Wild Turkey Reproductive Parameters from Two Different Forest Ecosystems In Central Mississippi

Darren A. Miller, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

Mike Weinstein, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

Stan R. Priest, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

Bruce D. Leopold, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

George A. Hurst, *Department of Wildlife and Fisheries, Box 9690, Mississippi State University, Mississippi State, MS 39762*

Abstract: Many pine (*Pinus* spp.) and pine-hardwood forests in the Southeast have been, and are being, converted to short-rotation (35 years) even-aged pine plantations. Effects of forest type conversion on wild turkey reproductive parameters have not been documented. Therefore, we compared reproductive performance of eastern wild turkeys (*Meleagris gallopavo silvestris*) in central Mississippi between a forest system dominated by short rotation loblolly (*P. taeda*) pine plantations (Kemper County) and Tallahala Wildlife Management Area (TWMA), a more "natural" forest system managed by the U.S. Forest Service, during 1987–1994. TWMA experienced higher nest and renest initiation rates. Kemper County had higher initial nest success rates. Mean clutch size was higher on TWMA than on Kemper County, but total productivity did not differ. Hens on TWMA probably entered the reproductive period in better condition, thus enabling them to initiate more nests with larger clutches; however, TWMA had high nest predation rates which limited reproduction. Kemper County offset lower clutch sizes and initiation rates with increased nest success. Research and management implications, particularly concerning turkey/predator interactions, are discussed.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 49:466–475

In many southeastern states, the forest industry is a leading economic factor. In Mississippi, forestry-related industries produced an economic impact of

2.9 billion dollars in 1993 (Miss. Coop. Ext. Serv. 1993). In 1990, an estimated 3 million ha of pine (*Pinus* spp.) plantations existed in Mississippi (Kelly 1990). As demand for forest products increases, more acres will be converted to intensively managed pine plantations.

Even-aged, short-rotation monocultures have been considered detrimental to eastern wild turkeys (*Meleagris gallopavo silvestris*) (Stoddard 1963, Markley 1967, Mosby 1975) and projected increases in land use intensity have been predicted to cause decreased wild turkey densities in the Southeast (Flather et al. 1989). However, recent research has indicated that intensively managed pine stands provided adequate habitat for brood-rearing and nesting (Exum 1985, Campo et al. 1989, Burk et al. 1990, Smith et al. 1990, Stys et al. 1992) and supported huntable populations (Hurst et al. 1991). An understanding of wild turkey population dynamics in intensively managed systems is required before any definitive conclusions can be made. However, quantitative comparisons of reproductive performance between intensively managed and more natural forested systems have not been performed. Therefore, we compared reproductive parameters of an eastern wild turkey population within a more natural system managed by the U.S. Forest Service to a wild turkey population existing in an area dominated (>70%) by loblolly pine (*Pinus taeda*) plantations (PP).

We acknowledge the assistance of L. W. Burger, J. T. Forbes, J. R. Lint, D. K. Lowery, T. A. McCabe, H. M. Miller, M. M. Miller, W. E. Palmer, J. E. Stys, W. N. Weinstein, and T. S. Wilson. This manuscript is a contribution of the Mississippi Cooperative Wild Turkey Research Project which is funded by Mississippi Department of Wildlife, Fisheries and Parks, National Wild Turkey Federation (NWTF), Mississippi Chapter of the NWTF, the USDA Forest Service and Weyerhaeuser Company. This research operated under IACUC protocol 93-030.

Methods

Our study was conducted on 2 areas. The short rotation PP area was in east-central Mississippi (Kemper County) in the Interior Flatwoods Land Resource Area (Pettry 1977). The 9,700-ha study area was dominated (70%) by loblolly PP but also had mature pine-hardwood forests (17%), mature hardwood forests (Sucarnochee creek and streamside management zones) (10%), and nonforested areas (3%) (Stys et al. 1992). Management included clearcutting, site preparation, planting pine seedlings, herbicide application, pre-commercial and commercial thinning, fertilizing, controlled burning, pruning, and a 30–35 year rotation (Smith 1988).

The more natural area was the Tallahala Wildlife Management Area (TWMA) located in Scott, Newton, Jasper, and Smith Counties, and was within the Strong River District of the Bienville National Forest (Hurst 1988, Palmer 1990). TWMA was 14,410 ha within the Lower Coastal Plain Province and the Blackland Prairie Resource Area. TWMA was 95% forested and was composed

of 30% mature bottomland hardwood forests, 37% mature pine forests, 17% mature mixed pine-hardwood forests, and 11% PP (1–14 years old). Pine regeneration was by clearcut, site preparation and plant, or seed tree methods. Controlled burning was conducted in mature pine stands during winter and early spring every 6 years on average (Lint 1990). Kemper County was located 104 km northeast of TWMA. Weather conditions throughout the study were assumed similar for both study areas.

Data Collection

We captured wild turkeys with cannon nets (Bailey 1976) or alpha-chloralose (Williams et al. 1966) from 7 January to 4 March and 1 July to 25 August, 1987–1994. Both capture procedures used cracked corn for bait. We removed cannon-netted turkeys from the net and placed them into cardboard boxes sized for wild turkeys. We sexed turkeys, classified them as adults or subadults (Williams and Austin 1988), and marked them with 2-patagial wing tags (Knowlton et al. 1964). Turkeys on TWMA also were marked with 2 metal, triple-lock leg bands. We fitted hens with an 108 g motion-sensitive (Kemper County) or mortality sensitive (TWMA) radio-transmitter (Wildl. Materials, Carbondale, Ill.) attached backpack-style. We released cannon-netted turkeys within 10–45 minutes of capture depending on number caught; tranquilized turkeys were transported to study area headquarters for marking and recovery and were released the next day. We released all turkeys at the capture site.

Beginning 14 March of each year, we monitored hens at least once daily using a 3-element hand-held Yagi antenna and a Telonics TR-2 receiver. During the nesting period, hens found in the same location for 2 consecutive days or those with a transmitter emitting a mortality signal were considered incubating. After 9–12 days of incubation behavior, we approached nests to a distance of approximately 50 m. We recorded azimuths toward nests on flags at various points encircling nests to facilitate location after termination of incubation. During incubation, we located hens twice daily to determine hatching date, nest destruction/desertion, or hen mortality (Palmer et al. 1993). We approached nests as soon as incubation stopped to determine fate. Causes of nest destruction or hen death were determined, if possible, by evidence left at nest/death sites (Davis 1959).

Data Analysis

Small sample sizes precluded estimating reproductive parameters independently for subadult (after hatching year) hens, therefore, we excluded them from all analyses due to probable age-related differences in reproductive parameters (Vangilder 1992). Additionally, hens for which radio-contact was lost prior to 1 August, regardless of their reproductive history, were excluded from analyses. August 1 was chosen because hens on Kemper County renested as late as 17 July (M. Weinstein, unpubl. data). This ensured that only hens for which we knew their reproductive performance were included.

We defined nesting rate for initial nests as percentage of hens in the 1 April sample population that were known to reach incubation (Palmer et al. 1993). We defined nesting rate for renests as percentage of hens unsuccessfully attempting first nests that began incubation behavior subsequent to initial nest failure. Because incubation was used as the sole indicator of nest initiation, estimates likely underestimate true nesting rates. Nest success for initial nests and renests was the proportion of hens initiating incubation that successfully hatched ≥1 egg. We calculated mean incubation date from all hens that began continuous initial nest or renest incubation behavior, respectively. We determined clutch sizes from successful nests (≥1 egg hatched) for each area. We estimated total productivity as number of nests that were successful, divided by the 1 April hen sample, multiplied by the study area specific estimate of clutch size.

We compared nesting rates and nest successes (initial nests and renests) between study areas using log-linear models (Fienberg 1977) at $\alpha = 0.1$. Log-linear models were used to test for significant interactions among year, study area, and nest success/initiation rates. We tested initial nests and renests separately. If we detected significant interactions, separate within-year chi-square analyses were used to test for differences between study areas. We tested for differences between mean date of incubation using Multiple Response Permutation Procedures (MRPP), blocked on year, at $\alpha = 0.1$ in BLOSSOM (Slauson et al. 1991). Because between year clutch size variation was not significant (MRPP, $P = 1.00$), clutch sizes were pooled across years to test for significant differences between areas using MRPP. We also used MRPP to test for differences in total productivity between areas, blocked on year, at $\alpha = 0.1$. MRPP has no underlying distributional assumptions and yields significance levels similar to parametric tests when underlying parametric assumptions are met. It is more powerful than parametric tests when data are sampled from a non-normal distribution (Crowley 1992).

Results

Sample sizes of 316, 190, 122, and 34 were available for nest initiations, initial nest success, renest initiations, and renest success, respectively (Table 1). A significant interaction occurred ($\chi^2 = 22.47$, $P = 0.002$, df = 7) among year, area, and success for nest initiation indicating that percentage nest initiation was significantly dependent on year and area. Therefore, pooling across years was not possible, and within year chi-square comparisons were necessary. Significant differences were detected between areas within 1990, 1991, and 1994 (Table 2). Nest initiation rates were higher on TWMA during 1990–1991 and were higher on Kemper County in 1994.

The 3-way interaction (year*area*nest success) for initial nest success was not significant ($\chi^2 = 8.67$, $P = 0.28$, df = 7) allowing pooling across years. Initial nest success interacted significantly with study area ($\chi^2 = 2.71$, $P = 0.10$,

Table 1. Nest initiation rates, initial nest success, renest initiation rates, and renest success for eastern wild turkeys, Kemper County and Tallahala Wildlife Management Area (TWMA), Mississippi, 1987–1994.

	Kemper County				TWMA			
Year	NESTINI[a]	NESTSUCC[b]	RENINIT[c]	RENSUCC[d]	NESTINI	NESTSUCC	RENINIT	RENSUCC
1987	100.0(11)[e]	36.3(11)	28.6(7)	50.0(2)	100.0(4)	25.0(4)	66.7(3)	0.0(2)
1988	69.7(33)	39.1(23)	14.3(14)	50.0(2)	53.6(28)	20.0(15)	11.1(9)	100.0(1)
1989	43.7(32)	14.3(14)	41.7(12)	20.0(5)	58.3(36)	23.8(21)	18.8(16)	33.3(3)
1990	43.0(35)	46.7(15)	37.5(8)	33.3(3)	100.0(10)	50.0(10)	100.0(4)	25.0(4)
1991	48.3(29)	57.1(14)	0.0(6)	0.0(0)	88.9(9)	0.0(8)	71.4(7)	20.0(5)
1992	76.4(17)	53.8(13)	28.6(7)	50.0(2)	100.0(9)	33.3(9)	50.0(4)	0.0(2)
1993	34.7(23)	25.0(8)	16.7(6)	0.0(1)	42.9(14)	16.7(6)	0.0(5)	0.0(0)
1994	91.6(12)	27.3(11)	12.5(8)	0.0(1)	57.1(14)	25.0(8)	16.7(6)	0.0(1)
Mean(n)	63.4(192)	37.5(109)	22.5(68)	25.3(16)	75.1(124)	24.2(81)	41.8(54)	22.3(18)

[a]Percentage of radio-monitored hens initiation nests.
[b]Percentage of initial nests that successfully hatched ≥1 poult.
[c]Percentage of radio-monitored hens unsuccessful on first nest attempt that renested.
[d]Percentage of renests that successfully hatched ≥1 poult.
[e]Paranthetical values indicate sample sizes.

Table 2. Chi-squared statistics, significance levels (P), and degrees of freedom (df) for within-year comparisons of nest and renest initiations, Kemper County and Tallahalla Wildlife Management Area (TWMA), Mississippi, 1987–1994.

	Nest initiation			Renest initiation		
Year	χ^2	df	P	χ^2	df	P
1987[a]				1.27	1	0.26
1988	1.68	1	0.19	0.05	1	0.82
1989	1.44	1	0.23	1.77	1	0.18
1990	10.28	1	0.001[b]	4.28	1	0.04[b]
1991	4.65	1	0.03[b]	6.96	1	0.008[b]
1992	2.50	1	0.11	0.51	1	0.47
1993	0.24	1	0.62	0.92	1	0.34
1994	3.91	1	0.04[c]	0.05	1	0.83

[a]All hens on both areas incubated eggs.
[b]TWMA significantly greater (α=0.05) than Kemper County.
[c]Kemper County significantly greater (α=0.05) than TWMA.

Table 3. Mean incubation date for initial nests and total productivity for Kemper County and Tallahalla Wildlife Management Area (TWMA), Mississippi, 1987–1994.

	Kemper County		TWMA	
Year	ID[a]	TP[b]	ID	TP
1987	31.70	3.11	19.25	2.35
1988	24.35	2.33	30.12	1.01
1989	30.00	0.53	22.18	1.57
1990	29.47	1.71	23.14	4.70
1991	38.18	2.36	15.29	0.00
1992	26.00	3.52	15.80	3.13
1993	25.50	0.74	32.17	0.67
1994	27.27	2.10	33.75	1.34

[a]Mean incubation date for initial nests (N days since 1 Apr that incubation began).
[b]Total productivity (N successful nests, divided by 1 Apr hen sample, multiplied by study-area specific estimate of clutch size).

df = 1) with Kemper County having a significantly higher initial nest success rate ($\bar{X}$ = 37.5) than TWMA ($\bar{X}$ = 24.2). A significant interaction occurred (χ^2 = 14.45, P = 0.04, df = 7) among year, area, and renest initiation preventing pooling across years. Within years, 1990 and 1991 significantly differed (Table 2) with a higher proportion of hens initiating renests on TWMA in 1990 and 1991. Only 34 observations of renest success were observed over 8 years between the 2 areas precluding testing for interaction effects.

Sample sizes were insufficient to test for differences in renest mean incubation dates (N = 21) and renest clutch sizes (N = 8). For initial nests (Table 3), mean nest incubation date within years did not differ between areas (P = 0.89). However, mean clutch size did differ significantly ($P < 0.001$) between study

areas with TWMA having a higher mean clutch size ($\bar{X}$ = 9.40) than Kemper County ($\bar{X}$ = 8.54). Total productivity (Table 3) did not significantly differ between TWMA and Kemper County (P = 0.55).

Discussion

Low sample sizes and associated lack of power for all within-year chi-square comparisons hampered our ability to detect significant differences. An alpha level of 0.1 mitigated some of these effects, but some large differences (>25%) were still not detectable. For example, a difference of 38% for renest initiation in 1989 failed to achieve statistical significance.

Observed initial nesting rates were higher on TWMA than on Kemper County in 6 of 8 years; renest initiation was higher on TWMA 5 of 8 years. This may have resulted from hens entering the nesting season in poorer condition on the PP dominated Kemper County area. Hens on TWMA had more access to a diversity of habitat types, especially to 2 acorn (*Quercus* spp.) producing habitat types (upland and bottomland areas). Acorn production on Kemper County was mostly limited to streamside management zones and the Sucarnochee Creek bottom. A higher diversity of hard mast-producing species and habitats on TWMA may have allowed turkeys to enter the nesting season in better condition.

Nesting hens on Kemper County were significantly more successful hatching eggs. Predation has been documented as a limiting factor for the TWMA population (Palmer et al. 1993, Miller et al. 1995) and is widely recognized as having a significant impact on wild turkey populations (Miller and Leopold 1992). For both areas, raccoons (*Procyon lotor*) were the predominant cause of nest failure (Palmer et al. 1993, G. A. Hurst unpubl. data). Leberg and Kennedy (1988) reported higher raccoon densities in bottomlands than in uplands. Juxtaposition of bottomland hardwood stands and upland pine stands on TWMA, the preferred nesting habitat (Seiss 1989), may have increased risk of nest predation. On Kemper County, most bottomlands occurred on the extreme southern portion of the area. The higher degree of geographic separation between bottomlands and preferred nesting habitats may have decreased probability of nest predation. Additionally, it is widely believed that predators prefer roads and edges for hunting (Conner 1995). Edge to area ratio was probably higher on TWMA potentially increasing probability of nest predation (Burger et al. 1994).

Mean incubation date did not differ between areas. This may have been because environmental conditions (e.g., weather) that affect nest initiation (Blankenship 1992) were similar on both areas due to their close proximity. However, clutch size was significantly larger on TWMA than on Kemper County. Again, this may have been a reflection of the hens' condition entering the reproductive period. Total productivity between areas did not differ. It appears that TWMA's lower reproductive success was at least partially offset by a higher clutch size. These areas may have been equally productive but for different reasons. On Kemper County, nests were more likely to be successful probably due to lower predation rates. However, these hens produced fewer eggs

possibly because they entered the reproductive season in poorer condition. On TWMA, hens were less likely to successfully hatch nests, but had more eggs/clutch and higher nest initiation rates.

The TWMA turkey population has been declining since 1988 from predation of hens, nests and poults (Palmer et al. 1993). A decline was not observed on Kemper County during the same time interval (Weinstein et al. 1995). However, productivity on these areas was similar. The decline observed on TWMA may have been directly related to predator density. Decreased trapping of furbearing animals and recovery of raccoon, skunk, and fox populations from a distemper outbreak in 1992 may have directly contributed to higher densities of predators on TWMA. This increase in predator densities may have masked the true productivity of TWMA. A similar increase in predator densities on Kemper County may not have the same impact due to the geographic separation of nesting areas and bottomlands as noted above.

Although higher nest success was associated with the Kemper County wild turkey population, it is important to note that study areas were not spatially replicated nor selected randomly. Replication is required to provide definitive conclusions regarding macro-habitat composition effects on wild turkey productivity. Because of availability of a large bottomland complex, which potentially mitigated negative reproductive effects of silvicultural practices, Kemper County may have been atypical of plantation-dominated systems. These data represent the first quantitative comparison of turkey reproductive parameters between an intensively managed system and more "traditional" turkey habitat where weather conditions were assumed similar. If replicated studies provide similar results, land conversion to more intensively managed systems may not have the severe impact on wild turkey populations once predicted.

Management and Research Implications

Effect of predation on wild turkey reproduction has not been documented for areas dominated by short-rotation PP. Additionally, because predation appears to be limiting productivity on TWMA, future research should be conducted to examine the predation process in different forest systems and relate predator density, prey densities (i.e., small mammals), and predator movements/habitat use to wild turkey productivity using spatially explicit models (Leopold and Hurst 1994). Such research may provide habitat management options to lessen effects of predation on turkey productivity on areas where it is limiting. We hypothesized that large block size and low juxtaposition of quality raccoon and turkey nesting habitats increased nest survival on Kemper County. Future work needs to quantitatively test this before definitive management conclusions can be drawn.

Research also should be conducted to experimentally manipulate and observe effects of predator removal on wild turkey productivity. Until effects of predator densities can be related to turkey productivity, management options involving predator removal cannot be justified. Experimental manipulation of

predator densities and associated affects on turkey reproduction would necessitate a long-term investigation to account for variations in weather, habitat conditions, and other extraneous factors.

Literature Cited

Bailey, R. W. 1976. Live-trapping wild turkeys in North Carolina. N.C. Wildl. Resour. Comm. Publ., Raleigh. 21pp.

Blankenship, L. H. 1992. Physiology. Pages 84–100 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books. Harrisburg, Pa.

Burger, L. D., L. W. Burger, and J. Faaborg. 1994. Effects of prairie fragmentation on predation on artificial nests. J. Wildl. Manage. 58:249–254.

Burk, J. D., D. R. Smith, G. A. Hurst, B. D. Leopold, and M. A. Melchoirs. 1990. Wild turkey use of loblolly pine plantations for nesting and brood rearing. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 44:163–170.

Campo, J. J., C. R. Hopkins, W. G. Swank. 1989. Nest habitat use by eastern wild turkeys in Eastern Texas. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:350–354.

Conner, L. M. 1995. Space use patterns and habitat utilization by bobcats in managed forests of Mississippi. Ph.D. Diss., Miss. State Univ., Miss. State 126pp.

Crowley, P. H. 1992. Resampling methods for computation-intensive data analysis in ecology and evolution. Annu. Rev. Ecol. Syst. 23:405–447.

Davis, J. R. 1959. A preliminary report on nest predation as a limiting factor in wild turkey populations. Proc. Natl. Wild Turkey Symp. 1:138–145.

Exum, J. H., Jr. 1985. Ecology of the eastern wild turkey on an even-aged pine forest in southern Alabama. Ph.D. Diss., Auburn Univ., Auburn, Ala. 109pp.

Fienberg, S. E. 1977. The analysis of cross-classified data. Mass. Inst. Tech. (MIT) Press, Cambridge. 151pp.

Flather, C. H., T. W. Hoekstra, D. E. Chalk, N. D. Cost, and V. A. Rudis. 1989. Recent historical and projected regional trends of white-tailed deer and wild turkey in the southern United States. Rocky Mountain Forest and Range Exp. Sta., Gen. Tech. Rep. RM-172. Fort Collins, Colo. 22pp.

Hurst, G. A. 1988. Population estimates for the wild turkey on Tallahala Wildlife Management Area. Completion rep., Proj. W-48, Study 21. Miss. Dep. Wildl., Fish., and Parks, Jackson. 46pp.

———, D. R. Smith, J. D. Burk, and B. D. Leopold. 1991. Wild turkey gobbler habitat use and home range in loblolly pine plantations. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 45:115–123.

Kelly, J. F. 1990. U.S. Forest Service survey provides picture of Mississippi's changing forests. Tree-Talk 12:24–30.

Knowlton, F. F., E. D. Michael, and W. C. Glazener. 1964. A marking technique for field recognition of individual turkeys and deer. J. Wildl. Manage. 28:167–170.

Leberg, P. L. and M. L. Kennedy. 1988. Demography and habitat relationships of raccoons in western Tennessee. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 42:272–282.

Leopold, B. D. and G. A. Hurst. 1994. Experimental designs for assessing impacts of predators on gamebird populations. 59th Proc. North Am. Wildl. Natl. Resour. Conf. 59:477–487.

Lint, J. R. 1990. Assessment of mark-recapture models and indices to estimate population size of wild turkeys on Tallahala Wildlife Management Area. M.S. Thesis, Miss. State Univ., Miss. State. 255pp.

Markley, M. H. 1967. Limiting factors. Pages 199–243 *in* O. H. Hewitt, ed. The wild turkey and its management. The Wildl. Soc., Inc. Washington, D.C.

Miller, D. A., M. D. Weinstein, B. D. Leopold, G. A. Hurst. 1995. Relationships between the wild turkey and predators in a managed forest ecosystem. Proc. 2nd Annu. Wildl. Soc. Conf. (Abstract).

Miller, J. E. and B. D. Leopold. 1992. Population Influences: Predation. Pages 119–128 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books. Harrisburg, Pa.

Mississippi Cooperative Extension Service. 1993. 1993 value of agricultural production, Mississippi counties. Miss. Coop. Ext. Serv., Agric. Econ. Dep., Miss. State Univ., Miss. State. 18pp.

Mosby, H. S. 1975. The status of the wild turkey in 1974. Proc. Natl. Wild Turkey Symp. 3:22–26.

Palmer, W. E. 1990. Relationships of wild turkey hens and their habitat on Tallahala Wildlife Management Area. M.S. Thesis, Miss. State Univ., Miss. State. 117pp.

———, S. R. Priest, R. S. Seiss, P. S. Phalen, and G. A. Hurst. 1993. Reproductive effort and success in a declining wild turkey population. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 47:138–147.

Pettry, D. E. 1977. Soil resource areas of Mississippi. Miss. Agri. and For. Exp. Sta. Info. Sheet 1278. Miss. State. 4pp.

Seiss, R. S. 1989. Reproductive parameters and survival rates of wild turkey hens in east-central Mississippi. M.S. Thesis, Miss. State Univ., Miss. State. 99pp.

Slauson, W. L., B. S. Cade, and J. D. Richards. 1991. User manual for BLOSSOM statistical software. Natl. Ecol. Res. Ctr., U.S. Fish and Wildl. Serv. Fort Collins, Colo. 61pp.

Smith, D. R. 1988. Use of midrotation-aged loblolly pine plantations by wild turkeys. M.S. Thesis, Miss. State Univ., Miss. State. 52pp.

———, 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. Natl. Wild Turkey Symp. 6:84–89.

Stoddard, H. L., Sr. 1963. Maintenance and increase of the eastern wild turkey on private lands of the coastal plain of the deep south. Tall Timbers Res. Sta. Bul. 3. Tallahassee, Fla. 49pp.

Stys, J. E., G. A. Hurst, B. D. Leopold, and M. A. Melchoirs. 1992. Wild turkey use of control-burned loblolly pine plantations. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 46:37–45.

Vangilder, L. D. 1992. Population Dynamics. Pages 144–164 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books, Harrisburg, Pa.

Weinstein, M., B. D. Leopold, and G. A. Hurst. 1995. Evaluation of wild turkey population estimation methods. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies. 49:476–487.

Williams, L. E. and D. H. Austin. 1988. Studies of wild turkeys in Florida. Fla. Game and Freshwater Comm., Tech. Bul. No. 10. Tallahassee. 232pp.

———, ———, and J. Peoples. 1966. Progress in capturing wild turkeys with drugs applied to bait. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 20: 219–226.