Management of the eastern turkey in oak-pine forests of Virginia and the Southeast. Pages 303–342 in O. H. Hewitt ed. *The wild turkey and its management*. The Wildl. Soc., Washington, D.C.
- Sisson, D. C., D. W. Speake, J. L. Landers, and J. L. Buckner. 1990. Effects of prescribed burning on wild turkey habitat preference and nest site selection in south Georgia. *Proc. Natl. Wild Turkey Symp.* 6:44–50.
- Smith, D. R., G. A. Hurst, J. D. Burk, B. D. Leopold, and M. A. Melchoirs. 1990. Use of loblolly pine plantations by wild turkey hens in east-central Mississippi. *Proc. Wild Turkey Symp.* 6:61–66.
- Speake, D. W., T. E. Lynch, W. J. Fleming, G. A. Wright, and W. J. Hamrick. 1975. Habitat use and seasonal movements of wild turkeys in the Southeast. *Proc. Natl. Wild Turkey Symp.* 3:122–129.
- , L. H. Barwick, H. O. Hillestad, and W. Stickney. 1969. Some characteristics of an expanding turkey population. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 23:46–58.
- Still, H. R., Jr. and D. P. Baumann, Jr. 1990. Wild turkey nesting on the Francis Marion National Forest. *Proc. Natl. Wild Turkey Symp.* 6:13–17.
- Stoddard, H. L., Sr. 1963. Maintenance and increase of the eastern wild turkey on private lands on the Coastal Plain of the deep southeast. *Tall Timbers Res. Sta. Bull.* No. 3. Tallahassee, Fla. 49pp.
- Stuck, W. M., C. B. Ware, Jr., and W. M. Steedly. 1980. Soil survey of the Beaufort and Jasper counties, South Carolina. *USDA Soil Conserv. Serv.* 179pp.

- U.S. Forest Service. 1988. The South's fourth forest: alternatives for the future. USDA For. Serv. Resour. Rep. 24. 512pp.
- Vangilder, L. D. 1992. Population dynamics. Pages 144–164 in J. G. Dickson, ed. The wild turkey—biology and management. Stackpole Books. Harrisburg Pa. 463pp.
- Williams, L. E., Jr. 1981. The book of the wild turkey. Winchester Press. Tulsa, Okla. 181pp.